Portland Harbor Superfund Site

Natural Resource Damage Assessment Plan

Draft

Prepared by Stratus Consulting

for the

Portland Harbor

Natural Resource Trustee Council

November 23, 2009

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Natural Resource Damage
Assessment Plan
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Prepared for:

Portland Harbor Natural Resource Trustee Council

Confederated Tribes of the Warm Springs Reservation of Oregon
Nez Perce Tribe
Confederated Tribes of Siletz Indians
Confederated Tribes of the Umatilla Indian Reservation
Confederated Tribes of the Grand Ronde Community of Oregon
National Oceanic and Atmospheric Administration
Oregon Department of Fish and Wildlife
U.S. Department of the Interior

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Acronyms and Abbreviations

BEST	Biomonitoring of Environmental Status and Trends
BT	benefit transfer
BTEX	benzene, toluene, ethylbenzene, and xylene
CAS	Chemical Abstract Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R.	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter
COI	contaminant of interest
CRBG	Columbia River Basalt Group
CSM	conceptual site model
CWA	Clean Water Act
DCE	Dichloroethene
DDD	dichloro-diphenyl-dichloroethane
DDE	dichloro-diphenyl-dichloroethylene
DDT	dichloro-diphenyl-trichloroethane
DDx	DDT, DDE, DDD
DNAPL	dense nonaqueous phase liquid
DOC	U.S. Department of Commerce
DOI	U.S. Department of the Interior
DOJ	U.S. Department of Justice
DSAY	discounted service acre-year
ECSI	Environmental Cleanup Site Information
EPA	U.S. Environmental Protection Agency
FDA	U.S. Food and Drug Administration
FS	Feasibility Study
Grand Ronde	Confederated Tribes of the Grand Ronde Community of Oregon
HEA	Habitat Equivalency Analysis

LCR	lower Columbia River
LWG	Lower Willamette Group
LWR	lower Willamette River
µg/L	micrograms per liter
MEK	methyl ethyl ketone
MOU	Memorandum of Understanding
MTBE	methyl tertiary butyl ether
NCP	National Contingency Plan
Nez Perce	Nez Perce Tribe
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRDA	natural resource damage assessment
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODHS	Oregon Department of Human Services
ODPR	Oregon Department of Parks and Recreation
OPA	Oil Pollution Act
OSMB	Oregon State Marine Board
OSP	Oregon State Parks
PAH	polycyclic aromatic hydrocarbon
PAS	Preassessment Screen
PBDE	polybrominated diphenylether
PCB	polychlorinated biphenyl
PCE	perchloroethylene
PCP	pentachlorophenol
pg/L	picograms per liter
PHAA	Portland Harbor Assessment Area
PI	Principal Investigator
Plan	Assessment Plan
PLP	potentially liable party
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control

RCDP	Restoration and Compensation Determination Plan
RCRA	Resource Conservation and Recovery Act
REA	Resource Equivalency Analysis
RI	Remedial Investigation
RM	river mile
ROA	Report of Assessment
ROD	record of decision
SDWA	Safe Drinking Water Act
Siletz	Confederated Tribes of Siletz Indians
Site	Portland Harbor Superfund Site
SOC	Species of Concern
SOP	Standard Operating Procedure
SQG	sediment quality guideline
Study Area	Willamette River miles 1 to 11.8
SVOC	semi-volatile organic compound
SWDA	Solid Waste Disposal Act
TBT	tributyltin
TCA	trichloroethane
TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin
TCE	trichloroethylene
TPH	total petroleum hydrocarbons
Trustee Council	Portland Harbor Natural Resource Trustee Council
TRV	toxicity reference value
TZW	transition zone water
Umatilla	Confederated Tribes of the Umatilla Indian Reservation
USACE	U.S. Army Corps of Engineers
U.S.C.	U.S. Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compound
Warm Springs	Confederated Tribes of the Warm Springs Reservation of Oregon
Yakama Nation	Confederated Tribes and Bands of the Yakama Nation

1. Introduction

The Portland Harbor Natural Resource Trustee Council (the Trustee Council) is conducting a natural resource damage assessment (NRDA) for the Portland Harbor Superfund Site (the Site) with the goal of restoring the natural resources[1] that have been injured by the release of hazardous substances or oil (collectively "hazardous substances") by potentially liable parties (PLPs). The Trustee Council is composed of representatives of eight trustees[2]: the U.S. Department of the Interior (DOI), acting through the U.S. Fish and Wildlife Service (USFWS); the U.S. Department of Commerce (DOC), acting through the National Oceanic and Atmospheric Administration (NOAA); the State of Oregon; the Confederated Tribes of the Grand Ronde Community of Oregon (Grand Ronde); the Confederated Tribes of Siletz Indians (Siletz); the Confederated Tribes of the Umatilla Indian Reservation (Umatilla); the Confederated Tribes of the Warm Springs Reservation of Oregon (Warm Springs); and the Nez Perce Tribe (Nez Perce). The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. §§ 9601 et seq.; the Oil Pollution Act (OPA) of 1990, 33 U.S.C. §§ 2701 et seq.; the Clean Water Act (CWA), 33 U.S.C. § 1251; the National Oil and Hazardous Substances Pollution Contingency Plan [National Contingency Plan (NCP)], 40 C.F.R. 300, Subpart G; Executive Orders 12580 and 12777; and other applicable federal and state laws and regulations, provide a legal framework for the Trustee Council's actions.

The purpose of an NRDA is to (1) assess natural resource injuries (including the services provided by those resources) caused by the releases of hazardous substances and/or oil; (2) quantify those injuries; (3) seek compensation from the parties responsible for the discharges; and (4) use the recoveries to restore, rehabilitate, replace, or acquire the equivalent of those injured natural resources and services. The issuance of this Assessment Plan (the Plan) is part of the NRDA process. The Plan describes the general approach for compiling and evaluating sources of existing information, identifying data gaps, and determining the scope of information and kinds of analyses expected to determine and quantify injuries and damages.

The U.S. Environmental Protection Agency (EPA) added Portland Harbor (the Site) to the CERCLA National Priorities List (NPL) in December 2000, and the Site clean-up is being

1. The term "natural resources" refers to "land, fish, wildlife, biota, air, water, groundwater, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States…." 43 C.F.R. § 11.14(z).

2. When originally established, the Portland Harbor Natural Resource Trustee Council also included the Confederated Tribes and Bands of the Yakama Nation (the Yakama Nation). The Yakama Nation withdrew from the Trustee Council, effective June 15, 2009. The Yakama Nation's contractor, Ridolfi, Inc., worked on this Plan prior to the withdrawal of the Yakama Nation. Ridolfi is no longer associated with this Plan.

addressed through federal and state actions. EPA is the lead agency for Willamette River sediment contamination issues, and the Oregon Department of Environmental Quality (ODEQ) is the lead agency for upland site contamination. The initial six-mile stretch of the Site from river mile (RM) 3.5 to 9.5 was extended to a nine-mile stretch between RM 2 and 11 and subsequently extended to RM 1 to 11.8 (the Study Area). Remedial Investigation (RI) sampling activities have been conducted by the PLPs within the Study Area, as well as upriver of the Study Area over the last few years.

In conducting their NRDA for the Site, the Trustee Council will consider the geographic areas being addressed by the remedial work (Figure 1.1) as well as other areas where hazardous substances or oil released from PLP facilities have come to be located to determine whether any injuries to natural resources have occurred as a result of those releases (Portland Harbor Assessment Area; PHAA). At this time, the Trustee Council has not made a final determination of the geographic scope of the PHAA.

The Trustee Council is coordinating with the ongoing remedial activities to the degree practical. The Trustee Council recognizes that the anticipated remedial clean-up activities will likely reduce injuries to the natural resources in the future, but past and residual injuries will need to be addressed by the NRDA. Damages will be determined for those situations where either the CERCLA "damage" or "release" occurred or continues after December 11, 1980, the enactment date of CERCLA. See 42 U.S.C. § 9607(f)(1).

This Assessment Plan is organized according to NRDA Regulations, 43 C.F.R. Part 11 (federal regulations), issued by the DOI pursuant to CERCLA. The regulations establish procedures for assessing natural resource damages. Although the regulations are not mandatory, the Trustee Council is using them to guide their NRDA. The Trustee Council, however, reserves their discretion to deviate from the regulations if necessary.

1.1 Statement of Purpose

The purpose of this Assessment Plan is to facilitate performing the NRDA in a systematic manner, using appropriate methodologies for evaluating and quantifying injuries and estimating damages for the injured natural resources. The planning process is designed to allow the Trustee Council to conduct the assessment in a streamlined manner, via a phased approach, and at a reasonable cost. Section 1.5 of this Plan describes the phased approach that the Trustee Council has devised to facilitate working cooperatively with parties potentially liable for natural resource damages. This phased approach is intended to provide the opportunity for early involvement and potential settlement with cooperating PLPs. This Plan includes background information and other information related to conducting the NRDA.

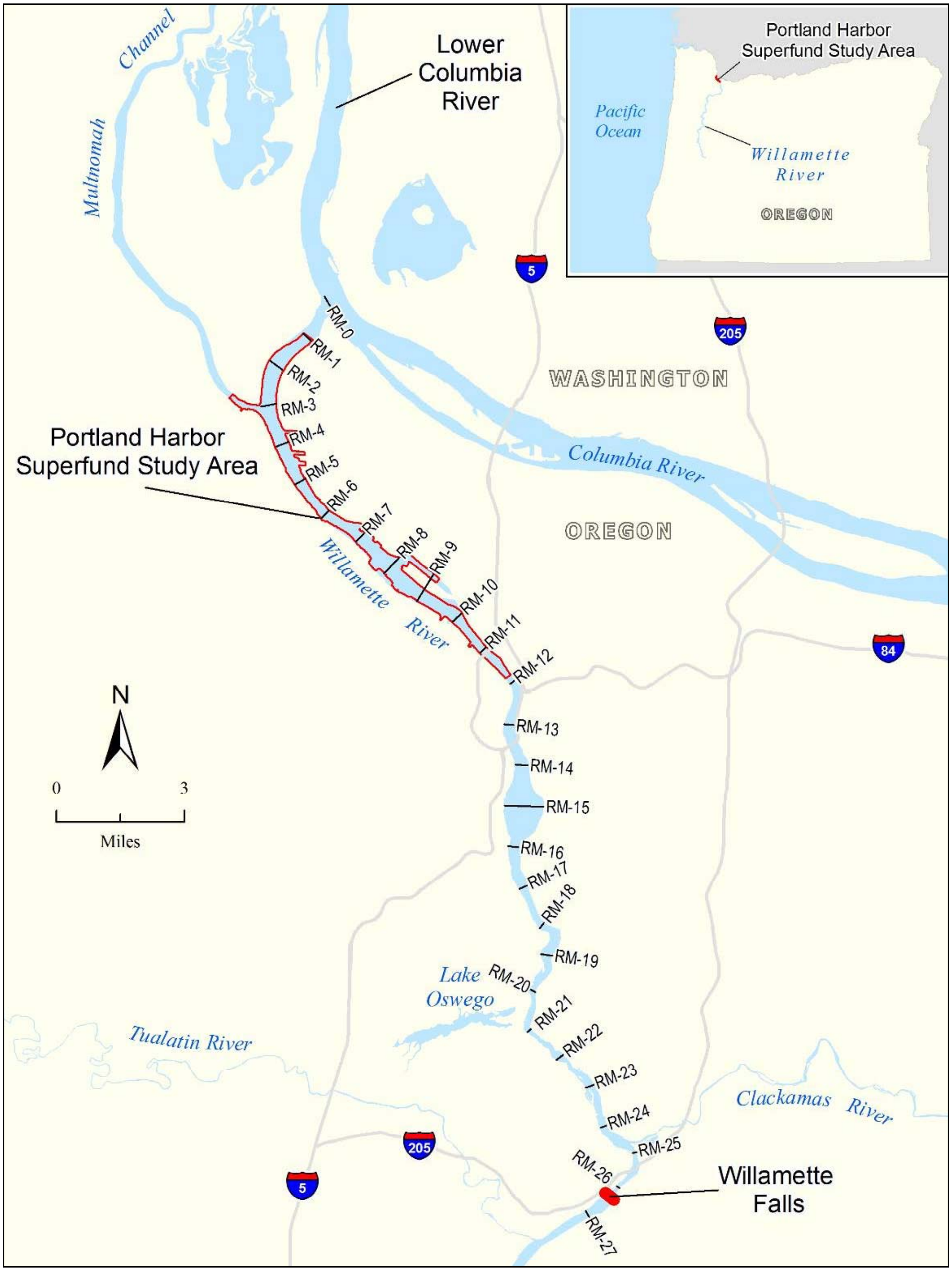


Figure 1.1. Portland Harbor Study Area.

1.2 Legal Authority of Trusteeship

The scope of trusteeship is outlined in the NCP, 40 C.F.R., Subpart G. The NCP interprets the scope of federal natural resource trusteeship to extend to resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States, including supporting ecosystems. Id. § 300.600. For states, the NCP provides that state trustees "shall act on behalf of the public as trustees for natural resources, including their supporting ecosystems, within the boundary of a state or belonging to, managed by, controlled by, or appertaining to such state." Id. § 300.605. The NCP addresses tribal trusteeship by stating that tribal leaders "shall act on behalf of the Indian tribes as trustees for the natural resources, including their supporting ecosystems, belonging to, managed by, controlled by, or appertaining to such Indian tribe, or held in trust for the benefit of such Indian tribe, or belonging to a member of such Indian tribe, if such resources are subject to a trust restriction on alienation." Id. § 300.610.

The natural resource trustees at the Site are the DOI, acting through the USFWS; the Department of Commerce, acting through NOAA; the State of Oregon, acting through the Oregon Department of Fish and Wildlife (ODFW); and six Pacific Northwest Tribes: the Grand Ronde, Nez Perce, Siletz, Umatilla, Warm Springs, and Yakama Nation, though the Yakama Nation is currently not participating in the NRDA outlined in this Assessment Plan.

The Trustee Council possesses a broad spectrum of legal authority for NRDA activities at this Site derived from a wide variety of federal and state statutes and regulations, tribal treaties, agreements and regulations, and land ownership. As a result, trusteeship for all the natural resources described in this Assessment Plan fall within the trusteeship of the Trustee Council. Collectively, the Trustee Council has trusteeship for the ecosystem of the Site and the affected environment.

1.3 Decision to Perform Type B Assessment

Under the federal regulations, the Trustee Council can elect to perform a Type A or Type B injury assessment. Type A assessment procedures use simplified model assumptions to address injuries that result from a single event or short-term exposure. Releases of hazardous substances from the Site have occurred from multiple sources over many decades, resulting in complex exposure conditions impacting aquatic and upland media and associated complex food webs. Therefore, a Type A assessment is not appropriate for the Portland Harbor NRDA.

The Trustee Council has elected to perform a Type B assessment, the procedures for which require "more extensive field observation than the Type A procedures." 43 C.F.R. § 11.33(b). This assessment method includes *injury determination*, *quantification*, and *damage* *determination*. Because substantial Site-specific data already exist to support the assessment, a Type B assessment can be conducted for the Site at a reasonable cost.

The federal regulations for a Type B assessment outline methods for determining (1) pathways through which hazardous substances released by PLPs expose natural resources, (2) injuries to natural resources, (3) the extent of those injuries and resultant public losses, (4) baseline conditions and time required for the resources to recover to baseline, and (5) the cost or value of restoring injured resources. These methods facilitate calculation of natural resource damages. 43 C.F.R. §§ 11.60-11.84.

1.4 The NRDA Process

The federal regulations provide a framework for performing an NRDA involving hazardous substances and describe methods for (1) making the decision to conduct an assessment, (2) establishing that hazardous substances have exposed and injured natural resources, (3) quantifying the extent of injury and resultant public losses, (4) determining the amount and cost of restoration required to return the injured resources and their services to baseline and to compensate the public for interim losses, and (5) planning and implementing projects designed to restore the injured natural resources and resultant public losses. Although the regulations are not mandatory, they provide useful guidelines for assessing injuries and damages, and planning and implementing restoration of the injured natural resources and resultant public losses. The Trustee Council has been, and will continue to be, guided by these regulations as practical and appropriate as they carry out the Portland Harbor NRDA.

The NRDA process begins with a Preassessment Screen (PAS), in which a rapid review of readily accessible information allows for an early decision about whether to perform a damage assessment. Proceeding with an NRDA then entails the assessment phase. Finally, the post-assessment requires restoration of natural resources. Restoration can be implemented by the Trustee Council or a third party using damages recovered from PLPs. Restoration can also be implemented directly by PLPs under Trustee Council oversight.

1.4.1 Preassessment Screen

The purpose of a PAS is to provide the foundation for determining the need and efficacy of proceeding with an NRDA. The Trustee Council prepared a PAS for the Site pursuant to 43 C.F.R. § 11.23(e) in January 2007 (Portland Harbor Natural Resource Trustee Council, 2007). The PAS provided information on hazardous substance releases, estimates of concentrations, preliminary identification of exposure pathways, and potentially affected natural resources. This information has been carried forward into this Assessment Plan, along with additional data generated from remedial activities, to confirm exposure. The Trustee Council's decision to proceed with a full assessment is based upon information gathered in the PAS that meets the following regulatory criteria:

1. **A discharge of oil or release of a hazardous substance has occurred.** Releases of appreciable quantities of an array of hazardous substances have been documented at the Site and have been released over a long period of time, as discussed in Section 2.3 of this Plan.

2. **Natural resources for which the federal or state agency or Indian tribe may assert trusteeship under CERCLA have been or are likely to have been adversely affected by the discharge or release.** Natural resources at Portland Harbor have been or are likely to have been adversely impacted. Existing field data indicate that hazardous substance concentrations spatially coincide or are elevated near areas with known releases from industrial facilities or other documented sources.

3. **The quantity and concentration of the discharged oil or released hazardous substance are sufficient to potentially cause injury to those natural resources.** Hazardous substance concentrations measured in Portland Harbor are elevated to levels sufficient to potentially cause injury to surface waters, biota, habitats, and other natural resources.

4. **Data sufficient to pursue an assessment are readily available or likely to be obtained at reasonable cost.** Data currently exist from the Site that will be helpful and cost effective to use to further assess injury of natural resources at the Site. Additional data may be needed, but these data can likely be obtained at reasonable costs. The Trustee Council will evaluate specific data collection needs and opportunities to ensure that assessment costs are unlikely to exceed natural resource damages at the Site.

5. **Response actions from Superfund remedial activities carried out or planned do not or will not sufficiently remedy the injury to natural resources without further action.** Past losses cannot be prevented by remedial actions still being planned. In addition, remedial actions at the Site are unlikely to eliminate all ongoing injuries quickly. Finally, remedial actions may themselves injure natural resources. Thus, additional restoration, replacement, acquisition, and rehabilitation of natural resources will be necessary.

1.4.2 Assessment Plan

Once the decision is made to proceed with an NRDA, an Assessment Plan is developed to facilitate performing the assessment in a systematic and cost-effective manner. For a Type B assessment, the plan provides a foundation for conducting the assessment, including injury determination, quantification, and damage determination. The Assessment Plan also confirms exposure with readily-available information, describes sampling and analysis objectives of any proposed studies, and provides an approach for quantifying injuries and damages. This Assessment Plan provides the foundation for guiding the assessment of the Site.

A Restoration and Compensation Determination Plan (RCDP) may be developed to plan and implement specific restoration activities. A Report of Assessment (ROA) will be prepared in accordance with the federal regulations. The ROA documents the determinations made in each phase of the assessment.

1.4.3 Post-assessment

Following the assessment, the Trustee Council may recover damages “calculated based on injuries occurring from the onset of the release through the recovery period, less any mitigation of those injuries by response actions, plus any increase in injuries that are reasonably unavoidable as a result of response actions taken or anticipated” as well as reasonable damage assessment costs. 43 C.F.R. § 11.15. The Trustee Council also will issue a restoration plan for public review and comment.

1.5 Portland Harbor Phased Assessment Approach

The Trustee Council took the first step in the formal NRDA process in January 2007 with the issuance of a PAS for the Site (Portland Harbor Natural Resource Trustee Council, 2007). The Trustee Council gave notice of their intent to conduct an assessment of injury and damages in January 2008 and have developed this Assessment Plan to guide them in performing the assessment.

To encourage cooperation with PLPs during the NRDA process, the Trustee Council is following an iterative, phased approach. The Trustee Council has established the following phases to conduct the Portland Harbor NRDA:

- Phase 1 – Development of the Assessment Plan
- Phase 2 – Implementation of the Settlement-Oriented Work Plan
- Phase 3 – Completion of the NRDA
- Phase 4 – Recovery of damages from non-settling PLPs.

Each phase builds upon preceding phases. Reasonable assumptions and estimates that protect the public interest may be used to fill data gaps without the need for extensive additional data collection, studies, and/or analysis, particularly in Phase 2.

1.5.1 Phase 1 – Development of Assessment Plan

The Phase 1 process includes:

1. **Assessment Plan**: develop a plan for completing the NRDA as described in the federal regulations. This Assessment Plan aims to coordinate and streamline NRDA activities and includes background information about the Site, including potential sources of hazardous substance releases, potential pathways, and a summary of available data to confirm exposure of natural resources to hazardous substances. The Plan also describes approaches that may be used to determine and quantify injury, resultant public losses, and damages.

2. **Three early studies**: conduct work related to salmon, lamprey, and osprey to help address known data gaps. Work related to salmon and osprey can be conducted at relatively minimal cost by coordinating with ongoing studies carried out by other entities. Plan study related to lamprey and implement to the extent possible.

3. **Public outreach**: develop a plan for initiating public outreach and communication for the Portland Harbor NRDA.

4. **Planning documents**: develop documents to help guide the NRDA process, including establishing and maintaining an administrative record and information management system, and developing a strategy for expeditiously resolving liability of cooperating PLPs.

5. **Literature review**: review existing Site data collected as part of the remedial process as well as other relevant data and literature to determine injury or damages and to evaluate data gaps.

6. **Phase 2 framework**: outline the scope of this phase (see Appendix B).

1.5.2 Phase 2 – Implementation of settlement-oriented assessment

Phase 2 is an intermediate step not required by the federal regulations. It will use existing information; reasoned estimates; and conservative, simplifying assumptions to the extent practicable; and guidance in the federal regulations, with the goal of arriving at realistic early settlements with cooperating PLPs. New data may be collected during this phase either cooperatively by the participating parties and the Trustee Council, or by the Trustee Council without the participation of participating parties. Participation in the early settlement process to resolve site-wide liability is limited to those parties who fund Phase 2 activities, including a damage-specific liability allocation process. This phase also will include a restoration planning process that will identify specific projects which could be used to compensate for natural resource liability. See Appendix B for a framework of this phase.

The goal of Phase 2 is to conduct a settlement-oriented assessment, including a natural resource damage-specific allocation and restoration planning, that will allow the Trustee Council and individual parties to settle their natural resource liability at or near the time that EPA issues the record(s) of decision [ROD(s)].

1.5.3 Phase 3 – Completion of NRDA

Phase 3 will fill remaining data gaps, as needed, to complete injury determination and quantification, damage determination, and restoration planning sufficiently for the Trustee Council to perfect natural resource damage claims against PLPs who have not settled during Phase 2. Assessment activities may be conducted cooperatively with PLPs or by the Trustee Council themselves. Additional settlements will be pursued during this phase.

1.5.4 Phase 4 – Recovery of damages from non-settling PLPs

The purpose of Phase 4 is to recover from non-settling Portland Harbor PLPs, jointly and severally, natural resource damages, including the cost of assessment, resulting from the release of hazardous substances at Portland Harbor. This stage will include litigation, if appropriate.

1.6 Coordination with Other Parties

The Trustee Council is engaged in a number of activities designed to enhance coordination with others involved in or interested in the Site. They are also establishing an administrative record and an information management system to facilitate dissemination of information concerning their activities.

1.6.1 Coordination with remedial activities

To conduct the NRDA efficiently, cost-effectively, and with minimal duplication of efforts, NRDA activities will be coordinated with ongoing remedial activities at the Site. This effort involves working with EPA, ODEQ, and the PLP-organized Lower Willamette Group (LWG). Existing data collected as part of the remedial process will be used to support the NRDA. The goal is to maximize the effectiveness of remedial and NRDA efforts by coordinating remedial and NRDA activities in conjunction with one another whenever feasible.

1.6.2 Coordination with participating parties

The goal of a cooperative assessment involving PLPs is to achieve restoration sooner, rather than later. The Trustee Council has invited, and will continue to encourage, the active participation of such parties in their assessment activities.

In 2008, the Trustee Council invited PLPs to participate in a cooperative assessment. A number of parties accepted the invitation and have been involved in Phase 1. Those participating PLPs had the opportunity to attend meetings and conference calls to share perspectives with the Trustee Council, were provided with project updates on early drafts of planning documents by the Trustee Council, and had the opportunity to provide their recommendations to the Trustee Council on the Assessment Plan development. Prior to the implementation of Phase 2, the Trustee Council will invite all PLPs to participate in that phase of the assessment.

1.6.3 Public outreach

To facilitate public outreach, a public involvement plan is being developed for the Portland Harbor NRDA. The Trustee Council will involve the general public in the NRDA process by (1) providing access to this Assessment Plan and other work products and documents, (2) seeking review and input during public comment periods, and (3) holding informational meetings to discuss the assessment process, report on progress, and answer questions. If this Assessment Plan is significantly modified, the Trustee Council will provide for additional public review.

Comments on this Assessment Plan should be submitted in writing, by January 15, 2010 to:

> Stephen Zylstra, PhD
> Portland Harbor NRDA Case Manager
> U.S. Fish and Wildlife Service
> 2600 SE 98th Avenue, Suite 1100
> Portland, OR 97266
> Stephen_Zylstra@fws.gov

The Trustee Council has developed a web-based portal to provide information related to the Portland Harbor NRDA. Reference materials and documents associated with the Assessment Plan have been made available electronically through the USFWS Oregon Fish and Wildlife Office website (http://www.fws.gov/oregonfwo/Contaminants/PortlandHarbor/).

Hard copies of these reference materials and documents are also available for review at the Portland Harbor NRDA Reading Room; located at the USFWS Office (2600 SE 98th Avenue, Portland, Oregon). Visitors may access the Reading Room only with an appointment. To schedule an appointment, please contact the NRDA Case Manager at Stephen_Zylstra@fws.gov.

2. Portland Harbor Site Background

Portland Harbor is located in the lower Willamette River (LWR) near Portland, Oregon. EPA listed the Site on the NPL in December 2000 due to elevated concentrations of polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and other semi-volatile organic compounds (SVOCs), dichloro-diphenyl-trichloroethane (DDT) and other pesticides, heavy metals, and other contaminants.

The initial study area for the Site incorporated a six-mile stretch of the LWR from RM 3.5 to 9.5. Based on EPA's evaluation of data collected in the initial phases of the RI, the Study Area was expanded first to RM 2 to 11 and later to over a ten-mile stretch between RM 1 and 11.8. The RI/Feasibility Study (FS) for the in-water contamination is being conducted by the LWG with oversight by EPA as the lead agency and input from ODEQ and the Trustee Council as governmental partners. Source control and response activities for upland sites are being conducted by the respective responsible parties with oversight by ODEQ as the lead agency and EPA and the Trustee Council as governmental partners. Under a Memorandum of Understanding (MOU), EPA, ODEQ, and the federal, state, and tribal Trustees routinely communicate and coordinate on technical and legal aspects of the remedial activities. A more detailed description of the Site can be found in the *Portland Harbor RI/FS Programmatic Work Plan* and the *Comprehensive Round 2 Site Characterization Summary and Data Gaps Analysis Report* (Integral Consulting et al., 2004, 2007).

2.1 The NRDA Assessment Area

Although the Trustee Council has not determined the geographic scope of the PHAA, a general definition is provided below to guide the overall NRDA process. This section also discusses relevant physical, biological, economic, and cultural attributes of Portland Harbor and the Willamette River Basin.

2.1.1 Definition

The Trustee Council will consider geographic areas where hazardous substances released to the Site have come to be located to determine whether any injuries to natural resources have occurred as a result of those releases. During Phase 2 of the NRDA, the Trustee Council will focus on the Portland Harbor Study Area and the immediate surrounding areas, including the Multnomah Channel (Phase 2 PHAA). The Trustee Council is including the Multnomah Channel in Phase 2 because hydrological information indicates that the Willamette River flows into the Columbia River via the Multnomah Channel under many flow conditions. These hydrological conditions make it possible for hazardous substances released by PLPs to reach the Multnomah Channel. Other areas may be included in subsequent phases of the assessment.

2.1.2 Description

The LWR, including Portland Harbor, contains important natural resources that provide habitat for aquatic and terrestrial plants and animals and supports extensive commercial, recreational, and cultural opportunities for the region.

Physical and habitat characteristics

The Willamette River is the tenth largest river in the contiguous United States based on volume, and the thirteenth largest based on discharge. It flows generally northward through Oregon, drains a watershed area of approximately 11,400 square miles, and has a total length of 309 miles from its origin in the Oregon Cascade Range to its confluence with the Columbia River (Kammerer, 1990). Between 1973 and 2000, the annual mean flow in the Willamette River at the Morrison Bridge in Portland was approximately 33,800 cubic feet per second (cfs) (Integral Consulting et al., 2004).

The Willamette River Basin is comprised of many tributary sub-basins, including the Mary's, Luckiamute, Yamhill, and Tualatin rivers that drain the Coast Range and flow eastward into the Willamette River; and the McKenzie, Calapooia, Santiam, Mollala, and Clackamas rivers that drain the Cascade Range and flow westward into the Willamette River. The upstream reaches of the Willamette constitute a meandering and, in some cases, braided river channel. The main channel of the Willamette forms near Eugene, Oregon, at the convergence of the Middle and Coast forks, then flows through the broad and fertile Willamette Valley region. After flowing over the Willamette Falls at Oregon City, it passes through the City of Portland before joining the Columbia River. The northern (downstream) portion of the river from the Willamette Falls to the Columbia River is considered the "lower Willamette River" (Integral Consulting et al., 2004). The LWR is a dynamic junction of ecosystems that links the Willamette Basin with the Columbia River, Sandy River Basin, Ridgefield National Wildlife Refuge wetlands and forests, Vancouver Lake lowlands, and the Pacific Ocean. This dynamic ecosystem facilitates dispersal of aquatic and avian species among rivers, floodplains, forests, and valleys (Adolfson Associates, 2008).

The LWR was historically about a half-mile wide, with banks dominated by beaches and wetlands, and a large shoal along the east river bank. The open water was unconstrained and dynamic, containing low-lying islands and floodplains that resulted in significant channel movement and alteration (Adolfson Associates, 2008). The Willamette River Basin in general was an extensive system of open waters with connected channels, emergent wetlands, and riparian and upland forests. In the last century, anthropogenic activities such as dam construction, river channelization, dredging, bank hardening (riprap, seawalls), non-native species introduction, fisheries supplementation, timber harvesting, agriculture, urbanization, and industrialization have altered the historic habitats and biota of the basin (Adolfson Associates, 2008).

The primary depositional area of the Willamette River system is the segment between RM 3 and 10, which is also the location of the highly-industrialized area known as Portland Harbor. Portland Harbor serves a commercial shipping industry, and contains a multitude of water-dependent and non-water-dependent industrial and commercial facilities as well as private and municipal wastewater outfalls. The federal navigation channel (RM 0 to 11.6) runs through the center of the river in Portland Harbor, and is maintained by the U.S. Army Corps of Engineers (USACE) at a depth of 40 feet. Bank stabilization and dredging measures have created a stable channel in the LWR (Portland Harbor Natural Resource Trustee Council, 2007; Adolfson Associates, 2008).

Although much of the Willamette River at Portland Harbor is lined by vertical walls or rock revetment, some natural habitats and shoreline areas remain in the lower reach (Friesen et al., 2003). In addition to unvegetated/disturbed areas, various distinct habitat types have been classified along the LWR: bottomland forest, foothill savanna, conifer forest, scrub, meadow, shrub, emergent wetland, beach, rock outcrop, and open water (Adolfson Associates, 2008). The most common habitat types in the Portland Harbor vicinity are open water, unvegetated/disturbed areas, and beach areas, with remnants of bottomland forest, emergent wetlands, scrub/shrub, and rock outcrop communities. Mixed emergent and submerged aquatic vegetation is associated with the natural nearshore areas, and beaches have generally been colonized by annual grasses, perennial shrubs, and willows. The upland areas are mostly comprised of fill, although some ponds, wetlands, sloughs, side channels, and forested habitats remain (Portland Harbor Natural Resource Trustee Council, 2007). Despite physical changes, the Willamette River system continues to provide important watershed functions, including flood storage during storm events, nutrient cycling, pollutant filtering, riverbank shading, and wildlife habitat and connectivity corridors for aquatic and terrestrial species (Adolfson Associates, 2008).

Biological characteristics

A wide variety of biological resources rely on the Willamette River in the vicinity of Portland Harbor to provide a corridor for upstream and downstream movements and for nesting, breeding, foraging, and rearing of young. At least 39 species of resident and anadromous fish, including 20 native species, have been documented in the LWR (Farr and Ward, 1993). The area serves as a critical migratory corridor for both juvenile and adult anadromous fish, and as juvenile rearing habitat for several fish species, including Pacific salmon *(Onchorhynchus* spp.*)*, Pacific lamprey *(Lampetra tridentata)*, and white sturgeon (*Acipenser transmontanus).* The Willamette River is an important lamprey production area for the greater Columbia River Basin (Portland Harbor Natural Resource Trustee Council, 2007; Adolfson Associates, 2008). A list of some of the special status species known to be in the vicinity of Portland Harbor is provided in Appendix A.

Migratory birds nesting near or within the Study Area and foraging in the open water and nearshore habitats include piscivorous species such as bald eagle *(Haliaeetus leucocephalus),* osprey *(Pandion haliaetus),* double-crested cormorant *(Phalacrocorax auritus),* great blue heron *(Ardea herodias),* belted kingfisher *(Ceryle alcyon),* common merganser *(Mergus merganser),* hooded merganser *(Lophodytes cucullatus),* and other waterfowl. The beach areas and aquatic plants along the shorelines provide good habitat for passerines and aquatic-associated birds. Bird species nesting and foraging along the beach, nearshore habitat, and in unvegetated areas or on developed structures include cliff swallows *(Petrochelidon pyrrhonota),* various waterfowl, and probing shorebirds such as spotted sandpiper *(Actitis macularius)* (Integral Consulting et al., 2007; Portland Harbor Natural Resource Trustee Council, 2007; Adolfson Associates, 2008).

Mammals, including mink *(Mustela vison)* and river otter *(Lontra canadensis),* also use the area as a corridor, and for foraging in the river and rearing young in shoreline habitats. Some amphibian species such as northern red-legged frogs *(Rana aurora aurora)* and Pacific treefrogs *(Pseudacris regilla)* have also been observed in the vicinity of Portland Harbor and may use the nearshore habitat as breeding areas (Portland Harbor Natural Resource Trustee Council, 2007). Reptiles, such as painted turtles, can be found using the lower river habitat as a corridor (Adolfson Associates, 2008). A number of species more common to habitats just outside the Portland Harbor Study Area may visit as transients.

Lower trophic level inhabitants of the Portland Harbor Study Area include infaunal and epifaunal benthic invertebrates. In the LWR, cladocerans such as daphnids, copepods, and aquatic insects made up the majority of organisms in drift net samples, while daphnia and chironomids made up the majority on multi-plate samples, and oligochaetes and chironomids dominated the ponar samples collected by ODFW between 2000 and 2002 (Friesen et al., 2005). A generally homogenous community structure was noted in samples from Portland Harbor.

Other representative invertebrate species include amphipods such as *Corophium* spp., decapods such as crayfish, and molluscs such as gastropods (snails) and bivalves. Two species of bivalves documented in the harbor are Asiatic clam *(Corbicula fluminea)* and western pearlshell *(Margaritifer falcata).* These organisms rely on plankton and detritus as food. All of these invertebrate species are important for processing organic matter and serve as common prey items for higher trophic level species within Portland Harbor. Daphnids and chironomids are particularly important food sources for juvenile salmonids in the LWR. The Columbia pebblesnail *(Fluminicola fuscus),* a species of concern to the USFWS, may also occur in the LWR (Portland Harbor Natural Resource Trustee Council, 2007).

Tribal characteristics

The Site is used by a diverse indigenous population. Native people have been using the resources of the LWR since time immemorial. These people are now members of Tribes that are still active in the perpetuation of their respective ways of life. Tribal members have used and continue to use Portland Harbor not just for the natural resources that it provides, but for additional reasons. For example, Tribes have depended historically on a wide range of resources in the area not only for sustenance but also for cultural and religious activities. Tribal culture is intricately linked to natural resources.

Historically, people traveled to Portland Harbor from near and distant locations. Today, this tradition continues with Tribes coming to Portland Harbor and the LWR to harvest fish and eels, although many tribal members avoid harvest of contaminated resources. In the past, people were drawn to the LWR due to the myriad resources available. These resources supported people who inhabited the area year-round as well as those seasonal inhabitants who traveled from other areas upstream and downstream. Estimates based on Lewis and Clark’s observations suggest that the seasonal population was nearly double the local population (Ellis et al., 2005).

One example of an abundant natural resource that brought native people to the LWR from throughout the Columbia and Willamette basins was eels (lamprey). Eels were and continue to be harvested in the area. They provide an important source of protein for tribal members, who ate them onsite and also dried and transported the eels back to their respective homelands. In addition to providing sustenance, the eel harvest created an opportunity for trading resources that were less abundant or absent from their respective homelands and for social interaction among the diverse tribal groups. Historically and today, the eel harvest provided opportunities for family groups to hand down knowledge of traditions associated with the resource.

Economic characteristics

The economic importance of Portland Harbor is reflected by the extensive commercial and recreational opportunities that have developed over time. In 1998, the Willamette River was named as an American Heritage River, a federal designation used to assist in restoring and protecting the river (Adolfson Associates, 2008).

The City of Portland originated as a seaport for timber and grain exports. Railroads and major highways were constructed to connect it with other major cities, facilitating the expansion of commerce and industrialization. A brief history of Portland Harbor, including industrial activities, is provided in Section 2.2. In addition to continuing to support commerce, the LWR remains a popular area for recreational activities such as swimming, boating, and wildlife viewing. Recreational fishing for spring Chinook, steelhead, Coho salmon, and white sturgeon is common. Exotic resident fish species such as largemouth bass and walleye, American shad, and panfish such as black and white crappie, support a large year-round sport fishery. Sport fishing is an important economic industry, generating approximately $34.7 million in local and travel expenditures annually in the Portland metropolitan area expenditures (Dean Runyan Associates, 2009).

2.2 History of Portland Harbor

Since the 1900s, much of the Willamette River has been modified to control flooding and for navigation, and the lower floodplain has been modified by filling and development of industrial facilities. Lakes, wetlands, bottomlands, and sloughs within the floodplain of the lower river have been filled by hydraulic dredging, particularly in Portland Harbor, including portions of Doane, Guilds, and Kittridge lakes. Numerous streams in along the lower Willamette River have been diverted and covered over during development of municipal and industrial areas. The lower reach from RM 0 to 11.6 has been dredged to maintain the 40-foot deep by 300-foot wide federal navigation channel, with some depths of over 70 feet occurring in the channel (Integral Consulting et al., 2004). Much of the material dredged from the river was used for bank stabilization and for filling in the floodplain. Over the last 100 years, much of the natural shoreline has been replaced by rock revetment or vertical walls for flood control (North et al., 2002).[1]

Industrial facilities along the Willamette River at Portland Harbor, some of which have been operating since the early 1900s, have released hazardous substances into the river system. Aerial photos indicate that lumber and steel mills, tank farms, a dry dock at Willamette Cove, and large rail yards existed prior to 1936, and much of the area was developed by 1948. Few land use changes occurred after 1974. Many of the original industrial facilities are no longer in operation, but other facilities continue to release or discharge contaminants into the Site (Portland Harbor Natural Resource Trustee Council, 2007).

Industrial activities that have resulted in releases of hazardous substances include bulk petroleum storage and distribution; manufacture, formulation, and storage of chemicals, pesticides, asphalt, paint, resins, and acetylene; raw materials handling and treatment, including loading and unloading; metal salvage and recycling; oil gasification; wood treating; lumber wood chip export; tar pitch distribution; marine construction, repair, and fueling; pipe manufacturing and coating; semiconductor manufacturing; electrical power generation and substation operations; and railroad operations, fueling, and maintenance (Roy F. Weston, 1998; Integral Consulting et al., 2004). Extensive ship building and repair were conducted in the 1940s during World

1. While such modifications impact natural resources and the services they provide, the Trustee Council natural resource damages claim is limited to those losses resulting from the releases of hazardous substances.

War II, and some of this work continues in the harbor but on a much reduced scale (Integral Consulting et al., 2004). Other activities contributing to contamination in the harbor include erosion of contaminated soils, stormwater runoff from roads and urban areas, recreational boating and marina operations, contamination associated with urban growth, sewage operations and overflows, atmospheric deposition of exhaust and emissions, industrial discharges, and historic direct waste disposal into the river.

2.3 Hazardous Substance Releases

Numerous industrial operations, facilities, and wastewater outfalls have been identified as potential sources of releases of hazardous substances to Portland Harbor. This section discusses the key potential sources and types of contamination.

2.3.1 Potential sources of hazardous substance releases

Discharges and releases of hazardous substances into the LWR at Portland Harbor have resulted from current and historical industrial and municipal activities and processes since the early 1900s. Facilities released materials through spills, permitted and non-permitted discharges, stormwater runoff from contaminated soils at upland facilities, and discharge of contaminated groundwater. Other releases into the Willamette River upstream of Portland Harbor include metals from historical mining activity, agrochemicals from agricultural and timber operations along the river and its tributaries, and resuspension of deposited contaminated materials from aggregate mining operations (Portland Harbor Natural Resource Trustee Council, 2007).

There are numerous industrial facilities associated with contamination within Portland Harbor. Many sites have contamination in upland soils. Clean-up activities, such as barrier wall installation, removal of contaminated sediments, and sediment capping, have been undertaken at some of the sites and are being developed for others. A summary of known industrial facilities operating along the LWR, chemicals associated with discharges and releases from those facilities, and potential pathways for chemicals to reach natural resources are listed in Appendix A.

Spills of hazardous materials into Portland Harbor have occurred, and continue to occur, on an intermittent basis as a result of product transfer and handling, overwater activities, utility crossings, releases from vessels refueling, and accidents. Records of some spills have been collected since at least the 1940s, and spills or mishandling of products and wastes were likely more common prior to development of regulations governing hazardous materials and reporting requirements. Spill reports indicate petroleum releases from vessels are fairly common. Although prevention and response techniques have improved, spills are considered an ongoing source of contamination (Integral Consulting et al., 2004).

Contaminants are also discharged under permit from various facilities in Portland Harbor. There are at least 90 National Pollutant Discharge Elimination System (NPDES) permitted discharges into Portland Harbor, many of which discharge into the City of Portland's stormwater system (U.S. EPA, 2008d). The discharges include industrial process wastewater (including contact and non-contact cooling waters), treated water from clean-up projects, and stormwater from municipal sources, construction sites, and industrial facilities. The City of Portland has identified 322 outfalls along both shores of the Study Area (Integral Consulting et al., 2007).

Discharge of contaminated groundwater is another source of hazardous substances into the Willamette River from contaminated upland facilities within Portland Harbor. The shallow, unconfined groundwater system occurs at or below the shoreline, and low river stages expose seeps along the bank (Groundwater Solutions, 2003a). The rate of discharge of the shallow system is gradient-dependent and full reversals are rare. Intermediate and deep groundwater discharges are also present in Portland Harbor, some of which are contaminated by upland sources.

Approximately 113 upland sites between RM 2 and 11 were identified as possible contaminant sources to Portland Harbor through surface seeps or subsurface discharge to sediments (Groundwater Solutions, 2003a). Of these, 19 sites have contaminants confirmed in groundwater and a reasonable likelihood that the groundwater plume reaches the Willamette River. Eighty-five sites have insufficient data to determine if groundwater is contaminated or if contaminated groundwater reaches the Willamette River, and nine sites have data indicating contaminants are not present or will not reach the Willamette River (Groundwater Solutions, 2003a). Metals and volatile and semi-volatile organic compounds are the most common contaminant issues at sites with available data on groundwater quality.

In addition to the in-water and upland sources just described, sediment within the Willamette River acts as a sink and an ongoing source for contaminants. These contaminated sediments may become resuspended and bioavailable to organisms due to bottom-disturbing activities such as dredging and shipping, recreational boating in shallow-water areas, and repair and maintenance of underwater cables and drainage pipes.

Little industrial activity occurs downstream of RM 2 on the LWR, although the Port of Portland grain terminal (Terminal 5) at RM 1 has received slag from Oregon Steel Mills (Integral Consulting et al., 2004). Marinas, rail yard maintenance activities, aluminum storage facilities, and aggregate mining operations occur upstream of RM 11.8. Ross Island Sand and Gravel operates at RM 15. This large, in-water gravel pit collects aggregate materials and has accepted contaminated dredged material for disposal into confined cells within the pit. A former ship dismantling facility, operated at the Zidell property, is located at RM 14. At and upstream of Willamette Falls (RM 26.5) there are over 800 permitted discharges from facilities, including sewage treatment plants and industries related to pulp and paper and lumber production, and over 300 permits for discharge of industrial stormwater into the Willamette River (Integral Consulting et al., 2004).

2.3.2 Hazardous substances

Hazardous substances released to the Portland Harbor Site include, but are not limited to, the chemicals listed in Table 2.1 [reported by name and Chemical Abstract Service (CAS) Registry Number]. In addition, chemical mixtures such as creosote used in wood treating have been documented in the river, along with non-aqueous phase liquids (organic liquids that do not mix with water such as petroleum products and other organic solvents) in groundwater (Portland Harbor Natural Resource Trustee Council, 2007).

Table 2.1. Portland Harbor hazardous substances released

Chemical type	Chemical examples	CAS number
Metals	Arsenic	7440-38-2
	Cadmium	7440-43-9
	Copper	7440-50-8
	Lead	7439-92-1
	Mercury	7439-97-6
	Silver	7440-22-4
	Zinc	7440-66-6
Butyltins	Tributyltin	688-73-3
PCBs	PCB congeners and Aroclor mixtures	–
Dioxins/furans	Dioxin and furan congeners	–
Pesticides	2,4’-DDD	53-19-4
	2,4’-DDT	789-02-06
	2,4’-DDE	3424-82-6
	4,4’-DDD	72-54-8
	4,4’-DDT	50-29-3
	4,4’-DDE	72-55-9
	Aldrin	309-00-2
	alpha-Hexachlorocyclohexane	319-84-6
	beta-Hexachlorocyclohexane	319-85-7
	delta-Hexachlorocyclohexane	31986-8
	Dieldrin	60-57-1

Table 2.1. Portland Harbor hazardous substances released (cont.)

Chemical type	Chemical examples	CAS number
Pesticides (cont.)	Endrin	72-20-8
	Endrin ketone	53494-70-5
	gamma-Hexachlorocyclohexane	58-89-9
	Heptachlor	76-44-8
	Heptachlor epoxide	1024-57-3
Polycyclic aromatic hydrocarbons	2-Methylnaphthalene	91-57-6
	Acenaphthene	83-32-9
	Anthracene	120-12-7
	Benzo(a)anthracene	56-55-3
	Benzo(a)pyrene	50-32-8
	Benzo(b)fluoranthene	205-99-2
	Benzo(g,h,i)perylene	191-24-2
	Benzo(k)fluoranthene	207-08-9
	Chrysene	218-01-9
	Dibenzo(a,h)anthracene	53-70-3
	Fluoranthene	206-44-0
	Fluorene	86-73-7
	Indeno(1,2,3-cd)pyrene	193-39-5
	Naphthalene	91-20-3
	Phenanthrene	85-01-8
	Pyrene	129-00-0
Phthalate esters	Bis(2-ethylhexyl)phthalate	117-81-7
	Dibutyl phthalate	84-74-2
Semi-volatile organic compounds	Hexachlorobenzene	118-74-1
	Pentachlorophenol	87-86-5
Volatile organic compounds	Chloroform	67-66-3
	Trichloroethene	79-01-6

Source: Integral Consulting et al., 2007, Tables 11.1-1 and 6.0-2.

2.4 Pathways

This section discusses potential pathways from releases of hazardous substances by PLPs to exposure of various natural resources. Contaminant releases are introduced into the LWR through point and non-point discharges, spills occurring during overwater activities, groundwater discharges, dredging activities, aerial deposition, and soil erosion. Surface water, sediment, groundwater, and biota all can transport hazardous substances over time and space.

Biological organisms are exposed to hazardous substances through direct contact or ingestion of dissolved or suspended contaminants in the water column, contact or ingestion of groundwater in seeps or transition zones, contact or ingestion of sediment or porewater, direct contact or ingestion of soils, and ingestion of contaminated prey items (trophic level transfer). Hazardous substances have been measured in tissues of invertebrates, fish, birds, and mammals in Portland Harbor (Portland Harbor Natural Resource Trustee Council, 2007). Exposure pathways to biological receptors are illustrated in the conceptual diagram in Figure 2.1.

2.5 Natural Resources Potentially Exposed to Portland Harbor Releases

This section provides a brief description of the natural resources in the PHAA that could be exposed to hazardous substances released from the Site.

2.5.1 Surface water resources

Surface water resources are defined in the federal regulations as "waters of the United States, including the sediments suspended in water or lying on the bank, bed, or shoreline and sediments in or transported through coastal and marine areas."[2] 43 C.F.R. § 11.14(pp). Surface water resources include pelagic and benthic waters, as well as transition zone water (TZW), which is the interface between surface water and upwelling groundwater.

2.5.2 Sediment resources

Sediment, although defined as part of surface water resources in the federal regulations, can be evaluated separately because of the large amount of data available. According to the *Portland Harbor RI/FS: Comprehensive Round 2 Site Characterization Summary and Data Gaps Analysis Report*, the Portland Harbor Study Area "is a relatively low-energy reach of the LWR that, without active anthropogenic removal or disturbance, accumulates sediments over time" (Integral Consulting et al., 2007). On rare occasions, however, high-energy scouring events occur that may transport accumulated materials downstream.

2. This term does not include groundwater or water or sediments in ponds, lakes, or reservoirs designed for waste treatment under the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §§ 6901-6992, or the CWA and applicable regulations, 43 C.F.R. § 11.14(pp).

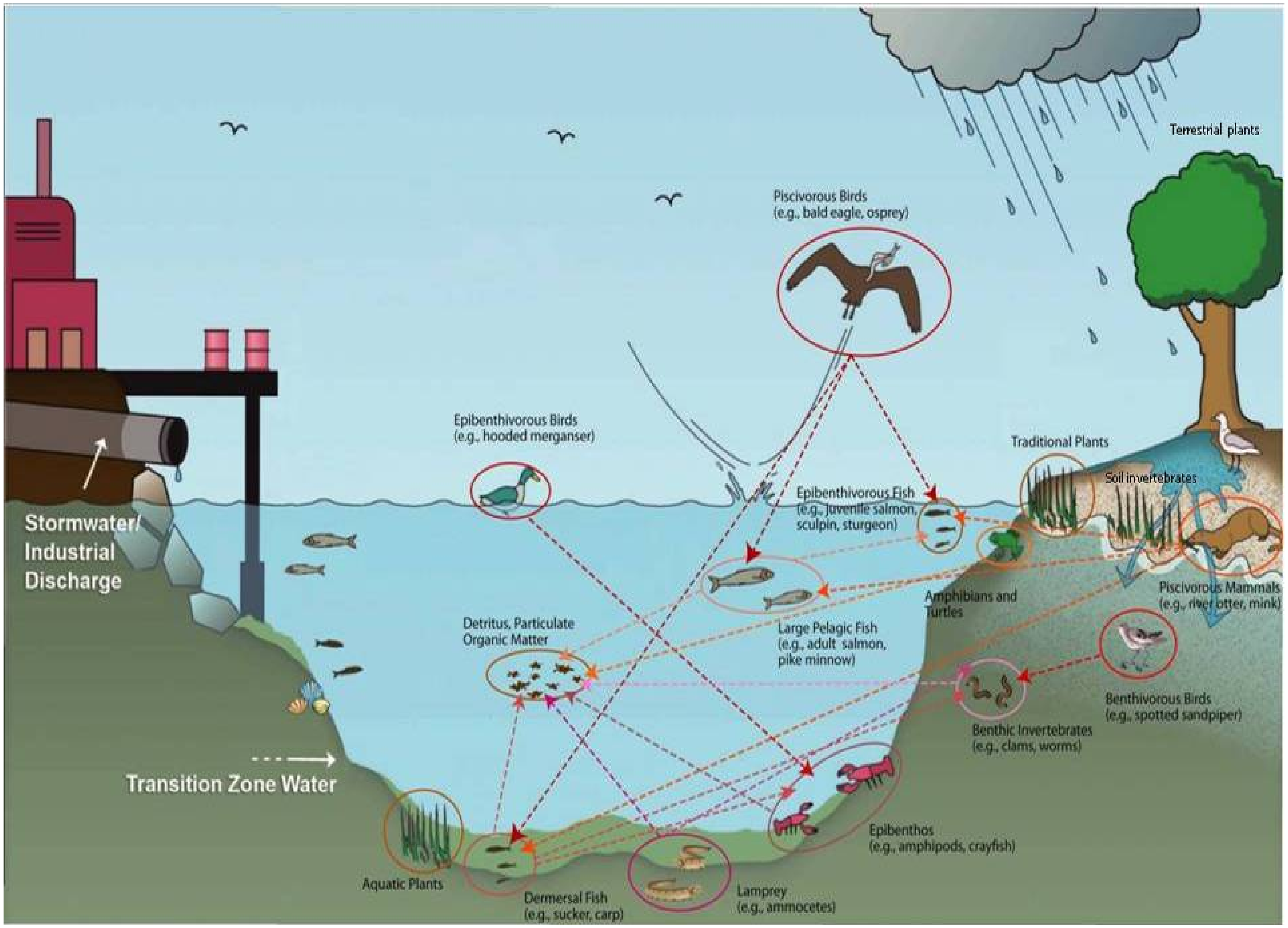


Figure 2.1. Portland Harbor conceptual diagram for biological exposure pathways.

2.5.3 Groundwater resources

Groundwater resources are defined in the federal regulations as “water in a saturated zone or stratum beneath the surface of land or water and the rocks or sediments through which groundwater moves.” 43 C.F.R. § 11.14(t). Groundwater resources include waters not visible beneath the Earth’s surface under natural conditions, and which are located beneath and adjacent to the LWR in the vicinity of the Portland Harbor Study Area. The main groundwater aquifers in the Willamette Basin occur in the alluvial sediment and basalt geologic units, and provide surface water recharge (Cole, 2004).

2.5.4 Geologic resources

Geologic resources are defined in federal regulations as “those elements of the Earth’s crust such as soils, sediments, rocks, and minerals.” 43 C.F.R. § 11.14(s). According to LWG’s Programmatic Work Plan (Integral Consulting et al., 2004), the Study Area is located along the southwestern edge of the Portland basin, which is a large geologic bowl-like structure bounded by folded and faulted uplands. The basin has been filled with up to 1,400 feet of alluvial and glacio-fluvial flood deposits since the middle Miocene period approximately 12 million years ago, which overlies older Eocene rocks that include the Columbia River Basalt Group (CRBG), Waverly Heights basalt, and older marine sediments. The older rocks are exposed where uplifting has occurred on the margins of the basin, including adjacent to the current Study Area. Recent fill now covers much of the lowland area next to the Willamette River and is predominantly dredged river sediment, including fine sand and silty sand (Integral Consulting et al., 2007).

2.5.5 Biological resources

Biological resources are defined in the federal regulations as “fish and wildlife and other biota. Fish and wildlife include marine and freshwater aquatic and terrestrial species; game, nongame, and commercial species; and threatened, endangered, and state sensitive species. Other biota encompass shellfish, terrestrial and aquatic plants, and other living organisms not otherwise listed in this definition.” 43 C.F.R. § 11.14(f).

Types of biological resources in the PHAA include, but are not limited to:

- Mammals such as mink and river otter and the aquatic species they depend on as prey
- Birds, including osprey, bald eagle, belted kingfisher, mergansers and other waterfowl, great blue heron, spotted sandpiper and other shorebirds, cliff swallow and other passerines, and the aquatic species they depend on as prey

- Threatened and endangered species
- Anadromous and resident fish
- Reptiles and amphibians
- Aquatic invertebrates
- Aquatic and terrestrial plants
- Wetland and upland habitats.

2.6 Services, Uses, and Values Provided by Natural Resources

The natural resources described above provide services that are important to the public for many reasons including, but not limited to:

- They are components of habitat in the PHAA
- They are used for hunting, fishing, swimming, boating, wildlife viewing and photography, and other outdoor recreational activities
- They are used for cultural, spiritual, and religious purposes
- They are used as foods
- They are used and enjoyed for their inherent (existence or passive use) value, including bequests to future generations (Portland Harbor Natural Resource Trustee Council, 2007).

Natural resources can be thought of, and measured over time for purposes of the assessment, as quantity of natural resources (e.g., gallons of water or numbers of fish); quantity or quality of habitat comprised of natural resources (e.g., acres of healthy wetlands); quantity of services provided by natural resources (e.g., fishing days); a cost (i.e., dollars) for preserving, maintaining, enhancing, or creating viable natural resources, including habitat; or a value (e.g., in dollars) for gains or losses in natural resource goods and services.

2.6.1 Ecological services and values

The natural resources in the PHAA comprise a natural ecosystem. That ecosystem has been modified by a variety of human activities but still provides food and habitat for plants, invertebrates, fish, and wildlife; species diversity; a hydrological system comprising surface water, groundwater, and wetland system recharge; and flood control and waste assimilation. The health and integrity of this ecosystem is of great importance to the public, both because of beneficial uses like hunting, fishing, boating, and cultural use and because of the inherent (existence and passive use) value of the ecosystem.

2.6.2 Tribal services, uses, and values

The natural resources in the PHAA provide services, uses, and values to tribal members in ways that can be distinct from the rest of the general public, including social, cultural, religious, medicinal, recreational, or subsistence services, uses, or values. Examples may include collecting sacred or medicinal plants; subsistence or ceremonial fishing, hunting, and gathering; and using sacred grounds for meetings, ceremonies, spiritual recognition, and worship. Tribal culture is intricately linked to natural resources. Loss of services in one area (e.g., fishing) may reduce the ability to provide other services (e.g., ceremonial services associated with fishing).

2.6.3 Recreational services, uses, and values

The natural resources in the PHAA provide recreational use services to members of the public who derive benefits from participating in activities such as sport fishing, hunting, and trapping; boating and swimming; hiking, exercising, camping, and picnicking; and observing wildlife. Changes in the availability and quality of natural resources may change the quantity and quality of recreational opportunities and the benefits derived by the public's use of those resources.

2.6.4 Current use versus future use and passive values

The natural resources of the PHAA are used by many people for many purposes. However, these resources are valuable for reasons beyond current use, for several reasons. First, people may value the option of having uninjured natural resources available for use in the future, even if they are not currently being used, or are not currently used to potential future extent. This is sometimes called *option value*. As an example of option value, clean groundwater might be a source of future drinking water supply in the face of expanding human population and climate change, even if a groundwater aquifer is not currently being used for drinking water.

Second, people may value the very existence of natural resources and healthy ecosystems even if they do not explicitly use the natural resources themselves. For instance, many people who intend never to visit the Grand Canyon are likely to be willing to pay to keep the Grand Canyon in its current state (undeveloped, in public domain, and accessible for public viewing). These values are called *existence value* when they are based on the inherent pleasure of knowing that a natural resource exists. These values are called *bequest value* when based on the desire for others to use and enjoy the natural resource.

2.6.5 How services, uses, and values relate to the NRDA

Natural resource trustees may measure or estimate the amount of natural resource injury caused by hazardous substance releases, as well as the amount of restoration needed to offset resulting public losses, by focusing on natural resource amounts (e.g., gallons of clean water or number of fish lost to injury and gained by restoration), habitat amounts (e.g., acres of healthy wetland lost to injury and gained by restoration), service amounts (e.g., fishing days lost to injury and gained by restoration), cost amounts (e.g., cost in dollars of enough restoration to offset losses), or value amounts (e.g., the value in dollars of the losses from injury or the gains from restoration). The Trustee Council for Portland Harbor will determine which methodologies are feasible and appropriate to measure or estimate losses and gains for specific resources and services based on their findings of injury and restoration opportunities during the assessment.

3. Confirmation of Exposure

The objective of this chapter is to present information used by the Trustee Council to confirm that at least one of the natural resources identified in the Preassessment Screen as potentially injured has in fact been exposed to the released hazardous substances. 43 C.F.R. § 11.37(a). A natural resource has been exposed to a hazardous substance if "all or part of a natural resource is, or has been, in physical contact with oil or a hazardous substance, or with media containing the oil or hazardous substance." Id. at § 11.14(q). Federal regulations also state that "whenever possible, exposure shall be confirmed using existing data" from previous studies of the assessment area. Id. at § 11.37(b)(1).

This chapter presents data confirming that natural resources have been exposed to hazardous substances released from the Site. It is meant to meet the objectives for confirmation of exposure, and does not necessarily present data regarding all resources that may have been exposed, all released hazardous substances, or all facilities or areas within the PHAA.

3.1 Data Sources

Data available from the Portland Harbor Study Area and adjacent areas were compiled from several key documents. These key documents include the *Portland Harbor RI/FS: Comprehensive Round 2 Site Characterization Summary and Data Gaps Analysis Report* (Integral Consulting et al., 2007), the *Preassessment Screen for the Portland Harbor Superfund Site* (Portland Harbor Natural Resource Trustee Council, 2007), and several recent RI/FS Round 3 data reports. To confirm exposure to groundwater and geologic resources, investigation reports and data included in the ODEQ files and summarized in the ECSI Database *Site Summary Reports* were reviewed (http://www.deq.state.or.us/lq/cu/nwr/portlandharbor/).

3.2 Surface Water Resources

This section discusses confirmation of exposure of surface water as well as transition zone water, which is the interface of surface water with groundwater. While sediments are considered part of the surface water resource, confirmation of exposure of sediments is discussed separately in Section 3.3.

In the Portland Harbor vicinity, exposed surface water resources include the LWR, including the Superfund Study Area from approximately RM 1 to 11.8, as well as potentially upstream and downstream reaches of the Willamette River, and tributaries and receiving waters.

Data sufficient to confirm exposure of surface water resources are taken from the *Portland Harbor RI/FS: Comprehensive Round 2 Site Characterization Summary and Data Gaps Analysis Report* (Integral Consulting et al., 2007). Round 2 sampling included the collection and analysis of surface water samples at 23 target locations from RM 2 to 11 in the LWR during three sampling events in 2004 and 2005. Additional samples were collected using high-volume sampling methods at seven of the 23 locations. The surface water samples were analyzed for organic compounds (PCB Aroclors, organochlorine pesticides, and SVOCs), metals, and conventional analytes. High-volume samples were analyzed using high-resolution methods for PCB congeners, dioxins and furans, organochlorine pesticides, phthalate esters, and PAHs. The results of surface water sampling are discussed by chemical group in this section. TZW is also discussed in this section.

3.2.1 Chemicals in surface water

Concentrations detected in surface water during Round 2A sampling include:

- **PCBs:** At sampling stations other than the Willamette Cove station (W013), total PCB congener concentrations ranged from 201 to 1,290 picograms per liter (pg/L) in the particulate phase, and from 137 to 630 pg/L in the dissolved phase. Total PCB congener concentrations at the Willamette Cove station were an order of magnitude greater than other samples, ranging from 3,340 to 12,000 pg/L.

- **Dioxins/furans:** Total dioxin concentrations in surface water transect samples from RM 4 to 11 ranged from 16.7 to 50.5 pg/L, and total dioxin concentrations at the single-point near-bottom samples (at Willamette Cove and at RM 6.9) ranged from 45.6 to 163 pg/L.

- **Organochlorine pesticides:** The pesticide DDT and its primary breakdown products, dichloro-diphenyl-dichloroethane (DDD) and dichloro-diphenyl-dichloroethylene (DDE) (collectively referred to as DDx), were detected in surface waters in the LWR. Total DDx concentrations at the surface water transect locations ranged from 42.8 to 236.5 pg/L, and concentrations at the near-bottom sampling locations ranged from 60.9 to 9,760 pg/L. Other pesticides detected in surface waters included, but were not limited to, aldrin (0.3 to 2.1 pg/L), beta-hexachlorocyclohexane (1.7 to 34.7 pg/L), and chlordane (13.4 to 42.4 pg/L).

- **Total PAHs:** Total PAHs were detected in surface waters throughout the LWR. At the 23 primary sampling locations, concentrations of total PAHs were less than 0.1 micrograms per liter (µg/L) with the exception of three locations, where concentrations ranged up to 288 µg/L. Total PAHs were detected at all seven high-volume sampling locations.

- **Metals:** Metals were detected in surface waters at all sampling locations within the Study Area. Concentrations of arsenic ranged from 0.33 to 0.75 µg/L, and concentrations of lead ranged from 0.077 to 1.8 µg/L.

3.2.2 Chemicals in transition zone water

Transition zone water is defined as water at the groundwater/surface water interface where both groundwater and surface water comprise some percentage of the water occupying pore space in sediments. TZW was sampled at nine locations between RM 4.2 and 9 that were identified as locations likely to discharge upland groundwater contaminants to Portland Harbor (Integral Consulting et al., 2007). TZW samples were analyzed for a subset of chemicals that were deemed to be relevant to the RI/FS ecological and human health risk assessments. The subset of chemicals evaluated included PAHs, TPH, metals, pesticides, VOCs, perchlorate, and cyanide. All chemicals evaluated were detected in TZW.

3.3 Sediment Resources

Sediment samples have been collected from well over 1,000 locations in the LWR over the past 20 years. These samples have been analyzed for a variety of toxic substances, although not all samples were subjected to the same analyses.

Recent evaluations conducted as part of the RI/FS studies compiled sediment contaminant data from many recent studies, including over 1,000 surface sediment samples collected as part of the RI/FS. Over 500 potentially toxic substances, comprising trace elements, butyltins, PCBs, organochlorine pesticides, PAHs, phthalate esters, other SVOCs, and petroleum hydrocarbons have been analyzed in sediment (Integral Consulting et al., 2007). The data were segregated into four major river reaches: RM 0 to 2, downstream; RM 2 to 11, the boundaries of the Study Area at the time; RM 11 to 15.5, the downtown reach adjacent to the City of Portland commercial center; and RM 15.5 to 26, the upstream reach to the Willamette Falls.

Summary data for selected substances in sediments collected between RM 2 and 11 are presented in Table 3.1. Concentrations of the selected substances are elevated in the sediments of the Site compared to results from upstream of the Site. In addition, the concentrations of most of the substances were elevated in the sediments downstream of the Study Area compared to the concentrations in the upstream sediments.

Table 3.1. Summary of select surface[a] sediment concentrations from LWR Round 2 sampling

Substance	Units	# analyzed	# detected	% detected	Minimum	Maximum	Median
Arsenic	mg/kg	1,259	1,132	89.9	0.7	132	3.66 J
Mercury	mg/kg	1,224	1,116	91.2	0.006 J	4.84	0.065
Zinc	mg/kg	1,240	1,240	100	17.3 G	2,010	106
Tributyltin ion	µg/kg	274	260	94.9	0.23 U	47,000	26
Total PCBs (Aroclors)	µg/kg	948	713	75.2	0.851 JT	27,400 JT	20 UT
Dioxin/furan 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) toxicity equivalent	pg/g	151	151	100	0.00803 T	16,600 JT	1.94 T
Total chlordanes	µg/kg	810	551	68	0.0349 JT	669 JT	0.913 JT
Total of 2,4’ and 4,4’-DDD, -DDE, -DDT	µg/kg	850	756	88.9	0.051 JT	16,200 JT	7.13 JT
Total PAHs	µg/kg	1,329	1,309	98.5	3.3 JT	7,260,000 T	1,278 JT
TPH	mg/kg	443	431	97.3	8.4 JT	33,100 JT	568 JT

G = estimate is greater than value shown.
J = an estimated quantity.
T = the value was mathematically derived, e.g., from summing multiple results such as Aroclors, or calculating the average of multiple results for a single analyte.
U = the substance was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.

a. Surface sediment collected at a depth of 0–30 centimeters (cm) collected between RM 2 and RM 11.

Source: Integral Consulting et al., 2007.

3.4 Groundwater Resources

Groundwater quality data from upland sites in the vicinity of the Portland Harbor Study Area are summarized in the document *Portland Harbor RI/FS Upland Groundwater Data Review Report, River Mile 2–11, Lower Willamette River* (Groundwater Solutions, 2003a), prepared in support of the Portland Harbor RI/FS. The *Data Review Report* includes information compiled from an intensive review of upland groundwater data available in ODEQ files. The information and evaluation included in the report were used to complete a *Portland Harbor RI/FS, Draft Technical Memorandum, Groundwater Pathway Assessment* (Groundwater Solutions et al., 2004).

The *Portland Harbor RI/FS, Draft Technical Memorandum, Groundwater Pathway Assessment* includes a categorization and prioritization of upland sites based on the potential for groundwater to impact in-water media. Upland sites are categorized into one of three groups: A, B, and C.

Group A sites, considered the highest priority for further evaluation, include sites where it has clearly been demonstrated that (1) an upland source of contaminants of interest (COIs) is present, (2) COIs have been detected in upland groundwater, and (3) a groundwater pathway from the upland site to the river is complete or is reasonably likely to be complete.

Groundwater data from the Group A sites confirm that groundwater resources in the vicinity of the Portland Harbor Study Area have been exposed to released hazardous substances. Group A sites have identified upland sources of hazardous substances, and data for these sites indicate that hazardous substances related to those sources are present in groundwater. There are a total of 19 Group A sites, located between RM 2.2 and 10, and encompassing areas on both sides of the LWR. Hazardous substances detected in groundwater at the Group A sites include, but are not limited to, metals; VOCs, including BTEX; PAHs and other SVOCs; DDTs and other organochlorine pesticides; PCBs; petroleum hydrocarbons; and polychlorinated dioxins and furans.

Table 3.2 provides a subset of groundwater data from the ODEQ ECSI database for Group A sites. The data demonstrate that the groundwater resource in the vicinity of the LWR has been exposed to hazardous substances. The data represent maximum concentrations included in the ECSI database for representative types of hazardous substances. Not all hazardous substances are found at all sites, and concentrations between sites may be extremely variable.

Table 3.2. Select groundwater concentrations from ODEQ site summary reports

Chemical type	Maximum concentration[a]	Site location	DEQ Site ID	River mile
PAHs				
Total PAHs	Free product (creosote)[b]	McCormick & Baxter	74	6.7
Benzo(a)pyrene	760 µg/L	Wacker Siltronic	183	6.5
VOCs				
Benzene	200,000 µg/L	Kinder Morgan – Linnton	1096	4.2
Toluene	470,000 µg/L	Kinder Morgan – Linnton	1096	4.2
Metals				
Arsenic	1,700 µg/L[b]	McCormick & Baxter	74	6.7
Chromium	26,700 µg/L	Arkema	398	7.2
Copper	5,400 µg/L[b]	McCormick & Baxter	74	6.7
Lead	740 µg/L	Triangle Park	277	7.5
Zinc	5,590 µg/L	Triangle Park	277	7.5
Dioxins				
TCDD	2.6 µg/L	Rhone-Poulenc	155	6.9
Pesticides				
2,4-D	364,000 µg/L	Rhone-Poulenc	155	6.9

Table 3.2. Select groundwater concentrations from ODEQ site summary reports (cont.)

Chemical type	Maximum concentration[a]	Site location	DEQ Site ID	River mile
TPH				
Total TPH	89,000 µg/L	Wacker Siltronic	183	6.5
Diesel	Free product	ARCO Bulk Terminal	1528	4.8

a. Concentrations represent the maximum reported in ODEQ Site Summary Reports for Group A sites, and may not represent actual maximums.
b. Concentrations may represent pre-remedial action conditions.

3.5 Geologic Resources[1]

Soils data from remedial investigation reports and other site assessment reports from numerous sites in the vicinity of the LWR are available from the ODEQ ECSI database *Site Summary Reports*. Detected concentrations of released hazardous substances in soils provided in the *Site Summary Reports* confirm that geologic resources in the vicinity of the Portland Harbor Study Area have been exposed to hazardous substances.

Table 3.3 provides a subset of soils data from 16 sites identified by ODEQ as High Priority Sites or Preliminary High Priority Sites, which include sites adjacent to the LWR between RM 2.2 and 9 and encompass areas on both sides of the river. Hazardous substances detected in soils at the High Priority Sites include, but are not limited to, metals; VOCs including BTEX; PAHs and other SVOCs; DDTs and other organochlorine pesticides; PCBs; petroleum hydrocarbons; and dioxins and furans.

Table 3.3. Select soil concentrations from ODEQ site summary reports

Chemical type	Maximum concentration[a]	Site location	DEQ Site ID	River mile
PAHs				
Total PAHs	27,500 mg/kg[b]	McCormick & Baxter	74	6.7
Benzo(a)pyrene	240 mg/kg	Wacker Siltronic	183	6.5
SVOCs				
Pentachlorophenol	190,000 mg/kg[b]	McCormick & Baxter	74	6.7
VOCs				
Benzene	360 mg/kg	Gasco	84	6.4
Toluene	23 mg/kg	Rhone-Poulenc	155	6.9

1. At this time, the Trustee Council is not planning to evaluate injury to geologic resources in their assessment. However, they are included in the confirmation of exposure because they represent an important pathway to other resources.

Table 3.3. Select soil concentrations from ODEQ site summary reports (cont.)

Chemical type	Maximum concentration[a]	Site location	DEQ Site ID	River mile
Metals				
Arsenic	25,000 mg/kg[b]	McCormick & Baxter	74	6.7
Chromium	17,000 mg/kg[b]	McCormick & Baxter	74	6.7
Copper	7,900 mg/kg[b]	McCormick & Baxter	74	6.7
Lead	4,800 mg/kg	Gunderson	1155	9
Zinc	12,000 mg/kg	Gunderson	1155	9
PCBs				
Total PCBs	19 mg/kg	Gunderson	1155	9
Dioxins				
2,3,7,8-TCDD	8.8 × 10-5 mg/kg	Rhone-Poulenc	155	6.9
Pesticides				
DDT	150,000 mg/kg	Arkema	398	7.2
TPH				
Total TPH	53,400 mg/kg	Foss Maritime	2364	5.7
Diesel	36,000 mg/kg	ARCO Bulk Terminal	1528	4.8

a. Concentrations represent the maximum reported in ODEQ Site Summary Reports for ODEQ High Priority sites, and may not represent actual maximums.
b. Concentrations may represent pre-remedial action conditions.

3.6 Biological Resources

3.6.1 Aquatic invertebrates

Aquatic invertebrates include pelagic (water-column) invertebrates such as zooplankton, benthic (sediment-dwelling) invertebrates such as worms and clams, and epibenthic (sediment surface-dwelling) invertebrates such as amphipods and crayfish. Contaminant concentrations measured in invertebrate tissue confirm that benthic invertebrates have been exposed to hazardous substances.

The stomach contents of the juvenile Chinook salmon included pelagic and benthic invertebrates, which were chemically analyzed and found to be contaminated with PAHs, DDT and other organochlorine pesticides, and PCBs (Integral Consulting and Windward Environmental, 2006). In addition, a number of recent studies have investigated both the composition and the extent of contamination of the benthic and epibenthic communities in the LWR. Samples of field-collected clams, crayfish, and the epibenthic community (collected on multiplate arrays) were contaminated with a variety of site-related substances, including metals, butyltins, PCBs, dioxins and furans, DDT and other organochlorine pesticides, PAHs, and phthalates (Integral Consulting et al., 2007). Concentrations of selected contaminants measured in clam samples from RM 2 to 11 of the LWR are shown in Table 3.4 and in crayfish samples are shown in Table 3.5 to illustrate the exposure data for those species of aquatic invertebrates.

Table 3.4. Summary of select clam tissue concentrations from LWR RI/FS Round 2 sampling[a]

Substance	Units	# analyzed	# detected	% detected	Minimum	Maximum	Median
Total PCB Aroclors	µg/kg-wet	32	32	100	30.2 JT	1,470 JT	77 JT
Tributyltin ion	µg/kg-wet	25	19	76	1.8 U	530	6
Dioxin/furan TCDD toxicity equivalent	pg/g-wet	27	27	100	0.116 T	6.76 T	0.568 JT
Arsenic	mg/kg wet	29	29	100	0.694	1.25	0.923
Mercury	mg/kg-wet	26	26	100	0.005 JT	0.016 J	0.009 J
Zinc	mg/kg-wet	29	29	100	21.4	54	35.6
Total PAHs	µg/kg-wet	30	30	100	34.2 JT	4,980 T	218 T
Total of 2,4’ and 4,4’-DDD, -DDE, -DDT	µg/kg-wet	32	32	100	7.82 JT	463 JT	23.6 T

J = an estimated quantity.
T = the value was mathematically derived, e.g., from summing multiple results such as Aroclors, or calculating the average of multiple results for a single analyte.
U = the substance was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.

a. Samples collected between RM 2 and RM 11.

Source: Integral Consulting et al., 2007.

3.6.2 Fish

Contaminant concentrations measured in fish tissue confirm that fish have been exposed to hazardous substances. Recent data are available for the Portland Harbor Study Area for black crappie, brown bullhead, Chinook salmon (juveniles), common carp, smallmouth bass, largemouth bass, lamprey ammocoetes and macropthalmia, northern pikeminnow, largescale sucker, peamouth, white sturgeon, and sculpin (PTI, 1992; U.S. EPA, 1992; Bonn, 1998; Integral Consulting et al., 2007; Windward Environmental and Integral Consulting, 2007, 2008; Integral Consulting, 2008a). Not all substances were analyzed for or detected in all samples, but these studies identified numerous hazardous substances in the fish tissues, including metals; butyltins; organochlorine pesticides, particularly DDTs; PCBs; phthalates; PAHs and other SVOCs; and dioxins and furans.

Table 3.5. Summary of select crayfish tissue concentrations from LWR RI/FS Round 2 sampling[a]

Substance	Units	# analyzed	# detected	% detected	Minimum	Maximum	Median
Total PCB Aroclors	µg/kg-wet	27	12	44.4	1.7 T	280 T	3.5 UT
Dioxin/furan TCDD toxicity equivalent	pg/g-wet	10	10	100	0.455 T	22.7 T	0.79 T
Arsenic	mg/kg-wet	27	27	100	0.25	0.5 J	0.35 J
Mercury	mg/kg-wet	27	27	100	0.02	0.041	0.028
Zinc	mg/kg-wet	27	27	100	13.7 J	20.3 J	16.6 J
Total of 2,4' and 4,4'-DDD, -DDE, -DDT	µg/kg-wet	27	27	100	1.6 JT	84.9 JT	7.2 JT

J = an estimated quantity.
T = the value was mathematically derived, e.g., from summing multiple results such as Aroclors, or calculating the average of multiple results for a single analyte.
U = the substance was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.

a. Samples collected between RM 2 and RM 11.

Source: Integral Consulting et al., 2007.

Illustrative data are presented in Table 3.6, which shows the concentration ranges for selected substances in sculpin collected from RM 2 to 11, one of the species most frequently tested in recent sampling in the LWR (Integral Consulting et al., 2007). Subyearling Chinook salmon sampled in the LWR were also found to contain substantial concentrations of many of the same substances, including high concentrations of PCBs, PAH metabolites, polybrominated diphenylethers (PBDEs), dioxins and furans, and DDTs (Integral Consulting et al., 2007; LCREP, 2007). Lamprey ammocoetes and macropthalmia from a few locations were contaminated with similar suites of site-related substances (Windward Environmental and Integral Consulting, 2007; Integral Consulting and Windward Environmental, 2007).

3.6.3 Birds

Eggs of piscivorous birds have been monitored from nests along the Willamette River (osprey) (Henny et al., 2009) and the lower Columbia River (bald eagle and osprey) (Anthony et al., 1993; Buck, 1999; Buck et al., 2005; Henny et al., 2004, 2008). Analyses of these eggs have shown elevated concentrations of contaminants in the vicinity of Portland Harbor compared to upstream sample locations (Table 3.7).

Table 3.6. Summary of select sculpin tissue concentrations from LWR RI/FS Round 2 sampling[a]

Substance	Units	# analyzed	# detected	% detected	Minimum	Maximum	Median
Total PCB Aroclors	µg/kg-wet	26	26	100	62 JT	3,360 T	226 JT
Dioxin/furan TCDD toxicity equivalent[b]	pg/g-wet	9	9	100	0.772 T	38.6 T	1.66 T
Arsenic	mg/kg-wet	26	26	100	0.13	0.3	0.21
Mercury	mg/kg-wet	27	27	100	0.025	0.086	0.039
Zinc	mg/kg-wet	26	26	100	13.6	18	15.4
Total PAHs	µg/kg-wet	26	10	38.5	27 UT[a]	132 T	16.5 UT
Total of 2,4’ and 4,4’-DDD, -DDE, -DDT	µg/kg-wet	26	26	100	18 JT	3,060 T	49 JT
Bis(2-ethylhexyl) phthalate	µg/kg-wet	26	3	11.5	82 UT	28,000 JT	80 UT

J = an estimated quantity.
T = the value was mathematically derived, e.g., from summing multiple results such as Aroclors, or calculating the average of multiple results for a single analyte.
U = the substance was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.

a. Samples collected between RM 2 and RM 11.
b. Note that this does not include dioxin-like PCBs.

Source: Integral Consulting et al., 2007.

Table 3.7. Contaminant concentrations in osprey eggs collected from the Willamette River, geometric mean, µg/kg

	Headwater reservoirs[a]	Upper River (RMs 187– 55)	Newberg Pool (RM 55 to Willamette Falls)	Tidal Portland (Willamette Falls to mouth)	
Year	2002	2001	2001	2001	1997/1999
Number of samples	7	11	5	4	5
p,p’-DDE	901	1,353	1,384	2,676	2,387
p,p’-DDD	29.5	29.4	20.3	83.4	144.6
p,p’-DDT	5.17	2.08	1.42	3.21	13.3
Total PCBs	275	245	677	1,460	1,030
Total chlordanes	3.88	8.53	10.3	16.7	21.4
Hexacholorbenzene	0.69	1.97	1.84	2.21	1.24
Dieldrin	0.62	1.66	1.81	1.63	4.93

a. Cottage Grove, Dorena, and Hills Creek reservoirs.

Source: Henny et al., 2009.

3.6.4 Mammals

Contaminants have been measured in river otters in both the LWR and lower Columbia River (Henny et al., 1996; Grove and Henny, 2005; Grove, 2006). In the Portland Harbor vicinity, Grove and Henny (2005) found elevated concentrations of a number of bioaccumulative substances in their tissues, including PCBs, dioxins, and furans (Table 3.8). Concentrations of these contaminants were higher in otter collected in Portland Harbor than in otter collected upstream.

Table 3.8. Concentrations of selected contaminants in river otter livers collected from the Willamette River, 1996–1999

	Upstream of Portland Harbor			**Portland Harbor**			**Sauvie Island**
Number of samples	**21**			**4**			**1**
Contaminant (units)	**Minimum**	**Maximum**	**Median**	**Minimum**	**Maximum**	**Median**	**Result**
Mercury (ppb ww)	3.65	14.67	8.09	6.99	17.84	11.98	8.63
Trans-nonachlor (ppb ww)	0.005	29.800	8.420	14.420	41.740	23.160	25.640
Dieldrin (ppb ww)	0.005	52.340	10.530	13.980	31.130	22.640	10.150
Total PCBs (ppb ww)	11.410	623.100	132.460	917.520	3,572.870	2,132.015	425.080
Total heptachlorodibenzodioxin (ppt ww)	0.005	631.240	28.410	324.410	750.480	363.280	52.460
Octachlorodibenzodioxin (ppt ww)	5.920	1,286.090	44.270	995.200	3,428.630	1,154.055	120.580
Total hexachlorodibenzofuran (ppt ww)	0.005	264.290	7.070	208.960	953.780	247.000	6.410

Source: Grove and Henny, 2005.

4. Injury Assessment and Quantification

The purpose of the injury assessment is to determine whether and how hazardous substances cause injuries to natural resources that result in public losses that can be offset through practical natural resource restoration. This section describes the approach that the Trustee Council intends to follow in assessing and quantifying injuries for the Portland Harbor NRDA.

4.1 General Approach

The Trustee Council will continue to evaluate several kinds of existing information to assess whether and how hazardous substances may be injuring natural resources. In particular, the Trustee Council will evaluate the concentrations of hazardous substances in various environmental media over time and space, in light of known sources of releases, environmental fate and transport mechanisms, relevant standards and thresholds, and injuries occurring in the PHAA. The Trustee Council will use this initial evaluation of existing information to assess whether damages and restoration can be adequately determined to propose settlement positions to PLPs, or whether additional information and data should be collected to better determine relevant injuries.

The Trustee Council anticipates an iterative assessment both within and between phases. In Phase 2, the Trustee Council will explore with participating PLPs specific assessment approaches and potential cooperative data collections or studies, in light of the Trustee Council's initial assessment of existing information (see Appendix B describing the Scope of Phase 2). Pursuant to this Assessment Plan, the Trustee Council will keep the public informed of relevant Phase 2 activities. The Trustee Council anticipates issuing, after Phase 2, an Assessment Plan Addendum regarding Phase 3 assessment approaches, data collections, and studies. Phase 3 approaches, data collections, and studies may be executed cooperatively by the Trustee Council and participating PLPs or by the Trustee Council themselves. The Trustee Council will develop sampling plans for studies to be conducted during Phases 2 and 3 and release those plans to the public (see Appendix C).

4.1.1 Evaluation of injury assessment information for specific natural resources

The Trustee Council will emphasize the use of existing information in assessing injury. For any particular natural resource with injury information that is likely relevant to scaling restoration or damages, the Trustee Council will evaluate the sufficiency of the information. The following steps will be included:

- Determine that the natural resource is covered by CERCLA and federal regulations at 43 C.F.R. § 11.14
- Determine that the injury information is relevant and reliable (see Appendix C for a description of Quality Assurance Management)
- Determine that the injury has occurred to that natural resource, pursuant to federal regulations at 43 C.F.R. § 11.62, or that reasonable injury assumptions can be made
- Determine that an exposure pathway to that natural resource exists from releases by Portland Harbor PLPs, or that reasonable pathway assumptions can be made under viable assessment approaches.

4.1.2 Data gaps analysis

Where insufficient information exists to determine injury and pathways, or make reasonable assumptions under a viable assessment approach, the Trustee Council will consider alternative assessment approaches, assumptions, data collections, or studies that appear viable for addressing data gaps. The Trustee Council will also explore assessment approaches that can use information about injuries to multiple natural resources for integrated scaling of restoration or damages. Where information is insufficient to scale integrated injury information to restoration or damages, the Trustee Council will rely on alternative assessment approaches, assumptions, data collections, or studies that appear viable for addressing data gaps.

Methodologies used for sampling and testing for injury will be consistent with available procedures or methods described in federal regulations at 43 C.F.R. § 11.64. In general, the federal regulations indicate that injury studies shall have defined objectives; that available information is considered; and that studies rely on methodologies with demonstrated performance, are cost-effective, will provide previously unavailable information, and are consistent with data requirements for quantification of injuries and damages.

4.1.3 Relationships between injury assessment, restoration, quantification, and damage determination

In evaluating available injury information, data gaps, and data collections or studies, the Trustee Council will consider:

- How data will be used to quantify the temporal and spatial extent of injury
- How baseline conditions will be determined
- How injury information will be used to scale restoration or damages.

4.1.4 Phased approach

As described in Section 1.5 of this report, the Trustee Council will follow an iterative, phased approach to the assessment of injuries at Portland Harbor.

In Phase 2, the Trustee Council will primarily rely on existing data and Phase 1 studies to develop reasoned estimates of injuries and damages to the extent possible. The Trustee Council will focus their evaluation in this phase on key resources, which include juvenile salmon, lamprey ammocoetes, sturgeon, sediment, benthos, piscivorous birds (osprey/bald eagle), piscivorous mammals (otter/mink), other natural resources with tribal value, and other fish covered by advisories and/or those that have recreational value. The Trustee Council intends to develop a Habitat Equivalency Analysis/Resource Equivalency Analysis (HEA/REA; see Section 5.1) to integrate information about injuries and quantify damages. More detailed information about the Phase 2 approach is presented in Appendix B.

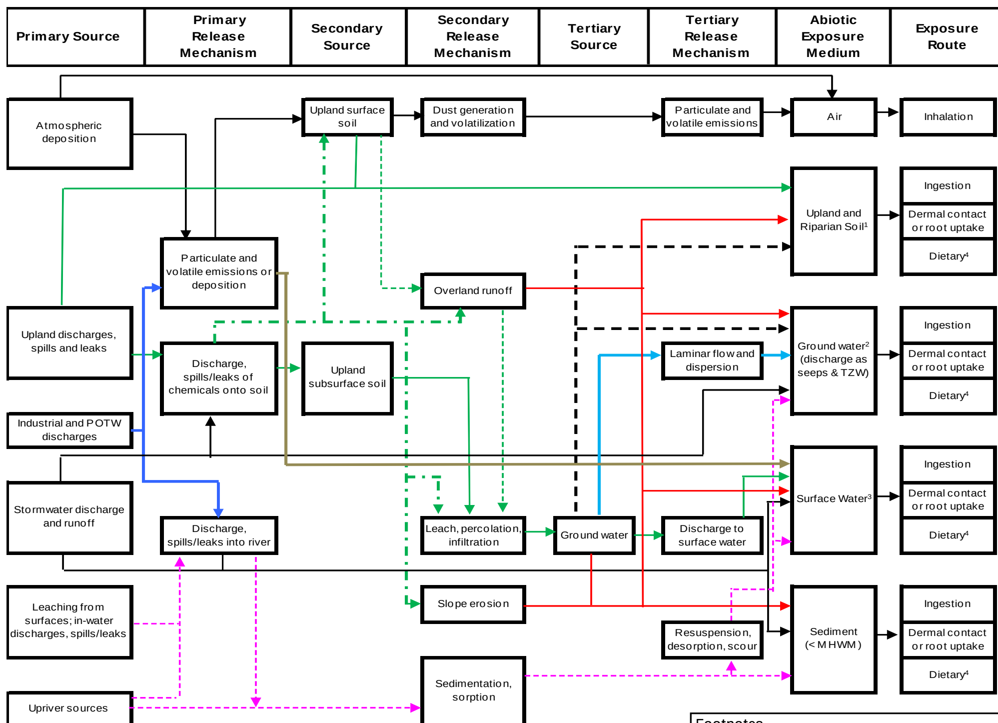
In Phase 3, the Trustee Council will fill apparent data gaps to evaluate potential pathways and exposure in the LWR, Multnomah Channel, and other areas where Portland Harbor contaminants have come to be located if the evidence suggests it would be advisable and in the Trustee Council's best interest to do so. This phase will most likely include comprehensive field studies, modeling, and other activities for key resources such as juvenile salmon and lamprey, osprey, and eagle.

4.2 Pathway Assessment

The Trustee Council will evaluate how hazardous substances move from sources of releases to injured natural resources. To determine pathways of hazardous substances, federal regulations at 43 C.F.R. § 11.63(a) state that the following shall be considered:

1. The physical and chemical characteristics of the hazardous substances in natural media
2. The mechanism or rate of transport of the hazardous substances by natural processes
3. The combinations of pathways that together may transport hazardous substances to the resources.

In Phase 2, the Trustee Council will consider whether existing information and reasonable assumptions are sufficient to determine pathways or whether additional information should be collected. Figure 4.1 provides the Trustee Council's working conceptual site model (CSM) for exposure pathways from releases to natural resources, adapted from Appendix G of the *Portland Harbor RI/FS: Comprehensive Round 2 Site Characterization Summary and Data Gaps Analysis Report* (Integral Consulting et al., 2007). The CSM portrays the general relationship of contaminant transfer among abiotic media and exposure pathways to representative biological receptors.



Biological Receptors[5]

Abiotic Exposure Medium	Exposure Route	Plants				Invertebrates						Fish									Amphibians Reptiles	Birds				Mammals
		Terrestrial Plants	Phytoplankton	Periphyton	Aquatic Plants	Terrestrial invertebrates	Zooplankton	Infauna	Epifauna	Macrofauna		Herbivore / Omnivore	Invertivore				Piscivore		Detritivore		Omnivore	Piscivore		Diving Carnivore	Sediment probing invertivore	Carnivore
										Shellfish	Crayfish	Largescale Sucker, Carp, Sturgeon	Sculpin	Peamouth	Juvenile Chinook Salmon	Adult Chinook Salmon	Smallmouth Bass	Northern Pikeminnow	Pacific Lamprey Ammocoete	Pacific Lamprey Adult	Frogs, Salamanders, turtles	Osprey	Bald Eagle	Hooded Merganser	Spotted Sandpiper	River otter, Mink
Air	Inhalation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Upland and Riparian Soil[1]	Ingestion	x	x	x	x	●	x	x	x	x	x	x	○	x	x	x	x	x	x	x	x	x	x	x	●	○
	Dermal contact or root uptake	●	x	○	○	●	x	x	x	x	●	x	●	x	x	x	x	x	x	x	○	x	x	x	x	○
	Dietary[4]	x	x	x	x	●	x	x	x	x	●	x	○	x	x	x	x	x	x	x	●	x	○	x	●	●
Ground water[2] (discharge as seeps & TZW)	Ingestion	x	x	x	x	●	x	x	x	x	x	x	○	x	x	x	x	x	x	x	x	x	x	x	○	x
	Dermal contact or root uptake	○	x	●	●	●	x	●	●	●	●	○	●	x	x	x	x	x	●	x	●	x	x	x	x	x
	Dietary[4]	x	x	x	x	●	x	●	●	●	●	●	●	x	x	x	●	x	●	x	●	●	●	●	●	●
Surface Water[3]	Ingestion	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Dermal contact or root uptake	x	●	●	●	x	●	●	●	●	●	●	●	●	●	●	●	●	●	○	x	○	○	○	○	○
	Dietary[4]	x	x	x	x	x	○	x	●	●	○	●	●	●	●	x	●	●	●	x	●	●	●	●	●	●
Sediment (< MHWM)	Ingestion	x	x	x	x	x	x	●	●	●	●	○	○	○	○	x	○	x	○	x	x	x	x	○	●	○
	Dermal contact or root uptake	x	x	●	●	x	x	●	●	●	●	●	●	x	x	x	x	x	●	○	○	x	x	x	x	○
	Dietary[4]	x	x	x	x	x	●	●	●	●	●	●	●	●	●	x	●	●	●	x	●	●	●	●	●	●

Legend
- ● = Complete and significant pathway
- ○ = Complete and significance unknown
- x = Incomplete pathway or complete but insignificant pathway
- Color shading indicates a complete pathway

Definitions
- A **Complete** pathway means there is a potential for a contaminant to reach a receptor via the proposed route.
- An **Incomplete** pathway means there is no potential for a contaminant to reach a receptor via the proposed route.
- A **Significant** pathway means there is a high potential that the receptor will receive a significant proportion of the contaminant dose via the proposed route.
- An **Insignificant pathway** means there is a low potential that the receptor will receive a significant proportion of the contaminant dose via the proposed route.
- **Significance Unknown** means that it is unknown if the receptor will receive a significant proportion of the contaminant dose via the proposed route alone. However, the receptor could receive a significant proportion of the contaminant dose when combined with other pathways or other contaminants.

Footnotes

[1] Riparian soil = The bank area between the Mean High Water Mark (MHWM) and the Ordinary High Water Mark (OHWM); Upland soil = Soil above the OHWM.

[2] Seeps = Ground water discharging on the bank area above the MHWM, including the in-point of small tributaries to the river, ground water seeping up to the bank area, and small piped discharges running over the bank; Transition Zone Water (TZW) is ground water discharging below the MHWM into the surface water.

[3] Surface Water includes fish bearing tributaries and the in-point of year-round, significant flow outfalls; and any areas with significant sheen.

[4] Dietary = Any tissue that is consumed by the species of interest within the exposure medium, and includes trophic transfer.

[5] Some receptors will be assessed as potential pathways for contaminant movement through the food web, but will not likely be assessed as endpoints themselves (e.g., phytoplankton).

● Complete and Significant (there are supporting data)

The following criteria should be met before the pathway of a contaminant should be considered complete and significant:

- The pathway is theoretically or potentially complete; pathway can be supported by the scientific literature .
- Both the receptor and the exposure media are known, based on site-specific information, or can reasonably be assumed to co-occur in Portland Harbor.
- The pathway has been shown to be a primary route of exposure for any life stage of a receptor or surrogate organism based on laboratory, field, or site-specific data, and there is a high potential that the receptor will receive a significant proportion of the contaminant dose via the proposed route.

For example, exposure of fish to dissolved metals via uptake through the gill, and exposure of fish-eating birds to PCBs by consuming contaminated prey.

Pathways that are complete and significant are considered to be indicators of potential injury to relevant receptors. Quantitative assessment will be considered for these receptors.

○ Complete and Significance Unknown (need supporting data)

A pathway should be classified as complete and significance unknown if it meets the following criteria:

- The pathway is theoretically or potentially complete; pathway can be supported by the scientific literature.
- Both the receptor and the exposure media are assumed to co-occur in the Portland Harbor, but it is unknown whether or not the receptor uses the area sufficiently enough to be exposed to contaminants at effect levels.
- The pathway has been shown to be a primary route of exposure for any life stage of a receptor or surrogate organism, but no laboratory, field or site-specific data are available to indicate that the receptor will receive a significant proportion of the contaminant dose.
- It is unknown if the receptor will receive a significant proportion of the contaminant dose when combined with other pathways or contaminants.

Pathways that are complete and significance unknown are considered to be indicators of potential injury to relevant receptors. Additional information on exposure will potentially be required.

x Complete and Insignificant OR Incomplete Pathway (no data and/or data unnecessary)

A pathway should be classified as complete and insignificant if it meets the following criteria:

- The pathway is theoretically or potentially complete; pathway can be supported by the scientific literature.
- The pathway is known to be a primary route of exposure for any life stage of a receptor or surrogate organism. However, laboratory, field or site-specific data indicate contaminants are unlikely to contribute a significant proportion of the contaminant dose solely by the proposed route or pathway, or it can be reasonably assumed that data would demonstrate that exposure via the pathway is insignificant compared to other pathways.

For example, while theoretically freshwater fish ingest water when feeding they do not actively drink due to the osmotic conditions in which they exist. Therefore, exposure to surface water via ingestion would be minor relative to other pathways. Also, PCB uptake from the water column is probably a complete pathway for piscivorous birds, but compared to the uptake of PCBs in contaminated prey items, the exposure is not significant.

Pathways that are complete and insignificant will not be assessed unless review of newly available additional data suggests that the significance value should be changed. Studies will not be specifically designed to address the complete and insignificant pathway combination.

A pathway should be classified as incomplete if it meets the following criteria:

- The pathway is theoretically and/or practically not possible or not likely to occur in the area evaluated.
- Both the receptor and the exposure media are known, based on site-specific data, or can reasonably be assumed not to co-occur in Portland Harbor or would not use the area to the extent where exposure would occur.
- The pathway is not a primary route of exposure for any life stage of a receptor or surrogate organism based on laboratory, field, or site-specific data.

For example, at this time it is assumed that juvenile salmon would not be eating fish.

Pathways that are incomplete will not be assessed.

Figure 4.1. Portland Harbor conceptual site model for exposure pathways to natural resources.

Sources of existing pathway information include Rosetta and Borys, 1996; Tetra Tech, 1996; McCarthy and Gale, 1999; Hill and McLaren, 2001; Groundwater Solutions, 2003a, 2003b; Buck, 2004; Groundwater Solutions et al., 2004; Integral Consulting et al., 2004, 2007; Johnson and Norton, 2005; ODEQ and U.S. EPA, 2005; Anchor Environmental et al., 2007; Integral Consulting, 2007a; LCREP, 2007; ODEQ, 2008; and U.S. EPA, 2008a, 2008b, 2008c.

4.3 Injury to Surface Water Resources

This section defines injury for surface water resources and identifies relevant literature and data sources. According to the federal regulations, surface water resources include surface water and suspended, bed, and bank sediments. 43 C.F.R. § 11.14 (pp). Injury to suspended bed and bank sediments is discussed in Section 4.4.

4.3.1 Injury definition

The federal regulations at 43 C.F.R. § 11.62(b) state that an injury to a surface water resource has resulted from the release of hazardous substances if one or more of the following changes in the physical or chemical quality of the resource is measured:

- Concentrations and duration of hazardous substances in excess of drinking water standards as established by Sections 1411-1416 of the Safe Drinking Water Act (SDWA), or by other federal or state laws or regulations that establish such standards for drinking water, in surface water that was potable before the release. 43 C.F.R. § 11.62(b)(1)(i).[1]

- Concentrations and duration of hazardous substances in excess of applicable water quality criteria established by Section 304(a)(1) of the CWA, or by other federal or state laws or regulations that establish such criteria, in surface water that before the release met the criteria and is committed use as habitat for aquatic life, water supply, or recreation. 43 C.F.R. § 11.62(b)(1)(iii).

Concentrations and duration of hazardous substances sufficient to have caused injury to groundwater, air, geologic, or biological resources, when exposed to surface water. 43 C.F.R. § 11.62(b)(1)(v).

1. Exceedences of criteria or standards constitute injuries according to the federal regulations. The Trustee Council may consider these injuries in Phase 3.

4.3.2 Data sources

Data sources relevant to injury of surface water include contaminant concentrations from many surface water sampling events: Harrison et al., 1997; Wentz et al., 1998; Johnson and Norton, 2005; Integral Consulting, 2006a, 2006b, 2007c, 2007d, 2007e; Integral Consulting et al., 2007; and LCREP, 2007.

4.4 Injury to Sediment Resources

This section defines injury for sediment resources and identifies relevant literature and sources of data.

4.4.1 Injury definition

Under federal regulations, there are two categories of injury applicable to bed and riparian sediments:

- The concentrations of released substances cause the sediments to exhibit the characteristics of a waste subject to control under Section 3001 of the SWDA. 43 C.F.R. § 1.62(b)(iv).
- The concentrations of the substance(s) are sufficient to cause injury to other resources. 43 C.F.R. § 11.62(b)(v).

4.4.2 Data sources

Four types of relevant data are available:

1. Contaminant concentration data for numerous hazardous substances in the LWR
2. Characteristics of SWDA wastes, described in federal regulations at 40 C.F.R. Part 261
3. Sediment quality guidelines (SQGs) that have been developed by state and federal agencies for the protection of biological resources
4. Direct measures of sediment toxicity based on laboratory exposures of benthic organisms to sediments from the assessment area.

The LWG, under direction from EPA, has collected numerous samples of surface sediment (defined as the upper 30 cm) and subsurface sediment samples from the LWR. Over 1,200 surface sediment samples were collected from below Willamette Falls (RM 26.5) to the mouth of the river (RM 0), as well as in the upper end of the Multnomah Channel. The majority of these data are contained in a Query Manager database managed by NOAA (NOAA, 2009c). In addition, as part of the RI/FS, the LWG developed a project database to include all sediment data, including data from sampling and analyses performed by others in the Study Area (Integral Consulting, 2008c). These latter data were carefully vetted for quality and for applicability. The database consists of recent data of known quality suitable for determining the current concentrations of the hazardous substances in sediment (Integral Consulting, 2007b, 2008a, 2008b; Integral Consulting et al., 2007).

Sediment quality guidance has been developed for many substances by a number of investigators and agencies, including the State of Oregon (Smith et al., 1996; MacDonald et al., 2000; WDOE, 1995; ODEQ, 2007). This guidance is intended to be protective of biota exposed to sediments, particularly benthic invertebrates, and is an appropriate measure of injury when exceeded.

As part of the RI/FS, EPA has directed the collection of over 300 sediment samples for testing in laboratory bioassays for toxicity to benthic organisms. The assessment endpoints of the bioassays were mortality and growth (Integral Consulting et al., 2007; Windward Environmental, 2008b). In addition, the RI/FS will include modeling to extend the results of the laboratory toxicity testing to estimate the likelihood that sediments that were not tested are toxic as well. Similar to sediment data, the RI/FS sample bioassay testing data are available in the LWG electronic database (Integral Consulting, 2008c).

4.5 Injury to Groundwater Resources

This section defines injury for groundwater resources and identifies relevant literature and other sources of data.

4.5.1 Injury definition

The federal regulations state that an injury to groundwater resources has resulted from the release of hazardous substances if one or more of the following changes in the physical or chemical quality of the resource is measured 43 C.F.R. § 11.62(b):

- Concentrations and duration of hazardous substances in excess of drinking water standards as established by Sections 1411-1416 of the SDWA, or by other federal or state laws or regulations that establish such standards for drinking water, in groundwater that was potable before the release. 43 C.F.R. § 11.62(c)(1)(i).[2]

- Concentrations and duration of hazardous substances in excess of applicable water quality criteria established by Section 304(a)(1) of the CWA, or by other federal or state laws or regulations that establish such criteria for domestic water supplies, in groundwater that before the release met the criteria and is committed use as a domestic water supply. 43 C.F.R. § 11.62(c)(1)(iii).

- Concentrations and duration of hazardous substances sufficient to have caused injury to surface water, air, geologic, or biological resources, when exposed to groundwater. 43 C.F.R. § 11.62(c)(1)(iv).

4.5.2 Data sources

Groundwater investigations are being conducted as part of the RI/FS primarily as part of upland source control activities, which are being directed by ODEQ. Data sources include the ODEQ ECSI Site Summary Reports (available at http://www.deq.state.or.us/lq/cu/nwr/portlandharbor/), as well as LWG reports evaluating ODEQ data and other information related to groundwater, such as seeps and TZW (Groundwater Solutions, 2003a, 2003b; Groundwater Solutions et al., 2004; Integral Consulting et al., 2007).

4.6 Injury to Biological Resources

This section defines injury for biological resources and identifies relevant literature and other sources of data.

4.6.1 Injury definition

The federal regulations list seven types of injuries to biological resources that are adverse effects on the organisms and that have been shown to be caused by exposure to hazardous substances: death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), and physical deformations. 43 C.F.R. § 11.62(f)(i). In addition, a biological resource is injured if the concentration of a hazardous substance is present

2. Ibid.

in the edible tissue of the organisms at concentrations that exceed an action or tolerance level established by the U.S. Food and Drug Administration (FDA), 43 C.F.R. § 11.62(f)(ii), or a concentration resulting in a consumption limit or ban issued by a state health agency. 43 C.F.R. § 11.62(f)(iii).

4.6.2 Data sources

Aquatic invertebrates

Relevant data for assessing benthic invertebrate injuries include studies directed by EPA as part of the Portland Harbor RI/FS. The data include analyses of hazardous substances in many sediment samples (the habitat of benthic invertebrates) as well as bioassays directly exposing benthic invertebrates to sediments collected from the Study Area to measure the effects on survival and growth (Integral Consulting et al., 2007; Integral Consulting, 2008a, 2008b; Windward Environmental, 2008b). The RI/FS studies included compiling sediment chemistry and bioassay data from studies conducted within the Study Area from 1990 to the present (Integral Consulting et al., 2004).

Data are also available for the concentrations of selected bioaccumulative substances in the tissue of benthic organisms. These data include the concentrations in benthic and epibenthic invertebrate samples, and in clams and crayfish collected from the Study Area; tissue concentrations in benthic organisms in laboratory exposures to Study Area sediments; concentrations in samples from the stomach contents of juvenile salmon; and tissue concentrations based on exposure modeling to estimate accumulation from measured sediment concentrations (Integral Consulting et al., 2007; Integral Consulting, 2008a). In addition, EPA and others also included limited surveys of the abundances of benthic organisms (McCabe et al., 1997; Striplin Environmental Associates and Windward Environmental, 2003; Windward Environmental and Integral Consulting, 2005; Integral Consulting et al., 2007).

There are numerous studies in the scientific literature that are available to demonstrate that the hazardous substances measured in the sediments injure benthic populations through death, growth and reproductive impairment, and adverse behavioral effects. The EPA RI/FS process identified SQGs from a number of sources that were used to predict injuries to biological organisms exposed to those sediments (Smith et al., 1996; MacDonald et al., 2000; WDOE, 1995; ODEQ, 2007). Similarly, studies that investigated the concentrations in the tissues of aquatic invertebrates associated with adverse effects have been compiled to develop toxicity reference values (TRVs) to compare to the concentrations measured in organisms (similar to SQGs) (Integral Consulting et al., 2007; U.S. EPA, 2008b).

Fish

Relevant data available for assessing injuries to fish include measurements of the concentrations of hazardous substances in the habitat of fish, in their prey, and in their tissues. Concentrations of selected hazardous substances were recently measured within the Study Area in samples of water; benthic and epibenthic invertebrates (including samples of the stomach contents of juvenile salmon); and fish, including juvenile Chinook salmon, black crappie, brown bullhead, carp, largescale sucker, northern pikeminnow, peamouth, sculpin, smallmouth bass, lamprey, and white sturgeon. The RI/FS will include food web modeling that will estimate the concentrations of selected hazardous substances in other fish and prey species (Integral Consulting et al., 2007; Integral Consulting, 2008a). Finally, the RI/FS data include tissue concentrations of hazardous substances in fish collected from 1990 to the present (Integral Consulting et al., 2004). EPA has also directed studies to expose lamprey ammocoetes in the laboratory to selected hazardous substance in water-only, acute bioassays (Windward Environmental, 2008a).

The U.S. Geological Survey (USGS) has also collected fish tissue samples from throughout the Columbia River Basin. In 1997, as part of the "Biomonitoring of Environmental Status and Trends" (BEST) program, fish were collected from two stations on the Willamette River, at Oregon City upstream of Portland Harbor, and from Portland, at approximately RM 10 (Hinck et al., 2004).

Data are also available from studies that examined the physical and physiological characteristics of salmon and other fish in the lower Willamette and Columbia rivers (LCRBSP, 1996; Tetra Tech, 1996; Hinck et al., 2004; Johnson et al., 2006, 2007; LCREP, 2007) that may be useful in assessing injury to fish in the LWR. For some species, including salmon and lamprey, there are data regarding the reductions in abundances of populations and specific genetic stocks over time. These data have been used to estimate population effects associated with the exposure to hazardous substances (Hughes and Gammon, 1987; Farr and Ward, 1993; Ellis et al., 1997; Friesen et al., 2003; Tinus et al., 2003; Friesen, 2005).

As part of Phase 1 of the NRDA, the Trustee Council is collaborating with the Northwest Fisheries Science Center of NOAA on a study of salmon collected along the LWR and the Columbia River. This study includes the collection and analysis of salmon and salmon prey for a variety of endpoints, including growth rates, fish condition, genetic stock, and contaminants (PAHs, PCBs, DDTs, and other organochlorine pesticides) (NOAA, 2008). At the time of this draft, validated data are not available, but the reports are (NOAA, 2009a, 2009b). When the validated data become available, the Trustee Council will also consider them in their evaluation.

The Trustee Council is also developing a study on the toxicity of Portland Harbor sediments to lamprey ammocoetes as part of Phase 1 of the NRDA. This study is currently in the development phase, and therefore results are not available. When they become available, the Trustee Council will also consider these data in their evaluation.

Birds

Relevant data available for assessing injuries to birds include studies on osprey and bald eagle that measured bioaccumulative hazardous substances in bird tissue, including eggs, as well as breeding success, eggshell thickness, and other injuries (Postupalsky, 1974; Thomas and Anthony, 1997, 1999; Anthony et al., 1993; Elliott et al., 1998, 2000; Buck, 1999; USFWS, 1996; Henny et al., 2003, 2004, 2008, 2009; Integral Consulting et al., 2004; Buck et al., 2005).

Other relevant data include measured concentrations of hazardous substances in the birds' prey (Anthony et al., 1993; Henny et al., 2003; Integral Consulting, 2008a, 2008b; Integral Consulting et al., 2007). In addition, the RI/FS process will include food web modeling to estimate the likely concentrations in prey and the dose of those hazardous substances to which birds are exposed (U.S. EPA, 2008b, 2008c). There is also substantial information in the literature regarding the causality of various injuries from a variety of hazardous substances.

As part of Phase 1 of the NRDA, the Trustee Council is collaborating with EPA on a study of osprey eggs collected along the LWR. The objectives of this study are to evaluate eggshell thickness and contaminant concentrations (15 PBDE congeners, 40 PCB congeners, dioxins/furans, organochlorine pesticides, and mercury) (Buck, 2008). At the time of this draft, validated data and reports from the osprey egg study are not available. When they become available, the Trustee Council will also consider these data in their evaluation.

Mammals

Relevant data for assessing injuries to mammals includes the concentrations measured in the tissue of prey. The concentrations in fish, crayfish, and clams have been measured in some locations in the Portland Harbor Study Area, and additional information is being developed through food web modeling to estimate the concentrations in prey in other locations. This modeling will also estimate the exposure rates to river otter and mink as sensitive surrogate species in the RI. Additional information is available regarding the concentrations of hazardous substances in mammal prey items (fish and clams) from the lower Columbia River (LCR; Sherman et al., 2009).

The concentrations of some bioaccumulative hazardous substances have been measured in the tissue of river otter. In addition, a number of physical and physiological metrics that meet the definition of injury have also been measured in these river otter (Henny et al., 1996; LCRBSP, 1996; Grove and Henny, 2005; Grove, 2006). Data are also available in the literature regarding the causality for various injuries from exposures to a variety of hazardous substances.

Reptiles and amphibians

Relevant data are available for assessing injuries to amphibians and reptiles, including concentrations of hazardous substances in the habitat of those species and in their prey. Concentrations of selected hazardous substances are available for surface water and water from riparian seeps, sediments and riparian soils, and in benthic and epibenthic invertebrates in the Study Area. In addition, the RI/FS investigations will include food web modeling that will estimate the concentrations of selected hazardous substances in potential prey species (Integral Consulting et al., 2007; Integral Consulting, 2008a, 2008b).

Data are also available from studies that examined the population distributions and habitat uses of amphibians (Altman et al., 1997; Titus et al., 1996; Adolfson Associates, 2008).

Plants

The concentrations of hazardous substances within the Study Area have been measured in surface water and seeps, as well as shallow sediments and riparian soils that can support aquatic or wetland plant growth (Integral Consulting et al., 2007). In addition, the concentrations of hazardous substances in shallow groundwater and soils have been measured at many adjacent upland sites (ODEQ, 2008).

Surveys have also been made to identify the locations and composition of shallow and riparian zone communities in the LWR. Broader surveys are also available that describe the types of plant communities that normally exist in different types of riparian habitat (Adolfson Associates, 2008). Data from the literature are also available regarding injuries to plants caused by exposure to a variety of hazardous substances.

4.7 Recreational Service Losses

Changes in the availability and quality of natural resources may change the quantity and quality of recreational opportunities and the benefits derived by the public’s use of those resources. The Trustee Council has collected and reviewed information on recreational uses and associated values of natural resources in the Portland Harbor vicinity. A summary of information reviewed to date, by category, follows.

4.7.1 Recreation resource inventories

Willamette River guides from the ODFW, Oregon State Parks (OSP), and the Oregon State Marine Board (OSMB), together provide a comprehensive list of recreational facilities, boat access points, and riverfront parks located on the Willamette River within and around Portland Harbor (Oregon State Marine Board and Oregon Parks and Recreation Department, 1998; City of Portland, 2001a).

4.7.2 Outdoor use

Interviews with local recreation managers in Portland, Gladstone, and Oregon City identified common uses and popular locations for recreation along the Willamette River. They also identified specific challenges (e.g., access, crowding, facilities, contamination) faced by recreational uses of natural resources along the Portland Harbor area of the Willamette River. An Oregon Department of Parks and Recreation (ODPR) study on the Willamette River Greenway collected information on park users' attitudes and preferences about outdoor recreation in the area (Wing and Pearson, 2005).

4.7.3 Recreational fishing

The ODFW estimates recreational fishing effort and catch for the spring sturgeon and Chinook salmon seasons (ODFW, 2009). These data provide an initial understanding of the amount and types of some of the recreational fishing use of the resource (ODFW, 2009). The ODFW also has historical data on recreational Chinook catch and total days fished on the LWR (1946–2006), which provide perspective on changes in resource use over time (ODFW, 2009). Additional information on the region's fishery (importance of species, timing of runs, etc.) was gathered through interviews with local fishing guides, public outdoor recreation managers, and members of user groups.

4.7.4 Boating

Data from the OSMB's triennial surveys (1978–2008) list information on motorized boating trips (total days, total trips taken, and the types of activities motor boat users participated in). Information is organized by body of water and by launch site/access site (OSMB, 2009). These data provide useful information on recreational motorized boating that occurs in and around the PHAA.

Limited information on non-motorized boat use (e.g., kayaks and canoes) was developed through conversations with the Willamette Riverkeeper and several local kayak shops.

4.7.5 Fish consumption advisories

Fish consumption advisories relevant to the PHAA have been compiled (ODHS, 1993, 1997, 2001, 2004, 2008) from the Oregon Department of Human Services (ODHS) website. The advisories within the PHAA mainly cover resident species such as bass, carp, and catfish, along with older sturgeon. The advisories recommend that general populations only eat one meal of those fish a month, while women of childbearing age and children should avoid consumption of those species in certain areas within the Study Area.

Willamette Riverkeeper surveyed anglers on the LWR concerning consumption of fish caught (Willamette Riverkeeper, 2003). Most anglers surveyed indicated that they consumed non-resident fish (sturgeon and Chinook salmon). Additional information indicated that anglers also catch and consume resident fish.

4.8 Tribal Service Losses

Tribal Trustees have significant interests in the vicinity of Portland Harbor. Releases of contaminants at the Site have potentially injured important tribal resources resulting in the lost use of those resources. The tribal Trustees have reviewed and continue to review available information associated with tribal resources and uses to evaluate the potential injury to resources and the loss of uses associated with the release of contaminants at the Site (e.g., Pettigrew, 1981; Minor et al., 1994; Ames and Maschner, 1999; Ellis et al., 2005; ODHS, 2005). These documents include reports developed as part of the remedial investigation process (Ellis et al., 2005). Through the information review, the tribal Trustees have identified a number of resources, locations, and uses of special interest to the Tribes. Resources of tribal importance include but are not limited to berries, wapato, camas, tarweed, nuts, dogbane, rushes, sedges, nettles, willow, skunk cabbage, salmonids, steelhead, eel (lamprey), sucker, smelt, crayfish, clams, and mussels.

The tribal Trustees will complete their review of existing information in Phase 1 of the assessment. Phase 2 activities to be undertaken by the tribal Trustees will focus on refining information regarding tribal resources and their services and uses, determining the need for tribal resource specific restoration actions, and if necessary, identifying and evaluating appropriate restoration projects or tribal resource-specific components of restoration projects (see Appendix B). At this time, the tribal Trustees anticipate a primarily restoration-based approach to compensation for identified tribal-specific natural resource damages in coordination with the overall approach identified in the Assessment Plan.

4.9 Quantification

The Trustee Council will quantify the relationship between (1) public losses caused by injuries to natural resources from PLP releases of hazardous substances, and (2) public gains resulting from the restoration of natural resources. The Trustee Council will determine damages using the cost of restoration, the value of restoration, the value of public losses, or a combination of approaches that avoids double-counting (the inclusion of damages to the same resources and services more than once). See Chapter 5 and Appendix B for more information.

Examples of factors that the Trustee Council may measure or estimate to quantify natural resource injuries and public losses include:

- Area, volume, or numbers of natural resources impacted
- Degree of natural resource injuries
- Ability of natural resources to recover to baseline
- Proportion of natural resource that has been affected in the area
- Services or values the resource normally provided that are reduced because of the releases
- Guidance specific to the different types of natural resource as provided in federal regulations. 43 C.F.R. § 11.71(c).

4.9.1 Baseline assessment

Federal regulations define baseline as “conditions that would have been expected at the assessment area had the discharge … not occurred, taking into account both natural processes and those that are the result of human activity.” 43 C.F.R. § 11.72(b)(1). The regulations further provide that “[i]f available and applicable, historical data for the assessment area or injured resource should be used to establish the baseline.” If such data are not available, “baseline data should be collected from control areas.” Id. at 11.72(c)-(d). Modeling approaches can also be used to determine baseline conditions.

The Trustee Council intends to use multiple approaches for assessing baseline. Some relevant information exists for the PHAA that may be useful in making baseline determinations such as Fuji and Clough, 2002; Kostow, 2002; Integral Consulting et al., 2004, 2007; and Ellis et al., 2005. The Trustee Council will consider using some types of historical data, such as the ODFW data related to recreational fishing and historical data on eggshell thicknesses. The Trustee

Council will use reference and control sites as appropriate and if feasible, as well as modeling and the use of reasonable assumptions. In addition, the Trustee Council will consider information and methods developed to define background conditions for the RI/FS in their evaluation of baseline. However, the Trustee Council notes that they may consider additional information and/or draw conclusions that differ from those made in the RI/FS in their evaluation.

4.9.2 Natural resource recovery assessment

The Trustee Council will estimate the length of time required for natural resources to recover under plausible remedial and primary restoration scenarios based on published studies, field and laboratory data, and other data sources, such as City of Portland, 2001a, 2001b, 2008a, 2008b; Integral Consulting et al., 2004; Anchor Environmental, 2006; ODEQ, 2008; and U.S. EPA, 2009.

5. Damage Assessment

The Trustee Council will seek damages to pay for reasonable assessment costs and natural resource restoration to make the public whole for natural resource injuries resulting from PLP releases of hazardous substances. The Trustee Council can determine damages for natural resource injuries by determining the amount of restoration required, the cost of restoration, and/or the value of either natural resource injuries or restoration.

Federal regulations at 43 C.F.R. Part 11 describe a number of techniques that can be used to determine costs and values of natural resource damages. Those methods include market price, appraisal, factor income, hedonic pricing, unit value/benefit transfer (BT), contingent valuation, conjoint analysis, Habitat Equivalency Analysis (HEA), Resource Equivalency Analysis (REA), random utility model, and other valuation methodologies. 43 C.F.R. § 11.83(c). In Phase 2, the Trustee Council intends to utilize three of these approaches: HEA, REA, and BT.

Future assessment activities would build upon Phase 2 efforts and, as appropriate, implement additional data collection, assessment approaches and valuation methodologies to determine damages. The remainder of this chapter describes the HEA, REA, and BT approaches and presents a summary of restoration planning work.

5.1 HEA/REA

HEA and REA are assessment techniques, which determine the amount of habitat or a natural resource, respectively, that must be restored to offset public losses caused by contamination of habitat or natural resources, including both toxicological impacts of hazardous substances and physical impacts of any response actions. In Phase 2, the Trustee Council will use existing information and reasonable assumptions to the extent possible to estimate habitat and natural resource losses for the PHAA and the type and amount of habitat or natural resource restoration required to offset those losses. The Trustee Council will determine the cost of this restoration as monetary damages. However, the Trustee Council will also consider reasonable options for PLP or third party implementation of restoration, under Trustee Council oversight, in lieu of monetary damages. Some descriptive background information about this modeling process is provided below.

What is HEA/REA?

In its simplest form, HEA quantifies ecological components lost due to contamination (in terms of ecological services provided by an area of habitat) to estimate how much restoration will be required to generate an equivalent amount of similar services. Because environmental losses and gains are not experienced at a single point in time, the estimation procedures also take into account the number of years over which losses were experienced and the rate at which losses or gains decrease or increase with time due to active clean-up or through natural recovery. Losses and gains are expressed in an area-time currency termed “discounted service acre-years” (DSAYs) that quantifies the amount of a given service lost or gained over a specified period of time and in present value terms via discounting (Figure 5.1).

REA uses the same underlying economic model as HEA, but input and output terms are numbers of individuals of a particular species affected. The model considers how many individuals of the species would have been lost by exposure to contamination over time, and how many individuals would need to be “produced” in the future to compensate for the losses.

What are ecological services?

Services provided by habitat are numerous. Ecological services provided by habitat that are commonly affected by contamination include fish and wildlife spawning/breeding, refuge, and feeding. For example, contaminated habitat often reduces survival of benthic invertebrates, reduces growth or reproduction of fish, birds, and mammals, and when most severe, it can reduce the presence or eliminate populations of animals most sensitive to contamination.

What is discounting?

Time has an important effect on the total amount of natural resource losses and gains. If contamination has been present for many years, cleaning up habitat and waiting for the ecological services to return to the condition they would have been in but for the release (baseline) will not fully compensate the public for the interim losses. Further, “payments” of natural resource damage claims made at different points in time have different values in the present. For example, if the public must wait 50 years for natural resources to return to baseline, those resources are worth less to today’s public than if recovery happens in five years. In order to compare values at different points in time, economists routinely apply a discount rate, compounding past losses and discounting future gains. If a discount rate were not applied to natural resource damage claims, the public would not be fully compensated, and responsible parties would have a strong incentive to defer settlement (and thus postpone restoration) for as long as possible. To avoid this outcome, a 3% annual discount rate will be applied by the Trustee Council to compound past environmental losses and discount future environmental gains (from restoration) and losses to a present value.

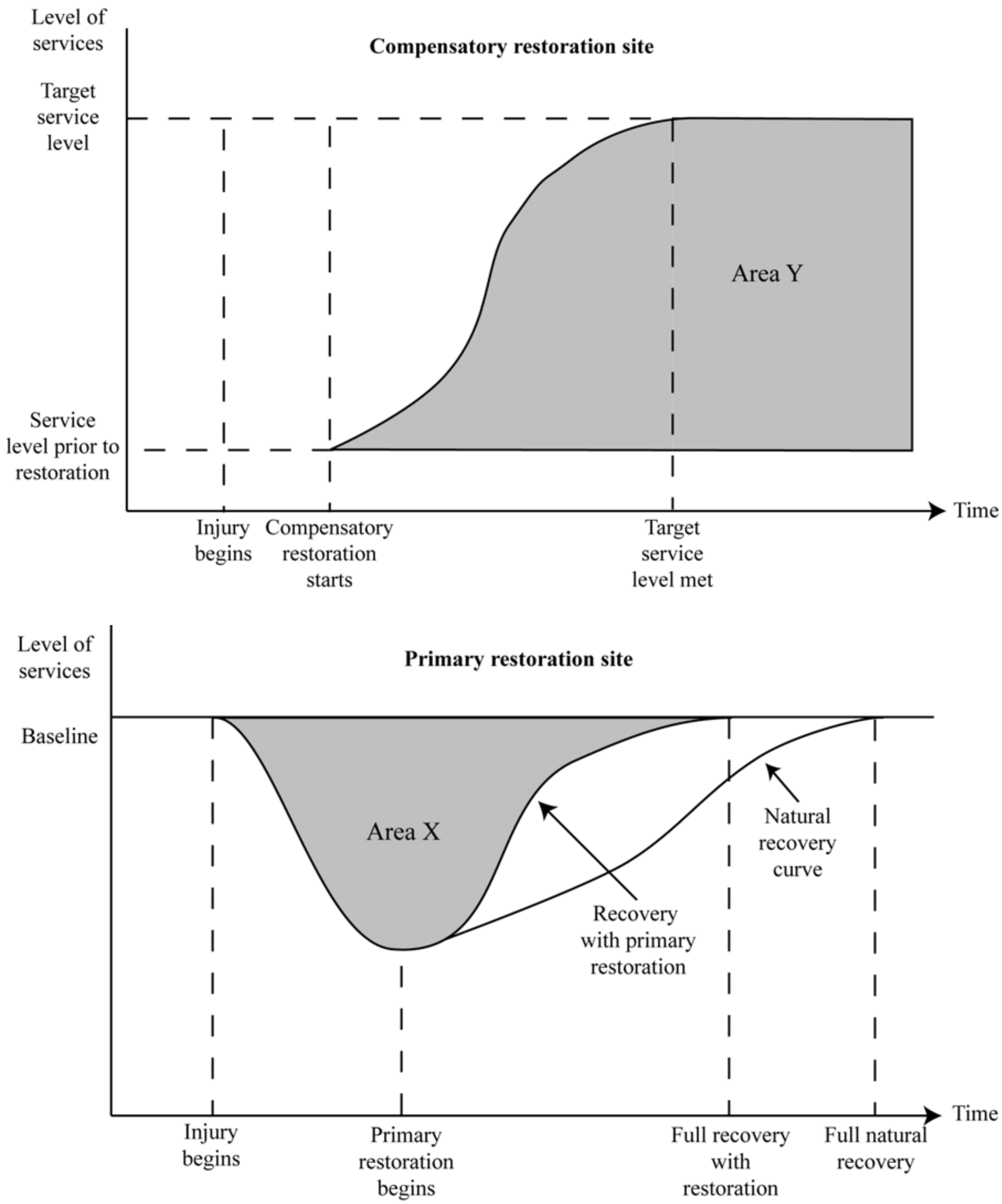


Figure 5.1. Model of losses and gains in HEA. Total gains (Area Y above) from restoration must be equivalent to total losses (Area X). "Primary Restoration" generally refers to actions designed to return resources to baseline conditions.

5.2 Benefit Transfer

BT is an assessment technique which calculates the value of changes in natural resource or service quantity or quality based on existing economics literature about similar changes at other sites. In Phase 2 the Trustee Council will use existing information to the extent possible, reasonable assumptions as appropriate, and limited additional information collection to estimate public losses associated with PLP releases of hazardous substances at the Site. The Trustee Council will focus this analysis on losses that are unlikely to be addressed through the HEA, described above. An example of the type of public losses that may not be adequately addressed by the HEA is recreational losses (e.g., fish consumption advisories).

What is BT?

BT is a technique used to estimate economic values for ecosystem/natural resource services by transferring available information from studies already completed in another location and/or context. For example, values for recreational fishing in a particular place may be estimated by applying measures of recreational fishing values from a study conducted previously in another place. The adversely affected recreational activities (the quantity of which must also be estimated) are typically expressed in terms of “activity days” or “user days.” To estimate the total value of lost recreational use (or damages) caused by contamination in a given place, the quantity of adversely affected trips is multiplied by the “unit value” of each trip (derived via benefit transfer). Unit values may be adjusted for the particular characteristics of the study site and/or the recreational activities to which they are applied.

What are recreational services?

Resources such as water, habitat, fish, birds, etc., are the necessary components of the environment that sustain, or provide essential inputs to humans producing recreational activities for themselves or others. Ecological resources in the PHAA provide a variety of recreational and other services to the public. Recreational services include sport fishing, hunting, trapping, boating, swimming, camping, picnicking, and wildlife viewing.

5.3 Restoration Planning

The Trustee Council is exploring restoration opportunities in the vicinity of Portland Harbor. The purpose of this restoration planning is to identify available, relevant restoration opportunities that can be implemented to resolve liability.

The Trustee Council will continue restoration planning efforts during Phase 2. The Trustee Council will identify a comprehensive list of viable restoration opportunities, and then categorize and prioritize those restoration opportunities using Trustee Council restoration criteria. The Trustee Council will determine preferred restoration alternatives based on those criteria. The Trustee Council will determine appropriate metrics for comparing natural resource restoration with natural resource injuries so that restoration can be scaled appropriately. The Trustee Council will determine the complete costs of implementing sufficient high-priority restoration at the appropriate scale to make the public whole. Finally, the Trustee Council will present restoration alternatives and preferred alternatives to the public.

A. Portland Harbor Special Status Species and Industrial Facilities, Releases, and Potential Pathways

Table A.1. Special status species in the vicinity of Portland Harbor

Common name	Scientific name	Federal status	State status
Mammals[a]			
Bat, myotis	*Myotis ssp.*	SOC	Sensitive – Vulnerable
Bat, pallid	*Antrozous pallidus pacificus*	SOC	Sensitive – Vulnerable
Bat, silver-haired	*Lasionycteris noctivagans*	SOC	Sensitive – Vulnerable
Bat, Townsend's western big-eared	*Corynorhinus townsendii townsendii*	SOC	Sensitive – Critical
Deer, Columbian white-tailed	*Odocoileus virginianus leucurus*	Endangered	Sensitive – Vulnerable
Gopher, camas pocket	*Thomomys bulbivorus*	SOC	–
Vole, red tree	*Arborimus longicaudus*	SOC	Sensitive – Vulnerable
Birds[b]			
Blackbird, tricolored	*Agelaius tricolor*	SOC	–
Chat, yellow-breasted	*Icteria virens*	SOC	Sensitive – Critical
Duck, harlequin	*Histrionicus histrionicus*	SOC	–
Eagle, bald	*Haliaeetus leucocephalus*	Delisted	Threatened
Flycatcher, olive-sided	*Contopus cooperi*	SOC	–
Goshawk, northern	*Accipiter gentilis*	SOC	–
Lark, streaked horned	*Eremophila alpestris strigata*	Candidate	Sensitive – Critical
Martin, purple	*Progne subis*	SOC	–
Owl, northern spotted	*Strix occidentalis caurina*	Threatened	Threatened
Owl, western burrowing	*Athene cunicularia hypugaea*	SOC	Sensitive – Critical
Pigeon, band-tailed	*Patagioenas fasciata*	SOC	–
Quail, mountain	*Oreortyx pictus*	SOC	–
Sparrow, Oregon vesper	*Pooecetes gramineus affinis*	SOC	Sensitive – Critical
Woodpecker, Lewis'	*Melanerpes lewis*	SOC	–

Table A.1. Special status species in the vicinity of Portland Harbor (cont.)

Common name	Scientific name	Federal status	State status
Reptiles and amphibians[a]			
Frog, cascades	*Rana cascadae*	SOC	–
Frog, coastal tailed	*Ascaphus truei*	SOC	–
Frog, northern red-legged	*Rana aurora aurora*	SOC	Sensitive – Vulnerable
Pond turtle, northern pacific	*Actinemys marmorata marmorata*	SOC	–
Salamander, larch mountain	*Plethodon larselli*	SOC	–
Salamander, Oregon slender	*Batrachoseps wrighti*	SOC	–
Fish[c]			
Lamprey, pacific	*Lampetra tridentata*	SOC	Sensitive – Vulnerable
Salmon, Chinook (lower Columbia River fall run)	*Oncorhynchus tshawytscha*	Threatened	Sensitive – Critical
Salmon, Chinook (upper Willamette River spring run)	*Oncorhynchus tshawytscha*	Threatened	–
Salmon, chum (Columbia River)	*Oncorhynchus keta*	Threatened	Sensitive – Critical
Salmon, Coho (lower Columbia River)	*Oncorhynchus kisutch*	Threatened	–
Steelhead (lower/middle Columbia River winter run)	*Oncorhynchus mykiss*	Threatened	Sensitive – Critical
Steelhead (upper Willamette River)	*Oncorhynchus mykiss*	Threatened	–
Trout, coastal cutthroat	*Oncorhynchus clarki spp.*	SOC	Sensitive – Vulnerable
Invertebrates[d]			
Caddisfly, Columbia Gorge neothremman	*Neothremma andersoni*	SOC	–
Caddisfly, Mt. Hood farulan	*Farula jewetti*	SOC	–
Caddisfly, Mt. Hood primitive	*Eobrachycentrus gelidae*	SOC	–
Mussel, California floater	*Anodonta californiensis*	SOC	–
Pebblesnail, Columbia	*Fluminicola fuscus (= columbianus)*	SOC	–
Stonefly, Wahkeena Falls flightless	*Zapada wahkeena*	SOC	–
Plants[e]			
Aster, whitetop	*Sericocarpus rigidus/Aster curtus*	SOC	Threatened
Bentgrass, Howell's	*Agrostis howellii*	SOC	Candidate
Checker-mallow, Nelson's	*Sidalcea nelsoniana*	Threatened	Threatened
Corydalis, cold-water	*Corydalis aquae-gelidae*	SOC	Candidate
Daisy, Howell's (Fleabane)	*Erigeron howellii*	SOC	Candidate

Table A.1. Special status species in the vicinity of Portland Harbor (cont.)

Common name	Scientific name	Federal status	State status
Plants[e] (cont.)			
Daisy, Willamette	*Erigeron decumbens var. decumbens*	Endangered	Endangered
Desert-parsley, Bradshaw's	*Lomatium bradshawii*	Endangered	Endangered
Fleabane, Oregon (Daisy)	*Erigeron oreganus*	SOC	Candidate
Howellia, water	*Howellia aquatilis*	Threatened	Threatened
Larkspur, pale (White rock)	*Delphinium leucophaeum*	SOC	Endangered
Lupine, Kincaid's	*Lupinus sulphureus kincaidii*	Threatened	Threatened
Paintbrush, cliff	*Castilleja rupicola*	SOC	–
Penstemon, Barrett's	*Penstemon barrettiae*	SOC	Candidate
Sullivantia, Oregon	*Sullivantia oregana*	SOC	Candidate
Wormwood, northern	*Artemisia campestris var. wormskioldii*	Candidate	Endangered

Note: This table is for illustrative purposes, only. It is not intended to be a complete listing of all special status species.

Endangered = Listed as Endangered by the USFWS or the Oregon Department of Agriculture (ODA) (in danger of extinction throughout all or a significant portion of its range).
Threatened = Listed as Threatened by the USFWS or ODA (likely to become endangered in the foreseeable future).
Candidate = Listed as Candidate by ODA (numbers believed low or declining, or habitat sufficiently threatened and declining in quantity and quality, so as to potentially qualify for listing as a threatened or endangered species in the foreseeable future).
SOC = Species of Concern (conservation status is of concern to the USFWS, but for which further information is still needed).
Sensitive – Critical = Identified as Critical by State of Oregon (imperiled with extirpation from a specific geographic area of the state).
Sensitive – Vulnerable = Identified as Vulnerable by State of Oregon (facing one or more threats to populations or habitats).

Sources:
a. All species listed in USFWS (2009) and their state status as described in ODFW (2008).
b. All species listed in USFWS (2009) and their state status as described in ODFW (2008, 2009).
c. All species listed in USFWS (2009) and their state status as described in ODFW (2008) plus all species described in ODFW (2008) as distributed in Lower Willamette Hydrologic Unit (17090012).
d. All species listed in USFWS (2009).
e. All species listed in USFWS (2009) and their state status as described in ODA (2008), with the following exceptions (Ted Buerger, USFWS, personal communication, August 5, 2009): Snake River goldenweed (*Pyrrocoma radiata*) and Peacock larkspur (*Delphinium pavonaceum*) do not occur in Multnomah County and will be removed from the USFWS website; Nelson's checker-mallow, Willamette daisy, and Kincaid's lupine were erroneously left off the USFWS website.

Table A.2. Portland Harbor industrial facilities, releases, and potential pathways

					Potential pathway (current or historic)				
Facility	**Approx. RM**	**ECSI#**	**Type of industry**	**Chemicals of interest**	**Storm-water**	**Waste-water**	**Ground-water**	**Spills/ disposal**	**Product handling/ transfer**
ACF Industries	4.0	794	Currently vacant; former lumber mill, railcar painting and repair, wood crate and pallet fabrication	PCBs, chlorinated solvents, PAHs, total petroleum hydrocarbons (TPH), antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, silver, selenium, thallium, zinc	X	X	X		
Alder Creek Lumber Co., Inc.	3.0	2446	Lumber	Wood waste/debris	X				
Anderson Brothers Property	8.0	970	Current use unconfirmed; former trucking company hauling agricultural products, freight, and bulk oil and gas	Petroleum products, solvents (toluene, mineral spirits), and paint wastes					
ARCO Bulk Terminal	5.2	1528	Petroleum product storage and transfer	PAHs; benzene, toluene, ethylbenzene, and xylene (BTEX); isopropylbenzene; n-propylbenzene; arsenic; cadmium; chromium; copper; lead; mercury; nickel; zinc	X		X	X	X
ARKEMA/ATOFINA Chemicals (formerly Penwalt Chemical, Elf Atochem)	7.5	398	Former chemical and pesticide manufacturing	DDT, dichloro-diphenyl-dichloroethane (DDD), dichloro-diphenyl-dichloroethylene (DDE), chlorobenzene, chloroform, chlorinated solvents, chloral, 2-chlorophenol, hexavalent chromium, ammonia, monochlorobenzene	X	X	X	X	

Table A.2. Portland Harbor industrial facilities, releases, and potential pathways (cont.)

					Potential pathway (current or historic)				
Facility	**Approx. RM**	**ECSI#**	**Type of industry**	**Chemicals of interest**	**Storm-water**	**Waste-water**	**Ground-water**	**Spills/ disposal**	**Product handling/ transfer**
Aventis Crop Science (Rhone-Poulenc)	7.3	155	Former herbicide, insecticide, fertilizer manufacturing	Pesticides, herbicides, phenols, volatile organic compounds (VOCs), PAHs, PCBs, arsenic, lead, mercury	X	X	X	X	
Babcock Land Co.	4.8	2361	Log and lumber storage; rail and railroad material storage	Unknown	X				
Burlington Northern Santa Fe/Portland Terminal Railroad Company and lessees below	9.5	3395							
Northern Hub Center/ Guild Lake Railyard	9.0	100	Switching yard, bulk petroleum storage, loading/unloading, locomotive refueling	TPH (diesel), PAHs, benzene, toluene, phenolic compounds, solvents (trichloroethylene, TCE), metals, possibly creosote	X		X	X	X
1. Kleen Blast (BNSF lessee)		3395	Storage, packing, and distribution of copper slag media, spent abrasive grit blast	See above					
2. Eastman Chemical (current lessee)/McWhorter Technologies/ McCloskey Corp.	8.8	135	Chemical storage	See above					

Table A.2. Portland Harbor industrial facilities, releases, and potential pathways (cont.)

Facility	Approx. RM	ECSI#	Type of industry	Chemicals of interest	Potential pathway (current or historic): Storm-water	Waste-water	Ground-water	Spills/ disposal	Product handling/ transfer
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 Chemical	9	330	Chemical supply; packaged and stored chemicals; distilled and recycled solvents	See above					
BNSF Willbridge Yard		3395	Staging and loading rail tank cars with petroleum products	See above					
Calbag Metals (Front Avenue)	8.5	2454	Staging area for recycling non-ferrous metals	PCBs, copper, lead, chromium, mercury, phthalates	X				
Cascade General Shipyard – see Swan Island Shipyard			See Swan Island Shipyard	See Swan Island Shipyard					
Christenson Oil – Plant No. 1	9.5	2426	Bulk petroleum product storage and transfer	TPH, PAHs, BTEX, copper, lead, zinc	X			X	X
Chevron USA Asphalt Refinery	8.3	1281	Asphalt refining	TPH, BTEX, PAHs, phenolic compounds	X		X	X	X

Table A.2. Portland Harbor industrial facilities, releases, and potential pathways (cont.)

Facility	Approx. RM	ECSI#	Type of industry	Chemicals of interest	Potential pathway (current or historic)				
					Storm-water	Waste-water	Ground-water	Spills/ disposal	Product handling/ transfer
City of Portland BES Water Pollution Control Lab	6.0	2452	Analytical testing laboratory; former lumber mill						
Columbia American Plating	9.0	29	Metal finishing and electroplating	Cadmium, chromium, lead, cyanide, zinc, TCE			X		
Columbia River Sand and Gravel – see also Linnton Plywood	4.8	2351	Sand and gravel storage and distribution; located on Linnton Plywood property	See Linnton Plywood					
Consolidated Metco	2.2	3295	Metal casting	TPH, PAHs	X		X		
Crawford Street Corp. (formerly Columbia Forge and Machine Works, TLS Steel, Lampros Steel	6.3	2363	Metal forging, stamping, and fabrication; steel recycling and distribution	PAHs, PCBs, arsenic, cadmium, chromium, copper, lead, nickel, zinc	X		X		
Equilon Enterprises, LLC	8.8	169	Bulk petroleum facility	TPH, BTEX, PAHs, methyl tertiary butyl ether (MTBE), ethanol, lead	X				
Foss Maritime/Brix Maritime	5.7	2364	Vessel dispatch, fueling, and maintenance	TPH, PAHs, BTEX, VOCs, cadmium, chromium, lead	X		X	X	X
Fred Divine Diving & Salvage Co. (Marine Salvage Consortium, Inc.)	8.2	2365	Storage and maintenance of boats and other marine salvage gear; vessel refueling; washing and storage of hazardous waste transportation equipment from 1989 to 1996	PAHs, bis(2-ethylhexyl) phthalate, bis(2-chloro-isopropyl) ether, arsenic, cadmium, copper, zinc	X			X	X

Table A.2. Portland Harbor industrial facilities, releases, and potential pathways (cont.)

Facility	Approx. RM	ECSI#	Type of industry	Chemicals of interest	Potential pathway (current or historic): Storm-water	Waste-water	Ground-water	Spills/ disposal	Product handling/ transfer
Freightliner (parts)	8.3	115	Truck parts manufacturing	Toluene, ethylbenzene, xylenes, vinyl chloride, other solvents/thinners [TCE, perchloroethylene (PCE), Dichloroethene (DCE)]			X	X	
Freightliner	8.3	2366	Truck manufacturing	TPH, PAHs, solvents, antifreeze, phthalate esters, aryl phosphate esters, PCBs, methyl phenols, barium, cadmium, chromium, copper, lead, mercury, zinc					
Front Ave. LLP (Tube Forgings)	8.5	1239	Pipe fitting manufacturing	TPH, VOCs, SVOCs, metals	X		X		
Front Ave. LLP (CMI/ Hampton Lumber)	8.5	1239	Lumber and construction material storage and loading	See above					
Front Ave. LLP/Glacier NW (former Lone Star NW)	8.5	2378	Concrete batch plant	See above					
GASCO (Northwest Natural)	6.5	84	Liquid natural gas production; storage and distribution of creosote oil, coal tar pitch, diesel, and fuel oil products; formerly oil gasification (Portland Gas & Coke Company)	PAHs, phenols, naphthalene, BTEX, cyanide, arsenic, chromium, copper, lead, nickel, zinc	X	X	X	X	X

Table A.2. Portland Harbor industrial facilities, releases, and potential pathways (cont.)

					Potential pathway (current or historic)				
Facility	**Approx. RM**	**ECSI#**	**Type of industry**	**Chemicals of interest**	**Storm-water**	**Waste-water**	**Ground-water**	**Spills/ disposal**	**Product handling/ transfer**
GATX/Kinder Morgan Liquid Terminals (formerly Helens Rd facility). Olympic Pipeline transfer corner of property. Also Santa Fe pipeline.	4	1096	Bulk petroleum product storage and transfer	TPH, PAHs, lead, BTEX, MTBE, chlorobenzene, dichlorobenzenes		X	X	X	X
General Construction – see Transloader International			See Transloader International	See Transloader International					
Georgia-Pacific – Linnton Fiber Terminal	3.5	2370	Formerly wood chip export terminal, lumber storage, sawmill, creosoting plant	TPH, PAHs; possibly arsenic and pentachlorophenol (PCP)	X		X		X
Goldendale Aluminum Co.	10	2440	Alumina off-loading, storage, and transfer	Metals, possibly PAHs	X			X	X
Gould Industries	7.5	49	Battery manufacturing/ recycling	Lead					
GS Roofing Products (Genstar)	7.3	117	Asphalt roofing products manufacturing	Fuel oil, asphalt, benzene, copper, zinc	X				X
Gunderson Inc. (former Schnitzer site, in part)	9.5	1155	Ship dismantling, auto salvage	1,1,1-trichloroethane, PAHs, TPH, waste copper, mercury, nickel, zinc	X		X	X	
Hendren Tow Boats – see Marine Finance		2389	See Marine Finance	See Marine Finance					
Kinder Morgan – see GATX			See GATX	See GATX					

Table A.2. Portland Harbor industrial facilities, releases, and potential pathways (cont.)

Facility	Approx. RM	ECSI#	Type of industry	Chemicals of interest	Potential pathway (current or historic): Storm-water	Waste-water	Ground-water	Spills/ disposal	Product handling/ transfer
Koppers Industries, Inc. – see also GASCO	7	2348	Creosote and tar pitch distribution	See GASCO					
Lakeside Industries	8.5	2372	No information on current use; former steel factory	Unknown	X				
Linnton Oil Fire Training Grounds	4.0	1189	No current use; formerly personnel training for extinguishing flammable fluid fires	TPH, PAHs, benzene, chlorinated solvents, arsenic	X				
Linnton Plywood Association (including Columbia R. Sand & Gravel)	4.8	2373	Currently inactive; formerly plywood manufacture	TPH, PAH, phthalates, VOCs, PCBs, cadmium, chromium, copper, lead, zinc	X		X	X	
MarCom, Inc.	5.8	2350	Ship repair, including machining, sandblasting, maintenance	TPH, PAHs, organotins, chlorinated solvents, PCE, arsenic, chromium, copper, lead, mercury, zinc	X		X	X	X
Marine Finance Corporation	6.0	2352	Tug maintenance, storage, and houseboat and sailboat construction; formerly ferry landing, oil storage, and metal salvage	PAHs, TPH, VOCs, phenols, PCBs, phthalates, SVOCs, butyltins, metals	X		X	X	
McCall Oil & Great Western Chemical	7.5	134	Petroleum product storage and transfer	TPH, chlorinated solvents, metals	X		X	X	X
McCormick & Baxter Creosoting Company	7	74	Currently vacant; formerly wood treating facility	PAHs, PCP, dioxins/furans, arsenic copper, chromium, cobalt, zinc	X	X	X	X	X
Mobil Oil Terminal (Exxon)	5.3	137	Petroleum storage and distribution	TPH, PAHs, BTEX, arsenic, copper, lead	X		X	X	X

Table A.2. Portland Harbor industrial facilities, releases, and potential pathways (cont.)

					Potential pathway (current or historic)				
Facility	**Approx. RM**	**ECSI#**	**Type of industry**	**Chemicals of interest**	**Storm-water**	**Waste-water**	**Ground-water**	**Spills/ disposal**	**Product handling/ transfer**
Morse Brothers – see Georgia-Pacific Linnton			See Georgia-Pacific Linnton	See Georgia-Pacific Linnton					
Olympic Pipeline Co.	3.5–7.9	2374	Petroleum products pipeline	PAHs, BTEX, TPH				X	X
St. Helens Road Petroleum Contamination		2630	Soil and groundwater contamination; may be related to Olympic Pipeline leaks	Diesel, heavy oil, gasoline, PAHs, BTEX			X		
Oregon Steel Mills – Rivergate	3	141	Steel mill; steel plate and coil manufacturing	TPH, PCBs, VOCs, and metals			X	X	
Owens Corning – Linnton	4.2	1036	Asphalt and roofing manufacturing; formerly wood treating and lumber-related uses	TPH, PAHs, arsenic, PCP					X
Portland Gas Manufacturing	12	1138	Currently inactive; formerly coal/gas manufacturing	Contaminants associated with other coal gas facilities (PAHs, TPH, BTEX, heavy metals, SVOCs)				X	X
Portland General Electric – Harborton Substn.	3.5	2353	Electrical substation	TPH, PAHs, unconfirmed chemicals: PCBs, BTEX, phthalates, PCP, herbicides			X		
Portland Shipyard – Swan Island	9	271	Ship repair, dry dock	PAHs, TPH, PCBs, VOCs, chlorinated solvents, metals, organotins	X	X	X	X	X

Table A.2. Portland Harbor industrial facilities, releases, and potential pathways (cont.)

Facility	Approx. RM	ECSI#	Type of industry	Chemicals of interest	Potential pathway (current or historic)				
					Storm-water	Waste-water	Ground-water	Spills/ disposal	Product handling/ transfer
Port of Portland – Terminal 1 North	10.5	3377	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	10.5	2642	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	10	2769	Cargo (steel, lumber, plywood, and pulp) and container shipping and handling	TPH, PCBs	X				X
Port of Portland – Terminal 4 – Slip 3	4.7	272	Marine shipping and handling	TPH, PAHs, BTEX	X		X	X	X
Port of Portland Terminal 4 – Toyota Motor Sales	5	172	Vehicle processing, shipping and unloading of automobiles	PAHs	X				
Port of Portland – Terminal 4 – Slip 1	4.3	2356	Shipping terminal for grain, breakbulk cargoes, logs, minerals, liquid bulks	SVOCs, PAHs, cadmium, chromium, lead, mercury, zinc	X				X

Table A.2. Portland Harbor industrial facilities, releases, and potential pathways (cont.)

Facility	Approx. RM	ECSI#	Type of industry	Chemicals of interest	Potential pathway (current or historic): Storm-water	Waste-water	Ground-water	Spills/ disposal	Product handling/ transfer
Port of Portland – Terminal 5 (Blue Lagoon)	1	1686	Currently grain terminal, bulk mineral shipping, and fiber optic submarine cable manufacture; formerly Oregon Steel Mill slag disposal site	Iron and manganese in groundwater; metals and PCBs at low levels	X				
Port/Shaver Oil Sump	2.5	None	No current use; formerly oily bilge wastewater discharge into ponds	TPHs	X		X	X	X
RK Storage & Warehousing	4.5	2376	Current use unknown; formerly log and lumber storage, also sand blast grit; West Coast Adhesives manufactured phenol formaldehyde glues on northern portion of property	TPH, formaldehyde, phenolics, phthalate esters	X		X	X	
Ross Island	15.4	2409	Disposal of contaminated dredged material	PCBs, PAHs, petroleum, metals, pesticides, herbicides					
Santa Fe Pipelines (purchased by Kinder-Morgan)	7	2104	Fuel pipeline	TPH, PAHs, BTEX	X			X	

Table A.2. Portland Harbor industrial facilities, releases, and potential pathways (cont.)

Facility	Approx. RM	ECSI#	Type of industry	Chemicals of interest	Potential pathway (current or historic)				
					Storm-water	Waste-water	Ground-water	Spills/ disposal	Product handling/ transfer
Schnitzer Investment Corp. (North Burgard Site)	3.7		Multiple lessees						
Schnitzer Steel/Calbag Metals	3.7	2355	Ship dismantling, scrap metal recycling, including automobiles	Metals, PAHs, PCBs, TPHs, solvents	X		X		
Boydston Metal Works	3.7	2362	Fabrication and painting of automobile transport trailers	Metals, TPH, solvents, PCBs	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	3.7	138	Pipe manufacturing and coating	PCBs, oil, gasoline, PAHs, solvents	X		X		
Portland Blast Media	3.7	2362	Sandblasting, manufacture of protective coatings for recycling containers	Metals, solvents, paints	X		X	X	X
Portland Container Repair	3.7	2375	Storage and maintenance of intermodal containers and chassis	Oil, solvents, fuel	X		X		
Premier Edible Oils	3.7	2013	Food grade product storage	TPH, PAHs, BTEX, chlorinated solvents	X		X		
RoMar Transportation Systems	3.7	2437	Warehousing	PCBs	X			X	

Table A.2. Portland Harbor industrial facilities, releases, and potential pathways (cont.)

Facility	Approx. RM	ECSI#	Type of industry	Chemicals of interest	Potential pathway (current or historic): Storm-water	Waste-water	Ground-water	Spills/ disposal	Product handling/ transfer
Ryerson Steel	3.7	2441	Manufacture and distribution of structural steel products	No data	X		X		
Jefferson Smurfit	3.7	2371	Unknown	Unknown	X				
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.)	7.3	395	Acetylene manufacturing, disposal of auto shredder waste from other Schnitzer facilities	Calcium hydroxide, lead, arsenic, TPH, PCBs, chlorinated solvents [trichloroethane (TCA), acetone, methyl ethyl ketone (MEK), 1,1-DCA]	X	X	X	X	
Schnitzer-Moody Ave. site		875	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	8.5	2442	No information						
Schnitzer-near NW 35th and Yeon (formerly Chase Bag, Great Western Chemical and Willard Storage Battery)	9.2	2424	Former multi-wall bag construction, hardware wholesale, chemical manufacture, storage battery manufacture	Chlorinated solvents [possibly PCE dense nonaqueous phase liquid (DNAPL)], metals (particularly lead)	X		X	X	X

Table A.2. Portland Harbor industrial facilities, releases, and potential pathways (cont.)

					Potential pathway (current or historic)				
Facility	**Approx. RM**	**ECSI#**	**Type of industry**	**Chemicals of interest**	**Storm-water**	**Waste-water**	**Ground-water**	**Spills/ disposal**	**Product handling/ transfer**
Shaver Transportation Co.	8.5	2377	Tug dispatch, refueling and maintenance	Materials handled on site include diesel fuel, paints, oils, solvents	X			X	X
South Rivergate Industrial Park – see Port of Portland Terminal 5 and Oregon Steel Mills	< 3.5	2980	See Port of Portland Terminal 5 and Oregon Steel Mills	See Port of Portland Terminal 5 and Oregon Steel Mills					
Sulzer Bingham Pumps		1235	Pump manufacturing	Petroleum products, chlorinated solvents, including BTEX, zinc	X		X	X	
Texaco Portland Bulk Pipeline	8.8	2117	Petroleum product transfer	TPH, PAHs, BTEX, MTBE, lead	X		X	X	
Texaco Portland Bulk Terminal – see Equilon			See Equilon	See Equilon					
Time Oil-Northwest Terminal	3.8	170	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 (ST Services)	5.5	1989	Bulk petroleum storage facility	TPH (gasoline), PAHs, BTEX				X	X
Triangle Park LLC	7.5	277	Currently inactive; former lumber mill, petroleum pipeline, fuel storage, marine construction, hazardous waste storage from 1908 to 1984	Metals, PCBs, chlorinated solvents, PAHs, PCP, possibly dioxins	X		X		

Table A.2. Portland Harbor industrial facilities, releases, and potential pathways (cont.)

					Potential pathway (current or historic)				
Facility	**Approx. RM**	**ECSI#**	**Type of industry**	**Chemicals of interest**	**Storm-water**	**Waste-water**	**Ground-water**	**Spills/ disposal**	**Product handling/ transfer**
Transloader Intl. Co. (aka: Marine Finance Corp; Hendron Tow Boat)	6	2367	Current use unknown; formerly log storage; no other information	No upland data, sediments do not appear to be impacted					
Trumbull Asphalt Plant		1160	Asphalt manufacturing	Petroleum hydrocarbons, diesel fuel, asphalt distillate	X		X	X	X
U.S. Coast Guard – Portland Station	8.3	1338	Docking, servicing and refueling of small boats; limited sandblasting	TPH, PAHs, metals [including mercury, tributylin (TBT)], possibly solvents, herbicides	X			X	X
USACE – Portland Moorings	6.2	1641	Maintenance and repair of Corps vessels	TPH, PAHs, metals including TBT	X			X	X
Union Pacific Railroad-Albina Yard	10	178	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	Currently vacant; former bulk fuel facility; pipeline extends to Terminal 4 – Slip 3	TPH, PAHs, BTEX	X		X	X	X
Wacker Siltronics Corp.	7	183	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

Table A.2. Portland Harbor industrial facilities, releases, and potential pathways (cont.)

Facility	Approx. RM	ECSI#	Type of industry	Chemicals of interest	Potential pathway (current or historic): Storm-water	Waste-water	Ground-water	Spills/ disposal	Product handling/ transfer
Willamette Cove/ St. Johns Riverfront	6–7	2066	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.	7.8	1549	Petroleum product storage and distribution; includes three separately-owned parcels	TPHs, PAHs, BTEX, chlorinated and non-chlorinated solvents, DDT	X		X	X	X
1. Kinder Morgan (formerly GATX, formerly Shell)		160	Historically, pesticide, nonchlorinated solvents, ammonia, ethylene glycol, asphalt products storage at GATX	See above					
2. TOSCO (formerly UnoCal)		177	Petroleum product storage and distribution	See above					
3. Chevron		25	Historically, naphtha solvents	See above					
Zidell	14	689	Ship dismantling, barge construction, tube forging	Metals, PCBs, TPH, chlorinated solvents, TBTs, asbestos				X	X

Note: This table is a summary of some of the information gathered during the remedial process. It does not necessarily summarize all information related to facilities, releases, and potential pathways.

Sources: Data adapted from Table E-1 of the *Portland Harbor RI/FS Programmatic Work Plan* (Integral Consulting et al., 2004), Table 5.1-2 of the *Portland Harbor RI/FS Comprehensive Round 2 Site Characterization Summary and Data Gaps Analysis Report* (Integral Consulting et al., 2007), and the Environmental Cleanup Site Information (ECSI) Site Database (http://www.deq.state.or.us/lq/ecsi/ecsi.htm).

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B. Phase 2 Framework

As outlined in the Portland Harbor natural resource damage assessment (NRDA) Assessment Plan, the Portland Harbor Natural Resource Trustee Council (the Trustee Council) have divided the NRDA process for this Site into four phases. These phases can be generally defined as (1) development of an assessment plan; (2) implementation of a settlement-oriented assessment; (3) completion of the assessment with additional data collection and analysis; and (4) recovery of damages from non-settling liable parties.

In Phase 2 of the NRDA case for Portland Harbor, the Trustee Council will:

1. Focus the assessment in the Portland Harbor Assessment Area (PHAA), defined at present as the Portland Harbor Superfund Site Study Area [Willamette River Mile (RM) 1 to 11.8] and immediate vicinity and the Multnomah Channel.[1]

2. Use a combination of Habitat Equivalency Analysis (HEA)/Resource Equivalency Analysis (REA) and benefit transfer (BT) to quantify ecological and recreational losses, relying on existing information to the extent possible and employing reasonable, conservative assumptions to evaluate and quantify exposure and injuries to trust resources. Some additional data will be collected collaboratively with participating parties, or independently by the Trustee Council, to quantify injury, as warranted.

3. Assess key resources – juvenile salmon, lamprey ammocoetes, sturgeon, sediment, benthos, piscivorous birds (osprey/bald eagle), piscivorous mammals (otter/mink), other natural resources with Tribal value and other fish covered by advisories or having recreational value.

4. Continue the lamprey study started in Phase 1.

5. Complete the restoration planning process.

6. Develop a natural resources damages liability allocation method.

The primary goal of Phase 2 is to complete an assessment of injuries to key trust resources so that the Trustee Council will be able to enter into settlements with participating parties at or near the time when the U.S. Environmental Protection Agency issues its record(s) of decision. Parties participating in these early settlements will avoid additional time and monetary costs associated

1. The Phase 2 assessment will not include the Columbia River.

with future Phase 3 assessment efforts, which would likely include comprehensive field studies, modeling, and other activities.

This appendix provides a framework for Phase 2 to highlight the actions the Trustee Council will undertake to further its early settlement objectives. More specifically, this appendix describes the Trustee Council's approach to evaluate the need for further assessment of the Multnomah Channel as well as quantifying service losses associated with key ecological, tribal, and recreational resources. Sections B.5 and B.6 of this appendix overview future actions associated with the restoration planning process and guidance for negotiating settlements with cooperating parties.

B.1 Evaluation of Contaminant Exposures in Multnomah Channel

During the review of literature for the Assessment Plan, the Trustee Council identified a potential data gap for analytical chemistry results from the Multnomah Channel. The Multnomah Channel is a branch of the Willamette River that diverges from the main channel at Sauvie Island (Willamette RM 3.5) and flows for 21 miles along the western shore of Sauvie Island. It converges with the Columbia River near St. Helens, Oregon (Columbia RM 88).

The Multnomah Channel has never been part of the Portland Harbor Study Area, though limited samples were collected in the first mile of the Channel downstream of the Willamette River during the Remedial Investigation (RI). As a result, the main body of literature related to Portland Harbor contains very little information on contaminants and contaminant transport in the Multnomah Channel. At times, however, significant flows from the Willamette River enter the Multnomah Channel and subsequently discharge to the Columbia River (Tetra Tech, 1992). In summary, contaminants from both Portland Harbor potentially liable parties (PLPs) and Multnomah Channel PLPs could enter and/or travel through the Multnomah Channel.

To address this data gap in Phase 2, the Trustee Council will review other sources of available information. The Trustee Council has thus far identified several additional sources of data including sediment chemistry collected at three Oregon Department of Environmental Quality (ODEQ) sites along the Multnomah Channel:

- ECSI site ID 959: Port of St. Helens Creosote (aka Pope and Talbot Wood Treating site)
- ECSI site ID 14: Boise Cascade – St. Helens (aka St. Helens Pulp and Paper Mill)
- ECSI site ID 91: Armstrong World Industries – St. Helens (aka St. Helens Fiberboard Plant site).

These three sites are located near the mouth of the Multnomah Channel between Scappoose Bay and the City of St. Helens, Oregon. The Trustee Council will review the available sediment chemistry data for these three sites. Because these sites and other industries near St. Helens, Oregon, may be additional sources of contaminants, the Trustee Council will likely focus their review on samples that have been collected upstream of these specific sites to develop assumptions about contaminants that may have moved downstream from Portland Harbor.

Additionally, the Trustee Council has identified ODEQ's Toxics Monitoring Project in the Willamette Watershed as a potential additional source of data for the Multnomah Channel (ODEQ, 2008). Through this study, designed to monitor toxic pollutants in surface waters, ODEQ is collecting surface water and fish tissue samples throughout the Willamette River Basin. According to the draft Sampling Plan (ODEQ, 2008), one fish collection site is located on the Multnomah Channel near St. Helens.

The Trustee Council will also consider the results of their Phase 1 osprey egg study. One egg from this study was sampled from a nest located at the head of Multnomah Channel (Buck, 2008).

The Trustee Council intends to acquire these data when they become available and review them to determine their appropriateness as a source of information for the Phase 2 evaluation. Data from the Multnomah Channel will be evaluated for relevancy and reliability for the purpose of estimation of injury from releases of hazardous substances from Portland Harbor PLPs. The Trustee Council intends to use the same method(s) that will be used for other parts of the PHAA. Though the Trustee Council anticipates that the Phase 2 assessment of Multnomah Channel will rely primarily on data collected for the Portland Harbor RI, they intend to use additional available data, if suitable, to determine whether injuries to Multnomah Channel natural resources have occurred due to releases into Portland Harbor or whether reasonable assumptions concerning injury can be made and considered along with other Portland Harbor data.

B.2 Injury to Ecological Resources

The river ecosystem associated with the PHAA includes biological and hydrological components that have significant value to the public. A broad diversity of plant and animal species, including legally protected species, utilize various habitat types within the PHAA. Although many of these habitats have been modified and degraded by human activity, they are critical to the maintenance and protection of these natural resources.

In Phase 2, the Trustee Council will apply HEA/REA modeling to quantify natural resource and ecological service losses resulting from releases of hazardous substances to the Site and to scale compensatory restoration necessary to compensate the public for these losses. The HEA/REA framework has been used effectively to facilitate settlement of numerous NRDA cases in the United States, as well as to support litigation claims on the part of the Trustee Council. Some descriptive background information about this modeling process is provided in Section 5.1 of this Plan. Specifics about the application of HEA and REA in Phase 2 are provided below.

How will the Trustee Council use HEA/REA to estimate service losses in Phase 2?

The Trustee Council will use data collected for the Portland Harbor RI/Feasibility Study (FS), other Site-specific and laboratory studies, and other published literature to estimate integrated service losses to the lower Willamette River habitats in the PHAA.[2] Services to key resources such as benthic organisms, juvenile salmon, juvenile lamprey, sturgeon, osprey, bald eagles, mink, and river otter will be considered. Direct measurements of sediment chemistry and toxicity, and modeled sediment toxicity for the PHAA will be used as indicators of injury to benthos. Sediment contamination distribution, tissue residues in fish and wildlife, Site-specific effects measurements, and literature-based effects concentrations will be evaluated to determine sediment-based threshold increments for integrated ecological service losses for the habitat. This habitat-based approach is beneficial because it will enable the Trustee Council to estimate service losses for species for which limited Site-specific injury information is available, thus reducing the need to collect new information on specific natural resource groups in Phase 2.

Habitat value factors will also be developed to evaluate service losses for key resources. The Trustee Council recognizes that the habitat requirements of different resources vary. As a result, some types of habitat (e.g., shallow water, low-gradient shorelines, riparian buffers, off-channel cool water refuges, or marsh/wetlands) may be more valuable to a larger number of key resources than other habitats. In practical terms, this means contiguous habitat types with different habitat value factors but similar levels of contamination may result in different amounts of service losses.

Once service loss thresholds and habitat value factors are established, habitat will be mapped and characterized using existing sediment contamination data. The areas of habitat with different service levels (based on contaminant concentrations and/or predicted toxicity) become input to the HEA model, along with assumptions about recovery times under various clean-up scenarios. The Trustee Council will use conservative assumptions regarding natural resource recovery times based on information developed as part of the FS and remedial process.

The Trustee Council will also consider the use of REA to estimate the losses to species such as osprey and bald eagle. Because osprey are present in the PHAA during courtship, incubation, and fledging, reproductive losses associated with bioaccumulative contaminants can be estimated by comparing egg concentrations with available effect levels. In addition, productivity data of

2. Additional data collection may be necessary.

individual nest sites for osprey in the PHAA and surrounding areas are available to relate contaminant concentrations to reproductive success and to estimate losses from the population. Eggshell thinning values, an injury linked to concentrations of dichloro-diphenyl-dichloroethylene, have also been measured for osprey and can be used to predict population level effects. As year-round residents and top predators in the food chain, bald eagles are suspected to accumulate contaminants in eggs to a greater degree than osprey, and this has been documented in eagles nesting in the lower Columbia River. Productivity and egg contaminant information available for bald eagles in the lower Columbia River can be used to model and predict concentrations for eagles specific to the PHAA based on relationships of these parameters between osprey and eagles from the Columbia River. Because restoration options for osprey and eagles lend themselves to evaluation of gains in terms of numbers of individuals, a REA instead of a HEA for these species might be more effective. The Trustee Council is aware of the potential for “double counting” of injuries, and will consolidate benefits for osprey and eagles during consideration of restoration options.

How will the Trustee Council account for baseline conditions in the estimation of service losses?

Because NRDA claims are limited to losses associated with releases of hazardous substances, the Trustee Council must consider other factors that may degrade natural resources. In highly modified urban waterways such as Portland Harbor, navigational dredging, filling, shoreline hardening, over-water structure placement, and other activities have reduced and degraded habitat over a period of decades. These degradations stress organisms and populations and may cause adverse effects for which the Trustee Council has no NRDA claims. Hence, the Trustee Council will develop baseline factors to account for non-contaminant-related stressors. For example, areas under docks and other overwater structures provide poor habitat for juvenile salmon and other important species and would subsequently be of less value relative to habitats where overwater structures are absent. The application of such factors will enable the Trustee Council to better estimate injuries related solely to the releases of hazardous substances.

How will the Trustee Council address background concentrations of contamination?

In Phase 2, the Trustee Council will evaluate methods and then select and apply an approach for considering contaminants in the lower Willamette River that would have been expected had the discharges of hazardous substances from Portland Harbor facilities not occurred. The Trustee Council will rely primarily on data from control areas (such as upstream of the PHAA) to address background concentrations. The Trustee Council will consider information and methods developed to define background conditions for the RI/FS but may consider additional information and/or draw conclusions that differ from those made in the RI/FS.

How might the Phase 2 HEA differ from Phase 3 approaches?

In Phase 2, the Trustee Council will primarily rely on existing information, expert judgment, and informed assumptions to develop inputs to the HEA framework and supporting geospatial analyses. Key inputs may include RI/FS-collected data, habitat information, as well as other available data sets. Because Phase 3 analyses will require greater scientific certainty, additional data and information will be required to quantify injury to specific resources, and for estimating baseline conditions and background concentrations of contaminants. Based on information available now, in Phase 3 the Trustee Council will consider additional studies to determine effects of Site contamination on juvenile salmon growth, osprey and eagle reproduction, and effects to juvenile lamprey. These additional studies will be considered as more information becomes available. The Phase 3 assessment may cover additional natural resources and may include a more expansive geographic scope, requiring additional assessment work.

B.3 Injury to Tribal Resources

The five tribal Trustees on the Portland Harbor Trustee Council include the Nez Perce Tribe, Confederated Tribes of the Grand Ronde Community of Oregon, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of Siletz Indians, and Confederated Tribes of the Warm Springs Reservation of Oregon. The U.S. Department of the Interior NRDA regulations define these Tribes as Trustees for trust resources. For the Tribes, the co-trust resources could include fish, wildlife, vegetation, and related supported habitat.

During Phase 1 of the assessment process for the Portland Harbor NRDA, the tribal Trustees reviewed a number of existing data sources to initiate an evaluation of potential effects from the release of contamination at the Site on important tribal resources and the services they provide. From these initial steps, the tribal Trustees also initiated discussions to define potential restoration approaches.

In Phase 2, the tribal Trustees will continue developing the above information on tribal resource injuries and services, and determine, or provide a basis for conservative assumptions about, the types of injuries that have occurred to important tribal resources and the services they provide. For Phase 2, the tribal Trustees plan to determine and quantify injuries to natural resources and services in a compensatory restoration based framework. Phase 2 investigations will focus on identifying losses that are either unique or additional to losses incurred by the general public, and restoration opportunities that can specifically address the identified losses. Moreover, as described below, tribal Trustees will quantify the amount of injury, including lost uses of tribal resources and their services, to the extent necessary to reach settlement. Similarly, the tribal

Trustees will determine the type and amount of restoration necessary to compensate the Tribes for these injuries.[3]

Specific tribal Trustee activities in Phase 2 may include:

1. Identify specific tribal member uses of natural resources and the services they provide that may have been affected because of the release of contamination

    a. Refine information regarding plant and animal types of tribal importance in the PHAA
    b. Assess the uses and services provided by natural resources of tribal importance based on existing tribal information sources
    c. Conduct additional oral history interviews, as necessary
    d. Consider finalizing the *Draft Cultural Resources Analysis Report for the Portland Harbor Superfund Site*, developed by AINW, Inc. for purposes of the NRDA (Ellis et al., 2005)

2. Develop methods to quantify, to the extent necessary to reach settlement, the lost uses of natural resources and their services as a result of the release of contamination along with the benefits of restoration

3. Identify potential tribal resource-specific and use-specific restoration projects appropriate for compensation

    a. Develop restoration project evaluation criteria
    b. Identify potential restoration projects or additional components of restoration opportunities previously identified by the Trustee Council Restoration Committee that specifically address tribal resources and the services they provide

4. Evaluate potential tribal-specific restoration projects or elements to be used as compensation.

B.4 Injury to Recreational Resources

During Phase 2, the Trustee Council will collect limited, primary data to fill identified data gaps, employ reasonable assumptions, and utilize a BT approach to assess lost recreational uses in the PHAA. BT is a technique used to estimate economic values for ecosystem/natural resource services by transferring available information from studies already completed in another location

3. This may include injuries caused by remedial actions.

and/or context. This method is described in Section 5.2 of this Plan. Specifics about the application of BT in Phase 2 are provided below.

How will the Trustee Council use BT to estimate recreational losses in Phase 2?

In general, the release of contaminants into the Willamette River and users' perceptions about the existence and location of any such releases, can negatively impact recreational uses and values in three main ways:

1. People may choose to forego certain types of recreational activities
2. People may choose to change the location, or types of recreation in which they participate
3. People may choose to continue to recreate at contaminated sites but enjoy them less.

Review of existing (secondary) data and information suggests that what is available for the PHAA and other areas, potentially supplemented with assumptions and/or focused additional (primary) data collection, will be sufficient to quantify this category of losses for a Phase 2 level assessment. So far, the Trustee Council has identified data gaps that will need to be addressed in Phase 2 to determine what the value of lost use is for the identified recreational impacts. The Trustee Council will investigate multiple sources of information to reduce the identified data gaps and existing uncertainty. Described below are the data gaps identified to date.

1. Information on the specific types of activities and user groups affected by the release of contamination within the PHAA

2. Information on baseline use of resources absent contamination

3. Information on substitution of recreational activities to less contaminated or uncontaminated sites

4. Information on the value of affected (e.g., lost, substituted, reduced enjoyment) recreational trips.

How might the Phase 2 BT approach differ from Phase 3 approaches?

In Phase 2, the Trustee Council will rely as much as possible on existing (secondary) data and information and reasonable assumptions (based on expert judgment). In some limited circumstances, the Trustee Council may also need to conduct primary data collection using some combination of small-scale surveys of user groups, aerial surveys, stationary photo counts, convenience samples, intercept surveys, and focus groups. Phase 3 will require greater scientific certainty. Therefore, additional, more detailed primary data collection will be required to estimate more precisely the number of recreational users affected, how and to what degree they are affected, and the value of the loss to each user. Based on what the Trustee Council knows now, the additional primary studies required in Phase 3 would likely use revealed and/or stated choice methods and would be much more expensive and time consuming to design and execute than the approach developed for Phase 2.

B.5 Restoration Planning

In November 2007, the Trustee Council began restoration planning efforts for the Portland Harbor NRDA. The Trustee Council has produced internal guidance and criteria for evaluating restoration opportunities to benefit fish and wildlife (Portland Harbor Natural Resource Trustee Council, 2009). Over the last two years, the Trustee Council has developed a preliminary list of potential restoration opportunities within the Portland Harbor Study Area, as well as fact sheets and maps for each of these potential projects and have begun applying the criteria for determining the relative value of restoration projects for fish and wildlife species. The Trustee Council staff toured various potential restoration sites, and the Trustee Council has begun informal discussions with local residents, landowners, and potential restoration partners to refine restoration opportunities and obtain input from various stakeholders.

In Phase 2, the Trustee Council intends to expand on previous work to ensure that restoration-based settlements can be accomplished with participating parties. To that end, the Trustee Council plans to accomplish the following tasks in Phase 2:

1. Fully develop restoration concepts and proposals for priority restoration projects and additional projects identified within the Trustee Council's preferred geographical areas through discussions with stakeholders and members of the public, to the extent practicable, including exploration and tracking of feasibility and design issues

2. Develop cost estimates for implementation, Trustee oversight, and monitoring of restoration projects

3. Quantify the benefits (outputs) of selected compensatory ecological restoration projects using HEA

4. Evaluate the potential for integrating tribal and recreational resource restoration actions with ecological restoration actions, using appropriate scaling methods

5. Develop a draft and final Restoration Plan/Programmatic Environmental Impact Statement, including public comment and outreach.

How will the Trustee Council value habitat to estimate gains from restoration?

The formula used to estimate gains in ecological services from restoration is essentially a mirror image of that used for estimating injuries. The primary difference lies in estimating annual changes in habitat value. When estimating injuries, annual reductions in ecological services by habitat and area are determined from the current time (or time of remediation) into the past (either to 1981 or initiation of the contaminant release, whichever is latest). Injuries are based on reductions in service levels from baseline values, with annual values compounded by 3% through the period of injury incurrence. When estimating gains in habitat value from restoration, annual increases in ecological services by habitat and area are determined yearly for every year the restoration site functions. Although usually identified as "in perpetuity" in legal documents, infinite time periods for the presence and productivity of restoration sites are difficult to estimate, and a maximum length of time for estimating the value of a restoration site in perpetuity is typically 300 years. As indicated, annual estimated ecological values are discounted by 3% annually, and the annual rate of increase is further affected by the length of time each type of habitat takes to achieve full functional maturity after remediation. For example, shallow-water mud-sand habitat may achieve full ecological function value in four years, while riparian woody habitat may take up to 50 years.

The units of restoration gained by applying the HEA/REA model are the same as those estimated for losses (discounted service acre-years, DSAYs, or numbers of birds). Individual projects will be valued by the Trustee Council in determining how many DSAYs (or individual birds created) can be credited toward injuries. The Trustee Council has produced guidance relating to restoration valuation (Portland Harbor Natural Resource Trustee Council, 2009) that is intended to be useful for restoration planning, but the Trustee Council will retain the responsibility for determining restoration credits for individual projects. The Trustee Council will evaluate the potential for integrating tribal and recreational resource restoration actions with ecological restoration actions using appropriate scaling methods.

B.6 Negotiated Settlements with Cooperating Parties

The goal of Phase 2 of the cooperative assessment process is to develop the data, information, and assumptions needed to support settlement of NRDA claims for the Site with willing parties at the most opportune time. By participating in Phase 2, cooperating parties will also have the opportunity to build relationships with the Trustee Council and communicate positions and perspectives that will be of considerable value in settlement negotiations.

The Trustee Council assumes that parties interested in negotiating settlements of their NRDA liability will most likely wish to resolve all of their liabilities simultaneously. Including in a single consent decree a settlement that addresses both remedial liability and NRDA liability can save transaction costs on both sides and give management of settling PLPs a clear picture of what it will take to resolve all liabilities for the Site. Consequently, the Trustee Council's aim is to complete Phase 2 in time to coordinate NRDA settlement negotiations with remedial liability settlement negotiations.

For species where continuity of habitat is important to their life cycles or survival, the Trustee Council has a preference for restoration projects in the PHAA, since restoration as close to the impacted area as possible has the greatest potential to benefit the affected species and relevant life stages injured by hazardous substances contamination. However, there may be opportunities near, but not in the PHAA, that might also have the same potential benefits for affected species and relevant life stages. The Trustee Council will consider how to value those potential projects as part of Phase 2. The higher value the Trustee Council assigns to projects in the PHAA will be reflected in the amount of credit such projects produce under the Trustee Council's HEA model. Projects in the PHAA are likely to be more expensive to develop, in terms of the cost per credit produced, than projects in more remote areas. In order to avoid having the cost differential discourage restoration within the PHAA, the Trustee Council will consider neutralizing the cost differential by developing a cost-avoided offset charge that the Trustee Council will require developers of projects outside the PHAA to pay into the Trustee Council's restoration account to fund further restoration within the PHAA.

Settlement process

The Trustee Council currently envisions issuing formal demand letters to PLPs identifying proposed settlement terms at or near the end of the Phase 2 process. To ensure that the negotiations proceed toward a prompt conclusion, the demand letters will identify a deadline for responses. The Trustee Council also anticipates holding one or more group meetings with cooperating parties to explain their settlement proposal and process and to answer general questions.

To give PLPs a sense of the terms that will be required in a final settlement and to make the negotiations process as efficient as possible, the Trustee Council intends to work with the U.S. Department of Justice (DOJ) and the Oregon Department of Justice to develop template consent decree clauses that will form the basis for all NRDA settlements. Among other things, the template clauses will address the legal, substantive, geographic, and temporal limits of the covenants not to sue, as well as reservations and reopener conditions.

Settlement elements

The Trustee Council currently anticipates offering PLPs the option of building or contributing to habitat restoration projects or entering into cash-based settlements to resolve their NRDA liability. To that end, as described above, in Phase 2 the Trustee Council will explore options for scaling losses using HEA/REA and BT. For cash-based settlements, determinations generated through use of the HEA/REA could be converted into a dollar equivalent figure, based on the Trustee Council's costs of acquiring property, developing habitat projects, and performing short-term monitoring, maintenance, and adaptive management. The Trustee Council has not yet determined how to address compensation for and restoration of tribal or recreational losses. Those matters will be resolved as part of Phase 2.

Restoration-based settlements will include a detailed project description with agreed performance goals, monitoring requirements, and adaptive management provisions to address performance shortfalls. The Trustee Council will require that restoration project sites be protected through fee title transfers, conservation easements, deed restrictions, or other terms to permanently prevent conversion of the sites to incompatible uses. The settlement will include deadlines for project milestones, plus enforcement terms such as stipulated penalties that will be imposed if deadlines are not met. Dispute resolution terms will be included to allow performance disputes to be addressed among the parties in the first instance before judicial enforcement is invoked. Restoration-based settlements will include the requirement that settling parties pay the costs of Trustee Council oversight of the development of the proposed restoration project(s).

Experience at other NRDA sites in the Pacific Northwest and elsewhere shows that restoration projects are often vulnerable to colonization by invasive vegetation and can be subject to human disturbance (e.g., encampments, vandalism, trash dumping). Consequently, provisions also must be made for continual monitoring and maintenance of restoration projects – after project permit requirements expire – to ensure that the ecological benefits of the projects are not lost due to neglect. Settling parties will be expected to contribute toward the costs of a permanent stewardship program the Trustee Council intends to develop to address project site oversight and maintenance in perpetuity. For cash-based settlements, the dollar-equivalent figure will also include a contribution to the permanent stewardship program. All settlements, whether project-based or cash-based, will include a requirement that settling parties reimburse their share of the Trustee Council's unreimbursed assessment costs.

Liability allocation

The Trustee Council maintains that contaminants have become so commingled in Portland Harbor sediments that any party responsible for releasing hazardous substances to the Site is jointly and severally liable for all the resulting natural resource damages. Solely for purposes of settlement, however, the Trustee Council is willing to consider settling with any party for only a reasonable share of the total Site-wide liability for natural resource damages and assessment costs. To derive the appropriate liability shares for settling parties, the Trustee Council will need to rely upon the results of a liability allocation process that can satisfy Trustee Council management, the DOJ, and any reviewing court.

A number of PLPs have entered into an agreement to conduct an allocation of remedial liability for the Portland Harbor Site. This agreement is not intended to address NRDA liability, and the Trustee Council will need to develop a completely independent liability allocation for settling NRDA claims. Alternatively, the Trustee Council and participating parties could agree to conduct a cooperative NRDA allocation that builds upon much of the work being done for the remedial allocation.

The advantages of a cooperative allocation are obvious: avoiding duplication of time and expense and minimizing the probability of conflicting or inconsistent allocation results that could call into question settlements for either remedial liability or NRDA claims.

To rely upon a cooperative allocation that utilizes factual information or analysis developed in the remedial allocation process, the Trustee Council would need to be able to independently confirm the fairness and reasonableness of that allocation process and its results. To enable that confirmation, participating parties will need to agree to the following steps:

1. The Trustee Council will be given access to the database of PLPs subject to the allocation, to data regarding the location and concentration of contaminants, and to public information on historic discharges developed in the remedial allocation. Trustee Council contractors will conduct an independent review of the historic discharge information for a sample of the PLPs to verify the completeness and accuracy of the database.

2. The Trustee Council will be given access to the analysis of contaminant/discharge linkages developed in the remedial allocation. Since these linkages may be based in part on confidential discharge information developed for the allocation, terms will need to be developed to address the confidentiality issue.

3. The Trustee Council will provide information to the remedial allocator regarding the weighting and priority the Trustee Council assigns to different contaminants and different areas of the Site so that the allocator can take these factors into consideration in developing the methodologies and approaches that will be used for conducting the allocation. As needed, the allocator will develop a subset of methodologies or approaches tailored to the focus of the damage assessment process. The Trustee Council will be given an opportunity to review and comment upon reports prepared by the remedial allocator that describe the methodology that will be used for allocating liability.

4. The allocator will apply the methodologies or approaches so developed to allocate liability for natural resource damages and damage assessment costs. The results will be presented in the form of a preliminary NRDA allocation report.

5. The Trustee Council will be given the opportunity to review and comment upon the preliminary NRDA allocation report. The allocator will consider the Trustee Council's comments in developing a final NRDA allocation.

6. The Trustee Council reserves the right not to follow the final NRDA allocation in negotiating settlements should the Trustee Council determine that the allocation results are not fair and reasonable or should the Trustee Council receive or obtain relevant information not considered by the allocator that prompts the Trustee Council to assign particular parties a different share of liability than recommended by the allocator.

B.7 Conclusions

The NRDA process has successfully produced numerous examples where natural resources were restored through a collaborative process between the Trustee Council and liable parties. This expedited approach not only equates to earlier restoration but is far less expensive than the alternative pathway requiring more comprehensive, detailed studies and analysis to quantify injuries to all trust resources at a level that meets litigation standards.

The Trustee Council strongly supports the collaborative approach to restoration and believe that the above actions proposed for Phase 2 offer opportunities for a cooperative early settlement as compensation for natural resource injuries in Portland Harbor.

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C. Quality Assurance Management

C.1 Trustee Council Approach to Quality Assurance

The Portland Harbor Natural Resource Trustee Council (the Trustee Council) may collect and analyze chemical, biological, physical, and/or economic data and rely on existing data for the Portland Harbor natural resource damage assessment (NRDA). The role of quality assurance (QA) is to provide a structured process for acquiring environmental information and ensuring that the collection of this information meets quality objectives. This appendix describes the QA management approach that the Trustee Council will employ in the collection and use of these data. 43 C.F.R. § 11.31(c)(2). The Trustee Council has modeled this QA management approach in large part on the QA Management appendix to the Hudson River NRDA Plan (Hudson River Trustee Council, 2002).

C.2 Quality Assurance Project Plans

The Trustee Council intends to develop project-specific Quality Assurance Project Plans (QAPPs) for data collection efforts conducted as part of the Portland Harbor NRDA. QAPPs describe the necessary QA procedures, quality control (QC) activities, and other technical activities that will be implemented (U.S. EPA, 2002). Through these plans, the Trustee Council will communicate the specifications for the implementation of data collection efforts. QA plans will provide clearly identified data quality objectives, a description of methods appropriate for achieving those objectives, and information on assessment procedures and limitations on the use of data. QA plans will be developed in accordance with U.S. Environmental Protection Agency (EPA) requirements for QAPPs (U.S. EPA, 2001) and EPA guidance for QAPPs (U.S. EPA, 2002) to the extent practical and applicable.

In accordance with EPA (U.S. EPA, 2001, 2002) guidance and regulations, each QAPP will address the following four basic elements:

1. **Project management**: identifies project administrative functions and project concerns, goal(s), and approach(es) to be followed

2. **Data generation and acquisition**: describes methods for sampling, measurement and/or analysis, data handling, and QC

3. **Assessment and oversight**: details assessments or evaluations that will be used to determine whether the QAPP is being implemented as intended

4. **Data validation and usability**: addresses quality checks that occur after data collection to see that data conform to the project's objectives and estimate the effect of any deviations.

The remainder of this appendix describes each of these elements in more detail, as well as QA considerations for the use of existing data.

C.2.1 Project management

Project management, including the project history and objectives, roles and responsibilities, and required documentation, helps ensure that the project has a defined goal, that the participants understand the goal and approaches to be used, and that the planning outputs have been documented. Key elements of project management are discussed in more detail below.

Project organization

This element of a QAPP identifies the roles and responsibilities of individuals involved in the project. The overall QA organization and lines of communication for the Portland Harbor NRDA are shown in Figure C.1. Individuals will be designated in the QAPP to fill the roles depicted in Figure C.1 and described below.

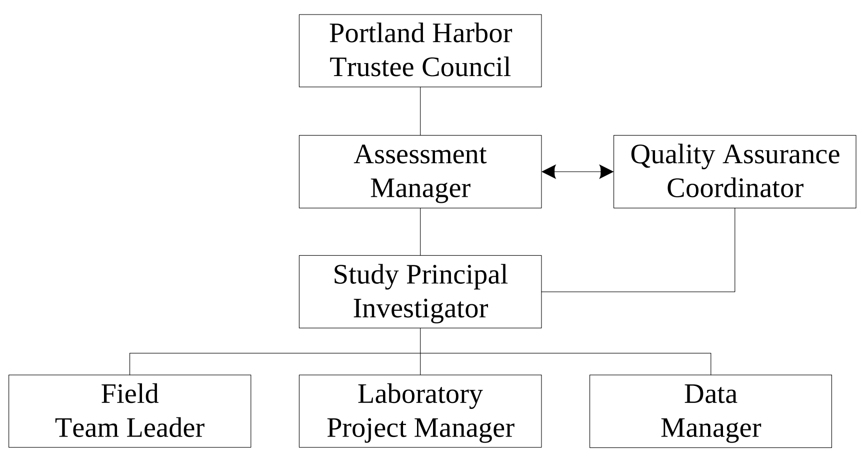

Figure C.1. Project QA organization chart.

The *Assessment Manager* is the designated Trustee Council representative (from the National Oceanic and Atmospheric Administration, Oregon Department of Fish and Wildlife, the U.S. Fish and Wildlife Service, or one of the Tribes) who is responsible for the review and acceptance of the QAPP and ensuring that Trustee agency efforts are coordinated with the Portland Harbor NRDA.

A *QA Coordinator* will be appointed by the Trustee Council. The QA Coordinator is responsible for quality planning and review; conducting audits; ensuring implementation of project and overall QA plans and procedures; archiving samples, data, and documentation supporting data; and reporting to the Trustee Council. The QA coordinator acts independently from those generating project information (U.S. EPA, 2002).

The *Study Principal Investigator (PI)* ensures that QA guidance and requirements are followed. The PI or a designee will note significant deviations from the QA plan and report them to the Assessment Manager and QA Coordinator.

Depending on the elements of the study, one or more managers will be employed to supervise day-to-day investigations. A *Field Team Leader* will supervise field investigations and is responsible for all field QA procedures defined in the QAPP. A *Laboratory Project Manager* will supervise, monitor, and document all laboratory QA procedures. A *Data Manager* will coordinate the implementation of data handling QA procedures.

Problem definition/background

This element presents an overview of the problem to be solved by conducting the study, as well as any pertinent background information (U.S. EPA, 2002). The Trustee Council will clearly define why the study is being conducted in this section, which will serve as the basis for all of the sections of the QAPP that follow.

Project/task description

This element presents an overview of the work to be performed and the intended products. The Trustee Council will describe the approach taken to address the study objectives. Information presented here may include a description on the information to be collected, contaminants of concern, sampling locations, number of samples, and a project schedule.

Quality objectives and criteria for measurement data

This element describes quality specifications for the study, such as measurement performance or acceptance criteria. The Trustee Council will develop these criteria to ensure that the quality of data produced is sufficient to meet project objectives and to avoid decision errors or incorrect interpretations. Performance and acceptance criteria are often expressed in terms of seven principal data quality indicators (U.S. EPA, 2002):

- **Precision**: The measure of agreement among repeated measures of the same property under identical, or substantially similar conditions.
- **Bias**: The systematic or persistent distortion of a measurement process that causes errors in one direction.
- **Accuracy**: A measure of the overall agreement of a measurement to a known value.
- **Representativeness**: The degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.
- **Comparability**: The measure of confidence that one data set can be compared to another and can be combined for decision-making.
- **Completeness**: A measure of the amount of valid data needed.
- **Sensitivity**: The capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest.

Documents and records

This element includes information about the management of project documentation and records (U.S. EPA, 2001). The Trustee Council will describe the process for distributing the QAPP, Standard Operating Procedures (SOPs), and other documents. The Trustee Council will also present information to be collected and maintained during the study, such as documentation in field notebooks, operational records, Global Positioning System data, chain-of-custody forms, and other records.

C.2.2 Data generation and acquisition

Procedures for data generation and acquisition are addressed in a QAPP to ensure that appropriate methods for the study are employed and documented. In this section, the Trustee Council will describe requirements for the collection, handling, and analysis of samples; the use of data obtained from other sources; and management (i.e., compiling and handling) of the data.

This section will provide detailed information on methods to be employed in studies that is well documented and readily available to project participants (U.S. EPA, 2001). It will describe the experimental design, including the types and number of samples required, the sampling design, sampling locations and frequencies, and the rationale for the design. In addition, this section will describe or reference attached SOPs for sampling or data-generating methods, including information about sampling handling and custody; QC; instrument and equipment testing, inspection, and maintenance; instrument and equipment calibration and frequency; and inspection of supplies.

C.2.3 Assessment and oversight

Studies will be overseen and audited by the QA Coordinator or their designee to ensure the effectiveness of project implementation and associated quality activities. This section will present a description of the assessments to be used to achieve this goal, which may include surveillance, management systems reviews, readiness reviews, technical systems audits, performance evaluations, and evaluations of data quality (U.S. EPA, 2001). The Trustee Council will define success criteria and the scope of the authority of the assessors. Finally, the Trustee Council will establish procedures for the QA Coordinator to stop work if data quality is compromised and for reporting to the Assessment Manager.

C.2.4 Data validation and usability

Data validation and usability QA is conducted after the data collection phase is completed (U.S. EPA, 2001). The Trustee Council will present procedures to evaluate whether the data conform to the specified criteria and whether study objectives have been satisfied. This section will include a set of criteria that will be used to review and validate (accept, reject, or qualify) data objectively. To this end, the Trustee Council will have data validated by an independent third party.

C.3 Use of Existing Data

The Trustee Council intends to rely extensively on existing data for the NRDA. Although existing data from other investigations may not have been generated for the Trustee Council, they are cost-effective sources of information for the NRDA.

The Trustee Council will take several steps to ensure the appropriateness of existing data for NRDA (U.S. EPA, 2002).

- **Determine data needs**: Identify the type of data needed, determine criteria for the level of data quality required, and identify how data will be used.
- **Identify existing data sources**: Identify sources of data that may meet these needs.
- **Evaluate existing data**: Review available metadata (information describing the data and their quality criteria) to determine whether data are appropriate to use.
- **Document quality issues**: Document the process of evaluating the existing data and the outcome of the evaluation.

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