Final Lower Duwamish River NRDA Restoration Plan and Programmatic Environmental Impact Statement

June 2013

Prepared by the National Oceanic and Atmospheric Administration on behalf of the Lower Duwamish River Natural Resource Damage Assessment Trustee Council

Lower Duwamish River NRDA Restoration Plan and Programmatic Final Environmental Impact Statement

Project Locations:	***Duwamish River and Green River, King County, Washington***
Lead federal agencies for the Restoration Plan and the PEIS:	National Oceanic and Atmospheric Administration (NOAA) and U.S. Department of the Interior, Fish and Wildlife Service (DOI/FWS)
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Cooperating agencies and tribes:	Washington Department of Ecology (as lead state Trustee) and Washington Department of Fish and Wildlife, Suquamish Tribe, Muckleshoot Indian Tribe, U.S. Army Corps of Engineers, and U.S. Environmental Protection Agency
Comments/Contact Person:	Rebecca Hoff, NOAA DARC NW, 7600 Sand Point Way NE, Seattle, WA 98115, Email: DuwamishPEIS.DARRP@noaa.gov Comments must be received no later than 30 calendar days after the notice of availability for the Final PEIS is published in the Federal Register.
Administrative Record:	This Restoration Plan/Programmatic Environmental Impact Statement and its supporting documentation may be reviewed by contacting the case records manager Rebecca Hoff at 206-526-6276 or Rebecca.Hoff@noaa.gov.

ABSTRACT

Hazardous substance releases into the Lower Duwamish River (LDR) resulted in the contamination of the sediments and injuries to natural resources. The Elliott Bay Trustee Council (Trustees) is developing the Lower Duwamish River Natural Resource Damage Assessment (LDR/NRDA) to determine the extent of injuries to natural resources resulting from these releases. Natural resources include fish, shellfish, wildlife, sediments, and water quality, and the services they provide. Trustees are also determining how to restore injured natural resources and lost resource services. The Restoration Plan, which is also a Programmatic Environmental Impact Statement (PEIS) will guide implementation of LDR/NRDA restoration activities. The PEIS analyzes the environmental impacts of the alternatives considered by the Trustees to restore, replace, rehabilitate, and/or acquire the equivalent of the injured natural resources and their services. The Trustees evaluated three alternatives: the No-Action Alternative, which is required to be included in the analysis; the Species-Specific Restoration Alternative; and the Integrated Habitat Restoration Alternative. The Trustees' preferred alternative is Integrated Habitat Restoration, which is a comprehensive plan based on restoration of key habitats that, together, will benefit the range of different resources injured by releases of hazardous substances in the LDR. In addition, the Trustees have included a detailed description of the methodology considered for use in a settlement-based approach to injury assessment for the Lower Duwamish River. A draft RP/PEIS was made available for public review on May 22, 2009, with the comment period ending on July 28, 2009. In response to comments received on that draft, the Trustees added more detail about the injury assessment and restoration valuation methodology used in the LDR/NRDA, and made some other minor changes to address other comments. The Trustees released the Supplement to the draft RP/PEIS for additional review and comment on July 27, 2012, with the comment period ending on October 10, 2012. This Final PEIS was developed after consideration of all comments received.

EXECUTIVE SUMMARY

The Elliott Bay Trustee Council (Trustees) is developing the Lower Duwamish River Natural Resource Damage Assessment (LDR/NRDA) to determine the extent of injuries to natural resources, such as fish, shellfish, wildlife, sediments, and water quality, and the services they provide. The LDR/NRDA is being conducted pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, the Oil Pollution Act of 1990, and other applicable laws. Concurrent with the damage assessment process, the Trustees are conducting restoration planning to determine the best approach to restoring, rehabilitating, replacing, and acquiring the equivalent of the injured natural resources and their associated services. To guide the restoration process, the Trustees have prepared this Restoration Plan/Programmatic Environmental Impact Statement (RP/PEIS), with the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Department of the Interior, Fish and Wildlife Service (DOI/FWS) as the lead federal agencies. The cooperating agencies are the other Trustees, the U.S. Army Corps of Engineers (ACOE), and the Environmental Protection Agency (EPA).

The RP/PEIS will guide decision-making regarding the implementation of LDR/NRDA restoration activities. This plan is intended to expedite and provide a point of departure for future site-specific projects and facilitate the preparation of subsequent project-specific environmental documents through the use of "tiering." Project-specific National Environmental Policy Act (NEPA) environmental evaluation documents will be prepared for future restoration projects and will be referenced back to (tiered from) the RP/PEIS.

The overall goal of the Restoration Plan is to restore, replace, or acquire the equivalent of those natural resources injured as the result of hazardous substance releases. The PEIS analyzes the environmental impacts of the alternatives that may be employed by the Trustees to restore, replace, rehabilitate, and/or acquire the equivalent of the injured natural resources as well as the services they would have provided but for the hazardous substance releases and oil discharges to the environment of the Lower Duwamish River. Three alternatives were evaluated in the RP/PEIS: 1) No Action, an alternative that is required to be considered, under which the Trustees would not conduct restoration actions to restore natural resources; 2) Species-Specific Restoration, under which the Trustees would develop specific restoration actions designed to benefit individual species; and 3) Integrated Habitat Restoration, under which habitat complexes would be developed to benefit, directly or indirectly, the suite of natural resources that were injured by releases of hazardous substances into the LDR. The Trustees preferred alternative is the Integrated Habitat Restoration Alternative, which is a comprehensive plan based on restoration of key habitats that, together, will benefit the range of different resources injured by releases of hazardous substances in the LDR. This alternative best meets the needs of the Trustees' restoration goals and principles by maximizing ecological benefits for a wider range of natural resources and their associated services.

The Trustees have taken an ecosystem approach to planning for the implementation of restoration projects as part of the LDR/NRDA. Trustees established priority focus areas for restoration that fulfill CERCLA requirements (restoration with a strong nexus to the injured resources) and puts restoration in areas where habitat is scarce and essential for fish and wildlife in the Lower Duwamish River. Each Habitat Focus Area (HFA) places boundaries around important target habitat features and incorporates geographic boundaries, restoration site clusters, exposure to wave energy, location, maritime uses, land uses, and development. Four HFAs are covered under this document:

- **HFA1—Lower Duwamish River**, extending from the northern tip of Harbor Island upstream to North Winds Weir.
- **HFA2—Inner Elliott Bay Shoreline**, between the Duwamish head and Port of Seattle Terminal 91.
- **HFA3—Duwamish River Reach (farther upstream of the Lower Duwamish)**, which goes from upstream of North Winds Weir to the confluence of the Green and Black rivers.
- **HFA4—Green River Reach** (upstream from the Duwamish River Reach) which extends from the confluence of the Green and Black rivers to the boundary of the Lower Green River Watershed (as defined by Green/Duwamish and Central Puget Sound Water Resource Inventory Area 9 (WRIA 9)).

The Trustees' ability to restore injured resources and the approach required varies among the HFAs. Priority will be given to projects within HFA1—Lower Duwamish River and HFA2—Inner Elliott Bay. Projects in other HFAs will be subject to minimum size and project type restrictions, and will be acceptable for NRDA settlements only if they are a component of a settlement proposal that includes restoration in HFA1.

<u>Restoration Goals</u>

The overall goal of the Restoration Plan is to restore, replace, or acquire the equivalent of those natural resources injured as the result of hazardous substance releases. To accomplish this goal, the Trustees will restore important habitats that support injured resources. Estuarine and riparian habitats of the LDR are a fraction of their historic acreage; this lack of habitat is believed to be a limiting factor for many natural resources and services within this system. To restore injured resources and improve the LDR's ability to support these resources, the Trustees will consider rehabilitation, creation, and enhancement projects.

Trustees intend to restore habitats that rebuild marine and aquatic resources and services lost from contamination. Marshes and mudflats are a top priority, because of their high habitat value to the types of natural resources believed to have been injured by releases of hazardous substances in the LDR. Riparian buffers, especially those adjoining marsh habitats, are also targeted because they support wildlife, filter runoff, and provide material inputs. The restoration of mudflats, marshes, and riparian buffers, especially in integrated habitat complexes, is the primary focus of the Trustees for the NRDA process because these have been determined to have the most direct benefits to injured resources. However, Trustees will consider other project types that show clear benefits to injured natural resources.

Restoration in the LDR is constrained by commercial and industrial uses and other physical developments in the river and along the shorelines. Restoring areas of habitat within a system that has undergone such a high level of alteration and that supports numerous land use types—including industry, commercial, residential, open space, and urban infrastructure—without negatively affecting those existing uses is challenging, but there are several examples of successful habitat restoration projects that have been built in the LDR without negatively impacting existing uses. Primary objectives of the Trustees for the LDR include:

1. Implement restoration with a strong nexus to the injuries caused by releases of hazardous substances in the Lower Duwamish River.
2. Provide a net gain of habitat function beyond existing conditions for injured fish and wildlife by restoring important habitat types and the physical processes that sustain them.
3. Integrate restoration strategies to increase ecosystem structure and function.
4. Preserve existing threatened functioning habitats while enhancing or creating new high-value habitats.
5. Coordinate restoration efforts with other planning and regulatory activities to maximize restoration potential.
6. Ensure that restoration sites and associated habitat functions are preserved in perpetuity.
7. Involve the public in restoration planning and implementation through education and outreach.

An initial draft RP/PEIS was made available for public review on May 22, 2009, with the comment period ending on July 28, 2009. A supplement to the RP/PEIS was available for public review from July 27, 2012, to October 10, 2012. In the supplement to the RP/PEIS, the Trustees added more detail about the injury assessment and restoration valuation methodology used in the LDR/NRDA, as requested in some of the comments received on the initial draft, and made some minor changes to address other comments.

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ACRONYMS AND ABBREVIATIONS

AET—Apparent Effects Threshold

ACOE—U.S. Army Corps of Engineers

CERCLA—Comprehensive Environmental Response, Compensation, and Liability Act

CEQ—Council on Environmental Quality

Cfs—Cubic feet per second

CWA—Clean Water Act

DOC—U.S. Department of Commerce

DOI—U.S. Department of the Interior

EBDRP—Elliott Bay/Duwamish Restoration Program (EBDRP)

ECY—Washington State Department of Ecology

EPA—U.S. Environmental Protection Agency

ESA—Endangered Species Act

HFA—Habitat Focus Area

HSI—Habitat Suitability Indices

LDR/NRDA—Lower Duwamish River Natural Resource Damage Assessment

MLLW—Mean Lower Low Water

MSQS—Marine Sediment Quality Standards

NEPA—National Environmental Policy Act

NOAA—National Atmospheric and Oceanic Administration

NRDA—Natural Resource Damage Assessment

PAH—Polycyclic aromatic hydrocarbons

PCBs—Polychlorinated biphenyls

PRP—Potentially Responsible Party

OPA—Oil Pollution Act of 1990

RCRA—Resource Conservation and Recovery Act

RI—Remedial Investigation

RI/FS—Remedial Investigation and Feasibility Study

RM—River mile

RP/PEIS—Restoration Plan/Programmatic Environmental Impact Statement

SEPA—State Environmental Policy Act

SOC—Substance of Concern

TOC—Total Organic Carbon

WRIA 9—Green/Duwamish and Central Puget Sound Water Resource Inventory Area 9

1. PURPOSE AND NEED

1.1 Introduction

This Restoration Plan and Programmatic Environmental Impact Statement (RP/PEIS) is designed to coordinate and implement restoration projects for the Lower Duwamish River Natural Resource Damage Assessment (LDR/NRDA). This document does not quantify the extent of restoration needed to satisfy claims under applicable law against parties deemed responsible for environmental injury. The scale of restoration activity that will be implemented under this RP/PEIS will depend upon the funds, property, and services made available through resolution of natural resource damage claims.

The Elliott Bay Trustee Council (Trustees) is developing the LDR/NRDA to determine the extent of injuries to natural resources, such as fish, shellfish, wildlife, sediments, and water quality, and the services they provide. Natural resource services are defined as the functions performed by a natural resource for the benefit of another natural resource and/or the public (15 CFR Subpart C §990.30). The LDR/NRDA is being conducted pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), the Oil Pollution Act of 1990 (OPA), the Clean Water Act (CWA), and other applicable laws.

Concurrent with the damage assessment process, the Trustees are conducting restoration planning to determine the best approach to restoring, rehabilitating, replacing, and acquiring the equivalent of the injured natural resources and their associated services. To guide the restoration process, the Trustees have prepared this RP/PEIS**,** with the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Department of the Interior, Fish and Wildlife Service (DOI/FWS) as the lead federal agencies. The cooperating agencies are the other Trustees (listed in Section 1.4), the U.S. Army Corps of Engineers (ACOE), and the Environmental Protection Agency (EPA).

A previous draft RP/PEIS was made available for public review on May 22, 2009, with the comment period ending on July 28, 2009. In the Supplement to the draft RP/PEIS, the Trustees added more detail about the injury assessment and restoration valuation methodology used in the LDR/NRDA, as requested in some of the comments received on the previous draft, and made some minor changes to address other comments. This final RP/PEIS was developed after considering comments received on both of the earlier drafts.

1.2 Purpose and Need for Action

Natural resource trustees are authorized under CERCLA, and other statutes referenced above, to evaluate potential injury to natural resources from releases of hazardous substances and, if warranted, to take actions that restore, replace, rehabilitate, and/or acquire the equivalent of the injured natural resources and their services. The LDR RP/PEIS discusses two potential approaches toward restoring injured natural resources and services in the LDR, and evaluates them as to their likely effectiveness and potential impacts on the environment. This RP/PEIS will also provide guidance to the Trustees in their decision-making regarding the implementation of the LDR/NRDA restoration activities. The need for this type of guidance arises because of the complicated situation in the LDR: widespread, historic contamination with liability being assigned to numerous potentially responsible parties (PRPs) who have owned, operated, or are operating facilities along the river. The PRPs, as well as the public, need to be fully informed of the decision-making process to be undertaken by the Trustees in order to properly engage in the process. Engagement in the process by all interested parties is a necessary component in the expeditious settlement of Natural Resource Damage liabilities.

If settlements are reached with potentially responsible parties, restoration projects will be conceptualized and designed as a result of individual or group settlements. This restoration plan articulates the Trustees' priorities for locating and designing these restoration projects in the LDR (HFA1), Elliott Bay (HFA2) and the lower Green River (HFA3 and HFA4). Details on each specific project will be discussed in a separate National Environmental Policy Act (NEPA) document.

1.3 Legal Mandates and Authorities

The RP/PEIS will guide decision-making regarding the implementation of LDR/NRDA restoration activities. The RP/PEIS is intended to expedite and provide a point of departure for future site-specific projects and facilitate the preparation of subsequent project-specific environmental documents through the use of "tiering."[1] The RP/PEIS was developed in accordance with the NEPA, and may be adopted by the State of Washington under its State Environmental Policy Act (SEPA). Project-specific NEPA environmental evaluation documents will be prepared for future restoration projects and will be referenced back to (tiered from) the RP/PEIS. Should unusual conditions warrant, the Trustees could apply any of the environmental evaluation documents provided by the NEPA process—such as an Environmental Impact Statement (EIS), supplemental EIS, categorical exclusion, or other documentation supported by the policies of each federal trustee—for implementing NEPA. Selection of the appropriate process will be decided by the Trustees with input from the public.

This RP/PEIS analyzes the environmental impacts of the alternatives that may be employed by the Trustees to restore, replace, rehabilitate, and/or acquire the equivalent of the injured natural resources as well as the services they would have provided but for the hazardous substance releases and oil discharges to the environment of the LDR. After consideration of comments received, the Trustees prefer the Integrated Habitat Restoration Approach, which is a comprehensive plan based on restoration of key habitats that, together, will benefit the range of different resources injured by releases of hazardous substances in the LDR. This alternative best

[1] Tiering is a staged analytical approach to NEPA defined in §1508.28 of the Council on Environmental Quality's (CEQ's) *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act* (40 CFR 1500 – 1508). Tiering addresses the coverage of general matters in broader environmental impact statements with narrower analyses concentrating solely on the issues specific to the subsequent statement .In our case, the Restoration Plan and Programmatic Environmental Impact Statement would be the broad analysis, and the appropriate project-level NEPA assessments would be done subsequently as specific restoration projects are proposed.

meets the needs of the Trustees' restoration goals and principles by maximizing ecological benefits for a wider range of natural resources and their associated services.

1.4 Natural Resource Trustees

Natural resource trustees act on behalf of the public to manage, protect, and restore natural resources. Stewardship of the nation's natural resources is shared among several federal agencies, states, and tribal trustees. The designation of trustees is explained in CERCLA (42 U.S.C. 9607(f)). During Natural Resource Damage Assessments, the trustees assess natural resource injuries resulting from oil discharges, hazardous substance releases, or vessel groundings. Trustees determine how to restore and compensate the public for such injuries, and seek funds to implement restoration projects from PRPs or reach settlements for PRPs to build these projects.

Natural resource trustees for Elliott Bay and the LDR established the Elliott Bay Trustee Council which operates under a 2006 Memorandum of Agreement (MOA). Members of the Elliott Bay Trustee Council are the National Oceanic and Atmospheric Administration of the U.S. Department of Commerce; the U.S. Department of the Interior, which includes the Fish and Wildlife Service and the Bureau of Indian Affairs; the State of Washington, including the Departments of Ecology (lead state trustee), Fish and Wildlife, and Natural Resources; the Muckleshoot Indian Tribe; and the Suquamish Tribe. Under the MOA, these governmental entities are collectively referred to as the "Trustees."

1.5 Differences between the Remediation Process and Natural Resource Damage Assessment

Trustees work in a complementary way with other agencies with CERCLA responsibility, such as EPA and the states. An effective response and/or remediation process will reduce the amount of injury to natural resources. Removal and remedial actions (collectively, "response actions") are conducted by EPA or state response agencies and focus on controlling exposure to released hazardous substances by removing, neutralizing, or isolating them in order to protect human health and the environment from harm. Although response actions can reduce the need for restoration, the two types of actions are separate and distinct. Trustees work to ensure that the remedies selected are protective of natural resources and consider the potential for deleterious impacts from cleanup actions when locating sites for restoration projects and timing their implementation.

Trustees support integrating restoration and remediation when this can be accomplished without slowing cleanup efforts, especially if this results in a more protective remedy, such as excavating more contaminated material from the site, or actions that improve habitat quality and/or quantity. Where possible, the Trustees' goal is to integrate restoration and remedial actions. Several potential sites for integrating remediation and restoration have already been identified in discussions with EPA and PRPs, and the Trustees will continue to seek such opportunities. It is important that these discussions occur early in order to maximize the chance of successfully accomplishing this goal, in part so it is clear what actions are being required for remediation and mitigation, and so the Trustees can determine what actions can be counted toward addressing a PRPs' NRDA liability. As this may not always be possible, the alternative is for NRDA restoration to take place once EPA- and state-led cleanups are complete or for restoration to occur in areas where recontamination from the cleanup is unlikely.

Restoration under CERCLA

Restoration actions for natural resource injuries and service losses under CERCLA are generally categorized as either "primary" or "compensatory."

Primary Restoration

Primary restoration is any action taken to enhance the return of injured natural resources and services to their baseline, i.e., the condition or level that would have existed had the hazardous substance releases not occurred. In many instances, the response actions undertaken at a site are sufficient to serve the purpose of primary restoration with natural recovery taking place within a reasonable period of time. As part of restoration planning for this site, the Trustees will consider the extent to which response actions undertaken as part of EPA's remedial process may be sufficient to allow natural resources and services to return to baseline without primary restoration actions by the Trustees. The Trustees are providing input to EPA in order to decrease the need for primary restoration actions. Therefore, our focus in this document will be on compensatory restoration.

Compensatory Restoration

Compensatory restoration actions compensate for resource injuries and services losses during the interim period until recovery to baseline occurs. Compensatory restoration is any action taken to compensate for interim losses, the reduction of resources and the services they provide relative to baseline levels, which occur from the onset of the injury until complete recovery of the injured resources or services.[2] The scale of the required compensatory restoration will depend both on the degree of the resource injuries and how quickly each resource and associated service returns to baseline. Remedial actions that facilitate or speed resource recovery reduce interim losses and the compensatory restoration required to offset those losses. Resource injuries and service losses caused by implementation of remedial actions are also injuries that may be compensated through appropriate restoration actions if not otherwise addressed through mitigation.

Cleanup of the highly industrialized LDR is being addressed through federal- and state-led remediation programs. Trustees work within the remedial process to improve the quality and scope of assessments in the remedial investigation. They provide input related to sampling plans and data interpretation of collected sediment, water, and tissue. In addition, Trustees provide input regarding potential impacts to trust resources, particularly through the ecological risk assessment process. As the process moves toward the feasibility study, Trustees recommend cleanup actions that will be protective in the long term and request long-term monitoring to track cleanup progress. Trustees encourage coordination among EPA, responsible parties, and

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[2] In the LDR/NRDA, the interim loss period is calculated from 1981 (after CERCLA was passed) until the projected recovery to baseline.

the Trustees to identify and incorporate restoration opportunities into the remedial process to create efficiency and more timely restoration.

For the LDR (including the Lower Duwamish Waterway Superfund site, the Harbor Island Superfund site, and the Lockheed West Superfund site) EPA-led Remedial Investigation and Feasibility Study (RI/FS) processes will serve as a means for investigating and determining remedial actions and source control efforts which are necessary or appropriate to eliminate unacceptable risks to the public and natural resources due to the contamination. Through the technical assistance they are providing to response agencies during these processes, the Trustees have and will continue to ensure the final remedy will both protect and facilitate the recovery of injured trust resources.

1.6 Overview of the Damage Assessment Process

Natural resource damage assessment is a complex process that may take years to complete. The three phases described below— Preliminary Assessment, Injury Assessment and Restoration Planning, and Restoration Implementation—provide a framework to structure the process..

1.6.1 Preliminary Assessment (Pre-Assessment)

The purpose of the pre-assessment screen is to provide a rapid review of readily available information to ensure that there is a reasonable probability of making a successful claim (i.e., there is likely to have been injury and damage to trustee resources). This work would include a review of existing information at the site along with applicable scientific literature. Based on the pre-assessment screen, the Trustees determine whether it is appropriate to move forward with the damage assessment process.

1.6.2 Injury Assessment/Restoration Planning

During the second phase, the Trustees quantify injuries to natural resources and the loss of resource services. This quantification can be done by conducting site-specific economic and/or scientific studies, especially if litigation is required. Alternatively, as discussed below, the results of injury studies conducted in similar areas and/or information in the scientific literature can be used to estimate injury using site-specific data (such as sediment contaminant levels). The results are used to develop a restoration plan that outlines alternative approaches to speed the recovery of injured resources and compensate for their loss or impairment from the time of injury to recovery.

Although the concept of assessing injuries may sound simple, understanding complex ecosystems, the services these ecosystems provide, and the injuries caused by oil and hazardous substances takes time—often years. The season the resource was injured, the type of oil or hazardous substance, and the amount and duration of the release are among the factors that affect how quickly resources are assessed and how quickly restoration and recovery occurs. The rigorous scientific studies that can be necessary to conclusively prove injury to resources and services may also take years to implement and complete. Trustees may not need to conduct detailed assessment studies if there is sufficient information available from the scientific literature, the results of other NRDAs, and studies conducted by the response agencies when determining what cleanup actions are needed in order to develop a reasonable estimate of injury to natural resources and services. Such estimates can often be used in settlement negotiations with cooperative PRPs and is the preferred method of the Trustees for the LDR/NRDA. However, even the development of injury estimates when appropriate data are available can be time-consuming.

Once injury assessment is complete or nearly complete, Trustees develop a plan for restoring the injured natural resources and services. Trustees must identify a reasonable range of alternatives, evaluate and select the preferred alternatives(s), and develop a draft and final Restoration Plan. Acceptable restoration actions include restoration, rehabilitation, replacement, or acquisition of the equivalent natural resources and services. Restoration actions are either primary or compensatory (see Section 1.5). Primary restoration is action taken to return injured resources and services to baseline, including natural recovery. Compensatory restoration is action taken to compensate for the interim losses of natural resources and/or services pending recovery. The type and scale of compensatory restoration depends on the nature of the primary restoration action, and the level and rate of recovery of the injured natural resources given the primary restoration action. When identifying compensatory restoration alternatives, trustees must first consider actions that provide services of the same type and quality and of comparable value as those lost. If compensatory actions of the same type and quality and of comparable value cannot provide a reasonable range of alternatives, Trustees then consider other compensatory restoration actions that will provide services of at least comparable type and quality as those lost. The restoration process and objectives are described in more detail in Section 6.4.

1.6.3 Restoration Implementation

The final phase is to implement restoration and monitor its effectiveness. Trustees work with the public to select and implement restoration projects. Examples of restoration include replanting wetlands and restoring salmon habitat. The PRP pays the costs of assessment and restoration and is often a key participant in implementing the restoration.

1.6.4 Current Stage of Natural Resource Damage Assessment in the Lower Duwamish River

For the LDR/NRDA, the Trustees are currently in the second phase—Injury Assessment and Restoration Planning. Trustees have begun the process of assessing injury in the LDR based on the results of remedial investigation studies, studies conducted as part of the Commencement Bay NRDA process, and scientific literature. Restoration planning is also underway. Restoration at locations where there would be little risk of the restoration project becoming contaminated from the surrounding area could be implemented relatively quickly. However, it can take significant time to locate and acquire property, develop restoration project designs, and undergo regulatory review and permitting.

In some locations, there is a significant risk of a restoration project being contaminated if it is built before the completion of remedial actions in the area and before achieving source control. Restoration projects that are integrated with remediation cannot be constructed until the remediation is implemented. As a result, there may be some restoration projects built in the relatively near future, while other projects may have to wait until remediation is completed. Remediation throughout the LDR (encompassing all the National Priorities List (NPL) and Resource Conservation and Recovery Act (RCRA) sites) will occur over several years, so restoration actions will also likely take place over many years. While this is not an ideal situation, it is similar to what has occurred in other large NRDA cases, such as in Commencement Bay (Tacoma, WA). Therefore, the Trustees believe that this staggered approach to restoration can also occur successfully in the LDR. Successful completion of these projects and subsequent release of PRP liability will conclude the NRDA process.

1.7 Restoration Goals

The overall goal of the Trustees is to restore, replace, or acquire the equivalent of those natural resources injured as the result of hazardous substance releases. To accomplish this goal, the Trustees propose to restore important estuarine and riparian habitats that support injured resources. Estuarine and riparian habitats of the LDR are a fraction of their historic acreage and this lack of habitat is a limiting factor for many natural resources and services within this system. To restore injured resources and improve the LDR's ability to support these resources, the Trustees will consider rehabilitation, creation, and enhancement projects.

While CERCLA requires the Trustees to seek restoration of injured trust resources, their actions should benefit whole ecosystems by:

1. Meeting statutory objectives of restoring, replacing, rehabilitating, or acquiring the equivalent of natural resources and services injured or destroyed as a result of the release of hazardous substances and discharge of oil.

2. Providing alternatives for those natural resources that will not recover without efforts above and beyond regulatory requirements for source control, sediment cleanup, and habitat restoration (e.g., certain fish and wildlife species, and water quality).

3. Providing a diversity of sustainable habitat types within the LDR ecosystem to enhance fish and wildlife resources.

Restoration in the LDR is constrained by industrial uses and other physical developments in the river and along the shorelines. Restoring to historical (pre-1900s) conditions is not possible in a system that has undergone such a high level of alteration and that supports numerous land use types, including industry, commercial, residential, open space, and urban infrastructure. The existing state of development with all the physical alterations to the LDR system, but without the contamination from hazardous substance releases, is included within the concept of baseline for the LDR. The goal of the LDR/NRDA process is to restore injured natural resources to baseline, which we hope will be accomplished by the response actions without the need for Trustees to engage in active primary restoration, and restore lost interim services through restoration projects to improve the ecosystem of the LDR so that it can better support injured natural resources.

1.8 Need for Restoration Planning

The Duwamish River, once a wide meandering river with thousands of acres of mudflats and wetlands, was channelized and narrowed through filling projects by the 1940s (Figure 1). The river flows through a highly industrial area and numerous facilities line its banks. These include port facilities, manufacturing plants, chemical and solid waste recycling companies, ship repair yards, numerous combined sewer outfalls and over two hundred storm drains (EPA, 2007). In addition to industry, important uses of the waterway include fishing, recreation, and wildlife habitat. Resources at risk include resident and migratory birds, the benthic community, flatfish, and salmon, including Chinook salmon and steelhead, which are listed as threatened under the Endangered Species Act.

Cleanup of the highly industrial LDR is being addressed through EPA-led (CERCLA and RCRA) and Washington Department of Ecology–led programs. It is important to understand that while these response agencies have subdivided the LDR into several CERCLA and RCRA sites, the Trustees are treating it as a single site for NRDA purposes.

The Lower Duwamish Waterway Superfund site includes the five-mile stretch from the southern end of Harbor Island to slightly past the Turning Basin, upstream. Contaminants vary throughout the waterway, including polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), metals, phthalates, and dioxins/furans. The site was listed on EPA’s National Priorities List in 2001. Early Action sites have been identified to address highly contaminated areas ahead of the overall process. Some of the Early Actions are RCRA sites that were in progress prior to the Superfund listing, and others are high-priority sites based on existing sediment data. Overall, the site is in the final phase of the feasibility study, which will develop cleanup goals and provide alternatives to meet those goals.

The Harbor Island site was listed on EPA’s National Priority List in 1983 due to releases of lead from a secondary lead smelter on the island as well as the release of other hazardous substances (primarily fuels and oily wastes) from other industrial sources. There are upland units as well as four marine sediments units. Contaminants in sediment vary by location, including PCBs, PAHs, metals, and pesticides. Cleanup at two of the four sediment units have been completed (Lockheed Shipyard Sediment Operable Unit (OU) and Todd Shipyards Sediment OU), one has been determined as no action (West Waterway OU), and one is in a supplemental RI/FS (East Waterway OU) (EPA, 2005, 2007).

The Lockheed West Seattle Superfund site is located in the southwest corner of Elliott Bay and includes both the property occupied by the former shipyard and the areas of Elliott Bay and the West Waterway of the LDR (by Harbor Island) immediately adjacent to the former shipyard property. It was listed on EPA’s National Priority List on March 7, 2007 (EPA, 2008). Shipbuilding, ship repair, and ship maintenance activities at the facility resulted in contamination of aquatic sediments. Contaminants of potential concern include, but are not limited to, PCBs, PAHs, mercury, other metals, and other organic compounds.

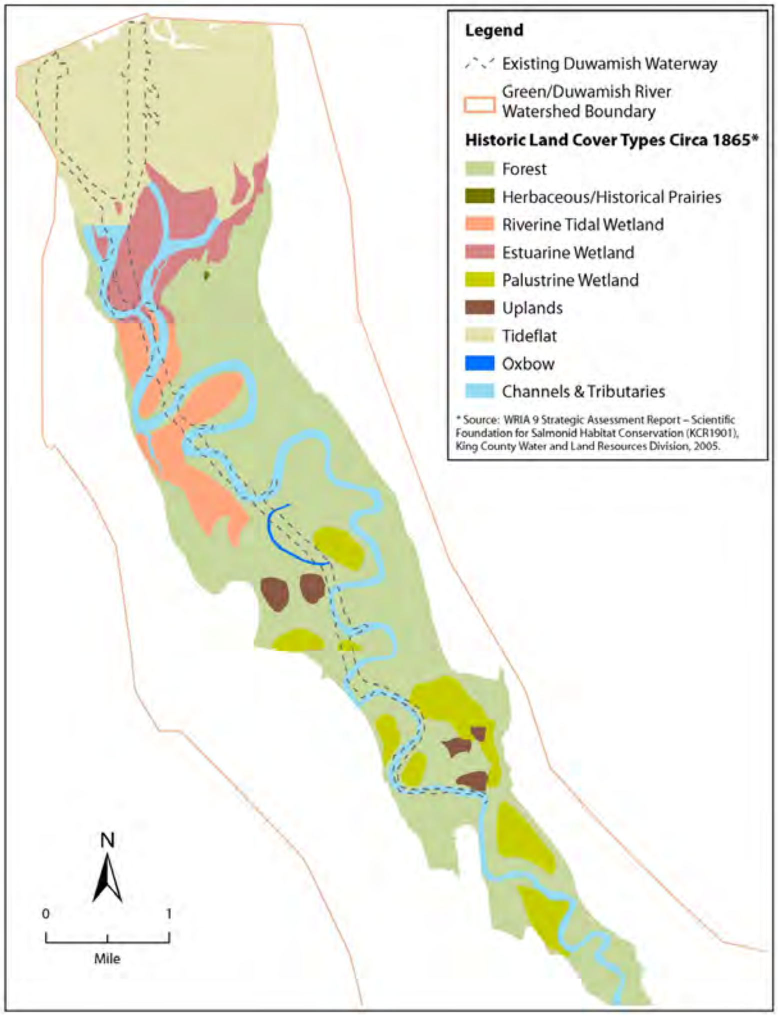

Figure 1. Historic view of the Lower Duwamish River before straightening, showing oxbows and current river channel (dotted line).

Pacific Sound Resources, formerly known as the Wyckoff West Seattle Wood Treating facility, is located on the south shore of Elliott Bay on Puget Sound, just outside the mouth of the Duwamish River. It was listed on EPA's National Priority List in 1994 (EPA, 2010). Wood-treating activities over nearly 90 years resulted in creosote and PAH contamination of intertidal and subtidal sediments and groundwater. A bankruptcy settlement entered in August 1994 covered remediation and restoration. Funds were designated for NRD restoration that included both the West Seattle and Bainbridge Island Wyckoff sites (U.S. District Court, 1994).

The present-day LDR ecosystem has habitat limitations that constrain fish and wildlife populations. The Green/Duwamish River watershed is one of the most hydrologically altered in the Puget Sound basin. To date, 97 percent of the Green/Duwamish River estuary wetlands have been dredged or filled, 70 percent of the historic flows from its former watershed have been diverted out of the basin, and about 90 percent of the floodplain is disconnected from the river (Figure 1). The Green/Duwamish River is still a viable habitat for fish and wildlife; however, many of the watersheds' anadromous fish are now produced by hatcheries. Some native populations of fish and wildlife are in decline and the watershed is increasingly urbanized. Despite this, important opportunities exist to restore ecosystem functions and processes to create and maintain natural habitats over time. Four species of anadromous fishes have been listed as threatened or endangered under the Endangered Species Act in Puget Sound and Western Washington: Chinook and coho salmon, bull trout (ACOE, 2000) and steelhead (NOAA, 2007).

Through the NRDA process, the Trustees examine the injuries to natural resources such as fish, wildlife, sediments, and water caused by releases of hazardous substances and discharges of oil. The Trustees calculate damages attributable to the injuries (in terms of dollars, lost acre-years of habitat, etc.) and recover the damages from parties who have caused the injuries. By law, the Trustees must use the recovered damages to restore, rehabilitate, replace, or acquire the equivalent of those injured natural resources and services. To determine what type of restoration is appropriate, the NRDA process includes restoration planning. Public participation is an important component of restoration planning by helping the Trustees select, shape, and protect restoration projects.

1.8.1 Purpose of Restoration Planning

The restoration approach for the LDR/NRDA is based on a combined knowledge of the natural processes of the waterway and estuarine environments, the nature and extent of contamination, and current plans for cleanup actions by response agencies. In addition, the factors responsible for wetlands loss, the techniques available for restoration, and experience gained from previous restoration projects in the Lower Duwamish inform the plan. Based on this knowledge, the Trustees drafted this document to provide a fit between established restoration techniques and the problems and resources of specific areas.

The restoration plan will:

1. Meet statutory objectives of restoring, replacing, rehabilitating, or acquiring the equivalent of natural resources and services injured or destroyed as a result of releases of hazardous substances.

2. Provide a diversity of sustainable habitat types within the LDR ecosystem to enhance fish and wildlife resources.

1.8.2 Benefits of Restoration Planning

Most of the Duwamish River's wetlands and mudflats have disappeared, and the restoration strategy proposed in this plan addresses the lack of valuable habitat in a comprehensive manner. Any restoration project implemented under this plan will be required to remain as habitat in perpetuity and not be subject to future development. Implementation of the projects proposed in this plan would have major regional benefits, including, but not limited to:

1. Protecting federal, state, and tribal Trust Natural Resources.

2. Enhancing the physical nature of existing degraded habitat.

3. Improving existing ecosystem functions and processes.
4. Addressing limiting factors to fish and wildlife production.
5. Restoring degraded habitats for anadromous fish.

2. INJURY ASSESSMENT METHODOLOGY

2.1 Introduction to Habitat Equivalency Analysis (HEA)

One methodology the Trustees propose to use for injury assessment and restoration scaling is Habitat Equivalency Analysis (HEA). HEA enables Trustees to apply a consistent approach based on a described methodology, relying on the best available scientific information and utilizing existing data sets collected by the state, EPA, and private parties. Because HEA can assess both injury impacts and beneficial effects from restoration, it enables the Trustees to scale restoration appropriate to the injury when evaluating settlements with responsible parties.

HEA is an economic model used as a tool to estimate the amount of habitat restoration that is needed to produce environmental gains sufficient to compensate for losses resulting from natural resource injuries. HEA is commonly used to estimate the amount of compensation required to address natural resource injuries resulting from discharges of oil and releases of hazardous substances. HEA is an example of a service-to-service approach to determining the scale of a restoration project or projects that will ensure that the present discounted value of natural resource service gains equals the present discounted value of interim natural resource service losses (NOAA, 2006). "Natural resource services" are defined as the functions performed by a natural resource for the benefit of another natural resource and/or the public (15 CFR Subpart C §990.30). In an HEA (also known as Resource Equivalency Analysis, or REA[3]) the Trustees develop estimates for the duration and level of service losses until recovery to baseline. The HEA also estimates the amount of services to be provided by the compensatory restoration project over the lifetime of the project. The analysis determines the size of the restoration project needed to equal the total interim losses of service resulting from the injury. Additional information about HEA is available online at http://www.darrp.noaa.gov/economics/papers.html. Appendix C also provides a detailed description of services and service losses.

HEA has been used successfully in a number of natural resource damage cases around the country for settlements as well as for litigated claims.[4] HEA has been used as the method for estimating natural resource injuries and the scale of restoration necessary to address these injuries in most of the NRDA settlements for the past several years (Roach and Wade, 2006; Zarafonte and Hampton, 2007). Its use as an appropriate methodology for determining the amount of compensatory restoration needed to address natural resource injuries is supported

[3] The HEA method is specifically used in cases of habitat injury when the service of the injured area is ecologically equivalent to the service that will be provided by the replacement habitat. This is termed service-to-service approach. When used for scaling losses of fish, birds, and other wildlife, the method is sometimes termed resource equivalency analysis (REA).

[4] *United States v. Fisher*, 977 F.Supp. 1193 (S.D. Fla. 1997); *State of Idaho, et al. v. The M.A. Hanna Company, et al.*, No. 83-4179, Consent Decree (D. Idaho Sept. 1, 1995).

by two recent Court decisions.[5] Moreover, in the LDR, the Trustees are using a HEA approach very similar to that used in Commencement Bay, Washington. Specific details of how that HEA approach was modified for the LDR are described in Appendices C, D, E, and F of this document.

2.2 Lower Duwamish River Habitat Equivalency Description

Because of the central role that sediments and the sediment-based biological community play in the LDR environment, the Trustees have decided to quantify natural resource injuries for settlement purposes in terms of affected habitat rather than numbers of individual species impacted. HEA is an ecosystem approach that in the LDR, focuses on assessing injury to benthic habitat. As the foundation for a complex web including small animals and plants, fish and birds, the benthic habitat is essential for a healthy aquatic ecosystem (See Figure 2). By benthic habitat we mean the bottom of the river and the plants and animals that live there or use the habitat for feeding, etc. To determine how much habitat restoration needs to be developed to compensate for contaminant-related injuries to marine sediments, the Trustees use the concept of *ecological services* (see Appendix C). The LDR HEA calculates the amount of ecological services lost as a result of contamination, and the amount of ecological services that would be gained from restoration projects, making past and future losses and gains comparable by applying a discounting factor. The results of the calculations are stated in terms of *discounted service acre-years*[6] *(DSAYs)*.

In determining the amount of ecological services lost due to sediment contamination, the Trustees take into consideration the type of habitat affected and its importance to key species. The Trustees reviewed scientific literature, technical data, applicable regulatory standards and the results of their own studies to determine the effect that varying concentrations of hazardous substances in sediment have on key species or species groups. This information was used to develop a series of concentration threshold levels for each hazardous substance, which are assigned a corresponding percent reduction in ecological services per acre of affected habitat. Using a geographical information system (GIS) and data developed by the Trustees and by PRPs, the Trustees calculate the acreage of areas exceeding the sediment contamination threshold criteria, taking into account whether areas were slated for remediation or natural recovery and when natural resource injuries are likely to cease. In addition to the sediment contamination, the Trustees determined whether ecological services provided by the habitat were diminished because of the effect of over-water structures. The Trustees also adjusted the level of ecological services assigned to certain areas depending upon the nature of adjacent habitats.

In its simplest form, HEA considers how much of a particular environmental component was lost (*e.g.*, number of acres destroyed, numbers of fish lost, etc.), to calculate how much restoration would be required to generate a net gain of an equivalent amount of the lost component. Because environmental losses and gains are not experienced at a single point in

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[5] *United States v. Fisher,* 977 F. Supp. 1193 – Dist. Court, SD Florida, Key West Div. 1997; *United States v. Great Lakes Dredge & Dock Company,* 259 F. 3d 1300 – Court of Appeals, 11th Circuit 2001.

[6] An acre-year represents the total level of ecological services provided by one acre of a habitat over a single year.

time, the calculation also takes into account the number of years of losses that were experienced and the rate at which losses and gains decrease or increase to determine the amount of gains the restoration must produce over what period of time (e.g., fish-years, acre-years, etc).

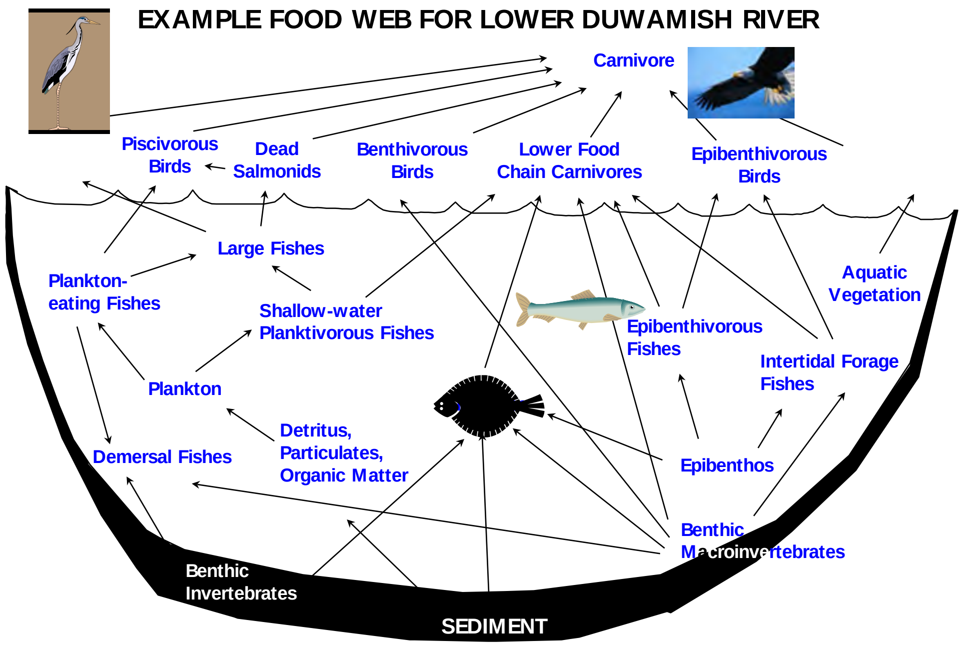

Figure 2. Example ecosystem food web, showing species used in the Lower Duwamish River HEA.

2.2.1 Discounting

HEA requires the Trustees take into account not just the number of years of losses and gains but the timing of the injuries, remediation, and restoration. Environmental losses and gains that occur at different points in time need to be equated in resolving natural resource damage claims. The Trustees are using HEA in essence to quantify natural resource damages in terms of environmental values rather than dollar values. However, by using non-monetary terms, the Trustees must ensure that any resulting settlement still adequately compensates the public for natural resource injuries. One important aspect of a monetary claim is the effect of the time-value of money. Payments made at different points in time have different values in the present. In order to compare payments made at different times, economists routinely apply a discount rate, compounding past gains and losses and discounting future gains and losses. If a discount rate were not applied to natural resource damage claims, the public would not be fully compensated, and responsible parties would have every incentive to put off settlement (and thus postpone restoration) as long as possible. To avoid this outcome, the LDR HEA applies a 3 percent discount rate to compound past environmental losses and discount future environmental gains and losses to a present value (NOAA, 1999).

2.2.2 Lower Duwamish River Habitat Equivalency Model

To apply the LDR HEA, the Trustees perform the following steps: 1) identify the environmental components to measure losses from natural resource injuries and gains from restoration actions; 2) identify and quantify the losses that occurred; 3) identify the time period over which the losses occurred, and the rate at which any changes in the losses occurred; 4) calculate the total losses over time and apply the discount rate to the losses to determine the present value of the total losses; and 5) determine what restoration actions need to be undertaken to generate ecological service gains with a present value equal to the total losses. Each of these steps are summarized below.

1. *Identify the environmental components to measure losses from natural resource injuries and gains from restoration actions.*

Hazardous substances released to the environment have tended to accumulate in the sediments of the Lower Duwamish River. The organisms that live in and on the sediment, and that are exposed to sediment contamination, form the base of the food web on which most of the fish, birds, and other wildlife that use the Duwamish River environment depend. As illustrated by Figure 2, contamination of the sediments consequently affects nearly all aspects of the Lower Duwamish ecosystem. As mentioned above, Trustee studies and other research have documented the contaminant-related impacts to salmon and flatfish as well as benthic invertebrates. Studies also show that several species of birds are being exposed to hazardous substances at potentially harmful levels (Johnson et al., 2009).

Studies and extensive sampling conducted through EPA's Superfund Remedial Investigation processes have delineated contaminated sediments throughout the LDR. Extensive studies conducted in other parts of Puget Sound (Commencement Bay) in addition to the Duwamish River, and the results of studies from elsewhere, have linked contaminated sediments with adverse impacts to trust resources, including flatfish, salmonids, and birds. Organisms can be exposed to contamination directly through contact with the sediments or water, or through the consumption of contaminated prey. But there can be injuries to resources outside of the LDR that are exposed to contaminants through other resources that had become contaminated in the Duwamish and then migrated to other areas in Puget Sound and beyond. A large number of different hazardous substances are contaminating LDR sediments and therefore a wide range of different types of adverse effects could occur to resources within the LDR and to resources outside the LDR that are indirectly impacted. The types of injuries to organisms can range from the minor effects (e.g., stimulation of enzyme pathways in response to contaminant exposure which results in the expenditure of energy in a detoxification process) to more serious impacts (e.g., impaired reproduction or death).

It would be extremely difficult and time-consuming to try to quantify injuries to all of the individual resources potentially impacted and to combine this information into resource service loss estimates for an HEA. The ecological service losses ultimately result from contaminated habitats, including those of the organisms that directly or indirectly depend on those habitats. Because of the central role that sediments and the sediment-based biological community play in the Duwamish Waterway, the Trustees decided to evaluate the potential loss of natural resources in terms of affected sediment habitat (i.e., loss of ecological services from the sediments) rather than numbers of individual organisms impacted. This was done using existing sediment chemistry data together with injury thresholds developed by the Trustees. More detail on this approach is presented in Appendix C.

Juvenile Chinook salmon and English sole were used as representative species to assess the value of habitat to fish. Although the various fish species in the Duwamish Waterway display a variety of life history requirements, juvenile Chinook salmon and English sole have feeding modes, behavioral characteristics, and habitat requirements that sufficiently overlap those of similar species to consider them appropriate surrogates. Four bird assemblages, representing the bird species occurring in the area, were used to assess the value of habitat to birds. The four bird assemblages are grouped according to their foraging behavior and include both resident and migratory species. These four assemblages are: 1) shallow-probing and surface searching shorebirds (e.g., sandpiper), 2) waders (e.g., great blue heron), 3) surface and diving birds (e.g., lesser scaup), and 4) aerial searchers (e.g., osprey). The bird assemblages use similar habitat as juvenile Chinook salmon, and are linked through their food webs, so habitat value for birds is linked to habitat value for juvenile salmon. Existing habitats in the River were classified and a determination made of the value, or ecological services, these habitats provided to the representative species. Although birds and fish were used to determine the value of restoration projects, a great many different species will benefit from these restoration projects, including clams and other shellfish that will have additional clean habitat to utilize from these restoration efforts.

Currently, the LDR environment is dominated by deep channels, uplands, and steep hard-surfaced (e.g., rip-rapped) banks. The habitats that are in short supply are intertidal mudflats and marshes. These latter types of habitats are ecologically important as food sources, rearing and refuge areas, and spawning and nursery habitat for a variety of LDR species. Because of their scarcity, these habitats serve as a limiting factor on the overall health of the LDR environment. As described in Section 1.7, the Trustees' restoration goals include developing a diversity of habitat types, with particular emphasis on habitats in short supply that are necessary to critical life stages of key injured species.

Trustees evaluated a range of habitat types in terms of their relative importance to impacted species. To keep the process manageable, the Trustees conducted the evaluation using Chinook salmon and English sole as representative fish species to assess the value of habitats to all fish. The Trustees used assemblages of bird species rather than individual species to assess habitat value to birds. Appendix D describes in detail the habitat needs of the selected species and assemblages.

Allowing for the creation of one habitat type to compensate for losses suffered in other habitat types requires the development of some means to equate different habitats. From a biological perspective, it is overly simplistic and difficult to calculate, for example, the amount of marsh habitat that needs to be created to compensate for contamination of LDR bottom sediments on a straight one-to-one, acre-for-acre basis. An acre-for-acre replacement approach does not take into account how the different habitats function or what ecological services the different habitats provide. Ecological services—providing food, cover, spawning, nursery or rearing habitat, refuge from predators, etc.—determine the value that different habitats have from a restoration perspective. As a result, the Trustees have decided to use the *ecological* *services* provided by the various habitats as the environmental component for measuring losses from natural resource injuries and gains from restoration actions. In essence, ecological services function as the currency for equating losses and gains for different habitat types (Appendix D).

2. *Identify and quantify the losses that occurred*

In order to use the ecological services currency to identify and quantify losses from natural resource injuries, the Trustees assigned an ecological services value to each of the injured habitats and the habitats potentially to be created through restoration actions. To compare different habitat types, the Trustees first identified a benchmark, or "gold standard," against which all habitat types would be measured. The Trustees reviewed scientific literature and consulted with experts to determine the benefits provided to key species by each of the other existing and potential LDR habitat types. Because of the Endangered Species Act listing of Chinook salmon and the significance of salmon to Indian Tribe Trustees and all regional populations, the Trustees weight habitats in terms of their importance to Chinook salmon at twice the value assigned due to their importance to flatfish or birds. Based on this analysis, the Trustees have created a matrix of assigned ecological service baseline values for the different habitat types that either exist now in the LDR or that may be the subject of restoration actions in the LDR. Since estuarine marsh habitats provide the greatest amount of ecological services to the species and species groups used as surrogates for all LDR resources, the ecological services provided by a given area of fully functioning estuarine marsh were chosen as that standard and assigned a baseline value of 1.0. The assigned baseline values range from 1.0 for fully functioning estuarine marsh, down to 0.1 for degraded habitat or areas of rip-rap. The following table shows the values assigned.

Table 1. Existing and Potential LDR Habitat Values

Habitat	**Fully Functioning**	**Baseline Adjusted**	**Degraded**
Estuarine Marsh	1.0	0.85	NA
Intertidal	0.9	0.75	0.1
Shallow Subtidal	0.7	0.55	0.1
Deep Subtidal	0.3	0.3	0.1
Rip-rap	NA	NA	0.1

The table introduces two additional habitat valuation concepts to the fully functioning concept: *baseline adjusted* and *degraded.* The Trustees adjust the baseline values of specific habitat areas to reflect the fact that habitats function in connection with each other. For certain habitat types to be fully functional, they must exist in conjunction with and interact with an adjacent habitat, often of a particular type, forming habitat complexes that enhance overall production. Habitats considered *baseline adjusted* do not have these adjacent habitats to enhance their function and are therefore assigned a lower value. For example, intertidal habitats not associated with an adjacent vegetated buffer or an adjacent, fully functioning marsh are designated baseline adjusted and given a value of 0.75. Based on a review of the physical characteristics present in the LDR, the Trustees have designated all existing intertidal and shallow subtidal habitats within areas contaminated above injury thresholds in the waterway as baseline adjusted.

The Trustees assign a designation of *degraded* to specific habitat areas to reflect the fact that hazardous substance contamination has not been the only source of harm to the LDR environment. LDR habitats have been degraded by development, physical modification, and non-hazardous pollution, among other things for which CERCLA does not authorize Trustees to recover natural resource damages. Degraded values are assigned when shading is cast by over-water structures. Over-water structures such as piers, aprons, buildings, etc., inhibit the production of benthic species that serve as food sources for fish. They also interfere with salmon migratory movements and feeding and render shaded areas less valuable for juvenile salmon.

To reflect the effects of these conditions, the Trustees assign a degraded value of 0.1 to intertidal and shallow subtidal habitats under over-water structures. The degraded classification is applied narrowly, only to situations causing severe physical impacts. Rip-rap is a special category of degraded habitat, reflecting its limited value to fish or birds. A more detailed explanation of the assignment of ecological service values and the underlying information and literature on which it is based can be found in Appendix D.

To quantify the impact of hazardous substances, the Trustees begin with the assumption that habitats contaminated to the point that they cause harm to species that use them provide less in the way of ecological services than do uncontaminated habitats. The Trustees reviewed scientific literature, technical data, applicable regulatory standards, and the results of their own studies to determine the effect that varying sediment concentration levels of the different hazardous substances have on key species or species groups. The Trustees judge contamination to be injurious when the concentration of the contaminants in the sediments is sufficient to result in an adverse effect to identified species. The adverse effects range from subcellular alterations up to mortality. The information shows that as hazardous substance sediment concentrations increase, the number of species adversely affected increases, and the effects themselves increase in severity. From this information, the Trustees have developed a series of concentration threshold levels for each hazardous substance, and have assigned to each threshold an increasing *percent reduction in ecological services* per unit of habitat. A description of this process, including tables showing threshold concentrations and percent service reductions, are included in Appendix D.

3. *Identify the time period over which the losses occurred, and the rate at which any changes in the losses occurred*

Once hazardous substances come to rest in marine sediments, many remain biologically available and can contribute to natural resource injuries over an extended period of time. The contaminants can cause ecological service reductions over a series of years, beginning when the concentrations reach injurious levels and continuing until the sediments are remediated or naturally recover. There are at present in the LDR some prominent areas of sediments contaminated by PCBs, for example, years after their production and use in the United States was banned. Releases of contaminants to the LDR, and resulting natural resource injuries, have occurred over many years. Significant efforts by industry and regulatory agencies to control many releases did not begin in earnest at some LDR facilities until well into the 1980s or later. Much of this effort has only begun to have an impact on sediment contamination.

Although natural resource injuries have apparently been occurring for decades, CERCLA precludes recovering natural resource damages where the damages and the releases from which the damages resulted occurred wholly before December 11, 1980. CERCLA's stipulation that both the releases and damages must have occurred prior to that date to be exempt from the statute means that the Trustees can legally seek compensation for natural resource damages that occurred after that date even if the release that resulted in the damages occurred before it. The Trustees ultimately must exercise their discretion and authority in determining, within the limits of CERCLA, what compensation they will consider appropriate from the PRPs for natural resource injuries. In the LDR, the Trustees have focused on restoration that would be scaled based on ecological service losses post-CERCLA (1981) through the completion of natural recovery following remediation.

The Trustees assume that service losses from contamination have occurred and will continue to occur at a constant rate until completion of remediation. Once the remediation is completed, the Trustees assume that ecological services provided by the affected area will increase at a constant rate until the area produces the services it would otherwise produce but for the contamination. The Trustees factor in the latest information on scheduled or proposed remediation and the estimated year they are expected to be completed. Trustees assume that areas subject to active remediation will recover to full service levels 4 to 10 years after remediation (depending on the type of remediation), and that areas subject to natural recovery will take 25 years to recover.[7]

4. *Calculate the total losses over time and apply the discount rate to the losses to determine the present value of the total losses*

To pull together the assignments of habitat ecological services, designation of degraded areas, and service reductions from contamination, and to show the effect of remedial plans, the Trustees have compiled a database of relevant information and used that database to develop a series of maps using a geographical information system (GIS). The Trustees developed GIS map layers showing habitat types (in terms of water depth and type of substrate, reflecting judgments about degraded conditions), baseline adjustments, areas exceeding hazardous substance threshold concentrations, and areas for which active remediation is planned. When the map layers are overlaid, the result is a combined map showing a series of patches or polygons, each with a unique combination of ecological characteristics. Figure 3 presents a portion of the GIS map for the LDR showing the polygons generated by the combined map layers.

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[7] Presumably, areas actively dredged as part of the remedial process will have injurious concentrations of contaminants immediately removed. However, it will take time for benthic organisms to re-colonize these areas to the point that they are generating the levels of ecological services they would be expected to produce.

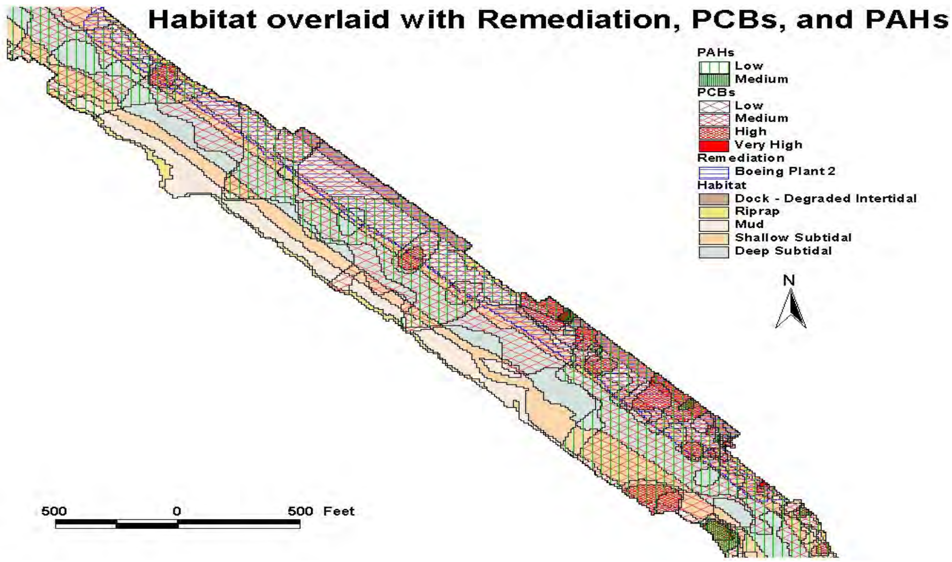

Figure 3. GIS map showing polygons generated by combined map layers

All available surface sediment data (pre-remediation) within the boundaries of the Lower Duwamish River are compiled, quality checked and added to NOAA's Query Manager Database for Puget Sound. This database is publically available online at: http://response.restoration.noaa.gov/maps-and-spatial-data

Appropriate types of data for the contaminants of concern to the Trustees (listed in Table 2) are extracted from Query Manager. These data points are mapped using a spatial data analysis called "inverse distance weighting" [8] to average concentration of each contaminant and create a contaminant "footprint." Values of sediment contamination are compared to values known to adversely impact benthic organisms and higher level predators. When actual contamination values exceed the toxicity threshold (service loss levels) of toxicity to aquatic animals and plants, this constitutes a service loss, or injury.

By comparing data on surface sediment concentrations (collected before remedial activities) to injury thresholds, injury maps are created for each contaminant of concern. Darker colors indicate higher levels of service losses (i.e., greater injury). Data from individual stations are averaged using inverse distance weighting.

[8] Inverse distance weighting is a method of determining the characteristics of objects from those of nearby objects. At locations where data has not been sampled, values are estimated, based on nearby sample values. More information is available online at http://www.ncgia.ucsb.edu/pubs/spherekit/inverse.html. A description of inverse distance weighting and its use in the HEA can be found in Appendix E: How habitat and sediment injury information is mapped via a geographic information system (spatial analysis of sediment chemistry data), prepared for The Commencement Bay Natural Resource Co-Trustees, February 28, 2002. Available at: http://www.cbrestoration.noaa.gov/documents/cbhy-e.pdf

Table 2. Substances of Concern for the Lower Duwamish River NRDA

Metals	**Phenols**
Arsenic	4-methyl phenol
Cadmium	2,4-dimethyl phenol
Chromium	Phenol
Copper	Hexachlorobutadiene
Lead	**Phthalates**
Mercury	bis(2-Ethylhexyl) phthalate
Silver	Butylbenzyl phthalate
Zinc	Di-n-butyl phthalate
Tributyltin	Di-n-octyl phthalate
Chlorobenzenes	dimethylphthalate
1,2-dichlorobenzene	**Pesticides**
1,4-dichlorobenzene	DDD
1,2,4-trichlorobenzene	DDE
Hexachlorobenzene	DDT
Other	
PAHs (total)	
PCBs (total)	

The particular combination of characteristics and habitat types that define a polygon generates a specific value of ecological service loss for that polygon. Taking into account the size of the polygon, and applying assumptions about the timing of remedial action and rates of recovery for remediated and un-remediated areas, a value of service acre-years loss is generated for the polygon. Adding those figures for all polygons produces a total service acre-years loss for the waterway as a whole. Applying the 3 percent discount rate to past and future losses to determine their present value results in a calculation of a total *discounted service acre-years (DSAYs)* loss.

5. *Determine what restoration actions need to be undertaken to generate ecological service gains with a present value equal to the total losses*

Calculating the amount of restoration needed to compensate for the natural resource injuries follows a similar analysis, using the same assumptions. As the goal of natural resource damage assessment is to compensate the public for natural resource losses, the objective of a restoration-based settlement must be to produce ecological service gains that would not otherwise occur that are equivalent to the calculated service losses.

To judge the gains expected from an individual proposed restoration project, the Trustees begin by calculating the present value of the ecological services the project site would generate without the restoration project. The Trustees analyze the current condition of the project site to determine the type of habitat present and the level at which it is functioning, and make informed judgments about any potential change in the service levels the site would provide without the project into the future. This information is used to calculate the present value of the total service acre-years the site would provide if the project were not built. A proposed project design must then be developed and reviewed to determine the types of habitat and levels of services the project will provide once constructed. The services to be provided each year of the project are summed up and the present value of the total service acre-years calculated. Subtracting the DSAYs produced by the site without the project from the DSAYs to be produced by the site assuming the project is constructed generates the total DSAY gain from the project.

Since proposed projects have obviously not yet been constructed, the Trustees must predict the likelihood of project success and the rate at which project elements may change over time (e.g., growth rate for vegetation) based on their own experience and the experience of others. Appendix C details the information and analysis Trustees have used in developing projections for the time different habitats will require to reach full function. Chapters 6 and 7 describe example restoration projects of types the Trustees expect to be developed and illustrate how the Trustees will evaluate the DSAY credit to be granted to proposed projects.

2.2.3 Allocation of Liability

Releases of hazardous substances into the LDR have become commingled and have likely combined to cause injury to trust resources. Under these circumstances, the law holds any party contributing to the contamination to be jointly and severally liable for the whole injury; however, in order to encourage settlement, the Trustees have attempted to apportion settlement shares among responsible parties. The Trustees have allocated the proposed settlement among LDR facilities or sites, and have not attempted to apportion liability among multiple parties responsible for individual sites or facilities. They have relied upon publicly available data and information, obtained mainly from the files of EPA and the Washington Department of Ecology, along with information obtained from public libraries. Details of the allocation process are discussed in more detail in Appendix F.

The Trustees' allocation analysis is designed to be fair and equitable to PRPs while ensuring that the interests of the public are appropriately served. To trigger allocation of liability to a site there has to be evidence of a pathway for water or sediment to travel from the site to the LDR, and evidence of an activity conducted at the site that is a likely source of a substance of concern. In addition, there has to be evidence of actual environmental contamination by the hazardous substance due to a water pollution control permit violation; the presence of contamination in surface water, groundwater, soil or sediment; or the presence of a sediment contamination footprint adjacent to the site.

Responsibility for contamination was based on the footprint maps, tax parcel information, and data on types of activities occurring on parcels adjacent to the LDR, the substances used or stored on site, wastewater, soil, groundwater and other sampling data, reports of spills/releases, and similar factors. Rather than assigning each facility associated with a particular contaminant a fixed percentage of liability, for settlement purposes the Trustees first apply a contaminant footprint approach to the extent possible. By examining concentration gradients of contaminants in surface sediments, and reviewing available information on hazardous substance releases, the Trustees have assigned liability for areas of sediment contamination to one or more facilities for most contaminants.

For some contaminants with widespread distribution such as polycyclic aromatic hydrocarbons (PAHs), allocation by discrete footprint to individual sites is not possible. For these contaminants, the Trustees use a mass-loading approach, which relies on a relative comparison of the duration and area of operations associated with releases and of the extent to which the type of activities conducted at each facility is likely to have generated significant releases. In cases where a large footprint can be linked to several sites, the Trustees employ a combination of the footprint and mass-loading approaches.

Using each of the above approaches still leaves some areas of waterway contamination unallocated based upon information currently available. Where there is no apparent connection to any facility, the Trustees designate the footprint involved as Type I Non-Allocated. Where there is an apparent physical connection between a footprint and a facility but no information indicating activities that may have resulted in the release, the Trustees designate the footprint as Type II Non- Allocated.

The Trustees use each of the above approaches to allocate liability for DSAY reductions generated by the contaminants in all the mapped polygons described earlier. As mentioned previously, the Trustees allocate liability to facilities rather than to parties and are expecting multiple parties associated with a given facility to resolve among themselves how to sub-allocate that facility's share of liability.

It is important to underscore that the Trustees have developed this allocation solely for settlement purposes. By performing this allocation, the Trustees are not suggesting or conceding that the effects of LDR contamination are readily divisible among contaminants, natural resource injuries, facilities, or parties. In the event that not all LDR natural resource damage claims can be resolved through settlement, the Trustees reserve the right to pursue all possible claims against non-settling parties on a joint and several liability basis through litigation.

2.3 Alternate Methods for Injury Assessment

The U.S Department of the Interior (DOI) NRDA regulations provide for a variety of methods to quantify damages (see 43 CFR 11.83). When HEA is used to quantify injuries, the cost of projects identified to restore an equivalent level of services represents the measure of damages. Alternatively, losses may be quantified in terms of *compensable value* using economic valuation methods. Compensable value reflects the change in the value of the resource due to injury and includes both use and nonuse components. Use value is the value of resources attributable to direct use, such as recreation. Nonuse value is the value of resources independent of any current or future use, motivated by a desire to preserve resources for future generations or to protect and maintain them in a natural state. Compensable value is typically expressed in terms of consumer surplus. Consumer surplus is the amount individuals are willing to pay for a good or service above and beyond what they may be required to spend. If an individual's willingness to pay for a good or service decreases (e.g., due to the impacts of contamination), a loss in surplus results.[9]

Valuation methods specified by the DOI NRDA regulations can be divided into two categories: market and non-market. Valuation via market prices is appropriate in circumstances when injuries have increased the cost of resource use, reduced the quality or quantity of the resource available for market, or induced changes in the market price of the resource. However, if injured resources are not traded and priced explicitly in markets, as is often the case, non-market valuation methods must be used. Non-market valuation methods are further divided into two types: revealed preference and stated preference.

Revealed preference methods infer values for natural resources and associated services from consumer behavior. For example, the value of a day of beach recreation can be estimated using information on the costs one incurs to travel to that beach (referred to as travel cost methods). Similarly, the value of an environmental amenity may be revealed through land and housing price premiums (referred to as hedonic methods).

Stated preference methods involve creation of a hypothetical market that allows individuals to explicitly state their value for a resource. This is accomplished through carefully designed and implemented surveys (referred to as contingent valuation and choice experiment methods). Damage estimation for the social, cultural, and spiritual loss of natural resources to affected tribes can be assessed using the Contingent Valuation Methodology or by using other valuation techniques.

Finally, when circumstances do not justify the time and expense required to implement a primary study using revealed or stated preference methods, secondary methods (i.e., methods that rely on information generated by other studies) can be used. This most common secondary method used in NRDA analyses is referred to as “benefit transfer,” a process where existing valuation information is adapted to new and/or alternative contexts. Within the DOI NRDA regulations this is referred to as the “unit value methodology.”

With respect to losses associated with degraded habitats in the LDR, two potential valuation approaches could be applied. First, a benefit transfer analysis could be undertaken where existing values for similar changes in ecological services are assigned to a relevant population of individuals or households. However, the accuracy and reliability of benefit transfer analyses depends critically upon the similarity between the conditions to be valued and those studied in existing literature. In this case it is unlikely that value estimates exist that adequately correspond to the specific injuries and associated ecological service losses documented in the LDR.

Second, a primary stated preference study could be undertaken. In this case, a survey would be developed to elicit individuals’ or households’ willingness to pay to avoid or restore ecological service losses within the LDR. Aside from the substantial time and expense likely associated with conducting such a study, there is uncertainty as to whether reliable economic

[9] Consumer surplus also can decrease if the price of a good or service increases.

values could be estimated. The accuracy and reliability of values derived from stated preference studies depends in part upon the extent to which the specific change to be valued is accurately and completely characterized and, in turn, fully understood and appreciated by survey respondents. In the case of the LDR, sediment contamination and associated injury to benthic habitats (and the biota that rely on those habitats) is likely to have manifested in a variety of complex ecosystem changes that would be difficult to translate into a cogent valuation scenario.

Thus, in this specific case, damage estimation via the direct cost of equivalent habitat restoration and enhancement actions (i.e., HEA) is a reasonable and appropriate approach.

3. ENVIRONMENTAL SETTING/AFFECTED ENVIRONMENT

For purposes of the Restoration Plan and the Programmatic Environmental Impact Statement, the LDR environment is defined as the river from the northern (downstream) tip of Harbor Island upstream to the feature known as North Winds Weir (located approximately seven miles upstream).

3.1 Affected Environment

The LDR watershed lies within King County, Washington. The area of restoration focus begins at North Winds Weir and ends in Elliott Bay in the vicinity of the mouth of the Duwamish River, Puget Sound. The water flows approximately seven miles through the most industrialized sections of the river (see Figure 4).

3.1.1 Sediment Quality

The LDR receives contaminant inputs from industrial activities and other sources, much of which has ended up in the sediments. Discharges and releases of oil and hazardous substances into the waterway resulted from current and historical industrial and municipal activities and processes since the early 1900s. Facilities released materials through permitted and non-permitted discharges, spills during cargo transfer and refueling, stormwater runoff through contaminated soils at upland facilities, and discharge of contaminated groundwater. The primary exposure pathways of a contaminant from media to receptors are via contaminants that accumulate in the sediments. The sediments in the estuary are contaminated with metals, petroleum products, and other organic materials (ACOE, 2000). The organisms that live in and on the sediments, and that are exposed to sediment contamination, form the base of the food web upon which most of the fish, birds, and other wildlife that use the LDR environment depend. Contamination of the sediments affects nearly all aspects of the LDR ecosystem. Contaminants have been found in tissues of benthic invertebrates and fish in the Duwamish Waterway, indicating that contamination from the sediments is being accumulated by organisms.

The Remedial Investigation Report for the Lower Duwamish Waterway Superfund Site and the Harbor Island Superfund Site Second Five-Year Review Report characterize the contamination of the LDR and the progress of remediation to date for these two superfund sites (EPA, 2005; LDWG, 2010a). Additional information can be found in the Draft Final Feasibility Study for Lower Duwamish Waterway (LDWG, 2010b) and the East Waterway Operable Unit Existing Information Summary Report (Port of Seattle, 2008). This information is incorporated here by reference.

3.1.2 Air Quality

The Puget Sound Clean Air Agency (PSCAA) is the primary entity responsible for regulating air pollution from business and industrial activities in King, Kitsap, Pierce, and Snohomish counties. PSCAA issues air quality data summary reports annually that summarize regional air quality by presenting air monitoring results for six criteria air pollutants. The EPA sets national ambient air quality standards (NAAQS) for these pollutants: particulate matter (10 micrometers and 2.5 micrometers in diameter), ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, and lead. The Air Quality Index (AQI) is a nationwide reporting standard developed by the EPA to report daily air quality. For 2009, King County reported 75 percent “good” days, 24 percent “moderate,” and 1 percent “unhealthy for sensitive groups” (Puget Sound Clean Air Agency, 2011).

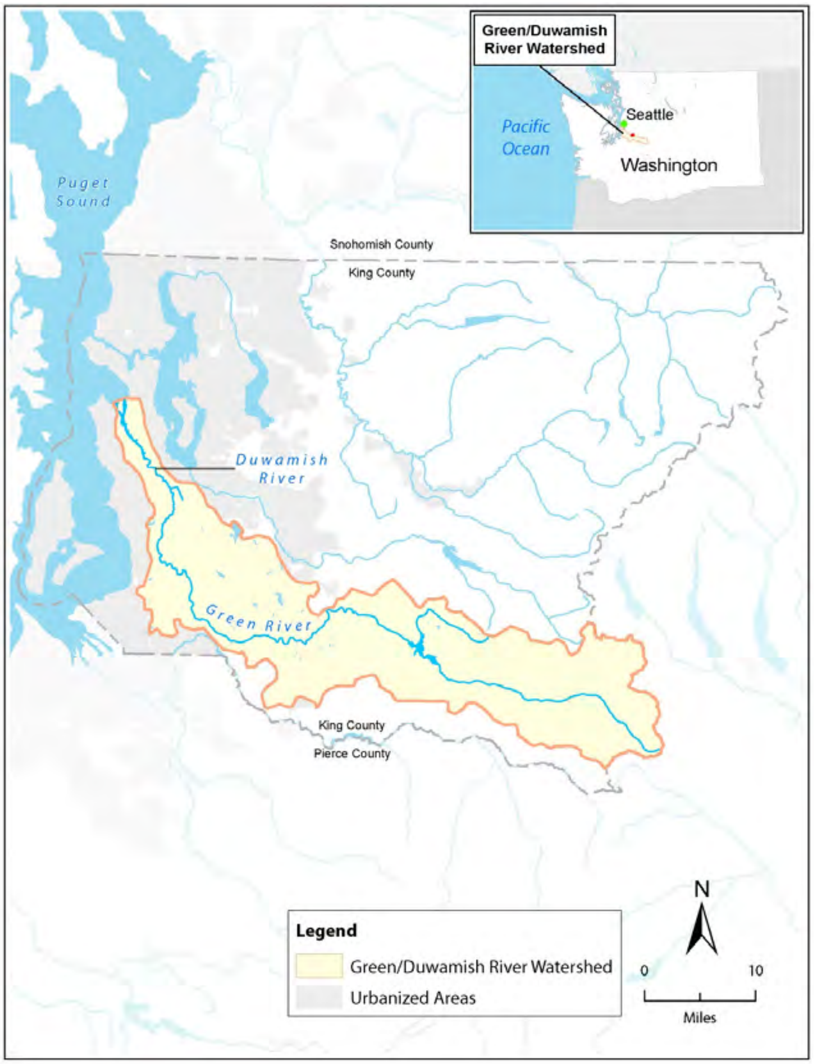

Figure 4. Map showing Duwamish/Green River Lower watershed and location of Lower Duwamish River.

Beginning in 2004, the agency added additional information on air toxics to the Air Quality Data Summary. Air toxics are pollutants broadly defined by the agency to include over 400 chemicals and compounds. Most air toxics are a component of either particulate matter or volatile organic compounds so there are overlaps between the criteria pollutants and toxics. Toxic pollutants are associated with a broad range of adverse health effects, including cancer.

PSCAA and the Washington State Department of Ecology work together to monitor air quality within the Puget Sound region. Real-time air monitoring data are available for some pollutants online at http://www.pscleanair.org/airq/aqi.aspx. Continuous air monitoring data provide information on how concentration levels of various pollutants vary throughout the year. An air monitoring station is located close to the Duwamish River at 4401 E. Marginal Way.

A recent study of air quality associated with the South Park Bridge Project gives much more in-depth information about air quality and is incorporated here by reference (King County Department of Transportation, 2004). It is available online at http://your.kingcounty.gov/kcdot/roads/cip/addlContent/documents/files/300197_DEIS_v4.pdf

3.1.3 Water Quality

Water quality in the Duwamish River has been characterized by King County Water and Land Resources as "fair," the Lower Green as "fair to good," and the Middle Green as "good to very good" (King County Water Quality Monitoring, Green River Watershed. http://green.kingcounty.gov/WLR/Waterres/StreamsData/WaterShedInfo.aspx?Locator=0311). King County conducted a water quality assessment of the Duwamish River and concluded that the levels of contaminants in the water posed "minimal" risk to aquatic life (King County, 1999).

State water quality standards were revised in 2003 (http://www.ecy.wa.gov/programs/wq/swqs/index.html). Under the 2003 rules the Duwamish River is categorized as "Salmonid Rearing and Migration Only" habitat. For recreational use the Duwamish is designated as "Secondary Contact." The Duwamish Waterway and River is on the Washington Department of Ecology's 303(d) 2004 list for not meeting Dissolved Oxygen, Fecal Coliform, pH, and various sediment toxics standards.

Additional information on water quality in the LDR is available from King County (1999) and in the Remedial Investigation (LDWG, 2010).

3.1.4 Potential Impacts of Climate Change on Proposed Restoration

The climate in the basin is a mid-Atlantic, west coast marine type characterized by cool wet winters and mild summers. The average rainfall in the basin ranges from 39 to approximately 100 inches annually. Approximately 75 percent of the precipitation falls between the months of October and April. The summer months from July through September are typically characterized by minimal, if any, precipitation, causing flows in the river to drop to minimums and water temperatures to increase (ACOE, 2000). Temperature extremes are moderated by the adjacent Puget Sound and Lake Washington as well as the more distant Pacific Ocean. The region is partially protected from Pacific storms by the Olympic Mountains and from Arctic air by the Cascade Range. As for temperature, winters are cool and wet with average lows around 35–40 F (2–4 C) on winter nights. Colder weather can occur, but seldom lasts more than a few days.

Summers are dry and warm, with average daytime highs around 73–80 F (22.2–26.7 C). Hotter weather usually occurs only during a few summer days (http://www.weather.com/).

Climate change is projected to impact Washington State in several ways, including sea level rise, increases in air and water temperatures, and changes in patterns of peak stream flows. While specific impacts will vary across the state, it is anticipated that the LDR and the habitats located there may be affected by sea level rise, changes in the quantity and timing of peak river flows, temperature increases, and changes in the waters of Puget Sound (such as stratification of the water or circulation patterns) (King County, 2005a; University of Washington, 2005).

Sea level rise is of particular concern in coastal areas. Factors influencing local sea level rise include global sea level rise, local land movement (such as tectonic land movement), and changes in wind patterns (University of Washington and Washington Department of Ecology, 2008). This recent report looks at the factors influencing sea level rise for coastal areas in Washington State, including Puget Sound. Relative vertical land movement in the Puget Sound area is not completely clear, as different reports show a range of values for vertical land movement. While the local rates of vertical land movement are somewhat uncertain, the driving factor of sea level rise in Puget Sound is the global sea level rise (see Table III, University of Washington and Washington Department of Ecology, 2008). For Puget Sound, the estimated very low, medium, and very high sea level rises are:

By 2050: very low = 8 cm (1”); medium = 15 cm (6”), very high = 55 cm (22”)

By 2100: very low = 16 cm (6”); medium = 34 cm (13”), very high = 128 cm (50”)

Estimated sea level rise must be considered for tidal and estuarine habitats. To ensure survival of the plant and animal communities, the habitat must have room to migrate upslope and stay at the same intertidal elevation required for the specific organisms. For example, if the water level increases over time, but there is no space upslope for a tidal marsh to migrate (i.e., located against a steep slope), the wetland will not be able to survive in the long term. The Trustees will endeavor to locate and develop restoration projects in such a way as to maximize the opportunity for restored habitats to migrate upslope. However, given the limited availability of property along the LDR, there are likely to be some restoration projects that could be negatively affected if some of the more severe predictions about sea level rise over the next couple of centuries are correct.

In addition to sea level rise, other impacts of climate change to Puget Sound and the LDR habitats are predicted from projected changes in air temperature and precipitation (King County, 2005a; University of Washington, 2005). Warmer air temperatures change the type of precipitation, with less precipitation falling as snow and more as rain; this in turn leads to another possible impact of climate change—a change in the quantity and timing of peak river flows. Restoration projects should consider the potential for changes in the quantity and timing of river flows. Since the Green River is dam regulated, flooding events are less likely to be a concern in the LDR (Washington State Department of Ecology and Department of Community, Trade, and Economic Development, 2006).

In addition to the freshwater system impacts, increases in the temperature of Puget Sound marine waters as well as the timing and quantity of freshwater inputs could impact the stratification of the marine waters, contributing to low oxygen events.

3.2 Physical Environment

The topography and character of the Green/Duwamish River Basin vary dramatically between its headwaters and mouth. The upper watershed is largely undeveloped and managed almost entirely for timber production. The terrain is generally steep and forested, timbered mainly by conifers except along the river and stream channels where deciduous and mixed forest stands dominate. In the upper basin above Howard Hansen Dam and reservoir, few manmade structures confine or restrict the river channels. In the middle basin below the Green River Gorge (River Mile 47) the Green River reaches the gentle slope of the valley floor. Much of the original forestland has been converted to farmland, and levees increasingly confine the river channel. Most of the lower basin (where this restoration plan applies) has been highly altered by the clearing of the original forestlands and the filling of freshwater and estuarine wetlands and intertidal flats, and now consists largely of industrial and residential development. The river channel is highly restricted along both banks by levees or rock revetments, and is dredged periodically between its mouth and River Mile 5.5 for navigation. Approximately 99 percent of the former estuarine wetlands and mudflats have been either dredged or filled in for industrial purposes (U.S. Department of Interior- Fish and Wildlife Service, 2000; U.S. ACOE, 2000).

The lower Green/Duwamish River valley was once a marine fjord to the town of Sumner. The Osceola Mudflow (5,800 years ago), and later mudflows occurring 2,500 and 1,100 years ago, provided sediment that gradually filled the marine embayment (Dragovich et al., 1994; Zehfuss et al., 2003). The soils of this lower valley are poorly studied because there has been extensive urban and industrial development along the river for many years. It is expected that most of the soils were alluvial in nature with significant quantities of organic material from the floodplain swampland and marshlands. Fill material from other sources has been placed in most of the floodplain.

Extensive water regime and channel modifications resulted in existing habitat conditions that were not historically present in the Green/Duwamish River system (Blomberg et al., 1988; King County, 2005b). Prior to 1910, the Duwamish River drained a much larger watershed including all flows from the present Green River watershed, the Lake Washington drainage basin, and the White River. Both natural and man-made modifications during the early 1900s reduced the drainage basin to its present size and configuration. Flows from the White River were diverted to the Puyallup River by a flood in 1906, and later man-made structures made this diversion permanent. Flows from Lake Washington were diverted west to Lake Union and Salmon Bay after the construction of Ballard Locks and Lake Washington Ship Canal in 1916. Around the same time, the Cedar River was diverted from the Black River into Lake Washington, so that the Green River no longer received those flows. By 1913, the City of Tacoma completed a water diversion dam on the Green River, with a maximum withdrawal of 113 cfs. In 1962, Howard Hansen Dam was built in the Eagle Gorge of the upper Green River for flood control and low flow augmentation.

Currently, the Green/Duwamish River drains about one-quarter of its original watershed (Warner and Fritz, 1995). The mean annual flow for the Duwamish River was estimated at 2,500 to 9,000 cfs prior to the diversions (Fuerstenberg et al., 2003). By 1996, the mean annual flow the Duwamish River was estimated to be approximately 1,700 cfs (ACOE, 1997). The long-term mean flow rate in the river from 1961 (when the Howard Hansen Dam was constructed) to 2004 is 1,340 cfs (LDWG, 2008).

The ACOE maintains a navigable waterway through dredging to the Upper Turning Basin. The typical cross section of the LDR includes a deeper maintained navigation channel in the middle, with shallow benches at intermittent locations along the margins of the channel (LDWG, 2008). The river banks are primarily occupied by structures, including piers and buildings, or armored with rip-rap and concrete debris. A bottom layer saltwater wedge moves up and down stream with the tide and stream flow, while freshwater moves downstream in a layer over the top of the salt wedge (Stoner, 1972).

3.3 Biological Resources

Historically, the Green/Duwamish River basin was heavily forested with evergreen coniferous trees and an understory of various shrubs, ferns, and herbs. In the lower valley, emergent wetland vegetation was interspersed with forested riparian (alder, willow, cottonwood) and patches of swamp with cedar and spruce. The Duwamish River meandered through an extensive estuarine zone where freshwater marsh transitioned into brackish and salt marsh with extensive mudflats. The estuary, marshy floodplain, and forested basin were utilized by many species of migratory and resident waterfowl, songbirds and raptors, large and small mammals, amphibians, and reptiles (King County, 2005b)

Fish species that were historically present in the basin included Chinook, coho, sockeye, pink and chum salmon, steelhead and sea-run cutthroat trout, Dolly Varden and bull trout, resident rainbow and cutthroat trout, and other resident fish (ACOE, 2000). A total of 53 resident and non-resident fish species were identified during the fish sampling conducted for the EPA Remedial Investigation (EPA, 2007). Significant numbers of Chinook, coho and chum salmon, and steelhead trout are released from state and tribal hatcheries.

Currently, the lower Green/Duwamish River basin is highly urbanized along most of the river corridor, particularly in the lower 12 miles. Upstream of the Duwamish Waterway, extensive levees line the river protecting residential, commercial, and industrial properties adjacent to the river. Small patches of red alder, black cottonwood, big-leaf maple, and willow grow along the riverbank, which is typically confined between flood control levees. More commonly, Himalayan blackberry and various grass species dominate the channel bank vegetation. Swallows, sparrows, coyote, raccoon, and river otter inhabit these remnant habitats.

Birds

An estimated 330,000 birds winter in Puget Sound, and several million shorebirds and other waterbirds stop during migration. Puget Sound is nesting habitat for an estimated 33,000 seabirds and South Puget Sound provides for approximately 30 percent of the total midwinter waterfowl use of Washington’s coastal areas (U.S. DOI, Fish and Wildlife Service, 1982). Nearly 100 bird species (see Appendix A) have been observed in the Duwamish River estuary, including migrating shorebirds, loons, grebes, alcids, geese, surface feeding and diving ducks, raptors, kingfishers, gulls, and terns (Cordell et al., 1999; EBDRP, 2000; FWS, 2006). Two recently de-listed migratory bird species under the Federal Endangered Species Act (ESA)—peregrine falcon (*Falco peregrinus*) and bald eagle (*Haliaeetus leucocephalus*)—are known to forage or spend time in the Elliott Bay/Duwamish River system (Anderson and Osmek, 2005; Cordell et al., 2001).

Several nesting areas have been identified in the vicinity of Harbor Island in the Elliott Bay area. They include the cavity-nesting pigeon guillemots (*Cepphus columba*) found historically in the West Duwamish Waterway under the P/S Freight Dock and Terminal Five in 1994 (U.S. DOI, Fish and Wildlife Service, 1989). Great blue heron (*Ardea herodias*) have nested in the bluffs of West Seattle just west of the Duwamish estuary since the 1940s (U.S. Department of Commerce (U.S. DOC, NOAA, 1985), but abandoned these colonies in 1999 (U.S. DOI, Fish and Wildlife Service, 2002). Since 2003, osprey (*Pandion haliaetus*) have begun nesting along the LDR from confluence of the Green River to Harbor Island in Elliott Bay (U.S. DOI, Fish and Wildlife Service, 2007). Kellogg Island, immediately upstream of Harbor Island, provides nesting and roosting habitat for a number of migratory and resident avian species including neotropical songbirds, raptors, and other waterfowl. Kellogg Island has also provided habitat for uncommon nesters to Western Washington such as the Northern oriole (*Icterus galbula bullockii*), gadwall (*Anas strepera*), and spotted sandpiper (*Actitis macularia*) (Port of Seattle, 1979).

<u>Federally Listed Species</u>

Federally listed threatened salmonid species under the ESA that are known to occur or may be found in the vicinity of the proposed projects include Coastal-Puget Sound bull trout, Puget Sound Chinook, and Puget Sound steelhead (WDFW, 2008). Other federally listed species that may occur within the area proposed for projects includes Steller sea lion, humpback whale, southern resident killer whale, leatherneck sea turtle, and marbled murrelet. Federal Species of Concern include bald eagle and peregrine falcon (U.S. DOI, Fish and Wildlife Service, 1986). In addition, the LDR is essential fish habitat for Chinook and steelhead* (*under development as of October 2011) (NOAA, http://www.nwr.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead.html). The State of Washington has listed Orca and humpback whales and leatherback sea turtles as endangered species. The state lists Steller sea lions as threatened species and lists bald eagle, peregrine falcon, purple martin (*Carpodacus purpureus*), and coho and chum salmon as species of concern.

<u>Chinook Salmon</u>

Puget Sound stocks of Chinook salmon (*Oncorhynchus tshawytscha*) are listed as a threatened species. The species occurs in the Green/Duwamish basin from the River mouth up to the Tacoma diversion dam. Designated critical habitat for Puget Sound Chinook salmon within the overall areas targeted for restoration (detailed in Section 5.6) include freshwater rearing sites, freshwater migration corridor, and estuarine and nearshore marine areas with appropriate environmental conditions. For this and other threatened and endangered species, specific analysis for the presence of, and potential effect on, critical habitat will be conducted for individual projects at their specific locations (within the overall area of restoration focus of this RP/PEIS) during consultations under the ESA.

Key habitat requirements for Chinook salmon include adequate stream flow, high-quality gravel for spawning, low temperatures, side channels, and estuarine habitat for rearing. The lack of side channels and estuarine habitat is a significant issue for Chinook salmon production. The natural origin Chinook salmon of the Duwamish River are included in the Puget Sound Evolutionarily Significant Unit (ESU). This ESU of Chinook salmon was listed in 1994. Decline for the species has been attributed to pollution, hydropower operations, harvest practices, hatchery practices, and the degradation and loss of habitat. Recovery for the species requires the improvement and integration of hatcheries, hydropower, harvest, and habitat (the “four Hs”). In the Duwamish River the Chinook salmon population ranges from 2,450 to 11,500 adults per year (Green/Duwamish and Central Puget Sound Watershed Resource Inventory Area 9 (WRIA 9), 2005, 2006a, 2006b). In the LDR one of the main limitations for species recovery is the lack of estuarine and off-channel habitat as well as the lack of habitat within the transition zone, where juveniles osmoregulate from freshwater to saltwater. This lack of habitat in critical areas has resulted in reduced growth rates for juvenile Chinook.

Bull Trout

Coastal-Puget Sound bull trout (*Salvelinus confluentus*) are listed as a threatened species. Puget Sound populations include both resident and migratory forms. The LDR is part of the Puget Sound Management Unit for bull trout. Historically, bull trout were found in abundance in the middle Green River basin. Currently no bull trout stock is recognized in the Duwamish/Green River. However, anadromous bull trout regularly visit the lower Duwamish downstream of river mile 5.8 (King County, 2003b). Bull trout inhabit side channels and stream margins and need woody debris and other complex forms of cover to hide from predators and to find prey. Unlike other salmonids, bull trout survive to spawn year after year (Shared Strategy for Puget Sound, 2007). Critical habitat for bull trout within the overall area targeted for restoration includes freshwater rearing, foraging, and overwintering habitat and estuarine/marine areas with the appropriate environmental conditions. As is the case for Chinook salmon, specific analysis for the presence of, and potential effect on, critical habitat will be conducted for individual projects at their specific locations (within the overall area of restoration focus of this RP/PEIS) during consultations under the ESA.

Steelhead

Puget Sound steelhead (*Oncorhynchus mykiss*) was listed as a threatened species on May 11, 2007. The distinct population segment includes all naturally spawned anadromous winter-run and summer-run steelhead populations in streams in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington, bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive), as well as the Green River natural and Hamma Hamma winter-run steelhead hatchery stocks (NOAA, 2007). Winter Steelhead enter the Duwamish River from November to May and spawn in the upper Green River and its tributaries. In addition to the wild stock, hatchery produced summer and winter steelhead also occur in the watershed (King County, 2003a). No critical habitat has yet been designated for Puget Sound steelhead, although their requirements would be similar to those for Chinook salmon.

Pacific Smelt

Pacific smelt, or eulachon, were listed as threatened, effective May 17, 2010. Although critical habitat has not yet been identified for Pacific smelt, it has only occasionally been seen in

Puget Sound and there is no evidence of it spawning in Puget Sound rivers (*Federal Register*, 2010).

Steller Sea Lion

Steller sea lions are listed as threatened, but only rarely occur in Puget Sound south of Admiralty Inlet (Yates, 1988). There are no known areas of critical habitat for Steller sea lions within the restoration area of this plan.

Humpback Whale

Humpback whales are listed as threatened, but have only rarely been seen in Puget Sound. No critical habitat for humpback whales is present within the restoration area for this plan.

Leatherback Sea Turtle

Leatherback sea turtles are listed as threatened, but there have been no sightings within Puget Sound and no critical habitat is present within the restoration area for this plan.

Marbled Murrelet

Marbled murrelets are listed as threatened. Murrelets feed on fish and invertebrates usually within two miles of shore. They nest in stands of mature and old-growth forest. The marbled murrelet typically forages for prey during the day and visits its nest site in the canopy of old-growth forests at dawn or dusk. No critical habitat for marbled murrelet is present within the restoration area for this plan.

3.4 Socioeconomic/Cultural Resources

The contemporary Duwamish River-Green River channels and floodplains between Auburn and Elliott Bay developed within a trough carved by continental ice sheets during the Pleistocene (Lewarch, 2003a). The Puget Lobe of the Cordilleran Ice Sheet filled the trough until approximately 16,000 years ago, when the ice sheet melted throughout the Central Puget Sound Basin during the glacial retreat at the end of the Pleistocene. The project area was available for pre-contact hunter-fisher-gatherer settlement during two periods over the past 16,000 years. Groups of generalized foragers may have inhabited the trough when glacial outwash deposits at the base of the Duwamish River-Green River trough were exposed during a time of much lower relative sea level in the Puget Sound Basin, between approximately 13,000 and 10,000 years ago (Dragovich et al., 1994; Zehfuss et al., 2003). The initial inhabitants may have left archaeological deposits dating to the early Holocene at depths between 60 and 30 meters below the contemporary floodplain surface. Base camps and specialized activity areas probably were located on the margins of wetlands that formed on the surface of the glacial outwash deposits and on stream levees and the confluences of streams that dissected the outwash plains. Geologists do not have data on the areal extent and locations of the early Holocene streams and wetlands (Nelson, 1989; Butler, 1990).

The entire project area was a marine fjord between approximately 10,000 and 5,600 years ago (Dragovich et al., 1994; Lewarch, 2003a; Zehfuss et al., 2003). Beginning around 5,600 years ago, deltaic and alluvial sediments were deposited in the Auburn vicinity as a result of the

Osceola Mudflow, a massive lahar that issued from the northeast flank of Mount Rainier. Deltaic and alluvial sediments gradually filled the Duwamish Embayment over the past 5,600 years, as the ancestral delta of the Duwamish-Green River prograded northward to what is now Elliott Bay. Relative sea level elevation was approximately 7 meters lower than today around 5,600 years ago (Dragovich et al., 1994; Zehfuss et al., 2003). The surface of the ancestral Duwamish-Green River floodplain in the southern portion of the project area may have archaeological deposits dating around 5,600 to 5,000 years ago at depths up to 10 meters below the modern floodplain. By 2,300 to 2,000 years ago, the ancestral delta of the Duwamish River had reached the Tukwila area. Surfaces of deltaic and alluvial deposits in the Kellogg Island vicinity, near the early historic period Duwamish River delta, formed between 1,300 and 1,100 years ago (Zehfuss et al., 2003).

Major environmental changes occurred on the floodplain around 2,000 years ago, when the main channel of the ancestral Duwamish River-Green River abruptly shifted from the east side of the valley to the west side (Mullineaux, 1970; Lewarch, 2003a, 2003b). Vestigial elements of the old river channel on the east side of the valley appear as marshes, streams, linear lakes, and ox bow lakes.

A variety of hunter-fisher-gatherer archaeological resources may occur in the project area, including remnants of residential or village sites, base camps, and specialized fishing, hunting, and plant collecting sites (Campbell, 1981; Chatters, 1981a, 1981b, 1988; Butler, 1990; Lewarch, 2003b, 2003c).

The Green/Duwamish River valley was among the first areas of Puget Sound to be extensively settled by European-American immigrants. Growth has continued unabated since the mid-1800s, and now includes the cities of Enumclaw, Auburn, Kent, Renton, Tukwila, Sea-Tac, Burien, Black Diamond, and Seattle, and the Muckleshoot Indian Reservation (Kruckeberg, 1991). King County estimates that approximately 518,090 people live in the Duwamish-Green Basin, with the primary population centers being Seattle, Renton, Kent, and Auburn. The majority of people live in urbanized areas (Washington Department of Ecology, 2006).

The majority of jobs in King County are in the manufacturing, wholesale and retail trade, financial services, and government sectors. These data are somewhat inappropriate for the Green/Duwamish basin area since there is still a large rural agricultural, timber harvest, and mining component in the basin. An economic analysis conducted in 2007–2008 estimated that the Port of Seattle Seaport is responsible for over 56,000 jobs (Port of Seattle, 2009a). As of May 2011, the seasonally adjusted unemployment rate for the civilian labor force for Seattle/Bellevue/Everett was 8.9 percent (U.S. Bureau of Labor Statistics, http://www.bls.gov/lau/ssamatab1.txt). The median family income in King County projected for 2010 was $66,398 (Washington Office of Financial Management, http://www.ofm.wa.gov/economy/hhinc/medinc.pdf) and the estimated median value for a house or condo in 2009 was $402,500 (http://www.city-data.com/county/King_County-WA.html#ixzz1ZlQBWAlB).

4. PROGRAMMATIC NEPA REQUIREMENTS

4.1 NEPA Requirements

This RP/PEIS has been prepared in accordance with requirements under the National Environmental Policy Act (NEPA) (42 USC 4321 *et seq.*). It evaluates and discloses potentially significant impacts on the quality of the human environment of alternative restoration plans under the LDR Natural Resource Damage Assessment. To comply with NEPA—including the Council on Environmental Quality's (CEQ) implementing regulations for NEPA (40 CFR 1500-1508) and NOAA Administrative Order 216-6—this document includes a description of the purpose and need for action, the affected environment, and the proposed program action, alternatives, and environmental consequences.

This programmatic document (the Programmatic Environmental Impact Statement and the Restoration Plan) characterize the potential impacts resulting from implementation of Restoration Plan alternatives in the LDR. Once specific projects are developed, future evaluations under NEPA will be developed for each project. Evaluations for a specific project will tier off and incorporate by reference the programmatic NEPA documentation (i.e., the PEIS/RP); and will thus be able to focus on issues specific to the project. Tiering off a PEIS will help facilitate an efficient, non-duplicative NEPA process for proposed restoration projects. This Programmatic EIS is prepared to generally address probable impacts associated with implementation of a Restoration Plan for the LDR. As stated here, individual projects associated with the RP will undergo additional environmental review under NEPA when they are proposed under the selected Alternative.

4.2 Public Participation

Public participation is an important part of the NRDA restoration planning process and is required under NEPA and the CEQ Regulations (40 CFR 1500-1508). The Trustees have held public meetings within the local LDR communities (described below) to provide information to and get input from the public; they have provided updates and answered questions at EPA LDR quarterly meetings and at a meeting of the Environmental Coalition of South Seattle. The Trustees intend to establish a regular schedule of periodic meetings to update the public on the LDR restoration process and provide a forum for the public to ask questions and provide additional input on the restoration process. The Trustees are especially interested in obtaining input on potential restoration projects that are consistent with the types of restoration within the HFAs that are described in this document.

June 6 and 7, 2007, Public Meetings

As part of the process to develop the Draft RP/PEIS, NOAA, on behalf of the Elliott Bay Trustee Council, solicited the input of stakeholders and the public on the scope and scale of the Draft RP/PEIS. NOAA began the formal scoping process by publishing a Notice of Intent in the *Federal Register* on May 25, 2007 (79 FR 29304). NOAA also released public notices about the scheduling of two public meetings for June 6 and June 7; these notices were sent through e-mail distribution lists on May 21 and published in the *Seattle Times* newspaper from May 21–23, 2007. Both through the Notice of Intent and the public meetings, NOAA requested written comments from the public regarding potential environmental concerns or impacts, additional categories of impacts to be considered, measures to avoid or lessen impacts, and suggestions on restoration priorities and projects. The period for submitting comments was from May 25 to August 1, 2007.

At the two public meetings, NOAA, as the Lead Administrative Trustee, gave presentations on the NRDA process, the process for developing a Draft RP/PEIS, and examples of restoration projects completed in the LDR that may be considered in the Draft RP/PEIS. A website was also developed and made available to the public that contained much of the same information released through the Notice of Intent and the public meetings.

Comments from the June 6 and June 7 public meetings, as well as written comments, are summarized in the October 2007 document prepared by NOAA: *Scoping Report for the Lower Duwamish River Draft Restoration Plan and Programmatic EIS Development (*http://www.darrp.noaa.gov/northwest/lowerduwamishriver/pdf/ScopingReport_FINAL.pdf).

March 12, 2008, Public Meeting

On March 12, 2008, the Trustees held a public meeting to update the public on the status of their work to develop a draft RP/PEIS as well as additional information about the content and application of the document. Notices for the meeting were sent through e-mail distribution lists on February 13, 2008, and published in the *Seattle Times* newspaper from February 25–27, 2008.

Public Review of Previous Drafts of Restoration Plan

On May 22, 2009, a draft RP/PEIS was released for public review and comment. The comments received and the responses to these comments are included in Appendix G of this document. In response to these comments, the Trustees decided to release a Supplement to the draft RP/PEIS for additional public review and comment. Many of the comments requested additional information about the methods used by the Trustees to assess injury and value potential restoration projects in order to evaluate our alternatives analysis of our restoration strategy. A general discussion of the methods was included in Section 2.0, Injury Assessment Methodology, and detailed descriptions of the assessment and valuation approaches were given in Appendices C,D, E and F of the Supplement. In addition, other comments suggested additional references and asked for clarification on certain issues. The Supplement included some of these references and additional or substitute language to address areas of confusion in the initial draft RP/PEIS. The Trustees' preferred Integrated Habitat Restoration Alternative generally received positive comments.

The Supplement to the draft RP/PEIS was released for additional review and comment on July 27, 2012, with the comment period ending on October 10, 2012. The comments received and the Trustees responses to those comments are presented in Appendix H. These comments were limited to the Trustees' methods for allocation of liability and estimation of injury used for the purpose of early settlement discussions, and did not address the Trustees' preferred Integrated Habitat Restoration Alternative. Therefore, the comments received on the original and Supplement draft RP/PEIS has not, in the judgment of NOAA and the Trustees, raised any issues requiring a change in our preferred approach.

Other Opportunities for Public Involvement

The Trustees maintain a public website with information on the Lower Duwamish NRDA at http://www.darrp.noaa.gov/northwest/lowerduwamishriver/restore.html. This website is updated periodically and provides a forum for the public to access documents and view notices about upcoming public meetings. It also provides contact information for questions or comments.

4.3 Administrative Record

This RP/PEIS references a number of resource documents prepared by and for the Trustees and through the NEPA and SEPA processes. These documents, incorporated by reference into this RP/PEIS, are part of the administrative record on file for these alternatives with the lead federal agency and may be viewed at:

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5. AFFECTED PROGRAM

5.1 Trust Natural Resources and Services

CERCLA and the Oil Pollution Act of 1990 (OPA) authorize the U.S. government, states, and Indian tribes to act on behalf of the public as trustees for natural resources under their respective trusteeship. One of the primary responsibilities of trustees under both CERCLA and OPA is to assess the extent and magnitude of injury to a natural resource and determine appropriate ways of restoring and compensating for that injury. Both CERCLA and OPA define "natural resources" broadly to include "land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources." Both statutes limit "natural resources" to those resources held in trust for the public, termed Trust Resources. While there are slight variations in their definitions, both CERCLA and OPA state that a "natural resource" is a resource "belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States, any state, an Indian tribe, a local government, or a foreign government."

NOAA and the U.S. Department of the Interior are Federal trustees active in the Lower Duwamish River NRDA. NOAA's trust resources include commercial and recreational fisheries; fish, such as salmon, that spawn in freshwater and migrate to the sea; endangered and threatened marine species; marine mammals; wetlands and other coastal habitats; and all resources associated with National Marine Sanctuaries and National Estuarine Research Reserves. The Department of the Interior conserves, protects, and enhances fish, wildlife, and their habitats and manages the 96-million-acre National Wildlife Refuge System for the continuing benefit of the American public, providing trusteeship for resources including but not limited to migratory birds and threatened and endangered species and their supporting ecosystems. Tribal Trust resources include, but are not limited to, fish, invertebrates, and wildlife. The State of Washington trust resources include state lands, fish and wildlife habitat, and clean water, including groundwater.

The concentrations of several contaminants in sediments within portions of the LDR are at levels demonstrated in Commencement Bay NRDA studies, as well as studies published in the scientific literature conducted elsewhere, to cause injury for salmon, flatfish, invertebrates that live on or in the sediment, larger invertebrates, and birds. These injuries reduce the amount of ecological services that these natural resources provide to other natural resources (e.g., provision of food). The major services provided by natural resources to humans within the Lower Duwamish River that may have been injured as identified by the Trustees include recreational services, non-consumptive uses, passive uses, and tribal services.

Injured resources will directly benefit from a combination of clean-up of contaminated nearshore habitats along with restoration of lost habitats, including shallow subtidal areas, mudflats, and marshes. Juvenile salmonids will benefit from more areas with clean intertidal salmon habitat as will salmon food organisms, crabs, shellfish, and juvenile flatfish. In addition to increasing the overall health of the ecosystem, this type of restoration increases opportunities for wading and shorebird use. Increased salmon production in the LDR ecosystem benefits recreational, commercial, and tribal fishing, and increased waterfowl and bird use benefits humans from an aesthetic point of view.

5.2 Responsible Party Liability

The CWA, CERCLA, and OPA mandate that parties that release hazardous materials and oil into the environment are responsible not only for the cost of cleaning up the release, but also for restoring any injury to natural resources that results. CERCLA 42. U.S.C. 9601 *et seq.* Section 107 establishes liability for injury to, destruction of, or loss of natural resources and authorizes natural resource trustees to recover compensatory damages for injury to natural resources as well as reasonable costs of assessing injury. It also mandates that all sums recovered as damages be used only to restore, replace, or acquire the equivalent of such injured natural resources.

When possible, Trustees work cooperatively with the parties responsible for the injury. By working with responsible parties and Co-Trustees to collect data, conduct assessments, and identify restoration projects, the Trustees avoid lengthy litigation and achieve restoration of injured resources more efficiently.

Different mechanisms are available to a PRP seeking to resolve natural resource liability. To compensate for natural resources damages, each PRP may build their own habitat restoration projects, participate in a habitat restoration project or projects implemented by another party, or cash out by agreement with the Trustees.

6. PROPOSED ACTION: REGIONAL RESTORATION PLANNING

6.1 Description of the Preferred Alternative (Integrated Habitat Restoration)

The Preferred Alternative consists of habitat projects that provide benefits to the wide suite of species that are likely to have been injured as a result of hazardous substance releases into the LDR. This alternative meets the basic purpose of NRDA, which is to restore the natural resources and services that were affected by these releases. The LDR is highly modified with relatively little remaining natural intertidal habitat, so creation of habitat projects such as marshes and mudflats—even on a relatively small scale compared to what had existed prior to the alteration of the river system—will be of great benefit to the injured natural resources utilizing this area. Ideally, projects will consist of integrated habitats, such as a mudflat bordered by marsh with a riparian buffer, to maximize the level of ecological services to affected resources. The preferred and other alternatives are discussed in more detail in Section 8.

6.2 Restoration of Injured Natural Resources and Services

The Trustees have identified key natural resources—including salmonids, flatfish, invertebrates, and birds—that are likely to have been injured by the contaminated sediments in the LDR, based on the Remedial Investigation (RI) studies, NRDA studies conducted in Commencement Bay, and the scientific literature. The major service types provided by natural resources within the River that may have been injured include ecological services provided by one resource to other resources, recreational services, non-consumptive uses, passive uses, and tribal services*.* The injury and damage assessment process for the LDR is not complete; therefore, there may be additions to the list of injured resources. Additional information regarding potential injuries in the LDR is presented in the Pre-Assessment Screen for the LDR (Elliott Bay Trustee Council (EBTC), 2009)

The Trustees have concluded that clean-up of intertidal and subtidal contaminated sediments—combined with restoration of marshes, intertidal mudflats, shallow subtidal habitats, and riparian habitat—would directly benefit injured key resources (Figure 5). The overall health of the LDR ecosystem also benefits since some of these habitats have been virtually eliminated from this system. The restoration of key habitats will directly benefit natural resources that depend on those habitats, but also will increase services to benefit humans. For example, increased salmon production in the LDR ecosystem benefits recreational, commercial, and tribal fishing; increased waterfowl and bird use in addition to the restoration of these green spaces within the urban matrix benefits humans from an aesthetic point of view.

6.3 Key Duwamish Habitats

The key Duwamish habitat types that could be part of an NRDA restoration project are marshes, intertidal mudflats, shallow subtidal, and riparian habitats. These habitat types will strongly benefit the resources injured in the LDR. Other habitats, such as deep subtidal, are not as valuable to the representative species and groups used by the Trustees. Even though deep subtidal habitat is abundant in the LDR, it is not desired as a component of any restoration projects under this plan. However, any additional value from restoration of less-desired habitat types that are included in projects with more-desired habitat types will be credited when valuing a potential restoration project.

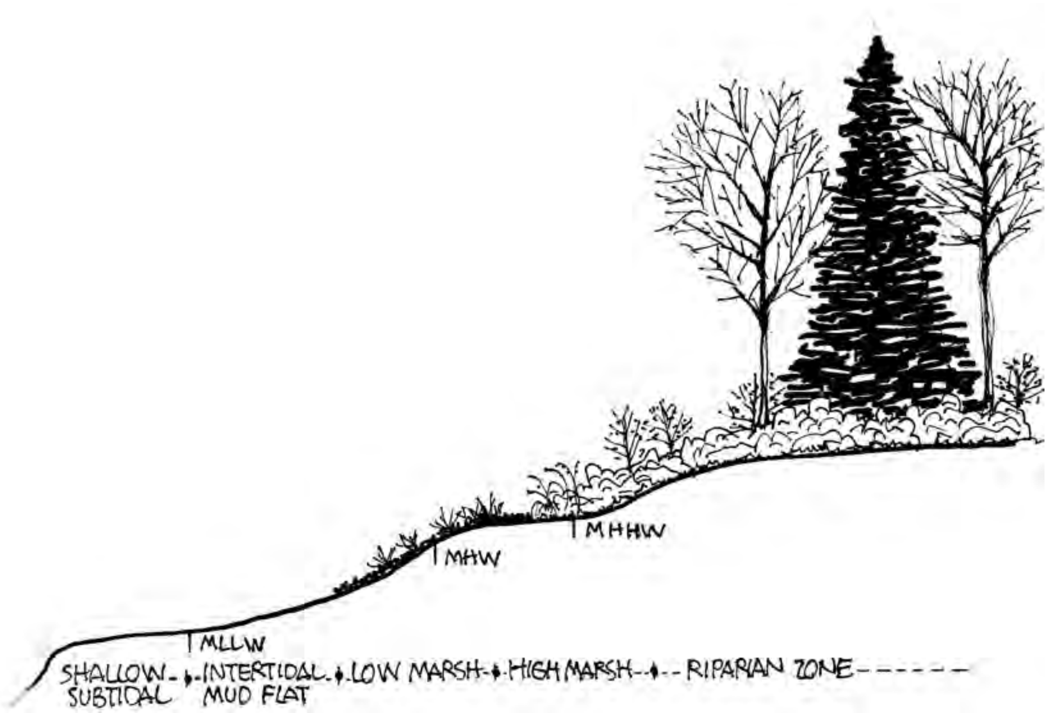

Figure 5. Schematic showing cross section of mudflat, marsh, and riparian habitat

Marshes

Salt marsh habitat that was once common in the Lower Duwamish is now extremely rare in the lower river and estuary. Only 3 percent of the original tidally influenced marsh habitat that existed prior to 1898 still exists in the LDR (Blomberg et al., 1988). Marsh vegetation increases the productivity of animals and plants living in and on the sediment and fosters a more complex community structure, providing high-quality refuge habitat for juvenile salmonids and other fishes. Marsh vegetation is also a valuable source of detritus to the ecosystem.

Restoration of estuarine marsh will provide habitat for salmon juveniles to forage, rest, and grow. Salmon species in the LDR have limited shallow protected areas in the river where juveniles can feed and grow before migrating into the Sound. Marshes will benefit Chinook salmon in particular, because ocean-type Chinook (the dominant life-history type in the Green River) rear for up to several months in estuaries. Other salmon species will benefit from the increased rearing opportunities and cover provided by the marsh vegetation. Many birds and waterfowl use estuarine marshes for perching, foraging, and nesting (ACOE, 2000).

Intertidal mudflats

Along with fringing salt marshes, low-gradient mudflats were once extensive in the lower Duwamish River and estuary and provided habitat for bottom-dwelling organisms important in the food web. Mudflats support diverse and abundant benthic and epibenthic communities, which serve as important food resources for numerous fish species, including juvenile salmonids and shorebirds. If located on side channels, mudflats serve as potential resting and feeding places for juvenile salmon, including Chinook. These shallow water habitats in the transition zone are critical for salmon as they move from freshwater to saltwater. Juvenile Chinook salmon migrating downriver prefer mudflats with channels that retain water at low tide and include quiet areas with lower water flow. Mudflats also provide key foraging opportunities for shorebirds and habitat for resident fish.

Shallow subtidal

Along with the loss of intertidal habitat, the amount of shallow subtidal habitat has been reduced by human activities in the LDR. Shallow subtidal sediments are less productive than intertidal flats, but do support benthic and epibenthic organisms that are important prey items for salmonids, flatfishes, and some birds. Shallow subtidal habitat serves as an important resting and foraging habitat for salmon, especially during lower tides when intertidal flats are exposed. Wading birds also utilize shallow subtidal habitat for foraging.

Riparian Habitat

The riparian zone, defined as the area of upland vegetation above the intertidal zone, is an important transition area, and increases the habitat value of adjacent marshes and mudflats. Containing a mix of trees, shrubs, and other plants, riparian buffers create complexity in the habitat, support insect production, provide food for fish and birds, and provide habitat for birds and other wildlife. Riparian areas also dampen noise and act as a filter for land-based runoff, improving water quality in the river. Wider buffers provide more benefit than narrow ones. Through these many functions, riparian buffers increase the likelihood that wetland and marsh habitats will be able to provide ecosystem services and sustain them over the long term.

When no marsh or mudflat is present and the riparian buffer abuts the river along a steep or armored bank (such as rip-rap), its benefits to the ecosystem are reduced. However, trees and plants along such a buffer still provide some habitat for birds and wildlife. They also contribute detritus and insects to the river and provide some degree of water filtration and shade.

6.4 General Restoration Strategy

Trustees are interested in restoring the kinds of habitats that contribute to estuarine and aquatic resource services lost as a result of contamination in the waterway. To establish a frame of reference, historic conditions in the waterway are used as a model for the desired mix of productive habitats that have lost function through dredging, building of dikes, and shoreline armoring. Although the return to historic conditions is not a goal of the LDR NRDA restoration effort, the restoration of some of the key habitat complexes that were abundant in the past will benefit natural resources and restore the services lost due to the releases of hazardous substances. Specific habitat preferences and corresponding elevations are site-specific within the LDR and are largely dependent on site constraints and sustainability of the habitat within the context of the surrounding conditions. Restoration of these key habitats will benefit the larger Duwamish River ecosystem and Puget Sound because the restored habitats contribute to ecosystem processes such as water filtration, nutrient input, and food webs.

Trustees prefer restoration projects that enhance ecosystem processes, are integrated into the adjacent natural landscape, and are naturally sustainable. Larger, integrated projects are likely to support a more diverse ecosystem similar to the historical landscape and are more likely to persist and function over time in the absence of active maintenance. Individual restoration sites may lend themselves to different approaches, depending on the constraints and opportunities at each site. Close coordination with the Trustees early in the restoration process will help ensure that the restoration projects include appropriate habitat types for the site. When possible, the Trustees look forward to working with EPA and the responsible parties to incorporate beneficial habitat into the remedial design. Integrating restoration planning into the remedial process instead of waiting until remediation is complete before implementing restoration can result in cost savings and a quicker completion of the restoration project.

Trustees also support projects that are spatially small, but help restore habitats in areas devoid of natural habitat. Smaller projects in priority areas that are highly developed help to create a network of habitats that juvenile Chinook salmon and other species can use as a corridor for movement and refuge.

6.5 Restoration Process and Objectives

Trustees developed the following primary objectives for this restoration plan. Several of these objectives are shared by other restoration plans in the region, including: Salmon Habitat Plan (WRIA 9, 2005), Duwamish River (ACOE, 2000), Commencement Bay (Commencement Bay Natural Resource Trustees, 1997), and Elliott Bay/Duwamish Restoration Panel (EBDRP, 1994, 1996, and 1997).

1. Implement restoration with a strong nexus to the injuries caused by releases of hazardous substances in the LDR.

2. Provide a functioning and sustainable ecosystem where selected habitats and species of injured fish and wildlife will be enhanced to provide a net gain of habitat function beyond existing conditions.

    - The restored ecosystem need not be pristine, but must contain the functional elements of a healthy ecosystem, support a diversity of habitats and species historically native to the area, and be environmentally sustainable and cost-effective.

    - Restoration projects will address limiting factors to fish and wildlife resource use in the waterway and enhance ecosystem processes.

3. Integrate restoration strategies to increase the likelihood of success.

    - Pursue an *ecosystem-based* approach to habitat restoration projects by integrating the projects into their surrounding environment and focusing on restoring function and processes as well as habitat structures.
    - Set priorities for restoration projects in accordance with sound restoration planning with a focus on habitats that provide functional benefits to injured natural resources. In general, if functioning and diverse habitats similar to naturally occurring habitats are provided, the appropriate species will follow.
    - Preserve existing threatened habitats while enhancing or creating new habitats.

4. Coordinate restoration efforts with other planning and regulatory activities to maximize habitat restoration.

    - Protect habitat restoration and preservation sites in perpetuity.
    - Encourage enforcement of existing municipal, county, state, tribal, and federal laws and regulations to ensure that restored habitat is not degraded and remaining habitat is protected.
    - Use the natural resource damage settlement to help leverage additional funds, property, or services to expand or enhance LDR/NRDA restoration projects.
    - Consider non-monetary components—such as land, long-term stewardship, in-kind services, and PRP-constructed projects under Trustee oversight—as part of LDR/NRDA settlements.

5. Involve the public in restoration planning and implementation.

    - Incorporate public input into restoration planning, implementation, and monitoring.
    - Foster greater public understanding and appreciation of indigenous (native) habitat resources.
    - Encourage long-term public stewardship of restoration projects and existing natural habitats through education and public involvement.
    - Guide public access at restoration sites by a concern for controlling disturbances and disruption of the sites.

6.6 Habitat Focus Areas

The Trustees acknowledge the limitations of placing restoration in areas adjacent to major commercial or industrial developments that may be contaminated and where source control may have only just begun. Detailed characterization of existing contamination in these areas is described in the RI and is incorporated here by reference (LDWG, 2010). The Trustees intend to coordinate the implementation of restoration projects with remedial activities overseen by EPA.

The purpose of creating Habitat Focus Areas (HFAs) is to break up a large, complex, industrial river corridor into smaller geographic and functional units so that potential restoration options can be more easily visualized. Each HFA was developed based on the nexus of injuries, important target habitat features, and considerations such as obvious geographic boundaries, clusters of restoration sites, exposure to wave energy, location, land uses and development, and maritime use. The Trustees' ability to restore injured resources and the approaches required for such restoration vary among the HFAs. Highest priority is assigned to HFAs that provide habitat for all the injured species groups identified by the Trustees (marine fish and shellfish, birds, and juvenile salmonids). Lower priorities are assigned to areas that provide habitat for some but not all of the natural resources the Trustees seek to restore.

The Trustees have developed four HFAs for addressing Natural Resource Damages from the LDR (Figure 6).

HFA1 – The Lower Duwamish River extending from the northern tip of Harbor Island upstream to North Winds Weir (approximately 7 miles) and including the east and west waterways. This is the area where natural resource injuries occurred as a direct result from hazardous substance releases into the LDR. HFA1 also provides habitat for marine fish, benthic invertebrates, and shorebirds, among other species injured. This is the area where the suite of resources injured by the releases of hazardous substances into the LDR can be most directly and efficiently restored. This is also an area of high significance for juvenile salmon because it includes the heart of the transition zone in the Duwamish. The transition zone is where freshwater and saltwater mix and where juvenile salmon osmoregulate so they can survive in the saline conditions of Puget Sound. Because habitat within the transition zone has been so greatly reduced in size and function and is critical in supporting salmon during a key life stage transition, it is a potential roadblock to salmon recovery and is a prime focus of WRIA 9 recovery efforts (Green/Duwamish and Central Puget Sound Water Resource Inventory Area 9).

Restoration projects in HFA 1 can include the mouths of tributaries to the LDR. These projects can potentially extend up the tributary to the limit of tidal influence. Restoration projects on tributaries (as with all other projects) are subject to approval by the Trustees, and must include permanently wetted areas at appropriate elevations for use by trust resources.

HFA2 – Inner Elliott Bay Shoreline between the Duwamish Head and Port of Seattle Terminal 91. Projects within this area may include restoration of shoreline and marshes, beach profiles, intertidal and shallow subtidal habitat, submerged aquatic vegetation, and the processes that support these habitats. Restoration projects in this location would benefit both marine and estuarine species that were injured by releases of hazardous substances into the LDR. Because of its higher salinity, however, this focus area is not a transition zone where Chinook or other salmon could spend time gradually adjusting to more marine salinities.

HFA3 – The Duwamish River Reach from North Winds Weir upstream to the confluence of the Green and Black rivers (approximately 4 miles). Restoration within this area would benefit many of the natural resources injured in the Duwamish, but would provide few benefits to the marine species that were injured.

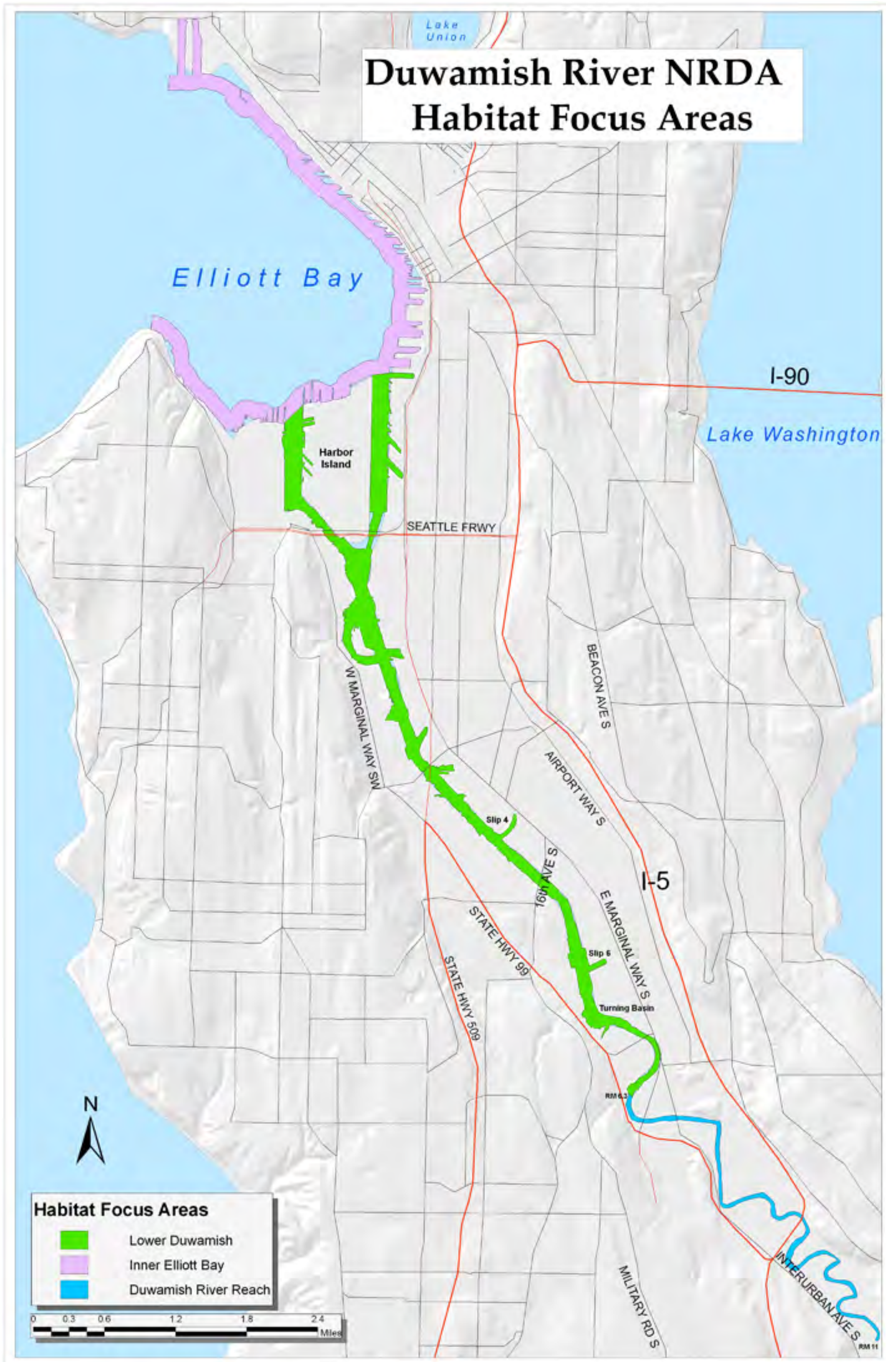

Figure 6. Map showing Habitat Focus Areas 1–3. (Habitat Focus Area 4 is not shown on this map).

HFA4 – The Green River Reach extends from the confluence of the Green-Black rivers upstream approximately 21 miles (identified by WRIA 9 as the Lower Green River Watershed). Projects in this area should be focused primarily on developing juvenile salmon rearing and over-wintering habitat. Restoration in this focus area would neither provide significant benefits to marine and estuarine species nor to the types of shorebirds located in the LDR.

Projects that restore habitat and natural resources within the LDR (HFA1) will receive top priority. As the nexus for the injury, restorations within the LDR will provide the most direct benefits to the whole suite of injured natural resources (including salmonids, marine fish, and birds). Projects outside of the LDR will still be considered, but will be valued less than those within HFA1 because of their distance from the injury. Restoration projects in HFA3 and HFA4 will only be considered if they are a component of a settlement proposal that includes restoration in the LDR (HFA1) and will also be subject to restrictions regarding minimum size and project type.

7. RESTORATION TYPES

An overall guiding principal for an ecosystem-based approach is to prioritize larger, more integrated projects that sustainably restore or enhance ecosystem processes and that are closely linked to the injury nexus. Larger projects that are well integrated into the landscape are more likely to support diverse habitats and species. For example, a larger project in HFA1 could incorporate low and high marsh habitat as well as vegetated upland buffers, and therefore support aquatic and terrestrial species (Figure 5). Projects that sustainably restore or enhance ecosystem processes are more likely to endure for longer periods of time without active maintenance and are more likely to adapt to changes in the environment, such as those that may result from climate change.

Successful restoration projects share certain attributes that contribute to their long-term sustainability. The six attributes described here were developed specifically for the LDR. Restoration projects under NRDA that include some or all of these elements will receive extra value and/or higher priority for selection, though Trustees will make final decisions on whether to accept a site after considering all the project specifics.

1. **Overall size –** In general, larger projects are preferred because these projects can incorporate more types of habitats, can support a more diverse assembly of species, and will likely be more resilient to stressors and climate change.

2. **Shape of the project –** Shape includes the geometry of the habitat, the orientation of the habitat to the river (i.e., parallel or perpendicular), and the width of any openings for channels. The preferred project shape will vary depending on the type of habitat being restored and whether it is located along the main channel or a side channel of the river. More information about shape is incorporated into the description of desired restoration types in Section 7.1.

3. **Habitat type –** Restoring or creating habitats that help replace lost estuarine and aquatic services are prioritized, such as marsh and mudflat. Also valued are habitats that are highly important to key organisms, such as threatened or endangered species, and habitats that have become scarce in a given part of the river. More details on desired habitat types are provided in Section 7.1.

4. **Diversity –** Projects that support several ecological niches as well as a diversity of species are preferred. Projects that support an array of habitats are more likely to have larger numbers of niches and species.

5. **Location in the river –** This attribute includes historic location for similar habitat, access and use by multiple species, societal/cultural factors, and potential for contamination. Commonly, restoration projects attempt to return an area back to its historical habitat condition; because the Duwamish River has been so drastically altered, NRDA projects will have to consider the types of habitats that were historically present in the lower river and where these habitats can now occur given current ecosystem processes and physical constraints. For example, transitional habitat where saltwater and freshwater

mix extends further upriver today than it did historically. This change was caused by reduced freshwater flow into the estuary and the presence of the deep navigation channel.

Projects may also be more or less desirable due to societal/cultural factors. Projects, especially those close to residential areas, might provide increased recreational opportunities or enhance the aesthetics of neighborhoods. Public access must be balanced with safety concerns for a particular site as well as potential negative impacts of overuse that might discourage some wildlife species or degrade habitats. As a result, some sites may provide more benefits by incorporating public access while others may not be appropriate for access. In addition, the selection and construction of restoration sites must also take into account the cultural consideration of tribes such as archeological artifacts or culturally important sites.

Selection of projects and the determination of their benefits must also include an examination of residual on-site or potential off-site contamination sources. Contamination of restored habitat may reduce the ability of that system to recover to a functional state and could negatively impact the species that use the site. Clean-up of contaminated areas would be completed as part of or prior to the implementation of the restoration project.

6. **Landscape connectivity –** Landscape connectivity is closely related to the location attribute. Restoration projects benefit from interconnections between habitats. These connections create wildlife travel corridors and enable the restored ecosystem to exchange materials and energy (seeds, nutrients, and biomass) throughout the ecosystem. Creating viable habitat corridors along the river provides the necessary biological requirements for fish and wildlife using the river, Elliott Bay, and Puget Sound.

   Projects that are located immediately adjacent to existing habitat will generally provide more ecological services than projects isolated from existing habitat. Connecting existing and restored habitats creates a larger overall habitat area and increases the transport of plants and animals to the newly restored site. Because the LDR has lost such significant amounts of natural habitat, it is also important that habitat restoration be located at regular intervals throughout the LDR. Habitat that is spaced at regular intervals will provide juvenile Chinook salmon with the opportunities to forage, find refuge, and osmoregulate during their lengthy seaward migration. Off-channel and side channel habitat are especially needed in the LDR.

Other important considerations related to functional uses of habitats by injured resources and their long-term sustainability include whether projects are located in the river's transition zone or in off-channel habitat.

<u>Habitats in the River Transition Zone</u>

The transition zone is the area where freshwater and saltwater mix, resulting in brackish conditions. The LDR (HFA1) encompasses most of the transition zone; the Duwamish River Reach (HFA3) contains the southern end of the transition zone during certain conditions (low freshwater flow and high tidal reach).

Recent studies have documented the importance of the transition zone in the Duwamish River for use by juvenile Chinook salmon (e.g., WRIA 9, 2006b). The transition zone is where juvenile salmon osmoregulate so they can survive in the saline conditions of Puget Sound. Historically the transition zone was a wide swath of marshes located further downstream; today it is greatly reduced in size and complexity with far fewer off-channel habitats. Because of its critical role for supporting a key life stage of salmon and its potential to become a hindrance for salmon recovery, the transition zone is a prime focus of WRIA 9 recovery efforts. Several restoration projects have already been established in this zone, and locating additional projects in this zone or near the existing projects may be particularly valuable.

Off-channel habitat

Historically, the LDR contained numerous small streams, oxbows, dead-end sloughs, and connected wetlands that provided off-channel habitats. These habitats allowed for easier downstream migration of salmon by providing staging areas for acclimation, feeding, and resting away from high water flows and large predators. They also provided isolated refuge for birds, access to water for wildlife, and overall habitat for a more diverse assemblage of species. The scarcity of these habitat features limits efforts to maintain or enhance injured fish populations and other natural resources. Creating off-channel sloughs, lagoons, and dendritic channels serves many of the NRDA target species (salmonids, flatfish, invertebrates, and birds). Off-channel habitat in the transition zone is particularly important to the recovery of Chinook salmon because the zone supports a key Chinook life stage. Existing off-channel habitat cannot fully support both the natural origin and hatchery fish.

7.1 Desired Types of Restoration

The Trustees are interested in restoring habitats that substantially contribute to marine and aquatic resources impacted from contamination of the river. Marsh and mudflat restoration are top priories in the NRDA effort. Also important are riparian buffers, especially those adjacent to marsh habitat. Riparian habitat supports wildlife and the ecological connection between the land and the river. Riparian habitats filter runoff and provide sources of organic material into the river. Restoration of mudflats, intertidal marshes, and riparian habitats will also benefit the larger marine system of Puget Sound and the species that inhabit that system such as Orca whales and other marine mammals and top-level predators. The NRDA habitat priorities directly contribute to the larger ecosystem through the food web; primary, secondary, and tertiary productivity; nutrient cycling;, and more natural sediment inputs.

The Trustees will entertain other project types for inclusion under the NRDA. However, clear and specific benefits to injured natural resources must be shown. The restoration of mudflats, marshes, and riparian buffers is the primary focus of the Trustees for the NRDA process because these have been determined to have the most direct benefits to injured resources following clean-up of the river. The description below for the creation of these habitat types in the LDR is based upon the experience of Trustees on other restoration projects in the Duwamish and elsewhere in Puget Sound and the input from experts.

7.1.1 Creation of Intertidal Mudflat

Intertidal mudflats are defined here as those habitats that occur within the tidal range of -4 and +12 feet mean lower low water (MLLW). This includes low intertidal mudflats between -4 and +4 feet MLLW as well as high intertidal mudflats between +4 and +12 feet MLLW. Intertidal mudflats in the LDR support a variety of benthic and epibenthic communities that are important food sources for fish—including juvenile Chinook salmon—and birds. Mudflats that are a part of a side channel also serve as important resting areas for juvenile salmon, including Chinook. Construction of mudflats also provides direct benefits to other species such as English sole.

Constructed mudflats should have a relatively shallow grade of less than 2 percent of unvegetated silt/clay to fine sand substrate. Ideally, restored mudflats would have a width (distance perpendicular to either the main or side channel) of at least five meters. Where possible and appropriate, mudflats should be constructed to border existing or restored marsh or vegetated buffer habitat. Because of the use of the LDR for navigational purposes, most restoration projects that include restored mudflats will need to cut into the existing riparian bank to create the appropriate tidal elevations for additional mudflats. Where the appropriate mudflat elevations still exist, construction activities may involve a less extensive bank cutting and site regrading to create the elevation gradient from mudflat up to low and high marshes. In some locations there may be a combination of cutting into the bank as well as filling in lower reaches to achieve the -4 to +12 mudflat elevations. Appropriate sediment grain size fractions and total organic carbon content may need to be added to restored mudflats. In addition, any derelict vessels, trash, or rubble located within the intertidal mudflat range will be removed during the course of construction.

7.1.2 Creation of Marsh

Marsh habitats include both low marsh that occurs between +5.5 and +10 feet MLLW and high marsh that occurs between +10 and +12 MLLW. Both the low and high marsh habitats experience regular tidal inundation and are vegetated with vascular plants. The vegetation of the marsh habitat and its primary productivity are key components of an estuarine food web. Primary productivity and the resulting secondary productivity influence the structure and abundance of the epibenthic and benthic communities, the ability of the marsh to serve as an adequate refuge, and the foraging habitat for salmonids and other fish and wildlife species.

High and low marsh habitat can be constructed on either the main channel or as side channels off of the Duwamish River. Side channel habitat will be more protected from boat wake and other related disturbances within the mainstem channel. Off-channel or side channel habitat also provides more of a refuge for juvenile salmon than habitats in the mainstem because they are subject to reduced currents.

The sustainability and ecological value of restored marsh habitat will depend, in part, on its size and depth (distance perpendicular to either the main or side channel). Judgments about these sizes and depths can be formed by observing systems of similar size in the Pacific Northwest. High marshes along the main channel would ideally be at least 10 meters deep and low marshes at least three meters deep and 10 meters long. Marshes greater than 10 meters deep may start to form multiple small drainage channels which provide important areas for fish foraging. Side channel high marsh habitat preferably would be at least three meters deep and low marsh habitat at least two meters deep, because these are more protected from disturbance regimes. Creation of marsh habitat will have an increased value if it contains both low and high marsh habitat as well as adjacent vegetated buffers and/or mudflats. Restored marshes that are adjacent to existing marsh habitat will also have greater value.

As with intertidal mudflats, marshes may be constructed in many portions of the LDR main channel by cutting into and regrading the existing upland to restore a marsh elevation and lower gradient slope. If the area of the marsh is deep enough, drainage channels may be constructed or allowed to form naturally. For off-channel habitat, existing tributaries could be enhanced by more natural marsh elevation, increased channel sinuosity, and additional native plantings. Side channels could also be created by removing fill or digging into upland habitat to create a side channel and its associated marsh and upland habitats. Side channels should be constructed to have a high level of shading to maintain cooler water temperatures and retain water during low tides so that fish can remain in these habitats for longer periods of time. The location of relic marsh sediments that would be uncovered when removing fill to create marsh can be used as a guide in helping to develop the marsh restoration plan, because these sediments contain the appropriate amount of organic matter and are at the appropriate elevation for marshes.

Marsh creation may also entail the placement of large woody debris to increase habitat complexity. Marshes should be well planted with native species to reduce time to full ecological function and prevent the establishment of invasive species. High marsh communities should contain a variety of herbaceous species such as *Deschampsia*, *Atriplex*, *Distichlis*, and *Potentilla* as well as appropriate shrubs such as willows and dogwood. Low marsh vegetation communities are dominated by herbaceous species, in particular *Carex* species. Dense vegetation communities in marshes will support insect inputs to the river and terrestrial wildlife habitat.

7.1.3 Creation of Riparian Habitat

Vegetated riparian habitats occur sporadically along the Duwamish River from its mouth up through the Green River, although they are greatly reduced or absent for some stretches of the riverbank in the urban areas. Riparian habitats have an elevation of +13 feet MLLW or higher and contain a mixture of native scrub/shrub vegetation and trees that range from water-tolerant species such as willows and Sitka spruce to more upland species such as hemlock, Douglas fir, salal, and Oregon grape. Many other native plant species have been used successfully in restoration efforts on the Duwamish and these will also be considered for use in riparian restoration projects.

Construction or restoration of upland habitat is most beneficial to LDR injured resources when it is adjacent to either restored or existing marshes, mudflats, or creek tributaries. These riparian habitats can dampen noise and filter stormwater runoff flowing into the wetland habitat and exchange materials and energy with adjacent marsh systems. Placement of riparian areas next to marshes increases the ability of multiple species to use both habitat types, such as birds that may perch in the larger trees and bushes and forage in the marsh and river system. Riparian habitats that are not located adjacent to restored or existing marshes, mudflats, or tributaries provide reduced ecological benefits to injured resources. The width of a restored riparian area will influence the integrity of the habitat and its ability to support wildlife. Riparian habitats should ideally be over five meters in width with larger areas providing more ecological benefits.

Restoration of riparian upland may include removal of invasive species, removal of bank armoring or other debris, re-grading the site, planting native vegetation, placing wood, and enhancing substrate. In some cases restoring riparian habitat may consist of enhancement actions such as planting willow stakes in a rip-rap shoreline or just behind it to create overhanging vegetation (known as willow whipping rip-rap). This helps shade the river or side channel and provides insects to the river. In cases where rip-rap is needed as a transition between a restored site and an adjacent bulkhead, this lessens the negative impacts of rip-rap. These types of activities provide some benefit but are significantly less valuable than complete removal of armoring and planting.

7.1.4 Potential Restoration Construction Actions

In addition to the specific construction actions listed above for intertidal mudflat, marsh, and riparian habitat restoration, projects under the NRDA process may include, but are not limited to, the following activities (specific restoration actions will vary by the site and the goal of the project):

- Re-grading slopes to create elevations suitable for mudflats, intertidal marshes, and establishing upland vegetated buffers.
- Re-creating off-channel habitats, such as side channels, through excavation.
- Removing artificial debris, including creosote pilings, bank armoring, derelict vessels, and old piers and docks.
- Incorporating natural debris, such as logs and root wads.
- Enhancing substrate of riparian, marsh, or mudflat habitats.
- Planting adjacent uplands to provide riparian habitat appropriate for fish and wildlife, including willow whipping rip-rap armoring that cannot be removed.
- Removing invasive species and planting native species in all target habitat types.
- Reconnecting freshwater sources to the Duwamish River.
- Increasing connectivity between existing and enhanced habitat components.

The removal of previously placed fill material, structures, shoreline armoring, and debris that will occur during these restoration efforts can be challenging, and some unanticipated difficulties will occur for some projects.[10] Careful site assessment investigations will help reduce the likelihood of unexpected problems, but some projects may need to be modified because of such discoveries.

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[10] For example, NRDA restoration projects implemented in the LDR to date have encountered unexpected problems such as underground storage tanks, previously unknown cultural resources, and large amounts of debris that resulted in extra disposal costs.

7.2 Types of Restoration Not Desired

NRDA restoration projects must benefit natural resources that have been injured as a result of releases of hazardous substances into the LDR in order to fulfill the Trustees' mandate under CERCLA to make the public and environment whole. This relates to the type of restoration as well as the location of the restoration projects in relation to the injured resources and services. Beyond that, practical considerations such as the amount and cost of actions necessary to maintain a project are important considerations. Restoration actions that do not fulfill the Trustees' mandate to restore injured resources or which would be difficult and/or costly to maintain are not appropriate as NRDA restoration for the LDR. Information on screening criteria for projects is given in Section 8.2. Projects that will not be considered in the NRDA process include but are not limited to:

- Those located outside of the pre-defined HFAs.
- Those within the HFAs that do not benefit injured resources. For example, projects within the Green River Reach (HFA4) that only benefit terrestrial species that do not use the LDR.
- Activities that only provide benefits to adjacent human communities and not to natural resources or habitats.
- Upland restoration projects without a direct tie to the LDR.
- Projects that do not restore natural ecosystem processes.
- Projects that are not sustainable or require an inordinate amount of care and maintenance.

7.3 Restoration Project Monitoring and Performance Criteria

Monitoring is a critical component of any restoration project. Monitoring provides a mechanism to determine whether the project has met its goals or performance criteria and helps to guide adaptive management actions and site maintenance. Monitoring plans must be tailored to specific restoration sites and reflect the project's goals and objectives. The parameters selected for monitoring should, where possible, also be ones that can be used collectively to evaluate restoration actions across the LDR. Collective evaluations of results from multiple restoration sites will allow the Trustees to evaluate the overall benefits from the NRDA restoration process and will help to inform future decisions and designs for projects.

7.3.1 Performance Criteria

Performance criteria are the measures that will assess the progress of the restoration sites toward project goals. Performance criteria should include both the performance anticipated as well as the time that is predicted for the restored habitat to reach intermediate milestones and the overall project goals. Because habitats and ecosystem processes can take up to 20 years, if not longer, to recover fully, intermediate milestones are necessary to determine whether a project is on an acceptable trajectory toward full recovery. Comparison to reference sites will help set anticipated milestones and goals for project performance. For PRP-implemented projects, all performance criteria and monitoring plans must be reviewed and approved by the Trustees before site construction can begin.

7.3.2 Adaptive Management

Restoration is a relatively young science. To ensure the success of a restoration site it is important for all projects to have an adaptive management strategy that will allow Trustees to determine what attributes are not on target for project success and what actions, including overall course corrections due to site conditions, need to be taken to achieve project success. Adaptive management actions may include replanting species, changing plant species or densities, adding mulch or further amending soils, adjusting or augmenting herbivore exclusion devices, and/or installing irrigation. The Trustees will consider lessons learned from previous restoration efforts on the LDR—including past practices to avoid—when initially developing restoration concepts and after construction when evaluating whether (and what kinds of) adaptive management actions are appropriate. For PRP-implemented projects, adaptive management plans that detail potential restoration or management actions for a site must be reviewed and approved by Trustees prior to project implementation.

Monitoring parameters should be designed to inform adaptive management actions. Monitoring data collection and analysis is critical in the first few years of site development, as that is the time during which management actions are most effective. Eradicating or controlling invasive species before the population is too large or planting different species because the hydrology or salinity of the site is different than what was originally anticipated are examples of adaptive management actions.

The key to a successful adaptive management plan is the critical evaluation of a problem or attribute that is not performing as expected. This critical analysis before actions are taken helps to ensure that issues are properly addressed and adaptive measures successful. For example, if there is a large die-off of certain plant species, managers should first evaluate potential causes. Was it poor plant stock? Unexpected salinities or hydrologic regimes? Or perhaps herbivore pressure? If the stock was poor, the same species could be successfully replanted. If the die-off resulted from a salinity change, different species should be planted that can tolerate the new salinity regime. Protective structures such as goose-excluder netting or roping can be constructed if herbivore pressure becomes too high.

7.3.3 Monitoring Parameters

The specific parameters being monitored should reflect both the physical structure and biological components of the restored habitat. More importantly, the selected parameters and plan must assess how the system and its ecological processes are functioning. For example, monitoring a low marsh and mudflat restoration might include an examination of how the benthic and epibenthic communities that support larger food webs are developing in relation to healthy systems. One might also examine how juvenile salmonids and birds are using the site; is it for resting and/or foraging? Examples of potential monitoring parameters include:

Physical parameters

- Intertidal area, including area of low and high marsh and mudflats.
- Slope stability and erosion.
- Soil/sediment structure and quality.
- Site salinity.
- Sediment accumulation patterns.
- Channel development.
- Tidal regime and circulation.
- Surface elevation gradients and channel morphology.

Biological parameters

- Vegetation survival and areal coverage.
- Herbivore control effectiveness.
- Invasive species cover and presence.
- Presence of desired fish and wildlife species.
- Fish or wildlife use of site.
- Food web structure.
- Benthic community structure.
- Primary productivity levels.
- Composition of insect fall-out.

Many ecosystem processes and restored habitats take time to fully develop. Monitoring should be conducted for a minimum of 10 years at each site to effectively capture how the system is functioning and whether it will achieve its desired goals. Sites develop more rapidly at first as plants become established and the species return, and then have a slower recovery rate. As previously mentioned, adaptive management actions can be more effective earlier in the restoration process. To account for this temporal variability, monitoring should be completed every year for at least the first three years and can then be spaced more infrequently in subsequent years.

7.3.4 Reporting Requirements

An as-built construction plan must be submitted to the Trustees after completion of construction. Monitoring plans along with identified adaptive management actions that need to be taken must be completed once a year for the first three years and according to the approved monitoring schedule thereafter.

7.4 Stewardship Model

The LDR is situated in a dense urban environment. The river and its estuary are highly altered with many ecosystem processes no longer fully functioning to support healthy habitats. Many habitats have an altered hydrologic regime because they have been cut off from ground water or surface water flows. Loss of riparian and marsh habitats have increased sediment and pollution inputs from reduced filtration and other attributes and reduced inputs of detritus matter and wood. Habitats in urban environments are also subjected to increased disturbance levels such as the establishment of invasive species, negative human impacts such as dumping or trampling, and increased herbivore pressures on young plants.

These stressors can slow or in some cases prevent restoration projects from achieving the desired long-term benefits to injured resources. Vegetation is likely to require irrigation and, for marsh plants, goose-exclusion fencing in order to become established successfully. In addition to adaptive management, long-term stewardship that includes site monitoring and maintenance activities will help ensure that NRDA restoration actions are able to provide the required long-term benefits to injured resources. Each NRDA settlement will include a period of required monitoring and adjustments to ensure the successful establishment and functioning of the habitat. In addition, a mechanism will be established by the Trustees to help ensure long-term stewardship of all NRDA sites in the LDR to come into effect after the period of active maintenance is complete. A long-term stewardship program is being developed for Commencement Bay NRDA restoration projects and is being considered for the Elliott Bay/Duwamish River Restoration Program, and the Trustees anticipate following a similar model for LDR restoration projects.

Stewardship is a combination of a monitoring and maintenance activities. Yearly inspections of restored sites will inform the site stewards as to what actions, if any, will need to occur over the course of a year. Potential management actions include:

- Invasive species removal and/or control.
- Removal of debris or trash.
- Planting vegetation, including species that require shade from a more established canopy and therefore could not have been planted immediately after construction.
- Mulching or soil amendments.

8. PROJECT SELECTION

8.1 Summary of Other Restoration Plans

In addition to this Restoration Plan and Programmatic EIS, several other restoration plans have been developed in the Duwamish River:

Puget Sound Salmon Recovery Plan, Water Resource Inventory Area (WRIA) 9, Green/Duwamish River Basin, 2005

The Puget Sound Salmon Recovery Plan section for the Green/Duwamish River includes watershed implementation priorities over the next three years. Of 35 projects identified (including nearshore Elliott Bay), six projects are located in the LDR focused on estuarine transition zone habitat.

U.S. Army Corps of Engineers Green/Duwamish River Basin Ecosystem Restoration Study, 2000

This plan covers the entire Green/Duwamish watershed (upper, middle, and lower), and proposes 45 restoration projects. Five of these proposed projects are located in the Duwamish estuary, with the remainder in the Green River and its tributaries. Duwamish Project One (now known as North Winds Weir, located in HFA1) was completed jointly with King County in 2010 (http://www.govlink.org/watersheds/9/plan-implementation/SRFB-northwinds.aspx). Project Codiga Farms, located in HFA3, was constructed in 2008 (http://pugetsound.org/science/projects/central/codiga.pdf).

Elliott Bay Panel, Elliott Bay and Duwamish River, 1994

The 1994 Concept Document of the Elliott Bay/Duwamish Restoration Program was the result of a consent decree signed in 1991 between the Elliott Bay Trustees, METRO (now King County) and the City of Seattle, to address natural resource damage liability (EBDRP 1994, 1996, 1997; U.S. District Court, 1994). The purpose of the Concept Document was to identify and evaluate potential sites for remediation and habitat development (restoration) to compensate for injuries in Elliott Bay and the Duwamish River estuary. The consent decree parties formed a Panel to carry out the program objectives. The Panel was involved in 11 projects, including three remediation projects and a recontamination study. Of the habitat projects, five are located in the LDR (Hamm Creek, Site 1 (now North Winds Weir), North Winds Weir/Cecil B. Moses Park, Turning Basin #3/Kenco Marine, and Herring's House). The Panel has directly restored fish and wildlife habitat in its focus areas. In addition to contributing funds to the construction of habitat sites by others, they directly restored fish and wildlife habitat at four Panel restoration sites in the LDR. Three of these Panel Habitat projects are summarized in more detail under section *8.3. Examples of Already Completed Restoration Projects.*

Lower Duwamish River Habitat Restoration Plan—An Inventory of Port of Seattle Properties, 2009

This plan by the Port of Seattle inventories port properties and suggests possible restoration opportunity sites that could be candidates for restoration projects. The plan also describes existing habitat restoration projects that the port has already completed (Port of Seattle, 2009b).

Duwamish Valley Vision Map and Report, 2009

The Duwamish River Cleanup Coalition produced this visioning document after holding a series of community meetings around future ideas for the Duwamish Valley. The report looks at economic development, transportation amenities, and environmental features. Various habitat projects and open space concepts are included in the Environmental Features section, including a habitat corridor along the South Park Shoreline (Duwamish River Cleanup Coalition, 2009).

8.2 Selection Criteria

Potential restoration sites will be identified by Trustees, PRPs, other government agencies, private firms, and the public. Initial screening will assess the site and its suitability for restoration. For example, if a proposed project is not located within one of the HFAs, it would not be evaluated further. A project within a HFA would merit further screening if it is determined to have the potential to benefit injured natural resources and services, but would not be considered further if it did not have such potential. Once a site is proposed, a project-specific restoration concept will be developed. This will determine what restoration is possible at the site and how it can be carried out, and will include site-specific goals. Based on these goals, specific restoration techniques will be designed and preliminary cost estimates prepared and compared with available funding. During the project design and implementation, Trustees will take advantage of opportunities to partner with other agencies or utilize economies of scale to reduce costs or improve project benefits where feasible.

Sites will be evaluated using a two-step process. For the initial screen (Tier 1), proximity to the affected area, potential to benefit injured natural resources and services, and future management will be considered. Sites that meet this initial screen will then be examined under Tier 2 criteria that are designed to focus on differences between sites and enable prioritization of potential sites.

Tier 1 Screening:

Habitat Focus Area

Is the potential site located within the higher priority HFA?

Benefits to Injured Resources

How similar are the habitats being created or enhanced to the natural resource injuries and service losses that resulted from the contaminant impacts? Projects that most directly benefit the resources and services that were injured will receive highest priority.

Future Management

Would the landowner agree to a conservation easement or other appropriate land management restriction? Without an understanding of the future management of the specific property under consideration, the Trustees cannot estimate future service flows, and therefore will not further consider the site.

Tier 2 Screening:

Technical Feasibility

What site-specific factors might influence project success? This includes residual contamination that may adversely affect resources and whether there is adequate acreage available for project implementation.

Cost to Carry Out the Restoration Alternative

What are the costs associated with implementation of the restoration project at the proposed location? This includes costs to purchase property or acquire appropriate easements, and costs for implementation. Everything else being equal, projects that cost less than other alternatives are preferred.

Source Control and Recontamination Potential

Is there adequate source control so that a restoration project will not be contaminated by new releases of hazardous substances? What is the likelihood of recontamination of a project site by hazardous substances from surrounding sediments? The Trustees do not want to build habitat projects that will become significantly contaminated such that resources utilizing the project sites would be injured. This may mean, for example, that a project would either not be built if there is a high potential for it to be contaminated or its construction would be delayed until adequate source control and clean-up of nearby and upstream contaminant sources is completed.

Extent to Which Each Location Will Maximize Benefits to Resources

Under this criterion, specific features of the site location, habitat type to be created, size of the project, location in the river, and proximity to other restoration sites will all be evaluated to determine benefits to resources. For example, if the site is located close to an existing restoration site, it may provide added benefit by increasing the habitat complexity of an area. This evaluation will rely on guidelines described in Section 7.

8.3 Examples of Restoration Projects from previous settlements

As a result of a NRDA settlement from 1991, the Elliott Bay Restoration Panel constructed several projects in the LDR. These projects are described in Appendix B and provide examples of the types of restoration projects that would be desirable for future settlements in the LDR.

9. RESTORATION ALTERNATIVE ANALYSIS

Relatively few types of restoration actions have proven over time to be reasonable approaches to restoring injured natural resources and services. The Trustees involved in CERCLA NRDA restoration in Commencement Bay faced a similar situation as that in the LDR, in terms of hazardous substances released and the types of natural resources that were injured. They underwent a detailed review of potential restoration approaches, and this analysis is presented in their Restoration Plan/Programmatic Environmental Impact Statement (RP/PEIS, Commencement Bay Natural Resource Trustees, 1997). Their review of restoration approaches (available at: http://www.cbrestoration.noaa.gov/docs.html) is incorporated into this LDR PEIS by reference. Three of the Commencement Bay restoration alternatives—two action alternatives and the no-action alternative (which must be analyzed under NEPA)—were chosen for further evaluation by the Trustees for this LDR NRDA Restoration Plan.[11]

The three restoration approaches proposed for analysis for the LDR are:

- Alternative 1: No Action
- Alternative 2: Species-Specific Restoration
- Alternative 3: Integrated Habitat Restoration

Restoration alternatives must be appropriate for NRDA restoration under CERCLA as an initial analysis and then must be analyzed for direct, indirect, and cumulative impacts under the National Environmental Policy Act (NEPA). The process used in this analysis is first to evaluate how well the alternative meets the goals of restoration under CERCLA. Alternative 1 was determined to be inconsistent with the Trustees' obligation under CERCLA to restore natural resources and resource services that were injured or lost as a result of releases of hazardous substances. The remaining two alternatives would be consistent with CERCLA restoration goals, but Alternative 3 was judged to be more appropriate as a NRDA restoration approach than Alternative 2.

It is worth noting that the Commencement Bay trustees proposed a different restoration approach for NRDA restoration in their RP/PEIS—which they termed the "Integrated Approach"—that was a combination of all of the action alternatives they considered, including what they termed the "Habitat Function" approach. However, all the restoration actions actually conducted by the Commencement Bay trustees following the finalization of their RP/PEIS belonged to their Habitat Function category (which is the conceptual equivalent to the

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[11] The other two action alternatives considered by the Commencement Bay trustees included "Acquisition of Equivalent Natural Resources and Services" (natural resources or services which would be the same or substantially similar to the natural resource or service that was injured but could not otherwise be restored) and "Integrated Approach" (combination of all four action alternatives considered by the Commencement Bay trustees). For the LDR NRDA, the Trustees believe that restoration of the injured natural resources and services is possible, so the Acquisition of Equivalent Natural Resources and Services was not further considered. The Integrated Approach is discussed further in the text.

Integrated Habitat Restoration approach in this RP/PEIS) and no projects were from other categories included in their Integrated Approach Alternative. Therefore, the actual restoration actions that will result from implementation of the LDR preferred alternative, if it is selected when the RP/PEIS is finalized, will be similar to those that have been so successful in restoring injured natural resources in Commencement Bay and its associated waterways. The Trustees are confident that restoration in the LDR under the Integrated Habitat alternative would be equally successful.

9.1 Analysis of the Alternatives for the Purposes of Restoration

NEPA requires that any federal agency proposing a major action (as defined under NEPA) consider reasonable alternatives to the Proposed Action. Screening criteria are used to determine whether an alternative is reasonable. The Trustees used three criteria to evaluate the three alternate approaches on their ability to fulfill the Trustees' requirements under CERCLA and other statutes to restore injured natural resources and services in the LDR:

- Likelihood that the Trustees' goals in fulfilling their requirements to restore injured natural resources would be achieved.
- Potential to provide benefits to multiple natural resources and services.
- Potential for environmental impacts.

The three Alternatives are discussed below with respect to these criteria and other considerations. Table 3 summarizes the comparison of Alternatives.

9.1.1 Alternative One: No Action

The No-Action Alternative would result in the Trustees not working to restore natural resources and services that were lost as a result of the release of hazardous substances into the LDR. While there would presumably be an eventual recovery of affected resources to or near to the baseline condition that would exist if these releases had not occurred, there would be no restoration actions taken to compensate for interim losses that occurred in the past and are occurring now and will continue to do so until the recovery to baseline occurs. This would mean that the Trustees' mandate under CERCLA to make the public and environment whole for injuries to natural resources from the releases of hazardous substances would not be met. This alternative does not address the purpose and need for restoration of lost natural resources and services, and therefore is not a preferred alternative for the LDR/NRDA restoration plan.

If this alternative was selected, the Trustees would not undertake any LDR/NRDA restoration projects. Any restoration actions in the LDR would take place under other current or future programs and regulations pursued by tribes, federal and state agencies, and other entities outside the NRDA process.

While short-term negative impacts are expected to continue under no-action as interim losses continue, the No-Action Alternative would have no direct, indirect, or cumulative adverse or beneficial impacts to the human environment as compared to the action alternatives. This is due to the fact that no new restoration actions are implemented under this alternative to improve water or sediment quality, habitat conditions, and fish and wildlife including threatened and endangered species. The No-Action Alternative is by far the least costly alternative. However, the No-Action Alternative is not consistent with the goal under CERCLA to restore natural resources and services that were injured or lost as a result of the release of hazardous substances. Because interim losses of natural resources and services have occurred and continue to occur during the period of recovery, and technically feasible alternatives exist to compensate for these losses, the Trustees determined that restoration actions are required, and the No-Action Alternative is not proposed as the Preferred Alternative.

9.1.2 Alternative Two: Species-Specific NRDA Restoration

This alternative would consist of planning and implementing individual NRDA restoration projects to benefit specific species or small groups of species that are likely to have been injured by hazardous substance releases to the LDR. Under this alternative, Trustees would evaluate potential restoration projects for the benefits provided to a specific species or group of species, without the organizational framework provided by the preferred Integrated Habitat Restoration Alternative (discussed below). Under the Species-Specific Alternative, Trustees would decide what species or group of potentially injured species would be targeted to benefit from a restoration action at a given time. Because there are a large number of species that the Trustees believe were injured as a result of exposure to hazardous substances, the species targeted for restoration actions could be subject to change over time in order to achieve restoration for more of the injured natural resources. Potential projects would be evaluated based largely on the benefits provided to the then-targeted species, not on benefits to a broader range of species. Under this approach, there would be more flexibility in locating restoration projects, because some of the species affected could benefit from projects outside the Duwamish/Green River and Elliott Bay system.

The variety of possible projects would also be greater under the species-specific approach, because non-habitat projects such as artificial propagation could be selected, in addition to habitat projects. Species-specific restoration activities could include projects such as restoration followed by re-introduction of individuals, artificial propagation of populations, and enhancing fitness of the population through selective breeding. Actions under this alternative might involve constructing net pens or hatcheries; creating or enhancing feeding, rearing, or spawning habitat; constructing artificial reefs; seeding intertidal mudflats with clams or oysters; or constructing nest boxes or perches. The Species-Specific Alternative, and possible types of projects that could fall within it, are discussed in detail in the Commencement Bay RP/PEIS (available at http://www.cbrestoration.noaa.gov/rp-eis/rpeis702.pdf).

The Species-Specific Alternative has a moderate potential for short-term impacts to water and sediment quality, habitat conditions, and fish and wildlife species. The nature and type of impacts from habitat creation projects designed to benefit target species would be similar to those for the Integrated Habitat Restoration Alternative (Alternative 3). But other, potentially more significant kinds of impacts could result from non-habitat restoration projects. For example, longer-term adverse impacts to water and sediment quality could result from construction of new hatcheries, net pens, or aquaculture facilities.

From a NRDA perspective, a species-specific restoration approach would be most appropriate if one or a few species were predominantly injured by the oil or hazardous substance releases, because projects could be designed to address injuries to these most affected species. For example, sometimes a particular species or a few species suffer a very large mortality as a result of an oil spill compared to other resources, and in those cases the Trustees have sometimes implemented a specific project to restore that species or a few species. The NRDA restoration for the North Cape Oil Spill is an example of this approach, where specific restoration projects were developed to restore species such as lobster and loons (see http://www.darrp.noaa.gov/northeast/north_cape/restore.html for more details).

However, when there is a broad range of species affected with a number of different life histories, trophic levels, etc., as is the case for the LDR NRDA, a species-specific restoration approach is more difficult. Targeting restoration for one or a few species runs the risk of having non-targeted species getting little or no restoration benefits to address their injuries.

It is likely that the process of restoration project selection would take longer and be less efficient than for the Integrated Habitat Restoration approach, because of the additional time required to assess the multitude of different types of projects and project locations, resulting in delayed restoration and higher planning costs. This alternative would result in less predictability, because a large number of different types of restoration could be considered at a number of different locations.

The Species-Specific Alternative would also be problematic for PRPs who would like to propose potential restoration projects as part of a settlement of their NRDA liability, but who would not have very clear guidance on what types of projects and project locations would be favored by the Trustees. Additionally, scaling restoration actions for non-habitat projects would be more difficult than scaling habitat projects, because the assessment approach used by the Trustees to develop estimates of injury is based on impacts to habitats, weighted by their value to a large number of species, not on one or a limited number of species. A species-specific restoration approach would require Trustees to develop estimates of injury to individual species, which would be extremely difficult, time-consuming, and expensive in a situation like that in the LDR, in order to scale the individual restoration projects.

A very detailed analysis of impacts from this alternative is difficult, as there are many possible types of projects, with greatly differing potential impacts. Therefore the impact analysis of the species-specific alternative is discussed generally beginning in Section 9.2. The more-detailed analysis of this alternative in the Commencement Bay RP/PEIS is incorporated in this RP/PEIS by reference. The species-specific restoration alternative is not proposed as preferred for the LDR RP/PEIS, given that the injuries are believed to be broad-based and not predominantly to one or a few species, and that a different assessment approach would be required from what the Trustees have determined to be most appropriate under the circumstances in the LDR.

9.1.3 Alternative Three: Integrated Habitat Restoration (Preferred)

This alternative involves actions designed primarily to restore certain types of habitats that support a range of species. Under this alternative, the Trustees would focus on habitat projects that benefit a suite of different species, using important surrogate species and groups to evaluate the benefits of potential habitat projects to injured resources. Under this approach, projects that provide benefits to a large number of potentially injured species would have greater value compared to projects that would tend to benefit largely one species or a small group of species. Typical kinds of restoration actions under this alternative include removal of intertidal fill to restore mudflats, marsh, and/or riparian habitats; creation of off-channel areas; removal of creosote pilings and overwater structures that shade habitats; and softening shorelines. These projects will create habitats that provide food, foraging, and resting areas for juvenile salmonids and other fish, shorebirds, and wildlife.

The Integrated Habitat Restoration Alternative should result in net improvement in water and sediment quality over the long term. Some habitat restoration actions would result in short-term adverse impacts, but these impacts can typically be minimized by using best management practices at a project level. Adverse impacts may include temporary increases in erosion associated with land disturbance, temporary increases in turbidity, temporary increases in noise from construction activities, and short-term increases in air pollution from construction equipment.

This alternative ties in well with the approach the Trustees used in estimating injury, which is based on habitat use and value to the surrogate species or species groups. By clearly laying out the types of projects that the Trustees favor, PRPs will be able to use these guidelines to develop potential project ideas for settlement discussions with Trustees. This will also allow PRPs to begin considering whether restoration actions can be integrated with response or remedial actions to save costs. Use of this alternative will be more efficient for the Trustees, because there will be a consistent set of criteria and a methodology for evaluating potential projects. This will result in lower process-associated costs, reducing costs to PRPs. It facilitates the establishment of a cash-out position for potential settlements, because there are existing habitat restoration projects in the LDR that match the types of projects that could be implemented as part of this restoration planning effort, allowing the development of a reasonable restoration cost estimate for construction, monitoring, adaptive management, and Trustee administrative costs.

This alternative is proposed as preferred because it is best suited of all the alternatives to fulfill the goal of NRDA under CERCLA to restore injured natural resources and services. It is specifically designed to improve habitats that function in support of multiple fish and wildlife resources, as well as the prey items of these species that reside in those habitats. Habitat restoration in the Duwamish River will provide indirect benefits to animals such as Orcas, even though they do not directly utilize habitats in the LDR. Since Orcas feed on fish and other prey that do depend on these habitats, they will benefit from increased biomass and lower contamination in prey items. In fact, part of the recovery plan for the distinct population segment of Southern Resident Orcas, which are now listed as endangered under the Endangered Species Act, includes habitat restoration to increase prey availability to Orcas (NOAA, 2008). The Trustees recognize the success of similar habitat restoration projects in the LDR by the Elliott Bay Panel and others, Commencement Bay, and elsewhere in Puget Sound, whether done in a NRDA context or not, and this alternative will build on those efforts. The potential impacts of this alternative are discussed at greater length below.

9.2 Direct, Indirect, or Cumulative Impacts of Alternatives under NEPA

NEPA regulations require the assessment of effects of an action, including direct and indirect effects (defined at 40 CFR 1508.8) and consideration of cumulative impacts as defined at 40 CFR 1508.7. Accordingly, each of the three alternatives identified above were evaluated to assess their direct, indirect, or potential for cumulative impacts on the human environment. In assessing the impacts, the context of the action is considered in several contexts—e.g., the society as a whole, the affected region and interests, and the locality. By assessing the direct, indirect, and cumulative impacts that could potentially arise from implementing each of the alternatives, the severity (intensity) of the impacts can be determined to support a comparison of alternatives. Since restoration actions are designed to be beneficial but may involve various temporary or long-term adverse impacts, both beneficial and adverse impacts are analyzed. This subsection is specifically provided to serve as the analysis of environmental consequences as required under 40 CFR 1502.16, including a more detailed analysis relative to specific resource areas, including biological, physical, aesthetic, socioeconomic, historic, and cultural resources.

As individual projects are proposed subsequent to this restoration planning process, each project will be evaluated to assess the significance of impacts in accordance with the NEPA context and intensity factors described in 40 CFR 1508.27, including evaluating the intensity of both the beneficial and adverse impacts under short- and long-term conditions. Therefore, to most readily support the future tiering to this document that may occur for analysis of environmental impacts associated with individual projects, this section analyzes the affected environment against those specific factors (40 CFR 1508.27(b)) in order to evaluate whether or not the alternatives would have a significant effect on the quality of the human environment. In addition, the potential impacts of the alternative were examined in keeping with NOAA Administrative Order (NAO) Series 216-6*, Environmental Review Procedures for Implementing the National Environmental Policy Act* (NAO 216-6).

The following definitions are used to characterize the nature of the various impacts evaluated in this EIS:

- *Short-term or long-term impacts.* These characteristics are determined on a case-by-case basis and do not refer to any rigid time period. In general, short-term impacts are those that would occur only with respect to a particular activity or for a finite period, or only during the time required for installation activities. Long-term impacts are those that are more likely to be persistent and chronic.
- *Direct or indirect impacts.* A direct impact is caused by a proposed action and occurs contemporaneously at or near the location of the action. An indirect impact is caused by a proposed action and might occur later in time or be farther removed in distance but still be a reasonably foreseeable outcome of the action. For example, a direct impact of erosion on a stream might include sediment-laden waters in the vicinity of the action, whereas an indirect impact of the same erosion might lead to lack of spawning and result in lowered reproduction rates of indigenous fish downstream.
- *Minor, moderate, or major impacts.* These relative terms are used to characterize the magnitude of an impact. Minor impacts are generally those that might be

perceptible but, in their context, are not amenable to measurement because of their relatively minor character. Moderate impacts are those that are more perceptible and, typically, more amenable to quantification or measurement. Major impacts are those that, in their context and due to their intensity (severity), have the potential to meet the thresholds for significance set forth in CEQ regulations (40 CFR 1508.27) and thus warrant heightened attention and examination for potential means for mitigation to fulfill the requirements of NEPA.

- *Adverse or beneficial impacts.* An adverse impact is one having adverse, unfavorable, or undesirable outcomes on the man-made or natural environment. A beneficial impact is one having positive outcomes on the man-made or natural environment. A single act might result in adverse impacts on one environmental resource and beneficial impacts on another resource.

The Trustees concluded overall that any potential adverse environmental impacts from the Integrated Habitat Restoration Alternative would largely be short-term and construction-related, while beneficial environmental impacts would result in long-term moderate increases in habitat benefits to the area's natural resources and the aesthetics for humans. There would be direct beneficial impacts to habitat function and indirect beneficial impacts to the suite of species that depend on these habitats. The Species-Specific Alternative has a greater potential for adverse impacts in the short and long term than does Alternative 3 (as detailed in the Commencement Bay RP/PEIS), but also has the potential for long-term beneficial environmental impacts. Some of the potential projects under this Alternative could benefit one or a few resources, in contrast to the Integrated Habitat Restoration Alternative. The No-Action Alternative would have no direct impacts, adverse or beneficial, and would result in no additional restoration beyond that that would otherwise be accomplished under other programs and authorities. There would be no actions to offset the continuing loss and degradation of habitat in the LDR.

9.2.1 Likely Impacts of the Alternatives

As noted above, adverse environmental impacts expected from restoration projects under the Integrated Habitat Restoration Alternative are all short-term and construction-related. The magnitude of environmental impacts would generally be a function of the extent and duration of construction. Mitigation measures (i.e., use of best management practices) would be included to minimize these short-term impacts and would be considered on a project-by-project basis. Adverse impacts would therefore be expected to be minor. The long-term impacts would be beneficial to the area's natural resources by, for example, providing additional fish habitat, protecting and improving water quality, and increasing aesthetics in the area. Although individual habitat restoration projects would provide relatively minor beneficial impacts, cumulatively the additional acreage of habitat from multiple projects implemented under the Integrated Habitat Restoration Alternative would be of more moderate impact given the severe lack of habitat in the LDR. Projects implemented under Alternative 3 would be developed to comply with all applicable local, state, tribal, and federal permits and approvals.

Adverse environmental impacts under a Species-Specific Alternative would be the same as those for Alternative 3 for those projects that are habitat-related, but also include other potential adverse impacts from other possible types of projects that could be implemented under this alternative. Potential issues with aquaculture projects, for example, could include organic enrichment of sediment, and disease. These have the potential to cause more long-term and moderate adverse impacts, although mitigation measures might reduce the likelihood of such impacts. The Commencement Bay RP/PEIS discussed those other potential impacts in detail.

In contrast, the No-Action Alternative would have no such construction-related impacts, but neither would it have the long-term beneficial impacts to natural resources in the LDR.

9.2.1.1 Aesthetics, Light, and Glare

During the construction phase of a project under the Integrated Habitat Restoration Alternative, the project site would have poor aesthetics from disturbed soils, piles of debris, and other construction-related untidiness, resulting in short-term minor impacts. It is possible that lights might be used if some of the construction work is done at night (for example, to work when there are favorable tides). There could be some glare off of machinery used in the construction. However, the duration of this phase would be relatively short, a few weeks to a few months, for projects under this alternative. Following construction, project sites are likely to have much better aesthetics than were present prior to the restoration action, if for example rip-rap or other shoreline armoring is replaced with marsh and riparian vegetation.

The same is largely true for the Species-Specific Restoration Alternative. There would be no visual impacts from the No-Action Alternative.

9.2.1.2 Economic Impacts

No significant economic impacts on neighborhoods would occur under the Integrated Habitat Restoration Alternative. The restoration projects implemented under this alternative would not result in a significant conversion of commercial property to habitat that could lead to job losses or decreases in income for the jurisdictions in which these projects would occur. There would be short-term, minor economic benefits to local businesses in the general area in which habitat projects would be located from spending by construction workers. Over the long term there should be no significant economic impacts from the implementation of this alternative.

The same is largely true for the Species-Specific Alternative. The No-Action Alternative would have no economic impacts, including no short-term benefits to local businesses.

9.2.1.3 Energy and Natural Resources

There are no known sources of energy or exploitable natural resources in the area to be affected by either of the action alternatives; therefore, no impacts would result from implementation of either of these alternatives. No impacts would result from the No-Action Alternative.

9.2.1.4 Geological and Soil Resources

There are no known mineral or oil deposits in the areas where projects under the Integrated Habitat Restoration Alternative would be located, and many of the project sites will be developed/disturbed/filled-in areas, and construction of habitat will therefore provide a slight increase in the quality of soils and sediments. This is also true for habitat projects under the Species-Specific Alternative. There is a slight potential for long-term minor to moderate impacts to sediment from nutrient enrichment from aquaculture facilities if not properly constructed and maintained. There would be no adverse impacts to geological and soil resources from the No-Action Alternative.

9.2.1.5 Recreation and Education

It is anticipated that many projects implemented under the Integrated Habitat Restoration Alternative would increase the aesthetics of the shoreline in the LDR, replacing hard armoring with vegetated shorelines. Therefore kayaking or boating in the area would be enhanced over the long term by the creation of more natural habitat along the river. No adverse impacts to recreation or education would be likely under this alternative. It is possible that some project locations would be or would become parks that could have passive recreational use, provide access to the LDR, and/or possibly have information kiosks that could provide environmental education to visitors. Public use on any restoration project site would need to be carefully considered and designed in order to minimize any loss of potential ecological value, since offsetting ecological injuries in the LDR is the primary mandate for the Trustees. Therefore, although there would be some long-lasting beneficial impacts from projects implemented under this alternative, these would not be expected to be major.

Similarly, no adverse impacts to recreation or education would be expected from the Species-Specific Alternative. Since there could be more types of projects under this alternative, there may be more educational benefits from this approach than from the Integrated Habitat Restoration approach. But non-habitat projects would be less likely to provide recreational benefits to the same extent as habitat projects, so the recreational benefits from the Species-Specific Alternative could be less than from Alternative 3.

Under the No-Action Alternative, there would be no impacts, adverse or beneficial, to recreation and education. Any improvements in recreational use under this alternative would be related to those from other programs, and any adverse impacts to recreation would be those that would occur from developmental activities and changes in natural conditions.

9.2.1.6 Land and Shoreline Use

The Integrated Habitat Restoration Alternative would result in minor impacts on land or shoreline use since no existing uses are anticipated to be eliminated. In most cases, projects could be built along the existing shoreline or with rip-rapped or otherwise hardened banks pulled back without affecting existing non-water-dependent uses. On some areas where there currently is water-dependent use, it may be possible to build projects in such a way as to facilitate continued commercial waterfront activities. Property owners would need to agree to these projects, because the Trustees have no authority to force owners to allow such projects. Properties that are not currently being utilized would be prime candidates for use for habitat development, especially if it is possible to create off-channel habitat. The conversion of currently unused land into habitat would remove these areas from potential future industrial development, but little property is anticipated to be available for purchase by the Trustees for restoration. Because existing uses on active properties are not expected to be altered as a result of this Alternative, and there is expected to be little opportunity to purchase property that is not being used on which to build restoration projects, the Integrated Habitat Restoration Alternative will not result in a large conversion of industrial/commercial property to habitat. As mentioned above, under this alternative it is possible that some of the projects may incorporate some additional passive recreational opportunities and so could increase public use of the LDR shoreline. This analysis generally applies to the Species-Specific Restoration Alternative as well.

Under the No-Action Alternative, any changes in land and shoreline use would be those that would occur from other programs and private activities, not from this Alternative.

9.2.1.7 Transportation, Utilities, and Public Services

Under the Integrated Habitat Restoration Alternative there could be short-term, minor impacts to transportation or utilities during construction of individual projects, although the impacts should be limited to small areas for brief time periods. Overall, implementation of Alternative 3 is not expected to increase demand for public services and utilities. Depending on the type of project, it is possible that the Species-Specific Alternative could result in some increase for public services and utilities, although any increase would be expected to be minor. The No-Action Alternative would have no impacts on transportation, utilities, and public services.

9.2.1.8 Wetlands

The shoreline along most of the LDR is armored, and many former wetlands have been filled, so relatively little wetlands remain compared to what was present historically. Implementation of the Integrated Habitat Restoration Alternative would increase somewhat the amount of wetlands in the LDR. The increase in wetlands from implementing this alternative would help offset any continuing loss of wetlands from other causes. It is likely that some wetlands would be a component of at least some habitat projects implemented under the Species-Specific Restoration Alternative. Under the No-Action Alternative, there would be no additional wetlands created except those created under other authorities and programs.

9.2.2 Likely Effects of the Alternatives on Public Health and Safety [40 CFR 1508.27(b)(2)].

As noted above, the adverse environmental impacts from the Integrated Habitat Restoration Alternative are all short-term and minor construction-related impacts and thereafter will provide long-term benefits to the areas' humans and natural resources, while the No-Action Alternative would not benefit humans and natural resources. The Species-Specific Alternative has more of a potential for adverse impacts than Alternative 3, but none of these alternatives would be expected to have long-term or major impacts on public health and safety, as is discussed below.

9.2.2.1 Air Quality

During the construction phase under the Integrated Habitat Restoration Alternative and Species-Specific Restoration Alternative there would be minimal short-term increases in exhaust and dust from use of construction equipment. No major or long-term impacts to air quality would be expected to result from the implementation of projects. For projects in which vegetated habitat will replace rip-rap or structures, a minor improvement (expected to be unmeasurable) in air quality should result. The vegetation will also take up carbon dioxide, which will offset greenhouse gas emissions during project construction. There would be no impacts to air quality for the No-Action Alternative.

9.2.2.2 Environmental Health and Noise

No long-term impacts to environmental health would be expected to result from projects under the Integrated Habitat Restoration Alternative since analysis of future projects would include consideration of whether construction of a project could expose or mobilize contaminants, as described under the Tier 2 screening criteria (presented in Section 7.2). The selection of projects based on these criteria would avoid those sites with a high potential to expose workers or the public to contaminated soils and sediments. A health and safety plan would be in place to address any potential hazards during construction and all appropriate safety equipment will be used.

Project implementation under this alternative would result in short-term, moderate noise impacts in a small area around each project location from the use of heavy equipment during the construction phase of the projects. Outside of the immediate project area the increase in noise should be minimal. The same analysis is true for the Species-Specific Restoration Alternative.

There would be no environmental health or noise impacts from the No-Action Alternative, as no activities would take place under this approach.

9.2.2.3 Floodplain and Flood Control

Projects under the Integrated Habitat Restoration Alternative would not have any significant impacts on flood control. Some projects will provide a minor, long-term benefit in flood control by providing off-channel habitat that will increase the volume of water that will be kept from contributing to any flood events. The amount of floodplain could increase slightly as a result of some of these projects. Non-habitat projects that could be implemented under the Species-Specific approach would not be expected to have significant adverse impacts to flood control but would not increase the amount of floodplain. There would be no impacts from the No-Action Alternative on the floodplain and flood control.

9.2.3 Unique Characteristics of the Geographic Area in Which the Alternatives Would be Implemented [40 CFR 1508.27(b)(3)].

The LDR is highly modified, and the loss of natural habitat is a significant problem for species, such as Chinook salmon, dependent on having habitat within the transition zone where freshwater and saltwater mix. The loss of natural habitat also resulted in reduced aesthetic quality. Implementation of NRDA restoration projects would yield positive environmental impacts for the humans and the natural resources that use the LDR. The area is also very important for commerce, and this must be accommodated when implementing restoration under Alternative 2 or 3. There would be no issues related to commerce from the No-Action Alternative, which would be unaffected, but there would also be no beneficial environmental impacts to this area.

9.2.4 Controversial Aspects of the Alternatives or Their Likely Effects on the Human Environment [40 CFR 1508.27(b)(4)].

Restoring lost habitat in the LDR is generally non-controversial. A large number of different planning efforts and non-governmental organizations have supported conducting habitat restoration in the LDR. Because of the community support for conducting restoration in the LDR, especially to address impacts resulting from the releases of hazardous substances, adopting the No-Action Alternative and not doing restoration would itself be controversial. However, some of the non-habitat types of projects under the Species-Specific Restoration Alternative could be controversial.

9.2.5 Degree to Which Possible Effects of Implementing the Alternatives are Highly Uncertain or Involve Unknown Risks [40 CFR 1508.27(b)(5)].

There are risks associated with any restoration effort, such as projects under the Integrated Habitat Restoration Alternative, especially in a highly developed area such as the LDR. Because the LDR shoreline is highly modified, there is some uncertainty about what will be found at a given site, because a variety of materials have been used as fill. There is also some uncertainty at a given location about potential contamination that may be present. Prior to implementing any restoration project, site investigations will be conducted to minimize the risk of running into problems during construction, and a project could be redesigned or abandoned if significant problems are found. A number of different habitat restoration projects have been completed in the LDR, and Trustees are aware of the types of problems that can arise and have been able to find solutions that have enabled prior restoration projects to move forward. The Trustees will try similarly to overcome any obstacles found in this restoration effort. The same is largely true for the Species-Specific Restoration Alternative.

There are no risks or uncertainties for the No-Action Alternative.

9.2.6 Precedential Effect of the Alternatives on Future Actions that May Significantly Affect the Human Environment [40 CFR 1508.27(b)(6)].

The Trustees believe that restoration projects such as those anticipated in the LDR under the Integrated Habitat Restoration Alternative and the other habitat enhancements being planned by other groups will exert strong, positive influences on resources utilizing the LDR. Enhancing and creating fish and wildlife habitat benefits the area's natural resources, helps to protect and improve water quality, bolsters native plant communities, enhances the visual quality of the area, and provides educational opportunities for the public. No negative precedential effects would be anticipated in the LDR from the restoration effort under Alternative 3. It is less clear whether negative precedential effects would result from implementation of the Species-Specific Alternative, since a wide variety of different types of projects could be included in this alternative. However, the use of integrated habitat restoration versus species-specific restoration approaches for the LDR would not set a precedent for how other restoration planning may occur, as each instance is evaluated on a case-specific basis.

The No-Action alternative would set a precedent of not fulfilling the mandate under CERCLA to restore natural resources injured by releases of hazardous substances.

9.2.7 Possible Significance of Cumulative Impacts from Implementing Restoration under These Alternatives and Similar Projects from Other Mechanisms; Potential Impacts on Connected Actions [40 CFR 1508.27(b)(7)].

The cumulative effects analysis in this RP/PEIS is commensurate with the degree of direct and indirect effects anticipated by implementing the proposed federal action or the alternatives considered. Restoration projects considered in accordance with an overall CERCLA action are intended to compensate for prior injury to natural resources under the Natural Resource Trustee's jurisdiction, and therefore typically have predominantly beneficial impacts toward redressing impacts to those resources. In the case of the LDR proposed restoration effort, it is one component of the overall CERCLA remediation and restoration for the LDR; therefore, the potential for cumulative impacts is considered in the context of that overall project site. When possible, Trustees will attempt to combine remedial and restoration processes to lessen the overall impacts of construction. Although impacts to natural resources under NOAA's jurisdiction, and impacts in general, may occur in the larger regional vicinity of Puget Sound, the potential for the proposed action to incrementally contribute to those effects does not warrant consideration here, as the goal of the effort is to increase available habitat for those resources. Therefore, the cumulative impacts analysis for this restoration action appropriately focuses on the incremental effects of the action in the context of other LDR ongoing actions under CERCLA.

The resources that may be temporarily impacted during construction actions are air quality (by increased dust, noise, and exhaust fumes from construction equipment), disturbance of soils and sediments (largely currently degraded and disturbed), and water quality (from temporary increases in turbidity). Some slight and temporary impacts to marine fauna and flora could occur, but impacts to these and other resources would be minimized by use of BMPs. Cleanup activities and other restoration projects that may occur in the vicinity at the same time would similarly incorporate required BMPs, such as dust control and soil and erosion practices. In some instances, it would be possible to integrate restoration with remediation, thereby reducing the amount of impact, compared to what would occur without this integration. Additionally, the overall footprint of projects that would be built under the Integrated Habitat Restoration Alternative or Species-Specific Restoration Alternative would be relatively small in the context of the overall LDR. Consequently, the minor and temporary impacts of the action on air quality, soils and sediments, and water quality has a low potential to result in cumulatively significant impacts to these resources.

An important consideration for Trustees' conduct while implementing restoration actions is the timing and location of restoration projects relative to the overall CERCLA actions. Specifically, it is important that habitat restorations occur on sites where contamination either did not occur, occurred at non-injurious levels, or has been successfully remediated to appropriate standards, and that habitats or living marine resources not be restored in an area where they may be impacted by other impacts associated with the larger remediation or restoration action. Completed restoration projects will be monitored to ensure that re-contamination of restored sites is not occurring. In the case of the proposed habitat restoration in and around the LDR site, completion of the anticipated restoration projects would result in additional and/or improved marsh, mudflat, shallow subtidal, and riparian habitat that would be more ecologically productive and support the types of natural resources—such as English sole, salmonids, and crabs—that were injured by releases into the LDR. Therefore, with respect to natural resources, over the mid and long term (i.e., after completion of the restoration actions) restoration under the Integrated Habitat Restoration Alternative will be wholly beneficial with no potential for incremental contribution to significant impacts related to contaminant exposure in the marine environment.

Outside of the CERCLA and other clean-up actions, it is difficult to predict exactly what other actions may be undertaken by other entities within the LDR that could combine with NRDA restoration actions to produce cumulative impacts, but some of these are known. The South Park Bridge replacement project is underway, and it is likely that there will be similar infrastructure projects undertaken in the LDR in the future. Maintenance dredging will occur as needed for navigation, and Port of Seattle and others' waterfront facilities will be maintained. Several other entities may conduct habitat restoration projects in the LDR for different purposes or under different authorities.[12] Outside of restoration projects, most of these actions would be expected to have at least short-term negative impacts from construction activities, but some of them may have long-term negative impacts if the construction is prolonged. It is possible that some may result in long-term adverse impacts to habitats or species in the LDR, although presumably mitigation measures would be used to minimize such impacts and actual mitigation of habitat might be required. To the extent that such impacts occur, the benefits from the restoration projects implemented under the LDR restoration program would tend to offset these impacts.

There would be no cumulative impacts under the No-Action Alternative. Restoration efforts would only occur from other programs, and there would be no additional habitat created beyond that which would otherwise occur.

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[12] Some entities that might build restoration projects could do so with the intent that they serve as restoration banks to be used to address NRD liability by PRPs who purchase credits, but for the purpose of this RP/PEIS, any such restoration bank that the Trustees would accept for use to resolve NRD liability would need to meet the requirements for projects as described in this document (and all Trustee policies with respect to restoration banking), and so are considered for the purpose of impact analysis as part of the NRDA restoration.

9.2.8 Effects of the Alternatives on National Historic Places, or Likely Impacts to Significant Cultural, Scientific, or Historic Resources [40 CFR 1508.27(b)(8)].

Prior to conducting restoration at a given location under Alternative 2 or Alternative 3, the Trustees will consult with the Muckleshoot Indian Tribe, the Suquamish Tribe, and the Washington Department of Archaeology and Historic Preservation under Section 106 of the National Historic Preservation Act. Trustees may conduct investigations to identify cultural and historic resources based on these consultations. Projects would be designed to avoid impacts to these resources if they are found in the project area. There would be no effects on these places and resources under the No-Action Alternative.

9.2.9 Degree to Which the Alternatives May Adversely Affect Endangered or Threatened Species or Their Critical Habitat [40 CFR 1508.27(b)(9)].

The restoration projects implemented under the Integrated Habitat Restoration Alternative would provide additional habitat for Chinook salmon and Puget Sound steelhead and would benefit other listed species in the area. Through selective scheduling of the construction period to minimize impacts to salmonids and implementation of methods to minimize in-water turbidity, short-term impacts to listed species would be relatively minor. Federal laws and regulations pertaining to fish and wildlife and Essential Fish Habitat, as well as applicable consultation and regulatory terms and conditions, would be followed to ensure that no long-term adverse impacts would result from this Alternative. For example, where appropriate, project-specific consultation under the Endangered Species Act would be initiated by the Federal Trustees if a project results in a “may affect” determination for a listed species. Following construction, restoration projects would improve fish habitat structure and function. Juvenile anadromous salmonids would benefit from increased habitat quantity and quality. There is also little potential for adverse impacts to listed species from the Species-Specific Restoration Alternative but, depending on the type of project, there might be less potential for beneficial impacts to listed species from this alternative.

There would be no adverse impacts on listed species or their critical habitats under the No-Action Alternative, nor would there be any beneficial impacts such as would occur under Alternatives 2 and 3.

9.2.10 Likely Violations of Environmental Protection Laws [40 CFR 1508.27(b)(10)}.

The Trustees would undertake stringent efforts to avoid violating environmental protection laws under either the Species-Specific or Integrated Habitat Restoration Alternatives. There are a number of potentially applicable laws and regulations that govern the Trustees’ restoration projects. Many federal, state, tribal, and local laws and regulations would need to be considered during the development of projects under the Integrated Habitat Restoration Alternative or the Species-Specific Restoration Alternative, as well as several regulatory requirements that are typically evaluated during the federal and state permitting process. A brief review of many potentially applicable laws and regulations that may pertain to these projects is presented in section 10.

The Trustees' requirements under the National Historic Preservation Act, detailed in the regulations at 36 CFR800, are discussed here as an example. When undertaking any project that has the potential to impact cultural resources or historic properties, the Trustees will consult with the Washington State Historic Preservation Officer, all tribes that might have cultural resources that could potentially be affected, and historians and experts that have local knowledge relevant to the area. The Trustees would identify the Area of Potential Effect for the project, and seek information on potential historic or cultural resources that might be present. Guidelines for monitoring during construction would be developed as well as procedures to be followed if there is a discovery of potential historic or cultural significance. The project could be redesigned or mitigated in the event of such a discovery, or the project could be abandoned.

The project manager would ensure that there is coordination among these programs where possible and that project implementation and monitoring is in compliance with all applicable laws and regulations. The Trustees anticipate that there would be no violations of environmental protection laws associated with projects under the action alternatives.

No environmental protection laws would be violated by the No-Action Alternative, although the Trustees' mandate to restore injured natural resources would be unfulfilled.

9.2.11 Introduction of Non-Indigenous Species [NAO 216-6 6.01(b)(11)].

No non-indigenous species will be introduced as part of the implementation of any alternative. Existing invasive and non-native plant species would be replaced with native species in accordance with the monitoring program and site-specific vegetation plans for the Integrated Habitat Restoration Alternative and for habitat projects under the Species-Specific Restoration Alternative. There would be no similar replacement of existing non-indigenous species under the No-Action Alternative.

9.3 Unavoidable Adverse Impacts

Unavoidable adverse effects could occur during the construction of individual projects (note that individual projects would be subject to subsequent tiered NEPA analysis). Such potential unavoidable adverse effects would be expected to be limited to temporary increases in turbidity during in-water construction, temporary disturbance and removal of upland vegetation on banks and adjacent uplands (e.g., for bank regrading), or similar minor effects associated with site preparation and implementation of restoration construction. However, the majority of the locations in the LDR are already urbanized or disturbed, so any unavoidable adverse impacts would not be expected to be significant, and would be the foundation for permanent improvements at the location via restoration actions. These temporary adverse effects are considered unavoidable because a majority of restoration actions will require disturbance of existing locations in order to implement the restoration action.

9.4 Relationship between Short-Term Uses of the Human Environment and the Enhancement of Long-Term Productivity

Alternative 3 would involve some short-term, localized effect to the environment, but these short-term effects would specifically be implemented in order to improve long-term productivity of habitats and human uses such as recreation and aesthetic enjoyment. No adverse effects to long-term productivity are expected.

9.5 Irreversible and Irretrievable Commitment of Resources

Implementation of specific individual projects subsequent to the completion of the Final PEIS and tiered NEPA analysis would result in minor irretrievable commitments of fuel and materials associated with restoration implementation.

9.6 Consideration of Mitigation Measures

The information above analyzes the potential impacts that could be associated with implementation of the Restoration Plan for the LDR. Since this is a programmatic approach that applies to a larger area, and at this time the details of specific restoration projects that may be proposed are unknown, the impacts were presented, above, in general terms. Specific projects would undergo additional environmental analysis. The project screening and prioritization presented as a two-tiered analysis would assist in preferring future projects with consideration of their potential environmental impacts. Accordingly, best management practices and mitigation measures associated with individual projects are not included in this RP/PEIS, but would be considered in the identification of priority projects and the analysis of proposed projects and their alternatives in subsequent NEPA analyses. Types of mitigation measures may include local and state-required best management practices for erosion control, reduction in air pollution via dust control during construction and stockpiling of materials, minimizing the area and time of disturbance of sediments and water flow to maximize protection of fish and their habitats, and other mitigation measures as appropriate to the proposed project. These measures would be considered on a project-specific basis and assessed for their capacity to reduce impacts as part of the analysis and selection of future restoration actions.

9.7 Summary of Alternatives Analysis

The Trustees evaluated the alternatives primarily on the bases of: 1) how well they meet the mandates under NRDA statutes and regulations to restore natural resources and services injured by releases of oil and hazardous substances; and 2) the potential impacts of the alternatives on the human environment. Comments received from the public during public meetings and on both the initial draft and the Supplement to the draft RP/PEIS were considered in this evaluation. The analysis is summarized in Table 3. The Trustees concluded that the preferred, Integrated Habitat Restoration Alternative is best for fulfilling the mandates under NRDA statutes and regulations for restoring injured natural resources and services. None of the alternatives analyzed are likely to have significant adverse impacts on the human environment. Both the Species-Specific and the Integrated Habitat Restoration Alternatives would have some minor, short-term direct adverse impacts during construction, but these would be mitigated through use of best management practices as required by permitting agencies and National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (FWS). The Species-Specific Alternative has some potential for somewhat larger impacts from non-habitat-related projects. Both would be expected to have long-term, largely minor but possibly some moderate beneficial impacts. Based on the better fit to the mandates under CERCLA and OPA for NRDA, and insignificant adverse impacts to the human environment, NOAA and the Trustees select the Integrated Habitat Restoration Alternative as the approach they will use in the restoration effort for the Lower Duwamish River.

Table 3. Summary of Potential Impacts from the Alternatives Analyzed

CRITERIA	**NO-ACTION ALTERNATIVE**	**SPECIES-SPECIFIC RESTORATION ALTERNATIVE**	**INTEGRATED HABITAT RESTORATION ALTERNATIVE**
1. Potential for the Trustees' Goal of Restoring Injured Natural Resources to be Met	Poor Under a No-Action Alternative there would be no compensation for interim losses, even if remedial actions and natural recovery return conditions to baseline	Low to Moderate Alternative has potential for direct restoration of specific species, but is less likely to restore the wide diversity of species that may have been injured	High Focus on habitat complexes will directly restore lost habitat services and indirectly restore injured species that depend on these habitats
2. Potential to Provide Benefits to Multiple Natural Resources and Services	Non-existent Under this Alternative, no actions would be taken so there would be no benefits provided to any resources	Moderate Some potential projects under this Alternative would have widespread benefits to many species (e.g., habitat projects), while others might benefit just one or only a few resources	High Habitats support communities of interacting species, so provision of additional habitat of various types will benefit many different species

CRITERIA	NO-ACTION ALTERNATIVE	SPECIES-SPECIFIC RESTORATION ALTERNATIVE	INTEGRATED HABITAT RESTORATION ALTERNATIVE
3. Potential for Environmental Impacts	Non-existent Under this Alternative, no actions would be taken so no adverse or beneficial environmental impacts would result	Moderate Minor short-term adverse impacts would be expected during construction of most potential types of projects; there is a potential for long-term moderate adverse impacts related to establishment and operation of new aquaculture facilities; beneficial long-term and direct impacts to some natural resources would be expected result from some projects under this Alternative	Minor-Moderate Minor short-term adverse impacts would be expected during construction; long-term, direct and moderate beneficial impacts to habitat services would be expected; long-term, indirect and moderate beneficial impacts would be expected to species dependent on restored habitat types
Water Quality	No adverse or beneficial impacts	Short-term minor adverse impacts would occur during construction of projects under this Alternative; long-term minor beneficial impacts would result from wetland habitat creation if such projects were implemented as part of this Alternative; potential long-term moderate adverse impacts are possible from new aquaculture facilities (e.g., increases in nutrients, bacteria)	Short-term minor adverse impacts would occur during construction of projects under this Alternative; long-term minor beneficial impacts would result from wetland habitat creation

CRITERIA	NO-ACTION ALTERNATIVE	SPECIES-SPECIFIC RESTORATION ALTERNATIVE	INTEGRATED HABITAT RESTORATION ALTERNATIVE
Sediment Quality	No adverse or beneficial impacts	Short-term minor adverse impacts might occur during construction of projects under this Alternative; there is a potential for long-term moderate adverse impacts due to nutrient enrichment from aquaculture; sediment quality at the location of any habitat projects would be improved at least initially	Short-term minor adverse impacts might occur during construction of projects under this Alternative; sediment quality at the location of projects under this Alternative would be improved at least initially
Air Quality	No adverse or beneficial impacts	Short-term minor adverse impacts would occur during construction of projects under this Alternative; there would potentially be a long-term minor beneficial impact on air quality provided by the increased vegetation from habitat projects that might be implemented under this Alternative	Short-term minor adverse impacts would occur during construction of projects under this Alternative; there would be a long-term minor beneficial impact on air quality provided by the increased vegetation

CRITERIA	NO-ACTION ALTERNATIVE	SPECIES-SPECIFIC RESTORATION ALTERNATIVE	INTEGRATED HABITAT RESTORATION ALTERNATIVE
Fish and Aquatic Resources	No adverse or beneficial impacts	Short-term minor adverse impacts could occur during construction of projects under this Alternative; there is a potential for long-term minor adverse impacts from new aquaculture facilities; long-term minor beneficial impacts would be expected from habitat projects under this Alternative	Short-term minor adverse impacts could occur during construction of projects under this Alternative; long-term minor beneficial impacts would be expected under this Alternative
Wildlife	No adverse or beneficial impacts	Short-term minor adverse impacts could occur during construction of projects under this Alternative; long-term minor beneficial impacts would be expected from habitat projects under this Alternative	Short-term minor adverse impacts could occur during construction of projects under this Alternative; long-term minor beneficial impacts would be expected under this Alternative

10. COORDINATION AND CONSULTATION

This section presents a review of the potentially applicable laws and regulations that govern the Trustees' restoration projects. Many federal, state, tribal, and local laws and regulations need to be considered during the development of this project, as well as several regulatory requirements that are typically evaluated during the federal and state permitting process. A brief review of potentially applicable laws and regulations that may pertain to these projects is presented below. When implementing projects under this Alternative, the project managers will ensure that there is coordination among these programs where possible and that project implementation and monitoring is in compliance with all applicable laws and regulations.

Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), 42 USC §§ 9601 *et seq.*, and National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR 300. CERCLA, also known as Superfund, provides the basic legal framework for clean-up and restoration of the nation's hazardous substances sites. CERCLA establishes a hazard ranking system for assessing the nation's contaminated sites, with the most contaminated sites being placed on the National Priorities List. Trustees are responsible, under CERCLA, for restoring injuries to natural resources and losses of natural resource services.

Oil Pollution Act of 1990 (OPA), 33 USC §§ 2701 *et seq.* OPA provides for the prevention of, liability for, removal of, and compensation for the discharge of the substantial threat of discharge of oil into or upon the navigable waters of the United States, adjoining shorelines, or the Exclusive Economic Zone. Section 1006(e) requires the President, acting through the Under Secretary of Commerce for Oceans and Atmosphere, to develop regulations establishing procedures for natural resource trustees in the assessment of damages for injury to, destruction of, loss of, or loss of use of natural resources covered by OPA. Section 1006(b) provides for the designation of federal, state, Indian tribal, and foreign natural resource trustees to determine resource injuries, assess natural resource damages (including the reasonable costs of assessing damages), present a claim, recover damages, and develop and implement a plan for the restoration, rehabilitation, replacement, or acquisition of the equivalent of the natural resources under their trusteeship.

Model Toxics Control Act, Ch. 70.105D RCW (1989) and Ch. 173-340 WAC (1992). Washington's toxic clean-up law is the state equivalent of the federal Superfund program and is managed by the Washington Department of Ecology. The statewide regulations establish clean-up standards and requirements for managing contaminated sites. The Washington Department of Ecology is a participant in the NRDA restoration process as a member of the LDR Trustee Council, so compliance with the Model Toxics Control Act will be inherent in the Trustees' decision-making process.

National Environmental Policy Act (NEPA), as amended, 42 U.S.C. §§ 4321 *et seq.*; 40 CFR Parts 1500-1508. NEPA was enacted in 1969 to establish a national policy for the protection of the environment. The Council on Environmental Quality was established to advise the president and to carry out certain other responsibilities relating to implementation of NEPA by federal agencies. Federal agencies are obligated to comply with the NEPA implementing regulations promulgated by the Council on Environmental Quality (40 CFR Parts 1500-1508). These regulations outline the responsibilities of federal agencies under NEPA and provide specific procedures for preparing environmental documentation to comply with NEPA. This RP/PEIS was prepared to analyze and disclose whether the proposed action (implementing restoration under the PEIS) will have a significant effect on the quality of the human environment. All comments received will be considered before the lead federal agency makes a final recommendation. Subsequent NEPA analysis will be conducted for individual proposed projects; it is anticipated that Environmental Assessments (EAs) tiered to this RP/PEIS will typically be appropriate for these individual proposed projects; however, Environmental Impact Statements (EIS) may be prepared after the initiation of an EA if significant impacts are found. If an action alternative is selected (Alternative 2 or 3) after completion of the Final RP/PEIS, subsequent NEPA documents for individual projects would be developed and made available as drafts for public review and comment. All comments received on project-based analyses will be considered before the lead federal agency makes a decision and begins project implementation.

State Environmental Policy Act (SEPA), Chapter 43.21C RCW and Chapter 197-11 WAC. SEPA sets forth the state's policy for protection and preservation of the natural environment. Local jurisdictions must also implement the policies and procedures of SEPA. Each project will undergo a public comment period under SEPA requirements and the SEPA checklist; the permit application, the permit, and the public comments will become a part of the administrative record for each project.

Clean Water Act (Federal Water Pollution Control Act), 33 USC §§ 1251 *et seq*. The Clean Water Act is the principal law governing pollution control and water quality of the nation's waterways. It requires the establishment of guidelines and standards to control the direct or indirect discharge of pollutants to waters of the United States. Discharges of material into navigable waters are regulated under Sections 401 and 404 of the Clean Water Act. The U.S. Army Corps of Engineers has the primary responsibility for administering the Section 404 permit program. Under Section 401, projects that involve discharge or fill to wetlands or navigable waters must obtain certification of compliance with state water quality standards.

Rivers and Harbors Act, 33 USC §§ 401 *et seq*. This Act regulates development and use of the nation's navigable waterways. Section 10 of the Act prohibits unauthorized obstruction or alteration of navigable waters and vests U.S. Army Corps of Engineers with authority to regulate discharges of fill and other materials into such waters. Actions that require Section 404 Clean Water Act permits are also likely to require permits under Section 10 of this Act.

Endangered Species Act of 1973 (ESA), 16 USC 1531 §§ *et seq*., 50 CFR Parts 17, 222, 224. The ESA directs all federal agencies to conserve endangered and threatened species and their habitats and encourages such agencies to utilize their authorities to further these purposes. Under the Act, NMFS and FWS publish lists of endangered and threatened species. Section 7 of the Act requires that federal agencies consult with these agencies to ensure their actions are not likely to jeopardize listed species or result in destruction or adverse modification of designated critical habitat. The regulatory permits and consultation conditions for projects implemented under this plan will set forth a number of operating measures designed to prevent or mitigate any such disturbances to these species.

Magnuson-Stevens Fishery Conservation and Management Act (MSA), 16 USC §§ 1801 *et seq.,* 50 CFR Part 600. In 1996, the Act was reauthorized and changed by amendments to require that fisheries be managed at maximum sustainable levels and that new approaches are taken in habitat conservation. Essential Fish Habitat is defined broadly to include "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" (62 Fed. Reg. 66551, § 600.10 Definitions). The Act requires consultation for all federal agency actions that may adversely affect Essential Fish Habitat. Under Section 305(b)(4) of the Act, NMFS is required to provide advisory conservation and enhancement recommendations to federal and state agencies for actions that adversely affect Essential Fish Habitat. Where federal agency actions are subject to ESA Section 7 consultations, such consultations may be combined to accommodate the substantive requirements of both ESA and MSA. NMFS will be consulted on each project regarding any MSA-managed species residing or migrating through the proposed project location.

Fish and Wildlife Coordination Act (FWCA), 16 USC §§ 661 *et seq.,* and the Migratory Bird Treaty Act (MBTA) of 1918, 16 USC §§ 703 *et seq*. The FWCA requires that federal agencies consult with the FWS, NMFS, and state wildlife agencies for activities that affect, control, or modify waters of any stream or bodies of water, in order to minimize the adverse impacts of such actions on fish and wildlife resources and habitat. Similarly, the MBTA requires the protection of ecosystems of special importance to migratory birds against detrimental alteration, pollution, and other environmental degradation. These consultations are generally incorporated into Section 404 of the Clean Water Act, NEPA, or other federal permit, license, or review requirements.

Executive Order 11988: Floodplain Management. On May 24, 1977, President Carter issued Executive Order 11988, Floodplain Management. This Executive Order requires each federal agency to provide opportunity for early public review of any plans or proposals for actions in floodplains, in accordance with Section 2(b) of Executive Order 11514, as amended, including the development of procedures to accomplish this objective.

Executive Order 11990: Protection of Wetlands. On May 24, 1977, President Carter issued Executive Order 11990, Protection of Wetlands. This Executive Order requires each agency to provide opportunity for early public review of any plans or proposals for new construction in wetlands, in accordance with Section 2(b) of Executive Order 11514, as amended, including the development of procedures to accomplish this objective.

Executive Order 12898: Environmental Justice, as amended. On February 11, 1994, President Clinton issued Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. This Executive Order requires each federal agency to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. EPA and the Council on Environmental Quality have emphasized the importance of incorporating environmental justice review in the analyses conducted by federal agencies under NEPA and of developing mitigation measures that avoid disproportionate environmental effects on minority and low-income populations.

The Trustees have not identified any disproportionate adverse impacts on human health or environmental effects on implementation of the Preferred Alternative on Native Americans or other minority or low-income populations, and believe that this project will be beneficial to these communities.

Executive Order 11514 (35 Fed. Reg. 4247) – Protection and Enhancement of Environmental Quality. This Executive Order directs federal agencies to monitor, evaluate, and control their activities in order to protect and enhance the quality of the nation's environment; to inform and seek the views of the public about these activities; to share data gathered on existing or potential environmental problems or control methods; and to cooperate with other governmental agencies. The release of this Draft RP/PEIS and the types of projects envisioned under the Preferred Alternative are consistent with the goals of this Order. The proposed plan is the product of intergovernmental cooperation and will protect and enhance the environment. The restoration planning process has and continues to provide the public with information about the restoration efforts.

Executive Order 13007 – Indian Sacred Sites, and Executive Order 13175 – Consultation and Coordination with Indian Tribal Governments. Executive Order 13007 describes federal policy for accommodating sacred Indian sites. This Executive Order requires federal agencies with statutory or administrative responsibility for managing federal lands to: 1) accommodate access to and ceremonial use of Indian sacred sites by Indian religions practitioners; 2) avoid adversely affecting the physical integrity of such sacred sites; and 3) maintain the confidentiality of these sacred sites.

Executive Order 13175 exists to: 1) promote regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications; 2) strengthen the United States government-to-government relationships with Indian tribes; and 3) reduce the imposition of unfounded mandates upon Indian tribes.

As part of the planning process for individual projects, appropriate coordination with federally recognized Indian tribes (Muckleshoot Indian Tribe and the Suquamish Indian Tribe) will be conducted.

Executive Order 12962 (60 Fed. Reg. 30,769) – Recreational Fisheries. This Executive Order directs federal agencies to, among other things, foster and promote restoration that benefits and supports viable, healthy, and sustainable recreational fisheries. The restoration projects that would be built under the Preferred Alternative would benefit recreational fish species and their prey.

Executive Order 13112 (64 Fed. Reg. 6,183) – Invasive Species. The purpose of Executive Order 13112 is to prevent the introduction of invasive species and provide for their control, and to minimize the economic, ecological, and human health impacts that invasive species cause.

No invasive species would be introduced by any projects under the Preferred Alternative, and any invasive species existing at the sites would be removed. Control of invasive species would also occur after restoration is implemented.

Information Quality Guidelines issued Pursuant to Public Law 106-554. Information disseminated by federal agencies to the public after October 1, 2002, is subject to information quality guidelines developed by each agency pursuant to Section 515 of Public Law 106-554 that are intended to ensure and maximize the quality of such information (i.e., the objectivity, utility, and integrity of such information). This PEIS is an information product covered by the information quality guidelines established by NOAA and the U.S. Department of the Interior for this purpose. The information collected herein complies with applicable guidelines.

Section 508 of the Rehabilitation Act, 29 U.S.C. 749D. Under Section 508 of the Rehabilitation Act, all federal agencies must take steps to afford persons with disabilities, including members of the public, access to information that is comparable to the access available to others. Section 508 was enacted in part to eliminate access barriers associated with information technology. For web accessibility under Section 508, documents posted must make text equivalents available for any non-text elements (including images, navigation arrows, multimedia objects (with audio or video), logos, photographs, or artwork) to enable users with disabilities access to all important (as opposed to purely decorative) content. Compliance also extends to making accessible other multimedia and outreach materials and platforms, acquisition of equipment and other assistive technologies, and computer software compliance. To provide for access to this document by disabled persons who use special assistive technology type devices and services, an electronic version of this draft RP/PEIS, incorporating electronically readable text equivalents for all non-text elements, has been created and is available at http://www.darrp.noaa.gov/northwest/lowerduwamishriver/restore.html. This website is regularly reviewed for Section 508 compliance. Disabled persons experiencing any difficulty accessing this document on this website should contact the DARRP Program webmaster at darrp.webmaster@noaa.gov for further technical assistance or to request an alternative means of access to the referenced information and data.

1855 Treaty of Point Elliott. The 1855 Treaty of Point Elliott sets forth articles of agreement between the United States and the Muckleshoot Indian Tribe, the Suquamish Tribe, and other federally recognized tribes within the Puget Sound area. Under the Supremacy clause of the United States Constitution, treaties are superior to any conflicting state laws or constitutional provisions.

Other potentially applicable federal, state, tribal, and local laws that are integrated into the regulatory process include:

- Archaeological Resources Protection Act, 16 USC §§ 469, *et seq*.
- Clean Air Act, as amended, 42 USC §§ 7401, et seq.
- Coastal Zone Management Act of 1982, as amended, 16 USC 1451 *et seq*.
- Marine Mammal Protection Act, 16 USC §§ 1361 *et seq*.
- National Historic Preservation Act, 16 USC §§ 470 *et seq*.
- Shoreline Management Act, Ch. 90.58 RCW and Ch. 173-14 WAC
- Historic Preservation Act, Ch. 27.34 RCW, Ch. 27.44 RCW, and Ch. 27.53 RCW

- Washington State Executive Order 05-05
- Washington State Hydraulic Code, Ch. 77.55 RCW and Ch. 220-110 WAC

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12. GLOSSARY

Absolute value—in mathematics, the absolute value |a| of a real number is its numerical value without regard to its sign. So, for example, 3 is the absolute value of both 3 and −3.

Acute—having or experiencing a rapid onset and short but severe course; such as an acute disease.

Adaptive management—an explicitly experimental approach to managing natural resource projects by integrating design, management, and monitoring to systematically test assumptions in order to adapt and learn.

Anadromous—a species, such as salmon, that is born in freshwater, spends a large part of its life in the sea, and returns to freshwater rivers and streams to spawn.

Baseline—the condition that would exist but for the releases of hazardous substances.

Benthic—relating to the bottom of a sea or lake or to the organisms that live there

Bioaccumulation—the accumulation of a substance, such as a toxic chemical, in various tissues of a living organism or in the food web over time.

Bioassay—a procedure for determining the biological activity of a substance (e.g., a drug or pollutant) by measuring its effect on an organism, tissue, or cell, compared to a standard preparation.

Bird assemblages—a group of avian species that display similar behavioral traits and perform more or less the same ecological role, making similar use of the same resource.

Chinook salmon (ocean-type)—one of two types (races) of Chinook salmon that typically migrate to sea within the first three months of life, but may spend up to a year in freshwater prior to emigration to the sea. They also spend their ocean life in coastal waters. Ocean-type Chinook salmon return to their natal streams or rivers as spring, winter, fall, summer, and late-fall runs, but summer and fall runs predominate. Ocean-type Chinook salmon tend to use estuaries and coastal areas more extensively than other pacific salmonids for juvenile rearing.

Compensatory restoration—under CERCLA, restoration that compensates for interim loss of natural resources and services pending recovery.

Detritus—dead plant and animal matter, usually consumed by bacteria, but some remains.

Ecological niche—the ecological space or role occupied by a species in an ecosystem; activities and relationships a species has while obtaining the resources needed to survive; where it lives, how it interacts with other species, and how it obtains food.

Ecological services—the processes by which the environment produces resources that we often take for granted such as clean water, timber, habitat for fisheries, and the decomposition of wastes.

Ecological service loss—diminishment or degradation of ecosystem services (the benefits people, animals, and other organisms obtain from ecosystems) due to physical alteration or pollution.

Ecosystem-based—considers both the individual parts of a system (plants and animals and physical environment) and how the parts are functioning together as a whole system. An ecosystem-based approach relies on a variety of restoration strategies and takes into consideration the current and historical states of the ecosystem, including its structure and functions and the processes that maintain them.

Ecosystem processes—the physical, chemical, and biological actions or events that link organisms and their environment. Ecosystem processes include decomposition, production of plant matter, nutrient cycling, and fluxes of nutrients and energy.

Epibenthic—living on the surface of bottom sediments in a water body.

Estuary—partially enclosed coastal body of water, having an open connection with the ocean, where freshwater from inland is mixed with saltwater from the sea. An estuary is thus defined by salinity rather than geography

Estuarine—describes organisms that live in estuary areas.

Evolutionarily Significant Unit—a classification of populations that have substantial reproductive isolation which has led to adaptive differences so that the population represents a significant evolutionary component of the species; a combination of Distinct Population Segments that are collectively protected by the Endangered Species Act.

Herbivore—an animal that eats only plants.

Immune dysfunction—a reduction in the function of the immune system so that a body, organ, or organ system cannot perform normally.

Intertidal—occurring within, or forming, the area between the high and low tide levels in a coastal zone.

Invasive species—native or non-native species that heavily colonize a particular habitat, displacing desirable native species and adversely affecting the ecosystem.

Lesion—any visible, local abnormality of tissue (e.g., injury, wound, boil, sore, rash).

Lethal—causing death.

Limiting factor—controls a process, such as organism growth or species population size or distribution. The availability of food, predation pressure, or availability of shelter are examples of factors that could be limiting for a species population in a specific area. For example, in the Lower Duwamish River, limiting factors for juvenile salmon include a lack of resting and feeding areas in the estuarine portion of the river as the juveniles acclimate from freshwater to saltwater.

Marsh—an area of soft, wet, low-lying land, characterized by grassy vegetation and often forming a transition zone between water and land.

Mean lower low water—the average height of the lower of the daily low waters over a 19-year period.

Natural resource services—the physical and biological functions provided by the resource that serve the ecological and human uses of the environment. Examples of ecological services include plant and animal habitat, food supply, etc.

Nekton—Animals that swim or move freely in the ocean.

Nexus—the degree of the linkage between the injured natural resource and the restoration actions. The strength of a nexus is determined, in part, by the location of the restoration in comparison to the location of the injured resources.

Osmoregulation—the control of the concentration of body fluids, a vital function affecting all aspects of fish health. If a fish is unable to regulate the effects of osmosis it will die. Salmon must maintain a constant volume of body fluids while migrating from freshwater to saltwater and back again. The behavioral (drinking or not drinking) and physiological changes a salmon must make when moving from freshwater to saltwater—and vice versa—are essential, but cannot be accomplished immediately. Salmon do this by spending days to weeks in estuarine waters, gradually moving into areas with increased salinity.

Oxbow—a U-shaped bend in a river or stream.

PAHs (polycyclic aromatic hydrocarbons)—a group of chemicals naturally found in coal, coal tars, oil, wood, tobacco, and other organic materials. There are more than 100 different PAHs. PAHs are the waxy solids found in asphalt, crude oil, coal, coal tar pitch, creosote, and roofing tar. Some types of PAHs are used in medicines and to make dyes, plastics, and pesticides. PAHs can be divided into the following two groups based on their physical, chemical, and biological characteristics:

- PAHs, Low Molecular Weight—PAHs with 2 to 3 rings, such as naphthalenes, fluorenes, phenanthrenes, and anthracenes, that have significant acute toxicity to aquatic organisms. In general, low molecular weight PAHs are more soluble and volatile and have less affinity for surfaces than do high molecular weight PAHs.

- PAHs, High Molecular Weight—PAHs with more than 3 rings (such as crysene). Several members of the high molecular weight PAHs are carcinogenic. In general, high molecular weight PAHs are less soluble and volatile than low molecular weight PAHs.

PCBs (polychlorinated biphenyls)—any of a family of industrial compounds produced by chlorination of biphenyl, noted primarily as an environmental pollutant that accumulates in animal tissue with resultant pathogenic and teratogenic effects.

Primary restoration—under CERCLA, actions taken to directly restore natural resources and services to baseline under an accelerated time frame.

Primary productivity—production by green plants.

Process water—water used in a manufacturing or treatment process or in the actual product manufactured. Examples would include water used for washing, rinsing, direct contact, cooling, solution make-up, chemical reactions, and gas scrubbing in industrial and food processing applications.

Rearing habitat—an area where larval and juvenile fish find food and shelter.

Riparian habitat—areas adjacent to rivers and streams with a differing density, diversity, and productivity of plant and animal species relative to nearby uplands.

Salt marsh/fringing salt marsh—a coastal wetland that extends landward up to the highest high tide line and is characterized by plants that are well adapted to living in saline soils. Fringing marshes are small salt marshes that form along estuary channels, protected coves, and other areas shielded from heavy wave action.

Secondary productivity—the biomass produced by heterotrophic organisms (who cannot synthesize their own food, and eat plants or other animals).

Service loss—*see* Ecological service loss.

Sublethal—referring to that which does not kill a cell or organism, but usually forces adaptation for survival.

Subtidal—areas below the low tide that are continuously submerged.

Tiering—a staged approach to NEPA described in the Council on Environmental Quality's *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act* (40 CFR 1500 – 1508). Tiering addresses broad systems level programs and issues in initial (Tier 1) analyses, and analyzes site-specific proposals and impacts in subsequent tier studies. In our case, the Restoration Plan and Programmatic Environmental Impact Statement would be the broad Tier 1 level, and the project-level Environmental Assessments would be done subsequently as specific restoration projects are proposed.

Total organic carbon (TOC)—a measure of the amount of carbon in a sample originating from organic matter only.; a physical sediment factor that can influence the concentration of other compounds.

Toxicopathic lesion—abnormal tissue caused by the action of a poison.

Transition zone—area where freshwater and saltwater mix, resulting in brackish conditions.

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14. INDEX

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Collaborative Focus
Container Properties LLC
Crowley Marine
Delta Marine
Douglas Management
Duwamish Shipyard
EMJ
ESI Management
Exxon Mobile
Farallon Consulting
Fox Ave Building LLC
General Services Administration
Geomatrix
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James Gilmur
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Kinder Morgan
Lafarge Corporation
Lehigh Northwest Cement
Lockheed Shipbuilding
Lone Star Northwest Inc
Longview Fibre Company
Lynden Inc.
Manson Construction Company
Merrill Creek Holdings LLC
PACCAR
Stoel Reeves
Trotsky, Herman & Jacqualine
URS Corporation
Vigor Marine

Appendix A. Alphabetical list of birds observed at the Elliott Bay/Duwamish Restoration Program sites on the Duwamish River and their associated reference sites from 1997 to 2005.

Common Name	Scientific Name
American Coot	*Fulica americana*
American Goldfinch	*Carduelis tristis*
American Robin	*Turdus migratorius*
American Wigeon	*Anas Americana*
Anna's Hummingbird	*Calypte anna*
Bald Eagle	*Haliaeetus leucocephalus*
Barn Swallow	*Hirundo rustica*
Barrow's Goldeneye	*Bucephala islandica*
Belted Kingfisher	*Ceryle alcyon*
Bewick's Wren	*Thryomanes bewickii*
Black-capped Chickadee	*Poecile atricapillus*
Brown-headed Cowbird	*Molothrus ater*
Bufflehead	*Bucephala albeola*
Bushtit	*Psaltriparus minimus*
Cackling Goose	*Branta hutchinsii*
California Gull	*Larus californicus*
California Quail	*Callipepla californica*
Canada Goose	*Branta Canadensis*
Canvasback	*Aythya valisineria*
Caspian Tern	*Hydroprogne caspia*
Cedar Waxwing	*Bombycilla cedrorum*
Cinnamon Teal	*Anas cyanoptera*
Cliff Swallow	*Petrochelidon pyrrhonota*
Common Goldeneye	*Bucephala clangula*
Common Merganser	*Mergus merganser*
Common Snipe	*Gallinago gallinago*
Common Yellowthroat	*Geothlypis trichas*

Common Name	Scientific Name
Cooper's Hawk	*Accipiter cooperii*
Dark-eyed Junco	*Junco hyemalis*
Domestic Duck	*Anas sp.*
Domestic Goose	*Anser sp.*
Double-crested Cormorant	*Phalacrocorax auritus*
Downy Woodpecker	*Picoides pubescens*
Dunlin	*Calidris alpine*
Eared Grebe	*Podiceps nigricollis*
European Starling	*Sturnus vulgaris*
Fox Sparrow	*Passerella iliaca*
Gadwall	*Anas strepera*
Glaucous-winged Gull	*Larus glaucescens*
Golden-crowned Kinglet	*Regulus satrapa*
Golden-crowned Sparrow	*Zonotrichia atricapilla*
Great Blue Heron	*Ardea herodias*
Greater Yellowlegs	*Tringa melanoleuca*
Green Heron	*Butorides virescens*
Green-winged Teal	*Anas crecca*
Heermann's Gull	*Larus heermanni*
Herring Gull	*Larus argentatus*
Hooded Merganser	*Lophodytes cucullatus*
Horned Grebe	*Podiceps auritus*
Common Name	*Scientific Name*
House Finch	*Carpodacus mexicanus*
House Sparrow	*Passer domesticus*
House Wren	*Troglodytes aedon*
Killdeer	*Charadrius vociferous*

Common Name	Scientific Name
Lesser Yellowlegs	*Tringa flavipes*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Mallard	*Anas platyrhynchos*
Marsh Wren	*Cistothorus palustris*
Merlin	*Falco columbarius*
Mew Gull	*Larus canus*
Northern Flicker	*Colaptes auritus*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Northern Shrike	*Lanius excubitor*
Northwestern Crow	*Corvus caurinus*
Orange-crowned Warbler	*Vermivora celata*
Oregon Junco	*Junco h. oregonus*
Osprey	*Pandion haliaetus*
Pacific Loon	*Gavia pacifica*
Pied-billed Grebe	*Podilymbus podiceps*
Pigeon Guillemot	*Cepphus columba*
Pine Siskin	*Carduelis pinus*
Purple Finch	*Carpodacus purpureus*
Purple Martin	*Progne subis*
Red-breasted Merganser	*Mergus serrator*
	Podiceps grisegena
Red-tailed Hawk	*Buteo jamaicensis*
Red-throated Loon	*Gavia stellata*
Red-winged Blackbird	*Agelaius phoeniceus*
Ring-billed Gull	*Larus delawarensis*
Rock Pigeon	*Columba livia*
Ruby-crowned Kinglet	*Regulus calendula*
Rufous Hummingbird	*Selasphorus rufus*
Rufous-crowned Sparrow	*Aimophila ruficeps*
Rufous-sided Towhee	*Pipilo maculatus/erythr.*
Sanderling	*Calidris alba*

Common Name	Scientific Name
Savannah Sparrow	*Passerculus sandwichensis*
Sharp-shinned Hawk	*Accipiter striatus*
Song Sparrow	*Melospiza melodia*
Spotted Sandpiper	*Actitis macularius*
Swainson's Hawk	*Buteo swainsoni*
Swainson's Thrush	*Catharus ustulatus*
Tree Swallow	*Tachycineta bicolor*
Violet-green Swallow	*Tachycineta thalassina*
Western Grebe	*Aechmophorus occidentalis*
Western Sandpiper	*Calidris mauri*
White-crowned Sparrow	*Zonotrichia leucophrys*
Winter Wren	*Troglodytes troglodytes*
Yellow Warbler	*Dendroica petechia*
Yellow-rumped Warbler	*Dendroica coronata*

Appendix B. Examples of Duwamish Restoration Projects Completed from Earlier NRDA Settlements

Herring's House

This restoration project is located at River Mile two of the Duwamish Waterway at the site of the former Seaboard Lumber Mill, which operated from around 1929 until the early 1980s. The site is in the vicinity of Kellogg Island and on the last remaining oxbow of the Duwamish River system. The site contains 5.7 acres of upland and 10 acres of tidelands. Historically, the upland site was a marsh/channel of the Duwamish River. Developed as an industrial site, the area was filled with waste-bearing fill material consisting of silt, sand, and gravel mixtures with broken asphalt, rock, concrete, brick, wood, and metal debris. Investigations revealed soils with concentrations of Total Petroleum Hydrocarbons (TPH), lead, mercury, and polycyclic aromatic hydrocarbons (PAHs) that exceeded Washington State Model Toxics Control Act cleanup criteria.

Design Objectives

- Restore intertidal habitat from areas that have been filled for use by juvenile salmonids.
- Create a protective low-energy environment with backwater pools to provide refuge and food sources.
- Establish areas of high intertidal salt marsh vegetation with a protective perimeter buffer of upland riparian vegetation.
- Remove and contain contaminated upland soils and industrial debris.
- Protect the site for natural resources in perpetuity.
- Provide opportunities for passive public access and environmental education.

Restoration Activities

In 1999, a protective outer berm was constructed, armoring and modifying the shoreline. The armor layer consists of 8 to 9 inches of quarry stone with voids filled with fish rock (fine/medium gravel and course sand to three-eighths of an inch). Parts of the berm serve to contain low-level industrial contaminants which has been monitored. Project construction was completed in 2000 and consisted of several primary activities:

- Structures associated with the mill operation were demolished; a 9,200 square foot shoreline dock structure was removed, including 248 creosoted wooden supporting piles, concrete foundations, areas of paving, and partially buried railroad spurs.
- Highly contaminated upland soil was removed.
- Low level TPH-contaminated soil was contained by covering with a minimum of two feet of clean soil with erosion control features to ensure containment.
- A 1.8-acre intertidal bay was excavated with a curvilinear edge to elevations between +6 to +12 feet MLLW, protected by two armored spits forming a mouth opening to the Duwamish River.
- On-site soil was amended with a mixture of silts and clays with a high organic content distributed to a depth of 18 inches over the basin.
- Slopes of the intertidal area were planted with emergent marsh plants at various elevations, and transitional scrub/shrub habitat between the intertidal marsh, upland meadow, and forested habitat.
- Intertidal habitat was monitored for a ten-year period.

Turning Basin no. 3

This project is located on the former Kenco Marine Services property at the western upstream boundary of the maintained navigation channel (Turning Basin No. 3) where the Duwamish Waterway is formed from the Duwamish River. The upland portion of the site was composed of fill material and was covered with asphalt and concrete pads, in addition to an office/warehouse structure, small storage sheds, and a house. A commercial pier extended 125 feet into the Turning Basin. Barges and other vessels moored in the intertidal and subtidal area.

Other portions of the Turning Basin have been restored to natural wetlands by federal agencies, including NOAA, the U.S. Fish and Wildlife Service, and the Port of Seattle, under various programs. The Panel partially funded the purchase of additional land to increase estuarine habitat, to be held under the trusteeship of the Muckleshoot Tribe. Over one acre of mudflats were “daylighted” by the removal of derelict vessels at the site. The commercial pier and shoreside structures were removed and the area was recontoured and revegetated to provide an enhanced intertidal wetland area.

Design Objectives

- "Daylight" intertidal and subtidal areas by removing vessels.
- Reduce pollution potential by curtailing commercial activity.
- Remove existing commercial upland and in-water structures.
- Recontour bank to create three intertidal and riparian habitat benches.
- Reestablish native intertidal and riparian vegetation.
- Increase food sources for trust resources.
- Protect the site in perpetuity for natural resources.

Restoration Activities

- Vessels and commercial activities were removed from the pier.
- Former commercial structures, concrete foundations and paved areas were removed, including the dock structure and creosoted wooden supporting piles.
- The area was recontoured and planted to create an enhanced intertidal wetland area consisting of three habitat benches at various elevations:
    - A "lower bench" at +2 to +6 feet at a 10:1 slope of sand over 3/4 inch gravel substrate to create 6,500 square feet of habitat. Bank stabilization will be accomplished by using "soft" substrates (wood) in lieu of riprap at the transition to the emergent zone bench.
    - An "emergent zone bench" at +9.5 to +11 feet at 20:1 slope planted with native intertidal vegetation and random rock placement will create 6,050 square feet of habitat.
    - A "groundcover and shrub zone bench" at elevation +14 to +17 feet at a 3:1 slope planted with native riparian vegetation to create 1,850 square feet of habitat.
- Future moorage of barges and other vessels was prohibited at the site, allowing 18,000 square feet of intertidal and subtidal mudflats to become permanently exposed.
- Intertidal habitat was monitored for success over a ten-year period under the Elliott Bay/Duwamish Restoration Program's monitoring plan

North Wind's Weir

The North Wind's Weir project is on a 3.1-acre parcel of King County's Cecil B. Moses Park on the free-flowing Duwamish River about a mile upstream of Turning Basin #3. The Elliott Bay/Duwamish Restoration Program purchased 1.03 acres of the park to construct an intertidal basin. The site was developed in the 1930s and 1940s for single-family residential housing. All dwellings were removed. A steep bank along the river right-of-way sloped downward (almost vertical) approximately 20 feet to the riverbed where the shoreline was poorly protected by riprap and debris in the lower intertidal to subtidal areas.

Design Objectives

- Create an intertidal basin for use by juvenile salmon.
- Shoreline protection improvements.
- Provide native intertidal and riparian vegetation.
- Improve habitat for out-migrating salmonid acclimation to salt water at a critical location in the Duwamish River.
- Provide refuge and food sources for trust resources.
- Protect the site in perpetuity for natural resources.

Restoration Activities

A 0.3-acre intertidal basin was constructed by excavating from an elevation of +6 to +15 feet MLLW. A curvilinear edge creates a more natural appearance and maximizes habitat diversity at the zone edge. The northeast end of the property connects to the Duwamish River via natural bank slopes stabilized with vegetation. Upland edges were revegetated with native trees and shrubs to form a riparian buffer designed to incorporate as many mature trees and native shrubs present on the site as possible and to restrict human access from the surrounding park. Monitoring for intertidal habitat success was conducted for a period of ten years under the Elliott Bay/Duwamish Restoration Program's restoration monitoring plan.

APPENDIX C: DEFINING INJURIES TO NATURAL RESOURCES IN THE LOWER DUWAMISH RIVER

(Adapted from Appendix D of March 14, 2002 Hylebos Waterway Natural Resource Damage Settlement Proposal Report)

Introduction

The Lower Duwamish River (LDR) Habitat Equivalency Analysis (HEA) evaluates and quantifies natural resource injuries in areas where surface sediments contain Substances of Concern (SOCs) at or above threshold concentrations defined for natural resource injury. The HEA also quantifies how much restoration is required to compensate for these injuries. This appendix describes how injuries are defined and how increasing concentrations of SOCs cause greater injury. It also explains how percent service loss is used in the injury calculations for estimating natural resource damages in the LDR.

Cacela *et al.* (2005) thoroughly discusses the concept of percent service loss. The focus in this appendix is on how service loss supports the HEA, what information is used to determine service loss and how service losses are estimated.[1] All of the processes and results described represent a means to establish groundwork for dialog for reaching NRDA settlements.

Associating Ecosystem Service Loss with Sediment Contamination

The concept of *service* is central to HEA. What is needed is a clear understanding of what service is being evaluated or modeled and how reductions in services are determined (Cacela *et al.,* 2005). Habitats typically provide many and varied types of ecological services (Strange *et al*, 2002) and promote a sustainable ecosystem through complex interactions among plants and animals and their habitat (Holmlund and Hammer, 1999). Examples of ecological services include providing places for shelter, feeding and resting for fish and birds. In addition, human use services include consumptive and non-consumptive uses such as fishing, nature photography, education, etc. Although some human use services are easy to evaluate, for example recreational beach use, others are not. It is difficult to connect services associated with human use with ecological services. Because of this, in the LDR HEA, only ecological services were used to estimate injury.

Ecological service is a term that may embrace several different structural or functional attributes of an ecosystem. In the context of HEA, ecological services are used as an exchange rate for determining how much habitat must be restored to compensate for harm to the environment. Injured and restored habitat is equated by comparing the services provided by each habitat. Although the injured and restored habitats may include human use services as well as ecological services, it is assumed that a focus on restoring ecological services will also support restoring human use services.

[1] Services (or natural resource services) mean the functions performed by a natural resource for the benefit of another natural resource and/or the public. Examples include ecological services such as provision of food, protection from predation, nesting habitat, as well as human services such as fishing, hunting, education, etc.

It is important to consider how an ecological service is lost, how much is lost, and how that loss can be represented. For the purposes of the LDR HEA, ecological services are considered lost when organisms are adversely affected by the presence of a specified concentration of an SOC. Adverse effects can be non-lethal, such as causing changes within the cells of an organism, or lethal (causing the death of the animal or plant). In terms of service losses, these effects would range from small to large. Death may impact the species' population, however it is very difficult to quantify effects at the population level. Consequently, we focus on effects to sample groups of organisms, individual organisms, and processes within an organism.

Organisms live on a finite energy budget. Because energy is limited, any stressor that occurs in addition to natural stressors (i.e., not human-caused) is detrimental to that organism. Organisms must redirect energy to counteract the effects of the stressor (Rowe *et al.,* 1998). Examples of energy redirection induced by stress include fighting any toxicity associated with the stressor and using additional energy to move to avoid unsuitable habitat (Cacela *et al.* 2005). Redirecting energy for these activities comes at the expense of other biological processes, such as growth, reproduction, and avoiding predation. If a particular habitat is more stressful than a reference site, it provides less service, meaning some portions of the habitat's services are lost. The lost portion of service is an injury. Because of the functional role that ecological services play in HEA, service reductions are expressed on a percentage basis. The ecological service index of a unit of habitat is reduced by a fractional amount that reflects the difference in habitat quality at the injured site relative to an uninjured reference location.

One way to evaluate service loss within a habitat is to identify the extent and types of injuries to resources using that habitat. This information is found in scientific literature; however, the breadth of information on injuries varies greatly between chemicals. Two examples of this are described for Hexachlorobenzene (HCB) and Polycyclic Aromatic Hydrocarbons (PAHs). Following the discussion of each of these SOCs is information about other SOCs that are handled in a similar manner.

HCB Injuries and the use of Apparent Effects Thresholds

The only data sets used to evaluate injuries from HCB and several other SOCs are benthic community analyses and bioassay information from the State of Washington's Sediment Management Standards (SMS, Chapter 173-204 WAC, revised 12/95). The State of Washington Department of Ecology maintains a database that determines the apparent effects of particular contaminants to specific organisms. These effects are listed in the Apparent Effects Thresholds[2] (AETs) and are associated with invertebrate bioassays and benthic community data. There are seven AETs considered in this appendix. Five AETs address invertebrate groups and two address the benthic community (Table C1). These include a benthic community analysis and bioassay results for an echinoderm, Microtox™, amphipod, *Neanthes* (*polychaete worm*), "bivalve", and oyster. The bivalve AET is used only when oyster data are not available, because the oyster AET has been more extensively reviewed.

The lowest AET establishes Marine Sediment Quality Standards (MSQS) for Puget Sound that "correspond to a sediment quality that will result in no adverse effects on biological resources…".

[2] An Apparent Effects Threshold is defined as the concentration of a single chemical (or chemical class) in sediments above which a particular biological effect has always been observed in a particular biological test.

Table C 1. Apparent Effects Thresholds (AETs) for a variety of substances of concern. These AETs are derived from data used to promulgate State of Washington (Marine) Sediment Management Standards. All concentrations are expressed at dry weight values.

SUBSTANCES OF CONCERN	***Amphipod Bioassay*** **[1994]**	***Benthic Community Analysis*** **[PSEP, 1988]**	***Bivalve Bioassay [1994]***
Metals (mg/kg or ppm)			
Arsenic	450	57	35
Cadmium	14	5.1	3.6
Chromium	>1,100	260	63.5
Copper	1,300	530	298
Lead	1,200	450	336
Mercury	2.3	2.1	1.7
Silver	6.1	>6.1	3.0
Tributyltin	>180	na	na
Zinc	3,800	410	839
Nonionizable organic compounds (ug/kg or ppb)			
Total LPAHs	29,000	13,000	3,825
2-Methylnaphthalene	1,900	1,400	120
Acenaphthene	2,000	730	660
Acenaphthylene	1,300	1,300	150
Anthracene	13,000	4,400	1,500
Fluorene	3,600	1,000	500
Naphthalene	2,400	2,700	180
Phenanthrene	21,000	5,400	2,000
High molecular weight PAHs (ug/kg or ppb)			
Total HPAHs	69,000	69,000	13,080
Benz[a]anthracene	5,100	5,100	1,100
Benzo[a]pyrene	3,500	3,600	1,000
Benzo[ghi]perylene	3,200	2,600	640
Total benzofluoranthenes	9,100	9,900	na
Chrysene	21,000	9,200	1,600
Dibenzo[a,h]anthracene	1,900	970	250
Fluoranthene	30,000	24,000	3,300
Indeno[1,2,3-cd]pyrene	4,400	2,600	590

SUBSTANCES OF CONCERN	***Amphipod Bioassay*** **[1994]**	***Benthic Community Analysis*** **[PSEP, 1988]**	***Bivalve Bioassay*** ***[1994]***
Pyrene	16,000	16,000	4,100
Chlorinated organic compounds (ug/kg or ppb)			
1,2,4-Trichlorobenzene	51	na	10
1,2-Dichlorobenzene	>110	50	6
1,4-Dichlorobenzene	120	110	97
Hexachlorobenzene	130	22	6

For our analyses, the MSQS for HCB is defined as our threshold for injury (22 parts per billion (ppb)). Within the State's database, all tested sediment samples containing more than 22 ppb of HCB show an adverse effect on benthic communities. This means that *all* analyses indicate a significant reduction in invertebrate population abundance and/or species diversity when compared to a reference location. The initial injury level is defined as relatively insignificant and is estimated as 5% of the ecological service value for any form of marine habitat.[3] In situations where contamination exceeds the threshold level, more AETs are exceeded, resulting in greater injury and greater service loss. We chose three additional injury levels for HCB (and other SOCs where only Washington SMS data are available): a 10% reduction in ecological service value or service loss when at least half of the AETs are exceeded, a 15% service loss when three-quarters of the AETs are exceeded, and a 20% service loss when all invertebrate AETs are exceeded. These additional injury levels are associated with HCB concentrations of 70, 130, and 230 ppb (Table C2).

A 20% service loss is the maximum injury level assigned to HCB because no data were available to indicate effects on biota other than invertebrates. Some may argue that assigning this level of service loss to marine sediments is too low if all tested invertebrate groups are adversely affected. This criticism results from several factors, such as:

[3] Habitats used in the LDR HEA include: marsh, intertidal areas (12 feet (ft) above to 4 ft below Mean Lower Low Water (MLLW); shallow subtidal areas (4 ft below to 14 ft below MLLW); and deep subtidal areas (depths more than 14 ft below MLLW).

- By definition, AETs reflect the *minimum* concentration at which an effect is observed in *ALL* tests. AETs are continually evolving; with associated concentrations usually moving higher simply because all you need to change the AET is to identify a test that shows no effect at that concentration.
- Marine AETs often measure mortality and frequently focus on a 10-day acute test. This usually does not reflect sublethal effects (effects that cause impairment but do not kill the organism). Hence, these AETs are a coarse measure of an organism's ability to survive in contaminated sediment.
- Some AETs only focus on the adult life stage, a period in the life cycle that is often less sensitive to chemical effects.
- None are life cycle tests that determine whether an animal can live, grow, reproduce and maintain their population.
- An invertebrate may ingest, but not metabolize chemicals. Though the invertebrate itself may not be injured, the 'body burden' of the contaminant may provide a source of contamination to predators that eat them, causing impacts to higher level organisms in the food web. For example, a fish may experience injury at a lower concentration than an invertebrate AET (see PCBs).

Although no information is available on HCB effects on animal groups other than invertebrates, mortality to invertebrates and diminished benthic community abundance or diversity should adversely impact higher -level organisms. This would result from diminished quantity or quality of food, requiring animals to expend greater amounts of their limited energy budget to find alternate food resources.

Table C 2. Concentrations of chlorobenzenes estimated to cause injuries to natural resources in Duwamish Waterway, based on Washington State SQS and AET values, expressed in dry weight.

SOC	BIOASSAY	CONCENTRATION	INJURY
Hexachlorobenzene (HCB)			
	"Bivalve" AET	6	(Not used)[1]
	Echinoderm AET	--	
	Benthic Community	22 ←	5% Service Loss
	Microtox AET	70 ←	10% Service Loss
	Amphipod AET	130 ←	15% Service Loss
	Neanthes AET	>120	
	Oyster AET	230 ←	20% Service Loss

SOC	BIOASSAY	CONCENTRATION	INJURY
1,2-dichlorobenzene (oDCB)			
	"Bivalve" AET	6	(Not used)[1]
	Echinoderm AET	na	
	Neanthes AET	na	
	Microtox AET	35 ←	5% Service Loss
	Benthic Community	50	
	Oyster AET	50 ←	20% Service Loss
	Amphipod AET	>110	
1,4-dichlorobenzene (pDCB)			
	"Bivalve" AET	97	(Not used)[1]
	Benthic Community	110 ←	10% Service Loss
	Microtox AET	110	
	Echinoderm AET	--	
	Oyster AET	120 ←	20% Service Loss
	Neanthes AET	--	
	Amphipod AET	120	
1,2,4-trichlorobenzene (TCB)			
	Echinoderm AET	>4.8	
	"Bivalve" AET	10	(Not used)[1]
	Benthic Community	--	
	Microtox AET	31 ←	5% Service Loss
	Amphipod AET	51 ←	10% Service Loss
	Oyster AET	64 ←	20% Service Loss
	Neanthes AET	--	

[1] The "bivalve" bioassay AET is not used if values are present for the more-accepted Oyster bioassay.

Although there are arguments to suggest a 20% Service Loss is either insufficient or too excessive, based on current information the service losses assigned to invertebrate bioassay data represent an appropriate level without overstating injury.

Injuries for Other SOCs Based Solely on Washington SMS Information—

For several other SOCs only benthic and bioassay data is available from the Washington Department of Ecology. In most instances, *four or more AETs* are present in our analytical database. In those cases, service loss is established in a manner identical to that used for HCB. SOCs in this category include:

Metals	**Phenols**	**Phthalates**	**Other SOCs**
Arsenic	4-methyl phenol	Butylbenzyl phthalate	Hexachlorobutadiene
Cadmium	2,4-dimethyl phenol		
Copper			
Lead			
Mercury			
Silver			
Zinc			

In some instances fewer than four AETs are available, and we identify service loss per SOC based on the following method: *when only three AETs* are available, the lowest concentration is identified as a 5% Service Loss, the second lowest is defined as a 10% Service Loss, and the third is defined as 20% Service Loss (all available AETs are exceeded). For Di-n-butyl phthalate, all three AETs have the same concentration: 1,400 ppb dw. In this instance, only one service loss level (20%) is assigned (Table C5). SOCs in this category include:

Metals	**Phenols**	**Phthalates**	**Other SOCs**
Chromium	Phenol	bis (2-ethylhexyl) phthalate	1,2,4-trichlorobenzene
		Dimethylphthalate	
		Di-n-butyl phthalate	

When *only two AETs* are available, the lowest is identified as a 5% Service Loss, and the highest as a 20% Service Loss. SOCs in this category include the following

Metals	**Chlorobenzenes**	**Phthalates**	**Other SOCs**
None	1,2-dichlorobenzene	Di-n-octyl phthalate	none
	1,4-dichlorobenzene		

Service losses associated with various concentrations of metals are presented in Table C3, and service losses associated with concentrations of phenols, phthalates, and Hexachlorobutadiene are presented in Tables C4, C5, and C6, respectively.

Table C 3. Concentrations of metals estimated to cause injuries to natural resources in Duwamish Waterway, based on State of Washington Sediment Quality Standards and AET values, expressed in parts per million dry weight.

SOC	BIOASSAY	CONCENTRATION (ppm)	INJURY
Arsenic (As)			
	"Bivalve" AET	35	(Not used)[1]
	Benthic Community	57	5% Service Loss
	Neanthes AET	63	
	Echinoderm AET	130	10% Service Loss
	Amphipod AET	450	15% Service Loss
	Microtox AET	700	
	Oyster AET	700	20% Service Loss
Cadmium (Cd)			
	"Bivalve" AET	3.6	(Not used)[1]
	Echinoderm AET	2.7	5% Service Loss
	Neanthes AET	3.0	
	Benthic Community	5.1	10% Service Loss
	Microtox AET	9.6	
	Oyster AET	9.6	15% Service Loss
	Amphipod AET	14	20% Service Loss
Chromium (Cr)			
	"Bivalve" AET	63.5	5% Service Loss
	Neanthes AET	94	10% Service Loss
	Microtox AET	--	
	Echinoderm AET	>96	
	Benthic Community	260	20% Service Loss
	Oyster AET	--	
	Amphipod AET	>110	
Copper (Cu)			
	Neanthes AET	270	5% Service Loss
	"Bivalve" AET	298	(Not used)[1]
	Oyster AET	390	
	Echinoderm AET	390	10% Service Loss
	Microtox AET	390	

SOC	BIOASSAY	CONCENTRATION (ppm)	INJURY
	Benthic Community	530	15% Service Loss
	Amphipod AET	1,300	20% Service Loss
Lead (Pb)			
	"Bivalve" AET	336	(Not used)[1]
	Neanthes AET	360	5% Service Loss
	Echinoderm AET	430	
	Benthic Community	450	10% Service Loss
	Microtox AET	530	15% Service Loss
	Oyster AET	660	
	Amphipod AET	1,200	20% Service Loss
Mercury (Hg)			
	Microtox AET	0.41	5% Service Loss
	Oyster AET	0.59	
	Neanthes AET	1.3	10% Service Loss
	Echinoderm AET	1.4	15% Service Loss
	"Bivalve" AET	1.7	(Not used)[1]
	Benthic Community	2.1	
	Amphipod AET	2.3	20% Service Loss
Silver (Ag)			
	"Bivalve" AET	3.0	5% Service Loss
	Microtox AET	>0.56	
	Oyster AET	>0.56	
	Neanthes AET	3.3	10% Service Loss
	Amphipod AET	6.1	15% Service Loss
	Benthic Community	>6.1	
	Echinoderm AET	8.4	20% Service Loss
Zinc (Zn)			
	Benthic Community	410	5% Service Loss
	Echinoderm AET	460	
	Neanthes AET	530	10% Service Loss
	"Bivalve" AET	839	(Not used)[1]
	Microtox AET	1,600	15% Service Loss
	Oyster AET	1,600	
	Amphipod AET	3,800	20% Service Loss

[1] The "bivalve" bioassay AET is not used if values are present for the more-accepted Oyster bioassay.

Table C 4. Concentrations of phenols estimated to cause injuries to natural resources in Duwamish Waterway Injuries are based on State of Washington Sediment Quality Standards and AET values, expressed in parts per billion dry weight.

SOC	BIOASSAY	CONCENTRATION (ppb)	INJURY
4-methyl phenol (MP4)			
	"Bivalve" AET	100	(Not used)[1]
	Echinoderm AET	110 ←	5% Service Loss
	Oyster AET	670	
	Microtox AET	670 ←	10% Service Loss
	Neanthes AET	880	
	Benthic Community	1,800 ←	15% Service Loss
	Amphipod AET	3,600 ←	20% Service Loss
2,4-dimethyl phenol (DMP)			
	"Bivalve" AET	--	(Not used)[1]
	Oyster AET	29 ←	5% Service Loss
	Microtox AET	29	
	Echinoderm AET	55 ←	10% Service Loss
	Neanthes AET	--	
	Amphipod AET	77 ←	15% Service Loss
	Benthic Community	210 ←	20% Service Loss
Phenol			
	"Bivalve" AET	160	(Not used)[1]
	Neanthes AET	180 ←	5% Service Loss
	Echinoderm AET	>220	
	Oyster AET	420 ←	10% Service Loss
	Microtox AET	1,200	
	Amphipod AET	1,200	
	Benthic Community	1,200 ←	20% Service Loss

[1] The "bivalve" bioassay AET is not used if values are present for the more-accepted Oyster bioassay.

Table C 5. Concentrations of phthalates estimated to cause injuries to natural resources in Duwamish Waterway. Injuries are based on State of Washington Sediment Quality Standards and AET values, expressed in parts per billion dry weight.

SOC	BIOASSAY	CONCENTRATION (ppb)	INJURY
bis [2-Ethylhexyl] phthalate (bEPH)			
	Benthic Community	1,300	5% Service Loss
	Echinoderm AET	1,700	
	Microtox AET	1,900	10% Service Loss
	Oyster AET	1,900	
	Neanthes AET	2,000	20% Service Loss
	"Bivalve" AET	2,200	(Not used)[1]
	Amphipod AET	>8,300	
Butylbenzyl phthalate (BBPH)			
	Microtox AET	63	5% Service Loss
	"Bivalve" AET	100	
	Echinoderm AET	200	10% Service Loss
	Oyster AET	>470	
	Neanthes AET	>580	
	Benthic Community	900	15% Service Loss
	Amphipod AET	970	20% Service Loss
Di-n-butyl-phthalate (DnBPH)			
	"Bivalve" AET	58	(Not used)[1]
	Microtox AET	1,400	20% Service Loss
	Neanthes AET	na	
	Echinoderm AET	>31	
	Oyster AET	1,400	
	Amphipod AET	1,400	
	Benthic Community	>5,100	
Di-n-octyl phthalate (DOPH)			
	"Bivalve" AET	61	5% Service Loss
	Microtox AET	na	
	Neanthes AET	na	
	Echinoderm AET	>98	
	Oyster AET	>420	

SOC	BIOASSAY	CONCENTRATION (ppb)	INJURY
	Amphipod AET	>2,100	
	Benthic Community	6,200 ←	20% Service Loss
dimethylphthalate (DMPH)			
	"Bivalve" AET	6	(Not used)[1]
	Microtox AET	71 ←	5% Service Loss
	Echinoderm AET	85 ←	10% Service Loss
	Neanthes AET	--	
	Oyster AET	160 ←	20% Service Loss
	Benthic Community	>1,400	
	Amphipod AET	>1,400	

[1] The "bivalve" bioassay AET is not used if values are present for the more-accepted Oyster bioassay.

Table C 6. Concentrations of hexachlorobutadiene estimated to cause injuries to natural resources in the LDR. Injuries are based on State of Washington Sediment Quality Standards and AET values expressed in parts per billion dry weight.

SOC	BIOASSAY	CONCENTRATION (ppb)	INJURY
Hexachlorobutadiene (HCBD)			
	"Bivalve" AET	6	(Not used)[1]
	Benthic Community	11	5% Service Loss
	Microtox AET	120	10% Service Loss
	Amphipod AET	180	15% Service Loss
	Echinoderm AET	1.3 [2]	
	Oyster AET	270	20% Service Loss
	Neanthes AET	--	

[1] The "bivalve" bioassay AET is not used if values are present for the more-accepted Oyster bioassay.

[2] There is some question about the validity of this number; therefore, it was not used.

PAH Injuries to Vertebrates and Invertebrates

Information on injuries from PAH contamination is more extensive than that for HCB, including effects data for both invertebrates and fishes. Our analysis includes two types of information: biological effects of PAHs on English sole *Pleuronectes vetulu, and AET invertebrate data* from the Washington Sediment Management Standards database.

PAH effects on English Sole are compiled from studies performed by the NOAA Northwest Fisheries Science Center by Johnson et al. (2002). These studies use Total PAHs, a combination of numerous high and low molecular weight PAHs that are listed in Table C7. PAH AETs do not provide a total PAH concentration, only total high molecular weight PAHs (Total HPAHs) and total low molecular weight PAHs (Total LPAHs). The Total HPAHs concentrations are used in this report for effects comparisons between the flatfish and invertebrates. These concentrations are chosen because they represent higher AETs than for LPAHs, and consequently are considered not to overstate injuries.

Table C 7. Polycyclic aromatic hydrocarbons (PAHs) combined to represent Total PAHs in NOAA Northwest Fisheries Science Center studies of PAH effects on English Sole.

Low Molecular Weight PAHs	**High Molecular Weight PAHs**
2-Methylnaphthalene	Benz[a]anthracene
Acenaphthene	Benzo[a]pyrene
Acenaphthylene	Benzo[ghi]perylene
Anthracene	benzofluoranthenes (b+k)
Fluorene	Chrysene
Naphthalene	Dibenzo[a,h]anthracene
Phenanthrene	Fluoranthene
	Indeno[1,2,3-cd]pyrene
	Pyrene

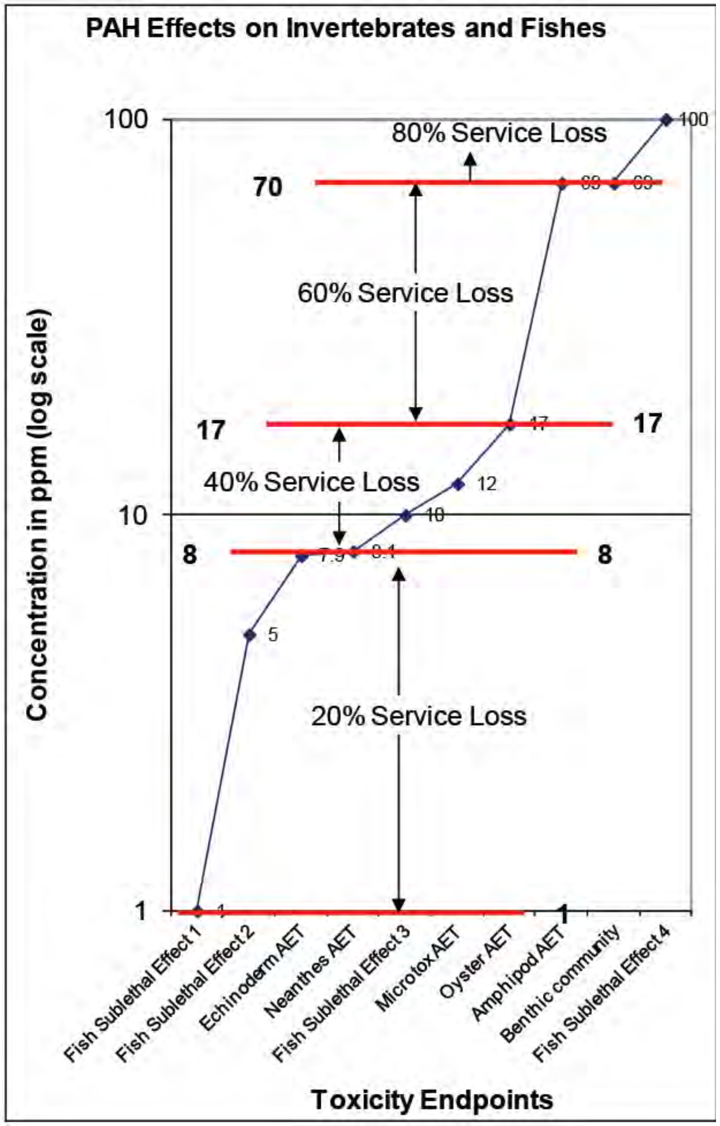
English sole continues to be one of the most extensively studied fish species in pollution monitoring research. Because it is a shallow-water bottom-dwelling flatfish and occurs in urban and non-urban environments along the Pacific Coast of North America, it is particularly likely to take up contaminants in sediment, through direct contact with sediments and through its diet. Since this species is relatively sedentary and spends most of its life in a small area, biological effects in English sole are an accurate reflection of PAH exposure at sites where they are collected. Numerous studies show that English sole from PAH-contaminated areas are highly susceptible to the development of liver cancer and related lesions, and are prone to several other adverse health effects, such as reproductive abnormalities, immune dysfunction, and alterations in growth and development (Myers *et al.* 1994, 1998; Arkoosh *et al.* 1996; and Johnson *et al.* 1998).

Based on a review of the English sole studies and the State of Washington SMS information, the following can be stated about PAH injuries to natural resources. (All PAH concentrations mentioned refer to levels of sediment contamination):

- The first sign of reproductive effects of PAHs on English sole in Puget Sound occurs at about 1 ppm dry weight, and cancerous or pre-cancerous lesions are found fairly frequently. At that concentration, nearly 10% of English sole studied contain 1 or more of a variety of toxicopathic lesions in soft body tissue and nearly 5% of adult females are infertile when compared to female populations in relatively uncontaminated areas.
- By 5 ppm, the number of individuals with lesions has increased three-fold and female infertility has increased to 17% above baseline. By 7.9 ppm, invertebrates also begin to be affected (Table C1).
- By 10 ppm, over 40% of all English sole studied have one or more lesions, nearly 25% of adult females are infertile, and between 10 and 69 ppm, more than half of the invertebrate bioassays show adverse effects.
- By 100 ppm, over 70% of all English sole studied in Puget Sound have some form of toxicopathic lesions, and for adult females, over half have inhibited reproduction capability, over two-thirds do not participate in spawning, and more than three-quarters are infertile. All invertebrate AETs are exceeded.

Information in the previous paragraph describes a significant range of injuries to natural resources from exposure to PAHs in marine sediments. This suggests that a significant range of service losses is associated with these varied injuries. Initial impacts to vertebrates are reported by Johnson et al. (2002) to begin at sediment concentrations as low as 54 ppb, and the variety and extent of injuries to English sole increase markedly with rising PAH concentrations. While this information is from studies focusing on direct exposure to contaminated sediments, these fish indirectly suffer substantial additional exposure through ingestion of invertebrate prey residing in contaminated sediment (Rice *et al.* 1999). In turn, the prey is directly affected by sediment concentrations of PAHs, as low as 7.9 ppm.

To map PAH injuries and identify a range of service losses, impacts on English sole and invertebrate AETs are graphed against PAH concentrations in sediments (Figure C1). The PAH concentrations are represented on the y-axis in (base 10) logarithmic form to permit observing effects details at low concentrations as well as evaluate effects at very high concentrations on the same scale. A 20% threshold service loss is assigned at 1ppm dry weight, with a general grouping of additional flatfish injuries and an invertebrate AET between 1 ppm and 8.1 ppm. This initial service loss is much higher than that assigned for HCB (discussed previously) because it impacts other members of the biological community through the food web.



References	Toxicity Endpoint	Concentration ppm dw
4	Fish Sublethal Effect [1]	1
4	Fish Sublethal Effect [2]	5
1	Echinoderm AET	7.9
1	Neanthes AET	8.1
4	Fish Sublethal Effect [3]	10
1	Microtox AET	12
1	Oyster AET	17
1	Amphipod AET	69
1	Benthic community	69
4	Fish Sublethal Effect [4]	100

References
1 Washington Department of Ecology
4 Johnson et al. 2002

Flatfish Injuries	
Sublethal 1	initial effects on fecundity and occurrence of lesions in soft tissue
Sublethal 2	significant increases lesion occurrence (>30%) and reduced fecundity (>15%)
Sublethal 3	>40% of all individuals with lesions and fecundity reduced by ~25%
Sublethal 4	~75% occurrence of lesions and fecundity reduced by ~50%.

80% Service Loss >70 ppm dry weight	All tested invertebrates affected; flatfish injuries include ~50% reduction in fecundity and ~75% occurrence of at least one lesion/fish
60% Service Loss 17 to 70 ppm	All tested invertebrates affected.
40% Service Loss 8 to 17 ppm	One-half of tested invertebrates affected; significant injuries to flatfish include ~25% reduction in fecundity & 31% occurrence of lesions
20% Service Loss 1 to 8 ppm	Begin to see effects on invertebrates and fishes. Flatfish fecundity reduced by ~5% and up to 10% of all fish with some form of lesion.

Figure C1. Information used to determine injury threshold concentrations for total PAHs and their associated percent Service Losses.

A 40% service loss is assigned to the range of 8 to 17 ppm because both the extent of biological effects on fish and the number of invertebrate AETs that are exceeded at these concentrations. A 60% service loss is assigned to the range of 17 to 70 ppm because of continued substantial increases of biological effects and the incorporation of all invertebrate AETs. Finally, an 80% service loss is assigned to PAH sediment concentrations above 70 ppm.

Other SOCs Handled Similarly to PAHs

Injuries from polychlorinated biphenyls (PCBs), p,p'DDT, p,p'DDE, and p,p'DDD are evaluated in a similar manner. In addition to the Washington SMS data, numerous studies were reviewed for PCBs and the various DDT congeners (forms of DDT that result from the breakdown of the original chemical) (MacDonald 1994). Data from research on PCB effects on several salmonid species were also included (Meador et al. (2002b). As with PAHs, a graph of toxic endpoints and associated concentrations was developed for each SOC. Higher service losses are assigned at points on the graph where there is a notable increase in effect concentration.

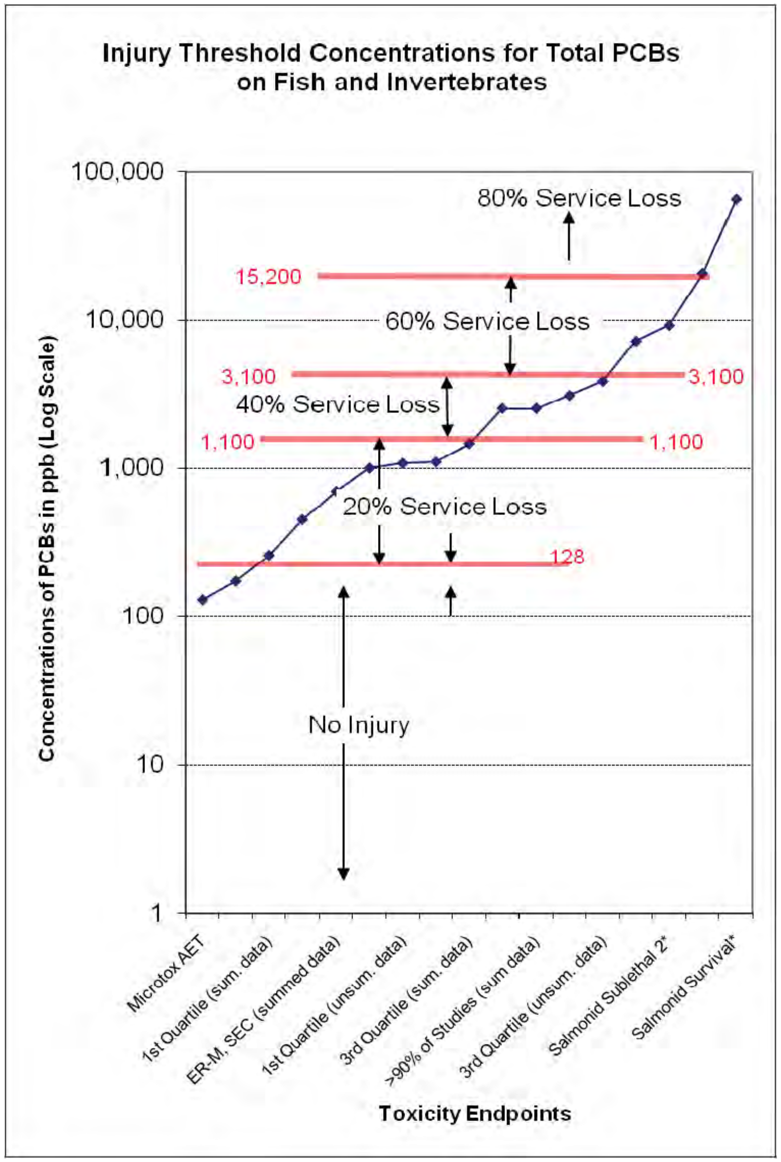
<u>PCBs</u>—The first threshold for PCBs in the LDR HEA was set by the "Sediment Effect Threshold" of "SET" described in Meador et al. (2002b). Since it represents a bioaccumulative effect, it is assigned a 20% service loss. The Trustees used a slightly different total organic carbon (TOC) value to derive the first PCB threshold than the TOC value used by Meador et al. The Trustees calculated an area-weighted average TOC value of 1.7%, based on a more comprehensive set of Duwamish sediment data. Meador et al. used 1.5%. The result is that where Meador et al shows a value of 113 ppb dry weight, the Trustees calculate 128 ppb dry weight. The value of 128 ppb dry weight corresponds to the Washington State Sediment Management Standards Lowest Apparent Effects Threshold, which is 130 ppb dry weight.

PCB injury thresholds are represented by 20-40-60-and 80% Service Losses for four concentration ranges of 128-1,100 ppb (20% Service Loss), 1,100-3,100 ppb (40% Service Loss), 3,100-15,200 ppb (60% Service Loss), and greater than 15,200 ppb (80% Service Loss (Figure C2).

<u>DDT Congeners</u>--DDTs are assigned 10-20-30-40% service losses. These SOCs are assigned a lower service loss range than PAHs and PCBs as most studies only describe injuries to invertebrates. A summary graph and table of service loss information for p,p' DDT is found in Figure C3. It identifies injury ranges as 12-34 ppb (10% Service Loss), 34-340 ppb (20% Service Loss), 340-1,500 ppb (30% Service Loss) and concentrations greater than 1,500 ppb (40% Service Loss).

Figure C4 summarizes toxic endpoint information for p,p' DDE. It identifies injury ranges as 9-65 ppb (10% Service Loss), 65-5,200 ppb (20% Service Loss), 5,200-16,300 ppb (30% Service Loss) and concentrations greater than 16,300 ppb (40% Service Loss).

Figure C5 summarizes toxic endpoint information for p,p' DDD. It identifies injury ranges as 16-70 ppb (10% Service Loss), 70-1,100 ppb (20% Service Loss), 1,100-2,600 ppb (30% Service Loss) and concentrations greater than 2,600 ppb (40% Service Loss).



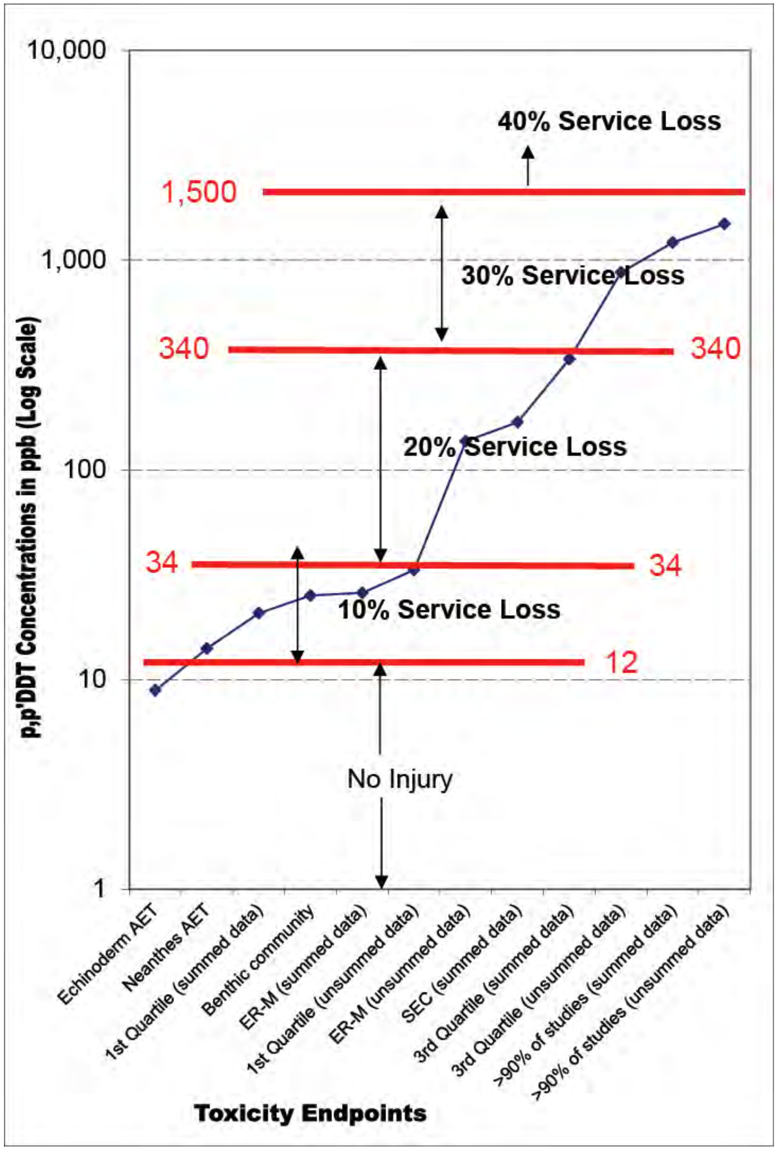
Reference	Toxicity Endpoint	Concentration ppb dw
1	Microtox AET	96
3	Chinook SEC1*	128
2	1st Quartile (sum. data)	191
1	Echinoderm AET	333
2	ER-M, SEC (summed data)	517
1	Benthic Community	739
2	1st Quartile (unsum. data)	798
1	Oyster AET	813
2	3rd Quartile (sum. data)	1,084
2	ER-M (unsum data)	1,870
2	>90% of Studies (sum data)	1,870
1	Amphipod AET	2,291
2	3rd Quartile (unsum. data)	2,856
2	>90% of Studies (unsum)	5,321
4	Salmonid Sublethal 2*	6,800
4	Salmonid Growth*	15,226
4	Salmonid Survival*	47,970

[1]--SEC = Sediments Effects Concentration
[2]--ER-M = Effects Range-Median
* concentrations based on 1.7% TOC

References
1 Washington Department of Ecology
2 MacDonald 1994
3 Meador et al. 2002 (b)
4 NOAA, 2001

80% Service Loss > 15.2 ppm dry weight	All tested invertebrates affected and salmonid growth and survival are affected
60% Service Loss 3.1 to 15.2 ppm	All invertebrates affected and sublethal effects on salmonids such as changes in immuno-suppression and P450 induction
40% Service Loss 1.1 to 3.1 ppm	Most tested invertebrates affected
20% Service Loss 0.128 to 1.1 ppm	First signs of cellular compromise in Chinook salmon; several invertebrates affected

Figure C2. Information used to determine injury threshold concentrations for total PCBs and their associated percent Service Losses.



Ref.	Toxicity Endpoint	Concentration (ppb dw)*
1	Echinoderm AET	9
1	Neanthes AET	14
3	1st Quartile (summed data)	21
1	Benthic community	25
3	ER-M (summed data)	26
3	1st Quartile (unsummed data)	33
3	ER-M (unsummed data)	137
3	SEC (summed data)	169
3	3rd Quartile (summed data)	337
3	3rd Quartile (unsummed data)	874
3	>90% of studies (summed data)	1,214
3	>90% of studies (unsummed data)	1,487

* Concentrations based on 1.7% TOC

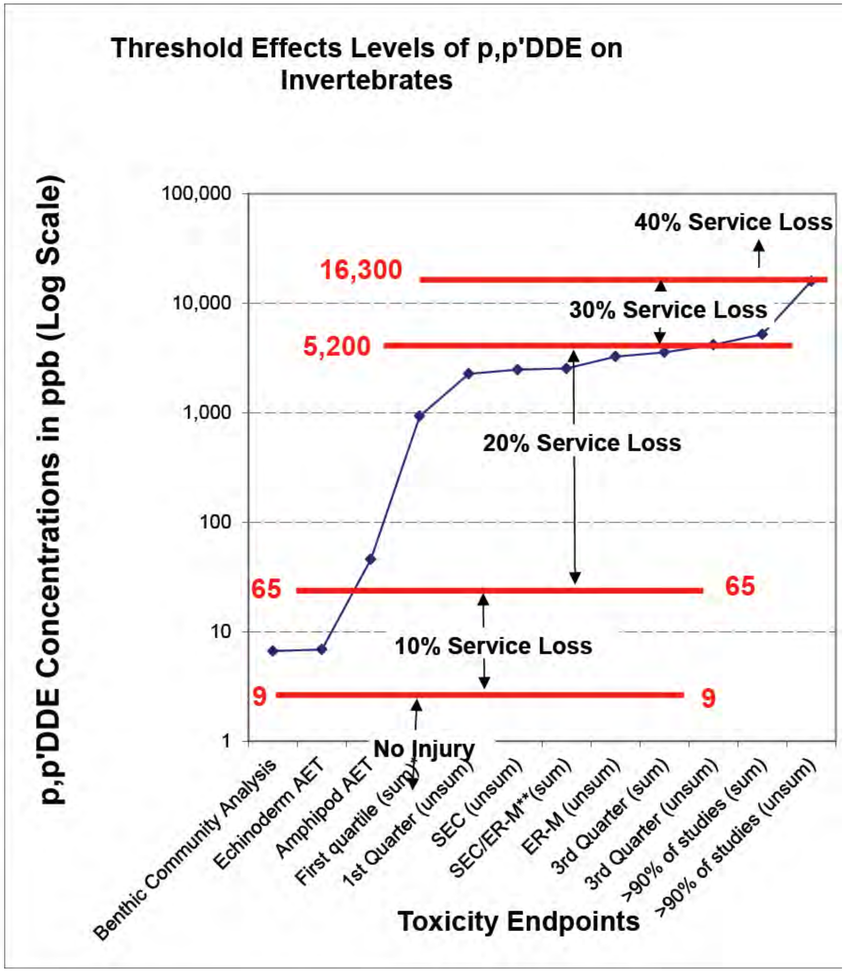
References

1 Washington Department of Ecology

3 MacDonald, 1994

40% Service Loss >1,500 ppb dw	All bioassays show effects.
30% Service Loss 340 to 1,500 ppb	Over 90% of studies reported by MacDonald 1994 show effects by this range.
20% Service Loss 34 to 340 ppb	All State of Washington AETs exceeded; Many studies reported by MacDonald 1994 report effects in this range
10% Service Loss 12 to 34 ppb	Initial level of adverse effects observed in State of Washington AETs.

Figure C3. Information used to determine injury threshold concentrations for p,p' DDT and their associated percent Service Losses.



Reference	Toxicity Endpoint	Concentration (ppb dw)
1	Benthic Community Analysis	7
1	Echinoderm AET	7
1	Amphipod AET	46
3	First quartile (sum)*	931
3	1st Quarter (unsum)	2,267
3	SEC (unsum)	2,473
3	SEC/ER-M**(sum)	2,531
3	ER-M (unsum)	3,254
3	3rd Quarter (sum)	3,554
3	3rd Quarter (unsum)	4,166
3	>90% of studies (sum)	5,196
3	>90% of studies (unsum)	15,899

* Concentrations for MacDonald (1994) data based on 1.7% TOC
** Effects Range-Median Sediment Effects Concentration

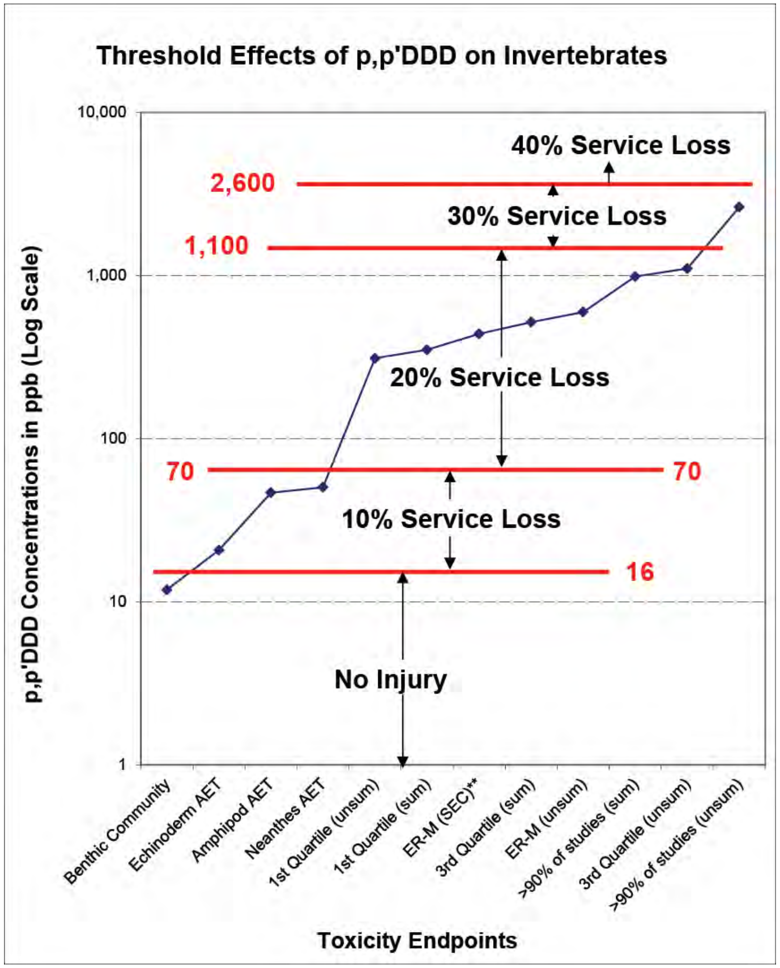
References

1 Washington Department of Ecology

3 MacDonald, 1994

40% Service Loss >16,300 ppb dw	All bioassays show effects.
30% Service Loss 5,200 to 16,300	Over 90% of studies examined by MacDonald 1994 show effects by this range.
20% Service Loss 65 to 5,200	All State of Washington AETs exceeded; Many studies reported by MacDonald 1994 report effects in this range.
10% Service Loss 9 to 65 ppb	Initial level of adverse effects observed in State of Washington AETs.

Figure C4. Information used to determine injury threshold concentrations for DDE and their associated percent Service Losses.



Reference	Toxicity Endpoint	Concentration (ppb dw)*
1	Benthic Community	12
1	Echinoderm AET	21
1	Amphipod AET	47
1	Neanthes AET	50
3	1st Quartile (unsum)	310
3	1st Quartile (sum)	350
3	ER-M (SEC)**	438
3	3rd Quartile (sum)	517
3	ER-M (unsum)	597
3	>90% of studies (sum)	986
3	3rd Quartile (unsum)	1,104
3	>90% of studies (unsum)	2,626

* Concentrations for MacDonald (1994) data based on 1.7% TOC

** Effects Range-Median Sediment Effects Concentration

References

1 Washington Department of Ecology

3 MacDonald, 1994

40% Service Loss >2,600 ppb dw	All bioassays show effects.
30% Service Loss 1,100 to 2,600 ppb	Over 90% of studies reported by MacDonald 1994 show effects by this range.
20% Service Loss 70 to 1,100 ppb	All State of Washington AETs exceeded; Many studies reported by MacDonald 1994 report effects in this range
10% Service Loss 16 to 70 ppb	Initial level of adverse effects observed in State of Washington AETs.

Figure C5. Information used to determine injury threshold concentrations for DDD and their associated percent Service Losses.

Tributyltin Service Losses—There is no MSQS associated with tributyltin (TBT), and more recent AET information is minimal. Consequently, we rely on information compiled from studies elsewhere and the analysis by Meador et al. (2002a) that supports a sediment quality threshold for TBT in Puget Sound to protect prey species for juvenile salmonids that are listed by the Endangered Species Act. In this document, he calculates an effects level of 6,000 ppb OC; a median concentration for all sublethal effects studies which is primarily growth impairment). With a calculated average TOC for the LDR of 1.7%, the previously stated carbon normalized number would translate to 102 ppb dry weight.

For specific studies, TBT concentrations associated with adverse effects range from 100 ppb to 1000 ppb dry weight. Meador (1997) indicates that 329 ppb is a concentration in a range needed to produce a lethal response for a sensitive invertebrate such as the amphipod, *Eohaustorius washingtonianus*. Bryan and Langston (1992), Langston and Burt (1991) and Meador et al. (2002a) have suggested that some populations of bivalves in United Kingdom waters have disappeared in locations with TBT sediment concentrations over 700 ppb. Fent and Hunn (1995) (from ibid) noted that clams have disappeared in other areas where sediment TBT exceeds 800 ppb. Lastly, Meador and Rice (2001) report severe reductions in growth of the polychaete, *Armandia brevis,* for sediment concentrations in the range of 100 to 1,000 ppb.

Based on the above TBT information, the threshold value for injuries from TBT is assigned at 102 ppb dry weight (Table C8). A 5% service loss is associated with this threshold value. A 20% service loss is assigned to concentrations greater than 1,000 ppb.

Table C 8. Concentrations of Tributyltin considered to cause injuries to natural resources in the LDR

SOC	BIOASSAY	Concentration in ppb	INJURY
Tributyltin (TBT)			
Tributyltin (TBT)	NMFS threshold[1]	102	5% Service Loss
	Bivalve abundance[2]	>800	
	Bivalve abundance[3]	>700	
	Polychaete growth[4]	1,000	20% Service Loss

[1] Meador et al.*(2002a*) proposes that a concentration of 6,000 ppb per gram Carbon would be protective for many, but not all prey species. For the average TOC for Duwamish stations, this would translate as 138 ppb DW (average TOC = 1.7%).

[2] Disappearance of clams in areas where TBT exceeded 800 ppb DW, reported by Fent and Hunn 1995.

[3] Populations of bivalves *Macoma balthica* and *Scrobicularia plana* have disappeared in locations with concentrations over 700 ppb--reported by Bryan and Langston (1992) and Langston and Burt (1991).

[4] Severe reductions in growth of *Armandia brevis* for sediment concentrations in the range of 100 - 1,000 ng/g (ppb), reported by Meador and Rice (2001).

Summary

This appendix assigns threshold sediment concentrations for injuries to natural resources from various SOCs. The ecological service losses assigned to each threshold and higher are based on the variety and extent of injuries caused by each SOC. If only invertebrate AET information is used to estimate injury thresholds, the maximum service loss value is determined to be 20%. If information from reports on injuries to fishes is incorporated into our analysis along with the AETs, both initial and maximum service losses are higher, with thresholds at 10-20% and maximum values up to 80%.

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APPENDIX D: HABITAT VALUATION IN THE LOWER DUWAMISH RIVER AND DETERMINATION OF TIME TO SUSTAINED FUNCTION

(Adapted from Appendix C of March 14, 2002 Hylebos Waterway Natural Resource Damage Settlement Proposal Report)

Habitat Valuation Introduction

For the purposes of the Lower Duwamish River Habitat Equivalency Analysis (HEA), habitats are valued by how well they support juvenile Chinook salmon, four bird assemblages that are representative of avian species occurring in the area, and juvenile English sole. These values are based on a habitat's potential to provide attributes that support feeding and refuge needs of these species and groups. Habitats are ranked according to their functional importance as relative rather than absolute values, similar to the concept in the Habitat Suitability Indices (HSI) used with the U.S. Fish and Wildlife Service Habitat Evaluation Procedures (USFWS, 1980).

Representative Species

Fifty three species of resident and non-resident fish were captured in recent remedial studies on the Lower Duwamish River (Lower Duwamish Waterway Group, 2010), including eight species of anadromous salmonids (Kerwin & Nelson, 2000). Chinook, coho, chum, and steelhead are common. Pink salmon, sockeye, sea-run cutthroat trout and bull trout are rare. Juvenile Chinook salmon and juvenile English sole are used as representative fish species to assess the value of habitat to fish. This is because juvenile Chinook salmon and juvenile English sole have feeding modes, behavioral characteristics, and habitat requirements that sufficiently overlap those of similar species found in the LDR so as to consider them appropriate surrogates for fish in LDR.

Bird assemblages rather than individual species are used to assess habitat value to birds along the LDR. The bird assemblages are grouped as a function of their foraging behavior and include both resident and migratory species found in the river. Because birds use similar habitat types as juvenile Chinook salmon and are linked with them through their food webs, habitat value for birds is linked to habitat value for juvenile Chinook salmon.

Scores are assigned to habitat types based on their value to each of these species. These scores are then used to quantify potential injuries to the habitat and to assess the relative value of restoration projects in the manner described below.

LDR Species Specific Habitat and Habitat Values

The LDR is an estuarine waterway. There is considerable information on the utilization of estuarine environments by anadromous salmonids, flatfishes, and birds. However, much of the information is qualitative and while it is useful in identifying what constitutes essential habitat, it is of less value in determining how specific habitat attributes relate to habitat value.

Habitat for Chinook salmon

Estuaries are particularly important to juvenile Chinook salmon, which may have the longest estuarine residence time of juvenile salmonids. Estuarine habitats are used as refuge from predators, foraging, and temporary residence during physiological transition for seawater acclimation (Simenstad et al., 1982). There is considerable information regarding the value of estuaries to juvenile salmon but much of it is qualitative, describing generalized relationships and attributes, rather than providing value measurements. The few quantitative data sets that exist are not in formats amenable to developing habitat-species relationships or adequately defining the relative value of different habitat types. The Trustees reviewed available information and assigned relative values of habitat for juvenile Chinook salmon based on the reasons set forth below.

Chinook salmon in the LDR consist primarily of summer/fall run fish. Spring Chinook are found occasionally in the Green River, which feeds upstream into the LDR, but it is not known if these fish constitute a self-sustaining run. Chinook in the LDR are a mixture of natural spawning and hatchery fish. Natural spawners are classified as ocean type fish because they typically spend little time in fresh water after emerging from eggs laid in the gravel. It is believed juvenile Chinook migrate from the LDR to the ocean from January through August; however, the complete migratory time period for juvenile Duwamish/Green River fall Chinook is not currently known (Kerwin & Nelson, 2000). Juveniles have been found in the Lower Duwamish through September, and may remain in the estuary even longer. Naturally spawning summer/fall Chinook juveniles generally remain in upstream areas for two to three months following emergence from eggs. They then begin their migration to the estuarine areas of the LDR (Williams et al., 1975, Kerwin & Nelson, 2000). Typically, the Green/Duwamish river basin summer/fall Chinook migrate within their first year of life.

Because of their extended estuarine residence, and the diversity of size classes, juvenile Chinook consume a diversity of prey and use a variety of estuarine habitats, shifting to reflect changes in food habits as they grow (Simenstad et al., 1982). Estuaries provide a diverse array of prey organisms, often in large populations, which allows juvenile salmon to sustain relatively high growth rates while occupying a refuge from predators. Chinook occupy three main zones of the LDR. Smaller individual Chinook occur primarily in the freshwater transition zone in the upper portion of the LDR where they feed on larval and adult aquatic insects, terrestrial insects, and epibenthic organisms. Larger subyearling fish move to tidal flats, gravel-cobble shorelines, and other shallow water habitats where they feed on epibenthic crustaceans such as *gammarid* amphipods, *mysids*, and *cumaceans*. Yearling Chinook occupy the open water habitat of the lower estuary, and may prefer habitats within confined embayments, where they feed on small nekton, insects, mysids, larval fish, and nuestonic drift organisms. Sampling in the LDR in 2005 documented the presence of the various life and transitional stages within the LDR as well as the importance of each of these three estuarine zones for juvenile Chinook salmon (Ruggerone et al, 2006).

Growth of juvenile Chinook while in the LDR may help increase their survival rates by narrowing the window of vulnerability to predators once they enter the ocean. Residence time in the estuary is related to foraging success and growth in the ocean, increasing marine survival. This suggests that the distribution and abundance of principal habitat types and the availability of prey for Chinook may be a reflection of salmon populations migrating through the system.

Thus, estuarine habitat is a critical factor in the life history of Chinook salmon, but there are no models available that describe the relationship between habitat types and species utilization. For the purpose of this appendix, relative values are assigned to habitat types using available information on the feeding and refuge functions of different habitats for juvenile Chinook salmon, the functional rarity of habitats in the LDR (e.g., tidal marshes, an important habitat for Chinook, are virtually nonexistent), and best professional judgment. References consulted included not only literature on juvenile salmonid habitat utilization and feeding preferences, but also information on the frequency of occurrence of preferred food organisms (Beauchamp et al., 1983; Northcote et al., 1976; Seliskar et al., 1983; Simenstad et al., 1982; Simenstad, 1982; Simenstad et al., 1985; Simenstad et al., 1991; Simenstad et al., 1993). Values were based on uncontaminated habitats.

Three estuarine habitat types, based on tidal elevation, are used in the LDR injury assessment: intertidal, shallow subtidal and deep subtidal. In addition, other habitats are identified for use in valuing potential restoration projects: marsh (intertidal habitat containing aquatic vascular plants), vegetated buffer (an upland zone adjacent to the aquatic habitat consisting of native floodplain vegetation with trees and shrubs), upland greenbelt (a vegetated zone landward of the vegetated buffer and outside of the shoreline zone, with trees and shrubs) and rip-rap (rock armor placed along shorelines to protect against erosion).

Chinook Habitat Values

Habitat values are unit-less numbers, based on relative, rather than absolute values, similar to the concept used in the Habitat Suitability Index (HIS) (USFWS 1980). LDR habitat types are assigned values for juvenile Chinook salmon using data from sediment composition and water depth surveys.

Habitat values were assigned to estuarine habitats, ranging from one (optimal conditions) to zero (unsuitable conditions). Each habitat value is relative to the value given to marsh with an associated vegetated buffer which is considered to be the best habitat available for the representative species in the LDR. The reason marsh with a vegetated buffer is considered the optimal habitat, and thus given the highest value is based on several factors. Marsh vegetation provides an environment that increases epibenthic and benthic production and available food for Chinook salmon. It provides an important refuge from predators and is a scarce habitat type in the LDR estuary.

Habitat values related to elevation (referenced to mean lower low water (MLLW) are assigned, from highest to lowest, to marsh (+ 6 to + 12 ft), intertidal (-4 to +12 ft), shallow subtidal (-4 to -14 ft), and deep subtidal (<-14 ft) (Table D1). These are based on larger number of species and greater populations of food for Chinook and on primary productivity and habitat use (Northcote et al., 1976; Simenstad et al, 1993). With depth, available light decreases, which results in fewer salmonid prey species and hence, a lower habitat value).

Benthic community structure is affected by a variety of conditions. Different species colonize different substrate types, and mixed substrates (sand, gravel, and cobble) can provide abundant prey species and suitable refuge habitat for juvenile salmonids. In this analysis, habitat classifications are based only on depth and silt, sand, coarse sand, and fine gravel substrates are combined. Shallow, low gradient, unconsolidated sediments are assumed to provide more prey organisms consumed by juvenile salmonids and are thus assigned higher values than structurally complex sediments such as riprap. Deep subtidal habitats (-14 ft and deeper) provide fewer prey organisms and are not preferred habitats of juvenile salmon, and are assigned a minimal value.

Birds

Birds utilizing estuarine areas may be classified into four assemblages based on their foraging behavior (Simenstad, 1983):

(1) Shallow-probing and surface searching shorebirds (e.g. sandpiper, dunlin, plover) that feed on benthic organisms.

(2) Waders, which prey on similar, though somewhat deeper benthic organisms than those that prey on the surface and shallow water (e.g. Greater yellowlegs), or prey on small fishes and crustaceans (e.g. Great blue heron).

(3) Surface and diving water birds, which include birds that find prey in deeper waters (e.g. Western grebe, Common merganser, mallard).

(4) Aerial searchers, which include omnivores and carnivores that find prey in all habitats (e.g. Osprey, belted kingfisher, Glaucous-winged gull).

Different types of estuarine birds use different foraging behaviors and thus, require diverse habitats for feeding and resting. Since certain bird species from these assemblages share common habitats and prey items with juvenile salmon, the value of habitat for salmon is related to its value for birds.

Shallow-probing and surface searching shorebirds, some waders, and some surface and diving birds feed on benthic macroinvertebrates in intertidal habitats. Shorebirds feed in exposed areas, however, they are restricted to the high intertidal area and the part of the lower intertidal area exposed at low tide. Tidal fluctuations affect habitat utilization by waders that feed on benthic organisms and by surface and diving waterbirds. Some waders, surface and diving waterbirds and aerial searchers feed on juvenile salmon and other fish species with similar habitat requirements. For the purposes of the LDR HEA, we assume that the value of a particular habitat type to estuarine birds is the same as the habitat value assigned to salmon (Table D2).

English sole

The model presented in “Habitat Suitability Index Models: Juvenile English Sole” (Toole et al., 1987) is used to quantify the habitat value for English sole. The model applies to juvenile English sole in estuaries and coastal lagoons year-round. It is based on the assumption that any environmental variable that has an impact on the growth, survival, distribution, or abundance of juvenile English sole can be expected to have an impact on the capacity of the habitat to support the species (Figure D1). Habitat Suitability Indices (HSI) are calculated based on Suitability Indices (SI) from either the Food or Water Quality component of the model. An HSI value of one indicates optimal conditions, and a value of zero indicates unsuitable conditions. The HSI is based on the concept of limiting factors. A limiting factor is a component of an organisms’ environment that can affect its growth, reproduction, or distribution. The availability of food, shelter or predation pressure, are examples of factors that could be limiting for an organism. Using this concept, the HIS is set at the value of the lowest limiting factor. Habitat values for English sole in the LDR are expressed in terms of HSI. There are two components in the model: water quality, with habitat variables related to bottom salinity, dissolved oxygen, and bottom water temperature; and food, with habitat variables related to the hydrodynamic regime and dominant sediment type.

Because of the river flow and tidal exchange in the LDR, the Water Quality variables (bottom water temperature, mean salinity, and dissolved oxygen concentration) fall primarily in the high suitability value ranges (1.0). Since HSI defaults to the limiting factor, in this situation the SI calculation defaults to use of the Food Component. The Food Component is related to hydrodynamic regime and dominant sediment type, therefore, the HSI value of the habitat is whichever has the lower SI value, that of the hydrodynamic regime or the substrate. Within the hydrodynamic regime model, there are three SI values: 0.2 for high energy areas of rapid erosion and deposition, 1.0 for areas of intermediate energy with stable substrates, and 0.3 for low energy areas with limited tidal exchange. The LDR fits best into the category of intermediate energy with stable substrates and was assigned a hydrodynamic regime value of 1.0. Therefore, the HSI value for LDR habitats is calculated based on dominant substrate.

Substrate SI values are based on data relating density and stomach fullness of English sole to substrate type. Fine substrate provides the best habitat for feeding sole, but sediment with as much as 20% gravel (>2 mm in diameter) are suitable. Values are low where gravel and rocks are the dominant substrate type; however, even 100% gravel is assumed to provide some food for English sole. Depth and cover do not affect habitat value. Intertidal, subtidal, and deep water habitats are used by sole at different life stages (Lassuy, 1989). Sole that have recently metamorphosed and juveniles in the 50 - 68 mm size range are found in intertidal and shallow subtidal areas where they feed primarily on small epibenthic crustaceans. As they grow, they move into deeper water, where prey items shift to polychaetes, mollusks and other infaunal organisms. The existing literature does not identify cover as an important factor influencing abundance or predation. The variable related to the substrate SI value is dependent upon the percentage of the substrate that is made of particles >2 mm in diameter.

Five substrate composition categories are presented in the HSI model, based on the percentage of substrate >2 mm. SI values for these categories are interpolated from the substrate composition suitability graph (Toole et al., 1987) with values ranging from 1.0 for substrate with less than 20% particles greater than 2 mm in diameter to 0.15 for substrate with less than 50% particles, smaller than two 2 mm in diameter (Table D3). The predominant substrate in the LDR consists of sand/silt, therefore a value of 1.0 is used to value habitats for English sole living in the LDR.

Combined Habitat Values

Seven habitat types were identified for use in this analysis for injury determination and for restoration planning. For restoration, habitats that provide the most benefit to the injured resource may not necessarily be those habitats that are injured, so habitats are included that may not have been injured in the LDR, but may provide considerable restoration benefit.

All habitats provide some value for all three representative species. In order to reduce some steps in the HEA, a single weighted value combining all three species for each habitat type was used in the calculation, rather than calculating the value for each species individually and adding the individual weighted values. There is no difference mathematically. The combined value does not weight the species equally. Chinook salmon in Puget Sound are a high profile species, listed as threatened under the Endangered Species Act. There is considerable regional interest in their restoration, and so they were given a higher weighting in the calculation of a combined habitat value. Species weighting in the final combined value was: 50% juvenile Chinook salmon, 25% juvenile English sole, and 25% birds. Individual and combined values for the habitat types are shown in Table D4.

Value adjustments associated with environmental conditions

Habitat values identified for the HEA are used both in quantifying loss of functional value associated with injuries and in assessing benefits associated with restoration project development. The LDR is in an urban/industrial/commercial setting, with extensive shoreline development. There are only remnant marshes and few upland areas that could be classified as functioning vegetated buffer habitat (TerraLogic GIS, Inc. & Landau Associates, 2004). We created value adjustment categories of "fully functional" and "baseline adjusted" to apply to marsh, intertidal, and shallow subtidal habitats. The "fully functional" category was based primarily on the premise that the presence of adjacent desirable habitat results in an ecological complex that enhances overall production. Habitats considered "baseline adjusted," have no adjacent habitat to enhance their value. As an example, the presence of insect and organic matter is increased when it is placed adjacent to a vegetated buffer. Also, created marsh habitats provide benefits that increase the value of adjacent habitats. Thus, the creation of a habitat that increases invertebrate recruitment and subsequent juvenile salmonid use of a intertidal area bordered by a marsh or vegetated buffer zone make it more valuable (fully functional) than one that does not have the benefits from these adjacent habitats (baseline adjusted). In restoration planning, adjustments to habitat values are beneficial in identifying habitat mixes to provide maximum benefits (e.g. an intertidal area created in association with a marsh or vegetated buffer area would have more value than one that is created as an isolated habitat).

All of the intertidal and shallow subtidal habitats in the LDR are considered “baseline adjusted,” with little to no adjacent habitat to enhance their value. This provides for the values of 0.75 for intertidal and 0.55 for shallow subtidal. For purposes of restoration planning, an enhancement of 0.15 is added to intertidal and shallow subtidal habitats constructed in association with a vegetated buffer or a fully functioning marsh. Therefore, fully functional values for intertidal and shallow subtidal habitats in LDR are 0.9 and 0.7, respectively (Table D5).

The premise for a fully functional classification in the LDR is that habitat complexes (e.g. a mix of marsh, mudflat and riparian) are necessary for proper ecosystem functioning. Marsh habitat alone and in optimal condition was assigned a value of 1.0. A marsh associated with a vegetated buffer likely has more ecological value than one that does not. Therefore, for a marsh to be considered fully functional, it must have an adjacent vegetated buffer. Marshes without a vegetated buffer are considered baseline adjusted, and do not receive the 0.15 enhancement and are consequently assigned a maximum value of 0.85 rather than 1.0.

In summary, for restoration planning in the LDR, fully functional value is given to the following:

- a marsh must be associated with an adjacent vegetated buffer habitat;
- an intertidal habitat must be associated with an adjacent vegetated buffer or an adjacent fully functioning marsh;
- a shallow subtidal habitat must be associated with an adjacent fully functioning intertidal habitat.

LDR restoration projects involving the creation of each of these habitats will be considered fully functional and valued as such (Table D5). All other types of restoration projects involving less complex habitats will be considered baseline with a lower value relative to the fully functional value.

Development in the LDR has resulted in facilities and activities that physically degrade habitat quality. The presence of large over-water structures such as piers, aprons and buildings creates conditions that limit the use of affected habitats by species considered in this analysis. This situation called for another category to represent these conditions and a “degraded” classification of reduced value (0.1) was created to decrease the value of habitats that are severely impacted by physical obstructions.

Potential impacts associated with severe physical habitat degradation warrant application of a lower habitat value in certain situations. Examples of physical habitat degradation that result in lower values are reduced light and disruption of migration and feeding behavior. There are gradations of impact from overwater structures related to their height over the water, piling type and density, orientation, type of structure, water depth and habitat type beneath them. However, there was no attempt to identify sub-classifications based on these gradations to cover the range of impacts. The degraded classification is applied narrowly and only to situations causing severe physical impacts.

Overwater structures include permanent and semi-permanent structures such as piers, aprons, buildings, boathouses, and houseboats. Because a juvenile salmonids’ visual ability to adapt from bright to subdued-light conditions proceeds slowly (Ali, 1959), they are reluctant to pass beneath structures where there is a high contrast between bright and low light levels. Smaller juvenile salmonids are shoreline and shallow water oriented. Over-water structures that produce sharp light contrasts may interfere with their feeding and migratory movements. The subdued light conditions found along the periphery of piers are often preferred over bright sunlight; however, lower light levels may also interfere with feeding. Moreover, structures covering intertidal and shallow subtidal habitat limit the available light to bottom substrates in the productive near-shore photic zone and have more impact on epibenthic production than those in deeper water. As a result, with all other factors being equal, only habitats under structures that extend directly from and are contiguous with the shoreline are assigned the degraded habitat value of 0.1.

Piers and docks that have the major pier structure away from the shore, and have a narrow overpass perpendicular to the shore (e.g. T-docks) usually have the major over-water portion in deeper water, and have less shoreline and near shore shading. They have less of an impact than structures extending from the shoreline, and are consequently not placed in the degraded category. Habitat beneath them is included in the baseline adjusted value, dependent on habitat type. Marinas with docks and boat houses are generally in deeper water, and the shoreline connections are usually narrow. They have an adverse impact, but not enough to be included in the degraded category. Habitat beneath them is assigned the baseline adjusted value.

The foregoing guidelines are not intended to represent acceptance or rejection of particular types of structures or activities. All of the in-water/over-water structures mentioned above can have an adverse impact on aquatic habitat and there are exceptions to each situation that could mitigate or exacerbate the expected impact. However, the decision to include or not include particular over-water structures is made in a general sense based on an evaluation of biological information on potential effects to representative species selected for the LDR. It is to be used for the sole purpose of classifying habitat values for the LDR HEA in as simple and as equitable of a manner as possible. Value adjustments associated with environmental conditions are shown in Table D5.

TIME TO SUSTAINED VALUE

Introduction

The assumption that environmental injury or habitat loss can be compensated by ecological restoration is based on the premise that restored habitat should provide the same values as the natural ecosystem (Pacific Estuarine Research Laboratory 1990). This restoration has been termed ecological equivalence, referring to the capacity of a restored, created, or enhanced habitat to reproduce the ecological structures and functions equivalent to an injured or lost habitat (Kentula et al. 1992). Determining the value of a restoration project depends not only on the level of function expected from the habitat, but also the time it takes for the habitat to reach and sustain this level of function. A created, restored, or enhanced habitat goes through natural successional patterns, gradually increasing in value from its initial condition over a period of time until it reaches some assumed endpoint, with a sustained functional value. There are two components to this function, the shape of the curve and the time to maturation.

Shape of the Curve

The shape of the curve means how the recovery appears when graphed and allows for a picture of the rate of increase in a habitat's recovery. The shape of the recovery curve will likely vary with habitat types. It may follow an "S" shaped curve, increasing gradually at first, rapidly approaching a stable maximum, then falling off as the final level of function is achieved; or it may follow some other pattern. A study on the use of different curves to describe the increase in wetland functions as created wetlands develop found that, for the purposes of evaluating restoration, the shape of the curve was not important and resulted in minimal percentage differences in the amount of restoration required (King et al., 1993). Growth rate or population dynamics data from existing restoration projects in the Pacific Northwest are not consistent enough to define specific recovery curves, and for the sake of simplicity, it is assumed that an ecological function will increase along a linear path until sustained value is achieved.

The number of years after construction when the restoration project is expected to achieve sustained value varies with habitat type (Strange et al. 1999). In restored salt marshes on the East coast, vegetative cover was similar to that of a natural marsh within 5 years; however, development of other physical and chemical properties necessary to support fish and shellfish production took 25-30 years. Estimates of time to sustained value for use in this assessment are based on observations made at similar restoration projects in Puget Sound, the scientific literature, unpublished research in the "gray" literature, and best professional judgment of the natural resource trustees. In determining time to sustained value for the various habitat types, the focus is on biological processes that generate and maintain food and habitat for the representative biota, such as benthic and epibenthic invertebrates, number of species present, abundance of individuals, and preferred prey species. Habitats considered are those that may be included in restoration projects: intertidal habitat, shallow subtidal habitat, marsh, vegetated buffer, upland greenbelt and degraded habitats.

Assumptions

The scientific literature suggests that replicating the services provided by a natural habitat with a created one is extremely difficult. Even restoration sites that are essentially identical in physical features to natural habitats may not provide the same ecological functions (Kusler and Kentula, 1990). However, for the purpose of this analysis, a 1:1 productivity ratio is assumed for the level of ecological services provided by created habitats relative to natural habitats. This implies that restored habitats will be as productive as natural habitats in terms of all associated services. There is uncertainty associated with the outcome of restoration projects. Certain types of habitats carry more risk of failure than others. Restoration project implementation in the Pacific Northwest commonly incorporates monitoring, success criteria, and mid-course corrective actions to increase the probability of success (Commencement Bay Natural Resource Trustees, 2000; Elliott Bay/Duwamish Restoration Program, 2000). Actions that can assist natural processes to achieve successful restoration projects include: developing and amending soil, transplanting plants, controlling weeds, including invasive and non-native species and other eco-engineering methods. For the purposes of this analysis, risk of failure is not incorporated. Habitats are assumed to achieve the expected function within the time identified.

Intertidal and shallow subtidal habitats

Achieving the expected sequence of invertebrate recruitment and subsequent use by juvenile salmon, juvenile English sole, and birds is related to the initial condition of the habitat. The farther initial conditions are from a mature steady state, the longer a habitat will take to approach a self-sustaining level (Mitsch and Wilson, 1996). Monitoring data from restoration projects in the Puget Sound area indicate that habitat functions associated with intertidal and subtidal sand/silt and gravel/cobble substrates develop rapidly. Many of these projects used excavation, regrading or filling to create intertidal or shallow subtidal habitats. Some sites showed rapid development of a diverse and abundant assemblage of benthic and epibenthic organisms, achieving within 50-100% of their long term trends within 1 - 2 years after construction, e.g. Milwaukee Habitat Area (Parametrix, 1998). The data indicate that newly placed, newly exposed, and sometimes, newly wetted materials require time to develop the natural processes necessary to support benthic and epibenthic production.

The rate of development of a stable community is related to substrate, slope, elevation, exposure, and salinity. Although the numbers of epibenthic invertebrates were often highly variable from year to year, by years three to four, benthic and epibenthic production at many restoration sites in the Puget Sound area approached long- term production levels and population structure and taxa richness comparable to reference areas. For a newly created LDR habitat, four years is assumed to be an appropriate time to reach sustained value for baseline adjusted intertidal and shallow subtidal habitats (0.75 and 0.55, respectively). Time to sustained value for fully functional intertidal and shallow subtidal habitats (0.9 and 0.7, respectively) is related to the time to sustained value of the adjacent habitat. This is generally eight years for vegetated buffer habitat.[1]

Marsh habitats

Marsh habitat is assumed to include both dendritic and fringing marshes. Success in creating estuarine habitats that support aquatic vascular plants has been mixed in the Puget Sound area. In other regions where salt marshes have been created, it is still unclear how well they actually replicate the ecological functions of natural marshes. The report Strange et al. (1999) investigated maturity rates and recovery of particular ecological structures and processes in salt marsh restoration and found that conclusions regarding success were dependent upon the metric used to measure it. If vegetative structure alone is assessed, a restoration project may be considered to have achieved equivalence to a natural marsh within five years. When the metric is community and ecosystem function, recovery was slower and was generally in excess of 15 years. Development of the physical and chemical properties of soils needed to support infaunal development and the production of higher order consumers, can take decades to become fully equivalent to a natural salt marsh. There is some thought in the ecological community that creation of a marsh that duplicates a natural marsh is not possible (Kusler and Kentula, 1990). This is because of the complexity and variation in natural marshes, and the subtle relationships

[1] See Part 1, Value adjustments associated with environmental conditions, for a description of “baseline adjusted” and “fully functional” habitats.

among hydrology, soils, vegetation, nutrients, and animal life. In this assessment, the marsh habitat is not assumed to duplicate a natural estuarine marsh. However, it is considered a habitat that has the structural characteristics to generate and maintain food and habitat for the representative biota within 15 years. Therefore, after this time, it is assumed to be a fully functional marsh with a value of 1.0 or a baseline adjusted marsh with a value of 0.85.

In the LDR, marsh habitat may be created in sand/silt substrates in the + 6 to + 12 ft elevation range. Depending on location, substrate, and salinity, low marsh (+ 6 to + 10 ft) and/or high marsh (+ 10 to + 12 ft) could be expected. This elevation range is included in intertidal habitat (- 4 to + 12 ft). The curve for fully functional marsh habitat is shaped as a stepped function. A newly created habitat intended to reach a marsh endpoint goes through natural successional stages, first becoming an intertidal mudflat, then gradually transforming into a marsh over a period of years as vegetation develops. The value increases in a straight line from its initial state to the value for a fully functional intertidal habitat (having a value of 0.9) in years zero through eight, then increases more gradually to the marsh value of 1.0 between years eight and 15. A baseline adjusted marsh is valued the same as baseline adjusted intertidal habitat with a value of 0.75 through year four, when it then increases gradually to its sustained marsh value of 0.85 between years five and 15.

Vegetated buffer and upland greenbelt

There is considerable information on the value and size requirements of vegetated buffers but much less on rates of development. Planting riparian buffer is part of several restoration projects in the Puget Sound area, e.g. Middle Waterway Shore Restoration Project in Commencement Bay Sitcum Waterway Remediation Project), but there is, as yet, insufficient data upon which to draw conclusions about how long it takes them to become fully functional. Related information is available to infer how fast a vegetated buffer will develop, and whether development follows a straight line or stepped trajectory. Monitoring guidelines for restoration projects include success criteria. Success criteria are defined generally as those measures used to evaluate whether the requirements for functional replacement have been met - if the criteria are met, the project is successful, and functional replacement is achieved.

The supposition used in this assessment is that if these monitoring guidelines are providing a measure of functional replacement, they should provide some determinant of the time frame within which success, in terms of functional habitat replacement, may be expected. This is based on guidance on the selection of functional performance objectives indicating that they should be: 1) known or likely benchmarks of success and 2) achievable on the site within the designated monitoring period (Ossinger, 1999)

In the U.S. Army Corps of Engineers' "Examples of Performance Standards for Wetland Creation and Restoration in Section 404 Permits and an Approach to Developing Performance Standards" (USACOE 1999) most monitoring programs for vegetated buffers (riparian, shrub-scrub, and woody vegetation) extend for five years. Specific project information is not provided for the examples in the document, but expectations as a measure of success for shrub-scrub and forested buffers from temperate zone areas are:

- California - 75% cover by native riparian species by year five
- Maryland - 85% of site vegetated by planted species and/or naturally regenerated vegetation by year five
- Maryland - 85% herbaceous cover, 75% areal cover by planted woody species by year two
- Alaska - vegetative cover equal to 75% of test plot cover in five years
- Washington - 60% cover by native shrub species by year five

An example of Seattle District ACOE 1994 monitoring guidelines for freshwater wetlands required 80% cover of native shrub/scrub species after five years and 40% canopy cover of native species forest vegetation after 20 years (USACOE, 1999). Ossinger et al. (1999), reported on findings of the "Success Standards Work Group," a group of wetland professionals from state, federal and private sectors convened to provide practical guidelines for mitigation planning. This report suggests benchmark values for herbaceous vegetation as 80% cover by year three, and 90% cover by year five. For woody cover (wetland buffer/forested zone) they suggest 50% cover by year five.

Developing guidelines for King County, Mockler (1998) suggested that buffers, defined as dense vegetation that will protect wetland from human encroachment and provide wildlife habitat, should have 60% emergent cover by year one, 80% by year three, and 90% by year five. Shrub or sapling tree cover should be >60% by year three.

A success criterion for establishing riparian vegetation in a recent monitoring program proposal specific to the area (Elliott Bay/Duwamish Restoration Program, 2000; Commencement Bay Natural Resource Trustees, 2000) specifies native trees and shrubs at the end of year five, the shrub layer is expected to be >50% and the tree layer >40 percent. Both native trees and shrubs should cover at least 90% of the upland vegetated area at the end of 10 years. Monitoring data from the Puget Sound area are sparse, but there are some that contribute to an understanding of the rate of development of buffer areas and functions provided. The Gog-Li-Hi-Te wetland system, created in 1986, included a mix of upland and wetland habitats. The 5-year monitoring report (Thom et al., 1991) shows that upland trees increased from 725 m^2 to approximately 1500 m^2. The data also show that the transitional zone between the intertidal and upland habitats was rapidly colonized by willow and alder, which increased from 0.4% of the area (160 m^2) in 1986 to approximately 4.3% (1,650 m^2) in 1990. The riparian vegetation increases are from natural recovery, as planting of these species was not included in the project design.

Duwamish River Coastal America sites included planted upland riparian vegetation, and monitored three years post-construction. Though there was no data provided on the post-construction monitoring (Cordell et al. 1999), insect production and juvenile salmon diets were reported. At the T-105 and Turning Basin sites, there was a shift in species composition of insect populations captured in fallout traps from 1996 to 1997. Insects with aquatic immature stages (shore flies, midges, biting midges) shifted to terrestrial insects and the authors conclude that this was probably due to the large increase in riparian and emergent vegetation at these sites between 1996 and 1997. This change also occurred in the juvenile Chinook salmon diets. The makeup of insects consumed was different between 1996 and 1997. The findings suggested that within three years after construction, the riparian area developed to the point that insects dependent on riparian plants were beginning to be produced and were utilized as a food source by juvenile salmonids. In 1999, there was a shift back to the insects dominant in 1996, leading the authors to speculate that the vegetation assemblages that support the insects might not yet be stable (Cordell et al, 2001). However, the study reported that although survival and expansion of riparian areas were not monitored, they appeared to have become established successfully.

Monitoring results for riparian vegetation coverage from LDR restoration projects constructed via the Elliott Bay Panel do not provide a good measure of natural succession over time due to complications associated with routine maintenance to remove debris, invasive and non-native species and replanting. The year five goals of >50% tree cover and >40% shrub cover were met at Herring's House, Hamm Creek, and North Winds Weir (USFWS, 2008).

The current definition for a vegetated buffer is native floodplain vegetation, with tree, shrub, and herbaceous layers. Buffers provide a range of functions, from minimizing human disturbance to filtering sediments from surrounding areas and moderating temperatures. In this assessment, buffers are important not only for the typical benefits they provide, but also for the value they add to adjacent habitats. In that regard, the most important benefits are providing organic matter in the form of leaves and litter, providing insects from riparian vegetation, and providing wildlife habitat. Mitigation monitoring guidelines suggest that significant growth and plant cover in vegetated buffer areas can be achieved in five years. Data from the Gog-Li-Hi-Te wetland site in Commencement Bay, WA, show significant increases in riparian vegetative growth within five years. Data from the Coastal America Sites on the Duwamish River show development of riparian vegetation and associated insect production within five years. Mitigation monitoring guidelines specific to Washington State indicate that 90% herbaceous cover may be expected by year five. Woody vegetation/shrub cover ranges from 50% to 80% by year five, to 90% by year ten. By assuming that full plant cover equals sustained ecological value, and by averaging projections of time to full plant cover for woody shrubs, then the time to sustained value for vegetated buffer habitats is about eight years. This eight year time frame is based on monitoring guidelines, which determine the time required for "success" in terms of functional replacement; and inferences from two studies (Gog-Li-Hi-Te wetland and Duwamish Coastal America sites). Upland greenbelts may consist of different species mixes but should be predominately native trees, shrubs, grasses and forbs (flowering plants that are not grasses). The time to sustained value for upland greenbelts is also assumed to be eight years.

Degraded habitat classification

As noted above, intertidal and shallow subtidal areas adversely affected by overwater structures are classified as degraded, so removal of structures and conditions adversely affecting these habitats could restore their habitat value, making them candidates for restoration projects.

Time to sustained value for intertidal and shallow subtidal habitats is four years, based on data from restoration projects in Puget Sound. The projects reviewed were habitat creation projects involving excavating, re-grading, or filling to create intertidal or shallow subtidal habitats. The expected sequence of invertebrate recruitment followed by juvenile salmonid use is related to initial conditions at the site. The degraded classification applies only to intertidal or shallow subtidal habitats. Prior to the introduction of the physical impairment, these areas likely provided the functions associated with their habitat type. Overwater structures limit production by shading the habitat; removal of this impact should allow the habitat to return to near natural production quickly. A literature review found no data addressing the effects of removing overwater structures. However, based on inferences drawn from studies on the impacts of shading, a time to sustained value following removal of overwater structures was assigned.

The low light environments under overwater structures affect juvenile salmonids by disrupting their behavioral and feeding patterns. Their reluctance to pass beneath piers and aprons and alteration of migratory behavior when encountering piers has been observed (Weitkamp, 1982, Pentec, 1997). The ability of juvenile salmonids to see and capture their prey is also reduced in low light situations. Removal of the overwater structure will eliminate this impact.

Evaluation of epibenthic zooplankton production at pier apron sites in Commencement Bay (Parametrix, 1991) showed that in areas having similar substrates, salmonid prey epibenthos at shaded apron stations was about 83% of the abundance at non-apron stations. One distinct difference was in the occurrence of the harpacticoid copepods *Harpacticus* and *Tisbe*, which are very important prey items for small juvenile salmon entering the estuary. *Tisbe* are found where there is abundant detrital vegetation, and there were no significant differences in abundance of *Tisbe* between apron and non-apron stations. However, in this study, *Harpacticus* is primarily epiphytic on growing algae and eelgrass, and was rarely found under aprons. Investigations on the effect of shading on eelgrass may also be helpful in determining the recovery time associated with removal of overwater structures. Pentilla and Doty (1990) reported that fixed dock structures reduced eelgrass density to zero, even when light attenuation did not approach full darkness. A floating dock site, which moved with the tide and did not cast a continuous shadow over the bottom, did not have negative impacts on eelgrass density. Studies associated with impacts from the Anacortes Ferry terminal showed eelgrass presence related primarily to the height of the docks, which affected the level of shading (Parametrix and Battelle, 1996). Fresh et al. (1995) evaluated dock structures and found measurable declines in eelgrass density under and adjacent to docks in Puget Sound, except for ones that moved up and down and side to side with tidal fluctuations, eliminating constant shading. The investigations all considered sites with similar substrates in areas with homogenous eelgrass coverage, eliminating variables other than shading. While we do not expect there to be eelgrass in the LDR, it is logical to assume that shading would similarly reduce primary production of benthic diatoms and other algae.

Shading appears to be the primary factor impacting primary and secondary production under overwater structures; therefore, the effect of shading on juvenile salmonid behavior will be eliminated immediately upon removal of the structure. The limited data that exist indicate that epibenthic production occurs under piers but at a level lower than unshaded sites. A 1991 study (Parametrix, 1991) linked the absence of particular epibenthic zooplankers under pier aprons to the absence of eelgrass and algae under the aprons, a condition related to the lack of light. Studies on the effects of shading on eelgrass indicate that within a particular substrate type, eelgrass distribution is limited only by the level of shading Pentilla and Doty (1990), Parametrix and Battelle, (1996), Fresh et al. (1995). With the foregoing information, it is reasonable to expect that once light becomes available to natural intertidal and shallow subtidal habitats currently shaded by overwater structures, algal and vegetative production necessary to support the functions normally provided by these habitats can be achieved quickly, possibly in as little as one year. Time to sustained value for various habitat types is provided in Table D6.

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Table D 1. Habitat classifications used in the HEA.

Habitat Type	**Elevation ft. (MLLW)**
Marsh (aquatic vascular vegetation)	+6 to +12
Intertidal	-4 to +12
Shallow Subtidal	-14 to -4
Deep Subtidal	< -14

Table D 2. Relative habitat values for juvenile Chinook salmon (and bird assemblages).

Habitat Type	**Relative Habitat Value for Juvenile Chinook Salmon (and Bird Assemblages)**
Estuarine habitats	
Marsh	1.0
Intertidal	0.67
Shallow Subtidal	0.40
Deep Subtidal	0.05
Rip-rap	0.10
Buffer Habitats	
Vegetated Buffer	0.50
Upland Greenbelt	0.20

Table D 3. Relative habitat values for English sole based on substrate composition.

Substrate composition: percentage by weight of substrate particle size greater than 2mm in diameter	Relative habitat value
<20	1.0
21 - 30	0.86
31 - 40	0.60
41 - 50	0.33
> 50	0.15

Table D 4. Relative habitat values for juvenile Chinook salmon, birds, and juvenile English sole; and species' combined habitat values.

Habitat Type	Relative Value for Salmon	Relative Value for Birds	Relative Value for English sole	Relative Combined Value for all Species
Intertidal	0.67	0.67	1.00	0.75
Shallow Subtidal	0.40	0.40	1.00	0.55
Deep Subtidal	0.05	0.05	1.00	0.29
Marsh	1.00	1.00	1.00	1.00
Rip-rap	0.10	0.10	0.15	0.11
Vegetated buffer	0.50	0.50	0.00	0.38
Upland Greenbelt	0.20	0.20	0.00	0.15

Table D 5. LDR habitat classifications and values applied in the HEA.

Habitat	**Value**		
	Fully Functioning	**Baseline Adjusted**	**Degraded**
Estuarine Marsh	1.0	0.85	NA
Intertidal	0.9	0.75	0.1
Shallow Subtidal	0.7	0.55	0.1
Deep Subtidal	0.3	0.3	0.1
Rip-rap	NA	NA	0.1

Table D 6. Restoration project habitat values and time to sustained value for fully functional (FF) and baseline adjusted (BA) habitats.

Habitat	final value and percent of final value (%) at end of year			
	1	4	8	15
Habitats formed through excavation, regrading, or material placement.				
Marsh	not applicable	0.825 (82.5%) FF 0.75 (88.2%) BA	0.936 (93.6%) FF 0.786 (92.4%)BA	1.0 (100%) FF 0.85 (100%) BA
Intertidal	not applicable	0.825 (91.6%) FF 0.75 (100%) BA	0.9 (100%) FF no change	no change
Shallow Subtidal	not applicable	0.63 (90.0%) FF 0.55 (100%) BA	0.7 (100%) FF no change	no change
Existing FF or BA habitats restored by over water structure removal				
Intertidal	0.9 (100%) FF 0.75 (100%) BA	no change	no change	no change
Shallow Subtidal	0.7 (100%) FF 0.55 (100%) BA	no change	no change	no change
Existing Fully Functional (FF) or Baseline Adjusted (BA) habitats restored by removal or log rafts or wood waste				
Intertidal	not applicable	0.825 (91.6%) FF 0.75 (100%) BA	0.9 (100%) FF no change	no change
Shallow Subtidal	not applicable	0.63 (90.0%) FF 0.55 (100%) BA	0.7 (100%) FF no change	no change

Habitat	**final value and percent of final value (%) at end of year**			
	1	4	8	15
Other				
Vegetated Buffer	not applicable	0.2 (50%)	0.4 (100%)	no change
Upland Greenbelt	not applicable	0.075 (50%)	0.15 (100%)	no change

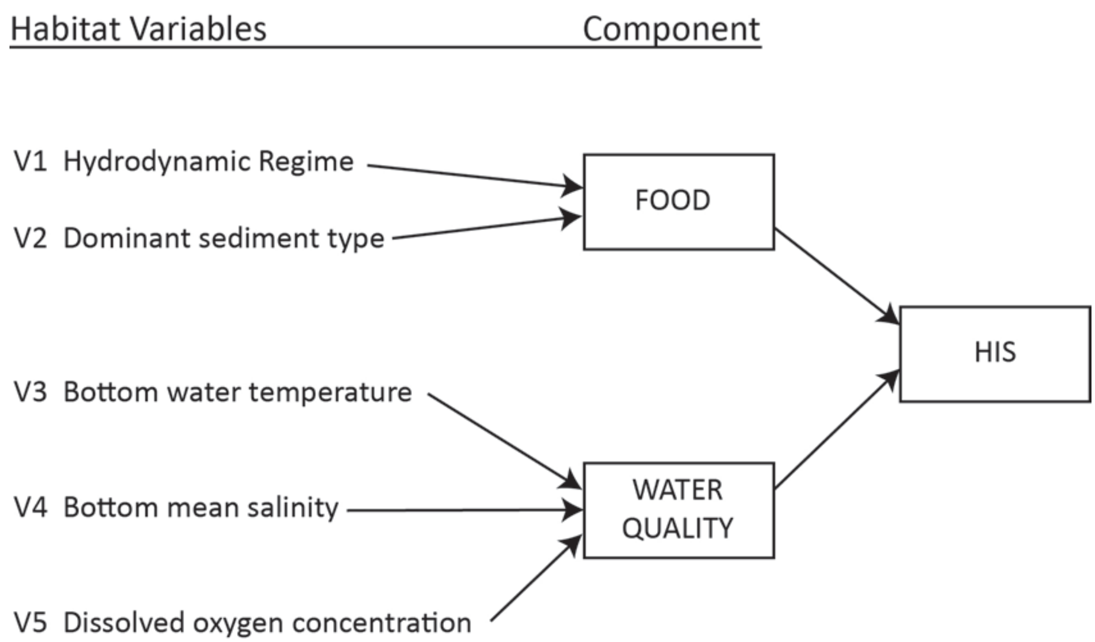

Figure D 1. The relationship of habitat variables, life requisite components, and the habitat suitability index (HIS) for juvenile English sole in estuaries and coastal lagoons. (Toole, C.L., Barnhart, R.A., and C.P. Onuf. 1987. Habitat Suitability Index Models: Juvenile English Sole. U.S. Dept. of the Interior, Fish and Wildlife Service Biological Report 82(10.133) February 1987.)

APPENDIX E: RECOMMENDATIONS FOR SELECTING & VALUING RESTORATION PROJECTS ON THE LOWER DUWAMISH RIVER: A COMPILATION OF RESULTS FROM THE FEBRUARY 19-20, 2004 EXPERT PANEL MEETING CONVENED BY THE Elliott Bay Trustee Council

(Adapted from a document prepared by the Elliott Bay Trustee Council March, 26, 2010)

Introduction

The Lower Duwamish River is an industrialized watercourse that has been polluted by a wide variety of contaminants over many years. The Elliott Bay Trustee Council[1] (Trustees) has begun to evaluate the extent of injuries resulting from past and ongoing contaminant releases to the waterway's natural resources. In order to offset injuries in the Lower Duwamish River (LDR), restoration actions must be designed and constructed to provide compensatory benefits to those injured natural resources. The Trustees developed methods to value certain attributes of habitat actions, such as the type of habitat to be created and its square footage. The Trustees sought outside, expert guidance to develop relative valuation factors for other attributes of restoration, including relative size, shape, and location within the river. On 19-20 February 2004 the Trustees convened a panel of experts to help determine how ecological attributes associated with various types of restoration may be valued.[2] Panel participants included Mr. Kurt Fresh of the National Marine Fisheries Service, Mr. Charles Simenstad of the University of Washington, and Dr. Ronald Thom of Battelle Pacific Northwest Marine Sciences, with Dr. Pete Peterson of the University of North Carolina serving as chair.

Trustees charged the panel with identifying and making recommendations on how to value key ecological attributes associated with potential restoration projects along the LDR. In particular, the panel was asked to focus on ecological attributes that: (a) were not captured by the Trustees' current methodology and that (b) might increase the ecological value of a project—i.e., characteristics that might result in a particular project deserving more credit than would normally have been given using current methodology. Guidelines based on these characteristics could be used to compare and evaluate potential LDR restoration projects.

The panel emphasized that its opinions and proposed quantification of the identified attributes were site-specific to the LDR. For example, the panelists based part of their approach on the potential value of restoration projects to the species groups evaluated in the LDR injury evaluation: juvenile Chinook salmon, English sole, and bird assemblages. A similar exercise for other sites might focus on the potential benefit to different species and result in different values.

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[1] National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service representing the Department of the Interior, Muckleshoot Indian Tribe, Suquamish Tribe, and State of Washington.

[2] This meeting was preceded by a pre-meeting and several less formal discussions, which laid the groundwork for the February meeting.

The overall guiding principle for the exercise was to provide more credit for larger, more integrated projects that sustainably restore or enhance ecosystem processes. This approach reflects two values. First, larger, more integrated projects are likely to support a more diverse ecosystem, one that is more similar to the historic ecosystem. Second, larger and more integrated projects are more likely to be sustainable and are more likely to endure for longer periods of time without active maintenance. The panel members identified a number of project attributes and restoration project credit guidelines, to encourage projects that are consistent with this approach. The remainder of this memorandum describes the general project attributes identified by the panel and the specific guidelines it developed for the LDR.

Key project attributes identified by the panel include the following:

- *Size.* The panel considered the question of whether one large project or several smaller projects totaling the same area would be preferable.[3] The panel generally felt that a single larger project would be superior, both because (up to a point) larger projects allow more diversity to develop and allow easier access by animals. Furthermore, a single, larger project would probably be more resistant to stressors and be more resilient following disturbances. The panel also pointed out that data is sparse in terms of the quantitative relationships between size and various functional attributes.
- *Shape.* A project of a given size could have its longest dimension oriented parallel to the waterway, perpendicular to the waterway, or anywhere in between. In general, the panel felt that both the parallel and perpendicular dimensions[4] are important to sustainability.
- *Habitat type.* The panel recognized the desirability of restoring the specific types of habitats that contribute to marine and aquatic resource services lost as a consequence of contamination in the waterway. Thus, for example, marsh and mudflat areas were generally provided with more credit per acre of project size than were upland vegetated areas. In addition, the panel recognized that different habitats provide services to different groups of organisms. If specific organisms or groups of organisms are identified as key, the habitat types of special importance to those groups might be granted more restoration credits than other habitat types. Similarly, if some habitat types are locally limiting (i.e., acting as a bottleneck) to the population of a key species group, these habitats could also be especially valuable.
- *Diversity provided by project*. The panel considered projects that sustainably[5] provide increased diversity to be preferable –in terms of number of ecological niches and numbers of supported species. Thus, the panel developed some guidelines to encourage the creation of projects that specifically create multiple kinds of habitat, as these are more likely to support a wider array of species.

[3] This question is analogous to the SLOSS (Single Large or Several Small) debate amongst conservation biologists.

[4] In this document, the length of a habitat refers the dimension that is parallel to the adjacent watercourse, while the width of a habitat refers to the dimension that is perpendicular to the watercourse.

[5] Although diversity is desirable, the panel pointed out the risk of trying fit too many habitat types, or too much diversity, into a project of a given size, as this may reduce sustainability of the project as a whole.

- *Siting - historic locations and the probability of success.* Restoration siting is commonly directed by history—i.e., a project tries to return an area to its baseline condition, based on the assumption that if the habitat was present at a particular location historically, it could presumably be sustained there again. However, historic locations are not as relevant for the LDR because of the extensive physical changes to the watershed and waterway since historic times (the hydrology, channel form, and wetland habitats of the LDR have been drastically altered due to industrial development and urbanization). The panel reviewed current ecosystem processes in the LDR to develop specific guidelines for appropriately choosing sites for projects to maximize their chances for success.
- *Siting - organism access and use*. Depending on the key species of interest, the specific location chosen for a project may affect the ability of key species groups to use it. Location, in this context, has three spatial dimensions: linear position along the waterway's length, distance from the waterway's edge, and elevation (e.g., height relative to mean lower low water). All three spatial dimensions are relevant. For instance, different locations along the waterway's length are subject to different salinity regimes, which may be more or less appropriate for different species groups. Variations in distance from the shoreline will also affect accessibility of the habitat to organisms, as will elevation. One specific example is provided by juvenile Chinook salmon. During its seaward migration, this species may spend a considerable period of time in the estuary and requires reasonably-spaced, sheltered areas for foraging, refuge from predation, and physiological transition for seawater acclimation. Not only should these areas be spaced appropriately along the river to account for this species' needs, they also need to be situated in shallow, protected areas, preferably in side channels. The panel considered the lifecycle requirements of key species groups and developed guidelines to provide extra credit for projects that reflect these benefits.
- *Siting - societal/cultural factors*. The panel recognized that a variety of societal and cultural factors might cause certain projects to be more or less desirable, depending on their location. Some projects, especially those near residential areas, might provide increased recreational opportunities or may enhance the well-being of local residents. On the other hand, access of these areas to people might increase the level of disturbance and discourage use by wildlife, or might ultimately degrade the restored habitat by overuse. Native American cultural considerations are also key: respecting any culturally important tribal sites is a fundamental requirement of any restoration project.
- *Siting - potential for contamination*. The panel was concerned about the potential for residual on-site or off-site contamination to prevent the successful re-establishment of a functioning ecosystem at project locations.
- *Siting - adjacency*. Projects that create a given habitat type will generally provide more ecological services if they are located immediately adjacent to existing habitat of the same or a different type. For instance, a marsh project that is located next to existing marsh is likely to be more sustainable, as the adjacent aquatic vegetation would serve as a seed source for the new marsh area. In addition, the new marsh would likely resist stressors better than it would if unconnected. Similarly, a marsh project fronted by a mudflat would be better protected from boat wakes, while one backed by a vegetated buffer could better support birds, which could use the upland buffer for roosting and/or nesting while feeding in the nearby marsh. In general, connectivity among habitats enhances the flow of materials and energy throughout the ecosystem, and provides corridors for animals to travel from location to location.

- *Landscape connectivity*. The remaining green space near the LDR lies within an urbanized/industrialized corridor and is fragmented. Furthermore, a significant amount of formerly-present freshwater inflow to the waterway has been diverted, reducing the availability of brackish areas, which are valued by juvenile Chinook salmon. Reconnecting existing green space drainage to the waterway, and increasing the total area of green space that could provide clean freshwater drainage (not storm water) to the waterway are important restoration goals. Restoring these connections would also enhance the transportation of organic materials and insects to the main channel.

After identifying the above set of attributes, the panel began to consider how best to value the attributes in the context of potential restoration projects. First, they determined that some attributes could not be quantified. For these attributes, the panel formulated general guiding principles or binary pass/fail criteria.

Second, the panel determined that many of the identified attributes are highly inter-related. For instance, a wider marsh is likely to be necessary along the main channel of the LDR, while a narrower marsh would be acceptable if along a side channel sheltered from boat wakes, where the physical energy regime is less rigorous. The panel chose to develop guidelines that simultaneously reflect two or more of the attributes listed above because it made the most ecological sense.

Third, although the panel relied on the best available science for northwest estuarine systems, in some cases, empirical data were not available to specify with certainty all parameters that relate to each guideline. In these cases, the panel used best professional judgment, while acknowledging that there is uncertainty in the selected values.

Subject to these caveats, Table E1 displays the panel's proposed guidelines for ecological value, organized approximately into the attribute categories noted above (see the shaded gray rows). The first column (Habitat) indicates the habitat or habitats to which the guideline applies. To assist the Trustees in defining these habitats, this first column may also contain a proposed definition of the habitat type. The second column (Guidelines) lists the guideline applicable to the particular habitat–e.g., thresholds for width ranges for high-elevation marsh. Particular habitat types are shown in order of increasing ecological value – e.g., for high elevation marsh, value increases as width increases over 10 m. The third column (Rationale/Notes) presents the panel's rationale for providing the proposed credit.

Application of Factors to Proposed Projects

The panel's emphasis was to provide recommendations that would most naturally support the target resources, and that would be sustainable. Because the ecosystem is so heavily altered, the panel acknowledged that options for ecosystem recovery were constrained. Overall, the panelists were relatively certain that implementation of the recommendations would result in significantly improved ecosystem conditions. Monitoring was strongly recommended in order to determine both the site specific and system-wide effects of multiple restoration projects.

The factors listed in Table E1 are intended to be used either alone or in conjunction with one another. To explore the total set of factors that might result from projects that take advantage of the guidelines set forth in these tables, the panel examined a variety of theoretical projects. These projects and the values related to habitat associations that should be considered are set forth in Table E2.

The most value would be achieved in a project that creates a high elevation marsh, over 50 meters in width and at least 5 acres in size, plus a fringe of low marsh at least two meters in width. The project would be located at a side-channel site between First Avenue Bridge and Hamm Creek, adjacent to an existing freshwater flow that enters the waterway. If the project also reconnected an existing freshwater flow to the waterway, additional value should be considered.

Altogether, the panel felt that it was able to meet its charge, and that it successfully identified ecological attributes that were: (a) not captured in the current methodology and that (b) may have a positive effect on the value of a project—i.e., characteristics that might result in a particular project receiving more credit than would normally have been calculated using the current methodology. These were determined within the context of the urbanized and industrialized nature of the river and alterations to the watershed.

Table E1. Value Considerations for LOWER DUWAMISH RIVER Restoration Projects.

(guidelines for each habitat presented in order of increasing ecological value)

Habitat	Guideline [a, b]	Rationale/Notes
	Shape and Habitat	
High elevation marsh (Occurs upland of channels, approx. 11-13 feet above mean lower low water (MLLW)[c]. Supports a more diverse complex of species, such as *Deschampsia*, *Atriplex*, *Distichlis*, and *Potentilla*.)	**Main channel** 10 m minimum width for additional value 10-50 m wide (channels begin, maybe at ~30 m widths) >50 m wide (>1st order channels form naturally) Project must be at least 10 m in length. **Side channel** 3 m minimum width for additional value 3-50 m wide (channels begin to form naturally) >50 m wide (>1st order channels form naturally) Project must be at least 10 m in length.	Wider marshes are significantly more likely to be sustainable and are more likely to develop higher order channel systems. Higher-order systems (especially tertiary channels and higher) provide substantially more edge area, which is where fish feed. They also allow fish to stay in channels for significantly longer, and fish are not forced out by lower tides as frequently. Side channel marshes are more likely to be protected from boat wakes and related disturbances; a smaller minimum width The additional values are applicable only to marsh projects of 10 m in length (measured parallel to the adjacent waterway).

Habitat	Guideline [a, b]	Rationale/Notes
	Shape and Habitat	
Low elevation marsh (Occurs surrounding channels – primarily *Carex* species, approx. 5.5-9.5 feet above MLLW.) [c]	**Main channel** 4 m minimum width for additional value 4 to 10 m wide > 10 m wide Project must be at least 10 m in length. **Side channel** 2 m minimum width for additional value 2 to 5 m wide >5 m (safe from destruction by geese) Project must be at least 10 m in length.	Wider marshes are significantly more likely to be sustainable and are more likely to develop higher order channel systems. Higher-order systems (especially tertiary channels and higher) provide substantially more edge area, which is where fish feed. They also allow fish to stay in channels for significantly longer, and fish are not forced out by lower tides as frequently. Side channel marshes are more likely to be protected from boat wakes and related disturbances; a smaller minimum width The additional values are applicable only to marsh projects of 10 m in length (measured parallel to the adjacent waterway).
Intertidal habitat (excluding mudflats)	No extra credit for width (or total size).	Few additional species diversity or other benefits are expected as a function of increasing size.
Vegetated buffer (Mixed scrub/shrub and trees, with an elevation +13 feet relative to MLLW. Must be contiguous with another habitat that is adjacent to water (marsh, mudflat, etc.)	< 5 m wide 5 to 30 m wide >30 m wide	Vegetated buffer provides habitat complexity and enhances flows of materials and energy between habitat types. It aids in the sustainability of adjacent habitats and encourages diversity, e.g., by providing roosting areas for birds. Buffers also dampen noise and can reduce contaminated runoff from uplands to aquatic systems. Additional width is important to protect the integrity of the stand; extra credit is therefore provided for wider buffers.

Habitat	Guideline [a, b]	Rationale/Notes
Total Size/Adjacency to Existing Habitats of Same Type		
Marsh and mudflats	<2 acres 2 to 5 acres >5 acres	The key issue here is total size, including size of the project itself and also the total area of laterally-contiguous habitat if a project is sited next to existing habitat of the same type. Larger areas are more robust towards disturbances, and (up to a point) provide more niches and enhance biodiversity. Further, connecting a new project to existing habitats allows the new project to tap into an existing source of propagules, providing a higher likelihood of success and faster recovery trajectory. Extra credit should be given for larger project size and for siting projects next to laterally contiguous areas of the same habitat type. Marsh and mudflats are productive habitats and are especially important for juvenile Chinook salmon. They also provided key foraging opportunities for birds. The higher credit factors for these areas reflect this extra value, relative to upland locations.

Habitat	Guideline [a, b]	Rationale/Notes
Total Size/Adjacency to Existing Habitats of Same Type		
Upland	<2 acres 2 to 5 acres >5 acres	The key issue here is total size, including size of the project itself and also the total area of laterally-contiguous habitat if a project is sited next to existing habitat of the same type. Larger areas are more robust towards disturbances, and (up to a point) provide more niches and enhance biodiversity. Further, connecting a new project to existing habitats allows the new project to tap into an existing source of propagules, providing a higher likelihood of success and faster recovery trajectory. Extra credit should be given for larger project size and for siting projects next to laterally contiguous areas of the same habitat type. Marsh and mudflats are productive habitats and are especially important for juvenile Chinook salmon. They also provided key foraging opportunities for birds. The higher credit factors for these areas reflect this extra value, relative to upland locations.
Adjacency to Existing Habitat of Another Type (Buffering)		
Any (except vegetated buffer projects)	Applicable for project creating new habitat adjacent to existing vegetated buffer.	The HEA currently allows an area to be fully functional only if the project includes a vegetated buffer. In the case of restoration projects, choosing a site adjacent to an existing buffer results in a faster time to full recovery because it doesn’t depend on the development of new upland areas.

Habitat	Guideline [a, b]	Rationale/Notes
	Diversity	
Marsh	Apply the factor if the maximum width threshold for one marsh type is exceeded, and a second type of marsh that meets its minimum threshold value is added. The factor is then applied to the entire created marsh area.	Two types of marsh provide more diversity than a marsh of only one type; the variety also enhances sustainability.
	Siting – Organism Access/Use	
Mudflat (Intertidal habitat with a grade of less than 2 percent, a fine sand to silt/clay substrate, lacking macrophyte vegetation, and having a width in excess of 5 meters.)	Main channel Side channel	Mudflats have special value for juvenile Chinook salmon and so are given some extra credit relative to other intertidal habitats, wherever they are created. Mudflats on side channels serve as potential way stations for juvenile Chinook and as such receive additional credit.
Mudflat	Northern tip of Kellogg Island downstream	Mudflat habitat is most appropriate in higher salinity areas and in these areas is especially beneficial to English sole, a marine species. This credit is intended to be applied in addition to the above credit for mudflat habitat created either on the main channel or a side channel.

Habitat	Guideline [a, b]	Rationale/Notes
	Siting – Organism Access/Use	
Marsh	Side channel location between First Avenue Bridge and Hamm Creek Side channel location between Turning Basin and upstream extent of injured area	In certain significant stretches (e.g., between the First Avenue Bridge and Hamm Creek), there are few opportunities for juvenile Chinook to get out of main channel and rest, which salmon prefer to do after traveling for about a day. Creating appropriate juvenile Chinook resting habitat in areas where little such habitat exists therefore receives extra credit. The area upstream of the Turning Basin is also important for juvenile Chinook: it is probably the local area of the most value in terms of providing brackish/oligohaline habitat. (This region used to occur much lower in estuary but does no longer, since the river(s) flow has been reduced.) For the habitat to meet the juvenile Chinook's needs, the project must be in a protected area (i.e., a side channels). If no side channel exists at an appropriate location in the specified reach, the channel would have to be created, as well as the specified habitat type. The panel notes that the mudflat credit provided in the most northern reach (see "Siting—Historic Considerations/Probability of Success" section of table below) has special benefit to English sole and is not repeated here.

Habitat	Guideline [a, b]	Rationale/Notes
	Siting – Contamination Avoidance	
All habitats	No site should be built without first ensuring adequate on-site source control. The potential for future contamination from off-site is a primary consideration in site selection. Monitoring, prior to and during project construction, is essential to evaluate and minimize the potential for on-site and off-site recontamination. Avoid project construction in areas likely to be adversely affected by boat traffic/wakes.	Restoration projects are less likely to be sustainable and less likely to support a full range of organisms if they are subject to significant ongoing or future contamination, whether from on-site or off-site sources.
	Siting – Historic Considerations/Probability of Success	
Marsh	Low marsh is more appropriate in upstream portions of waterway near the Turning Basin, as compared to lower reaches near Kellogg Island. The panel encourages restoration or preservation programs upstream of the primary area of consideration.	Restoration efforts are commonly directed by history—i.e., a project tries to return an area to its baseline condition, based on the assumption that if the habitat was present at a particular location historically, it could presumably be sustained there again. However, historic locations are not as relevant for the LDR because of the extensive physical changes to the waterway since historic times (in hydrology, sediment transportation, etc.). These guidelines therefore focus only on important habitat types previously present in the area. For instance, based on salinity and elevation considerations low marshes are most likely to thrive in the more upstream parts of the waterway near the Turning Basin.

Habitat	Guideline [a, b]	Rationale/Notes
	Siting – Social/Cultural Considerations	
All habitats	Avoid impacting human cultural or heritage sites.	Representatives of the Suquamish and Muckleshoot Tribes are co-Trustees for the LDR. Respecting any culturally important tribal sites is a fundamental requirement of any restoration project.
All habitats	Projects adjacent to residential communities	The First Avenue Bridge/Hamm Creek stretch also includes the sole residential area along the waterway; actions in this area might have human services as well in terms of recreation, wildlife viewing, etc. On the other hand, enhancing access for humans might detract from the ecological value of the site in that the increased presence of humans might discourage some organisms from making use of the area.

Habitat	Guideline [a, b]	Rationale/Notes
Landscape Connectivity		
Marsh and Mudflat	Add freshwater flow via reconnection (minimum of 50 green space acres, maximum of 100 acres) Add freshwater flow via green space creation directly next to an existing freshwater flow into the Duwamish [d] Project involving both of the above	Historically, the LDR was connected to a wider variety of freshwater sources. The panel feels that increasing clean flows to the waterway (and thereby increasing the number/size of brackish areas) would enhance access of the waterway to juvenile Chinook salmon. Increasing freshwater flow also enhances the transfer of organic materials and insects to the main channel. The panel points out that there are three conceptual ways in which freshwater flows to the LDR could be increased in a given project: (a) reconnecting neighboring freshwater flows to the LDR (e.g., Puget Creek), (b) creating additional green space habitat adjacent to existing freshwater inflows (e.g., Hamm Creek), (c) doing both of the above. For (a), the panel proposes providing additional value based on the total area of green space drained by the newly-formed connection. To provide a significant amount of new flow, the panel determined that flow from a minimum of 50 acres of green space must be added to receive this credit. For (b), credit is based on the size of the newly-created habitat. Option (c) is the sum of (a) and (b). The panel also noted that any new flows should meet relevant water quality standards.

Habitat	Guideline [a, b]	Rationale/Notes
Notes: a. Unless otherwise indicated, the basis for the specified guidelines is professional judgment. b. Size and shape thresholds for each habitat are listed in order of increasing ecological value: e.g. for a high marsh in a side channel, 3 m is the minimum width for which additional value is considered, value increases linearly as the width increases from 3 m to 50 m, and a marsh > 50 m in width is given the greatest value. c. Elevations of these marshes are based on data from the WET monitoring of the Coastal America reference sites. d. The panel notes that the added green space areas will probably be narrow, in order to keep the streams deeper, to allow access to the juvenile Chinook. Therefore, this additional value consideration probably would not be found in combination with credits for project size.		

TABLE E2. VALUE CONSIDERATIONS FOR HABITAT/ATTRIBUTE ASSOCIATIONS [a]

(X indicates additional value should be considered for this attribute)

Habitat Type and Width	Width (on/off main channel)	Mudflat Siting (mudflat only, on/ off main channel)	Diversity (marsh only)	Total Size, Connectivity	Buffering	Adjacent to Freshwater Flow [b]	Habitat Siting
Vegetative buffer >30 m wide	(on or off) X	N/A	N/A	(>5 acres) X	N/A	N/A	N/A
Mudflat	N/A	X (on)	N/A	(>5 acres) X	Reduce time to full functionality	N/A	(downstream)[c] X
Mudflat	N/A	X (off)	N/A	(>5 acres) X	Reduce time to full functionality	X	(downstream)[c] X
Low Marsh >10 m wide	X (on)	N/A	(+ high marsh) X	(>5 acres) X	Reduce time to full functionality	N/A	(midreach)[d] X
Low Marsh > 5 m wide	X (off)	N/A	(+ high marsh) X	(>5 acres) X	Reduce time to full functionality	X	(midreach)[d] X
High Marsh > 50 m wide	X (on)	N/A	(+ low marsh) X	(>5 acres) X	Reduce time to full functionality	N/A	(midreach)[d] X
High Marsh > 50 m wide	X (off)	N/A	(+ low marsh) X	(>5 acres) X	Reduce time to full functionality	X	(midreach)[d] X

Habitat Type and Width	Width (on/off main channel)	Mudflat Siting (mudflat only, on/ off main channel)	Diversity (marsh only)	Total Size, Connectivity	Buffering	Adjacent to Freshwater Flow [b]	Habitat Siting

Notes:

[a] The factors shown in this table are meant to demonstrate the combined ecological values, by habitat type, that might result for a given project. Therefore, not all factors included in Table E1 are listed in this table.

[b] This credit is for creating the project adjacent to an existing freshwater flow into the LDR. The panel notes that green space projects added adjacent to existing (side channel) freshwater flows will probably be narrow, in order to keep streams deeper to allow access for the juvenile Chinook. Therefore, receiving the "Adjacent to Freshwater Flow" credit in addition to the Width credit, as done in this table, is unlikely.

[c] Northern tip of Kellogg Island downstream

[d] Between First Avenue Bridge and Hamm Creek

APPENDIX F: ALLOCATION PROCESS IN THE LOWER DUWAMISH RIVER NATURAL RESOURCE DAMAGE ASSESSMENT

Each site that contributed to contamination in Lower Duwamish River (LDR) sediments was allocated a percentage of the natural resource liability based on specified criteria and decision rules. Allocations were made to specific land parcels, called 'sites' and not to Potentially Responsible Parties (PRPs). A site is defined as a group of contiguous tax parcels that contributed chemicals responsible for natural resource damages in the LDR. Our approach allocates only to the current property owner and does not attempt to allocate damages among historical and current owners, tenants, operators, generators or transporters. This convention is not intended to limit the liability of any party involved with these sites. Many sites have had numerous owners and tenants over the past several decades and current owners are encouraged to engage with these entities as part of settlement negotiations.

Allocations are based on data from Washington Department of Ecology (ECY), the U.S. Environmental Protection Agency (EPA) and other publically available reports produced over the last several decades. While available data are extensive, it is possible that other data exist that might influence the allocations. If parties identify additional data that that could impact proposed allocations, these can be incorporated into the analysis.

This allocation apportions responsibility for contamination in sediment in the Lower Duwamish River using footprint maps created for 27 Substances of Concern (SOCs). Each footprint delineates sediment concentrations that exceed threshold levels for injury to aquatic resources. The thresholds for determining injury reflect Washington State Sediment Standards and Effects Thresholds established in the scientific literature (See Appendix D for additional information). Footprint maps were constructed using sediment contamination data from 1991 to 2008 for 27 substances of concern, including but not limited to PAHs, PCBs, metals, and chlorobenzenes. A contaminant footprint map was developed for each substance of concern, reflecting the degree of contamination relative to threshold concentrations.

The impact of the SOC footprints was quantified using a Habitat Equivalency Analysis (HEA), producing Discounted Service Acre Year (DSAY) values for each footprint. The HEA is described in detail in Chapter 2 of this document. Sites that were potential contributors to contamination were identified using King County tax parcel data: (http://www.kingcounty.gov/operations/GIS/PropResearch/ParcelViewer.aspx). We considered all parcels of land adjacent to the LDR and all non-residential properties between the main roadways parallel to the LDR (East Marginal Way and West Marginal Way). King County International Airport and Boeing Field parcels were also included because they are known to drain directly to the LDR. In addition to properties, the allocation also included public storm drains and combined sewer outfalls (SDs/CSOs) that discharge into the LDR. Residential parcels were not included, because releases of SOCs from residential properties were expected to be low and would likely be part of the contributions from CSOs and storm drains.

This initial identification process resulted in the designation of 458 non-residential sites for evaluation. In many cases, contiguous tax parcels were combined by owners or operators to support a common set of activities. For example, the King County International Airport encompasses five tax parcels. For allocation purposes, tax parcels used to support a common set of activities are grouped together and considered a single site. The combined parcels are assumed to share a consistent SOC discharge profile.

While sites further inland contribute to contaminant loads in LDR sediments, their effects are assumed to be captured through storm drains (SDs) and combined sewer overflows (CSOs) in the drainage basin. The discharges from these drains were considered as a potential source of SOCs separate from the adjacent tax parcels.

For parcels adjacent to the river, information from EPA and ECY on activities occurring on the site, substances used or stored on site, wastewater, soil, groundwater and other sampling data, reports of spills and releases and other factors were incorporated into the allocation.

Based on the footprint maps, tax parcel information and data from EPA and ECY files, responsibility for contamination was allocated using a tiered, hybrid approach. Wherever possible, individual footprints were allocated to specific parcels, small groups of parcels, or SDs and CSOs. In general, a parcel allocated responsibility in this way is adjacent to a footprint and is known to have stored, used and/or released the substance of concern on site. We also considered patterns in the gradient of contamination such as shown in Figure F1. Here, highest concentrations are seen near the presumed source on land, and concentrations decrease with distance from the source. A footprint was assigned to a storm drain or CSO if the associated SOC is known to be a common component of storm drains or CSOs and the associated footprint exhibited a spatial pattern consistent with nearby contaminant releases from the drain (Figure F1).

The allocation process requires the use of professional judgment, largely to address variability in the amount, type and quality of data available for each site. Sites are allocated responsibility only if there is a link (called a ‘nexus’ in the CERCLA regulations) between the site and contamination found in the LDR (Table F1). For each site and substance of concern, we examine three criteria:

1. Is there a pathway for the contamination to travel from the site to the LDR?
2. Is it more likely than not that the SOC was used or generated at the site or were actions conducted at the site which could result in the transfer of the substance of concern to the LDR?
3. Is the chemical found in the LDR adjacent to the site, on-site groundwater, on-site surface water, an NPDES discharge, or potentially erodible soil or sediment?

Figure F1. Hypothetical injury footprint showing a gradient of contamination emanating from a land-based source.

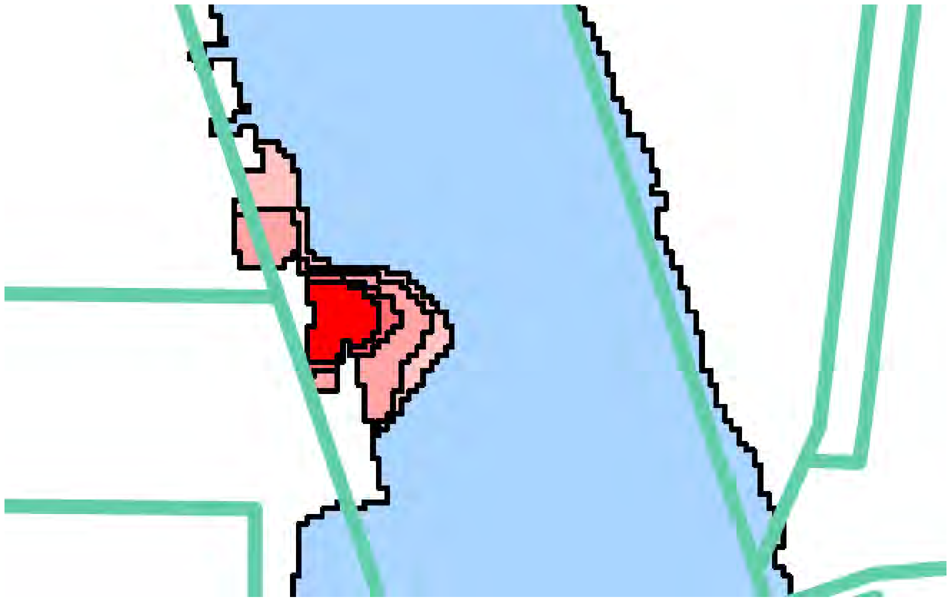

Table F1. Factors Considered to Trigger Allocation to a Site

1. Pathway. Is there a pathway for process water, surface water, groundwater, or sediment to travel from the site to the Duwamish Waterway?	Yes/No
2. Activity. Was an activity conducted at the site that is a likely source of an SOC or which resulted in the release of a chemical likely to exacerbate the impact of an SOC?	Yes/No
3. Evidence of Contamination	
a. NPDES violations	Yes/No
b. Surface water contamination	Yes/No
c. Groundwater contamination	Yes/No
d. Soil or sediment contamination	Yes/No
e. Sediment "footprint" in very close proximity to site.	Yes/No
To trigger continuation in the allocation process, the answers to 1, 2 and at least one component of 3 must be "**Yes**".	

A site is considered to be a source of the SOC if (and only if) the answer to all three questions is yes. First, a pathway must exist for process water[1], surface water, groundwater, or sediment to travel from the site to the LDR. Because sites identified for this allocation border or drain directly to the LDR, it is reasonable to assume the existence of a viable pathway for SOC transport at every site. Groundwater is very shallow along the LDR (5-10 feet below the soil surface), so contamination in soils can easily leach into the groundwater. Second, there must be evidence of on-site activities that could be a source of one or more SOCs or result in the release of substances that mobilized or otherwise exacerbated the release of one or more SOCs to the LDR. For example, the transport of lead from lead-painted surfaces would not be considered a potential release to the LDR. However, sandblasting of lead-painted surfaces to the adjacent ground would be considered a potential source of lead to the LDR, because of the deposition of waste grit material in shipways and other areas susceptible to stormwater or erosional transport.

Finally, we require evidence that one or more SOCs were present in site wastewater, discharges, soil, surface water and/or groundwater. Information used to make this determination included records of NPDES violations and contamination measured in surface water, ground water, soil or sediment.

Establishing the potential for an SOC release to the LDR depends on the amount of information available for each site. If site records are incomplete and therefore insufficient to satisfy the criteria discussed above, the site is not included in the allocation. As a result, the allocations may exclude viable contributors of SOCs to the LDR for which there are no publicly available data. Our evaluation process systematically and objectively used all data available at the time of the analysis. If additional information is made available it can be incorporated into the allocation at a later date.

The sequential steps and decision junctions in the allocation process are shown in Figure F2. This methodology produces a separate allocation for each of the 27 SOCs. For many of these SOCs, individual footprints could be linked to specific parcels. For others, we relied on a combination of footprint-specific and mass balance approaches. For example, some stretches of the LDR are broadly contaminated with a substance of concern potentially attributable to a large number of parcels. In addition, some discrete footprints are located in places that potentially implicate several sites and/or SDs/CSOs. In these cases, the allocation relied on a mass-balance approach. Sites in close proximity to the footprint that used, stored and/or released the substance of concern were given partial responsibility for the footprint, taking into account contamination gradients and likely contaminant transport dynamics. Estimates of each sites' relative contribution of the substance of concern were derived from EPA and ECY data and general reference information from the scientific literature. For Polycyclic aromatic hydrocarbons (PAH), the allocation relied solely on the mass balance approach, because PAH contamination is pervasive throughout the LDR at concentrations above injury thresholds. This was the only SOC treated in this manner.

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[1] Process water is water used in a manufacturing or treatment process or in the actual product manufactured. Examples would include water used for washing, rinsing, direct contact, cooling, solution make-up, chemical reactions, and gas scrubbing in industrial and food processing applications.

A small set of footprints could not be allocated using either methodology. "Type I" unallocated footprints are those that could not be linked to a particular site, group of sites, or SD/CSO. "Type II" unallocated footprints are those that appear to be linked to a particular site, group of sites, or SD/CSO, but available data is not sufficient to trigger an allocation. However, a methodology was developed to allocate these footprints to parcels with a history of use of the particular SOCs.

Allocation by Unique Footprint

Under this approach, individual footprints were allocated to specific sites or SDs/CSOs. In general, the site allocated responsibility in this way is adjacent to the associated footprint, is known to have stored, used and/or released the substance of concern on site, and exhibits contamination gradients consistent with nearby contaminant release and LDR transport dynamics. In the case of CSOs or SDs, if the footprint is located next to the CSO or SD discharge to the river, and is a commonly detected contaminant in storm water discharge, then the footprint was assigned to the CSO or SD.

In assigning footprints to individual sites or SDs/CSOs, the following criteria were used:

- The footprint must be within or immediately adjacent to the tax parcel boundary of the “paired” site and no other site; or at the approximate point of discharge of a SD or CSO and not shared with a site, and
- The paired site must have an activity that could potentially result in the release of the SOC in question; or the contaminant must be commonly detected in storm water if the footprint is associated with a SD or CSO.

This approach reflects the common sense notion that discrete, elevated concentrations of SOCs found in sediments bordering a site should be attributed to that site when activities that used those SOCs took place. There is a possibility that these footprints received minor contributions from other sources. However, when a spatial and causal link between a footprint and a bordering site is apparent, we presume that impact diminishes with distance and thus rely on the likelihood that sources closer to the footprint dominate. The “Allocation by Unique Footprint” approach was the default allocation methodology used in the analysis. If a particular footprint did not meet the criteria listed above, the “Allocation by Mass Loading” approach was applied.

Allocation by Mass Loading

In some cases, SOC contamination is so widespread and diffuse that contamination footprints blend together and are not readily linked to specific sites. Footprints potentially associated with several sites are best allocated using a mass loading approach. The mass loading allocation is based on establishing the total loading of an SOC to the LDR from each site.

When the data are available, the most direct method to determine the mass released to the LDR is based on ’Flux’. The term flux applies to the time rate of release: for example, pounds per day. If the rate is multiplied by the duration (e.g., in days), total loadings released to the LDR can be calculated and relative contributions assessed through comparisons of loadings estimates. Unfortunately, in almost all cases, information was not sufficient to estimate SOC flux.

In most cases, the approach used assumed that the SOC mass released to the LDR will be a function of the type of activity, the scale and duration of the activity, and the fate and transport mechanisms for the contaminant. Under this 'Activity Ratings' approach, the scale and duration of the activity generally can be quantified (e.g. acres and years). While it is difficult to quantify the amount of an SOC potentially released by different activities, the absolute quantity of a release is less important than the relative quantity compared to other sources of the same SOC. Relative amounts can be estimated from information in the general literature and by analyzing site-specific information (e.g., groundwater and surface water data). The fate and transport mechanisms depend on the physical and chemical characteristics of the SOC and the location of the site and pathways by which the SOC could reach the LDR. In some cases the footprints for certain SOCs can be used to estimate the releases of other SOCs with less clearly defined footprints.

Table F2. Mass Loading Allocation Method for Shared Footprints (not PAH). For each Substance of Concern choose the best method – depending on data:

Allocation Index = (Duration Index) x (Flux)

Allocation Index = (Size Index) x (Duration Index) x (Activity Index)

Allocation to Site A = Allocation Index for Site A / ∑ Allocation Indices in Segment

Size and Duration Indices:

Size Index: Use the size of the site, or area of activity, in acres. If the size has changed, use the weighted size (weighted by years of different size)

Duration Index: Years from start of activity to present for on-going activities, termination of activity (for activities leaving no residual upland or groundwater contamination) or final cleanup. Use the same weighting for pre-1981 and post-1981 (it is assumed that waste generated prior to 1981 could lead to post-1981 releases).

Ultimately, both mass balance approaches (Activity Ratings and Flux) generate allocation indices that become the basis for apportioning responsibility for contamination between multiple sites. The Flux approach is used when sufficient data are available to quantify actual releases from the sites subject to a mass loading allocation. When such data were not available, the Activity Ratings approach was used to assign index values based on the type, duration, and size of activities that took place on site and are associated with relevant SOCs. Table F2 summarizes the Flux and Activity Ratings approaches for mass loading. Table F3 describes the Activity Ratings in greater detail. These methods require consideration of the fate and transport properties listed in Table F4, particularly when:

- The flux or release is measured at a significant distance from the LDR.
- The activity takes place at some distance from the LDR.
- Releases involving different pathways (surface water, groundwater, and soil/sediment erosion) are being added together or compared.

One SOC (PAH) was allocated solely through use of the mass loading approach because the contaminant concentrations were widely diffused throughout the LDR. Concentration gradients were discernable, but footprints were not readily defined. Thus, allocation to each site within the entire LDR was determined by mass loading, taking into account various sources of PAH to the Lower Duwamish River.

For all other SOCs, if a footprint was associated with more than one site, then the mass loading approach was used for allocation among sites. If one or more CSOs or SDs was located in the vicinity of a footprint and no site triggered within that area, then the footprint was assigned to the CSO and/or SD.

Unallocated Footprints

Some footprints could not be allocated using any of the methods described above. These unallocated footprints fit one of the following two categories:

- **Type I Unallocated:** The SOC footprints are not clearly adjacent to or otherwise linked to specific sites.
- **Type II Unallocated:** The SOC footprints abut or are adjacent to an individual site according to the criteria outlined above but no documentation exists to establish that activities at the site represent a likely source of the SOC in question.

To allocate the unallocated footprints we developed an approach based on a site's share of the particular SOC allocated by the abovementioned methods. The total allocated and unallocated DSAYs in the study area were determined for each SOC. For each site that had DSAYs allocated for a particular SOC, the percentage of the total allocated DSAYs for that SOC was determined. Then, the site's share of the unallocated DSAYs was calculated by multiplying the total unallocated DSAYs for a particular SOC by the site's percentage of the allocated DSAYs for that SOC.

Here is a hypothetical example that illustrates the process described above:

- The HEA calculates a total of 200 DSAYs for contaminant A for the entire study area.
- Of the 200 DSAYs, 180 are allocated to multiple sites, 20 are from unallocated footprints.
- Site X, one of the sites responsible for contaminant A, is allocated 45 of the 180 DSAYs, or 25% of the total allocated DSAYs (45/180 = 25%).
- Site X's share of the DSAYs associated with the unallocated footprints for contaminant A is, therefore, 25%.
- Site X receives five additional DSAYs for contaminant A as their share of the unallocated footprints (20 unallocated footprint DSAYs * 0.25 = 5).
- Site X's total allocation for contaminant A is 50 DSAYs (45 allocated + 5 unallocated share).

Table F3. Activity Ratings

This table is intended to represent an initial screening of the relative ranking of activities with respect to their potential to release PCBs. Thus, all other things being equal (e.g. size, duration, degree of case, fate and transport, chemical concentrations, etc.) an activity near the top of the list is expected to result in the release of a greater mass of SOCs than an activity near the bottom of the list. However, where things are not equal the actual mass contribution could be much different than that implied by the order noted in the table.

PCBs	
Activity	**Activity Index**
PCB transformer recycling	High
PCB contaminated oil spill	
Recycling waste oil	
PCB transformer use	
Ship dismantling	
Vehicle recycling	
PCB use in oils and fluids for machining	
PCB use in paints, resins, sealants, and adhesives	
Ship maintenance	
Solvent mobilization of PCB's in the environment	Low

Table F4. Fate and Transport Considerations

Surface Water

- Flow path to the Waterway (e.g., distance, velocity)
- Presence of free product
- Chemical concentration
- Potential for volatilization and degradation
- Adsorption to sediments

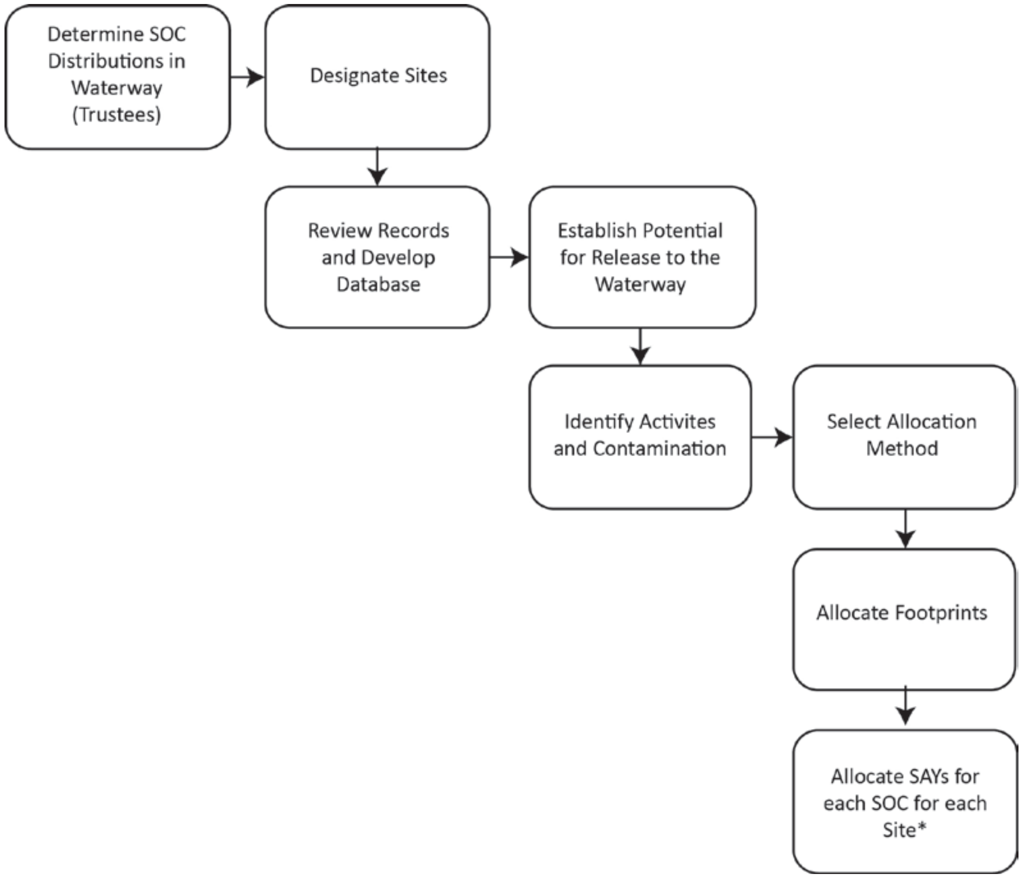
Groundwater

- Flow path to the Waterway (e.g., distance, gradient)
- Transmissivity of aquifer
- Floating or sinking free product
- Chemical concentration
- Potential for adsorption by aquifer soil
- Potential for volatilization and degradation
- Mobilization by other chemicals
- Mobilization of natural substances
- Adsorption to sediments

Sediments

- Proximity to ditch, swale, or waterway
- Covered or uncovered
- Velocity of eroding water
- Particle size
- Potential to settle before reaching Waterway

Figure F2. Overview of Allocation Steps



Note: this step does not include allocation to individual parties, but rather allocates contaminants to physical sites (or land parcels). Each site may have multiple owners and/or operators.

APPENDIX G: 2009 RESPONSE TO COMMENTS

Presented below are the comments received on the Draft Recovery Plan (RP) and Programmatic Environmental Impact Statement (PEIS) released for public review in 2009. NOAA and the other Trustees have prepared responses to the concerns and issues raised in these comments, also provided below. Eight stakeholders provided comments: Boyer Logistics (M.C. Halvorsen), King County Department of Natural Resources and Parks (KC), U.S. EPA region 10 (USEPA), Duwamish River Cleanup Coalition (DRCC), People for Puget Sound (PFPS), Water Resource Inventory Area 9 Watershed Ecosystem Forum (WRIA 9), City of Seattle Public Utilities (Seattle), and the Port of the Seattle (POS). The stakeholder comments are paraphrased and/or quoted directly and are written in italics with the commenters identified in parentheses, the actual comments are included in the last pages of this document.

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Preferred Alternative

Several commenters support the preferred alternative. (KC) (USEPA) (DRCC) (PFPS) (WRIA 9)

Response: Support noted.

The description of typical kinds of restoration actions under the preferred alternative is well stated and consistent with recent practical experience in the Duwamish Waterway. (POS)

Response: Comment noted.

What is planted in the banks will die. The dead material would accumulate on the bed of the river, which would be excessive, which in turn would cause the algae to grow, which in turn would suck the oxygen out of the river. This plan will surely kill the river. (M.C. Halvorsen)

Response: Riparian vegetation has been successfully established at several locations along the Lower Duwamish River (LDR). Because the benefits of riparian vegetation to river systems are widely recognized, the Trustees believe that planting riparian vegetation as part of restoration projects will only benefit the river.

Habitat Focus Areas (HFA)

Commenters support HFA approach that gives highest priority to HFA1 that benefit all injured species. (DRCC) (WRIA 9)(Seattle)

Response: Support noted.

Commenter encourages Trustees to only modestly discount the value of projects in HFA3 compared to HFA1 because there is great ecological benefit from projects throughout the Upper Duwamish. (WRIA 9)

Response: The Trustees appreciate the ecological benefit from projects in HFA3, but are discounting the value of projects in this HFA for the purpose of Natural Resource Damage Assessment (NRDA) restoration because restoration there will provide relatively little benefit to the marine and largely estuarine aquatic species injured in the LDR.

The upstream 1.5 miles of HFA1 is not straightened and developed as the rest of HFA1 is, and so should be included in HFA3 rather than HFA1. (M.C. Halvorsen)

Response: The Trustees disagree with this comment and have kept the farthest upstream 1.5 miles in HFA1. The designation of the HFAs is based on the environmental conditions and importance to the injured natural resources, not the state of development. HFA1 includes the portion of the Duwamish River below the North Winds Weir and has mixed salinity. HFA3 is above the influence of marine water and is entirely influenced by freshwater.

If the restoration work is intended to focus on the transition zone for juvenile salmon, the areas upstream of river mile 3.5 (measured from the mouth of the Duwamish River) in HFA1 and areas in HFA3 should be the focus because areas downstream have high salinity. (KC)

Response: The restoration effort is not focused on the transition zone for juvenile salmon exclusively, but on benefiting the suite of resources injured in the LDR, including areas downstream of river mile 3.5. Incorporating parts of HFA3 into HFA1 is not appropriate, as conducting restoration in HFA3 will not benefit the entire suite of injured natural resources; some of the injured species would not be expected to be present in HFA3. Habitat restoration in HFA3 would provide less direct benefit to those species compared to projects in HFA1.

Commenter objects to conducting any restoration outside of the LDR and Elliott Bay. (PFPS)

Response: The Trustees are prioritizing restoration within the LDR (HFA1) and will require settlements with Potentially Responsible Parties (PRPs) to provide for some restoration within HFA1 as part of any package, because projects in this area have the greatest potential to benefit the entire suite of resources injured as a result of hazardous substance releases. Inner Elliott Bay (HFA2) is the next highest priority for restoration. However, we will consider restoration in the other HFAs as part of a proposed settlement or for implementation by Trustees as a lower priority. Projects in these HFAs will address at least some of the injured resources, and thus there is a nexus between natural resource injuries and restoration in HFA3 and HFA4. Additionally, the Trustees recognize that practical restoration opportunities within the LDR itself may not be sufficient to provide full compensation.

Restored Habitat: Types, Characteristics, Priorities

Commenter concurs with the primary focus of restoration being on the creation of mudflat, marsh, and riparian habitat, as these habitat types are most needed to restore the estuarine ecology of the Duwamish and of greatest benefit as salmonid habitat. (WRIA 9)

Response: Support noted.

Commenter supports the general approach presented in the restoration plan identifying the types of all-purpose habitat that should be developed. (KC)

Response: Support noted.

Commenter supports the importance given to landscape connectivity in the plan. (KC)

Response: Support noted.

In an area as devoid of upland vegetation as the Duwamish, some greater emphasis on riparian habitat is important and with encouragement it will be possible to integrate this type of habitat into many of the industrial sites. (Seattle)

Response: The Trustees recognize the importance of riparian habitat and believe that our approach provides an appropriate value for riparian habitat. Not only does created riparian habitat get restoration credit based on the area of riparian habitat created, it can also provide an increase in value for associated marsh and mudflat habitats from a baseline adjusted to a fully functional value. This is discussed in detail in the additional material provided in the Supplement to the draft RP/PEIS.

The language describing the goal of the restoration effort in the draft RP/PEIS ("restore injured natural resources to baseline by helping improve the ecosystem of the Lower Duwamish River to a more acceptable condition that can support both natural resources and human use of the system") is inadequate and high-quality, not "acceptable," habitat is needed. (PFPS)

Response: The commenter is confusing the goal of making the LDR ecosystem better as a whole through the creation of habitat projects, with the goal of individual projects being of high quality. The restoration projects themselves will create high-quality habitat. The addition of more acreage of high-quality habitat as provided by the restoration projects will help improve the entire ecosystem of the LDR, in which very little habitat is not degraded. It is the creation of such high-quality habitat projects that will improve the functioning of the LDR ecosystem ("to a more acceptable condition"), thus restoring the injured natural resources that will benefit from this new high-quality habitat.

Clams and other shellfish are historical traditional tribal foods and should be a high priority for habitat recovery along with salmon. (DRCC)

Response: The Trustees agree that restoration of shellfish resources is important in achieving restoration in the LDR. Restoration projects implemented under the RP/PEIS will provide clean areas of intertidal and shallow subtidal sediment, which will provide good habitat for shellfish.

High priority should be given to projects that integrate habitat restoration and public access. (DRCC)

Response: The Trustees will seek to integrate public access with habitat restoration at some of the restoration projects. This will not be possible at all sites; for example, projects built by PRPs on their own property would likely not include public access. Where public access is provided, it would be designed to minimize any impact on use by natural resources. The Herring's House restoration project, implemented by the Elliott Bay Panel, is a good example of integrating restoration projects and public access.

Habitat Valuation

Commenter concurs with the use of juvenile Chinook salmon as one of the two fish species used to assess value of habitat in the restoration effort. (WRIA 9)

Response: Support noted.

Commenters support integration of different habitats within restoration projects and giving them additional value. (DRCC) (PFPS)

Response: Support noted.

Commenter disagrees that created habitats should have the same level of ecological services as natural habitats (i.e., 1:1) because some percentage of the created habitat will fail and that the time factor in *development of habitat service provision in created habitats should be incorporated into replacement ratio requirements.* (PFPS)

Response: The Trustees recognize that it is virtually inevitable that some of the created habitat will not provide all the ecological services expected, despite the Trustees' efforts in monitoring, long-term stewardship, and adaptive management. For projects implemented by PRPs as part of a settlement, we try to minimize this risk through the terms of the settlement that will require evaluation of adaptive management measures when monitoring indicates that a project's development is not matching expectations. Although some projects are likely to underperform, it is not possible to identify those projects in advance, and we do not believe it is appropriate to require more restoration from all PRPs simply because some of their projects may fail to meet predictions. Based on experience gained from other projects, the habitat most likely not to provide full function is marsh habitat, due to failure of marsh vegetation to become established. Under these circumstances, a failed intertidal marsh would instead function as mudflat (unvegetated intertidal) and would have a relative value of 0.9 instead of 1.0. The Trustees recognize that the ecological services from created habitats develop gradually as the project matures and account for this in the Habitat Equivalency Analysis (HEA) approach, which incorporates this factor in the determination of the size of that habitat needed to compensate for the injury. In this approach, restoration projects are not given full credit until they are mature.

The draft plan does not indicate that the Trustees are willing to recognize the time value of habitat by giving greater consideration to habitat created earlier as opposed to habitat that may be created 10 years later, although the Trustees have indicated this verbally, and it should be noted in the PEIS. (Seattle)

Response: The HEA method used accounts for when restoration projects are constructed, and a project built earlier will provide more restoration credits. As noted in response to another comment, additional information on HEA was added to the Supplement to the RP/PEIS, and the new material explains how timing is incorporated in the analysis.

Commenter requested that additional information on the valuation approach for restoration projects be included as an appendix to the plan. (PFPS)

Response: Extensive information on habitat valuation in the LDR was provided in Appendix D of the Supplement to the RP/PEIS.

The WRIA 9 plan discussed in the section Summary of Other Restoration Plans did state there is no scientific evidence that docks and other structures over water harm or interfere with the fish run. (M.C. Halvorsen)

Response: In contrast to this statement, the referenced WRIA 9 plan specifically identifies overwater structures as one of the "Factors of Decline" for salmonids in Table 3-1.[1] As discussed in Appendix D, the

[1] Green/Duwamish and Central Puget Sound Watershed Resource Inventory Area. 2005. *Salmon Habitat Plan: Making our Watershed Fit for a King*. Seattle. Available online at http://www.govlink.org/watersheds/9/plan-implementation/HabitatPlan.aspx#download.

Trustees treat areas under overwater structures as degraded, which means that removal of overwater structures, as part of a restoration project, will provide restoration credits. It also means that the amount of injury estimated for an area under an overwater structure would be less than for a similar area with exactly the same levels of contaminants that is not shaded by any overwater structures.

Please state which bird assemblages were used to assess habitat value to birds. (KC)

Response: The requested information was added to the Supplement to the draft RP/PEIS.

Please present more information on how the potential loss of natural resources in terms of fish and bird habitat were evaluated. (KC)

Response: The Trustees' authority under NRDA statutes regarding loss of habitat is limited to addressing losses caused directly by response actions (unless addressed under mitigation requirements) and by the contamination in the habitats resulting in a reduction of ecological services. Loss of habitat due to development or other factors is not within the purview of the Trustees under NRDA. However, the Trustees recognize that loss of habitat has impacted many species and the habitat restoration implemented under this plan will help address those impacts.

Coordination

Commenter supports the objective of coordinating restoration efforts with other planning and regulatory activities, to maximize habitat restoration. (KC)

Response: Support noted.

NOAA and the Duwamish Trustees should ensure a robust public involvement and review process for each NRDA restoration project under consideration. (DRCC)

Response: Although the public will have the opportunity to review and provide comments on all restoration projects, the extent to which the Trustees can involve the public in the development process for any specific restoration project will vary depending on the circumstances for that project. For example, if a PRP or group of PRPs were to propose a restoration project to the Trustees as part of settlement negotiations, the public would be able to review and comment on projects the Trustees believe are acceptable when the proposed settlement is out for public review. For projects implemented by the Trustees themselves, there would be more opportunity for public involvement during the development of the project.

Comment that local governments are identified in CERCLA and OPA as having trustee responsibilities and should be consulted in the development of restoration plans and related decisions. (KC)

Response: Under relevant NRDA statutes, including CERCLA and Oil Pollution Act (OPA), local governments do not have authority to participate as trustees in NRDAs unless so designated by the governor of the state. The Trustees recognize that local governments have valuable knowledge, and they intend to continue seeking input from local governments throughout the restoration process.

Encourage coordination with other parties that have developed habitat plans in the Green/Duwamish watershed. (KC)

Response: The Trustees recognize the value of coordinating with others interested in habitat restoration and will continue to do so.

Industry, particularly the maritime industry, should be among those helping to identify restoration sites. (M.C. Halvorsen)

Response: The Trustees welcome suggestions from industry as well as from other interested parties for potential restoration project sites.

The Trustees should pursue opportunities to include private property of businesses who are not PRPs but whose property is adjacent to NRDA restoration sites to increase habitat size and functionality. (DRCC)

Response: The Trustees will pursue such opportunities.

Commenter questions whether the guidance for habitat laid out in the Coordination and Consultation section of the document has been determined to adequately address concerns of the federal agencies required for consultation under various federal agencies, and suggests it would promote implementation of the restoration plan if this point was clarified and the document more clearly identified requirements for individual projects regarding compliance with specific regulations or orders. (KC)

Response: This section presents a review of potentially applicable laws and regulations that may be applicable to projects. Many of the consultations and coordination are conducted as part of the process of obtaining necessary permits. Which specific requirements are applicable to any given project depends on a number of factors unique to that project, and it is not feasible to pre-identify requirements for hypothetical projects to be constructed in the future. The relevant consultations and coordination will be made for each project based on the specific details of the project.

Emphasis should be given to the goals developed by the Green-Duwamish Fish Habitat Enhancement Group/WRIA 9 Steering Committee. (DRCC)

Response: Although the goals of the Trustees extend beyond those of WRIA 9—in that additional injured natural resources besides salmonids need to be restored as part of the NRDA restoration process—we believe our efforts will help address the goals developed by WRIA 9.

Project Planning and Implementation Issues

Commenters supported integrating habitat restoration with clean-up actions where feasible; WRIA 9 requested that more specificity be included about when and how decisions about integrating clean-up with restoration will be coordinated with USEPA, the Washington Department of Ecology, and PRPs. (DRCC) (PFPS)(POS) (WRIA 9)(Seattle)

Response: Support for integration of restoration and remediation is noted; additional information regarding coordination with clean-up agencies and PRPs was added to the Supplement to the draft RP/PEIS.

Commenter indicates that the list of potential construction actions necessary for restoration is well done, but notes that excavation entails removal of fill materials, active or inactive structures, shoreline armoring, and debris, and that these materials often present unanticipated project implementation challenges. (POS)

Response: The Trustees are well aware of the challenges faced in constructing restoration projects in the LDR as a result of the restoration projects undertaken by the Elliott Bay Panel. Implementing restoration in this highly modified system is indeed challenging, and unexpected discoveries often result in increased costs and sometimes require modification of the project to accommodate these discoveries, especially if historical or culturally significant discoveries are made.

It would be useful in the section on Adaptive Management to note that future work would benefit from incorporating successful designs and techniques used in the LDR and avoiding unsuccessful past practices. (POS)

Response: This suggestion was adopted in the Supplement to the draft RP/PEIS.

The Stewardship Model section should acknowledge the need to provide temporary irrigation and control of Canada geese grazing as essential to successful establishment of riparian and marsh vegetation. (POS)

Response: This suggestion was adopted in the Supplement to the draft RP/PEIS.

It would be difficult to overstate the importance of the need for adequate source control to prevent recontamination of restoration sites. (POS)

Response: Comment noted. The Trustees agree that adequate source control is extremely important in the development of restoration projects that provide all the ecological services provided.

Commenter requested additional information supporting dimensions of restoration projects in the sections on creation of mudflat and marsh habitats, suggested the importance of uncovering relic sediment layers in former locations of marsh as a guide in planning restoration, and noted that the list of plant species in the section on riparian restoration does not include all appropriate native riparian plant species. (POS)

Response: Additional information regarding the dimension of restoration projects is included in Appendix E to the Supplement to the draft RP/PEIS. The discussion regarding habitat creation in the draft RP/PEIS was not intended to be exhaustive, but rather to provide basic information sufficient to help readers evaluate the alternatives. For any specific project, the presence of relic marsh platforms will be considered during project development, as will evaluation of other appropriate native plant species beyond those listed in the document.

Commenter suggested that emphasis be given to local business and workforce in restoration planning, implementation, and monitoring. (DRCC)

Response: The Trustees will need to follow federal, state, or tribal contracting requirements if one of the Trustees implements a project, and therefore have limited ability to follow the commenter's suggestion.

Commenter is supportive of restoration in the Duwamish, which thoughtfully co-exists with the important manufacturing and industrial base along the LDR. (Seattle)

Response: Comment noted.

Commenter supports more rigorous timelines for completion of the individual restoration plans and for the overall river-wide restoration. (DRCC)

Response: The Trustees are seeking to speed restoration of natural resources in the LDR through negotiations with PRPs for early settlement based on the Trustees' approach to estimating injuries with existing data, as discussed in the Supplement to the RP/PEIS. However, negotiations are often time-consuming and unpredictable, so setting a rigorous timeline for individual restoration projects or the overall restoration is not possible. Additionally, some PRPs may choose not to settle early, and litigation may be required in order to obtain settlements resulting in funds for restoration. So it will take many years to complete the overall river-wide NRDA restoration, despite the efforts of the Trustees to accomplish restoration as quickly as possible.

Some of the restoration plan would need to be done on private property, which cannot be taken for restoration purposes. (M.C. Halvorsen)

Response: The Trustees cannot take property for restoration, but instead will rely on property being made available by PRPs who wish to build restoration projects or provide property for others to build restoration projects, public entities that would like to see habitat restoration on their property, third parties who undertake a project for restoration banking purposes, and landowners who willingly sell property to the Trustees for restoration purposes.

The restoration process—including land acquisition, design, permitting, construction, and potential litigation—could take a decade or more, and the document should describe how the length of this process would affect the potential success of the alternatives. (KC)

Response: Although it is likely to take many years to complete NRDA restoration in the LDR, it is likely that many PRPs will want to settle with the Trustees before conducting further assessment activities and the costs associated with those activities, and so restoration will occur gradually over time. Boeing has already reached a NRDA settlement to address natural resource injuries from some of their properties and restoration actions have begun. Additional early settlements are anticipated. The most likely potential impact from a drawn-out restoration process is that land availability for restoration within HFA1 may change. If the amount of land available for restoration in HFA1 decreases, a larger proportion of restoration would need to be constructed in other HFAs under the preferred alternative or for habitat or other types of projects under the species-specific alternative. Alternatively, it is possible that additional land may be available in the future, so it is difficult to predict what impacts might result from an extended restoration process.

Priority should be given for restoration efforts that show a clear plan that the site will be able to adapt with climate change impacts. (PFPS)

Response: The Trustees share the commenter's concern about the potential for effects of climate change to impact the restoration effort, and will consider this potential in designing restoration projects.

Commenter supports giving small restoration projects more priority than is proposed, and suggests it is unnecessary in this system to give higher priority to large projects. (PFPS)

Response: When developing the valuation approach, the Trustees consulted with experts from academia and NOAA on factors that would provide higher value for restoration projects in the LDR. One of the factors identified as influencing the value of projects was size, with larger projects having more value than smaller projects with otherwise similar features. Therefore the Trustees believe that giving additional value to larger projects is appropriate. However, because there are relatively few opportunities within the LDR for large projects, many small projects will be part of the restoration effort in the LDR despite their lower value.

Commenter would like to see greater emphasis given to habitat in areas of the Duwamish where little habitat exists, suggesting a goal of having habitat sites within each of a fixed length of linear shoreline (specific length of shoreline desired is not specified in the comment). (Seattle)

Response: The Trustees recognize the value of having habitat areas throughout the length of the LDR and will try to spread restoration throughout the LDR so as to not have large gaps without habitat (existing and/or restored). We believe that all reasonable potential locations to conduct restoration in the LDR will need to be used in order to meet restoration goals. These locations include property where PRPs or third parties interested in NRDA restoration banking are willing to build restoration projects, public property made available for restoration by the Trustees or others, and property that can be purchased by the Trustees with settlement funds for restoration.

Impacts Analysis

The analysis of impacts should include a statement relating to potential greenhouse gas emissions. (POS)

Response: Comment adopted in the Supplement to the draft RP/PEIS.

Commenter believes that both action alternatives would have short-term impacts on energy and natural resources in contrast to description in the draft RP/PEIS that no impacts would be expected. (KC)

Response: The referenced section in the draft PEIS (8.2.1.3) addresses the issue of whether the alternatives would impact the **development** of energy or natural resources. The analysis of impacts expected from the action alternatives on natural resources themselves is discussed elsewhere in the document, and the potential for short-term impacts is noted. Although implementing either action alternative would use energy (fuel for construction equipment, electricity, etc.), by any reasonable standard this would be so negligible that no measurable impact to energy supplies or prices would be expected.

Commenter expresses concerns about the safety of recreational uses, such as boating and fishing, of the LDR. (M.C. Halvorsen)

Response: The LDR is already used by the public for recreation, and the creation of habitat restoration projects will not affect the safety of such activities. Instead, habitat restoration should enhance the quality of recreational uses of the LDR.

Placement of large woody debris is not feasible and would be dangerous to boats. (M.C. Halvorsen)

Response: Large woody debris has been used safely in restoration projects in the LDR. Wood can be anchored when necessary to prevent danger to navigation. All such restoration projects in the LDR require a permit from the USACE, and safety to navigation is one of the factors considered in the permit review process.

The banks of the lower 5.5 miles of the Duwamish River are made up of fill or are otherwise altered, plants will not grow there, and creation of marsh, mudflat, or riparian habitat in a working commercial waterway is impossible as it would interfere with navigation. (M.C. Halvorsen)

Response: Several successful restoration projects have been implemented within the lower 5.5 miles of the LDR. These projects have not negatively affected navigation, and projects implemented consistent with this plan will be designed so as to not interfere with navigation. These projects generally involve removal of artificial fill, pulling back and contouring the banks, and planting native vegetation.

Chinook salmon return to the Duwamish River in greater numbers than any other river in Puget Sound, Chinook salmon "like" industry, and the Trustees' plans may reduce the amount of returning Chinook salmon; birds like the industry in the river. (M.C. Halvorsen)

Response: The Trustees disagree with the contention that industrial development and activities along the LDR benefit either Chinook salmon or birds. It is widely recognized that loss of habitat, especially within the transition zone, is a factor in the reduction of Chinook salmon populations in Puget Sound, and therefore the Trustees believe that increasing the amount of habitat within the LDR will positively affect Chinook salmon runs in the Duwamish. We believe that creation of additional habitat will similarly benefit birds. Finally, a number of habitat restoration projects have been constructed in the LDR by the Port of Seattle and others, including between Kellogg Island and Turning Basin #3.

The discussion of land and shoreline use in the draft RP/PEIS should include a discussion of impacts caused by the conversion of shoreline properties from their current designated use. (KC)

Response: Additional language has been added to this discussion that property conversion to habitat would remove land from commercial use (in addition to the existing discussion related to economic impacts in that section). As discussed in the document, the Trustees do not believe that significant amounts of property would be available for the Trustees to purchase, so the impacts of such conversion would be slight. Many projects on commercial property could be done without affecting current uses (as will be the case for the two habitat restoration projects Boeing has agreed to build in their NRDA settlement) or could be built on public property made available for habitat work.

NRDA Process, Injury Assessment Issues

Section 2.1 of the draft RP/PEIS ("Affected Environment") would be clearer if information describing the timeline for compensatory restoration decision making is added. (POS)

Response: This section is intended to be a description of the LDR and surrounding environment as they exist today, and it would be confusing to include a discussion related to timelines for aspects of the NRDA process here. As discussed elsewhere in the response to comments, it is not possible to develop a specific timeline for restoration decisions or actions given the uncertainty of how different PRPs might decide to be involved in the process. Decisions about compensatory restoration actions will be made gradually over time as the Trustees engage with PRPs in settlement negotiations on projects to resolve their liability, obtain settlement funds in which to implement restoration ourselves, and after any litigation is concluded for non-settling PRPs.

The discussion under Restoration Goals and elsewhere confuses injured natural resources with the effects of past physical alterations, and how this relates to baseline is not clear. (POS)

Response: Changes were made in the text to help clarify that the goal of the NRDA in the LDR is to restore injuries resulting from releases of hazardous substances, not from past physical alterations of the LDR. The past physical alterations are considered as part of the baseline conditions at the site.

Under CERCLA, there is liability for clean-up of oil spills but not for natural resource damages, and this is contrary to the Equal Protection Clause of the 14th amendment. (M.C. Halvorsen)

Response: Liability for injury to natural resources resulting from oil spills is covered under OPA, and the Trustees include injuries resulting from releases of oil in our approach toward estimating injury in the LDR.

Commenter requested additional details on the injury assessment process. (PFPS)

Response: Extensive information on the injury estimation approach for early settlement in the LDR was provided in Appendix C of the Supplement to the RP/PEIS.

It would be helpful to include reference materials on economic analyses that are noted as part of the damage assessment process in Section 1.6.2 ("Injury Assessment/Restoration Planning"). (POS)

Response: Additional information regarding potential approaches for injury assessment was included in the Supplement to the RP/PEIS. However, it is important to stress that this section was included in an overview of the NRDA process in general. The HEA approach used by the Trustees to develop the estimates of injury for early settlement does not include any economic analyses. Such analyses could be conducted as part of future assessment work for those PRPs who choose not to seek settlement based on the Trustees' early settlement approach.

The interaction of groundwater with the system in the LDR has been poorly characterized to date and should be included in the evaluations. (PFPS)

Response: The Trustees are evaluating available information from the state and USEPA efforts in the LDR on groundwater as a pathway for contamination in developing our estimates of injury in our early settlement process. The Trustees may conduct investigations of groundwater in future assessment work to evaluate injury for PRPs that have not reached settlement with the Trustees as part of the early settlement process. However, the Trustees believe that the current method for estimating injury for early settlement in the LDR is the best approach to getting significant early restoration in the LDR and do not intend to conduct additional investigations of groundwater at this time.

The LDR has been extensively altered, is a commercial working waterway, and restoring conditions to the historical state is not possible; information is not available on pre-development conditions as a standard to compare with today's conditions. (M.C. Halvorsen)

Response: The Trustees believe the text makes clear that the goal of the restoration is not to attempt to restore conditions to a pre-development state and that restoration to address injured natural resources resulting from the release of hazardous substances needs to co-exist with the existing commercial activities along the LDR. Several restoration projects have been implemented by the Trustees, as well as others including the Port of Seattle, without affecting navigation. The consideration of baseline conditions in the Duwamish incorporates existing development and is not based on conditions existing prior to development.

The damage assessment process is ill-defined in Sections 1.1 and 1.2 and needs appropriate detail. (POS)

Response: The Trustees feel that the discussion of the damage assessment process (discussed in more detail in later sections of the document) is sufficient to provide the necessary background to evaluate the different alternatives for restoration. Readers who want additional information on the NRDA process can find more information in the references cited.

Commenter requests that documentation of injuries be provided and to clarify any intended difference between descriptions of injuries in the Duwamish in the subsections "Trust Natural Resources and Services" and "Need for Restoration Planning." (KC)

Response: The basis for the Trustees' determination that injuries have occurred is discussed in more detail in the Supplement to the RP/PEIS. As explained in the document, a full damage assessment has not been undertaken at this time, but there is evidence that injuries have occurred. Further information regarding injuries to natural resources is available in the Pre-Assessment Screen Determination (EBTC, 2009).

The description of injuries in the subsection "Trust Natural Resources and Services" provides a broad description of the injuries that have occurred and/or potentially occurred in the LDR. The description in the subsection "Need for Restoration Planning" describes the approach of using sediment contamination as the basis for estimating injury for the purpose of early settlement. The Trustees would decide which among the suite of potential injuries provided in the subsection "Trust Natural Resources and Services" would be pursued in any injury assessment for PRPs that do not choose to settle based on the early settlement approach.

The discussion on air quality should link air quality concerns from the river corridor to natural resources covered by the restoration plan. (KC)

Response: The discussion on air quality is included in the description of the affected environment, and was not intended to address potential impacts to natural resources due to air quality issues. At this time the Trustees have not tried to evaluate potential impacts to natural resources from air pollution, and have focused instead on impacts related to contaminated sediments.

Monitoring and Stewardship

Commenter encourages specific metrics for measuring salmon, wildlife, and habitat recovery so we will know when natural resource services are recovered. (DRCC)

Response: The Trustees will monitor the performance of the habitat created at each project in order to ensure that the habitats are providing the ecological services expected. However, it is not feasible to try to monitor salmon or other wildlife populations as a metric for performance of individual NRDA restoration projects or for the NRDA restoration projects as a whole. Using salmon as an example, it would require an enormous effort over many years to try to identify the effect that a restoration project or group of projects is having on salmon populations because there are so many other critical factors for salmon, including ocean conditions, quantity and timing of river flows, harvest, etc.

Commenters supported requiring long-term stewardship as part of every project and one suggested that programs being developed by the Commencement Bay Trustees and the Elliott Bay/Duwamish Restoration Program could serve as models. (KC) (DRCC) (PFPS)(WRIA 9)

Response: The Trustees will require that long-term stewardship be a component of every project and will look to those stewardship programs as potential models. Although the exact mechanism for performing long-term stewardship may differ depending on the circumstances of individual projects, the Trustees recognize that long-term stewardship is necessary for restoration projects to achieve their goals.

Commenter suggested that whoever is doing the environmental monitoring of restoration projects would be prejudiced, and that more than one person and industry should be present. (M.C. Halvorsen)

Response: Monitoring of projects will be done by environmental firms with appropriate qualifications to undertake this work. In the case of PRP-implemented projects, the PRP could choose the environmental firm with Trustee concurrence.

Conditions change so protection of habitat restoration projects in perpetuity should be changed to "as long as these conditions remain." (M.C. Halvorsen)

Response: The Trustees recognize that conditions change and that some of the restored habitats may be affected. However, ecological services will still be provided by habitats as they adjust to changing conditions and adaptive management actions can be performed to mitigate such change; therefore, habitat restoration projects should be protected in perpetuity.

Requests for Clarification and Additional Information

Commenter requests an explanation of whether the intent of the plan is to include the Harbor Island and Lockheed West Superfund sites in addition to the Lower Duwamish Waterway Superfund site, and asks if the Lockheed West site is included whether the plan should include the affected portion of Elliott Bay. (POS)

Response: The Trustees are approaching the LDR as a single "site" for the purpose of NRDA restoration planning, and all injuries resulting from releases of hazardous substances into the LDR—wherever they originate—are included in this planning effort. As part of the estimation of injury, the area under consideration for injury assessment includes the near shoreline area of Elliott Bay fronting the Lockheed West and Harbor Island Superfund sites.

Commenter noted that the plan indicates that the Harbor Island site is included for the purpose of covering compensatory mitigation, but wanted clarification as to whether this includes the East Waterway Operable Unit. (Seattle)

Response: As noted previously, the Trustees are evaluating injuries in the entire LDR, which includes the East Waterway Operable Unit.

Services provided by natural resources are discussed but not defined clearly. (POS)

Response: A definition for the services provided by natural resources—"ecological services"—was added to the Supplement to the RP/PEIS.

The discussion about primary and compensatory restoration does not clearly distinguish them, particularly regarding implementation of "timely and efficient remedial restoration actions." (POS)

Response: Additional discussion was added in the Supplement to the draft RP/PEIS on primary restoration. Information regarding the HEA approach, and how the timing of remedial actions is factored in the determination of compensatory restoration requirements, was also added to this Supplement.

Commenter suggested specific additional references be included regarding water quality, fish species, contamination, and progress on remediation. (KC)

Response: The requested references were added to the Supplement to the RP/PEIS.

Commenter requested more information on the types of risk faced by the resources listed in the document; for example, habitat loss and impacts to food resources. (KC)

Response: The RP/PEIS addresses restoration for injuries to natural resources resulting from releases of hazardous substances. Other risks are not within the purview of the Trustees under NRDA statutes. However, the restoration actions taken under this plan will help address impacts to resources from habitat loss, by creation of new habitat which will increase the availability food resources.

The document does not provide enough detail to fully assess the species-specific restoration alternative and the PEIS from Commencement Bay which discusses this, and other alternatives should be added as an appendix. (KC)

Response: Additional information was provided in the Supplement to the draft RP/PEIS rather than adding the Commencement Bay PEIS as an Appendix. It is difficult to be specific about potential species-specific restoration projects because the approach taken by the Trustees to estimate injury for settlement purposes is based on lost services from habitats and not on direct injury to various species. The types of projects that could be included in a species-specific restoration approach are described generally, as injuries to individual species have not been quantified at this time.

Commenter requested more information related to the injuries in the LDR in order to better evaluate the preferred alternative and the nexus between the restoration and the injuries. (KC)

Response: The Trustees have not conducted a formal damage assessment at this time, so it is not possible to provide detailed information concerning impacts to species in the LDR. A description of the types of resources that were potentially injured is provided in the document. Information on how injury has been estimated for the purpose of early settlement was added in Appendix C and on how habitat restoration is valued was added in Appendix D in the Supplement to the RP/PEIS. The approach used is based on a "lost ecological services" approach due to contaminated sediments, and not on estimating injury to

individual species. The Trustees believe that the approach toward restoring injuries can be evaluated without having conducted a damage assessment and fully quantified injuries. However, further information regarding injuries to natural resources is available in the Pre-Assessment Screen Determination, available online at:
http://www.darrp.noaa.gov/northwest/lowerduwamishriver/pdf/Final_Pre-Assessment_Screen_for_the_Lower_Duwamish_River._Elliot_Bay_Trustee_Council,_December_2,_2009.pdf

There is no mention of the cfs that were diverted to Lake Washington or Lake Union in the Section on Biological Resources (Section2.3 of first draft). (M.C. Halvorsen)

Response: The modifications of the Duwamish River are discussed in Section 3.2 of the RP/PEIS, and the Trustees believe that this discussion is sufficient to inform the reader.

Interstate shipping commerce generates 70,000 jobs for the Seattle area and this is not mentioned in the plan. (M.C. Halvorsen)

Response: A 2009 estimate from the Port of Seattle that the seaport generates 56,000 jobs was added to the Supplement to the RP/PEIS.

Commenter requests additional information on injuries such as recreational services or non-consumptive uses. (KC)

Response: The consumption advisory for resident fish in the LDR is a recreational service loss that results from releases of hazardous substances in the LDR. Non-consumptive uses are described in the subsection "Alternate Methods for Injury Assessment" in the Supplement to the RP/PEIS. A more detailed description of injuries is provided in the Pre-Assessment Screen for the LDR.

Commenters requested additional information regarding restoration projects at the mouths of tributaries to HFA1. (KC) (POS)

Response: Restoration projects located near the mouths of tributaries in HFA1 are expected to provide similar benefits to the injured natural resources as projects located along the LDR itself. The extent to which projects can extend up into the tributaries will depend on the specific details of the project, since fewer of the injured resources would benefit directly as a project extends up into the tributary. The project would need to benefit aquatic habitat used by injured natural resources.

Commenter requests that information be provided about the number of projects identified in the 1994 EBDRP concept document and those specifically in the LDR. (KC)

Response: This information was added to the final document.

Commenter requested that additional information be included on baseline water quality contamination levels, source control, and bank stability. (USEPA)

Response: The Trustees believe that the level of detail provided in the RP/PEIS is sufficient to provide a background to review the alternatives and have provided references (incorporated by reference) where additional information can be found.

Clarify if the term "wetland" in Section 2.1.3, page 13 of the draft RP/PEIS refers to emergent plants and marsh. (POS)

Response: The reference to wetlands was meant to refer to marsh in this section.

Commenter requested clarification about language related to increased sediment and pollution inputs from riparian and marsh habitats. (KC)

Response: The final document clarifies that the loss of riparian and marsh habitats increases sediment and pollution inputs due to reduction in filtration and other attributes of these habitats.

Editorial Comments

The first sentence in Section 1.8.2 does not reflect present environmental decision-making and overstates the ability to alter aquatic area resources without directly linked compensatory mitigation actions. (POS)

Response: The sentence was rewritten in the Supplement to the RP/PEIS to more clearly identify that the loss of habitat that has occurred is significant, and that the Trustees' proposed approach will help address the lack of habitat.

Section 2.0 ("Environmental Setting/Affected Environment") and subsections of the draft RP/PEIS could be improved. (POS)

Response: A number of modifications were made in response to suggestions to improve this section in the Supplement to the RP/PEIS (Section 3.0).

The abstract does not adequately convey the specifics of this plan and is too generic. (PFPS)

Response: The abstract was rewritten and details were added to the Supplement to the RP/PEIS.

The discussion of the role of sediment contamination in the Trustees' injury estimation process does not belong in the section on "Need for Restoration Planning" and should be relocated to a section discussing injury assessment. (KC)

Response: This recommendation was adopted in the Supplement to the draft RP/PEIS.

Commenter recommends adding a subsection on sediment quality in addition to the subsections on air quality, water quality, and climate change. (KC)

Response: Requested subsection was added to the Supplement to the RP/PEIS.

Commenter suggests using the term "rock revetments" instead of "rock breakwaters" and moving the last sentence in the second paragraph in the subsection "Physical Environment." (KC)

Response: Comments adopted.

The Executive Summary would be improved if additional details were included. (POS)

Response: Additional detail was added to the Executive Summary in the Supplement to the RP/PEIS.

Commenter suggested that the EIS provide details about the communities affected by past contamination and industrial activities and how their concerns are being addressed. (USEPA)

Response: The Trustees believe that a more detailed discussion of how past industrial activities have affected local communities is not necessary for assessing the impacts of the restoration alternatives, and they direct those interested in these details to the USEPA website for the Lower Duwamish Superfund Site. The Trustees have held public meetings in the local area to facilitate public participation by the affected community in the process, and are prioritizing restoration within the LDR (HFA1) as part of the restoration effort. The Trustees believe this not only is best for restoring natural resources injured by the releases of hazardous substances, but it is also consistent with our understanding of the desire of the community to do restoration within the affected area.

Actual Comments from the Public from 2009

To: Rebecca Hoff, NOAA

From: M. C. Halvorsen

Subj.: Draft Lower Duwamish River Restoration Plan

Date: June 19, 2009

Fax: 206-526-6665

10002 Aurora Ave. N., #5546
Seattle, WA 98133
June 19, 2009

Roberta Hoff, NOAA
NOAA Damage Assessment and Restoration Center NW
7600 Sand Point Way N.E., Building 1
Seattle, WA 98115

Re: Draft Lower Duwamish River
Restoration Plan

Dear Roberta Hoff:

It was good to talk with you by telephone yesterday afternoon. As promised I am sending you my comments regarding the above-referenced plan. I will comment generally first and then specifically with reference to specific pages and specific sections. As I told you, I am concerned with the 5.5 miles from the north tip of Harbor Island to Turning Basin 3 (and boats still turn around in Turning Basin 3) as that is a working, industrial, commercial, federal waterway and is not acknowledged as such in the Plan.

Because that area has had more alteration than the other areas included in the plan, the industrial, commercial waterway should be treated separately. Instead NOAA has designated HFA 1 as extending up to the North Wind Weir, a distance of 7 miles. The last mile and a half were never straightened and should more properly be included with HFA 3. The Plan is very fuzzy that indeed the first 5.5miles is a working industrial commercial waterway; that the banks of that stretch are fill and trying to plant anything there is like trying to grow flowers in cement. The bank cannot be removed because that would cause the river to return to its winding channel thereby wiping out the industrial, commercial area, which incidentally generates 70,000 jobs. This is unconstitutional as it would interfere with the commerce clause of the U.S. Constitution. It should be explicitly stated that the industrial, commercial waterway has certain alterations that cannot be undone.

In two cases dealing with commercial waterways, United States v. Chandler-Dunbar Water Power Co. 229 U.S. 53, 33 S.Ct. 667, 57 L.Ed 1063) 1913) and United States v. River Rogue Improvement Co., 269 U.S. 411, 46 S.Ct 144, 70 L.ed 339 (1923), the United States Supreme Court, the final arbiter of what the law is in the United States, declared that the primary purpose of a commercial waterway is navigation. It is not fish. There are many more cases dealing in general with navigable bodies of water that state the same thing. The Court has been consistent on this issue all the way down to 2003. I haven't checked past that year and it may be to the present time.

The Chinook return in greater numbers to the Duwamish River than any other rivers in Puget Sound, a fact never mentioned in NOAA's plan. Maybe what the other rivers need is a little industry. The Chinook certainly like it. NOAA plans to change the river. What effect will this have on the Chinook? NOAA and everyone else just assumes the Chinook will adapt. That is an assumption, not science. It could very well be that the Chinook don't like the changes and won't return. If that happens and NOAA ruins the Chinook run, then more harm than good has been done.

Specifically, I have the following comments:

1.7 Goals. P.7, para. 1: Restoring to historical (pre 1911s) conditions is not possible in the first 5.5 miles of the Duwamish Commercial Waterway because it has undergone such a high level of alteration and and they should be clearly stated.

1.8 Need for Restoration Planning. P.8-9, para. 4 on P.8 and para. 1 on P. 9. It is ignored that 5.5 miles of the river is a commercial industrial waterway and cannot be accomplished here. Again, this reads as if that area is just a country stream.

1..8.1 Purpose of Restoration Planning. P 10 in Perpetuity. Conditions change. Perpetuity should be changed to as long as these conditions remain.

2.2 Physical Environment. P. 14, para. 3:The Duwamish River, as were other rivers throughout the country, straightened between 1911-1916 to be a commercial, industrial waterway and it still is in the first 5.5 miles from the north tip of Harbor Island to Turning Basin 3. The banks are fill, not dirt and nothing will grow in them.

2.3 Biological Resources. P.15, para. 1: In discussing the cfs, there is no mention that some of the original cfs were diverted to Lake Washington or Lake Union. This is not really a complete picture.

Birds. P.16, para. 2: Kellogg Island, near Harbor Island, close to the mouth of the Duwamish, is a nature preserve. The next bird area is upland at Turning Basin 3 at Hamm Creek, 5.5 miles distant. Like the Chinook, the birds like the industry in the river. Anyone reading this would never know that an industrial area existed.

Chinook Salmon. P. 17, both paras: See my general comments, P. 1, para. 4. See the legal definition of what is the primary purpose of a commercial waterway.

2.4 Socioeconomic/Cultural Resources. P. 20, para. 20. The interstate shipping commerce in the Duwamish Commercial Waterway generates 70,000 jobs for the Seattle area. There is no mention of that in this plan and in any paragraph muchless this one. I consider the failure to include the maritime industry when listing the jobs in King County as downright underhanded and misleading.

3.2 Public Participation. I have a summer place in B.C., Canada and usually leave for the property in April and return in October. Consequently, I never know of these meetings. The only meeting I heard of and attended was one where NOAA stated, very vindictively , that NOAA was going to punish polluters again after EPA already punished them once for polluting. It sounded like double jeopardy, which is unconstitutional as it violates the 5th amendment to the U.S. Constitution. However, since neither I nor members of my family were polluters, I did not pay further attention to NOAA. Nothing was said about a restoration plan, for if it had been mentioned, I would have paid close attention. Further, I did not subscribe to the Seattle Times. I preferred the now defunct Post-Intelligencer. I am here this year because I hurt my back and am undergoing physical therapy.

4.2 Responsible Party Liability. P. 26, para. 1: CERCLA 42 U.S.C. 9601 et seq. holds oil spills liable only for cleanup and exempts them from natural resource responsibility. (I know because I spent 50 hours in the University of Washington Law Library studying that law.) To me, it violates the Equal Protection clause of the 14th amendment to the U.S. Constitution because oil companies are more equal than the rest of us.

5.1 Description of Preferred Alternative. P.27, line 6: Creation of marshes and mudflats in a working industrial, commercial waterway such as the first 5.5 miles of the Duwamish from the north tip of Harbor Island to Turning Basin 3 is impossible as it would interfere with navigation. It is ludicrous to pretend that such things can be done.

5.2 Restoration of Injured Natural Resources and Services. P. 27. When the 5.5 miles of the Duwamish River was straightened between 1911-1916, fill was placed to create the banks. No assessment to natural resources occurred; thus there is no standard to compare today's existing situation with what was there in 1916. Any comparison would be complete guesswork.

5.3 Key Duwamish Habitats. P. 27 and 28: It is impossible to restore marshes, intertidal mudflats, and shallow subtidal in a working industrial, commercial waterway. I wonder if someone is fantasizing. This is ridiculous. As to riparian habitat, the land in question is private property and cannot be taken for buffers. Riparian Habitat. P.28, para. 4: The property beyond mean high water is privately owned. NOAA cannot take property for the proposed purposes without paying just compensation. Again, this is another hopeless proposal.

5.5 Restoration Process and Objectives. P. 29, last para.: Generally stated these objective sound fine. The problem is it won't work in a working, commercial industrial waterway. I don't like to sound like a broken record but I reiterate: the primary purpose of a commercial waterway is navigation. It isn't fish. Interfering with navigation is unconstitutional and violates U.S. Supreme Court rulings. The banks are fill, 10 ft. deep and trying to grow anything there is like trying to grow flowers in cement.

There is no recognition in this plan that the Chinook return in greater numbers to the Duwamish River that any other river in Puget Sound. See my general remarks, paragraph 4.

In this 5.5 miles, only Hamm Creek is a tributary and enters the Duwamish just south of Turning Basin3, where boats still turn around. I was unaware that hazardous substances were released south of Turning Basin 3. All of the property in the 5.5 miles is used. It is not vacant land. Exactly where does NOAA plan to have permanently wetted areas at appropriate elevations? Incidentally, Mean High Water is 8 feet, not 13.

5.6 Habitat Focus Areas, HFA 1. P. 31, last para., P. 32-33, all: I object to including past 5.5 miles as that has a different history with different effects. The proposed plan for the Lower Duwamish River first surfaced 10 years ago and was discarded as unworkable. The scientists told us that the banks of the river are fill and nothing will grow with them; that there are exactly 7 "spots", some on private property, that do have dirt but that they are not connected. What is planted in the banks will die. The dead material would accumulate on the bed of the river, which would be excessive, which in turn would cause the algae to grow which in turn would suck the oxygen out of the river. This plan will surely kill the river. This is the third time this plan has been dredged up and I cannot for the life of me understand why.

HFA 1The Lower Duwamish River. P.31, last para. nd continues to P.32 Again, this designation including the 5.5 miles of the industrial, commercial waterway of the Duwamish River and extending it another mile and a half is unnatural. The areas have different histories and different characteristics. It is like comparing apples and oranges. The commercial, industrial 5.5 miles of the Duwamish River should be considered separately and the other area should be placed with HFA 3. I don't know if this designation is to camouflage what is being planned but I suspect it is. Obviously, in a commercial waterway weirs cannot exist as ships and boats cannot navigate around them.

HFA 2 Inner Elliott Bay Shoreline. P.32: Again, much of this property is privately owned. The harbor is a busy harbor, not just Port shipping but privately owned interstate vessels, ferries, sightseeing boats and recreational boats. I do not see how this could possibly work.

HFA 3and HFA 4 The Duwamish River Reach and The Green River Reach, respectively, P.32: These areas are not commercialized as the first two areas but much of that land is privately owned and the property owners have riparian rights. NOAA cannot go upon private land without just compensation and cannot abolish anyone's rights, which is what NOAA would be doing.

6. RESTORATION TYPES. 5 Locations in the River P. 35, last para., P. 36, para. 1,2, 3: It is totally ludicrous to try to restore the Lower Duwamish River, a working industrial, commercial waterway to its historical habitat condition, and talking about marshes and mudflats therein is ridiculous.

6. Landscape connectivity. P.36, last para.: In the commercial waterway off-channels and side channels are used by boats to navigate the channel. Any interference with navigation is unconstitutional. I cannot understand why anyone at the Seattle Office of NOAA would seriously propose this. It is totally not feasible and downright ridiculous.

6.1 Desired Types of Restoration. P.37, last para.: Again marshes and mudflats in the industrial, commercial waterway cannot be achieved. This is not a country stream. Furthermore, these plans would interfere with riparian rights of upland owners. Riparian rights, the free use of water in rivers, lakes and streams by the upland owner, can be traced to the Middle Ages. They came to this country from England and are in all 50 states. NOAA cannot abolish rights as that is unconstitutional.

6.1.1 Creation of intertidal Mudflats and 6.1.2 Creation of Marsh. P. 38: my comments are the same as for 6.1. I begin to wonder if people are hallucinating.

P.39, last para.: The placement of large woody debris is not only not feasible but also dangerous to boats. Such debris could become entwined in the propellers of boats and damage them. This is another silly idea.

6.1.3 Creation of Riparian Habitat. P.40, para. 1,2,3: This gives a false picture of where riparian habitats occur. Kellogg Island, near Harbor Island, at the north tip of Harbor Island, is a nature preserve. For 5.5 miles up to Turning Basin 3 there is very little habitat. This is the highly industrialized, commercial waterway whose upland is privately owned and this is where the banks of the river are fill. It is a fantasy to talk of planting Willows, Sitka Spruce, Hemlocks, Douglas Firs, Salal and Oregon grapes. Nothing will grow in the 10’ fill. As it is privately owned, NOAA cannot go upon the private property. Mean High Water in the Duwamish River, according to the line drawn up by the Coast and Geodetic Survey, is 8’.

Paras. 2 and 3 are fantasies also. When the Washington State Derelict Vessel Department informed us that this was the lowest priority with them and it would take years to get to them, Boyer Towing, Inc., an adjacent property owner, in front of whose property there is no pollution, decided to obtain the necessary permits and remove the derelict vessels at their own expense. Removal can only be done at certain times of the year because of the Chinook run.

In the lower Duwamish River, Hamm Creek is the only Creek in that 5.5 mile stretch of the river and it has already been reconnected.

Planting on adjacent lands on private property is the taking of property without due process of law.

6.2 Types of Restoration Not Desired. P.41, whole para.: This whole plan for the 5.5 mile stretch of the Lower Duwamish River is a type not desired. It won't work. As I said I spent 50 hours in the University of Washington Law Library studying CERCLA. It does not give NOAA or anyone else the right to destroy the interstate commerce industry in the name of making the public and environment whole again (which cannot be accomplished with this plan). This proposed plan for the Lower Duwamish River is totally misleading, unrealistic and unobtainable.

6.3 Restoration Project Monitoring and Performance Criteria. 6.3.1 Performance Criteria. P.42: This is too vague to comment on.

6.3.2 Adaptive Management. P. 42: This is too vague to comment on.

6.3.3 Monitoring Parameters. P.43, whole section: I agree monitoring should take place for 10 years but I would be concerned that whoever is doing the monitoring would be prejudiced. Therefore, it should be more than one person and industry should be present or eve be a member of the persons doing the monitoring in the Lower Duwamish River.

6.4 Stewardship Model. P.44, whole section: There is no way that the Lower Duwamish River can be restored to its 1911 condition. Instead a new plan, focusing on the 5.5 miles comprising the working industrial, commercial waterway separately, that realistically evaluates what can be done without interfering with interstate commerce and private property owners' rights should be undertaken.

7. PROJECT SELECTION. 7.1 Summary of Other Restoration Plans. P.45, last para.: WRIA 9 was very general but did state there is no scientific evidence that docks and other structures over the water harm or interferes with the fish run.

The Port of Seattle's Plan, having been discarded 10 years ago and dredged up this year, was not adopted. It was sent back for further scientific scrutiny. I know it won't stand up to such scrutiny because 10 years ago the scientists told us it wouldn't. However, with all these flawed plans out there, there is no need for another restoration plan.

Duwamish Valley Vision Map is another fantasy.

7.2 Selection Criteria. P.46: The Lower Duwamish River(5.5 miles) is not included with those identifying the sites. Industry should particularly include representatives from the maritime industry.
Tier 1 Screening. P.45: Again, a new plan should be drawn up realistically assessing the Lower Duwamish River as it is today and realistic standards should be based on that.

Future Management. P.47: Under no circumstances would I agree to a conservation easement on my properties. One is in the industrial, commercial waterway and I lease to a man who operates a marina there. The other is residential and when I replaced my bulkhead I was asked to plant native species. I did. They died. The banks are fill. It was a waste of money.

Examples of Restoration Projects from Previous Settlements. Appendix C sites Kellogg Island, near the mouth of the Duwamish River and Turning Basin 3. There are none in the 5.5 mile industrial, commercial waterways which separates these two sites.

8. Restoration Alternative Analysis. P.49, para.3: The point that is lost on NOAA is that the damages done by releases of hazardous substances cannot be determined since no assessment of the damages done to natural resources was undertaken as a result of the 1911-1916 straightening. We cannot go back to 1911 which is what this proposal for the lower Duwamish River is. It is completely unrealistic.

8.1 Analysis of the Alternatives for the Purposes of Restoration. 8.1.1. P. 50: The problem here is that is seems that the point is lost on NOAA that it is impossible to return to 1911; that no assessment was taken in 1916 as to what would constitute a baseline for natural resources; and that it is not still occurring. I have owned property on the Duwamish River since 1967 and the river is cleaner now than it was then precisely because people have been stopped from dumping anything they please in the river. CERCLA provides for the restoration of natural resources and services that were injured or lost as a result of the release of hazardous substances. It does not provide for restoration of natural resources and services lost by the straightening of the river. Herein is the fallacy of this plan.

The rest of section 8 to 8.2 is meaningless for the Lower Duwamish River. I cannot comment on other areas.

8.2.1.2 Economic Impacts. P. 55: The economic impact on the 5.5 miles of the working commercial, industrial Duwamish Commercial waterway would be catastrophic as it would destroy the interstate commercial shipping.

8.2.1.5 Recreation and Education. P. 56:The banks of the Lower Duwamish River are fill, 10 feet deep. There is no way NOAA could remove hard armoring without the river reverting to its original winding course thereby destroying the industrial, commercial industry that incidentally provides 70,000 jobs. Kayaking and boating may not be desirable in such a busy waterway. Homeland Security and the Coast Guard do not want such activity because it isn't safe around ships, tugs and large barges. It is not possible to have any more parks in the 5.5 mile area that comprises the working industrial, commercial waterway. Parks in an industrial area are used by prostitutes, drug dealers and transients. The Police Department cannot patrol them and the Fire Department is adamantly opposed to them. This particular paragraph reads like something out of Alice-in-Wonderland where people pretend the working industrial, commercial waterway is just a country stream.

8.2.1.6 Land and Shoreline. P 56: This is private property and cannot be used the way NOAA proposes.

8.2.1.8 Wetlands. P.57: There is no way to have wetlands in the 5.5 miles of the working industrial, commercial Lower Duwamish River.

8.2.2.3 Floorplain and Floor Control . P.58: Off-channels in the Lower Duwamish River are used by ships, tugs and barges to reach the channel. It is not possible for NOAA to place off-channel habitat there as it would interfere with navigation, which is unconstitutional.

8.2.3 Unique Characteristics of the Geographic Area in Which the Alternatives Would be implemented [40 CFR 1508.27 (B) (3)]. P.58, last para.: The Chinook salmon return in greater numbers to the Duwamish River than any other river in Puget Sound. Maybe what the other rivers need is a little industry. The Chinook certainly like it. However, it is obvious the Chinook like the river the way it is. NOAA proposes to change the river. What fish biologist did you talk to who told NOAA it would not hurt the Chinook, possibly destroying the run altogether? Assuming that the fish will adjust is an assumption/ not science.

Ten years ago, when a plan for the 5,5 miles of the Lower Duwamish River first surfaced, very similar to the plan NOAA is putting forth here, scientists old us it would not work. The banks of the river are fill and nothing will grow in them. It is like trying to grow flowers in cement. Therefore, the plantings will die, causing excess dead material on the riverbed, causing in turn the algae to grow, causing in further turn for the oxygen to be sucked out of the river. That would surely kill every living thing in the river and do more harm than good.

I have no way of knowing if the environmentalists do not know of this scientific evidence; whether the environmentalists cannot admit of this scientific evidence; or whether they think no one will remember ten years ago.

In addition, this plan is unconstitutional as it would abolish the riparian rights of the upland owners and would ignore the rulings of the U.S. Supreme that navigation is the primary purpose of a commercial waterway.

8.2.4 Controversial Aspects of the Alternates. P.59: It is highly controversial in the 5.5 miles that comprise the working industrial, commercial waterway as it would completely destroy the industrial shipping industry. Unfortunately, no one cares about the 70,000 job loss generated by that industry or the resultant tax loss in addition to the job loss.

8.2.6 Precedential Effect of the Alternatives. P.59: This paragraph totally ignores the character of the 5.5 miles comprising the working industrial, commercial waterway and pretends NOAA is dealing with a county stream. It is totally unrealistic.

I am not commenting on the plans on pages 60-64 as I do not know how it would affect the areas other than the Lower Duwamish River. It will not work in the 5.5 miles of the working industrial, commercial Duwamish River. My only other observation is that Elliott Bay is a very busy harbor and I have serious doubts that it will work there either. However, I have not studied Elliott Bay and just pass my observation along.

9. COORDINATION AND CONSULTATION, Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), etc. P. 65: As I said before, I spent 50 hours in the University of Washington Law Library studying 42 USC 9601 et seq., and I am very familiar with it. Damage to natural resources is specifically for damage caused by the dumping of hazardous material. The Duwamish Waterway was straightened between 1911-1916. In 1916 no assessment was done to determine what natural resources suffered damage. There is no way to return to 1911; thus baseline conditions must be as of 1916. NOAA has no standard against which to measure what damage was done by the hazardous materials subsequently dumped in the river. The 5.5 mile work industrial, commercial waterway should be treated separately because only that area was straightened and has different factors affecting it.

Oil pollution Act of 1990 (OPA) 33 USCNo. 2701 et seq. P. 65: This act is later than CERCLA but the two laws say different things. CERCLA holds the oil companies responsible for the oil spill only for the cleanup and specifically exempts them from natural resources damage..

Rivers and Harbors Act, 33 USC 401 et seq., P.66: I am familiar with this act as I had occasion to read it in 2005. I am delighted to see that NOAA acknowledges the prohibition of unauthorized obstruction or alteration of navigable waters. This proposed plan, insofar as the 5.5 mile working industrial commercial Duwamish Waterway would do just that. Therefore, NOAA is prohibited from breaking the law.

Magnuson-Stevens Act (MSA)…16 USC No. 1801 et seq.,50 CFR Part 600. P.67: This act did not say that fisheries is the most important industry and that all other industries are subservient to it. Indeed, it could not do so. Where the U.S. Supreme Court had ruled that navigation is the primary purpose of a commercial Waterway, Congress cannot overturn that body.

Executive Order 11988 Floorplain Management. P. 67: This really does not pertain to commercial, industrial waterways.

Executive Order 11990 Protection of Wetlands. P.68: This is in regard to new wetlands. It does not give NOAA the right to interfere with navigation in rivers.

Executive Order 12898 Environmental Justice, as amended. P. 68: This is not applicable to an industrial, commercial waterway as the first 5.5 miles of the Duwamish River are.

Executive Order 11514 (35 Fed. Reg. 4247) – Protection and Enhancement of Environmental Quality. P 68 I cannot see that Order gives NOAA the right to interfere with navigation in navigable bodies of water; nor the right to take private property for whatever purposes; nor the right to rearrange a commercial waterway, all of which this plan would do.

Executive Order 12962 (^) Fed. Reg. 30, 769) – Recreational Fisheries. P. 69: This Order does not give NOAA the right to develop recreational fisheries along a busy working industrial, commercial waterway such as the Duwamish Commercial Waterway. No one seems concerned with safety. Such fisheries would not be safe the recreational users nor for those engaged in interstate commercial shipping. I have no objection to recreational fisheries as long as they are not in an industrial area.

10. REFERENCES

Blomberg, G., C. Simenstad, and P. Hickey. Changes in Duwamish River Estuary Habitat Over the Past 15 Years. P.71: George Blomberg, a Port of Seattle employee, is an environmentalist, not a fish biologist. He has an agenda of his own and needs to be taken with a grain of salt.

Duwamish River Cleanup Coalition. Duwamish Valley Vision Map and Report, 2009. P. 71: This is a fantasy.

Port of Seattle, Lower River Habitat Restoration Plan: An Inventory of Port of Seattle Properties, by AHBL, Seaport Planning Group. January 13, 2009. I am not familiar with this document. I do know that the Port of Seattle, Lower River Restoration Plan itself was not adopted by the Commissioners of the Port of Seattle but was referred to further scientific scrutiny.

In general, many references pertain to pre-establishment of the straightening of the river and are not applicable to the Lower Duwamish River as a basis of restoration. No reference pertains to the straightening of the river itself and the creation of the working industrial, commercial waterway that became the Duwamish Commercial Waterway. I find them slanted leading to bias.

11. Glossary. P.79

Baseline Condition. P.79: I could not find this in any dictionary that I looked in, so I am assuming NNOAA is creating a new condition. However, it is not clear which year NOAA is using. Indeed, different parts of Puget Sound have different years. At least you know a Baseline is a measuring.

Primary Restoration. P. 81: I disagree with your interpretation of CERCLA.

Appendix C Examples of Restoration Projects Completed from Earlier NRDA Settlements. Turning Basin 3. P. 95: Boats still turn around in Turning Basin 3. It is afterall still a part of the working industrial commercial waterway that is know as the Duwamish Commercial Waterway.

My conclusions are as follows:

1. The proposed plan, as regards the Lower Duwamish River, will not work and should be discarded.

2. The 5.5 mile working industrial, commercial Duwamish Waterway should be a separate unit that is studied separately. South of Turning Basin 3 to the North Wind Weir should be included in HFA 3.

3. A new plan should be formulated for the Duwamish Commercial Waterway establishing that it is a working industrial, commercial waterway and stating that restoration is limited. The extent of damage from pollution cannot be determined because the River was straightened and no evaluation was undertaken to determine damage from the straightening, thus no basis exists from which to compare present day damage.

Thank you for your attention to this matter.

Very truly yours,

M. C. Halvorsen

M. C. Halvorsen

cc: Patricia Montanio, NOAA
Dir. Eduardo Ribas, NOAA
Acting Chrmn, FMC
Senator Patty Murray
Senator Maria Cantwell
Representative Jay Inslee
Ken Brunner, ACOE
Matt Longgenbaugh, National Marine Services
Boyer Towing, Inc.
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July 28, 2009

Rebecca Hoff
NOAA Office of Response and Restoration
7600 Sand Point Way N.E.
Seattle, WA 98115

Dear Ms. Hoff:

Thank you for the opportunity to submit comments on the Draft Lower Duwamish River Natural Resource Damage Assessment (NRDA) Programmatic Restoration Plan and Programmatic Environmental Impact Statement (RP/PEIS). King County's Wastewater Treatment Division and Water and Land Resources Division offer the following comments.

General Comments

1) We support the general approach laid out in the draft restoration plan identifying the basic types of all-purpose habitat that should be developed to help facilitate the development of future projects. By targeting the restoration or enhancement of ecosystem functions typical to the system, the likelihood of developing sustainable habitat is increased. We feel this is a sound approach to removing barriers for parties that have some liability under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Oil Pollution Act of 1990 (OPA).

2) We encourage coordination with the other existing entities that have developed habitat plans in the Green/Duwamish watershed, listed in Section 7, to take advantage of the prioritization work already accomplished. A process to ensure that parties pursuing individual projects work with these entities should help maximize their habitat value.

3) Other NRDA work conducted by the Trustees referred to in this document is often central to positions stated and conclusions drawn. Without the ability to see these documents, which are only available for review at the National Oceanic and Atmospheric Administration (NOAA), it is difficult to determine if the statements made are appropriate and the conclusions drawn acceptable. At a minimum, the relevant documents should be clearly referenced in the document so that reviewers have some idea what material is the basis for statements presented. It is preferred that relevant materials be included as appendices to the Programmatic Environmental Impact Statement (PEIS) so that reviewers have access to all relevant material for their review. Specifically, the lack of adequate documentation creates the following problems:

-- The preferred restoration alternative is difficult to evaluate without understanding more about the species that are injured and the degree of injury. It would be helpful to have more information on the types of injuries NOAA determined has occurred. For example, are there injuries to species' habitat, food resources or directly to the species of concern?

-- It was difficult to assess Alternative 2 (Species-specific) versus Alternative 3 (Integrated Habitat) because of the lack of information presented for Alternative 2. The report refers the reader to the Commencement Bay PEIS for various aspects of the evaluation. We recommend that summaries of the Commencement Bay PEIS findings be included to facilitate the evaluation of the alternatives. However, this is not to say we disagree with the preferred approach (see Comments 34 and 35). It would be easier to evaluate the alternatives if more information was presented with regards to references to the Commencement Bay PEIS.

4) The document should address impacts associated with the length of time it would take to implement each alternative. Land acquisition, funding, design, permitting, and construction of habitat restoration projects could take a decade or longer. Litigation could add more time. How will implementation timeframes impact the alternatives' potential for success?

<u>Specific Comments</u>

5) Section 1.8, pages 7-8: It would be helpful to understand the types of risk faced by the resources listed, for example, habitat loss and impacts to food resources.

6) Section 1.8, page 9: The paragraph beginning "Because of the central role that sediments ..." does not seem to fit the discussion under this section heading, "Need for Restoration Planning." We suggest this paragraph be moved to a section that includes discussion of injury assessment.

7) Section 1.8, page 9: Please state which bird assemblages were used to assess the value of habitat to birds, similar to how specific fish species were listed. Also, present more information on how NOAA evaluated the potential loss of natural resources in terms of fish and bird habitat.

8) Section 2.1, page 11: Please add the Draft Feasibility Study for Lower Duwamish Waterway to the list of documents detailing contamination and progress on remediation *(AECOM 2009. Draft Feasibility Study for Lower Duwamish Waterway. Prepared for US EPA and Department of Ecology by AECOM, Seattle, WA).* Also include the East Waterway Operable Unit Existing Information Summary Report (*Anchor Environmental and Windward Environmental 2008. East Waterway Operable Unit Existing Information Summary Report. Prepared for US EPA by Anchor Environmental and Windward Environmental, Seattle, WA*).

9) Section 2.1.1, pages 11-12: In general, air quality concerns include a broader area and source than the Lower Duwamish River corridor. If air quality is included, the text should link air quality concerns from the river corridor to natural resources covered by the restoration plan.

10) Section 2.1.2, page 12: The King County report cited did not evaluate water quality conditions on the majority of the Lower Duwamish River. It focused on the very upstream segment as well as tributaries to the Duwamish River. King County's Water Quality Assessment of the Duwamish River and Elliott Bay would be a better source of water quality evaluation for the Duwamish River (*King County Combined Sewer Overflow Water Quality Assessment for the Duwamish River and Elliott Bay. King County Department of Natural Resources, Seattle, WA, 1999*). The Lower Duwamish Waterway Remedial Investigation would be another source of water quality information (*Windward 2007. Lower Duwamish Waterway Remedial Investigation Report; draft. Prepared for the USEPA and Washington DOE, Seattle, WA*).

11) Section 2.1: We recommend adding a subsection that discusses sediment quality to make Section 2.1 complete, in addition to the existing subsections that address air quality, water quality, and climate change.

12) Section 2.2, page 14: In the first paragraph of this Section, the term "rock breakwaters" should be replaced with "rock revetments."

13) Section 2.2, page 14: The last sentence of the second paragraph is not appropriate in this section. Please delete it or move it to a more appropriate section.

14) Section 2.3, pages 15-16: Additional information on fish species found in the river can be obtained from the Lower Duwamish Waterway Remedial Investigation (RI). A number of fish trawls were conducted and the results of these are summarized in the RI.

15) Section 4.1, page 25: The explanation of Federal Trustee responsibilities in the second paragraph does not acknowledge the role of local governments and their responsibilities related to Trust Resources. Local governments are clearly identified in CERCLA and OPA ("the Acts") among the entities with resources "belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by…" Local government responsibilities include: (a) Metro (now King County), under state legislation, is responsible for water quality in the central Puget Sound region in portions of Water Resource Inventory Areas 7, 8, and 9; (b) Local governments regulate land use, which is key to the ability to protect and restore natural resources defined under the Acts; (c) Under the Growth Management Act (GMA), local governments have the responsibility to protect critical areas including the lower Duwamish River; (d) King County and other jurisdictions own, manage, and hold in trust various resource lands and critical habitat in the Habitat Focus Areas; and (e) As general purpose governments, local governments have the responsibility to protect the health and welfare of the public, which includes public resources such as air, water, and land. Local governments have trustee responsibilities and should be consulted in the development of restoration plans and related decisions.

16) Section 4.1, page 25: The third paragraph in Section 4.1 states "Injuries have been documented…" Please list all of these documents. Also clarify any intended difference between the statement in the last sentence of the paragraph and the discussion of injuries presented in Section 1.8.

17) Section 5.2, page 27, first sentence: Please provide citations for where the Trustees have documented key natural resources in the lower Duwamish River as well as injuries to those resources. This information is needed to determine the appropriateness of the restoration plan and adequacy of the PEIS.

18) Section 5.2, page 27, first paragraph: Please provide more specific information on the services the Trustees believe may have been injured, for example, what recreational services or non-consumptive may have been injured?

19) Section 5.2, page 27: The last sentence discusses how marsh vegetation increases productivity of animals and plants living in and on sediments. Please note that marsh vegetation also increases productivity of salmonids and resident fish species.

20) Section 5.5, objective 1: We agree with this objective but find it difficult to assess the nexus without more documentation being provided in the document.

21) Section 5.5, objective 4: We strongly support this objective and request meaningful coordination with local governments, as they have both trustee and regulatory responsibilities.

22) Section 5.5, objective 4, fourth bullet: This flexibility will be the key to the long-term success of the restoration plan and we strongly support allowing all these options. See later comments on concerns with long-term stewardship needs, Comments 23 and 31.

23) Section 5.5, objective 5, third bullet: While we understand the need for long-term commitment and public involvement for the success of these types of programs, we feel a more formal approach is needed to ensure that long-term stewardship is maintained. Without such commitment, the efforts and expense of restoration have very low probability of achieving the designed functions. We suggest that long-term stewardship plans be required as part of every project. Those funds could then be coordinated into a single stewardship program that can coordinate with the public and non-profit organizations to provide the site work needed over time to ensure that restoration projects develop into fully functioning habitat. Programs being developed by the Elliott Bay/Duwamish Restoration Program (EBDRP) and Commencement Bay can be used as models.

24) Section 5.6, page 31: The first paragraph of Section 5.6 should include a reference to the Lower Duwamish Waterway Remedial Investigation Report. The reference cited in the document does not cover most of the Duwamish River.

25) Section 5.6, page 31: Habitat Focus Area1 (HFA) is defined as the Lower Duwamish River from the northern tip of Harbor Island to North Winds Weir. The document describes this area as the heart of the transition zone for juvenile salmon. The transition zone is described as the area where fresh and salt water mix and where juvenile salmon osmoregulate. Based on data and modeling described in the Draft Lower Duwamish Waterway Remedial Investigation Report, the transition zone would not include the entire HFA1, but a portion of it. The movement of the saltwater wedge in the Duwamish River begins at approximately river mile 3.5 (if River Mile 0 begins at the northern tip of Harbor Island). The area downstream of this point consists of marine water with only a thin freshwater lens along the surface of the river. Therefore, it seems if the restoration work is to focus on the transition zone for juvenile salmon, the areas upstream of river mile 3.5 in HFA1 and areas in HFA3 would be the focus.

26) Section 5.6, page 32, HFA1: Please clarify the last sentence in this section as this particular situation is not discussed under habitat types.

27) Section 5.6, page 32: HFA2 refers to areas of higher salinity as not being part of the transition zone for juvenile salmon; higher salinity is also found in approximately the last 3-4 miles of HFA1.

28) Section 6, page 36, first paragraph: An additional reason why the transition zone has moved further upstream is that the deeper navigation channel dug in the waterway allows saltwater to intrude further than would natural river bathymetry.

29) Section 6, page 36: We strongly encourage that landscape connectivity is highly valued as a habitat function. Particularly in an urban system, it is critical to the habitat value, especially to the terrestrial species targeted under the restoration plan.

30) Section 6.4, page 44: The fourth sentence in the first paragraph currently says that riparian and marsh habitats have increased sediment and pollution inputs. Please explain how the lack of riparian and marsh habitats have increased sediment and pollution inputs. We assume it is because of the lack of natural filtration and other attributes these habitats provide to reduce pollution from entering a river system.

31) Section 6.4, page 44: It is unclear exactly what is required for stewardship in the restoration plan. We support development of a permanent long-term stewardship program that is sustained by required contributions from each project. Once proponents meet short-term survivorship commitments, there is little incentive to continue to provide the long-term stewardship required to develop sites into fully functioning habitat. Both the EBDRP and Commencement Bay have viable models for such a program and we suggest coordinating the stewardship needed for these projects with those programs for efficiency and certainty.

32) Section 7.1, page 45: Please list the number of projects identified in the 1994 EBDRP concept document and those specifically in the lower Duwamish River.

33) Section 8, page 49: The PEIS that reviewed potential restoration approaches in Commencement Bay is key to this document and should be included as an appendix.

34) Section 8.1.2, page 51: The discussion of Alternative 2 includes statements about a broad range of affected species. However, the case has not been presented in this document to determine which species these may be or how they may be affected. Without this information, it is not possible to determine if this alternative is feasible and potentially more appropriate. Because this document does not clearly identify what species-specific injuries have occurred, we cannot determine if appropriate specific restorations could target those needs as effectively as the general habitat approach. We believe this information should be provided and assume it will clearly demonstrate that the conclusions presented in the document are supported.

35) Section 8.1.3, page 53: We support this alternative as the preferred alternative. This alternative meets the needs of the resources and provides the most realistic implementation.

36) Section 8.2.1.3, page 55: We believe that both action alternatives would have short-term impacts on energy and natural resources.

37) Section 8.2.1.6, page 56: We believe that both action alternatives would impact land and shoreline use. Land use of the areas converted to habitat would effectively be removed from their current designated use. In particular, sites in the waterway would remove industrial land from the land use inventory. In many cases it would be relatively minor, but as the GMA has identified, industrial land use is limited and is to be protected. Such impacts should be identified in the document.

38) Section 9, page 65: It is not clear in this section if the guidance for habitat laid out in this document has been determined to adequately address concerns of the federal agencies required for consultation under the Endangered Species Act, Magnuson-Stevens Act, Fish and Wildlife Coordination Act, and relevant Executive Orders. It would promote implementation of the restoration plan if this point was clarified and the document more clearly defined requirements for individual projects with regards to compliance with specific regulations or orders.

Thank you for the opportunity to comment. Please contact Sue Meyer, Environmental Planner, King County Wastewater Treatment Division, at 206-684-1171 or sue.meyer@kingcounty.gov with any questions and future opportunities to comment on the Lower Duwamish River RP/PEIS.

Sincerely,

Christie True
Director
King County Wastewater Treatment Division

Mark Isaacson
Director
for
King County Water and Land Resources Division

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OFFICE OF
ECOSYSTEMS, TRIBAL AND
PUBLIC AFFAIRS

July 28, 2009

Ms. Rebecca Hoff
NOAA
Damage Assessment and Restoration Center NW
7600 Sand Point Way NE, Building 1
Seattle, WA 98155

Subject: Draft Lower Duwamish River NRDA Programmatic Plan and Environmental Impact Statement. EPA Project number 07-023-NOA

Dear Ms. Hoff:

The U.S. Environmental Protection Agency (EPA) has reviewed the draft Environmental Impact Statement (EIS) for the **Duwamish River NRDA Programmatic Restoration Plan and Programmatic EIS** (EPA Project Number 07-023-NOA) in accordance with our responsibilities under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act. Section 309, independent of NEPA, specifically directs EPA to review and comment in writing on the environmental impacts associated with all major federal actions. Under our policies and procedures we evaluate the document's adequacy in meeting NEPA requirements.

The EIS is being developed to provide guidance to the Lower Duwamish River Natural Resource Trustees (Trustees) in their decision to implement restoration of natural resources that have been impacted by hazardous substance releases. The Trustees include NOAA; US Fish and Wildlife Service; the Bureau of Indian Affairs; Washington State Departments of Ecology, Fish and Wildlife Service, and Natural Resources; the Muckleshoot Indian Tribe; and the Suquamish Indian Tribe. The Duwamish River has undergone widespread contamination with numerous potentially responsible parties (PRPs) and therefore, this EIS is also intended to keep the public and PRPs informed of restoration planning and the decision making process.

We appreciate the coordination with EPA staff involved in clean up activities through our Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) authority. We believe that the EIS comprehensively describes the restoration strategy, restoration objectives, and monitoring criteria. We have assigned a rating of Lack of Objection (LO) to the draft EIS. This rating and a summary of our comments will be published in the Federal Register.

While we support the project, we have suggestions we believe would strengthen the document. In our comments on the preliminary draft EIS, we recommended inclusion of additional detail on baseline water quality. We acknowledge that this is a broad scale programmatic EIS and that more detail will be provided as restoration proposals are submitted to NOAA and Environmental Assessments are developed. However, we believe that the programmatic EIS should also provide data and a discussion of current water quality contamination levels, details about sources impacting water quality and potential restoration effectiveness (e.g. non point source, storm water outfalls, invasive species), and bank stability.

The EIS includes good references to other restoration plans that exist for the Duwamish River. We are glad to see that the Duwamish River Cleanup Coalition Visioning Report was included in this list. This report is a great resource that helps readers understand the perspective of the impacted community. Their main concerns are about health and environmental impacts from multiple sources of pollution and they look forward to a cleaned up Duwamish River Valley. Although the EIS includes a section on public participation, and a section on cultural resources and Tribal resources that have been impacted, the EIS should provide more detail about coordination with communities of concern and how restoration proposals can address their issues. We recommend that the EIS provide some detail about the communities affected by the past contamination and industrial activities, what their concerns or ideas are with restoration projects, and how these concerns are being addressed.

Thank you for the opportunity to comment on this draft EIS. If you would like to discuss our comments further, please contact Lynne McWhorter of my staff at (206) 553-0205.

Sincerely,

Christine B. Reichgott

Christine Reichgott, Manager
Environmental Review and Sediment Management Unit

Duwamish River Cleanup Coalition

Community Coalition for Environmental Justice • The Duwamish Tribe• Georgetown Community Council • IM-A-PAL • ECOSS • People for Puget Sound • Puget Soundkeeper Alliance • South Park Neighborhood Association • Washington Toxics Coalition • Waste Action Project

Rebecca Hoff, NOAA
NOAA Damage Assessment and Restoration Center NW
7600 Sand Point Way NE, Building 1
Seattle, WA 98115
Email: Rebecca.Hoff@noaa.gov

July 28, 2009

Dear Ms. Hoff,

RE: Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement

The Duwamish River Cleanup Coalition is the Community Advisory Group for the Lower Duwamish River Superfund Site. We represent ten stakeholder organizations, including the Duwamish Tribe, Environmental Coalition of South Seattle, South Park Neighborhood Association, Georgetown Community Council, People for Puget Sound, Puget Soundkeeper Alliance, Community Coalition for Environmental Justice, IM-A-PAL Foundation, Washington Toxics Coalition and Waste Action Project. DRCC attended the previous scoping Meetings for the Lower Duwamish River Restoration Plan and Programmatic Environmental Impact Statement and the May, 2009 presentation on the Plan

Overall Restoration Strategy. DRCC strongly supports the restoration project evaluation utilizing an ecosystem based approach rather than a single species.

Integrated habitat Restoration. We support Integrated Habitat Restoration and agree that restoration that can integrate intertidal mudflats, shallow subtidal, marsh and riparian habitat is of high value and more natural resource credits be awarded to those areas.

Coordinated Restoration and Cleanup. Emphasis on restoration projects that are coupled with site cleanup and treatment to minimize impacts to the river, fish, wildlife and human communities .

Long-term Monitoring, stewardship and site maintenance. DRCC supports the commitment to long term monitoring, ongoing stewardship and maintenance. NOAA and the trustees should specify what range of mechanisms "will be established by the Trustees to ensure long-tem stewardship of NRDA sites."

Partnerships Opportunities. Opportunities to include private property of businesses that are not classified as PRP's but are adjacent to NRDA restoration sites should be pursued in order to increase size and functionality of habitats.

Inclusion of public in restoration planning, implementation and monitoring. Emphasis should be given to local business and workforce including utilizing local educational and training institutions toward that end.

Marine fish, shellfish, birds, juvenile salmonids. DRCC support the "highest priority for Habitat Focus Areas are assigned to HFAs that provide habitat for all the injured groups of species identified by the Trustees (marine fish and shellfish, birds, juvenile salmonids)." Clams and other shellfish are historical traditional tribal foods and should continue to be a high priority for habitat recovery along with salmon, both adult and juvenile.

WRIA 9. Emphasis should continue to be given to the fish habitat needs and goals developed by the Green-Duwamish Fish Habitat Enhancement Group/WRIA 9 Steering Committee.

Integration of Restoration with Cleanup. DRCC strongly supports integration of habitat restoration with the EPA riverwide cleanup the Department of Ecology Source Control efforts. This will reduce cost, encourage cleanup that is habitat restoration focused from the onset and reduce the impact on the surrounding communities by a prolonged clean up and restoration process.

Public Access. DRCC would like to see a high priority for projects that integrate habitat restoration and public access. long term public access to the river ensures long term support for monitoring and stewardship.

Public Involvement. The RI/FS for the Lower Duwamish Waterway is carried out under an enhanced Public Participation Plan. The Duwamish River Valley Residents have come to expect that level of public. DRCC encourages public involvement including outreach to immigrant, Latino and Pacific-Islander populations. NOAA and the Duwamish Trustees should ensure a robust public involvement and review process for each NRDA restoration project under consideration.

Timelines and Metrics for Recovery. DRCC supports more rigorous timelines for completion of the individual restoration plans and for the overall riverwide restoration. In addition, we encourage specific metrics for measuring salmon, wildlife and habitat recovery. i.e. How will we know when populations and natural resource services are recovered?

Lower Duwamish River. DRCC supports a strong emphasis on projects in the Lower Waterway. Projects outside the waterway are a low priority.

Thank you for the opportunity to review the Lower Duwamish River NRDA Programmatic Restoration Plan & Programmatic Environmental Impact Statement.

Thea Levkovitz
Duwamish River Cleanup Coalition
thea@duwamishcleanup.org

PEOPLE FOR PUGET SOUND

pugetsound.org

July 28, 2009

Rebecca Hoff
NOAA Office of Response and Restoration
7600 Sand Point Way NE
Seattle, WA 98115
Via email: DuwamishPEIS.DARRP@noaa.gov

RE: Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement

Dear Ms. Hoff,

Thank you for the opportunity to comment on the *Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement*, dated May 22, 2009.

People For Puget Sound is a nonprofit, citizens' organization whose mission is to protect and restore the health of Puget Sound and the Northwest Straits.

Background: CERCLA allows trustees to seek damages for injury to, destruction of, loss of, or loss of use of natural resources. The process that must be used for restoration uses selection criteria (extent of restoring resources that have been impacts, likelihood of success, risk of collateral injury, and effect on public health and safety, and cost). Responsible parties and third parties can do the work.

The NRDA process relates to the multiple Superfund cleanups in the Duwamish/Elliott system (Lower Duwamish, Harbor Island and Lockheed W and RCRA sites). Technical approach will be the same as Commencement Bay.

The programmatic EIS is designed to be general for the whole program but more specific efforts will accompany each project.

Our specific comments follow:

1. **Overall approach.** People For Puget Sound agrees with the ecosystem approach selected in this plan, specifically the Integrated Habitat Restoration Approach (rather than a species-specific approach). This will integrate habitats to maximize ecological function, looks to long-term sustainability and includes a commitment to stewardship. We agree that the highest priority (as identified by the WRIA effort) is marsh and mudflat, followed by riparian buffers.

2. **Integration of restoration with cleanup.** Integration of restoration with cleanup is an excellent idea. We believe that this should be a high priority and these projects should be given an incentive. Not only will it be more cost effective, it will also help push cleanup efforts to be more habitat-friendly from the start.

3. **Scope.** We object to allowing any projects outside of the Duwamish Elliott geographic area. The damage occurred in this area and the restoration needs to also occur here. There are plenty of needs within the lower river and the bay.

4. **Goal too low.** A goal of "restore injured natural resources to baseline by helping improve the ecosystem of the Lower Duwamish River to a more acceptable condition that can support both natural resources and human use of the system." is too low a bar. We need high quality habitat, not "acceptable" habitat.

5. **Groundwater.** Groundwater – its interaction with the system – has been poorly characterized in the lower watershed to date. This should be included in evaluations.

6. **Climate change.** We believe that priority should be given for restoration efforts that show a clear plan that the site will be able to adapt with Climate Change impacts, such as sea level rise or significantly changed hydrologic regimes.

7. **Long-term stewardship**. We strongly support long-term stewardship as this ensures that our dollar investment is protected. The draft plan needs to more clearly require this (on page 31). The term "encourage" is not adequate.

8. **Size of restoration projects**. We support giving small projects more priority rather than what is proposed. Linear and small, frequent projects in this constrained watershed can make sense and improve the corridor function of extant habitats. It seems unnecessary in this system to give more priority to large projects.

9. **Technical valuation.** This is a significant deficit in this document as the omission of the technical valuation approach hampers public understanding of the program. The specific technical approach should be included as an appendix to this plan. It is difficult for the public to determine that the habitat will be valued in a transparent way for this area. A highly detailed description is not needed but a basic overview, basically a 2-4 page overview of the approach, the types of factors taken into consideration, a referral to the Commencement Bay documents (specifically Appendix C), representative species, habitat values (and general range of these), species weighting, what qualifies as "fully functional," "baseline adjusted," and "degraded" and values associated, habitat polygon determination, time period for recovery. In addition, the injury assessment process should be included.

10. **Production ratio.** In the Commencement Bay process "a 1:1 productivity ratio is assumed for the level of ecological services provided by created relative to natural habitats. This implies that restored habitats will be as productive as natural habitats in terms of all associated services. There is uncertainty associated with the outcome of restoration projects…" We disagree that 1:1 is adequate because a certain percentage of the habitat WILL fail. The Trustees are asking us to take it on faith that monitoring, etc. will ensure 100% habitat and this is unreasonable. In addition, as an entity responsible for several restoration projects in the Duwamish, we can vouch for the considerable long term effort needed to control invasive species until plant succession

creates an adequate riparian canopy. The temporal loss of habitat function while this succession is taking place should be incorporated into replacement ratio requirements. Washington Department of Ecology provides guidance on this issue.

Document style:

1. **Abstract**. The abstract needs to be improved. As written, it doesn't really convey the facts of the document and therefore does not stand alone. We suggest that it be rewritten to be more specific to the specific situation of this plan rather than a generic abstract that could apply to any site.

Thank you for your consideration. If you have any questions, please contact me at (206) 382-7007/htrim@pugetsound.org.

Sincerely,

Heather Trim
Urban Bays and Toxics Program Manager

Port of Seattle

DATE:	July 28, 2009
TO:	Rebecca Hoff NOAA Office of Response and Restoration
FROM:	Kathy Bahnick, Geo. Blomberg Seaport Environmental Programs
SUBJECT:	Comments—Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement

Please find below comments and notes regarding the 5-22-09 draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement. The port is grateful for the opportunity to see the draft EIS take shape. In addition, the port is pleased for the contributions your office made to the port's recently completed Lower Duwamish River Habitat Restoration Plan (final document dated 7-7-09). The ability to collaborate in planning, and potentially implementing, habitat improvements in south Elliott Bay and the Duwamish Waterway is an essential element of successful fish and wildlife restoration.

Executive Summary:

The executive summary derives from the body of the draft EIS, however, several of the summary statements would benefit from using descriptions presented in Chapter One and Chapter Five. In particular, discussion of habitat focus areas, use of an integrated habitat restoration approach, restoration goals, and restoration planning is expertly evaluated in sections 1.7, 1.8, and 5.1 through 5.6. The executive summary would be improved using more similar statements and evaluations.

Discussion under Restoration Goals confuses injured natural resources with the effects of past physical alteration of south Elliott Bay and the Duwamish River estuary. It is important to clearly distinguish between CERCLA decision-making, subsequent natural resource damage determinations, and derivative fish and wildlife habitat restoration actions. The latter may be based on appropriate environmental planning, recognizing the context of past changes, however, natural resource damages are linked with specific applicable laws and more recent timeframes.

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Item (2), under Trustees' Primary Objective, notes that the trustees seek a net gain of habitat function beyond existing conditions. It is important that readers understand that this objective is based on CERCLA (and other applicable laws) NRD determinations, distinct from past environmental changes.

The para under Desired Types of Restoration clearly summarizes the hierarchy of restoration goals. The statements refer to aquatic resources and services lost due to the effects of contamination. Natural resources service is not well defined in the body of the EIS and using the term in the summary statement is confusing.

DEIS comments listed by section

Sections 1.1 and 1.2, refer to the decision-making sequence linking CERCLA, the Elliott Bay Trustee Council, and the damage assessment process. The objective of the trustees is outlined, however, the damage assessment process is ill-defined and it would be helpful to clarify and outline the process. The link between planning and the damage assessment process needs appropriate detail. The term "services" is also used, without sufficient definition. "Services" are described indirectly in Section 4.1.

Section 1.3, last para, includes an excellent description of the integrated habitat restoration approach suggested by the DEIS. This would be helpful in the executive summary, noting the need to describe "associated services".

Section 1.5, notes the benefit of integrating restoration and remediation work. The port agrees with this approach and hopes to work with your office in this respect regarding future fish and wildlife habitat restoration and enhancement actions. Discussion in this section seeks to distinguish between primary restoration and compensatory restoration. The distinction is unclear and, although the DEIS pertains to compensatory actions, later statements are not entirely clear regarding primary in contrast with compensatory restoration, particularly regarding implementation of timely and efficient remedial restoration actions

Section 1.6.2 notes economic analyses important to natural resource damage assessments. It would be helpful to include reference materials in this instance. This section uses "natural resources and services" throughout, without any definition.

Section 1.7 is unclear regarding the distinction between CERCLA-related damages and past physical development in the area of evaluation, particularly relating to baseline conditions. Items (1) and (3) are clear, while item (2) is not sufficiently analyzed or evaluated in order to link the statement with the body of the DEIS. Finally, the last sentence must be clear regarding compensatory actions based on a stated baseline.

Section 1.8, provides important context and background. It is important to note that by 1920 approximately 75 percent of the habitat features emphasized in the DEIS as restoration objectives had been lost due to physical changes, with approximately 15 percent additional change prior to 1940. This simply notes that the scope of change that shaped the present in urban/industrial waterway took place more than 60 years ago. It is important to refer to resident and migratory marine fish, mammals, and birds, as well as anadromous fish. The LDW superfund site includes 4.6 miles of the 5.2 mile long Duwamish Waterway. This section also mixes Harbor Island and Lockheed West superfund decision-making with the lower Duwamish context. Is the intent of the DEIS to cover resource damages from all three superfund sites? If the Lockheed West superfund site is included in restoration planning, should the plan include the affected portion of Elliott Bay as an appropriate focus area? Later DEIS statement indicate the rationale for extending restoration decision-making from the north margin of Harbor Island to approximate river mile six (total of seven river miles), however, including these additional CERCLA matters requires explanation.

Sections 1.8.1 and 1.8.2 include very useful statements indicating "what" the restoration plan will do and the "benefits" of restoration planning. However, the first sentence in Section 1.8.2 does not reflect present environmental decision-making and over-states the ability to alter aquatic area resources without directly linked compensatory mitigation actions.

Section 2.0 can be improved. Seven miles separate the north end of the West Waterway from North Winds Weir. The Duwamish Waterway is 5.2 miles in length, with the West Waterway approximately 0.9 miles long.

Section 2.1 would be more clear with the addition of information describing the timeline for compensatory restoration decision making.

Section 2.1.3, page 13, third para: Clarify if term "wetland" refers to emergent plants and marsh.

Section 2.3 includes a very useful summary of biological resources. In light of subsequent statements relating to native vegetation and riparian environments, including off-channel areas and large woody debris, it would be useful to describe forested wetland/tidal swamp in context. Terminal 30 no longer supports nesting glaucous-winged gulls. It would be useful to refer to river mile or study mile for some of the features noted. For example, Kellogg Island is located at approximately river mile 1.3.

Section 4.1, last para, includes a well written description of the relationship between injured resources and cleanup remedies.

Section 5.1 repeats the potential for confusing CERCLA-related natural resource damages in the lower Duwamish River with the historic scope of physical change in the Duwamish estuary.

The statement in second para, Section 5.2, firmly establishes the link between habitat restoration and injured resources.

Section, 5.3, describes key habitats in concise statements. As with later text (page 39) it would be useful to emphasize export of detritus from emergent plants. The inter-tidal mudflat description overlooks the relative abundance of existing deep inter-tidal and shallow sub-tidal, low-slope mudflat area in the Duwamish Waterway. Riparian habitat discussion could be improved with more description of the benefits of forested wetland plant communities

Section 5.4 is another example of the need to distinguish between CERCLA related NRD actions and resource functions lost due to dredging, building or dikes, and shoreline armoring.

The discussion of process and objectives in Section 5.5 is well done.

The Section 5.6 discussion of habitat focus areas is clear, however, HFA1 abruptly introduces "mouths of tributaries" and does not clarify the insertion. This requires clarification and supporting evaluation.

Section 6 and the discussion of restoration types is well done and logical. More support of the dimensions noted in 6.1.1 and 6.1.2 is required, however. Section 6.2.1 should note the importance of uncovering relic sediment layers, in the location of former marsh areas, as a guide to planning restoration site dimensions. Section 6.1.3 includes a list of riparian trees and shrubs. Recent experience with riparian restoration in the Duwamish Waterway includes a more extensive list of appropriate native riparian vegetation trees and shrubs.

Section 6.1.4 describes potential construction actions necessary for restoration actions. It should be noted that in all cases, excavation would entail removal of previously placed fill materials, active or in-active structures, shoreline armoring and debris. These materials often present significant un-anticipated project implementation challenges. The list is well done.

Section 6.3.2 describes adaptive management regarding fish and wildlife restoration site design, construction, and implementation. It would be useful to note that future work would benefit from incorporating successful designs and techniques used recently in the Duwamish Waterway, while avoiding past practices that did not create useful conditions or provide the most environmental resources possible.

Section 6.4 should acknowledge the need to provide temporary irrigation and control of Canada geese grazing as essential to successful establishment of riparian and marsh vegetation.

Section 7.2, Tier 2 screening, refers to the need for adequate source control to prevent re-contamination of restoration sites. It would be difficult to over-state the importance of this matter. Construction of relatively large habitat focus sites, connected with more modest habitat corridor improvements requires confidence that past sources of sediment and water column contamination are controlled. Recent experience with habitat restoration in light of superfund re-contamination oversight has required substantial negotiation and commitment of resources.

The description of typical kinds of restoration actions included in Section 8.1.3, the preferred alternative, is well stated and consistent with recent practical experience in the Duwamish Waterway.

Section 8.2.1, and the following discussion of anticipated effects, is concise and consistent with recent SEPA analysis prepared by the port's Lower Duwamish River

Habitat Restoration Plan. The analysis should include a statement relating to potential greenhouse gas emissions.

The port would be pleased to provide clarification and additional information regarding the above at your convenience.

WATER RESOURCE INVENTORY AREA 9 (WRIA 9) WATERSHED ECOSYSTEM FORUM

GREEN / DUWAMISH AND CENTRAL PUGET SOUND WATERSHED

Algona
Auburn
Black Diamond
Burien
Covington
Des Moines
Enumclaw
Federal Way
Kent
King County
Maple Valley
Normandy Park
Renton
SeaTac
Seattle
Tukwila

King Conservation District
Vashon/Maury Island Community Council
Covington Water District
Port of Seattle
Tacoma Public Utilities
Washington Department of Ecology
Washington Department of Fish and Wildlife
Washington Department of Natural Resources
U.S. Army Corps of Engineers

Washington Environmental Council
Green/Duwamish Watershed Alliance
Trout Unlimited/Mid-Sound Fisheries Enhancement Group
Save Habitat and Diversity of Wetlands (SHADOW)

The Boeing Company
Master Builders Association
King County Agricultural Commission

July 23, 2009

Rebecca Hoff
NOAA Office of Response and Restoration
7600 Sand Point Way N.E.
Seattle, WA 98115

Re: Comments on Draft Lower Duwamish River Restoration Plan & Programmatic Environmental Impact Statement (RP/PEIS)

Dear Ms. Hoff:

Thank you for the opportunity to submit comments on the Draft Lower Duwamish River NRDA Programmatic Restoration Plan & Programmatic Environmental Impact Statement (RP/PEIS) for the Lower Duwamish River.

The following comments are offered on behalf of the WRIA 9 Watershed Ecosystem Forum, a broad-based partnership of governments, businesses, and non-profit groups working on watershed health and salmon habitat recovery in the Green/Duwamish and Central Puget Sound Watershed. These comments are intended to complement the comments that may be provided by WRIA 9 partner jurisdictions such as Seattle, Tukwila, and King County.

1) Thank you for your responsiveness to comments provided during the scoping process in the July 31, 2007 letter from WRIA 9 Watershed Coordinator Doug Osterman. Most of the comments in that letter were acted on in the draft RP/PEIS. As a corollary, we appreciate the use in the RP/PEIS of recommendations from the 2005 WRIA 9 Salmon Habitat Plan: Making Our Watershed Fit for a King.

2) We concur with the policy of integrating restoration with the sediment cleanup effort under the Lower Duwamish Superfund process. The WRIA 9 Salmon Habitat Plan includes a policy (DU2 on page 7-78) supporting concurrent cleanup and restoration. We ask the Trustees to be more specific about when and how they expect to coordinate decisions about integrated cleanup/restoration with the Environmental Protection Agency, Department of Ecology, and potentially responsible parties. Greater clarity on this matter will increase the likelihood that restoration occurs sooner rather than later, which in turn will generate greater ecological value.

*Financial support provided by signers of Watershed Planning Interlocal Agreement for WRIA 9 including:
Algona, Auburn, Black Diamond, Burien, Covington, Des Moines, Enumclaw, Federal Way, Kent, King County, Maple Valley, Normandy Park, Renton, SeaTac, Seattle, Tacoma, Tukwila*

3) We concur with the primary focus on creation of mudflats, marshes, and riparian habitats. These are the habitat types most needed to restore/rehabilitate the estuarine ecology of the Duwamish and thus of greatest benefit in terms of salmonid habitat. We appreciate the recognition given to the importance of transition zone habitat to juvenile Chinook salmon.

4) We concur with the use of juvenile Chinook salmon as one of two fish species used to assess the value of restored/rehabilitated habitat to fish.

5) We concur with the Trustees' preferred restoration alternative: Alternative 3: Integrated Habitat Restoration. WRIA 9 partners are working to restore the ecological health of the Green/Duwamish and Central Puget Sound Watershed as a means toward recovering habitat used by Chinook and other salmonids. The proposed ecological approach, informed by the needs of juvenile Chinook as a surrogate species for other fish species, is consistent with our approach.

6) We concur with the approach of using Habitat Focus Areas to prioritize restoration/rehabilitation and support directing as much restoration/rehabilitation as possible into Habitat Focus Area 1, the Lower Duwamish. The WRIA 9 Salmon Habitat Plan, in fact, is counting on the success of the Restoration Program in the Lower Duwamish to complement habitat restoration work done upstream and in the marine nearshore. We encourage the Trustees to only modestly discount the value of any projects done in Habitat Focus Area 3 (the Duwamish from North Wind's Weir [RM 6.3] to Black River [RM 11]) as compared to projects done in HFA 1. While the Salmon Habitat Plan identifies the known transition zone as extending to RM 7.0, there is great ecological benefit from projects throughout the Upper Duwamish.

7) We strongly support the recommended use of a mechanism that funds and arranges for long-term stewardship of the restored/rehabilitated sites.

Thank you for the opportunity to comment. Please contact WRIA 9 staff Dennis Clark, 206-296-1909, dennis.clark@kingcounty.gov with any questions and regarding future comment opportunities.

Sincerely,

Dow Constantine, Co-Chair
Councilmember, King County

Bill Peloza, Co-Chair
Councilmember, City of Auburn

Cc: WEF Members

City of Seattle
Gregory J. Nickels, Mayor

Seattle Public Utilities
Ray Hoffman, Acting Director

July 28, 2009

Rebecca Hoff
NOAA Office of Response and Restoration
7600 Sand Point Way N.E.
Seattle, WA 98115

Re: Comments on Draft Lower Duwamish River Restoration Plan & Programmatic Environmental Impact Statement (RP/PEIS)

Dear Ms. Hoff:

Thank you for the opportunity to submit comments on the Draft Lower Duwamish River NRDA Programmatic Restoration Plan & Programmatic Environmental Impact Statement (RP/PEIS) for the Lower Duwamish River.

The City is glad to see a preference for habitat in focus area 1—the Lower Duwamish. We understand that this area is both the most habitat poor area and the most difficult to find opportunities to bring in habitat. Thus we agree it is important to discount to some degree habitat proposals elsewhere in order to encourage Lower Duwamish proposals.

The manufacturing and industrial base located along the Lower Duwamish is important locally, regionally, and globally. Therefore the City of Seattle is supportive of restoration in the Duwamish which thoughtfully co-exists with these important economic resources.

We note that the Trustees' document recognizes that there are areas of the Duwamish with little or no habitat at all (p. 29) and supports restoration in those areas. However follow-up on that recognition is not apparent (see notable absence of "underserved" areas as a consideration on p. 35,#5). The City would like to see greater emphasis given to habitat in areas where no other habitat exists. A parallel is the City's goal of having a City park within specified distance of all residential areas. Here we might strive for habitat sites of some sort in every x mile of lineal shoreline.

The plan, in its draft form, does not indicate that the Trustees are willing to recognize the time value of habitat by giving greater consideration to habitat created earlier, as opposed to that habitat that may be created 10 years hence. Although I have heard verbally that such consideration is built into the valuation process, I think it should also be noted in the PEIS. This is as important to the potential environmental impact of the plan as the designation of primary habitat focus areas.

P. 4 in the draft PEIS indicates that the plan is to cover compensatory mitigation for the Harbor Island site. I assume this then also covers the East Waterway site as a Operable Unit of the Harbor Island site.

The City would like to encourage the Trustees to reflect on the value of diversity of upland vegetation related to insect production, and the consequent value to the target species which the plan addresses. In an area as devoid of upland vegetation as the Duwamish, some greater emphasis on riparian habitat is important. With some encouragement we believe it is possible to integrate this type of habitat into many of the industrial sites.

Lastly, the City would like to encourage the Trustees to quickly tackle the thorny problem of integrating habitat into remediation sites. While the plan does encourage such integration, the process for doing so in a way that assures recognition of credit by the Trustees does not appear to have been worked out. Conversations with EPA and Ecology to work through the bureaucratic aspects of this dilemma are clearly needed in order to reap the promise that the plan puts forward.

Again, thank you for seeking our comments. We look forward to continual engagement on this issue.

Sincerely,

Judith Noble

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APPENDIX H: 2012 RESPONSE TO PUBLIC COMMENTS

Presented below are the major issues that capture the substantive concerns raised in the comments received on the Supplement to the Draft Restoration Plan (RP) and Programmatic Environmental Impact Statement (PEIS). The Trustees' responses to the concerns are provided below. Three stakeholders provided comments: EPA region 10, the Port of Seattle, and Vigor Industrial. The EPA assigned the document a Lack of Objection (LO) rating, while the Port of Seattle and Vigor commented on each issue with identical analyses prepared by Windward Environmental. The comments are re-written in italics and the page number and the document source are located at the end of each comment in parentheses. The actual comments are included in the last pages of this document. For references mentioned in the italicized comments, please see the last pages of this document (the actual public comments) for a complete reference citation. Because the EPA supports the proposal, their only comment was a continued suggestion that additional environmental conditions be considered in the analysis to support restoration decisions. The Trustees will follow the guidance of the EPA suggestion as restoration decisions are made.

All of the comments received from the Port of Seattle and Vigor Industrial concern Appendix C and Appendix F of the Supplement to the Draft RP/PEIS. It is important to note that these appendices describe different aspects of the approach used by the Trustees in estimating injury and assigning liability for the purpose of reaching early settlement with those Potentially Responsible Parties (PRPs) interested in settling with the Trustees early to facilitate integration of remedial and restoration actions and/or to avoid having to pay for future assessment costs that non-settling PRPs will share. The Trustees' approach for estimating injury for the purpose of early settlement relies on published scientific literature on the effects of contaminants, data collected by the Trustees and by the various parties who have been doing remedial investigations within the Lower Duwamish River (LDR), and sediment quality standards such as Apparent Effects Thresholds (AETs). It is generally consistent with the approach used successfully at other hazardous waste sites, such as Commencement Bay, Washington, and Lavaca Bay, Texas. There is some uncertainty associated with developing injury estimates using any approach, and the Trustees have been careful to develop a balanced approach in which assumptions used do not predominantly favor either an over- or under-estimate of likely injury. Although the damage assessment is not complete, the Trustees believe they have sufficient information and data available to frame a settlement proposal that would adequately compensate the public for natural resource damages associated with the LDR.

Contents

Appendix C – Defining Injuries to Natural Resources in the Lower Duwamish River

Category A –GENERAL CONCERNS

A1 - Ecological Risk Assessment (ERA) vs. Natural Resource Damage Assessment (NRDA)

In general, we believe that the analysis provided in Appendix C (NOAA and USFWS 2009) is inappropriately based entirely on literature toxicity values and state screening values, ignoring the extensive dataset associated with the Lower Duwamish Waterway (LDW) remedial investigation (RI), including sediment bioassay testing and tissue concentrations, and the assessment of ecological risk in the LDW ecological risk assessment (ERA). (Page 1, Windward Memo)

*In general, the selected values are well below the toxicity reference values used to evaluate these chemicals in the LDW RI; and for PAHs and PCBs, threshold values were established based on biomarkers of exposure that cannot be definitively associated with an effect that would result in a service loss. (*Page 2, Windward Memo*)*

The high hazardous substance concentrations that demonstrably result in meaningful effects on the species present in the Duwamish are simply not found at many locations, resulting in low ecological risk. (Page 3, Port letter)

RESPONSE: The Trustees interpreted the above comments to assert that the Ecological Risk Assessment (ERA) should be used to formulate the natural resource damages. The Trustees determined they cannot base the Natural Resource Damage Assessment (NRDA) on the conclusions of the ERA because the two processes have different programmatic objectives and different statutory and regulatory requirements that result in different data requirements and analytical approaches (Gala et al., 2009). ERAs are not designed to gather data appropriate for a NRDA although, with appropriate coordination, data collected may sometimes be useful to both ERA and NRDA (US EPA, 1992).

For an ERA to serve the needs of a NRDA, the ERA endpoints "need to include natural resource services valued by the natural resource trustees as well as endpoints of concern to the regulators" (Bascietto et al., 1993). One of the major differences between NRDA and ERA approaches is the focus of the assessment effort. ERAs incorporate tests and studies to estimate community or population level effects (US EPA, 1999; Suter et al., 2005; Gala et al., 2009). In contrast, NRDAs commonly include biological responses at the sub-organismal level, such as enzyme induction and physiological changes, and at the organism level (Cacela et al., 2005; Gouguet, 2005; Gala et al., 2009). The U.S. Department of the Interior (DOI) NRDA regulations specifically include a number of suborganism and organism biological responses as injuries (see, for example, 43 CFR §11.62(f)(1)(i)).

Studies have shown that biochemical alterations in response to contaminants can lead to effects such as impaired behavior in predators, leading to population alterations (e.g., Weis et al, 2001). Biochemical and physiological effects are useful in evaluating contamination because of their sensitivity and relationship to populations and communities (e.g., Adams et al., 2000). The ERAs performed for the Lower Duwamish Waterway Superfund site and the East Waterway Operable Unit of the Harbor Island Superfund site specifically excluded biomarker, histological, and behavioral endpoints (LDWG, 2007; Port of Seattle, 2012). The Trustees did use these types of endpoints in estimating injury, as was done in the Commencement Bay NRDA and consistent with the definition of injury in the DOI regulations.

The Commenters suggest that the results of the site-specific toxicity tests should be used in the development of injury thresholds, rather than using AETs to establish such thresholds. The appropriateness of the use of AETs to develop injury thresholds is discussed more specifically in response C1 of this document—Use of AETs for determining injury thresholds. Under the recently revised Washington State Sediment Management Standards (SMS) program, toxicity tests are one method used to delineate and screen areas for future cleanup in addition to other applications. Other criteria are also considered in addition to toxicity tests under SMS. While they are sometimes used to determine injury, toxicity tests are based on short term exposures of a small number of organisms, which limits their applicability. . If site-specific biological data were to be used as part of the Habitat Equivalency Analysis (HEA) process in the LDR, more comprehensive data collection would be needed to identify actual injury thresholds.It is illustrative to show how the results of site specific toxicity testing from an ERA were considered in the NRDA process at Lavaca Bay, Texas. At that site, the ERA included sediment quality triad (SQT) sampling to examine the risk from mercury in the sediments. Those tests did not indicate a significant adverse effect with mercury levels in the sediment from 0.3 to 4.6 mg/kg (a range encompassing both the AET and NOAA Effects-Range Median or ERM values), yet in recognition that sublethal toxicological endpoints were not measured in the SQT approach, the trustees and PRP agreed to use the NOAA ERM value of 0.71 mg/kg as the initial threshold for injury to the benthos and assigned a 10% service loss to that level (Gouguet, 2005). The approach taken by the Trustees in developing injury estimates for the purpose of early settlement is therefore consistent with the approach used in Lavaca Bay in not relying on the results of sediment toxicity tests conducted for the ERA to determine initial thresholds for injury, given that the endpoints utilized do not take into account many potential injuries that could occur.

Another difference between ERA and NRDA that makes using the ERA results in the Lower Duwamish River difficult, is that where ERAs and NRDAs are prospective (related to the future) or current, only NRDAs are also retrospective – evaluating injuries that occurred in the past (Gala et al., 2009). The ERAs conducted in the Duwamish River did not consider past conditions, and were conducted after some dredging and other response actions were undertaken. Therefore, the ERAs are not reflective of conditions that existed in the decades prior to the ERA studies. Even if the ERA had incorporated the Trustees' recommendations concerning endpoints and studies, the results of the ERAs would not quantify the entire injury, because response actions and source control measures have improved conditions in LDR habitats. This means that past injuries would not be accounted for. In their analysis, the Trustees have combined recent sediment contaminant data with older data (when contaminant levels were higher).

The Trustees' approach toward estimating injury in the LDR is based on ecological service reductions provided by contaminated areas of habitat, in this case intertidal and subtidal habitat within the LDR. The Commenter's statement that English sole have expansive home ranges and thus have only a low exposure to contamination is irrelevant to the injury estimation approach used in the LDR that is described in Appendix C. While the Trustees do not agree with Commenters analysis concerning English sole (see comment PAH B1b), the Commenters' assertion ignores the fact that the contaminated areas **themselves** are injured. Specifically, the ecological service of providing clean food is reduced when contaminant levels exceed those that would cause adverse effects to organisms feeding within that area.

The LDR is important in serving as the transition zone for salmonids where they spend time adjusting to higher salinities that they will encounter in the ocean environment, so the services provided by the small amount of remaining habitat in the LDR is critical and has a high value. The importance of small areas of injury is recognized by EPA in its ERA guidance, acknowledging that the "ecological function" can be "more important than its size" (US EPA, 1999). In conclusion, though the Trustees provided input into the development of the ERAs for the LDW and East Waterway investigations, many of these recommendations were not adopted. The decision not to include many of the Trustees' recommendations has severely limited the value of the ERAs for the purpose of estimating natural resource injuries in and proximate to the LDR which, for natural resource purposes includes Harbor Island and Lockheed West Superfund Sites. Unfortunately the ERAs conducted in the LDR do not include consideration of assessment endpoints that reflect ecosystem services, as has been recommended by Munns et al. (2009) to improve the value of ERA data to the NRDA process.

A2 - Data from the EPA Remedial Investigation (RI) and Ecological Risk Assessment (ERA) is not used, haven't incorporated newer datasets

NOAA should…take into account the mountain of new data and information that has been developed for the Duwamish and Harbor Island Waterways since the early-to mid-1990s. (Page 2, Port letter)

In general, we believe that the analysis provided in Appendix C…ignoring the extensive dataset associated with the Lower Duwamish Waterway remedial investigation (RI) (Page 1, Windward Memo)

RESPONSE: The Trustees used all available surface sediment data that meet criteria for use in the Habitat Equivalency Analysis. Only surface sediment data are used, as these represent the biologically active zone that would most directly impact benthic organisms, fish and wildlife. Datasets collected by the Lower Duwamish Waterway Group (LDWG) under the auspices of the EPA Remedial Investigation comprise the bulk of the available data. In addition, any pre-remedial samples that are not located in a dredge footprint (that represent the historical record of contamination in the LDR) are included as they become available and go through a quality assurance process. For a discussion on issues related to use of toxicity test data and the EPA- ERA, please see comment A1.

A3 - Measurement Precision and Service Loss Levels Overlap (e.g. phthalates, dichlorobenzenes)

For many of the chemicals discussed in Appendix C, the AET values that are used to represent different levels of injury are not analytically distinct concentrations. (Page 7, Windward Memo)

RESPONSE: Since the Trustees have chosen at this stage of early settlement to rely on data previously collected under the auspices of the EPA-led Remedial Investigation, we do not control the precision of these data. Unfortunately, for some Substances of Concern (SOCs), detection limits are higher than would be ideal. For non-detect values where the detection limit exceeds the service loss levels, no injury is assigned and the concentration is assumed to be close to zero for purposes of the geographic interpolation. Use of this assumption may result in an underestimation of injury, and illustrates the care taken by Trustees to minimize the likelihood of overestimating injury.

Category B - INJURY THRESHOLDS FOR PAHS, TBT AND PCBS

B1 – PAH Injury Assessment

B1a: Liver disease & injury

The two studies that were cited in Appendix C to support the assessment of injury to fish by PAHs in sediment are Johnson et al. (2002) and Rice et al. (2000). The values selected from these studies to assess injury to fish overpredict injury by assigning injury based on physiological indicators of exposure and reversible suborganismal effects. The data underlying the effects thresholds overestimate the potential for adverse effects. The sediment effects thresholds for liver disease from Johnson et al. 2002 were biased low because all lesion types were assumed to cause disease in affected fish, whereas only a fraction of the lesion types were frank lesions indicative of disease. (Page 2, Windward Memo)

RESPONSE: The Trustees do not agree with the Commenters' conclusion. The federal regulations for NRDAs list seven types of injuries to biological resources that are defined as 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 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), or a concentration resulting in a consumption limit or ban issued by a state health agency Id. §11.62(f)(ii),(iii).

Fish are particularly sensitive to PAH toxicity because they metabolize PAHs to toxic and mutagenic intermediates, something that does not occur in invertebrates, or only to a very limited extent (Meador et al., 1995a). Thus fish are susceptible to carcinogenic and mutagenic effects of PAHs, which can occur even at relatively low exposure concentrations (Varanasi et al., 1987). Numerous studies have shown that English sole exhibit biological effects from exposure to PAHs in sediments, including liver cancer and related lesions, reproductive abnormalities, immune dysfunction, and alterations in growth and development (Myers et al., 1994, 1998, 2003; Arkoosh et al., 1996; Johnson et al., 1998).

Physiological indicators of exposure are not the same as liver lesions which equal injury. In fact, all the lesions referred to in the comment are measures of disease, and their presence indicates injury in fish, causing compromised condition that can lead to a reduced ability to survive in the wild. Typically, all pre-neoplastic focal lesions have the potential to progress to neoplasms (tumors), and although not all of them do, it is not correct in the terminology of pathology to call these pre-neoplastic lesions reversible.

Some lesions or other effects may theoretically be reversible (though not neoplasms, or pre-neoplastic focal lesion or foci of cellular alteration) *if the exposure to PAH is eliminated* and the lesions can then heal. The lesion-causing substance or condition MUST be removed to potentially achieve positive outcome. Even if all exposure to harmful levels of PAH stopped—something that will only occur in the LDR after a successful clean up—injury would still take place through reduced fitness, less growth resulting in smaller sized adults and impaired reproduction (Johnson et al., 1988, 1998; Meador et al., 2006; Myers et al., 2008). The Habitat Equivalency Analysis includes a function that accounts for recovery of natural resources once remediation has taken place and the habitat has returned to full function.

B1b: English Sole Ranges

Furthermore, the co-located sediment and tissue data used to develop the hockey stick regression underestimated the PAH concentrations to which English sole were likely *exposed prior to sampling. Stern et al. (2003) conducted a re-analysis of the hockey stick regression using the same lesion data as that used in Johnson et al. (2002) and a larger sediment dataset. Instead of using co-located data from trawls, Stern et al. (2003) used spatially weighted average sediment PAH concentrations from the trawl area collected over realistic home range. This re-analysis resulted in an effects threshold for lesions that is four times higher than that presented in Johnson et al. (2002).* (Page 2-3, Windward Memo)

<u>RESPONSE</u>: The Stern et al. (2003) presentation contains a number of biases. Unlike Johnson et al. (2002), Stern et al. (2003) was not published in a scientific journal that requires a rigorous scientific review process. (The Stern study is part of the Puget Sound Research Conference 2003, Vancouver B.C., proceedings.) The Trustees question several of Stern's assumptions. In the Johnson study, the sediment chemistry was paired with fish samples collected within the trawl track, which were then translated into threshold exposure values linked to certain biological effects such as liver lesions. Sediment samples were collected at the same time or within one year of the fish samples. In this way, the authors determined that fish were present in the area where the sediment samples were measured.

In contrast, Stern's sediment data were not paired directly with the fish samples. Stern used data from a variety of sources and many data points were separated in time by 3 to 4 years. An arbitrarily determined "home range" was defined as 1 km^2, and it was assumed that a sole will use that entire range. However, it is incorrect to assume homogeneity of habitat over a species' entire range. Different types of habitat (preferred and not-preferred) can occur within the larger assumed range.

The Trustees are concerned that the Stern samples are not truly unbiased. The Stern analysis did not account for remediation and restoration actions that were taking place during the time period when the samples were selected, which would have impacted the PAH sediment concentrations. The Johnson et al. scientists also do not believe that several of the areas where Stern chose sediment samples are used by English sole as habitat (Johnson, pers. comm., 2012). Stern assumed that English sole uniformly used the entire area of their defined "home range." Tagging studies conducted on English sole (Moser et al., 2005) in Eagle Harbor provide solid data on English sole movements and suggest that their home range is quite a bit smaller than 1 km^2, and in fact is more in the vicinity of 0.2 km^2.

At Eagle Harbor the tagged fish did not use the shallow nearshore area, which is where the highest PAH concentrations are found. Stern's analysis included these high PAH concentrations in developing thresholds, even though there is no evidence that sole use those areas. Sole migrate into deeper waters at night, but they do not feed at night. During the day they stay within a relatively small area, which could range from 0.2 km^2 – 0.7 km^2 (Moser et al., 2005; Myers, pers. comm., 2012).

B1c: Reproductive Effects- threshold levels and inflection points

The sediment effects thresholds for reproductive dysfunction from Johnson et al. (2002) are highly uncertain. The statistical analysis relied on estimates of the background level of reproductive dysfunction and the inflection point (i.e., the concentration at which effects begin to be elevated above background) because insufficient data were available to calculate these parameters. (Page 3, Windward Memo)

RESPONSE: As shown in Figure C1, threshold levels for service losses are established using a weight of evidence approach based on research with as many different types of organisms and effects from the contaminant of concern as are available. There is an abundance of data on PAH effects to benthic organisms and fish in the Lower Duwamish River. The service loss values and threshold levels for PAH were established using a variety of data showing impacts to fish, including liver lesions, reduced fecundity, and several kinds of reproductive effects. In addition, AETs for echinoderm and Neanthes represent impacts to the benthic community. This weight of evidence of multiple effects from PAH to many ecosystem levels support the service loss levels used in the Habitat Equivalency Analysis.

B1d: Reproductive Effects-Casillas et al. 1991 study

Furthermore, the causal relationship between observed reproductive effects and sediment PAH concentration is unclear. For example, in one study, (Casillas et al. 1991) that underlies the Johnson et al. (2002) relationship for gonadal growth, PAH concentrations accounted only for 34% of the variance in ovarian development, indicating that other factors may be causative. Differences in ovarian development could be due to natural variation in maturation timing among English sole subpopulations in Puget Sound or to exposure to other environmental stressors. (Page 3, Windward Memo)

RESPONSE: It is not clear on what Windward based its 34% assertion for variance in ovarian development in Casillas et al. (1991). However, considering the many possible parameters that could affect gonad development in English Sole, having one parameter (PAH contamination) account for approximately one third of the variance is considered evidence of a highly significant relationship. The authors in Casillas et al. say that natural variability is unlikely to be a major contributor to the effects measured, because of the careful timing of the sampling conducted for the study. Johnson et al. (2002) data indicated that PAH are a major cause of these effects. Another study on the causal relationship between liver neoplasms and other neoplasia-related liver lesions in English sole as related to PAH exposure published in the *Journal of Human and Ecological Risk Assessment* (Myers et al., 2003) corroborated these results with their finding that 54% of the variation in the prevalence of toxicopathic liver lesions in English sole from Puget Sound was explained by PAH concentrations in sediment (Myers et al., 2003).

PAH exposure is identified as a major risk factor for inhibited ovarian development in adult English sole (Johnson et al., 1988). In addition, English sole from areas contaminated with PAH experience inhibited spawning ability and reduced viability of eggs and larvae.

B1e: Creosote / Growth

The sediment effect threshold for growth from Rice et al. (2000) is also uncertain…The major chemical contaminants present at Eagle Harbor were associated with creosote, which is used as a wood preservative. The major creosote-related chemicals generally associated with toxicity are PAHs, phenols, and cresols (ATSDR 2002). About 300 chemicals have been identified in coal tar creosote, but as many as 10,000 other chemicals may also be in this mixture (ATSDR 2002). (Page 3, Windward Memo)

RESPONSE: Sixty-three percent of the creosote from Eagle Harbor is comprised of PAHs, with other components constituting a minor contribution. Therefore, PAHs are likely to be the major contributor to any effects from this creosote.

B1f: Growth Effects

Rice et al. (2000) showed that in one experimental trial, fish exposed to contaminated worms that contained a total PAH concentration of 11.3 parts per million (ppm) dry weight (dw) had a lower daily growth rate than did the controls. In a second trial of the experiment, a similar trend was observed, but the effect was not statistically significant. (Page 3, Windward)

RESPONSE: Rice et al. (2000) found a severe impact to growth at a total PAH concentration of 11.3 ppm dry weight in prey (polychaete worms) fed to English sole. This would equal a prey whole-body concentration of approximately 2.2 ppm wet weight. The total PAH concentration in the test sediments for prey exposure were 3.1 and 3.6 ppm dry wt. Rice et al. (2000) conducted two experiments with very similar results producing severe growth impairment. One experiment was highly significant and the other was not, even though the mean percent change in fish weight was 24 times lower (1.2% per day increase for the control versus 0.05% per day for the treatment) for the non-significant test. Because the first test was highly significant and the second test supported those results, these data strongly implicate total PAHs as a growth inhibitor. As the authors (Rice et al., 2000) admit, these tests had low statistical power, making these results even more striking. There is no doubt that if the power was higher, the second test would have also been statistically significant. Even though this study was conducted with field contaminated sediment, it was diluted with clean sediment, producing a concentration that was only 0.1% of the fully contaminated sediment. The predominant contaminants at Eagle Harbor are PAHs and the main source is creosote. The only other contaminants of note at Eagle Harbor are elevated PCBs (up to 2.5 ppm dry wt. in sediment) (Misitano et al., 1994). For the diluted sediment of 0.1% (used in Rice et al., 2000), the concentration of PCBs in the polychaetes would be extremely low due to an equivalent test sediment concentration of only 2.5 ppb. The expected PCB concentration in these worms would have likely been in the 10–20 ppb range, which is far below any toxic threshold for this class of toxicants.

B1g: Evaluating PAH impacts to sole

The exposure of highly motile organisms such as English sole is integrated over the entirety of their home range and cannot be evaluated on a point basis. (Page 4, Windward Memo)

RESPONSE: The comment misses the point that, as explained in A1, the Trustees are basing their approach to estimating injury on the reduction in ecological services provided by the habitat. In addition, areas of sediment with contaminant concentrations above those that could cause injury to organisms feeding within those areas are themselves injured. Moreover, contrary to the Commenters' assertion, it *is* possible to directly measure PAH exposure in fish. This can be done with metabolites from fish bile, which have been shown to be strongly correlated with sediment PAH values and dietary dose (Collier et al., 1993, as seen in Meador et al., 1995b; Meador et al., 2008). Also see comment B1b which discusses issues related to English sole home range size and feeding habits.

B2 – TBT Injury Assessment

B2a: Use of Armandia Brevis

The development of TBT injury threshold values is based on work that evaluated the effect of TBT on the marine polychaete Armandia brevis (Meador and Rice, 2001) and bioaccumulation modeling based on relatively few datasets, including the A. brevis data (Meador et al., 2002). There is a significant amount of literature on the effects of TBT on benthic organisms that is not represented. The bioaccumulation potential for TBT has been shown to be highly species specific (Meador et al., 1997). Further justification should be provided to support setting injury thresholds based on a polychaete species that has not been observed in the Lower Duwamish River. (Page 4, Windward Memo)

RESPONSE: Meador (2011) summarized information from several studies on the occurrence of organotins in the tissues of fish and invertebrates and their toxicological significance. The information from nine studies dealt with a variety of adverse effects from TBT exposure (e.g., behavior, imposex, growth impairment, reproductive impairment, and mortality) and listed five mean critical body residues with values between 13 and 85 ppb. Regarding the statement questioning the appropriateness of using

A. brevis data for the injury threshold analysis, that species is a commonly occurring marine polychaete in Puget Sound. Schoch and Dethier (2001) indicated *A. brevis* was encountered at over 80% of stations sampled within six miles of the mouth of the Duwamish River during their intertidal surveys in 1999 and 2000. This information strongly suggests that *A. brevis* is a very appropriate candidate for injury assessment. If *A. brevis* is not currently present in the LDR, it could very well be because contamination levels in the river sediment prevent them from surviving there.

B2b: TBT and EPA Ecological Risk Assessment (ERA)

TBT was not identified as a risk driver in the ERA conducted for the LDW Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) evaluation based on the evaluation of imposex in benthic organisms collected throughout the site and the evaluation of chemical concentrations in tissue collected from throughout the site and compared with tissue effect concentrations. The data collected from the site is not consistent with the level of injury that would be predicted by the proposed injury threshold values. (Page 4, Windward Memo)

RESPONSE: See comment A1 clarifying the differences between the objectives for ERA and NRDA. While TBT was not identified as a risk driver in the LDW ERA, it *was* included as a risk driver in the East Waterway ERA, based on recommendations and rationale presented by NOAA.

Meador et al. (2002b) concluded that protection against severe adverse sublethal effects for many salmonid prey species should be achieved with a TBT sediment concentration of 6,000 ng/g OC (organic carbon). For the Lower Duwamish River (average TOC = 1.7%) this would equal 102 ng/g dry wt. The Trustees assigned the lowest injury (service loss) level (5%) to this concentration. However, it should be noted that Meador (2002b) further mentioned that many of the sublethal responses reported for TBT exposure would eventually lead to death of the organism in the environment. A later publication (Meador, 2011) listed several additional studies of fish species with low threshold levels that would further diminish the Duwamish TBT threshold, should the Trustees re-evaluate TBT injury thresholds utilizing these new studies. Based on these new studies, the current TBT injury thresholds used by the Trustees cannot reasonably be said to overestimate injury.

B3 – PCB Injury Assessment

B3a: Estimated parameters in Meador 2002a

The relationships between sediment concentrations and adverse effects reported in Meador et al. (2002) rely on several assumptions that are highly uncertain. Meador et al. (2002) estimated organic carbon-normalized sediment effect thresholds from lipid-normalized PCB concentrations in salmon that were associated with various effects. In each of the 15 studies underlying this relationship, some data critical to the analysis (e.g., *tissue PCB concentrations, tissue lipid concentrations) were not reported but were instead estimated based on uncertain assumptions…* (Page 4, Windward Memo)

RESPONSE: Meador et al. (2002a) did not use uncertain assumptions. Meador reviewed numerous studies on PCB effects to salmonids. From the larger pool of published studies, 15 were selected using rigorous screening criteria (Meador et al., 2002a). These 15 studies used different methodologies and measured different types of PCB effects, therefore it was necessary to standardize the results based on appropriate scientific methodology. Because PCB effects on individual fish are greatly affected by the lipid content of the fish, Meador developed lipid values to lipid normalize the results. The lipid values used in Meador et al. (2002a) were taken from literature studies that actually measured (not estimated) lipid levels. Meador et al. (2002, Table 1) shows the extensive dataset used to develop the lipid values incorporated into the PCB threshold values. Data from 18 different studies including adult and juvenile fish were examined with sample sizes ranging from 3 to 180 individual fish.

B3b: Tissue residue concentrations

Based on these assumptions, Meador et al. (2002) calculated a PCB tissue residue of 1.7 ug/g lipid as the effect threshold. A later report… by (Melancon et al. 1989) suggested that such effects occur at a muscle concentration of approximately 0.3 ug/g wet weight (ww) which, using the assumptions from Meador et al. (2002) would correspond to 3.3 ug/g lipid. Similar assumptions made for the other 14 studies are more likely to underestimate rather than overestimate the tissue concentration at which the effect is likely to occur. Consequently, the sediment effects thresholds are more likely to underestimate than overestimate realistic effect thresholds and result in an overprediction of injury. (Page 5, Windward Memo)

RESPONSE: The sediment effect thresholds do not underestimate realistic effect thresholds and do not result in over-prediction of injury. Meador et al. (2002) used a Melancon study (Melancon et al., 1989) which suggested an effects level of 1.7 ug/g lipid. The overall effect threshold recommended by Meador for all the studies considered is 2.4 ug/g lipid. For PCBs, muscle concentrations are usually lower than whole body concentrations. Using measurements in muscle ignores the PCBs in the rest of the fish. Additionally, lipid concentrations in muscle are not comparable to whole-body lipid levels and should not be used interchangeably, as assumed here by Windward when they converted the wet weight concentration in muscle to a lipid normalized value. Meador et al. (2002) cites a number of studies that demonstrate how PCB levels in fish differ between muscle and other organs, and how PCB levels will re-distribute themselves within the fish depending on its life stage, energy content, and availability of food.

B3c: Physiological indicators of exposure

> *…many of the effects included in Meador et al. (2002) are physiological indicators of exposure and reversible suborganismal effects. Examples included altered levels of hormones, changes in enzyme activity, or decreases in the synthesis of vitellogenin. The effects associated with a 60% service loss from NOAA (2001) are also biomarkers (i.e. immune suppression and cytochrome P450 induction). The consequences of such alterations in biochemical processes with regard to the health of the fish are largely unknown.* (Page 5, Windward Memo)

RESPONSE: The statement that consequences of alterations in biochemical processes on fish health are unknown is misinformed. This is another reiteration of the commenters' assertion that a reversible or sublethal effect does not cause injury, which is simply untrue. The commenters assert that altered hormone levels, increased enzyme activity, and disease susceptibility are not 'injuries.' Individual salmon must undergo complex physiological processes that allow them to make the transition from freshwater to the marine environment. Throughout the transition, they need to be able to resist disease, mature normally and successfully complete their lifecycle (Meador et al., 2002). Thus, the physiological indicators noted in Meador et al. (2002) and NOAA (2001) indicate alteration in the biochemical processes that negatively impact salmon. These sublethal impacts caused by PCBs adversely impact these processes by reducing the fitness of the salmon. Impairment of vital functions may also affect a fishes' ability to tolerate normal environmental fluctuations, including smoltification. These impacts are discussed in more detail in Meador et al. (2002).

Even if the studies showing P450 induction were removed from the list of studies supporting the service losses for PCBs, the result would not change. Immune suppression and reduction in growth are both well-defined indicators of injury (Meador, pers. comm., 2012). Furthermore, vitellogenin is a precursor for many yolk proteins necessary to provide nutrients during early development of vertebrates, and so a reduction in vitellogenin production would be expected to impact reproductive success.

Published studies using disease challenge have shown the effects of immune suppression, which leads to death of fish.

Category C – USE OF AETS IN INJURY ASSESSMENT

C1 - Use of AETs for determining injury thresholds

> *"For chemicals other than PCBs, PAHs, and TBT, apparent effects thresholds (AET) values are used to calculate service losses. This use of AETs is not consistent with their intended use as screening values that most accurately identify sediment for which no*

biological effects would be expected. The exceedance of an AET may or may not indicate the presence of biological effects." (Page 2, Windward Memo)

AET values were developed as screening concentrations and are inherently conservative values that will overestimate biological effects. (Page 5, Windward Memo)

The sediment used in the development of AETs contained a variety of chemicals with a range of concentrations. (Page 6, Windward Memo)

AETs are inherently conservative values and are most useful as screening benchmarks. There is no basis for using AET values as the threshold concentrations at which a particular hazardous substance causes damage to natural resources because AETs do not establish a causal relationship between biological effects and a chemical of concern. (Page 5, Windward Memo)

RESPONSE: Sediment quality guidelines such as AETs, are frequently used as thresholds for injury in settlements of natural resource damages across the country. Using sediment quality guidelines by the Trustees for the purpose of developing estimates of injury for settlement in the LDR is built on this established practice. Though the commenters suggest that AETs *over*estimate biological effects, AETs may actually *under*estimate injury because they incorporate effects only on benthic invertebrates and then measure very few potential adverse effects to those organisms (such as mortality).. Neither do AETs take into consideration effects of contaminants on fish or bioaccumulative effects in higher trophic levels.

The approach used by Trustees in the LDR uses AETs to establish the initial threshold for injury for most contaminants. A recent paper discussing the use of Sediment Quality Guidelines in NRDAs recommends that a "reasonably conservative threshold" near the Lowest Observed Adverse Effects Level (LOAEL) should be used for the "onset of injury" and "less conservative" sediment quality guidelines, such as AETs, be used to represent an increased level of severity of injury in damage assessments (Gouguet, 2005). This was how an AET was used in the NRDA at the Lavaca Bay, Texas Superfund Site.[1] The use of AETs to set the initial threshold for injury by the Trustees in the LDR is therefore less conservative than this recommendation, and not likely to overestimate injury.

[1] ***The approach taken in the LDR NRDA may underestimate injury compared to the approach used in Lavaca Bay since the benthic AET for mercury of 2.1 mg/kg was used there as recommended in Gouguet (2005) as an indicator of an increased level of severity of injury, and was assigned a 25% service loss, whereas the approach used by trustees in the LDR uses AETs as the initial threshold for injury for most contaminants and assigns only a 5% service loss. Additionally, injury to fish due to mercury contamination of habitats was evaluated separately and added to the injury from contamination of habitat to benthic organisms in Lavaca Bay (Trustees, 2000), resulting in much higher service loss estimates than would have been developed using the approach utilized by Trustees in the LDR with the same data.***

The Trustees recognize that AETs were developed from field data which contained a variety of different chemicals. This reflects the actual situation in the LDR, which also contains a mixture of contaminants. This approach takes into account the synergistic effects of mixtures that commonly exist in Puget Sound sediments that influenced results of the toxicity tests used to derive AETs.

The Trustees' methodology for estimating injury for purposes of early settlement is based solely on ecological losses and does not attempt to quantify or recover human use losses and other economic damages; therefore, it cannot be reasonably viewed as overstating the extent of the damages resulting from releases of hazardous substances to the LDR. Rather, the Trustees may be understating their natural resource damage claim. Human use losses and other economic damages may be evaluated for inclusion in any damage assessment process moving forward for those non-settling parties along with further assessment of ecological damages that may be necessary to support all natural resource injuries.

C2 – Injury Ramps

… the "injury ramp" for butyl benzyl phthalate (BBP) is presented in Table 1. No effort was made to evaluate the available sediment bioassay data for the Lower Duwamish River to determine the relevance of the AET thresholds for the mixture of contaminants at these sites. Increasing levels of injury are assigned based on the exceedance of multiple AET values. No justification is provided for increasing service loss percentages when multiple AET values are exceeded. (Page 5, Windward Memo)

RESPONSE: Justification is provided for increasing service loss percentages when multiple AET values are exceeded in Appendix C, which provides a detailed explanation of how different levels of service loss were estimated. The basic approach advocated by Gouguet (2005) is utilized: higher levels of service loss are assumed as the number of sediment quality guidelines exceeded increases. For most SOCs, there is insufficient information to establish sediment thresholds that are protective of fish. Therefore, the only injury thresholds used are those to protect the benthic community, largely AETs. For all of these chemicals, the minimum injury threshold is 5%, and the maximum is 20%--based solely on effects to invertebrates. Appendix C includes a detailed discussion of why assigning only a 20% loss of service when all invertebrate AETs are exceeded can be criticized as being too low, using HCB as an example. These chemicals may actually affect fish and other higher trophic levels as well, and most likely a higher service loss would be applied if the data were sufficient to make these determinations. On the other hand, for PAHs, there are known effects on fish as well as on benthic organisms. Therefore, a higher service level loss is applied. Although PAHs are metabolized by fish, it is during this very process that harmful effects occur. Since this HEA is directly oriented toward protection of living marine resources (versus human uses), known effects on fish at the minimum injury threshold, as well as known effects on benthic organisms, justifies a higher service loss than SOCs for which there are only known benthic effects. It is the difference in the available data regarding the effects of contaminants, rather than a subjective view of a contaminant's importance, that leads to the difference in assignment of service level losses.

C3 - Case Study: Evaluation of Effects Predicted by AETs Compared with Effects Measured in Lower Duwamish Waterway (LDW) and East Waterway (EW) Sediment

In order to evaluate the predictive power of AETs in the Lower Duwamish River, a dataset of 101 sediment samples collected from the LDW and East Waterway (EW) of Harbor Island was evaluated…The reliability of the chemical concentrations above the AETs as indicators of biological effects, as measured by the sediment bioassays, was evaluated…However, for the 95 samples that exceeded at least one of the AET values, the exceedance of the AET did not necessarily accurately predict the biological effects associated with the bioassay results. In 54% of these samples, the chemical exceedence of the AET was consistent with a bioassay result, which also exceeded the SQS threshold. However, in 46% of the samples, no toxicity was observed in the three sediment bioassay results for a sample. (Page 10-11). *These results suggest that the exceedance of an AET value should not be used as a reliable indicator of certain biological effects. AETs may function well as screening levels, but they are clearly not a reliable indicator of biological effect as demonstrated by the LDW and EW sediment bioassay results.* (Page 7, Windward Memo)

Finally, the LDW data was examined to determine whether the exceedance of multiple AETs increased the predictive power of the AET evaluation….This analysis would suggest that predictive power of the AETs is not improved when multiple AET exceedances are present. (Page 7, Windward Memo)

RESPONSE: The commenters assert that the Trustees' assessment is flawed because it relies on AETs and does not consider the results of toxicity tests performed as part of the ERAs for the Lower Duwamish Waterway (LDW) superfund site and the East Waterway Operable Unit of the Harbor Island Superfund site. As discussed in section A1, ERA for remedial purposes and NRDA are structured to address very different objectives. The toxicity tests performed as part of the ERA were intended to help inform what remedial actions should be performed, and did not include important sublethal endpoints that would be important in determining injury. Furthermore, the results of the analyses conducted by Windward are biased by the way samples were chosen for toxicity testing for the ERA. The ERA toxicity tests from the LDW intentionally excluded samples that were highly contaminated, under the assumption that these samples would be toxic (LDWG, 2007). If this assumption is true, (i.e. that the excluded samples are toxic), then the reliability of AETs to predict adverse biological effects in the LDW would be far greater than is suggested in the comment. Despite this, for more than half of the 95 samples included in the commenters' analysis, the chemical exceedance of the AET was consistent with the bioassay result. This is also true of the Windward analysis of multiple AET exceedances, which suffers from the same bias in the selection of samples- over 50% of the samples matched the predictions.

An independent evaluation of the ability of AETs to predict adverse biological effects using data from 13 Puget Sound embayments indicated that adverse effects were not found for samples with contaminant concentrations below the AET but were found for samples exceeding the AET in over 85% of the samples (Barrick et al., 1988). This means that approximately 85% of samples were in accordance with the predictions. A more recent evaluation of AETs found that reliability of the AETs in predicting adverse effects was 84% (Gries and Waldow, 1996). The results of these two studies, using unbiased samples, support the reliability of AETs in Puget Sound as predictors of adverse effects. Given that the AETs are based only on a few potential endpoints with a few receptors, ignoring other receptors and other endpoints indicative of other potential types of injuries, the use of AETs in the Trustees' injury estimation approach is very unlikely to result in an *over*estimate of the ecological injuries.

Appendix F - Allocation Process in the Lower Duwamish River Natural Resource Damage Assessment

Category D – TEXT IS TOO GENERAL, NOT SITE-SPECIFIC, AND ALLOCATION IS ARBITRARY

D1 - General allocation - liability allocation methodology is arbitrary

…arbitrary allocation methodology…certain public and private entities are unjustifiably assigned vast amounts of natural resource damages liability, with other parties that have been responsible for significant releases apparently being assigned little or no such liability. (Page 1, Port cover letter)

RESPONSE: This is a vague and conclusory statement for which the Port does not provide any documentation or other evidence. Moreover, the allocated liability for each potentially responsible party is not publicly available as such discussions are legally protected as settlement negotiations pursuant to the Federal Rules of Evidence; therefore, it is unclear as to how the Port reached this conclusion. The Trustees disagree with the Port's assertion. This is not an arbitrary allocation methodology and no entities were unjustifiably assigned vast amounts of natural resource damages liability. Allocations of liability for the purposes of early settlement are based on publicly available records and follow the specific parameters outlined in Table F1 in Appendix F. To the extent the Port has any additional information that the Trustees have not considered relating to significant releases by other PRPs, the Trustees will review and consider such information. In the event a PRP resolves their liability through a settlement, the Trustees must show the court a fair and equitable basis as to the liability and resolution of any PRP's liability. An existing example is the Boeing Consent Decree.

D2 - Allocation does not take advantage of available information

In general, the process provided here is overly simplistic and does not take advantage of the extensive chemistry dataset and current and historical source control documentation that is available for use in the allocation model. (Page 2, Windward Memo App. F)

RESPONSE: Trustees considered all of the sediment chemistry and current and historical source control information available to them at the time the allocation was done. When the process was first undertaken in 2001, source control information in the LDR was limited, and incomplete for some areas. As the Washington Department of Ecology and US EPA have completed additional source control studies for properties along the LDR, the Trustees continue to incorporate this data into the allocation at regular intervals. For example, in 2011, the Trustees updated the allocation of PAH liability and revised the analysis using current scientific research and new data.

D3 - Allocation of overlapping contaminant footprints

In cases where a plume that originates at one parcel overlaps onto adjacent parcels, liability has been allocated to multiple parcels rather than to the single parcel that is the likely source. In cases where sufficient information is available to identify the unique sources, the Trustees should allocate liability to the specific source rather than simply allocating liability to all adjacent properties. (Page 2, Windward Memo, App. F)

RESPONSE: The Trustees allocate liability to the specific source to the extent there is evidence that the use of a SOC could be associated with an activity on that property, and a pathway is established. Specifically, when an injury footprint for an individual SOC touches more than one property, each property is examined for a possible connection to that contaminant. Allocations of liability for the purposes of early settlement are based on publicly available records and follow the specific parameters outlined in Table F1 in Appendix F.

For all parcels where the criteria noted in Table F1are answered in the affirmative, liability is assigned for the SOC in question. In some instances, a large footprint is shared among several parcels, and in other cases, a single parcel will receive the full allocation for the footprint, depending on the results of the decision tree in F1. If the Port or other parties have access to information not in the public domain that they feel would contribute to the allocation decision process, and are willing to share such information with the Trustees, the Trustees would include any viable evidence in the allocation process.

D4 - Unfair to Allocate Only to Current Property Owners

…the approach to liability allocation used by NOAA, as described in Appendix F, that results in current shoreline property owners being assigned essentially all site NRD liability, including liability for activities that occurred in the distant past that current shoreline property owners had no role in, and liability for hazardous substance releases that clearly originated from other parties. (Page 1, Port Cover Letter)

RESPONSE: Each person's allocated liability is attributable to publicly available information showing releases of hazardous substances from each identified property. In general, current owners are strictly liable for any on-going releases from their property and as such are liable for such releases. To the extent that any current owner is able to bring evidence that another person is responsible for specific contamination on their property and which contributed to injury to the natural resources in the LDR, the Trustees remain open to allocate such liability, in whole or in part, to the prior owners and/or operators. As noted above, in the event a PRP resolves their liability through a settlement, the Trustees must show the court a fair and equitable basis as to the liability and resolution of any PRP's liability.

Category E – DOCUMENT DOES NOT CONSIDER SOURCES WITHIN THE PIPESHED

E1 – Allocation of Pipeshed Sources

The approach does not adequately consider sources within the pipeshed for storm or combined overflows; …characterization of the chemical loads used for this purpose was not provided. (Page 2, Windward Memo, App. F)

RESPONSE: The allocation methodology does consider the sources within the pipeshed for both storm drains and combined overflows. Trustees accounted for contaminant inputs to the river via combined sewer outflows (CSO) and storm drains using the same methodology used to assign liability to properties. If a contaminant footprint was closely associated with an outfall, if available data showed a contaminant was known to occur in storm drains or CSOs, and if there was no other source of that contaminant on adjacent properties, then the footprint liability was assigned to the CSO or storm drain. The basins that drain into each CSO or public storm drain are large, covering hundreds of acres and properties. It is unlikely that quantification of these large basins and storm drains is readily available or likely to be obtained at a reasonable cost.

E2 - Allocation doesn't include parcels that are not adjacent to the LDR

The document fails to address parcels that do not abut the Lower Duwamish River but are associated with current and historical activities that may have resulted in the release of contaminants in to the Lower Duwamish River (Page 1, Windward Memo App. F)

RESPONSE: Trustees included all properties within the designated area of the NRDA that are adjacent to the LDR as well as those that have a documented connection to the LDR (See page F-1). Initially, 458 parcels were reviewed. In addition, storm drains and CSOs that drain large areas beyond the river were included in the allocation.

If the Commenters have knowledge of and can document other sources that have contributed contaminants to the LDR, the Trustees request that the Commenters submit such for review and analysis.

Category F – PAH ALLOCATION ISSUES

F1 - Mass balance approach for PAHs is incomplete, concerns related to creosote pilings

The mass balance approach used for polycyclic aromatic hydrocarbons (PAHs) is not fully explained in this document. The information that has been provided on the calculation of PAH release rates for marine pilings suggests that the release of PAH from creosoted marine pilings has been greatly overestimated. (Page 1, Windward Memo, App. F)

RESPONSE: The Trustees do not agree that releases of PAH from creosoted marine pilings has been greatly overestimated. Estimates of PAH releases from creosote-treated marine pilings were derived using information published in a 2007 study of PAH sources to the New York/New Jersey Harbor (Valle, 2007) and a 2011 report by the Washington Department of Ecology (ECY) regarding sources of contamination to the Puget Sound basin (ECY 2011).

Using the size of pilings removed as reported in the Washington Department of Transportations' (WSDOT) Creosote Removal Initiative for state ferry terminals and PAH leaching rates as reported by Valle, ECY reported that 0.062 Kg of PAH per pile per year is released to the air and 0.48 Kg PAH/pile/year is released to the water. As shown in Figure F1, it was assumed that 10% of the pile was exposed to air, 60% to water, and 30% to the sediments. Since ECY only reported values for air and water, it was assumed that the 0.48 Kg PAH/pile/year included both the portion of the piling exposed to the water column and the portion embedded in the sediment.

The assumption was made that pilings used in the LDR would be of lesser length and smaller diameter than those used by the ferry system, so only 75% of the 0.48 Kg PAH/pile/year value was used to represent the release from smaller pilings. This result (0.36 Kg PAH/pile/year) was then multiplied by 0.3 to represent the 30% of the piling exposed to the sediment (0.11 Kg PAH/piling/year), and then by 0.2 (on-site diminution factor) which results in the assumption that only 6% of the area of the piling is contributing PAH to the sediments biologically active zone (0.022 kg PAH/piling/year). Although there is evidence in the literature that some portion of the PAH released to the air and water does contribute to the PAH levels in the sediment, these releases were not included in the NRDA PAH assessment. Other creosote-treated elements associated with the pilings (cross-beams, ties, planking, etc.) were also not included, although PAH contribution would also be expected from both releases to the air and from rainwater leaching. These exclusions provide a buffer that compensates for potential differences in the leaching rate (reported by Valle and ECY) when salinity, temperature, flow rate, and other factors specific to conditions in the LDR are considered.

As shown in Figure F1, two different Diminution Factors were applied to the 0.11 Kg PAH/pile/year value. First, an on-site factor of 0.2 was applied. The on-site Diminution Factor addresses the portion of the PAH that was likely to impact the biologically active zone. The following mechanisms for migration to the biologically active zone were considered: direct leaching from the pile and spreading caused by scour; direct leaching to the sediments within the zone of disturbance caused by ship operations (this zone was assumed to be up to two feet thick at the face of the piers with a lesser thickness below the piers); convective migrations in the pore water; migration in preferred seepage paths along the piles caused, in part, by pile movement; and loss of treated wood resulting from ship impact and pile aging.

Next, the in-river Diminution Factor of 0.5 was applied. This is based on the assumption that approximately half of the PAH released to the sediment would remain in the same general area after being adsorbed or absorbed.

The product of the two Diminution Factors is 0.1. Essentially, after application the two Diminution Factors, only 10% of the 0.11 Kg PAH/pile/year was included when impacts to the waterway sediments were quantified: a final value of 0.011 Kg PAH/pile/year.

Google maps and United States Army Corps of Engineers Report No. 36 (USACE 2002) were then used to determine the size of pile-supported structures such as docks, causeways, dolphins, etc. Where dock dimension data were incomplete, the length was assumed to be 71% of the property length (the average for known sites) and the width perpendicular to the waterway was assumed to be 60 feet. A 10-foot pile spacing was assumed based on the USACE guidelines.

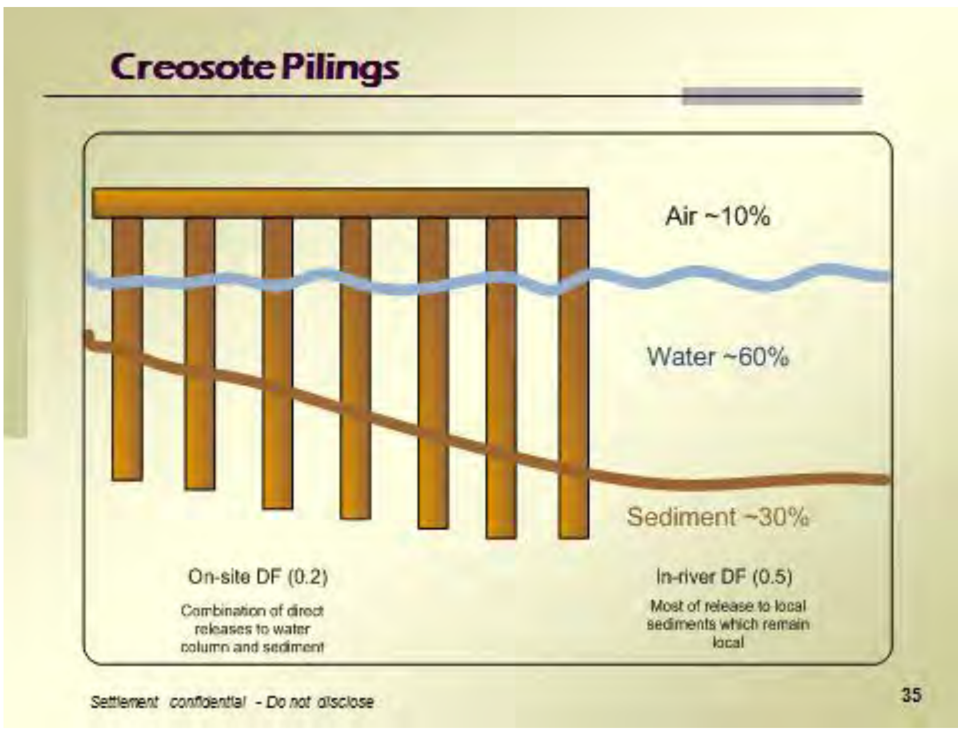

Figure F1. Schematic showing how creosote pilings were treated in the PAH NRDA analysis.

F2- Release rates for creosote pilings are overestimated; concerns about the leaching rate from the Valle and Ecology reports; effects of temperature and salinity

The desorption rate is based on freshwater exposure…has been shown to be strongly temperature dependent… (Page 3, Windward Memo, App. F)

The leaching rate of PAHs was observed only at the surface (1mm) of the treated piling…therefore, only a small volume of creosote is available to function as a source of PAHs due to leaching. (Page 3, Windward Memo, App. F)

PAH desorption rates decline exponentially following the placement of freshly treated wood. (Page 3-4, Windward Memo, App. F)

…the rate of PAH release derived by Valle et al. (2007) is an overestimation of the release of PAHs from the pilings into the water column in Puget Sound waters… (Page 4, Windward Memo, App. F)

<u>RESPONSE</u>: Both Valle et al. (2007) and Washington Department of Ecology (2011) agree that there is a level of uncertainty associated with the leaching rate. In Valle et al. 2007, leaching rates from two reports (Ingram et al., 1982; Bestari et al., 1998) were reviewed and used to calculate leach rates using four different methods (Valle, Table 3.5). The authors selected the average value (23% loss of PAH over 30 years) as the leach rate for the New York/New Jersey harbor. This same rate was used in the Ecology report and the NRDA PAH analysis.

A number of authors have attempted to produce a model which quantifies the PAH leach rates from a creosote-treated pilings. In a 2006 report prepared by Stratus Consulting and Duke University *2006*), the leaching models from twelve different researchers were reviewed to determine the relative strengths and weaknesses of each approach. The Stratus report did not identify any leach rate model as a preferred or definitive approach.

For the NRDA PAH analysis, it was necessary to estimate the amount of PAH in the waterway sediments that originated from creosote-treated pilings. Due to the differences in the leach rate models discussed in the literature and the uncertainty about the inputs to the models, the relatively straight-forward model proposed in Valle et al. 2007 (and also used in ECY 2011) was used as the leaching rate.

The assumption that the leach rate continues to decrease with time has been contradicted in the literature. For example, a more recent report by Kang et al. (2005) shows that after about a week at a very high leach rate, the leach rate reached a lower steady state. Also, as pilings age, other factors such as crumbling and abrasions (from ship traffic, debris, etc.) would expose fresh creosote that would leach at a rate closer to the much higher initial rate.

It is understood that this analysis is based on data generated from warmer and less saline waters, and if the analysis was re-run using conditions similar to those found in the Duwamish waterway, a lower value might be calculated. Other studies show that leaching rates increase with increased water velocity. However, since our analysis uses diminution factors that reduce the amount of PAH so that only 3% of the estimated PAH leached is considered to have contributed to sediment contamination, we believe our approach compensates for uncertainty in the leaching rates.

Additional assumptions in the PAH loading estimate from creosote pilings:

- No contribution from the portion exposed to the water column is included. Using the ECY example and applying the same factors as were used for the portion exposed to the sediment, an additional 0.022 Kg PAH/pile/year would be allotted for the portion exposed to the water.

- No contribution from the portion exposed to the air is included, although some research indicates that when creosote-treated wood is warmed by sunlight, micro-droplets of creosote are exuded from the wood, fall into the water and directly impact the sediments (Goyette and Brooks, 1998). Using the ECY example and applying the same factors, an additional 0.005 Kg PAH/pile/year would be allotted for the portion exposed to the air.

- No contribution was included from other materials such as cross-ties, planking, etc., which would leach PAH into the water from both rainfall and from micro-droplets.

- It was assumed that pilings only leach for 30 years, even though pilings often remain in the water for up to 70-90 years and continue to leach during that time frame.

In summary, there is some uncertainty in creosote leach rates and these may be influenced by site-specific factors such as temperature, salinity, velocity and age and condition of the pilings. The leach rate calculated here is based on the available scientific literature and is applied to the loading estimate with diminution factors so that only 3% of the PAH estimated to leach from a piling over 30 years is considered to contribute to PAH sediment contamination. The use of diminution factors accounts for uncertainty in the leach rates and provides a conservative estimate of creosote pilings contribution to PAH in sediments.

F3- Inappropriateness of relating PAHs with sandblast grit

"The association of PAHs with sandblast grit is inaccurate and results in an inappropriate assignment of discounted service acre years (dSAYs) to non-contributing parcels." (Page 1, Appendix F)

"…the rationale for associating PAHs with sandblast grit is not known." (Page 6, Appendix F)

"Metals and tributyltin are the primary chemicals associated with sandblast (also known as abrasive grit blast [AGB])…For the …CERCLA sediment remediation project implemented at Todd Pacific Shipyards…constituents of AGB were analyzed, and a definition of AGB in sediment was prepared and approved by the US …EPA…Copper, arsenic, and zinc, as well as grain size, were considered diagnostic of AGB, not PAHs." (Page 6, Appendix F)

"PAHs are not constituents present in sandblast grit, and the manufacturers do not analyze for PAHs. Based on the above information, the correlation between sandblast grit and PAHs is inaccurate and should be removed." (Page 6, Appendix F)

<u>RESPONSE</u>: The Commenter contends that metals (copper, arsenic, and zinc) and TBT are the primary chemicals associated with sandblast grit, which they refer to as abrasive grit blast. The USEPA definition referred to in the comment is published in USEPA (2003), related to the sediment remedial action at Todd Shipyards. The purpose of the definition was to provide guidelines to determine whether abrasive grit blast was present, and not to state what may be present in *spent (used)* abrasive grit blast. Specifically, the definition states that abrasive grit blast is present if it is visually identified, *or* if copper, arsenic, or zinc is present above certain concentrations and the material is coarse (0.15 – 2.0 mm in size).

The purpose of this definition was solely to identify abrasive grit blast that needed to be removed as part of the remedial action, which was to lower the levels of lead. The EPA states "the abrasive grit blast definition is a generic definition developed solely for the TSSOU" (operable unit at Todd Shipyards).

The Commenter also contends that there is no correlation between sandblast grit and PAH, based on a review of the constituents of grit from three different manufacturers (Kleen Blast, Tuf-Kut, and Green Diamond). The Trustees agree that it is unlikely that PAH would be present in clean (unused) sandblast grit when the product is received from the manufacturer. *Used* sandblast grit, however, will contain elevated levels of contaminants based on the surfaces that were sandblasted and the general cleanliness of the sandblast areas in the shipyards.

Historical and recent data analysis from shipyard sites in the Lower Duwamish River support the conclusion that spent sandblast grit can contain significant levels of PAH, along with other contaminants (McLaren Hart, 1992; Duwamish Shipyard Inc., 2011).

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Actual Comments from the Public from 2012

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October 10, 2012

Rebecca Hoff
NOAA Office of Response and Restoration
7600 Sand Point WayNE
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Re: Port of Seattle Comments on Draft Programmatic Restoration Plan & Programmatic Environmental Impact Statement

Dear Ms. Hoff:

The Port of Seattle is submitting the enclosed comments on NOAA's Supplement to the Draft Programmatic Restoration Plan & Programmatic Environmental Impact Statement (RP/PEIS) issued July 27, 2012. Included in our comments are analyses prepared by Windward Environmental on behalf of the Port and the Puget Sound Commerce Center, Inc. (formerly Todd Shipyards) concerning RP/PEIS Appendix C (Defining Injuries to Natural Resources in the Lower Duwamish River) and Appendix F (Allocation Process in the Lower Duwamish River Natural Resource Damage Assessment).

The Port is very concerned that NOAA has greatly overestimated damages to natural resources in the Lower Duwamish River and the Harbor Island Waterways by relying on unsupported assumptions and an overly simplistic approach to what must necessarily be a complex damage assessment analysis. The Port is also concerned with the approach to liability allocation used by NOAA, as described in Appendix F, that results in current shoreline property owners being assigned essentially all site NRD liability, including liability for activities that occurred in the distant past that current shoreline property owners had no role in, and liability for hazardous substance releases that clearly originated from other parties. This approach to damage assessment does not meet NOAA's burden of demonstrating that a party's natural resource damages debit "result[s] from" hazardous substance releases associated with that party. 42 U.S.C. 9607(a)(4)(C).

The result of the approach to damage assessment and the arbitrary allocation methodology documented in RP/PEIS Appendices C and F is that certain public and private entities are unjustifiably assigned vast amounts of natural resource damages liability, with other parties that have been responsible for significant releases apparently being assigned little or no such liability. Substantially overestimating natural resource damages, and then unfairly allocating the purported liability, has unfortunate consequences for both the environment and the current shoreline property owners along the Duwamish and Harbor Island Waterways. Without a reasonable and defensible damage assessment and liability allocation, parties assigned large shares of liability will be unwilling to enter into agreements to restore habitat and provide needed environmental improvements. Many Duwamish corridor parties, including the Port, are both willing and eager to participate in habitat restoration projects and to resolve issues associated with the natural resource damages for which they can legitimately be held liable. However, the approaches used by NOAA for damage assessment and liability allocation have stood as an impediment to moving forward for many years, resulting in very few substantial settlements.

As documented in the attached comments, NOAA should revisit its assessment of damages to take into account the mountain of new data and information that has been developed for the Duwamish and Harbor Island Waterways since the early- to mid-1990s. The Port and other parties have spent tens of millions of dollars in the characterization of the sediments at those sites and the evaluation of their potential impacts on human health and the environment. Rather than focusing on that wealth of new and more reliable information, NOAA has chosen for most hazardous substances to use screening levels taken from a more limited, and much older, dataset. NOAA has taken the screening levels calculated from that limited dataset and misapplied them based on the faulty assumption that those values represent the concentrations at which significant injuries to biota begin to occur. Instead, as explained in the Windward comments, the calculated screening levels are conservative values most appropriately used as thresholds for determining when damage to biota is *not* occurring due to a particular hazardous substance rather than values that show the onset of damage.

Further, for a limited set of substances, NOAA has rejected the screening values taken from the old dataset and used a small set of highly questionable studies to derive even lower thresholds for damages. The values derived by NOAA from those studies are inconsistent with the results of numerous other studies and with generally accepted reference toxicity values of the type used for the Duwamish and East Waterway Ecological Risk Assessments. For example, the PAH thresholds used in Appendix C were derived based on an assumption that the sampled fish had lifetime exposures to the concentrations ofPAHs found immediately adjacent to where the fish were caught. However, the highly mobile fish involved range over a larger area. When the same analysis is performed using average concentrations across a more realistic home range area, the threshold concentrations go up four fold.

NOAA's mistake in assuming that exposure indications for mobile species can be validly correlated to point concentrations of contaminants is compounded by the assumption that any indication of exposure, such as the presence of biomarkers, represents an actual injury. In reality, biomarkers and other exposure indicators are just that- mere indications that exposure has occurred and that the species in question has reacted to that exposure by, e.g., producing more of the enzyme needed to metabolize a certain compound. An indication of exposure is the first step in evaluating whether an effect may be present, not the last.

Finally, NOAA's damage assessment mistakes are compounded yet again by simply assuming that substantial service losses occur at the extraordinarily low concentrations where NOAA believes exposure indications begin to appear. Although scientific studies exist demonstrating actual harm at much higher concentrations, meaning service losses at those concentrations could validly be estimated, NOAA has assigned very significant service losses to concentrations far below those levels. By contrast, the Duwamish and East Waterway Ecological Risk Assessments, which were performed under the oversight of the U.S. Environmental Protection Agency and the Washington Department of Ecology, relied on more credible and accepted science and found relatively little ecological risk at these sites. The high hazardous substance concentrations that demonstrably result in meaningful effects on the species present in the Duwamish are simply not found at many locations, resulting in low ecological risk.

The unsupportable approaches to damage assessment and liability allocation presented in Appendices C and F demonstrate the need for NOAA to rework both its assessment of damages and its assignment of liability for those damages. This need not be a multi-year, multi-million dollar effort. A more streamlined, reasonable approach is possible using existing data and more defensible damage thresholds. Plumes can readily be defined based on the data that NOAA has to date chosen to ignore, and liability can proportionally be assigned to those parties that can clearly be shown to have caused significant releases of the hazardous substances involved.

Continuing to rely on an outdated and indefensible damage assessment and an arbitrary damages allocation will result in the continued waste of valuable public and private resources that could be better spent actually restoring habitat. The Port urges NOAA to apply a more reasoned approach to damage assessment and liability allocation. An approach of that type will avoid the situation where some parties are assigned huge amounts of liability, while other genuinely liable parties are assigned virtually none, or are ignored altogether. The "winners" in the game that NOAA is currently playing will, of course, consider moving forward with settlements, but little new habitat will be created because their assigned liability is minimal. The "losers" will not be willing to settle based on the damage assessment and liability allocation as it is currently structured, as their liability has been dramatically overestimated. The result is that the habitat that could have been created by settlements with those parties will have to wait, as it already has for the 20 years following NOAA's settlement with the City and County. NOAA should turn away from this lose/lose approach that has stymied habitat creation in the Duwamish for two decades and move forward with a more defensible, streamlined approach.

Thank you for considering the Port's comments. We would be happy to discuss the issues raised by our comments at any time.

Very truly yours,

S

Senior Port Counsel
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Enclosure

cc: Stephanie Jones Stebbins

October 10, 2012

VIGOR
INDUSTRIAL

Rebecca Hoff
NOAA Office of Response and Restoration
7600 Sand Point Way NE
Seattle, WA 98115

Re: Puget Sound Commerce Center, Inc. (f/k/a Todd Shipyards Corporation) Comments on Draft Programmatic Restoration Plan & Programmatic Environmental Impact Statement

Dear Ms. Hoff:

Puget Sound Commerce Center, Inc. (f/k/a Todd Shipyards Corporation) ("Todd") is submitting the enclosed comments on NOAA's Supplement to the Draft Programmatic Restoration Plan & Programmatic Environmental Impact Statement (RP/PEIS) issued July 27, 2012. Included in our comments are analyses prepared by Windward Environmental on behalf of the Port and Todd concerning RP/PEIS Appendix C (Defining Injuries to Natural Resources in the Lower Duwamish River) and Appendix F (Allocation Process in the Lower Duwamish River Natural Resource Damage Assessment).

Todd is concerned that NOAA has greatly overestimated damages to natural resources in the Lower Duwamish River and the Harbor Island Waterways by relying on questionable assumptions and a simplistic approach. As documented in the attached comments, we urge NOAA, in performing its assessment of damages, to utilize the extensive new data and information that has been developed for the Duwamish and Harbor Island Waterways since the early- to mid-1990s. NOAA's assumptions of significant service losses at extremely low concentrations is in direct contrast to the Duwamish and East Waterway Ecological Risk Assessments, which were performed under the oversight of the U.S. Environmental Protection Agency and the Washington Department of Ecology, which found relatively little ecological risk at these sites.

Todd believes that the assessment of damages and assignment of liability presented in Appendices C and F need to be revised. This need not be a multi-year, multi-million dollar effort. A more streamlined, reasonable approach is possible using existing data and more defensible damage thresholds.

Thank you for considering our comments. Please let me know if you would like to discuss our comments in more detail.

Very truly yours,

T. Alan Sprott

T. Alan Sprott
Vice President, Environmental Affairs

Enclosure

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MEMORANDUM

To: Jon Sloan, Port of Seattle, and Alan Sprott, Puget Sound Commerce Center, Inc. (fka Todd Pacific Shipyards)

From: Ron Gouguet and Susan McGroddy, Windward Environmental LLC

Subject: Review of Appendix C, Defining Injuries to Natural Resources in the Lower Duwamish River, in the *Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement*

Date: October 9, 2012

The natural resource trustees (Trustees) for the Duwamish River published a draft update to their *Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement* (NOAA and USFWS 2009). The document attempts to explain how the Trustees intend to adapt the damage assessment approach used to scale injury in the Hylebos Waterway to conduct a damage assessment for the Lower Duwamish River. We have reviewed Appendix C, Defining Injuries to Natural Resources in the Lower Duwamish River, and have the following comments.

In general, we believe that the analysis provided in Appendix C (NOAA and USFWS 2009) is inappropriately based entirely on literature toxicity values and state screening values, ignoring the extensive dataset associated with the Lower Duwamish Waterway (LDW) remedial investigation (RI), including sediment bioassay testing and tissue concentrations, and the assessment of ecological risk in the LDW ecological risk assessment (ERA). Furthermore, the use of literature toxicity values and sediment guidelines to calculate service loss rather than site-specific data results in an overly conservative assessment of injury. In many cases, the sediment concentration associated with a given service loss is associated with a threshold for the induction of biomarkers of organism exposure that are not causally linked to measurable effects on populations or communities that would constitute a service loss. For polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and tributyltin (TBT), service loss threshold concentrations have been identified based on a small number of studies that do not provide sufficient justification in support of the values used in Appendix C. Specific concerns regarding the values for each of these chemicals are identified below.

For chemicals other than PCBs, PAHs, and TBT, apparent effects threshold (AET) values are used to calculate service losses. This use of AETs is not consistent with their intended use as screening values that most accurately identify sediment for which no biological effects would be expected. The exceedance of an AET may or may not indicate the presence of biological effects. In the following sections, specific issues associated with the analysis presented in Appendix C (NOAA and USFWS 2009) are discussed, followed by an evaluation of AETs as predictors of biological effects conducted using sediment collected within the Lower Duwamish River.

Finally, there is no discussion provided in Appendix C (NOAA and USFWS 2009) to support the service loss percentages assigned to each threshold concentration. The lowest threshold concentration for every chemical is consistently associated with 5% service loss; and for all chemicals other than PAHs, PCBs, and dichlorodiphenyltrichloroethane (DDT) isomers, the highest threshold concentration is associated with a 20% service loss. The highest level of service loss for PAHs and PCBs was 80%; and for DDT isomers, the highest level of service loss was 40%. There is no explanation provided for the different levels of service loss assigned to different chemicals or to justify the levels of service loss associated with the threshold values for each chemical.

1 Injury Thresholds For PAHs, TBT and PCBs

For most chemicals, AETs are used in Appendix C (NOAA and USFWS 2009) as the basis for determining whether damage to natural resources from hazardous substance releases has occurred. However, injury thresholds for PAHs, TBT, PCB, and DDT isomers were not calculated based solely on Washington State AET values. For these chemicals, a combination of AETs and a small number of literature studies were used to establish injury thresholds. Very little detail is provided in Appendix C to support the threshold values that have been identified for these chemicals. In general, the selected values are well below the toxicity reference values used to evaluate these chemicals in the LDW RI; and for PAHs and PCBs, threshold values were established based on biomarkers of exposure that cannot be definitively associated with an effect that would result in a service loss.

1.1 PAH Injury Assessment

The two studies that were cited in Appendix C (NOAA and USFWS 2009) to support the assessment of injury to fish by PAHs in sediment are Johnson et al. (2002) and Rice et al. (2000). The values selected from these studies to assess injury to fish overpredict injury by assigning injury based on physiological indicators of exposure and reversible suborganismal effects.

The data underlying the effects thresholds overestimate the potential for adverse effects. The sediment effects thresholds for liver disease from Johnson et al. (2002) were biased low because all lesion types were assumed to cause disease in affected fish, whereas only a fraction of the lesion types were frank lesions indicative of disease. Furthermore, the co-located sediment and tissue data used to develop the hockey stick regression underestimated the PAH concentrations to which English sole were likely exposed prior to sampling. Stern et al. (2003) conducted a re-analysis of the hockey stick regression using the same lesion data as that used in Johnson et al. (2002) and a larger sediment dataset. Instead of using co-located sediment data from trawls, Stern et al. (2003) used spatially weighted average sediment PAH concentrations from the trawl area collected over realistic home range. This re-analysis resulted in an effects threshold for lesions that is four times higher than that presented in Johnson et al. (2002).

The sediment effects thresholds for reproductive dysfunction from Johnson et al. (2002) are highly uncertain. The statistical analysis relied on estimates of the background level of reproductive dysfunction and the inflection point (i.e., the concentration at which effects begin to be elevated above background) because insufficient data were available to calculate these parameters. In addition, as described above, for liver disease, the sediment concentrations to which English sole were exposed prior to sampling were likely to be underestimated. Furthermore, the causal relationship between observed reproductive effects and sediment PAH concentrations is unclear. For example, in one study (Casillas et al. 1991) that underlies the Johnson et al. (2002) relationship for gonadal growth, PAH concentrations accounted only for 34% of the variance in ovarian development, indicating that other factors may be causative. Differences in ovarian development could be due to natural variation in maturation timing among English sole subpopulations in Puget Sound or to exposure to other environmental stressors.

The sediment effect threshold for growth from Rice et al. (2000) is also uncertain. In this study, juvenile English sole were fed polychaete worms that had previously been exposed in the laboratory to 0.1% sediment from the Eagle Harbor, Washington, Superfund site mixed with 99.9% sediment from a reference site. PAH concentrations were reported for the sediment and worm tissue; other uncharacterized chemicals may also have been present but were not analyzed.[1] The major chemical contaminants present at Eagle Harbor were associated with creosote, which is used as a wood preservative. The major creosote-related chemicals generally associated with toxicity are PAHs, phenols, and cresols (ATSDR 2002). About 300 chemicals have been identified in coal tar creosote, but as many as 10,000 other chemicals may also be in this mixture (ATSDR 2002). Rice et al. (2000) showed that in one experimental trial, fish exposed to contaminated worms that contained a total PAH concentration of 11.3 parts per million (ppm) dry weight (dw) had a lower daily growth rate than did the controls. In a second trial of the experiment, a similar trend was observed, but the effect was not statistically significant.

There is no discussion in Appendix C (NOAA and USFWS 2009) of how the results of the toxicity studies (Johnson et al. (2002) and Rice et al. (2000) support the establishment

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[1] Concentrations were reported as low-molecular-weight PAHs (LPAHs) and HPAHs; the specific individual PAHs quantitated were not reported.

of 20 and 40% service losses for invertebrates and fish, respectively, at a total PAH concentration of 1 ppm in individual sediment samples. The exposure of highly motile organisms such as English sole is integrated over the entirety of their home range and cannot be evaluated on a point basis. The development of these thresholds has been shown to be highly sensitive to the sediment data selected as the exposure concentration. The assumption that a concentration at a point located proximate to the trawl line represents the lifetime exposure of a highly mobile fish is not logical. Furthermore, the 1-ppm concentration is associated with the presence of lesions that are reversible suborganismal effects. The consequences of such alterations in biochemical processes with regard to the health of the fish are largely unknown. They are not clearly linked to effects on populations or communities that constitute a measurable ecological service loss. It should also be noted that the 1 ppm total PAH concentration is much lower than the AET of 69 ppm for high-molecular-weight PAHs (HPAHs). Finally, PAHs were evaluated in the LDW ERA for potential risk to English sole; and based on an evaluation of the prey items collected throughout the LDW, no risk to English sole from exposure to PAH concentrations in the LDW was identified.

1.2 TBT Injury Assessment

The development of TBT injury threshold values is based on work that evaluated the effect of TBT on the marine polychaete *Armandia brevis* (Meador and Rice 2001) and bioaccumulation modeling based on relatively few datasets, including the *A. brevis* data (Meador et al. 2002). There is a significant amount of literature on the effects of TBT on benthic organisms that is not represented. The bioaccumulation potential for TBT has been shown to be highly species specific (Meador et al. 1997). Further justification should be provided to support setting injury thresholds based on a polychaete species that has not been observed in the Lower Duwamish River.

TBT was not identified as a risk driver in the ERA conducted for the LDW Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) evaluation based on the evaluation of imposex in benthic organisms collected throughout the site and the evaluation of chemical concentrations in tissue collected from throughout the site and compared with tissue effect concentrations. The data collected from the site is not consistent with the level of injury that would be predicted by the proposed injury threshold values.

1.3 PCB Injury Assessment

The assessment of service losses due to the exposure of benthos to PCBs is based on total PCB AET values. The assessment of injury to fish is based on work done by Meador et al. (2002) and NOAA (2001), which evaluate effects of PCB exposure on juvenile Chinook salmon. Meador et al. (2002) is cited as the source of the values used as thresholds for the 20 and 60% service losses. The relationships between sediment concentrations and adverse effects reported in Meador et al. (2002) rely on several assumptions that are highly uncertain. Meador et al. (2002) estimated organic carbon-normalized sediment effects thresholds from lipid-normalized PCB concentrations in salmon that were associated with various effects. In each of the 15 studies underlying this relationship, some data critical to the analysis (e.g., tissue PCB concentrations, tissue lipid concentrations) were not reported but were instead estimated based on uncertain assumptions. For example, in the study associated with the lowest effects threshold, Melancon and Lech (1983) reported increased levels of a biomarker of chemical exposure (hepatic mono-oxygenase activity [ethoxyresorufin-O-deethylase (EROD)]) in juvenile rainbow trout associated with the injection of PCBs into their body cavity. Melancon and Lech (1983) did not report the tissue concentration of PCBs in the trout, so Meador et al. (2002) assumed that 75% of the injected dose was absorbed into the tissue. In addition, Melancon and Lech (1983) did not report the lipid content of the trout so Meador et al. assumed 9% lipid based on estimates for adult fish. Based on these assumptions, Meador et al. (2002) calculated a PCB tissue residue of 1.7 µg/g lipid as the effect threshold. A later report by the authors of the original study (Melancon et al. 1989) suggested that such effects occur at a muscle concentration of approximately 0.3 µg/g wet weight (ww), which, using the assumptions from Meador et al. (2002), would correspond to 3.3 µg/g lipid. Similar assumptions made for the other 14 studies are more likely to underestimate rather than overestimate the tissue concentration at which the effect is likely to occur. Consequently, the sediment effects thresholds are more likely to underestimate than overestimate realistic effect thresholds and result in an overprediction of injury.

Furthermore, as is the case for PAHs, many of the effects included in Meador et al. (2002) are physiological indicators of exposure and reversible suborganismal effects. Examples included altered levels of hormones, changes in enzyme activity, or decreases in the synthensis of vitellogenin (a precursor protein of egg yolks). The effects associated with a 60% service loss from NOAA (2001) are also biomarkers (i.e., immune suppression and cytochrome P450 induction). The consequences of such alterations in biochemical processes with regard to the health of the fish are largely unknown.

2.0 USE OF AETS IN INJURY ASSESSMENT

For all chemicals other than PAHs, TBT, PCBs, and DDT congeners, Washington State AETs were used to identify threshold concentrations for service losses. AET values were developed as screening concentrations and are inherently conservative values that will overestimate biological effects. In the following sections, the development of AETs is described, and the use of AETs in the Hylebos Model is examined. Finally, the predictive power of AETs is tested with a dataset that includes sediment chemical concentrations and bioassay results from the LDW and East Waterway (EW).

2.1 Development of Apparent Effects Thresholds

In Washington State, AETs have been developed for several biological endpoints, including field measures of benthic infaunal abundance, results of laboratory toxicity tests using marine benthic invertebrate organisms (i.e., amphipods [survival] and oysters [percent abnormal development of oyster larvae]), and results of laboratory toxicity tests using bacteria (Microtox® [decreases in luminescence from the bacteria *Vibrio fisheri*]). For each hazardous substance, the AET is the chemical concentration in sediment above which statistically significant biological effects are always expected for one or more biological effects indicators.

The sediment used in the development of AETs contained a variety of chemicals with a range of concentrations. These complex mixtures present issues when interpreting the cause of any observed biological effects because it is difficult to identify the chemical or chemicals that are responsible for the biological effects or toxicity. If, for example, a particular chemical consistently co-occurred with a more toxic chemical in sediment sampled for the calculation of AETs, the AET value for the less toxic chemical could be much lower than the "true" toxic threshold for the chemical based on exposure to the chemical alone.

In addition to the complexity of the chemical mixture, other confounding factors that can affect the bioassay result are geochemical (e.g., organic carbon, sulfides, ammonia) and physical properties (e.g., grain size, porosity) of the sediment. These confounding factors can result in significant organism mortality, or other observed effects, resulting in the attribution of effects to chemical concentrations that are not causing the effects. Because effects associated with co-occurring chemical and other confounding factors are not taken into account when AETs are calculated using field sediment. AETs are inherently conservative values and are most useful as screening benchmarks. There is no basis for using AET values as the threshold concentrations at which a particular hazardous substance causes damage to natural resources because AETs do not establish a causal relationship between biological effects and a chemical of concern.

The Washington State Sediment Management Standards (SMS) recognize the uncertainty associated with the use of the AET values and allow for the use of sediment bioassay results as the direct measure of the biological effects to supersede the chemical exceedances of AET thresholds in the characterization of sediment. The SMS use AET values as a screening tool that can be superseded by bioassay results, which provide a direct measurement of sediment toxicity and are recognized as a more reliable predictor of sediment quality.

2.2 Use of AETs in the Hylebos Model

AET values in conjunction with the Hylebos Model are used to predict benthic effects presented in Appendix C (NOAA and USFWS 2009). Sediment with a chemical concentration above an AET value is assigned a specific level of injury. As an example, the "injury ramp" for butyl benzyl phthalate (BBP) is presented in Table 1. No effort was made to evaluate the available sediment bioassay data for the Lower Duwamish River to determine the relevance of the AET thresholds for the mixture of contaminants at these sites. Increasing levels of injury are assigned based on the exceedance of multiple AET values. No justification is provided for increasing service loss percentages when multiple AET values are exceeded.

Table 1. Hylebos/Commencement Bay damage assessment injury ramp for butyl benzyl phthalate

Endpoint	AET	% Service Loss
Microtox	63	5
Bivalve	100	na
Echinoderm	200	10
Oyster	> 470	na
Neanthes	> 580	na
Benthic community	900	15
Amphipod	970	20

Source: Table C-5 of Appendix C (2009)
AET – apparent effects concentration
na – not available

For many of the chemicals discussed in Appendix C (NOAA and USFWS 2009), the AET values that are used to represent different levels of injury are not analytically distinct concentrations. For example, in Table 1, a butyl benzyl phthalate sediment concentration of 900 µg/kg is associated with a 15% service loss, and a sediment concentration of 970 µg/kg is associated with a 20% service loss. The standard allowable analytical precision for the measurement of butyl benzyl phthalate in sediment is ± 50% of the measured concentration. The difference between the two AET values is less than 10% and is well within the allowable analytical precision for this chemical, which means that the duplicate analysis of a sediment sample that yielded 900 and 970 µg/kg would represent acceptable accuracy for the analysis. Other chemicals for which there are AETs associated with variable injury levels that are clearly within the analytical precision of the measurements are 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2,4-trichlorobenzene, cadmium, lead, mercury, silver, bis(2-ethylhexyl) phthalate, and dimethylphthalate.

2.3 Case Study: Evaluation of Effects Predicted by AETs Compared with Effects Measured in LDW and EW Sediment

In order to evaluate the predictive power of AETs in the Lower Duwamish River, a dataset of 101 sediment samples collected from the LDW and East Waterway (EW) of Harbor Island was evaluated. All of these samples were submitted for chemical analysis and sediment bioassays for the LDW or EW CERCLA remedial investigations. The reliability of the chemical concentrations above the AETs as indicators of biological effects, as measured by the sediment bioassays, was evaluated.

For the purpose of this evaluation, the degree of chemical or bioassay exceedance was not considered; the only consideration was whether or not the chemistry and bioassay results exceeded the AET threshold for chemistry or the sediment quality standards (SQS) threshold for the bioassay results.

However, for the 95 samples that exceeded at least one of the AET values, the exceedance of the AET did not necessarily accurately predict the biological effects associated with the bioassay results. In 54% of these samples, the chemical exceedance of the AET was consistent with a bioassay result, which also exceeded the SQS threshold. However, in 46% of the samples, no toxicity was observed in the three sediment bioassay results for the sample. For this dataset, the AETs have functioned as intended, as a conservative screening tool with a strong tendency to overpredict toxicity in order to ensure that sediment classified as non-toxic on the basis of the chemistry results were reliably confirmed as non-toxic by the bioassay results.

These results suggest that the exceedance of an AET value should not be used as a reliable indicator of certain biological effects. AETs may function well as screening levels, but they are clearly not a reliable indicator of biological effect as demonstrated by the LDW and EW sediment bioassay results.

Finally, the LDW data was examined to determine whether the exceedance of multiple AETs increased the predictive power of the AET evaluation. The sediment concentrations in the LDW sediment were compared with six AET values. Of the 95 samples that exceeded at least one AET value, 48 samples exceeded 1 to 3 AET values, and 47 samples exceeded 4 to 6 AET values. Of the 48 samples that exceeded 1 to 3 AET values, 24 samples (50%) showed that there were no significant biological effects associated with the sediment bioassays. Of the 47 samples that exceeded 4 to 6 AET values, 20 samples (42%) showed that there were no significant biological effect associated with the sediment bioassays. This analysis would suggest that predictive power of the AETs is not improved when multiple AET exceedances are present. These results further suggest that it is not accurate to ascribe a greater level of effect or injury on the basis of the number of AET values exceeded.

In conclusion, our analysis of LDW sediment data does not support the assessment of benthic injury provided in Appendix C of the programmatic environmental impact statement (PEIS) (NOAA and USFWS 2009). Specifically, the exceedance of an AET value does not appear to predict benthic effects as represented by sediment bioassays undertaken using the same sediment to which the Appendix C evaluations were applied. Half of the sediment samples that exceeded at least one AET value did not exhibit significant biological effects in the sediment bioassays. Finally, it was determined that the exceedance of multiple AET values did not appear to improve the predictive power of the AET analysis and do not support the idea that the exceedance of greater numbers of AETs represents a greater injury or service loss as presented in Appendix C.

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MEMORANDUM

To: Jon Sloan, Port of Seattle, and Alan Sprott, Puget Sound Commerce Center, Inc. (fka Todd Pacific Shipyards)

From: Ron Gouguet and Susan McGroddy, Windward Environmental LLC

Subject: Review of Appendix F, Allocation Process in the Lower Duwamish River Natural Resource Damage Assessment, in the *Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement*

Date: October 9, 2012

The natural resource trustees (Trustees) have developed a set of highly conservative screening-level assessment tools to help the Trustees provide an opportunity for early settlement of claims for alleged natural resource damages in the Lower Duwamish River. This is the step in the process where the total service losses estimated by the Trustees are apportioned to a subset of the parties that contributed contamination, as identified by the Trustees. We reviewed Appendix F, Allocation Process in the Lower Duwamish River Natural Resource Damage Assessment, in the *Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement* (NOAA and USFWS 2009) and have the following comments.

GENERAL COMMENTS

- The text provided in Appendix F (NOAA and USFWS 2009) is very general, with virtually no information specific to the Lower Duwamish River, which does not allow for a thorough review of the proposed Lower Duwamish River allocation.
- The approach does not adequately consider sources within the pipeshed for storm or combined overflows; and although the Trustees say that this was accounted for in the pipe discharges, the characterization of the chemical loads used for this purpose was not provided. The document fails to address parcels that do not abut the Lower Duwamish River but are associated with current and historical activities that may have resulted in the release of contaminants in to the Lower Duwamish River.
- The mass balance approach used for polycyclic aromatic hydrocarbons (PAHs) is not fully explained in this document. The information that has been provided on

the calculation of PAH release rates for marine pilings suggests that the release of PAH from creosoted marine pilings has been greatly overestimated.

- The association of PAHs with sandblast grit is inaccurate and results in an inappropriate assignment of discounted service acre years (dSAYs) to non-contributing parcels.

ALLOCATION BY UNIQUE FOOTPRINT

The Trustees applied the gradient analysis technique to provide an indication of the locations of sources potentially responsible for a portion of the contaminants in sediment. This technique assumes that maximum concentrations occur near sources and decline with distance. Appendix F, Figure F1 (NOAA and USFWS 2009), is a hypothetical injury footprint showing a gradient of contamination emanating from a land-based source with a resulting sediment plume.

In cases where a plume that originates at one parcel overlaps onto adjacent parcels, liability has been allocated to multiple parcels rather than to the single parcel that is the likely source. In cases where sufficient information is available to identify the unique sources, the Trustees should allocate liability to the specific source rather than simply allocating liability to all adjacent properties.

Additional information, such as co-occurrence of chemicals, grain size, bathymetry, and historical marine development, can allow for a better understanding of a plume and assist in the assignment of responsibility for portions of a plume. More-sophisticated fingerprinting methods could be used to develop source signatures for unique plumes and could assist in a more rigorous allocation process. In general, the process provided here is overly simplistic and does not take advantage of the extensive chemistry dataset and current and historical source control documentation that is available for use in the allocation model.

ALLOCATION BY MASS LOADING

One substance of concern (SOC) (i.e., PAH) was allocated solely through the use of the mass loading approach because the contaminant concentrations were widely diffused throughout the Lower Duwamish River. Concentration gradients were discernible, but footprints were not readily definable. Thus, allocation to each site within the entire Lower Duwamish River was determined through mass loading, taking into account various sources of PAH to the Lower Duwamish River.

PAH MASS BALANCE ALLOCATION APPROACH

The Trustees chose to use a so-called “mass balance” approach to the allocation of PAH (the major injury driver in the Lower Duwamish River) as a substitute for the site-specific footprint approach used for all other chemicals. The details of the mass balance calculations conducted for PAHs are not provided in Appendix F. There is insufficient information provided Appendix F (NOAA and USFWS 2009) to justify the use of an alternative allocation approach for this important class of chemicals.

The use of the mass balance approach has resulted in a gross overestimation of the contribution of PAHs from marine pilings. In discussions with the Trustees, we have learned that the leaching rate used to characterize the loss of PAHs from marine pilings was 23%, which is the rate calculated by Valle et al. (2007) based on the release of PAHs from pilings into the water column. This rate is based on work by Ingram et al. (1982) and Bestari et al. (1998). In their work, the authors provided empirical observations on variables that control the rate at which PAHs leach from creosoted pilings, including the fact that PAH release rates are higher at higher temperatures, and PAH release rates in fresh water are twice the release rates in marine water. Although these uncertainties were noted by Valle et al. (2007) and Ecology (2012), they were not taken into account when site-specific release rates were calculated. Instead, Ecology (2012) and Valle et al. (2007) used a release rate based on freshwater releases at elevated temperatures to characterize the contribution of PAHs from pilings in the colder, marine waters of Puget Sound and other marine water of Washington State (Ecology and WDOH 2012). Based on the controlling factors identified by Ingram et al. (1982) and Bestari et al. (1998), a reliance on release rates obtained from warm fresh water greatly overestimates the contribution from creosote pilings to the waters in Washington State, including the Lower Duwamish River. The primary uncertainties associated with the PAH leaching rate are:

- The desorption rate is based on freshwater exposure. Results by Ingram et al. (1982) indicated that PAH release rates in salt water are half the rates reported in Bestari et al. (1998).
- The desorption rate of PAHs from pilings has been shown to be strongly temperature dependent. The laboratory experiments carried out by Ingram et al. (1982) were conducted at temperatures ranging from 20 to 40 °C, and the mesocosm experiments carried out by Bestari et al. (1998) were conducted outdoors in August with a water depth of 1 m. The temperature data were not reported, but the shallow water depth likely involved temperatures that were higher than the cooler water temperatures found in Puget Sound and other Washington State marine waters. Based on the analysis of temperature presented in Xiao et al. (2002), it appears that the PAH release rate at 20 °C is approximately twice the PAH release rate at 10 °C.
- The leaching of PAHs was observed only at the surface (1 mm) of the treated piling; no loss was observed from the deeper regions of the piling (Bestari et al. 1998). Therefore, only a small volume of creosote is available to function as a source of PAHs due to leaching.
- PAH desorption rates decline exponentially following the placement of freshly treated wood. The rate calculated by Bestari et al. (1998) was based on the

placement of treated wood in a mesocosm for 84 days, during which an exponential decline in PAH releases was measured.

> "In this study, total water column PAHs increased steadily to a maximum concentration at 7 d post-treatment, followed by an exponential decline to approximately background levels by 84 d" (Bestari et al. 1998).

The application of this rate to the 30-year lifespan of a piling is not supported by the research because it does not account for the fact that significant releases of PAHs only occur following the installation of the piling.

- Other important variables that have been shown to affect the release of PAHs but have not been accounted for in this analysis include creosote composition, the type of wood, the method of creosote application, water temperature, and flow rates.

It is our understanding that the rate of PAH release from marine pilings into the water column was applied to the portion of the marine piling in the sediment in order to estimate the contribution of the piling to the sediment PAH concentration. The many reasons why the rate of PAH release derived by Valle et al. (2007) is an overestimation of the release of PAHs from the pilings into the water column in Puget Sound waters are provided above. If this rate was applied to the portion of the piling buried in the sediment, then the release of PAHs from pilings has been greatly overestimated. There is no reason to assume that the rate of PAH release in the water column represents the rate of PAH release in the sediment. The physical and chemical properties of PAHs suggest that there is a strong thermodynamic tendency for PAHs to remain associated with the hydrophobic organic matrix of the creosote. Furthermore, there is no viable transport mechanism to move PAHs released into sediment 10 to 40 ft below the sediment surface upward into the biologically active zone where there is a potential for biological uptake.

Impacts Associated with PAH Leaching from Pilings

Numerous studies have been conducted in an effort to quantify the effects of PAHs released from creosote-treated pilings in terms of increased PAH concentrations in the water column, sediment, and biota in the vicinity of these pilings. The conclusions of a variety of studies are summarized below. Very few impacts have been observed in the immediate vicinity of the pilings during the time period that immediately follows the placement of the pilings.

Ingram et al. (1982) conducted laboratory desorption experiments and concluded that:

> "The amount of creosote that migrates from creosote-treated marine piling is extremely small…. This small annual loss, plus the fact that PAHs apparently are rapidly broken down in sea water, indicates that the PAHs

> that migrate from creosote piling should have a negligible effect on the environment."

Bestari et al. (1998) conducted mesocosm studies in which changes in water column and sediment PAH concentrations were monitored over a period of months and concluded that there were no significant impacts from the leaching of PAHs in creosote from pilings:

> "The loss of PAHs from the water was not reflected as an increase in the sediments although an increase in PVC-bound PAHs was observed. Thus, it appears that the majority of PAHs leached into the water from the pilings is lost via natural physical (volatility, photodegradation) and biological (microbial degradation) pathways. In this sense, environmental impacts associated with loss of creosote from impregnated wood structures are most likely to occur during the initial periods following their placement in aquatic environments. Further, relatively low concentrations were recorded in this study so any impacts that do occur may be chronic, rather than acute, in nature."

A long-term *in situ* study carried out by Goyette and Brooks (1998) was conducted in Sooke Bay on Vancouver Island, British Columbia, Canada. This study is particularly relevant to Washington State marine waters because of the similarity in the conditions of exposure. This study included the placement of creosoted pilings and 4 years of monitoring of the chemical and biological impacts of the pilings. According to Goyette and Brooks (1998):

> "This study has shown that under worst case conditions, significant PAH contamination was restricted to an area within 7.5 meters from the perimeter of a significant structure. The response of an extensive infaunal community analysis and laboratory bioassays indicates that significant adverse biological effects were found within a distance of approximately 0.65 meters from the perimeter of the structure. Slight adverse effects were observed to a distance of 2.0m."

Finally, the Stratus report prepared for NOAA (Stratus 2006) is a compilation and critical review of the available literature that describes the release of PAHs from creosote-treated wood structures. The authors concluded that the impacts associated with PAHs released from pilings are likely to be small in both temporal and spatial scales.

> "Overall, the laboratory and field studies described above indicate that treated wood structures can leach PAHs and other toxic compounds into the environment. However, the degree of PAH accumulation to sediment associated with these structures appears to be relatively minor in many settings, particularly in well-circulated waters and over time. PAH accumulation also appears to be relatively limited spatially (within approximately 10 m of the structure) and has not generally been

> associated with measured, significant, biological effects except in close proximity to the structures. The duration of any biological effects also appears to become attenuated within several months of construction (the time period when leaching rates are likely to be highest)."

The conclusions of these studies would suggest that the injury resulting from the release of PAHs from pilings should not be large. However, it is our understanding from discussions with the Trustees that the preponderance of the PAH injury has, in fact, been allocated to releases from marine pilings.

ASSOCIATION OF PAHS WITH SANDBLAST GRIT

In addition, the Trustees have asserted that PAHs are associated with sandblast grit. This assertion has not been supported and is inappropriate. At a February 16, 2012, Trustee presentation regarding the natural resource damage assessment, the Elliot Bay Trustee Council listed "sandblasting grit" as a site-specific activity related to PAHs, along with asphalt production, creosote pilings, and vehicle washing. The Trustees stated that using their methodology, sandblast grit is associated with 18% of the total mass of PAHs released. However, the rationale for associating PAHs with sandblast grit is not known.

Metals and tributyltin are the primary chemicals associated with sandblast (also known as abrasive grit blast [AGB]). For the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sediment remediation project implemented at Todd Pacific Shipyards (now known as Puget Sound Commerce Center, Inc.), constituents of AGB were analyzed, and a definition of AGB in sediment was prepared and approved by the US Environmental Protection Agency (EPA). Copper, arsenic, and zinc, as well as grain size, were considered diagnostic of AGB, not PAHs. These metals plus grain size and/or a visual assessment allowed for the identification of AGB. PAHs were never associated with AGB nor used to identify AGB releases to the sediment.

In addition, as part of the source control work required by EPA for the CERCLA process at Todd Pacific Shipyards, the historical use and constituents of sandblast grit were evaluated. Kleen Blast, a vitreous copper smelter slag grit, and Tuf-Kut and Green Diamond, nickel slag grits, were evaluated. Kleen Blast grit contains moderate to trace levels of copper, lead, arsenic, and zinc, with copper occurring in highest concentration. PAHs are not constituents present in sandblast grit, and the manufacturers do not analyze for PAHs. Based on the above information, the correlation between sandblast grit and PAHs is inaccurate and should be removed.

UNALLOCATED FOOTPRINTS

The hypothetical example that illustrates the process described in Appendix F (NOAA and USFWS 2009) is not useful. It provides percent allocation figures as if there were a precise basis for them and explains the arithmetic of the calculation.

It is not clear why the Trustees included Table F3, activity ratings for polychlorinated biphenyls (PCBs) in Appendix F (NOAA and USFWS 2009). The explanation provided in Appendix F follows:

> "This table is intended to represent an initial screening of the relative ranking of activities with respect to their potential to release PCBs. Thus, all other things being equal (e.g., size, duration, degree of case, fate and transport, chemical concentrations) an **activity near the top of the list is expected to result in the release of a greater mass of SOCs than an activity near the bottom of the list. However, where things are not equal the actual mass contribution could be much different than that implied by the order noted in the table**."

The bold text is confusing and does not provide a clear explanation as to how this information was used in the allocation process.

Conclusions

The screening exercise described in Appendix F (NOAA and USFWS 2009) provides a brief and cursory description of the process that has been used to determine who is likely responsible for hazardous substance contamination and resulting injury in the Lower Duwamish River. The description of the approach employed by the Trustees does not provide enough information to allow for a full evaluation of the decision process that has been developed for this site.

The Trustees state that "The allocation process requires the use of professional judgment, largely to address variability in the amount, type and quality of data available for each site." The professional judgment that has been used for this site has not been sufficiently described in Appendix F. Furthermore, the results of the allocation process must be released in order to allow for a full understanding of the implications of the allocation process.

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
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Portland, Oregon 97232-4181

In Reply Refer To:
FWS/R1/AES/HC/NRDA

SEP 24 2013

To: Office of the Solicitor
Pacific Northwest Region
Portland, Oregon
Attention: Barry Stein

From: Regional Director, Region 1
Portland, Oregon

Robyn Thorson

Subject: Record of Decision for the Final Lower Duwamish River Natural Resource Damage Assessment Plan and Programmatic Environmental Impact Statement in Seattle, Washington

As Authorized Official for the U.S. Department of the Interior (Department) in the Elliott Bay Natural Resource Damage Assessment (NRDA), we intend to adopt the Final Lower Duwamish River NRDA Restoration Plan and Programmatic Environmental Impact Statement for the Elliot Bay/Lower Duwamish River area in Seattle. Washington as indicated by signature on the attached Record of Decision.

If you have any questions on this issue, please contact Julie Concannon, Regional Office at 503-231-2325 or Jeff Krausmann, Washington Fish and Wildlife Office a 360-753-6053.

Attachments:

cc:
FWS, Portland, OR (J. Concannon)
FWS, WFWO, Lacey, WA (J. Krausmann)

RECORD OF DECISION
for the Final Lower Duwamish River NRDA
Restoration Plan & Programmatic Environmental Impact Statement

Introduction

The U.S. Department of Interior, Fish and Wildlife Service, along with other members of the Elliott Bay Trustee Council (Trustees), has prepared a Final Lower Duwamish River NRDA Restoration Plan and Programmatic Environmental Impact Statement (RP/PEIS). The RP/PEIS will guide decision-making regarding the implementation of Lower Duwamish River Natural Resource Damage Assessment (LDR/NRDA) restoration activities. This plan is intended to expedite and provide a point of departure for future site-specific projects and facilitate the preparation of subsequent project-specific environmental documents through the use of tiering. Project specific National Environmental Policy Act (NEPA) environmental evaluation documents, usually in the form of Environmental Assessments, will be prepared for future restoration projects and will be referenced back to, or "tiered" from, the RP/PEIS.

This Record of Decision (ROD) represents the conclusion of the programmatic planning process and provides guidance for the Trustee's future actions and documents the decision of the Trustees regarding the approach to take to restore injured natural resources in the LDR. It presents reasons for selecting the course of action and the alternatives considered. The ROD briefly discusses elements considered in reaching a final decision and supporting rationale.

The Federal government, acting together with other Trustees for natural resources, is responsible for taking actions necessary to restore injured resources and the services they provide. The LDR/NRDA is being conducted pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, *42 U.S.C. §§ 9601 et seq.*(CERCLA), the Oil Pollution Act of 1990, and other applicable laws, which provide the legal basis for these responsibilities. Concurrent with the damage assessment process, the Trustees conducted restoration planning to determine the best approach to restoring, rehabilitating, replacing, and acquiring the equivalent of the injured natural resources and their associated services. The Trustees prepared the RP/PEIS, which included: the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Department of Interior, Fish and Wildlife Service (U.S. DOI/U.S. FWS) as the lead federal agencies, with the State of Washington, the Suquamish Tribe, and the Muckleshoot Indian Tribe as participating trustees, and the U.S. Army Corps of Engineers (U.S. ACOE), and the Environmental Protection Agency (U.S. EPA) as cooperating agencies.

A previous draft RP/PEIS was made available for public review on May 22, 2009 with the comment period ending on July 28, 2009. A supplement to the draft RP/PEIS was made available for public review on July 27, 2012 with the comment period closing on October 10, 2012. In the supplemental document, the Trustees added more detail about the injury assessment and restoration valuation methodology used in the LDR/NRDA, as requested in some of the comments received on the previous draft, and made some other more minor changes to address other comments.

Key Issues

The Trustees have taken an ecosystem approach to planning for the implementation of restoration projects as part of the LDR/NRDA. Trustees established priority focus areas for restoration that fulfill CERCLA requirements (restoration with a strong nexus to the injured resources) and puts restoration in areas where habitat is scarce and essential for fish and wildlife in the Lower Duwamish River. Each Habitat Focus Area (HFA) places boundaries around important target habitat features and other factors important to restoring injured natural resources. There are four HFAs covered under this document: **HFA1- Lower Duwamish River**, extending from the northern tip of Harbor Island upstream to North Winds Weir; **HFA2- Inner Elliott Bay Shoreline**, between the Duwamish head and Port of Seattle Terminal 91; **HFA3- Duwamish River Reach** (farther upstream of the Lower Duwamish), which goes from upstream of North Winds Weir to the confluence of the Green and Black rivers; and **HFA4- Green River Reach** (upstream from the Duwamish River Reach) which extends from the confluence of the Green and Black rivers to the boundary of the Lower Green River Watershed as defined by the Water Resource Inventory Area (WIRA) 9. The Trustees' ability to restore injured resources and the approach required varies among the HFAs. Priority will be given to projects within HFA1 - the Lower Duwamish River- and HFA2- Inner Elliott Bay. Projects in other habitat focus areas will be subject to minimum size and project type restrictions, and will be acceptable for NRD settlements only if they are a component of a settlement proposal that includes restoration in the Lower Duwamish River (HFA1).

Alternatives Considered

The Programmatic Environmental Impact Statement (PEIS) analyzes the environmental impacts of the alternatives that may be employed by the Trustees to restore, replace, rehabilitate, and/or acquire the equivalent of the injured natural resources as well as the services they would have provided but for the hazardous substance releases and oil discharges to the environment of the Lower Duwamish River. Three alternatives were evaluated in the RP/PEIS: 1) No-Action, an alternative which is required to be considered, under which the Trustees would not conduct restoration actions to restore natural resources; 2) Species-Specific Restoration, under which the Trustees would develop specific restoration actions designed to benefit individual species; and 3) Integrated Habitat Restoration, under which habitat complexes would be developed to benefit, directly or indirectly, the suite of natural resources that were injured by releases of hazardous substances into the LDR.

Preferable Alternative (Integrated Habitat Restoration)

The Preferred Alternative (Alternative #3 from the list above) consists of habitat projects that provide benefits to the wide suite of species that are likely to have been injured as a result of hazardous substance releases into the LDR. The Trustees preferred alternative is a comprehensive plan based on restoration of key habitats that, together, will benefit the range of different resources injured by releases of hazardous substances in the LDR. This alternative best meets the needs of the Trustees' restoration goals and principles by maximizing ecological benefits for a wider range of natural resources and their associated services. This alternative meets the basic purpose of NRDA, which is to restore the natural resources and services that were affected by these releases. The LDR is highly modified with relatively little remaining natural intertidal habitat, so creation of habitat projects such as marshes and mudflats, even on a relatively small-scale compared to what had existed prior to the alteration of the river system, will be of great benefit to the injured natural resources utilizing this area. Ideally, projects will consist of integrated habitats, such as a mudflat bordered by marsh with a riparian buffer to maximize the level of ecological services to affected resources.

Decision

Based upon the review of the alternatives and their environmental consequences described in the PEIS, the decision of NOAA and Trustees is to implement Alternative 3, the integrated approach. This alternative is proposed as preferred because it is best suited of all the alternatives to fulfill the goal of NRDA under CERCLA to restore injured natural resources and services. It is specifically designed to improve habitats that function in support of multiple fish and wildlife resources, as well as the prey items of these species that reside in those habitats. The Trustees recognize the success of similar habitat restoration projects in the LDR by the Elliott Bay Panel and others, Commencement Bay, and elsewhere in Puget Sound, whether done in a NRDA-context or not, and this alternative will build on those efforts. The potential impacts of this alternative are discussed in greater length below.

The Restoration Plan will be utilized to coordinate and implement restoration projects under the LDR/NRDA. The Restoration Plan will allow existing settlement funds to be utilized to implement restoration projects and will facilitate additional settlements. The ultimate scale of restoration activity that will be undertaken will depend upon the funds, property and services made available through resolution of natural resources damage claims. By adopting the preferred alternative with its mitigation measures to avoid significant adverse impacts, all practicable means to avoid or minimize harm have been adopted.

Rationale for Selection of the Preferred Alternative

This alternative involves actions designed primarily to restore certain types of habitats that support a range of species. Under this alternative, the Trustees would focus on habitat projects that benefit a suite of different species, using important surrogate species and groups to evaluate the benefits of potential habitat projects to injured resources. Under this approach, projects that provide benefits to a large number of potentially injured species would have greater value compared to projects that would tend to benefit largely one species or a small group of species. Typical kinds of restoration actions under this alternative include removal of intertidal fill to restore mudflats, marsh, and/or riparian habitats, creation of off-channel areas, removal of creosote pilings and overwater structures that shade habitats, and softening shorelines. These projects will create habitats that provide food, foraging, and resting areas for juvenile salmonids and other fish, shorebirds and other wildlife.

The Integrated Habitat Restoration Alternative should result in net improvement in water and sediment quality over the long term. Some habitat restoration actions would result in short-term construction-related impacts, but using best management practices at a project-level can typically minimize these impacts. Adverse impacts may include temporary increases in erosion associated with land disturbance, temporary increases in turbidity, temporary increases in noise from construction activities, and short-term increases in air pollution from construction equipment.

This alternative ties in well with the approach the Trustees used in estimating injury, which is based on habitat use and value to the surrogate species or species groups. By clearly laying out the types of projects that the Trustees favor, potentially responsible parties (PRPs) will be able to use these guidelines to develop potential project ideas for settlement discussions with Trustees. This will also allow PRPs to begin considering whether restoration actions can be integrated with response or remedial actions to save costs. Use of this alternative will be more efficient for the Trustees, because there will be a consistent set of criteria and a methodology for evaluating potential projects. It also facilitates the establishment of a cash-out position for potential settlements. Previous habitat restoration projects constructed in the LDR by the Elliott Bay/Duwamish Restoration Panel enables Trustees to develop make reasonable restoration cost estimates for construction, monitoring, adaptive management, and Trustee administrative costs for future restoration projects that may result from settlements.

Consideration of Mitigation Measures

Since this is a programmatic approach that applies to a larger area, and at this time the details of specific restoration projects that may be proposed are unknown, the impacts were presented in general terms. Specific projects would undergo additional environmental analysis. The project screening and prioritization presented as a two-tiered analysis would assist in preferring future projects with consideration of their potential environmental impacts. Accordingly, best management practices and mitigation measures associated with individual projects are not included in this RP/PEIS, but would be considered in the identification of priority projects and the analysis of proposed projects and their alternatives in subsequent NEPA analyses. Types of mitigation measures may include local and state-required best management practices for erosion control, reduction in air pollution via dust control during construction and stockpiling of materials, minimizing the area and time of disturbance of sediments and water flow to maximize protection of fish and their habitats, and other mitigation measures as appropriate to the proposed project. These would be considered on a project-specific basis and assessed for their capacity to reduce impacts as part of the analysis and selection of future restoration actions.

The Elliott Bay Trustee Council approves the Supplement to the Draft Lower Duwamish River NRDA Programmatic Restoration Plan and Programmatic Environmental Impact Statement for restoration of the Lower Duwamish River environment and authorizes the implementation of the preferred alternative contained therein.

Robyn Thorson

Robyn Thorson
Regional Director, U.S. Fish and Wildlife Service
Authorized Official for the U.S. Department of the Interior

SEP 24 2013
Date