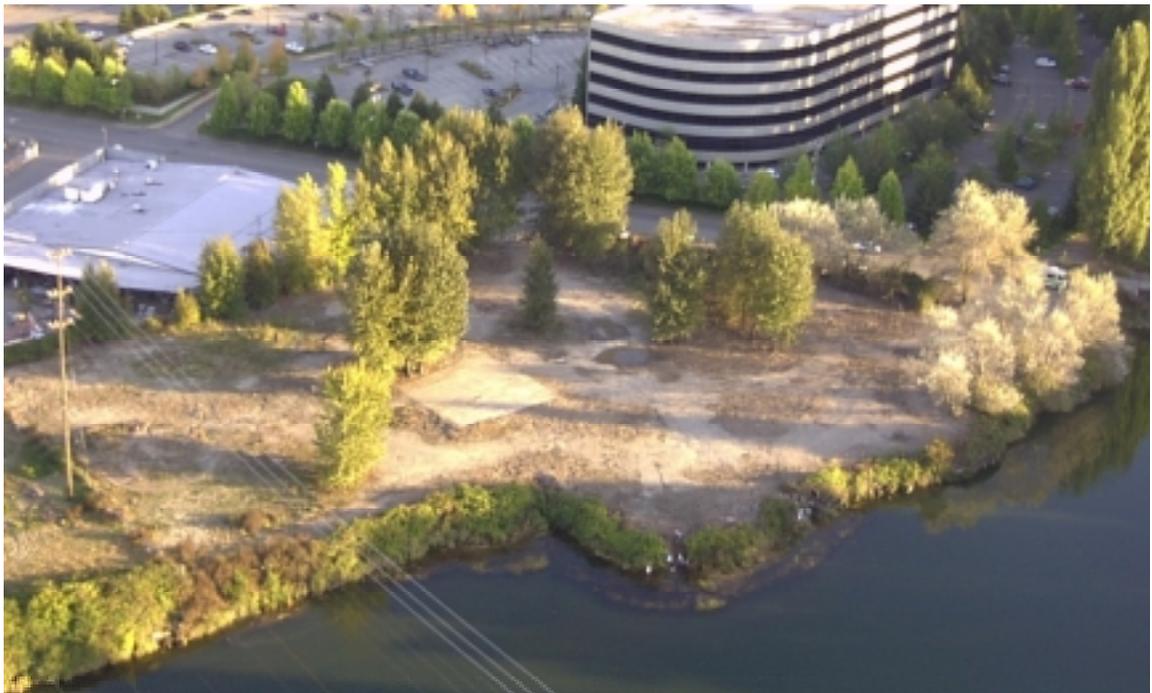


Environmental Assessment

**Green-Duwamish General Investigation
Ecosystem Restoration**

North Wind's Weir Intertidal Restoration Duwamish River Tukwila, Washington



Draft of January 5, 2004



**US Army Corps
of Engineers®**
Seattle District

North Wind's Weir Intertidal Restoration
Duwamish River
Tukwila, Washington
January 2004

Draft Environmental Assessment

Responsible Agencies: The agencies responsible for this project are the U.S. Army Corps of Engineers, Seattle District (Corps), and the King County Department of Natural Resources and Parks, Water and Land Resources Division (King County DNRP), along with a number of other groups which provided funds toward acquisition of the site. These groups include the City of Tukwila, the Salmon Recovery Funding Board (SRFB), the Washington State Department of Natural Resources Aquatic Lands Enhancement Account (ALEA), the Elliott Bay/Duwamish Restoration Program, and the City of Seattle.

Summary: Nearly all intertidal marsh and mudflat habitats of the Duwamish River have been eliminated as a result of dredging and filling of the estuary for urban and industrial development; only about 1 percent of an estimated 4,000 acres of tidal and intertidal habitat remains today. As a result, the river and its estuary have lost the ecological functions of these intertidal areas, including critical rearing and refuge habitat for juvenile salmon. The majority of the project area has been excavated and filled with industrial debris, and much of the shoreline has been armored. As a result, the project area is substantially elevated above the river, isolated from tidal influence, inaccessible to fish, and virtually uninhabitable by native vegetation and wildlife species.

The Corps and its partner agencies are therefore proposing to remove the historic fill and shoreline armoring and restore the connection of this site to the river and the tides. This project would restore critical intertidal functions such as foraging and refuge habitat for juvenile salmon by restoring mudflat, marsh, and riparian habitats. In accordance with the National Environmental Policy Act (NEPA), this document evaluates the potential environmental impacts of the proposed restoration alternative.

Impacts will generally be highly localized in nature, short in duration, and minor in scope. As the site is almost completely paved and/or disturbed, there will be virtually no temporal loss of habitat. Minor temporal losses will be compensated for through restoration of tidal connectivity that will restore a variety of native habitats where none now exist. Impacts from this restoration project should not be significant, either individually or cumulatively.

THE OFFICIAL COMMENT PERIOD ON THIS DRAFT ENVIRONMENTAL ASSESSMENT ENDS ON February 6, 2004.

This document is available online at: <http://www.nws.usace.army.mil/ers/envirdocs.html>

Hard copies of the Programmatic Biological Assessments and this draft EA document (including appendices) are available from the Corps upon request.

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1.0 INTRODUCTION

During the summer of 2004, the Corps and King County Department of Natural Resources and Parks (King County DNRP) are proposing to restore the historic tidal connectivity and intertidal habitats of the project area. The proposed restoration work includes: (1) removing between 7 and 20 feet of fill material from the site, including steel slag, concrete pads, and associated industrial debris (2) removing riprap and blackberries along the shoreline, (3) grading the site to elevations typical of intertidal mudflat and marsh, and (4) planting native intertidal marsh and riparian forest communities. In accordance with the National Environmental Policy Act (NEPA), this Environmental Assessment (EA) evaluates the potential environmental impacts of the proposed restoration project.

1.1 Project Location

The project area is located along the eastern bank of the lower Duwamish River at approximately River Mile 6.2, in the southeast quarter of Section 4, Township 23 North, Range 4 East, within the City of Tukwila Washington (Figure 1). The project area encompasses approximately 3.27 acres (including areas waterward of Mean Higher High Water that are exposed at low tide), and is bordered on the west by the Duwamish River and a fringe of intertidal habitats, to the north by Seattle City Light property, to the east by an existing industrial facility (Pacific Strapping Inc.), and to the south by South 112th Street (Photo 1). The project area is directly across the river from an intertidal habitat restoration project (the Cecil B. Moses Park) recently completed in early 2003 by the Elliott Bay Duwamish Restoration Panel that included KC DNRP and the City of Seattle (Photo 2).

Existing land use consists of vacant industrial land on historic fill material. Property topography is flat, with 0 to 3 percent slopes. All structures have been demolished and the fill material is largely unvegetated, with the exception of scattered red alder (*Alnus rubra*) and black cottonwood (*Populus balsamifera*) trees (Photo 1). The property is fringed on the east and south by a small group of ornamental white poplar (*Populus alba*) trees, with a scattered and disturbed understory of non-native shrubs. The western shoreline has been rip-raped and currently supports a dense thicket of Himalayan blackberry (*Rubus discolor*). Approximately 11 feet in elevation below the eastern edge of the site, a small patch of intertidal saltmarsh dominated by Lyngby's sedge (*Carex lyngbyei*) and an extensive area of unvegetated mudflat fringe the Duwamish River (Photo 3). Two large concrete pads from abandoned buildings are present in the central portion of the site. A sparse mixture of grasses, blackberries, and other disturbance adapted plants are scattered across the site. A large rock outcrop, locally referred to as the North Wind's Weir, is located within the river, just off the southwestern corner of the project area (Photo 2).

1.2 Project Purpose and Need

The lower Green/Duwamish River estuary was historically an area of very low gradient with a sinuous, meandering main channel. Most of the larger sediment had been deposited in the middle river, and the lower river had primarily sand and mud substrate. The original intertidal mud and sand flats historically extended east to what is now Interstate 5 and west to the West Seattle Hills. The Duwamish River originally flowed through the mud flats in three braided, winding channels. Substantial areas of marsh vegetation (approximately 1,270 acres) and forested tidal swamps (approximately 1,230 acres) existed upstream (south) of these intertidal

mud and sand flats. Large woody debris was carried into the lower river and estuary from the upper watershed during floods (Perkins 1993, USACE 1997a, 1997b).

The estuarine mud flats and marshes were nearly completely destroyed by dredging and filling activities that occurred between the late 1800's and the mid-1900's as part of an early plan for a canal that would establish a navigable link between the salty waters of Puget Sound and the inland fresh waters of Lake Washington. Ultimately, intertidal habitats in the Duwamish River were reduced from about 2,100-2,500 acres to less than 25 acres (Benoit 1979, Bortleson et al. 1980, Blomberg et al. 1988).

Thus, the purpose of the North Wind's Weir Intertidal Restoration Project is to restore important intertidal habitat within the lower Duwamish River, with the intent of specifically providing mudflat and saltmarsh habitats suitable for rearing and foraging by juvenile salmonids. This will be accomplished by removing the fill and regrading the site to intertidal elevations, reconnecting the site to the river, restoring the natural shoreline, and planting native intertidal and riparian vegetation. As the result of this project, the native habitats and natural processes conducive to the survival of juvenile salmonids would be restored at this site. The resulting intertidal mudflat, salt marsh, and riparian habitats would provide critically important transitional habitat where juvenile salmonids would have the opportunity to feed, rest, and undergo smoltification prior to out-migrating through Puget Sound to the Pacific Ocean. These habitats would also provide important refuge, foraging, and perhaps breeding habitat for a variety of other urban-adapted native fish and wildlife species.

1.3 Authority

Federal involvement in ecosystem restoration is supported in law and Executive Order. The Corps Civil Works Ecosystem Restoration Policy (ER 1165-2-501), the Fish and Wildlife Coordination Act of 1958, Federal Water Project Recreation Act of 1965, National Environmental Policy Act of 1969, Water Resource Development Act (WRDA) of 1986, and the WRDA of 1990 provide national policy directing consideration of projects that benefit ecological resources.

Specifically, Section 306 of the WRDA of 1990 authorized the Secretary of the Army to include environmental protection as one of the primary missions of the Corps. The larger Green/Duwamish Ecosystem Restoration Study stems from the Corps' authority under Section 216 of the River and Harbors and Flood Control Act of 1970, which enables the Corps to undertake restoration related to the hydrologic regime of aquatic ecosystems. Congress specifically authorized the Green/Duwamish River Basin Feasibility Study and thus the North Wind's Weir Intertidal Restoration project, in Section 101(b)(26) of WRDA 2000.

King County DNRP is the non-Federal sponsor for the North Wind's Weir Intertidal Restoration project evaluated in this document. The Corps and King County DNRP have cooperated in regular interagency meetings from which the objectives for the proposed restoration work were developed. King County DNRP has also contributed technical expertise, including design drawings, during plan formulation.

1.4 Associated Studies and Reports

General information regarding the Green/Duwamish River basin and its associated existing conditions, fish and wildlife populations, and potential impacts on federally listed endangered or threatened species is incorporated into this document by reference to the:

Final Programmatic Environmental Impact Statement and Restoration Plan (FPEIS) for the Green/Duwamish River Basin Ecosystem Restoration Program, prepared by the Seattle District Corps and King County DNRP in November 2000.

Green Duwamish Ecosystem Restoration Study, Final Feasibility Report, prepared by the Seattle District Corps, October 2000.

Programmatic Biological Assessments for Green/Duwamish Ecosystem Restoration Program, King County, Washington. Separate documents were prepared for species under National Marine Fisheries and US Fish and Wildlife jurisdictions for the Seattle District Corps by Jones & Stokes, June 2000.

Seattle's Urban Blueprint for Habitat Protection and Restoration: Review Draft, prepared by the City of Seattle's Salmon Team, June 2001.

2.0 ALTERNATIVES CONSIDERED

In order to comply with the National Environmental Policy Act (NEPA), CEQ rules, and Corps regulations, the Corps performed an analysis of potential alternatives to meet the purpose and need of the project. The Corps evaluated the no-action alternative as well as three alternatives for restoration of the site. These alternatives differed in the proportions of the site restored to intertidal mudflat versus marsh elevations, the location and configuration of the connection with the Duwamish River, and the amount and configuration of the natural marsh that could be retained and still allow for tidal connection to the Duwamish River. Ultimately, Alternative 3 was modified to create the Preferred Alternative (Alternative #4). Table 1 lists the goals, objectives, and constraints that were used to develop and assess possible alternatives.

2.1 The No-Action Alternative

Under the no-action alternative, the project area would likely remain undeveloped due to limitations on development encumbered during the purchase of the property by King County DNRP. The site would remain in a disturbed state for many years as pioneering, generally weedy vegetation colonize the compacted soils of the site. An increase in non-native invasive upland shrubs such as Himalayan blackberry and Scot's broom would be expected across the site in the short term, due to the seed sources on and surrounding the property. Herbaceous weeds would also be expected to colonize cleared portions of the site. Over time, the existing trees on the site would continue to grow and shade the edges of the site and young trees could colonize and develop on the site, likely dominated by species such as black cottonwood and red alder that are common in the area and are generally early colonizers of open spaces. The approximately 0.176 acres of existing intertidal salt marsh would continue to fringe the edge of the site and would continue to directly receive storm water discharge from the adjacent industrial facility to the east. People would continue to have unrestricted access to the site and the deposition of refuse and garbage would likely continue.

The no action alternative would not meet the authorized project objectives because no intertidal habitat would be created, no salmonid rearing habitat would be created, and there would be no increase in native plant diversity on the site; thus, the no-action alternative results in much smaller and much lower quality environmental benefits from the site than the other alternatives considered. Furthermore, the no action alternative is not considered to be a less environmentally damaging alternative when compared to the proposed action because existing areas of low-level soil contamination would likely not be removed from the site.

2.2 Alternative 1 – Single Entrance Intertidal Marsh

Under Alternative 1, the majority of the site would be lowered to elevations ranging from +2 to +8 feet NAVD 88 (+4.35 to 10.35 MLLW) and would be connected to the Duwamish River via an entrance off the east side of the rock weir and its associated scour pool. All the existing riprap and abandoned rubble along the shoreline would be removed. This alternative would require grading of the western side of the existing intertidal marsh to match graded contours with existing contours. This alternative would create approximately 1.91 acres of intertidal marsh and a narrow zone of approximately 0.48 acres of intertidal mudflat in the center of the site below approximately the +2 feet contour (NAVD 88). The outer slope of the restored intertidal marsh would increase in elevation rather quickly along the northern edge and would then transition to approximately 0.54-acres of created forested riparian buffer along the outer edge of the site.

Alternative 1 would result in the loss of the 0.06 acres of the western extent of the existing intertidal marsh (approximately one-third of the marsh) and its replacement with restored intertidal marsh habitat of similar functional value to invertebrates, fish, and birds. The single entrance design would result in a narrow intertidal channel and associated mudflat that would be wetted and accessible to juvenile salmonids.

This alternative was eliminated from further consideration principally due to the low amount of intertidal channel and mudflat that would be restored at the design elevations. In order to maximize the diversity and complexity of foraging, refuge, and resting habitats available for juvenile salmonids, a design with a more balanced proportion of marsh to mudflat and channel habitats was sought.

2.3 Alternative 2 – Double Entrance Mudflat

Under Alternative 2, the majority of the site would be lowered to elevations ranging from –2 feet NAVD 88 to +2 feet NAVD 88 (approx. +0.35 to +4.35 feet MLLW) and would be connected to the Duwamish River in two areas. All the existing riprap and abandoned rubble along the shoreline would be removed. This alternative would require grading across the existing intertidal marsh and mudflat out to the -2-foot elevation contour of the Duwamish River to match graded contours with existing contours. This alternative would create approximately 1.76 acres of intertidal mudflat and a thin fringe of approximately 0.37 acres of marsh at the upper edge of the +2 feet contour (NAVD 88) as it slopes up to the riparian buffer. A forested riparian buffer of approximately 0.36 acres would be restored along the outer edge of the site.

Alternative 2 would result in the complete loss of the 0.176 acres of existing intertidal marsh and its replacement with intertidal mudflat habitat of different functional value to invertebrates, fish, and birds. The double entrance design would result in complex hydraulics as predominately fresh river water entered the restoration site from upstream during normal and high river flows and more estuarine water entered the site on incoming and higher tides. The channel would be accessible to juvenile salmonids during most tidal cycles and from both the upstream and the downstream ends of the project site.

This alternative was eliminated from further consideration due to ecological impacts (including the loss of juvenile salmonid foraging habitat and prey resources) that would result from the complete loss of the existing intertidal marsh. While a fringe of intertidal marsh would be restored around the outer edge of the site, functional replacement of the existing marsh would not be immediately accomplished, nor would there be any guarantee that the restored marsh areas would support the same density and diversity of vegetation as the existing marsh. Consideration of this risk and uncertainty contributed to the elimination of Alternative 2. Uncertainty regarding the hydrodynamics and long-term viability of the created channel, coupled with the ecological impacts of the amount and complexity of excavation necessary to lower the existing mudflat off the northern end of the site to the design elevations between –2 and +2 feet NAVD 88 also contributed to the elimination of Alternative 2 from further consideration.

2.4 Alternative 3 – Single Entrance Intertidal Marsh and Mudflat

Under Alternative 3, the majority of the site would be lowered to elevations ranging from -1 to +4 feet NGVD 88 (+1.35 to 6.35 MLLW) and would be connected to the Duwamish River via an entrance off the east side of the rock weir and its associated scour pool. All the existing riprap and abandoned rubble along the shoreline would be removed. This alternative would require grading of the western side of the existing intertidal marsh to match graded contours with existing contours. This alternative would result in an increase of approximately 0.09 acres of intertidal mudflat over Alternative 2, but with a wider and more gently sloped zone of intertidal marsh than in Alternative 1. Approximately 1.85 acres of mudflat would be created under this alternative, compared to 1.76 acres of mudflat created under Alternative 2. The outer slope of a restored intertidal marsh (of approximately 0.75 acres) would gradually transition to an approximately 0.5-acre restored forested riparian buffer along the outer edge of the site.

Alternative 3 would also result in the loss of the 0.06 acres of the western extent of the existing intertidal marsh (approximately one-third of the marsh) and its replacement with restored intertidal marsh habitat of similar functional value to invertebrates, fish, and birds. The single entrance design under Alternative 3 would result in a broader intertidal channel and larger area of mudflat than under Alternative 2. Thus, more intertidal habitat would be wetted and accessible to juvenile salmonids during a greater portion of the tidal cycle under this alternative.

Based on concerns for the stability of the upstream side of the entrance, this alternative was refined into the Preferred Alternative (described below in Section 3). As a result of refinement of Alternative 3, a small area of armoring and bank stabilization was incorporated into the upstream side of the entrance channel to better maintain the existing hydrodynamics while continuing to maximize the diversity and complexity of habitats available for juvenile salmonids through a balanced proportion of marsh to mudflat and channel habitats. The Preferred Alternative also incorporates techniques to salvage the portion of the existing marsh slated for excavation and replanting the salvaged areas at appropriate elevations within the restored areas of marsh.

3.0 DESCRIPTION OF THE PROPOSED PROJECT (PREFERRED ALTERNATIVE):

Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

3.1 Restoration of Tidal Connectivity and Intertidal Habitats

Under the Preferred Alternative, the majority of the site would be lowered to elevations ranging from -1 to +4 feet NGVD 88 (+1.35 to 6.35 MLLW) and would be connected to the Duwamish River via an entrance off the east side of the rock weir and its associated scour pool (see Figures 2 through 5). This would create approximately 1.66 acres of tidal channel and associated intertidal mudflat (below elevation +4 NGVD 88) and approximately 0.76 acres of intertidal and high marsh between elevations +4 and +10 feet NGVD 88 (+6.35 and +12.35 MLLW). A scrub-shrub wetland community between elevations +10 and +12 feet NGVD 88 (+12.35 and +14.35 MLLW) of approximately 0.17 acres would gradually transition to a forested riparian buffer encompassing approximately 0.29 acres to the top of the area of excavation. The upstream side of the entrance channel would be armored and bank stabilized to better maintain the existing hydrodynamics of the shoreline, better preserve the undisturbed portion of the existing saltmarsh, and support a self-maintaining channel opening. The top and backside of the armoring would be capped with soil and planted with vegetation (likely willows) to increase habitat function and improve aesthetics. On in-coming tides, the site would fill with water through the tidal channel, flooding the mudflat and marsh areas. On very high tides, in-coming water would also likely overtop the existing marsh of the site and flood into the site through the restored marsh along the northern edge of the site. On out-going tides, water would flow off of the restored marsh and mudflat and exit the site through the tidal channel. The slopes and elevations are designed for the mudflats and marsh to drain completely at low tides; the tidal channel may retain some ponded water during some of the higher low tides of the year.

Much of the existing riprap and abandoned rubble along the shoreline would be removed and the slope currently colonized by Himalayan blackberries would be excavated and removed. This alternative would require grading of the western side of the existing intertidal marsh to match graded contours with existing contours. The Preferred Alternative would thus result in the loss of the 0.06 acres of the western extent of the existing intertidal marsh (approximately one-third of the marsh) and its replacement with approximately 0.76 acres of restored intertidal marsh habitat that would ultimately be of similar functional value to invertebrates, fish, and birds. Native species planted within the restored marsh area would likely include a variety of species selected for the anticipated tidal regime and salinity conditions of the site, such as Lyngby's sedge (*Carex lyngbyei*), Pacific silverweed (*Potentilla anserine* spp. *pacifica*), hardstem bulrush (*Scirpus acutus*), softstem bulrush (*Scirpus validus*), tufted hairgrass (*Deschampsia cespitosa*), and Douglas aster (*Aster subspicatus*) (Figure 5). Other emergent species may also be considered for the site, such as slough sedge (*Carex obnupta*), small-fruited bulrush (*Scirpus microcarpus*), and spike rush (*Eleocharis* spp.) based on the presence of these species in reference patches of intertidal vegetation along the Duwamish River (Williams et al. 2001).

In order to reduce grazing by geese within the newly planted marsh, a complex of goose excluders will be installed over and around the entire mudflat and marsh areas. Based on designs implemented on other restoration sites along the Duwamish shoreline, the excluders will use open weave steel mesh fencing to prevent 'walk-in' or 'float-in' access and overhead cables to prevent 'fly-in' access to the marsh. The large mesh of the fencing does not restrict access by

juvenile salmonids. It is anticipated that these goose excluders will remain in place for a minimum of three years post-planting to allow the restored marsh time to establish and spread sufficiently to withstand herbivory by foraging geese.

In order to minimize the functional and temporal loss of the existing marsh, the portion of the marsh to be graded would be salvaged just prior to grading and replanted within the restoration site at the same elevation. Salvage would be accomplished by cutting the root-mat of the existing marsh into sections, sliding a steel plate under the root-mat, and then lifting out sections of the marsh and its root-mat. The salvaged pieces of marsh would then be transplanted to the appropriate elevation contour in the restored marsh within the same tidal cycle. If possible, the salvaged marsh would be transplanted contiguous with retained areas of the marsh to maximize the likelihood that it would re-root with minimal dieback. The expectation is that much of the relocated marsh would re-root within the restoration area and would thus retain its temporal and functional value to the suite of benthic invertebrates, fish, and wildlife that currently utilize this marsh.

During approximately the first three years post-planting, the scrub-shrub and riparian buffer vegetation would be seasonally irrigated by a temporary, above-ground irrigation system supplied with water from a pumper-truck. The system would be set on a timer to allow for irrigation between May and October of each year. Once the plants are well established (as indicated by reduced mortality rates, evident growth, and the presence of flowers or fruits), the irrigation system would be removed from the site.

3.2 Restoration of Habitat Complexity and Functional Benefits

The Corps and King County DNRP consulted with the Washington Department of Fish and Wildlife (WDFW), Washington Department of Ecology, the US Fish and Wildlife Service (USFWS), NOAA Fisheries, the Muckleshoot Indian Nation, and representatives of WRIA 9 regarding the design of the preferred alternative. The Preferred Alternative incorporates an undulating edge to the elevation contours to increase the habitat complexity and amount of edge habitat at the interface between the mudflat and marsh. In order to increase the functional value of the site for a variety of fish and wildlife species, the Preferred Alternative also incorporates an osprey nesting platform in the southwest corner of the site, nesting boxes suitable to purple martins, native songbirds, and bats, snags erected within the scrub-shrub/forested riparian buffer, and large woody debris placed within the mudflat, marsh, and riparian buffer (Figures 2 and 5). These habitat elements provide a diversity of nesting, foraging, and resting opportunities for wildlife species, and create habitat complexity within the mudflat and marsh areas that is beneficial to juvenile salmonids. Native species planted within the scrub-shrub and forested buffer would include species selected for their fruits, flowers, and berries, including Nootka rose (*Rosa nutkana*), red-osier dogwood (*Cornus sericea*), salmonberry (*Rubus spectabilis*), willow (*Salix* spp.), black twinberry (*Lonicera involucrata*), hawthorn (*Crataegus douglasii*), snowberry (*Symphoricarpos albus*), thimbleberry (*Rubus parviflorus*), Indian plum (*Oemleria cerasiformis*), oceanspray (*Holodiscus discolor*), hazelnut (*Cornus coronata*), big-leaf maple (*Acer macrophyllum*), Douglas-fir (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*), black cottonwood (*Populus balsamifera*), red alder (*Alnus rubra*), Oregon ash (*Fraxinus latifolia*), and shore pine (*Pinus contorta*) (Figure 5).

3.3 Directed Human Access and Passive Recreational Use

Because this restoration site is located within a highly urbanized area and is adjacent to commercial and industrial work places, the project team expects the restoration site to be an attractive place for local residents/workers to visit for passive recreation. The Preferred Alternative incorporates several design elements intended to minimize the environmental impacts associated with human visitors, while at the same time educating and supporting the existing recreational use of the area (Figures 2, 3, and 5). A crushed rock trail constructed from South 112th Street around the outer buffer of the site would direct visitors down to the river's edge while providing them viewing areas to see the restoration site and read interpretive signs. The trail would be accessible to disabled visitors and would incorporate viewing areas edged by split rail fencing and dense, thorny native shrubs such as rose and hawthorn to prevent visitors from accessing the fragile marsh and mudflat habitats in the center of the site. Interpretive signs will educate visitors about the process of restoration and the value of intertidal habitats to a variety of fish and wildlife species. The trail would end at the river's edge with a crushed rock boat ramp suitable for hand-launch crafts such as kayaks and canoes. The incorporation of a hand-launch boat ramp will direct the existing recreational use of the site to an area that will not impact the restored habitats or disturb wildlife use of the site, while still providing access to the river.

3.4 Comparative Environmental Impacts and Benefits

In comparison to the other alternatives considered, the Preferred Alternative would result in more of the site becoming intertidal mudflat than under Alternative 2, but with a wider and more gently sloped zone of intertidal marsh than in Alternative 1. The single entrance design would result in a broader intertidal channel and larger area of mudflat than under Alternative 2. In contrast to Alternative 3, the armoring and bank stabilization of the upstream side of the entrance channel under the Preferred Alternative would better maintain the existing hydrodynamics of the shoreline to create a self-maintaining opening and to better preserve the undisturbed portion of the existing marsh.

Thus, under the Preferred Alternative, environmental impacts are minimized through efforts to maintain existing hydrodynamics of the river and the incorporation of salvaging efforts to minimize the functional and temporal loss of the existing marsh. Environmental benefits are maximized through the creation of a complex mixture of intertidal channel, mudflat, marsh, and riparian zone that will provide the variety of habitats preferred by juvenile salmonids for foraging, rearing, and refuge over a greater portion of the tidal cycle under this alternative. The complex edge habitat created at the transition between mudflat and marsh and between the marsh and the scrub-shrub/forested riparian zone will similarly net greater environmental benefits for a variety of small mammals, shorebirds, songbirds, and foraging raptors by offering a variety of foraging, nesting, and refuge habitats. The incorporation of an osprey nesting platform, nest boxes, and large woody debris and snags will also increase the habitat complexity and reproductive opportunities for a variety of wildlife species. Benefits to the human environment are also increased under the Preferred Alternative through the incorporation of an accessible trail and viewing platforms and a hand-launch boat ramp.

4.0 EXISTING ENVIRONMENT

Characteristics of the existing environment have been addressed in detail within a number of documents previously prepared as part of the Green/Duwamish River Basin Restoration Program. Characteristics of the existing environment that are specific to the lower Duwamish River and the proposed project site are described in detail below based on reconnaissance work and review of available documentation. Rather than repeating information for the general Green/Duwamish River system here, that information is incorporated largely by reference to the documents listed below:

Final Programmatic Environmental Impact Statement and Restoration Plan (FPEIS) for the Green/Duwamish River Basin Ecosystem Restoration Program, prepared by the Seattle District Corps and King County DNRP in November 2000.

Programmatic Biological Assessments for Green/Duwamish Ecosystem Restoration Program, King County, Washington. Separate documents were prepared for species under National Marine Fisheries and US Fish and Wildlife jurisdictions for the Seattle District Corps by Jones & Stokes, June 2000.

Seattle's Urban Blueprint for Habitat Protection and Restoration: Review Draft, prepared by the City of Seattle's Salmon Team, June 2001.

4.1 Physical Characteristics

The history and physical characteristics of the Green/Duwamish River basin is described in detail in Sections 3.1 and 3.2 of the FPEIS (USACE and King County DNR 2000). A synopsis of physical characteristics and historic conditions relevant to the proposed restoration project site is presented below.

4.1.1 Green/Duwamish River Basin: Historic Conditions

The lower Green/Duwamish River estuary was historically an area of very low gradient with a sinuous, meandering main channel. Most of the larger sediment had been deposited in the middle river, and the lower river had primarily sand and mud substrate. Most of the lower reach of the river was affected by tidal influence, whether freshwater tidal or brackish tidal. The Duwamish River had several distributary channels spread over the broad delta floodplain as it emptied into Elliott Bay. Large woody debris was carried into the lower river and estuary from the upper watershed during floods (Perkins 1993, USACE 1997a, 1997b).

The Duwamish River delta at one time was over 4,000 acres of tidal and intertidal habitat (Bloomberg et al. 1988), characterized by a vast, tidally influenced mosaic of swamp and marsh wetlands that supported a large salmon and clam fishery in the Duwamish River and Elliott Bay available to Native Americans before Euro-American settlement.

4.1.2 Green/Duwamish River Basin: Current Conditions

Over the last 100 years, the braided flows of the lower river have been extensively channelized and reduced to a single permanent channel for much of its length (the Duwamish Waterway)

through dredging and filling of river meander channels. Dredging has resulted in the replacement of 9.3 miles of meandering tidal channel habitat with the 5.2 miles of deep channel habitat that exists today (Bloomberg et al. 1988). The consequence on the environment of these actions has been a substantial degradation of the entire ecosystem of the lower Duwamish River and estuary through a combination of levees, severe channelization, water source diversion dams, dams for flood control, and the destruction of nearly all the intertidal habitats in the estuary.

A natural rock weir at approximately river mile 6.2 retards saltwater intrusion into upriver areas except during high tides and low stream flows and creates a small series of rapids on falling tides at this location. This rock weir is locally known as the North Wind's Weir and is located just off the southwestern corner of the project site (Figure 2, Photo 2).

Nearly all intertidal wetlands and shallow subtidal aquatic habitats in the vicinity of Elliott Bay and the lower Duwamish River have been eliminated as a result of urban and industrial development; only about 1 percent of estimated 4,000 acres of tidal and intertidal habitat remains today. In addition to patches of remnant native marsh, a series of ten small intertidal marsh restoration projects have been constructed downstream of the proposed project site since 1995, and one site upstream is currently under construction in 2003-2004. The existing shoreline banks are thin bands of mud- and sandflats along the toe of riprap.

The lower end of the River (downstream of the project site) is the heavily industrialized portion known as the Duwamish Waterway. The navigation channel is a major shipping route for containerized and bulk cargo with intense marine traffic. The shoreline along the Duwamish Waterway is intensively developed for industrial and commercial operations and the upland areas are heavily industrialized. Upstream of the project site, the Duwamish River similarly contains intense industrial, commercial and residential development along both shorelines.

4.1.3 Geology and Soils

Due to the degree of dredging, filling, and industrialization of the lower Duwamish River, little is directly known about the native river delta soils. The soils in this area were likely fine materials from alluvium mixed with organic materials from the vast amounts of plant material produced in the estuarine marshes. These soils are generally very deep, poorly drained, and subject to being compacted and destabilized when disturbed (Perkins 1993, USACE 1997a, 1997b).

Due to history of excavation, fill, and varied industrial uses of the project site, the native soil horizon is generally not evident until approximately 14 feet below the existing ground surface. The native soil horizon is generally characterized as a very dark gray to black colored fine sandy loam to silty clay loam overlying an organic rich silty clay loam. From just below the surface to a depth of approximately 14 feet, a mixture of historic fill consisting of steel slag, bricks, and steel debris characterize much of the site.

4.1.4 Hazardous and Toxic Materials

The Environmental Protection Agency (EPA) is evaluating the sampling record within the lower Duwamish River for designation as a Superfund site on the National Priorities List due to sediment contamination. Sediment sampling within the portion of the Duwamish River

downstream of the project site has identified several contaminants of concern, including oil and grease, sulfides, pesticides, polychlorinated biphenyls (PCBs), and polyaromatic hydrocarbons (PAHs) (USACE 1995, 2000d).

The potential for hazardous and toxic materials to enter the Duwamish River and subsequent sediment contamination is of concern in the project area due to the history of industrial development, unregulated discharge of combined sewer overflows, storm water runoff, industrial waste, and large-scale excavation and filling of the shoreline in this area. The development history of the site is summarized in the Phase I Environmental Assessment (Phase I EA), performed for King County DNRP by Environmental Associates (2001a). This history indicates use of the site as a former warehouse and former storage and parts salvage yard, with several diesel and gasoline underground storage tanks that were reportedly removed in 1988.

As a supplement to the Phase I EA, subsurface borings were conducted in June 2001 (Environmental Associates, 2001b) to determine if petroleum hydrocarbon, metal, and semivolatile contamination above regulatory levels was present in surface and sub-surface soils. The investigation found that metal and semivolatile concentrations were below Washington Department of Ecology (WDOE) Method A Cleanup criteria. Two locations near the surface (0-5 feet below ground) where there was olfactory evidence of petroleum hydrocarbons were analyzed for NWTPH-Gx (gasoline range) and NWTPH-Dx (diesel and motor oil range). The samples showed NWTPH-Gx of 4-28 parts per million (no benzene detections) and NWTPH-Dx of 160-340 parts per million. A third sample at the same depth interval was analyzed for NWTPH-Dx and was found to have concentrations of 20-86 ppm. All concentrations were below Model Toxics Control Act (MTCA) Level A 2002 cleanup levels (which area: 100 ppm NWTPH-Gx and 2000 ppm NWTPH-Dx).

On June 13, 2003, the Corps and King County DNRP conducted a site investigation designed to collect archeological and geophysical information (Figure 6). Additional information regarding the chemical constituents on the site was also obtained during that investigation (USACE 2003a, 2003b). Copies of the Field Sampling Plan, Final Analytical Services Agreement with Analytical Resources, Inc., the Quality Control Summary Report, and the field results of the June 13, 2003 investigation are available upon request from the Corps.

Petroleum contamination was found in three of the excavations where soil had olfactory and visual signs of petroleum contamination. Samples were collected and benzene, toluene, ethyl benzene, and xylenes (BTEX), total petroleum hydrocarbons (TPH)-gasoline range, TPH-diesel range, and TPH-motor oil range were analyzed with the following summary results:

- a. BTEX: non-detect in all samples
- b. TPH-gasoline range: non-detect in two samples, 10 ppm in the remaining sample, concentrations were below MTCA Level A unrestricted soil cleanup levels (SCL) of 100 ppm
- c. TPH-diesel range: detections in all samples, concentration range 54-1300 ppm. All samples were below the MTCA Level A unrestricted SCL of 2000 ppm. Two samples (460 and 1300 ppm) were above the estimated threshold level (100 ppm) for potential negative effects on juvenile salmon (Kroeger et al., 2001).

d. TPH-motor oil range: detections in all samples, concentration range 140-2300 ppm, one sample was above MTCA Level A unrestricted (SCLs) of 2000 ppm.

The two samples with the highest TPH-diesel and TPH-motor oil concentrations were analyzed for the presence of hazardous waste constituents. These include polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and RCRA metals. Total organic carbon levels were also analyzed so results could be normalized for organic carbon to compare against the Washington State Sediment Quality Standards (SQS). This analysis provided the following results:

Polyaromatic hydrocarbons (PAHs)

Seven PAHs were detected. Results as normalized to % carbon were less than the individual and total Washington State PAH Sediment Quality Standards (SQS).

Polychlorinated biphenyl's (PCBs)

One PCB was detected. Result as normalized to % carbon was less than the Washington State PCB SQS.

RCRA Metals (soil)

Four metals (barium, cadmium, chromium, and lead) were detected. Levels were all below respective Washington State metal SQS.

A hard, porous material, apparently steel slag, was also found in several of the excavations. A Toxicity Characteristics Leaching Procedure (TCLP) for metals was run on the slag to determine if special disposal procedures were necessary. A Synthetic Precipitation Leaching Procedure (SPLP) for metals was also run to determine if the slag posed a threat to ambient water quality. This analysis provided the following results:

Slag TCLP, Metals. All metal TCLP concentrations were below Washington Dept. of Ecology Maximum concentrations for Toxicity Characteristics.

Slag SPLP, Metals. All metal SPLP concentrations were below Washington Dept. of Ecology Ambient Water Quality Criteria.

Based on evaluation of the June 2003 data, there was no evidence that CERCLA hazardous substances were present on the site and therefore, the site was not subject to the restrictions on sponsor/Corps activities described in Regulation 1165-2-132 Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects. The data indicate that the PAHs, PCBs, and metals at the site pose no threat to ambient water quality or native habitat. The data on the slag indicates it is likely that slag does not have to be disposed of as hazardous waste and that the slag is not a threat to ambient water quality or native habitat.

Although petroleum hydrocarbons are present, they are exempt from the definition of "hazardous substances" in CERCLA. However, the petroleum results indicate that soil testing will need to be performed when the soil is excavated during construction to determine what type of disposal

is required. Also, the petroleum results indicate soil contaminate levels that are potentially toxic to juvenile fish (Kroeger et al. 2001). The potential toxicity of the petroleum-contaminated soil indicates that it will need to be removed or measures taken to prevent migration of the petroleum to the channel surfaces.

A geophysical survey is also being planned to determine if there are any underground features that may be indicative of potential contamination. If such features are found, they will be removed or remediated in place, along with removal or remediation of any affected soil.

In addition to the soil samples collected in the June 2001 subsurface investigation (Environmental Associates, 2001b), groundwater samples were collected at the bottom of the soil borings. All samples were analyzed for BTEX, NWTPH-gasoline range, NWTPH-diesel range, and NWTPH-motor oil range and two samples were analyzed for arsenic, cadmium, chromium, and lead. All samples were nondetect in BTEX and NWTPH-gasoline range. All samples were also nondetect or below NWTPH-diesel range and NWTPH-motor oil range WDOE MTCA Method A groundwater cleanup levels. In addition, all metal concentrations were below WDOE MTCA Method A groundwater cleanup levels except one sample where the arsenic concentration was 9.42 micrograms/L. This compares to the WDOE MTCA Method A cleanup level of 5 micrograms/L and the Federal Safe Drinking Water Act Maximum Contaminant Level (MCL) of 10 micrograms/L. The other sample where arsenic was analyzed was non-detect. King County is in the process of reporting the single arsenic exceedance to WDOE to determine if any additional measures need to be taken.

4.1.5 Hydrologic Regime

Prior to 1900, the Duwamish River estuary was fed by the basin areas of the Cedar, Black, Green and White Rivers, with an undeveloped drainage area of approximately 1,640 square miles. This drainage basin contributed an estimated 2,500 to 9,000 cfs of fresh water to the estuary (Corps 1997a). Diversion of the White, Black, and Cedar Rivers and the construction of Howard Hanson Dam have greatly reduced fresh water input and decreased river flows. A general increase in the distance of saltwater intrusions inland has been documented and is largely attributed to this loss of freshwater flows (from the diversion of the White, Black, and Cedar Rivers) coupled with the regular deepening and channelization that comes with navigation dredging (USACE 1997a).

The Duwamish River is currently fed by runoff from rainfall and groundwater inflows, along with snowmelt from the upper elevations. The tributaries in the basin collect surface waters and route them into the mainstem of the Green River and then downstream into the Duwamish River. Highest flows generally occur in December or January, declining through March with a subsequent snowmelt peak then occurring in April or May. Since construction of the Howard Hanson Dam in 1963, floods have been controlled within the river system, not allowing discharges above the regulated high flow of approximately 12,500 cfs (as measured at the USGS gauge at Auburn). Thus, there is very little difference between the 2-, 5-, 10-, 25-, and 50-year events downstream of the dam, all range between 11,000 to 12,500 cfs. Flood events that inundated the adjacent floodplain no longer occur and large, channel altering flows have an extremely low probability of occurrence (Corps 1997a).

Hydrologic information for the lower Duwamish River is available from a USGS gauge located at the Foster Golf Links golf course in Tukwila Washington (Station No. 12113390) for the period between October 1995 and September 1998. This station is located approximately 4 miles upstream of the project site.

Average discharge for water years 1995 to 1998 is 1,840 cubic feet per second (cfs). Peak stream flows have generally fluctuated between 10,000 and 12,000 cfs, with the maximum discharge was recorded on February 8, 1996 as 13,000 cfs. Characteristic minimum discharges of 247 cfs have been repeatedly recorded during the last weeks of September.

Mean daily stream flow fluctuates on a seasonal basis, with November through February having the highest flows and August through September the lowest flows. January is generally characterized by stream flows between 1,600 and 5,800 cfs; February by flows ranging between 1,400 and 11,000, March through May by flows between 1,500 and 2,800 cfs; June through October by flows between 250 and 800 cfs; October flows between 300 and 2,400; November flows vary between 780 and 8,000 to 12,000 cfs depending the on onset of fall rains, and December flows are between 1,200 and 12,000 cfs.

4.2 Water Quality

The historic and current water quality characteristics of the Green/Duwamish River basin are described in detail in Section 3.4 of the FPEIS (USACE and King County DNR 2000). A synopsis of water quality conditions relevant to the proposed restoration project site is presented below.

Water quality information for the lower Duwamish River is available from a USGS gauge located at the Foster Golf Links golf course in Tukwila Washington (Station No. 12113390) for the period between September 20, 1995 and September 10, 2002. This station is located approximately 4 miles upstream of the project site.

4.2.1 Water Quality Class

The Washington State Department of Ecology is responsible for setting water quality standards for surface waters of the State based on designated water uses and criteria. The waters of the lower Duwamish River from the mouth to river mile 11.0 (the Black River) have an 'aquatic life use' designation of "salmon and trout rearing and migration only" (WAC 173-201A-600, 602). This area encompasses the navigation channel and the entire lower river including the project site.

Pollutants within the Duwamish River are derived primarily from industrial point and non-point sources, storm water runoff, discharges from vessels, and resuspension of contaminated bottom sediments. The Duwamish Waterway (downstream of the project site) remains on the Department of Ecology's 303(d) list of threatened and impaired waters. Listed parameters in this area include a multitude of chemical contaminants including PCB's PAH's, mercury, lead, and arsenic. The enforcement of total maximum daily load limitations and the continual cleanup of the toxic sites along the shoreline is expected to result in additional improvements in water quality.

4.2.2 Turbidity

The highest sources of turbidity within the vicinity of the project site are the periodic pulses of sediment moving downstream within the Duwamish River from seasonal rainfall events. We reviewed water quality sampling gauge data from the U.S. Geological Survey gauge located at the Foster Golf Links golf course in Tukwila Washington (Station No. 12113390) for the period since September 1995. This data indicates that the Duwamish River reaches its maximum suspended sediment levels generally between December and March. Average suspended sediment levels recorded between September 20, 1995 and September 10, 2002 were 48.9 mg/L, including the highest readings of 787 mg/L on February 9, 1996. The Duwamish is also characterized by occasional high levels of suspended sediment occurring during the late spring and even well into the driest portions of the year (274 mg/L on March 19, 1997, 264 mg/L on August 7, 1997, 101 mg/L on March 22, 1998), likely due to intense precipitation from seasonal storm events.

4.2.3 Dissolved Oxygen

The water quality sampling gauge data (gauge # 12113390) indicates that dissolved oxygen levels in the Duwamish River reach maximum levels generally between mid-December and mid-April. Average dissolved oxygen levels recorded between September 20, 1995 and September 10, 2002 were 10.09 mg/L, including the highest readings of 12.4 mg/L on February 12, 1996. Lowest readings were 7.1 mg/L, recorded on August 16, 2001. Any number of controlled or uncontrolled discharges may exacerbate water quality conditions within the Duwamish River. However, because vertical stratification of Elliott Bay and seasonal periods of low dissolved oxygen are to some extent natural conditions in Elliott Bay and the Duwamish River estuary, local fish populations are presumably adapted to avoid areas of seasonally low dissolved oxygen conditions.

4.2.4 Temperature

In the lower Duwamish, the relative temperatures of the freshwater inflow and the saltwater intruded from Elliott Bay primarily influence water temperature (Warner and Fritz 1995). This saltwater intrusion profoundly influences water temperature at various depths in the Turning Basin, approximately one mile downstream of the project site (Muckleshoot Indian Tribe Fisheries Department, unpublished data). For example, in January, water temperatures measured at 1-meter depths can increase from 36.5 to 46.8°F over a depth of 26.2 feet. In May, temperature measured at 3.3-foot depths can decrease from 63.9 to 52.9°F measured over a total depth of 13.1 feet. In September, temperatures are more uniform decreasing from 61.9 to 56.8°F. The range of temperatures over depth is also influenced by the tidal stage. The variation in water temperature with depth provides adult and juvenile salmonids some refuge from the higher temperatures. However, in the late summer and early fall, the general range of temperatures offers no refuge from temperatures considered outside the preferred range for sensitive salmonid species. The water quality gauge data (gauge # 12113390) indicates that the Duwamish River has an average temperature of 51°F with a maximum-recorded temperature of 71°F on August 12, 1998 and a minimum temperature of 39°F recorded on February 6, 1997.

Lack of large vegetation in the riparian zone has also been cited as a significant contributor to elevated stream temperatures. Due to the heavy industrialization, there is a near complete lack of

riparian trees along the shoreline of the lower Duwamish River. Thus, the contribution of vegetation as an effective buffer against increasing water temperature from direct sun exposure is probably minimal for the action area and the lower Duwamish River on the whole.

4.3 Vegetation

The historic and current characteristic vegetation of the Green/Duwamish River basin are described in detail in Section 3.6 of the FPEIS (USACE and King County DNR 2000). A synopsis of characteristic vegetation communities at the proposed restoration project site is presented below.

4.3.1 Subtidal and Intertidal Vegetation

There are extremely few areas of naturally occurring intertidal marsh on the lower Duwamish River and no known areas of subtidal vegetation such as eelgrass. Areas of native saltmarsh occur along the western shoreline of the river approximately 1.5 miles downstream of the project site adjacent to the Hamm Creek restoration site, along the edges of Kellogg Island and at the Herring's House restoration site (approximately 4 miles downstream of the project site), as well as along the western shoreline of the project site. The approximately 0.176 acre saltmarsh adjacent to the project site (Photos 3 and 4) is dominated by Lyngby's sedge (*Carex lyngbyei*) and hard-stem bulrush (*Scirpus acutus*), with scattered patches of Pacific silverweed (*Potentilla anserine* spp. *pacifica*), brass-buttons (*Cotula coronopifolia*), western lilaepsis (*Lilaeopsis occidentalis*), and fat-hen saltbush (*Atriplex patula*). The upper edges of the marsh also support creeping bentgrass (*Agrostis stolonifera*) and Douglas aster (*Aster subspicatus*) up to the abrupt edge of the rip rapped shoreline that supports a thicket of overhanging Himalayan blackberry (*Rubus discolor*).

The total area of intertidal wetlands and more naturally vegetated shorelines along the lower Duwamish River has increased modestly over the last few years through restoration projects and projects constructed as the result of litigation against the City of Seattle and Metro (currently known as the King County Department of Metropolitan Services) for damage to river habitats from the release of hazardous substances (primarily metals and organic chemicals) from sewer overflows and storm drains. A series of nine small intertidal marsh restorations have been constructed downstream of the project since 1995 and represent nearly the only areas of native intertidal marsh within the lower Duwamish River. The Codiga Farms side channel restoration site is located upstream of the proposed restoration site and is scheduled for completion by the Corps and the City of Tukwila in late 2003.

However, these areas of habitat are isolated (for terrestrial species) by intensive development between patches. The intertidal marshes at these restoration sites are generally dominated by Lyngby's sedge (*Carex lyngbyei*), hard-stem bulrush (*Scirpus acutus*), and common cattail (*Typha latifolia*) with upland buffers that have also been planted with native trees and shrubs as part of the restoration efforts. Agencies and non-profit groups including, but not limited to, the Port of Seattle, King County DNRP, the City of Seattle, the COE, USFWS, and People for Puget Sound are actively monitoring and maintaining many of these areas. These restored areas receive substantial utilization by juvenile salmon, including chinook, and provide important benthic and epibenthic prey resources (e.g., Cordell et al. 1997, 1999). The restoration of these

habitats is part of an overall trend toward improvement in the estuary that began with improvements in source control and water quality in the 1970s and continues today.

4.3.2 Riparian and Upland Vegetation

There are virtually no functional riparian communities along the lower Duwamish River, with the exception of Kellogg Island, located approximately four miles downstream of the proposed project site. Scattered patches and individual trees are all that remains of the once diverse riparian forests and tidal swamps that fringed the lower Duwamish River (Bloomberg et al. 1988). Currently, dominant riparian species include black cottonwood (*Populus balsamifera*), Pacific willow (*Salix lucida*), Hooker's willow (*Salix hookeriana*), and red alder (*Alnus rubra*) trees, with understory shrubs dominated by invasive Himalayan blackberry (*Rubus discolor*) and evergreen blackberry (*Rubus laciniatus*) growing out of the rip rapped shorelines.

The uplands surrounding the project site are predominately industrial and commercial facilities (Photo 1). While some of these facilities do support landscaped areas, they are generally not composed on native tree or shrub species and are not maintained as natural areas of habitat. The Seattle City Light property north of the site is dominated by low-growing, disturbance adapted shrubs and herbaceous species such as bracken fern (*Pteridium aquilinum*) and Himalayan blackberry (*Rubus discolor*) (Photo 1).

The proposed project site is vegetated only along its perimeters (Photos 1 and 3). Invasive Himalayan blackberry (*Rubus discolor*) and evergreen blackberry (*Rubus laciniatus*) dominates the rip rapped shoreline along the western side of the property. A small group of 12- to 18-inch diameter ornamental white poplar trees (*Populus alba*) occur in the southwestern corner of the site and several black cottonwood (*Populus balsamifera*) and red alder (*Alnus rubra*) trees fringe the southern edge of the site (Photo 1). Virtually no understory exists beneath these trees due to the site's history of disturbance.

4.4 Fish

The historic and current characteristic fish communities of the Green/Duwamish River basin are described in detail in Section 3.5 of the FPEIS (USACE and King County DNR 2000). A synopsis of characteristic fish communities relevant to the Duwamish River within the vicinity of the proposed restoration project site is presented below.

4.4.1 Anadromous Salmonids

Multiple migratory runs of both native and hatchery reared salmonid stocks occur seasonally in Elliott Bay and the Duwamish River (Warner and Fritz 1995). The use of Elliott Bay by salmonids is believed to be predominantly as a migration corridor. In-migrating adult salmon use deeper areas of Elliott Bay prior to moving into the Duwamish River. However, some rearing and foraging by juvenile salmonids is likely, particularly in the limited shoreline areas with some structural diversity. Returning adult salmon congregate at the mouth of the Duwamish River prior to upstream migration, and juvenile salmonids may use the nearshore reaches Elliott Bay to transition into marine waters.

The Green/Duwamish River system supports a diversity of salmonid species compared to other rivers of this size in the Puget Sound region. There are nine species of anadromous salmonids that have been documented in the Green/Duwamish River: summer/fall chinook salmon, fall run

coho salmon, fall run chum salmon, cutthroat, sockeye, and summer/winter steelhead trout, and native char (recently broken into two species - dolly varden (*Salvelinus malma*) and bull trout (*Salvelinus confluentus*). Pink salmon are also present in the system, but generally not in large numbers, perhaps due to the dramatic loss of estuarine and intertidal habitats in the lower Duwamish River. Chinook and chum utilize Elliott Bay and the Duwamish estuary more extensively than other anadromous species (Weitkamp and Schadt 1982; Meyer et al. 1981), especially when congregating at the mouth of the Duwamish River during their adult return. The principal juvenile salmonid out-migration season occurs from mid-April through mid-June for steelhead, coastal cutthroat, coho, and chinook; chum salmon generally out-migrate slightly earlier, between mid-March and early May (Grette and Salo 1986, USACE 1998).

As federally threatened species, the occurrence and potential effects of the proposed project on Puget Sound chinook salmon and Coastal/Puget Sound bull trout are addressed in Section 4.6.

4.4.2 Forage Fish

Forage fish larvae are ubiquitous in Puget Sound and are a common component of the nearshore plankton. As such, it is difficult to determine the source of this prey item within any given estuary. Very little research has been done to determine if larvae using any given estuary originate in nearby spawning grounds. Intertidal spawning habitat was historically more abundant, however, armoring and other shoreline modifications have limited the amount of available spawning areas.

Forage fish include Pacific herring, surf smelt, and sand lance larvae and juveniles prey on epibenthic invertebrates and crustaceans and are themselves important prey items for larger juvenile salmon and for bull trout. Sand lance is particularly important for juvenile chinook and bull trout. None of these forage fish species spawn within the lower Duwamish River, likely due to the modified shoreline and lack of intertidal gravel and sandy beaches (WDFW PHS database search, June 9, 2003). Fish sampling conducted by USFWS in 2001 captured small numbers (less than ten individuals) of Pacific sand lance at both the Turning Basin and the Hamm Creek estuary restoration sites (Low and Myers 2002).

4.5 Wildlife

The historic and current characteristic wildlife communities of the Green/Duwamish River basin are described in detail in Section 3.7 of the FPEIS (USACE and King County DNR 2000). A synopsis of characteristic wildlife communities relevant to the proposed restoration project site is presented below.

4.5.1 Birds

The shorelines of and the waters of Elliott Bay provide habitat to a number of terrestrial and water dependent birds. These species include loons, grebes, cormorants, scaups, mergansers, coots, and gulls. The majority of these birds utilize the water column habitats during their respective over wintering periods. These over wintering waterfowl species are generally found in the central Puget Sound region from early November through late April, with the highest concentrations during December through February. The remaining waterfowl are present year-round. Most of the year-round and over wintering species are classified as “divers” and actively pursue pelagic and benthic organisms up to 10 meters or more below the water surface. The

horned grebe and red-necked grebe (State Monitor species), as well as the western grebe, Brandt's cormorant, merlin, and common murre (State Candidate species) and the common loon (State Sensitive species) may also forage over or utilize surface waters of Elliott Bay.

Similarly, abundant waterfowl species also utilize the waters of the lower Duwamish River. Common species include greater scaups, ring-necked ducks, scoters, American wigeons, Canada geese, mallards, common goldeneye, mergansers, and bufflehead. Other common species include western grebes, double-crested cormorants, American coots, pigeon guillemots, and several gull species. Shorebirds observed in the vicinity of the Duwamish waterway have included sandpipers, dunlins, and snipe. These waders are generally present in the tidal mudflats and marshes or along sandy shorelines.

Several other bird species expected to inhabit the affected area are either Federal Species of Concern or are listed by Washington State as Monitor, Candidate, or Sensitive species. The peregrine falcon (Federal Species of Concern and State Sensitive), osprey (State Monitor), great blue heron (State Monitor), and purple martin (State Candidate) all occur fairly frequently within the area and have been observed utilizing habitats within and along the lower Duwamish River.

Since 1994, a pair of peregrine falcons has been nesting in downtown Seattle, atop the east side of the Washington Mutual Tower. While this pair has not been active at the Washington Mutual site in 2003, the female may be nesting about four blocks away at One Union Square and the male may be nesting with other females either in West Seattle. Peregrine falcons were also reported using a nest box under the West Seattle Bridge just south of Harbor Island in 1999 (Priority Habitat and Species database search June 5, 2003). Peregrine falcons would be expected to hunt waterfowl over Elliott Bay, and to hunt waterfowl and pigeons over the lower Duwamish River and shoreline industrial facilities.

Osprey are frequently seen foraging for fish over Elliott Bay and the lower Duwamish River and appear to be fairly tolerant of human disturbance when choosing nesting locations. Since 1999, osprey nests have been documented on utility poles or other man-made structures in at least three locations within five miles of the project site: on the east side of the Turning Basin, at Terminal 105 (Crowley Marine facility), and at Terminal 18 on Harbor Island (Priority Habitat and Species database search June 5, 2003). A pair of osprey fledged two chicks in 2003 from a nest atop a constructed nesting platform approximately 1.5 miles downstream of the project site at the Hamm Creek restoration site.

Similarly, great blue herons are also frequently seen wading within the lower Duwamish River and its remaining intertidal habitats. Three heron rookeries have been documented within the vicinity of the proposed project: approximately five miles downstream of the site on the forested slope west of Terminal 105 (nests unoccupied in 2000), the Black River rookery approximately three miles southeast has been active since 1985, and the Seahurst park rookery has been active since 1981 approximately 2.5 miles southwest of the site (Priority Habitat and Species database search June 5, 2003).

A purple martin nest was noted in 1979 within the Bon Marche parking garage in downtown Seattle (Priority Habitat and Species database search June 5, 2003). In recent years, private individuals have erected nest boxes around Puget Sound and the lower Duwamish River and

these boxes have successfully attracted nesting purple martins. As of June 2003, ten pairs are nesting in Jack Block Park on the west side of Harbor Island, a pair is nesting at Kellogg Island, and one to two pairs are nesting at Terminal 105. There are currently no nest boxes erected further upstream (i.e. toward the project site) than the Terminal 105 site (Kevin Lee, personal communication, June 9, 2003).

As federally threatened species, the occurrence and potential effects of the proposed restoration project on bald eagles, spotted owls, and marbled murrelets are addressed in Section 4.6.

4.5.2 Marine Mammals

Harbor seals and Dall's porpoise are known to frequently forage in Elliott Bay and are both State Monitor Species (Calambokidas 1991). Harbor seals are also common within the lower Duwamish River where they forage for fish. Similarly, orca whales and Pacific harbor porpoise are also common within Elliott Bay and are both State Candidate Species (Calambokidas 1991). California gray whales, Pacific harbor porpoise, and California sea lions are also common inhabitants of the area. Harbor porpoise and harbor seals are year-round residents. California sea lions may utilize waters of Elliott Bay in the winter to feed on migrating salmon and steelhead trout (Pfeifer 1991). Both harbor seals and California sea lions have been seen hauled out on floats and navigation buoys moored within Elliott Bay.

Stellar sea lion and humpback whale are the only marine mammal species potentially within the action area that are federally proposed or listed as threatened or endangered species and as such, are addressed in Section 4.6 below.

4.5.3 Amphibians, Reptiles, and Terrestrial Mammals

Due to its highly developed and disturbed character, only a few disturbance-tolerant amphibians, reptiles, or terrestrial mammals would be expected to occur within or around the proposed restoration site. Adult tree frogs and garter snakes may occur within the power line corridor to the north of the site. Raccoons, opossums, rats, mice, and voles may inhabit the remnant patches of riparian trees and blackberries that fringe the lower river and the southern edge of the site.

4.6 Threatened and Endangered Species

The potential occurrence of federally listed threatened and endangered species within the Green/Duwamish River basin are described in detail in Section 3.7.2 of the FPEIS (USACE and King County DNR 2000). A synopsis of this information relevant to the proposed restoration project site is presented below.

In accordance with Section 7(a)(2) of the Endangered Species Act of 1973, as amended, federally funded, constructed, permitted, or licensed projects must take into consideration impacts to federally listed and proposed threatened or endangered species. The Corps prepared two Programmatic Biological Assessments (BA) to assess potential impacts of the proposed work on species protected under the Act, one for species under the jurisdiction of the USFWS and one for species under the jurisdiction of NOAA Fisheries. Those BAs covered the federally listed threatened or endangered species listed in Table 2. Only the bald eagle, chinook salmon, and

bull trout occur within the vicinity of the North Wind's Weir restoration site. Copies of the Programmatic Biological Assessments are available from the Corps upon request.

4.7 Cultural Resources

The cultural and historic resources of the Green/Duwamish River basin are described in detail in Section 3.16 of the FPEIS (USACE and King County DNR 2000). Site-specific information is presented below. The project area is situated on the banks of the Duwamish River adjacent to a stretch of low tide rapids with a deep pool below. This location would have been a prime fishing site for Native Americans and the adjacent shores are considered likely to contain evidence related to this activity. However, the apparent removal of native soils and the placement of deep fill in the project area would have removed all potential archaeological deposits in the upper soil profile.

Section 106 of the National Historic Preservation Act of 1966, as amended, requires that Federal agencies identify and assess the effects of Federally assisted undertakings on historic properties and to consult with others to find acceptable ways to resolve adverse effects. Properties protected under Section 106 are those that are listed on or eligible for listing on the National Register of Historic Places (NRHP). Eligible properties must generally be at least 50 years old, possess integrity of physical characteristics, and meet at least one of four criteria for significance. Regulations implementing Section 106 (36 CFR Part 800) encourage maximum coordination with the environmental review process required by the National Environmental Policy Act (NEPA) and with other statutes. The Washington State Archaeological Sites and Resources Act (RCW 27.53) and the Indian Graves and Records Act (RCW 27.44) may also apply.

Cultural resources studies related to this project are being conducted by a Corps archaeologist separately from the NEPA process. These studies are part of the National Historic Preservation Act of 1966, as amended (NHPA), Section 106 compliance process for the project. Studies completed to date include an examination of the archaeological and historical site records at the Washington State Office of Archaeology and Historic Preservation (OAHP), a pedestrian reconnaissance survey of the project area, and the excavation of backhoe trenches. The records search indicated that no properties listed on the National Register of Historic Places (NRHP) or the state listing are located within the proposed project area. Background research indicated that a Native American legendary location may be situated adjacent to the project area and research on this subject is continuing. Due to the presence of imported fill covering the project area, backhoe trenches were excavated to determine if subsurface archaeological deposits were present below the fill (Figure 6). The backhoe testing indicated that the upper levels of native soils within the project area were removed sometime in the past and the area covered with imported fill of varying characteristics. The extreme depth of the fill greatly reduces the possibility that any of the proposed alternatives could affect buried archaeological deposits. The results of the Section 106 cultural resource investigation and a determination of the project's potential affects to historic properties will be reported in a separate document that will be submitted to the State Historic Preservation Officer (SHPO) for review.

4.8 Native American Concerns

The cultural and historic resources of the Green/Duwamish River basin are described in detail in Section 3.16 of the FPEIS (USACE and King County DNR 2000). Site-specific information is

presented below. The project area is situated within the usual and accustomed fishing and shellfish harvesting areas of the Muckleshoot Indian Tribe on the Duwamish River. The tribe historically and presently harvests salmon and shellfish from the lower river. Gill-netting for salmon occurs within the river just downstream of the project site.

4.9 Land Use

The historic and current land and shoreline use of the Green/Duwamish River basin are described in detail in Section 3.11 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

The lower end of the River (downstream of the Turning Basin and the North Wind's Weir restoration site) is the heavily industrialized portion known as the Duwamish Waterway. The shoreline along the Waterway is intensively developed for industrial and commercial operations and the upland areas are similarly heavily industrialized by a variety of water dependent industrial users. Beginning just downstream of the project site and continuing to the mouth, over-water structures (such as piers and docks) occupy 12,150 linear feet (2.3 miles) on both banks of the river. This represents about 20 percent of the lower estuarine shoreline (King County DNR 2001). As a major shipping route for containerized and bulk cargo, the navigation channel is subject to intense marine traffic, in addition to recreational boaters and other river users.

Upstream of the North Wind's Weir restoration site, the shoreline and uplands are similarly developed with intense industrial, commercial and residential development. Large land users include The Boeing Company, the King County Regional Airport (Boeing Field), and the Museum of Flight.

4.10 Recreation

The historic and current land and shoreline use of the Green/Duwamish River basin are described in detail in Section 3.12 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

The Green/Duwamish River Trail runs along the western side of the Duwamish River, beginning approximately one mile downstream of the proposed restoration site. The trail supports day-use recreation such as jogging and biking by local residents and workers. The 3-acre Cecil Moses Memorial County Park is located along the trail, directly across the river (to the west) from the proposed restoration site. The park includes an intertidal restoration site as well as landscaping and bathroom facilities. It also supports day-use by local area workers and is connected to the east side of the river by a footbridge extending over the river approximately 500 feet downstream of the proposed restoration site.

The rock weir located just off the western edge of the property attracts kayakers to the rapids that form as the river cascades over the rocks (Photo 2). Birdwatchers and people interested in watching the kayakers and the rapids can view the river from the footbridge.

4.11 Air Quality and Noise

Information characterizing the air quality and noise levels within the Green/Duwamish River basin is described in detail in Sections 3.8 and 3.9 of the FPEIS (USACE and King County DNR 2000). A synopsis of current site-specific information relevant to the proposed restoration project site is presented below.

The Puget Sound region has been an attainment area for carbon monoxide since October 11, 1996; the Seattle-Tacoma area has been an attainment area for ozone since November 25, 1996. As of May 14, 2001, the Seattle, Tacoma, Kent areas were classified as attainment areas for particulate matter (PM10) pollution (J. Anderson, Puget Sound Clean Air Agency, pers. comm. October 22, 2003 via email). Thus, the project area is within attainment areas for all criteria pollutants. The reductions in PM10 pollution that led to attainment status are a result largely of changes enacted by the legislature in the 1991 Clean Air Washington Act (Puget Sound Clean Air Agency website: http://www.pscleanair.org/news/2001/05_14_epa.shtml). Those changes tightened up emission standards for wood stoves and fireplaces, prohibited outdoor burning in urban areas, and authorized an inspection program for diesel trucks and buses, which was implemented by the Department of Ecology. In addition, a partnership between the Clean Air Agency and the Northwest Hearth Products Association encouraged people to trade out their old wood stoves and fireplaces for cleaner natural gas, propane, pellet or EPA-certified models.

4.12 Transportation

Information characterizing traffic and transportation within the Green/Duwamish River basin is described in detail in Section 3.10 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

Traffic within the vicinity of the proposed restoration site is occurs primarily along East Marginal Way, Tukwila International Boulevard, and the South Boeing Access Road to the east of the site and along West Marginal Way and Highway 99 across the river and to the west of the project site. Traffic volumes are highest during peak commuting hours, but are sustained throughout the day by changes in shifts at the Boeing facilities, tourism to the Museum of Flight, traffic related to Boeing Field, and the movement of tractor-trailers and other commercial vehicles along the Duwamish corridor to Harbor Island and the Port of Seattle. While South 112th Street borders the southern property boundary, the street supports only local traffic into and out of the adjacent commercial facilities.

4.13 Aesthetics

Information characterizing visual quality and aesthetic resources within the Green/Duwamish River basin is described in detail in Section 3.13 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

Due to its highly developed and industrialized location, the visual and aesthetic resources of the project site are limited. The rock weir, footbridge over the Duwamish River, and the Cecil B. Moses County Park are visible to the west/southwest of the site and provide limited areas of increased visual quality. From the footbridge, upstream and downstream portions of the river are

visible and provide limited bird and marine mammal watching opportunities. The rock weir is visible for much of the tidal flux of the river and the rapids produced as the river flows over the rocks provides visual interest and attracts kayakers to this portion of the river (Photo 2).

5.0 ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTION

5.1 Physical Characteristics

5.1.1 River Basin

Information describing the environmental effects on the Green/Duwamish River basin is presented in Section 4.4 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

No Action Alternative

Under the No Action Alternative, there would be no change to the current conditions of the Green/Duwamish River basin. The project site would remain undeveloped and largely dominated by invasive, non-native herbs and shrubs, with the progressive colonization of trees such as red alder and black cottonwood.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, the current condition of the Green/Duwamish River basin would be improved by the restoration of the project area to intertidal elevations and intertidal and riparian native plant communities. This would create approximately 1.66 acres of tidal channel and associated intertidal mudflat and approximately 0.76 acres of intertidal and high marsh. A scrub-shrub wetland community of approximately 0.17 acres would gradually transition to a forested riparian buffer encompassing approximately 0.29 acres to the top of the area of excavation. While the Preferred Alternative would result in the loss of the 0.06 acres of the existing intertidal marsh, the disturbed portions of the marsh would be salvaged and replaced by the restored intertidal marsh habitat that would ultimately be of similar functional value to invertebrates, fish, and birds.

5.1.2 Geology and Soils

Information describing the environmental effects on the geology and soils of the Green/Duwamish River basin is presented in Section 4.4.1 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

No Action Alternative

Under the No Action Alternative, there would be no change to the current conditions of the geology or soils within the project site. The layers of fill, steel slag, bricks, and industrial debris that currently encompass the soil horizons of the site, as well as the riprapped shoreline, would remain in place.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, the mixture of historic fill, steel slag, bricks, steel debris, and shoreline riprap that characterize the site would be excavated, removed from the site, and properly disposed of at approved landfill facilities. This would improve the soil conditions of the site and would eliminate approximately 234 lineal feet of armored shoreline, as well as 2 to acres

of industrial fill and associated chemical constituents from the shoreline of the lower Duwamish River. Approximately 300 cubic yards of riprap/angular rock would be placed as bank armoring along the upstream slope of the entrance channel to stabilize the entrance slope and to prevent changes in the existing split in river flow over the rock weir.

5.1.3 Hazardous and Toxic Materials

Information describing the environmental effects on hazardous and toxic materials of the Green/Duwamish River basin is presented in Section 4.4.2 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

No Action Alternative

Under the No Action Alternative, there would be no change to the current extent and character of the hazardous and toxic materials noted at the project site. The layers of fill, steel slag, bricks, and industrial debris that currently encompass the soil horizons of the site, as well as the rip rapped shoreline, would remain in place. There would be no cleanup of the hydrocarbon contamination of the soils on site, removal of any underground objects and/or associated contamination, or any measures implemented with respect to arsenic in the groundwater.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, the layers of fill, steel slag, bricks, industrial debris, and areas of hydrocarbon contamination, as well as the rip rapped shoreline, would be removed from the site and properly disposed of at approved facilities. This would improve the conditions of the site and would eliminate approximately 2 to 3 acres of industrial fill and associated chemical constituents from the shoreline of the lower Duwamish River.

The petroleum-contaminated soil would be removed or isolated from contact with or migration to surfaces of the fish channel. Any underground objects and associated contamination would be removed. Any measures that are necessary to take with respect to the arsenic in the groundwater would be performed.

5.1.4 Hydrologic Regime

Information describing the environmental effects on the water resources of the Green/Duwamish River basin is presented in Section 4.5 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

No Action Alternative

Under the No Action Alternative, there would be no change in the discharge or daily stream flows in the lower Duwamish River.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, the entrance to the restored intertidal areas would allow rising tides and river stages to flow from the main channel into the restoration site, filling the site on incoming tides and draining the site on outgoing tides. This would not result in a measurable change in the discharge or daily stream flows in the lower Duwamish River.

5.2 Water Quality

Information describing the environmental effects on the water quality of the Green/Duwamish River basin is presented in Section 4.6 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

5.2.1 Water Quality Class

No Action Alternative

Under the No Action Alternative, there would be no change in the water quality classification as ‘aquatic life use’ for “salmon and trout rearing and migration only” (WAC 173-201A-600, 602). Similarly, there would be no change to the pollutants within the Duwamish River nor in its listing on the Department of Ecology’s 303(d) list of threatened and impaired waters.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, there would also be no change in the water quality classification as ‘aquatic life use’ for “salmon and trout rearing and migration only” (WAC 173-201A-600, 602). However, restoration of intertidal habitats within the project site and reconnection of the project site with the Duwamish River will improve rearing and foraging conditions for juvenile salmonids by increasing the area of intertidal mudflat and saltmarsh that support the benthic and epibenthic food web on which juvenile salmonids depend. Similarly, while there would be no change to the listing of the Duwamish River on the Department of Ecology’s 303(d) list of threatened and impaired waters as result of this project, excavation and proper disposal of the fill material from the project site will incrementally reduce the pollutant load to the Duwamish River improving its water quality.

5.2.2 Turbidity

No Action Alternative

Under the No Action Alternative, there would be no change in the characteristic turbidity of the Duwamish River because there would be no change to the shoreline armoring and no grading taking place at the project site.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, there would be small-scale, temporary increases in turbidity within the river channel as a result of construction activities to remove the shoreline riprap, armor and stabilize the upriver side of the entrance channel, and during the grading necessary to salvage portions of the native marsh and connect the intertidal channel to the river. In order to reduce temporary increases in turbidity and potential related effects on juvenile salmonids in the river, all ‘in-water’ construction work will take place during the appropriate fish window (August 1 to August 31, or as otherwise determined by WDFW) and will take place during the lowest portions of the tidal cycle. Construction techniques, sequencing, and timing will

minimize soil disturbance to the extent practical to minimize the generation of turbidity during connection of the tidal channel to the Duwamish River. Similarly, the design and implementation of the erosion-control and the Storm Water Pollution Prevention (SWPPP) plans will incorporate best management practices (BMPs) to further reduce the duration and magnitude of the temporary increases in turbidity. Because such increases will occur only during the portions of the construction sequence that require ‘in water’ work, turbidity impacts will be localized and temporary, and are expected to return to normal levels as soon as ‘in-water’ construction activities are completed. Turbidity monitoring during construction will ensure that these temporary increases are in compliance with State Water Quality Conditions.

Ultimately, by removing compacted surface fill and restoring tidal connectivity and native plant communities to the project site, the Preferred Alternative will incrementally improve the filtration of overland flow and will reduce stormwater runoff from the site into the Duwamish River.

5.2.3 Dissolved Oxygen

No Action Alternative

Under the No Action Alternative, there would be no change in the characteristic dissolved oxygen levels in the Duwamish River because there would be no change to shoreline vegetation and no grading taking place at the project site.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, there could be small-scale, temporary decreases in dissolved oxygen within the river channel as a result of increases in turbidity related to construction activities to remove the shoreline riprap, armor and stabilize the upriver side of the entrance channel, and during the grading necessary to salvage portions of the native marsh and connect the intertidal channel to the river. In order to reduce temporary decreases in dissolved oxygen and potential related effects on juvenile salmonids in the river, all ‘in-water’ construction work will take place during the appropriate fish window (August 1 to August 31, or as otherwise determined by WDFW) and will take place during the lowest portions of the tidal cycle. Construction techniques, sequencing, and timing will minimize soil disturbance to the extent practical to minimize the generation of turbidity (and consequent reduction in dissolved oxygen concentrations) during connection of the tidal channel to the Duwamish River. Similarly, the design and implementation of the erosion-control and the Storm Water Pollution Prevention (SWPPP) plans will incorporate best management practices (BMPs) to further reduce the duration and magnitude of the temporary increases in turbidity and potential impacts of dissolved oxygen levels. Because such decreases might occur only during the portions of the construction sequence that require ‘in water’ work, any reduction in dissolved oxygen will be localized and temporary, and would be expected to return to normal levels as soon as ‘in-water’ construction activities are completed. Monitoring of water quality conditions during construction will ensure that these temporary decreases are in compliance with State Water Quality Conditions.

5.2.4 Temperature

No Action Alternative

Under the No Action Alternative, there would be no change in the characteristic temperature profile of the Duwamish River because there would be no change to overhanging shoreline vegetation.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, the existing rip rapped shoreline armoring and thicket of blackberries would be removed and replaced with intertidal mudflat and saltmarsh fringed by native riparian plantings. As the approximately 0.47 acres of riparian buffer develops, the trees along the riverward edge of the project would ultimately provide some shade to the river banks and would incrementally benefit water temperature conditions in the river channel. In addition, the incorporation of large woody debris into the intertidal areas of the site will also provide localized areas of temperature refuge for foraging salmonids utilizing the restoration site.

5.3 Vegetation

Information describing the environmental effects on vegetation in the Green/Duwamish River basin is presented in Section 4.8 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

5.3.1 Subtidal and Intertidal Vegetation

No Action Alternative

Under the No Action Alternative, there would be no change in the existing extent or configuration of the intertidal saltmarsh adjacent to the western edge of the property. It is anticipated that this marsh would continue to provide a source of ecological data for the various Federal and State agencies that utilize it as a reference site.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, there would be an increase in the extent and species diversity of intertidal mudflat and saltmarsh on the restoration site. The existing rip rapped shoreline armoring and thicket of blackberries would be removed and replaced with intertidal mudflat and saltmarsh fringed by native riparian plantings. Approximately 1.66 acres of the site would become intertidal mudflat, fringed by an approximately 0.76-acre band of intertidal and high marsh that would gradually transition to a scrub-shrub and forested riparian buffer. While the Preferred Alternative would result in the loss of the 0.06 acres of the existing intertidal marsh (Photo 4), the disturbed portions of the marsh would be salvaged and replaced by the restored intertidal marsh habitat that would ultimately be of similar functional value to invertebrates, fish, and birds (Photo 3). The remaining portions of the existing saltmarsh would still be accessible to researchers as a reference site and the salvaged portions of the marsh would also provide data to researchers on the degree and nature of changes to stem density, species diversity, and characteristic invertebrate populations after the salvaged portions have been relocated to suitable elevations within the restoration site. The salvaged portions would also be available for comparisons to the development of the planted marsh vegetation and as a seed source for the natural spread of intertidal marsh within the restoration site.

5.3.2 Riparian and Upland Vegetation

No Action Alternative

Under the No Action Alternative, the existing trees on the site would remain and the site would likely continue to recruit limited patches of invasive and weedy herbaceous species on the areas

that are not covered with debris. Over time, the site would be expected to recruit trees such as black cottonwood and red alder, but these plants would be unlikely to recruit into the river due to the isolation of the river from its floodplain in this developed area. Thus, there would be largely no change in the existing extent or species diversity of riparian or upland vegetation along the Duwamish River.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, there would be an increase in the extent and species diversity of riparian and upland vegetation on the restoration site. While a few of the existing trees in the center of the site would be removed (and retained as large woody debris), approximately 0.47-acres of scrub-shrub and forested riparian buffer would be created around the outer edge of the site. The upland trees along the southern and eastern sides of the property would be retained to the extent possible and their understory would be planted with native upland shrubs to further increase the species richness and habitat value of the site (Photo 1).

5.4 Fish

Information describing the environmental effects on the fisheries resources of the Green/Duwamish River basin is presented in Section 4.7 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

5.4.1 Anadromous Salmonids

No Action Alternative

Under the No Action Alternative, there would be no change to the site that would affect anadromous salmonids in the Duwamish River. The small area of existing intertidal saltmarsh would remain as foraging and refuge habitat for juvenile salmonids in the river.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, there would be an increase of 1.66 acres of intertidal mudflat and an increase of 0.76 acres of intertidal saltmarsh created as a result of this restoration project. These habitats would directly increase foraging habitat for juvenile salmonids in the lower Duwamish River by increasing habitat for the benthic and epibenthic invertebrates that juvenile salmon feed on. Similarly, removal of the existing rip rapped shoreline and the addition of a planted riparian buffer would contribute to an increase in the functional value of the site for exporting organic material and littoral insects into the food web of juvenile salmonids. In addition, creation of accessible intertidal habitat within this specific reach of the lower Duwamish will also benefit juvenile salmonids by providing habitat at the upper edge of the salt wedge for their physiological transition to life in salt water.

Water quality impacts such as increased turbidity and decreased dissolved oxygen during the periods of ‘in-water’ work could reduce the suitability of the eastern shoreline of the Duwamish River for salmonids during construction, but this effect would be temporary and localized. All ‘in-water’ work would be conducted within the fish window of August 1 to August 31. Avoiding ‘in-water’ work during peak salmonid out migration periods (generally between

February 15 and July 15) would minimize the short-term effects of the Preferred Alternative on juvenile salmonids. This timing would also avoid noise impacts to juvenile salmonids.

There would be a temporary decrease in benthic and epibenthic invertebrates within the portion of the existing salt marsh that is excavated during connection of the tidal channel to the Duwamish River. However, the small area of impact would be regraded to intertidal elevations and as such is expected to be quickly recolonized by invertebrates from adjacent undisturbed areas. Similarly, the 'in water' excavation and grading will take place soon after the mid-July end of the juvenile salmonid outmigration period (i.e. beginning in early August). This schedule will allow for maximum recovery of the benthic and epibenthic communities prior to the subsequent year's juvenile salmonid outmigration period.

Such temporary impacts are limited in time to periods outside the fish window and are limited in space to the immediate vicinity of construction activities that need to take place below mean higher high water. As such, they are not expected to have significant or long-term impacts on fish populations in the river.

5.4.2 Forage Fish

No Action Alternative

Under the No Action Alternative, there would be no change to the site that would affect forage fish species in the Duwamish River. The small area of existing intertidal saltmarsh would remain as an area of native habitat supporting the food web interactions between benthic invertebrate, forage fish, and anadromous salmonids.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, there would be an increase of 1.66 acres of intertidal mudflat and an increase of 0.76 acres of intertidal saltmarsh created as a result of this restoration project. These habitats would directly increase foraging habitat for forage fish in the lower Duwamish River by increasing habitat for the benthic and epibenthic invertebrates that they feed on. Similarly, removal of the existing rip rapped shoreline and the addition of a planted riparian buffer would contribute to an increase in the functional value of the site for exporting organic material and littoral insects into the food web.

Water quality impacts such as increased turbidity and decreased dissolved oxygen during the periods of 'in-water' work could reduce the suitability of the eastern shoreline of the Duwamish River for forage fish species during construction, but this effect would be temporary and localized. As there are no known areas of forage fish spawning in the lower Duwamish River, the Preferred Alternative would not impact forage fish reproduction.

The excavation would likely kill any sand lances that are buried within the sediment in this area. However, based on fish sampling conducted by USFWS in 2001, few sand lances are expected within the limited area of intertidal work. Less than ten sand lance were captured downstream of the project site at both the Turning Basin and the Hamm Creek estuary restoration sites (Low and Myers 2002). There would also be a temporary decrease in benthic and epibenthic invertebrates within the portion of the existing salt marsh that is excavated during connection of the tidal

channel to the Duwamish River. The small area of intertidal impact would be regraded to elevations suitable for use by sand lance once excavation is completed and is also expected to be quickly recolonized by invertebrates from adjacent undisturbed areas.

Such temporary impacts are limited in time and in space to the immediate vicinity of construction activities that need to take place below mean higher high water. As such, they are not expected to have significant or long-term impacts on forage fish populations in the river.

5.5 Wildlife

Information describing the environmental effects on wildlife of the Green/Duwamish River basin is presented in Section 4.9 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

5.5.1 Birds

No Action Alternative

Under the No Action Alternative, the small area of existing intertidal saltmarsh would remain as an area of native habitat supporting the food web interactions between benthic invertebrates, fish, and birds. The progressive development of vegetation on the site would provide limited refuge and foraging habitat for species of birds such as sparrows, nuthatches, and chickadees that are adapted to urban environments and capable of utilizing such habitats.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, there would be an increase of 1.66 acres of intertidal mudflat and an increase of 0.76 acres of intertidal saltmarsh created as a result of this restoration project. These habitats would directly increase foraging habitat for shore and water birds in the lower Duwamish River by increasing habitat for the intertidal plants, invertebrates, and fish that they feed on. Similarly, removal of the existing rip rapped shoreline and the addition of a planted riparian buffer would contribute to an increase in the functional value of the site through restoration of a greater variety of native tree and shrub species to the riparian zone. The installation of nesting boxes and platforms, large woody debris, and the undulating edges of the project design will also enhance nesting and foraging opportunities for a greater variety of birds.

Shorebirds, waterfowl, great blue herons, and the variety of passerines foraging or resting within and along the Duwamish River at the time of construction may be temporarily displaced due to the noise and movement of the machinery. However, these effects would be temporary and displaced birds would be expected to return to the area after construction is completed. As urban-adapted predators, bald eagles, osprey, peregrine falcons, and other raptors that may be foraging over the area are unlikely to be affected by the construction activities as the forage for fish and birds over the Duwamish River. No breeding or nesting areas will be directly impacted, as the construction will take place in mid to late summer. Construction of the restoration site is not expected to result in a long-term reduction in the abundance or distribution of any prey items local birds would be seeking.

5.5.2 Marine Mammals

No Action Alternative

Under the No Action Alternative, there would be no change to the site that would affect marine mammals within the Duwamish River. The small area of existing intertidal saltmarsh would remain as an area of native habitat supporting the food web interactions that support marine mammals.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, there would be an increase of 1.66 acres of intertidal mudflat and an increase of 0.76 acres of intertidal saltmarsh created as a result of this restoration project. These habitats would directly increase foraging habitat for fish in the lower Duwamish River by increasing habitat for the benthic and epibenthic invertebrates that they feed on. Thus, this restoration project provides food web support to marine mammals such as the harbor seal that forage on fish within the lower Duwamish River.

Any marine mammals (most likely harbor seals) that are foraging within the Duwamish River at the time of construction may be temporarily displaced due to the noise and movement of the machinery. However, these effects would be temporary and displaced seals would be expected to return to the area after construction is completed. No haul out or pupping areas exist on the lower Duwamish River. Construction of the restoration site is not expected to result in a long-term reduction in the abundance or distribution of any prey items local marine mammals would be seeking.

5.5.3 Amphibians, Reptiles, and Terrestrial Mammals

No Action Alternative

Under the No Action Alternative, the small area of existing intertidal saltmarsh would remain as an area of native habitat supporting the food web interactions between benthic invertebrates, fish, and terrestrial mammals such as raccoons. The progressive development of vegetation on the site would provide limited refuge and foraging habitat for species of amphibians, reptiles, and terrestrial mammals that are adapted to urban environments, capable of utilizing such habitats, and able to move between isolate patches of habitats within an urban setting. Such species could include raccoons, opossums, rats, and garter snakes.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, there would be an increase of 1.66 acres of intertidal mudflat and an increase of 0.76 acres of intertidal saltmarsh created as a result of this restoration project. These habitats would directly increase foraging habitat for urban adapted amphibians, reptiles, and terrestrial mammals in the lower Duwamish River by increasing habitat for the invertebrates and fish that they feed on. Similarly, removal of the existing rip rapped shoreline and the addition of a planted riparian buffer would contribute to an increase in the functional value of the site through restoration of a greater variety of native tree and shrub species in the riparian zone, providing habitat for terrestrial mammals and possibly for urban adapted reptile species such as garter snakes and amphibian species such as Pacific chorus frogs. The installation of large

woody debris and the undulating edges of the project design will also enhance refuge and foraging opportunities for these species.

Amphibians, reptiles, and terrestrial mammals foraging or resting within and along the Duwamish River at the time of construction may be temporarily displaced due to the noise and movement of the machinery. However, these effects would be temporary and displaced animals would be expected to return to the area after construction is completed. As there is very little vegetated habitat currently on the site, little direct impact to local animals is expected during construction. Similarly, no breeding areas will be directly impacted, as the construction will take place in mid to late summer. Construction of the restoration site is not expected to result in a long-term reduction in the abundance or distribution of any prey items local amphibians, reptiles, or terrestrial mammals would be seeking.

5.6 Threatened and Endangered Species

Information describing the environmental effects on threatened and endangered fish species of the Green/Duwamish River basin is presented in Section 4.7.4 of the FPEIS (USACE and King County DNR 2000); the effects on threatened and endangered plant species is presented in Section 4.8.3 of the FPEIS and effects on threatened and endangered wildlife species is presented in Section 4.9.2 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

No Action Alternative

Under the No Action Alternative, there would be no change to the site that would affect threatened or endangered species that could be utilizing habitats within and along the Duwamish River. The small area of existing intertidal saltmarsh would remain as an area of native habitat supporting the food web interactions between benthic invertebrates, Puget Sound Chinook salmon, Coastal/Puget Sound bull trout, and fish-eating birds such as the bald eagle. The progressive development of vegetation on the site could ultimately provide perching opportunities for bald eagles.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, there would be an increase of 1.66 acres of intertidal mudflat and an increase of 0.76 acres of intertidal saltmarsh created as a result of this restoration project. These habitats would directly increase foraging habitat for Puget Sound Chinook salmon, Coastal/Puget Sound bull trout, and bald eagles in the lower Duwamish River by increasing habitat for the invertebrates and fish that they feed on. Similarly, removal of the existing rip rapped shoreline and the addition of a planted riparian buffer would contribute to an increase in the functional value of the site through restoration native tree and shrub species to the riparian zone, ultimately providing roosting or perching habitat for bald eagles and additional foodweb support into the aquatic food web. The installation of large woody debris and the undulating edges of the project design will also enhance refuge and foraging opportunities for Puget Sound Chinook salmon and Coastal/Puget Sound bull trout.

The in-water construction of this project would occur when juvenile and adult Puget Sound chinook salmon and bull trout are least likely to be present in the Duwamish River, and during the portion of the year when bald eagles are not nesting and are most tolerant of disturbance.

Therefore, while the proposed construction may affect these species, it is not likely to adversely affect them.

The effect determinations made in the Programmatic Biological Assessments for this project are listed in Table 3. The USFWS concurred with the determination of “may affect, but not likely to adversely affect” for the bald eagle, marbled murrelet, northern spotted owl, gray wolf, Canada lynx, and bull trout in relation to the North Wind’s Weir restoration project via a concurrence letter dated March 27, 2001 (Appendix B). Similarly, NOAA Fisheries concurred with the determination of “may affect, but not likely to adversely affect” for Puget Sound chinook salmon in relation to the North Wind’s Weir restoration project via a concurrence letter dated April 10, 2001 (Appendix B). Copies of the Programmatic Biological Assessments are available from the Corps upon request.

5.7 Cultural Resources

Information describing the effects on cultural and historic resources of the Green/Duwamish River basin is presented in Section 4.18 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

No Action Alternative

Under the No Action Alternative there will be no compliance issues with Section 106 of the NHPA.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, the project has the potential to affect unrecorded historic properties if excavation extends below the fill covering the area. Archaeological monitoring during construction will be conducted due to the possibility that the excavation could reach intact sediments below the fill.

5.8 Native American Concerns

Information describing the effects on cultural and historic resources of the Green/Duwamish River basin is presented in Section 4.18 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

No Action Alternative

Under the No Action Alternative there will be no change to the site that would affect the harvest of fish or shellfish by Native American Tribes. There would also be no increase in the area or quality of locally available foraging and rearing habitat for salmon in the lower Duwamish River and thus no benefit to the local harvest of salmon by Native American Tribes.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, the project would increase the amount of intertidal habitat available to salmon in the lower Duwamish River and would improve the quality of rearing and foraging habitat available to this important resource for Native American Tribes in the area.

Coordination with the Muckleshoot Indian Tribe has been ongoing throughout this project to ensure fishing and shellfish harvesting concerns were incorporated into the site design. Construction of the project would be timed to avoid impacts to both out-migrating juvenile salmonids and adults moving upstream to spawn. Thus, construction would also avoid impacts to fishing rights of the Muckleshoot Indian Tribe.

5.9 Land Use

Information describing the environmental effects on land and shoreline use in the Green/Duwamish River basin is presented in Section 4.13 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

No Action Alternative

Under the No Action Alternative, there would be no change to the site that would affect local land use along the Duwamish River. The area would continue to be heavily industrialized and the shoreline would continue to be rip rapped.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, the increase of 1.66 acres of intertidal mudflat and 0.76 acres of intertidal saltmarsh created as a result of this restoration project would incrementally increase the area of restored habitat within the lower Duwamish River and would thus change the land use of the immediate project site. There would likely be no change in the use of adjacent industrial or commercial facilities as a result of the project, nor would there be any change in the use of the Duwamish River by industrial or commercial vessels.

5.10 Recreation

Information describing the environmental effects on recreation in the Green/Duwamish River basin is presented in Section 4.14 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

No Action Alternative

Under the No Action Alternative, there would be no change to the site that would affect local recreation along the Duwamish River. The area would continue to be heavily industrialized and the shoreline would continue to be rip rapped. The Duwamish River would continue to support heavy industrial, commercial, and recreational vessel use, but no new areas of recreational interest would be created.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, it is possible that recreational use of the portion of the channel around the rock weir might increase slightly as a result of attracting passive recreational use to the site via the hand-launch boat ramp and the interpretive trail within the riparian buffer of the project site. However, due to the highly industrialized area surrounding the project, it is unlikely

that this area would become a recreational destination or that this project would otherwise significantly increase recreational visitors to the immediate area of the project.

As stated below in Section 5.12, construction vehicles may temporarily disrupt local traffic around the restoration site. Noise associated with the usage of heavy machinery may disturb recreational users of the footbridge over the river, the Cecil B. Moses Memorial park across the river, or recreational kayakers on the river. However, these impacts will be temporary and highly localized, so no significant impacts on recreation are anticipated following construction.

5.11 Air Quality and Noise

Information describing the environmental effects on air quality and noise in the Green/Duwamish River basin is presented in Sections 4.10 and 4.11, respectively, of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

No Action Alternative

Under the No Action Alternative, there would be no change to the site that would affect local air quality or noise levels along the Duwamish River. The area would continue to be heavily industrialized with the incumbent air quality and noise issues associated with industrial traffic and processes. The Duwamish River would continue to support heavy industrial, commercial, and recreational vessel use with the associated levels of air pollution and noise generated.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

As stated above in Section 5.8, under the Preferred Alternative, construction vehicles may temporarily increase air emissions and noise in the immediate project vicinity. Noise associated with the usage of heavy machinery may disturb recreational users of the footbridge over the river, the Cecil B. Moses Memorial Park across the river, or recreational kayakers on the river. However, these impacts will be temporary and highly localized, and are not expected to result in significant impacts.

5.12 Transportation

Information describing the environmental effects on traffic and transportation in the Green/Duwamish River basin is presented in Section 4.12 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

No Action Alternative

Under the No Action Alternative, there would be no change to the site that would affect local transportation routes or volumes along the Duwamish River. Traffic would continue to occur primarily along East Marginal Way, Tukwila International Boulevard, and the South Boeing Access Road to the east of the site and along West Marginal Way and Highway 99 across the river and to the west of the project site.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, construction vehicles may temporarily increase the volume of traffic in the immediate project vicinity during excavation of the site. Construction vehicles may disrupt traffic along East Marginal Way, Tukwila International Boulevard, and the South Boeing Access Road. Congestion could increase slightly during peak commuting hours due to the movement of construction vehicles back and forth to the restoration site, particularly along South 112th Street, which currently receives very little traffic. However, these impacts will be temporary and highly localized, and are therefore not expected to be significant.

5.13 Aesthetics

Information describing the environmental effects on visual quality and aesthetic resources of the Green/Duwamish River basin is presented in Section 4.15 of the FPEIS (USACE and King County DNR 2000). A synopsis of site-specific information relevant to the proposed restoration project site is presented below.

No Action Alternative

Under the No Action Alternative, there would be no change to the site that would affect local aesthetics along the Duwamish River. The area would continue to be heavily industrialized with few areas of native habitat providing visual interest. No change would be expected to the rock weir, footbridge over the Duwamish River, or the Cecil B. Moses County Park to the west/southwest of the site. The upstream and downstream portions of the river would continue to be visible from the footbridge to provide limited bird and marine mammal watching opportunities.

Preferred Alternative: Single Entrance, Mudflat and Marsh, Armored Upstream Entrance, Salvage Disturbed Portions of Marsh

Under the Preferred Alternative, removing the fill and remnant foundations on the site and replacing them with a variety of native plant species would increase the visual and aesthetic resources of the project site. Wildlife attracted to the site would also likely increase the aesthetic attractiveness of the project site. However, due to the highly industrialized area surrounding the project, it is unlikely that this area would become a recreational destination due to its aesthetic resources. Rather, as noted in Section 5.10 above, increased recreational use of the site could result from more frequent or longer visits by local workers and recreational kayakers as a result of the restoration actions.

As stated above in Section 5.12, during excavation and construction of the site, the aesthetic attractiveness of the general area could be reduced due to the noise and air emissions generated by the construction equipment, which may disturb recreational users of the footbridge, the Cecil B. Moses Memorial Park, or recreational kayakers on the river. However, these impacts will be temporary and highly localized, and are not expected to result in significant impacts.

6.0 UNAVOIDABLE ADVERSE EFFECTS

Unavoidable adverse effects of the proposed project include: (1) noise disturbance to wildlife and recreational users in the vicinity of operating heavy machinery during excavation and construction of the restoration site; (2) disruption of local traffic in the project vicinity during construction; (3) mortality of sessile and mobile benthic and epibenthic fish and invertebrates

within the portions of the existing intertidal marsh and mudflat during excavation down to design elevations; (4) mortality of the limited understory vegetation and some trees within the project site, and (5) excavation of approximately 0.06 acres of existing intertidal marsh. Given the temporary, localized, and minor nature of these effects, the Corps has determined that the proposed restoration project is not expected to result in significant adverse environmental impacts.

7.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The proposed restoration project would not entail any significant irretrievable or irreversible commitments of resources. The construction work would require use of existing machinery and export of the fill material to an existing, licensed landfill for disposal. Replanting of the site following excavation would require contracting with local existing nurseries for native plant materials and hiring existing contractors to plant the site.

8.0 CUMULATIVE IMPACTS

Cumulative impacts result from the “individually minor but collectively significant actions taking place over a period of time” (40 CFR 1508.7). As such they include the impacts of this restoration project considered in conjunction with current and future restoration projects constructed or planned within the lower Green/Duwamish River watershed.

By the end of calendar year 2003, there will be nine major intertidal projects (mostly restoration projects, some with mitigation components) implemented within the lower nine miles of the Duwamish River. These sites have been constructed under the Coastal America program, as remediation under the Natural Resources Defense Act (NRDA), or by the Corps under Section 1135 of the Water Resources Development Act. The sites encompass a total of approximately 29.5 acres of restored habitat (acreage sources include People for Puget Sound, Taylor and Associates, Inc. and Corps records). Negative effects of the North Wind’s Weir Intertidal Restoration project add to the cumulative negative effects of the previous series of nine constructed restoration projects. However, these negative effects are temporary and are associated only with the actual construction of the project, concentrated mainly as the restored site is hydraulically rejoined to the Duwamish River. The combination of mitigation measures, BMPs, and post-construction monitoring of the restored sites reduce the cumulative, short-term (i.e. construction related) impacts of these projects to an insignificant level.

More significantly, these short term negative effects are compensated for by the long-term, spatially cumulative benefits to the amount and functional value of restored habitat, improvements in the overall watershed condition through decreased fragmentation of habitats, and the ultimately increased ability of the watershed to support critical life history stages of native fish and wildlife populations. Thus, the proposed restoration project will have beneficial cumulative effects within the watershed and would also incrementally offset adverse impacts on habitats from past, present, and future redevelopment projects along the lower river.

The North Wind’s Weir restoration project will encompass approximately 3.27 acres of restored habitat in the lower nine miles of the Duwamish River, an increase of approximately 11% in the

total area of restored habitat in the lower river. Ultimately, the cumulative positive effects of the progressive increase in restored areas along the Duwamish River remains to be documented. The Corps and King County DNRP hope that the system may ultimately reach a point of exporting sufficient viable seeds to recolonize appropriate elevations within the lower river. The point at which this may occur along the trajectory of progressively increasing areas of intertidal habitat, remains unknown. One day these restored habitats could thus become the catalyst for natural restoration of the albeit limited areas of shoreline left along the Duwamish River.

9.0 ENVIRONMENTAL COMPLIANCE

LAWS AND REGULATIONS RELATING TO THE PROPOSED ALTERNATIVES	ISSUES ADDRESSED	CONSISTENCY OF PREFERRED ALTERNATIVE
National Environmental Policy Act (NEPA) 42 U.S.C. 4321 et seq.	Requires all federal agencies to consider the environmental effects of their actions and to seek to minimize negative impacts	Consistent per FONSI and EA document
State Environmental Policy Act (SEPA) RCW 43.21	Requires state agencies to consider the environmental effects of their actions and actions of permit applicants.	Consistent
Clean Water Act (CWA) 33 U.S.C. 1251 et seq.; Section 404	Requires federal agencies to protect waters of the United States. Disallows the placement of dredged or fill material into waters (and excavation) unless it can be demonstrated there are no reasonable alternatives.	Consistent per 404(b)(1) Evaluation
Clean Water Act Section 401	Requires federal agencies to comply with state water quality standards.	Will be consistent with 401 permit requirements as issued by Washington Department of Ecology
Fish and Wildlife Coordination Act 16 U.S.C. 661 et seq.	Requires federal agencies to consult with the US Fish & Wildlife Service on any activity that could affect fish or wildlife.	Consistent based on acceptance of Final FWCA Report prepared for the FEIS
Endangered Species Act 16 U.S.C. 1531 et seq.;	Requires federal agencies to protect listed species and consult with US Fish & Wildlife or NMFS regarding the proposed action.	Consistent based on the Biological Assessment prepared for the FEIS
National Historic Preservation Act 16 U.S.C. 461;	Requires federal agencies to Identify and protect cultural and historic resources.	Consistent upon review of determination of no effect by SHPO
Shoreline Management Act (SMA) and Shoreline Management Program (SMP) RCW 90.58, WAC 173-14	State law implementing the Coastal Zone Mgmt Act requiring local jurisdictions to plan and protect shorelines.	Consistent
Coastal Zone Management Act (CZMA) 16 U.S.C. 1451 et seq.; 15 CFR 923	Requires federal agencies to comply with state and local plans to protect and enhance coastal zone and shorelines.	Consistent to the maximum extent practicable
Washington Hydraulic Code	Requires proponents of developments, etc to protect state waters, wetlands and fish life.	Will be consistent with HPA conditions issued by WDFW

LAW AND REGULATIONS RELATING TO THE PROPOSED ALTERNATIVES	ISSUES ADDRESSED	CONSISTENCY OF PREFERRED ALTERNATIVE
Executive Order 11988: Floodplain Management Guidelines	Requires federal agencies to evaluate the potential effects of actions on floodplains and to avoid undertaking actions that directly or indirectly induce growth in the floodplain or adversely effect natural floodplain values	Consistent, project will not induce growth in floodplain and will restore natural floodplain values
Executive Order 11990: Protection of Wetlands	Encourages federal agencies to take actions to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands when undertaking Federal activities and programs	Consistent, wetland area will be increase as a result of this project; majority of existing marsh will be protected; a portion of marsh will be salvaged and replanted during construction
Executive Order 12898: Environmental Justice	Requires federal agencies to consider and address environmental justice by identifying and assessing whether agency actions may have disproportionately high and adverse human health or environmental effects on minority or low-income populations	Consistent due to lack of adverse human health or environmental effects on minority or low-income populations in local area

10.0 CONCLUSION

Based on this Environmental Assessment and on coordination with Federal agencies, Native American Tribes, and State agencies, the North Wind's Weir Intertidal Restoration project is not expected to result in significant adverse environmental impacts. The North Wind's Weir Intertidal Restoration project is not considered a major Federal action having a significant impact on the human environment. Therefore, the preparation of an environmental impact statement supplement is not required.

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Table 1: Project goals, objectives and constraints

PROJECT GOALS	OBJECTIVES	TARGETED FUNCTIONS	ECOLOGICAL DESIGN CRITERIA	OPPORTUNITIES	CONSTRAINTS	INFORMATION GAINED FROM OTHER SITES*
1) Restore process-based ecological functions of estuarine intertidal and riparian habitats	1) Restoration of intertidal mudflat and marsh habitats	Primary productivity and detrital export from intertidal marsh	Establish correct intertidal elevations to allow native marsh species competitive advantage (at least below +10' based on Turning Basin)	Utilize existing natural marsh as reference site to determine appropriate elevations and species diversity	Need goose excluders over the created marsh and maintenance plan for invasive species	Lack of grading to sufficiently low elevations limited establishment of marshes; Delayed planting could allow development of natural contours
		Secondary productivity (benthic & epibenthic inverts and insects) produced in mudflats and marsh	Establish extremely gradual slopes for mudflat and marsh and diverse microtopography to maximize types of microhabitats	Design to maximize available intertidal area with max. 3:1 slope at outer edge transition to forested buffer; need to overexcavate and back-fill with fine grained, organic rich sediments	Mudflat and marsh can't occupy same space; Desire to retain existing large trees; Proximity of forested buffer to powerlines	Abrupt changes in elevation limited establishment of vegetation and caused erosion
		Habitat complexity and refuge areas	Incorporate large woody debris to create scour pools and increase microtopography	Need to stockpile trees downed during excavation for use on site and retain root-wads during excavation	Investigate potential for scour from woody debris to undermine banks or vegetation	Beneficial use of snags for wildlife habitat at Herring's House; osprey platform used first season at Hamm Creek
	2) Preservation of natural marsh to the greatest extent possible	Very scarce area of natural habitat and source for colonization of created marsh	Physically retain marsh and do not alter hydraulics that maintain marsh	Use model to evaluate anticipated hydraulics to determine impact to natural marsh and erosion potential	Need entrance constructed through part of natural marsh to restore tidal prism to site	Changes in hydraulics post restoration have eliminated some natural marshes

PROJECT GOALS	OBJECTIVES	TARGETED FUNCTIONS	ECOLOGICAL DESIGN CRITERIA	OPPORTUNITIES	CONSTRAINTS	INFORMATION GAINED FROM OTHER SITES*
	2) continued Preservation of natural marsh to the greatest extent possible	Natural marsh functions as reference area for monitoring of restoration effectiveness at other restoration sites on the River by multiple groups of researchers	Minimize area of marsh impacted through design process. Research salvage and replanting techniques to relocate impacted area and minimize total impacts	Retention of natural marsh affords project an ideal reference site to determine effectiveness of design and achievement of objectives; establish baseline conditions in natural marsh prior to construction	Likely need entrance constructed through part of natural marsh to create hydraulics to retain channel and mudflat habitats	Natural marsh at Hamm Creek has been lost due to unanticipated impacts of restoration project; valuable habitat and reference site data lost
1) continued Restore process-based ecological functions of estuarine intertidal and riparian habitats	3) Create habitat conditions attractive to juvenile salmonid rearing	Physical space for osmoregulation & transition; create habitat for fish to forage on benthic invertebrates from mudflat and epibenthic inverts and insects from marsh and riparian	Excavate site low enough to allow unrestricted ingress and egress to marsh and mudflats over max. tidal range	Large site could accommodate the grading and slopes necessary to create mudflat habitat, variety of elevations and habitat types would be attractive to juvenile chinook, coho, and chum	Preservation of natural marsh may preclude a second opening; could construct permeable weir if opening isn't feasible or grade to elevations allowing inflow over marsh at higher tides	Area between Turning Basin and Cecil B. Moses Park important space for juvenile osmoregulation, transition, and rearing – especially for chinook
		Anticipate hydraulic influences on inlet/egress to ensure sufficient tidal prism and address erosion	Excavation to sufficiently low elevation to create juvenile habitat over broadest range of tidal conditions	Large site can accommodate gradual slopes for mudflat and an area of marsh for maximum diversity in habitats. Diversity of elevations max. potential for meeting objective #1	Maximizing the area of mudflat replaces the natural marsh without replacement of lost habitat functions; 404 permitting implications result	Allow for changes in location/extent of inlet/egress to reduce retrofitting as channel may migrate in future.
	4) Increase density and diversity of plant species in buffer	Riparian export of organic matter to intertidal areas; wildlife habitat	Deciduous=leaves berries, fruits, flowers; conifers = cover & nesting	Retain existing large trees where possible	Invasive species maintenance following planting	Invasive species control needed for at least 5 years beyond construction

PROJECT GOALS	OBJECTIVES	TARGETED FUNCTIONS	ECOLOGICAL DESIGN CRITERIA	OPPORTUNITIES	CONSTRAINTS	INFORMATION GAINED FROM OTHER SITES*
1) continued Restore process-based ecological functions of estuarine intertidal and riparian habitats	5) Increase density and diversity of plant species in buffer	Use buffer vegetation to discourage human access to site and/or to provide interpretive overlooks	Target species with thorns or dense branching (roses, hawthorn, vine maple) to discourage access into site by visitors, boaters, dogs	Use existing openings in the trees along outside edge as interpretive overlooks; create interpretive signage to educate about restoration	Human access and recreational use limits wildlife benefits; lack of interpretive facilities limits human benefits	Limited interpretive facilities at other sites; unrestricted human access has compromised ecological potential of some sites
PROJECT GOALS	OBJECTIVES		HUMAN DESIGN CRITERIA	COORDINATION NEEDS	CHALLENGES TO DESIGN TEAM	INFORMATION GAINED FROM OTHER SITES*
2) Respect Tribal uses of site (both current and historic)	1) Preserve cultural integrity of site through early and consistent coordination with Tribes		'North Wind's' weir rocks are of historical significance and are eligible for registration on National Register of Historical Places	Need to establish areas for Tribal use/ preservation early in design phase	Depends upon consistent and accurate communication between Tribes and COE, King County	
3) Support access to hand-launch boat site	2) Direct existing recreational use of site to avoid impacting ecological functions		Kayakers currently launch into rapids from unstable bank at end of 112 th Street	Coordinate with kayaking community to ensure support and integrate needs into design	May need access through City Light property; Need to limit human disturbance to restored habitats	Unlimited and undirected human access has compromised ecological functions at other sites

*Cecil B. Moses Park, Hamm Creek, Turning Basin, and Herring's House are other restoration sites located on the lower Duwamish River

Table 2. Protected Species Addressed in Programmatic Biological Assessments

Species	Listing Status	Critical Habitat
Bald Eagle <i>Haliaeetus leucocephalus</i>	Threatened	—
Marbled Murrelet <i>Brachyramphus marmoratus</i>	Threatened	Designated
Northern Spotted Owl <i>Strix occidentalis caurina</i>	Threatened	Designated
Gray Wolf <i>Canis lupus</i>	Threatened	
Canada Lynx <i>Lynx canadensis</i>	Threatened	—
Coastal/Puget Sound Bull Trout <i>Salvelinus confluentus</i>	Threatened	—
Puget Sound Chinook Salmon <i>Oncorhynchus tshawytscha</i>	Threatened	Designated

Table 3. Threatened and Endangered Species Effect Determination Summary

Species	Listing Status	Critical Habitat	Effects Determination	Services Concurrence for North Wind's Weir?
Bald Eagle <i>Haliaeetus leucocephalus</i>	Threatened	—	Not likely to adversely affect	Yes
Marbled Murrelet <i>Brachyramphus marmoratus</i>	Threatened	Designated	Not likely to adversely affect species or critical habitat	Yes
Northern Spotted Owl <i>Strix occidentalis caurina</i>	Threatened	Designated	Not likely to adversely affect species or critical habitat	Yes
Gray Wolf <i>Canis lupus</i>	Threatened		Not likely to adversely affect	Yes
Canada Lynx <i>Lynx canadensis</i>	Threatened	—	Not likely to adversely affect	Yes
Coastal/Puget Sound Bull Trout <i>Salvelinus confluentus</i>	Threatened	—	Not likely to adversely affect	Yes
Puget Sound Chinook Salmon <i>Oncorhynchus tshawytscha</i>	Threatened	Designated	Not likely to adversely affect species or critical habitat	Yes



Photo 1: Aerial view of site, illustrating developed nature of surrounding land and existing vegetation on the site. Photo is facing upriver to the southeast at high tide.



Photo 2: Southern, downstream portion of rock weir at outgoing tide showing rapids along western (right bank) of Duwamish River. The entrance to the Cecil B. Moses Park restoration site is pictured in the background along the western (right bank). Photo is facing west from the project site.

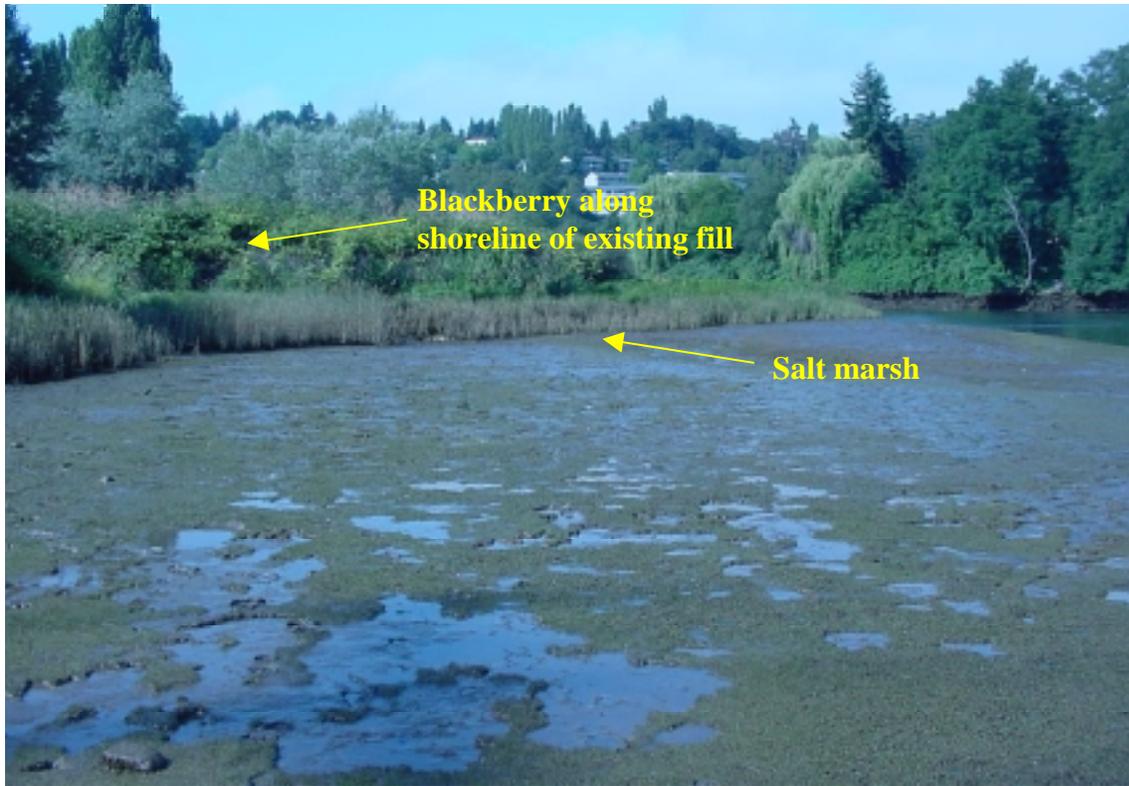


Photo 3: Existing mudflat and salt marsh located off the western side of the project site. Photo is facing upstream to south at low tide. Note the elevation difference between the project site and the mudflat and marsh. Excavation would remove the existing fill and restore the site to intertidal elevations and habitats.



Photo 4: Southern portion of existing saltmarsh along the shoreline of project site, facing downstream to north at low tide. This portion of the marsh is located at the proposed entrance to the restoration site. The marsh in this area will be salvaged and replanted during construction of the restoration site.

FIGURES and APPENDICES