Washington State Department of Transportation

SR 520 Bridge Replacement and HOV Program

I-5 to Medina: Bridge Replacement and HOV Project

Draft Aquatic Mitigation Plan

SR 520, I-5 to Medina: Bridge Replacement and HOV Project

Prepared for

Washington State Department of Transportation

and

Federal Highway Administration

August 2011

Washington State Department of Transportation

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August 2011

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Executive Summary

The Washington State Department of Transportation (WSDOT) is proposing to construct the SR 520, I-5 to Medina: Bridge Replacement and HOV Project (SR 520, I-5 to Medina Project) to reduce transit and high-occupancy vehicle (HOV) travel times and to replace the aging spans of the Portage Bay and Evergreen Point bridges, which are highly vulnerable to windstorms and earthquakes. The project will also widen the State Route (SR) 520 corridor to six lanes from I-5 in Seattle to Evergreen Point Road in Medina, and will restripe and reconfigure the lanes in the corridor from Evergreen Point Road to 92nd Avenue NE in Yarrow Point. The project will complete the regional HOV lane system across SR 520, as called for in regional and local transportation plans.

The SR 520, I-5 to Medina project will extend approximately 5.2 miles from I-5 in Seattle to 92nd Avenue NE in Yarrow Point. The project will widen the SR 520 corridor to six lanes between I-5 and Evergreen Point Road in Medina. The project will also construct an additional bridge over the Montlake Cut and replace the Portage Bay Bridge, the Union Bay Bridge, and the vulnerable Evergreen Point Bridge with new structures. It will restripe and reconfigure the traffic lanes between Evergreen Point Road and 92nd Avenue NE in Yarrow Point and complete the regional HOV system across SR 520. The project passes through Section 24, in Township 25 North, Range 5 East, and Sections 20, 21, and 22 in Township 25 North, Range 4 East. The aquatic resources evaluated in the *Draft Aquatic Mitigation Plan* analysis occur within and adjacent to the limits of construction.

Construction for the SR 520, I-5 to Medina project is planned to begin in 2012, with major construction expected to be completed in 2018. In order to maintain traffic flow in the SR 520 corridor, the project will be built in stages. The most vulnerable structures (Evergreen Point Bridge and Portage Bay Bridge) will be built first, followed by the less vulnerable components.

The environmental review process was originally initiated by WSDOT and Sound Transit in 2000, when a Notice of Intent was issued to prepare an environmental impact statement (EIS) to evaluate improvements in the SR 520 corridor. WSDOT issued a Draft EIS in 2006, a Supplemental Draft EIS, in 2010, and has since identified the preferred alternative in a Final EIS issued in June 2011 for the SR 520 Bridge Replacement and HOV Project. This aquatic mitigation plan assumes that the Federal Highway Administration (FHWA) will select the preferred alternative identified in the Final EIS; thus, it presents the design and impacts associated with the preferred alternative. A formal decision on the selected alternative will be described in the Record of Decision (ROD) expected in August 2011. During construction, the project will affect Portage Bay of Lake Union, the Lake Washington Ship Canal and Lake Washington, aquatic resources that are regulated by federal, state, or local agencies.

This aquatic mitigation plan serves to:

- Identify the project's impacts on aquatic resources;
- Describe project actions and design features that will minimize or avoid impacts on aquatic resources; and
- Describe proposed compensatory mitigation to offset unavoidable impacts to aquatic resources.

The mitigation plan presented in this document is based on the most current information on project impacts and on characteristics of the mitigation site. WSDOT will continue to develop and modify the mitigation concept in response to agency comments, and additional technical investigations and analyses as they are completed.

Aquatic Resources Impacts

A diverse group of native and non-native fish species inhabit the Lake Washington watershed, including several species of native salmon and trout such as Chinook (*Onchorhynchus tshawytscha*), coho (*O. kisutch*), and sockeye (*O. nerka*) salmon; and steelhead *(O. mykiss*), rainbow (*O. mykiss irideus*), and cutthroat trout (*O. clarki clarki*). Most of these species are likely to occur at least occasionally in the project area, which is located adjacent to a primary migration corridor (i.e., Ship Canal) for all anadromous salmonids spawned in the watershed. The project has the potential to affect several life history stages of anadromous salmonids, primarily rearing and migrating juveniles. In addition to discussing these species, this report presents information on fish species that are significant predators on salmonids in Lake Washington, including bass and pikeminnow.

Construction and operation of the preferred alternative will result in long-term operational impacts and short-term construction impacts to the species and life history stages of the salmonids mentioned above. Project construction may result in long-term impacts to shoreline and open-water habitats in the project area. The largest impacts are associated with construction of a wider floating bridge, bridge approaches, and interchanges. The impacts include (1) loss of benthic habitat due to placement of larger (although fewer) bridge columns, (2) increased over-water bridge structure that could result in an increase in the amount or intensity of in-water shade, and (3) changes in habitat complexity due to new arrangements of in-water piers and columns. Short-term construction impacts to the aquatic environment include pile driving, the construction of cofferdams, construction lighting, anchor placement, and other in-water work.

The mitigation team developed a conceptual model to characterize the interaction between anadromous salmonids and the aquatic habitat in the project area. The model is based on existing literature on salmonid habitat functions and features in Lake Washington. It uses the primary life history stages of anadromous salmonids as surrogates for related population-level metrics (i.e., survival, growth, fitness, and reproductive success) to represent all anadromous salmonids in the Lake Washington system, although the importance of specific habitat features varies by species.

The mitigation team reviewed the proposed project actions to determine the scope and scale of the impacts on relevant aquatic functions in the project area. Potential changes in aquatic functions were analyzed based on their effects on salmonid life history stages and populations. Based on this review, WSDOT determined which impact metrics best represented important aquatic impacts. The three primary metrics are as follows:

1. Area of over-water shading, which is tied to changes in juvenile salmonid outmigration.

2. Benthic fill, representing the physical displacement of aquatic habitat.

3. Habitat complexity, representing alterations in predation on juvenile salmonids.

A mitigation framework was created to assess impacts and resulting mitigation needs, based on salmonid life histories and habitat utilization. The framework was used to establish a methodology to assess both impacts and mitigation uplift. Impacts were assigned based on the two-dimensional area of affected habitat, modified by a geographic (spatial) factor called the Fish Function Modifier (this modifier accounts for differences in fish utilization). The resulting impacts are calculated in acres. The methodology also calculates temporary impacts by integrating the temporal aspect of the impact structures, and therefore results in impacts based on the integration of both impact area and duration (service-acre years).

Under the mitigation approach used by WSDOT, compensation is required for unavoidable adverse impacts that exist after avoidance and minimization measures have been employed. With the exception of the three impact metrics listed above, other types of construction impacts, including in-water noise, temporary lighting, in-water turbidity/contaminants, and barge operation and moorage, have been avoided and/or minimized to the extent that compensatory mitigation will not be required. Similarly, potential operational effects such as stormwater discharge and permanent bridge lighting have also been sufficiently minimized through project design and will represent an improvement over the existing condition. Any residual effects are expected to be insignificant and will not require compensatory mitigation. This document describes the specific avoidance and minimization measures employed for potential construction and operational impacts.

Based on the types and locations of potential impacts, the project has the greatest potential to affect juvenile salmonids in the rearing/feeding and migration life history stages; impacts during these life history stages could result in decreases in juvenile growth, survival, and fitness. The impact assessment characterized effects on aquatic resources based on area (acreage) of bridge structures and related changes to salmonid life history stages. The raw area calculations were adjusted based on the use of specific impact zones by salmonids, including the amount and type of fish utilization. This application of the Fish Function Modifier factor adjusted the impacts according to their ecological relevance (in most cases the modified impact acreage is less than the un-modified impact area). The specific metrics for habitat impacts were calculated and the modified totals are 7.30 acres of permanent impacts and 16.16 acre-years of temporary impacts (one acre-year is defined as one acre of impact over one year). The modified totals are broken down as follows:

- Permanent shading impacts of 6.94 acres and temporary shading impacts of 11.92 acre-years.
- Permanent benthic fill impacts of 0.37 acre and temporary benthic fill impacts of 0.52 acre-years.
- Temporary habitat complexity impacts of 3.72 acre-years (no permanent habitat complexity impacts result from the project).

Aquatic Resources Mitigation

To offset project impacts that could not be adequately avoided or minimized, WSDOT focused on mitigation projects that would benefit the same salmonid species and life history phases to which impacts could occur. Because on-site, in-kind opportunities were not feasible, WSDOT sought off-site mitigation opportunities within the watershed that addressed the same functions and values that could be affected by the project.

The same conceptual model and impact assessment methodology used for calculation of impacts were also applied to the various mitigation sites to translate the type and amount of functional uplift at a given site to habitat acres. The acres were adjusted using the Fish Function Modifier, using the same criteria used for the impact sites. WSDOT also recognizes that some types of mitigation, such as riparian or floodplain enhancement, offer less direct improvement of aquatic habitat than do other types of mitigation that occur directly in the aquatic environment, such as beach creation or in-water structure removal. Therefore, WSDOT has reduced the mitigation credit for these activities to accurately characterize uplift to fish survival, growth, and fitness.

Using the methods listed above, it was determined that a suite of seven mitigation sites, located in various key locations in the Lake Washington basin, will offset the temporary and permanent impacts of the project (Table ES-1). These seven sites were chosen primarily for the salmonid life history stages that will be enhanced (juvenile rearing and outmigration), although most of the sites will also have direct benefits to spawning salmonids. The entire mitigation package will equal about 8.61 acres of permanent mitigation credit and 40.46 acre-years of temporary mitigation credit, which will provide mitigation for project impacts sufficient to meet federal, state, and local regulatory requirements. Table ES-1 illustrates the proposed allocation of those credits.

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Table ES-1. Mitigation Sites, Activities, and Credits

Mitigation Site	Mitigation Actions	Species/ Life Stage Addressed	Permanent Mitigation Credit (acres)	Temporary Mitigation Credit (acre-years)
Seward Park 1	Shoreline enhancement + hard structureremoval, riparian restoration	Chinook (juvenile rearing/ feeding, juvenile migration),	0	7.08
Seward Park 2	Shoreline enhancement (gravel supplementation)	Chinook (juvenile rearing/ feeding, juvenile migration), Sockeye (spawning, rearing/feeding)	0	0.85
Seward Park 3	Shoreline enhancement (gravel supplementation), riparian restoration	Chinook (juvenile rearing/ feeding, juvenile migration),	0	2.27
Seward Park 4	Shoreline enhancement (gravel supplementation)	Sockeye (spawning)	0	19.37
Magnuson Park 1	Shoreline Enhancement + Hard Structure Removal, Riparian Restoration	Chinook (Juvenile Rearing/ Feeding, Juvenile Migration),	0	2.61
Magnuson Park 2	Shoreline Enhancement + Hard Structure Removal	Chinook (Juvenile Rearing/ Feeding, Juvenile Migration),	0	3.09
Taylor Creek	Channel and Delta Restoration, Riparian + Floodplain Restoration	Chinook (Rearing/ Feeding) Sockeye (Spawning, Rearing/ Feeding), Coho (Spawning, Rearing/ Feeding)	0	5.20
South Lake Washington Shoreline Restoration	Shoreline Enhancement + Hard Structure Removal, Riparian Restoration, Dolphin Removal	Chinook (Juvenile Rearing/ Feeding, Juvenile Migration) Sockeye (Juvenile Rearing/ Feeding)	1.84	0
Bear Creek	Stream Enhancement, Riparian Restoration	Chinook (Rearing/ Feeding) Sockeye (Rearing/ Feeding) Coho (Rearing/ Feeding)	4.55	0

Mitigation Site	Mitigation Actions	Species/ Life Stage Addressed	Permanent Mitigation Credit (acres)	Temporary Mitigation Credit (acre-years)
Cedar River/ Elliott Bridge	River Margin and Aquatic Off-channel Creation, Riparian + Floodplain Restoration	Chinook (Spawning, Rearing/ Feeding) Sockeye (Spawning, Rearing/ Feeding) Coho (Spawning, Rearing/ Feeding) Steelhead (Spawning, Rearing/ Feeding)	1.62	0
East Approach	Shoreline enhancement (gravel supplementation, bulkhead removal), riparian enhancement	Sockeye (Spawning) Chinook (Juvenile Rearing/ Feeding, Juvenile Migration)	0.60	0
		Total	**8.61**	**40.46**

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Acronyms and Abbreviations

AKART	all known, available, and reasonable technology
BMPs	best management practices
C	Celsius
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter
CWA	Clean Water Act
dB	decibel
DDD	metabolite of DDT
DDE	breakdown product of DDT
DDT	dichlorodiphenyltrichloroethane
DNR	Washington State Department of Natural Resources
DO	dissolved oxygen
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
ELJs	engineered logjams
ESA	Endangered Species Act
F	Fahrenheit
FHWA	Federal Highway Administration
FHWG	Fisheries Hydroacoustic Working Group
HOV	high-occupancy vehicle
HPA	Hydraulic Project Approval
HRM	*Highway Runoff Manual*
LWD	large woody debris
m	meter
mg/L	milligrams per liter
MITFD	Muckleshoot Indian Tribe Fisheries Division
mm	millimeter

NAVD	North American Vertical Datum
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	National Oceanic and Atmospheric Administration, National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NRTWG	Natural Resources Technical Working Group
OHW	ordinary high water
OHWM	ordinary high water mark
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PGIS	pollutant-generating impervious surface
PSPL	Puget Sound Power and Light
ppm	parts per million
ROD	Record of Decision
SEL	sound exposure level
SPCC	Spill Prevention Control and Countermeasures (Plan)
SPL	sound pressure level
SPU	Seattle Public Utilities
SR	State Route
SWPPP	Stormwater Pollution Prevention Plan
TCDD	dioxin
TESC	Temporary Erosion and Sediment Control (Plan)
TSS	total suspended solids
TWG	Technical Work Group
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington State Department of Fish and Wildlife

WQPMP	Water Quality Protection and Monitoring Plan
WRIA	Water Resource Inventory Area
WSDOT	Washington State Department of Transportation
WWTIT	Western Washington Treaty Indian Tribes

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1. Introduction

The Washington State Department of Transportation (WSDOT) is proposing to construct the SR 520, I-5 to Medina: Bridge Replacement and HOV Project (SR 520, I-5 to Medina Project) to reduce transit and high-occupancy vehicle (HOV) travel times and to replace the aging spans of the Portage Bay and Evergreen Point bridges, which are highly vulnerable to windstorms and earthquakes. Specifically, the project proposes to enhance travel time reliability, mobility, access, and safety for transit and HOVs in the rapidly growing areas along State Route (SR) 520 between I-5 in Seattle and 92nd Avenue NE in Yarrow Point (Figure 1-1). Construction of the project will have permanent and temporary impacts to fish habitat and aquatic resources.

This report identifies the project's permanent and temporary impacts to aquatic habitat and species, and describes the mitigation strategy for the project. Permanent and temporary impacts discussed in this report will result from over-water structure, benthic fill, and changes in in-water habitat complexity associated with the construction and operation of a widened roadway and accessory facilities. The mitigation strategy includes minimization and avoidance measures and a proposal for compensatory mitigation for the unavoidable permanent and temporary impacts of the project. The discussion in this report focuses on the project's compensatory mitigation elements.

A separate report, the *SR 520, I-5 to Medina: Bridge Replacement and HOV Project Draft Wetland Mitigation Report* (WSDOT 2011a), discusses wetland impacts resulting from this project and mitigation for these impacts. For the purposes of this report, aquatic habitats are those areas without aquatic bed vegetation and/or habitats with water depths greater than 6.6 feet.

This report will be used in part to obtain the following permits:

- U.S. Army Corps of Engineers (USACE) – Clean Water Act (CWA) Section 404, Individual Permit and Section 10 Rivers and Harbors Act of 1899.
- Washington State Department of Ecology (Ecology) – CWA Section 401, Water Quality Certification.
- Washington State Department of Fish and Wildlife (WDFW) – Hydraulic Permit Approval.
- City of Seattle – Shoreline Substantial Development Permit and Critical Areas Review.
- City of Medina– Shoreline Substantial Development Permit and Critical Areas Review.

Overall site conditions are discussed in the project Biological Assessment (WSDOT 2010a) and the Ecosystems Discipline Report, SR 520, I-5 to Medina: Bridge Replacement and HOV Project (appendix to WSDOT 2010b).

WSDOT is coordinating technical and planning efforts for the SR 520, I-5 to Medina Project through two teams: the Mitigation Core Team and the Mitigation Technical Work Group (which includes the Aquatic Resources Technical Work Group).

The Mitigation Core Team serves as a steering group for mitigation planning activities and is led by Shane Cherry (Confluence Environmental). The Mitigation Core Team is multi-disciplinary, composed of engineers, planners, and biologists from WSDOT HQ Environmental Services, the SR 520 Program, and private consulting companies. The Mitigation Core Team includes (or has included) the following individuals: Bill Leonard (WSDOT, initiation through December 2007), Paul Fendt (Parametrix, initiation through March 2008), Ken Sargent (Headwaters Environmental Consulting), Michelle Meade (WSDOT), Phil Bloch (WSDOT), Shane Cherry (Confluence Environmental), Jeff Meyer (Parametrix), Gretchen Lux (WSDOT, replaced Bill Leonard in December 2007), Chris Berger (Confluence Environmental), and Beth Peterson (HDR Engineering, Inc).

The Aquatic Resources Technical Work Group is led by Phil Bloch, and provides technical detail and policy guidance to team members conducting analyses and preparing aquatic resource mitigation planning products. This group consists of Michelle Meade (WSDOT), Shane Cherry (Confluence Environmental), Chris Cziesla (Confluence Environmental), Beth Peterson (HDR Engineering, Inc.), Pete Lawson (Parametrix, through May 2011), Chris Berger (Confluence Environmental), and Chad Wiseman (HDR Engineering, Inc.).

WSDOT engaged regulatory agencies (USACE, USEPA, U.S. Coast Guard, WDFW, Ecology, Seattle Planning), the Services (NMFS, USFWS), the University of Washington, Seattle Parks, and the Muckleshoot Indian Tribe in a collaborative Natural Resources Technical Working Group (NRTWG) process to assist in identification and refinement of effect mechanisms on aquatic resources and in the development of appropriate mitigation measures. To observe existing conditions, WSDOT also conducted field trips with NRTWG members to the Evergreen Point Bridge across Union Bay and the I-90 Bridge across Mercer Slough.

An Initial Aquatic Mitigation Plan was prepared in 2006, and was superceded by the Initial Aquatic Mitigation Plan (WSDOT 2009b) incorporating field investigations, scientific research, and the collective knowledge from the TWGs and WSDOT project mitigation teams. The initial plan was submitted to the NRTWG for review and comment. In addition, the general methodologies for calculating project impacts and mitigation benefits were discussed, including potential project impacts, appropriate metrics to measure these impacts, and the general types of mitigation to offset these impacts. The NRTWG meetings in which impacts and compensatory mitigation were discussed were held from June to October 2010. The goal of the meetings was to clearly identify a set of impacts to aquatic resources associated with the project, and to then identify a list of potential mitigation sites that had the greatest potential to directly mitigate for the types and amounts of project effects. In some cases, the specific metrics and methods presented in the NRTWG meetings has changed slightly, based on refinements to project design or additional scientific information. All the changes are based on the best available science, which is discussed in the appropriate sections of this document. Likewise, each of the mitigation sites initially proposed in the NRTWG meetings underwent detailed additional analysis prior to inclusion in the draft aquatic mitigation plan, resulting in slightly altered and refined mitigation concepts.

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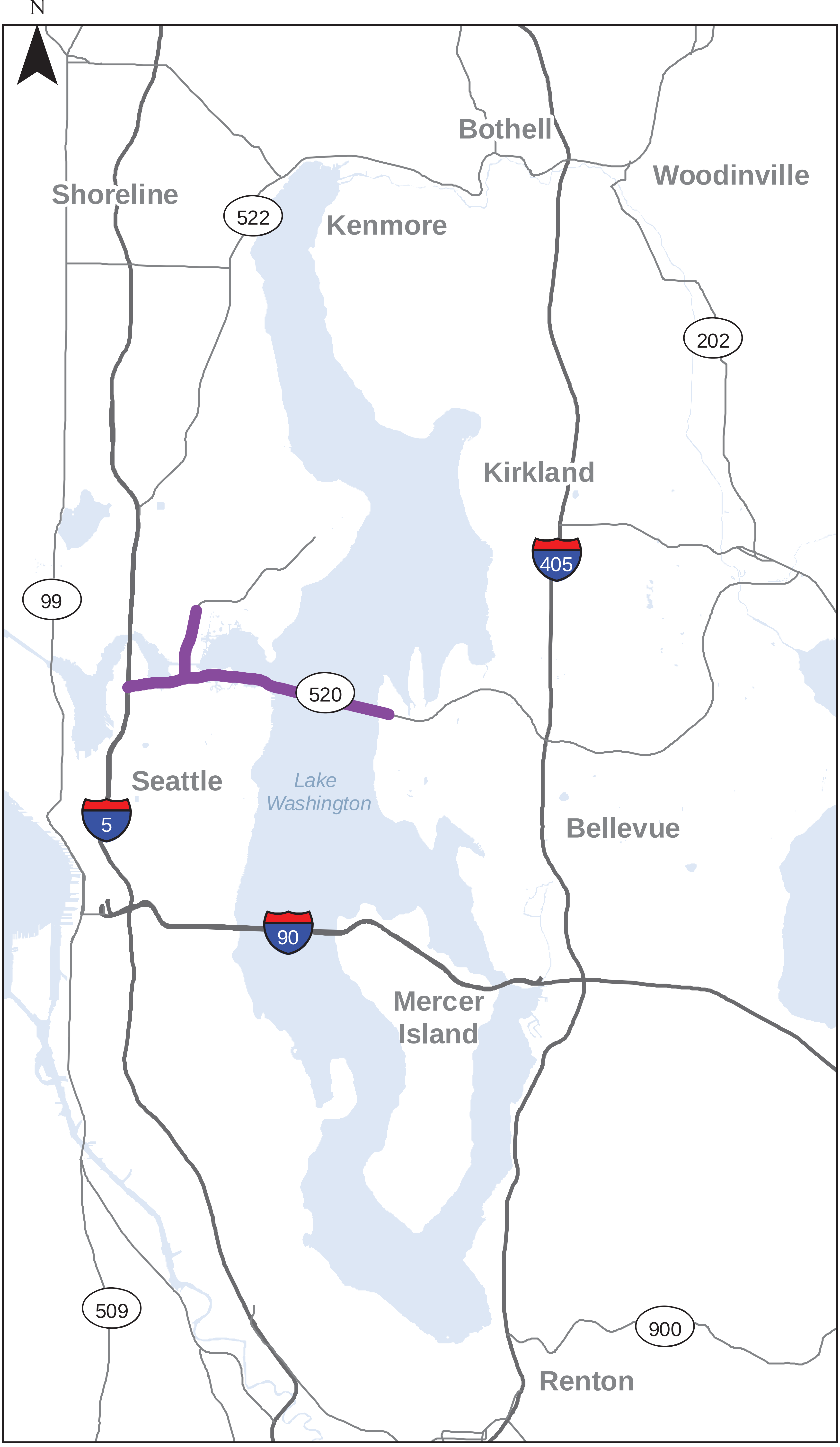

Figure 1-1.
Project Vicinity Map

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2. Project Description

The SR 520, I-5 to Medina Project will widen the SR 520 corridor to six lanes (Figure 2-1) from I-5 in Seattle to Evergreen Point Road in Medina, and restripe and reconfigure the traffic lanes between Evergreen Point Road and 92nd Avenue NE in Yarrow Point. The proposed SR 520 bridge will be six lanes (two 11-foot-wide outer general-purpose lanes in each direction and one 12-foot-wide inside HOV lane in each direction), and include a 14-foot-wide bicycle/pedestrian path), 4-foot-wide inside shoulders, and 10-foot-wide outside shoulders. The width of the combined roadway cross-section (115 feet) will be greater than the existing width of 60 feet, although in places the eastbound and westbound lanes will consist of separate structures with a gap between them. The additional roadway width is needed to accommodate the new HOV lanes and the wider, safer travel lanes and shoulders.

Major elements of the project are discussed below in Section 2.1, while construction activities are summarized in Section 2.2. Operational elements of the project that have some potential to affect aquatic species or habitats (stormwater, lighting, etc.) are discussed in Section 2.3. For detailed design and construction elements, see the project Biological Assessment (WSDOT 2010a) and Supplemental Draft Environmental Impact Statement (EIS) (WSDOT 2010b) for the SR 520, I-5 to Medina Project.

2.1 Proposed Project Elements

To simplify the description of the proposed project, the sections below discuss project features in seven subareas within the project limits. Figure 2-1 shows the project limits and identifies the six subareas, as well as three discrete geographic areas (Seattle, Lake Washington, and the Eastside) that were incorporated into the Endangered Species Act (ESA) consultation and National Environmental Policy Act (NEPA) analysis.

2.1.1. I-5 Interchange Area

The SR 520 and I-5 interchange ramps will be reconstructed in generally the same configuration as those for the existing interchange. The only exceptions are that a new reversible HOV ramp will connect to the existing I-5 reversible express lanes south of SR 520, and the alignment of the ramp from northbound I-5 to eastbound SR 520 will shift to the south.

The East Roanoke Street bridge over I-5 will provide an enhanced pedestrian crossing. The 10th Avenue East and Delmar Drive East overcrossing will be rebuilt as part of the proposed lid structure, generally within the same alignment and with a similar vertical profile as the existing overcrossing.

Construction activities and durations in the I-5 area will occur over a 2- to 3-year period. Activities in this area will include roadway reconstruction, excavation and embankment grading, retaining wall and abutment construction, and paving. Up to two staging areas will be located within the existing right-of-way. Construction will result in the temporary clearing of approximately 2.9 acres of vegetation. Three facilities—a bioswale and two media treatment vaults—will be constructed to treat stormwater from the I-5 interchange area. No aquatic areas will be affected by the construction and demolition activities.

2.1.2. Portage Bay Area

WSDOT will replace the Portage Bay Bridge with a new bridge that will include two general-purpose lanes in each direction, an HOV lane in each direction (six lanes total), and a westbound shoulder. Connections between the new bridge and the exit lanes and ramps to Roanoke Street and northbound I-5 will be configured much as they are currently. Two facilities–one basic treatment bioswale and one constructed wetland for enhanced treatment—will be constructed to treat stormwater from this area.

The height of the western half of the new bridge will match that of the existing bridge, but the eastern half will be higher (Figure 2-2). The new bridge will be about 14 feet higher than the existing bridge’s lowest point near the middle of Portage Bay, and will remain at a greater height above the water than the existing bridge throughout the eastern portion. The new bridge will be supported by larger, but fewer, concrete columns than the existing bridge. It will begin just east of Delmar Drive, extend across Portage Bay, and end west of Montlake Boulevard. The new Portage Bay Bridge will be a fixed-span bridge. The adjacent interchange ramps to I-5 and Montlake Boulevard will add width near the west and east ends of the bridge as they taper on and off the freeway.

The Portage Bay Bridge substructure will have three main parts: drilled shafts, shaft caps, and concrete support columns. Collectively, the substructure elements constitute a pier bent. The Portage Bay Bridge superstructure will consist of two main parts: cast-in-place box girders that span between the bridge piers, and the roadway slab (bridge deck). The superstructure will also include false arches for aesthetic treatments under the westerly three over-water spans. The bridge configuration will range between 105 and 143 feet wide, compared to the 61- to 75-foot-wide existing bridge. The maximum over-water height of the western half of the new bridge will increase from 55 feet to approximately 62 feet, and the height of the eastern half will increase from 5 to 16 feet.

Source: King County (2005) GIS Data (Stream and Street), King County (2007) GIS Data (Waterbody), CH2M HILL (2008) GIS Data (Park). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

Figure 2-1. **Geographic Areas within the Project Limits**

SR 520, I-5 to Medina: Bridge Replacement and HOV Project

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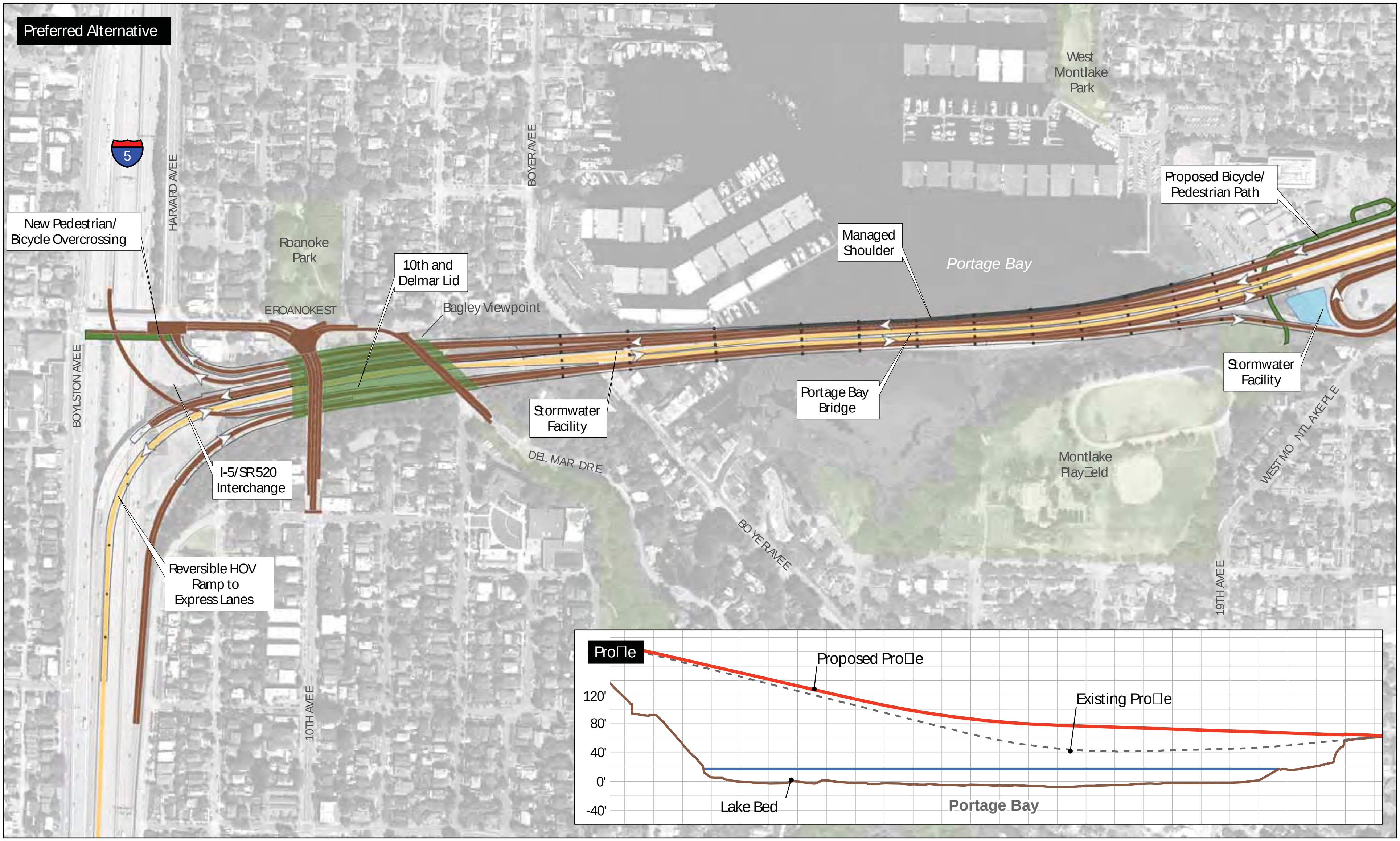

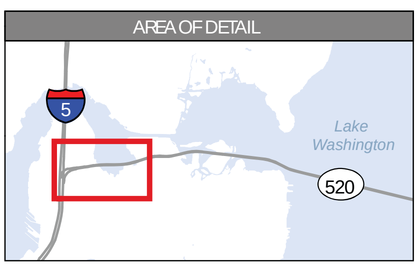

- • Column
- General-Purpose Lane
- HOV, Direct Access, and/or Transit-Only Lane
- Westbound Managed Shoulder
- Proposed Bicycle/Pedestrian Path
- Lid
- Park

N
0 200 400 800 Feet

Source: King County (2006) Aerial Photo, CH2M HILL (2008) GIS Data (Park). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

Figure 2-2. **Project Layout – I-5 to Portage Bay**

SR520, I-5 to Medina: Bridge Replacement and HOV Project

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The construction elements include the following:

- 75,000 cubic yards of excavation
- 82 drilled shaft foundations
- 17 upland shafts supporting individual columns
- 65 in-water shafts: 30 supporting mudline footings and 35 extending through the lake bed and supporting individual columns
- 3 mudline footings at lake bed (capping 10 drilled shafts each)
- 67 permanent concrete columns (50 in-water)
- 900 work bridge support piles
- 400 falsework piles
- 5- to 6-year construction duration, excluding mobilization and project closeout

Starting with the bottom foundation elements, the new bridge substructure will consist of a total of 82 drilled shafts with diameters of 8 to 10 feet; 65 of these shafts will be constructed in the water. Thirty-five of the proposed in-water shafts will intersect with the substrate, resulting in approximately 3,000 square feet of substrate displacement. Each mudline footing will consist of a rectangular concrete block embedded into the lake bed, and will typically be supported by 10 drilled shafts each (i.e., the remaining 30 shafts will terminate at mudline footings). The mudline footings will be constructed at the three westerly in-water pier bents (i.e., those with the longest span lengths) to tie the multiple shafts together and distribute the load from the columns. Two footings will be 116-by-35 feet, and one footing will measure 125-by-35 feet. These three footings will occupy approximately 12,500 square feet (0.3 acre) of bottom substrate.

The Portage Bay Bridge will be supported by 50 in-water columns (ranging in size from 7-by-7 feet to 7-by-10 feet). The support columns will be constructed either on top of the mudline footing or directly on top of the drilled shaft, and each pier bent will consist of five columns. Each of the three mudline footings will support five 7-by-10-foot bridge support columns extending from the top of the footing to the bottom of the bridge superstructure. The remaining 35 columns (7 feet in diameter) will be supported by individual drilled shafts. These columns will replace the 76 in-water columns (4.5 feet in diameter) currently supporting the Portage Bay Bridge. The column's cross-sectional area will occupy approximately 4,000 square feet of the lake's surface.

Substructure construction will occur from temporary work bridges. The work bridges will ultimately be designed by the contractor and will be built along the outer edge of both the north and south sides of the proposed structure. Finger piers will typically span beneath the existing and proposed bridge structures at regular intervals, connecting the north and south work bridges. The work bridges will not exceed 4.1 acres (1.9 acres over open water) and will consist of up to 900 steel piles with diameters of 24 to 30 inches.

The completed permanent substructure will consist of 11 in-water pier bents, with span distances (length between pier bents) ranging between 300 and 116 feet, moving from west to east. In-place casting of box girder bridge sections is proposed, which requires the use of falsework to support the concrete forms. Two falsework structures will be built, each supported by no more than 200 piles. Cast-in-place box girders generally allow for longer span lengths. The completed superstructure will have an over-water width of 124 feet at the west end, narrowing to 105 feet in the middle, and then widening to 143 feet at the east end. The bottom of the bridge deck will range from 62 to 16 feet above the water (moving west to east). Total over-water cover resulting from the Portage Bay Bridge will be approximately 4.5 acres.

Construction activities and durations in this area will occur over a 5- to 6-year period and will include construction of work bridges, falsework, and structures, as well as bridge demolition. The new Portage Bay Bridge will be built in halves (north and south) so that traffic flow will not be interrupted.

To accommodate four lanes of traffic for the duration of the project, construction must be sequentially staged by temporarily widening the existing Portage Bay Bridge to the south. Approximately 42 temporary 8-foot-diameter drilled shafts/columns, occupying about 4,000 square feet, and 2.5 acres of additional superstructure will be constructed on the south side of the existing bridge. Traffic will be diverted to this expanded southern half of the bridge to allow the northern half of the existing bridge to be demolished and the northern half of the new bridge to be constructed. Following construction, traffic will be shifted to the newly constructed northern half of the proposed bridge to allow demolition of the existing and temporary south bridge lanes and construction of the new southern columns and superstructure to complete the proposed Portage Bay Bridge.

A detailed account of the construction and demolition activities and the duration and sequence of these activities by construction season is provided in the Biological Assessment (WSDOT 2010a). Construction seasons are structured around the published in-water construction period of October 1 to April 15.[1]

1 Some in-water construction elements (see Table 5-2) may occur outside of the published work window, as presented to the In-Water Technical Work Group (TWG) participants.

2.1.3. Montlake Area

The Montlake interchange will be widened to the north to accommodate a shift in the mainline alignment, HOV lanes and ramps, and the widened mainline ramps. The Montlake Boulevard and 24th Avenue East overcrossing structures will be demolished and replaced with a lid structure, and a new two-leaf bascule bridge (drawbridge) will be constructed over the Montlake Cut.

Montlake Interchange

The SR 520 interchange with Montlake Boulevard will be similar to the existing interchange, connecting to the University District via Montlake Boulevard and the existing and new bascule bridges (Figure 2-3). A large new lid will be provided over SR 520 in the Montlake area, configured for transit and bicycle/pedestrian connectivity. The alignment of Montlake Boulevard over SR 520 will be similar to that of the existing alignment; however, the new bridge over SR 520 will be longer and wider than the existing bridge and provide wider through lanes, shoulders, a center median, and additional turning lanes on Montlake Boulevard over SR 520. This bridge will be integrated as part of the new Montlake lid over SR 520.

Construction activities in this area will occur over about a 4-year period and will include roadway reconstruction, excavation, retaining wall and abutment construction, and paving. However, most of these construction activities will occur in upland areas, and with implementation of best management practices (BMPs), are not expected to affect aquatic habitat areas.

Bascule Bridge

Construction activities in the Montlake area also include constructing a new bascule bridge over the Montlake Cut, east of the existing bascule bridge. This new bridge will be approximately 60 feet wide, similar to the existing bridge. The two bridges will each operate with three lanes: the existing bridge will serve southbound traffic with three lanes, and the new bridge will serve northbound traffic with three lanes. In addition to the three travel lanes, each bridge will have a bicycle lane and sidewalks.

The bridge construction activities will be staged from the shoreline, and except for the temporary use of barges positioned in the Montlake Cut, no in-water construction activities are expected. Upland construction activities will occur outside and east of the existing Montlake Boulevard roadway and will consist of constructing upland pier supports to form the foundation for the bridge superstructure. Upland pier construction will be isolated from the water through the construction of cofferdams installed upland of the ordinary high water mark (OHWM).

After the upland pier supports are completed, the bascule-leaf structural steel members will be attached to the piers. A barge-mounted derrick will lift the bridge sections into position while they are attached to the support structures.

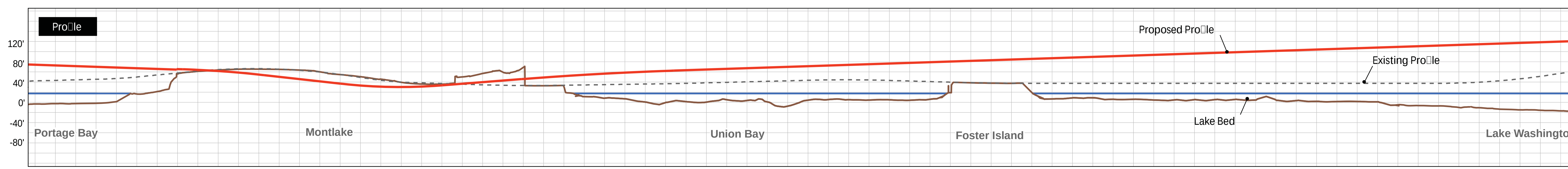
These on-water activities will likely require closing the Montlake Cut to boat traffic periodically over a 3- to 4-week period, typically for less than 48 hours at a time. The construction barges will be located in the Montlake Cut only during bridge assembly work. Based on these closure requirements, it is likely that this work will be scheduled during the winter months, when reduced boat traffic through the area is expected.

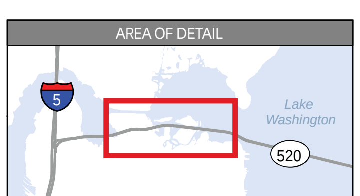
Construction of the bascule piers and the leaf spans is proposed to occur during the latter part of 2017 and extend into 2018.

2.1.4. Union Bay and West Approach Area

The existing Union Bay Bridge and the west approach will be replaced by two new west approach structures: an eastbound bridge and a westbound bridge with a gap between the structures. The new west approach structures will be continuous fixed-span bridges throughout their lengths. The west approach will begin in Montlake and extend through Union Bay, across Foster Island, and into Lake Washington, terminating at the west transition span and the beginning of the floating bridge (see Figure 2-3). The combined width of the west approach structures will be wider than the existing bridge. A constructed wetland for enhanced stormwater treatment will be built on the site occupied by the Museum of History and Industry. Barges and the staging sites described above for the Montlake interchange area will be used for construction staging. No construction staging will occur on Foster Island outside of the construction easement. Construction will include a temporary work bridge on Foster Island that will be removed after the permanent structure has been completed.

Like the Portage Bay Bridge, substructure elements will include drilled shafts and concrete support columns; however, no mudline footings are planned. The superstructure will consist of precast-concrete girders (which will not require falsework) and the roadway deck. The spans of the new bridges will be longer than those of the existing bridge (i.e., the pier bents will be farther apart). The increase in span length will result in fewer in-water columns and foundation shafts. Overall, the width of the new west approach will range between 252 feet near Montlake and 112 feet at the west transition span, with a gap width ranging between 7 and 40 feet. The width of the existing west approach varies between 57 and 104 feet. The height of the bridge over water will increase from a minimum of less than 3 feet to 11.6 feet near Montlake and from 45 to 48 feet near the west transition span. The proposed structure will have a constant grade, whereas the existing structure remains low from Montlake to east of Foster Island.





- Column
- Existing Regional Bicycle/Pedestrian Path
- Proposed Bicycle/Pedestrian Path
- General-Purpose Lane
- HOV, Direct Access, and/or Transit-Only Lane
- Westbound Managed Shoulder
- Stormwater Treatment Facility
- Lid
- Park

N

0 250 500 1,000 Feet

Source: King County (2006) Aerial Photo, King County (2008) GIS Data (Stream), CH2M HILL (2008) GIS Data (Park). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

Figure 2-3. **Project Layout – Portage Bay to Lake Washington**

SR 520, I-5 to Medina: Bridge Replacement and HOV Project

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The construction elements include the following:

- 50,000 cubic yards of excavation
- 254 drilled shafts (233 in-water, with 46 extending above the lake bed, and 87 transition to columns at the mudline)
- 254 permanent concrete columns (233 in-water and 87 extending below the lake bed)
- 2,050 work bridge support piles
- 6-year construction duration, excluding mobilization and project closeout

The west approach substructure will consist of 42 pier bents: 39 in-water pier bents and an additional 3 pier bents on Foster Island. Most span lengths will be 150 feet, although spans #13 to #14 and #17 to #18 (on either side of Foster Island) will be 129 feet in length, and span #41 (the easternmost span before the transition span) will be 160 feet in length.

The west approach pier bents will consist of drilled shafts with columns attached directly to the shafts. No mudline footings or waterline shaft caps are proposed. Of the 254 10-foot-diameter shafts supporting the west approach, 233 will occur in the water. The Union Bay section (between Montlake and Foster Island) will consist of 104 in-water shafts, and the Lake Washington section (east of Foster Island) will consist of 129 in-water shafts. The bridge superstructure will be supported by either 6-by-6-foot (piers #2 to #22) or 7.5-by-7.5-foot (piers #23 to #42) square columns built on top of the drilled shafts. The westerly half of the shaft-to-column connections will occur below the mudline. For the easterly 21 pier bents (those in the deepest water), the drilled shafts will extend up through the water, and the connection to the columns will be above the surface water elevation. The shafts and columns combined will occupy approximately 13,000 square feet of substrate and in-water cross-sectional area.

The west approach is expected to consist of precast girders with a cast-in-place deck. The westbound structure will be 66 to 145 feet wide, while the eastbound approach structure will be 47 to 108 feet wide (moving east to west). The majority of the westbound structure will have a 66-foot deck width (approximately the easterly half-mile); however, as the span approaches Foster Island (within 840 feet), the deck width will increase gradually to 145 feet as it extends through Union Bay and makes landfall at the Lake Washington shoreline at Montlake. Through Union Bay, the combined deck width will range from 200 to 233 feet. The bottom of the bridge deck will range from 11 to 25 feet above the water in Union Bay, and from 28 to 68 feet above the water between Foster Island and the west transition span.

The new west approach area bridges will require construction of work bridges on both the north and south sides of the existing west approach structures and along the existing Lake

Washington Boulevard ramps. The construction work bridges will allow the new bridges to be built in halves so that traffic flow will not be interrupted. These work bridges will be in place for 3 to 5 years. Work bridges constructed adjacent to the Lake Washington Boulevard on- and off-ramps will be in place for 2 years, to facilitate demolition of these existing ramps.

The northern portion of the new west approach will be constructed first, with traffic diverted to this structure while the existing west approach bridge is demolished and construction of the southern half of the new west approach begins. Construction activities in this area will occur over a 5- to 6-year period.

Prior to construction of the west approach in its final configuration, WSDOT anticipates constructing a new interim connection, four lanes wide and approximately 1,500 feet long, between the new floating span and the existing west approach bridge. The interim connection will be supported on columns that will later be used for the new west approach bridge (eastbound structure) when it is constructed in a later phase. When the new west approach bridge is constructed, the interim bridge deck will be removed and the columns heightened to support the west approach bridge at its planned grade.

The interim connection structure will be a fixed-span bridge with substructure elements including drilled shafts and concrete support columns; however, no mudline footings are planned. The superstructure will consist of precast-concrete girders (which will not require falsework) and the roadway deck.

The interim west approach substructure will consist of 12 pier bents: the westerly six pier bents coinciding with the existing west approach piers (piers 25–30) and an additional six pier bents that will be used later for the new west approach structure (piers 31–36). Span lengths coinciding with the existing bridge will be 100 feet and the easterly six spans will be 150 feet in length.

The pier bents will consist of drilled shafts with columns attached directly to the shafts. Drilled shafts will range between 6 and 8 feet, and columns between 3.5 and 5 feet in diameter for piers 25–30. Piers 31–36 will consist of 10-foot-diameter shafts and 7.5-by-7.5-foot square columns built directly on top of the drilled shafts. The westerly six shaft-to-column connections will occur below the mudline. For the easterly six pier bents, the drilled shafts will extend up through the water, and the connection to the columns will be above the surface water elevation. The shafts and columns combined will occupy approximately 0.03 acre of substrate area. Of that, the temporary columns will occupy 0.01 acre of substrate area.

The interim west approach is expected to consist of precast girders with a cast-in-place deck. The easterly half of the structure from the floating bridge to pier 30 will be approximately 57 feet wide. The structure will taper down from 49 feet wide from the point where the interim structure joins the existing west approach (pier 30), to 11 feet wide at its western terminus (pier 25). Total over-water cover resulting from the interim west approach structure will be approximately 1.4 acres.

2.1.5. Evergreen Point Floating Bridge Area

The floating bridge will be replaced by an elevated roadway deck, likely supported by a combination of concrete columns and steel trusses on a foundation of hollow concrete pontoons connected in series across the deepest portion of Lake Washington. Figure 2-4 shows the alignment of the floating bridge and its connections to the west and east approaches.

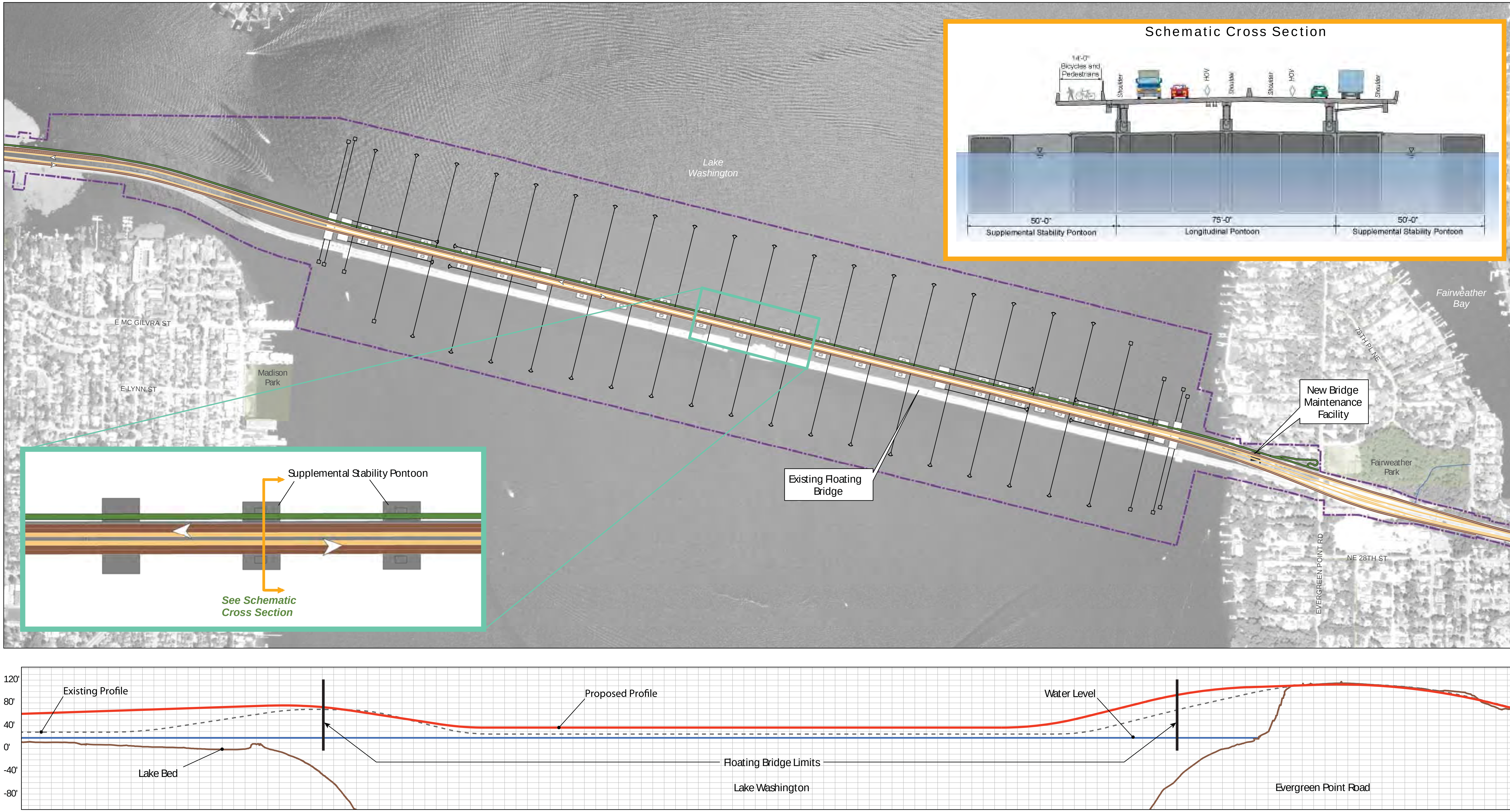
The new floating span will be located approximately 190 feet north of the existing bridge (measured from centerline to centerline). The new floating bridge will consist of two 11-foot-wide general purpose lanes in each direction and one 12-foot-wide HOV lane in each direction, along with 4-foot-wide inside shoulders and 10-foot-wide outside shoulders. A 14-foot-wide bicycle and pedestrian path with several scenic vantage points and pullouts will be located on the north side of the bridge. The project will eliminate the drawspan opening on the Evergreen Point Bridge.

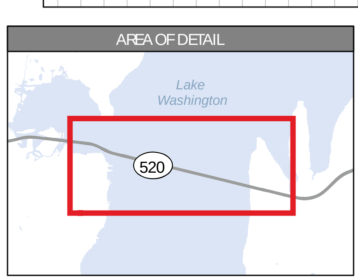
The foundation of the floating bridge will consist of a single row of 21 longitudinal pontoons connected end to end, two cross pontoons (one at each end), and 54 supplemental stability pontoons along the row of longitudinal pontoons (27 on each side). The longitudinal pontoons will measure 360-feet-long by 75-feet-wide by 28.5-feet-vertically. The cross pontoons will measure 240-feet-long by 75-feet-wide by 35-feet-vertically. The supplemental stability pontoons will measure 98-feet-long by 50- to 60-feet-wide by 28.5-feet-vertically. The overall length of the new floating span will be 7,710 feet, compared to the existing 7,580 feet. The new pontoons will have a deeper draft than the existing pontoons, typically ranging from 21.5 to 27.5 feet below the surface of the water, compared to existing pontoons at 7 to 14.5 feet below the water surface. The number and size of the new pontoons will be larger than the existing ones to provide the flotation needed for additional lanes, wider lanes, the bicycle/pedestrian path, and shoulders.

As with the existing floating bridge, the floating pontoons for the new bridge will be anchored to the lake bottom to hold the bridge in place. Anchor types are likely to consist of fluke anchors for the deepest anchor locations (180 feet deep or more), gravity anchors for shallower, sloped anchor locations (likely between 60 and 180 feet), and shaft anchors in the shallowest locations (likely less than 60 feet). A total of 58 anchors are proposed: 45 fluke anchors, up to 13 gravity anchors (if no shaft anchors are used), or a combination of gravity anchors and up to 6 shaft anchors. Shaft anchors are most likely to be used in the shallower waters in the northeastern and southwestern corners of the floating span layout.

The roadway will likely be supported above the pontoons by rows of three 10-foot-tall concrete columns spaced 30 to 35 feet apart, transversely, at both ends of the bridge. These rows of columns will be longitudinally spaced about 90 feet apart across the floating bridge. The roadway through the middle portion of the span will likely be supported above the pontoons by three lines of steel trusses in the middle portion of the bridge. The truss lines will likely be spaced 30 to 35 feet apart transversely. The roadway of the new bridge will be approximately 13 feet higher than the existing bridge and approximately 21 feet above the lake surface in the middle portion of the bridge.

Construction activities associated with pontoon installation will occur over an estimated 3-year period, beginning in 2012. The construction activities related to the floating bridge do not involve pile driving, cofferdam installation, or other activities that have the potential to substantially affect aquatic species; construction is not expected to be limited to in-water construction windows. Therefore, the sequence of activities refers to the calendar year as opposed to in-water work seasons.





Anchor and Cable
Pontoons
Limits of Construction
Proposed Bicycle/Pedestrian Path
General-Purpose Lane
HOV, Direct Access, and/or Transit-Only Lane
Park

N
0 500 1,000 2,000 Feet

Source: King County (2006) Aerial Photo, CH2M HILL (2008) GIS Data (Park). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

Figure 2-4. **Project Layout – Floating Bridge and Approaches**

SR520, I-5 to Medina: Bridge Replacement and HOV Project

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2.1.6. East Approach and Maintenance Facility Area

WSDOT will replace the east approach span of the Evergreen Point Bridge with a new structure that is both higher and wider, and the alignment will be shifted north. The new east approach will consist of an eastbound and westbound structure with a gap in the middle. The east approach will span the east end of the floating bridge to the high bluff along the Medina shoreline. Like the Portage Bay Bridge, the east approach substructure will consist of drilled shafts, mudline footings, and concrete support columns. The superstructure will also consist of cast-in-place concrete girders and the roadway deck. The combined width of the north and south structures will range from 134 to 152 feet, from west to east. The structure will be approximately 660 feet long and range from 66 to 78 feet above the water surface.

The east approach will have two column piers. Pier #1 will be approximately 350 feet (or less) out from the shoreline, and Pier #2 will be onshore, several feet from the shoreline. Each column pier foundation will consist of ten 10-foot-diameter drilled shafts and two mudline footings to transfer column forces into the shaft group. The two in-water mudline footings making up Pier #1 will measure approximately 90-by-50 feet for the north bridge and 50-by-50 feet for the south bridge, and together will occupy approximately 7,000 square feet of substrate. The two in-water footings will support a total of five rectangular bridge columns, each measuring 11-by-7.5 feet or roughly 420 square feet.

In-place casting of box girder bridge sections is proposed, which will require the use of falsework to support the concrete forms. The completed superstructure will have an over-water width of 83 and 51 feet (for the north and south bridges, respectively) at the west end, and then widening to 91 and 61 feet (north and south, respectively) at the east end. The gap between the bridges will gradually widen from 6 feet at the west end to 10 feet at the east end. The bottom of the bridge deck will range from a low of about 66 feet above the water at Pier #1 to 78 feet above the water at the midpoint of the adjacent (landward) span. An existing stormwater treatment wetland will be modified to accommodate additional flow from the increased area of impervious surface.

Construction of the new east approach span will be concurrent with the floating bridge construction, over a 3-year period starting in 2012. Construction will take place from work bridges, barges, and land. The north and south approach structures will be constructed simultaneously and completed before traffic is shifted onto the bridge.

Maintenance Facility

A new bridge maintenance facility will be built at the same time as the east approach structure. Permanent and temporary access roads, retaining walls, a building, and a dock will be constructed while the east approach structure is being built. The facility will consist of a 12,000-square-foot, two-story maintenance building to house personnel and equipment, and a parking facility constructed in the hillside under the proposed approach span, as well as a working dock.

The proposed dock design will likely consist of a T-shaped (hammerhead) dock, with the moorage platform extending no more than 100 feet perpendicular to the shoreline. The dock stem will be approximately 10 feet wide, and the moorage platform may be as much as 14 feet wide. Both the walkway to the dock, as well as the dock itself, will be constructed of fish-friendly grated decking, allowing light to penetrate below the structure. The moorage platform will extend approximately 60 feet in a north–south direction parallel to existing bathymetry. No creosote-treated wood will be used in the construction of the dock. Two work boats, as large as 32 and 50 feet long, may be moored at the dock. The dock may be supported by up to five columns measuring 3 feet in diameter and resting on 5- or 6-foot-diameter drilled shafts. Vibratory installation of up to 20 piles may be needed to support the shaft drilling rig.

Three or four ladders will be mounted to the dock for safety and to provide access to the boats. These ladders will extend into the water a short distance. A fender system will be mounted to the dock to protect the boats and dock from damage. Fender spacing will be approximately 3 feet on-center along the mooring area and will extend approximately 5 feet below ordinary high water (OHW).

2.1.7. Eastside Transition Area

Once the east approach and floating portions of the Evergreen Point Bridge have been replaced, grading and paving operations will occur east to Evergreen Point Road, and the Evergreen Point Road transit stop will be relocated to the inside median (constructed as part of the SR 520, Medina to SR 202: Eastside Transit and HOV Project) at Evergreen Point Road.

In order to make ramps and lanes connect for proper traffic operations, the SR 520 mainline will be restriped, beginning at the east end of the physical improvements near Evergreen Point Road and extending east to 92nd Avenue NE. Lane restriping is needed to tie into improvements that are part of the SR 520, Medina to SR 202: Eastside Transit and HOV Project. This project activity will occur over a 3.5-year period starting in January 2012.

2.1.8. Ancillary Project Features

The project also includes ancillary features such as a regional bicycle and pedestrian path, noise reduction measures, stormwater treatment facilities, and lighting. These features are summarized below.

Regional Bicycle/Pedestrian Path

The project includes a 14-foot-wide bicycle/pedestrian path along the north side of SR 520 through the Montlake area and across the Evergreen Point Bridge to the Eastside. On the west side of the lake, the path will connect to the existing Bill Dawson Trail that crosses underneath SR 520 near the eastern shore of Portage Bay. It will also connect to the Montlake lid and East Montlake Park. On the east side of the lake, the path will connect to the bicycle/pedestrian path built as part of the SR 520, Medina to SR 202: Eastside Transit and HOV Project.

A new path beginning in East Montlake Park will connect to a proposed new trail in the Washington Park Arboretum, creating a loop trail. The portion of the existing Arboretum Waterfront Trail that crosses SR 520 at Foster Island will also be restored or replaced after construction of the SR 520 west approach structure.

Stormwater Treatment Facilities

The project includes the installation of stormwater treatment facilities to collect and treat stormwater runoff. Two facility types incorporating stormwater treatment methods approved by Ecology have been identified for the project biofiltration swales and constructed stormwater treatment wetlands. A portion of the land-based drainages associated with local streets currently discharges to the Seattle combined sewer system and/or the King County Metro combined sewer system. Those discharges are treated at the King County West Point Treatment Plant.

Lighting

The project includes roadway lighting, pedestrian lighting, and lighting for the maintenance facility dock. Roadway lighting will be limited to areas that constitute conflict points, such as merge lanes. All lighting will be designed to minimize spillage onto adjacent aquatic habitat.

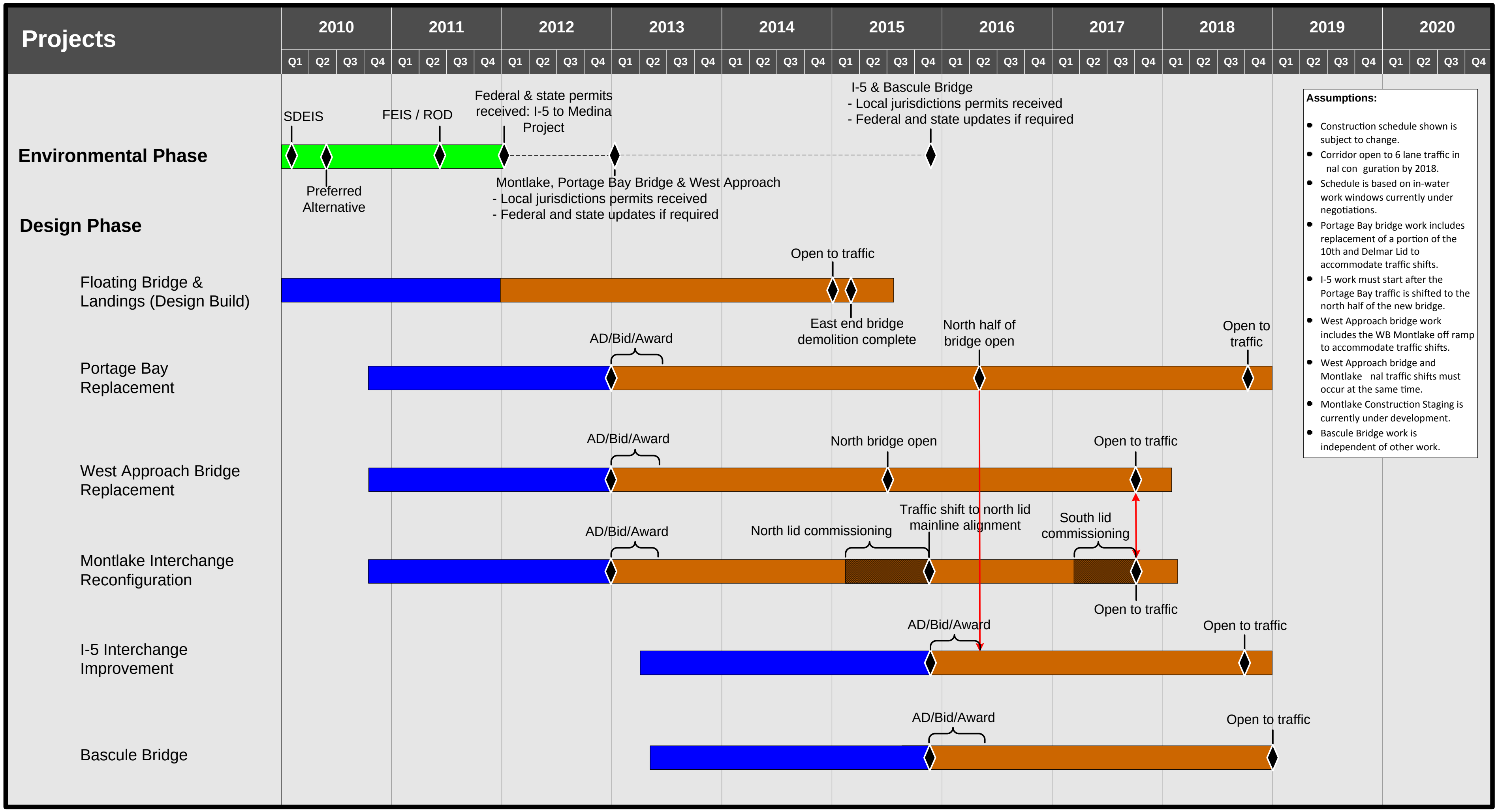
2.2 Construction Activities

Project construction activities, sequencing, and scheduling within the project area have the potential to affect aquatic habitat and fish resources. A list of the typical construction activities and associated methods expected to be used for the proposed in-water, over-water, and upland structures is provided below. These activities include the following:

- Staging area establishment
- Implementation of BMPs
- Site preparation activities
- Work bridges/falsework construction
- Pile driving
- Drilled shaft construction
- Mudline footing construction
- Cofferdam construction
- Waterline shaft cap construction
- Column/pier construction
- Fixed bridge superstructure construction
- Bascule bridge construction
- Anchor installation
- Pontoon assembly
- Floating bridge superstructure outfitting
- Bridge maintenance facility and dock construction
- Materials transport, handling, and storage
- Demolition

Figure 2-5 shows a preliminary project construction schedule.

Preliminary



Environmental

Design

Construction

Figure 2-5. **Project Delivery Schedule**

SR 520, I-5 to Medina: Bridge Replacement and HOV Project

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2.3 Project Operation

Operation and maintenance of the SR 520, I-5 to Medina Project will differ from the existing operation and maintenance and have the potential to result in changes to the Lake Washington environment. The following section characterizes the long-term operation of the new facility and potential mechanisms of effects on aquatic species and habitats.

2.3.1. Stormwater

Stormwater treatment for the project is constrained by urban geography and the characteristics of the bridges. Stormwater treatment includes using the combined sewer system, conventional treatment BMPs, and—in the case of the floating bridge portion of the project—an innovative stormwater treatment approach identified in an "all known, available, and reasonable technology" (AKART) study (WSDOT 2010c).

The SR 520, I-5 to Medina Project will result in 42.6 acres of new pollutant-generating impervious surface (PGIS) and will replace 25.7 acres of existing PGIS, while 21.4 acres of existing PGIS will remain on-site for a total PGIS of 89.7 acres after project construction. The amount of post-construction PGIS requiring treatment will be reduced by 6.3 acres due to two landscaped lids, which will reduce the amount of effective PGIS contributing flows to outfalls. All new and replaced PGIS will receive stormwater quality treatment; however, approximately 13.12 acres of existing PGIS within the project limits will not be treated after project construction. Areas not receiving post-construction treatment are primarily associated with restriping activities in the I-5 interchange. Project stormwater will be treated by facilities that will be designed based on requirements identified in WSDOT's 2008 *Highway Runoff Manual* (HRM) and *Hydraulics Manual* (WSDOT 2010f). New and replaced PGIS requires stormwater treatment to a basic level of treatment for Lake Union and Lake Washington. The project will also provide enhanced treatment to stormwater discharging to Lake Washington from SR 520 to further minimize any effects on the lake due to dissolved metals. The proposed stormwater facilities will use eight existing outfall locations; however, three outfalls will need to be rebuilt to accommodate increased flow rates. All outfalls will be located above the OHWM, typically discharging to ditches for stormwater conveyance to the lakes. Four outfalls will discharge to Lake Union (including Portage Bay) and four will discharge to Lake Washington. The floating span will discharge directly to Lake Washington through stormwater wells in the stability pontoons.

The project proposes to provide water quality treatment for new and replaced PGIS wherever practicable; however, in some areas where stormwater currently flows to the combined sewer system, flows will continue to be routed to the combined sewer system for treatment and discharge. Contributions to the combined storm and sewer systems will be treated by the West Point Wastewater Treatment Plant and discharged to Puget Sound. The project will reduce the total area contributing to the combined sewer system by approximately 1.25 acres; however, the amount of PGIS contributing to the combined sewer system will increase slightly (0.27 acre) because of the conversion of existing surfaces to PGIS. WSDOT will provide detention for stormwater entering the combined system where required by the Seattle code. Since both Lake Washington and Lake Union are flow-exempt water bodies per Ecology, no detention will be required on the separate stormwater system.

The existing project corridor has no stormwater treatment prior to discharges into Lake Union, Lake Washington, or the combined sewer system. All proposed PGIS (new and replaced) draining to both water bodies will receive basic or enhanced treatment. While enhanced treatment is not required, WSDOT will provide for enhanced treatment where practicable to improve water quality and reduce effects on aquatic life. When insufficient space is available to provide enhanced treatment for a specific outfall, basic treatment will be included in the stormwater treatment design. For this project, stormwater wetlands are the proposed enhanced treatment BMP, and bioswales will be the BMPs used for basic treatment. Oil control will be provided for roadway intersections with an average daily traffic count greater than or equal to 15,000 vehicles, as prescribed by the HRM. Where existing PGIS located within the project area will not be altered (disturbed) by the project, it will not be redirected to a water quality facility.

The project will reduce the discharge concentrations of total suspended solids, and total and dissolved zinc and copper. More importantly, the project will reduce the total loading of these substances discharged into the receiving environment (Lake Washington and the Ship Canal), including reductions in both dissolved copper and dissolved zinc loading (WSDOT 2010a). In addition, the current floating bridge drainage system is leaching high levels of zinc, and the WSDOT (2005) stormwater monitoring report suggests that dissolved zinc may decrease dramatically in some areas of Lake Washington as a result of the proposed project because the drainage system of the new bridge will use materials constructed of alternative materials. Overall, all stormwater discharges will comply with Clean Water Act standards and will meet state water quality standards for the protection of aquatic life.

2.3.2. Artificial Lighting

Similar to the current roadway lighting configuration, continuous lighting will be provided along the SR 520 corridor from I-5 to Foster Island and on bridge or tunnel structures crossing the Montlake Cut. Except for the interim west approach connection, no roadway lighting is proposed for the fixed portions of the bridge east of Foster Island. The floating bridge will include six luminaires in the easternmost portion to illuminate a transit merge point. Recessed lighting will illuminate the proposed bicycle and pedestrian path along the west approach structure and the Evergreen Point Bridge. Lighting will be designed to minimize effects on aquatic habitat, likely through the use of shielded downlights similar to those on the I-90 floating bridges.

Artificial lighting currently illuminates the majority of the SR 520 corridor, including the entire existing bridge structure. The proposed design will reduce the overall artificial lighting for the replacement bridge. Artificial lighting from the roadway luminaires, pedestrian walkway, vehicles, and the maintenance facility dock is discussed below.

Roadway Lighting

For the replacement structure, overhead lighting will be limited to traffic conflict points (e.g., add lanes, drop lanes, merges, diverges, auxiliary lanes, or weaving sections) and the westernmost portion of the project between Foster Island and I-5. East of Foster Island, no roadway lighting is proposed, thus reducing the amount of light reaching the water surface compared to existing conditions.

Specifically, a continuous roadway illumination system will be installed from the I-5 interchange to Foster Island, including all major arterial streets within the construction limits. To reduce the effects of lighting on the Lake Washington fish habitat, roadway illumination will not be continuous in the section from where additional ramp lanes begin and end around the Foster Island area, to where the Evergreen Point Flyer stop merges (westbound) into the westbound HOV lane on the eastern portion of the floating span. This unlit section of the proposed bridge generally encompasses the primary migration areas of juvenile Chinook salmon (*Onchorhynchus tshawytscha*), located in the west approach area in the transition area between Lake Washington and the Ship Canal (Fresh et al. 2001; City of Seattle and USACE 2008; Celedonia et al. 2008b). However, a portion of the west approach span and a portion of the floating span in the vicinity of the west navigation channel will have temporary roadway illumination during interim traffic configurations. This interim lighting is expected to be in place for approximately 18 months. The approximate number of lights on each structure will be as follows:

- 12 lights on the Montlake bridges (6 existing)
- 18 lights on the Portage Bay Bridge (18 existing)
- 43 lights on the west approach bridge (52 existing)
- No lights on the floating bridge (44 existing)
- 6 lights on the east approach bridge (4 existing)

The existing roadway lighting on the floating bridge consists of WSDOT-standard cobra-head, flat-glass, high-pressure sodium light fixtures with Type III, 250-watt medium cut-off lights. These lights are staggered on both sides of the roadway at intervals of about 350 feet. The lights are mounted 30 to 40 feet above the roadway, with the shorter light standards occurring east of the center drawspan of the bridge. While the shorter lights are not shielded, the taller light standards have shielded light fixtures. Existing nighttime light levels extend up to 5 to 300 feet from the bridge near Portage Bay, and Foster Island has light levels measured from 0.45 to 0.01 foot candles (WSDOT 2009a).

Pedestrian Lighting

Lighting for the shared use pedestrian and bicycle pathway on the bridge will be similar to the design used for the pedestrian pathway lighting on the I-90 floating bridge. The proposed design provides lighting fixtures recessed into the concrete barrier that separates the vehicular lanes and the pedestrian/bicycle path. Model predictions suggest that this design will prevent walkway lighting from reaching the lake surface. The maximum light level simulated was 0.05 foot candles.

Maintenance Dock Lighting

Lighting proposed for the maintenance dock beneath the east approach will have up to four Class C dock luminaires, in addition to path lighting. Overhead lights will be on-demand and will remain off except during dock use, while low-intensity path lighting will be on at all times. Private aids to navigation will be provided as required.

2.3.3. Maintenance Facility Operation

The proposed maintenance facility will be located directly beneath the east approach, built into the hillside along the Medina shoreline. The facility will consist of an upper-level parking area with elevator and stair access to lower-level office and shop spaces. The shop space will open to a level terrace, roughly at lake level for staff and materials access to a dock, and the maintenance vessel moorage.

Several distinct operational elements are associated with the maintenance facility. In addition to lighting, operational elements that have some potential to affect listed salmonids include handling and transport of petrochemicals, and vessel moorage and operations.

Handling and Transport of Petrochemicals

Petrochemicals necessary for the operation and maintenance of the floating span will include fuels, lubricants, and hydraulic fluids. Much of the handling of these materials will occur on upland portions of the facility; however, fueling of the maintenance vessels and transport of some of these materials to the pontoons will occur over water. Activities to limit risks associated with material handling will include hazardous materials training for staff, use of properly functioning and secure containment devices, and implementation of BMPs such as drip pans and absorbent pads (refer to BMPs described in Section 5).

Vessel Moorage and Operations

The facility dock is expected to be used almost daily for mooring of maintenance vessels. The large maintenance vessel is expected to be in the 40- to 50-foot-long range and powered by an inboard diesel engine; the small maintenance vessel is expected to be in the 20- to 30-foot-long range. The dock will extend approximately 100 feet perpendicular from the shoreline, with boat moorage at the end in approximately 8 feet of water (relative to high lake level—18.72 feet).

2.3.4. Spill Control

Currently, any spills that occur on the existing bridge drain directly into Lake Washington, Union Bay, and Portage Bay if the quantities of spilled materials are large enough to reach storm drains. The existing Montlake Bridge is grated, so any spills on this bridge flow directly into the Montlake Cut. The replacement bridge over Lake Washington will discharge these spills into the adjacent spill control lagoons within the supplemental stability pontoons, allowing subsequent cleanup of floatable materials. Similarly, the replacement bridge structures over the Montlake Cut, including Portage Bay and Union Bay, will collect and route stormwater to treatment ponds in the Montlake area, before it is discharged to adjacent water bodies.

Traffic Noise and Vibration

Vehicle traffic on the floating portion of the Evergreen Point Bridge produces noise and vibration through movement of tires on the roadway. Although much of that sound is deflected into the air, some of the noise is transmitted into and through the pontoons to Lake Washington and, to a lesser extent, through the solid concrete support columns or anchor cables.

The existing bridge likely transmits more of the traffic noise to the water than the proposed replacement bridge will transmit, because the existing bridge's roadway sits directly on the surface of the pontoons, while the replacement bridge deck will be constructed on columns and trusses to elevate it above the pontoons. This design places the bridge deck typically about 22 feet higher than the existing deck and about 10 feet above the pontoons. The new design will provide reduced transmission of noise to the pontoons; however, the degree of the reduction in noise level is unknown. Underwater noise monitoring during the SR 520 Test Pile Program (Illingworth and Rodkin, Inc. 2010) did not detect measurable levels of noise in the water obviously attributable to roadway noise from the existing 520 bridge.

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3. Aquatic Habitat Baseline Conditions

The project is located in the Lake Washington watershed, which comprises 13 major drainage sub-basins and numerous smaller drainages, totaling about 656 miles (1,050 kilometers) of streams, two major lakes, and numerous smaller lakes. Lake Washington and its major drainages (Issaquah Creek, the Sammamish River, and the Cedar River) are located in the Cedar-Sammamish Watershed Basin, or Water Resource Inventory Area (WRIA) 8.

The majority of the watershed is highly developed, with 63% of the watershed fully developed; WRIA 8 has the highest human population of any WRIA in Washington state (NMFS 2008a). Lake Washington is the second largest natural lake in Washington with 80 miles (128 kilometers) of shoreline. The lake is approximately 20 miles long (32 kilometers) with a mean width of approximately 1.5 miles (2.4 kilometers), has a circumference of 50 miles (80 kilometers), covers 22,138 surface acres (8,960 hectares), and has a mean depth of approximately 100 feet (30 meters) and a maximum depth of approximately 200 feet (60 meters) (Jones and Stokes 2005).

3.1 Lake Washington Hydrology

The Lake Washington watershed has been dramatically altered from its pre-settlement conditions primarily due to urban development and removal of the surrounding forest, as well as the lowering of the lake elevation and rerouting of the outlet through the Ship Canal. As a result, the Cedar River is now the major source of fresh water to Lake Washington, providing about 50% (663 cubic feet per second [cfs]) of the mean annual flow entering the lake (NMFS 2008a). The Cedar River drainage area is approximately 184 square miles (476 square kilometers), which represents about 30% of the Lake Washington watershed area.

The Lake Sammamish basin is also a substantial source of fresh water, providing about 25% (307 cfs) of the mean freshwater flow into Lake Washington. The Sammamish sub-basin has a drainage area of about 240 square miles (622 square kilometers) and represents about 40% of the Lake Washington basin. Tributaries to the Sammamish River include Swamp, North, Bear, and Little Bear creeks, as well as the surface waters of Lake Sammamish. Hydrology in the Lake Sammamish sub-basin is generally affected by the same factors that affect Lake Washington.

The remainder of freshwater flow into Lake Washington originates from a variety of small creeks located primarily along the northern and eastern shores. These smaller tributaries and sub-basins in the Lake Washington system include Thornton, Taylor, McAleer, Forbes, Juanita, Kelsey, Coal, and May creeks, and Mercer Slough. Within Lake Washington, the natural hydrologic cycle has been altered. Historically, lake elevations peaked in winter and declined in summer. Present operation of the Hiram M. Chittenden Locks (Ballard Locks) produces peak elevations throughout most of the summer.

USACE is mandated by Congress (Public Law 74-409, August 30, 1935) to maintain the level of Lake Washington between 20 and 22 feet (USACE 1919 datum) as measured at the locks, which correlates to 16.72 and 18.72 feet NAVD 88 (the datum used by the project). USACE operates this facility to systematically manage the water level in Lake Washington over four distinct management periods, using various forecasts of water availability and use. The four management periods are as follows:

- Spring refill – lake level increases to 22 feet between February 15 and May 1 (USACE datum).
- Summer conservation – lake level maintained at about 22 feet for as long as possible, with involuntary drawdown typically beginning in late June or early July.
- Fall drawdown – lake level decreasing to about 20 feet from the onset of the fall rains until December 1.
- Winter holding – lake level maintained at 20 feet between December 1 and February 15.

Operation of the locks, and other habitat changes throughout the Lake Washington basin, have substantially altered the frequency and magnitude of floods in Lake Washington and its tributary rivers and streams. Historically, Lake Washington's surface elevation was nearly 9 feet higher than it is today, and the seasonal fluctuations further increased that elevation by an additional 7 feet annually (Williams 2000). In 1903, the average lake elevation was recorded at approximately 32 feet (USACE datum) (NMFS 2008a).

3.2 Lake Washington Shoreline Habitat

Lowering the lake elevation after completion of the Ship Canal in 1917 transformed about 1,334 acres (540 hectares) of shallow water habitat into upland areas, reducing the lake surface area by 7% and decreasing the shoreline length by about 13% (10.5 miles or 16.9 kilometers) (Chrzastowski 1983). The most extensive changes occurred in the sloughs, tributary delta areas, and shallow portions of the lake. The area of freshwater marshes decreased about 93%, from about 1,136 acres (460 hectares) to about 74 acres (30 hectares) (Chrzastowski 1983). The vast majority of existing wetlands and riparian habitatcurrently associated with Lake Washington, developed after the lake elevation was lowered 9 feet. Currently, this habitat occurs primarily in Union Bay, Portage Bay, Juanita Bay, and Mercer Slough (Dillon et al. 2000).

Lake level regulation by USACE has eliminated the seasonal inundation of the shoreline that historically shaped the structure of the riparian vegetation community. Winter lake drawdowns expose the roots of riparian vegetation in the drawdown zone to winter temperatures (rather than being protected by the standing water during this dormant period). This, in turn, produces a vegetation-free zone between the high and low lake levels (2 feet vertically, with variable horizontal distance depending on shoreline slope). Lake level regulation and urban development have replaced much of the hardstem bulrush- and willow-dominated community with developed shorelines and landscaped yards, and this affects the growth of many species of native terrestrial and emergent vegetation. In addition, lake level regulation indirectly buffers the shorelines from potential winter storm wave effects. The loss of natural shoreline has also reduced the historic complex shoreline features such as overhanging and emergent vegetation, woody debris (especially fallen trees with branches and/or rootwads intact), and gravel/cobble beaches. The loss of native shoreline vegetation and wetlands has reduced the input of terrestrial detritus and insects that support the aquatic food web.

These natural shoreline features have been largely replaced with armored banks, piers, and floats, and limited riparian vegetation. A survey of 1991 aerial photos estimated that 4% of the shallow water habitat within 100 feet (30.5 m) of the shore was covered by residential piers (ignoring coverage by commercial structures and vessels) (USFWS 2008). Later studies report about 2,700 docks in Lake Washington as well as armoring of more than about 80% of the shoreline (Warner and Fresh 1998; City of Seattle 2000; Toft 2001; DNR 2010).

An even greater density of docks and shoreline modifications occurs throughout the Ship Canal, Portage Bay, and Lake Union (City of Seattle 1999; Weitkamp et al. 2000). Areas that have some amount of undeveloped shoreline include Gas Works Park, the area south of SR 520 (in Lake Union and Portage Bay), and a protected cove west of Navy Pier at the south end of Lake Union. Vegetation within these areas is limited, with the area south of SR 520 possessing the highest abundance of natural riparian vegetation, consisting primarily of cattails (*Typha* spp.) and small trees (Weitkamp et al. 2000). The loss of complex habitat features (i.e., woody debris, overhanging riparian and emergent vegetation) and shallow water habitat in Lake Washington has reduced the availability of prey refuge habitat and forage for juvenile salmonids. Dense growths of introduced Eurasian milfoil and other aquatic macrophytes effectively isolate much of the more natural shoreline from the deeper portions of the aquatic habitat.

Portage Bay is lined by University of Washington facilities, commercial facilities, and houseboats. The southeastern portion of Portage Bay has an area of freshwater marsh habitat and naturally sloped shoreline, while the remainder of the shoreline is developed, with little natural riparian vegetation. The Montlake Cut is a concrete-banked canal that connects Portage Bay to Union Bay, which extends eastward to Webster Point and the main body of Lake Washington.

Prior to construction of the Ship Canal, Union Bay consisted of open water and natural shorelines extending north to 45th Street. The lowered lake levels resulting from the Ship Canal construction produced extensive marsh areas around Union Bay, with substantial portions of this marsh habitat subsequently filled, leaving only the fringe marsh on the southern end (Jones and Jones 1975). The south side of the bay is bordered by the Arboretum, with a network of smaller embayments and canals, and extensive marsh habitats. The north side of Union Bay contains a marshy area owned by the University of Washington; the area was previously filled with landfill material. Numerous private residences with landscaped waterfronts and dock facilities dominate the remainder of the shoreline.

Development and urbanization have also altered base flow in many of the tributary systems (Horner and May 1998). Increases in impervious and semi-impervious surfaces add to runoff during storms and reduce infiltration and groundwater discharge into streams and rivers. A substantial amount of surface water and groundwater is also diverted into the City of Seattle and King County wastewater treatment systems and is eventually discharged to Puget Sound.

Although the frequency and magnitude of flooding in the lake and the lower reaches of tributary streams have declined due to the operation of the locks, flooding has generally increased in the upstream reaches of tributary rivers and streams. This change is largely because of the extensive development that has occurred within the basin over the last several decades (Moscrip and Montgomery 1997).

No measurable changes in shoreline habitat condition are expected to occur in the near future, although gradual changes (both positive and negative) are likely to occur. Therefore, the existing degraded habitat in the greater Lake Washington watershed is expected to continue to affect salmonid species in the watershed for the foreseeable future.

3.3 Lake Washington Water Quality

The water quality and sediment quality in the Lake Washington basin are degraded as a result of a variety of current and historic point and non-point pollution sources. Historically, Lake Washington, Lake Union, and the Ship Canal were the receiving waters for municipal sewage, with numerous shoreline area outfalls that discharged untreated or only partially treated sewage directly into these waterways. Cleanup efforts in the 1960s and 1970s included expanding the area's wastewater treatment facilities and eliminating most untreated effluent discharges into Lake Washington. Although raw sewage can no longer be discharged directly into Lake Washington waters, untreated, contaminated flows in the form of combined sewer overflows occasionally enter these waterways during periods of high precipitation (NMFS 2008b). For example, a recent incident resulted in the accidental discharge of an estimated 6.4 million gallons of sewage into Ravenna Creek, which discharges into Union Bay (King County 2008). However, CSO events tend to occur during high stormwater flow when the composition of water in the system is approximately 90% stormwater.

In addition to point source pollution, a variety of non-point sources continue to contribute to the degradation of water and sediment quality. Non-point sources include stormwater and subsurface runoff containing pollutants from road runoff, failing septic systems, underground petroleum storage tanks, gravel pits/quarries, landfills and solid waste management facilities, sites with improper hazardous waste storage, and commercial and residential sites treated with fertilizers and pesticides.

Historical industrial uses in the basin, such as those around Lake Union and southern Lake Washington, Newcastle, Kirkland, and Kenmore, have contaminated sediments with persistent toxins; these toxins include polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and heavy metals (King County 1995). The expanding urbanization in the basin has also increased sediment input into the Lake Washington system water bodies.

Along with the physical changes to the Lake Washington basin, substantial biological changes have occurred. Non-native plant species have been introduced into Lake Washington, and years of sewage discharge into the lake increased phosphorus concentration and subsequently led to extensive eutrophication. Blue-green algae dominated the phytoplankton community and suppressed production of zooplankton, reducing the available prey for salmonids and other species. However, water quality improved dramatically in the mid 1960s as sewage was diverted from Lake Washington to Puget Sound; at this time, dominance by blue-green algae subsided and zooplankton populations rebounded.

The Ship Canal and Lake Union are listed on the Ecology 303(d) list of impaired water bodies for exceeding water quality criteria for total phosphorous, lead, fecal coliform, and aldrin (Ecology 2008). In addition, portions of Lake Washington are listed on the 303(d) list for exceeding water quality criteria for fecal coliform, as well as the tissue quality criteria for 2,3,7,8 TCDD (dioxin), PCBs, total chlordane, 4,4’ DDD (metabolite of DDT) and 4, 4’ DDE (breakdown product of DDT) in various fish species (Ecology 2008). Therefore, the overall water quality conditions in the project vicinity are degraded compared to historical conditions.

3.4 Dissolved Oxygen and Temperature Conditions

Despite reversing the eutrophication trend in the lake, the introduction of Eurasian milfoil to Lake Washington in the 1970s caused additional localized aquatic habitat and water quality problems. Milfoil and other aquatic vegetation dominate much of the shallow shoreline habitat of Lake Washington, Lake Sammamish, Lake Union, Portage Bay, and the Ship Canal. Dense communities of aquatic vegetation, or floating mats of detached plants, can adversely affect localized water quality conditions. Dense communities can reduce dissolved oxygen (DO) to below 5 ppm (parts per million), and the decomposition of dead plant material increases the biological oxygen demand, further reducing DO and pH (DNR 1999). Under extreme conditions, these localized areas can become anoxic.

In addition to the substantial modification aquatic vegetation has made to habitat in the water column, excessive accumulation and decomposition of organic material has overlain areas of natural sand or gravel substrate with fine muck and mud. Substantial shoreline areas of Lake Washington, the Ship Canal, and the project vicinity have soft substrate, with substantial accumulations of organic material from the decomposition of milfoil and other macrophytes. The dense vegetation also reduces the currents and wave energy in these areas, which encourages the accumulation of fine sediment material. As microorganisms in the sediment break down the organic material, they consume much of the oxygen in the lower part of the lake. By the end of summer, concentrations of DO in the hypolimnion (the lowest water layer in the lake) can be reduced to nearly 0.0 milligrams per liter (mg/L). Despite these effects in some shallow nearshore habitats, mean hypolimnetic DO levels recorded at long-term monitoring sites in the lake between 1993 and 2001 ranged from 7.7 to 8.9 mg/L (King County 2003). However, it should be noted that water depths in the hypolimnion extend well below the photic zone, to more than 200 feet. Also, the portions of the hypolimnion closer to the shoreline, which show the lowest DO concentrations, support outmigrating and rearing juvenile salmonids to a greater degree than do deep water habitats.

The thermal stratification of Lake Washington and Lake Union can produce surface temperatures in excess of 68°F (20°C) for extended periods during the summer. In addition, there is a long-term trend of increasing summer and early fall water temperatures (Goetz et al. 2006; Newell and Quinn 2005; Quinn et al. 2002; King County 2007). From 1932 to 2000, there was a significant increase in mean August water temperature from about 66° to 70° Fahrenheit (F) (19° to 21° Celsius [C]) at a depth of 15 feet (Shared Strategy 2007). If this trend continues, surface water temperatures could exceed the lethal threshold (22° to 25° C) for returning adult salmon in some years.

Lake Washington Ship Canal

Saltwater intrusion occurs in the Ship Canal above the locks, but very little of the deeper, heavier salt water mixes with the lighter freshwater surface layer. Consequently, this area lacks the diversity of habitats and brackish water refuges characteristic of most other (unaltered) river estuaries. Usually, this saltwater intrusion extends to the east end of Lake Union, but can extend as far as the University Bridge in an extremely dry summer. The extent of this intrusion into the Ship Canal and into Lake Union is primarily controlled by outflow at the locks and the frequency of large and small lock operations.

Historical data indicate that reduced mixing of the water column due to the saltwater layer likely produced year-round anaerobic conditions in the deeper areas of Lake Union and the

Ship Canal (Shared Strategy 2007). The lack of mixing, along with a significant oxygen sediment demand, can reduce dissolved oxygen levels to less than 1 mg/L, and could prevent fish from using the water column below a 33 foot (10-meter) depth. This condition was likely more severe before about 1966, when a saltwater barrier was constructed at the locks, thereby improving water quality conditions upstream. Water quality in Lake Union has also improved since the 1960s because of the reduction in direct discharges of raw sewage and the closure of the Seattle Gas Light Company gasification plant, along with the upland cleanup activities at the gas plant and other industrial sites. However, Lake Union still experiences periods of anaerobic conditions that typically begin in June and can last until October (Shared Strategy 2007).

Adult fish returning through the Ship Canal and project area contend with anoxic conditions in the deeper water column from July through October (King County 2009). High temperatures in the upper layer generally restrict adult salmonid distribution, including Chinook salmon, to depths below 5 to 10 meters, while anoxic conditions below depths of 50 to 65 feet (15 to 20 meters) prevent Chinook use, thus concentrating them in the relatively narrow [16 to 32 feet (5 to 10 meters)] middle portion of the water column. These physical restrictions can also affect juvenile outmigrants, limiting foraging opportunities and exposing juvenile fish to predators occupying habitat in the metalimnion.

3.5 Fish and Aquatic Resources in Lake Washington and the Ship Canal

A diverse group of native and non-native fish species inhabit the Lake Washington watershed, including several species of native salmon and trout such as Chinook (*Onchorhynchus tshawytscha*), coho (*O. kisutch*), and sockeye (*O. nerka*) salmon; and steelhead *(O. mykiss*), rainbow (*O. mykiss irideus*), and cutthroat trout (*O. clarki clarki*). Most of these species are likely to occur at least occasionally in the project vicinity. The following section describes the various species of salmonids (the primary species of concern for compensatory mitigation) in the project area, and pertinent information on their habitat requirements and life history trajectories. In addition, information is presented on fish species that are significant predators on salmonids in Lake Washington, including bass and pikeminnow.

3.5.1. Salmonid Species and Life Histories

Salmonids in the Lake Washington watershed are a mix of native and non-native species, and sometimes a single species can include both native and non-native stocks. For example, recent evidence for sockeye indicates that the Cedar River and Issaquah Creek spawners are likely descendents of introduced fish (Baker Lake stock), while those spawning in Bear Creek may be native fish (Hendry et al. 1996). Man-made changes to the historical drainage patterns in the Lake Washington basin— such as the connection of the Cedar River, disconnection of the Black River, and creation of the Ship Canal—have had a significant effect on salmonid populations, including species distribution, within the Lake Washington system.

Chinook Salmon

Small numbers of Chinook fry begin migrating into Lake Washington from the Cedar River in January, while most Chinook fry enter the lake in mid-May. Initially, the Cedar River Chinook fry tend to concentrate in the littoral zone at the south end of Lake Washington between February and mid-May until they grow large enough to move offshore (Fresh 2000; Tabor et al. 2004a; Tabor et al. 2006). Therefore, the lakeshore area near the Cedar River mouth appears to be an important nursery area for juvenile Chinook salmon. Tabor et al. (2004a) found that the mean abundance of juvenile Chinook from February through May was positively related to proximity to the Cedar River mouth, but there was no difference by June. Juveniles migrate away from the Cedar River mouth and along the Lake Washington shorelines as they grow.

After entering the lake, the juvenile Chinook salmon rear in the shallow littoral zone (1 to 2 feet deep) as they gradually migrate to Union Bay and the Ship Canal. Juvenile Chinook salmon tend to prefer gradually sloping, sand-silt substrate habitat less than 1.6 feet deep (Tabor et al. 2006). They also congregate at the mouths of small tributary streams, possibly attracted by flow, shallow-water depths, benthic invertebrate or terrestrial insect food sources, fine particle substrate accumulated at the stream delta fans, or by some combination of these factors (Shared Strategy 2007). Juvenile Chinook salmon tend to increase their use of deeper-water habitat areas as they get larger, likely as a response to prey availability, reduced predation risks, and possibly more favorable water temperature conditions (Warner and Fresh 1998; Celedonia et al. 2008a).

Chinook fry typically rear in the lake from 1 to 4 months before migrating through the Ship Canal to Puget Sound (Seiler et al. 2004; Tabor et al. 2006). The larger fingerlings enter the lake between mid-May and June after spending up to 6 months rearing in the rivers and streams. Little information is available on the timing of north Lake Washington Chinook in the project vicinity.

Recent observations in the Ship Canal show that young Chinook salmon tend to be relatively uniformly distributed over a range of depths in this area (Celedonia et al. 2008b). Smaller juvenile Chinook salmon appear to prefer shallow areas with over-water cover, particularly during the day (Tabor et al. 2006), but tend to avoid overhead cover areas as they grow (Tabor et al. 2004a). While riparian vegetation tends to be the preferred over-water cover habitat, docks and piers are sometimes used as substitute cover, particularly during the day (Tabor and Piaskowski 2002). The large number of piers and docks lining the Lake Washington shoreline is expected to substantially affect the natural behavior of juvenile Chinook salmon and other salmonids rearing and migrating through the lake.

Celedonia et al. (2008b) determined that the response of juvenile Chinook salmon to the existing Evergreen Point Bridge was at least partially dependent on whether they were actively migrating or holding (remaining in one area). About two-thirds of actively migrating smolts appeared delayed by the bridge, while the remaining smolts appeared negligibly affected by the bridge. Delayed fish varied widely in the time of delay and distance traveled during delay. Nearly half (45%) of the delayed smolts took less than 3 minutes to pass beneath the bridge after the initial encounter, travelling less than 33 meters along the edge of the bridge during this time. Conversely, many smolts that exhibited holding behavior characteristics, as opposed to active migration behavior, appeared to selectively choose to reside in areas near the bridge for prolonged periods. This behavior was distinctly different from the apparent bridge-induced delay observed in some actively migrating smolts. Holding fish often crossed beneath the bridge to the north and were later observed returning to and holding in areas immediately adjacent to the bridge’s southern edge (less than 20 meters from the edge of the bridge). The bridge did not appear to be a factor in delaying the migration of fish that displayed holding behavior prior to continuing their outmigration.

Artificial lighting associated with the proposed roadway and bridge also has the potential to affect the distribution and behavior of fish, depending on its intensity and proximity to the water. Adaptations and responses to light are not universal for all species of fish—some predatory fish are adapted for hunting in low light intensities, while others are attracted to higher light intensities; some species school and move toward light sources (Machesan et al. 2005).

Based on Lake Washington tagging data, Celedonia et al. (2009) indicate that juvenile Chinook salmon are attracted to areas where street lamps on the existing Evergreen Point Bridge cast light onto the water surface, suggesting that bridge lighting is at least partially responsible for the nighttime selection of near-bridge areas by Chinook salmon. It has been conjectured that the illuminated areas may allow juvenile Chinook salmon an opportunity to forage throughout the night when under normal, low light conditions they would normally stop feeding.

Each year, adult Chinook salmon pass through the Ship Canal and Lake Union from the end of July through the beginning of September (City of Seattle and USACE 2008). The total time of adult Chinook salmon migration from the Ballard Locks to arrival at tributary spawning grounds can take up to 55 days, but averages less than 30 days (Fresh et al. 2000). In general, migration time, both through the Ship Canal and to spawning grounds, decreases as the season progresses and could reflect maturation level of the fish.

Once Chinook leave the locks, most fish move through the Ship Canal in less than 1 day (varying from 4 hours to 7.7 days) (Fresh et al. 1999; Fresh 2000). Adult Chinook salmon may enter Lake Washington several days before moving into rivers for spawning, with the average time spent by adult Chinook in Lake Washington around 3 days for Cedar River fish and 5 days for Sammamish watershed fish (Fresh et al. 1999). Due to the short time most Chinook adults spend in the lake and the Ship Canal, the modified habitat in these areas may have a limited effect on returning adults, although the relatively short time spent in the lake may be related to the long-term trend of increasing late summer water temperatures.

Acoustic and temperature tags on adult Chinook salmon show that these fish inhabit lake waters ranging from 48º to 70º F (9º to 21º C) (F. Goetz in City of Seattle and USACE 2008). The adult Chinook do not seem to seek out cool waters, but will hold near the mouths of the Cedar and Sammamish rivers in warm, shallow waters.

Steelhead

Juvenile steelhead migrating out of the Lake Washington watershed will pass through the project area. No information is available that identifies the project area as a location specifically used by juvenile steelhead for rearing. Juvenile steelhead rear in fresh water, including the lake, for several years before migrating to Puget Sound; therefore, they are expected to be less dependent on the shallow nearshore habitat in the lake than are the smaller Chinook salmon fry.

Adult steelhead pass through the Ballard Locks to Lake Washington between December and early May (WDFW et al. 1993). Spawning occurs throughout the Lake Washington basin, including the lower Cedar River, the Sammamish River and its tributaries, and several smaller Lake Washington tributaries (WDFW 2006). Steelhead spawn primarily in the main stem Cedar River from March through early June (Burton and Little 1997), although there are historical records of steelhead spawning in Cedar River tributaries such as Rock Creek.

Bull Trout

Little is known about the historical distribution and abundance of bull trout in the Lake Washington system. A 1-year survey in the Lake Sammamish basin during 1982 and 1983 reported no char (a subset of the salmonids that includes bull trout and Dolly Varden) (WDFW 1998). While bull trout occasionally occur in Lake Washington, there are no indications of an adfluvial population (i.e., lake residents that migrate up streams to spawn) in the lake, and bull trout are not expected to occur in the surface waters of Lake Washington during the summer when water temperatures typically exceed 59ºF (15ºC) for several months. Therefore, the apparent remnant anadromous population likely uses the lake primarily as a migration route to marine waters for foraging and rearing.

Although bull trout may occasionally occur in the project area, there is no known regular occurrence of bull trout in the lake. There have been only a few reports of bull trout and Dolly Varden in the entire Lake Washington watershed. Some bull trout are believed to enter the Lake Washington system from the isolated population above the Chester Morse Dam. No bull trout observations have been documented between October and December, likely because the fish are presumed to be on or near their spawning grounds during this time.

Several large native char (approximately 410 millimeters long) have been observed passing through the viewing chamber at the Ballard Locks, but only one was identified as bull trout (Bradbury and Pfeifer 1992; USFWS 1998). Bull trout were caught in Shilshole Bay and the Ballard Locks during late spring and early summer in both 2000 and 2001, with up to eight adult and subadult fish caught in Shilshole Bay below the locks between May and July in 2000. In 2001, five adult bull trout were captured in areas within and immediately below the Ballard Locks. One bull trout was captured within the large locks and one in the fish ladder, as well as three adult bull trout captured below the tailrace during the peak of juvenile salmon migration in mid-June (USFWS 2008). Observations of bull trout near the Ballard Locks suggest migration of bull trout from other core areas to Lake Washington.

Anadromous adult and subadult bull trout likely occur in the project area throughout the year, most likely in spring and early summer during outmigration of juveniles. This observation is based on bull trout captured at the Ballard Locks and the Ship Canal between May and July. Bull trout likely use the project area for either foraging or migrating through the area to other marine or estuarine foraging habitats. Bull trout in the project area likely originate from the core areas of the Stillaguamish, Snohomish-Skykomish, and Puyallup rivers.

Sockeye

Juvenile sockeye salmon commonly rear in the open-water habitat of the lake for a year before migrating to salt water, including the area along the floating portion of the Evergreen Point Bridge, although juvenile sockeye salmon use of Lake Washington varies. Smaller sockeye fry first entering the lake may inhabit shallow water areas such as river deltas at night (City of Seattle and USACE 2008) or other parts of the littoral zone (Martz et al. 1996), although the amount of time fry are present in this area is unknown. In general, sockeye fry travel in schools in limnetic areas (open-water areas of the lake away from shore) and are located below 66 feet in depth during the daytime, then ascend to shallower waters at dusk to feed during the night (Eggers et al. 1978). This diurnal difference in depth can be up to 43 feet. During summer lake stratification, sockeye are confined to deeper, cooler waters because during this period, sockeye are unable to access the high densities of zooplankton in the epilimneon (uppermost water layer in a lake) due to high water surface temperatures in Lake Washington.

Juvenile sockeye salmon begin to migrate out of Lake Washington in April and continue outmigration until June or early July. Sockeye are usually outmigrate at 1 year of age, after spending the previous summer and winter rearing in the lake, although some sockeye outmigrate within their first year. Outmigration behavior of sockeye has not been studied in Lake Washington.

In-lake survival for sockeye salmon, from fry entry to pre-smolts the following spring, was estimated to be about 2.91% over the 2000 to 2005 brood years (McPherson and Woodey 2009). This is a very low survival rate for this life history stage compared with that of other sockeye salmon populations. A hypothesis for this finding is based on timing of sockeye fry entry into Lake Washington, which often takes place before or early in the spring bloom period, potentially placing the fry at risk due to suboptimal food resources for large populations entering in the south end of the lake from the Cedar River (McPherson and Woodey 2009). However, studies of Lake Washington sockeye's pre-smolt to adult survival have indicated that survival is consistent with other sockeye stocks (Ames 2006).

Once adult sockeye have migrated through the Ballard Locks, they have a rapid migration through the Ship Canal, averaging about 4 days (Newell and Quinn 2005). As with Chinook salmon, timing of sockeye passage through the Ship Canal and Lake Union is thought to be influenced by several factors, including warm water temperatures in the Ship Canal.

All sockeye salmon tend to have similar life history patterns in the Lake Washington watershed, but the adult sockeye returning to spawn in the Cedar River tend to be larger and older than the Bear Creek spawners (Hendry and Quinn 1997). In addition to spawning in the Cedar River and other Lake Washington tributaries, sockeye salmon also spawn along Lake Washington's shoreline. This includes past spawning records for the existing and proposed east end of the Evergreen Point Bridge, based on WDFW map records (Buchanan 2004). However, no recent surveys have been conducted to determine whether sockeye salmon currently spawn in this location. This area is one of more than 85 shoreline spawning beaches and is less than 1% of the beach spawning habitat previously identified in Lake Washington on maps provided by WDFW (Buchanan 2004).

Estimated annual escapement of Lake Washington beach spawning sockeye (i.e., hatchery fish that spawn in natural areas versus returning to hatchery waters) varied from 54 to 1,032 fish from 1976 through 1991 (WDFW 2004). These sockeye spawn wherever suitable gravel beaches and groundwater upwelling occur around the lake, particularly along the north shore of Mercer Island and the east shore of Lake Washington. These spawning areas occur over a wide range of water depths. The estimated total beach spawning population ranged between 200 and 1,500 fish between 1986 and 2003 (WDFW 2004).

Coho Salmon

Not much information is known about coho salmon's use of Lake Washington habitats. In general, these fish enter Lake Washington with a typically larger body size than Chinook salmon, which influences their habitat choice. Upon initial entry into Lake Washington, these juvenile coho salmon are likely to eat prey items similar to those consumed by Chinook and sockeye. However, as these fish grow larger, they may switch to piscivory (eating other fish).

Age 1+ coho outmigration occurs from late April until late May, usually peaking in early May (Fresh and Lucchetti 2000). As with steelhead, it is thought that coho generally move through the lake and into marine waters more quickly than Chinook salmon because of their large size upon entry into Lake Washington. Most coho salmon tagged and released in the

Ship Canal pass the Ballard Locks within 2 weeks. Habitat use and behavior during this period have not been studied in Lake Washington, and are largely unknown.

Returning adult coho salmon pass through the project area from late September through November. Little is known about adult coho behavior and habitat choice upstream of the Ballard Locks.

Cutthroat Trout

Lake Washington contains populations of cutthroat trout, both anadromous (migrating from fresh to salt water) and potamodromous (migrating only within freshwater areas). Most anadromous cutthroat trout juveniles move to salt water at age 2 if they migrate to sheltered saltwater areas, or age 3 or 4 if they migrate to the open ocean. Seaward migration peaks in May. Potamodromous forms migrate to main stem rivers or to lakes; otherwise, their life history characteristics are much like those of the anadromous form. Prey includes insects, crustaceans, and other fish including perch, coho smolts, minnows, and other young fish.

3.5.2. Salmonid Distribution and Densities: Salmonid Functional Zones

Anadromous salmonids in the project area are classified into several stocks, based on both geographical distribution of the fish and genetic similarities. Table 3-1 lists the identified stocks of anadromous salmonids in the Lake Washington basin. Based on geography, all anadromous juveniles originating in the Cedar River or along the southern shoreline of Lake Washington (for beach spawning sockeye salmon) must migrate through the project area to reach the Lake Washington Ship Canal, the only available route to the marine environment of Puget Sound. In some cases, a high percentage of a particular salmon species originates in the Cedar River. For example sockeye salmon from the Cedar River have accounted for approximately 85.3% of sockeye (1982 to 2002 range: 68 to 98%; Standard Deviation: 7.8%) estimated to have spawned annually in the Lake Washington watershed (McPherson and Woodey 2009).

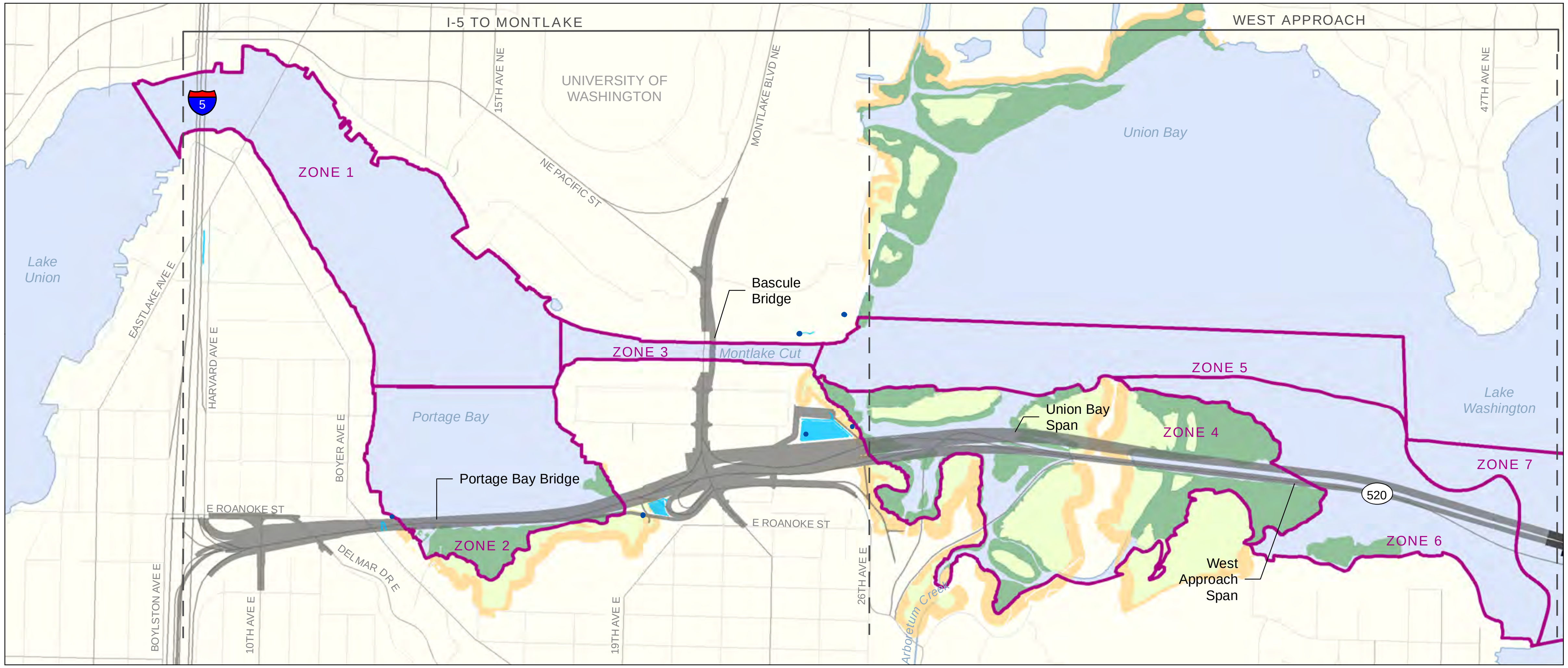
Table 3-1. Stock Summary of Lake Washington Basin Salmonids

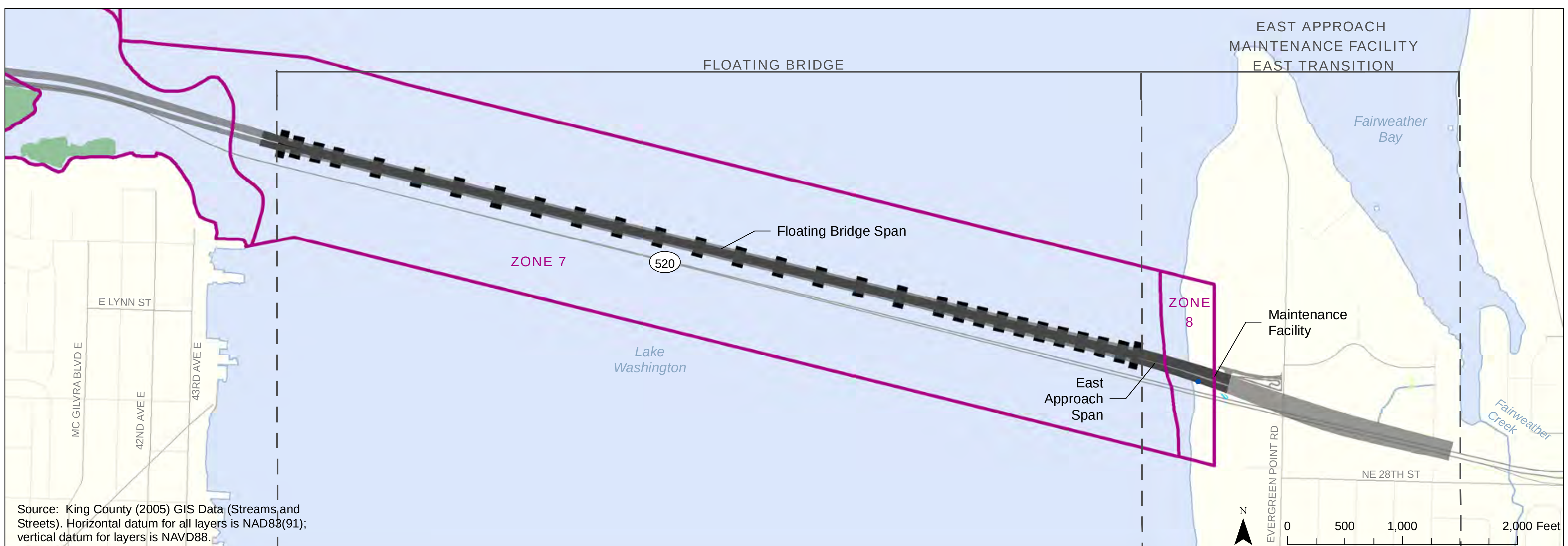
Species	Stock	Population Estimate Metric	1986–2003 Average (Max – Min)[b]
Chinook	Cedar River Chinook	Index escapement	525 (120 – 1540)
	Sammamish River[a]	Carcass counts and index escapement	3,438 (1,153 – 7,851)
Coho	Cedar River Coho	Cumulative fish-days	2,040 (128 – 9,204)
	Lake Washington/ Sammamish Tributaries Coho	Cumulative fish-days	4,120 (339 – 13,804)
Sockeye	Cedar River Sockeye	Run size	176,503 (30,084 – 512,257)
	Lake Washington Beach-Spawning Sockeye	Total escapement	1,895 (200 – 4,800)
	Lake Washington/ Sammamish Tributaries Sockeye	Total escapement	25,980 (2,080 – 81,090)
Steelhead	Lake Washington Winter Steelhead	Total escapement	158 (20 – 1,816)

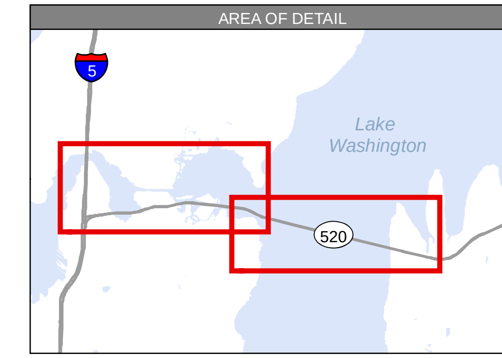
[a] As defined by NOAA Fisheries Puget Sound Technical Recovery Team. This stock includes Issaquah Chinook and North Lake Washington Tributaries Chinook as listed in WDFW (2004). The stock includes substantial hatchery origin fish, including strays and fish allowed to spawn after egg taking goals have been achieved.
[b] Data from WDFW 2004

In other cases, salmonids spawn in the tributaries that enter the north end of the lake (e.g., Bear Creek, Issaquah Creek) or along Lake Washington's beaches to the north of the SR 520 bridge. Larger juvenile sockeye and Chinook salmon from these locations in Lake Washington inhabit deeper limnetic lake habitat prior to outmigration, although some outmigrants may cross back and forth through the bridge corridor during this time.

In addition to the geographic location of spawning areas, the density and distribution of salmonids in the project area are also determined by the physical, chemical, and biological conditions in the project area. To assess and discuss the salmonids' variable use of the project area, it is helpful to break the project area into smaller zones. Eight salmonid functional zones have been identified in Lake Washington and the Ship Canal (Figure 3-1) to characterize the ecological conditions, salmonid habitat functions, and salmonid species' use of each zone. The zones were defined, and fish use evaluated, by a team of technical experts on Lake Washington fisheries. The results identified by the team were then reviewed and approved by the NRTWG. Each zone is briefly described in more detail below.







Proposed Stormwater Outfall

Stream

Salmonid Use Ecological Zone

Zone 1. Ship Canal from Hiram M. Chittenden Locks to Portage Bay
All successful juvenile outmigrants and adult returns must pass through this zone during their life cycle.

Zone 2: Southern portion of Portage Bay
Highly used by University of Washington Hatchery fish. Sub-optimal rearing and migration habitat, believed to be little utilized by native salmonids.

Zone 3: Ship Canal Montlake Cut
Lack of suitable habitat. Shallow, warm and heavily armored on both sides makes residency times low, All juvenile outmigrants and returning adults must pass through this segment of the Ship Canal prior to entering Lake Union or Lake Washington, respectively.

Zone 4: Arboretum and Foster Island Waterways
Low habitat use by salmonids. Shallow, warmer environment with dense macrophytes. This is believed to provide habitat for bass and other species tolerant of warmer waters.

Zone 5: Union Bay
This area may be used by outmigrating juvenile Chinook salmon for extended time periods (multiple days) and it may provide rearing habitat or refuge to fish about to enter or just exiting the relatively hostile environs associated with the Ship Canal

Zone 6: SR 520 West Approach (Foster Island to 10 m depth)
Believed to be primary migration route for Cedar River juvenile outmigrants and returning adults. This area may be used by outmigrating juvenile Chinook salmon for extended time periods (multiple days) and it may provide rearing habitat (primarily in 2-6 m depths).

Zone 7: Floating Bridge (areas deeper than 10 m)
Deep water area believed to be of lower importance for juvenile salmonids, which are generally shoreline oriented, while adult salmonids may use this portion of the lake. Juvenile salmonids may migrate into deeper waters at night in pursuit of feeding opportunities or use pontoon edge as migration corridor.

Zone 8: East Approach (from 10-meter depth contour to shore)
The east shoreline of Lake Washington is believed to be of less importance to migrating juvenile salmonids, however some shoreline-oriented salmonids likely use this area. Lake spawning sockeye salmonids have been documented to spawn in the vicinity of the East Approach bridge structure.

Proposed Edge of Pavement

Aquatic Bed Wetland

Palustrine Wetland

Wetland Buffer

Proposed Stormwater Facility

Pontoon

Figure 3-1. **Project Scale - Salmonid Function Zones in Lake Washington**

I-5 to Medina: Bridge Replacement and HOV Project

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Salmonid Functional Zone 1 – Ship Canal West of Portage Bay

The Ship Canal is an 8.6-mile-long man-made navigation waterway connecting Lake Washington to Puget Sound in the city of Seattle. Lake Washington was isolated from Puget Sound until 1903, when the construction of the Ship Canal created a connection from Lake Washington to Puget Sound through Lake Union. From west to east, the Ship Canal passes through Shilshole Bay, Ballard Locks, Salmon Bay, the Fremont Cut, Lake Union, Portage Bay, the Montlake Cut, and Union Bay on the edge of Lake Washington. Although all successful juvenile outmigrants and adult returns must pass through this zone during their life cycle, project activities occurring in this area are minimal, and limited to the movement of barges and pontoons.

Salmonid Functional Zone 2 – Portage Bay

The project area crosses through the southern portion of Portage Bay, which is thought to be south of the primary salmonid migration route through the Ship Canal. This area is a shallow, quiescent bay with abundant aquatic macrophytes during the spring and summer months. It provides limited habitat for anadromous fish populations, which are believed to migrate relatively rapidly through the northern portion of Portage Bay.

Salmonid Functional Zone 3 – Ship Canal at Montlake Cut

The Ship Canal at Montlake Cut is relatively shallow, warm, and heavily armored on both sides. The lack of suitable habitat makes fish residency times low; however, all outmigrating juveniles and returning adult salmonids must pass through this segment of the Ship Canal prior to entering Lake Union or Lake Washington. Construction activities to build a second bascule bridge will occur above the Montlake Cut, and will be conducted primarily from upland areas, with some periodic support from barges and tugboats anchored or positioned in the Montlake Cut.

Salmonid Functional Zone 4 – Arboretum and Foster Island

This zone includes the Washington Park Arboretum, Foster Island, and Union Bay. The area is generally characterized by shallow, quiescent waterways where dense growths of macrophytes are abundant during the spring and summer months. This zone contains a single stream, Arboretum Creek, which may have historically supported salmonids, although it has since been modified and degraded to the point where under current conditions it does not support any salmonids. While much of this zone is thought to provide habitat for bass and other species tolerant of warmer waters, it is not considered important or highly utilized salmonid habitat. A substantial amount of in-water construction will occur in this zone, including the installation of temporary work bridges and permanent bridge columns and superstructure.

Salmonid Functional Zone 5 – Union Bay

This area may be used by outmigrating juvenile Chinook salmon for extended time periods (multiple days). It may also provide rearing habitat and refuge to fish about to enter or just exiting the relatively hostile environment associated with the Ship Canal. As with Salmonid Functional Zone 1, project construction activities in this area will generally be limited to the movement of barges and pontoons.

Salmonid Functional Zone 6 – West Approach

This zone occurs east of the dense macrophyte communities associated with Foster Island, out to the 10-meter depth contour. This area is believed to be the primary migration route for Cedar River juvenile outmigrants and returning adults. Recent fish tracking studies (Celedonia et al. 2008b) suggest that this area may be used by outmigrating juvenile Chinook salmon for multiple days, and may provide rearing habitat (primarily in 2- to 6-meter depths). Fish travelling to or from the southern end of Lake Washington generally pass underneath the bridge in this zone. In addition, there will be a substantial amount of in-water and over-water construction in this zone, including the installation of temporary work bridges and permanent bridge columns and superstructure.

Salmonid Functional Zone 7 – Floating Bridge

The floating portion of the Evergreen Point Bridge resides in deeper water (greater than 10 meters deep) supported by floating pontoons. This zone is believed to provide limited habitat for the smaller juvenile salmonids, which are generally shoreline-oriented; however, adult and larger juvenile salmonids may use this portion of the lake. In addition, juvenile salmonids may migrate into deeper waters at night or in pursuit of feeding opportunities because a preferred food item, zooplankton, tends to be more abundant offshore.

Salmonid Functional Zone 8 – East Approach

This zone occurs along the east shoreline of Lake Washington, which is thought to be of less importance to migrating juvenile and adult salmonids because these fish are generally believed to pass through the project area closer to the western shoreline of the lake. It is likely that some shoreline-oriented salmonids use this area. Sockeye beach spawning has also been identified historically in this area (see Section 3.5.1), though no surveys have been conducted recently. Construction activities in this zone include installation of permanent bridge columns and superstructure, and construction of the bridge maintenance facility and associated dock.

3.5.3. Salmonid Predators

Predation of salmonids by native and non-native predatory fishes is a substantial source of mortality in Lake Washington and the Ship Canal (Fayram and Sibley 2000; Warner and Fresh 1998; Kahler et al. 2000). However, any effects on associated predator–prey distributions resulting from the existing bridge and associated structures are expected to apply mainly to juvenile salmon outmigration. Current information does not indicate that the existing bridge structure has an influence on the predator–prey interactions associated with adult salmonids in Lake Washington.

Fayram and Sibley (2000) and Tabor et al. (2004a, 2006) demonstrated that bass may be a risk factor for juvenile salmonid survival in Lake Washington. Celedonia et al. (2008a, b) found that larger bass tend to be present near shoreline structures and bridge piers, including areas where young salmon are likely to migrate and rear. Therefore, juvenile Chinook and steelhead may be particularly vulnerable to predation as they migrate through Lake Washington to marine waters, as well as through the relatively-confined Ship Canal. The highly modified habitat throughout the Ship Canal and the locks may also contribute to an increased potential of predation due to the reduced refuge habitat available.

The primary freshwater predators of salmonids in the lakes and waterways in the Lake Washington basin include both native and non-native species. Primary non-native predator fish include yellow perch (*Perca flavescens*), smallmouth bass (*Micropterus dolomieui*), and largemouth bass (*Micropterus salmoides*). Predominant native fish predators include cutthroat trout, northern pikeminnow (*Ptychocheilus oregonensis*), and prickly sculpin (*Cottus asper*). However, sampling in February and June of 1995 and 1997 found only 15 juvenile Chinook salmon in the stomachs of 1,875 predators (prickly sculpin, smallmouth and largemouth bass, and cutthroat trout) examined, with most of the predation by prickly sculpin (Tabor et al. 2004a). These data suggest predation of less than 10% of the Chinook salmon entering the lake from the Cedar River.

Smallmouth bass distribution in Lake Washington overlaps with that of juvenile Chinook salmon in May and June, when both species occur in shoreline areas. However, predation rates are also affected by physical conditions. For example, smallmouth bass do not feed as actively in cooler temperatures as they do in waters above 68ºF (20ºC) (Wydoski and Whitney 2003), while Chinook avoid the warmer-water areas. Chinook also avoid overhead cover, docks and piers, and the coarse substrate habitat areas preferred by smallmouth bass (Tabor et. al 2004a; Gayaldo and Nelson 2006; Tabor et al. 2006; Celedonia et al. 2008a, b).

Tabor et al. (2006) concluded that under existing conditions, predation by smallmouth and largemouth bass has a relatively minor effect on Chinook salmon and other salmonid populations in the Lake Washington system. However, predation appears to be greater in the Ship Canal than in the lake. Tabor et al. (2000) estimated populations of about 3,400 smallmouth and 2,500 largemouth bass in the Ship Canal, with approximately 60% of the population occurring at the east end at Portage Bay. They also observed that smallmouth bass consume almost twice as many Chinook salmon smolts per fish as largemouth bass (500 smolts versus 280 smolts annually, respectively). This consumption occurs primarily during the Chinook salmon outmigration period (mid-May to the end of July) when salmon smolts represented 50 to 70% of the diet of smallmouth bass (Tabor et al. 2000). An additional study estimated the overall consumption of salmonids in the Ship Canal at between 36,000 and 46,000 juvenile salmon, corresponding to mortality estimates ranging from 0.5 to 0.6% (Tabor et al. 2006).

Although smallmouth bass showed an affinity for the bridge columns, information suggests that their overall abundance is no greater at the bridge than in other suitable habitat types (Celedonia et al. 2009). Also, a study of the stomach contents of predators under the existing bridge found that predator diets near the bridge include a similar proportion of salmonids as the diets of predators studied in other locations of Lake Washington (Celedonia et al. 2009).

In addition to selecting bridge columns as a structural habitat component, smallmouth bass were found to have an affinity for a depth of 4 to 8 meters and often sparse vegetation or edge habitat associated with macrophytes. Moderately dense to dense vegetation was used only occasionally. Neither pikeminnow nor smallmouth bass have been shown to have an affinity for the shading (i.e., overhead cover) provided by the overhead bridge structure.

As noted previously, artificial lighting associated with the proposed roadway and bridge could affect the distribution and behavior of fish. Any increased abundance of salmonids around illuminated areas may then also attract visual predators. Neither smallmouth bass nor northern pikeminnows appeared to be particularly attracted to the artificially illuminated area adjacent to the existing bridge. Other studies, however, suggest that predation rates by other salmonids such as cutthroat trout and rainbow trout may be higher due to increased visibility of the prey species in illuminated areas, even if the predators on the whole do not select these areas (Mazur and Beauchamp 2003; Tabor et al. 2004b). No information was presented regarding increased potential for predator detection by prey in artificially illuminated areas.

While there has been an obvious increase in the number of non-native predators in the lake in the twentieth century, changes in the number of native predators have been less apparent. However, there is some anecdotal evidence that the number of cutthroat trout has increased considerably over time (Nowak 2000). In addition, Brocksmith (1999) concluded that the northern pikeminnow population increased by 11 to 38% between 1972 and 1997. Brocksmith (1999) also found evidence that larger northern pikeminnows are more numerous than they were historically, indicating that the pikeminnow population is currently not limited by their density (i.e., they can increase in density if limiting environmental factors became more favorable). The greater number and the larger size of pikeminnows suggest an overall increase in predation mortality of anadromous juvenile salmonids, compared with historical conditions. The incidence of freshwater predation by fish in Lake Washington and the Ship Canal may also be increasing due to the increasing water temperatures that favor these species (Schindler 2000).

Data suggest that northern pikeminnow do not select areas near the bridge over other habitat types. Northern pikeminnow were primarily concentrated at 4- to 6-meter depths during all periods, and moderately dense vegetation was the most commonly used habitat type. Limited attraction to nighttime lights was noted, although this was inconsistent from year to year (Celedonia et al. 2008a, 2008b, 2009).

In general, the amount of predation currently occurring in the project area is likely to be primarily a function of the overlap in available predator and prey habitat areas and selection preferences. Assuming smallmouth bass are selecting the bridge columns as preferential habitat for predation, and that migrating Chinook show no preference where they cross in the primary migration corridor, predation is likely to occur adjacent to the in-water structure (columns) of the existing bridge structure.

Aside from potential changes in predator distribution, the information suggests that migrating juvenile salmonids that exhibit a holding behavior in association with the bridge are more likely to be susceptible to increased predation rates. The increased residence time around the structure may simply result in prolonged exposure to bridge-associated predators.

3.6 Lake Washington Salmonid Conceptual Model

A conceptual model was developed to characterize the interaction between anadromous salmonids and aquatic habitat in the project area. The model (Figure 3-2), based on literature on salmonid habitat functions and features in Lake Washington, uses the primary life history stages of anadromous salmonids as surrogates for related population-level metrics (i.e., survival, growth, fitness, and reproductive success). To simplify the model, the life history stages have been generalized, and serve to represent all anadromous salmonids within the Lake Washington system, although the importance of specific habitat features varies by species. For example, natural shoreline habitat is extremely important to Chinook fry when they enter the lake from the Cedar River, while sockeye salmon, which are generally larger upon lake entry, rely somewhat less on shoreline habitat and for a shorter period.

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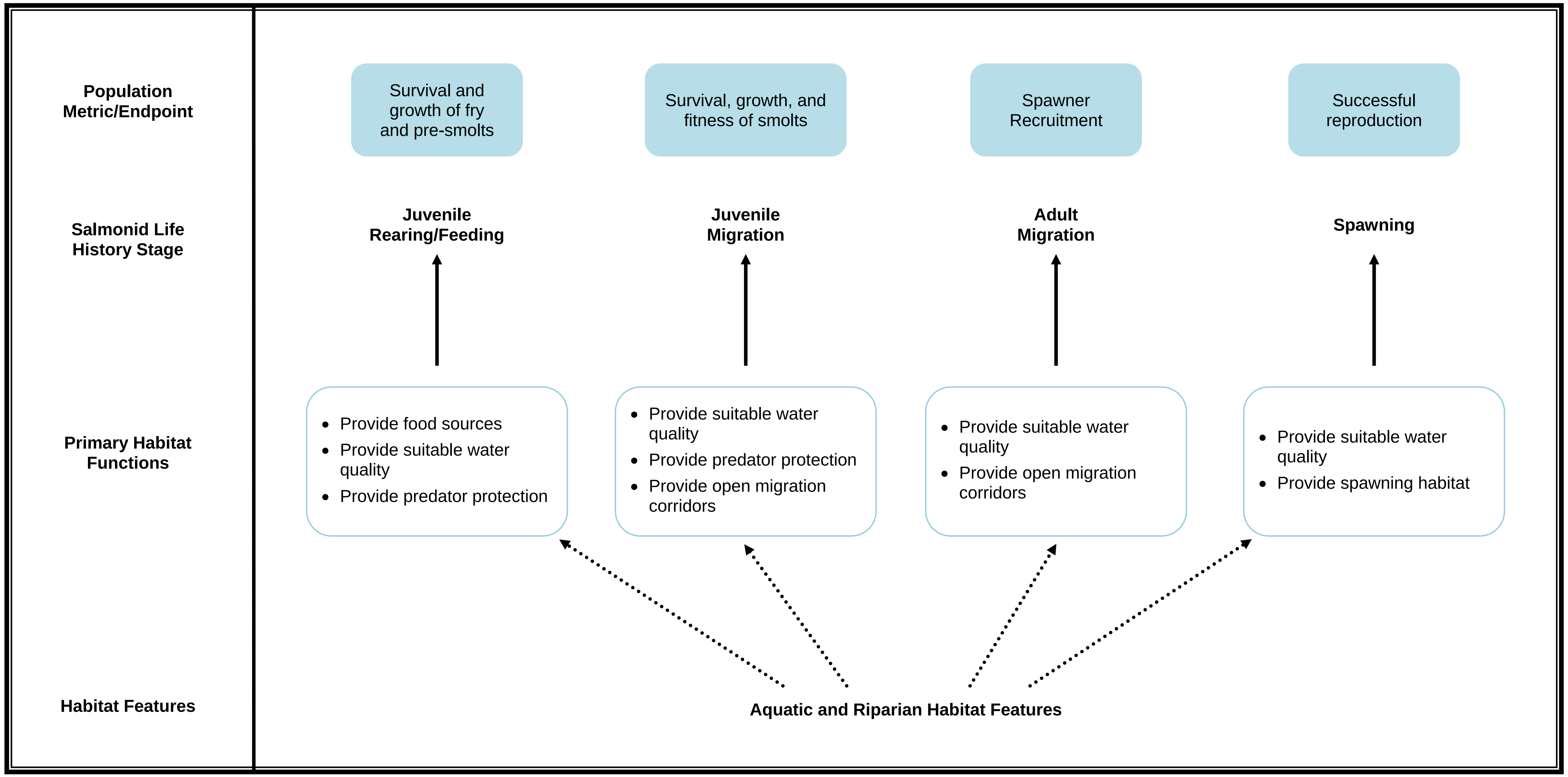
Figure 3-2. Conceptual Model of Anadromous Fish in Lake Washington



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The aquatic habitat functions listed in the model also apply to all species of anadromous salmon in the project area. These functions, listed in Figure 3-2 and listed in more detail in Table 3-2, are based on scientific literature on salmonid habitat requirements and limiting factors (City of Seattle and USACE 2008; Kerwin 2001; Wydoski and Whitney 2003) and directly relate to specific life history stages.

Table 3-2. Aquatic Habitat Functions and Related Salmonid Life History Stages

Aquatic Habitat Function	Primary Salmonid Life History Stage(s) Affected
Provide adequate food sources (macroinvertebrate and zooplankton)	Juvenile Rearing/Feeding Juvenile Migration
Provide water quality with constituents within acceptable levels for salmonids (DO, temperature, TSS, contaminants, etc.)	All stages
Provide protection from predator species (piscivorous and avian)	Juvenile Rearing/Feeding Juvenile Migration
Provide migration corridors free from obstruction and disturbance	Juvenile Migration Adult Migration
Provide accessible spawning habitat of suitable quantity and quality	Adult Spawning

DO = Dissolved oxygen
TSS = Total suspended solids

The model relates these general population metrics to specific habitat functions that support salmonid life stages. Each habitat function is supported by a number of physical, biological, and chemical habitat features that can be affected by project actions. Alteration of these habitat features can influence habitat functions, which then can affect salmonid life history stages and result in population-level effects. Since this methodology looks at salmonid life history and related population-level effects, it can be used to either assess project impacts (negative effects) or project mitigation (positive effects), and allows evaluation and comparison of both types of effects, using identical metrics.

The potential project impacts and mitigation actions may affect different habitat features, but the overall aquatic functions, and in turn, life history elements affected, are similar. The discussion below summarizes general information on the life histories of salmonids, and the relationship of several habitat features to these life stages.

3.6.1. Juvenile Salmonid Rearing and Feeding

Rearing

Juvenile salmonids require habitat that provides refuge from predatory, physiological, and high-energy challenges. High-quality freshwater refuge habitat, limited in Lake Washington and the Ship Canal (Tabor and Piaskowski 2002; Weitkamp et al. 2000), consists of unarmored, shallow-gradient littoral zone with large woody debris (LWD) and overhanging vegetation (Tabor and Piaskowski 2002). Low-quality refuge habitat is prevalent in most Lake Washington shoreline areas due to shoreline development, lack of LWD, and the proliferation of non-native predatory fish species. Shoreline modifications that preclude shallow water habitat comprise most of the Lake Washington shoreline (Toft 2001; Toft et al. 2003). In Lake Washington, pilings and riprap likely contribute to increased energy expenditure and risk of predation on juvenile salmonids by bass and northern pikeminnow (Celedonia et al. 2008 a, b). Riprap areas have been shown in other lakes to exhibit higher water velocities, depths, and steep slopes compared with unaltered habitats (Garland et al. 2002). Due to littoral zone activities and modifications including dredging, filling, bulkheading, and construction, very little native vegetation remains on the Lake Washington shoreline (Weitkamp et al. 2000; Toft 2001; Toft et al. 2003).

Refuge is limited in the Lake Washington basin near the fresh/saltwater transition at the Ballard Locks due to the limited natural habitat and sharp osmotic gradient. Juvenile salmonids exiting Lake Washington may seek tributary mouths as refuge habitats because overhead vegetative cover and the water from these tributaries provide refuge from higher salinities or temperatures (Seattle Parks and Recreation 2003). In nearshore shallow and/or marine areas, features considered to be high-quality refuge habitat are aquatic and marine riparian vegetation, LWD, and larger substrates (City of Seattle 2001). In Puget Sound, this habitat is limited due to the prevalence of bulkheads and over-water structures, and extensive filling, dredging, and grading in shoreline areas (Weitkamp et al. 2000; City of Seattle 2001).

Foraging

Juvenile salmon require habitat that provides and supports the production of ample prey resources; this habitat includes unaltered shorelines with organic inputs and small substrates. Juvenile Chinook in Lake Washington prey on insects and pelagic invertebrates, namely chironomids and *Daphnia* spp. (Koehler 2002). Juvenile salmonids in Puget Sound feed on forage fish larvae and eggs as well as on other pelagic, benthic, and epibenthic organisms from nearshore, intertidal, and eelgrass/kelp areas (Simenstad and Cordell 2000). Although the literature generally concludes that prey resources are not a limiting factor for juvenile salmon (Kerwin 2001), in-water construction activities have the potential to temporarily affect the juveniles’ foraging behavior by decreasing primary productivity, changing water clarity (sedimentation), or creating in-water noise and disturbance. Because the proposed project has the potential to temporarily affect the foraging ability of juvenile outmigrant salmonids, this life history element was incorporated into the conceptual model.

3.6.2. Juvenile Migration

Lake habitat that is generally considered favorable for migration includes gently sloping beaches with no over-water structures restricting light penetration of the water. Juvenile salmonids require habitat with few barriers to their seaward migration. Lake Washington is free of these barriers, but concern exists among biologists that over-water structures such as docks and piers may indirectly act as a barrier to alter migration patterns (Weitkamp et al. 2000). Juvenile salmon readily pass under small docks and narrow structures under which darkness is not complete, but studies have indicated that under some conditions, large over-water structures with dark shadows can alter migration (Fresh et al. 2001). However, juvenile migration of salmonids is complex and influenced by a variety of factors. In a study of the effects of the existing SR 520 bridge, Celedonia et al. (2008a) observed no apparent holding behavior of juvenile Chinook at the existing bridge during year 1 of the study, while in another year minutes to hours of holding were observed for about half the fish (Celedonia et al. 2008a). Some juveniles pass directly under the bridge without delay, while others spend up to 2 hours holding close to the bridge. Overall, these short delays are unlikely to result in detectable changes in survival of Chinook or other juvenile salmon as they migrate through Lake Washington and the Ship Canal.

Several studies have shown that in nearshore areas of the Duwamish estuary and Elliott Bay, over-water structures do not have a detrimental effect on juvenile salmonid migration patterns, unlike some larger docks and piers on Lake Washington. However, this has been attributed to the difference in size and construction of similar structures along the Lake Washington and Lake Union shorelines (Weitkamp et al. 2000). Some studies have shown that drastic changes in ambient underwater light environments may alter fish migration behavior (Nightingale and Simenstad 2001).

The migratory corridor is severely modified at the Ballard Locks, as the fresh- to saltwater transition occurs rather abruptly within the salt wedge and mixing zone near the locks.

3.6.3. Adult Migration

Adult salmonids returning to spawn in the Lake Washington basin must pass through the Ship Canal and the lake. Details on migration timing through the Ship Canal are discussed in Section 3.5.1. Adult Chinook salmon may enter Lake Washington days before moving into rivers for spawning. The average time spent by adult Chinook in Lake Washington in 1998 was 2.9 days (Fresh et al. 1999). For Sammamish watershed fish, the average was 4.9 days. Acoustic and temperature tags on adult Chinook salmon show that these fish inhabit waters of varying depths and temperatures. Temperature tag studies show that areas in the lake occupied by fish range in temperature from 48 to 70º F (9 to 21º C) (F. Goetz unpublished data in City of Seattle and USACE 2008). Adult sockeye salmon enter Lake Washington well before spawning. Freshwater entry occurs in the summer and the fish spawn in October and November (Newell and Quinn 2005). A fish tracking study conducted in 2003 indicated that 25 of 29 adult sockeye salmon that were initially detected south of the existing Evergreen Point Bridge were subsequently detected south of the bridge (Newell 2005). Of these, 10 fish exhibited back-and-forth behavior, meaning they swam under the bridge at least three times. Fish remained in the lake for an average of 83 days (range of 57 to 132 days) before migrating upstream to spawn; however, there was no apparent correlation between freshwater arrival date and spawning date. Most adult sockeye spend their time in Lake Washington below the thermocline, where temperatures are cooler. Over 90% of temperature detections in the lake were between 48° and 52° F (9° and 11°C), corresponding to water depths of 18 to 30 meters, with the fish rarely occupying available cooler and warmer waters (Newell 2005).

Ship Canal Water Quality Conditions and Adult Salmon Migration

Upstream of the Ballard Locks, water quality parameters such as temperature and DO may inhibit adult salmon movement away from the cool water refuge. The results of previous tagging studies indicate inter-annual variability in the duration of Chinook salmon holding just upstream of the locks, resulting in annual average delays of 2 days to 19 days (K. Fresh in City of Seattle and USACE 2008; Timko et al. 2002). These studies identified 19ºC as a temperature that most fish move through and 22ºC as the boundary beyond which fish do not migrate. In general, water temperatures above 19ºC correlate with fish staying longer at the locks.

This suggests that the Ballard Locks have been delaying the entry of some fish into Lake Washington, potentially based on elevated water temperatures. Water temperatures in the Ship Canal and Lake Union consistently exceed values that are physiologically stressful to salmon (i.e., greater than 20ºC) and can greatly exceed this threshold, as in 1998, when the daily average temperature peaks were 23.5ºC in early August (City of Seattle and USACE 2008).

Adult salmon passage through the Ship Canal and Lake Union is thought to be influenced by warm water temperatures in the Ship Canal, among other things. Both sockeye and Chinook salmon may be affected by these high temperatures. Sockeye tend to spend longer in the Ship Canal, but also keep to a tighter temperature range than Chinook. Chinook enter the Ship Canal later in the season when temperatures are higher, however.

The combined effect of the locks and the stratification of the water column contribute to water quality conditions that may adversely affect adult salmon, especially in years of high summer temperature. The potential biological effects on individual adult salmon from these degraded water quality conditions in the Ship Canal are not well documented; however, it is possible that physical conditions in the Ship Canal are a stress to holding or migrating adults that could cause pre-spawning mortality and reduced egg survival for those adults that survive to spawn, or make affected fish more susceptible to other stressors encountered during their migration.

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4. Impact Assessment

The purpose of this section is to characterize impacts on aquatic habitat and species from construction and operation of the SR 520 bridge replacement in Lake Washington and the Ship Canal, as part of the SR 520, I-5 to Medina Project. The characterization of impacts (and related mitigation benefits) required the development of impact assessment and mitigation methodologies that are applicable to the unique site conditions, impact types, and mitigation limitations of the proposed project, and that relate to the conceptual model presented in Section 3.6. The development of these methodologies was necessary to accurately describe and characterize those aquatic functions and values that will be negatively affected as a result of the project.

WSDOT recognizes that the mitigation benefits will almost certainly be of a different type than the impacts (based on the location and type of impacts); therefore, any methodology developed must be based on a framework that characterizes the aquatic functions and values lost at the impact site, as well as the aquatic functions and values improved at the mitigation sites.

In addition, some of the impact types for this project are unique and require a methodology that can accurately characterize and sum such impacts. One limitation to the methodology as proposed is that it is somewhat limited in its ability to characterize the benefits of minimization measures (such as bridge height) on impacts (e.g., shading).

An overriding goal of developing a conceptual framework and associated methodology was to create a relatively simple and tractable method for assessing impacts and benefits while acknowledging its limitations. Therefore, WSDOT developed a framework and associated methodology for impact assessment and mitigation evaluation that addresses the following key factors:

- **Biologically-Relevant Common Endpoints –** The methodology can sum a variety of stressors and impact mechanisms, as well as beneficial actions (e.g., mitigation actions) into several biologically-relevant endpoints, including life history stage effects and associated population endpoints/metrics. Endpoints were chosen based on their direct relation to important aquatic functions and values in the project area.

- **Spatial Sensitivity –** The methodology differentiates between the biological importance of specific geographic areas, and relates the physical impacts to the biological functions these areas support. The sensitivity includes the habitat/functional differences between various locations along the bridge alignment (floating bridge versus west approach) as well as differences between the project site and other sites (potential mitigation site locations) in the larger Lake Washington basin.

- **Temporal Sensitivity –** The methodology is able to integrate the overlap of temporary spatial impacts over time, which allows an assessment of the biological importance of impacts to specific fish life history stages.

The methodology described below was developed based on these key factors and was presented to resource agencies participating as part of NRTWG process. The final impact assessment methodology was formulated and refined incorporating NRTWG input.

The sections below describe the methodology in detail, including its direct application to the site-specific impacts of the SR 520, I-5 to Medina Project.

4.1 Impact Assessment Methodology

This section summarizes the project's approach to characterizing temporary and permanent aquatic impacts resulting from the project's construction and operation. The approach is applied to those impacts that cannot otherwise be avoided or minimized, and that are of a scale that will potentially negatively affect aquatic resources to a degree that will require compensatory mitigation. WSDOT has applied specific avoidance and minimization measures to potential impacts; these measures are discussed in detail in Section 5.The methodology focuses on those project impacts that deleteriously affect fish habitat, either directly or in most cases, indirectly (degradation of habitat functions), without full habitat displacement. The methodology is used to calculate both permanent and temporary impacts.

The use of such a habitat-based methodology is consistent with the guidance in WDFW Policy M-5002, which states that a project will not result in a net loss of aquatic habitat or habitat functions. The methodology was not designed to calculate other types of potential impacts that are disturbance-based or chemical in nature (e.g., pile driving or turbidity-related impacts) and that are generally related to construction activities. However, construction-related impacts do not result in a loss of habitat or function and their effect ceases almost immediately upon cessation of the activity. Furthermore, potential construction impacts, including in-water noise, temporary lighting, in-water turbidity/contaminants, and barge operation and moorage, have been avoided and/or minimized (see Section 5) to the extent that compensatory mitigation is not required. Similarly, potential non-habitat operational effects such as stormwater discharge and permanent bridge lighting (see Section 2) have been designed to be an improvement over the existing conditions.

The primary metrics for both impact characterization and subsequent calculation of functional uplift resulting from mitigation activities are based on the two-dimensional area of affected habitat. These metrics are then modified by a geographic (spatial) factor to account for differences in fish use by area and habitat type. The methodology calculates temporary impacts by integrating the temporal aspect of the impact-generating structures, and therefore results in impacts based on the concept of service-acre-years (the sum of impacted acres over time). The service-acre-year methodology proposed in this document is an adaptation of the concept used in Habitat Equivalency Analysis (NOAA 1995) to determine compensation for resource damages under the Natural Resource Damage Assessment (NRDA) process.

Figure 4-1 presents the primary functions in the aquatic habitat that will be affected by project construction and operation, and also shows the subsequent aquatic functions and salmonid life history stages affected. Habitat features will primarily be changed by physical mechanisms (e.g., alterations in benthic fill or daylight/shade-intensity), that in turn negatively affect aquatic habitat functions that support juvenile salmon migration and rearing. Based on an analysis of those habitat features substantially altered as a result of project construction and operation, three impact mechanisms were identified that produce the greatest effects on aquatic functions:

1. Artificial shading produced by project structures.
2. Changes in the number, size, and spacing of in-water structures all affect salmonid habitat complexity, which has the potential to attract salmonid predators.
3. Displacement of benthic habitat by in-water structures.

This impact assessment methodology is designed to calculate effects from habitat-based impacts. A detailed discussion of these three impact mechanisms is presented in Section 4.2.

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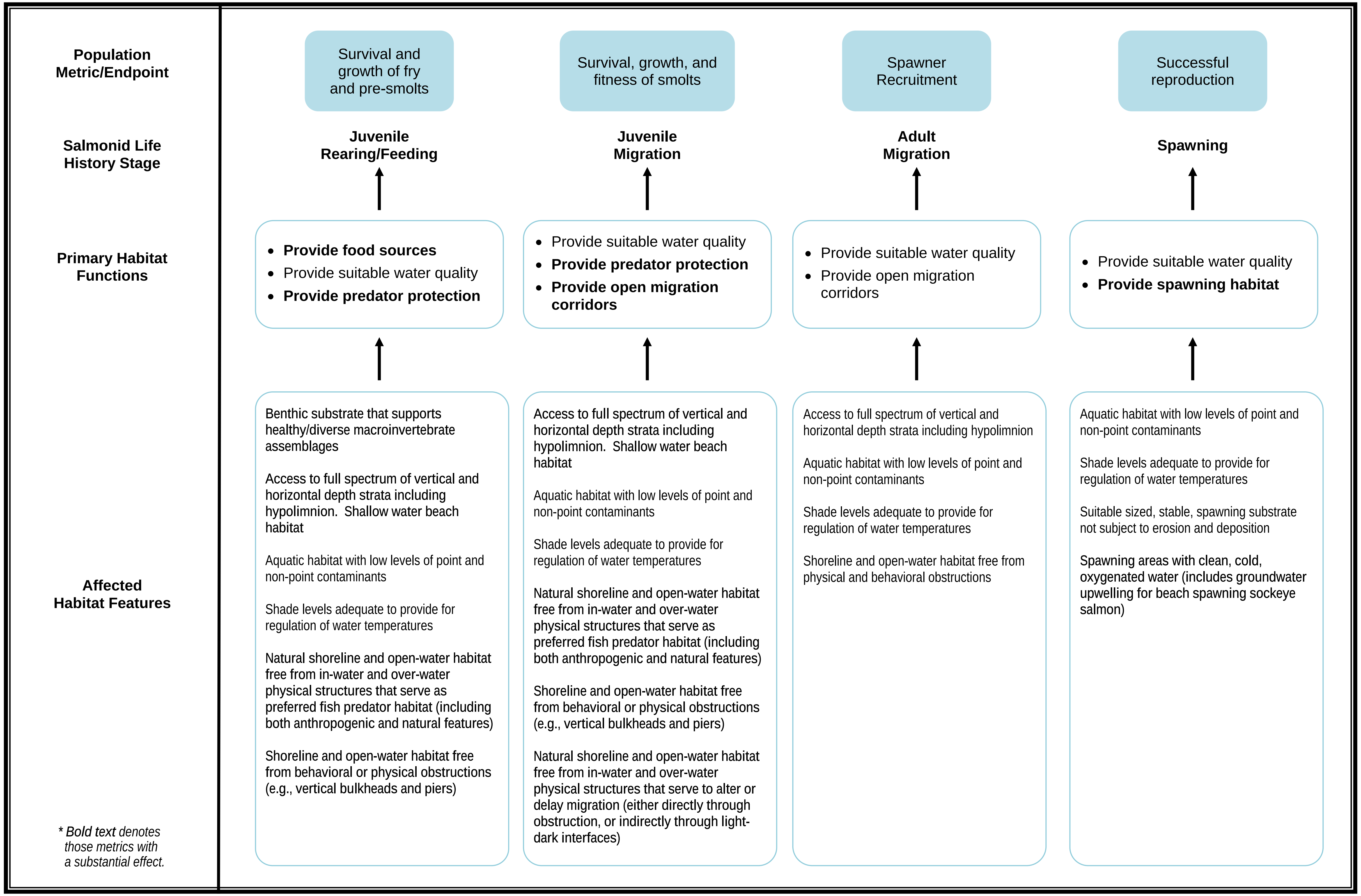
Figure 4-1. Conceptual Model of Project Impacts



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Fish Function Modifier

The impact assessment methodology applies a geographic (spatial) modifier to the impact metrics in order to characterize ecological function. This modifier (called the Fish Function Modifier) accounts for differing levels of fish use at various sites throughout Lake Washington. It is used to calculate the potential exposure of salmonid species to temporary and permanent stressors from project construction. Fish Function Modifiers were assigned based on (1) fish use numbers (i.e., the number of fish that likely use a specific geographic area); (2) the type of fish use (i.e., the life stages that are likely present); and (3) the duration of fish use (i.e., the temporal distribution of fish in the area throughout the year).

Project impacts were separated into eight geographically-distinct Salmonid Functional Zones that were based on salmonid utilization (as described in Section 3.5.2). Each zone containing a project-related impact was assigned an individual Fish Function Modifier, scaled to a number between 0 and 1. Zones 1 and 5 do not include any impacts and were not assigned a modifier. The modifier scores were based on the abundance and distribution factors listed above, and were scaled to represent the range of fish utilization in the Lake Washington basin. Table 4-1 describes the criteria used to determine the modifiers.

Two zones that have the highest fish use are Zones 3 and 6, which serve as the primary juvenile outmigration corridor for most (Zone 6) or all (Zone 3) salmonids spawned in the Lake Washington basin. These two zones were assigned the highest possible Fish Function Modifier, of 1.0. Zone 8, the East Approach Area, has some historical beach spawning use by sockeye salmon, as well as some use by shoreline-oriented juvenile outmigrants from the Cedar and Sammamish basins; therefore, the Fish Function Modifier is 0.8. Zone 2 (Portage Bay) has low to moderate use by Chinook and potentially by coho salmon outmigrants, although fish distribution is generally oriented away from the aquatic macrophytes beds on the zone's southern edge. Nonetheless, the entirety of the zone was assigned a Fish Function Modifier of 0.6. Zone 4 (Arboretum and Foster Island) was assigned a Fish Function Modifier of 0.1 based on the very low densities of Chinook and other juvenile salmonids present in this relatively shallow habitat that is heavily impacted by invasive aquatic macrophytes.

Zone 7 (Floating Bridge) represents deep-water and open-water habitat (depths greater than 30 feet). Although this zone has moderate use by rearing and outmigrating juvenile salmonids, it was assigned a relatively low Fish Function Modifier for several reasons. The mechanism of effect on salmonids is unique in this area (as discussed in Section 4.3.1), and does not fit well into the project effects analysis, which uses calculations based entirely on area. Therefore, the Fish Function Modifier in Zone 7 was adjusted downward for impact analysis purposes.

Furthermore, the Fish Function Modifier also takes into account the vertical distribution of fish in the water column in Zone 7. When considering Zone 7 from a plan view perspective (the entire water column bounded by the zone limits), the use of the entire zone by salmonids could be considered moderate. However, fish are not limited by depth, thus, their potential exposure to the project structures in the zone is expected to be fairly low. Likewise, returning adult salmonids are also able to use much of the water column during their spawning migrations, not only the portions of the water column containing the pontoons or their anchors. Therefore, the distribution of salmonids within Zone 7 that have the potential to be affected by the project is low in comparison with other habitat types. For these reasons, Zone 7 was assigned a Fish Function Modifier of 0.1.

Table 4-1. Proposed Scaling Factors and Criteria

Fish Function Modifier Score	Fish Function Modifier Criteria	Potential Impact Zones Within Category[1]
1 – Very High	Aquatic sites that are defined as critical migration or rearing areas for multiple species and stocks of juvenile salmon, or that serve as critical migration areas for multiple species and stocks of returning adults.	Zone 3 – Montlake Cut Zone 6 – West Approach
0.8 – High	Aquatic sites that are known to support documented spawning of at least one salmonid species, or Aquatic sites that serve as migration or rearing areas of considerable importance for one or more species of juvenile salmon, or that serve as migration areas of considerable importance for returning adults.	Zone 8 – East Approach
0.6 – Moderate	Aquatic sites that do not support salmon spawning, and where juvenile migration or rearing areas for juvenile salmonid species occurs, but where fish density, or temporal distribution of fish is lower compared to that of other sites.	Zone 2 – Portage Bay
0.1 – Low	Aquatic sites that do not support salmon spawning, and that have low or nominal use by salmonids for migration or rearing.	Zone 4 – Arboretum and Foster Island Zone 7 – Floating Bridge

[1] Zones 1 (north Portage Bay) and 5 (Union Bay) do not have structural impacts; therefore, no Fish Function Modifiers were assigned to these zones.

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4.2 Impact Characterization and Impact Mechanisms

The mitigation team calculated primary mechanisms of effect on aquatic ecological habitat by overlaying the proposed design onto the project base maps of aquatic features. The team then determined affected habitat areas as the area of intersection of the two sets, or a zone of effect around design features (e.g., predator habitat around bridge columns). Effects were calculated based on the project action that will cause the effect, and were broken down by the type of ecological stressors that the project action will affect. Specifically, impact characterization is based on areal cover of over-water structures (representing shading, which has potential impacts to fish migration and predator–prey relationships) and in-water structures (representing displacement of benthic habitat, and alteration of habitat complexity, which has potential impacts to fish predator–prey relationships).

The existing bridge structure likely has some effect on fish due to these mechanisms, and its removal will eliminate those effects. Therefore, the methodology for assessing permanent impacts estimates the change in effects to fish as a result of the project. Impact calculations are based on the net change (future conditions minus existing conditions) of area affected by the project to account for the ecological benefits of removing the existing structures.

Unlike the regulatory process for wetland mitigation, federal and state regulations and guidance do not prescribe calculation metrics or mitigation formulas for the majority of the effects to aquatic habitat. In addition, many of the potential effects to fish and other aquatic species will be indirect, and will result from effects to organism behavior patterns or effects to fish predators or prey resources. For example, partial shading effects from the new bridge structures could alter the migration patterns or timing of juvenile salmon, or influence the distribution of their predators. These effects could ultimately change the success rate of juvenile salmon migrating to marine waters.

Salmon, in particular Chinook salmon, were chosen as key indicator species when studying the impact mechanisms of the SR 520, I-5 to Medina Project, because these species are the most studied in the watershed, and a comprehensive data set is available that links habitat variables in the watershed to salmonids (City of Seattle and USACE 2008; King County 2005). The key salmonid life history functions that will be affected are directly related to the life history phases of the affected fish. These functions are juvenile rearing/feeding, juvenile migration, and beach spawning (sockeye) (se Figure 4-2).

The measurable impacts that affect the life history functions of salmonids are benthic habitat loss (e.g., fill), and those mechanisms that can alter fish behavior or predator–prey interactions (e.g., over-water and in-water structures, which can both increase predation and result in migration alterations or delays). It is important to note that of the identified and measurable impact mechanisms, the only category that includes complete habitat loss is the benthic habitat impact category. Shade and alteration of habitat complexity do affect fish, but do not measurably diminish the amount of available habitat. The following text describes each of these impact mechanisms in more detail.

4.2.1. Benthic Habitat Impacts

Biological effects to fish and benthic organisms come from the following:

- Temporary reduction in water quality associated with the installation and removal of temporary piles.
- Temporary loss of benthic organisms and other prey due to disturbance of the lake substrate.
- Permanent loss of benthic habitat from the installation of support columns and floating bridge anchors.

Increased turbidity is likely to occur from some of these project activities, although the distribution of the plumes will be limited due to the low-velocity water currents in the area. The size of the sediment particles is typically correlated with the duration of sediment suspension in the water column. Larger particles, such as sand and gravel, settle rapidly, but silt and very fine sediment may be suspended for several hours.

Sediment put into suspension by bottom disturbance may adversely affect salmonids' migratory and social behavior as well as their foraging opportunities (Bisson and Bilby 1982; Sigler et al. 1984; Berg and Northcote 1985). However, this impact pathway is considered temporary, and will be minimized by appropriate BMPs, as listed in Section 5.

Disturbed substrate sediments could have indirect effects on benthic flora and forage organisms, including the elimination or displacement of established benthic communities and thus a reduction in prey available for juvenile salmon. Suspended sediments can clog the feeding structures of filter-feeding benthic organisms; this reduces their feeding efficiency and increases their stress levels (Hynes 1970). However, benthic communities are expected to recover relatively quickly after the disturbance, resulting in a short-term loss rather than long-term loss. Also, there is no indication that prey abundance is a limiting factor in Lake Washington for salmonids. Some of the highest recorded juvenile sockeye growth rates have been observed in Lake Washington compared with the growth rates in other lacustrine systems (Eggers et al. 1978; Edmondson 1994), and Chinook salmon exhibit exceptional growth compared with growth in other populations (Koehler et al. 2006). Therefore, benthic habitat disturbance and displacement are expected to have potential effects only on those areas directly disturbed, and impacts to salmonid populations in Lake Washington and the Ship Canal will be minor.

4.2.2. Shading Impacts

Numerous factors are believed to affect the migration of salmonids through Lake Washington. It is unlikely that the presence of the existing bridge substantially affects most of these factors. Such factors include physiological development (smoltification) of migrating juvenile salmonids, overall water temperature of the lake and Ship Canal, and the size and condition of the migrating fish. However, the bridge and in-water bridge structures do present unnatural conditions in the migration corridor, which have the potential to alter the behavior of migrating fish. Alteration of migratory behavior could cause the fish to occupy or migrate through areas that are more or less productive than habitats they would otherwise occupy, require different energy expenditure levels, or subject the fish to more or less viable survival conditions.

The placement of permanent over-water structures will alter in-water shading intensities and patterns. Shade effectively creates a different habitat type that contrasts with the adjacent aquatic environment (lacking shade). In particular, the transition between light and shade (described as the edge effect) is considered a potential influence on fish behavior and habitat selection. The shadow cast by an over-water structure affects both the plant and animal communities below the structure.

Factors that influence in-water shade levels include the width and over-water height of new bridge decks, light diffraction (bending of light around an object) around the structures, light refraction (change in speed and direction of light when travelling from one medium to another, e.g., air to water), and the spatial alignment of the structures in relation to the path of the sun.

These factors are expected to change during project construction as temporary structures (e.g., work bridges) are built to facilitate construction, as the new bridge is constructed, and as the existing bridge is removed. Therefore, the overall extent and duration of over-water and in-water structures in the migration corridor will change over time, as will the potential effects of these changing features on migration behavior throughout the construction and operation phases of the SR 520, I-5 to Medina Project. Past studies of Lake Washington have indicated that the influence of in-water shading on fish behavior is complex and variable, and it may vary by species, time of year, and other factors.

New permanent fixed bridge structures will replace the existing Portage Bay Bridge and west approach. When the impact of shading from permanent bridge structures is considered, it is important to note that although these structures will be wider than the existing structure, they will also be substantially higher. The Portage Bay Bridge will be 7 to 11 feet higher (moving west to east) than the existing structure, and the new west approach structure will range in height above the water surface from approximately 18 feet just east of Foster Island to approximately 48 feet near the west transition span. Approximately 65% of the existing structure (western portion) is less than 10 feet above the surface water elevation at high water. This increase in height for the proposed structures will allow more ambient light under the structures, and although they will be wider, the intensity of the light-dark transition will be reduced overall.

Likewise, temporary over-water structures (work bridges) will also result in increased shading in the work area, although recovery to non-shaded conditions will be instantaneous and coincident with the removal of the structures. Furthermore, although work bridges tend to be very low to the water (5 to 10 feet), they are relatively narrow (about 30 feet) and in the case of the west approach, will extend only to approximately 10 feet of water depth. This means that much of the primary migratory corridor will be free of obstruction by work bridges, allowing fish to migrate around the work bridges, as fish have been documented to do for docks and other structures.

Shading and Effects on Outmigration

Shading from the bridge may affect several different salmonid species and stocks, particularly anadromous salmon produced in the Cedar River, because the proposed bridge will cross the migratory path of all juvenile fish from the river's spawning grounds. The bridge will cross the southeast edge of Union Bay, which serves as a migration corridor and as a short-term (less than 24 hours) holding area (Celedonia et al. 2008a). The new bridge will have an over-water approach structure at the edge of Union Bay, similar to the existing structure in this area. Studies of site-specific migration in this area focused on juvenile Chinook salmon, and these studies do not indicate that the existing bridge substantially alters the migration paths or timing of Chinook juveniles (Celedonia et al. 2008a, 2008b, 2009). As previously mentioned, the proposed bridge structure will be wider and higher above the lake surface than the existing bridge. Current information does not indicate that these differences are likely to substantially change the behavior of juvenile Chinook migrating under the bridge.

Some juveniles pass directly under the bridge without delay, while others spend up to 2 hours holding close to the bridge. These short delays are unlikely to result in detectable changes in survival of Chinook or other juvenile salmon as they migrate through Lake Washington and the Ship Canal. In-water and over-water structures could affect the rate and/or route of juvenile outmigration. However, the specific effect will differ by species and by the particular behavior patterns exhibited by individual fish. For some species and behavior patterns (e.g., Chinook juveniles exhibit active migration behavior), migration rates could be slowed slightly if fish tend to hold under a wider bridge deck for longer periods than they do under existing conditions. This change is not readily quantifiable; it is expected to be unmeasurable relative to existing conditions. Based on past studies, overall migration routes are unlikely to change significantly because individuals will encounter a transition point (i.e., shadow boundary) similar to that of the baseline condition and are expected to react in a similar manner. Therefore, the fish will pass through relatively quickly, move to deeper water to pass, or will be inclined to hold and/or rear for some period of time. Because salmonids can see in dim conditions, the information suggests that contrast in the boundary of shade may be the primary factor affecting behavior. Once the transition is made, fish either appear to move quickly through or hold in the shaded areas.

Celedonia et al. (2008b, 2009) showed that actively migrating fish demonstrated the three commonly observed behavior types: (1) minimal response, (2) paralleling, or (3) meandering or milling near the bridge after paralleling. The majority of fish that exhibited a holding behavior crossed multiple times or were observed milling under the bridge. None of these observations suggests that the width of the bridge shadow is influencing behavior. Spatial frequency data suggest that the majority of fish are not selecting for habitat under the bridge, so increased bridge width is not likely to result in a meaningful benefit in holding habitat. The data suggest that the transition between light and shade and the sharpness of that contrast may have the greatest influence on migration behavior.

Biological Effects of Outmigration Delays

A number of factors affect the migration rate and route of juvenile and adult salmonids through Lake Washington. Such factors include depth preferences, temperature gradients, macrophyte density, and size of the migrating fish. Although the project could incrementally affect fish behavior in terms of these innate biological factors, information on fish behavior in the project vicinity suggests that the existing structures do not result in substantial alterations of migration behavior. The location of new bridge will overlap the location of the existing bridge for a substantial portion of the primary juvenile migration route through the project area (near the west high-rise). Therefore, individuals will encounter a similar transition point (i.e., shade boundary) and similar depth conditions, although the extent and density of aquatic macrophytes could change slightly due to the wider bridge structure.

Studies indicate that active migration behavior is predominant in juvenile Chinook as opposed to holding behavior. Alteration of migration rate or migration route may result in increased energy expenditures by actively migrating fish that exhibit paralleling behavior. Relative to the overall energy expenditure (using time as a surrogate) of outmigration, actively migrating juvenile Chinook are adding only minutes to a migration typically lasting days to weeks. This change in the migration rate should not represent a significant disruption to migration behavior. Gauging any potential increase in energy expenditure in actively holding fish is speculative because they are likely taking advantage of foraging benefits during the holding period. Current information suggests that holding fish will likely behave in a manner similar to the current condition; moreover, the primary potential residual effect on migration behavior for holding fish may result in exposure to increased mean water temperatures from a later migration. The extent to which this effect may reduce survival is likely highly variable and speculative.

The project team concluded that a relatively minor migration delay may result from the increased shade from the new bridge structure. In many cases, this delay will have an insignificant effect on juvenile survival and fitness. In other cases, slight reductions to juvenile survival or fitness may result. However, several factors suggest that effects on migration patterns will be moderated:

1. Data do not indicate that the existing bridge has a detrimental influence on the migration behavior associated with adult or juvenile salmonids in the Lake Washington system.
2. Although the new structure will be wider, it will also be higher and will contain fewer columns than the existing structure. This will produce narrower, more diffuse shadows than the existing structure.
3. Adult Chinook salmon mainly migrate away from the existing bridge approaches, within deeper waters.

4.2.3. Habitat Complexity-Predation Impacts

The placement of temporary and permanent in-water structures will alter the structural complexity of the aquatic habitat. The effects of these structures on benthic habitat are discussed above; this section addresses the structures' effects on water column habitat.

Habitat complexity influences the behavior and distribution of fish, including both salmonids and their predators. Project-related factors that influence this complexity are primarily the amount of in-water structure per unit area and the spatial alignment of the structures in relation to one another, such as distance between shafts (or columns) and the distance between piers (span length).

Current information does not indicate that the existing bridge structure has any influence on adult salmonids' predator–prey interactions in Lake Washington. Because the new structures will be sufficiently similar in arrangement and size to the existing structures, they are not likely to have a different influence on these predator–prey interactions.

Therefore, any effects on associated predator–prey distributions requiring compensatory mitigation are expected to apply mainly to juvenile salmon outmigration. Any such effects will likely be much reduced for older age classes and larger-size fish (such as residual Chinook, steelhead, or coho). During outmigration, these larger fish are generally not exposed to predation because of their limnetic distribution; they do not show the same affinity for the shoreline as do smaller migrants such as 0-age Chinook salmon and sockeye.

The work bridges and the replacement bridge will result in substantial increases in shading and habitat complexity in the project area. These conditions are expected to provide additional predator habitat in the area during the proposed construction period, although the long-term habitat conditions are expected to be similar to existing conditions.

Species known to prey on juvenile salmon include northern pikeminnow and smallmouth bass. The data suggest that northern pikeminnow do not select areas near the bridge over other habitat types. Studies found that this species was primarily concentrated at 4- to 6-meter depths, and most commonly used habitat with moderately dense vegetation. Some attraction to nighttime lights was noted, although this was inconsistent from year to year (Celedonia et al. 2008a, 2008b, 2009). Although smallmouth bass showed an affinity for the bridge columns, information suggests that their overall abundance is no greater at the bridge than in other suitable habitat types. In addition to selecting the bridge columns as a structural habitat component, smallmouth bass were found to prefer a depth of 4 to 8 meters and often sparse vegetation or edge habitat associated with macrophytes. Moderately dense to dense vegetation was used only occasionally. Neither pikeminnow nor smallmouth bass have been shown to prefer the shade or cover provided by the overhead bridge structure.

The fewer and more widely spaced in-water columns of the proposed permanent bridge structures are expected to generally reduce habitat complexity in the immediate area of the bridge, although the columns will extend out. This alteration is not expected to substantially affect the quality of predator and prey habitat provided by the permanent bridge structures. With the exception of Zone 7 (Floating Bridge), the increased habitat complexity associated with temporary structures will occur primarily in shallow water areas, which already contain substantial complexity from aquatic macrophyte beds. An increase in bridge height could allow more ambient light under the bridge and an increase in macrophyte density, particularly along the southern exposure. An increase in height will also reduce the intensity of cover caused by shading. This increase could in turn positively affect northern pikeminnow habitat and negatively affect smallmouth bass habitat. Therefore, while the project may slightly increase the quality of the available predator habitat in the project area, this increase will generally be minor.

However, some proportion of outmigrating juvenile Chinook salmon (and possibly other salmonid species) is likely to exhibit a holding behavior, resulting in increased residence time around the west approach structure. Of those fish exhibiting holding behavior, some may experience direct mortality via predation while holding near the structure, or a reduction in overall fitness as suggested by later saltwater entry (Celedonia 2009).

Although impacts to the aquatic habitat are expected to occur due to increased shade and structural complexity, several factors suggest that associated changes to predator–prey relationships will be low:

1. The new bridge will represent an improvement over the baseline conditions because the bridge is higher (although wider) and has fewer and more widely spaced in-water structural elements, reducing the overall complexity per unit area.

2. Current data do not indicate that the existing bridge has an influence on predator–prey relationships associated with adult salmonids.

3. Adult Chinook salmon mainly migrate away from the existing bridge approaches, within deeper waters.

4.2.4. Potential Effects on Adult Salmon

The impact mechanisms associated with the long-term operation of the project (shading/migration effects, predation, and benthic fill) apply primarily to juvenile salmonids, specifically to outmigrating fish. Adult salmonids are not expected to be measurably affected by project operation because they are not rearing, nor are they subject to piscivory, and they migrate through the project area quickly in deeper water. However, returning adults will be migrating through the project area during a time when relatively intensive in-water construction activities occur. Project avoidance and minimization measures will limit or eliminate direct construction effects.

Data are insufficient to assess the potential influence of the existing west approach bridge structure on the migration behavior of adult salmonids as they return to the Lake Washington watershed to spawn. Most Lake Washington adult Chinook salmon adults are likely to migrate through the action area from June through late September. However, individual adult salmonids are expected to migrate relatively quickly through the project area, and in relatively deep water (where water temperatures are cooler) away from the most intensive in-water construction areas. This behavior is likely to minimize potential effects on adult salmonids. The average time spent by adult Chinook salmon in the Lake Washington in 1998 was 2.9 days (Fresh et al. 1999). This tendency of adult salmonids to migrate quickly through Lake Washington, once they begin moving, and their lack of dependence on shoreline habitat, limit their susceptibility to construction and operation of the Evergreen Point Bridge structures. The existing data indicate that adult salmon do not congregate within the west approach/Union Bay area during their migration to spawning areas in the Lake Washington basin. Available data do not indicate that returning adults respond to light and they are not susceptible to piscivory in Lake Washington.

An analysis of the extent of project-related construction impacts concludes that returning adult salmon will not be adversely affected. Through pre-project studies, including the test pile project, WSDOT has sought to identify and demonstrate that best management practices will minimize the potential for impacts to fish. Turbidity and noise observations during the test pile project (Illingworth and Rodkin 2010) suggest that construction impacts from in-water work activities are not expected to affect the primary migratory corridor for returning adult salmonids. Research suggests that adult salmon use a migratory corridor with water depths of approximately 20 feet or greater through the Ship Canal (Fresh et al. 1999). WSDOT analyses show that underwater noise and turbidity will not exceed identified thresholds within 300 feet of this migratory corridor in the Ship Canal. Although construction activities will cross the migratory corridor in the west approach vicinity, this is after adult fish have completed their migration through the Ship Canal, and adult fish are expected to use deeper water in this area where the only in-water construction activities will be anchor placement. Anchor placement occurs in Lake Washington in deep waters after adult salmon have successfully migrated through the Ship Canal. As such, the potential for adult exposure to construction-related impacts is considered to be very limited, and would most likely occur in the deep anchor placement locations where avoidance would require little effort.

For these reasons, no causal link can be established from the project regarding potential effects to adult fish, so direct compensatory mitigation for adults is not warranted. However, WSDOT recognizes that returning adult fish in the Lake Washington Ship Canal are exposed to potential stress due to degraded water quality conditions in this area (see Section 3.6.3 for discussion). Therefore, while the proposed mitigation activities are generally focused on offsetting impacts to future year-classes of juvenile salmonids, several mitigation actions are included that will also directly and indirectly benefit adult fish in the unlikely event that adult fish are affected by project construction activities.

4.2.5. Potential Effects on Limnology

In response to comments from the Muckleshoot Indian Tribe Fisheries Division (MITFD) on the potential effects of the floating span on lake circulation, WSDOT undertook a study to evaluate the possibility of effects to aquatic life (WSDOT 2011e). A conceptual model was developed to analyze the interaction of the proposed floating span on circulation and temperature, and found that the floating span will not have measurable effects on these limnological processes. As such, no impacts to aquatic life are anticipated from an alteration of limnological process.

4.3 Impact Assessment

4.3.1. Shading Impacts

To calculate the shading impacts of the permanent and temporary over-water structures, WSDOT first determined the total net acreage of (plan view) over-water structure resulting from construction and operation of the project (Figure 4-2; Tables 4-2 and 4-3). This calculation did not include the column and footing areas because these impacts were calculated as a separate impact type (see Section 4.3.2, Benthic Habitat Impact). For each impact type (permanent and temporary), the impacts were then sorted by Salmonid Functional Zone and multiplied by the appropriate Fish Function Modifier (see Section 4.1).

Impacts to juvenile salmonids, if any impacts occur in this zone, are believed to be generally limited to slight migration delays in the deep water habitat. Therefore, WSDOT used the total area of the pontoon structures to calculate the shading (migration) impact. WSDOT believes that this approach is a conservative approximation of environmental risks from the floating bridge, which are insignificant and discountable.

For permanent shading, the modified acreages were then summed to produce a total impact number (6.94 acres) that will require offsetting mitigation (see Table 4-2). For temporary shading impacts, a similar process was used, but the modified acreage was calculated by year (based on the area of over-water structure present during each construction year), and then summed to yield a time-weighted impact number of 11.92 acre-years (see Table 4-3). One acre-year is defined as one acre of impact over one year. This calculation takes into account the cumulative temporal effect of multiple structures present for specific time periods.

As noted in Section 4.1, impact calculation for shading (as a surrogate for migration impacts) in Zone 7 represents a special case, because unlike the other zones, any migration effects in this area would be caused by an obstruction in open water habitat and not shading on an open water column. Although the draft of the new pontoons will be slightly deeper than that of the existing pontoons, migrating fish could still move under the structure, and/or orient along the structure.

Additional over-water structure (potential shading impact) will result from construction of the new maintenance dock. However, this impact is considered self-mitigating because construction will require removal of two existing docks located directly under the new east approach bridges. Removal of the southern dock will eliminate about 860 square feet of over-water structure, while removal of the northern dock will benefit about 545 square feet of lake habitat. These docks are constructed of creosote-treated timber and have wooden decking with little to no space between the deck planks, both factors that are known to degrade habitat quality for salmonids. Therefore, removal of these two structures (totaling 1,405 square feet in over-water area) will fully offset construction of the maintenance facility dock, which although slightly larger in area (about 1,660 square feet over water), will be constructed using fish-friendly methods. These methods include the use of approximately 300 square feet of grated decking that allows a significant amount of ambient light to pass through, and the use of materials that do not negatively affect water quality. Additionally, the maintenance facility dock will be generally higher off of the water surface than the existing docks (also increasing ambient illumination), ranging from about 1 foot off the water at the lowest point, gradually rising up to about 7 feet above the water at the shoreline. These actions will maintain or improve aquatic habitat conditions along the shoreline area of the east approach.

Temporary shade impacts will result from the work bridges. Preliminary project design did not include full engineering of temporary work bridges, a task that will be undertaken during future design phases, but work bridges are expected to span beneath both the existing bridges and the proposed bridges. Further review of the impact assessment methodology described in the conceptual plan indicated that areas underneath the proposed bridge and work bridges were calculated as both temporary and permanent impacts for the same areas. This plan reflects a change to account for those areas affected only by the work bridges' temporary shade impacts and the proposed bridge's permanent shade impact.

During the NRTWG process, WSDOT described the elevation of temporary and permanent work bridges and explored whether higher bridges might have less impact on aquatic resources. During these discussions it was established that work bridges would likely have little clearance between the bottom of the structure and the water's surface, creating a high potential for shade impacts, whereas permanent bridges are expected to be considerably higher, providing opportunities for direct and refracted light to limit shade intensity. Ultimately, due to the complexities involved in analyzing shade impacts, the NRTWG process concurred with considering all areas under bridge limits to be shaded and to require equivalent impact quantification.

The Conceptual Aquatic Mitigation Plan used the proposed bridge limits to quantify permanent shade impact irrespective of height, which makes double-counting the work bridge shade impact unwarranted and inconsistent with traditional impact assessment methodologies. Consequently, WSDOT has revised the methodology to exclude the overlap of temporary shade impacts with permanent shade impacts, and remain consistent with the concept of counting an impact as either temporary or permanent. The temporary shade impact quantities contained in this document reflect the area of work bridges over aquatic habitat outside of the proposed bridge limits.

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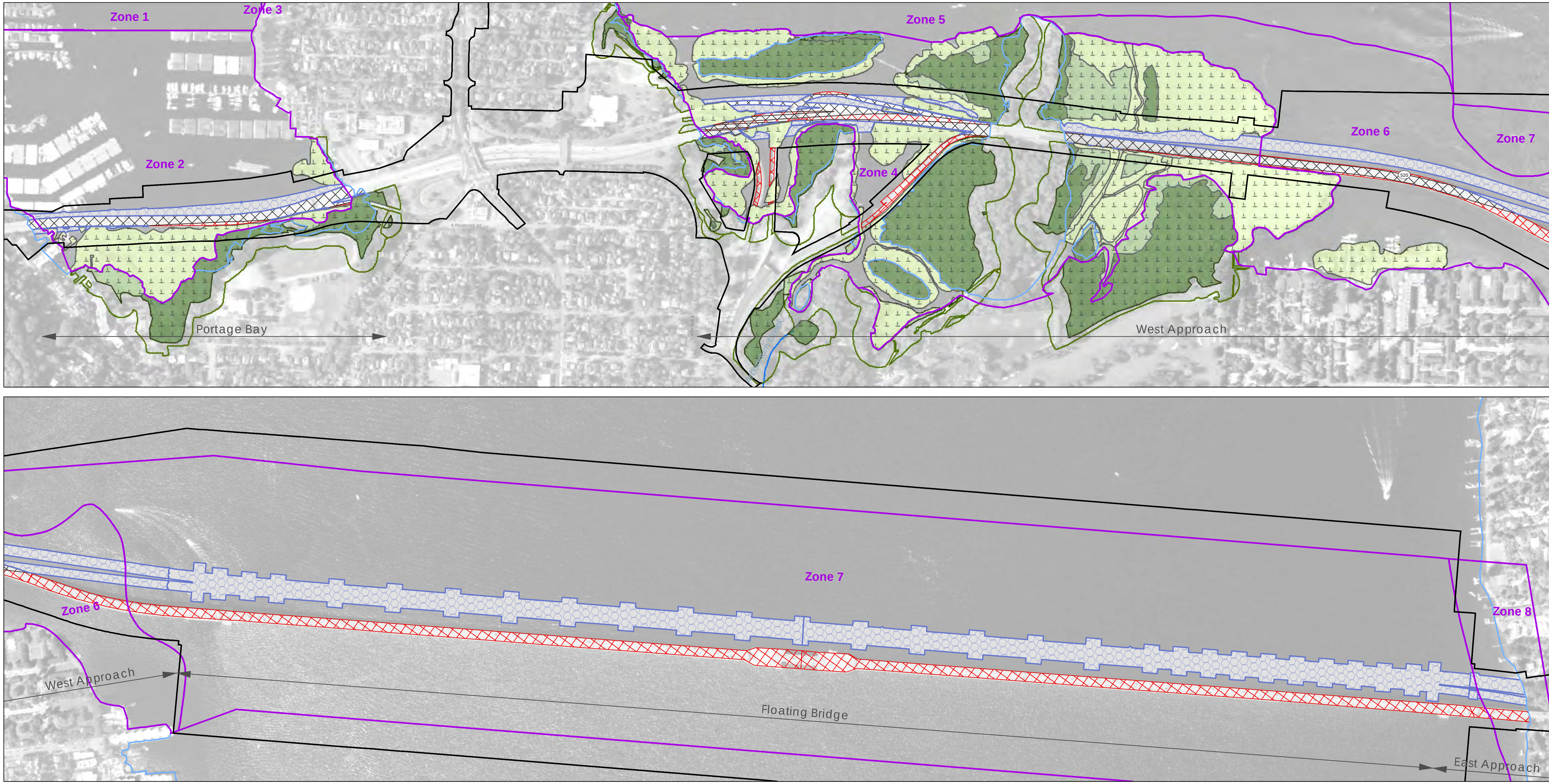

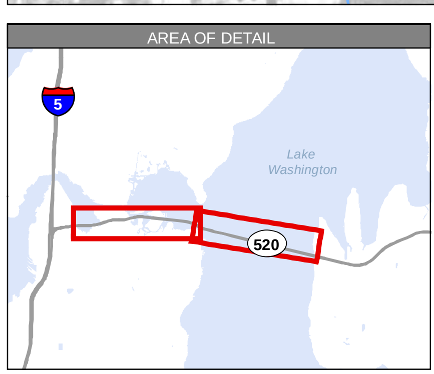

Limits of Construction
Ordinary High Water Mark (18.57')
Stream
Salmonid Use Ecological Zone

Wetland Class
Aquatic Bed
Emergent
Forest/Shrub
Wetland Buffer

Aquatic Shading Impacts
Proposed Permanent Shading
Maintained Shading
Removed Shading

N
0 150 300 600 Feet

Figure 4-2
Proposed and Existing Shading Impacts

SR 520; I-5 to Medina: Bridge Replacement and HOV Project

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Table 4-2. Permanent Project Impacts

Salmonid Use Ecological Zone	Existing Acreage	Proposed Acreage	Net Acreage	Fish Function Modifier	Permanent Impacts (acres)[1]
Permanent Shading Impacts					
Zone 8: East Approach	0.30	0.65	0.35	0.8	0.28
Zone 7: Floating Bridge	12.09	26.59	14.50	0.1	1.45
Zone 6: West Approach	2.61	5.28	2.67	1.0	2.67
Zone 4: Arboretum and Foster Island	7.22	8.50	1.28	0.1	0.13
Zone 3: Montlake Cut	0.14	0.18	0.18	1.0	0.18
Zone 2: Portage Bay	3.13	6.85	3.72	0.6	2.23
		Total Permanent Shading Impacts			**6.94**
Permanent Benthic Impacts (includes impacts to sockeye spawning beach habitat)					
Zone 8: East Approach	0.01	0.05	0.04	0.8	0.03
Zone 7: Floating Bridge	0.02	1.00	0.98	0.1	0.10
Zone 6: West Approach	0.03	0.09	0.05	1.0	0.05
Zone 4: Arboretum and Foster Island	0.11	0.09	-0.02	0.1	0.00
Zone 2: Portage Bay	0.04	0.34	0.30	0.6	0.18
		Total Permanent Benthic Impacts			**0.37**
Permanent Habitat Complexity Impacts					
Zone 8: East Approach	0.03	0.01	-0.03	0.8	-0.02
Zone 7: Floating Bridge	0.11	0.07	-0.04	0.1	0.00
Zone 6: West Approach	0.46	0.36	-0.10	1.0	-0.10
Zone 4: Arboretum and Foster Island	1.08	0.48	-0.60	0.1	-0.06
Zone 2: Portage Bay	0.37	0.25	-0.12	0.6	-0.07
	Total Permanent Habitat Complexity Impacts				**0**[2]
			Grand Total Permanent Impacts		**7.30**

[1] The sum of individual impact numbers may not equal the totals due to rounding.

[2] The negative values for each zone are negative, as is the total. Therefore, permanent habitat complexity habitat conditions will improve, and no impact will result.

Table 4-3. Temporary Project Impacts

Salmonid Use Ecological Zone	Sequence (Calendar Year)	Acreage	Fish Function Modifier	Modified Acreage	Impact Duration (Years)	Temporary Impacts (Acre-Year)
Shading Impacts						
Zone 8: East Approach	2012	0.35	0.8	0.48	1	0.48
	2013	0.35	0.8	0.48	1	0.48
	2014	0.35	0.8	0.48	1	0.48
	2015	0.0	0.8	0	1	0
	2016	0.0	0.8	0	1	0
	2017	0.0	0.8	0	1	0
					Subtotal	**1.44**

Salmonid Use Ecological Zone	Sequence (Calendar Year)	Acreage	Fish Function Modifier	Modified Acreage	Impact Duration (Years)	Temporary Impacts (Acre-Year)
Zone 7: Floating Bridge	2012	0.14	0.1	0.01	1	0.01
	2013	0.14	0.1	0.01	1	0.01
	2014	0.14	0.1	0.01	1	0.01
	2015	0	0.1	0	1	0
	2016	0	0.1	0	1	0
	2017	0	0.1	0	1	0
					Subtotal	**0.03**
Zone 6: West Approach	2012	0	1.0	0.00	1	0.00
	2013	1.10	1.0	1.10	1	1.10
	2014	1.10	1.0	1.10	1	1.10
	2015	1.86	1.0	1.86	1	1.86
	2016	1.86	1.0	1.86	1	1.86
	2017	0.76	1.0	0.76	1	0.76
					Subtotal	**6.68**
Zone 4: Arboretum and Foster Island	2012	0	0.1	0.00	1	0.00
	2013	1.23	0.1	0.12	1	0.12
	2014	1.23	0.1	0.12	1	0.12
	2015	2.80	0.1	0.28	1	0.28
	2016	2.80	0.1	0.28	1	0.28
	2017	1.57	0.1	0.16	1	0.16
					Subtotal	**0.96**
Zone 2: Portage Bay	2012	0	0.6	0.00	1	0.00
	2013	1.77	0.6	1.06	1	1.06
	2014	2.16	0.6	1.30	1	1.30
	2015	2.16	0.6	1.30	1	1.30
	2016	0.69	0.6	0.41	1	0.41
	2017	0.30	0.6	0.18	1	0.18
					Subtotal	**4.25**
					Total Shading Temporary Impacts	**11.92**
Benthic Impacts[1]						
Zone 8: East Approach	2012	0.01	0.8	0.01	1	0.01
	2013	0.01	0.8	0.01	1	0.01
	2014	0.01	0.8	0.01	1	0.01
	2015	0.0	0.8	0	1	0
	2016	0.0	0.8	0	1	0
	2017	0.0	0.8	0	1	0
					Subtotal	**0.03**
Zone 7: Floating Bridge	2012	0.01	0.1	0.00	1	0.00
	2013	0.01	0.1	0.00	1	0.00
	2014	0.01	0.1	0.00	1	0.00
	2015	0	0.1	0	1	0
	2016	0	0.1	0	1	0
	2017	0	0.1	0	1	0
					Subtotal	**0.00**

Salmonid Use Ecological Zone	Sequence (Calendar Year)	Acreage	Fish Function Modifier	Modified Acreage	Impact Duration (Years)	Temporary Impacts (Acre-Year)
Zone 6: West Approach	2012	0	1.0	0.00	1	0.00
	2013	0.04	1.0	0.04	1	0.04
	2014	0.04	1.0	0.04	1	0.04
	2015	0.07	1.0	0.07	1	0.07
	2016	0.07	1.0	0.07	1	0.07
	2017	0.03	1.0	0.03	1	0.03
					Subtotal	**0.24**
Zone 4: Arboretum and Foster Island	2012	0	0.1	0.00	1	0.00
	2013	0.06	0.1	0.01	1	0.01
	2014	0.06	0.1	0.01	1	0.01
	2015	0.13	0.1	0.01	1	0.01
	2016	0.13	0.1	0.01	1	0.01
	2017	0.07	0.1	0.01	1	0.01
					Subtotal	**0.05**
Zone 2: Portage Bay	2012	0	0.6	0.00	1	0.00
	2013	0.08	0.6	0.05	1	1.06
	2014	0.09	0.6	0.06	1	1.30
	2015	0.09	0.6	0.06	1	1.30
	2016	0.04	0.6	0.02	1	0.41
	2017	0.02	0.6	0.01	1	0.18
					Subtotal	**0.20**
					Total Benthic Temporary Impacts	**0.52**
Habitat Complexity/Predator Impacts						
Zone 6: West Approach	2012	0	1.0	0	1	0
	2013	0.64	1.0	0.64	1	0.64
	2014	0.64	1.0	0.64	1	0.64
	2015	1.00	1.0	1.00	1	1.00
	2016	1.00	1.0	1.00	1	1.00
	2017	0.44	1.0	0.44	1	0.44
					Subtotal	**3.72**
					Grand Total Temporary Impacts	**16.16**

[1] Based on the absence of design information on the location of piles to support temporary work trestles, benthic habitat impacts were computed using the estimated pile area to work bridge area for the entire over-water structure area of the work bridge decks.

4.3.2. Benthic Habitat Impact

To calculate the benthic habitat impacts of the permanent over-water structures, WSDOT first determined the total net acreage of benthic structures at all water depths less than 60 feet (see Figure 4-3, and Tables 4-2 and 4-3). This depth cut-off was deemed appropriate by NRTWG participants based on the life history of salmonids in the project area because these salmonids do not use benthic habitat in these greater depths. For permanent benthic habitats, the modified acreages were then summed to produce a total impact number (0.37 acre) that will require offsetting mitigation (see Table 4-2).

Temporary benthic impacts will result primarily from the work bridges, with the exception of temporary columns associated with the interim west approach connection (anticipated in construction years 2015 and 2016). Preliminary design resulted in estimates of the general location and size of the work bridges, as well as the approximate number of piles and their diameters. However, preliminary design does not include the exact size, configuration, or location of individual piles, so no spatial data were available to overlay on aquatic habitat. Therefore, for the purposes of temporary impact calculations shown in Table 4-3, benthic impacts were computed using the ratio of pile area to work bridge area for the entire extent of work bridges over aquatic habitat, and then summed to yield a time-weighted impact quantity. The combination of work bridge piles and the temporary interim west approach columns would result in 0.52 acre-years of impact.

Based on preliminary geotechnical investigations (WSDOT 2011b), the underdrain associated with the maintenance facility under the east approach could result in a slight reduction in the aquifer pressure, which may result in a slight decrease in upwelling rates within benthic habitat areas that support sockeye salmon spawning. However, the potential reduction is of very small magnitude (a worst case estimate is about a 7% reduction in hydraulic head, which relates to flow velocity) (WSDOT 2011g), and therefore no substantial reduction in either the distribution or success of spawning sockeye salmon is expected. Based on the geotechnical information, this potential impact is considered insignificant, and does not require compensatory mitigation.

4.3.3. Habitat Complexity Impacts

To calculate the impacts of the permanent in-water structures (columns and piers) on habitat complexity (predation), WSDOT first determined the area of the predation zone around each in-water structure. The predation zone area is based on data describing predator behavior (discussed in Section 3) and is defined as the plan view distance of the portion of the water body extending from the outside edge of a column or pier to a distance of 5 feet (i.e. a 5-foot buffer around each vertical structure).

The 5-foot distance was chosen based on field observations and scientific studies of the visual detection and reaction distances in picivorous fish. For example, Sweka and Hartman (2003) measured a maximum reactive distance for smallmouth bass of 65 centimeters (cm) (2.1 feet) in clear water. The reactive distance decreased exponentially with increasing turbidity. Similar reactive distances (between 0.8 and 6.6 feet) have been measured for largemouth bass (Howick and O'Brien 1983; Savino and Stein 1989), with the vast majority of strikes occurring within a distance of 5 feet. Based on these data, a predation zone of 5 feet was applied to each bridge column. For each Salmonid Functional Zone, the net change in predation area was calculated and then multiplied by the appropriate Fish Function Modifier (see Table 4-2).

For permanent habitat complexity impacts, all modified acreages for each Salmonid Functional Zone were negative. This indicates that the net predation area will decrease under future conditions. Therefore, no compensatory mitigation is required (see Figure 4-4 and Table 4-2). For temporary habitat complexity impacts, an identical method was used for impact calculation, although temporary predation was calculated only for Zone 6, the west approach, because it includes the only area where temporary in-water structure overlaps with the primary outmigration route. The modified acreage was calculated by year (based on the area of over-water structure present during each construction year), and then summed to yield a time-weighted impact number of 3.72 acre-years (see Table 4-3).

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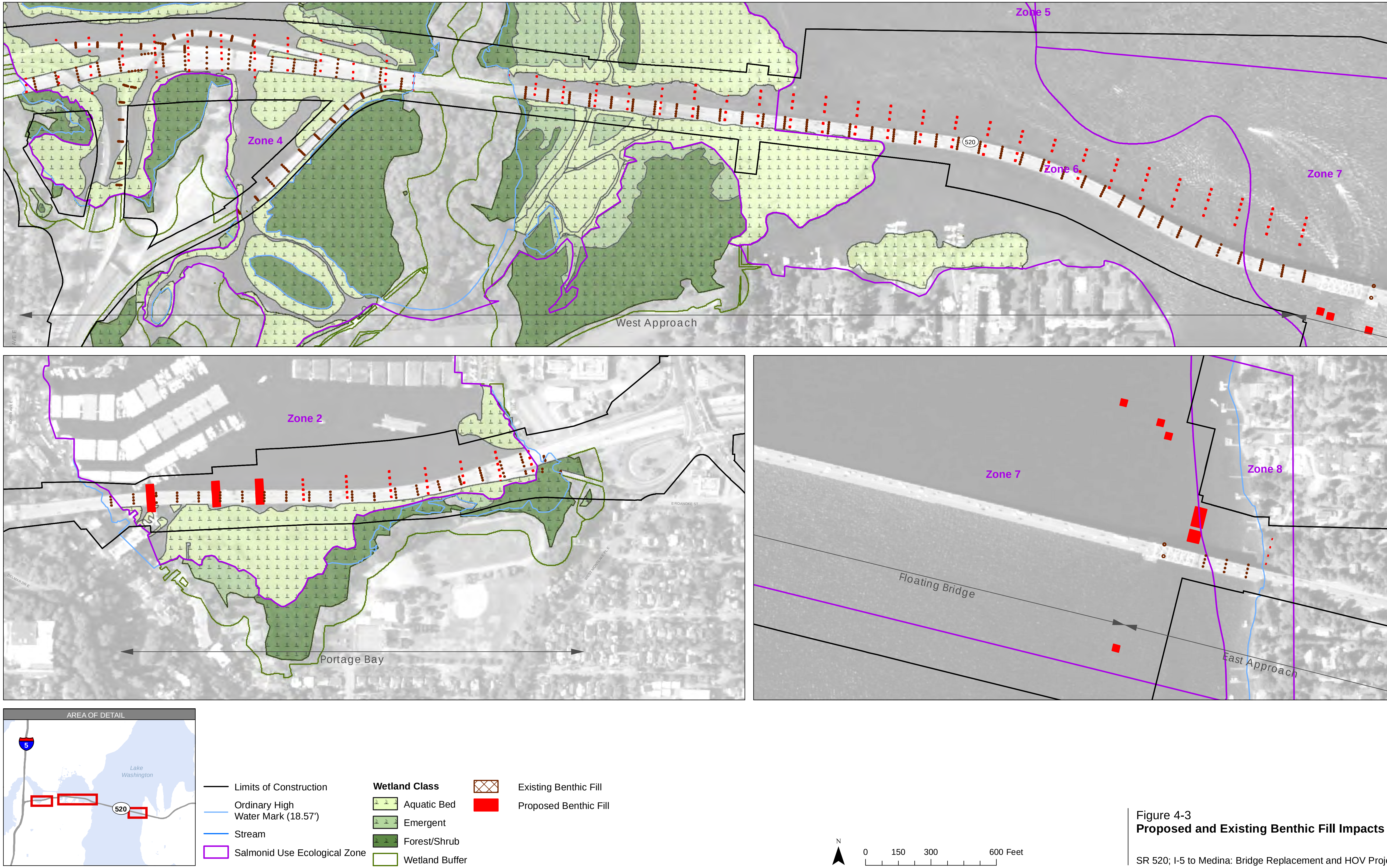

Figure 4-3
Proposed and Existing Benthic Fill Impacts

SR 520; I-5 to Medina: Bridge Replacement and HOV Project

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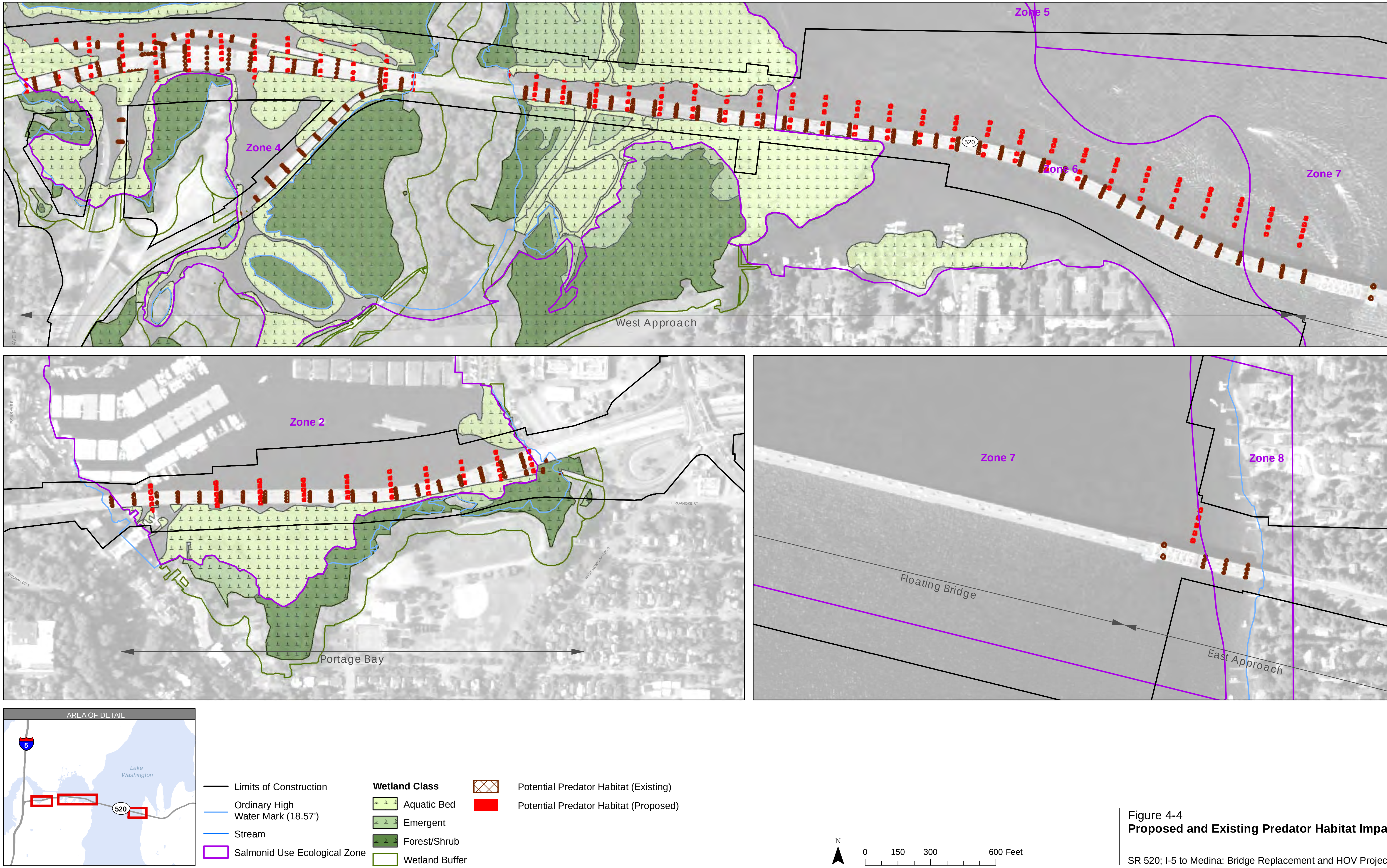

Figure 4-4
Proposed and Existing Predator Habitat Impacts

SR 520; I-5 to Medina: Bridge Replacement and HOV Project

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4.3.4. Impact Summary

To determine overall project mitigation needs, the mitigation team summed the impact calculations for shading, benthic fill, and structural complexity (see Tables 4-2 and 4-3). Using the methods discussed above, permanent project impacts are 7.30 acres, while temporary project impacts equate to 25.12 acre-years. The impact numbers were derived using the habitat function and life history stage model presented in Section 3 (see Figure 3-2).

Conservative Impact Analysis Assumptions

The mitigation team believes these methods are appropriate to describe the primary impact mechanisms, and that the methodology uses generally conservative assumptions and rules, which tend to err on the side of overstating the potential impacts to fishery resources. Some of the conservative assumptions used in impacts analysis are listed below.

Over-water and structural complexity: Under the methodology, over-water and structural complexity impacts from temporary and permanent structures are effectively treated as affecting 100% of both the available habitat and the associated habitat functions (for the time frame they are physically present). That is, they are treated as if the affected habitat was being removed or filled. In reality, although aquatic habitat functions will be affected, the habitat will generally be available for use and will support salmonid life histories, albeit at a somewhat reduced level. For example, juvenile salmonids will still migrate under the permanent bridge and temporary work bridges, with many of these fish experiencing no negative effects to survival or fitness. Also, although some increase in predation rate may occur in the vicinity of the temporary and permanent structures compared to existing conditions, the vast majority of rearing and migrating juveniles will not likely become prey due to these structures.

Benthic impacts: Permanent impact calculations for benthic impacts were also conservative because they included the area of column footings. Although the footings will initially displace benthic habitat, over time the mudline will form over the footings as sediment is redistributed. Final design may include the burial of mudline footings immediately following construction, thereby immediately providing available substrate. Although the footing area will provide at least some important benthic habitat functions over time, these areas were counted in the total impact area.

Shading impacts: Under the methodology, permanent shading impacts are assessed using a metric of net increase of over-water structure. This does not account for the net increase of height, and therefore of light intensity, under the new bridge structure compared to the existing structure. In addition, the gap between the north and south superstructures will also allow a greater amount of light under the bridge. Although the exact change in light intensity over the project area cannot be accurately calculated (and thus was not used for analysis purposes), it is likely that under future conditions, the intensity of shading will be less than under existing conditions, at least in key areas such as the west approach (Zone 6) or Portage Bay (Zone 3).

At all permanent structures and temporary work bridges in the west approach area (Zone 6), shading and structural complexity impacts were double-counted in cases where they overlapped (each impact type was counted separately and summed). This approach is conservative because an individual fish cannot be affected on multiple endpoints (e.g., both survival and growth).

In addition, a conservative approach to calculating shading impacts was taken where temporary over-water structures overlapped with future permanent bridge structures. In these cases, the impacts were counted separately for both permanent and temporary shading impacts where these impacts overlap.

Temporary work bridges: Preliminary engineering on the configuration and extent of the temporary work bridges was based on relatively conservative assumptions. Once final engineering on the work bridges is complete and a contractor is chosen, there is a likelihood that the extent (length) of the work bridges, and the associated over-water and in-water structures associated with the work bridges will substantially decrease for reasons including potential materials cost savings, schedule savings, and/or the use of different construction methods.

Fish Function Modifier: Furthermore, in several cases the methodology took a conservative approach to the assignment of Fish Function Modifiers by defaulting to the highest level of salmonid use documented for any given area. For example, in Zone 2 (Portage Bay), the entire zone was assigned a modifier of “moderate”, even though most studies have shown only minor use of the zone’s shallower southern portion by juvenile and adult salmonids (City of Seattle and USACE 2008).

5. Mitigation Framework

The overall goal of WSDOT mitigation measures is to achieve no net loss of habitat functions and values. Mitigation for impacts to aquatic functions and values from the proposed project activities will be considered and implemented, where feasible, in the following sequential order:

1. Avoiding the impact altogether by not taking a certain action or parts of an action.
2. Minimizing impacts by limiting the degree or magnitude of the action, and restoring temporary impacts.
3. Compensating for the impact by replacing or providing substitute resources or environments.

5.1 Avoidance of Aquatic Impacts – Design Features

The structures included in this project have been designed to avoid and minimize aquatic impacts whenever practicable. Specific design features to avoid and minimize effects on aquatic habitat are listed in the Ecosystems Discipline Report Addendum and Errata (WSDOT 2011f) and described in the following sections.

5.1.1. In-water Structures

An increased span length has reduced the number of in-water structures, relative to the existing condition. The use of precast girders will eliminate the need for falsework in most locations. Columns will be spaced farther apart, relative to the existing condition. Piers that require footers will be avoided, when possible. When structure foundations require footings, mudline footings will be installed. Mudline footings will result in a reduction of in-water structure and shading compared to waterline footings. The footings will be installed below the mudline, allowing for natural deposition on top of the footing. Finally, the length and over-water coverage of the maintenance dock was designed with the minimum dimensions necessary to provide its required function. The size and number of pilings have been minimized to the most practicable extent. A detailed description of in-water structures in each project area is included in Section 2.1 and in the biological assessment (WSDOT 2010a).

5.1.2. Shading

Shading from over-water structures can delay juvenile salmonid migration by invoking a behavioral response such as milling, paralleling, or holding, and because a shade edge provides a foraging opportunity (see Section 4.2.2 for a discussion). Piscivorous fishes also use this shade edge to forage, thereby increasing the risk of predation on juvenile salmonids.

The shading intensity and sharpness of the shade edge is attenuated by increasing bridge height and reducing bridge width (see Section 4.2.2 for discussion).

The Portage Bay, west approach, and east approach bridges will be wider, but significantly higher than the existing structures (see Table 5-1, and Figures 2-2, 2-3, and 2-4). Increasing bridge width can increase shading intensity. The proposed widths of the Portage Bay, west approach, and east approach bridge structures are greater than the existing widths, even though the number of lanes and shoulder widths have been minimized. The west approach bridge will have a gap between eastbound and westbound lanes, further minimizing shading intensity. A detailed description of bridge height and width for each project area is included in Section 2.1 and in the biological assessment (WSDOT 2010a).

Table 5-1. Proposed Changes to Bridge Height Over Water (feet)

Statistic	Portage Bay		West Approach		East Approach	
	Existing	**Proposed**	**Existing**	**Proposed**	**Existing**	**Proposed**
Minimum	6	16	4	12	52	66
25th Percentile	8	19	5	21	ND[1]	ND[1]
75th Percentile	37	35	21	42	ND[1]	ND[1]
Maximum	63	63	45	49	64	78

[1]Percentiles were based on bridge height at pier locations. The proposed East Approach structure only has two piers. Therefore, no percentiles were calculated.

5.1.3. Stormwater Discharge

The proposed stormwater management condition will be substantially improved over the existing condition. All new pollutant-generating impervious surfaces (PGIS) will receive stormwater quality treatment. Enhanced stormwater treatment will occur where possible. Stormwater treatment includes the combined sewer system, conventional treatment BMPs, and—in the case of the floating bridge portion of the project—an innovative stormwater treatment approach identified in an “all known, available, and reasonable technology” (AKART) study (WSDOT 2010c).

Existing areas that will not receive post-construction treatment are primarily areas associated with restriping activities in the I-5 interchange. Project-related stormwater will be treated by facilities designed on the basis of the requirements in the 2008 WSDOT *Highway Runoff Manual* (HRM) and the WSDOT *Hydraulics Manual*. New and replaced PGIS requires stormwater treatment to a basic level of treatment for Lake Union and Lake Washington. The project will also be providing enhanced treatment for stormwater discharge from SR 520 into Lake Washington to further minimize any effects on the lake due to dissolved metals.

Stormwater discharge impacts will be minimized because of outfall location and design. New outfalls will be located at or near existing outfalls. Outfall discharge and energy dissipation will occur above the OHWM. Discharged stormwater will be conveyed to the lake. Revegetation will occur between outfalls and water bodies.

A detailed description of operational stormwater treatment and management is in section 2.3.1 and the biological assessment (WSDOT 2010a).

5.1.4. Lighting

The proposed lighting plan has minimized the number of luminaires to occur in areas of potential traffic conflicts such as merge lanes and transit stops. The number of luminaires will be decreased from 124 under existing conditions to 79 for the proposed condition. A photometric analysis has conluded that light spillage from proposed luminaires will be limited to areas of lesser importance to juvenile salmonids, and none will occur in Zone 6 along the west approach. Where proposed, cut-off light fixtures with shielding will be used when fixtures are adjacent to water. Cut-off lights focus on the target area, reducing the amount of light that shines outside the bridge roadway onto the water surface. Lights will be placed on the center median whenever possible to limit light spillage. During bridge operation, nighttime lighting on water surfaces will be avoided or minimized where feasible, and the net effect of light spillage will be an improvement over the baseline condition. A detailed description of proposed roadway lighting is included in Section 2.32 and in the biological assessment (WSDOT 2010a).

5.2 Avoidance of Aquatic Impacts – Construction Timing

WSDOT has been collaborating in research that improves our understanding of juvenile Chinook distribution, movement, and transit time through the project area (Tabor et al. 2010a; Celedonia et al. 2008a; 2008b). Juvenile Chinook are the most vulnerable to the presence of in-water structures and construction impacts because of their small size during migration. These tracking studies confirmed the benefit of previously published work periods, and also contributed to the basis of the project impact assessment (see Section 4).

The construction schedule has been optimized to limit the number of construction years. Seasonal restrictions (i.e., work windows) will be applied to the project to avoid or minimize potential impacts to fish species based on the Hydraulic Project Approval (HPA) issued by WDFW. The in-water work windows vary between water bodies (Table 5-2). The in-water work window is timed to protect peak abundances of juvenile and adult salmonids.

In-water construction will adhere to the proposed in-water construction timing shown in Table 5-2. The proposed dates were developed through a series of in-water construction Technical Work Group meetings attended by representatives from WSDOT, the United States Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), the Washington Department of Fish and Wildlife (WDFW), the Muckleshoot Indian Tribe, and local fish experts. Each in-water construction period is predicated on the nature of the construction activity, the habitat function zones described in Section 3.5.2, and the expected timing of fish use in the habitat function zone.

Table 5-2. Proposed In-Water Construction Periods for the Various Project Elements

Project Element	Proposed In-Water Construction Timing
Portage Bay [a]	
Work bridge/falsework pile installation	September 1 to April 30
Work bridge deck	N/A
Cofferdam – vibratory	August 16 to April 30
Mudline footings in cofferdam	N/A
Drilled shaft – vibratory	August 16 to April 30
Bridge superstructure	N/A
Materials transport	N/A
Column demolition	N/A
Pile removal	August 16 to April 30
Cofferdam removal	August 16 to April 30
Union Bay and West Approach – Salmonid Habitat Zone 4 [b]	
Work bridge pile installation	September 1 to April 30
Work bridge deck	N/A
Drilled shaft – vibratory	N/A
Bridge superstructure	N/A
Materials transport	N/A
Column demolition	N/A
Pile removal	N/A
West Approach – Salmonid Habitat Zone 6 [b]	
Work bridge pile installation	October 1 to April 15
Work bridge deck	N/A
Drilled shaft -–vibratory	August 1 to March 31
Bridge superstructure	N/A
Materials transport	N/A
Column demolition	N/A
Pile removal	August 1 to March 31
West Approach Connection Bridge [b]	
Work bridge deck	N/A
Drilled shaft – vibratory	August 1 to March 31
Bridge superstructure	N/A
Materials transport	N/A
Column demolition	N/A

Project Element	Proposed In-Water Construction Timing
Floating Bridge [b]	
Temporary pile anchors – vibratory	July 16 to March 15
Gravity or shaft anchor installation – west end	July 16 to March 15
Gravity or shaft anchor installation – east end	September 1 to May 15
Fluke anchor installation	N/A
Pontoon assembly	N/A
Bridge outfitting/superstructure	N/A
Materials transport	N/A
Pile removal	July 16 to March 15
East Approach [c]	
Work bridge/falsework pile installation	August 16 to March 15
Work bridge deck	N/A
Cofferdam – vibratory	September 1 to May 15
Mudline footings in cofferdam	N/A
Drilled shaft – vibratory	September 1 to May 15
Bridge superstructure	N/A
Materials transport	N/A
Column demolition	N/A
Pile removal	July 1 to March 15
Cofferdam removal	July 1 to March 15

[a] Published In-Water Construction Timing October 1 to April 15
[b] Timing July 16 to March 15 north of bridge and July 16 to April 30 south of existing bridge
[c] Published In-Water Construction Timing July 16 to March 15
N/A = not applicable

Note: In-water construction windows are not proposed for the Ship Canal because all construction related to the Montlake Bascule Bridge will occur above water or from a barge.

5.3 Minimization of Impacts during Construction

BMPs will be used during all construction activities to eliminate or minimize potential environmental effects. Many of these BMPs are standard and will apply universally to many project construction activities, including upland staging areas. The following section discusses provisional BMPs that WSDOT anticipates will be included as construction commitments for the project. A detailed description of construction methods that avoid or minimize aquatic impacts is described in the project biological assessment (WSDOT 2010a).

Monitoring will occur during construction to measure BMP efficacy. Activities will be adjusted as necessary, depending on monitoring results. Environmental performance (e.g., turbidity, underwater noise, water quality) will be reviewed during initial construction activities. Turbidity and noise will be monitored before and during construction. If environmental results are unsatisfactory during construction, subsequent similar activities will be implemented in a more conservative fashion to minimize these impacts.

5.3.1. Temporary Stormwater Management Strategy

The project's temporary stormwater management strategy is to reduce the risk of potential pollutants being discharged to a watercourse that may cause or contribute to the exceedances of water quality standards during construction and demolition activities. The strategy is to use BMPs and adhere to regulatory requirements to manage construction-related stormwater runoff and thereby minimize environmental impacts. The plan will include planning system design and water quality monitoring and sampling. The components of the temporary stormwater management strategy are listed below.

Stormwater Pollution Prevention Plan

A Stormwater Pollution Prevention Plan (SWPPP) is prepared to meet National Pollutant Discharge Elimination System (NPDES) permit requirements for stormwater discharges at construction sites. The SWPPP will address the following elements:

- Planning and organization
- Formation of a pollution prevention team
- Building on pre-existing plans
- Assessment
- Development of a site plan
- Material inventory
- Record of past spills and leaks
- Non-stormwater discharges
- Site evaluation summary
- BMP identification
- Preventive maintenance
- Spill prevention and response
- Sediment and erosion control
- Management of runoff
- Implementation
- Implementation of appropriate controls
- Employee training
- Evaluation and monitoring
- Annual site compliance evaluation
- Recordkeeping and internal reporting
- Plan revisions

Temporary Erosion and Sediment Control Plan

A Temporary Erosion and Sediment Control (TESC) Plan will be prepared and implemented to minimize and control pollution and erosion from stormwater runoff. Temporary erosion and sediment control is required to prevent erosive forces from damaging project sites, adjacent properties, and the environment. The TESC plan will address the following elements:

- Marking clearing limits
- Establishing construction access
- Controlling flow rates
- Installing sediment controls
- Stabilizing soils
- Protecting slopes
- Protecting drain inlets
- Stabilizing channels and outlets
- Controlling pollutants
- Controlling dewatering
- Maintaining BMPs
- Managing the project

Spill Prevention Control and Countermeasures Plan

WSDOT requires the implementation of a Spill Prevention Control and Countermeasures (SPCC) Plan on all projects to prevent and minimize spills that may contaminate soil or nearby waters. The plan is prepared by the contractor as a contract requirement and is submitted to the project engineer prior to commencement of any on-site construction activities.

Spill avoidance and containment BMPs will include the following:

- Maintain all construction equipment to minimize the risk of fuel and fluid leaks or spills.
- Implement spill control and emergency response plans for fueling and concrete activity areas. All spill-control materials will be present on the site prior to and during construction.
- If a leak or spill should occur, cease all work until the source of the leak is identified and corrected and the contaminants have been removed from the site.
- Clean all equipment that is used for in-water work prior to operations waterward of the OHWM. Remove external oil and grease as well as dirt and mud. Prohibit the discharge of untreated wash and rinse water into local waters. Ensure that all construction equipment working in the water, particularly pile-driving machines, use vegetable-based hydraulic fluid.
- Conduct refueling activities within a designated refueling area away from the shoreline, streams, or any designated wetland areas.
- Minimize refueling activities on work bridges whenever feasible, and ensure that appropriate spill containment and cleanup equipment is on hand and in use as needed during any refueling of equipment on work bridges.
- Inspect daily all vehicles operating within 150 feet of any water body for fluid leaks before vehicles leave the staging area. Repair any leaks detected before the vehicle resumes operation. When vehicles are not in use, store them in the vehicle staging area.
- Modify off-pavement construction entrances according to WSDOT standard plans to reduce the spread of dirt from the project site.

Concrete Containment and Disposal Plan

A Concrete Containment and Disposal Plan will be developed to maintain water quality when handling and managing concrete. The plan will be used during construction of bridge columns and their footings, and also during demolition of the existing bridge.

Water Quality Sampling, Recording, and Reporting Procedures

All projects with greater than 1 acre of soil disturbance, except federal and tribal land, that may discharge construction stormwater to Waters of the State are required to seek coverage under the NPDES Construction Stormwater General Permit. Sampling guidance for meeting permit requirements is listed in WSDOT’s HRM (2008), Section 6-8.

5.3.2. Land-Based Construction – Best Management Practices

The following BMPs and procedures are to be implemented for the proper use, storage, and disposal of materials and equipment on land-based construction limits, staging areas, or similar locations that minimize or eliminate the discharge of potential pollutants to a watercourse or Waters of the State. These procedures will be implemented for construction materials and wastes (solid and liquid), soil or dredging materials, or any other materials that may cause or contribute to exceedance of water quality standards.

Upland construction BMPs will involve the following:

- Clearly define construction limits with stakes and a high visibility fence before beginning ground-disturbing activities. No disturbance will occur beyond these limits.
- Minimize vegetation and soil disturbance to the extent possible.
- Avoid or reduce adverse impacts to critical areas during project construction, including shoreline buffers. These measures will include clearing, grading, and stormwater management.
- Protect designated sensitive areas, including the shoreline, with silt fencing. All silt fencing will be removed when construction is completed.
- Control all stormwater discharges from construction sites and ensure that NPDES permit requirements are met.
- Use construction BMPs to control dust and limit impacts to air quality; these BMPs include the following:
    - Wet-down fill material and dust on-site.
    - Ensure adequate freeboard to prevent soil particles from blowing away during transport.
    - Remove dirt, dust, and debris from the roadway on a regularly scheduled basis in accordance with final permitting requirements.
    - Minimize potential erosion from areas of disturbed soil by stabilizing and/or revegetating cleared areas in accordance with the TESC Plan.
    - Wet-down concrete structures during demolition activities.

5.3.3. Over-Water Work – Best Management Practices

The following BMPs and procedures are expected to be implemented at a minimum for the proper use, storage, and disposal of materials and equipment on barges, boats, temporary construction pads (e.g., work bridges), or at similar locations that minimize or eliminate the discharge of potential pollutants to a watercourse or to Waters of the State. These procedures will be implemented for construction materials and wastes (solid and liquid), soil or dredging materials, or any other materials that may cause or contribute to exceedance of water quality standards.

Barge Moorage

Barge moorage will be limited to the extent pracicticable to minimize effects of over-water cover. During the primary juvenile outmigration period of April 15 to September 1, a 100-foot wide unobstructed corridor will be maintained between moored barges or between barges and work bridges in the primary outmigration corridor through the west approach area. In the east approach area, a 15-foot unobstructed corridor will be maintained between moored barges and work bridges except for weather or delivery needs, and moorage of barges in the Montlake Cut of the Ship Canal will be avoided from April 1 through September 15.

Construction Lighting

Construction lighting will be limited to areas of active work and directed at work surfaces. To the extent practicable, construction lighting will be shielded to minimize spillage onto adjacent waters.

Watertight Curbs, Bull Rails, or Toe Boards

Watertight curbs, bull rails, or toe boards will be installed around the perimeter of a work bridge, platform, or barge to contain potential spills and prevent materials, tools, and debris from leaving the over-water structure. These applications will be installed with a minimum vertical height of 10 inches.

Oil Containment Boom

An oil containment boom is a floating barrier that can be used to contain oil, and aids in preventing the spread of an oil spill by confining the oil to the area in which it has been discharged. The purpose of containment is not only to localize the spill and thus minimize pollution, but to assist in the removal of the oil.

Floating Sediment Curtain

These barriers can aid in controlling the settling of suspended solids (silt) in water by providing a controlled area of containment. This condition of suspension (turbidity) is usually created by disrupting natural conditions through construction or dredging in the aquatic environment. The containment of settleable solids is desirable to reduce the impact area.

Tie-Downs

Tie-downs can be used to secure all materials, which can aid in preventing discharges to receiving waters via wind.

Absorbent Materials

Absorbent materials will be placed under all vehicles and equipment on docks, barges, or other over-water structures. Absorbent materials will be applied immediately on small spills, and promptly removed and disposed of properly. An adequate supply of spill cleanup materials, such as absorbent materials, will be maintained and available on-site.

Equipment Maintenance and Inspection

- Vehicle and construction equipment inspection will occur daily. Vehicles will be inspected prior to entering any over-water work zone. Vehicles and equipment will be kept clean of excessive build-up of oil and grease.
- Land-based fueling stations will be used to the extent practicable.
- Off-site repair shops will also be used to the extent practicable. These businesses are better equipped to properly handle vehicle fluids and spills. Performing this work off-site can also be economical by eliminating the need for a separate maintenance area. If a leaking line cannot be repaired, the equipment will be removed from over-water areas.
- If maintenance must take place on-site, only designated areas away from drainage courses will be used. Dedicated maintenance areas will be protected from stormwater run-on and runoff.

Cover and Catchment Measures

Portable tents, drop cloths, tarps, blankets, sheeting, netting, and plywood panels will be used to cover work areas, temporary stockpile materials, or demolition debris. Nets, tarps, platforms, scaffolds, blankets, barges, and/or floats will be used to contain and control debris beneath structures being constructed or demolished. Vacuums, diverters, squeegees, absorption materials, holding tanks, and existing drainage systems will be used to control and contain concrete-laden water. These BMPs will also facilitate the suppression and dispersal of fugitive dust generated from the demolition process.

Construction Water Treatment Systems

These systems generally consist of temporary settling storage tanks, filtration systems, transfer pumps, and an outlet. The temporary settling storage tank provides residence time for the large solids to settle out. The filtration system will be provided to remove additional suspended solids below an acceptable size (typically 25 microns). The pumps provide the pressure needed to move the water through the filter and then to an acceptable discharge location. Once the solid contaminants are filtered out, the clean effluent is then suitable for discharge to a municipal storm drain or an acceptable discharge location. These systems will be located on work bridges and barges.

Spill Containment Kits and Containment Products

These pre-manufactured products will aid in spill containment and cleanup. These kits and products will be kept on-site and within construction vehicles for easy deployment.

Alternative Lubricants and Fuels

Eco-friendly lubricants and fuel sources (e.g., vegetable-based) will be used for in-water and over-water construction where practicable.

Barges and Floats

Barges and floats can be used to store stockpiled materials, store construction equipment, transport demolition debris, and store water containment systems and water storage tanks. The barges and floats can also be used as a catchment for demolition debris if located below a proposed demolition activity.

Protection will be required to prevent debris or water from entering adjacent live traffic lanes and prevent the spread of such material over a larger area. The prevention of such occurrences can be accomplished by using temporary barriers and protective panels, and containing or vacuuming water from concrete saw usage.

5.3.4. In-Water Work – Best Management Practices

In addition to applicable BMPs described above for over-water work, the following BMPs apply where demolition or construction activity will occur in Waters of the State. These procedures will be implemented to contain construction materials and wastes (solid and liquid), soil or dredging materials, or any other materials that may cause or contribute to the exceedances of water quality standards. Equipment that enters waterways will be maintained such that no visible sheen from petroleum products appears within waterways. If a sheen appears around equipment in the water, the equipment will be contained within an oil boom and shall be removed from the water, cleaned, and/or maintained appropriately.

Construction Work Bridges and Barges

Work over open water will be accomplished from work bridges or barges. Construction will be done from barges where feasible, because of their relatively small impact. The impacts are relatively small because (1) they do not require in-water pile driving; (2) they will result in only limited disturbance of the substrate; and (3) they will remain in any one place for a shorter time than the work bridges.

The extent of work bridges has been estimated with an assumption that construction barges cannot travel into waters less than 10 feet deep. However, contractors will be allowed to use barges at shallower depths (potentially to a 6-foot depth) if they have equipment capable of safely navigating and operating in shallow waters (WSDOT 2010d). Where the lake depth is too shallow for barges to operate, temporary work bridges will be constructed. Portage Bay, Union Bay, and the west approach areas all have shallow waters that are inaccessible by barge and will require work bridges. In addition, a work bridge across Foster Island will be constructed instead of temporary work roads, thereby reducing temporary clearing. The over-water height of the work bridges has been maximized to the furthest extent practicable, thereby minimizing shading impacts. Piles will be installed with a vibratory hammer, but proofed with an impact hammer. These structures will be removed at the earliest possible date, even if removal occurs outside of the in-water work window. The piles will be removed with a vibratory hammer and simultaneous lifting of the pile (WSDOT 2010d).

Underwater Containment System/Temporary Cofferdam

These systems will be implemented to prevent sediment, concrete, and steel debris from mixing with Waters of the State. Examples include a temporary cofferdam, an oversized steel casing, or another type of approved underwater containment system. This application will allow demolition work to be completed on and around an underwater structure, and will allow the work zone to be isolated. The system will also allow work to be completed at or below the mudline as determined by the state or contractor’s removal requirements. Construction water and slurry within the containment system will be removed, treated, and pumped to an acceptable discharge location when demolition is complete. Fresh concrete will be prevented from coming in contact with Waters of the State.

Noise Attenuation

The Fisheries Hydroacoustic Working Group (FHWG) defined interim criteria for injury to fish from pile driving activities. The criteria identify sound pressure levels (SPLs) of 206 decibels (dB) peak and 187 dB accumulated sound exposure level (SEL) for all listed fish except those that are less than 2 grams. For the fish less than 2 grams, the criteria for the accumulated SEL is 183 dB.

To compare these criteria with the proposed pile driving activities, WSDOT initiated a Pile Installation Test Program (WSDOT 2010e). During this program, a vibratory hammer and an impact hammer were used on test piles, and WSDOT measured the peak and attenuated noise. Three minimization measures were employed and measured for effectiveness. Bubble curtains were very effective at reducing noise down to acceptable levels and will be installed during in-water impact pile driving for the SR 520, I-5 to Medina Project. The use of a bubble curtain is expected to substantially minimize the area affected by above-threshold sound levels. In-water pile driving in the Union Bay area will occur during the in-water work window to further avoid noise disturbance to fish.

Several factors suggest that the project's noise will have a relatively low impact to fish:

- Few juvenile or adult Chinook salmon are likely to occur in the project area during this construction period. The in-water work period is outside of the peak of Chinook outmigration from the Cedar River into Lake Washington (begins in January, but most fry enter the lake in mid-May), and is also outside of the adult migration period.
- Adult Chinook salmon are believed to migrate through deeper waters, away from behavioral and injury disturbance areas.
- WSDOT will deploy a bubble curtain matching the specifications of that used in the Pile Installation Test Program during impact pile driving. The use of a bubble curtain is expected to substantially minimize the area affected by above-threshold sound levels.

The underwater SPLs from in-water impact pile driving will be monitored by the contractor, per a forthcoming and agreed-upon monitoring plan. If the recorded SPLs exceed the thresholds agreed upon by the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA Fisheries), the U.S. Fish and Wildlife Service (USFWS), FHWA, and WSDOT, appropriate energy reduction measures shall be deployed by the contractor to attenuate the SPLs.

If a fish kill occurs or fish are observed in distress from pile driving, the contractor will immediately cease the activity and WSDOT will be notified. WSDOT will notify the WDFW Habitat Program immediately. The contractor will ensure that a project inspector/biologist is on-site during all in-water pile driving operations to monitor for distressed fish. The contractor will ensure that this inspector has full authority to stop work in the event that dead or distressed fish are observed.

5.3.5. Water Quality Monitoring

Discharges from construction and operation activities will be monitored per the contractor's Construction Water Quality Protection and Monitoring Plan (WQPMP) approved by Ecology. The contractor will submit the WQPMP to WSDOT for submittal to Ecology at least 30 calendar days prior to beginning construction. The purpose of the WQPMP is to assess compliance with water quality standards during the project's construction and operation activities. The WQPMP will identify all the construction and operation activities at the site that may have a discharge (e.g., dewatering water, construction stormwater, channel dredging, operational stormwater, etc.) to surface water or groundwater. Specific locations of proposed discharge points to be monitored and their water quality parameters will be defined in the WQPMP. If any of the monitoring parameters exceed the water quality standards, the contractor will cease construction activities in the vicinity and notify WSDOT until appropriate measures are taken to bring the project back into compliance. In the event that a violation of the state water quality standards occurs or if a revision from the permitted work is needed, WSDOT will immediately notify Ecology.

5.4 Compensatory Mitigation

Given the measures described in Sections 5.1–5.3, many potential impacts to the aquatic environment will be effectively avoided or minimized. However, some project elements and activities will require compensatory mitigation for impacts to aquatic habitat, or habitat functions will still be degraded after avoidance and minimization measures have been applied (see Section 4.1).

Many of the construction-related impacts will not result in a long-term impact to aquatic habitats or functions because the effect ceases almost immediately upon cessation of the activity (see Table 5-3). Furthermore, potential construction impacts, including in-water noise, temporary lighting, in-water turbidity/contaminants, stormwater discharge, and barge operation and moorage, will be effectively avoided and/or minimized (see Sections 5.1–5.3) to the extent that compensatory mitigation is not required. On an operational basis, the bridge lighting and stormwater impacts will be minimized through the implementation of design elements and BMPs.

Three types of activities will cause habitat function degradation (see Table 5-3). These functional effects will occur on both a temporary and a permanent basis. The bridge superstructure and temporary work bridges will alter the quality of migratory habitat for juvenile salmonid by projecting a shade edge onto the water. The bridge columns and temporary work bridge piles will result in permanent and temporary displacements of benthic habitat. The columns and temporary work bridge piles will also increase vertical habitat complexity, thereby attracting smallmouth bass, a juvenile salmonid predator. These impacts have the greatest potential to affect aquatic habitat functions, particularly in terms of salmonid life history stages and populations. A detailed discussion of these impact mechanisms is provided in Sections 4.1–4.2.

Table 5-3. Potential Impacts and Compensatory Mitigation Requirements

	Potential Impact	Avoided/ Minimized	Compensatory Mitigation
Temporary	In-water noise	X	
	Lighting	X	
	Turbidity	X	
	Construction stormwater	X	
	In-water work	X	
	Barge Operation	X	
	Barge Moorage	X	
	Over-water Shading (work bridges)		X
	Benthic fill (piles)		X
	Habitat complexity (piles)		X
Permanent	Lighting	X	
	Stormwater	X	
	Over-water Shading (work bridges)		X
	Benthic fill (piles)		X
	Habitat complexity (piles)		X

5.5 Compensatory Mitigation Framework

The following agencies have authority to require compensatory mitigation for aquatic (i.e., non-wetland) impacts that were not sufficiently avoided or minimized:

- USACE
- WDFW
- Ecology
- City of Seattle

The aquatic mitigation framework for the SR 520, I-5 to Medina Project is commensurate with the mitigation policies of these agencies. The WDFW policy "Requiring or Recommending Mitigation", POL-M5002, has stated goals to "…achieve no loss of habitat functions and values" and "to maintain the functions and values of fish and wildlife habitat in the state."

The following WDFW policy language applies to infrastructure projects:

"WDFW may not limit mitigation to on-site, in-kind mitigation when making decisions on hydraulic project approvals for infrastructure development projects. The State Legislature has declared that it is the policy of the state to authorize innovative mitigation measures by requiring state regulatory agencies to consider mitigation proposals for infrastructure projects that are timed, designed, and located in a manner to provide equal or better biological functions and values compared to traditional on-site, in-kind mitigation proposals. For these types of projects, WDFW may not limit the scope of options in a mitigation plan to areas on or near the project site, or to habitat types of the same type as contained on a project site. When making a permit decision, WDFW shall consider whether the mitigation plan provides equal or better biological functions and values, compared to the existing conditions, for the target resources or species identified in the mitigation plan…"

The City of Seattle has a similar policy goal on maintaining habitat functions and values. Policy SMC 25.09.200, Section B.3.b pertains to over-water structures and states that the "Mitigation is provided for all impacts to the ecological functions of fish habitat on the parcel resulting from any permitted increase in or alteration of existing over-water coverage."

Unlike the regulatory process for wetland mitigation, federal and state regulations and guidance do not prescribe calculation of metrics or mitigation formulas for the majority of the effects to aquatic habitat. In addition, many of the potential impacts to fish and other aquatic species will be indirect. For example, partial shading impacts from the new bridge structures could alter juvenile salmon migration patterns or timing, or influence the distribution of salmonid predators in the project area. These potential impacts could reduce the number of juvenile salmon completing successful outmigration to marine waters. Impacts on individual fish, or populations of fish, resulting from habitat alterations are generally mitigated by increasing the quality and quantity of habitat for the species of interest.

Since on-site, in-kind opportunities were not feasible, WSDOT sought off-site mitigation opportunities that addressed the same functions and values that could be affected by the project. Aquatic functions and values were defined in terms of the following fish species and their life history requirements:

- Fall Chinook
- Sockeye

- Coho
- Steelhead

The spatial locations of project impacts and mitigation sites were classified in terms of their importance to these species, and assigned a score commensurate to their value to the focal fish. These Fish Function Modifier scores were assigned to impact and mitigation sites, in the form of a 0-1 weighting factor. Section 4.1 describes criteria and rationale for the Fish Function Modifier scoring. The acreage of a given mitigation action is multiplied by the applicable Fish Function Modifier score (Figure 5-1). Next, the mitigation acreage (adjusted by Fish Function Modifier score) is weighted in terms of the "Project Type" score (Figure 5-1).

Using this framework, all in-water mitigation activities (riprap removal, shoreline grading, levee removal, dredging) were assigned a Project Type score of 1.0. A score of 1.0 is indicative of the direct and immediate aquatic benefits that these projects produce. Riparian and floodplain restoration projects received a score of 0.2, to recognize the delay in achieving full function/and or the indirect nature of these projects to functioning aquatic habitat. While riparian function along the shoreline may directly benefit fish (e.g., fish cover), the functional value becomes indirect farther from the shoreline (e.g., pollutant filtration, shading, etc.). Floodplains provide indirect fish benefits by attenuating flood flows, performing water quality functions, maintaining riverine wetlands, providing off-channel salmonid habitat, and providing the opportunity for dynamic channel creation over time. Mitigation areas that improve both riparian and floodplain functions received a Project Type score of 0.4 to reflect the additive value of riparian and floodplain functions. After adjusting the mitigation acreages by Fish Function Modifier and Project Type scores, the adjusted acreage can be applied to permanent impacts (see Section 4.1).

If the adjusted mitigation acreage is applied to temporary impacts instead of permanent impacts, an additional step is required. Temporary impacts are calculated in terms of service-acre-years (see Section 4.1), i.e., the total area of impact summed for all years the impact is present. Restoration actions that are intended to mitigate for these temporary impacts must also be valued in terms of their temporal contribution to aquatic functions and values. The acreage of each mitigation action (adjusted by Fish Function Modifier and Project Type scores) is multiplied by the percent aquatic function that the project provides on an annual basis for the first 18 years after project completion. For example, if a mitigation project was completed in 2012, the service-acre mitigation credits will be counted until 2030 (18 years). A total of 18 years was selected as a suitable timeframe in which ecological functions could be realized and become established to fully offset the temporal loss of functions at the impact site, yet credits would not be overstated by extending the timeframe out into perpetuity. It should be noted, however, that ecological functions at the mitigation sites will continue in perpetuity.

Mitigation actions that have full and immediate benefits are multiplied by 1.0 (i.e., 100% function) for all 18 years. Projects that take time to realize full function are multiplied by an increasing proportion (i.e., percent function) over time. Riparian restoration projects are assumed to realize 10% function during years 1 through 5, 50% function during years 6 through 10, and 100% function thereafter. The acre-years for all 18 years are summed to yield a total mitigation value that can be credited toward temporary impacts. In conclusion, the service acre-years provided by proposed mitigation actions will exceed the sum of temporary impact acre-years (Figure 5-2).

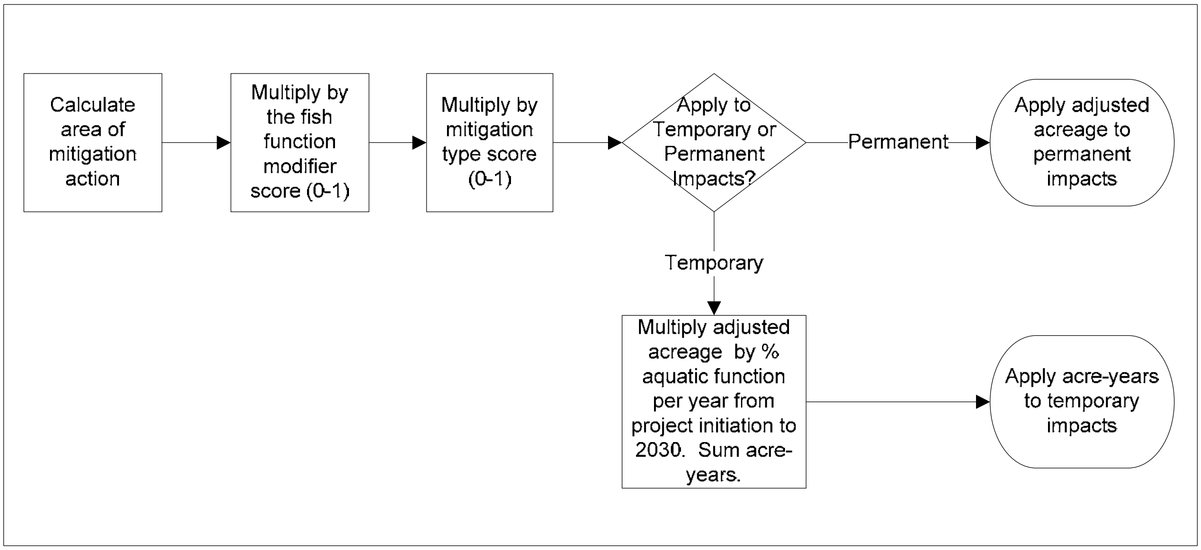

Figure 5-1. Process for Determining Value of Mitigation Actions

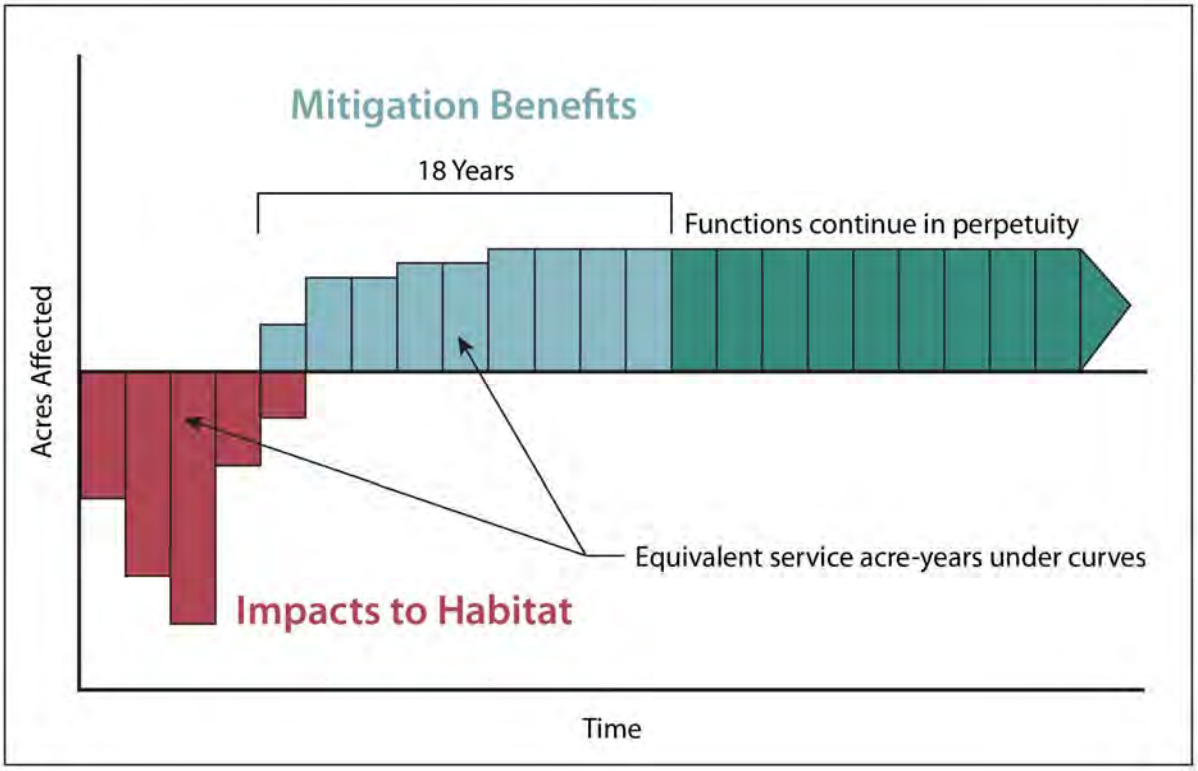

Figure 5-2. Conceptual Basis of Service-Acre Years

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6. Aquatic Mitigation Sites

6.1 Rationale for Site Selection

The goal of the mitigation screening and ranking process was to select a suite of habitat restoration projects that increase aquatic functions and values enough to offset the SR 520, I-5 to Medina Project's effects on similar functions and values. Chinook salmon, sockeye salmon, coho salmon, and winter steelhead were chosen as key indicator species because they are the most studied species in the watershed and a comprehensive data set is available linking salmonids to habitat variables in the watershed (City of Seattle and USACE 2008; King County 2005).

The project will affect four key life history functions of Lake Washington salmonids: juvenile rearing/ feeding, juvenile migration, adult migration, and lakeshore beach spawning. The mitigation screening approach looked at habitat features and ecological functions that supported these key life history phases in Lake Washington, and linked them with potential enhancements of such features.

Mitigation opportunities were sought from throughout WRIA 8, specifically in the marine nearshore, the Ship Canal, and throughout Lake Washington, and were organized through a screening plan (WSDOT 2009b). However, the results of this plan were substantially adjusted through agency input, coordination, and further field work.

Mitigation Opportunities in the Marine Nearshore and Ship Canal

Mitigation opportunities along the marine nearshore (and in proximity to the Ship Canal) are extremely limited. WSDOT has worked with the resource agencies and tribes in identifying mitigation measures that might be applied to the Lake Washington Ship Canal to benefit adult fish survival and migration into the Lake Washington system.

WSDOT evaluated the feasibility of options for reducing summer water temperatures in the Lake Washington Ship Canal to improve conditions for returning adult salmon. The two options evaluated (a dredging option and a pumping option) were determined to provide a slight improvement to temperature in the vicinity of the Montlake Cut and eastward; however, the benefits to adult salmon from this improvement would be insignificant, given the short duration which adults actually occupy this area during their return migration (minutes to hours). These options also presented a series of technical, regulatory, schedule, and cost issues, as well as risks that rendered them not feasible for implementation by WSDOT. A complete discussion of the evaluation and conclusions is available in the Draft Ship Canal Evaluation Report (WSDOT 2011d).

Mitigation Opportunities in Lake Washington

The objectives of the Lake Washington General Investigation (City of Seattle and USACE 2008) include habitat improvement for juvenile salmon in Lake Washington. The Lake Washington General Investigation prescribed management actions to support this objective, including the following:

- Continue to remove shoreline armoring and create shallow-water habitat with overhanging vegetation. These actions will improve rearing conditions for Chinook fry. Focus these activities in the southern portion of Lake Washington.
- Continue to improve habitat around over-water structures by removing structures, reducing their footprint, or by improving light penetration.
- Remove in-water solid waste debris (e.g., concrete, asphalt, and scrap metal) and riprap to reduce available predator habitat.
- Prioritize the restoration of tributaries and tributary mouths in south Lake Washington tributaries.

Some project opportunities in Lake Washington are located along juvenile salmonid migration routes; these opportunities were prioritized, because of the relatively high fish benefits. Juvenile Chinook (and sockeye to a lesser extent) use the lake shoreline for foraging, rearing, and refugia from predators (Tabor and Piaskowski 2002). They also slowly migrate along the shoreline toward the Ship Canal during this time. As noted above, once juvenile salmonids have migrated into the Ship Canal, holding and foraging is not desirable because of rapidly-degrading water quality in the late spring and the presence of warm-water predators. However, opportunities for habitat improvement along the more desirable Lake Washington migration corridors are extremely limited because the overwhelming majority of opportunities are on private residential land (WSDOT 2009b). These private residential lots were not pursued, because restoration of the narrow shoreline on a typical residential lot would not result in a large habitat gain. Projects on individual parcels would be surrounded by adjacent bulkheads, piers, and docks. Acquiring multiple contiguous residential properties was considered very unlikely.

WSDOT has investigated the possibility of conducting mitigation on privately-owned Boeing property and on City of Renton parcels near the mouth of the Cedar River to complement the South Lake Washington Restoration (see below), but has not been successful. Out of the limited public property with shoreline that has fisheries value, the following sites are proposed for restoration by the WSDOT 520 Program:

- Seward Park 1-4 (four spatially discrete actions are proposed)
- Magnuson Park 1 and 2 (two spatially discrete actions are proposed)
- Taylor Creek
- South Lake Washington Shoreline Restoration (DNR Parcel)
- East approach

These mitigation sites, and all of their attendant mitigation actions subdivided (e.g., Seward 1-4, Magnuson 1-2), are described in the subsequent sections of this section. The site locations are shown at the landscape scale in Figure 6-1. The known salmonid uses of each site, as well as their Fish Function Modifier scores, are shown in Table 6-1.

Mitigation Opportunities in Lake Washington Tributaries

Habitat improvement in the WRIA 8 Lake Washington tributaries is also an objective defined in the WRIA 8 watershed management plans. The WRIA 8 Chinook Salmon Conservation Plan (King County 2005) prioritizes the Lower Cedar River for restoration with a focus on actions that protect water quality, restore riparian zones, increase LWD and pools in the river (via installation and natural recruitment), and set back levees to increase floodplain function and off-channel habitat. The Chinook Salmon Conservation Plan also recommends restoration actions on Lower Bear Creek, Upper Bear Creek, and Cottage/Cold Creeks. However, the plan indicates that Lower Bear Creek has the poorest habitat function of these three water bodies, thereby representing the greatest improvement opportunity.

WSDOT will address these restoration priorities by implementing restoration projects at the following riverine locations:

- Cedar River/ Elliott Bridge reach
- Lower Bear Creek, near the mouth

The current and potential use of these mitigation sites by the focal fish species is discussed in detail in subsequent sections. Although none of the sites meet the “very high” fish function criteria (Table 6-1), they are all important locations in the watershed and will provide ecological functions that are priorities for fish recovery.

All of the proposed sites are publicly owned, and as such, WSDOT has engaged in partnerships with the public entities to use these sites for compensatory mitigation. Details regarding cost-sharing, construction, monitoring, and maintenance responsibility, and the long-term protection of the sites are provided in site description and summarized in Section 6.13.

These sites have undergone a basic screening for fatal flaws such as site access, landowner consent, hazardous materials, and cultural resources. However, if it becomes apparent during advanced design that a site is no longer feasible due to technical constraints, the site will be removed from this plan and replaced with another appropriate mitigation site. A mitigation site may also be replaced with another if WSDOT develops a new site concept that is of higher ecological value or has more ecological value per monetary cost for the State of Washington.

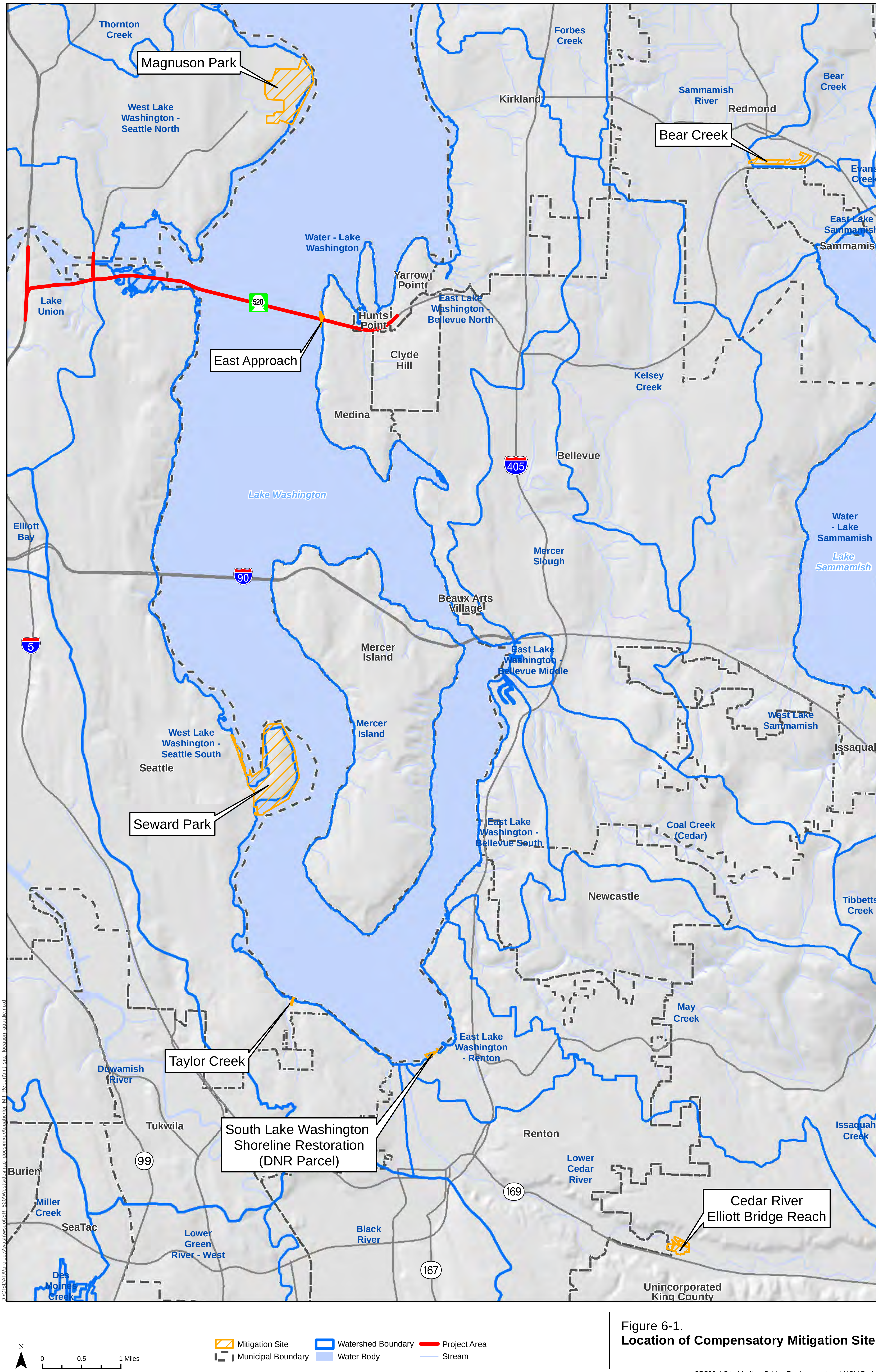

Figure 6-1.
Location of Compensatory Mitigation Sites

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Table 6-1. Mitigation Site Fish Use and Fish Function Modifier Scores

Fish Function Modifier Score	Proposed Mitigation Site Classification	Adult Salmonid Use	Juvenile Salmonid Use	Stocks Affected
0.8 – High	**Seward Park** 1 Shoreline Enhancements		Chinook (Rearing)	Taylor Creek Cedar River
0.8 – High	**Seward Park** 2 Shoreline Enhancements	Sockeye (Spawning)	Chinook (Rearing) Sockeye (Rearing/Feeding)	Taylor Creek Cedar River Lake Washington
0.6 – Medium	**Seward Park** 3 Shoreline Enhancements		Chinook (Rearing)	Taylor Creek Cedar River
0.8 – High	**Seward Park** 4 Shoreline Enhancements	Sockeye (Spawning)	Chinook (Rearing) Sockeye (Rearing/Feeding)	Taylor Creek Cedar River Lake Washington
0.6 – Medium	**Magnuson Park 1** Shoreline Enhancements		Chinook (Rearing)	North Lake Washington Issaquah
0.6 – Medium	**Magnuson Park 2** Shoreline Enhancements		Chinook (Rearing)	North Lake Washington Issaquah
0.8 – High	**Taylor Creek** Restoration	Coho (Spawning) Sockeye (Spawning)	Coho (Rearing) Chinook (Rearing) Sockeye (Rearing/Feeding)	Taylor Creek Cedar River

Fish Function Modifier Score	Proposed Mitigation Site Classification	Adult Salmonid Use	Juvenile Salmonid Use	Stocks Affected
0.8 – High	**South Lake Washington Shoreline Restoration (DNR Parcel)** Shoreline Enhancements		Chinook (Rearing/Feeding) Chinook (Migration) Sockeye (Rearing; Feeding)	Cedar River
0.8 – High	**Cedar River/ Elliott Bridge Reach** Enhancements	Coho (Spawning) Sockeye (Spawning) Chinook (Spawning) Steelhead (Spawning	Coho (Rearing/Feeding) Steelhead (Rearing/Feeding) Chinook (Rearing/Feeding	Cedar River
0.8 – High	**Bear Creek** Restoration		Sockeye (Rearing/Feeding) Chinook (Rearing/Feeding) Coho (Rearing/Feeding)	North Lake Washington
0.8 – High	**East Approach** Spawning Beach Enhancement	Sockeye (Spawning)	Sockeye (Rearing/Feeding)	Lake Washington

6.2 Seward Park Project 1

6.2.1. Site Location

Seward Park is in the City of Seattle, along the western shore of Lake Washington, as shown on Figure 6-1. Seward Project 1 is located on the southern portion of the peninsula (Figure 6-2).

6.2.2. Mitigation Site Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization of shoreline conditions is available in the SR 520 Draft Aquatic Assessment Report (WSDOT 2011c).

Shoreline Conditions

This segment is approximately 550 feet long, has a vertical concrete bulkhead (2.5 feet high, 3 feet wide) along its length, and has very little riparian vegetation (Figure A-1). The vertical elevation gain between the uplands and the lake water level is approximately 6 to 7 feet (Appendix B).

The major shoreline feature at Seward 1 is a continuous 550-foot-long concrete bulkhead (Figure A-1). The bulkhead is 2.5 feet high and 3 feet wide. There is very little overhanging vegetation other than a few trees near the eastern half of the shoreline (Figure 6-2). One piece of large woody debris (LWD) was observed along the shoreline in 2011 (WSDOT 2011c). There are gradual slopes (4 to 13%) and a relatively shallow bathymetry along this shoreline. However, the bulkhead truncates this gradual transition to the uplands. The substrate along the shoreline is predominantly gravel. Riparian vegetation varies with distance from the shoreline. From the shoreline to the walking path, the riparian zone is primarily composed of grass, with lesser amounts of impervious surfaces (the walking path), invasive weeds, and a few scattered trees. The remainder of the riparian zone landward of the walking path transitions from grass to mature forest.

Ecological Condition of Adjacent Parcels

Immediately east of the project area, the Seward shoreline has been previously restored with bulkhead removal, bank re-grading, gravel placement, and riparian re-vegetation. Immediately to the west of the project area, the shoreline is steep and rip-rapped with a parking lot landward of the shoreline. In general, the Seward Park shoreline has discontinuous shoreline segments that vary by bank height, bank slope, bulkheads, native vegetation, or nuisance aquatic vegetation. Many of these shoreline segments were armored as early as 1916, and in many places the nearshore, creating a cobble substrate along the shoreline. In some locations, particularly hardened shoreline has altered wave-generated sediment processes, creating a cobble substrate along the shoreline. The cut-and-fill technique used to build the path along the shoreline has also resulted in modified bank shapes and slopes. Some segments of the park shoreline were restored in 2001 and 2006 by re-grading the bank to a lower slope, importing gravel to the re-sloped beaches, installing LWD for fish cover, and re-vegetating narrow riparian zone strips immediately adjacent to the shoreline. Parcels adjacent to Seward Park are residences with bulkheads and docks (to the south), and include a marina (to the north).

Fish Use

The Seward Park shoreline is used by juvenile Chinook for feeding, rearing, and migration from the Cedar River toward the Ship Canal, though Chinook abundance is lower here than along the South Lake Washington shoreline (Tabor and Piaskowski 2002). The southeast shoreline has shallow water and vegetative cover providing food resources (invertebrates) and protection from piscivorous fish and avian predators. The absence of piers, ramps, and floats along the park's natural shorelines allows unhindered migration along the area's littoral zone. Historical records document sockeye spawning along the Seward Park nearshore (Buchanan 2004). During a 1999 snorkel survey along the Seward Park shoreline, the presence of adult sockeye carcasses at various locations on the Seward Park shoreline throughout October, November, and December indicated that beach spawning was occurring (City of Seattle 2001).

Fish use along the southwest shoreline of Seward Park (a natural shoreline area adjacent to Seward 1) is documented in Tabor et al. (2006). During snorkel surveys in 2003 (April 7–May 6), a total of 76 Chinook salmon were observed, and their abundance was higher on each date than at any other site in Seward Park (Tabor et al. 2006). On two of these three surveys, more Chinook salmon were observed along this shoreline than at the other sites combined. Only six Chinook salmon were observed in this area during the last two surveys in 2003 (May 22 and June 10) and their abundance was similar to that at other sites in Seward Park. The high abundance of Chinook salmon at this site is likely due to better habitat conditions, specifically the sand substrate and gradual slope, and the site is closer to the Cedar River than other Seward Park sites. Given the high use by Chinook juveniles in this area of the park, Seward 1 fits the "high" FFM definition of "aquatic sites that serve as migration or rearing areas of considerable importance for one or more species of juvenile salmon". Therefore, Seward 1 has an FFM score of 0.8.

6.2.3. Rationale for Site Selection

Seward Park was selected for shoreline and riparian restoration because of documented use of this shoreline by Chinook salmon juveniles for foraging, rearing, and outmigration, and by sockeye salmon for beach spawning and early rearing. Shoreline restoration actions are proposed in areas where juvenile Chinook are known to rear and migrate, and where sockeye salmon are known to have spawned in the past. These restoration actions will increase habitat connectivity with adjacent high quality shoreline segments, including areas that were restored in 2001 and 2006. These past restoration projects created shallow water habitat and sediment that support both juvenile rearing and sockeye beach spawning. Recent effectiveness monitoring of these shoreline restoration projects concluded that the shallow habitat was functioning for juvenile Chinook refugia and migration. However, the gravel supplementation did not significantly increase epibenthic prey preferred by juvenile Chinook (Armbrust et al. 2009). This monitoring study recommended incorporating organic material into the gravel. The proposed restoration project will be very similar to these past projects, and will also cover eroded quarry spall along the shoreline with appropriate substrate. The size and amount of organic material in the new substrate will be determined by the erosive potential along the shoreline. Past gravel supplementation projects on adjacent shoreline segments have determined that wave exposure and lake currents will mobilize and erode pea gravel and finer sediments (Graves 2006). Covering the quarry spall with coarse gravel, however, will have multiple benefits, including reducing predator (e.g., sculpin) habitat and providing suitable substrate for sockeye spawning.

Seward Project 1 was defined as a project because of its southeastern location and documented high use by juvenile Chinook in adjacent natural areas.

6.2.4. Mitigation Site Design

Mitigation actions at this site will include bulkhead removal, bank regrading, gravel installation, LWD installation, and riparian revegetation (Figure 6-2). Grading plans will be developed that are consistent with cross-sections 1A and 1B (Figure 6-2, Appendix B). Approximately 780 cubic yards of gravel will be offloaded and distributed to a depth of 1 foot. Although the substrate size and distribution will be determined from an subsequent analysis of of sediment transport from wind generated waves and currents, the substrate will be installed with the smallest size distribution possible, in order to maximize habitat function for rearing juvenile Chinook. Based on previous substrate enhancement projects, the substrate distribution will likely be similar to what is shown in Table 6-2. LWD will be anchored into the bank at the high lake level at a frequency of approximately 1 piece per 100 feet.

Table 6-2. Gravel Size Distribution for Recent Substrate Enhancement Projects in Lake Washington

Sieve Size (mm)	Percent Passing by Weight
127	100%
102	95 – 100%
76	90 – 95%
38	65 – 80%
32	45 – 60%

Revegetation will include a live stakes community near high lake level elevation and transition to a riparian upland community. Proposed planting zones, species lists, and densities for revegetation are included in Appendix C. Specific planting plans for site-specific conditions and constraints will be developed during the design phase. The implementation schedule is detailed in Section 6.13.

The following constraints will limit design elements of this project:

- Riparian restoration will not occur in public access areas or landward of the public walking trail.
- Riparian plantings will be grouped to provide access to the restored beach from the walking trail and picnic area.
- LWD will not be installed along the shoreline associated with public access areas.
- Construction schedule and access may be dependent on SPU's CSO reduction project planned for Seward Park parking areas.

The site design objectives and criteria are summarized below.

<u>Engineering Objectives:</u>

- Provide a low-gradient shoreline between low and high lake levels.
- Provide gravel (round rock) and sand substrate along the shoreline that will not erode from the target location.

<u>Habitat Objectives:</u>

- Provide shallow, low-gradient rearing and mitratory habitat during juvenile Chinook and early juvenile sockeye rearing periods.
- Provide gravel and sand substrate along the shoreline that minimizes predator habitat.
- Provide LWD keyed into the shoreline for fish cover.
- Provide overhanging vegetation along the shoreline for juvenile salmonid refugia and forage base.
- Provide indirect riparian functions, including shading, pollutant filtration, and LWD recruitment to the shoreline.

- Minimize construction impacts to existing habitat.

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components.

Project Design Criteria

- Bulkhead will be removed below sediment line.
- The slope of the enhanced shoreline habitat will be at or below 15% grade, as measured from low lake level to high lake level.
- Substrate will be installed along the shoreline according to an analysis of sediment transport from wind-generated waves and currents.

Habitat Design Criteria

- Create 0.45 acre of shallow aquatic habitat.
- Gravel substrate in the shallow littoral zone will be installed with the smallest size distribution possible in order to maximize habitat function for rearing juvenile Chinook.
- Provide 0.38 acre of enhanced riparian habitat adjacent to the shoreline.
- Include a vegetation plan to provide adequate shade and overhanging cover along the shoreline.
- The spatial and temporal extent of in-water work will be minimized.
- In-water work will occur during designated in-water work windows.
- Impacts to native vegetation will be minimized.
- Erosion will be minimized.

6.2.5. Ecological Functions and Benefits

The mitigation actions at Seward Project 1 will benefit Cedar River Chinook juveniles (Table 6-3). The juvenile Chinook will benefit from the conversion of shorelines with bulkheads to a gradual, sloping natural condition with functional riparian vegetation. These improved habitat features will provide an unobstructed migratory pathway, protection from piscivorous and avian predators, and enhanced food sources from the natural sediments and overhanging vegetation.

Table 6-3. Seward Park Project 1 Mitigation Benefits

<table>
<tr><th>Mitigation Action</th><th>Acreage</th><th>Habitat Features Improved</th><th>Habitat Functions Improved</th><th>Species/Life Stage Addressed</th></tr>
<tr><td>Shoreline Enhancement + Hard Structure Removal</td><td>0.45</td><td>Gradual, sloped bank
Suitable sediment
Prey input</td><td>Protection from predators
Migratory corridor
Spawning habitat</td><td rowspan="2">Chinook
(Juvenile Rearing/Feeding)

Chinook
(Juvenile Migration)</td></tr>
<tr><td>Riparian Restoration</td><td>0.38</td><td>Vegetative cover
Prey input</td><td>Protection from predators
Food sources</td></tr>
</table>

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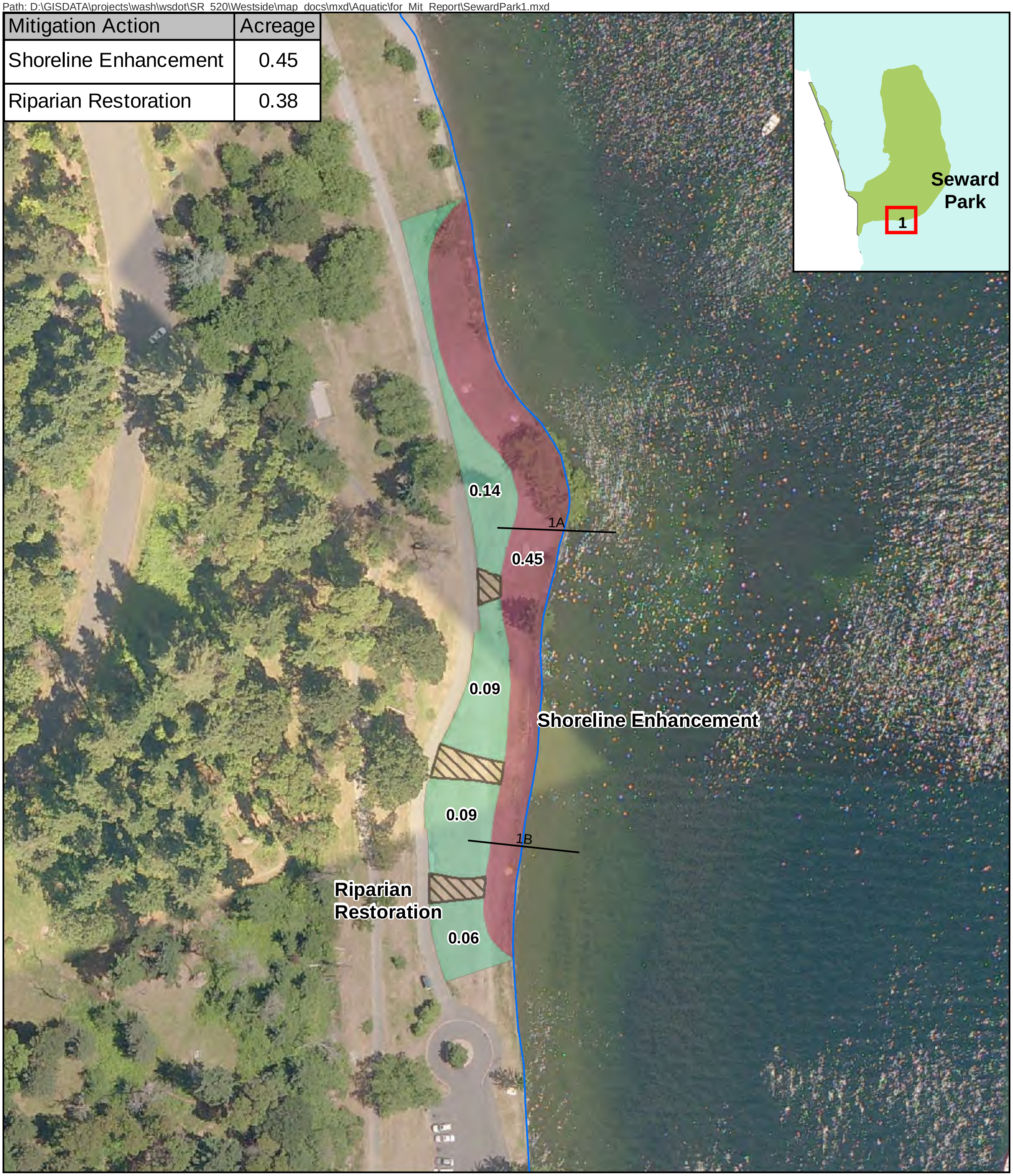
Mitigation Action	Acreage
Shoreline Enhancement	0.45
Riparian Restoration	0.38



N

0 50 100 Feet

- Shoreline Enhancement
- Riparian Restoration
- Public Access
- Shoreline
- Parcel
- Cross-Section
- 2-foot Contour

Figure 6-2.
Conceptual Restoration Plan at the Seward Park Mitigation Site, Project 1

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6.3 Seward Park Project 2

6.3.1. Site Location

Seward Park is in the City of Seattle, along the western shore of Lake Washington, as shown on Figure 6-1. Seward Project 2 is located on the eastern shore of the park (Figure 6-3).

6.3.2. Mitigation Site Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization of shoreline conditions is available in the SR 520 Draft Aquatic Assessment Report (WSDOT 2011c).

Shoreline Conditions

At Seward Project 2, the shoreline has a narrow bench that extends about 50 feet from the shoreline where water is less than 10 feet deep during high lake level (Figure 6-3) before transitioning to a steep slope. The shallow bench has gravel substrate for approximately the first 30 feet, then quickly turns to predominantly sand. A 100-foot by 25-foot area is covered in cobble-sized angular basalt, very similar to the material found along the shoreline at Seward 3. Sand substrate is waterward of the angular basalt. The angular cobble area and the remainder of the shallow bench (waterward of the angular basalt) is the Seward 2 project area.

Ecological Condition of Adjacent Parcels

See Section 6.2.2 for a general description of the Seward Park shoreline. The adjacent shorelines to the north and south have bathymetry similar to that of the Seward 2 project area. Immediately to the north and south of the project area the substrate is gravel transitioning to sand.

Fish Use

See Section 6.2.2 for a general description of Seward Park fish use. The Seward 2 shoreline is used by migrating juvenile Chinook, primarily from the Cedar River. Although this segment of shoreline is along their primary migration path, the density of juvenile Chinook is not as high as at the southeastern extremity of the park (Tabor et al. 2006).

Historical records document sockeye spawning along this specific segment of the Seward Park nearshore (Buchanan 2004). During a 1999 snorkel survey along the Seward Park shoreline, the presence of adult sockeye carcasses at various locations on the Seward park shoreline throughout October, November, and December indicated that beach spawning was occurring (City of Seattle 2001). Therefore, this project area meets the 0.8 FFM criterion of being an “aquatic site that is known to support documented spawning of at least one salmonid species”, and is assigned an FFM of 0.8.

6.3.3. Rationale for Site Selection

The overall rationale for shoreline restoration at Seward Park is described in Section 6.2.3. Seward Project 2 will cover large, cobble-sized angular basalt with gravel suitable for sockeye spawning. Covering the angular cobble with coarse gravel will have multiple benefits, including reducing predator (e.g., sculpin) habitat for migrating and rearing juvenile Chinook as well as providing suitable substrate for sockeye spawning.

6.3.4. Mitigation Site Design

Seward Park Project 2 is located on the southeastern portion of the peninsula (Figure 6-3). In general, sockeye dig redds in gravel and small cobbles between 13 and 102 mm (Reiser and Bjornn 1979). Olsen (1968) indicated that sockeye may use either sand or gravel, depending upon which is available. If small amounts of silt, detritus, or fine sand are mixed with the coarser gravel, they are removed by the fish in the process of excavating the redd (Foerster 1968). Mathisen (1955) observed sockeye salmon egg concentrations 6 to 9 inches below the gravel surface. These observations on suitable habitat will govern the design requirements for Lake Washington spawning supplementation. Approximately 0.06 acre of lake nearshore will be supplemented with 97 yards of suitable gravel. The gravel will be offloaded and spread to a depth of 1 foot. Although the substrate size and distribution will be determined from a forthcoming analysis (design phase) of sediment transport from wind-generated waves and currents, the substrate will be installed with the smallest size distribution possible in order to maximize habitat function for rearing juvenile Chinook. Based on previous substrate enhancement projects, the substrate distribution will likely be similar to what is shown in Table 6-2. There are no apparent constraints to this project. The implementation schedule is detailed in Section 6.13.

The site design objectives and criteria are summarized below.

<u>Engineering Objectives:</u>

- Provide gravel (round rock) and sand substrate along the shoreline that will not erode from the target location.

<u>Habitat Objectives:</u>

- Provide gravel substrate along the shoreline that is suitable for sockeye beach spawning.
- Provide gravel and sand substrate along the shoreline that minimizes habitat for juvenile Chinook predators.
- Minimize construction impacts to existing habitat.

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components.

Engineering Design Criteria

- Substrate installed along the shoreline according to an analysis of sediment transport from wind-generated waves and currents.

Habitat Design Criteria

- Create 0.06 acre of suitable sockeye spawning habitat.
- To the extent possible, gravel substrate will be installed with the size distribution most suitable for sockeye beach spawning.
- Gravel substrate in the shallow littoral zone will be installed with the smallest size distribution possible in order to maximize habitat function for rearing juvenile Chinook.
- The spatial and temporal extent of in-water work will be minimized.
- In-water work will occur during designated in-water work windows.

6.3.5. Ecological Functions and Benefits

The mitigation actions at Seward Park will benefit the Cedar River Chinook juveniles and lake spawning sockeye salmon (Table 6-4). The conversion of angular cobble to gravel will reduce predation and increase prey productivity for juvenile Chinook. Sockeye salmon will benefit from the coversion of angular cobble and sand to substate that is suitable for swawning. Sockeye salmon are known to spawn along the Seward Park shoreline, particularly where there is sufficient current to move water through the gravels.

Table 6-4. Seward Park Project 2 Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/Life Stage Addressed
Shoreline Enhancement	0.06	Suitable sediment	Protection from predators Migratory corridor Spawning habitat	Chinook (Juvenile Rearing/Feeding) Chinook (Juvenile Migration) Sockeye (Juvenile Rearing/Feeding) Sockeye (Spawning)

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Mitigation Action	Acreage
Spawning Gravel Supplementation	0.06

N

0 50 100 Feet

Spawning Gravel Supplementation

Shoreline

2-foot Bathymetry

Figure 6-3.
Conceptual Restoration Plan at the Seward Park Mitigation Site, Project 2

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6.4 Seward Park Project 3

6.4.1. Site Location

Seward Park is in the City of Seattle, along the western shore of Lake Washington, as shown on Figure 6-1. Seward Project 3 is located on the northeast end of the peninsula (Figure 6-4).

6.4.2. Mitigation Site Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization is available in the SR 520 Draft Aquatic Assessment Report (WSDOT 2011c).

Shoreline Conditions

The Seward 3 shoreline has a steep bank above the high lake level (OHW) with vegetation growing through the riprap (Figure A-2). There are some native shrubs along the face of the shoreline intermingled with weedy forbs (Photograph A-2). Landward of the shoreline, the riparian cover is lawn, followed by the impervious walking path (Figure A-2). Landward of the path, the riparian vegetation consists of mature forest. A 20-foot segment of concrete bulkhead is present along the shoreline at the high lake level. One piece of large woody debris was observed on the southern end of the project. The shoreline bathymetry has a 16 to 18% slope near the shore. Substrate at the 1.3-foot depth interval is mostly gravel and sand, with scattered angular cobble (Figure A-3). Substrate at the 2.6-foot depth interval is mostly angular cobble.

Ecological Condition of Adjacent Parcels

See Section 6.2.2 for a general description of the Seward Park shoreline. A public access and heavily-used swimming area is located to the west of Project 3. Immediately to the south is 100 feet of vegetated shoreline, followed by approximately 400 feet of shoreline without trees. The walking trail is close to the shoreline to the south of the Project 3 area.

Fish Use

See Section 6.2.2 for a general description of Seward Park fish use. The Seward 3 shoreline is used by migrating juvenile Chinook, primarily from the Cedar River. Although this segment of shoreline is along their primary migration path, the Chinook juveniles are not as dependent on shallow littoral areas as they are earlier in their life history. Therefore, this project area does not meet the 0.8 FFM criterion of being “migration or rearing areas of considerable importance for one or more species of juvenile salmon”, and is assigned an FFM of 0.6.

6.4.3. Rationale for Site Selection

The rationale for shoreline restoration along the Seward Park shoreline is described in Section 6.2.3. Seward Project 3 was selected because of the presence of angular cobble (quarry spall) along the shoreline and restoration potential along the adjacent riparian zone. Covering the angular cobble with gravel substrate will provide juvenile Chinook rearing opportunity. Previous restoration projects by USACE and Seattle Parks in the immediate vicinity have restored similar shorelines. This project extends and builds upon those previous efforts.

6.4.4. Mitigation Site Design

Mitigation actions at this site will include gravel substrate installation and riparian revegetation (Figure 6-4). Approximately 290 yards of gravel will be offloaded and spread to a depth of 1 foot. Although the substrate size and distribution will be determined from subsequent analysis of sediment transport from wind-generated waves and currents, the substrate will be installed with the smallest size distribution possible in order to maximize habitat function for rearing juvenile Chinook. Based on previous substrate enhancement projects, the substrate distribution will likely be similar to what is shown in Table 6-2.

Because the riprap is largely above the managed lake levels and thinly applied, plants will be installed through the riprap matrix. Revegetation will include live stakes near high lake level elevation and transition to a riparian upland community. Riparian plantings will be installed along the riprap face and adjacent uplands. Proposed planting zones, species lists, and densities for revegetation are included in Appendix C. Specific planting plans for site-specific conditions and constraints will be developed during the design phase. The implementation schedule is detailed in Section 6.13.

The following constraints will limit design elements of this project:

- Riparian restoration will not occur landward of the public walking trail.

The site design objectives and criteria are summarized below.

Engineering Objectives:

- Provide a low-gradient shoreline between low and high lake levels.
- Provide gravel (round rock) and sand substrate along the shoreline that will not erode from the target location.

Habitat Objectives:

- Provide shallow, low-gradient rearing and migratory habitat during juvenile Chinook and early juvenile sockeye rearing periods.
- Provide gravel and sand substrate along the shoreline that minimizes predator habitat.
- Provide overhanging vegetation along the shoreline for juvenile salmonid refugia and forage base.
- Provide indirect riparian functions, including shading, pollutant filtration, and LWD recruitment to the shoreline.
- Minimize construction impacts to existing habitat.

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components.

Project Design Criteria

- Substrate installed along the shoreline according to an analysis of sediment transport from wind-generated waves and currents.

Habitat Design Criteria

- Enhance substrate in 0.18 acre of shallow aquatic habitat.
- Gravel substrate in the shallow littoral zone will be installed with the smallest size distribution possible in order to maximize habitat function for rearing juvenile Chinook.
- Provide 0.26 acre of enhanced riparian habitat adjacent to the shoreline.
- Include a vegetation plan to provide adequate shade and overhanging cover along the shoreline.
- The spatial and temporal extent of in-water work will be minimized.
- In-water work will occur during designated in-water work windows.
- Impacts to native vegetation will be minimized.
- Erosion will be minimized.

6.4.5. Ecological Functions and Benefits

The mitigation actions at Seward Park will benefit the Cedar River Chinook juveniles (Table 6-5). The conversion of angular cobble to gravel will reduce predation and increase prey productivity for juvenile Chinook. Riparian restoration will increase overhanging vegetation and woody debris cover.

Table 6-5. Seward Park Project 3 Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/Life Stage Addressed
Shoreline Enhancement (gravel supplementation)	0.18	Gradual, sloped bank Suitable sediment Prey input	Protection from predators Migratory corridor Spawning habitat	Chinook (Juvenile Rearing/Feeding) Chinook (Juvenile Migration)
Riparian Restoration	0.26	Vegetative cover Prey input	Protection from predators Food sources	

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Mitigation Action	Acreage
Shoreline Enhancement	0.18
Riparian Restoration	0.26

N

0 50 100 Feet

Shoreline Enhancement
Public Access
Parcel
Riparian Restoration
Shoreline
2-foot Bathymetry

Figure 6-4.
Conceptual Restoration at the Seward Park Mitigation Site, Project 3

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6.5 Seward Park Project 4

6.5.1. Site Location

Seward Park is in the City of Seattle, along the western shore of Lake Washington, as shown on Figure 6-1. Seward Project 4 is located on the northern shore of the park (Figure 6-5).

6.5.2. Mitigation Site Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization of shoreline conditions is available in the SR 520 Draft Aquatic Assessment Report (WSDOT 2011c).

Shoreline Conditions

At Seward Project 4, the shoreline has a shallow shelf that extends to the north (~200 feet) where the water is less than 20 feet deep during high lake level (Figure 6-5) before transitioning to a steep slope. For the first 75 feet, the substrate is mostly cobble, gravel, and sand. From there, the substrate quickly turns to predominantly sand. This shallow area is predominantly gravel with some sand, and exposed hardpan. The project area includes the shallow shelf that is predominantly sand.

Ecological Condition of Adjacent Parcels

See Section 6.2.2 for a general description of the Seward Park shoreline. The adjacent shoreline to the west has a narrowing shelf with similar substrate. Immediately to the south and west of the project area, the shelf is extremely narrow with gravel substrate.

Fish Use

See Section 6.2.2 for a general description of Seward Park fish use. The Seward 4 shoreline is assumed to be used by migrating juvenile Chinook from the Cedar River, although this segment of shoreline has never been snorkeled for evidence of this fish use. Historical records document sockeye spawning along this specific segment of the Seward Park nearshore (Buchanan 2004). During a 1999 snorkel survey along the Seward Park shoreline, the presence of adult sockeye carcasses at various locations on the Seward park shoreline throughout October, November, and December indicated that beach spawning was occurring (City of Seattle 2001). Therefore, this project area meets the 0.8 FFM criterion of being an "aquatic site that is known to support documented spawning of at least one salmonid species", and is assigned an FFM of 0.8.

6.5.3. Rationale for Site Selection

The overall rationale for shoreline restoration at Seward Park is described in Section 6.2.3. Seward Project 4 was selected because of the historical sockeye beach spawning records and the potential to create new spawning habitat by covering sand substrate with gravel suitable for sockeye spawning.

6.5.4. Project Objectives and Design Criteria

Seward Park Project 4 is located on the southeastern portion of the peninsula (Figure 6-5). In general, sockeye dig redds in gravel and small cobbles between 13 and 102 mm (Reiser and Bjornn 1979). Olsen (1968) indicated that sockeye may use either sand or gravel, depending upon which is available. If small amounts of silt, detritus, or fine sand are mixed with the coarser gravel, they are removed by the fish in the process of excavating the redd (Foerster 1968). Mathisen (1955) observed sockeye salmon egg concentrations 6 to 9 inches below the gravel surface. These observations on suitable habitat will govern the design requirements for Lake Washington spawning supplementation. Approximately 1.36 acres of lake nearshore will be supplemented with suitable gravel. Approximately 2,194 yards of gravel will be offloaded and spread to a depth of 1 foot. Although the substrate size and distribution will be determined from subsequent analysis of sediment transport from wind-generated waves and currents, the substrate will be installed with a substrate size distribution that will be most suitable for sockeye spawning. Based on previous substrate enhancement projects, the substrate distribution will likely be similar to what is shown in Table 6-2. There are no apparent constraints to this project. The implementation schedule is detailed in Section 6.13.

The site design objectives and criteria are summarized below.

Engineering Objectives:

- Provide gravel (round rock) and sand substrate along the shoreline that will not erode from the target location.

Habitat Objectives:

- Provide gravel substrate along the shoreline that is suitable for sockeye beach spawning.
- Minimize construction impacts to existing habitat.

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components.

Engineering Design Criteria

- Substrate installed along the shoreline according to an analysis of sediment transport from wind-generated waves and currents.

Habitat Design Criteria

- Create 1.36 acres of suitable sockeye spawning habitat.
- To the extent possible, gravel substrate will be installed with the size distribution most suitable for sockeye beach spawning.
- The spatial and temporal extent of in-water work will be minimized.
- In-water work will occur during designated in-water work windows.

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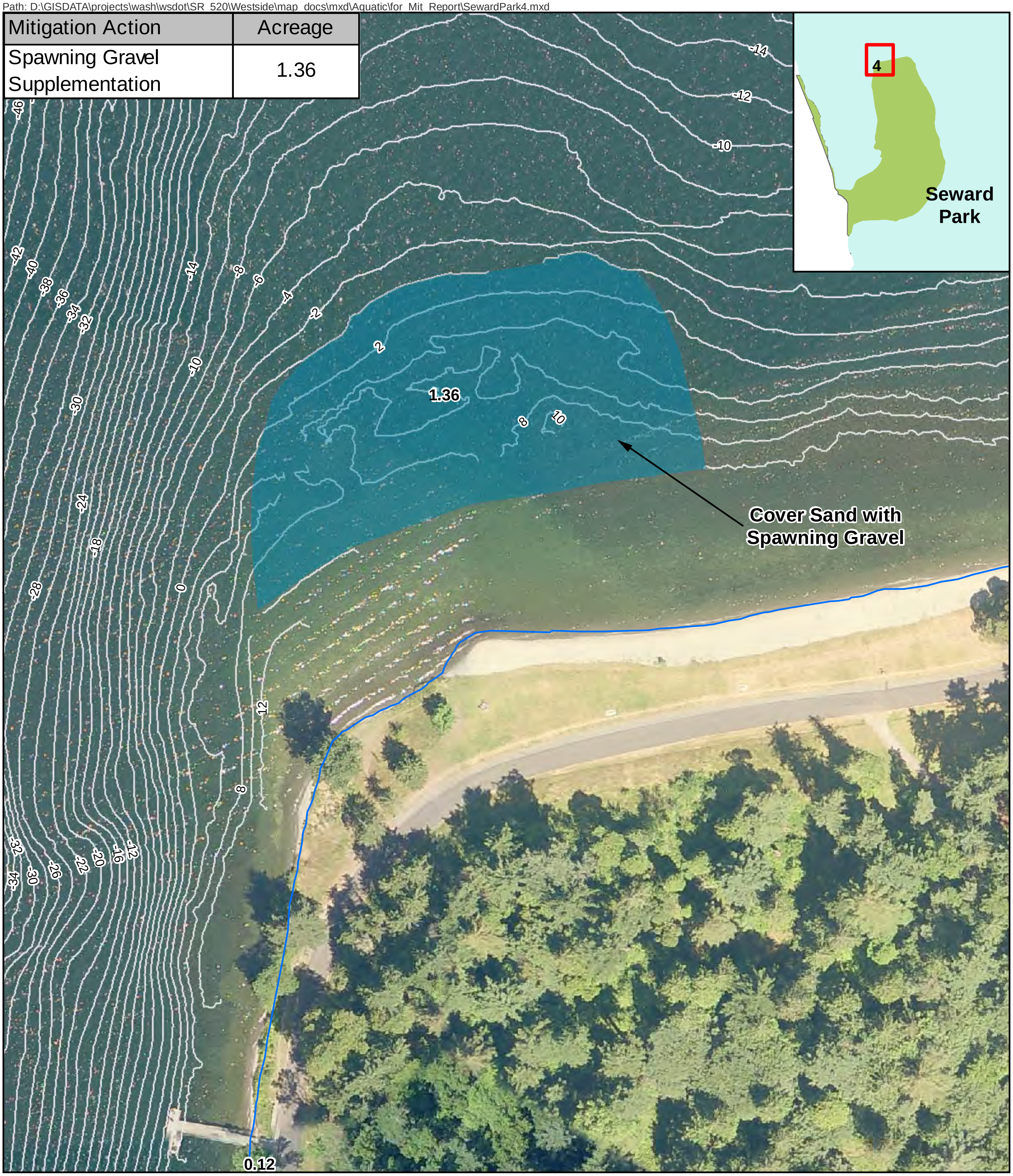
Mitigation Action	Acreage
Spawning Gravel Supplementation	1.36



Spawning Gravel Supplementation

Shoreline

2-foot Bathymetry

N

0 50 100 Feet

Figure 6-5.
Conceptual Restoration Plan at the Seward Park Mitigation Site, Project 4

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6.5.5. Ecological Functions and Benefits

The mitigation actions from Seward Project 4 will benefit lake spawning sockeye salmon (Table 6-6). The conversion of sand and cobble substrate to gravel will result in substrate that is suitable for sockeye spawning. Sockeye salmon are known to spawn along the Seward Park shoreline, particularly where there is sufficient current to move water through the gravels.

Table 6-6. Seward Park Project 4 Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/Life Stage Addressed
Shoreline Enhancement (Gravel Supplementation)	1.36	Suitable sediment	Spawning habitat	Sockeye (Spawning)

6.6 Magnuson Park Project 1

6.6.1. Site Location

The Magnuson Park mitigation site is located on the northwest shore of Lake Washington (Figure 6-1). Magnuson Project 1 is located south of the park boat launch (Figure 6-6).

6.6.2. Mitigation Site Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization of shoreline conditions is available in the SR 520 Draft Aquatic Assessment Report (WSDOT 2011c).

Shoreline Conditions

Magnuson Park has an extensive shoreline. The shoreline has discontinuous segments that vary by presence of bulkheads, presence of native vegetation, bank height, and bank slope. Similar to Seward Park, some segments of the Magnuson Park shoreline have been restored by regrading the bank to a lower slope, importing gravel to the re-sloped beaches, and revegetating narrow riparian zone strips immediately adjacent to the shoreline. A boat launch on the southern end of the park has a heavily armored shoreline at approximately 50 feet on either side of the ramps, and is incompatible with shoreline restoration. Two swimming areas are also incompatible with restoration.

The length of the Magnuson 1 shoreline is approximately 300 feet. A 2-foot-high vertical bank is actively eroding and has concrete/asphalt rubble along the shore. Vertical profiles are provided in Appendix B. One piece of large woody debris was observed on the shoreline. The shoreline has a 9 to 14% slope (WSDOT 2011c; Appendix B). Substrate is predominantly cobble and gravel. Riparian vegetation is managed grass lawn, with one area of native vegetation along the shoreline. This area has been planted with native shrubs and a few trees and contributes about 500 sq. ft. of cover from overhanging vegetation. A wide impervious walking path runs through the riparian zone.

Ecological Condition of Adjacent Parcels

The adjacent parcels south of Magnuson Park are residences with bulkheads and docks. The adjacent parcels to the north and west belong to the National Oceanic and Atmospheric Administration (NOAA). The adjacent NOAA shoreline has a character similar to that of the Magnuson Park shoreline.

Directly adjacent to and south of Magnuson Project 1, the shoreline is vegetated with a thin and discontinuous row of deciduous trees. The shoreline is mostly vertical and varies in height above the water line. Bank protection associated with the boat launch is directly adjacent to and north of the project area. Park structures constrain riparian revegetation to the north.

Fish Use

The Magnuson Park shoreline is likely used by juvenile Chinook from the North Lake Washington tributaries and the Sammamish/Issaquah Creek system as they migrate toward the Ship Canal. The shoreline segments with shallow water and cover are used by the juvenile Chinook for rearing, foraging, and refugia. North Lake Washington Chinook juveniles have bimodal migration timing, with a some 0+ juveniles migrating out of their natal streams toward the lake as newly emerged fry (35–40 millimeter [mm] fork length) in early spring and others as smolts (85–95 mm fork length) in late May–June (Seiler et al. 2003). The early fry may use the Magnuson Park shoreline and other nearshore areas in Lake Washington for rearing, foraging, and migration. The larger Chinook juveniles reside in waters between 3 and 18 feet deep during the day, primarily over sand-gravel substrates. These larger juveniles will use the shoreline features for fish cover on an infrequent basis (King County 2005). Because juvenile migration or rearing areas for juvenile Chinook are thought to occur, but fish density or temporal distribution of fish is likely lower compared to that of other sites, Magnuson Project 1 scores a “Moderate” FFM score of 0.6 in terms of the juvenile rearing criterion (Table 4-1).

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Mitigation Action	Acreage
Shoreline Enhancement + Hard Structure Removal	0.20
Riparian Restoration	0.36

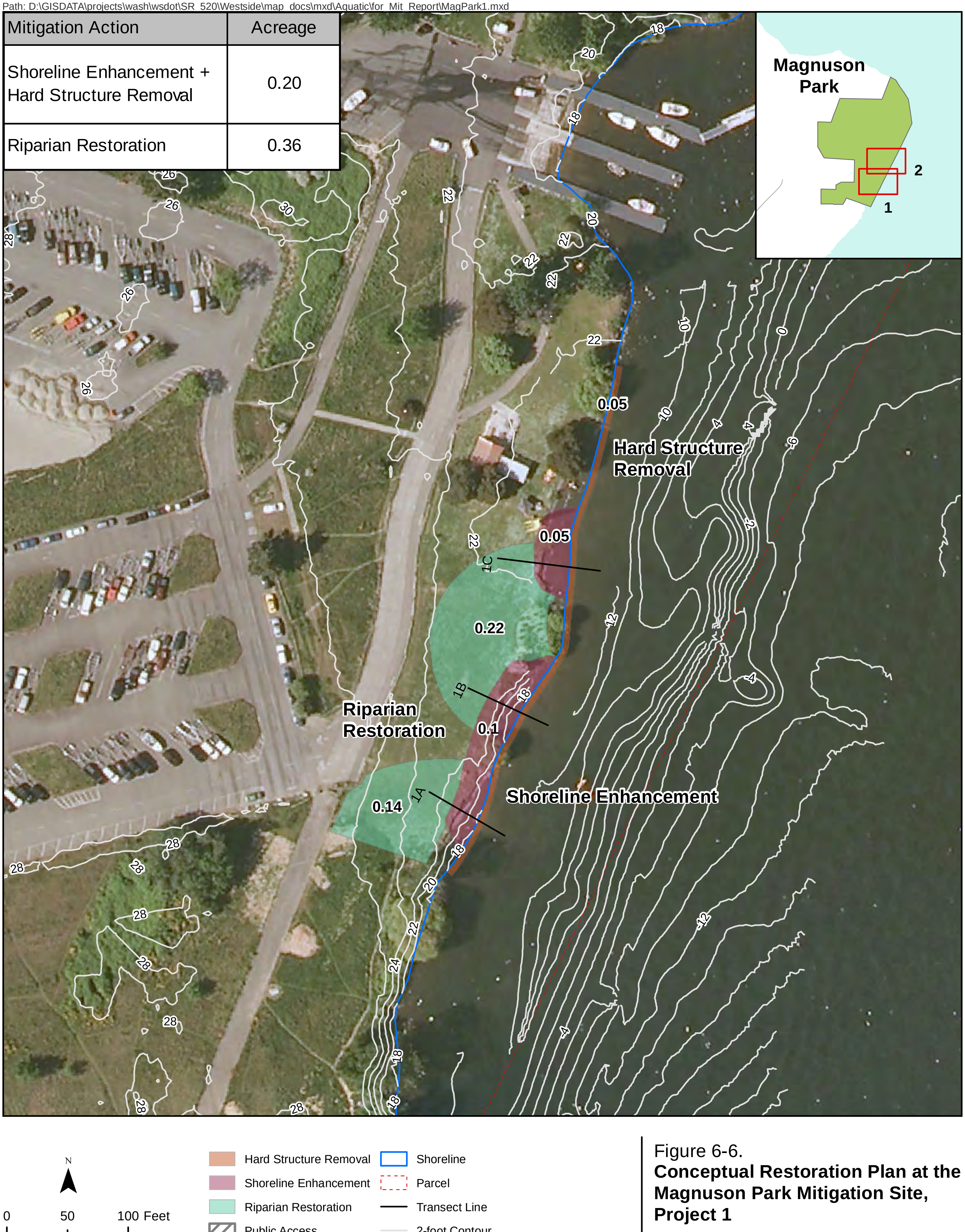

Figure 6-6.
Conceptual Restoration Plan at the Magnuson Park Mitigation Site, Project 1

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Mitigation Action	Acreage
Shoreline Enhancement + Hard Structure Removal	0.14
Riparian Restoration	0.80
Stream Channel	0.05

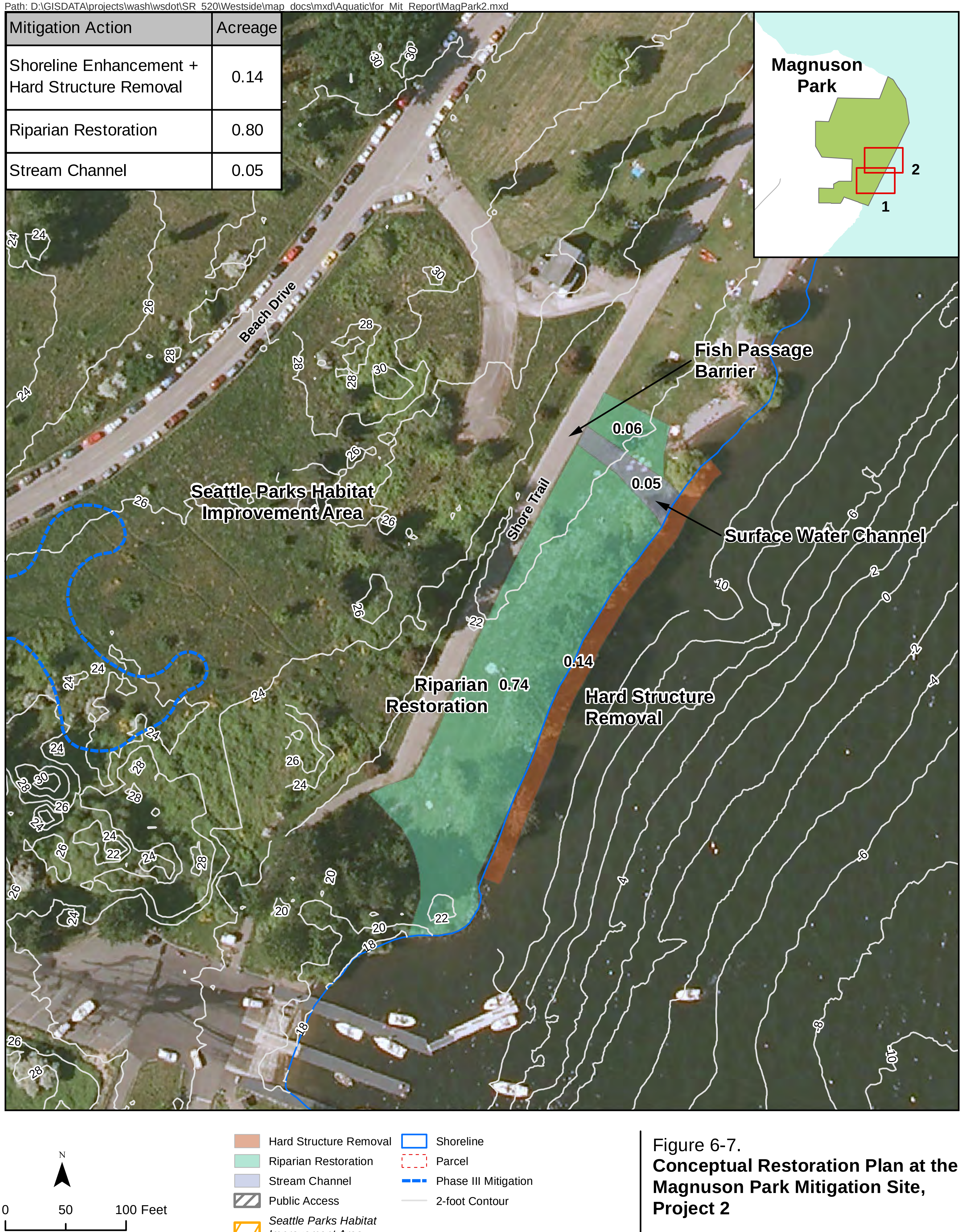

Figure 6-7.
Conceptual Restoration Plan at the Magnuson Park Mitigation Site, Project 2

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Historical records document sockeye spawning along the Magnuson Park nearshore at Sand Point, to the north of Magnuson Projects 1 and 2 (Buchanan 2004). Sockeye fry originating from adults spawning on the Magnuson Park shoreline may use the littoral zone of Magnuson Park for very early rearing. Because sockeye spawning has not been documented in the specific project area, Magnuson Project 1 scores a “Moderate” FFM score of 0.6 in terms of the spawning criterion (Table 4-1).

6.6.3. Rationale for Site Selection

Magnuson Park was selected for shoreline and riparian restoration because of its predicted use by North Lake Washington and Sammamish/Issaquah Chinook salmon juveniles for foraging, rearing, and migration toward the Ship Canal (Seiler et al. 2003). Some shoreline segments in and adjacent to the park have already been restored. Magnuson Project 1 will build on these past efforts and provide a more continuous natural shoreline.

6.6.4. Mitigation Site Design

Mitigation actions at Magnuson Project 1 will include the creation of two cove beaches, separated by an existing vegetated point (Figure 6-6). In addition, targeted areas of the riparian zone will be restored in a configuration that will allow for public access to both cove beaches. Implementing this concept includes bank re-sloping, gravel augmentation, LWD installation, and revegetation. Grading plans will be developed that are consistent with Magnuson cross-sections A–C (Figure 6-6, Appendix B). Shoreline sediments may be comprised of rubble and anthropogenic backfill. Therefore, over-excavation and placement of clean material may be warranted. Approximately 323 cubic yards of gravel will be offloaded and spread to a depth of 1 foot. Although the substrate size and distribution will be determined from a subsequent analysis of of sediment transport from wind-generated waves and currents, the substrate will be installed with the smallest size distribution possible in order to maximize habitat function for rearing juvenile Chinook. Based on previous substrate enhancement projects, the substrate distribution will likely be similar to what is shown in Table 6-2. LWD will be installed at the bank at the high lake level at a frequency of approximately 1 piece per 100 feet. Revegetation will include live stakes installed near high lake level elevation and transition to a riparian upland community. Proposed planting zones, species lists, and densities for revegetation are included in Appendix C. Specific planting plans for site-specific conditions and constraints will be developed during the design phase. The implementation schedule is detailed in Section 6.13.

The following constraints will limit design elements of this project:

- Riparian restoration will not occur landward of the public walking trail.
- The extensive use of this area by the public will require existing uses to persist in a portion of the riparian zone (grass, paths, etc.).

The site design objectives and criteria are summarized below.

Engineering Objectives:

- Provide two cove beaches with a low-gradient shoreline between low and high lake levels.
- Provide gravel (round rock) and sand substrate along the shoreline that will not erode from the target location.

Habitat Objectives:

- Provides shallow, low-gradient rearing and mitratory habitat during juvenile Chinook rearing periods.
- Provides overhanging vegetation along the shoreline for juvenile salmonid refugia and forage base.
- Provides gravel and sand substrate along the shoreline that minimizes predator habitat.
- Provides LWD keyed into the shoreline for fish cover.
- Provides indirect riparian functions, including shading, pollutant filtration, and LWD recruitment to the shoreline.
- Minimizes construction impacts to existing habitat.

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components.

Engineering Design Criteria

- The slope of the enhanced shoreline habitat will be at or below 15% grade, as measured from low lake level to high lake level.
- Excavate shoreline sediments until the extent of rubble and anthropogenic backfill is reached and replace with clean material.

- Substrate will be installed along the shoreline according to an analysis of sediment transport from wind-generated waves and currents.

Habitat Design Criteria

- Provide 0.2 acre of shallow aquatic habitat.
- Gravel substrate will be the smallest possible size distribution in order to provide maximum habitat benefits to rearing juvenile Chinook.
- Provide 0.36 acres of enhanced riparian habitat adjacent to the shoreline.
- Include a vegetation plan to provide adequate shade and overhanging cover along the shoreline.
- The spatial and temporal extent of in-water work will be minimized.
- In-water work will occur during designated in-water work windows.
- Impacts to native vegetation will be minimized.
- Erosion will be minimized.

6.6.5. Ecological Functions and Benefits

The mitigation actions at Magnuson Park will benefit a portion of the North Lake Washington and Sammamish/Issaquah Chinook juveniles that require shallow water rearing and foraging habitat (Table 6-7). The juvenile Chinook will benefit from the conversion of the eroding shoreline and bulkheads to a gradually-sloping natural condition with functional riparian vegetation. These improved habitat features will provide an unobstructed migratory pathway, protection from piscivorous and avian predators, and enhanced food sources from the natural sediments and overhanging vegetation. The larger juveniles spend most of their time in deeper water, between 3 and 18 feet deep, but the gravel supplementation proposed within this depth range will match their preferred substrate. The Magnuson Park shoreline is located along the migratory corridor for Sammamish/ Issaquah Creek juvenile Chinook; these juveniles are using the entire littoral zone (shallow and deeper) during migration.

The mitigation action benefits survival of juvenile Chinook by increasing habitat function along their migratory path toward the Ship Canal.

Table 6-7. Magnuson Project 1 Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/ Life Stage Addressed
Shoreline Enhancement + Hard Structure Removal	0.2	Gradual, sloped bank Suitable sediment Prey input	Protection from predators Migratory corridor	Chinook (Juvenile Rearing/Feeding) Chinook (Juvenile Migration)
Riparian Restoration	0.366	Vegetative cover Prey input	Protection from predators Food sources	

6.7 Magnuson Park Project 2

6.7.1. Site Location

The Magnuson Park mitigation site is located on the northwest shore of Lake Washington (Figure 6-1). Magnuson Project 2 is located adjacent to and north of the Magnuson Park boat launch (Figure 6-7). The length of this segment is approximately 450 feet.

6.7.2. Mitigation Site Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization of shoreline conditions is available in the SR 520 Draft Aquatic Assessment Report (WSDOT 2011c).

Shoreline Conditions

See Section 6.6.2 for a discussion of the Magnuson Park shoreline. Riparian vegetation at Magnuson 2 is mostly grass, but a narrow band of deciduous trees along the shoreline provides a substantial amount of bank protection and cover. The trees have stabilized the banks and created cover from overhanging vegetation along the entire project area. Approximately the same area has either concrete rubble or a concrete bulkhead in the water. The 2-foot-wide concrete bulkhead is about 5 feet waterward of the shoreline and is a continuous barrier to fish accessing this functional shoreline (Figure A-5). The shoreline has a 14 to 38% slope. The bulkhead appears to cause sediment to accrue inside the bulkhead and erode waterward of the bulkhead. The natural substrate is predominantly gravel and cobble, but concrete rubble is widespread.

Ecological Condition of Adjacent Parcels

See Section 6.2.2 for a description of parcels adjacent to Magnuson Park. Immediately adjacent to and south of the Magnuson Project 2 area is the public boat launch and riprap shoreline. Immediately adjacent to and north of the the project area is a previously restored shoreline with gradually sloped banks and gravel substrate.

Fish Use

See Section 6.2.2 for a discussion of fish use in the Magnuson Park area. Since juvenile migration or rearing areas for juvenile Chinook are thought to occur, but where fish density or temporal distribution of fish is likely lower compared to that of other sites, Magnuson Project 2 scores a “Moderate” FFM score of 0.6 in terms of the juvenile rearing criterion (Table 4-1).

Historical records document sockeye spawning along the Magnuson Park nearshore at Sand Point, to the north of Magnuson Projects 1 and 2 (Buchanan 2004). Sockeye fry originating from adults spawning on the Magnuson Park shoreline may use the littoral zone of Magnuson Park for very early rearing. Because sockeye spawning has not been documented in either specific project area, Magnuson Project 2 scores a “Moderate” FFM score of 0.6 in terms of the spawning criterion (Table 4-1).

6.7.3. Rationale for Site Selection

Magnuson Park was selected for shoreline and riparian restoration because of its predicted use by North Lake Washington and Sammamish/Issaquah Chinook salmon juveniles for foraging, rearing, and migration toward the Ship Canal (Seiler et al. 2003). Some shoreline segments in and adjacent to the park have already been restored. Magnuson Project 2 will build on these past efforts and provide a more continuous natural shoreline.

6.7.4. Mitigation Site Design

The primary mitigation actions at this site will include removal of the continuous bulkhead and rubble. The existing root structure of the bank vegetation will likely prevent shoreline erosion when the bulkhead and rubble are removed. However, if the existing root structure is insufficient to prevent shoreline erosion, re-grading and gravel placement will be considered. A surface water channel would also be constructed to convey flows from both WSDOT’s wetland mitigation site and Seattle Park’s planned habitat improvements upstream. It is anticipated that the channel will typically carry 1 to 2 cfs of baseflow and will be accessible to fish upstream for a distance (roughly 100 feet) to the point of the existing path. From this point, fish passage will be prevented by the installation of a weir, or similer impediment, to avoid the potential of fish access to unsuitable habitat or fish stranding. The implementation schedule is detailed in Section 6.13.

The site design objectives and criteria are summarized below.

Engineering Objectives:

- Provide a surface water channel downstream of wetland complex.
- Prevent fish passage into upstream wetland complex.
- None.

Habitat Objectives:

- Provide access to the existing shoreline to juvenile Chinook by removing bulkhead.
- Provide shallow aquatic habitat to juvenile Chinook by removing rubble.
- Provide shallow surface water channel habitat downstream of the Seattle Parks proposed wetland complex that is suitable for juvenile Chinook rearing.
- Prevent fish access between the proposed stream channel and the Seattle Parks wetland complex.
- Minimize construction impacts to existing habitat.

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components.

Engineering Design Criteria

- Surface water channel banks will not erode from wetland discharge or lake wave action.
- Surface water channel will not have angular cobble (riprap) below the OHWM.
- None.

Habitat Design Criteria

- Provide stream channel with overhanging vegetation and substrate suitable for juvenile Chinook rearing.
- Enhance 0.14 acre of shallow aquatic habitat by removing bulkhead and rubble material.
- Restore 0.80 acre of riparian habitat and function.

- The spatial and temporal extent of in-water work will be minimized.
- In-water work will occur during designated in-water work windows.

6.7.5. Ecological Functions and Benefits

The ecological functions and benefits of Magnuson Project 2 will be the same as described in Section 6.6.5. The quantities of the benefits are shown in Table 6-8.

Table 6-8. Magnuson Park Project 2 Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/ Life Stage Addressed
Shoreline Enhancement + Hard Structure Removal	0.14	Gradual, sloped bank Suitable sediment Prey input	Protection from predators Migratory corridor	Chinook (Juvenile Rearing/Feeding) Chinook (Juvenile Migration)
Surface Water Channel Creation	.05	Suitable sediment Prey input		
Riparian Restoration	0.80	Vegetative cover Prey input		

6.8 Taylor Creek Site

6.8.1. Site Location

Taylor Creek is located in southeast Seattle (Figure 6-1). It is the fourth-largest creek in Seattle and drains a predominantly residential and park watershed. Its headwaters lie in King County and over two-thirds of the creek flows through relatively undisturbed wooded areas. Within the city limits, the creek flows through a large forested park before flowing into Lake Washington close to the southern city limits. The creek is unique in Seattle because of the length of contiguous forested buffers, low levels of development, and intact headwater wetlands. Taylor Creek enters the lake approximately 1.7 miles from the mouth of the Cedar River. The project area is the most downstream segment between Rainier Avenue South and Lake Washington (Figure 6-8).

6.8.2. Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization is available in the SR 520 Draft Aquatic Assessment Report (WSDOT 2011).

Shoreline Conditions

The site's shoreline along Lake Washington consists of a delta that has been naturally armored with cobbles in the prevailing stream flow paths, and gravel and sand in the remainder (Figure A-7 in Appendix A). Due to accretion from sediment deposits consisting of large particle sizes, the delta can inhibit fish passage during periods of low lake levels. The delta transitions into a sandy beach with small pockets of marsh vegetation (i.e., rushes). This very narrow marsh fringe transitions into a residential lawn (Figure A-8). Upstream, , the creek flows from Rainier Avenue South through residential properties for approximately 560 feet before reaching the delta (Figure A-9). The stream habitat in this reach is degraded because it has been confined by modifications including concrete walls, boulders, and pavers. The channel has been straightened to allow for the current residential use adjacent to the creek. The riparian/ floodplain area has been modified with fill, residential homes, asphalt driveways, and a patio/dock structure on the shoreline. The small amount of vegetation along the creek consists of a few mature trees and ornamental plants. The culvert under Rainier Avenue South is a total barrier to salmonids. No salmon have been found upstream of Rainier Avenue South for decades. The culvert was built in sections over time with different-sized pipes. Portions of the culvert are on private property.

Ecological Condition of Adjacent Parcels

Adjacent parcels along the shoreline and creek are high-density residential. The shoreline consists of bulkheads and docks.

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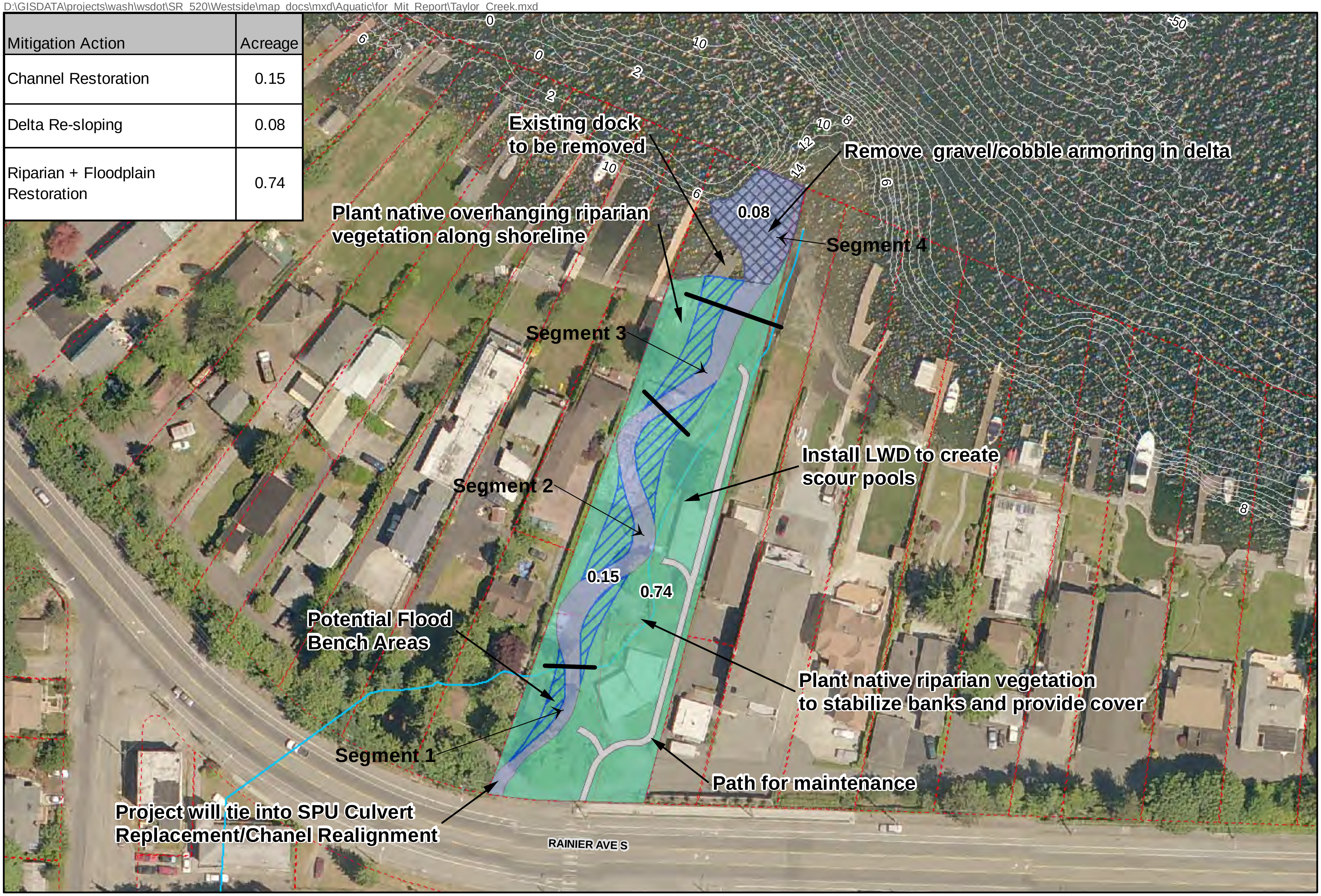
Mitigation Action	Acreage
Channel Restoration	0.15
Delta Re-sloping	0.08
Riparian + Floodplain Restoration	0.74



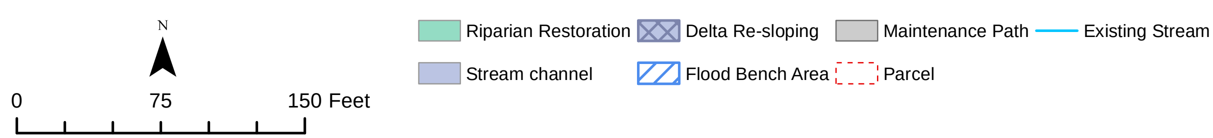


Figure 6-8.
Conceptual Restoration Plan at the Taylor Creek Mitigation Site

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Fish Use

Taylor Creek is used by sockeye, coho, and Chinook salmon, as indicated during surveys by Washington Trout (2000). These surveys are part of an annual program to document spawning salmon. Washington Trout inspects Seattle's major creeks weekly during the spawning season and documents the number of live and dead fish as well as the locations of redds (excavations dug by salmonids in gravel or other substrate for depositing eggs). Annual salmon spawning surveys have found coho and sockeye pooling just downstream of Rainier Avenue South. The results of these surveys are shown in Table 6-9. Juvenile Chinook use the Taylor Creek delta and convergence pool for feeding and rearing, but cannot typically access the upstream habitat because the gradient is too high (Tabor et al. 2004a) during low lake levels. Tabor et al. (2010b) surveyed Taylor Creek in the summer and found juvenile Chinook and coho in Taylor Creek.

Table 6-9. Spawing Survey Results on Taylor Creek

Year	Coho	Sockeye
2000	0	28
2001	2	20
2002	4	29

Source: SPU and Washington Trout

A fish use and habitat evaluation of Taylor Creek concluded that the creek is capable of supporting coho and sockeye (Washington Trout 2000).

6.8.3. Rationale for Site Selection

The WRIA 8 Chinook Salmon Recovery Plan (King County 2005) prioritized the reduction of predation on juvenile migrants in Lake Washington by providing increased rearing and refuge opportunities. The Recovery Plan prescribes the restoration of shallow water habitats and creek mouths for juvenile rearing and migration. Chinook are known to make extensive use of tributary habitat in South Lake Washington (Tabor et al. 2006).

6.8.4. Mitigation Site Design

The stream, delta, and riparian restoration proposed by WSDOT will work in concert with separate restoration actions that will be implemented upstream by SPU. SPU is currently developing plans to replace the Taylor Creek culvert under Rainier Avenue South to the southeast at a new grade to restore fish passage. The City's work will accomplish the following objectives:

- Provide full fish passage for all life stages and species of native salmonids.
- Pass flows beyond the 25-year flood event to meet drainage service levels.
- Minimize any flow constrictions that affect flooding conditions.

SPU has already acquired the properties in the WSDOT project area, below Rainier Avenue South to Lake Washington (Figure 6-8) and is independently developing alternative restoration designs for the WSDOT project area. The WSDOT project will begin at the outlet of the SPU culvert replacement under Rainier Avenue South.

WSDOT proposes to develop a restoration design that both meets the objectives of SPU's restoration concept and satisfies the compensatory mitigation requirements of the project. Based on a functional assessment of the baseline conditions at the Taylor Creek site (WSDOT 2011) restoration actions in the WSDOT project area will focus on the following goals to address functional deficiencies of the site:

- The site presently has a high degree of hydromodification along the stream banks. WSDOT proposes to increase floodplain and stream capacity and natural floodplain and stream functions.
- WSDOT proposes to improve the channel configuration and gradient to allow for proper sediment transport and minimize large gravel and cobble depositing on the delta. The larger SPU project will need to address sediment management upstream to support this approach.
- WSDOT proposes to improve channel complexity with increased sinuousity and incorporation of woody debris.
- Riparian quality is very poor. WSDOT proposes to enhance the full extent of riparian habitat available at the site.

The entire project area, including out into the delta will undergo channel, floodplain, and riparian restoration. Floodplain restoration will include excavation of a floodway on the site to create a lower elevation zone along the channel throughout the site that can be accessed by higher flows. Berms will be created along the parcel boundaries to allow natural flooding in the project area, but protect adjacent private property. All structures, impervious surfaces, non-essential utilities, underground storage tanks, and the existing patio and dock will be removed. In addition, the existing channel armoring and floodplain fill will be removed, providing a natural floodplain grade.

The channel will be reconstructed with the primary objective of differential sediment size deposition to reduce the load of particles larger than 1 inch in diameter reaching the delta. Allowing only finer sediments to reach the delta would enable more effective erosive processes from wave and current action, thereby minimizing accretion. The mitigation site does not have sufficient capacity to completely manage the estimated sediment load delivered by the Taylor Creek system. The proposed sediment sorting approach will need to work in concert with the larger SPU project to address sediment management both upstream and on the site.

The channel design is predicated upon manipulating the competence of the stream's transport capacity. The competence refers to the largest particle size that will be moved by a given discharge, and in the case of this channel design is the 2-year discharge. The 2-year discharge was selected as the design flow for channel size and sediment dynamics because the proposed addition of a floodway and active floodplain on-site ensures that sediment transport does not increase significantly during flow events exceeding the bankfull discharge.

Using sediment data collected by SPU (2007), an analysis is being conducted to generally correlate the deposition of different sediment sizes to stream gradient. Based on the sediment load and grain size distribution data for the design flow, channel segments with a transport capacity specific to target size fractions of the load are proposed. The channel hydraulic radius and slope will be specified to result in an even and progressively coarse to fine distribution of sediment size fractions deposited under normal flows toward the delta. A schematic of the geomorphic analyses required to develop a channel design is shown in Figure 6-9.

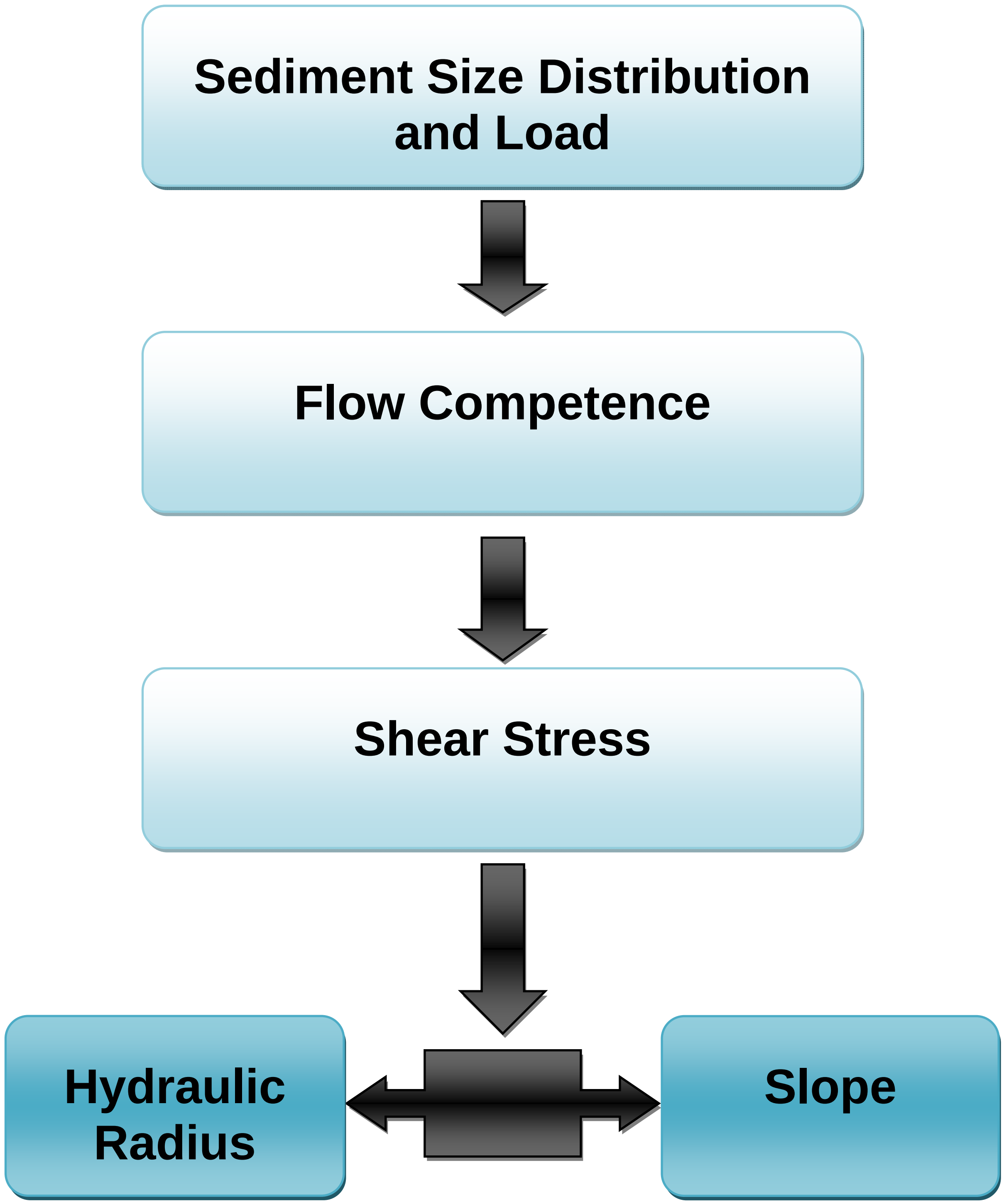

Figure 6-9. Taylor Creek Channel Design Schematic

The mouth and delta of Taylor Creek will be configured to minimize constraints on the natural evolution of the stream delta. The cobble substrate that is currently armoring the delta will be removed. This will expose the smaller sand and gravel that can be reworked by stream flows and waves to maintain an open channel across the delta at low lake levels. This change will result in a more complex delta that is passable by juvenile and adult salmon.

The full available width of the site will be planted with riparian vegetation and the lake shoreline plantings will focus on overhanging woody vegetation to promote juvenile rearing habitat. Once the riparian vegetation has become established, it will provide cover, bank stability, water quality filtration, and (long-term) LWD recruitment. Proposed planting palettes for revegetation are included in Appendix C. Specific planting plans will be based on site-specific conditions and constraints. The following site constraints limit restoration on the site:

- Riparian and floodplain restoration is limited by the width of the acquired parcels.
- Maintenance paths (Figure 6-8) will not be vegetated.
- Channel design is constrained by the available space in the acquired parcels.
- Channel design must be compatible with the SPU restoration work upstream of Rainier Avenue South, and the new realigned culvert under Rainier Avenue South.

The site design objectives and criteria are summarized below.

<u>Engineering Objectives:</u>

- Provide a design that is supported by SPU and is forward-compatible with, or sequenced after, the planned restoration actions upstream of Rainier Avenue South.
- Support delta processes that promote fish passage at all flows and lake levels by inhibiting deposition of larger particles and general accretion of the delta.
- Provide a channel geometry that promotes the deposition of larger particle sizes in the upstream segments, and a progressive fining of sediment size deposition toward the lake.
- Provide a channel with lateral and vertical stability to maintain the target function of sediment deposition.
- Excavate accreted delta material and salvage for use in constructed channel.
- Do not adversely impact adjacent property owners.
- Do not adversely impact existing habitat within the littoral habitat of Lake Washington.
- Anticipate future changes in stream dynamics and develop appropriate contingency measures.

- Work closely with SPU to develop and implement an overall integrated sediment management plan that will facilitate manageable sediment dynamics in the constrained context of the site and ensure the success of the mitigation project downstream of Rainier Avenue South.

Habitat Objectives:

- Improve upstream passability through delta re-sloping.
- Improve instream habitat complexity.
- Improve riparian conditions along the channel and at the mouth to promote allochthonous materials input to the channel and nearshore lake habitats.
- Improve spawning and rearing conditions for native salmonids, with an emphasis on juvenile Chinook rearing habitat along the lake shoreline and in the creek (Tabor et al. 2006).
- Minimize construction impacts to existing habitat.

The following criteria define the successful outcomes that would result if the above objectives are met. Criteria have been compiled for both engineering and habitat components.

Engineering Design Criteria

- Provide a laterally stable channel geometry within the project limitis that transports only particles 1 inch or smaller to the confluence of Lake Washington for the 2-year design flow.
- Match transport capacity to sediment size distribution and load to create differential deposition zones or channel segments. Provide channel cross-section and planform (sinuousity) that correlate with transport capacity.
- Progressively sort coarse to fine sediment deposition from downstream; use competence and related shear stress to determine channel cross-section and profile.
    - Segment 1 – 4 inch particle size competence
    - Segment 2 – 3 inch particle size competence
    - Segment 3 – 2 inch particle size competence
    - Segment 4 – 1 inch particle size competence
- Size channel sub-grade material to maintain stability.
- Lower elevation of delta at a < 15% slope from mouth of constructed channel. Salvage excavated material for use as appropriate in reconstructed channel.
- The mitigation site alone does not have sufficient capacity to accept the entire estimated sediment load without overwhelming the proposed graded deposition zone. The proposed approach critically relies on establishing an overall sediment management plan as part of the larger SPU project that reduces the sediment load delivered to the site located downstream of Rainier Avenue South.

Habitat Design Criteria

- Provide approximately 600 linear feet of channel.
- Provide 0.74 acres of enhanced riparian habitat adjacent to channel.
- Include a vegetation plan to provide adequate shade and overhanging cover along channel.
- Incorporate LWD where feasible to provide cover and to promote pool formation.

6.8.5. Ecological Functions and Benefits

The proposed channel will be more complex, much less confined, and will attenuate sediment transport to the delta relative to the existing condition. This proposed condition will benefit multiple fish uses (Table 6-10). Coho and sockeye will have suitable spawning habitat in the riffle habitat and rearing habitat in the pools and margins. Pools associated with LWD will be particularly beneficial for coho and sockeye rearing. Chinook and sockeye fry will benefit from rearing and feeding in the delta, shoreline fringe, and the vegetated margins of the creek. Because the site is a migratory and rearing area of considerable importance for juvenile Chinook salmon, and coho and sockeye spawning occurs in the project area, the channel and riparian areas have a Fish Function Modifier score of 0.8 (Table 6-1). Because of the uncertainty regarding sediment delivery to the delta, WSDOT has made a conservative assumption that the improvements there are likely to be temporary unless an effective sediment management plan is implemented upstream; thus, a Fish Funtion Modifier score of 0.4 was assigned to that action.

Table 6-10. Taylor Creek Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/Life Stage Addressed
Channel Restoration	0.15	LWD recruitment Off-channel Protection from predators	Food sources Suitable spawning habitat	Chinook (Rearing/Feeding) Sockeye (Spawning)
Delta Re-Sloping Restoration	0.08	Protection from predators Prey inputsubstrate size	Protection from predators Fish passage potential Food sources	Sockeye (Rearing/Feeding) Coho

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/Life Stage Addressed
Riparian + Floodplain Restoration	0.74	Vegetative cover Prey input	Protection from predators Food sources	(Spawning) Coho (Rearing/Feeding)

6.9 South Lake Washington Shoreline Restoration (DNR Parcel)

6.9.1. Site Location

The Washington State Department of Natural Resources (DNR) manages approximately 3 acres of filled shoreline area in South Lake Washington. The property is located adjacent to the Boeing plant, approximately 1,300 feet east of the mouth of the Cedar River and 600 feet west of Gene Coulon Park (Figures 6-1, 6-10).

6.9.2. Mitigation Site Existing Conditions and Fish Use

Shoreline Conditions

This property was created in 1965 when Puget Sound Power and Light (PSPL) was permitted to place 150,000 cubic yards of fill into the lake (Figure A-10 in Appendix A). The fill was placed alongside a flume made of two sheet-pile walls that PSPL used to release cooling waters from its Shuffleton Steam Plant. The flume is still located along the shoreline of this property.

Approximately half of the hardened shoreline consists of the 650-foot-long flume on the northeastern half of the project area (Figure A-11). Portions of the adjacent upland and a private dock require sections of the flume for stability. The remaining shoreline in the project area (600 feet) has a natural grade, but is hardened with riprap. The entire shoreline and riparian zone is in a degraded condition, but with native vegetation cover (Figure A-12). Three dolphins are located east of the shoreline. Dolphins are man-made structures extending above the water level and not connected to the shore. Each dolphin at this site consists of seven creosote piles.

Ecological Condition of Adjacent Parcels

The shoreline to the west is a vertical bulkhead shoreline and paved commercial yard associated with the Boeing plant. However, this degraded shoreline is only 1,200 feet long, and the mouth of the Cedar River is at the other end of this bulkhead. The shoreline to the east consists of additional lengths of the flume, a bulkhead, and a floating dock. Gene

Coulon Park is located on the other side of these adjacent features, and offers additional rearing habitat for salmonids.

Fish Use

The project area is most heavily used by Chinook fry that migrate through the site from the Cedar River toward the Ship Canal. The Chinook fry primarily use the portions of shoreline that contain naturally-sloped beach, though this shoreline is degraded from the presence of riprap and lack of native vegetation. High levels of Chinook fry/smolt use have been documented on the site (Tabor et al. 2004a; Tabor et al. 2006). Sockeye fry are known to use the shallow littoral zone in South Lake Washington, especially during the early stages of rearing. Since this site is located adjacent to the mouth of the Cedar River, it is likely that sockeye fry are present in the project area during early rearing. Given the high use by Chinook juveniles in this area, Seward 1 fits the "high" FFM definition of "aquatic sites that serve as migration or rearing areas of considerable importance for one or more species of juvenile salmon". Therefore, Seward 1 has an FFM score of 0.8.

6.9.3. Rationale for Site Selection

The WRIA 8 Chinook Salmon Recovery Plan (King County 2005) prioritized the reduction of predation on juvenile migrants in Lake Washington by providing increased rearing and refuge opportunities. The Recovery Plan prescribes the restoration of shallow water habitats and creek mouths for juvenile rearing and migration. The South Lake Washington DNR Shoreline Restoration Project is listed as project number C266 on the 3-year work plan under the WRIA 8 Chinook Salmon Conservation Plan. This project is a Tier 1 priority under the WRIA 8 Plan due to the project's capacity to provide high-quality shallow water habitat, and location in a migratory and rearing corridor of Chinook salmon. Shorelines that are free of over-water structures, bulkheads, and other shoreline hardening structures are rare in Lake Washington.

6.9.4. Mitigation Site Design

The Washington State DNR has advanced this design to 30% (Appendix E). The objective of restoration at this parcel is to restore approximately 1.68 acres of shoreline/ aquatic habitat and approximately 2 acres of upland habitat. This is intended to improve water quality and restore migratory habitat for juvenile Chinook salmon. This project will be funded by WSDOT, but is being permitted separately by DNR. Following the restoration of this property, DNR proposes to withdraw the lands from leasing with a Commissioner's Order as well as maintain the property under a conservation easement. The following project elements are proposed for this project.

Shoreline Enhancement and Hard Structure Removal

The outer, waterward edge of the flume does not appear to provide structural support to the adjacent uplands and will therefore be removed (Figure 6-10). The inner, landward edge of the flume will be removed where it is not required to maintain the structural integrity of the Boeing parcel. Where the inner flume needs to be retained, the lakebed grade will be restored to the extent possible to match this shoreline elevation. This may include raising the grade of the adjacent lakebed and excavating portions of the uplands to create a gradual shoreline grade. The grade of the lakebed will be raised such that a shallow bench waterward of the shoreline will be created. The remainder of the shoreline will undergo minor regrading and enhancement for juvenile Chinook foraging and rearing habitat. Approximately 600 linear feet of riprap will need to be removed.

Additional in-water debris will be removed from the entire site to the extent that it will provide ecological benefit to do so. The entire shoreline will undergo placement of appropriately-sized sediment and incorporation of small woody debris to provide cover for juvenile salmonids at or near the 16- to 18-foot elevation range.

Two engineered features will likely be constructed along the shoreline. First, an engineered log structure will be installed at the western edge of the existing flume to maintain the existing cove beach. Second, an engineered log structure will be constructed at the eastern edge of the project area to guide juvenile fish to Gene Coulon Park and Bird Island instead of along the shoreline into a future marina development.

Riparian Restoration

Approximately 2 acres of shoreline and riparian zone will be restored by removing non-native invasive plants and planting native trees and understory vegetation. The upland vegetation palette is largely open with the exception of limited easement adjacent to the Boeing property for wingtip clearance. Large, native plants will be installed where practicable to quickly provide overhanging vegetation fish cover along the shoreline. Proposed planting palettes for revegetation are included in Appendix C. Specific planting plans will be based on site-specific conditions and constraints. The Boeng Corporation has a wing-tip easement that precludes planting trees. This easement area, and an additional buffer area adjacent to the easement, will only be planted with shrubs.

Dolphin Removal

Three derelict dolphins, consisting of approximately 21 creosote-treated piles, will be removed from the lake. The dolphins are located along the eastern portion of the project area (Figure 6-10).

6.9.5. Ecological Functions and Benefits

Once this shoreline is restored, it will provide functional habitat features such as naturally sloped shoreline, native vegetation, LWD, and appropriately-sized substrate (Table 6-11). All these functions help meet the goals set in the WRIA 8 Chinook Salmon Conservation Plan. The plan states that the restoration of Lake Washington is a high priority for regional restoration efforts, and the remaining areas with sandy shallow water habitat, overhanging vegetation, and large woody debris should be protected and maintained. Restoration of sites close to the mouth of the Cedar River will have a significant benefit for fisheries because juvenile Chinook and sockeye salmon are very abundant near the mouth of the Cedar River (Tabor 2006). The mouth of the Cedar River does not have a functioning delta with estuarine marsh or freshwater emergent wetlands that Chinook typically depend on during early rearing (King County 2005). Therefore, Cedar River Chinook fry are dependent on suitable Lake Washington shoreline immediately adjacent to the mouth of the Cedar River during early rearing for feeding opportunities and refugia from predators. Sockeye salmon fry only use the Lake Washington shoreline early in their life history. The proximity of this site to the mouth of the Cedar River (where most sockeye enter the lake as young fry) make it one of the few areas relevant for this life history function. Since this project is a migratory and rearing area of considerable importance for juvenile Chinook and sockeye salmon, this site's mitigation areas have a Fish Function Modifier score of 0.8 for mitigation accounting purposes.

Table 6-11. South Lake Washington Shoreline Restoration (DNR Parcel) Mitigation Benefits

<table>
<tr><th>Mitigation Action</th><th>Acreage</th><th>Habitat Features Improved</th><th>Habitat Functions Improved</th><th>Species/ Life Stage Addressed</th></tr>
<tr><td>Shoreline Enhancement + Hard Structure Removal</td><td>1.93</td><td>Gradual, Sloped Bank;
Suitable Sediment;
Prey Input</td><td>Protection from Predators;
Migratory Corridor</td><td rowspan="3">Chinook
(Juvenile Rearing/ Feeding)

Chinook
(Juvenile Migration)

Sockeye
(Juvenile Rearing/Feeding)</td></tr>
<tr><td>Riparian Restoration</td><td>2.04</td><td>Vegetative Cover;
Prey Input</td><td>Protection from Predators;
Food Sources</td></tr>
<tr><td>Remove Dolphins</td><td>0.01</td><td>Removal of predator habitat and toxic material</td><td>Protection from Predators;
Water Quality</td></tr>
</table>

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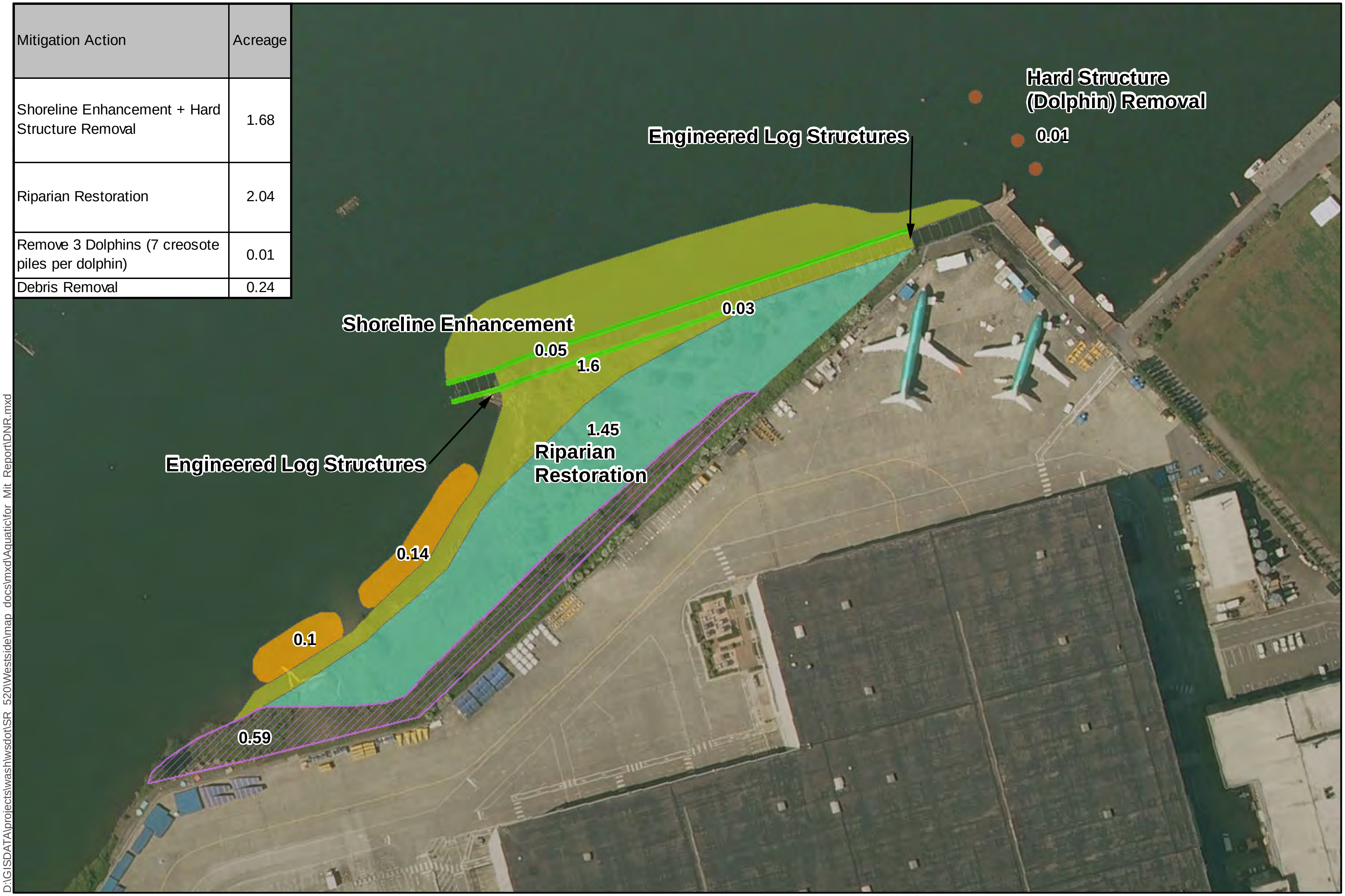
Mitigation Action	Acreage
Shoreline Enhancement + Hard Structure Removal	1.68
Riparian Restoration	2.04
Remove 3 Dolphins (7 creosote piles per dolphin)	0.01
Debris Removal	0.24



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Project details pending acquisition of 30% design information from DNR.

N

0 75 150 Feet

Flume Removal
Hard Structure Removal
Shoreline Enhancement
Riparian Restoration
Debris Removal
Riparian Restoration- Shrubs
Parcel

Figure 6-10.
Conceptual Restoration Plan at the South Lake Washington Shoreline Restoration (DNR Parcel) Mitigation Site

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6.10 Cedar River/ Elliott Bridge Site

6.10.1. Site Location

The Cedar River/Elliott Bridge site is located on the main stem Cedar River. The project area is on the right (north) bank of the Cedar River between the 154th Place SE Bridge and the 149th Avenue SE right-of-way, just east of the City of Renton Ron Regis Park (Figures 6-1, 6-11).

6.10.2. Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization is available in the SR 520 Draft Aquatic Assessment Report (WSDOT 2011).

Shoreline Conditions

The river channel throughout most of this reach is confined and stabilized by levees and revetments, all of which contribute to a loss of connectivity between the river and its floodplain and to poor riparian conditions (King County 2005). The aquatic habitat has very little complexity, fish cover, or pool habitat for adult holding and juvenile rearing.

Several residences with associated structures are located in the project area. King County has acquired several of these properties on both sides of the river, including the homes and related structures, as part of a floodplain property acquisition program. The residences on the left (south) bank have not yet been vacated. The structures on the right bank have been vacated and demolished as part of the restoration project.

On the upstream half of the left bank, the floodplain is unconfined. An upper terrace on the left bank floodplain is likely formed from fill (3 to 5 feet above the active floodplain; see Figure A-13 in Appendix A). A levee with large riprap extends along the left bank of the river from the approximate midpoint of the project reach down to the remnant 149th Avenue SE bridge abutment (Figure A-14). The river is confined along this stretch, resulting in concentrated flow with the potential to erode unprotected riverbanks. The river has sufficient gradient and energy to produce a dynamic channel morphology if the artificial constraints confining the existing channel are removed. Just upstream of the levee and riprap, the river has been eroding the bank. Toward the downstream end of the levee and riprap and just upstream from the old 149th Street bridge abutment, a stormwater conveyance ditch passes through the levee in two culverts and extends through the project area to the south. King County actively maintains this ditch. The 149th Street bridge abutment is still present on the left bank, with large boulders in the water around the abutment.

A King County mitigation site for the 154th Avenue SE Bridge Project is located on the right bank just northeast of the 154th Avenue SE Bridge. The site is vegetated with a native riparian community and contains an off-channel habitat feature. Immediately downstream from the restoration area, a levee extends about 500 linear feet farther downstream. The levee has large boulder-size riprap below the OHWM that extends approximately 5 feet waterward and 3 to 5 feet below the observed waterline (Figure A-15). The upper portion of the levee consists of cobble-sized riprap. The elevation change from the observed waterline to the top of the levee is approximately 7 feet. Landward of the levee, there is an elevation drop of 2 to 3 feet. There are variable amounts of fill on each residential parcel. Downstream of the levee, the floodplain is at a natural grade and is equal to or around 2 feet higher than the base flow river stage.

Because of the constraints on channel migration, the river exhibits a simplified morphology through this reach. The reach could be characterized as having a riffle-pool morphology, though the lack of lateral movement diminishes the development of pronounced channel habitats. Generally, scour pools form along the toe of the revetments and riffles in the softer water margins of the channel. Large wood is notably absent throughout the project reach.

The riparian condition is generally poor due to past residential land use. The site is characetrized predominantly with scattered native and ornamental trees and shrubs and a substantial amount of lawn that has now gone fallow. Bare ground is present in the footprints of the demolished homes. The downstream portion of the site contains a small amount of native riparian habitat comprised of predominantly deciduous species.

Ecological Condition of Adjacent Parcels

The upstream parcels along the left bank belong to King County for several thousand feet upstream. The upstream parcels along the right bank also belong to King County, but only for approximately 1,000 feet. These parcels have mature vegetation with functioning riverine and off-channel habitat. Downstream parcels on both banks are privately owned and are typical of residential properties in the area that are primarily landscaped with scattered trees and shrubs. Avoiding risk to these properties forms a key constraint to the feasibility of restoration actions undertaken on the site. About 800 feet downstream of the site, a large tract of land owned by the City of Renton (Ron Regis Park) occupies the left bank for about 1,500 feet. These parcels also have mature vegetation with functioning riverine and off-channel habitat. The right bank across from Ron Regis Park is a steep forested slope.

Fish Use

This reach provides spawning habitat for all focal species: Chinook, sockeye, coho, and steelhead (WDFW and WWTIT 1994). Sockeye spawning is particularly heavy along the left (south) bank, upstream of the levee. This reach also functions as juvenile and adult migratory habitat for the four species listed above. Although side- and off-channel habitat does not currently exist in the project area because of past development, adjacent side- and off-channel habitat occurs naturally and is likely used by all four species.

6.10.3. Rationale for Site Selection

The WRIA 8 Chinook Salmon Recovery Plan (King County 2005) identified this portion of the Cedar River as lacking the habitat diversity needed for increased Chinook salmon productivity. The plan prescribes actions to increase Chinook salmon habitat diversity including protecting and restoring riparian habitat, removing or setting back levees and revetments to restore connections with off-channel habitat, and restoring sources of LWD and installing new LWD to restore pool habitat (King County 2005). The Cedar River/ Elliott Bridge project is listed as Project #C213 on the 3-year work plan under the WRIA 8 Chinook Salmon Conservation Plan. This project is a Tier 1 priority under the plan due to the project's capability to provide floodplain connectivity and riparian functions, and the heavy use of this reach by multiple salmonid species. This project will also increase floodplain capacity in the river, thereby attenuating downstream flooding and erosion problems in Ron Regis Park, directly downstream of the project area. The study of flooding and erosion in this downstream reach is also a Tier 1 priority C214 under the 3-year work plan.

6.10.4. Mitigation Site Design

The project area will include the right bank properties acquired by King County as part of its floodplain property acquisition plan. The proposal is to restore an active floodplain on the approximately 4 available acres. Along the right bank, the levee will be lowered to the approximate 2-year flood elevation to restore connectivity to the floodplain. The riprap toe of the revetment will need to remain, however, because the site does not provide enough acreage to allow for active channel migration without significant risk to downstream properties. A setback levee will also be constructed along the the north and east boundaries of the site (Jones Road SE and 149th Avenue SE, respectively). Should downstream properties be acquired, future phases of restoration at this site could undertake complete removal of the setback levee and all bank hardening to allow channel migration.

Approximately 3.55 acres of floodplain behind the levee will undergo significant excavation, reducing the overall elevation by 3 to 5 feet down to the approximate 1.5-year recurrence interval elevation (Figure 6-11). Excavation to this elevation will make wetland and off-channel habitat creation feasible. A backwater side channel will be excavated into the floodplain, along the toe of the Jones Road and 149th Avenue SE road prisms, with the confluence near the old 149th Avenue SE bridge abutment. The dimensions and configuration of the backwater channel mimic those of an abandoned former river channel of the Cedar River. This floodplain feature can be expected to evolve over time in the same way as a backwater slough formed by channel avulsion and abandonment.

Approximately 2.28 acres of the lowered floodplain between the primary channel and the backwater channel will function as a wetland and riparian mosaic. The backwater channel will emulate a valley wall channel because the Jones Road prism is at the toe of a steep slope (East Renton Highlands). It is anticipated that groundwater flow off the hillside and hyporheic flow from the river will provide sufficient year-round hydrology to the backwater channel. Piezometers will be installed prior to final design to determine hydrology and establish relative channel elevations. To provide additional hydrologic input, the unnamed tributary will be re-routed through a culvert beneath 149th Avenue SE. The channel will result in 0.61 acres of aquatic habitat.

LWD features will be installed along the right bank of the channel to provide fish cover and substrate for algae and macroinvertebrates. A large woody debris jam is proposed at the right bank mouth of the channel to provide cover and promote a scour pool suitable for adult holding.

From the approximate mid-point of the project reach downstream to the outlet of the backwater channel, the levee will be lowered to achieve an enlargement of the active channel. The formation of a gravel bar is anticipated in this location because the thalweg occurs along the left bank revetment. This would result in approximately 0.3 acre of additional main stem channel habitat below OHW and an increase in spawning habitat.

The design of this site has the following constraints:

- Riparian restoration is limted to the acquired parcels.
- The Cedar River cannot be allowed to move across the channel migration zone when the floodplain is restored, because of the limited area acquired to date and the potential detriment to adjacent private properties.

<u>Engineering Objectives:</u>

- Provide a self-sustaining backwater channel with appropriate baseflow, depth, and other habitat features to provide quality habitat function for salmonids throughout the year.
- Reduce, to the maximum extent feasible, the elevation of the existing training levee to allow overbank flood flows, but avoid channel migration.
- Remove floodplain fill upstream of backwater channel to enlarge the active channel of the Cedar River.
- Reduce the floodplain grade throughout portions of the site to allow formation of wetland conditions.
- Route un-named tributary under 149th Avenue SE into the backwater channel.
- Provide stable LWD features.
- Do not adversely impact adjacent property owners; maintain the 149th Avenue SE road prism and right-of-way.
- Do not adversely impact existing habitat within the main stem of the Cedar River.

- Be forward-compatible with future phases of floodplain and/or channel migration restoration in this reach.

Habitat Objectives:

- Provide off-channel rearing and high-flow refuge salmonid habitat for the target species and life stages.
- Provide habitat elements, cover types, and substrate appropriate to the target species, life stages, and side channel hydraulics imposed by site conditions.
- Provide ingress and egress for juvenile and adult salmonids for all flow conditions.
- Provide spawning habitat in the main stem of the Cedar River.
- Preserve existing natural vegetation to the extent practical; trees or other vegetation removed during construction will be incorporated in the backwater channel design.
- Enhance riparian vegetation to provide cover and allochthonous inputs.
- Minimize construction impacts to existing habitat.

Project Design Criteria

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components.

Engineering Design Criteria

- Backwater channel geometry: Low flow depth = $\geq$ 1.5 feet; channel area = approximately 0.3 acre; Bankfull Depth = 6feet. Create a channel profile to maintain positive drainage to the Cedar River – $\leq$ 1% slope.
- Size bed material to provide a suitable substrate for spawning. Size channel side-slope material to maintain stability.
- Lower the elevation of levee to the 1.5-year recurrence flow elevation of 98 feet.
- Lower the average elevation of floodplain wetland complex to the 1.2-year recurrence flow elevation of 97 feet.
- Provide an engineered log jam to withstand 100-year flow conditions. Provide a LWD roughened toe of the backwater channel. Wood should be exposed to the normal range of flows.

Habitat Design Criteria

- Provide a total of 0.61 acres of of new active channel and off-channel habitat.
- Incorporate LWD and channel dimensions to create preferred habitat elements through the backwater channel and main stem bar restoration.

- Include a vegetation plan to provide adequate shade and overhanging cover along the backwater channel. Provide 3.55 acres of riparian vegetation throughout the floodplain/wetland complex that promotes LWD recruitment to the Cedar River.
- Avoid the potential for fish stranding in the backwater channel.

6.10.5. Ecological Functions and Benefits

The Cedar River will be reconnected to its historic floodplain on the right bank through levee setbacks and excavation of historic fill. Reconnection of the floodplain will attenuate flood intensity downstream, thereby reducing channel incision and erosion in the main stem (Table 6-7). Increased connectivity to the floodplain will also increase maintenance of freshwater emergent wetlands, will import materials (LWD, etc.) into the main stem, and will function as temporary fish habitat during high flows. Riparian restoration in the floodplain will provide fish cover, increase prey resources for fish, filter pollutants from nearby roads and development, provide bank stability, and contribute LWD to the river (Table 6-12). LWD recruitment is currently rated as poor along almost all of the Lower Cedar River, and land use practices generally preclude active recruitment. Also, large amounts of LWD are removed at Landsburg Dam due to liability concerns (King County 2005).

The creation of off-channel rearing habitat will benefit all salmonid species. In the Cedar River, this habitat was historically used by juvenile Chinook for rearing, which in turn likely resulted in a larger and later timing of outmigration from the Cedar River. The loss of habitat has forced juvenile Chinook to migrate into Lake Washington as very young fry, a life history trajectory that may have reduced their survival (King County 2005). Coho rely on off-channel habitat for rearing and overwintering (Bustard and Narver 1975; Brown and Hartman 1988; Swales and Levings 1989). Therefore, the off-channel rearing habitat will also function as high-flow refugia.

The channel is positioned close to the valley wall to intercept groundwater flow coming off the hillside. Groundwater discharge wetlands are common along the valley slopes in this vicinity, suggesting that hydrology is persistent and sufficient to support baseflow in the channel. The un-named tributary has been observed to provide perennial flow and would augment the channel hydrology.

The installation of LWD along the right bank of the backwater channel will provide complex cover for juvenile salmonids and an organic substrate for prey items.

The proposed engineered logjam could provide scour pools suitable for use by adults of multiple salmonid species during upstream migration and for pre-spawn holding. This reach has very few pools and areas of fish cover. Juvenile coho often rear in pools associated with LWD and fish cover. Chinook salmon, in particular, will benefit from increased pools in the reach because they hold in pools prior to spawning, then spawn in riffle habitat adjacent to pools. The enlarged portion of the primary river channel upstream of the backwater should provide suitable spawning habitat in close proximity to the holding pool.

Lastly, the wetland/riparian mosaic of the restored floodplain will provide multiple indirect benefits to Cedar River salmonids. The capacity for overbank flow will alleviate stream velocities and erosive forces on the adjacent channel for anything larger than the 2-year flood event. The increased roughness of the floodplain will attenuate flows across it, allowing fine sediments to drop out of suspension. Connectivity to the floodplain will also restore energy transfer between the channel and riparian, allowing inputs of allochthonous materials to support the food web and large woody debris recruitment. It should be noted that the floodplain wetland mosaic is anticipated to be dynamic, with quantities of wetland area changing periodically in response to sediment deposition and scour.

This site will be protected in perpetuity through a conservation easement.

Table 6-12. Cedar River/Elliott Bridge Mitigation Benefits

<table>
<tr><th>Mitigation Action</th><th>Acreage</th><th>Habitat Features Improved</th><th>Habitat Functions Improved</th><th>Species/Life Stage Addressed</th></tr>
<tr><td>River Margin and Aquatic Off-channel Creation</td><td>0.61</td><td>Vegetative cover
Pools
Off-channel</td><td>Protection from predators
Food sources
High-flow refugia</td><td rowspan="2">Sockeye (Spawning)
Sockeye (Rearing/Feeding)

Chinook (Spawning
Chinook Rearing/Feeding)

Coho (Spawning)
Coho (Rearing/Feeding)

Steelhead (Spawning)
Steelhead (Rearing/Feeding)</td></tr>
<tr><td>Riparian + Floodplain Restoration</td><td>3.55</td><td>Vegetative cover
Prey input
LWD recruitment
Bank stability</td><td>Protection from predators
Food sources
Water quality</td></tr>
</table>

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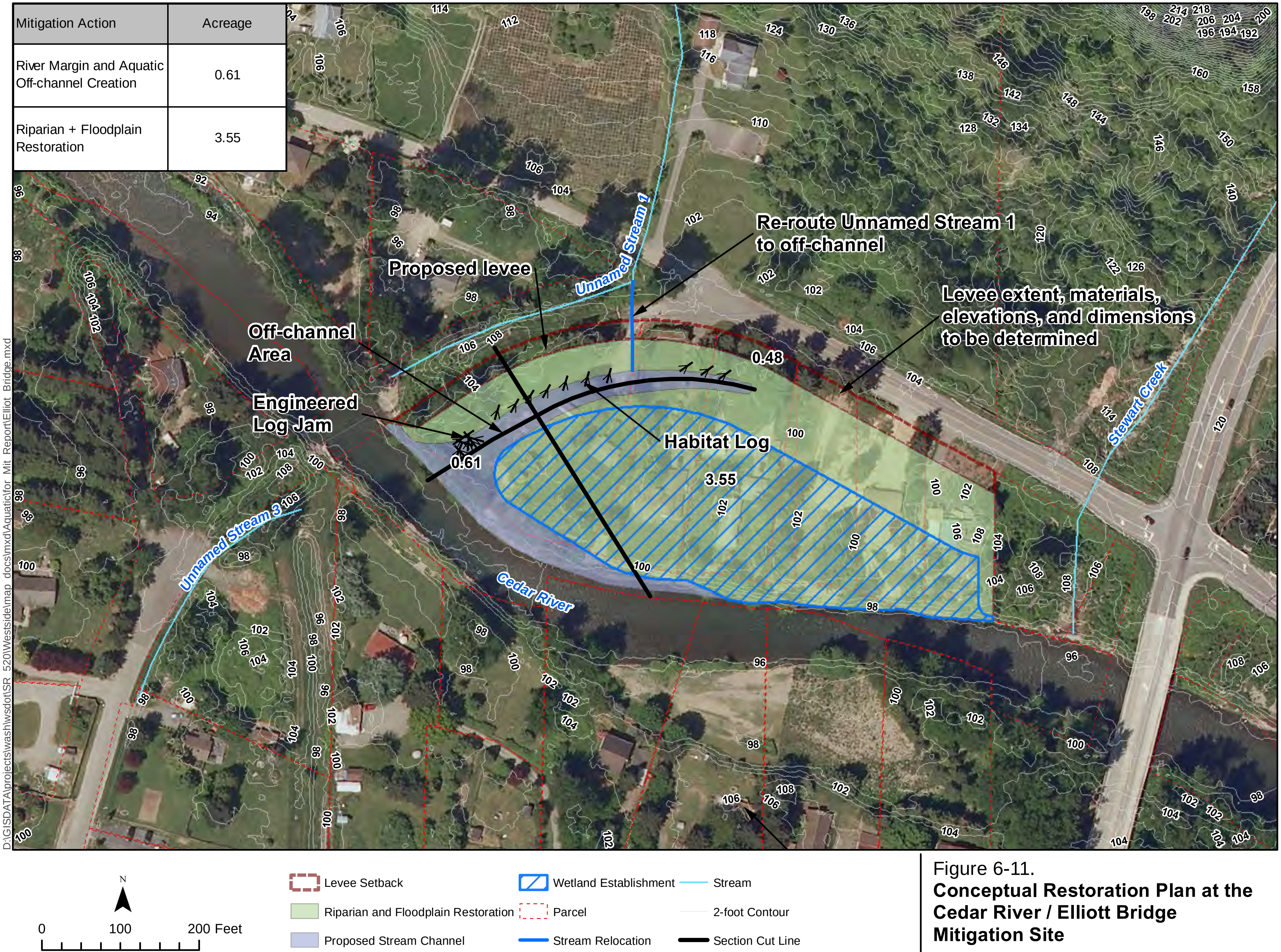

Mitigation Action	Acreage
River Margin and Aquatic Off-channel Creation	0.61
Riparian + Floodplain Restoration	3.55

Figure 6-11.
Conceptual Restoration Plan at the Cedar River / Elliott Bridge Mitigation Site

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6.11 Bear Creek Site

6.11.1. Site Location

The project site is within the city of Redmond, in King County, adjacent to the Redmond Town Center. The site is located east of the Sammamish River, south of the Redmond Town Center, and north of SR 520 (Figures 6-1, 6-12).

6.11.2. Mitigation Site Existing Conditions and Fish Use

Shoreline Conditions

The project site is primarily an open space area managed by the City of Redmond and Redmond Town Center. A 10-foot-wide asphalt trail connects to the Sammamish River trail in the project area. Although the trail is near the creek, it provides limited viewing of the creek. The trail accommodates pedestrian and bicycle use.

Structures on the property include the trail and stormwater treatment facilities for Bear Creek Parkway. Existing environmental conditions are degraded. The Bear Creek stream channel is an artificial, straight, riprap-lined channel created to convey flood flows (Figure A-16). From the mouth up to 2,600 feet upstream, Oregon ash (*Fraxinus latifolia*) and black cottonwood (*Populus trichocarpa*) grow adjacent to the stream banks in a narrow (one tree-width) riparian corridor. The stream buffer on either side of this narrow riparian zone is primarily vegetated with reed canarygrass (*Phalaris arundinacea*), thistle (*Circium* sp.), and blackberries (Figure A-17). From 2,600 to 3,000 feet upstream, a riverine wetland exists with a buffer of black cottonwood and Oregon ash.

Ecological Condition of Adjacent Parcels

The project area is bounded by developed parcels. Redmond Town Center is to the north, consisting of commercial properties. SR 520 lies to the south, and Marymoor Park is on the south side of SR 520. The park consists of ball fields, roads, parking lots, and some small buildings.

Fish Use

Although stream and buffer habitat is degraded in the area planned for mitigation, Bear Creek is a major producer of salmon in WRIA 8. Chinook, coho, and sockeye all spawn in Bear Creek upstream of the mitigation area. In the mitigation area, Bear Creek is used by salmonids as a migration and rearing corridor, but not for spawning. Given the high use of the project area for rearing by Chinook, and by coho juveniles, Bear Creek fits the “high” FFM definition of “aquatic sites that serve as migration or rearing areas of considerable importance for one or more species of juvenile salmon”. Therefore, Bear Creek has an FFM score of 0.8.

6.11.3. Rationale for Site Selection

The WRIA 8 Chinook Salmon Recovery Plan (King County 2005) identified this portion of Bear Creek as lacking the habitat diversity needed for increased Chinook salmon productivity. Actions prescribed by the Recovery Plan to increase habitat diversity include the restoration of meanders, in-stream complexity, off-channel habitat, and riparian vegetation in the lower 3,000 feet of Bear Creek. Because of its role in upstream staging and downstream migration and rearing, and as a refuge for salmonids escaping the warmer waters of the Sammamish River, the Lower Bear Creek sub-basin has been recognized as a Locally Significant Resource Area by King County. The Lower Bear Creek project is listed as Project #N201 on the 3-year work plan under the WRIA 8 Chinook Salmon Conservation Plan, and is a Tier 1 priority under the plan. This project was funded by WSDOT, but was permitted separately by the City of Redmond.

6.11.4. Mitigation Site Design

The Bear Creek project has advanced to 90% design (Appendix F). Restoration will include increased meandering, LWD, bank stabilization, stream gravel, and native riparian plantings (Figure 6-12). Created wetlands will be hydraulically connected to the stream to provide high-flow refuge habitat and floodplain functions. Adjacent uplands will also be excavated to create more floodplain storage and habitat associated with the new channel. New riparian/floodplain plantings will enhance in-stream and riparian functions such as cover, shading, LWD recruitment, bank stabilization, terrestrial insect food production, and leaf-litter organic debris in support of in-stream food sources. By making the stream channel more sinuous, the channel's length will be increased by 340 feet. The existing stream channel will be connected to the new channel in places to provide off-channel habitat. The remainder of the existing stream channel will be filled in with excavated gravels from the new channel. The new channel will include 1,300 linear feet of pool habitat with two different types of LWD bank stabilization methods. The outside of stream meanders will have a Type 3 configuration that will provide extra bank protection. A total of 3,000 pieces of LWD will be added to the stream channel within the bankfull width.

Three riparian planting zones will be located along elevational gradients across the site relative to flood stages of Bear Creek. The three riparian planting zones are listed in descending order of expected inundation:

1. Floodway Zone (1.71 acres): Tree layer consists of black cottonwood (12%) and Oregon ash (13%); shrub layer consists of Pacific ninebark (*Physocarpus capitatus*, 15%), Pacific willow *(Salix lucida*, 15%), red-osier dogwood (*Cornus sericea* 15%), salmonberry (*Rubus spectabilis*, 15%), and Sitka willow (*Salix sitchensis*, 15%).

2. Transition Slope Zone (4.35): Tree layer consists of black cottonwood (9%), Sitka spruce (*Picea sitchensis*, 8%), and western red cedar (*Thuja plicata*, 8%); shrub layer consists of black twinberry (*Lonicera involucrate*, 15%), Indian plum (*Oemleria cerasiformis*, 15%), peafruit rose (*Rosa pisocarpa*, 15%), salmonberry (15%), and Sitka willow (15%).

3. Upland Buffer Zone (5.22 acres): Tree layer consists of big leaf maple (*Acer macrophyllum*, 8%), Douglas fir (*Pseudotsuga menziesii*, 9%), and western hemlock (*Tsuga heterophylla*, 8%); shrub layer consists of bitter cherry (*Prunus emarginata*, 9%), cascara (*Rhamnus purshiana*, 9%), nootka rose (*Rosa nutkana*, 10%), oceanspray (*Holodiscus discolor*, 9%), red elderberry (*Sambucus racemosa*, 10%), tall Oregon grape (*Berberis aquifolium*, 10%), and vine maple (*Acer circinatum*, 9%).

Trees will be planted at an approximate spacing of 10 to 15 feet on center and shrubs at an approximate spacing of 5 feet on center, in randomly mixed groupings. In areas where the current vegetation will be retained, plant spacing will depend on the densities of the existing desirable native vegetation. Plants will be installed during specified planting windows. Native plants will be obtained from approved nurseries. A temporary irrigation system will be installed, if necessary, for watering during the plant establishment period. Emergent vegetation will not be planted for this project because of limiting factors such as depredation by waterfowl (e.g., Canadian geese) and reed canarygrass infestation. The intended vegetation types after restoration will be forested wetland and riparian plant communities, facultative or wetter, to withstand inundation. Scrub-shrub wetland plant communities may be included in final design. This will also lead to quicker establishment of woody vegetation close to the channel for habitat benefits, including in-stream cover and shading.

This site has the following design constraints:

- Riparian and floodplain restoration is constrainted by the SR 520 on the left bank, and the Bear Creek Parkway on the right bank.

- Cultural and archeological resources have been found on the site, and will constrain the grading plan for the final design.

6.11.5. Ecological Functions and Benefits

The project will create significant habitat improvements to establish a compositionally and structurally complex ecosystem with attributes important for supporting fish and wildlife with an emphasis on anadromous fish such as Chinook, coho, and sockeye salmon (Table 6-13). As the riparian/floodplain vegetation matures, it will increase the continuous patch riparian corridor and contribute to channel and bank stabilization, riparian corridor habitat diversity, and cover and refuge for both juvenile and adult fish and wildlife.

Table 6-13. Bear Creek Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/Life Stage Addressed
Stream Enhancement	3.16	Off-Channel Pools LWD Fish Cover	Protection from Predators Food Sources	Sockeye Rearing/Feeding) Chinook (Rearing/Feeding) Coho (Rearing/Feeding)
Riparian Restoration	12.62	Fish Cover, LWD recruitment	Water Quality Protection from Predators Food Sources	

Mitigation Action	Acreage
Stream Enhancement	3.16
Riparian Restoration	12.62

N

0 150 300 Feet

Forested Wetland
Riparian - Floodway
Riparian - Transition Slope
Riparian - Upland Buffer
Stream Buffer - Planting by Others
Proposed Stream Channel
Parcel
Proposed OHW
Existing OHW
Proposed Trail

Figure 6-12.
Conceptual Restoration Plan at the Bear Creek Mitigation Site

SR520, I-5 to Medina: Bridge Replacement and HOV Project

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6.12 East Approach

6.12.1. Site Location

Shoreline and nearshore enhancement is proposed near the existing and proposed SR 520 east approach (Figure 6-1 and Figure 6-13).

6.12.2. Mitigation Site Existing Conditions and Fish Use

The following section summarizes the existing conditions of the site from a habitat standpoint. A detailed baseline characterization of shoreline conditions is available in the SR 520 Draft Aquatic Assessment Report (WSDOT 2011c).

Shoreline Conditions

Portions of the shoreline in the project area are highly modified with bulkheads, docks, and landscaped riparian zones (WSDOT 2009c). Natural, undisturbed shoreline in the project area is limited to a stretch directly below the Evergreen Point Bridge. In addition, boat traffic here is concentrated relatively close to the shoreline, leading to considerable wave action. As a result, vegetation densities tend to be relatively low close to shore, and substrate material relatively large. In general, the lake bottom substrate is cobble and gravel near the shoreline and transitions to sand and finer material moving away from the shoreline.

The shoreline consists of a failing wood bulkhead, some large boulder-sized riprap, and two piers (Figure A-17). Both docks are fixed piers with treated wood piles, substructure, and decking. Both docks have solid decking with no functional grating. A deciduous tree recently fell into the lake, over the wood bulkhead, and is providing cover (Figure A-17). The East Approach shoreline has a 12 to 13% slope. Substrate is predominantly gravel near the shoreline. The riparian zone at the East Approach has mature deciduous and coniferous trees throughout the area, except for some bare ground near the shoreline. The understory is dominated by invasive plants.

The two piers will be removed and replaced with one pier that will be used for WSDOT maintenance activities (see Section 4.3.1). The non-native species Eurasian watermilfoil (*Myriophyllum spicatum*) and native species of pondweed (*Potamogeton* sp.) and American wild celery (*Vallisneria americana*) are the most abundant aquatic plants (WSDOT 2009c). Lake bottom substrate in the project area is dominated by cobble and sand. In general, substrate near the shore consists of cobble and transitions through gravel to sand and silt moving offshore (Figure A-19); patches of bare clay are also present (WSDOT 2009c).

Ecological Condition of Adjacent Parcels

Much of the shoreline is modified with bulkheads and boat docks, although the shoreline immediately under the existing bridge is relatively unmodified, with a natural slope. Parcels in the project vicinity consist of the SR 520 approach, bridge, and residential properties with piers, ramps, and floats.

Fish Use

The site has been identified in the past as a sockeye spawning area based on historical WDFW map records (Buchanan 2004). Estimated annual escapement of Lake Washington beach-spawning sockeye varied from 54 to 1,032 fish from 1976 through 1991 (WDFW 2004). These sockeye spawn wherever suitable gravel beaches and groundwater upwelling occur around the lake, particularly along the north shore of Mercer Island and the east shore of Lake Washington. These spawning areas occur over a wide range of water depths. The estimated total beach spawning population ranged between 200 and 1,500 fish between 1986 and 2003 (WDFW 2004). This sockeye spawning area is one of more than 85 shoreline spawning areas identified in Lake Washington on maps provided by WDFW (Buchanan 2004). Therefore, this project area meets the 0.8 FFM criterion of being an “aquatic site that is known to support documented spawning of at least one salmonid species”, and is assigned an FFM of 0.8.

6.12.3. Rationale for Site Selection

This site was selected for sockeye spawning enhancement because of documented sockeye spawning and known groundwater upwelling. The colluviums/weathered till geologic strata probably result in a patchy distribution of upwelling areas from the underlying pressurized aquifer. In much of this area, the existing sediments do not currently appear suitable for sockeye spawning (WSDOT 2009c). Therefore, gravel supplementation is expected to maximize spawning habitat suitability where groundwater upwelling does occur.

Shoreline restoration is proposed because of the paucity of natural shoreline in this area of the lake and because of likely Chinook and sockeye use during early rearing. Chinook juveniles migrating along from the shoreline from the south lake and local beach spawning sockeye are the most likely to benefit from a natural shoreline feature.

6.12.4. Mitigation Site Design

Mitigation actions at this site will include sockeye gravel supplementation, bulkhead removal, nearshore substrate enhancement, and riparian restoration (Figure 6-13).

In general, sockeye spawn in areas of clean gravel substrate and groundwater upwelling. Sockeye dig redds in gravel and small cobbles between 13 and 102 mm (Reiser and Bjornn 1979). Olsen (1968) indicated that sockeye may use either sand or gravel, depending upon which is available. If small amounts of silt, detritus, or fine sand are mixed with the coarser gravel, they are removed by the fish in the process of excavating the redd (Foerster 1968). Mathisen (1955) observed sockeye salmon egg concentrations 6 to 9 inches below the gravel surface. The site has some areas of clean cobble and gravel that have the potential to support sockeye spawning (WSDOT 2009c). However, most of the nearshore substrate consists of cobble material and the offshore areas are dominated by sandy substrate. The site is generally less than 50 feet deep. This depth stratum is associated with the Colluvium/ Recessional geologic stratum (WSDOT 2011b). A confined and pressurized aquifer underneath the Colluvium/ Recessional stratum provides localized groundwater upwelling into the project area.

Approximately 1,210 yards of gravel will be offloaded and spread to a depth of 1 foot. Although the substrate size and distribution will be determined from subsequent analysis of of sediment transport from wind-generated waves and currents, the substrate will be installed within the suitable range for beach spawning sockeye, to the greatest extent practicable. Based on previous substrate enhancement projects, the substrate distribution will likely be similar to what is shown in Table 6-2.

The wood bulkhead and adjacent boulder-sized riprap will be removed. The shoreline behind the bulkhead will be re-graded to a gradually sloped shoreline and supplemented with appropriately-sized gravel. Grading plans will be developed that are consistent with cross-sections 1A and 1B (Figure 6-13, Appendix B). The grass upland immediately landward of the bulkhead will be revegetated. Revegetation will include a live stakes community near high lake level elevation and transition to a riparian upland community. Proposed planting zones, species lists, and densities for revegetation are included in Appendix C. Specific planting plans for site-specific conditions and constraints will be developed during the design phase. The implementation schedule is detailed in Section 6.13.

In the associated SR 520, Medina to SR 202: Eastside Transit and HOV Project, a stormwater pond had a self-mitigation component to it that included the following elements directly south of the project area:

- All existing large rock (greater than 100 pounds) located underneath the existing eastside SR 520 Bridge on the shoreline and in the water shall be removed. Area specified on sheet 3 of 47 plans entitled “Purpose: Reduce travel times and enhance reliability, mobility, access and safety for transit and HOV vehicles”, dated April 30, 2010.

- Fifty cubic yards of clean (washed), well-rounded gravel, 2-inch minus in gradation spawning gravel shall be placed extending from the bulkhead waterward 15 feet to fill in the created holes.

These actions may be completed concurrently with the larger bulkhead removal, re-grading, and gravel installation project. This site has the following design constraints:

- Riparian restoration cannot occur in the footprint of the proposed maintenance facility or paths.
- Shoreline restoration must be compatible with the proposed maintenance dock.
- Spawning gravel supplementation cannot occur within the footprint of the maintenance dock, or where the maintenance boat ties up to the dock.

The site design objectives and criteria are summarized below.

Engineering Objectives:

- Provide a low-gradient shoreline between low and high lake levels.
- Provide gravel (round rock) and sand substrate along the shoreline that will not erode from the target location.

Habitat Objectives:

- Provides gravel substrate along the shoreline that is suitable for sockeye beach spawning.
- Provides shallow, low-gradient rearing and mitratory habitat during juvenile Chinook and early juvenile sockeye rearing periods.
- Provides overhanging vegetation along the shoreline for juvenile salmonid refugia and forage base.
- Provides gravel and sand substrate along the shoreline that minimizes predator habitat.
- Provides indirect riparian functions, including shading, pollutant filtration, and LWD recruitment to the shoreline.
- Minimizes construction impacts to existing habitat.

Design criteria describe the successful outcome that would result if the objectives are met. Criteria have been compiled for both engineering and habitat components.

Engineering Design Criteria:

- Bulkhead will be removed below the sediment line.
- The slope of the enhanced shoreline habitat will be at or below 15% grade, as measured from low lake level to high lake level.
- Substrate installed along the shoreline according to an analysis of sediment transport from wind-generated waves and currents.

Habitat Design Criteria:

- Create 0.75 acre of suitable beach spawning habitat for sockeye.
- To the extent possible, gravel substrate will be installed with the size distribution most suitable for sockeye beach spawning.
- Provide 0.8 acre of shallow rearing habitat for juvenile Chinook.
- Gravel substrate in the shallow littoral zone will be installed with the smallest size distribution possible in order to maximize habitat function for rearing juvenile Chinook.
- Provide 0.6 acre of enhanced riparian habitat adjacent to the shoreline.
- Include a vegetation plan to provide adequate shade and overhanging cover along the shoreline.
- The spatial and temporal extent of in-water work will be minimized.
- In-water work will occur during designated in-water work windows.
- Impacts to native vegetation will be minimized.
- Erosion will be minimized.

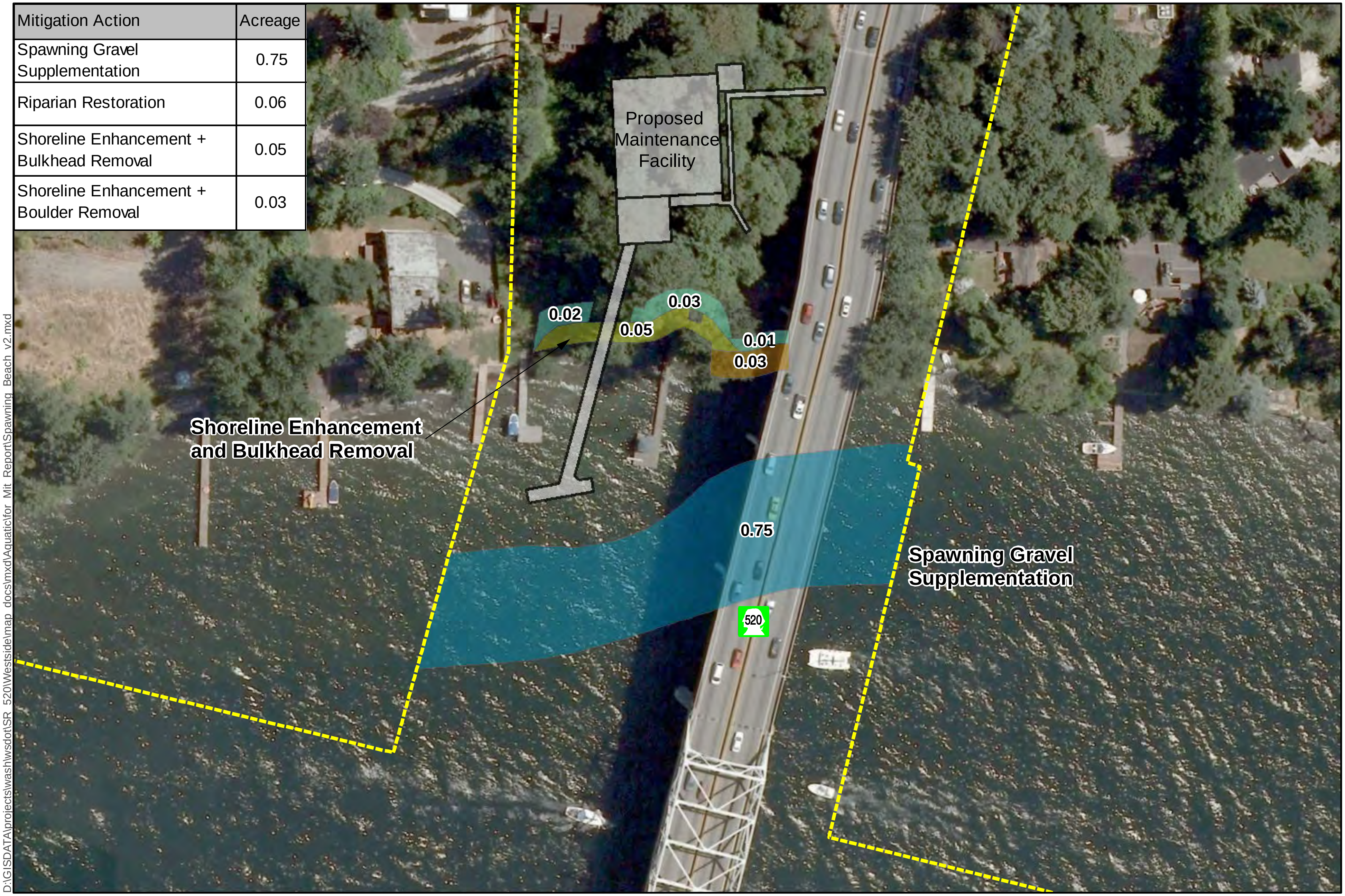
6.12.5. Ecological Functions and Benefits

This mitigation action will primarily benefit sockeye salmon spawning habitat (Table 6-14). Shoreline areas with upwelling and suitable sockeye spawning substrate are an important habitat feature in Lake Washington.

Table 6-14. East Approach Mitigation Benefits

Mitigation Action	Acreage	Habitat Features Improved	Habitat Functions Improved	Species/Life Stage Addressed
Spawning Gravel Supplementation	0.75	Suitable sediment	Suitable spawning habitat	Sockeye (Spawning)
Riparian Enhancement	0.08	Vegetative cover Prey input	Protection from predators Food sources	Chinook (Juvenile Rearing/Feeding) Chinook (Juvenile Migration) Sockeye (Juvenile Rearing/Feeding)
Shoreline Enhancement + Bulkhead Removal	0.06	Gradual, sloped bank Suitable sediment Prey input	Protection from predators Migratory corridor	

Mitigation Action	Acreage
Spawning Gravel Supplementation	0.75
Riparian Restoration	0.06
Shoreline Enhancement + Bulkhead Removal	0.05
Shoreline Enhancement + Boulder Removal	0.03



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Spawning Gravel Supplementation
Riparian Restoration
Shoreline Enhancement and Bulkhead Removal
Shoreline Enhancement and Boulder Removal
Proposed Maintenance Facility
Parcel
Proposed Right-of-Way

Figure 6-13.
Conceptual Restoration Plan at the East Approach Mitigation Site

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6.13 Implementation

All the proposed mitigation sites are on publicly-owned land, and WSDOT has engaged in several partnerships with the landowning entities, some of whom have initiated restoration design concepts for the sites independent of this process. Table 6-15 summarizes the roles and responsibilities shared between WSDOT and its partner agencies on the mitigation sites.

The following technical studies may be implemented for each project, as appropriate, prior to and as part of the design process:

- Shallow groundwater monitoring
- Identification of historic elevations, fill elevations, etc.
- Hydrologic and hydraulic modeling
- Topographic survey
- Geotechnical survey
- Hazardous materials site assessment (Phase I)
- Cultural and archeological investigation

A more comprehensive implementation schedule will be developed as each project design advances.

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Table 6-15. Compensatory Mitigation Project Implementation Schedule

Project Element	Mitigation Sites													
	Magnuson Park		Seward Park		Taylor Creek		S. Lake WA - DNR		Elliott Bridge Reach		Bear Creek		East Approach	
	Implementing Agency	Schedule	Implementing Agency	Schedule	Implementing Agency	Schedule	Implementing Agency	Schedule	Implementing Agency	Schedule	Implementing Agency	Schedule	Implementing Agency	Schedule
Pre-Design	WSDOT	2011-2012	WSDOT	2010-2011	WSDOT/SPU	2010-2011	DNR	2010-2011	WSDOT	2011-2012	WSDOT	2010	WSDOT	2011
Technical Studies	WSDOT	2013-2014	WSDOT	2013-2014	WSDOT/SPU	2011	DNR	2010-2011	WSDOT	2013-2014	WSDOT	2010-2011	WSDOT	2011-2012
Design and Permitting	WSDOT	2014-2015	WSDOT	2014-2015	WSDOT	2012-2013	DNR	2011	WSDOT	2014-2015	WSDOT	2011-2012	WSDOT	2011-2012
Construction	WSDOT	2016-2017	WSDOT	2016-2017	WSDOT	2014-2015	WSDOT	2012-2013	WSDOT	2016-2017	WSDOT	2012-2014	WSDOT	2014
Monitoring and Maintenance	WSDOT	2017-2027	WSDOT	2017-2027	WSDOT	2015-2025	WSDOT	2013-2023	WSDOT	2017-2027	WSDOT	2014-2024	WSDOT	2014-2019
Long-Term Management	Seattle Parks	NA	Seattle Parks	NA	SPU[a]	NA	DNR	NA	King County	NA	City of Redmond	NA	WSDOT	NA
Protection Mechanism	Conservation Easement[b]		Conservation Easement[b]		Conservation Easement[b]		Conservation Easement[b]		MOA		MOA		WSDOT Ownership	

[a] Ownership will be transferred to the the Seattle Parks Department in 2012

[b] WSDOT will develop site management agreements with the public agencies that manage each site. These agreements will identify allowed uses and activities within the restoration areas and provide perpetual protection to the restored areas.

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6.14 Summary of Ecological Functions and Benefits

Under the proposed mitigation approach, these temporary impacts could be offset by applying temporary mitigation value from variety of project combinations (Table 6-16). The specific application of mitigation toward temporary or permanent impacts should match the species, stock, life stage, and habitat function, respectively.

Table 6-16. Proposed Mitigation Sites and Their Compensatory Value

	Mitigation Type (mitigation acreage applied to one or the other category, not both)		
Mitigation Site	**Permanent Mitigation Credits (acres)**		**Temporary Mitigation Credits (acre-years)**
Seward 1	0.42		7.08
Seward 2	0.05		0.85
Seward 3	0.14		2.27
Seward 4	1.09	**OR**	19.37
Magnuson 1	0.16		2.61
Magnuson 2	0.21		3.09
Taylor Creek	0.38		5.20
S. Lake WA	1.84		30.83
Cedar/ Elliott	1.62		21.18
Bear	4.55		67.21
East Approach	0.60		11.92

6.14.1. Mitigation for Temporary Impacts

Temporary project impacts that require compensatory mitigation include partial shading, fill, and increased predator fish habitat from the construction work bridges and falsework. These temporary impacts will bear the largest effect on juvenile Chinook as they migrate towards the Ship Canal in the shallow nearshore, where these work bridges are proposed to occur (see Section 4.3).

Based on a review of project impacts and available mitigation types, WSDOT is currently proposing using the restoration projects at Seward Park, Magnuson Park, and Taylor Creek to offset temporary impacts (Table 6-17). The mitigation actions will benefit survival of juvenile Chinook by increasing habitat function along their migratory path toward the Ship Canal. These projects will also benefit adult coho and sockeye, in terms of suitability of spawning habitat. Most of the juvenile rearing habitat restoration will benefit the juvenile Chinook originating from the Cedar River (i.e., Seward Park, Taylor Creek). Magnuson Park will benefit the North Lake Washington and Issaquah/ Sammamish stocks. This allocation of compensatory mitigation is proportional to the higher exposure of the Cedar River stocks to the temporary work bridge impacts. While some of the North Lake Washington and

Issaquah/ Sammamish stocks may encounter the temporary work bridges during outmigration, most will outmigrate through the Ship Canal without straying south into the work zone.

The assignment of mitigation sites to specific impact categories (permanent or temporary) has not been finalized, and could change pending finalization of the suite of mitigation sites and/or input from regulatory agencies. A summary of the compensatory mitigation value of these projects is presented in Appendix D, Table D-1. As described in Section 5.4 and Appendix D, the mitigation value is based on plan view acreages of mitigation actions. The plan view acreages are weighted by (1) relative fish use, (2) project type, and (3) discounts for the temporal lag of project function.

6.14.2. Mitigation for Permanent Impacts

A wide range of habitat restoration projects are proposed to address potential impacts to different salmonid species at various life stages during operation of the proposed SR 520, I-5 to Medina Project. Under the proposed mitigation approach, these permanent impacts could be offset by applying permanent mitigation value in a variety of project combinations Table 6-16). Based on a review of project impacts and available mitigation types, WSDOT is currently proposing using the South Lake Washington Shoreline, Cedar River/ Elliott Bridge, Bear Creek, and East Approach restoration projects to offset permanent (operational) impacts because the benefits include a wide range of species and life stages (Table 6-17). The assignment of mitigation sites to specific impact categories (permanent or temporary) has not been finalized, and could change pending finalization of the suite of mitigation sites and/or input from regulatory agencies. The mitigation accounting for each project is detailed in Appendix D, Table D-2.

Table 6-17. Proposed Mitigation Sites and Their Allocation to Permanent and Temporary Impacts

Mitigation Site	Mitigation Actions	Species/ Life Stage Addressed	Permanent Mitigation Credit (acres)	Temporary Mitigation Credit (acre-years)
Seward Park 1	Shoreline enhancement + hard structure removal, riparian restoration	Chinook (juvenile rearing/ feeding, juvenile migration),	0	7.08
Seward Park 2	Shoreline enhancement (gravel supplementation)	Chinook (juvenile rearing/ feeding, juvenile migration), Sockeye (spawning, rearing/feeding)	0	0.85
Seward Park 3	Shoreline enhancement (gravel supplementation), riparian restoration	Chinook (juvenile rearing/ feeding, juvenile migration),	0	2.27
Seward Park 4	Shoreline enhancement (gravel supplementation)	Sockeye (spawning)	0	19.37
Magnuson Park 1	Shoreline enhancement + hard structure removal, riparian restoration	Chinook (juvenile rearing/ feeding, juvenile migration),	0	2.61
Magnuson Park 2	Shoreline enhancement + hard structure removal	Chinook (juvenile rearing/ feeding, juvenile migration),	0	3.09
Taylor Creek	Channel and delta restoration, riparian + floodplain restoration	Chinook (rearing/ feeding) Sockeye (spawning, rearing/ feeding), Coho (spawning, rearing/ feeding)	0	5.20

Mitigation Site	Mitigation Actions	Species/ Life Stage Addressed	Permanent Mitigation Credit (acres)	Temporary Mitigation Credit (acre-years)
South Lake Washington Shoreline Restoration	Shoreline enhancement + hard structure removal, riparian restoration, dolphin removal	Chinook (Juvenile rearing/ feeding, juvenile migration) Sockeye (juvenile rearing/ feeding)	1.84	0
Bear Creek	Stream enhancement, riparian restoration	Chinook (rearing/ feeding) Sockeye (rearing/ feeding) Coho (rearing/ feeding)	4.55	0
Cedar River/ Elliott Bridge	River margin and aquatic off-channel creation, riparian + floodplain restoration	Chinook (spawning, rearing/ feeding) Sockeye (spawning, rearing/ feeding) Coho (spawning, rearing/ feeding) Steelhead (spawning, rearing/ feeding)	1.62	0
East Approach	Shoreline enhancement (gravel supplementation, bulkhead removal), riparian enhancement	Sockeye (spawning) Chinook (juvenile rearing/ feeding, juvenile migration)	0.60	0

6.14.3. Comparison of Impacts and Mitigation

According to the impact and mitigation–assessment framework, the SR 520, I-5 to Medina Project's proposed mitigation actions compensates for both permanent and temporary impacts (Table 6-18). Although the final dispensation of permanent and temporary mitigation credit assignment to individual sites has not been finalized, the current site assignment, as discussed above, the variety and quantity of proposed mitigation is adequate to compensate for both temporary and permanent project impacts.

The mitigation value to the focal fish and their survival at various life stages are commensurate with potential impacts to the same species and life stages, as modeled in Figure 6-14. Although the impacted habitat features (see model in Figure 4-1) and mitigation habitat features (see model in Figure 6-14) differed in type and spatial location, the project's mitigation targeted the same species, stocks, and life stages that were impacted (Section 4.1; Table 6-1). Because the temporary and permanent impacts are likely to affect juveniles migrating toward the Ship Canal, most compensatory mitigation actions are designed to benefit juvenile survival. In addition, these restoration projects are intended to enhance spawning success of all focal species in order to address the concern of unanticipated project effects on adults migrating from the Ship Canal into the lake. Any unknown project impacts that are identified in the future will be mitigated, as appropriate.

Table 6-18. Total Impact and Mitigation Metrics after Application of the Mitigation Framework

	Permanent (Acres)	Temporary (Acre-Years)
Impacts	7.30	16.16
Mitigation	8.61	40.46

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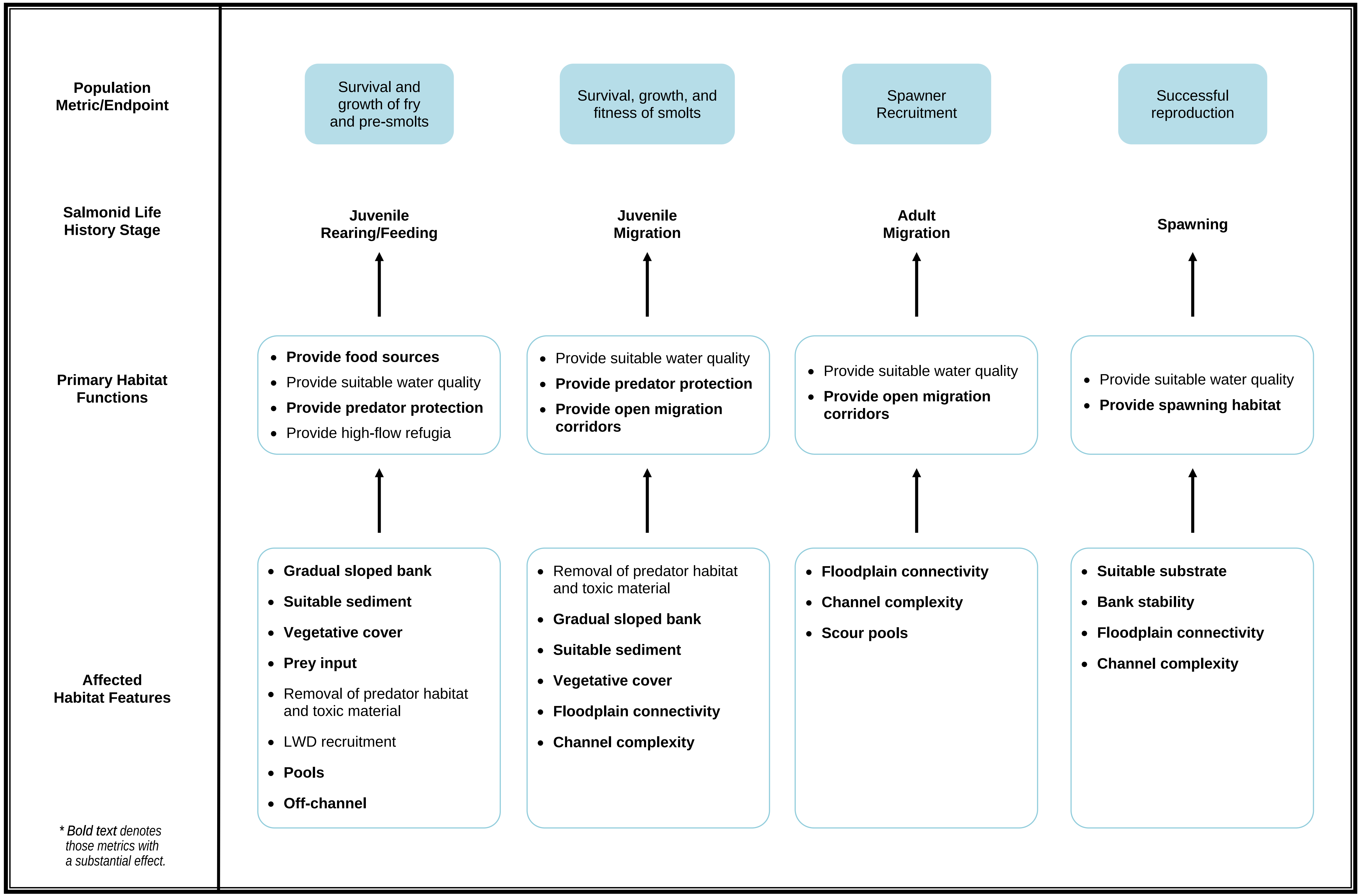
Figure 6-14. Conceptual Model of Mitigation Benefits



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7. Mitigation Goals, Objectives, and Performance Criteria

WSDOT uses goals and objectives to guide mitigation design and construction. Goals and objectives typically are based on area or function. Goals describe the overall intent of mitigation efforts; objectives describe individual components of the mitigation site in detail. Performance standards are the benchmarks that define success for each objective and direct adaptive management. These standards describe specific on-site characteristics that indicate whether the mitigation site meets an objective. They also guide the management of the mitigation site. Performance standards are also used to evaluate compliance with regulatory permits during the monitoring period. Contingency plans describe what actions can be taken to correct site deficiencies.

WSDOT uses the adaptive management process to improve mitigation success. Adaptive management is a process through which changes to mitigation activities, maintenance procedures, or monitoring protocols are developed based on the successes or failures in other mitigation projects. These changes are then incorporated into the current mitigation projects. Information from ongoing monitoring further directs subsequent site management activities. WSDOT will monitor the site for up to 10 years and perform maintenance, as necessary, to achieve the mitigation performance standards. As part of the adaptive management process, mid-course corrections may be necessary if the site develops in ways that were not anticipated during design and permitting of the project. These mid-course corrections require coordination with regulators, and may, in some cases, require negotiation of revised performance standards.

7.1 Goals

The SR 520, I-5 to Medina Project will use a comprehensive mitigation plan to compensate for permanent aquatic impacts by restoring 2.77 acres of shoreline, 17.83 acres of riparian/ floodplain habitat, and 3.77 acres of stream and off-channel habitat. This mitigation plan will compensate for temporary aquatic impacts by restoring 2.67acres of lacustrine shoreline/ stream habitat, 2.54 acres of riparian/ floodplain habitat. This mitigation plan will be sufficient to meet federal, state, and local regulatory requirements.

7.2 Objectives

7.2.1. Seward Park 1

Off-site compensatory mitigation at Seward Park Project 1 will provide the following:

SEW1_1: *Enhance 0.0.45 acre of shoreline habitat by removing bulkheads and riprap, excavating the shoreline to a gradual grade, and installing appropriate-sized gravel and LWD.*

SEW1_2: *Enhance 0.38 acre of riparian habitat through removal of invasive vegetation and installation of native tree and shrub vegetation.*

7.2.2. Seward Park 2

Off-site compensatory mitigation at Seward Park Project 3 will provide the following:

SEW2_1: *Enhance 0.06 acre of shoreline habitat by covering angular cobble and sand with appropriately sized gravel.*

7.2.3. Seward Park 3

Off-site compensatory mitigation at Seward Park Project 2 will provide the following:

SEW3_1: *Enhance 0.18 acre of shoreline habitat by covering angular cobble with appropriately sized gravel.*

SEW3_2: *Enhance 0.26 acre of riparian habitat through removal of invasive vegetation and installation of native tree and shrub vegetation.*

7.2.4. Seward Park 4

Off-site compensatory mitigation at Seward Park Project 4 will provide the following:

SEW4_1: *Enhance 1.36 acres of shoreline habitat by covering sand and cobble with appropriately sized gravel.*

7.2.5. Magnuson Park 1

Off-site compensatory mitigation at Magnuson Park Project 1 will provide the following:

MAG1_1: *Enhance 0.2 acre of shoreline habitat by removing concrete rubble, excavating the shoreline to a gradual grade, and installing appropriate-sized gravel and LWD.*

MAG1_2: *Enhance 0.36 acres of riparian habitat through removal of invasive vegetation and installation of native tree and shrub vegetation.*

7.2.6. Magnuson Park 2

Off-site compensatory mitigation at Magnuson Park Project 2 will provide the following:

MAG2_1: *Enhance 0.14 acre of shoreline habitat by removing bulkheads and concrete rubble.*

MAG2_2: *Create 0.05 acre of stream channel by excavating a new outlet that will function as an outlet for the Seattle Parks Department Habitat Improvement Area wetland complex.*

MAG2_3: *Enhance 0.80 acre of riparian habitat through removal of invasive vegetation and installation of native tree and shrub vegetation.*

7.2.7. Taylor Creek

Off-site mitigation will take place at Taylor Creek, between the Lake Washington shoreline and Rainier Avenue SW. The off-site compensatory mitigation will provide the following:

TAY1*: Restore 0.15acre of stream habitat by relocating and reconfiguring the existing stream channel, and installing appropriate-sized gravel and LWD.*

TAY2: *Enhance 0.74 acre of riparian habitat through removal of invasive vegetation and installation of native tree and shrub vegetation.*

TAY3: *Restore 0.74 acre of floodplain habitat by removing historical fill, structures, asphalt, concrete, utilities, underground storage tanks, etc.*

TAY4: *Restore 0.08 acre of the Taylor Creek delta, temporarily, by re-sloping the delta to a configuration that is passable by adult salmon during the managed low lake level.*

7.2.8. South Lake Washington Shoreline Restoration (DNR Parcel)

Off-site mitigation will take place at four locations at the South Lake Washington Shoreline Restoration (DNR Parcel). The off-site compensatory mitigation will provide the following:

DNR1: *Enhance 1.93 acres of shoreline habitat through removal of a corrugated sheet metal flume, rubble, shoreline excavation to attain a gradual grade, and installation of appropriate-sized gravel.*

DNR2: *Enhance 2.04 acres of riparian habitat, where invasive weeds will be removed and native vegetation will be installed.*

7.2.9. Cedar River/ Elliott Bridge Reach

Off-site mitigation will take place at the Elliott Bridge reach mitigation site. The off-site compensatory mitigation will provide the following:

__CED1__: Restore 3.55 acres of floodplain habitat, where existing levees will be removed, areas behind the levees excavated to appropriate grades, and the natural hydrologic processes restored along the Cedar River.

***CED2:** Create 0.61 acre (approximately 500linear feet) of off-channel rearing habitat and riverine marginal habitat. Install an engineered logjam (ELJ) at the mouth of the channel and LWD habitat features along the right bank of the channel.*

***CED4:** Enhance 3.55 acres of riparian habitat through removal of invasive vegetation and installation of native tree and shrub vegetation.*

7.2.10. Bear Creek

Off-site mitigation will take place at the Bear Creek mitigation site. The off-site compensatory mitigation will provide the following:

***BEAR1:** Restore 12.62 acres of floodplain habitat through removal of existing levees, excavation within areas behind the levees to appropriate grades, and restoration of natural hydrologic processes along Bear Creek.*

***BEAR2:** Enhance 12.62 acres of riparian habitat through removal of invasive vegetation and installation of native tree and shrub vegetation.*

***BEAR3:** Restore 3.16 acres of stream habitat by relocating existing stream channel, stabilizing stream banks, and installing appropriate-sized gravel and LWD.*

7.2.11. East Approach

Off-site mitigation will take place at the east approach site. The off-site compensatory mitigation will provide the following:

***SOCK1:** Enhance 0.75 acre of sockeye salmon beach-spawning habitat through installation of spawning gravel offshore.*

***SOCK2:** Enhance 0.08 acre of shoreline habitat through removal of bulkheads and riprap, excavation of the shoreline to a gradual grade, and installation of appropriate-sized gravel and LWD.*

***SOCK3:** Enhance 0.06 acre of riparian habitat through removal of invasive vegetation and installation of native tree and shrub vegetation.*

7.3 Performance Criteria

The performance standards described below provide benchmarks for measuring the progress of the mitigation sites' goals and objectives. Mitigation activities are intended to meet these performance standards within 10 years. Methods to monitor each performance standard are described in general terms.

Performance criteria describe measurable attributes that can be used to evaluate success in meeting the goals and objectives of a compensatory mitigation project. Performance measures are used to guide site management activities during the monitoring period. Success standards are benchmarks measured during the final year of monitoring (Year 5 or 10) that are used to help evaluate compliance with regulatory requirements. Performance measures will be used to verify that the mitigation is on track to achieve the success standards.

Performance criteria and contingency plans will be organized by objectives that re-occur in the array of mitigation sites proposed in this plan. The mitigation projects and their objectives are summarized in Table 7-1.

Table 7-1. Generalized Project Objectives

Mitigation Site	Objective			
	Shoreline Enhancement (Lacustrine)	Stream Restoration	Riparian Restoration	Floodplain Restoration
Seward Park 1	X		X	
Seward Park 2	X			
Seward Park 3	X		X	
Seward Park 4	X			
Magnuson Park 1	X		X	
Magnuson Park 2	X	X	X	
Taylor Creek	X	X	X	X
South Lake Washington Shoreline Restoration (DNR Parcel)	X		X	
Cedar River		X	X	X
Bear Creek		X	X	X
East Approach	X		X	

7.3.1. Shoreline Enhancement (Lacustrine) Performance

The shoreline enhancement performance standards document and verify that the shoreline features are established according to the criteria specified during the design. The shoreline restoration performance standards also ensure that the shoreline features are functioning as intended. These shoreline performance standards directly relate to Objectives SEW1_1, SEW2_1, SEW3_1, SEW4_1, MAG1_1, MAG2_1, TAY4, DNR1, SOCK 1 and SOCK2.

Interim Performance Standards

Year 1

- As-built condition is consistent with the project design elements, including hard structure removal, site grading plan, gravel supplementation specifications, and installed habitat features.

Year 3

- The slope of the enhanced shoreline habitat is at or below 15% grade, as measured from low lake level to high lake level.
- The LWD structures are hydraulically engaged within the wetted portion of the lakes (at high lake level).
- At least 80% of placed LWD pieces is retained within the project limits.
- The areas between created shoreline habitat and adjacent upland does not show signs of obvious and significant bank failures, including sloughing, slumping, or bank fractures, as determined from visual inspection.
- At the shoreline substrate enhancement sites (not including the deep water gravel installation at the east approach site), substrate composition is maintained within 80% of the D_{50} (the size at which 50% of the pebbles are finer) compared with as-built gravel installation.

Success Standard

Year 5

- The slope of the enhanced shoreline habitat is equal to or less than 15%, as measured from low lake level to high lake level.
- The LWD structures are engaged within the wetted portion of the lakes (at high lake level).
- At the shoreline substrate enhancement sites (not including the deep water gravel installation at the east approach site), substrate composition is maintained within 60% of the D_{50} compared with as-built gravel installation.
- At least 50% of placed LWD is retained within the project limits.

7.3.2. Stream Restoration Performance

The performance standards for stream restoration document and verify that the stream features are established according to the criteria specified during the design. The stream restoration performance standards also assure that the stream features are functioning as intended. These stream restoration performance standards directly relate to Objectives MAG2_2, TAY1, CED2, and BEAR3.

Interim Performance Standards

Year 1

- As-built condition is consistent with the project design elements, including hard structure removal, site grading plan, and installed habitat features.

Year 3

- Stream habitat is accessible to adult and juvenile fish, specifically at the Cedar River side channel, the lower reach of Taylor Creek, and the off-channel habitat at Bear Creek. Methods presented in the Stream Habitat Restoration Guidelines (Saldi-Caromile et al. 2004) will be used to determine if the water depths and velocities within these features support use by juvenile and adult salmonids.
- The channel does not show signs of significant headcutting, avulsion, or subsurface seepage as determined from visual inspection.
- The LWD and ELJ structures are hydraulically engaged within the wetted portion of the streams (at low water).
- The in-stream structures (LWD and ELJ) remain intact and properly functioning as determined from visual inspection. The inspection should look for evidence of structure movement, cover creation, sediment trapping, and development of pools.
- At least 80% of placed LWD is retained within the project limits.

Success Standard

Year 5

- Stream habitat is accessible to adult and juvenile fish, specifically at the Cedar River side channel, the lower reach of Taylor Creek, and the off-channel habitat at Bear Creek. Methods presented in the Stream Habitat Restoration Guidelines (Saldi-Caromile et al. 2004) will be used to determine if the water depths and velocities within these features support use by juvenile and adult salmonids.
- The channel does not show signs of significant headcutting, avulsion, or subsurface seepage as determined from visual inspection.

- The LWD and ELJ structures are engaged within the wetted portion of the streams (at low water).
- The in-stream structures (LWD and ELJ) remain intact and properly functioning as determined from visual inspection. The inspection should look for evidence of structure movement, cover creation, sediment trapping, and development of pools.
- At least 60% of placed LWD is retained within the project limits.

7.3.3. Riparian Restoration Performance

The riparian performance criteria document the establishment of a plant community that (1) stabilizes shoreline or stream banks, and (2) provides fish cover. The riparian performance criteria directly relate to Objectives SEW1_2, SEW3_2, MAG1_2, MAG2_3, TAY2, DNR2, CED4, and BEAR2.

Interim Performance Standards

Year 0

- As-built condition is consistent with the planting plan.

Year 1

- Native woody species (planted and volunteer) achieve an average density of at least four plants per 100 square feet in the overall riparian zone and a density of 6 plants per 100 square feet within 10 feet of the shoreline.

Year 3

- Native woody species (planted and volunteer) achieve an average density of at least four plants per 100 square feet in the overall riparian zone and a density of 6 plants per 100 square feet within 10 feet of the shoreline.

Year 5

- Cover of native woody species (planted and volunteer) is at least 30% in the riparian zone.

Year 7

- Cover of native woody species (planted and volunteer) is at least 40% in the riparian zone.

All years

- Washington State and King County listed Class A Noxious Weeds indentified on the site are eradicated.

- King County listed Class B and C Weeds identified on the site are controlled. Control of noxious weeds means to prevent all seed production and to prevent the dispersal of all propagative parts capable of forming new plants. If Japanese knotweed is found at the mitigation site during monitoring, WSDOT (or its designated representatives) will promptly remove the stems above ground and chemically treat it to facilitate elimination of roots and rhizomes below ground.

- Noxious weeds listed by King County as Non-Designate including reed canarygrass, non-native blackberries, and Scot's broom do not exceed 25% aerial cover in riparian zones.

Success Standard

Year 10

Cover of native woody species (planted and volunteer) is at least 50% in the riparian zone.

7.3.4. Floodplain Restoration Performance

The floodplain restoration performance criteria document the establishment of a plant community that (1) provides habitat for native wildlife, (2) allows for regular inundation above the OHWM, and (3) provides vegetative roughness to slow floodwaters and allow the deposition of sediment and associated pollutants. The buffer woody vegetation performance criteria directly relate to Objectives TAY3, CED1, and BEAR1.

Interim Performance Standards

Year 0

- As-built condition is consistent with the grading, planting, and habitat structure elements of the project design.

Year 1 and Year 3

- Native woody species (planted and volunteer) achieve an average density of at least four plants per 100 square feet in the floodplain.

Year 5

Cover of native woody species (planted and volunteer) is at least 30% in the floodplain.

Year 7

- Cover of native woody species (planted and volunteer) is at least 40% in the floodplain.

All years

- Washington State and King County listed Class A Noxious Weeds identified on the site are eradicated.
- King County listed Class B and C Weeds identified on the site are controlled. Control of noxious weeds means to prevent all seed production and to prevent the dispersal of all propagative parts capable of forming new plants. If Japanese knotweed is found at the mitigation site during monitoring, WSDOT (or its designated representatives) will promptly remove the stems above ground and chemically treat it to facilitate elimination of roots and rhizomes below ground.
- Noxious weeds listed by King County as Non-Designate including reed canarygrass, non-native blackberries, and Scot's broom do not exceed 25% aerial cover in floodplain.

Success Standard

Year 10

Cover of native woody species (planted and volunteer) is at least 50% in the floodplain

7.4 Monitoring

WSDOT staff (or its designated representatives) will monitor the mitigation site for 10 years after installation. If all the performance standards are achieved in less than 10 years, WSDOT may terminate monitoring with approval of the review agencies.

Quantitative monitoring will be completed and documented 1, 3, 5, 7, and 10 years after initial acceptance of the mitigation construction. The site should be evaluated during the summer following plant installation to assess survival rates and document the presence of non-native invasive species. Engineered stream channels and structures will be monitored during years 1, 3, 5, and 7 to verify that their habitat and hydraulic elements are functioning as intended. The WSDOT HQ Monitoring Program (or its designated representatives) will also complete informal (qualitative) assessments of the mitigation sites in years 2, 4, 6, 8, and 9 for adaptive management purposes only.

Quantitative monitoring will be designed to determine if the performance standards have been met. Monitoring reports will be submitted to the recipients listed in Table 7-2 by the month of April following the formal monitoring activities conducted the previous year.

Table 7-2. Monitoring Report Recipients

Permitting Agency or Organization	Contact Name and Address
U.S. Army Corps of Engineers	TBD
Washington State Department of Ecology	TBD
WDFW	TBD
City of Seattle	TBD

WSDOT has established a comprehensive set of monitoring methods used to monitor mitigation sites. The actual methods used to monitor each site are documented in annual monitoring reports prepared by WSDOT's Monitoring Program based in the Environmental Services Office in Olympia, Washington, or its designated representatives.

Contingency Plans

WSDOT anticipates that the mitigation goals will be accomplished with the construction and installation of the mitigation design shown on the grading and planting plans. Contingency actions, however, may be needed to correct unforeseen problems. Contingency revisions typically require coordination with the permitting agencies.

As necessary, contingency measures (site management or revisions to performance criteria with permitting agency agreement) will be implemented to meet performance measures and standards.

7.5 Site Management

WSDOT (or its designated representatives) will manage the sites annually for the first 10 years. Site management activities shall include noxious weed control and may include mulching, fertilizing, supplemental watering, maintaining access, repairing damage from vandals, correcting erosion or sedimentation problems, or picking up litter. During the first year, supplemental watering of installed vegetation will occur during July, August, and September to ensure, at a minimum, the equivalent of normal rainfall levels and no periods of drought (no rainfall or watering) longer than 3 weeks.

Reed canarygrass dominates the watershed and suppression/control of this invasive plant will require careful site preparation and active site management. While complete elimination of reed canarygrass from the mitigation site may not be possible, it should be managed sufficiently to ensure survival of the native planted species until they can effectively compete.

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Appendix A

Compensatory Mitigation Site Photos

Figure A-1. Seward Project 1, existing bulkhead. View is to the east.

Figure A-2. Seward Park Project 3. View is to the NNE.

Figure A-3. Seward Park Project 3. Angular Cobble.

Figure A-4. Magnuson Park Project 1 shoreline has very little riparian vegetation and an actively eroding vertical bank.

Figure A-5. Magnuson Park Project 2 existing shoreline.

Figure A-6. Taylor Creek delta.

Figure A-7. Taylor Creek existing shoreline.

Figure A-8. Taylor Creek, just upstream of the delta. Note the channel confinement with placement of boulders, the adjacent asphalt parking area, and upstream culvert. Also note the abundant gravel bedload.

Figure A-9. DNR Parcel, looking east toward the undeveloped shoreline. The end of the flume is located on the left side of the photo.

Figure A-10. DNR Parcel, looking east at the opening of the flume.

Figure A-11. DNR Parcel looking south toward Boeing plant.

Figure A-12. The narrow floodplain bench on the right bank of the Elliott Reach, Cedar River.

Figure A-13. Levee with riprap on the right bank of the Elliott Reach, Cedar River.

Figure A-14. Cedar River, levee and riprap on right (north) bank.

Figure A-15. Bear Creek low gradient riffle and armored stream banks near mouth.

Figure A-16. Southern riparian buffer of Bear Creek. SR 520 in background.

Figure A-17. WSDOT shoreline at the East Approach Gravel Supplementation project area.

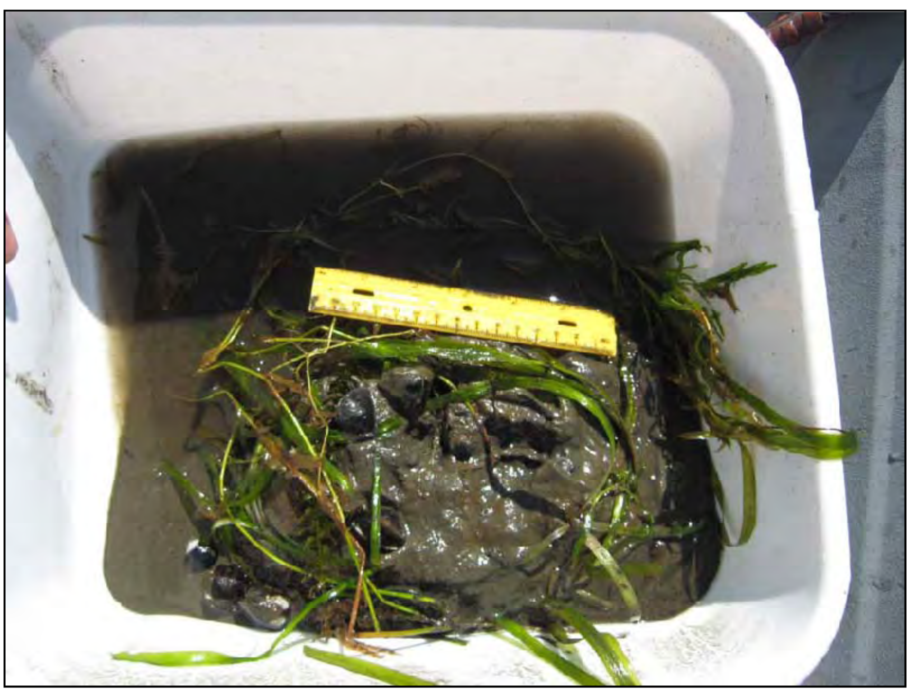

Figure A-18. Existing substrate in the East Approach project area targeted for gravel supplementation.

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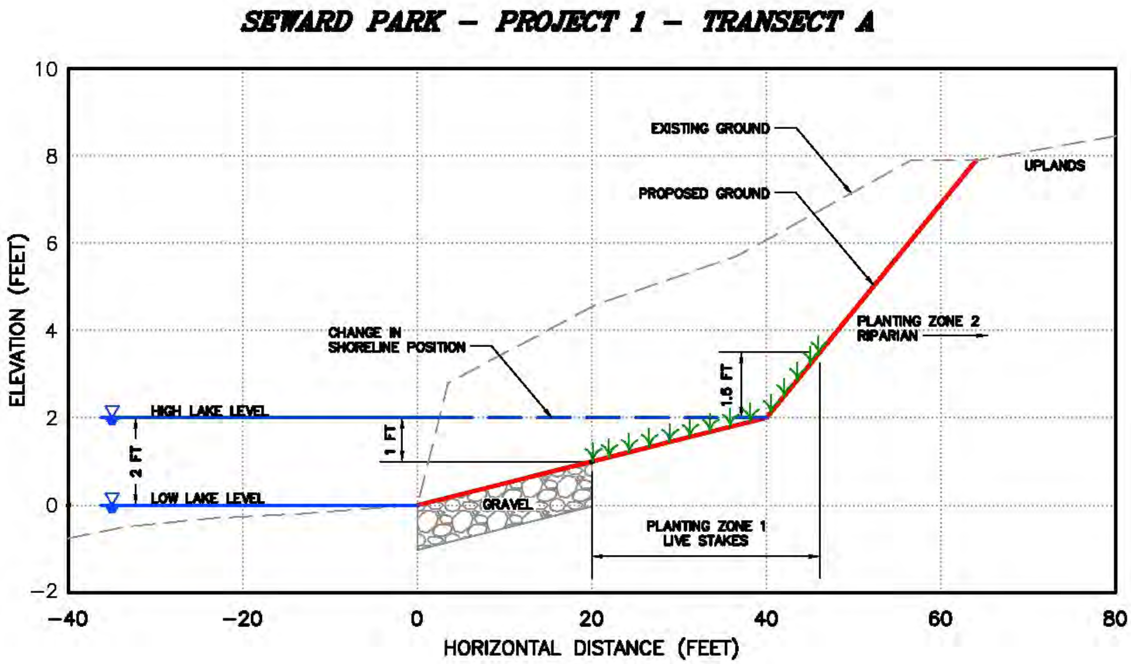
Appendix B

Grading Profiles



EXISTING	
Slope of in-water reach (%)	2
PROPOSED	
From Low to High Lake Level (%)	5
From High Lake Level to Upland (%)	25
Change in Shoreline Position (ft)	37

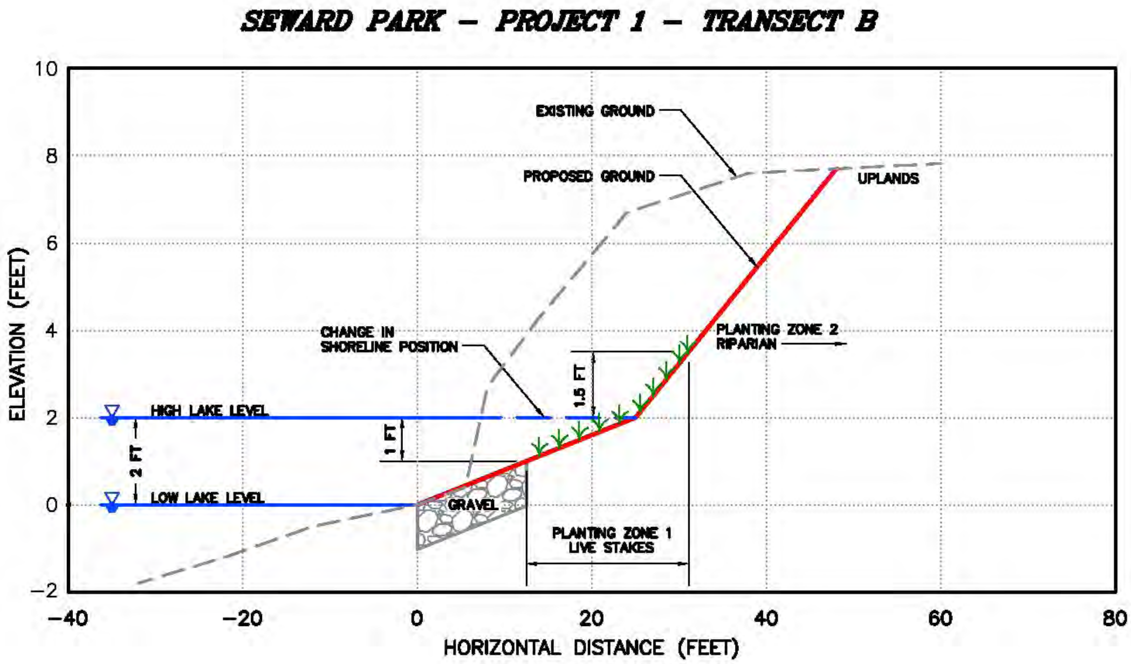


Figure B-2. Seward Park Project 1, Transect B

EXISTING	
Slope of in-water reach (%)	6
PROPOSED	
From Low to High Lake Level (%)	8
From High Lake Level to Upland (%)	25
Change in Shoreline Position (ft)	18

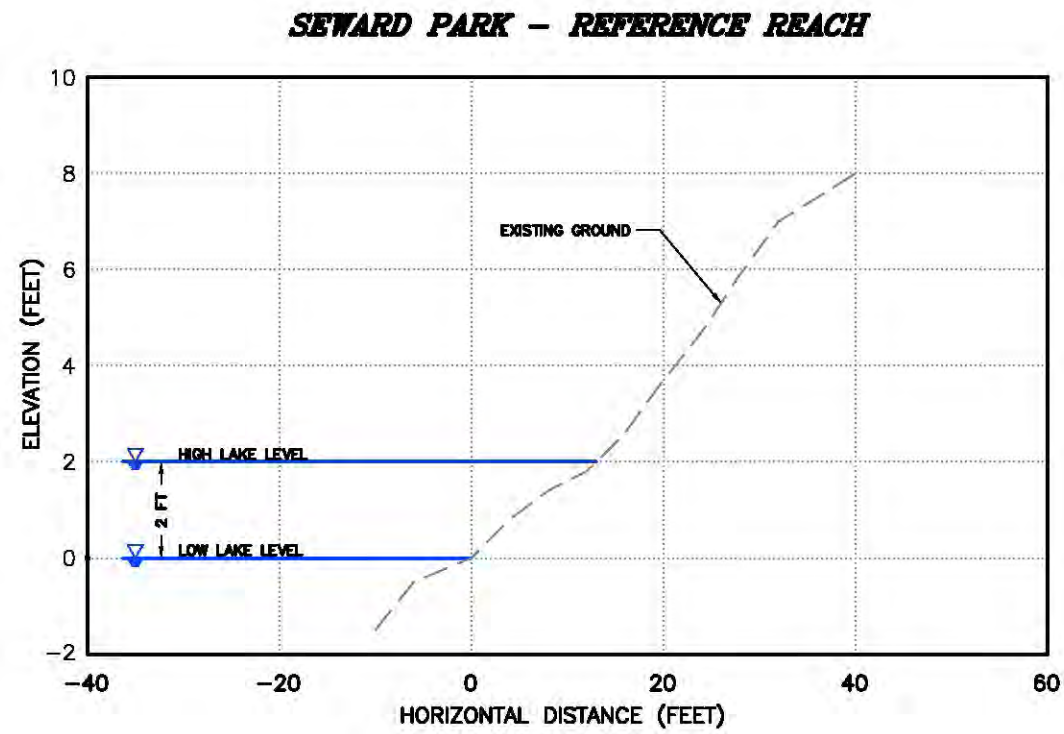
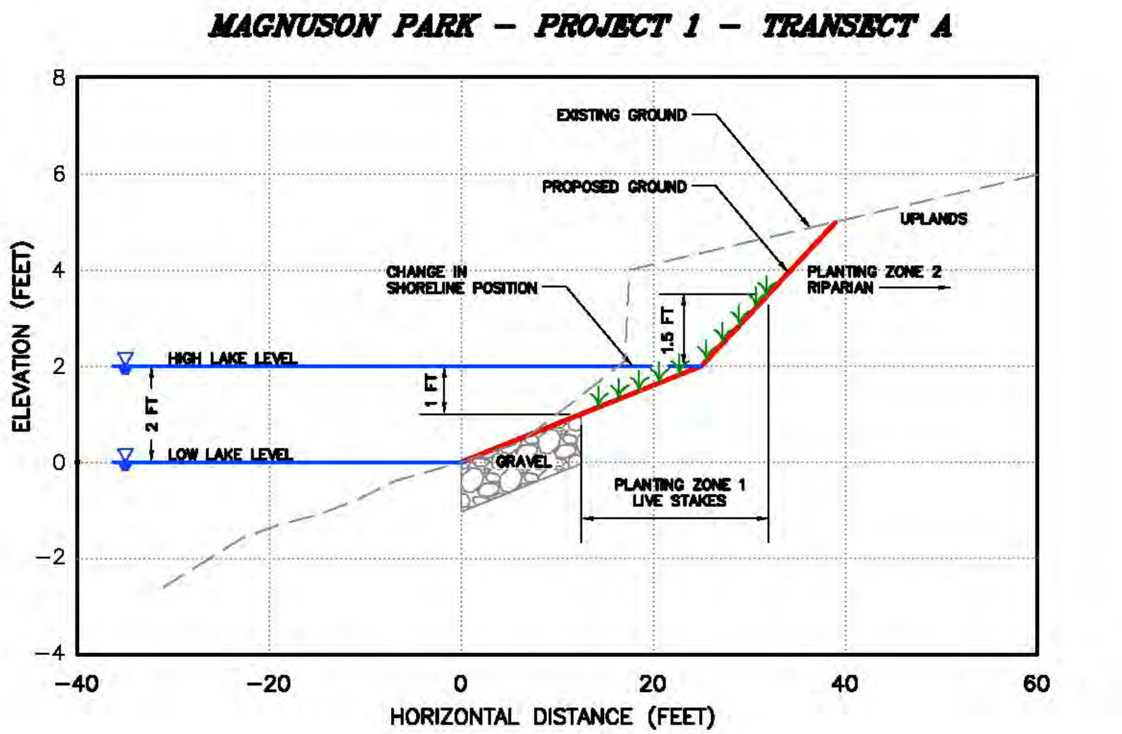
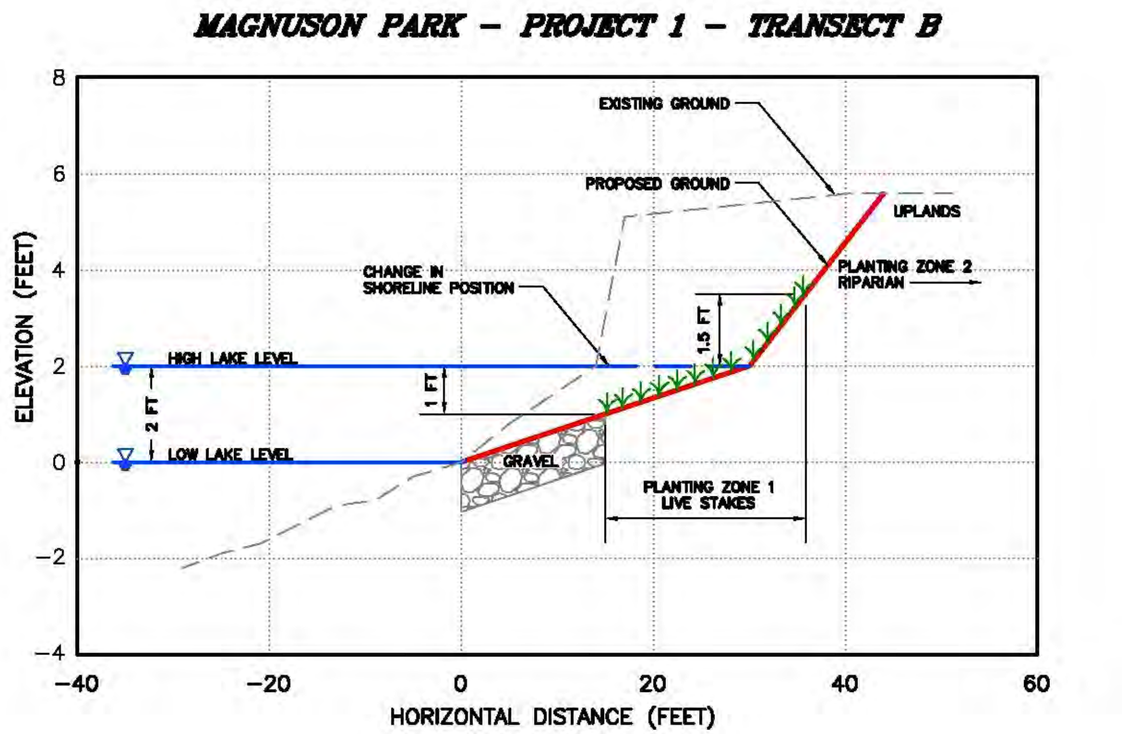


Figure B-1. Seward Park Project 1, Transect A

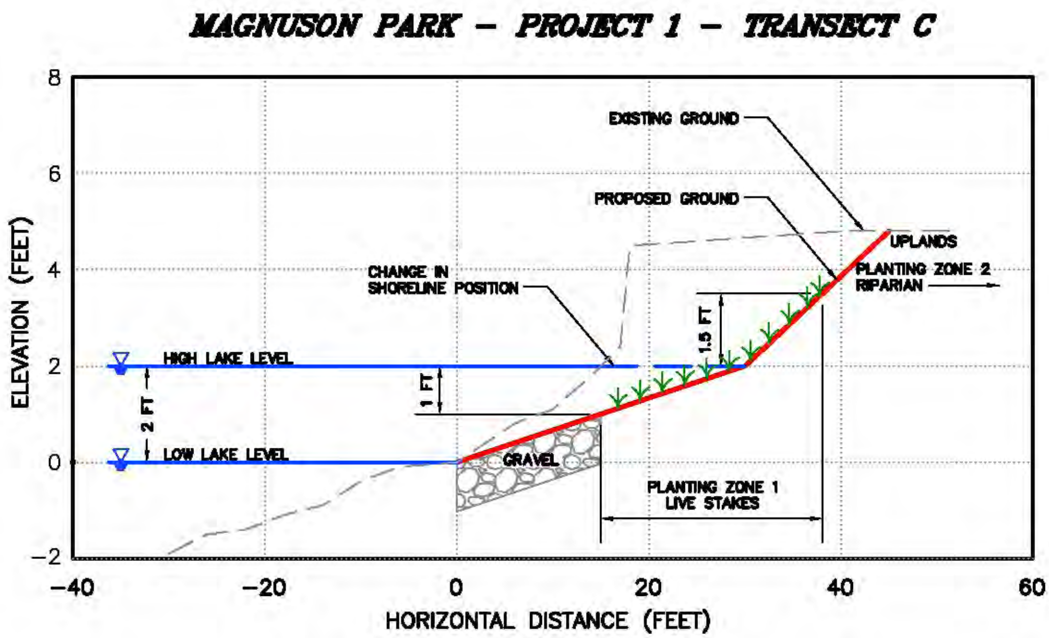
EXISTING	
Slope of in-water reach (%)	15.0
Slope of non-wetted reach (%)	20.0



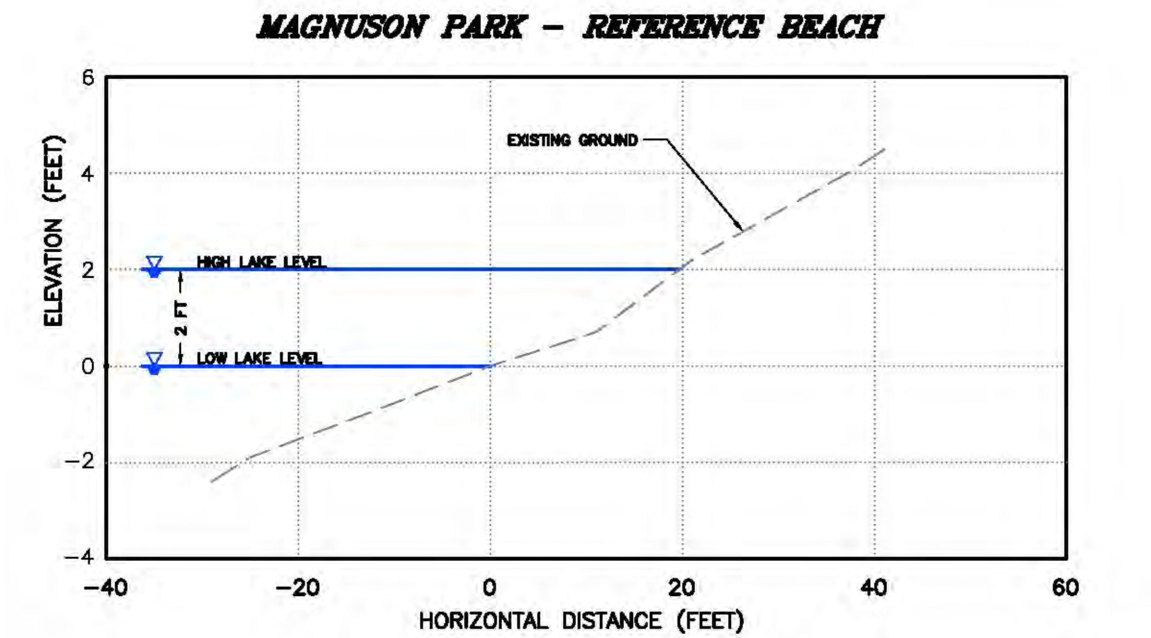
EXISTING	
Slope of in-water reach (%)	8
Slope of non-wetted reach (%)	13
PROPOSED	
From Low to High Lake Level (%)	8
From High Lake Level to Upland (%)	21
Change in Shoreline Position (ft)	8



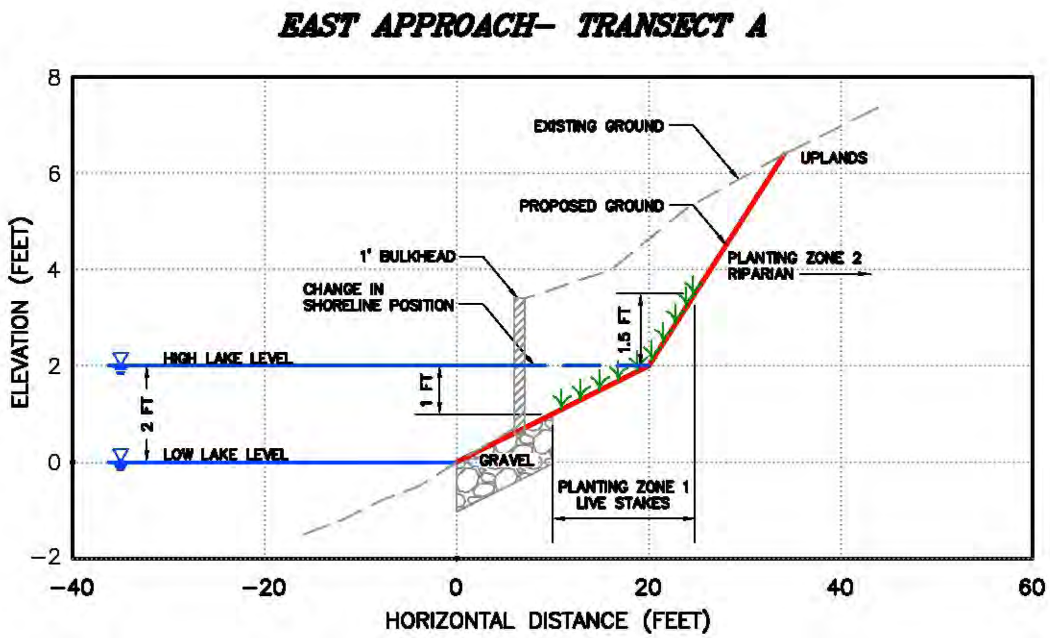
EXISTING	
Slope of in-water reach (%)	8
Slope of non-wetted reach (%)	14
PROPOSED	
From Low to High Lake Level (%)	7
From High Lake Level to Upland (%)	25
Change in Shoreline Position (ft)	16



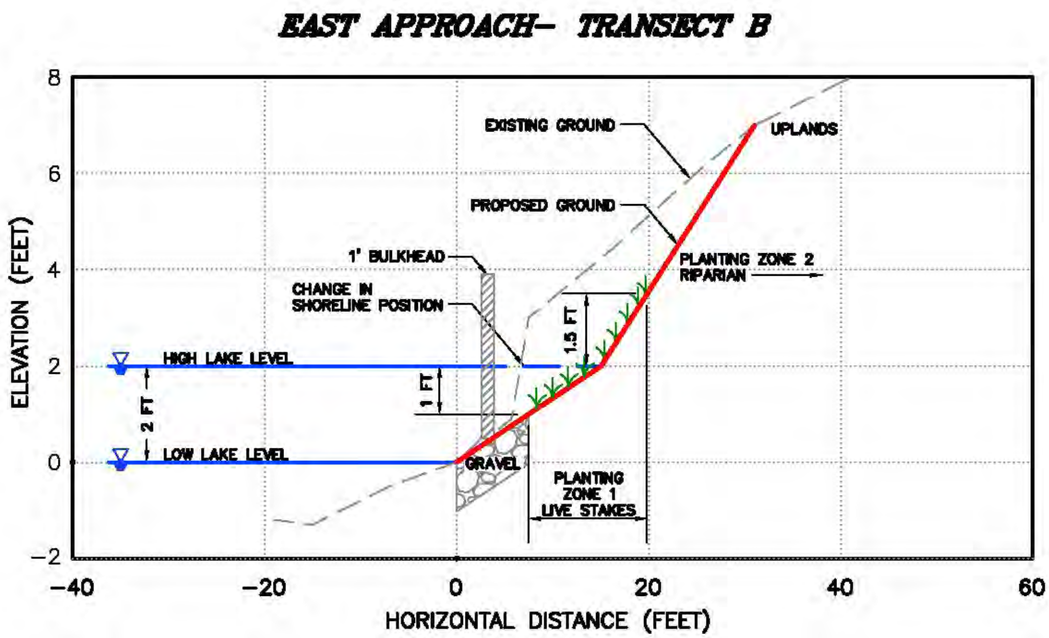
EXISTING	
Slope of in-water reach (%)	6
Slope of non-wetted reach (%)	12
PROPOSED	
From Low to High Lake Level (%)	7
From High Lake Level to Upland (%)	25
Change in Shoreline Position (ft)	15



EXISTING	
Slope of in-water reach (%)	8.3
Slope of non-wetted reach (%)	11.0

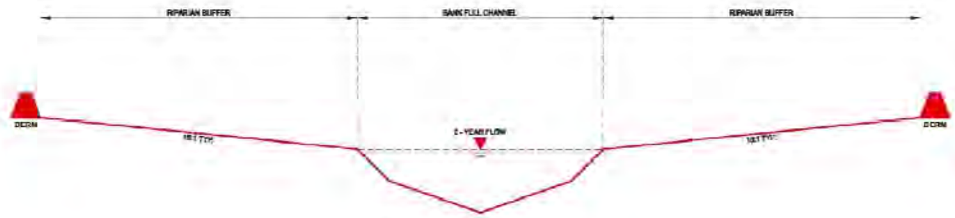


EXISTING	
Slope of in-water reach (%)	9.4
Slope of non-wetted reach (%)	18.8
PROPOSED	
From Low to High Lake Level (%)	10.0
From High Lake Level to Upland (%)	31.4
Change in Shoreline Position (ft)	12.9

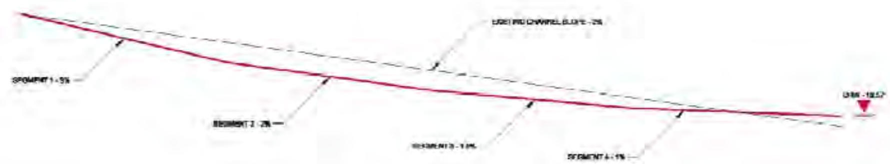


EXISTING	
Slope of in-water reach (%)	6.3
Slope of non-wetted reach (%)	22.6
PROPOSED	
From Low to High Lake Level (%)	13.3
From High Lake Level to Upland (%)	31.3
Change in Shoreline Position (ft)	8.4

Taylor Creek



Typical Section

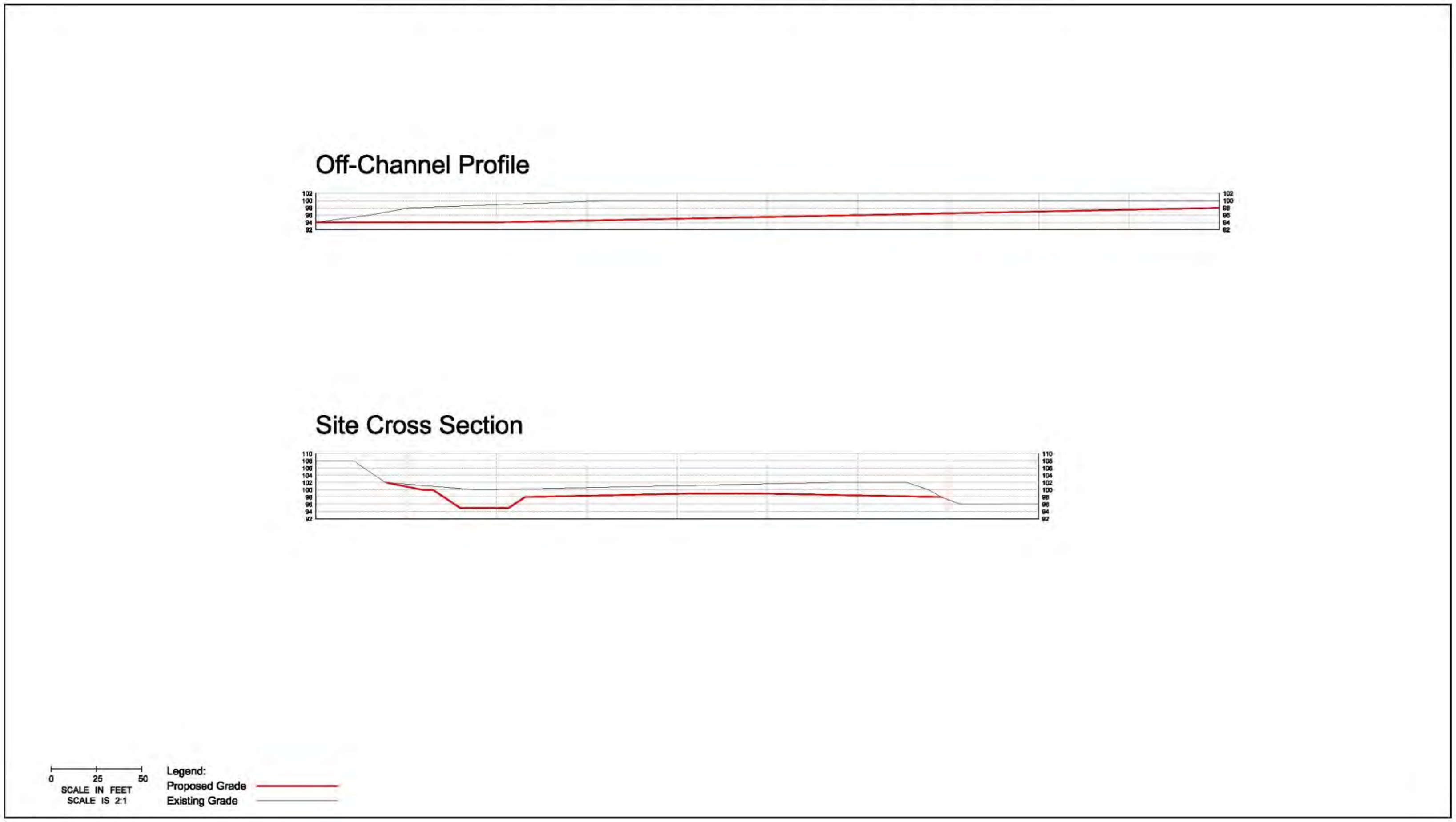


Typical Profile

0 25 50
SCALE IN FEET
SCALE IS 2:1

Legend:
Proposed Grade
Existing Grade

Cedar River / Elliot Bridge Site



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Appendix C

Riparian Planting Palette

Riparian plantings at the Lake Washington aquatic mitigation sites will be largely composed of versatile and robust woody species. A typical species list is shown in Table C-1. The list includes canopy and shrub communities, and includes species that quickly develop a high amount of biomass. Planting at the Elliott Bridge mitigation site is more diverse due to the objectives of creating a complex wetland mosaic and an upland buffer component in the floodplain. A typical wetland species list is shown in Table C-2 and the upland buffer list is shown in Table C-3

Table C-1. Proposed Typical Planting List for Riparian Areas at Lake Washington Mitigation Sites

Common Name	Scientific Name	Size and Condition	Plant Spacing (in feet on center)
Zone 1 – Shoreline Fringe			
Scouler's willow	*Salix scouleriana*	Live Stake	1'
Sitka willow	*Salix sitchensis*	Live Stake	1'
Red-osier dogwood	*Cornus sericea*	Live Stake	1'
Zone 2 – Riparian			
Salmonberry*	*Rubus spectabilis*	#1 Container	4'
Red-osier dogwood*	*Cornus sericea*	#1 Container	4'
Pacific ninebark*	*Physocarpus capitatus*	#1 Container	4'
Sitka willow*	*Salix sitchensis*	#1 Container	4'
Nootka rose	*Rosa nutkana*	#1 Container	4'
Vine maple	*Acer circinatum*	#1 Container	4'
Beaked hazelnut	*Corylus cornuta*	#1 Container	4'
Oceanspray	*Holodiscus discolor*	#1 Container	4'
Common snowberry	*Symphoricarpos albus*	#1 Container	4'
Red alder*	*Alnus rubra*	#1 Container	10'
Black cottonwood	*Populus balsamifera ssp.*	#1 Container	10'
Douglas-fir	*Pseudotsuga menziesii*	#1 Container	10'
Sitka spruce*	*Picea sitchensis*	#1 Container	10'

* Best planted in close proximity to water.

Table C-2. Proposed Typical Planting List for Wetland Areas at Elliott Bridge Mitigation Site

Common Name	Scientific Name	Indicator Status	Size and Condition	Plant Spacing (in feet on center)
Water's Edge Planting				
Live Stakes				
Scouler's willow	*Salix scouleriana*	FAC	Live Stake	1'
Sitka willow	*Salix sitchensis*	FACW	Live Stake	1'
Scrub-shrub Wetland Planting				
Black twinberry	*Lonicera involucrata*	FAC+	#1 Container	4'
Peafruit rose	*Rosa pisocarpa*	FAC	#1 Container	4'
Salmonberry*	*Rubus spectabilis*	FAC+	#1 Container	4'
Red-osier dogwood	*Cornus sericea*	FACW+	#1 Container	4'
Pacific ninebark	*Physocarpus capitatus*	FACW-	#1 Container	4'
Scouler's willow	*Salix scouleriana*	FAC	#1 Container	4'
Sitka willow	*Salix sitchensis*	FACW	#1 Container	4'
Emergents				
Sawbeak sedge	*Carex stipata*	OBL	Plug	2'
Slough sedge	*Carex obnupta*	OBL	Plug	2'
Creeping spikerush	*Eleocharis palustris*	OBL	Plug	2'
Baltic rush	*Juncus balticus*	FACW+	Plug	2'
Daggerleaf rush	*Juncus ensifolius*	FACW	Plug	2'
Skunk cabbage*	*Lysichiton americanum*	OBL	Plug	2'
Small fruited bulrush	*Scirpus microcarpus*	OBL	Plug	2'
Hardstem bulrush	*Schoenoplectus acutus*	OBL	Plug	2'
Forested Riparian Wetland Planting				
Trees				
Red alder**	*Alnus rubra*	FAC	4', B&B	12'
Oregon ash	*Fraxinus latifolia*	FACW	4', B&B	12'
Sitka spruce*	*Picea sitchensis*	FAC	4', B&B	12'
Black cottonwood	*Populus balsamifera ssp.*	FAC	4', B&B	12'
Pacific willow	*Salix lucida var. lasiandra*	FACW+	4', B&B	12'
Western red cedar*	*Thuja plicata*	FAC	4', B&B	12'
Shrubs				
Red-osier dogwood	*Cornus sericea*	FACW+	#1 Container	4'
Black twinberry	*Lonicera involucrata*	FAC+	#1 Container	4'

Common Name	Scientific Name	Indicator Status	Size and Condition	Plant Spacing (in feet on center)
Nootka rose	*Rosa nutkana*	FAC	#1 Container	4’
Salmonberry	*Rubus spectabilis*	FAC+	#1 Container	4’
Emergents				
Skunk cabbage	*Lysichiton americanum*	OBL	Plug	2’
Water parsley	*Oenanthe sarmentosa*	OBL	Plug	2’

* Species to be planted in shaded areas or as secondary planting into established canopy.

Table C-3. Proposed Typical Planting List for Upland Buffer Areas at the Elliott Bridge Reach Mitigation Site

Common Name	Scientific Name	Indicator Status	Size and Condition	Plant Spacing (in feet on center)
Upland Forested				
Trees				
Big leaf maple	*Acer macrophyllum*	FACU	4’, B&B	12’
Red alder	*Alnus rubra*	FAC	4’, B&B	12’
Black cottonwood	*Populus balsamifera ssp. trichocarpa*	FAC	4’, B&B	12’
Bitter cherry	*Prunus emarginata*	FACU	4’, B&B	12’
Douglas-fir	*Pseudotsuga menziesii*	FACU	4’, B&B	12’
Cascara*	*Rhamnus purshiana*	FAC-	4’, B&B	12’
Western red cedar*	*Thuja plicata*	FAC	4’, B&B	12’
Shrubs				
Black hawthorn	*Crataegus douglasii*	FAC	#1 Container	4’
Vine maple*	*Acer circinatum*	FAC-	#1 Container	4’
Serviceberry	*Amelanchier alnifolia*	FACU	#1 Container	4’
Salal	*Gaultheria shallon*	FACU	#1 Container	4’

Common Name	Scientific Name	Indicator Status	Size and Condition	Plant Spacing (in feet on center)
Beaked hazelnut*	*Corylus cornuta*	FACU	#1 Container	4’
Oceanspray	*Holodiscus discolor*	NL	#1 Container	4’
Oregon Grape	*Mahonia nervosa*	FACU	#1 Container	4’
Indian plum*	*Oemleria cerasiformis*	FACU	#1 Container	4’
Baldhip rose	*Rosa gymnocarpa*	FACU	#1 Container	4’
Nootka rose	*Rosa nutkana*	FAC	#1 Container	4’
Thimbleberry	*Rubus parviflorus*	FAC-	#1 Container	4’
Red Elderberry	*Sambucus racemosa*	FACU	#1 Container	4’
Common snowberry	*Symphoricarpos albus*	FACU	#1 Container	4’

* Species to be planted in shaded areas or as secondary planting into established canopy.

Appendix D

Mitigation Accounting

The overall approach to mitigation accounting is described in this excerpt from Section 5.5 “Mitigation Framework”. Figure D-1 (Figure 5-1 in the report) summarizes the process. The Fish Function Modifier (FFM) criteria are shown in Table D-1.

Since on-site, in-kind opportunities were not feasible, WSDOT sought off-site mitigation opportunities that addressed the same functions and values that could be affected by the project. Aquatic functions and values were defined in terms of the following fish species and their life history requirements:

- Fall Chinook
- Sockeye
- Coho
- Steelhead

The spatial locations of project impacts and mitigation sites were classified in terms of their importance to these species, and assigned a score commensurate to their value to the focal fish. These Fish Function Modifier scores were assigned to impact and mitigation sites, in the form of a 0-1 weighting factor. Section 4.1 describes criteria and rationale for the Fish Function Modifier scoring (Table D-1). The acreage of a given mitigation action is multiplied by the applicable Fish Function Modifier score (Figure 5-1, Figure D-1). Next, the mitigation acreage (adjusted by Fish Function Modifier score) is weighted in terms of the “Project Type” score (Figure 5-1, Figure D-1).

Using this framework, all in-water mitigation activities (riprap removal, shoreline grading, levee removal, dredging) were assigned a Project Type score of 1.0. A score of 1.0 is indicative of the direct and immediate aquatic benefits that these projects produce. Riparian and floodplain restoration projects received a score of 0.2, to recognize the delay in achieving full function/and or the indirect nature of these projects to functioning aquatic habitat. While riparian function along the shoreline may directly benefit fish (e.g., fish cover), the functional value becomes indirect farther from the shoreline (e.g., pollutant filtration, shading, etc.). Floodplains provide indirect fish benefits by attenuating flood flows, performing water quality functions, maintaining riverine wetlands, providing off-channel salmonid habitat, and providing the opportunity for dynamic channel creation over time. Mitigation areas that improve both riparian and floodplain functions received a Project Type score of 0.4 to reflect the additive value of riparian and floodplain functions. After adjusting the mitigation acreages by Fish Function Modifier and Project Type scores, the adjusted acreage can be applied to permanent impacts (see Section 4.1).

If the adjusted mitigation acreage is applied to temporary impacts instead of permanent impacts, an additional step is required. Temporary impacts are calculated in terms of weighted acre-years (see Section 4.1). Restoration actions that are intended to mitigate for these temporary impacts must also be valued in terms of their temporal contribution to aquatic functions and values. The acreage of each mitigation action (adjusted by Fish Function Modifier and Project Type scores) is multiplied by the percent aquatic function that the project provides on an annual basis for the first 18 years after project completion. For example, if a mitigation project was completed in 2012, temporary mitigation credit will be counted until 2030 (18 years). A total of 18 years was selected as an intermediate timeframe in which ecological functions could be realized and become established, yet credits would not be overstated by extending the timeframe out into perpetuity.

Projects that have full and immediate benefits are multiplied by 1.0 (i.e., 100% function) for all 18 years. Projects that take time to realize full function are multiplied by an increasing proportion (i.e., percent function) over time. Riparian restoration projects are assumed to realize 10% function during years 1 through 5, 50% function during years 6 through 10, and 100% function thereafter. The acre-years for all 18 years are summed to yield a total mitigation value that can be credited toward temporary impacts.

Figure D-1. Process for Determining Value of Mitigation Actions

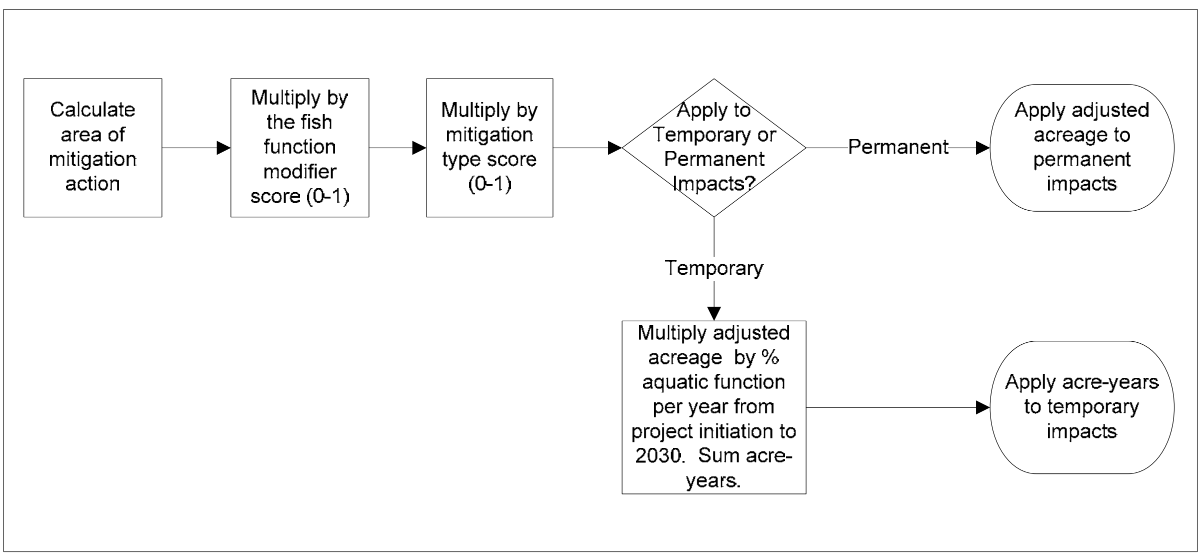

Table D-1. Proposed Scaling Factors and Criteria

Fish Function Modifier Score	Fish Function Modifier Criteria	Proposed Mitigation Sites Within Each Category
1 – Very High	Aquatic sites that are defined as critical migration or rearing areas for multiple species and stocks of juvenile salmon, or that serve as critical migration areas for multiple species and stocks of returning adults.	
0.8 – High	Aquatic sites that are known to support documented spawning of at least one salmonid species, or Aquatic sites that serve as migration or rearing areas of considerable importance for one or more species of juvenile salmon, or that serve as migration areas of considerable importance for returning adults.	Seward 1 Seward 3 Seward 4 Taylor Creek So. Lake WA Restoration Cedar River/ Elliot Reach Bear Creek East Approach
0.6 – Moderate	Aquatic sites that do not support salmon spawning, and where juvenile migration or rearing areas for juvenile salmonid species occurs, but where fish density, or temporal distribution of fish is lower compared to that of other sites.	Seward 2 Magnuson 1 Magnuson 2
0.1 – Low	Aquatic sites that do not support salmon spawning, and that have low or nominal use by salmonids for migration or rearing.	

The following excerpts from the “Mitigation Site Existing Conditions and Fish Use” sections in Chapter 6 of the mitigation plan justify the assignment of FFM values used in mitigation accounting, as shown in Tables D-2 and D-3.

Seward 1 (excerpt from Section 6.2.2)

Fish use along the southwest shoreline of Seward Park (a natural shoreline area adjacent to Seward 1) is documented in Tabor et al. (2006). During snorkel surveys in 2003 (April 7–May 6), a total of 76 Chinook salmon were observed and their abundance was higher on each date than at any other site in Seward Park (Tabor et al. 2006). On two of these three surveys, more Chinook salmon were observed along this shoreline than at the other sites combined. Only six Chinook salmon were observed in this area during the last two surveys in 2003 (May 22 and June 10) and their abundance was similar to that at other sites in Seward Park. The high abundance of Chinook salmon at this site is likely due to better habitat conditions, specifically the sand substrate and gradual slope and the site is closer to the Cedar River than other Seward Park sites. Given the high use by Chinook juveniles in this area, Seward 1 fits the “high” FFM definition of “aquatic sites that serve as migration or rearing areas of considerable importance for one or more species of juvenile salmon”. Therefore, Seward 1 has an FFM score of 0.8.

Seward 2 (excerpt from Section 6.3.2)

The Seward 2 shoreline is used by migrating juvenile Chinook, primarily from the Cedar River. Although this segment of shoreline is along their primary migration path, the density of juvenile Chinook is not as high as at the southeastern extremity of the park (Tabor et al. 2006).

Historical records document sockeye spawning along this specific segment of the Seward Park nearshore (WDFW map records; K. Buchanan, Fish Biologist, WDFW, Olympia, Washington. July 26, 2004. Pers. Comm.). During a 1999 snorkel survey along the Seward Park shoreline, the presence of adult sockeye carcasses at various locations on the Seward Park shoreline throughout October, November, and December indicated that beach spawning was occurring (City of Seattle 2001). Therefore, this project area meets the 0.8 FFM criterion of being an “aquatic site that is known to support documented spawning of at least one salmonid species”, and is assigned an FFM of 0.8.

Seward 3 (excerpt from Section 6.4.2)

The Seward 3 shoreline is used by migrating juvenile Chinook, primarily from the Cedar River. Although this segment of shoreline is along their primary migration path, the Chinook juveniles may not be as dependent on shallow littoral areas as they are earlier in their life history. Therefore, this project area does not meet the 0.8 FFM criterion of being a “migration or rearing areas of considerable importance for one or more species of juvenile salmon”, and is assigned an FFM of 0.6.

Seward 4 (excerpt from Section 6.5.2)

The Seward 4 shoreline is assumed to be used by migrating juvenile Chinook from the Cedar River, although this segment of shoreline has never been snorkeled for juvenile Chinook fish use. Historical records document sockeye spawning along this specific segment of the Seward Park nearshore (WDFW map records; K. Buchanan, Fish Biologist, WDFW, Olympia, Washington. July 26, 2004. Pers. Comm.). During a 1999 snorkel survey along the Seward Park shoreline, the presence of adult sockeye carcasses at various locations on the Seward Park shoreline throughout October, November, and December indicated that beach spawning was occurring (City of Seattle 2001). Therefore, this project area meets the 0.8 FFM criterion of being an “aquatic site that is known to support documented spawning of at least one salmonid species”, and is assigned an FFM of 0.8.

Magnuson 1 and 2 (excerpt from Section 6.6.2)

The Magnuson Park shoreline is likely used by juvenile Chinook from the North Lake Washington tributaries and the Sammamish/Issaquah Creek system as they migrate toward the Ship Canal. The shoreline segments with shallow water and cover are used by the juvenile Chinook for rearing, foraging, and refugia. North Lake Washington Chinook juveniles have bimodal migration timing, with some 0+ juveniles migrating out of their natal streams toward the lake as newly emerged fry (35–40 millimeter [mm] fork length) in early spring and others as smolts (85–95 mm fork length) in late May–June (Seiler et al. 2003). The early fry may use the Magnuson Park shoreline and other nearshore areas in Lake Washington for rearing, foraging, and migration. The larger Chinook juveniles reside in waters between 3 and 18 feet deep during the day, primarily over sand-gravel substrates. These larger juveniles will use the shoreline features for fish cover on an infrequent basis (King County 2005). Since juvenile migration or rearing areas for juvenile Chinook are thought to occur, but where fish density, or temporal distribution of fish is likely lower compared to that of other sites, both projects score a "Moderate" FFM score of 0.6, in terms of the juvenile rearing criterion.

Historical records document sockeye spawning along the Magnuson Park nearshore at Sand Point, to the north of Magnuson Projects 1 and 2 (WDFW map records; K. Buchanan, Fish Biologist, WDFW, Olympia, Washington. July 26, 2004. pers. comm.). Sockeye fry originating from adults spawning on the Magnuson Park shoreline may use the littoral zone of Magnuson Park for very early rearing. Since sockeye spawning has not been documented in either specific project area, both projects score a "Moderate" FFM score of 0.6, in terms of the spawning criterion.

Taylor Creek (excerpt from Section 6.8.5)

The proposed channel will be more complex, much less confined, and will attenuate sediment transport to the delta relative to the existing condition. This proposed condition will benefit multiple fish uses (Table 6-10). Fish passage into the stream would improve with a reduction in delta accretion processes. Coho and sockeye will have suitable spawning habitat in the riffle habitat and rearing habitat in the pools and margins. Pools associated with large, woody debris (LWD) will be particularly beneficial for coho and sockeye rearing. Chinook and sockeye fry will benefit from rearing and feeding in the delta, shoreline fringe, and the vegetated margins of the creek. Because the site is a migratory and rearing area of considerable importance for juvenile Chinook salmon, and coho and sockeye spawning occurs in the project area, the mitigation areas have an FFM score of 0.8.

South Lake WA Shoreline Restoration (excerpt from Section 6.9.2)

The project area is most heavily used by Chinook fry that migrate through the site from the Cedar River toward the Ship Canal. The Chinook fry primarily use the portions of shoreline that contain naturally-sloped beach, though this shoreline is degraded from the presence of riprap and lack of native vegetation. High levels of Chinook fry/smolt use have been documented on the site (Tabor et al. 2004a; Tabor et al. 2006). Sockeye fry are known to use the shallow littoral zone in South Lake Washington, especially during the early stages of rearing. Because this site is located adjacent to the mouth of the Cedar River, it is likely that sockeye fry are present in the project area during early rearing. Given the high use by Chinook juveniles in this area, Seward 1 fits the "high" FFM definition of "aquatic sites that serve as migration or rearing areas of considerable importance for one or more species of juvenile salmon". Therefore, Seward 1 has an FFM score of 0.8.

Cedar River/ Elliott Reach (excerpt from Section 6.10.2)

This reach provides spawning habitat for all focal species: Chinook, sockeye, coho, and steelhead (WDFW and WWTIT 1994). Sockeye spawning is particularly heavy along the left (south) bank, upstream of the levee. This reach also functions as juvenile and adult migratory habitat for the four species listed above. Although side- and off-channel habitat does not currently exist in the project area because of past development, adjacent side- and off-channel habitat occurs naturally and is likely used by all four species. Given the known spawning and potential high use of the project area for rearing by Chinook, coho, and steelhead juveniles, The Elliott Reach of the Cedar River fits the "high" FFM definition of "aquatic sites that serve as migration or rearing areas of considerable importance for one or more species of juvenile salmon". Therefore, this project area has an FFM score of 0.8.

Bear Creek (excerpt from Section 6.11.2)

Bear Creek is a major producer of salmon in WRIA 8. Chinook, coho, and sockeye all spawn in Bear Creek upstream of the mitigation area. In the mitigation area, Bear Creek is used by salmonids as a migration and rearing corridor, but not for spawning. Given the high use of the project area for rearing by Chinook, and coho juveniles, Bear Creek fits the "high" FFM definition of "aquatic sites that serve as migration or rearing areas of considerable importance for one or more species of juvenile salmon". Therefore, Bear Creek has an FFM score of 0.8.

East Approach (excerpt from Section 6.12.2)

The site has been identified in the past as a sockeye spawning area based on historical WDFW map records (Kurt Buchanan, Biologist, WDFW, Olympia, WA, July 26, 2004, pers. comm.). This sockeye spawning area is one of more than 85 shoreline spawning areas identified in Lake Washington on maps provided by WDFW (Kurt Buchanan, Biologist, WDFW, Olympia, WA, July 26, 2004, pers. comm.). Therefore, this project area meets the 0.8 FFM criterion of being an "aquatic site that is known to support documented spawning of at least one salmonid species", and is assigned an FFM of 0.8.

Table D-2. Potential Value of Compensatory Mitigation Sites to Offset Temporary Impacts.

	Mitigation Action	Acreage	Fish Function Modifier	Fish Function Modified Acreage	Mitigation Type Modifier	Mitigation Type Modified Acreage	Duration (Years)	Proportion of Full Function	Mitigation Credit (Acre-Year)
Seward 1	Shoreline Enhancement + Hard Structure Removal	0.45	0.80	0.36	1.0	0.36	1	0.8	0.29
						0.36	17	1.0	6.12
	Riparian Restoration	0.38	0.80	0.30	0.2	0.06	5	0.1	0.03
						0.06	5	0.5	0.15
						0.06	8	1.0	0.49
								Subtotal	**7.08**
Seward 2	Spawning Gravel Supplementation	0.06	0.80	0.05	1.0	0.05	1	0.8	0.04
						0.05	17	1.0	0.82
								Subtotal	**0.85**
Seward 3	Shoreline Enhancement	0.18	0.60	0.11	1.0	0.11	1	0.8	0.09
						0.11	17	1.0	1.84
	Riparian Restoration	0.26	0.60	0.16	0.2	0.03	5	0.1	0.02
						0.03	5	0.5	0.08
						0.03	8	1.0	0.25
								Subtotal	**2.27**
Seward 4	Spawning Gravel Supplementation	1.36	0.80	1.09	1.0	1.09	1	0.8	0.87
						1.09	17	1.0	18.50
								Subtotal	**19.37**
Magnuson 1	Shoreline Enhancement + Hard Structure Removal	0.20	0.60	0.12	1.0	0.12	1	0.8	0.10
						0.12	17	1.0	2.04
	Riparian Restoration	0.36	0.60	0.22	0.2	0.04	5	0.1	0.02
						0.04	5	0.5	0.11
						0.04	8	1.0	0.35
								Subtotal	**2.61**
Magnuson 2	Shoreline Enhancement + Hard Structure Removal	0.14	0.60	0.08	1.0	0.08	1	0.8	0.07
						0.08	17	1.0	1.43
	Stream Creation	0.05	0.60	0.03	1.0	0.03	1	0.8	0.02
						0.03	17	1	0.51
	Riparian Restoration	0.80	0.6	0.48	0.2	0.10	5	0.1	0.05
						0.10	5	0.5	0.24
						0.10	8	1	0.77
								Subtotal	**3.09**
Taylor Creek	Channel Restoration	0.15	0.8	0.12	1.0	0.12	1	0.8	0.10
						0.12	17	1.0	2.04
	Delta Re-sloping	0.08	0.8	0.06	0.4	0.03	1	0.8	0.02
						0.03	17	1.0	0.44
	Riparian + Floodplain Restoration	0.74	0.8	0.59	0.4	0.24	5	0.1	0.12
						0.24	5	0.5	0.59

	Mitigation Action	Acreage	Fish Function Modifier	Fish Function Modified Acreage	Mitigation Type Modifier	Mitigation Type Modified Acreage	Duration (Years)	Proportion of Full Function	Mitigation Credit (Acre-Year)
						0.24	8	1.0	1.89
								Subtotal	**5.20**
South Lake Washington Shoreline Restoration (DNR Parcel)	Shoreline Enhancement + Hard Structure Removal	1.94	0.8	1.55	1	1.55	1	0.8	1.24
						1.55	17	1.0	26.38
	Riparian Restoration	1.6	0.8	1.28	0.2	0.26	5	0.1	0.13
						0.26	5	0.5	0.64
						0.26	8	1.0	2.05
	Riparian Restoration- Shrubs	0.44	0.8	0.35	0.1	0.04	5	0.1	0.02
						0.04	5	0.5	0.09
						0.04	8	1.0	0.28
								Subtotal	**30.83**
Cedar River/ Elliott Bridge	River Margin and Aquatic Off-channel Creation	0.61	0.8	0.49	1	0.49	1	0.8	0.39
						0.49	17	1.0	8.30
	Riparian + Floodplain Restoration	3.55	0.8	2.84	0.4	1.1	5	0.1	0.57
						1.1	5	0.5	2.84
						1.1	8	1.0	9.09
								Subtotal	**21.18**
Bear Creek	Stream Enhancement	3.16	0.8	2.53	1	2.53	1	0.8	2.02
						2.53	17	1.0	42.98
	Riparian Restoration	12.62	0.8	10.10	0.2	2.02	5	0.1	1.01
						2.02	5	0.5	5.05
						2.02	8	1.0	16.15
								Subtotal	**67.21**
East Approach Gravel Supplementation	Spawning Gravel Supplementation + Shoreline Enhancement + hard Structure Removal	0.83	0.8	0.664	1	0.66	1	0.8	0.53
						0.66	17	1.0	11.29
	Riparian Restoration	0.06	0.8	0.048	0.2	0.01	5	0.1	0.00
						0.01	5	0.5	0.02
						0.01	8	1.0	0.08
								Subtotal	**11.92**
					Total Potential Permanent Mitigation				**171.60**

Table D-3. Potential Value of Compensatory Mitigation Sites to Offset Permanent Impacts.

	Mitigation Action	Acreage	Fish Function Modifier	Fish Function Modified Acreage	Mitigation Type Modifier	Mitigation Credit (acres)
Seward 1	Shoreline Enhancement + Hard Structure Removal	0.45	0.8	0.4	1.00	0.36
	Riparian Restoration	0.38	0.8	0.3	0.20	0.06
					Subtotal	**0.42**
Seward 2	Spawning Gravel Supplementation	0.06	0.8	0.05	1.00	0.05
					Subtotal	**0.05**
Seward 3	Shoreline Enhancement	0.18	0.6	0.11	1.00	0.11
	Riparian Restoration	0.26	0.6	0.16	0.20	0.03
					Subtotal	**0.14**
Seward 4	Spawning Gravel Supplementation	1.36	0.8	1.1	1.00	1.09
					Subtotal	**1.09**
Magnuson 1	Shoreline Enhancement + Hard Structure Removal	0.2	0.6	0.12	1.00	0.12
	Riparian Restoration	0.36	0.6	0.22	0.20	0.04
					Subtotal	**0.16**
Magnuson 2	Shoreline Enhancement + Hard Structure Removal	0.14	0.6	0.08	1.00	0.08
	Stream Channel	0.05	0.6	0.03	1.00	0.03
	Riparian Restoration	0.80	0.6	0.48	0.20	0.10
					Subtotal	**0.21**
Taylor Creek	Channel Restoration	0.15	0.8	0.12	1.0	0.12
	Delta Re-Sloping	0.08	0.8	0.06	0.40	0.03
	Riparian + Floodplain Restoration	0.74	0.8	0.59	0.40	0.24
					Total	**0.38**
South Lake Washington Shoreline Restoration (DNR Parcel)	Shoreline Enhancement + Hard Structure Removal	1.93	0.8	1.54	1.00	1.54
	Riparian Restoration	1.6	0.8	1.28	0.20	0.26
	Riparian Restoration- Shrubs	0.44	0.8	0.35	0.10	0.04
	Remove 3 Dolphins (7 creosote piles per dolphin)	0.01	0.8	0.01	1.0	0.01
					Total	**1.84**
Cedar River/ Elliott Bridge	River Margin and Aquatic Off-channel Creation	0.61	0.8	0.49	1.0	0.49
	Riparian + Floodplain Restoration	3.55	0.8	2.84	0.40	1.14
					Subtotal	**1.62**
Bear Creek	Stream Enhancement	3.16	0.8	2.53	1.00	2.5
	Riparian Restoration	12.62	0.8	10.10	0.20	2.0
					Subtotal	**4.55**
East Approach Gravel Supplementation	Spawning Gravel Supplementation	0.75	0.8	0.60	1	0.60
	Shoreline Enhancement + Hard Structure Removal	0.08	0.8	0.06	0.2	0.01
	Riparian Restoration	0.06	0.8	0.05	0.2	0.01
					Subtotal	**0.60**
		Total Potential Permanent Mitigation				**11.07**

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