

Water Resources Discipline Report

SR 520: I-5 to Medina Bridge
Replacement and HOV Project
Supplemental Draft EIS

**Water Resources
Discipline Report**



Prepared for
Washington State Department of Transportation
Federal Highway Administration

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Contents

| | |
|---|------------|
| Acronyms and Abbreviations | vii |
| Introduction | 1 |
| What are water resources? | 1 |
| Why are water resources considered in an environmental impact statement? | 2 |
| What are the key points of this report? | 2 |
| What is the I-5 to Medina: Bridge Replacement and HOV Project? | 7 |
| What are the project alternatives? | 8 |
| Affected Environment | 19 |
| How was the information collected? | 19 |
| What are the existing water resource characteristics of the study area? | 37 |
| Potential Effects of the Project | 65 |
| What methods were used to evaluate the potential effects? | 65 |
| How would construction of the project affect water resources? | 66 |
| How would construction of the project affect groundwater? | 70 |
| How would operation of the project affect water resources?..... | 72 |
| Comparison of Effects for All Three Options | 77 |
| How would operation of the project affect groundwater? | 77 |
| Mitigation | 79 |
| What has been done to avoid or minimize negative effects on surface water? | 79 |
| What has been done to avoid or minimize negative effects to groundwater? | 80 |
| How could the project compensate for unavoidable negative effects to groundwater? | 80 |
| How could the project compensate for unavoidable adverse effects? | 80 |
| References | 81 |

Attachments

- 1 Description of Puget Sound Area Aquifers

List of Exhibits

- 1 Jurisdictions and Their Policies that Regulate and Manage Surface Water in the Study Area
- 2 Ecology’s Policies and Regulations for Groundwater Management in the Study Area
- 3 Project Vicinity Map
- 4 No Build Alternative Cross Section
- 5 6-Lane Alternative Cross Section



- 6 Option A, K and L: Montlake and University of Washington Areas
- 7 6-Lane Alternative at the Evergreen Point Bridge (Common to All Options)
- 8 Possible Towing Route and Pontoon Outfitting Locations
- 9 Geographic Areas along SR 520 and Project Phasing
- 10 Pathways for Water Moving through the Study Area
- 11 Location of Affected Basins within WRIA 8
- 12 Land Cover within and around WRIA 8
- 13 Lake Washington Ship Canal
- 14 Affected Basins Located in the Study Area
- 15 Study Area Groundwater Resources
- 16 Study Area Surficial Geology and Associated Aquifers
- 17 Current Study Area Creeks, Stormwater Outfalls, Culverts, and Basin Boundaries
- 18 How Ecology's Stormwater Regulations Apply to Road Projects
- 19 Stormwater Treatment and Flow Control Requirements for Study Area Threshold Discharge Areas
- 20 Threshold Discharge Areas 7 to 14 for the Study Area
- 21 Steps Involved in Applying the Presumptive and Demonstrative Approaches for the Proposed Project
- 22 Proposed Stormwater Management Facility Characteristics
- 23 Proposed Stormwater Management Facilities (Option A)
- 24 Proposed Stormwater Management Facilities (Option K)
- 25 Proposed Stormwater Management Facilities (Option L)
- 26 Schematic Section View of Floating Bridge Showing Stormwater Lagoons and Mixing Zone Boundaries
- 27 Schematic Representation of Stormwater Mixing Processes for Floating Bridge
- 28 Project Pollutant-generating Impervious Surface Examples
- 29 Pollutant-generating Impervious Surface (acres)



- 30 Net Changes in Pollutant Loads Between Pre- and Post-project Conditions (pounds)
- 31 Effluent Concentrations of Dissolved Metals at Specific Locations on the Floating Bridge



Acronyms and Abbreviations

| | |
|----------------|--|
| AKART | All Known, Available, and Reasonable methods of prevention, control, and Treatment |
| BMP | best management practice |
| CFR | Code of Federal Regulations |
| CSO | combined sewer overflow |
| Draft EIS | draft environmental impact statement |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| GIS | geographic information system |
| HOV | high-occupancy vehicle |
| HRM | Highway Runoff Manual |
| I-5 | Interstate 5 |
| mg/L | milligrams per liter |
| N/A | not applicable |
| NOAA Fisheries | National Oceanic and Atmospheric Administration, National Marine Fisheries Service |
| NPDES | National Pollutant Discharge Elimination System |
| NTU | nephelometric turbidity unit |
| PAH | polycyclic aromatic hydrocarbon |
| PGIS | pollutant-generating impervious surface |
| RCW | Revised Code of Washington |
| SDEIS | supplemental draft environmental impact statement |
| SPCC | spill prevention control and countermeasures |
| SPUI | single-point urban interchange |
| SR | State Route |
| SSP | supplemental stability pontoon |



| | |
|-------|---|
| TDA | Threshold Discharge Area |
| TESC | temporary erosion and sediment control |
| TSS | total suspended solids |
| WAC | Washington Administrative Code |
| WRIA | water resource inventory area |
| WSDOT | Washington State Department of Transportation |



Introduction

What are water resources?

This discipline report uses the phrase “water resources” to refer collectively to surface water bodies (for example, lakes, rivers, and streams), stormwater, and groundwater. The report discusses the existing surface water bodies and the project’s stormwater treatment facilities, as well as the existing groundwater and project effects on groundwater.

The Clean Water Act (33 United States Code 1251 et seq.) is the cornerstone of legislation protecting water resources in the United States (U.S. EPA 2004a). Passed in 1972, the Clean Water Act responded to widespread public concern about controlling water pollution and protecting America’s water bodies (U.S. EPA 2004b). The goal of the Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of the nation’s waters (U.S. EPA 2004a).

The United States Environmental Protection Agency (EPA) is the federal agency responsible for implementing and enforcing the Clean Water Act. In most cases, however, EPA has delegated its authority and implementation duties to state agencies. In Washington, EPA has authorized the Washington State Department of Ecology (Ecology) to regulate discharges to the state’s water resources. Ecology has adopted laws that regulate the concentrations of toxic substances allowed in stormwater and surface water bodies and has developed manuals detailing approved stormwater treatment and detention procedures. Ecology administers the National Pollutant Discharge Elimination System (NPDES) permit program, as well as other permit programs related to water quality (such as the Pretreatment and General Permits programs). In addition to the state, the counties and incorporated cities have jurisdiction over water resources, wetlands, and other critical areas in the project vicinity.

The Washington Department of Fish and Wildlife, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA Fisheries), and the U.S. Fish and Wildlife Service also have jurisdiction over water quality as it applies to protecting wetlands and fish and wildlife resources. Regulations related to wetlands and fish

What are “water resources”?

As used in this report, the phrase “water resources” refers collectively to surface water bodies (for example lakes, rivers, and streams), stormwater, and groundwater. When the issue being considered applies to only one element, the water resource analyst will use the terms “surface water bodies,” “stormwater,” or “groundwater” to identify the specific resource being discussed.

Surface water bodies include lakes, streams, ponds, and wetlands.

Stormwater includes stormwater runoff, snow melt runoff, surface runoff, and drainage (40 CFR 122.26(b)[13]). Drainage can flow across the ground in open ditches, in pipes, or below the surface as interflow.

Groundwater is water found underground in the saturated zone, which is the layer of soil that is soaked or loaded to capacity with water.



and wildlife resources are discussed in the Ecosystems Discipline Report (WSDOT 2009a).

Exhibit 1 lists the jurisdictions responsible for protecting surface water resources, describes the policies and regulations these agencies follow, and explains the purpose of the policies under all design options (the 6-Lane Alternative would provide an overall benefit to water resources compared with the No Build Alternative). Groundwater regulations are discussed in Exhibit 2.

The Clean Water Act establishes the basic structure for regulating pollutant discharges to groundwater. As previously described, EPA has authorized Ecology to enforce and implement the Clean Water Act. Ecology has developed regulations, water quality standards, programs, and guidelines to protect groundwater and allow its use for drinking, irrigation, and manufacturing and commercial uses, as shown in Exhibit 2. Groundwater resources are studied as part of this supplemental draft environmental impact statement (SDEIS) to determine if drinking water resources would be affected by the project and if the project or construction activities would affect the quantity of groundwater located in the study area.

Why are water resources considered in an environmental impact statement?

Water resources are evaluated in this environmental impact statement because of their importance in maintaining the animals and plants of the ecosystems of Washington and the environment in which we live, as well as our need for clean, drinkable water to support our individual health and economy. After more than a century of dramatic population growth and climate change, we now realize that water resources are not unlimited and are not free.

What are the key points of this report?

Surface Water Resources

The proposed design options and potential effects on surface water resources evaluated as part of this project are summarized below:

- All design options would meet water quantity and quality regulations.



Exhibit 1. Jurisdictions and Their Policies that Regulate and Manage Surface Water in the Study Area

| Jurisdiction | Regulations | Purpose/Intent |
|---|--|---|
| U.S. Army Corps of Engineers | Clean Water Act (33 CFR Part 320) | Establishes jurisdictional waters for the regulation of discharges of dredged or fill material into waters of the United States. |
| Washington State Department of Ecology | Clean Water Act (33 United States Code 1251 et seq.) | Establishes the basic structure for regulating discharges of pollutants to receiving waters. |
| | Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201a-240) | Sets goals for a water body by designating beneficial uses and assigning water quality criteria to protect those uses. |
| | <i>Stormwater Management Manual for Western Washington</i> (Ecology 2005) | Provides technical standards and guidance on stormwater management measures to control quantity and quality of stormwater produced by new development and redevelopment. |
| Washington State Department of Transportation | Puget Sound Highway Runoff Program (WAC 173-270) | Establishes procedures and water quality criteria for WSDOT's highway runoff program. |
| | <i>Highway Runoff Manual</i> (WSDOT 2008a) | Directs the planning and design of stormwater management facilities for new and redeveloped Washington state highways and other facilities. Directs the planning and design of stormwater control measures during construction. WSDOT's <i>Highway Runoff Manual</i> is considered equivalent to Ecology's <i>Stormwater Management Manual for Western Washington</i> . |
| | <i>Environmental Procedures Manual</i> (WSDOT 2008b) | Provides guidelines for complying with federal and state environmental laws and regulations for all phases of project delivery. |
| City of Seattle | Standard Plans and Specifications | The 2008 Standard Plans and Specifications apply whenever any public or private construction is performed within the rights of way of the City of Seattle. |
| Cities of Seattle, Medina, and Hunts Point | City and county critical or sensitive area ordinances that establish allowed uses, mitigation standards, and buffers for streams and lakes | Establishes policies and development guidelines to protect the functions and values of critical areas. All cities and counties in Washington are required by the Growth Management Act to adopt critical area regulations (RCW 36.70A.060). |
| Cities of Seattle, Medina, and Hunts Point | City and county shoreline management programs that establish allowed uses and buffer and/or setback requirements for regulated waterways | City and County Shoreline master programs that establish allowed uses, buffers, setback requirements, and mitigation requirements for regulated waterways. All cities and counties in Washington are required by the Shoreline Management Act to enact shoreline management programs (RCW 90.58). |



Exhibit 2. Ecology's Policies and Regulations for Groundwater Management in the Study Area

| Agency/ Organization | Policies/Regulations | Role |
|-------------------------|---|---|
| Ecology | EPA water pollution control regulations (Section 431.02 of the Clean Water Act and corresponding State of Washington regulations) | Establishes the basic structure for regulating discharges of pollutants to groundwater. |
| | Water Quality Standards for Groundwaters of the State of Washington (WAC 173-200) | Establishes maximum contaminant concentrations for the protection of a variety of beneficial uses of Washington's groundwater. |
| | Washington Groundwater Management Areas (WAC 173-100) | Establishes procedures to designate groundwater management areas and procedures for developing groundwater management programs to protect groundwater quality. |
| | Washington Well Head Protection (WAC 246-290) | Establishes the boundaries for each well, well field, or spring with 6-month and 1-, 5-, and 10-year travel times; plans to identify potential groundwater contamination and contingency sources of drinking water for users of this water. |
| | Washington Underground Injection Control Program (WAC 173-218) | Protects groundwater quality by regulating the disposal of fluids into the subsurface. |
| | Washington water rights regulations (various) | Establishes a permitting process to allow applicants to apply water to a specific beneficial use. |
| Local cities | Local Critical Aquifer Recharge Area ordinances | Provides local governments with a mechanism to classify, designate, and regulate areas deemed necessary to provide adequate recharge and protection for aquifers used as sources of potable (drinking) water. |

- Stormwater would be discharged without treatment or flow control under the No Build Alternative scenarios, either maintaining existing conditions or further degrading surface water bodies. Conversely, stormwater would be treated and flows would be controlled (as required by Ecology to protect small streams in the Fairweather Creek basin only) for the 6-Lane Alternative.
- The proposed 6-Lane Alternative would increase the amount of land covered by pollutant-generating impervious surfaces in the WSDOT study area (Option A – 35 percent increase, Option K – 45 percent increase, and Option L – 44 percent increase). By applying stormwater treatment in the designs, however, this alternative would meet state and federal water quality regulations and would provide more water quality treatment than is required for



stormwater under the specific conditions of WSDOT's *Highway Runoff Manual* (HRM) for several sections of this project.

- In general, the 6-Lane Alternative would reduce pollutant-loading compared with existing levels because stormwater would be treated before discharge. Although pollutant-loading would be reduced overall in the study area, the 6-Lane Alternative would add more of some kinds of pollutants (for example, dissolved copper and zinc) in specific subbasins than the No Build Alternative. Because Ecology does not require flow control for Lake Union, Portage Bay, Lake Washington Ship Canal, Union Bay, or Lake Washington, flow control would not be included in the treatment facilities discharging treated stormwater to these water bodies. These water bodies are exempt from flow control requirements because Ecology has determined that discharge flow rates would not adversely affect their physical characteristics.
- Temporary water quality effects during construction of the 6-Lane Alternative would be avoided or minimized by developing and implementing required erosion control plans, spill control plans, and NPDES construction permit conditions. These plans and permits regulate construction activities on land and in the water to prevent or reduce water quality effects.
- Installing bridge anchors and piers during construction could temporarily disrupt lake-bottom sediments and the organisms living in them. These sediments and organisms would be displaced due to the use of hydrojets (which loosen sediments for anchor placement using high-pressure hoses, for which no construction best management practices [BMPs] are available), and organisms living in these sediments might die. These effects would be localized, however, and these organisms would reestablish communities quickly. Water quality near the in-water construction activities could become turbid (cloudy), although the water would not likely become turbid enough to reduce lake productivity or directly harm fish and invertebrates.
- Effects on water quality would not differ for any of the alternatives or options under the Phased Implementation scenario. Regardless of when a section of the proposed project is constructed, all proposed stormwater treatment facilities for that section would be in place and operational. Therefore, operation of the all newly constructed and replaced pollutant-generating impervious surfaces



would be treated prior to discharge in accordance with the descriptions provided in this analysis and would not vary with phased construction.

Groundwater Resources

The overall effects from groundwater resources based on the project's proposed design options are summarized as follows:

- Overall, permanent effects on groundwater from the proposed project would be negligible. While the 6-Lane Alternative would increase pollutant-generating impervious surfaces in the study area, this increase would not cause a detectable change to groundwater recharge. The increased impervious surface associated with the 6-Lane Alternative would have minimal or no effect on groundwater recharge because increases would only be a fraction of the total recharge area of the groundwater system.
- Effects on groundwater used for drinking purposes would be negligible because there is very limited use of groundwater for drinking water in the study area.
- Groundwater levels in some areas may need to be temporarily lowered by dewatering during construction so some of the structures can be built in dry conditions. This dewatering could temporarily alter the groundwater flow direction or the volume of groundwater discharge to surface water; however, these effects would be temporary and localized.
- Water generated by dewatering would be stored to allow particles to settle, or chemical flocculants (chemicals that promote flocculation by causing colloids and other suspended particles in liquids to aggregate, forming a floc) could be used to reduce suspended particles before the water is discharged to the stormwater system. Alternatively, this water could be discharged to the sanitary sewer system.
- There would be no need to further mitigate or compensate for long-term project effects because all regulatory requirements to address negative effects are included in the designs of the 6-Lane Alternative.
- Construction effects would be avoided or minimized by implementing required erosion control plans and spill control plans and by meeting established permit conditions.



What is the I-5 to Medina: Bridge Replacement and HOV Project?

The Interstate 5 (I-5) to Medina: Bridge Replacement and High-Occupancy Vehicle (HOV) Project is part of the State Route (SR) 520 Bridge Replacement and HOV Program (SR 520 Program) (detailed in the text box below) and encompasses parts of three main geographic areas—Seattle, Lake Washington, and the Eastside. The project area includes the following:

- Seattle communities: Portage Bay/Roanoke, North Capitol Hill, Montlake, University District, Laurelhurst, and Madison Park
- Eastside communities: Medina, Hunts Point, Clyde Hill, and Yarrow Point
- The Lake Washington ecosystem and associated wetlands
- Usual and accustomed fishing areas of tribal nations that have historically used the area’s aquatic resources and have treaty rights

The SR 520 Bridge Replacement and HOV Project Draft Environmental Impact Statement (EIS), published in August 2006, evaluated a 4-Lane Alternative, a 6-Lane Alternative, and a No Build Alternative. Since the Draft EIS was published, circumstances surrounding the SR 520 corridor have changed in several ways. These changes have resulted in decisions to forward advance planning for potential catastrophic failure of the Evergreen Point Bridge, respond to increased demand for transit

What is the SR 520 Program?

The **SR 520 Bridge Replacement and HOV Program** will enhance safety by replacing the aging floating bridge and keep the region moving with vital transit and roadway improvements throughout the corridor. The 12.8-mile program area begins at I-5 in Seattle and extends to SR 202 in Redmond.

In 2006, WSDOT prepared a Draft EIS—published formally as the **SR 520 Bridge Replacement and HOV Project**—that addressed corridor construction from the I-5 interchange in Seattle to just west of I-405 in Bellevue. Growing transit demand on the Eastside and structure vulnerability in Seattle and Lake Washington, however, led WSDOT to identify new projects, each with a separate purpose and need, that would provide benefit even if the others were not built. These four independent projects were identified after the Draft EIS was published in 2006, and these now fall under the umbrella of the entire **SR 520 Bridge Replacement and HOV Program**:

- **I-5 to Medina: Bridge Replacement and HOV Project** replaces the SR 520 roadway, floating bridge approaches, and floating bridge between I-5 and the eastern shore of Lake Washington. This project spans 5.2 miles of the SR 520 corridor.
- **Medina to SR 202: Eastside Transit and HOV Project** completes and improves the transit and HOV system from Evergreen Point Road to the SR 202 interchange in Redmond. This project spans 8.6 miles of the SR 520 corridor.
- **Pontoon Construction Project** involves constructing the pontoons needed to restore the Evergreen Point Bridge in the event of a catastrophic failure and storing those pontoons until needed.
- **Lake Washington Congestion Management Project**, through a grant from the U.S. Department of Transportation, improves traffic using tolling, technology and traffic management, transit, and telecommuting.



service on the Eastside, and evaluate a new set of community-based designs for the Montlake area in Seattle.

To respond to these changes, the Washington State Department of Transportation (WSDOT) and the Federal Highway Administration (FHWA) initiated new projects to be evaluated in separate environmental documents. Improvements to the western portion of the SR 520 corridor – known as the I-5 to Medina: Bridge Replacement and HOV Project (the *I-5 to Medina project*) – are being evaluated in a Supplemental Draft EIS (SDEIS); this discipline report is a part of that SDEIS. Project limits for this project extend from I-5 in Seattle to 92nd Avenue NE in Yarrow Point, where it transitions into the Medina to SR 202: Eastside Transit and HOV Project (the *Medina to SR 202 project*). Exhibit 3 shows the project vicinity.



Exhibit 3. Project Vicinity Map

What are the project alternatives?

As noted above, the Draft EIS evaluated a 4-Lane Alternative, a 6-Lane Alternative (including three design options in Seattle), and a No Build Alternative. In 2006, following Draft EIS publication, Governor Gregoire identified the 6-Lane Alternative as the state’s preference for the SR 520 corridor, but urged that the affected communities in Seattle develop a common vision for the western portion of the corridor. Accordingly, a mediation group convened at the direction of the state legislature to evaluate the corridor alignment for SR 520 through Seattle. The mediation group identified three 6-lane design options for SR 520 between I-5 and the floating span of the Evergreen Point Bridge; these options were documented in a Project Impact Plan (Parametrix 2008). The SDEIS evaluates the following:

- No Build Alternative
- 6-Lane Alternative
 - Option A
 - Option K
 - Option L

These alternatives and options are summarized below. The 4-Lane Alternative and the Draft EIS 6-lane design options have been eliminated from further consideration. More information on how the



project has evolved since the Draft EIS was published in 2006, as well as more detailed information on the design options, is provided in the Description of Alternatives Discipline Report (WSDOT 2009b).

What is the No Build Alternative?

Under the No Build Alternative, SR 520 would continue to operate between I-5 and Medina as it does today: as a 4-lane highway with nonstandard shoulders and without a bicycle/pedestrian path. (Exhibit 4 depicts a cross section of the No Build Alternative.) No new facilities would be added to SR 520

between I-5 and Medina, and none would be removed, including the unused R.H. Thomson Expressway ramps near the Washington Park Arboretum. WSDOT would continue to manage traffic using its existing transportation demand management and intelligent transportation system strategies.

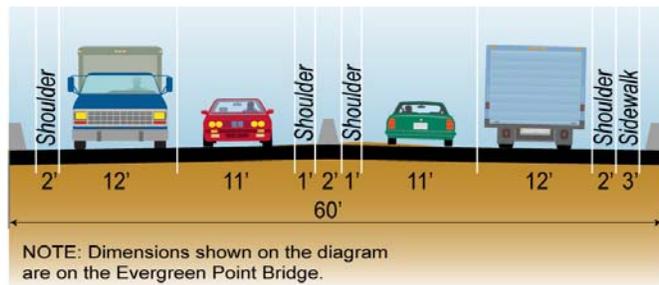


Exhibit 4. No Build Alternative Cross Section

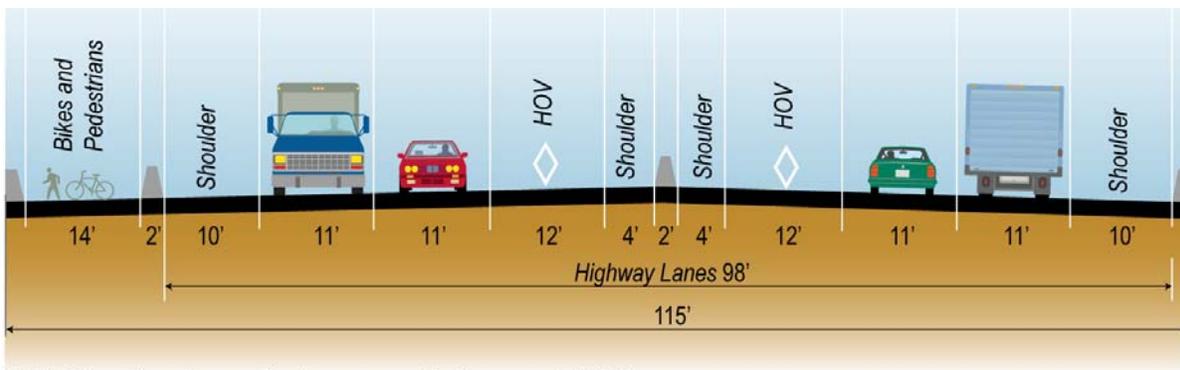
The No Build Alternative assumes that the Portage Bay and Evergreen Point bridges would remain standing and functional through 2030 and that no catastrophic events, such as earthquakes or extreme storms, would cause major damage to the bridges. The No Build Alternative also assumes completion of the Medina to SR 202 project as well as other regionally planned and programmed transportation projects. The No Build Alternative provides a baseline against which project analysts can measure and compare the effects of each 6-Lane Alternative build option.

What is the 6-Lane Alternative?

The 6-Lane Alternative would complete the regional HOV connection (3+ HOV occupancy) across SR 520. This alternative would include six lanes (two 11-foot-wide outer general-purpose lanes and one 12-foot-wide inside HOV lane in each direction), with 4-foot-wide inside and 10-foot-wide outside shoulders (Exhibit 5). The proposed width of the roadway would be approximately 18 feet narrower than the one described in the Draft EIS, reflecting public comment from local communities and the City of Seattle.

SR 520 would be rebuilt from I-5 to Evergreen Point Road in Medina and restriped and reconfigured from Evergreen Point Road to 92nd Avenue NE in Yarrow Point. A 14-foot-wide bicycle/pedestrian path





NOTE: Dimensions shown on the diagram are on the Evergreen Point Bridge.

Exhibit 5. 6-Lane Alternative Cross Section

would be built along the north side of SR 520 through the Montlake area and across the Evergreen Point Bridge, connecting to the regional path on the Eastside. A bridge maintenance facility and dock would be built underneath the east approach to the Evergreen Point Bridge.

The sections below describe the 6-Lane Alternative and design options in each of the three geographical areas the project would encompass.

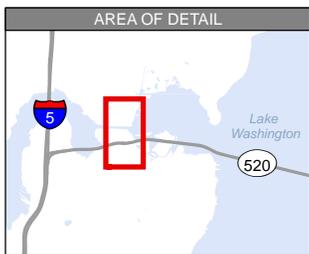
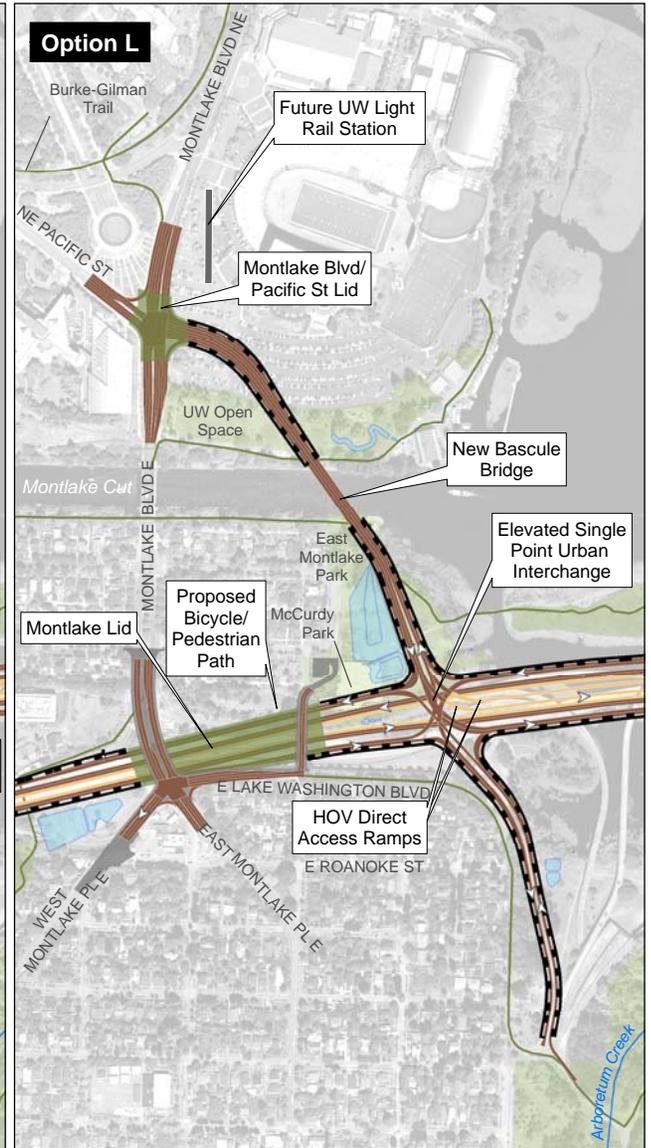
Seattle

Elements Common to the 6-Lane Alternative Options

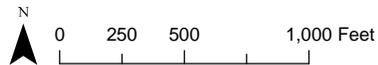
SR 520 would connect to I-5 in a configuration similar to the way it connects today. Improvements to the I-5/SR 520 interchange would include a new reversible HOV ramp connecting the new SR 520 HOV lanes to existing I-5 reversible express lanes. WSDOT would replace the Portage Bay Bridge and the Evergreen Point Bridge (including the west approach and floating span), as well as the existing local street bridges across SR 520. New stormwater facilities would be constructed for the project to provide stormwater retention and treatment. The project would include landscaped lids across SR 520 at I-5, 10th Avenue East and Delmar Drive East, and in the Montlake area to help reconnect the communities on either side of the roadway. The project would also remove the Montlake freeway transit station.

The most substantial differences among the three options are the interchange configurations in the Montlake and University of Washington areas. Exhibit 6 depicts these key differences in interchange configurations, and the following text describes elements unique to each option.





- Potential Sound Wall
- Existing Regional Bicycle/Pedestrian Path
- Tunnel
- Lid or Landscape Feature
- Proposed Bicycle/Pedestrian Path
- Stormwater Facility
- General-Purpose Lane
- HOV, Direct Access, and/or Transit-Only Lane
- Future UW Light Rail Station
- Park



Source: King County (2006) Aerial Photo, King County (2005) GIS Data (Streams), City of Seattle (1994) GIS Data (Bike/Ped Trail), Seattle Bicycle Map (2008) GIS Data (Bike/Ped Trail) CH2M HILL (2008) GIS Data (Park). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.



Exhibit 6. Options A, K, and L: Montlake and University of Washington Areas

I-5 to Medina: Bridge Replacement and HOV Project

Option A

Option A would replace the Portage Bay Bridge with a new bridge that would include six lanes (four general-purpose lanes, two HOV lanes) plus a westbound auxiliary lane. WSDOT would replace the existing interchange at Montlake Boulevard East with a new, similarly configured interchange that would include a transit-only off-ramp from westbound SR 520 to northbound Montlake Boulevard. The Lake Washington Boulevard ramps and the median freeway transit stop near Montlake Boulevard East would be removed, and a new bascule bridge (i.e., drawbridge) would be added to Montlake Boulevard NE, parallel to the existing Montlake Bridge. SR 520 would maintain a low profile through the Washington Park Arboretum and flatten out east of Foster Island, before rising to the west transition span of the Evergreen Point Bridge. Citizen recommendations made during the mediation process defined this option to include sound walls and/or quieter pavement, subject to neighborhood approval and WSDOT's reasonability and feasibility determinations.

Suboptions for Option A would include adding an eastbound SR 520 on-ramp and a westbound SR 520 off-ramp to Lake Washington Boulevard, creating an intersection similar to the one that exists today but relocated northwest of its current location. The suboption would also include adding an eastbound direct access on-ramp for transit and HOV from Montlake Boulevard East, and providing a constant slope profile from 24th Avenue East to the west transition span.

Option K

Option K would also replace the Portage Bay Bridge, but the new bridge would include four general-purpose lanes and two HOV lanes with no westbound auxiliary lane. In the Montlake area, Option K

Is it a highrise or a transition span?



A transition span is a bridge span that connects the fixed approach bridge to the floating portion of the bridge. The Evergreen Point Bridge has two transition spans, one at the west end of the floating bridge transitioning traffic on and off of the west approach, and one on the east end of the floating bridge transitioning traffic on and off of the east approach. These spans are often referred to as the "west highrise" (shown) and the "east highrise" during the daily traffic report, and the west highrise even has a traffic camera mounted on it.

Today's highrises have two characteristics—large overhead steel trusses and navigation channels below the spans where boat traffic can pass underneath the Evergreen Point Bridge. The new design for the floating bridge would not include overhead steel trusses on the transition spans, which would change the visual character of the highrise. For the SDEIS, highrise and transition span are often used interchangeably to refer to the area along the bridge where the east and west approach bridges transition to the floating bridge.



would remove the existing Montlake Boulevard East interchange and the Lake Washington Boulevard ramps and replace their functions with a depressed, single-point urban interchange (SPUI) at the Montlake shoreline. Two HOV direct-access ramps would serve the new interchange, and a tunnel under the Montlake Cut would move traffic from the new interchange north to the intersection of Montlake Boulevard NE and NE Pacific Street. SR 520 would maintain a low profile through Union Bay, make landfall at Foster Island, and remain flat before rising to the west transition span of the Evergreen Point Bridge. A land bridge would be constructed over SR 520 at Foster Island. Citizen recommendations made during the mediation process defined this option to include only quieter pavement for noise abatement, rather than the sound walls that were included in the 2006 Draft EIS. However, because quieter pavement has not been demonstrated to meet all FHWA and WSDOT avoidance and minimization requirements in tests performed in Washington State, it cannot be considered as noise mitigation under WSDOT and FHWA criteria. As a result, sound walls could be included in Option K. The decision to build sound walls depends on neighborhood interest, the findings of the Noise Discipline Report (WSDOT 2009c), and WSDOT's reasonability and feasibility determinations.

A suboption for Option K would include constructing an eastbound off-ramp to Montlake Boulevard East configured for right turns only.

Option L

Under Option L, the Montlake Boulevard East interchange and the Lake Washington Boulevard ramps would be replaced with a new, elevated SPUI at the Montlake shoreline. A bascule bridge (drawbridge) would span the east end of the Montlake Cut, from the new interchange to the intersection of Montlake Boulevard NE and NE Pacific Street. This option would also include a ramp connection to Lake Washington Boulevard and two HOV direct-access ramps providing service to and from the new interchange. SR 520 would maintain a low, constant slope profile from 24th Avenue East to just west of the west transition span of the floating bridge. Noise mitigation identified for this option would include sound walls as defined in the Draft EIS.

Suboptions for Option L would include adding a left-turn movement from Lake Washington Boulevard for direct access to SR 520 and adding capacity on northbound Montlake Boulevard NE to NE 45th Street.



Lake Washington

Floating Bridge

The floating span would be located approximately 190 feet north of the existing bridge at the west end and 160 feet north at the east end (Exhibit 7). Rows of three 10-foot-tall concrete columns would support the roadway above the pontoons, and the new spans would be approximately 22 feet higher than the existing bridge. A 14-foot-wide bicycle/pedestrian path would be located on the north side of the bridge.

The design for the new 6-lane floating bridge includes 21 longitudinal pontoons, two cross pontoons, and 54 supplemental stability pontoons. A single row of 75-foot-wide by 360-foot-long longitudinal pontoons would support the new floating bridge. One 240-foot-long by 75-foot-wide cross-pontoon at each end of the bridge would be set perpendicularly to the longitudinal pontoons. The longitudinal pontoons would be bolstered by the smaller supplemental stability pontoons on each side for stability and buoyancy. The longitudinal pontoons would not be sized to carry future high-capacity transit (HCT), but would be equipped with connections for additional supplemental stability pontoons to support HCT in the future. As with the existing floating bridge, the floating pontoons for the new bridge would be anchored to the lake bottom to hold the bridge in place.

Near the east approach bridge, the roadway would be widened to accommodate transit ramps to the Evergreen Point Road transit stop. Exhibit 7 shows the alignment of the floating bridge, the west and east approaches, and the connection to the east shore of Lake Washington.

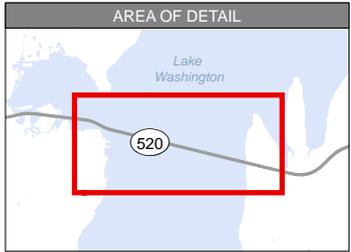
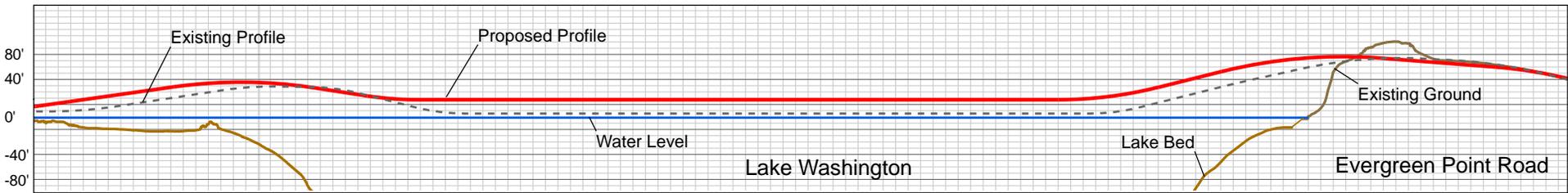
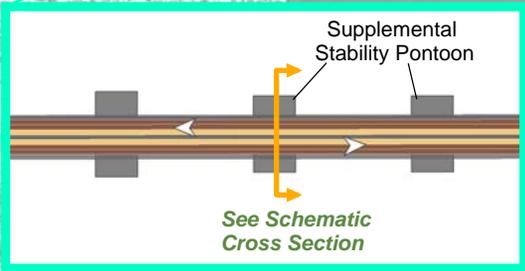
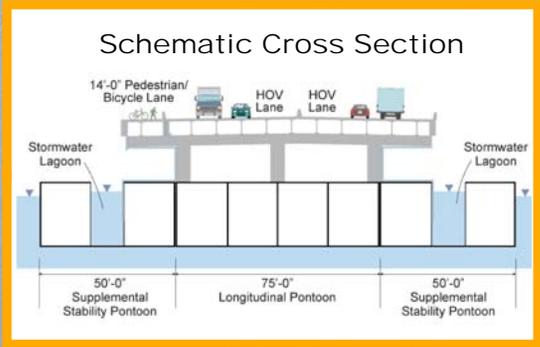
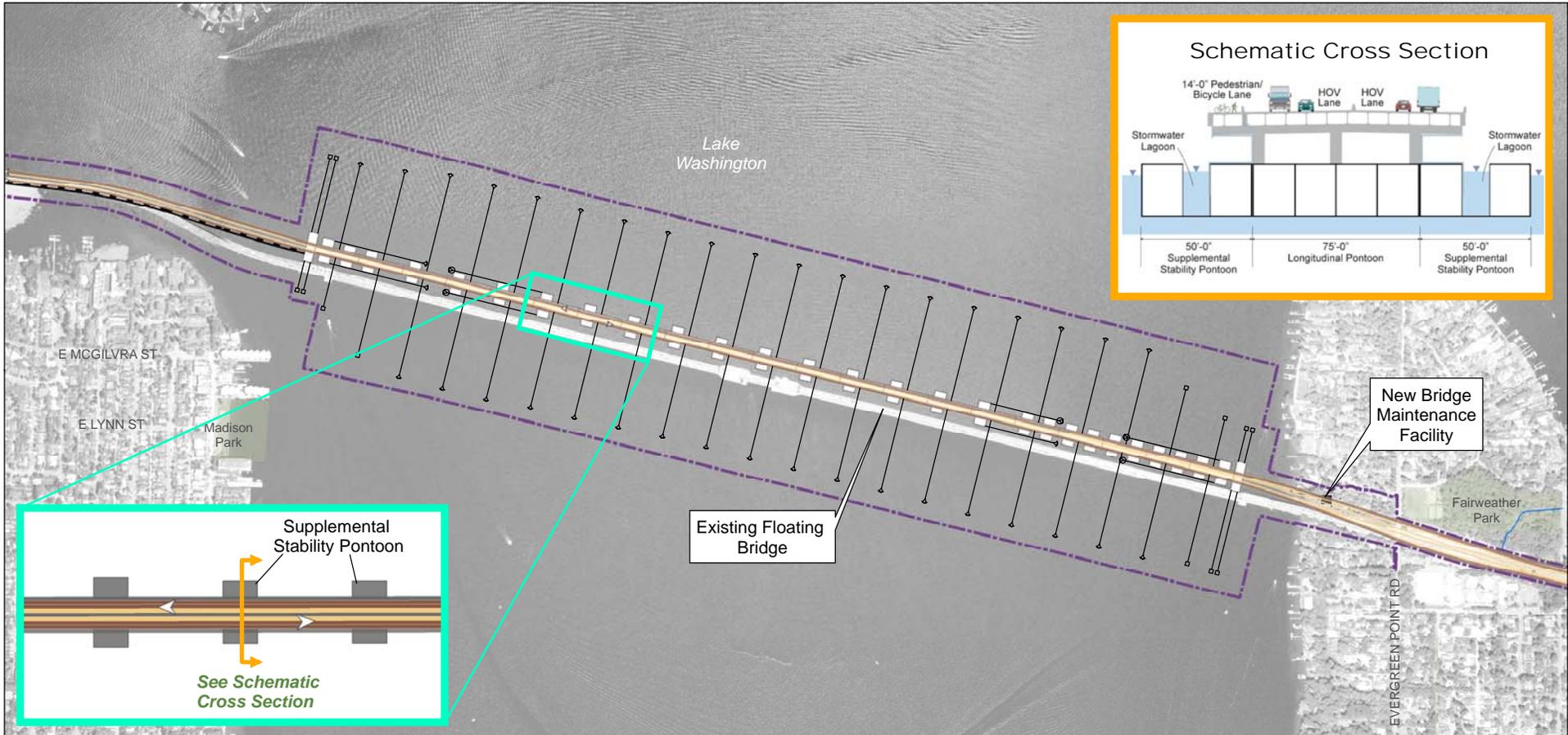
Bridge Maintenance Facility

Routine access, maintenance, monitoring, inspections, and emergency response for the floating bridge would be based out of a new bridge maintenance facility located underneath SR 520 between the east shore of Lake Washington and Evergreen Point Road in Medina. This bridge maintenance facility would include a working dock, an approximately 7,200-square-foot maintenance building, and a parking area.

Eastside Transition Area

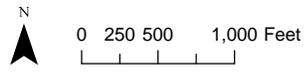
The I-5 to Medina project and the Medina to SR 202 project overlap between Evergreen Point Road and 92nd Avenue NE in Yarrow Point. Work planned as part of the I-5 to Medina project between Evergreen Point Road and 92nd Avenue NE would include moving the Evergreen





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

Park



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.

Exhibit 7. 6-Lane Alternative at the Evergreen Point Bridge (Common to All Options)
 I-5 to Medina: Bridge Replacement and HOV Project

Point Road transit stop west to the lid (part of the Medina to SR 202 project) at Evergreen Point Road, adding new lane and ramp striping from the Evergreen Point lid to 92nd Avenue NE, and moving and realigning traffic barriers as a result of the new lane striping. The restriping would transition the I-5 to Medina project improvements into the improvements to be completed as part of the Medina to SR 202 project.

Pontoon Construction and Transport

If the floating portion of the Evergreen Point Bridge does not fail before its planned replacement, WSDOT would use the pontoons constructed and stored as part of the Pontoon Construction Project in the I-5 to Medina project. Up to 11 longitudinal pontoons built and stored in Grays Harbor as part of the Pontoon Construction Project would be towed from a moorage location in Grays Harbor to Puget Sound for outfitting (see the sidebar to the right for an explanation of pontoon *outfitting*). All outfitted pontoons, as well as the remaining pontoons stored at Grays Harbor would be towed to Lake Washington for incorporation into the floating bridge. Towing would occur as weather permits during the months of March through October.

What is Outfitting?
 Pontoon outfitting is a process by which the columns and elevated roadway of the bridge are built directly on the surface of the pontoon.

Exhibit 8 illustrates the general towing route from Grays Harbor to Lake Washington, and identifies potential outfitting locations.



Exhibit 8. Possible Towing Route and Pontoon Outfitting Locations



The I-5 to Medina project would build an additional 44 pontoons needed to complete the new 6-lane floating bridge. The additional pontoons could be constructed at the existing Concrete Technology Corporation facility in Tacoma, and/or at a new facility in Grays Harbor that is also being developed as part of the Pontoon Construction Project. The new supplemental stability pontoons would be towed from the construction location to Lake Washington for incorporation into the floating bridge. For additional information about pontoon construction, please see the Construction Techniques Discipline Report (WSDOT 2009d).

Would the project be built all at once or in phases?

Revenue sources for the I-5 to Medina project would include allocations from various state and federal sources and from future tolling, but there remains a gap between the estimated cost of the project and the revenue available to build it. Because of these funding limitations, there is a strong possibility that WSDOT would construct the project in phases over time.

If the project is phased, WSDOT would first complete one or more of those project components that are vulnerable to earthquakes and windstorms; these components include the following:

- The floating portion of the Evergreen Point Bridge, which is vulnerable to windstorms. This is the highest priority in the corridor because of the frequency of severe storms and the high associated risk of catastrophic failure.
- The Portage Bay Bridge, which is vulnerable to earthquakes. This is a slightly lower priority than the floating bridge because the frequency of severe earthquakes is significantly less than that of severe storms.
- The west approach of the Evergreen Point Bridge, which is vulnerable to earthquakes (see comments above for the Portage Bay Bridge).

Exhibit 9 shows the vulnerable portions of the project that would be prioritized, as well as the portions that would be constructed later. The vulnerable structures are collectively referred to in the SDEIS as the Phased Implementation scenario. It is important to note that, while the new bridge(s) might be the only part of the project in place for a certain



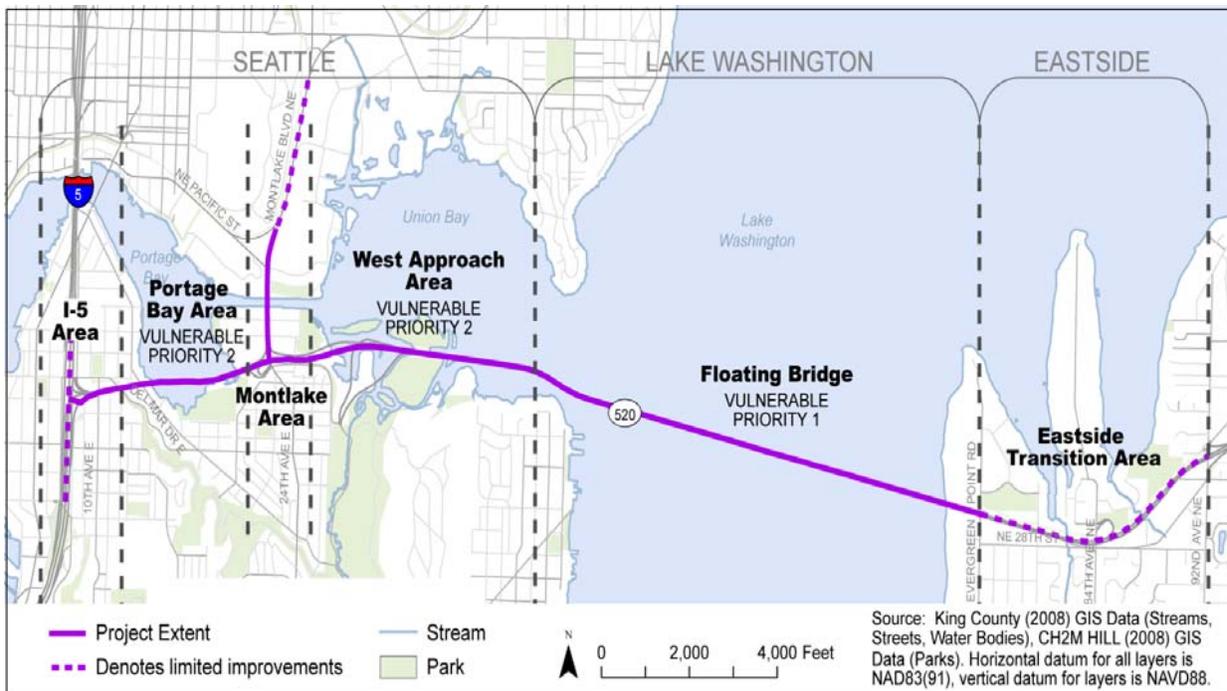


Exhibit 9. Geographic Areas along SR 520 and Project Phasing

period of time, WSDOT's intent is to build a complete project that meets all aspects of the purpose and need.

The Phased Implementation scenario would provide new structures to replace the vulnerable bridges in the SR 520 corridor, as well as limited transitional sections to connect the new bridges to existing facilities. This scenario would include stormwater facilities, noise mitigation, and the regional bicycle/pedestrian path, but lids would be deferred until a subsequent phase. WSDOT would develop and implement all mitigation needed to satisfy regulatory requirements.

To address the potential for phased project implementation, the SDEIS evaluates the Phased Implementation scenario separately as a subset of the "full build" analysis. The evaluation focuses on how the effects of phased implementation would differ from those of full build and on how constructing the project in phases might have different effects from constructing it all at one time. Impact calculations for the physical effects of phased implementation (for example, acres of wetlands and parks affected) are presented alongside those for full build where applicable.



Affected Environment

How was the information collected?

The study authors identified surface water resources in the study area by collecting and reviewing maps and government reports. They combined several maps using geographic information system (GIS) software to create a single project base map that incorporated the following data:

- Surface waters (streams and lakes)
- Wetlands and wetland buffers
- Soil types
- Floodplains and floodways
- Culverts
- Subbasin and watershed boundaries

The study authors consulted with various state and local agencies to obtain other important information about surface water resources and stormwater in the study area. Local agencies identified existing flooding problems in the study area. Water quality information came from Washington state's Water Quality Assessment 303(d) list and *Water Quality Assessment Report* (also called the 305[b] Report), both prepared by Ecology. King County provided water and sediment quality data for Lake Union and Lake Washington (King County 2009a).

WSDOT provided information about the existing stormwater system on SR 520. The existing stormwater system is a collection, conveyance, and discharge system that has been in place since the construction of SR 520, without any current flow control or water quality treatment facilities. The study authors also consulted with project team members, WSDOT, and other agencies to obtain information about hazardous materials, edges of existing pavement lines, and the quantity and quality of treated stormwater from the existing highway within the study area.

Surface Water Bodies in the Study Area

The following surface water bodies are located in the study area:

- Lake Union and Portage Bay. These water bodies are located in heavily developed basins (more than 50 percent impervious surface) in the Seattle portion of the study area.

How does impervious surface affect surface water resources?

Impervious surfaces such as rooftops, sidewalks, roads, parking lots, and compacted urban soils prevent rain from infiltrating soils as it would naturally. These barriers shift more water into creeks and lakes, and can increase the transport of pollutants from land to adjoining surface waters.

How do state agencies regulate increases in impervious surface?

Current state regulations require new and redeveloping construction projects to treat stormwater and sometimes control the flow of stormwater from existing and new impervious surfaces.

What is the 303(d) List?

The 303(d) list identifies surface water body segments (lakes, streams, and ponds) with degraded water quality. Ecology assembles available water quality data and publishes this list, as required under Section 303(d) of the federal Clean Water Act (40 CFR 130.7, as revised July 1, 2003).

What is the Ecology 305(b) Report?

Ecology prepares the Section 305(b) Report to inform the U.S. Congress and the public about the current condition of the state's waters. This report describes the status of *all* waters in the state, while the 303(d) list reports only the *impaired* waters in the state.



- Lake Washington
- Arboretum Creek

Water flows through the study area via the following pathways:

- In surface water bodies such as streams, ponds, wetlands, and lakes
- Across the impervious surfaces as stormwater runoff, where it flows directly to surface water bodies, or is conveyed to surface water bodies in open ditches or drainage pipes
- Below ground in soil and groundwater

Although surface water bodies, stormwater, and groundwater are typically managed and regulated independently, they are interconnected and interdependent. Exhibit 10 shows how stormwater runoff can percolate into soil and become groundwater and how groundwater can move into and out of surface water bodies.

Urban Development and Stormwater Runoff

The study area is located entirely in Water Resource Inventory Area (WRIA) 8, the most heavily developed of the 15 WRIAs directly bordering Puget Sound. As shown in Exhibit 11, WRIA 8 is divided into two watersheds: Lake Washington/Cedar and Sammamish. The proposed project’s study area lies within the Lake Washington/Cedar watershed, which is the more highly developed of the two watersheds.

Water Resource Inventories

Water resource inventory areas were established by state legislative acts, which gave the overall responsibility for the development and management of these administrative and planning boundaries to Ecology.

Watersheds are areas of land where all of the water that is under it or drains off of it goes into the same place.

A **basin** is the portion of land drained by a river and its tributaries. A watershed can be composed of a single or multiple basins.

A **Threshold Discharge Area** is an onsite area draining to a single natural discharge location or multiple natural discharge locations that combine within 0.25 mile downstream (as determined by the shortest flow path).

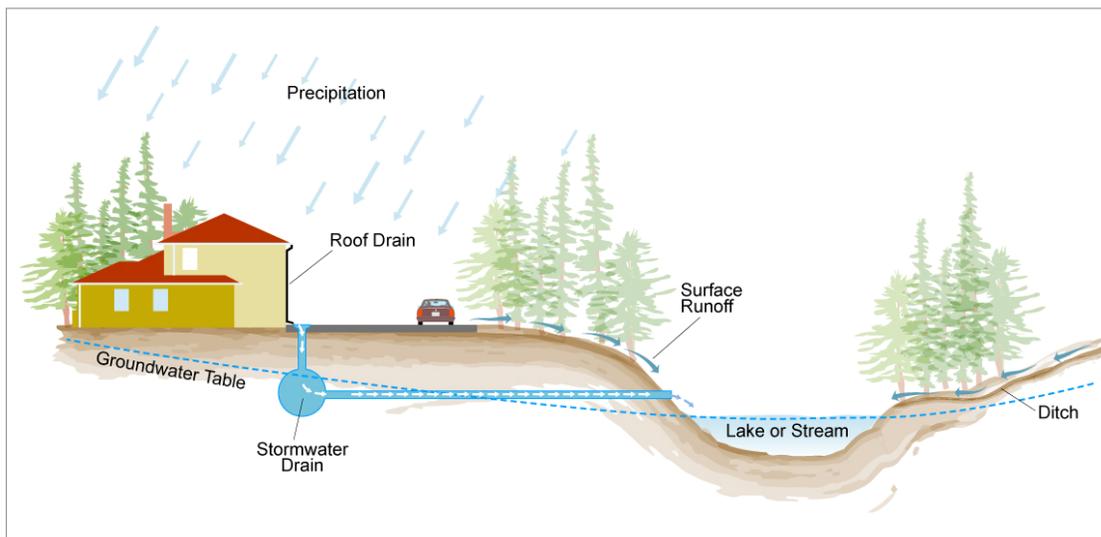
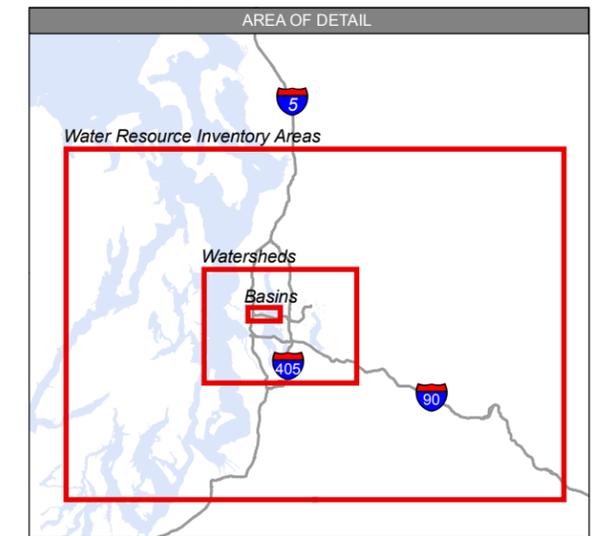
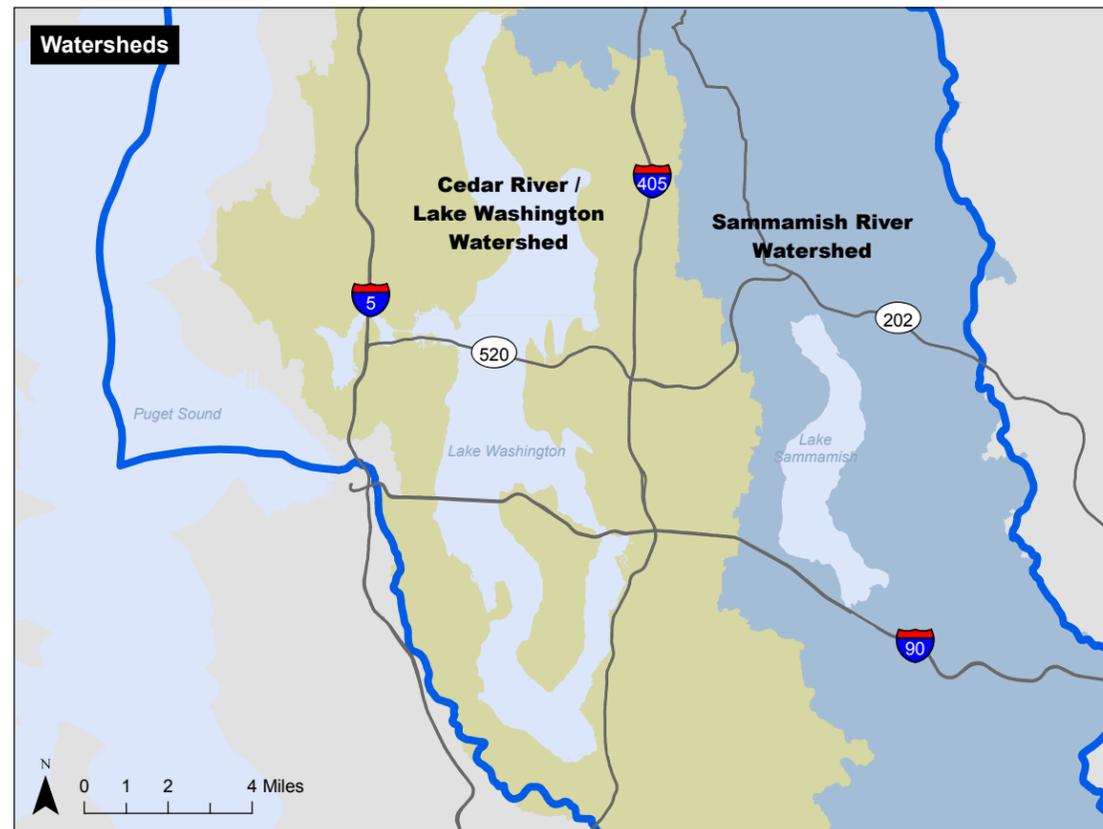
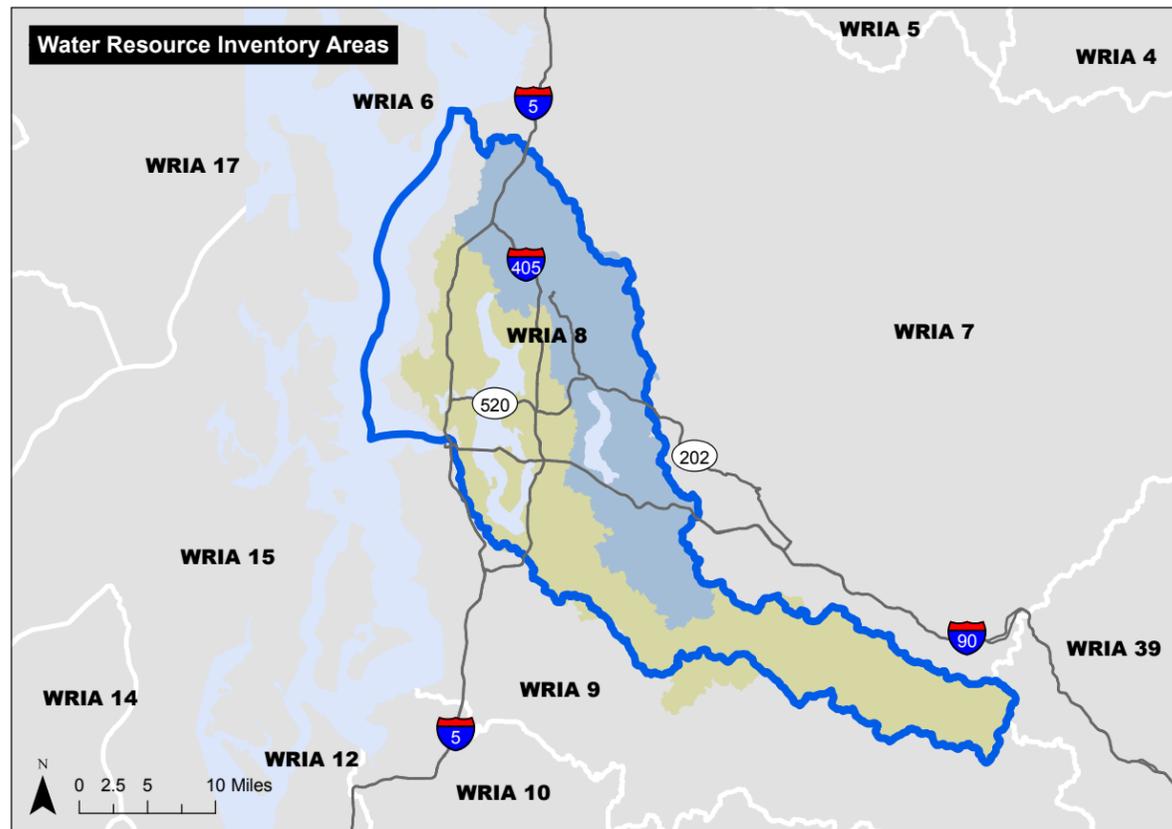
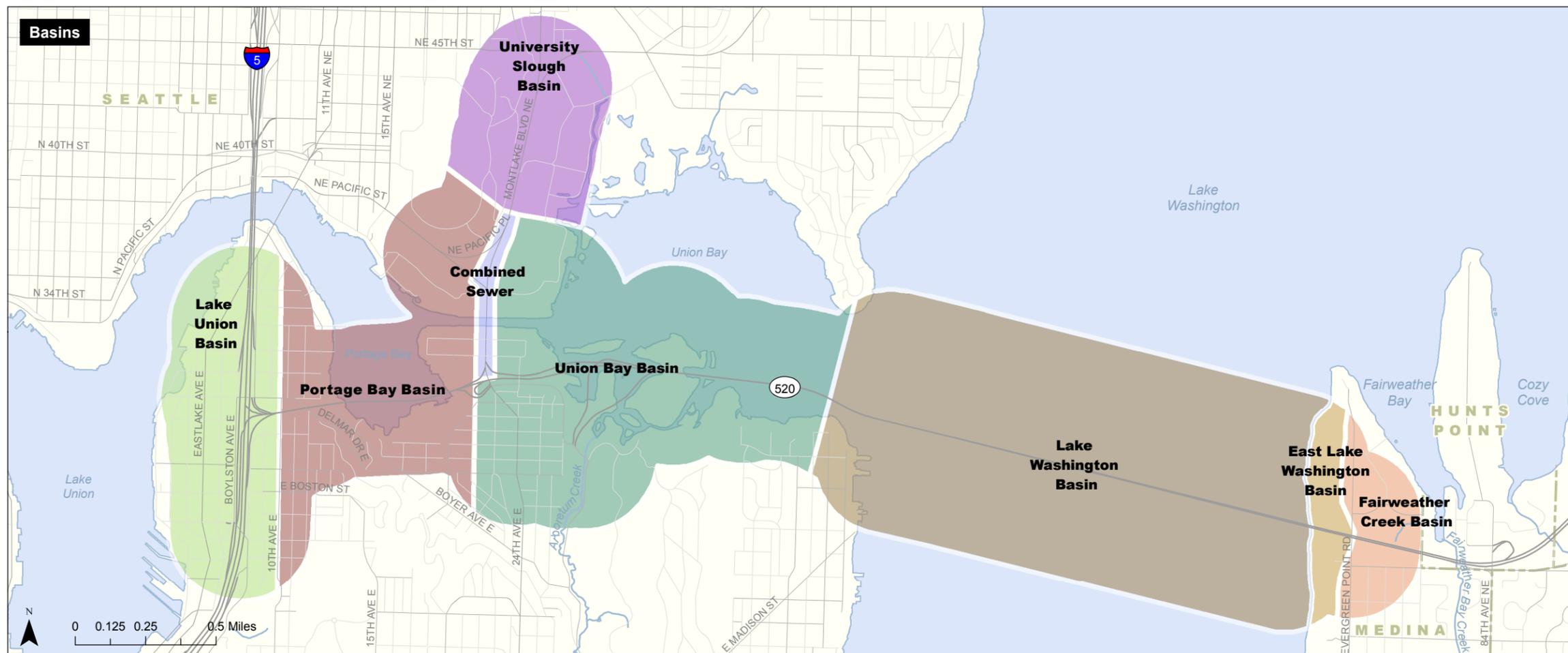


Exhibit 10. Pathways for Water Moving through the Study Area





- Water Resource Inventory Area 8 Boundary
- Water Resource Inventory Area
- Watershed**
- Cedar River / Lake Washington Watershed
- Sammamish River Watershed
- Basin**
- Combined Sewer
- East Lake Washington
- Fairweather Creek
- Lake Union
- Lake Washington
- Portage Bay
- Union Bay
- University Slough



Source: King County (2007) GIS Data (Water Bodies), King County (2005) GIS Data (Streets and Streams), King County (2006) GIS Data (Watershed), Ecology (2000) GIS Data (WRIA), Ecology (2001) GIS Data (Shoreline), WSDOT (2004) GIS Data (State Routes). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.



Exhibit 11. Location of Affected Basins within WRIA 8

I-5 to Medina: Bridge Replacement and HOV Project

These two watersheds are further divided into a number of smaller basins. Rural areas of King County (in which most of the Lake Washington/Cedar watershed is located) have a higher forest cover (67 percent) than urban areas (17 percent) (King County 2009b). Impervious cover in the urban areas of King County (47 percent) is substantially greater than that of the rural areas (5 percent) (King County 2009b).

The study area is a part of the highly urbanized area of King County that is densely developed with commercial, industrial, residential, and transportation land uses. Exhibit 12 shows the developed and undeveloped areas located within WRIA 8. Urbanization overlays the natural landscape with impervious surfaces made up of sidewalks, streets, parking lots, and buildings. These impervious surfaces prevent rain from percolating into the ground and altering the distribution and movement of surface water and groundwater.

Urbanization and its associated impervious surfaces alter water flows in a watershed through the following:

- Lowering stream summer minimum flows (known as base flows)
- Raising stream winter maximum flows (known as peak flows)
- Lowering groundwater levels
- Increasing stream flow runoff rates

This alteration can also lead to more rapid increases and decreases (termed “flashiness”) in stream flow rates and the frequency, extent, and duration of flooding when it rains.

Researchers have documented a decline in the quality of aquatic habitat in urban streams. Degraded aquatic habitats have been associated with a decline in the numbers and types of fish and invertebrates in these streams (Booth 1989; Booth and Jackson 1997; Karr and Chu 1999; Kleindl 1995).

Following are the results when the flow of water is modified by increases in impervious surface:

- Changed streamside conditions (such as increased streambank erosion and loss of riparian vegetation, which shades streams and helps to filter out stormwater pollutants)
- Reduced structural complexity and stability of stream channels.

New impervious surfaces can further affect water resources by accumulating and retaining pollutants, which can then be transported



by stormwater runoff to surface water bodies and to groundwater. A range of pollutants and sources is present in both urban and suburban areas. These constituents include sediments from development and new construction; oil, grease, and chemicals from vehicles; nutrients and pesticides from turf management and gardening; viruses and bacteria from failing septic systems; road salts; and heavy metals from automobile tire and brake wear (U.S. EPA 2004c). Sediments and solids constitute the largest volume of pollutant loads to receiving waters in urban areas. Impervious surfaces that accumulate and retain pollutants are called pollutant-generating impervious surfaces (PGISs). PGISs can adversely affect the quality of water resources because of:

Pollutant-Generating Impervious Surfaces—or PGISs—are impervious surfaces that are a source of pollutants in stormwater runoff. Study area PGISs include roadways that receive direct rainfall or the run-on or blow-in of rainfall.

- Increased fertilizer amounts that encourage algae growth and lead to lower dissolved oxygen levels
- Increased turbidity (cloudiness due to sediments) that limits algal productivity and harms fish and aquatic insects
- Increased levels of metals, pesticides, and oil and greases that harm fish, aquatic insects, and algae
- Increased levels of bacteria and viruses that can cause illness to people and animals

Automobile, truck, and bus traffic traveling on SR 520 impervious surfaces would likely generate only a subset of types of pollutants present on this list of potential stormwater constituents. Vehicles could act as sources of metals (for example, copper, zinc, and cadmium from brake and tire wear), hydrocarbons (for example, oil and grease from leaky engines and polycyclic aromatic hydrocarbons [PAHs] from engine exhaust), and total suspended solids (TSS) (from dirt on car exteriors and tires, and brake and tire wear particles). Vehicles are unlikely to generate nutrients, pesticides, or bacteria.

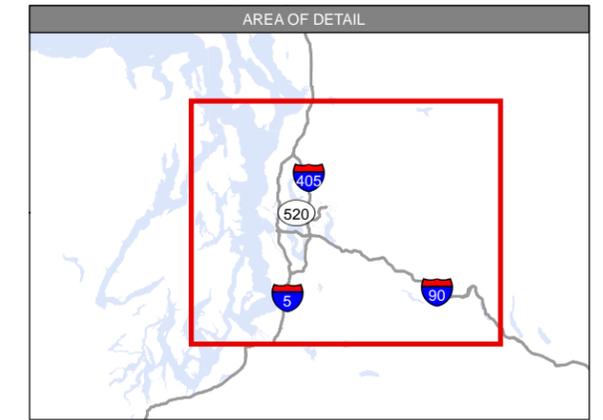
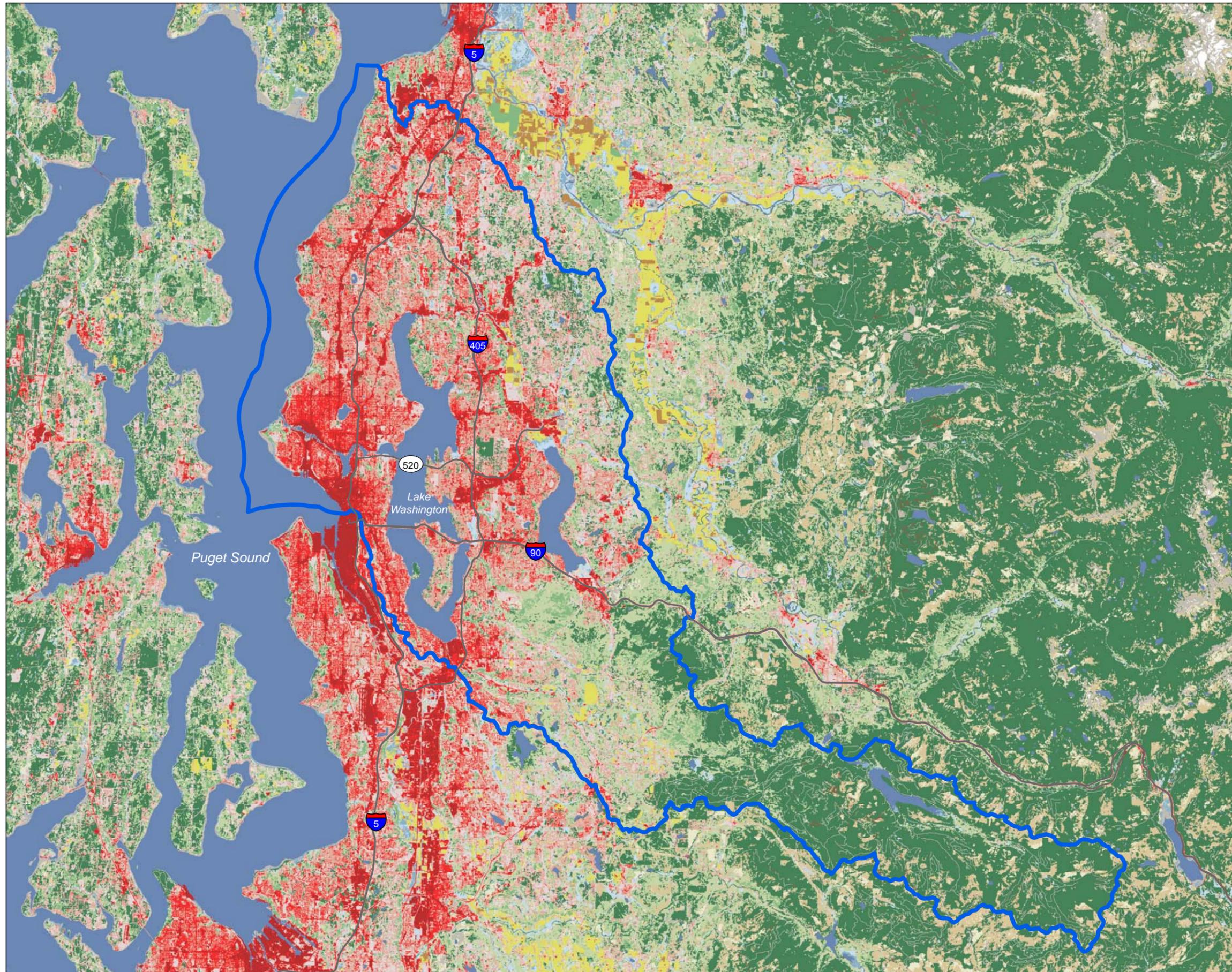
Study Area Surface Water Bodies

Surface water bodies in the Seattle area potentially affected by the proposed project include portions of the Lake Washington Ship Canal system and part of the western shoreline of Lake Washington. Arboretum Creek is the only stream in the Seattle portion of the study area.

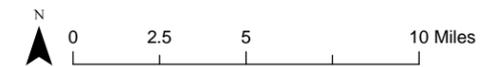
Lake Washington Ship Canal

The Lake Washington Ship Canal system is an 8.6-mile-long manmade navigable waterway connecting Puget Sound to Lake Washington in





-  Water Resource Area Inventory 8 Boundary
- Land Cover Classification**
-  Low Intensity Residential
-  High Intensity Residential
-  Commercial/Industrial/Transportation
-  Bare Rock/Sand/Clay
-  Deciduous Forest
-  Evergreen Forest
-  Mixed Forest
-  Shrubland
-  Grasslands/Herbaceous
-  Pasture/Hay
-  Row Crops
-  Woody Wetlands
-  Emergent Herbaceous Wetlands



Source: USGS (2003) National Land Cover Dataset, Ecology (2000) GIS Data (WRIA), and WSDOT (2004) GIS Data (State Routes). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.



Exhibit 12. Land Cover within and around WRIA 8

I-5 to Medina: Bridge Replacement and HOV Project

Seattle (Exhibits 13 and 14). The Lake Washington Ship Canal system includes the following interconnected waterways:

- Shilshole Bay
- Hiram M. Chittenden Locks (Ballard Locks)
- Salmon Bay
- Salmon Bay Waterway
- Fremont Cut
- Lake Union
- Portage Bay
- Montlake Cut
- Union Bay on the edge of Lake Washington

Of these waterways, Lake Union, Portage Bay, the Montlake Cut, and the western shoreline of Lake Washington lie within the proposed project's study area.

Lake Union and Portage Bay

Lake Union and Portage Bay represent a transitional area between the marine water of Puget Sound and the freshwater of Lake Washington. These waters are critical passageways that provide rearing habitat for migrating salmon.

Impervious surfaces from development cover approximately 63 percent of the land around Lake Union and Portage Bay. Lake Union and Portage Bay receive most of the stormwater draining from the densely developed surrounding low- and high-intensity residential, commercial, industrial, and transportation land uses.

Seattle Floodplains

The floodplains for both Lake Union and Portage Bay have been extensively altered and are no longer functioning as floodplains. These alterations include (1) heavy armoring of the banks with riprap, and (2) controlling of the water level by the U.S. Army Corps of Engineers to prevent flooding and improve navigation and commerce.

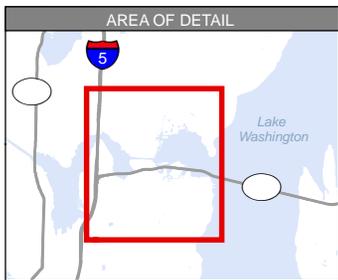
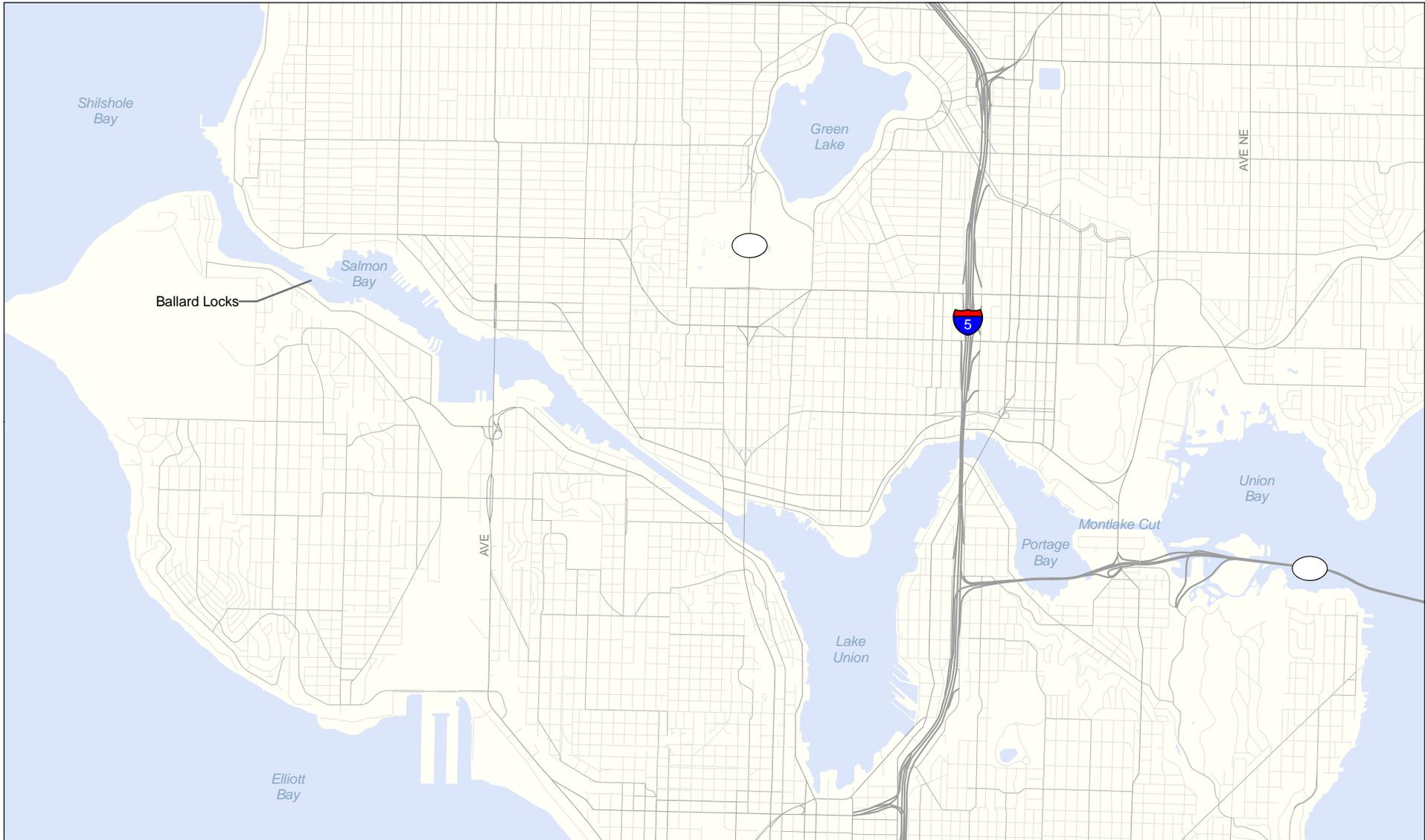
Arboretum Creek

Arboretum Creek (also known as Washington Park Creek) is a small stream that originates in the vicinity of the Seattle Japanese Garden in the Washington Park Arboretum. The creek flows about 0.8 mile north to Willow Bay, a minor arm of Union Bay. Upstream of the mouth, the stream flows under Lake Washington Boulevard East and through a narrow, uniform channel immediately parallel to Lake Washington Boulevard East. Two inline culverts,

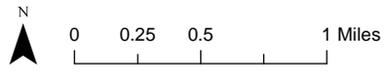
What is a floodplain?

Land adjacent to water bodies that can regularly be inundated by floodwater is called a floodplain. The Federal Emergency Management Agency regulates flood hazards within a 100-year floodplain (the area adjoining a river, stream, or watercourse covered by water in a 100-year flood, which occurs on average once every 100 years).



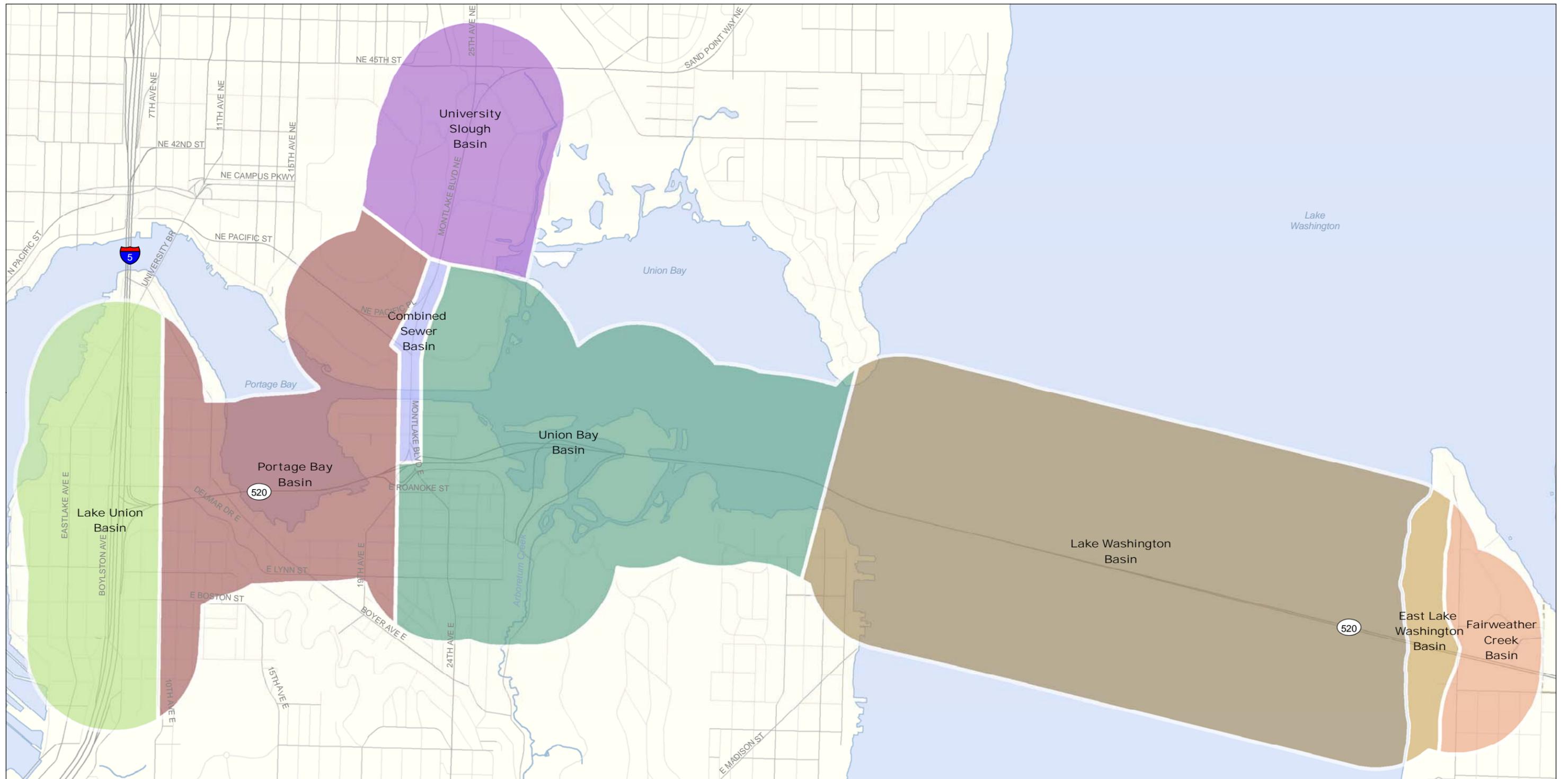


Waterbody

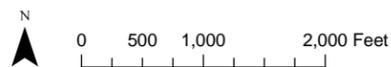


Source: King County (2005) GIS Data (Streams and Streets), King County (2007) GIS Data (Water Bodies). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

Exhibit 13. Lake Washington Ship Canal
 I-5 to Medina: Bridge Replacement and HOV Project



- Basin**
- Combined Sewer
 - East Lake Washington
 - Fairweather Creek
 - Lake Union
 - Lake Washington
 - Portage Bay
 - Union Bay
 - University Slough



Source: King County (2005) GIS Data (Streams and Streets), King County (2007) GIS Data (Water Bodies). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.



Exhibit 14. Affected Basins Located in the Study Area

I-5 to Medina: Bridge Replacement and HOV Project

connected at a manhole, with a total length of about 400 feet, convey the stream under Lake Washington Boulevard East and an Arboretum parking lot. The outlet of the culvert is about 2.5 feet above the stream. This prevents fish from passing through it. Downstream of the roadway, the channel widens as it flows several hundred feet northeast toward the open water of Willow Bay.

Lake Washington

Lake Washington is the second largest natural lake in the state, with a surface area of 21,500 acres and a watershed of 472 square miles. Overall, almost two-thirds of the land use in the Lake Washington watershed has been converted to residential, commercial, or industrial uses (King County 2009a).

Historically, Lake Washington drained to the south through the Black River to the Duwamish River and Puget Sound. In 1912, the Cedar River was diverted into Lake Washington from its original discharge into the Duwamish River. In 1916, construction of the Lake Washington Ship Canal system (see photo) diverted Lake Washington's outlet from the Black River to Shilshole Bay (Chrastowski 1983).



Beginning of the water-level adjustment between Lake Washington and Lake Union in 1916 (printed with permission from the Museum of History and Industry, Seattle, Washington).

The Cedar River currently provides over half the inflow to Lake Washington. The Sammamish River at the northern end of Lake Washington and numerous smaller tributaries make up the remaining lake inflow (King County 2009a).

Lake Washington Floodplains

The Lake Washington floodplain is limited to a narrow fringe of land controlled and maintained by the U.S. Army Corps of Engineers at the Ballard Locks. The U.S. Army Corps of Engineers maintains daily lake elevations to within 0.01 foot. The summer high-water level is 22 feet mean sea level; the lake is lowered approximately 2 feet during the winter to minimize shoreline erosion and property damage and to allow dock and other facility maintenance (Chrastowski 1983; U.S. Army Corps of Engineers 2004a; U.S. Army Corps of Engineers 2004b).



Eastside Transition Area—Fairweather Creek

Fairweather Creek drains a small, urban residential basin (approximately 600 acres) that discharges north into Fairweather Bay, which is part of Lake Washington (Exhibit 14). The 1.4-mile-long stream is rock-lined in places and its banks are nearly vertical (4 to 6 feet high and higher) for much of its length (Anderson et al. 2001). The stream originates at the Overlake Golf Course ponds where drainage from the Medina and Clyde Hill communities is collected. These ponds function as stormwater flow control facilities that reduce flooding downstream. Beginning at the golf course ponds, Fairweather Creek passes through four culverts (including one under SR 520) before entering Lake Washington at Fairweather Bay.

Information Collected to Identify Groundwater Resources

The study authors obtained information on the following groundwater resources from Ecology, the Washington State Department of Health, the U.S. Geological Survey, and King County:

- Sole source aquifers
- Critical aquifer recharge areas
- Public water supply wells
- Domestic/residential water wells

What is a Critical Aquifer Recharge Area?

A critical aquifer recharge area is defined as a geographic area that has a critical recharging effect on aquifer(s) used for drinking water supply (RCW 36.70A.030(5)).

Groundwater Resources Located in the Study Area

There are several aquifers in the study area, but human use of groundwater from these aquifers is limited (with none identified as a sole-source aquifer, meaning that they do not supply more than 50 percent of the drinking water in the area overlying that aquifer). Groundwater resources and their uses are discussed in detail in the following sections.

General Groundwater Information

It is important to first provide a regional perspective on groundwater because of its complex overlapping nature. Groundwater in the study area is contained within aquifers, which are geological units or groups of units that hold and convey water.

Every location within a drainage basin can be designated as either a groundwater recharge or discharge area. This designation depends on the direction that groundwater flows within the aquifer. Near the ground surface of a recharge area, flow is directed downward, while a



discharge area will have an upward flow to the surface (Freeze and Cherry 1979). In the Puget Sound basin, most groundwater recharge occurs from precipitation in upland areas – especially where higher permeability soils are present at or near land surface. Prior to urbanization, 70 percent of the annual rainfall recharged aquifers in the Puget Sound region (Vaccaro et al. 1998). The extensive conversion of forested ecosystems to residential and commercial development over the last 100 years has reduced the amount of water that can infiltrate and has also reduced recharge rates.

Aquifers in the Puget Sound basin located close to the surface are often shallow, making them more susceptible to contamination. Deeper aquifers in the Puget Sound basin are better protected from contamination by aquitards. Attachment 1 contains a detailed description of the major study area aquifers and their relationships.

An **aquitard** is a subsurface semi-confining layer that can store groundwater and also transmit groundwater slowly from one aquifer to another.

Study Area Groundwater Resources

As part of this analysis, the study authors reviewed available information to determine which types of groundwater resources existed in the study area. Exhibit 15 summarizes and provides the sources of this information. This report does not provide any further discussion of resources that were not found in the study area.

Study Area Groundwater Use

The use of groundwater as a drinking water supply within the study area is limited. Seattle Public Utilities supplies most of the drinking water in the study area from three primary sources – Chester Morse Reservoir, South Fork Tolt Reservoir, and the Highline Well Field (located in the Renton area). There are 23 water wells of record listed in the area 1 mile north and south of SR 520. The current condition, uses, or continued existence of these wells are unknown. Because they are generally located in areas supplied by municipal water, if these wells still exist, they are most likely not used for drinking water supply.

Study Area Groundwater Aquifers

Seattle

Exhibit 16 shows the surface geology associated with underlying aquifers located in the study area. The Recessional and Advance outwash deposits (Q_{VR} and Q_{VA}) are primarily composed of permeable soils and materials that can allow for stormwater recharge and



Exhibit 15. Study Area Groundwater Resources

| Type of Resource | Does this Resource Exist in the Study Area? | Source |
|---|---|--|
| Sole source aquifer | No | U.S. EPA (2004d) |
| Critical aquifer recharge area | No | King County iMap Tool; King County Groundwater Department (Johnson pers. comm. 2004) |
| Designated wellhead protection area | No | King County iMap Tool; King County Groundwater Department (Johnson pers. comm. 2004) |
| Group A public water supply well | No | Washington State Department of Health; King County Groundwater Department (Johnson pers. comm. 2004) |
| Group B public water supply well | No | Washington State Department of Health; King County Groundwater Department (Johnson pers. comm. 2004) |
| Domestic/residential water well | Yes, 23 water wells of record are listed in the area 1 mile north and south of SR 520. The current condition, uses, or existence of the wells are unknown, but because they are generally located in areas supplied by municipal water, if they exist, they are most likely not used for drinking water supply. | Ecology (2009) |
| Exposed aquifers crossed by the project corridor | Yes, SR 520 crosses 5,800 feet of exposed Alluvial Aquifer deposits and 1,700 feet of exposed Vashon Advance Outwash Aquifer deposits (see Exhibit 16). | |
| Aquifer recharge areas where stormwater percolates to groundwater in the project corridor | Yes, all pervious surfaces are potential aquifer recharge areas. | Morgan and Jones (1999) |

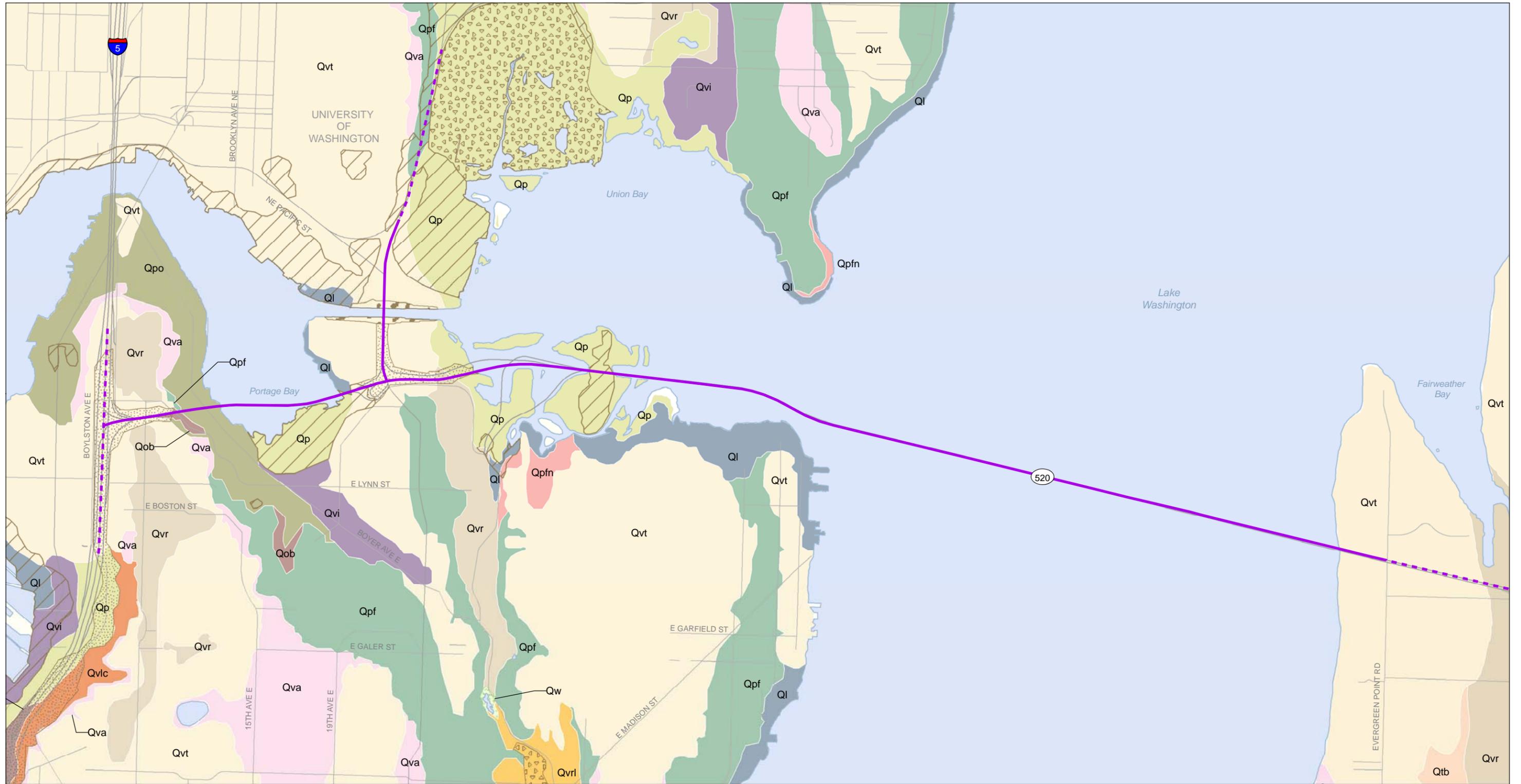
pollutants to reach the underlying aquifer. Vashon Till (Q_{VT}) is typically much less permeable and acts as a barrier to the movement of surface water and pollutants to the groundwater.

The Alluvial Aquifer flows toward Portage Bay, the Montlake Cut, and Union Bay from all sides. The Vashon Advance Outwash Aquifer underlies all of this area, except where it has been eroded beneath Portage Bay.

Lake Washington

The Alluvial Aquifer is present on the shores of Lake Washington. The Vashon Advance Outwash Aquifer has been eroded beneath portions of the lake (Exhibit 16). Groundwater from the Alluvial and Vashon





Source: Troost et al (2005) GIS Data (Surficial Geology), Surficial Geology Map: King County (2003) GIS Data (Surficial Geology) based on Booth et al. (2002) and King County (2005) GIS Data (Streams and Streets) King County (2007) GIS Data (Water Bodies). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

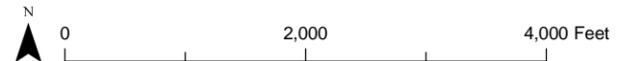


Exhibit 16. Study Area Surficial Geology and Associated Aquifers
I-5 to Medina: Bridge Replacement and HOV Project

Advance Outwash Aquifers (and probably the Sea-Level Aquifer) locally discharges to the lake.

What are the existing water resource characteristics of the study area?

The overall quality of surface water bodies in the study area is summarized below and is discussed in greater detail in the following sections.

- Surface water bodies in the study area currently receive urban surface runoff from roadways, commercial and industrial neighborhoods, residential areas, and combined sewer overflows (CSOs).
- Ecology has designated Lake Union/Ship Canal as impaired water bodies because of elevated concentrations of total phosphorus, lead, fecal coliform, and aldrin (Ecology 2009).
- Water quality in Lake Washington has improved over the last 50 years. Most parameters meet water quality standards, but the lake is still listed by Ecology as impaired because of bacterial contamination (Ecology 2009).
- Ecology has listed most of the streams in the study area as impaired because of elevated water temperatures and bacteria levels (Ecology 2009).

What are combined sewer overflows?

Combined sewers carry sewage in the same pipe as stormwater. During normal storm events, the combined sewers convey sewage and stormwater to wastewater treatment plants, where the water is treated and discharged. During heavy rainfall, the combination of sewage and stormwater sometimes exceeds the capacity of the pipe and the wastewater treatment plant. When this occurs, the combined sewage and stormwater will overflow and discharge into a nearby lake or stream without being treated.

Surface Water Quality in the Study Area

Lake Union and Portage Bay Water Quality

Surface water quality in Lake Union and Portage Bay is influenced by several factors:

- Natural underlying and surrounding geology
- Freshwater inflows from Lake Washington
- Salt water inflows from Puget Sound through the Ballard Locks
- CSOs
- Storm drains from the surrounding urbanized watershed
- Roof drains
- Boat discharges

The water in Lake Union is completely replaced about once per week during high freshwater flows (King County 2009a), a fairly high flushing rate (Ecology 2004). High flushing rates can lower nutrient



levels, thereby reducing algal growth rates, leading to clearer water and better light penetration (Ecology 2004). High flushing rates can also reduce pollutant concentrations in the water column.

Potential pollutant sources include roads, commercial and industrial neighborhoods, residential areas, and CSOs. The shores of Lake Union and Portage Bay are completely surrounded by marinas, houseboat moorage, commercial docks, and dry docks.

The combination of freshwater and salt water in Lake Union affects the amount of oxygen in this lake. During the summer months (July, August, and September), a layer of water with very low dissolved oxygen (approximately 1 milligram per liter [mg/L]) and increased salinity forms along the bottom of Lake Union (Hansen et al. 1994). The layer of water at the bottom of the lake has a higher-density than the warm water at the top of the lake because it is a mixture of freshwater and marine water. As a result, the higher density water concentrates at the bottom of the lake and does not mix with the lower-density warm water closer to the surface of the lake to any great extent during the summer (CH2M HILL 1999). This combination of low dissolved oxygen and increased salinity would be stressful to most invertebrates living in Lake Union sediments and would make the bottom of the lake unhealthy for aquatic invertebrates and fish.

Ecology has placed Lake Union on its 303(d) list because it exceeds the water quality criteria for total phosphorus, lead, fecal coliforms, and aldrin (Ecology 2009). Past studies have shown that concentrations of some metals and some PAHs are twice as high in Lake Union sediments as in Lake Washington sediments (Cubbage 1992). A comparative study of Lake Union and Portage Bay sediments conducted in 1992 found that metal concentrations in Portage Bay sediments were consistently lower than those measured in Lake Union (Cubbage 1992) and did not exceed national and international freshwater sediment guidelines.

King County has monitored surface water chemistry annually in Portage Bay since 1998 (King County 2009a). Most of the water quality parameters measured (for example, temperature, pH, and dissolved oxygen) were within acceptable ranges, except for temperature. Temperatures at 3.28 feet below the surface consistently reached approximately 68°F or higher each August between 1998 and 2002 (King County 2009a).

Why is oxygen important for a healthy lake?

Healthy lake systems provide aquatic animals and plants with high levels of dissolved oxygen, low levels of salt (salinity), and a range of moderate temperatures. The colder the temperature and the lower the salt content, the more dissolved oxygen the water can hold, expressed in units of mg/L.

How much oxygen is needed?

Above 6 mg/L dissolved oxygen, most aquatic plants and animals have plenty of oxygen. When the level of dissolved oxygen is low (below 3 mg/L), the water is called hypoxic. If all of the dissolved oxygen is used up (below 0.5 mg/L), the water is called anoxic. Under hypoxic conditions, many aquatic plants and animals may not survive.

What are polycyclic aromatic hydrocarbons?

PAHs are a group of chemicals, many of which can cause cancer, formed by incomplete combustion of organic material. Typical substances that can form PAHs include coal, oil, gas, wood, garbage, and tobacco.



Arboretum Creek Water Quality

No information was available to characterize the overall water quality of Arboretum Creek.

Lake Washington Surface Water Quality

The average water-residence time in Lake Washington is currently about 2.3 years (Emery et al. 1973; Chrzastowski 1983), which is about half of its historical flushing rate of 5 years (Chrzastowski 1983). This change in replacement rate was caused by the construction of the Lake Washington Ship Canal system and diversion of the Cedar River into the lake.

The water in Lake Washington is considered high quality for most parameters important to fish, wildlife, and human uses (dissolved oxygen, temperature, pH, conductivity, metals, and nutrients such as phosphorus). However, Lake Washington is on the Ecology 303(d) list of impaired water bodies because these areas exceed the fecal coliform bacteria criterion (Ecology 2009). Potential pollutant sources include those typical of urbanized basins such as residential, commercial, and industrial neighborhoods and roads. Stormwater containing pet and wildlife wastes and CSOs are potential contributors of fecal coliform bacteria to the lake.

Fairweather Creek Water Quality

Ecology placed Fairweather Creek on the 303(d) list because the stream exceeds the fecal coliform, dissolved oxygen, and temperature water quality criteria (Ecology 2009). This same listing identified pH in Fairweather Creek as meeting water quality standards (a 303(d) listing of Category 1). Metro (1989) sampled water quality in 1988 and between 1990 and 1993. The sampling showed that high-temperature violations occurred during the summer low-flow months when the stream was nearly dry (King County 1994). Metro also measured exceedances of fecal coliform and dissolved oxygen water quality criteria (Metro 1989), as well as elevated levels of copper, zinc, and nickel in sediments located at the mouth of the stream (King County 1994).

A study by The Watershed Company also showed water quality to be poor in Fairweather Creek during the summer (the study was limited to the summer). Ammonia levels exceeded the state standard. For salmon, the creek's manganese and iron levels were unacceptably high, dissolved oxygen levels were marginal to low, and temperature levels were higher than ideal during summer low flows and acceptable



during summer high flows. The Watershed Company also noted a lack of stream shading and stream channel complexity, as well as a prevalence of nonnative and invasive vegetation along the stream corridor (Anderson et al. 2001). Potential stormwater pollutant sources in this basin, in addition to SR 520, include single-family residential neighborhoods, a golf course, and local roads.

Groundwater Quality in the Study Area

In the state of Washington, all groundwater is considered to be a potential drinking water source, and the state regulates the quality of this resource to protect it from degradation. In general, groundwater quality in the study area is good and suitable for most purposes (Vaccaro et al. 1998). Groundwater contamination may occur locally due to industrial, commercial, or agricultural activities. Soil and groundwater contamination has been documented at a number of locations in Seattle and on the Eastside. Please see the Hazardous Materials Discipline Report for further details (WSDOT 2009e).

Stormwater Management in the Study Area

Overall, stormwater management in the study area occurs as follows:

- Most stormwater runoff discharged from SR 520 is not treated before it is discharged.
- Stormwater runoff in the Seattle portion of the study area discharges to water bodies identified above.
- Stormwater runoff from the existing Portage Bay Bridge and Evergreen Point Bridge discharge directly to Portage Bay and Lake Washington, respectively.

The following sections describe in detail how stormwater runoff is managed in the Seattle and Lake Washington portions of the study area.

Seattle

In the Seattle portion of the study area, stormwater runoff from SR 520 is not treated before it is discharged to the Lake Washington Ship Canal, Lake Union, or Portage Bay. The SR 520 corridor crosses a heavily urbanized area of Seattle, where little of the natural stormwater drainage patterns remain. Most stormwater in this area is diverted into manmade channels and conveyance systems that direct stormwater to Lake Union and Portage Bay.



The drainage system in this portion of the study area consists primarily of storm drains and bridge drains on the elevated bridge structures, which discharge untreated stormwater directly to major water bodies such as Lake Union and Portage Bay. Stormwater from I-5 between East Lynn Street and the Lake Washington Ship Canal Bridge (which includes the I-5/SR 520 interchange) is conveyed north in storm drains to East Allison Street, where it flows west to an outfall in Lake Union (Exhibit 17). An existing 30-foot-deep stormwater pump station located between the southbound and express lanes just south of the Roanoke Bridge over SR 520 pumps stormwater into the storm drain system conveyed to East Allison Street.

Stormwater from the section of SR 520 between approximately 10th Avenue East and Montlake Boulevard is conveyed in storm drains and discharged to two outfalls in Portage Bay – one under the SR 520 structure at Boyer Avenue East and the other under the Montlake Boulevard eastbound off-ramp. Stormwater on the Portage Bay Bridge discharges directly into Portage Bay (Exhibit 17).

Lake Washington

None of the stormwater runoff from the Lake Washington portion of the study area is treated before it is discharged. Stormwater from SR 520 between Montlake Boulevard and Union Bay is conveyed in storm drains that flow east, discharging to outfalls in Union Bay, located near the R.H. Thompson Expressway ramps next to the Lake Washington Boulevard interchange (Exhibit 17). Stormwater on the west approach to the Evergreen Point Bridge discharges from numerous bridge drains directly into Union Bay. No constructed drainage systems exist where SR 520 crosses Foster Island; as a result, stormwater is discharged through the bridge drains to the lake below. Stormwater from the floating bridge deck flows into bridge drains that discharge directly into Lake Washington.

Fairweather Creek

Stormwater from SR 520 discharges in storm drains and curb openings at multiple locations, eventually flowing into Fairweather Bay. There are four primary discharge locations from SR 520 – Fairweather Park, 80th Avenue NE, a culvert under SR 520 at the tip of Fairweather Bay, and Fairweather Creek.

At Fairweather Park, a culvert beneath SR 520 conveys flows to a diversion structure near Medina. Low flows are conveyed through Fairweather Park to a steep ravine; high flows are conveyed around the park and down a storm drain under 80th Avenue NE to Fairweather



Bay. This outfall is located on single-family residential property at the end of NE 32nd Street in Hunts Point. The third discharge location is a pipeline at the tip of Fairweather Bay between single-family residential properties. The easterly discharge location is Fairweather Creek, which crosses under SR 520 just west of the NE 84th Street ramp. The creek flows northwesterly for a short distance through single-family residential properties to Fairweather Bay.

Pertinent Stormwater Regulations

Ecology requires that stormwater from all new PGISs be treated with BMPs before it can be discharged. These BMPs are identified in stormwater management manuals (for example, the *Stormwater Management Manual for Western Washington* or the HRM). In addition, Ecology requires certain stormwater flows to be controlled (detained) before they are treated and discharged. Exhibit 18 describes how Ecology's regulations apply to the design of stormwater systems for road projects in general, and to the I-5 to Medina: Bridge Replacement and HOV Project specifically.

Ecology's *Stormwater Management Manual for Western Washington* (Ecology 2005) describes how project proponents must design storm-water systems that meet the water quality criteria. WSDOT implements this guidance on transportation projects by using the HRM to design stormwater systems to meet Ecology's regulations (WSDOT 2008a). WSDOT's HRM has been approved by Ecology and is considered to be equivalent to Ecology's *Stormwater Management Manual for Western Washington* (Ecology 2005).

Required Level of Water Quality Treatment and Flow Control

The HRM establishes the level of water quality treatment (basic or enhanced) required for a project. It also identifies if and where flow controls are required. Using the guidelines provided in the HRM, all design options of the 6-Lane Alternative would construct combinations of flow control and water quality treatment facilities, as shown in Exhibit 18.

In the study area, the specific receiving environments—Lake Union, Portage Bay, Union Bay, and Lake Washington—have been determined to be exempt from flow control requirements (WSDOT 2008a). In addition, discharges to these water bodies have been identified as requiring basic treatment for any of the build alternative options (WSDOT 2008a). However, where possible, the study authors

What are best management practices?

BMPs are practices and treatment technologies or methods that can be used to meet water quality criteria. There are many different types of BMPs. Some are treatment technologies such as wet vaults and stormwater treatment wetlands. Others are maintenance measures that can be implemented as part of a project, such as sweeping streets of debris. Some BMPs are permanent features of a project; others can be temporary measures employed during construction.

What are basic and enhanced stormwater treatment BMPs?

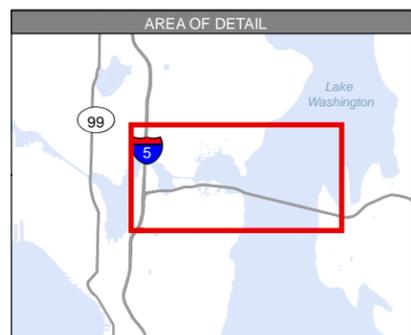
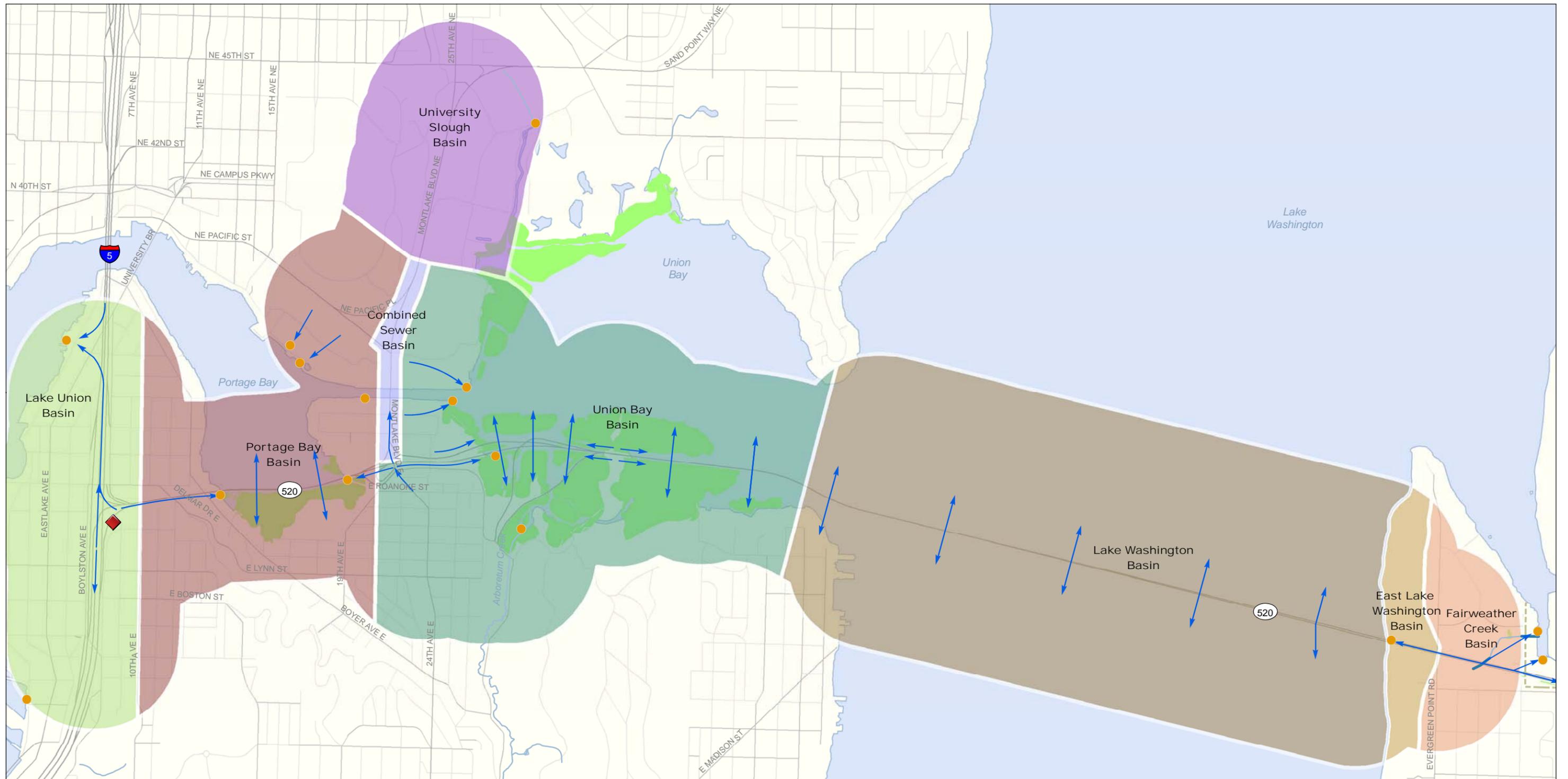
Basic and enhanced stormwater treatment BMPs are different types of BMPs that have been designated in the HRM to treat stormwater (see page 3-15, Chapter 3 of the HRM [WSDOT 2008a]).

Basic treatment BMPs remove pollutants such as metals, suspended solids, and nutrients from contaminated stormwater. The HRM performance goal for basic treatment BMPs is 80 percent removal of total suspended solids (WSDOT 2008a).

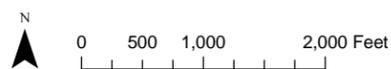
Enhanced treatment BMPs are designed to achieve greater removal of dissolved metals than basic treatment. In addition to removing 80 percent total suspended solids, the HRM performance goal for enhanced treatment is 50 percent removal of dissolved copper and zinc for influent concentrations, ranging from 0.003 to 0.02 mg/L for dissolved copper and 0.02 to 0.3 mg/L for dissolved zinc (WSDOT 2008a).

While these families of BMPs have different performance goals for the stormwater they are designed to treat, the intent of treatment is the same—to produce stormwater discharges that comply with state and federal water quality criteria.





- Basin**
- Combined Sewer
 - East Lake Washington
 - Fairweather Creek
 - Lake Union
 - Lake Washington
 - Portage Bay
 - Union Bay
 - University Slough
- Outfall
 - Pump Station
 - Flow Pattern to Outfall
 - Wetland



Source: King County (2005) GIS Data (Streams and Streets), King County (2007) GIS Data (Water Bodies). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.



Exhibit 17. Current Study Area Creeks Stormwater Outfalls, Culverts, and Basin Boundaries

I-5 to Medina: Bridge Replacement and HOV Project

have included enhanced treatment facilities in the proposed stormwater treatment design (Exhibit 19).

Exhibit 18. How Ecology's Stormwater Regulations Apply to Road Projects

| If... | Then | How Does this Apply to the I-5 to Medina: Bridge Replacement and HOV Project? |
|--|--|---|
| A project proposes to add new impervious surface | Stormwater from the new impervious surface area must be treated. In addition, stormwater flow control measures would be required when increased discharges to local streams would alter aquatic habitats. | This project must build and maintain stormwater treatment and required flow control facilities in areas where new impervious surfaces are proposed. |
| A project proposes to retrofit existing impervious surfaces where stormwater is not treated and flows are not controlled | A project must build a system to treat stormwater from the existing impervious surface area. In addition, flow control measures would be required when increased discharges to local streams would alter aquatic habitats. | This project must build and maintain stormwater treatment and required flow control facilities in areas where existing impervious surfaces would be replaced. |

Exhibit 19. Stormwater Treatment and Flow Control Requirements for Study Area Threshold Discharge Areas

| TDA | Outfall Location | Detention Required | Required Treatment Level | Type of Proposed Facility |
|-----|---|----------------------|--------------------------|---|
| 7 | Lake Washington | Not applicable (N/A) | Basic | |
| 8 | Lake Washington | N/A | Basic | Emerging Technology BMP |
| 9 | Lake Washington | No | Basic | Constructed stormwater treatment wetland ^a ; media filter vaults |
| 10 | Union Bay via existing City of Seattle outfall | No | Basic | Constructed stormwater treatment wetland |
| 11 | Portage Bay via existing storm drain outfall at eastern shoreline | No | Basic | Constructed stormwater treatment wetland |
| 12 | Portage Bay via existing storm drain outfall at eastern shoreline | No | Basic | Constructed stormwater treatment wetland |
| 13 | Portage Bay via existing storm drain outfall at western shoreline | No | Basic | Constructed stormwater treatment wetland |
| 14 | Lake Union via existing storm system at Allison Street | No | Basic | Constructed stormwater treatment wetland; media filter vaults |

^aConstructed stormwater treatment wetlands have been designated as enhanced treatment BMPs.



Sizes of Stormwater Treatment and Flow Control Facilities

After establishing the type of treatment (basic or enhanced) system, designers determined the size of the facilities based on the expected volume of stormwater that would be generated by what is termed the “Water Quality Design Storm.” The Water Quality Design Storm volume is defined as “the volume of runoff predicted from a 6-month, 24-hour storm” (Ecology 2005). The total volume of stormwater runoff is a function of the Water Quality Design Storm designated for the study area and the area of impervious surface on which rain falls. For this project, designers determined the size of the individual treatment and flow control facilities based on the volume of water generated during the Water Quality Design Storm for each individual portion of the study area.

The **Water Quality Design Storm** is defined in the *Stormwater Management Manual for Western Washington* (Ecology 2005) as “a 24-hour storm with a 6-month return frequency” (also known as the 6-month, 24-hour storm). The design storm is used to calculate the size and capacity of flow control and stormwater treatment BMPs needed to effectively treat the volume of stormwater generated during such an event.

Basins versus Threshold Discharge Areas

In the typical stormwater treatment scheme, two terms are used to refer to the land area where the water resources are located – basins and Threshold Discharge Areas (TDAs). The HRM (WSDOT 2008a) defines these terms as follows:

- **Basin:** The area of land contributing runoff to a river and its tributaries that drains water, organic matter, dissolved nutrients, and sediments into a lake or stream (see watershed). Basins typically range in size from 1 to 50 square miles.
- **Threshold Discharge Area:** An onsite area draining to a single natural discharge location or multiple natural discharge locations that combine within 0.25-mile downstream (as determined by the shortest flow path).

Essentially, the basin is the entire land surface that contributes water to the water body of concern. In the study area, extensive development has disrupted the general pattern of water movement across the land surfaces into surface waters such as streams and lakes. Surface water flows have been redirected into ditches and culverts that drain to the major receiving water bodies.

Consequently, for this report, the study authors evaluated the specific environmental effects of this project by focusing on the impervious surfaces located in the study area that would generate stormwater runoff before and after construction. The TDA is the portion of the overall basin within the project limits that could be contributing surface water runoff, by redirecting precipitation from infiltrating the ground into stormwater runoff. TDAs provide a critical piece of information



used to determine the volume of water treated for flow control and water quality, as mandated by state law and the HRM. The individual TDAs for the study area numbered 7 through 14, with TDA 14 being the westernmost (Exhibit 20). The TDAs start with the number 7 rather than 1 since the numbering starts on the Eastside portion of the SR 520 right way (meaning that TDAs 1-6 are between Median and STR 522).

Types of Stormwater Treatment and Flow Control Facilities

The HRM presents two approaches to designing a system that complies with federal and state water quality regulations. These approaches are called the *presumptive approach* and the *demonstrative approach*. Both approaches “are based on best available science and result from existing federal and state laws that require stormwater treatment systems to be properly designed, constructed, maintained and operated” (WSDOT 2008a).

In the HRM, the presumptive approach specifies a menu of BMPs that designers can use to design a stormwater system to meet Ecology’s stormwater regulations. The HRM provides information to guide designers in “the proper selection, design, construction, implementation, operation, and maintenance of BMPs” (WSDOT 2008a). The HRM states that “projects that follow the stormwater BMPs contained in [the HRM] are presumed to have satisfied [the] demonstration requirement and do not need to provide technical justification to support the selection of BMPs” (WSDOT 2008a).

Alternatively, under the demonstrative approach, designers can design stormwater systems using stormwater BMPs and management approaches that are not included in the HRM. The demonstrative approach can be used if it:

- Can be demonstrated “that the project will not adversely impact water quality by collecting and providing appropriate supporting data to show that the alternative approach protects water quality and satisfies state and federal water quality laws”
- Satisfies the technology-based requirements of state and federal law (WSDOT 2008a)

Based on this guidance from the HRM, the study authors followed the presumptive approach to design the flow control and stormwater treatment facilities for the project’s study area. However, project designers determined that standard BMPs specified for water quality treatment under the presumptive approach could not be designed for



the floating bridge portion of the project. Instead, project designers applied the demonstrative approach to design a water quality treatment system for the floating portion of the bridge and to evaluate the potential effects of stormwater from the floating bridge to surface water bodies. Exhibit 21 identifies the steps followed to determine how the project would affect surface water resources using the presumptive and demonstrative approaches.

Proposed Stormwater Treatment Facilities for the 6-Lane Alternative Design Options

Project designers selected each BMP based on space constraints and discharge location. The designers also sized the treatment facilities to meet the HRM requirements for the 6-Lane Alternative with individual assessments for each design option. This report includes a description of the proposed stormwater treatment facilities for the receiving water body, as discussed below and summarized in Exhibit 22. Exhibits 23 through 25 provide maps with the locations of the facilities discussed below. Each treatment facility has a distinct designation on the Exhibit 23, 24, and 25 maps and in the discussion below.

Proposed Project Stormwater Treatment Facilities

Because of the absence of naturally operating basins that drain the land features to naturally meandering streams and creeks in the study area, the proposed project stormwater treatment facilities discussed here are based on land surface basins defined as all the water draining to specific receiving environments.

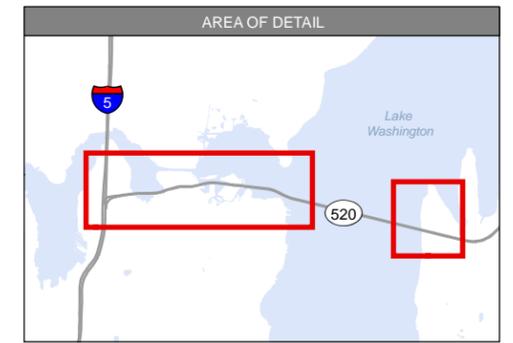
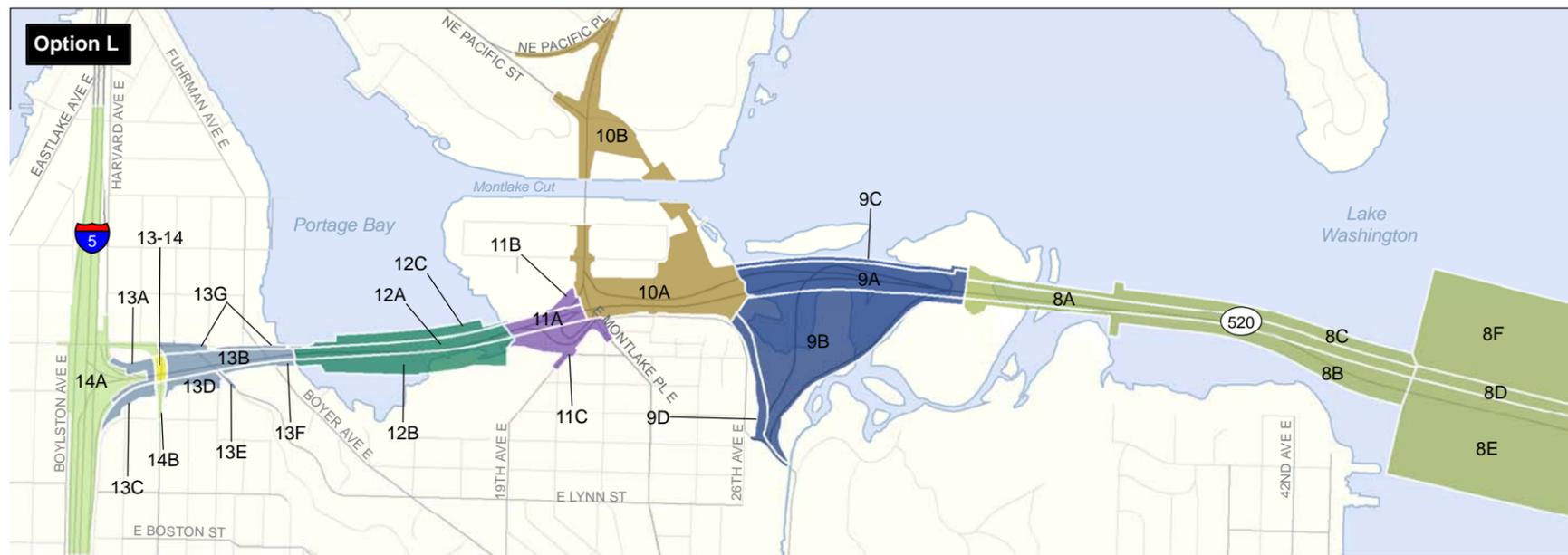
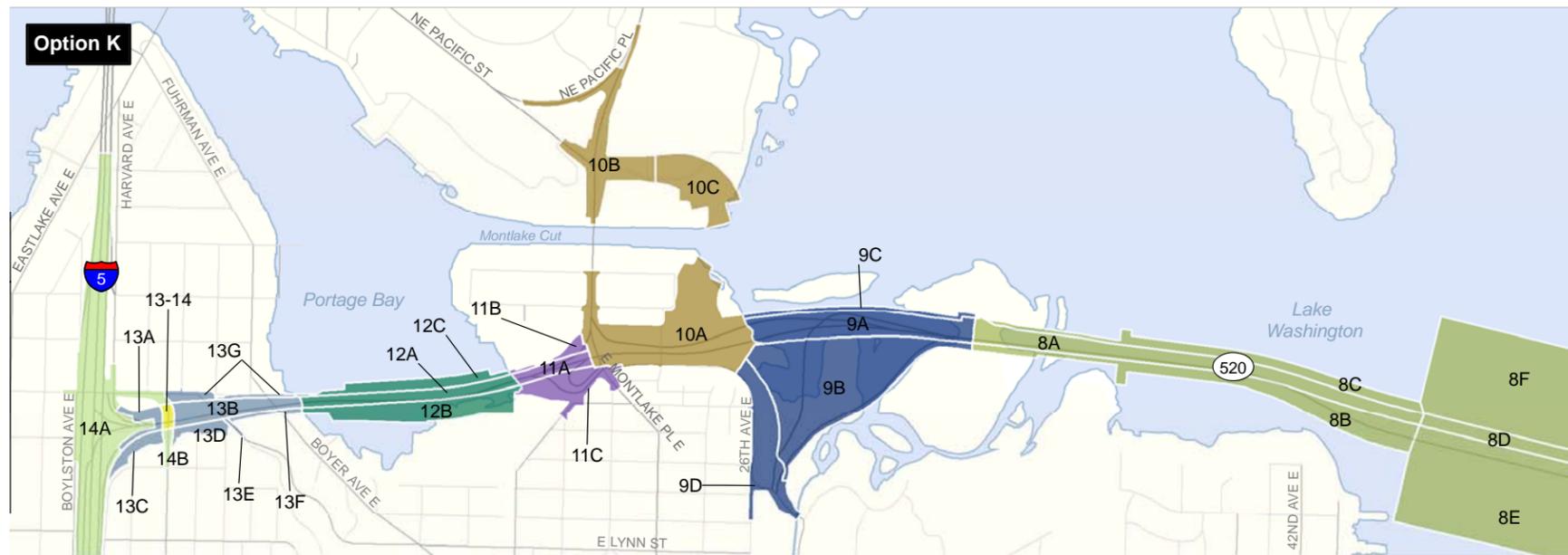
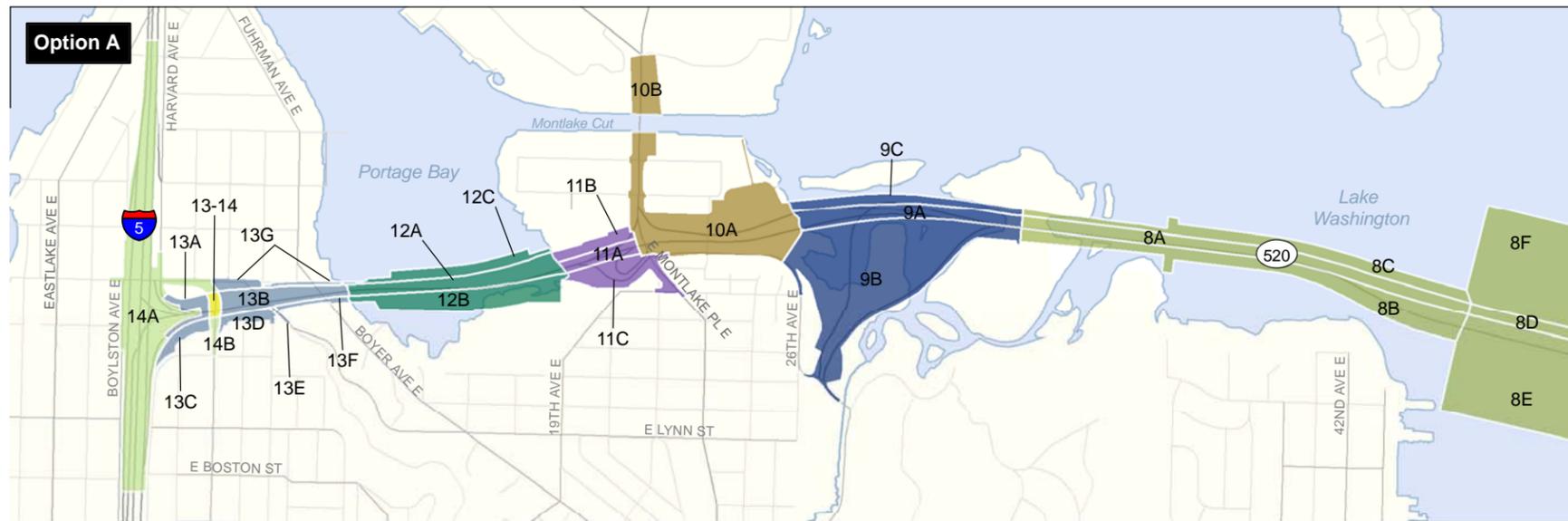
Lake Union

Three treatment facilities (P, Q, and T) would convey treated stormwater from TDA 14 to Lake Union via an existing stormwater system outfall located at Allison Street (Exhibits 22 through 25). Facility P would consist of a constructed stormwater treatment wetland (an enhanced BMP), while facilities Q and T would use media treatment vaults (a basic BMP) (Exhibit 22). All three options (A, K, and L) would use the same treatment BMPs at each facility location.

Portage Bay

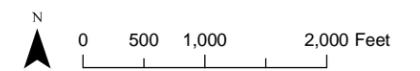
Three TDAs (11, 12, and 13) would discharge treated stormwater to Portage Bay through two existing outfalls – one on the eastern shoreline of Portage Bay and one on the western shoreline (Exhibits 22 through 25). Stormwater from TDA 13 would be treated at facility O with a constructed stormwater treatment wetland (an enhanced BMP) prior to discharge at the western shoreline. Stormwater from TDAs 11





Threshold Discharge Area (TDA)

- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 13-14
- 14



Source: King County (2005) GIS Data (Streets), King County (2007) GIS Data (Water Bodies), Parametrix (2009) GIS Data (TDA). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

Exhibit 20. Threshold Discharge Areas 7 to 14 for the Study Area

I-5 to Medina: Bridge Replacement and HOV Project



Exhibit 21. Steps Involved in Applying the Presumptive and Demonstrative Approaches for the Proposed Project

Steps followed to apply the presumptive approach for this project

- 1) Identify the surface water bodies receiving stormwater and the associated level(s) of flow control and water quality treatment required by the HRM.
- 2) Determine the total area of PGIS and the Water Quality Design Storm for the study area. With that information, determine the appropriate size and location for required treatment and flow control facilities.
- 3) Identify the types and combinations of flow control and water quality treatment BMPs to be used from the flowcharts provided in the HRM. Evaluate feasibility, location constraints, and costs.
- 4) Presume that the project has demonstrated compliance with state and federal water quality criteria based on the HRM guidance (WSDOT 2008a).

Steps followed to apply the demonstrative approach for this project

- 1) Identify the surface water bodies receiving stormwater and the associated level(s) of flow control and water quality treatment required by the HRM.
- 2) Determine the types of flow control BMPs that can be used. The BMPs can be taken from the HRM, or they can be new or innovative emerging technologies.
- 3) Perform All Known, Available, and Reasonable methods of prevention, control, and Treatment (AKART) analysis to identify and evaluate all possible stormwater treatment techniques that can be used on the floating portion of the replacement bridge.
- 4) Develop an approach to demonstrate that stormwater discharges would meet the flow control standards of the HRM and *Stormwater Management Manual for Western Washington*.
- 5) Demonstrate that stormwater discharges would meet relevant state criteria.

and 12 would also be treated using individual constructed wetlands then discharged to Portage Bay on the eastern shoreline (Exhibits 22 through 25). Options A, K, and L would use the same stormwater treatment designs for all three TDAs discharging to Portage Bay.

Union Bay

Treated stormwater from TDAs 8 (Option L only), 9, and 10 would be discharged to Union Bay using an existing City of Seattle outfall (Exhibits 22 through 25). Options A and K would convey stormwater from all of TDA 10 and part of TDA 9 to treatment facility M, which would consist of a constructed stormwater treatment wetland BMP (Exhibits 22 through 25). Option L would convey all stormwater from TDAs 9 and 10 and part of TDA 8 to treatment facility M for treatment using a stormwater wetland/pond BMP prior to discharge to Union Bay.

Lake Washington

The proposed treatments and Lake Washington discharge locations vary the greatest for TDAs 8 and 9. For Option A, approximately 15 percent of the stormwater volume from TDA 9 would be treated



using media filter vaults (a basic treatment BMP) at treatment facility V prior to discharge to Lake Washington (Exhibits 22 through 25). For Option K, approximately 6 percent of the stormwater volume in TDA 9 would be treated with media filter vaults at treatment facility Y, and approximately 11 percent would be treated with media filter vaults at treatment facility V. Both facilities would discharge treated stormwater to Lake Washington (Exhibits 22 through 25). As noted above, all stormwater from Option L would be conveyed to treatment facility M and then discharged to Union Bay. Stormwater from TDA 8 would be treated with an emerging technology BMP that is not yet identified and then discharged to Lake Washington (Exhibits 22 through 25).

Fairweather Creek Basin

Stormwater generated within the Fairweather Bay TDA would be treated using a constructed wetland to enhance water quality. This treatment facility would have no flow control (again because the discharge environment is the flow-exempt water body, Lake Washington). This facility (treatment facility I3) would be approximately 1.5 acres, with a 4-foot settling basin.

Acquisition of the Aubin property means that there would be only one discharge to Fairweather Bay – at the center of the south facility between the Aubin and Madden properties (ponds J and I3 would both discharge to this location). This outfall would discharge above ordinary high water into a constructed rock-lined ditch that would discharge through a weir constructed on the existing bulkhead. This weir would have a trapezoidal notch approximately 1 foot above lake full elevation. Water would be discharged through that weir. In-water work would be limited to the installation of up to two gabion mats (approximately 6 feet by 9 feet by 6 inches thick), which would be used to prevent scouring under the outfall (water depth in this area is approximately 5 feet).

Floating Bridge AKART Analysis Overview

As noted above, the floating bridge portion of the project has several features that restrict or prevent the use of Ecology-approved BMPs for stormwater treatment from the floating section of the bridge.

Specifically, the lack of adjacent land for treatment, along with weight restrictions on the bridge itself, precludes the use of the types of BMPs proposed for the land sections of this project, such as constructed wetlands and media filter vaults.

An **AKART Analysis** is conducted when a determination has been made that the standard BMPs identified in applicable stormwater management manuals cannot be used in a specific project or component of a project. The purpose of the AKART analysis is to develop and implement a project approach that met WSDOT objectives for stormwater treatment and discharge options, to evaluate stormwater treatment options, and to define and document the design constraints and feasible stormwater engineering options for a replacement floating bridge.



Exhibit 22. Proposed Stormwater Management Facility Characteristics

| TDA | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 |
|---|--|---|---|---|--|---|-------------------------|------------------------------|
| Outfall Location | Lake Union via existing storm system at Allison Street | Portage Bay via existing storm drain outfall at western shoreline | Portage Bay via existing storm drain outfall at eastern shoreline | Portage Bay via existing storm drain outfall at eastern shoreline | Union Bay via existing City of Seattle outfall | Lake Washington | Lake Washington | Lake Washington |
| Detention Required | No | No | No | No | No | No | No | No |
| Quality Treatment Required | Basic | Basic | Basic | Basic | Basic | Basic | Basic | Basic |
| Type of Proposed Facility | Constructed stormwater treatment wetland; media filter vault | Constructed stormwater treatment wetland; media filter vault | Constructed stormwater treatment wetland | Constructed stormwater treatment wetland | Constructed stormwater treatment wetland; bioswale; media filter vault | Constructed stormwater treatment wetland; media filter vaults | Emerging Technology BMP | Bioswale; media filter vault |
| Detention/Wet Vault Depth | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Detention/Wet Vault Width | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Stormwater Wetland/Wet Pond Depth (Average depth in wetland 1.5') | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | N/A | N/A | N/A |
| Option A | | | | | | | | |
| Existing Impervious Area (acres) | 23.57 | 5.36 | 2.99 | 5.38 | 13.23 | 9.31 | 17.6 | 1.26 |
| Proposed Impervious Area (acres) | 24.58 | 7.57 | 5.61 | 6.09 | 15.05 | 8.44 | 33.93 | 4.33 |
| Added Impervious Area | 1.01 | 2.21 | 2.62 | 0.71 | 1.82 | -0.87 | 16.33 | 3.07 |
| Added Impervious (%) | 4% | 41% | 88% | 13% | 14% | -9% | 93% | 244% |
| Proposed Facilities | P, Q | O, T | N | N | M, U | M, V | V | K |
| Treatment Volume (cubic feet) | 14,835 | 32,190 | 54,023 ^a | 54,023 ^a | 90,827 ^b | 90,827 ^b | N/A | N/A |
| Level 2 Detention Volume (cubic feet) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Surface Area of Stormwater Wetland/Pond (square feet) | 6,600 | 12,279 | 18,895 ^a | 18,895 ^a | 41,942 ^b | 41,942 ^b | N/A | N/A |
| Media Filter Vault Dimension | 6' x 12' | 6' x 12' | N/A | N/A | 8' x 16' | 6' x 12' | 8' x 16' | 6' x 12' |
| Option K | | | | | | | | |
| Existing Impervious Area (acres) | 23.57 | 5.36 | 2.99 | 4.27 | 19.52 | 10.23 | 17.63 | 1.26 |
| Proposed Impervious Area (acres) | 24.58 | 7.57 | 4.59 | 3.54 | 25.05 | 15.48 | 35.26 | 3.79 |
| Added Impervious Area | 1.01 | 2.21 | 1.6 | -0.73 | 5.53 | 5.25 | 17.63 | 2.53 |
| Added Impervious % | 4% | 41% | 54% | -17% | 28% | 51% | 100% | 201% |



Exhibit 22. Proposed Stormwater Management Facility Characteristics

| TDA | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 |
|---|--|---|---|---|--|------------------------------|----------------------|-----------------|
| Outfall Location | Lake Union via existing storm system at Allison Street | Portage Bay via existing storm drain outfall at western shoreline | Portage Bay via existing storm drain outfall at eastern shoreline | Portage Bay via existing storm drain outfall at eastern shoreline | Union Bay via existing City of Seattle outfall | Lake Washington | Lake Washington | Lake Washington |
| Proposed Facilities | P, Q | O, T | N | N | M, U | M, Y, V | V | K |
| Basic Treatment Volume (cubic feet) | 14,835 | 32,190 | 39,906 ^a | 39,906 ^a | 135,015 ^b | 135,015 ^b | N/A | N/A |
| Level 2 Detention Volume (cubic feet) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Surface Area of Stormwater Wetland/Pond (square feet) | 6,600 | 12,279 | 41,065 ^a | 41,065 ^a | 46,993 ^b | 46,993 ^b | N/A | N/A |
| Media Filter Vault Dimension | 6' x 12' | 6' x 12' | N/A | N/A | 8' x 24' | 8' x 16'; 6' x 12' | 8' x 16' | 6' x 12' |
| Option L | | | | | | | | |
| Existing Impervious Area (acres) | 23.57 | 5.36 | 2.99 | 4.18 | 19.38 | 9.14 | 17.6 | 1.26 |
| Proposed Impervious Area (acres) | 24.58 | 7.57 | 4.85 | 3.92 | 21.61 | 13.25 | 33.93 | 3.79 |
| Added Impervious Area | 1.01 | 2.21 | 1.86 | -0.26 | 2.23 | 4.11 | 16.33 | 2.53 |
| Added Impervious % | 4% | 41% | 62% | -6% | 12% | 45% | 93% | 201% |
| Proposed Facilities | P, Q | O, T | N | N | M, U | M, L | M | K |
| Basic Treatment Volume (cubic feet) | 14,835 | 31,290 | 42,062 ^a | 42,062 ^a | 156,522 ^b | 156,522 ^b ; 9,234 | 156,522 ^b | N/A |
| Level 2 Detention Volume (cubic feet) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Surface Area of Stormwater Wetland/Pond (square feet) | 6,600 | 12,279 | 33,198 ^a | 33,198 ^a | 62,613 ^b | 62,613 ^b ; 5,089 | 62,613 ^b | N/A |
| Media Filter Vault Dimension | 6' x 12' | 6' x 12' | N/A | N/A | 8' x 24' | 8' x 16'; 6' x 12' | 8' x 16' | 6' x 12' |

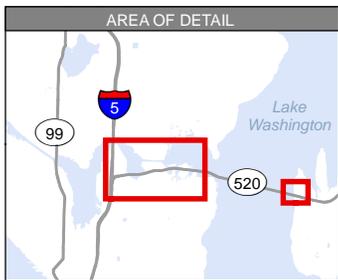
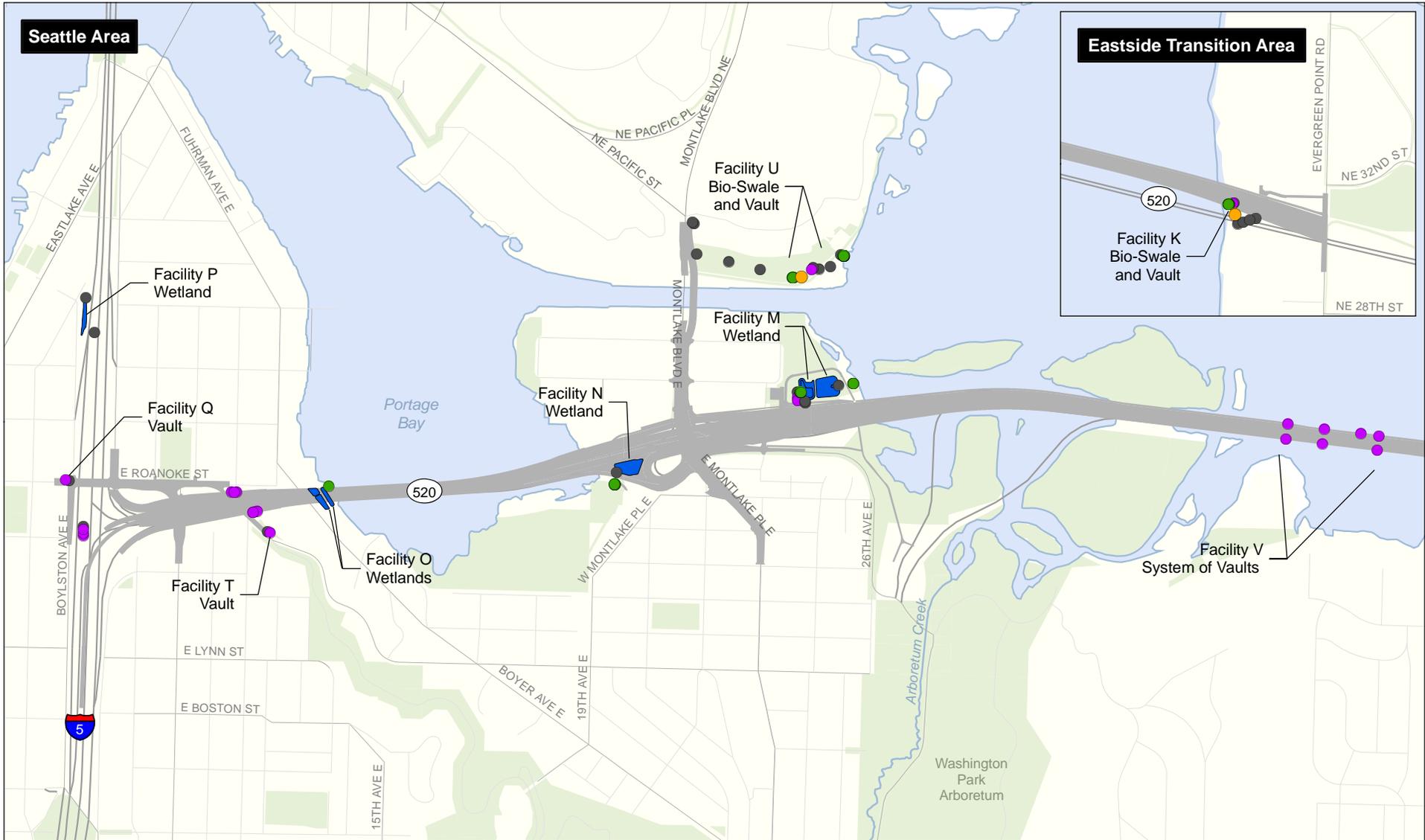
Source: HDR et al. 2009

Note: TDAs are presented in order from west to east (that is, TDA 14 is the westernmost TDA in the project).

^a Treatment volume for Facility N is computed for TDAs 11 and 12 combined as a single facility.

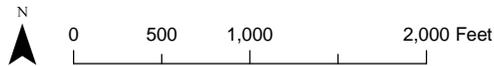
^b Treatment volume for Facility M is computed for TDAs 9 and 10 combined as a single facility.





Proposed Stormwater Facility

- Biofiltration Swale
- Drainage Structure
- Outfall
- Vault
- Stormwater Pond
- Stream
- Park
- Pavement

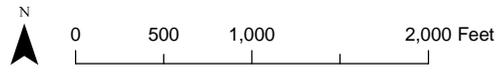
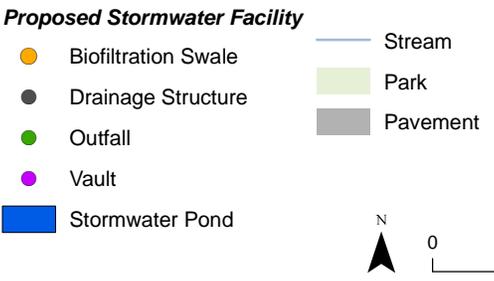
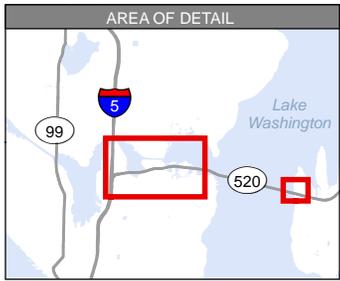


Source: King County (2005) GIS Data (Streets), King County (2007) GIS Data (Water Bodies). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.



Exhibit 23. Proposed Stormwater Management Facilities (Option A)

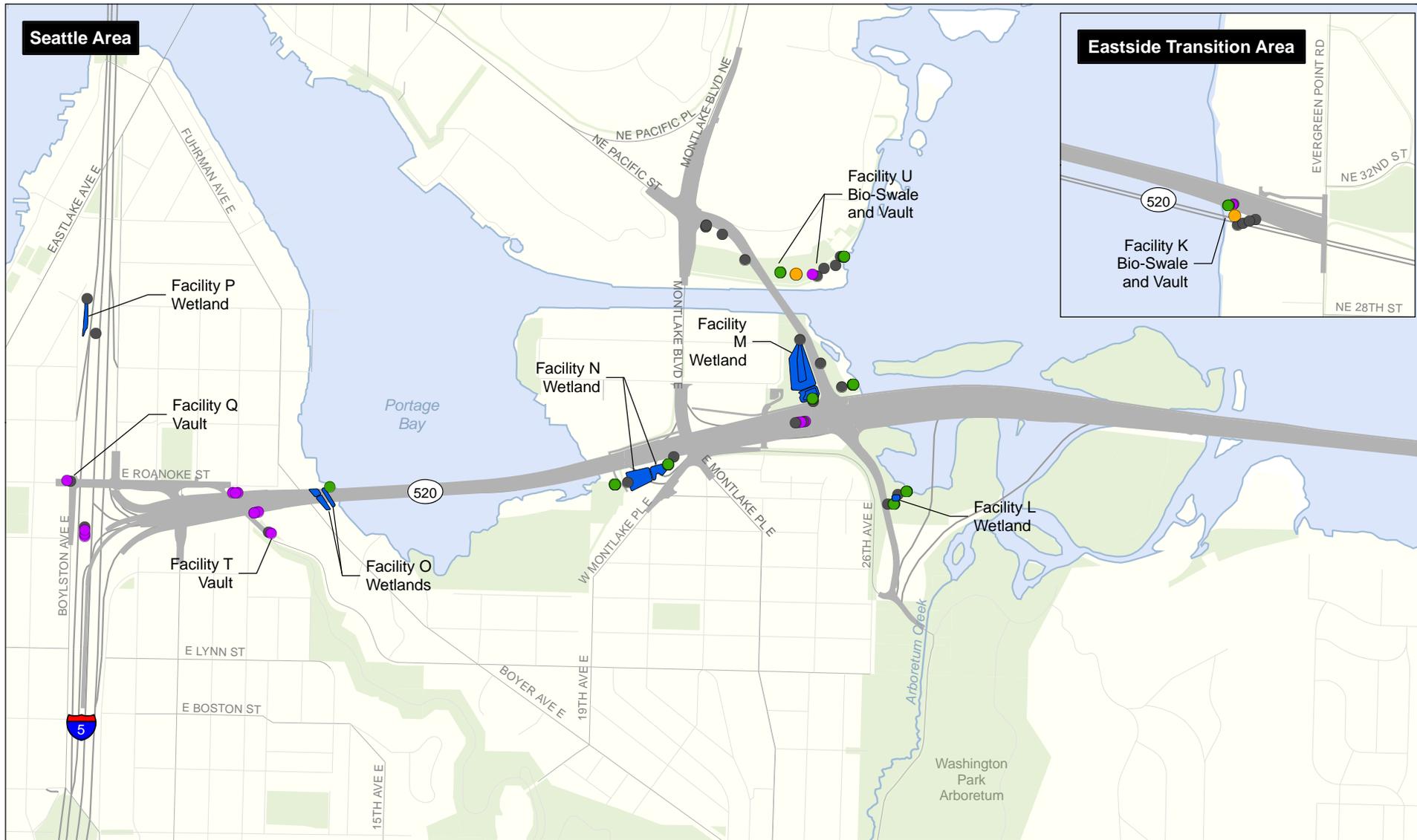
I-5 to Medina: Bridge Replacement and HOV Project



Source: King County (2005) GIS Data (Streets), King County (2007) GIS Data (Water Bodies). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.

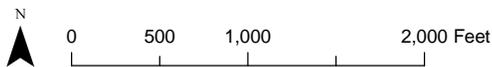


Exhibit 24. Proposed Stormwater Management Facilities (Option K)
I-5 to Medina: Bridge Replacement and HOV Project



Proposed Stormwater Facility

- Biofiltration Swale
- Drainage Structure
- Outfall
- Vault
- Stormwater Pond
- Stream
- Park
- Pavement



Source: King County (2005) GIS Data (Streets), King County (2007) GIS Data (Water Bodies). Horizontal datum for all layers is NAD83(91); vertical datum for layers is NAVD88.



Exhibit 25. Proposed Stormwater Management Facilities (Option L)

I-5 to Medina: Bridge Replacement and HOV Project

WSDOT conducted a series of evaluations of available and reasonable technologies that could be applied in the bridge setting, referred to as an All Known, Available, and Reasonable methods of prevention, control, and Treatment (AKART) analysis (CH2M HILL 2002; CH2M HILL 2006; CH2M HILL 2009a; CH2M HILL 2009b).

The AKART analysis conducted for the floating bridge had two phases:

- **AKART Technology Survey:** evaluating and selecting the most cost-effective stormwater treatment technologies that could work within the confines and limitations of the floating bridge
- **AKART Water Quality Modeling:** a modeling assessment of future stormwater discharges after treatment from the floating bridge

AKART Technology Survey

The technology survey and evaluation identified four technology categories to review:

- Media filtration – vaults
- Catch basin media filtration
- High-efficiency sweeping
- Modified catch basins/cleaning

After applying a set of screening criteria, the AKART analysis determined the most effective stormwater treatment technology to be the high-efficiency sweeping and modified catch basin/cleaning stormwater BMPs on the floating portion of the proposed bridge. These BMPs are considered to offer the most reasonable technologies for addressing water quality on the floating bridge based on technical feasibility and cost effectiveness. This combination of technologies has the following benefits for the proposed floating bridge:

- It can meet water quality standards for sediments and metals that would be discharged to surface water bodies.
- It is able to retain turbid stormwater effectively removing sediment before stormwater is discharged.
- It does not have an unreasonable or unknown level of risk of treatment failure associated with operation and maintenance, which can be characteristic of the other technologies.

High-efficiency Sweeping

This category is an "emerging technology" described in the *Stormwater Management Manual for Western Washington* (Ecology 2005). This alternative uses "new generation" sweeping equipment to prevent pollutants from entering the drainage systems and receiving waters. The technology consists of high-pressure air circulation and vacuuming of pollutants from the bridge road surface into a sweeping vehicle. Pollutants are collected in the sweeping vehicle and driven off the bridge.

Modified Catch Basin Sweeping/Cleaning

This technology category consists of combining larger than standard catch basin drainage structures (sized for increased sediment trapping capability) with a scheduled cleaning of trapped pollutants. Larger than standard sumps would provide increased residence time for sediments to collect prior to removal. In addition, oil/grease trapping could be provided with submerged outlets.



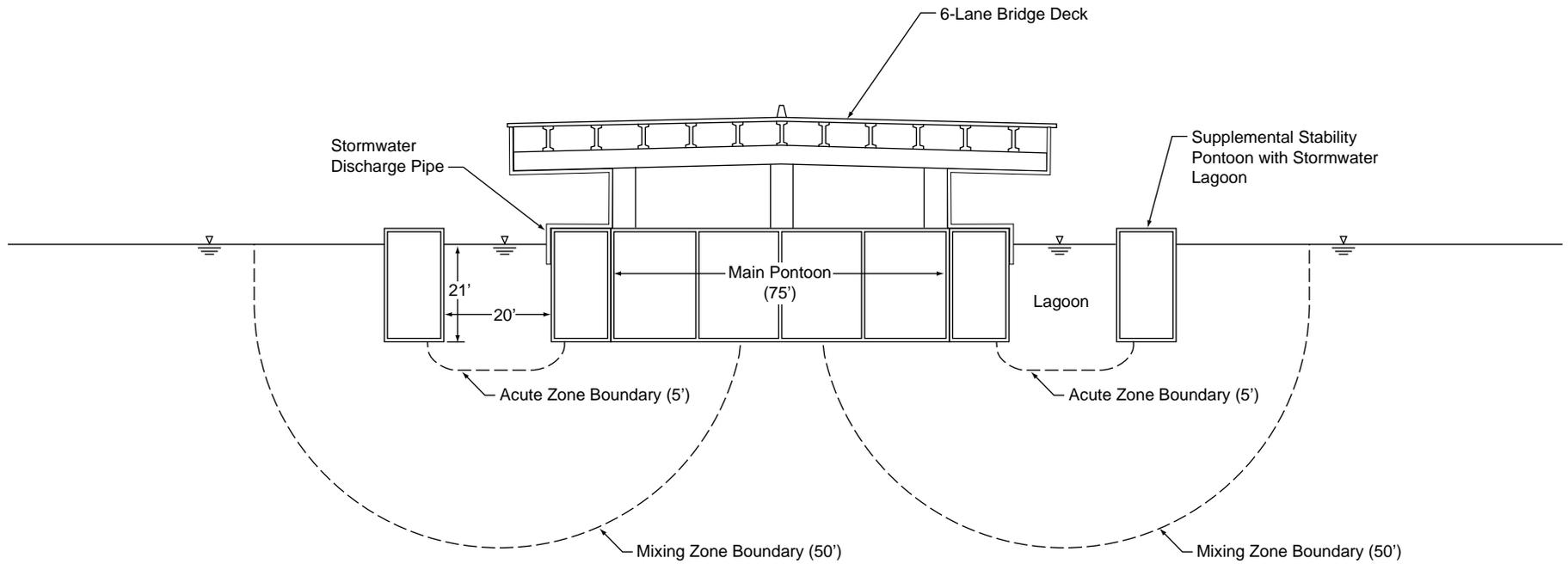
The proposed floating bridge design creates separate enclosed spill containment lagoons within supplemental stability pontoons (SSPs). The SSPs are designed to provide (1) structural stability, (2) an area where roadway spill of petroleum or floatable substances would be contained and allow for efficient cleanup, and (3) an area where additional dilution of stormwater would occur prior to discharge beneath the bridge. Exhibit 26 provides a schematic plan view drawing of the spill containment lagoon for the 6-Lane Alternative, which is currently being considered for the I-5 to Medina: Bridge Replacement and HOV Project. The proposed stormwater drainage system is designed to discharge all runoff into the spill containment lagoons within the SSPs.

AKART Water Quality Modeling

The water quality modeling element of the AKART study evaluated discharges to assess their potential effect in the lagoon and the adjacent lake. Using relevant stormwater and Lake Washington water quality data, the AKART water quality modeling used dilution models representing potential bridge stormwater discharges for the replacement floating bridge design (CH2M HILL 2009a; CH2M HILL 2009b). Analyses used the parameters that the Federal Highway Administration lists as constituents of highway runoff: TSS, copper, zinc, cadmium, lead, and oil and grease. Concentrations of these pollutants were compared with the applicable state water quality standards in WAC 173- 201A. After stormwater has mixed with the lake waters, existing water quality was compared with the state water quality standards at appropriate distances from the point of discharge, referred to as mixing zone boundaries. Exhibit 27 shows the three regions where mixing would occur: (1) within the lagoon, (2) at the interface of the lagoon bottom and the lake, and (3) between the interface region and the defined mixing zone boundary.

The stormwater discharges into each lagoon would be conveyed directly below the lagoon surface through an 8-inch or larger vertical pipe. The vertical drop from catch basins or vaults under the roadway deck to the pipe terminus below the water surface would range from 20 feet to 30 feet in sections of the bridge. These substantial distances create a gravity-induced discharge jet velocity for the stormwater discharged into the lagoons. This discharge jet velocity provides immediate turbulent mixing of stormwater with lagoon water. In addition, the density differences between stormwater and lagoon





Note: Ambient current direction will orient stormwater plume to one side of the mixing zone (north or south) at a time.

Exhibit 26. Schematic Section View of Floating Bridge Showing Stormwater Lagoons and Mixing Zone Boundaries
I-5 to Medina: Bridge Replacement and HOV Project

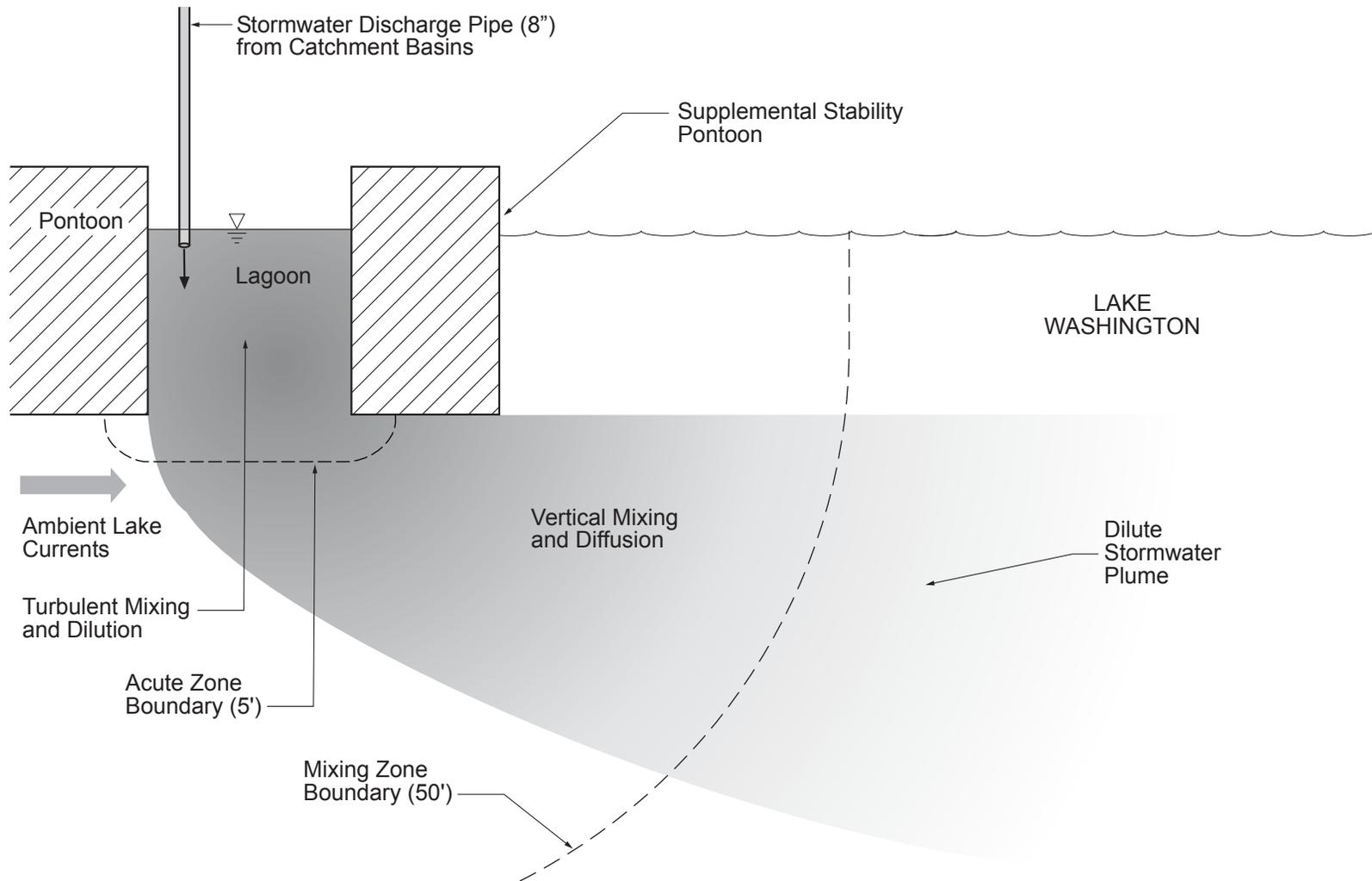


Exhibit 27. **Schematic Representation
of Stormwater Mixing Processes for
Floating Bridge**

I-5 to Medina: Bridge Replacement and HOV Project

water enable entrainment of lagoon water into the stormwater (dilution), as well as density-driven diffusion in the lagoon. The lagoon depths would be 21 feet at a minimum and greater with the bridge loaded with automobiles.

The dilutions predicted at the lagoon interface with the lake are based on dilution modeling of the lagoon discharge into the lake water. These predictions represent the dilutions at a distance of 5 feet from the lagoon opening. A dilution model produced by EPA (called UOUTPLM) was used to construct a representation of the vertical discharge from the lagoon into the lake. Results of the dilution modeling are discussed below under Potential Effects of the Project.



Potential Effects of the Project

What methods were used to evaluate the potential effects?

Surface Water Resources

The study authors used WSDOT- and Ecology-approved methods to evaluate effects of stormwater on surface water bodies. WSDOT's approved methods for evaluating effects on surface water resources are described in WSDOT's *Environmental Procedures Manual* (2008b) and the HRM (WSDOT 2008a). The *Environmental Procedures Manual* provides guidance to ensure compliance with federal, state, and local laws during the planning, design, construction, and maintenance of WSDOT road projects. The HRM is the manual used by WSDOT to design stormwater systems that meet Ecology's water quality standards. Dilution modeling was performed as part of the AKART analysis to evaluate the resulting water quality in the receiving environment.

In addition, the study authors evaluated temporary effects to surface water during construction. These effects were evaluated by determining construction actions that may disturb soil and in-water sediments and by assessing the potential for accidental spills of hazardous materials.

Groundwater Resources

The study authors reviewed Ecology's policies and regulations to establish the criteria for determining the potential effects of this project. They then evaluated the potential permanent effects on groundwater quantity and quality, focusing on how each alternative could decrease existing well yields, decrease base flow discharge to local surface waters, or degrade the quality of groundwater pumped for water supply or local surface water flow. They also evaluated whether the project would reduce the size of the recharge areas, degrade the quantity of runoff entering the recharge area, or cause dangerous and hazardous chemical spills. The qualitative and quantitative measures they used to evaluate potential effects were:

- Length of highway crossing over critical aquifer recharge areas and wellhead protection areas



- The number of people using groundwater for their water supply who could potentially be affected
- Length of highway crossing over shallow unconfined aquifers unprotected by overlying till or another similar low-permeability layer

The study authors determined the effects on groundwater by asking the following questions:

1. Could stormwater infiltration transport contaminants into groundwater aquifers and degrade aquifer water quality?
2. Would groundwater recharge be affected enough to reduce the quantity of groundwater for drinking sources and base flows to surface water?

How would construction of the project affect water resources?

Construction effects on surface water bodies were evaluated by determining construction actions that may disturb soil and in-water sediments and by assessing the potential for accidental spills of hazardous materials.

Portage Bay and Union Bay

Potential effects on surface water bodies from constructing any of the three options of the 6-Lane Alternative in the study area could be related to:

- The installation, use, and removal of work bridges for construction of the Portage Bay Bridge, as well as the demolition of the existing Portage Bay Bridge
- The installation, use, and removal of work bridges for Option K in the Montlake area to allow for the construction of this option
- Installation, use, and removal of the temporary detour bridge to allow construction of the new Evergreen Point Bridge's west approach from the existing bridge, as well as demolition of the existing bridge (which applies to all three options)

These effects could be avoided, minimized, and mitigated through the development and implementation of a temporary erosion and sediment control (TESC) plan, a spill prevention control and countermeasures (SPCC)



plan, and a concrete containment and disposal plan (WSDOT 2008a). A TESC plan would detail the risk of erosion in different parts of the study area and would specify BMPs to be installed prior to construction activities. The SPCC plan would be prepared by the contractor(s) selected to complete the final design of the project, as required by WSDOT Standard Specification 1-07.15(1) (WSDOT 2008a). In the concrete containment and disposal plan, the contractor would explain how concrete would be managed, contained, and disposed of. The contractor should also discuss how high pH levels could be mitigated because it is of concern to aquatic species due to the use of concrete for bridge construction. Each of these plans would include performance standards based on state regulations, such as turbidity and TSS levels in stormwater discharged from construction staging and work areas. Construction of any of the three options for the 6-Lane Alternative would require compliance with approved TESC and SPCC plans that would be based on these performance standards.

In-water Work—Containment Best Management Practices

The following BMPs apply where demolition activity would occur in waters of the state. These procedures could be implemented for demolition 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.

- Construction Stormwater Pollution Prevention Planning—Preparation of a stormwater pollution prevention plan, TESC plan, and a SPCC plan would be completed prior to any construction or demolition activities.
- Oil Containment Boom—An oil containment boom is a floating barrier that can be used to contain oil and help to prevent 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—This barrier is designed to control 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 marine environment. The containment of settleable solids is desirable to reduce the impact area.
- Underwater Containment System/Temporary Cofferdam—The contractor can implement this element to prevent sediment, concrete, and steel debris from mixing with waters of the state. Examples could include



a temporary cofferdam, an oversized steel casing, or another type of underwater containment system that is developed by the contractor. This application would allow demolition work to be completed on and around an underwater structure and isolate the work zone. The system could also allow work to be completed at or below the mudline as determined by removal requirements by the state and the contractor. Construction water and slurry within the containment system could be removed, treated, and pumped to an acceptable discharge location upon completion of the demolition.

- **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 is provided to remove additional suspended solids below an acceptable size (25 microns typical). 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 can be located on a work bridge or a barge.

Portage Bay

Construction of the Portage Bay Bridge would require building temporary work bridges to the north and south of the existing bridge. Finger piers, perpendicular to the existing bridge, would be constructed to allow access to the existing and proposed bridge columns. Construction of the Evergreen Point Bridge would require building a 60-foot-wide temporary detour bridge south of the existing west approach to the Evergreen Point Bridge.

Montlake Area—Option A

No temporary bridge would be necessary to construct a second, parallel bascule bridge.

Montlake Area—Option K

Work bridges and finger piers would be constructed east of the Montlake shoreline to facilitate construction of the new SR 520 roadway. A temporary main-line detour bridge would be constructed for traffic from Montlake Boulevard to Foster Island south of the existing roadway.



Montlake Area—Option L

Work bridges and finger piers would be constructed along the Montlake shoreline to facilitate construction of the new SR 520 roadway. Also, additional temporary roadways would be constructed to facilitate traffic movement from Portage Bay eastbound and to and from the neighborhood areas south of the roadway to Montlake Boulevard.

West Approach Area—Option A

The northern half of the new west approach bridge would be constructed first, beginning with work bridges north of the existing Union Bay and west approach bridges. Finger piers would allow access from the work bridges to the existing and proposed columns. The northern half of the west approach bridge would be constructed from a work bridge. If possible, barges would be used in certain locations.

West Approach Area—Option K

Use of work bridges and construction of the west approach bridge leading up to the depressed SPUI and tunnel construction activities would occur similar to that described under Option A. Stormwater vaults and a pump station would be constructed at the east and west end of the Foster Island land bridge.

West Approach Area—Option L

Use of work bridges and construction of the west approach bridge leading up to the elevated SPUI and Montlake Cut crossing would occur similar to that described under Option A.

Lake Washington

The potential construction water quality effects of replacing the floating bridge section in Lake Washington would involve installing the pontoons for the floating portion of the Evergreen Point Bridge. The bridge pontoons would be held in place by attaching anchor cables to either large concrete blocks or 35- to 40-foot fluke anchors. All anchors and blocks would be located at a depth of 29 feet or deeper in the lake. Installation of these anchors will likely temporarily displace sediment from the substrate and suspend it in the water column.

Over the long term, placement of the anchors likely would not have a detectable effect on the lake bottom benthic community. The area that would be excavated is very small in comparison to the area of the entire



lake bottom. New colonies of benthic organisms would rapidly repopulate those areas of the lake bottom that were disturbed.

The sediments that are disturbed during installation of the anchors could result in an increase in the mortality of benthic organisms living in the sediments next to where the anchors would be installed. As with the displaced invertebrates, this is not likely to have a detectable effect on the lake bottom benthic community over the long term. The overall small area that would be covered by redeposited sediment and the rapid rates of recruitment by these organisms from the water column would help ensure that these covered areas are quickly recolonized.

Increased turbidity could affect water quality by (1) absorbing and scattering light, and (2) interfering with oxygen exchange of fish and invertebrates by clogging and damaging their gills. The level of turbidity that would clog and damage fish gills would be much higher than what would be discharged to the lake. Under the typical NPDES permit conditions, any time turbidity is 249 nephelometric turbidity units (NTUs) or greater, WSDOT is required to report this condition to Ecology and correct it within 7 days. The BMPs and implementation of the TESC plan are designed to ensure that the observed NTU levels are low (typically under 25 NTUs). In addition, a common water quality standard for an NPDES general construction permit may also establish a mixing zone and a turbidity standard at the edge of that zone – typically not to exceed 5 NTUs over background levels for the water body in question, when such background levels are less than 50 NTU (as is the case with Lake Washington, which can have summertime background turbidity of 2 to 8 NTUs).

How would construction of the project affect groundwater?

Potential effects on groundwater during construction of the 6-Lane Alternative would be related to:

- The project's disturbed area footprint during construction
- Any dewatering required during construction

Construction of roadways and bridges may temporarily alter the flow of groundwater. For example, groundwater could be affected by the temporary piles being driven into the ground to provide a framework for bridge or wall construction. Piles or shafts act as obstacles that groundwater must flow around. Another construction activity that



could temporarily alter groundwater flow is the use of dewatering wells to lower groundwater levels to allow subsurface construction in a dry environment. This could cause a temporary reversal of groundwater flow towards the construction area; however, these effects would be localized and temporary.

Possible areas of dewatering include the east side of the Portage Bay Bridge (Dawson pers. comm. 2004). Where retaining walls need to be installed, dewatering rates would be an estimated 5 gallons per minute or fewer per linear foot of wall construction. The duration of a wall installation would be between 1 and 5 weeks (Dawson pers. comm. 2004).

Groundwater generated from dewatering activities during construction would be stored in either temporary treatment ponds at or near the location of the permanent constructed stormwater treatment wetlands or in portable steel tanks. Water would be stored for a sufficient amount of time to allow particles to settle, or chemical flocculants could be used to reduce suspended particles before the water is discharged to the stormwater system. For more details, see the Geology and Soils Discipline Report (WSDOT 2009f).

The three options – A, K, and L – would add different amounts of impervious surface, thereby reducing the size of the recharge area; this reduction in recharge area would be small compared with the entire groundwater basin. Therefore, for all practical purposes, there would be no difference among the options in their effects on groundwater recharge.

The effects on groundwater quality from the three options are minor. Under the No Build Alternative, stormwater runoff would continue to be directly discharged to surface water bodies, but the 6-Lane Alternative options would include permanent stormwater BMPs to treat stormwater runoff removes particles and compounds before discharging to surface water bodies. The treated stormwater would infiltrate into the ground and provide some groundwater recharge within the study area.

Construction effects on groundwater would also be similar under any of the three options. Each option would require the same kinds of construction activities, including installation of temporary piles or shafts and dewatering. These activities would have similar effects on the groundwater system.



How would operation of the project affect water resources?

Operation of the future replacement bridge and HOV/transit lanes could affect water resources by the discharge of stormwater containing typical road surface pollutants to adjacent receiving environments. Evaluating these operational effects requires determining the existing loads of these pollutants to compare with future pollutant loads. Making this comparison requires identifying the existing and future pollutant generating surfaces for each option. There are four types of PGISs (Exhibit 28) for each option that are involved in this calculation:

- Existing PGIS, untreated, replaced
- Existing PGIS, untreated, removed
- Replaced PGIS (future), treated
- New PGIS (future), treated

Existing pollutant loads were generated by the sum of existing PGIS, untreated, to be replaced, and of existing PGIS, untreated, to be permanently removed (Exhibit 28). Future pollutant loads were generated from the sum of replaced PGIS (future), treated, and new PGIS (future), treated (Exhibit 28). The specific acreages varied among options due to specific design elements (Exhibit 29).

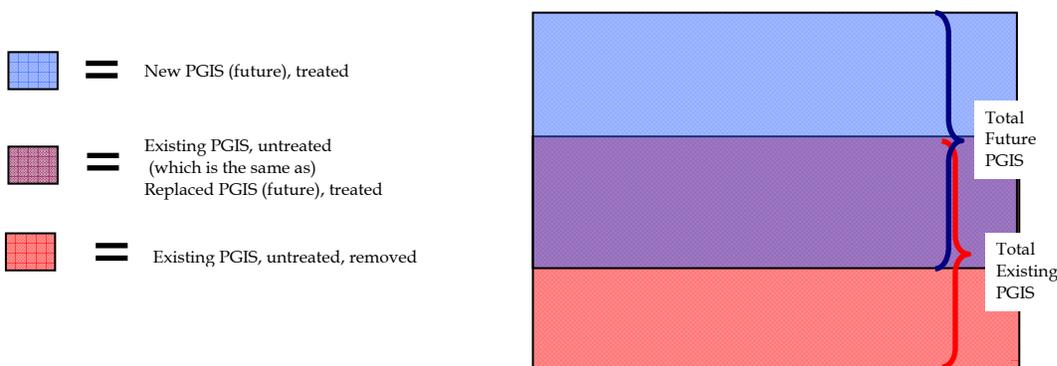


Exhibit 28. Project Pollutant-generating Impervious Surface Examples

No Build Alternative

Surface water quality in Lake Union, Portage Bay, and the west side of Lake Washington would be unchanged under the No Build Alternative. Under this alternative, stormwater from the highway discharging to Lake Union, Portage Bay, and the west side of Lake Washington would



Exhibit 29. Pollutant-generating Impervious Surface (acres)

| | Threshold Discharge Areas | | | | | | | | Total Project |
|---|---------------------------|------|------|------|-----|-----|-----|------|---------------|
| | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | |
| Option A – Pollutant-Generating Impervious Surface (acres) | | | | | | | | | |
| Existing Untreated | 1.3 | 17.6 | 8.5 | 12.8 | 5.3 | 3.0 | 5.4 | 3.7 | 57.5 |
| Replaced Treated | 0.7 | 2.8 | 4.5 | 9.5 | 4.2 | 2.1 | 5.3 | 3.7 | 32.8 |
| Removed Untreated | 0.5 | 14.8 | 4.0 | 3.3 | 1.2 | 0.9 | 0.1 | 0.0 | 24.8 |
| New Treated | 2.8 | 26.9 | 2.9 | 4.0 | 1.4 | 3.5 | 2.3 | 1.0 | 44.7 |
| Total Future | 3.5 | 29.6 | 7.4 | 13.5 | 5.6 | 5.6 | 7.6 | 4.7 | 77.5 |
| % Total Future Treated ^a | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Option K – Pollutant-Generating Impervious Surface (acres) | | | | | | | | | |
| Existing Untreated | 1.3 | 17.6 | 10.2 | 18.8 | 4.3 | 3.0 | 5.4 | 3.7 | 64.2 |
| Replaced Treated | 0.7 | 3.7 | 6.6 | 16.3 | 3.2 | 2.5 | 5.3 | 3.7 | 42.0 |
| Removed Untreated | 0.5 | 13.9 | 3.6 | 2.5 | 1.1 | 0.5 | 0.1 | 0 | 22.2 |
| New Treated | 2.8 | 27.1 | 8.0 | 7.7 | 0.3 | 2.1 | 2.3 | 1.03 | 51.3 |
| Total Future | 3.5 | 30.8 | 14.6 | 24.1 | 3.5 | 4.6 | 7.6 | 4.72 | 93.3 |
| % Total Future Treated | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Option L – Pollutant-Generating Impervious Surface (acres) | | | | | | | | | |
| Existing Untreated | 1.3 | 17.6 | 6.8 | 18.5 | 4.2 | 3.0 | 5.4 | 3.7 | 60.4 |
| Replaced Treated | 0.7 | 2.78 | 5.4 | 15.8 | 3.3 | 2.5 | 5.3 | 3.7 | 39.5 |
| Removed Untreated | 0.5 | 14.8 | 1.4 | 2.7 | 0.9 | 0.5 | 0.1 | 0 | 20.9 |
| New Treated | 2.8 | 26.9 | 7.0 | 4.7 | 0.6 | 2.4 | 2.3 | 1.0 | 47.5 |
| Total Future | 3.5 | 29.6 | 12.4 | 20.4 | 3.9 | 4.9 | 7.6 | 4.7 | 87.0 |
| % Total Future Treated | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

^aFuture treated pollutant-generating impervious surface includes both the new and the remaining existing impervious surface that would be present once the project has been constructed.

continue to be untreated. Planning-level forecasts conducted as part of this project estimated that traffic levels between the I-5/SR 520 interchange and the Montlake interchange would increase 5 percent over existing levels between 2002 and 2030, which could increase future pollutant-loading to SR 520 roadways. Surface water effects under this scenario would be the same as for existing conditions, where water resources affected by discharges of untreated stormwater or water quality could slightly degrade due to predicted increased pollutant-loading.



Option A

Option A of the 6-Lane Alternative would construct a stormwater system that, overall, would reduce pollutant-loading to stormwater discharged to Lake Union, Portage Bay, and Union Bay compared with existing conditions (Exhibit 30). Stormwater discharges from these areas would meet water quality according to the HRM presumptive approach. Stormwater discharges to a portion of Lake Union, including all of Portage Bay and Union Bay, would receive enhanced treatment that would exceed the minimum level of treatment required by the HRM.

The stormwater treatment system proposed under Option A would decrease pollutant-loading to Lake Union, Portage Bay west, and Union Bay compared with the No Build Alternative (Exhibit 30). Loading of dissolved zinc to TDA 7 would increase slightly as would dissolved copper to TDAs 7, 8, and 12 under Option A, while the total project load of all five pollutants to all TDAs under Option A would decrease relative to existing conditions.

Option K

Option K of the 6-Lane Alternative would construct a stormwater system that, overall, would reduce pollutant-loading to stormwater discharged to Lake Union, Portage Bay, and Union Bay compared with existing conditions (Exhibit 30). Stormwater discharges from these areas would meet water quality according to the HRM presumptive approach. Stormwater discharges to a portion of Lake Union, including all of Portage Bay and Union Bay, would receive enhanced treatment that would exceed the basic treatment required in the HRM.

Loading of dissolved zinc to TDA 7 would increase slightly, as would dissolved copper to TDAs 7 and 8. Similarly to Option A, total loading for TSS, total and dissolved copper, and total and dissolved zinc would decrease relative to existing conditions.

Option L

Option L of the 6-Lane Alternative would construct a stormwater system that, overall, would reduce pollutant-loading to stormwater discharged to Lake Union, Portage Bay, and Union Bay compared with existing conditions (Exhibit 30). Stormwater discharges from these areas are presumed to meet water quality criteria according to the HRM. Stormwater discharges to a portion of Lake Union, including all of Portage Bay and Union Bay, would receive enhanced treatment that would exceed the basic treatment required in the HRM.



Exhibit 30. Net Changes in Pollutant Loads Between Pre- and Post-project Conditions (pounds)

| TDA | TSS | Total Zinc | Dissolved Zinc | Total Copper | Dissolved Copper |
|--|----------------|---------------|----------------|--------------|------------------|
| Option A—Stormwater Treatment Applied | | | | | |
| TDA 7 | -553.95 | -0.4 | 0.2 | -0.02 | 0.06 |
| TDA 8 | -8,611 | -11.06 | -1.11 | -1.59 | 0.1 |
| TDA 9 | -4,466.1 | -7.28 | -1.93 | -1.22 | -0.19 |
| TDA 10 | -6,625.4 | -10.31 | -2.42 | -1.68 | -0.21 |
| TDA 11 | -2,759.9 | -4.3 | -1.01 | -0.7 | -0.09 |
| TDA 12 | -1,436.9 | -1.72 | -0.07 | -0.23 | 0.04 |
| TDA 13 | -2,687.75 | -3.78 | -0.63 | -0.58 | -0.02 |
| TDA 14 | -1,872 | -2.74 | -0.53 | -0.43 | -0.03 |
| Total Load | -29,013 | -41.58 | -7.52 | -6.47 | -0.34 |
| Option K—Stormwater Treatment Applied | | | | | |
| TDA 7 | -553.95 | -0.4 | 0.2 | -0.02 | 0.06 |
| TDA 8 | -8,575 | -10.77 | -0.89 | -1.52 | 0.14 |
| TDA 9 | -5,096.5 | -7.12 | -1.16 | -1.09 | -0.03 |
| TDA 10 | -9,551 | -13.97 | -2.72 | -2.2 | -0.16 |
| TDA 11 | -2,253.7 | -3.71 | -1 | -0.62 | -0.1 |
| TDA 12 | -1,482.8 | -2 | -0.28 | -0.3 | 0 |
| TDA 13 | -2,687.75 | -3.78 | -0.63 | -0.58 | -0.02 |
| TDA 14 | -1,872 | -2.74 | -0.53 | -0.43 | -0.03 |
| Total Load | -32,074 | -44.49 | -7.02 | -6.77 | -0.14 |
| Option L—Stormwater Treatment Applied | | | | | |
| TDA 7 | -553.95 | -0.4 | 0.2 | -0.02 | 0.06 |
| TDA 8 | -8,611 | -11.06 | -1.11 | -1.59 | 0.1 |
| TDA 9 | -3,295.75 | -4.03 | -0.25 | -0.56 | 0.07 |
| TDA 10 | -9,527.05 | -14.62 | -3.31 | -2.37 | -0.26 |
| TDA 11 | -2,185.3 | -3.5 | -0.89 | -0.58 | -0.08 |
| TDA 12 | -1,471.1 | -1.93 | -0.23 | -0.28 | 0.01 |
| TDA 13 | -2,687.75 | -3.78 | -0.63 | -0.58 | -0.02 |
| TDA 14 | -1,872 | -2.74 | -0.53 | -0.43 | -0.03 |
| Total Load | -30,204 | -42.06 | -6.75 | -6.42 | -0.15 |

Note: Blue shading indicates pollutant loads are same or less than the No Build Alternative.



The stormwater treatment system proposed under Option L would decrease pollutant-loading to Lake Union, Portage Bay west, and Union Bay compared with the No Build Alternative (Exhibit 30). Loading of dissolved zinc to TDA 7 would increase slightly, as would dissolved copper, to TDAs 7, 8, 9, and 12, while the total project load of all five pollutants to all TDAs under Option L would decrease relative to existing conditions.

Floating Bridge

The modeling results presented in Exhibit 31 represent the AKART evaluation of the mid-span and east approach regions of the floating bridge. The model used the following parameters: largest lagoon size under consideration, use of oversized catch basins, and high-efficiency sweeping (CH2M HILL 2009a; CH2M HILL 2009b). Receiving water concentrations for both total and dissolved metals were compared with hardness-adjusted Washington state water quality standards at various stages in the discharge path:

- Untreated stormwater runoff
- At discharge pipe to spill control lagoon (treated stormwater unmixed with Lake Washington water)
- In spill control lagoon (at end of water quality treatment storm event)

| | Cadmium (µg/L) | Copper (µg/L) | Lead (µg/L) | Zinc (µg/L) |
|---|-------------------|------------------|----------------|----------------|
| Untreated Stormwater Runoff | 0.7 | 10 | 9.2 | 93 |
| At Discharge Pipe to Spill Control Lagoon | 0.7 | 10 | 9.2 | 93 |
| In Spill Control Lagoon | 0.14 | 2.0 | 1.8 | 18.6 |
| At 5-foot Mixing Zone Boundary | 0.12 | 1.7 | 1.3 | 15.5 |
| At 50-foot Mixing Zone Boundary | 0.02 | 0.2 | 0.2 | 2.0 |

X Does not meet Acute Water Quality Criteria (dissolved metals)

X Does not meet Chronic Water Quality Criteria (dissolved metals)

Exhibit 31. Effluent Concentrations of Dissolved Metals at Specific Locations on the Floating Bridge



- At 5-foot mixing zone boundary (located 5 feet beyond lagoon boundary)
- At 50-foot mixing zone boundary (located 50 feet beyond lagoon boundary)

The resulting receiving water concentrations meet all applicable water quality acute criteria in the spill control lagoon, including all chronic water quality criteria at the 50-foot mixing zone boundary.

Comparison of Effects for All Three Options

As presented above, Option A would reduce total loading of TSS, total and dissolved copper, and total and dissolved zinc to Portage Bay, Lake Union, and Union Bay, while both Options K and L would reduce loading of TSS, total and dissolved copper, and total zinc, while increasing loading of dissolved zinc to these same water bodies.

How would operation of the project affect groundwater?

No Build Alternative

Under the No Build Alternative, the amount of impervious surface and the quantity of stormwater infiltration would not change. Based on the current movement of stormwater from the existing SR 520 pavement and the location of stormwater outfalls (Exhibit 17), there is a low probability that stormwater infiltration would further degrade groundwater in the study area.

6-Lane Alternative

The 6-Lane Alternative would have either minimal or no effect on the quantity or quality of study area groundwater.

The increased impervious surface associated with all options of the 6-Lane Alternative in the study area would have minimal or no effect on groundwater recharge because the increase in impervious surface of the overland portions of the roadway is only a fraction of the total recharge area of the groundwater system. The size of the associated groundwater basins is unknown, but typically they can be much greater in size than surface water basins. Therefore, these minimal reductions in potential recharge areas based on surface water basin sizes are conservative.



Groundwater quality would not be affected because the 6-Lane Alternative would treat stormwater prior to discharging to Lake Union, Portage Bay, and Lake Washington. Considering the net movement of groundwater from adjacent aquifers into Lake Union, Portage Bay, and Lake Washington (and not back into these aquifers from these lakes), stormwater discharged to these water bodies would not be a source of groundwater contamination in these aquifers.

Because stormwater runoff from the existing bridge does not affect the aquifers underlying Lake Washington, the proposed bridges would also not affect the aquifers.



Mitigation

What has been done to avoid or minimize negative effects on surface water?

Permanent negative effects of the 6-Lane Alternative would be avoided by including stormwater treatment facilities as part of the project. Overall, these facilities would reduce current pollutant-loading levels to water bodies in the study area.

Negative effects on surface water bodies during construction would be avoided or minimized by implementing water quality pollution control measures outlined in the required TESC and SPCC plans and by following permit conditions.

Potential sedimentation effects on study area streams and lakes during construction and operation would be minimized in the following ways:

- **Avoidance**—Using retaining walls to minimize effects to streams, wetlands, and other critical areas. Except where absolutely necessary, construction equipment would not enter below the ordinary high water mark of project streams. Staging areas and stockpiling areas would be located far from streams and lakes.
- **Prevention**—Use of appropriate BMPs to reduce the risk of erosion and reduce or minimize the chance of sediments entering project water bodies. Erosion and sediment control measures could include mulching, matting, and netting; filter fabric fencing; quarry rock entrance mats; sediment traps and ponds; surface water interceptor swales and ditches; and placing construction material stockpiles away from streams. In addition, a TESC plan would be prepared and implemented to minimize and control pollution and erosion from stormwater. Erosion and sediment control BMPs would be properly implemented, monitored, and maintained during construction. No long-term water quality effects would be expected, although even with BMPs, some temporary short-term water quality effects from sediment (such as increases in turbidity) could occur, particularly during large storm events. However, the magnitude of these effects would be small and would not likely adversely affect water resource quality.



What has been done to avoid or minimize negative effects to groundwater?

The project's stormwater treatment facilities would protect groundwater quality.

How could the project compensate for unavoidable negative effects to groundwater?

The 6-Lane Alternative would increase the amount of land covered by PGIS in the study area; however, this increase would not cause a detectable change to groundwater recharge. Pollutant-loading to stormwater discharges would be maintained or reduced; therefore, potential groundwater contamination is not a concern. Because permanent effects on groundwater would be negligible and human use of groundwater in the study area is limited, no additional compensation is required.

Potential effects on groundwater during construction would be negligible. These potential effects would be minimized through the implementation of the TESC and SPCC plans. Constructing the depressed interchange as part of Option K would result in the short diversion of groundwater flow to Lake Union and the ship canal. However, this would not prevent the amount of groundwater from flowing into these receiving environments and, as such, would not require any additional project compensation.

How could the project compensate for unavoidable adverse effects?

No compensation would be required because negative effects would be avoided or minimized through provision of stormwater treatment facilities as part of the project design. Discharges from the 6-Lane Alternative would meet or exceed HRM requirements, as well as water quality regulations with the designation of a 50-foot mixing zone to the spill control lagoons on the floating portion of the bridge. Any unavoidable impacts would be mitigated to meet the requirements of local Shoreline Master Programs.



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Attachment 1

Description of Puget Sound Area Aquifers

Description of Study Area Aquifers

In the Puget Sound basin, groundwater is contained in two major aquifers – the Vashon Advance Outwash Aquifer and the Sea-Level Aquifer. These aquifers are also known as the Fraser Aquifer and the Puget Aquifer, respectively (Vaccaro et al. 1998). The Vashon Advance Outwash and Sea-Level Aquifers are present throughout most of the study area and are sufficiently thick and water-saturated to be considered an important source of groundwater (see Exhibit 16 in the main text).

Two minor aquifers also underlie parts of the study area: the Alluvial Aquifer and the Vashon Recessional Outwash Aquifer. These aquifers are either not present in the large majority of the study area or, where present, do not store large amounts of groundwater (Vaccaro et al. 1998). These aquifers can be found in a few places in the study area such as around Lake Washington and atop several hills.

Vashon Advance Outwash Aquifer

The Vashon Advance Outwash Aquifer consists of glacial advance outwash sand and gravel deposits. In areas where it is overlain by the Vashon Till Aquitard, it is semi-confined. Where the till has eroded, the Vashon Advance Outwash Aquifer is unconfined. The Vashon Advance Outwash Aquifer is located in the highlands on both sides of Lake Washington (Exhibit 16). The main source of recharge to the aquifer in the study area is precipitation or downward seepage through the Vashon Till. In areas where the Vashon Advance Outwash Aquifer is close to the ground surface, the aquifer is susceptible to contamination. Water from the aquifer is transported underground and discharged into creeks and lakes. This water can be an important contribution to these water bodies during the summer when precipitation and flows are low. Some of the water contained in the aquifer leaks through the aquitard and provides recharge to the Sea-Level Aquifer.

Sea-Level Aquifer

The Sea-Level Aquifer, the deepest regional aquifer, is confined. Although it is present throughout the Puget Sound basin and has good water quality, the Sea-Level Aquifer is seldom used for water supply in the study area because of its greater depth beneath other aquifers (Exhibit 16). Recharge to the Sea-Level Aquifer occurs from precipitation in the Puget Sound basin, as well as leakage from overlying aquifers, lakes, and rivers. Because of the great thickness of



this aquifer, its large areal extent, and the quantity of precipitation in the Puget Sound basin, this aquifer has the capacity to store the greatest amount of groundwater. The Sea-Level Aquifer ultimately discharges to Puget Sound.

Alluvial Aquifer

The Alluvial Aquifer consists of sand and gravels deposited by water on the shores of lakes and in streams or river valleys. Groundwater in this aquifer is unconfined and is generally encountered just below the ground surface to 100 feet below ground throughout the study area. The gravel composing the Alluvial Aquifer is permeable. Water, and any contaminants it may contain, is easily transported into and through the aquifer. Within the study area, this aquifer is located near the ground surface and is susceptible to contamination.

Vashon Recessional Outwash Aquifer

The Vashon Recessional Outwash Aquifer consists of stratified sand and gravel and well-bedded silty sand and silty clay deposited during the retreat of the Vashon glaciers (Booth et al. 2002). Groundwater in this aquifer is unconfined or semi-confined. Groundwater in the aquifer is generally encountered from just below the ground surface to 100 feet below ground surface throughout the study area. The Vashon Recessional Outwash Aquifer is saturated beneath Portage Bay and Lake Washington, while east of Lake Washington (between the highlands), the aquifer may be unsaturated (Exhibit 16). In areas where the permeable geologic units that comprise the Vashon Recessional Outwash Aquifer are close to the ground surface, the aquifer is also susceptible to contamination.

