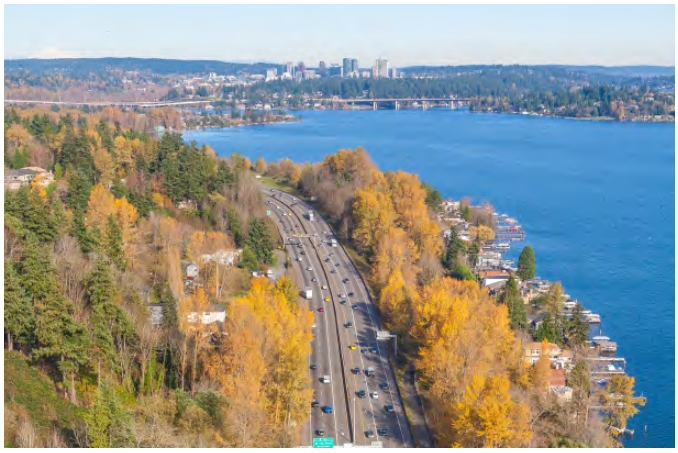
WSDOT

U. S. Department of Transportation
Federal Highway Administration

July 2018

I-405, Tukwila to I-90 Vicinity Express Toll Lanes Project (MP 0.0 to 11.9)

Attachment J: Geology, Soils, and Groundwater Technical Memorandum



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SUMMARY

The Washington State Department of Transportation (WSDOT) is proposing to construct the I-405, Tukwila to I-90 Vicinity Express Toll Lanes Project (milepost [MP] 0.0 to 11.9) (the Project) to improve traffic operations and safety on Interstate 405 (I-405) through Tukwila, Renton, and Bellevue.

The Project is part of a comprehensive strategy identified in the 2002 *I-405 Corridor Program Final Environmental Impact Statement* (EIS) and subsequent *Record of Decision* (ROD) to reduce traffic congestion and improve mobility along the state's second-busiest highway. The Project is needed because travelers on I-405 face one of the most congested routes in the state, particularly during peak travel times.

What is our study approach?

To evaluate the Project's effects on geology, soils, and groundwater during construction and operation, this study consisted of the following main tasks:

- Review the available information on project design.
- Evaluate soils and geologic conditions.
- Identify and assess potential effects of the Project.
- Identify and assess ways to avoid or minimize effects.

We also reviewed relevant regulatory criteria and WSDOT design and construction standards to determine the existing conditions in the study area and assess the appropriate construction/design activities to minimize effects on the environment. Where appropriate, the study area also extended outside these limits to properly assess the relevant conditions.

What are the existing conditions?

The Project is located along the west-facing slopes of the topographic trough occupied by Lake Washington. The geology within the study area is heavily influenced by glacial scour and deposition such that the soils that would be encountered during construction are anticipated to vary from very soft to dense and very dense. Groundwater levels are variable from at or near the surface to depths of 25 feet or below the ground surface. Perched groundwater conditions can also be expected. The area is seismically active and

potentially subjected to ground motions resulting from the Cascadia subduction event or rupture along the Seattle fault. There is a low to moderately high potential for liquefaction in the study area. Prior work in the area has shown there are several landslide hazard areas within the Project corridor and surface erosion from construction disrupting the surface soils should be anticipated. These risks can be mitigated through existing best management practices (BMPs).

How would the Project affect geology, soil, and groundwater?

Anticipated short-term effects of the Project would include increased erosion, construction-related vibration, and possible excavation of soft, wet soils. These effects are common to highway construction, but can represent an annoyance to anyone living near the study area.

What measures will WSDOT use to avoid or minimize effects?

WSDOT has well-established design and construction practices for avoiding or minimizing potential effects associated with geology, soils, and groundwater. Appropriate construction plans and procedures will be incorporated into the Project specifications. These anticipated effects will be minimized through BMPs.

Would there be any unavoidable effects?

With proper construction practices, there should be no unavoidable effects related to geology, soils, and groundwater.

How would geology, soil, or groundwater be affected if the Project is not built?

No effects on the geology, soils, or groundwater would occur under the No Build Alternative other than those associated with routine maintenance and local improvements to existing transportation facilities.

SECTION 1 INTRODUCTION

This report was prepared in support of the *I-405, Tukwila to I-90 Vicinity Express Toll Lanes Project (MP 0.0 to 11.9)* (the Project) *Environmental Assessment* (EA). The Project proposes to make several roadway, structural, drainage, and transit improvements to the I-405 corridor.

The Project is part of a comprehensive strategy identified in the 2002 *I-405 Corridor Program Final Environmental Impact Statement (EIS)* and subsequent *Record of Decision* (ROD) to reduce traffic congestion and improve mobility along the state's second-busiest highway. The Project is needed because travelers on I-405 face one of the most congested routes in the state, particularly during peak travel times.

This report describes the geologic, soil, and groundwater conditions in the study area, identifies and assesses potential effects of the Project on these conditions, and identifies measures to avoid or reduce effects resulting from the Project. Common to any large highway project, the geologic, soil, and groundwater conditions in the study area would have some environmental effects during construction and operations.

Why are geology, soils, and groundwater important elements to consider?

Geology and soils relate to the physical material that makes up the ground, while groundwater refers to the subsurface water contained in the soil and bedrock. These conditions are major factors in determining the type of foundations for structures, pavement sections, subsurface drainage requirements, allowable cut/fill slopes, and retaining wall requirements. These conditions also determine the risk of landslides, liquefaction, erosion, and other types of behavior that would affect the environment. Potential effects of the Project on groundwater quantity and quality also depend on these conditions.

SECTION 2 PROJECT DESCRIPTION

What improvements are proposed with the Project?

Exhibit 2-1 describes in detail the improvements proposed with the Project. Exhibit 2-2, sheets 1 through 8, show the proposed improvements on a series of maps. In general, the Project proposes to add one lane to I-405 in each direction for about 9 miles beginning on I-405 near State Route (SR) 167 and continuing approximately 1 mile north of I-90. The Project would also add a general purpose (GP) (auxiliary) lane to southbound I-405 between MP 6.7 (north of N 30th Street) and 7.1 (south of NE 44th Street) and MP 9.4 (north of 112th Avenue SE) to 10.5 (north of Coal Creek Parkway). The existing high-occupancy vehicle (HOV) lane on I-405 and the additional lane would be operated as a two-lane express toll lane (ETL) system. Additional details describing the ETLs are provided in the next question, "How would the express toll lanes work?"

Exhibit 2-1. Improvements Proposed with the I-405, Tukwila to I-90 Vicinity Express Toll Lanes Project

Project Element	I-405, Tukwila to I-90 Vicinity Express Toll Lanes Project
I-405/I-5 Interchange Exhibit 2-2, Sheet 1	– Extend the southbound left lane at the I-5 interchange west for approximately 500 feet to provide additional merge distance.
I-405 Lanes and Shoulders from SR 167 to north of I-90 Exhibit 2-2, Sheets 2 through 8	– Create a dual ETL system from MP 2.9 (northeast of the I-405/SR 167 interchange) and MP 11.9 (north of the I-405/I-90 interchange) by adding one new lane in each direction and converting the existing HOV lane to an ETL. – Convert the existing HOV lane to a single ETL from MP 2.4 (at the I-405/SR 167 interchange) to MP 2.9 on northbound I-405 and from MP 1.6 (in Renton over Springbrook Creek) to MP 2.9 on southbound I-405. – Add an additional GP (auxiliary) lane on southbound I-405 between MP 6.7 (north of 30th Street) and MP 7.1 (south of NE 44th Street) and MP 9.4 (north of 112th Avenue SE) to MP 10.5 (north of Coal Creek Parkway). – Bring I-405 up to current freeway standards where feasible.
I-405 Tolling from SR 167 to north of I-90 Exhibit 2-2, Sheets 2 through 8	– Construct tolling gantries to collect the tolls for the ETL system (see description in the row above).
Cedar Avenue Exhibit 2-2, Sheet 4	– Reconstruct the bridge over I-405 to widen southbound I-405.
Renton Avenue Exhibit 2-2, Sheet 4	– Reconstruct the bridge over I-405 to widen southbound I-405.
Cedar River Bridge Exhibit 2-2, Sheet 4	– Widen the southbound I-405 bridge over the Cedar River.
Sunset Boulevard N Interchange Area Exhibit 2-2, Sheet 4	– Widen the I-405 northbound and southbound bridges over Sunset Boulevard N.
NE Park Drive Interchange Area Exhibit 2-2, Sheet 5	– Widen the I-405 southbound bridge over NE Park Drive.
N 30th Street Interchange Area Exhibit 2-2, Sheet 5	– Replace the local road overpass abutment slopes with retaining walls on both sides of I-405 and lower the southbound I-405 roadway by approximately one foot.
NE 44th Street Interchange Area Exhibit 2-2, Sheet 6	– Replace the northbound and southbound I-405 bridges over May Creek with two new single span bridges and provide habitat improvements. – Replace the NE 44th Street bridge over I-405. Construct new direct access ramps and two inline transit stations (one in each direction) in the I-405 median. Transit stations would include station platforms, signage, artwork, lighting, fare machines (ORCA), and site furnishings such as shelters, lean rails, benches, bollards, bicycle parking, and trash receptacles. – Realign and reconstruct the northbound access to I-405 from a loop ramp to a new on-ramp from Lake Washington Boulevard NE. – Build four roundabouts along local arterials. – Construct an at-grade park-and-ride lot at Lake Washington Boulevard N and N 43rd Street with a minimum of 200 parking stalls and a roundabout (improvements would be built, but may be built by Sound Transit or others).

Exhibit 2-1. Improvements Proposed with the I-405, Tukwila to I-90 Vicinity Express Toll Lanes Project

Project Element	I-405, Tukwila to I-90 Vicinity Express Toll Lanes Project
112th Avenue SE Interchange Area Exhibit 2-2, Sheet 7	– Replace the 112th Avenue SE bridge over I-405. – Construct new direct access ramps, two inline transit stations (one in each direction) in the I-405 median. Transit stations would include station platforms, signage, artwork, lighting, fare machines (ORCA), and site furnishings such as shelters, lean rails, benches, bollards, bicycle parking, and trash receptacles. – Construct a roundabout on 112th Avenue SE. – Reconfigure the Newport Hills Park-and-Ride.
Coal Creek Parkway Interchange Area Exhibit 2-2, Sheet 7	– Construct a new southbound I-405 bridge on a new alignment. Convert the existing southbound I-405 bridge to northbound ETLs. – Convert the four local road intersections on Coal Creek Parkway SE to roundabouts.
I-405/I-90 Interchange Area Exhibit 2-2, Sheet 8	– Reconfigure the I-405 southbound to I-90 eastbound ramp from one to two lanes. – Realign the I-405 northbound to I-90 eastbound ramp. As part of this work, construct two new bridges over the eastbound I-90 ramp to Factoria Boulevard and over Factoria Boulevard.
Fish Passage Exhibit 2-2, Sheet 6	– Construct four fish passage crossings for unnamed tributary (UNT) 08.LW.0283 (formerly Gypsy Creek). – Construct a fish passage crossing under I-405 mainline for Stream UNT 08.LW.7.7A.[a] – Construct a fish passage crossing under I-405 mainline for Stream UNT 08.LW.7.8.[a]
Lake Washington Trail Exhibit 2-2, Sheets 6 and 7	– Realign and reconstruct the existing trail west of its current location to reside in the King County's Eastside Rail Corridor property between Ripley Lane in Renton (MP 7.7) and Coal Creek Parkway in Bellevue (MP 10.2). As part of this work, widen a portion of the King County's Eastside Rail Corridor Regional Trail.
Noise Walls Exhibit 2-2, Sheets 4, 6, 7 and 8	– Construct 4 new noise walls. – Relocate 2 existing noise walls.
Stormwater Management Exhibit 2-2, Sheets 1 through 8	– Add 46.92 acres of new PGIS and 5.7 acres of non-PGIS. – Provide enhanced treatment for 100% of new impervious surfaces. – Retrofit 51 percent (111.5 acres) of existing untreated PGIS and continue to treat stormwater from the 21.27 acres of PGIS that currently receives treatment. – Treat a total of 179.69 acres of PGIS.
Construction Duration	– 5 years of construction is expected from 2019 through 2024. – The direct access ramps and associated transit improvements at 112th Avenue SE, reconfiguring the Newport Hills Park-and-Ride lot, and building four roundabouts on Coal Creek Parkway SE may be constructed after 2024, depending on when allocated funds for these elements become available.

ETL = express toll lane GP = general purpose; HOV = high-occupancy vehicle; MP = milepost PGIS = pollutant generating impervious surfaces

[a] For these culverts, a restrictor plate will be put in place to prevent flooding until a downstream barrier is removed, at which time the restrictor plate will be removed.

How would the express toll lanes work?

At this time, the Washington State Transportation Commission (WSTC) has not established operational hours, user exemptions, occupancy requirements, and operating parameters for the ETLs proposed with the Project. The WSTC would set operational requirements for the ETLs prior to opening day. For this analysis, we assumed the requirements for the current I-405, Bellevue to Lynnwood ETL system would be used for this project. These assumptions, listed below, represent the most recent operating guidance from the WSTC for ETLs:

- **Limited Access** – The system would have designated entry and exit points, with a buffer between the ETLs and the GP lanes. These access points would vary in length, depending on the location.
- **Dynamic and Destination Pricing** – The I-405 ETL system would use both dynamic and destination pricing to determine a driver's toll at the time they enter the ETL. With *dynamic pricing*, toll rates vary based on congestion within the corridor to maintain performance. Electronic signs would be used to communicate the current toll rate for drivers. Toll rates are updated every few minutes, but the driver's price is set when they enter the system. With *destination pricing*, the toll is based on the driver's destination. Toll signs would show up to three toll rates for different toll zones, or destinations. Drivers would pay the rate they see upon entering the ETLs to reach their destination, even if they see a different toll rate for their destination further down the road. When both of these pricing approaches are used together, it means that the toll that drivers pay is based both on the congestion in the corridor and the distance they are traveling.
- **Operating Hours and *Good To Go!* Passes** – The ETL system is expected to operate from 5 a.m. to 7 p.m. on weekdays, with the system toll-free and open to all at other hours and on major holidays. Transit, HOVs, and motorcycles would need to have a *Good To Go!* pass to use the ETLs for free during operating hours. Eligible HOV users would be required to set the *Good To Go!* pass to the HOV mode to avoid charges. Single-occupant vehicles (SOVs) could choose to pay a toll to

How does dynamic pricing work?

Electronic monitors along the roadway measure real-time information on the speed, congestion, and number of vehicles in the ETLs. This information is used to determine whether tolls go up or down to optimize lane use.

As the ETLs become congested, toll rates increase, and as congestion decreases, toll rates decrease. The use of dynamic pricing allows the lanes to operate with high volumes but avoid becoming congested.

When would tolls be charged to use the ETLs?

It is assumed the ETLs would operate from 5 a.m. to 7 p.m. on weekdays. At all other times and major holidays, the lanes would be free and open to all without a *Good To Go!* pass.

During operating hours:

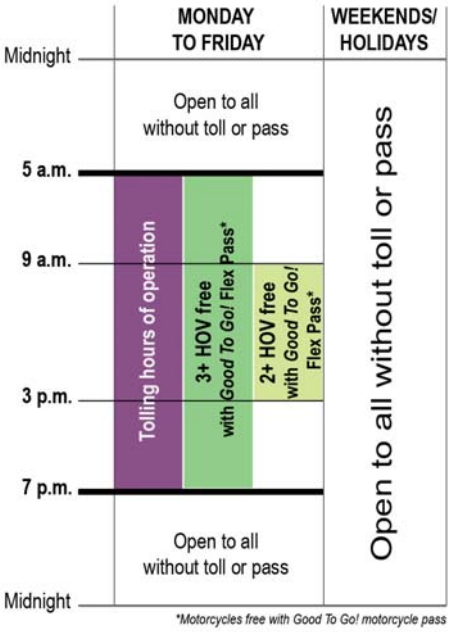
- **SOVs** would pay a toll to use the lanes.
- **Transit, HOV 3+, and Motorcycles** would travel for free with a *Good To Go!* pass.
- **HOV 2+** would travel for free from 9 a.m. to 3 p.m. with a *Good to Go!* pass. From 5 a.m. to 9 a.m. and 3 p.m. to 7 p.m. HOV2+ would pay a toll to use the ETLs with or without a *Good To Go!* pass.
- **Large vehicles** over 10,000 pounds gross vehicle weight would not be able to use the ETLs at any time.

use the ETLs during operating hours with or without a *Good To Go!* pass.

- **Occupancy Requirement**s – During the peak periods (weekdays from 5 a.m. to 9 a.m. and 3 p.m. to 7 p.m.), transit vehicles and carpools with three or more persons (HOV 3+) would be able to use the lanes for free with a *Good To Go!* pass. From 9 a.m. to 3 p.m., the system would be open toll-free to those with two or more passengers (HOV2+) with a *Good To Go!* pass. Motorcycles ride toll-free in the ETLs with a *Good To Go!* pass. During non-operating hours, SOVs will not be permitted to enter the ETLs from ramps where access is provided directly from local streets. SOV access would only be permitted from freeway GP entry and exit points.
- **Vehicle Weight** – Vehicles over 10,000 pounds gross vehicle weight will be prohibited, which is consistent with HOV lane restrictions throughout Washington.
- **Electronic Tolling** – Payments would be made via electronic tolling with a *Good To Go!* pass. For drivers who choose not to use a *Good To Go!* Pass, WSDOT offers optional photo billing (pay by mail) for an extra fee.

What is a *Good to Go!* Account?

A *Good To Go!* account is the cheapest and easiest way to pay tolls in Washington. With an account, your tolls will be paid automatically without having to stop at a toll booth or worry about bills in the mail. For more information please go to: http://www.wsdot.wa.gov/GoodToGo/default.htm



How would the Project be constructed?

WSDOT expects to construct the Project using a design-build contract. Design-build is a method of project delivery in which WSDOT executes a single contract with one entity for design and construction services to provide a finished product. With design-build projects, contractors have the flexibility to offer innovative and cost-effective alternatives to deliver the Project, improve project performance, and reduce project effects. Some design modifications that the contractor may propose could affect the Project footprint and design details described in this EA; however, if the contractor proposes modifications not covered by this EA, environmental review would be conducted as needed.

Construction work would include the removal of existing asphalt and concrete surfaces, clearing and grading adjacent areas, laying the aggregate roadway foundation, and placing of asphalt and concrete surfaces. Changing the vertical and

horizontal alignments of the I-405 mainline would require earthwork, with approximately 780,000 cubic yards of excavation and approximately 700,000 cubic yards of fill.

Construction equipment such as backhoes, excavators, front loaders, pavement grinders, jack hammers, pile drivers, trucks, as well as grading and paving equipment would be used. Equipment used for construction would include cranes, pile drivers, drilling rigs and augers, backhoes and excavators, jack hammers, concrete pumping equipment, and slurry processing equipment.

Staging areas in unused right of way would provide room for employee parking, large equipment storage, and material stockpiles. The contractor may also find other locations for construction staging.

Exhibit 2-2. I-405, Tukwila to I-90 Vicinity Express Toll Lanes Project Improvements, Sheet 1 of 8

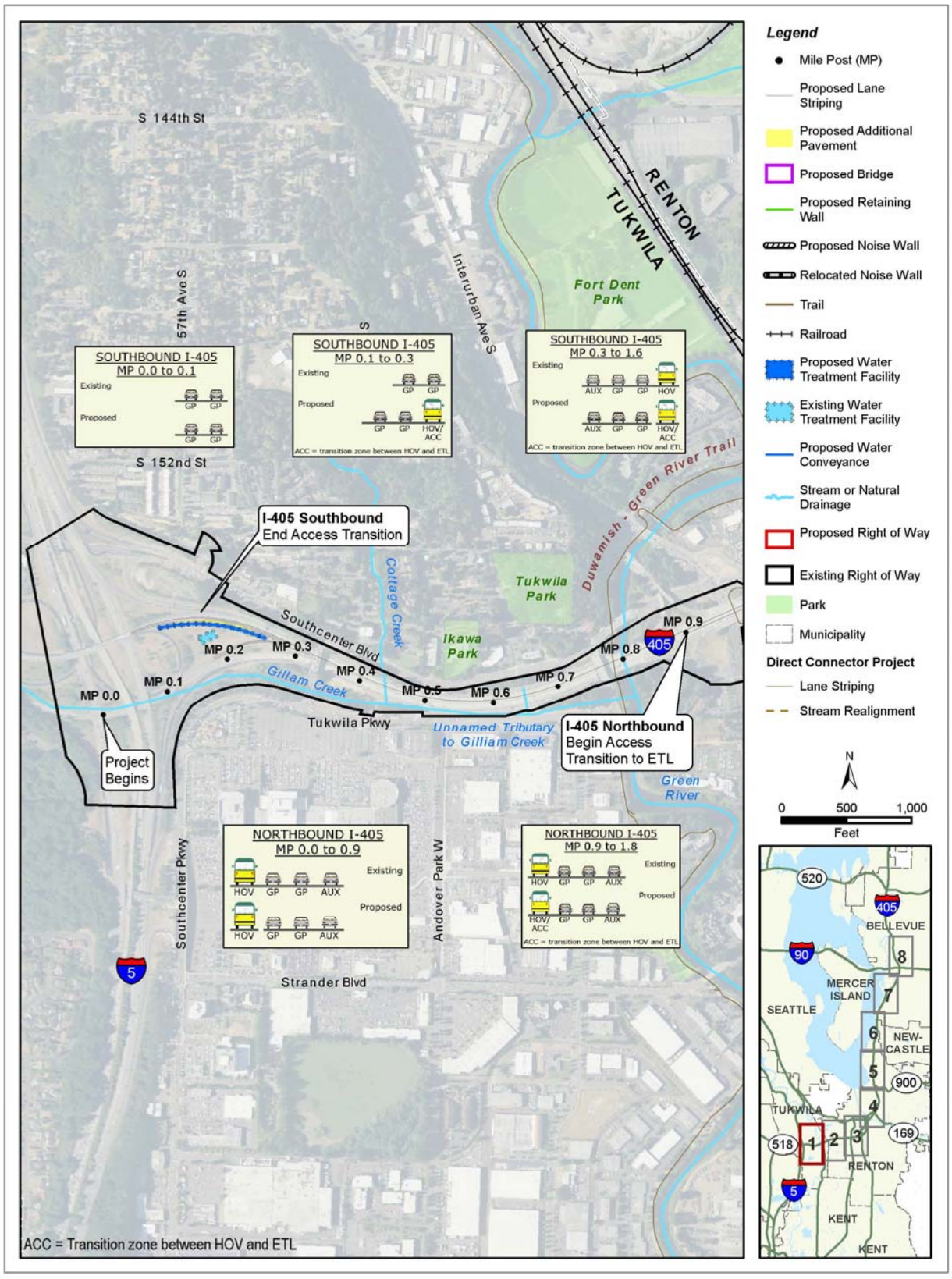
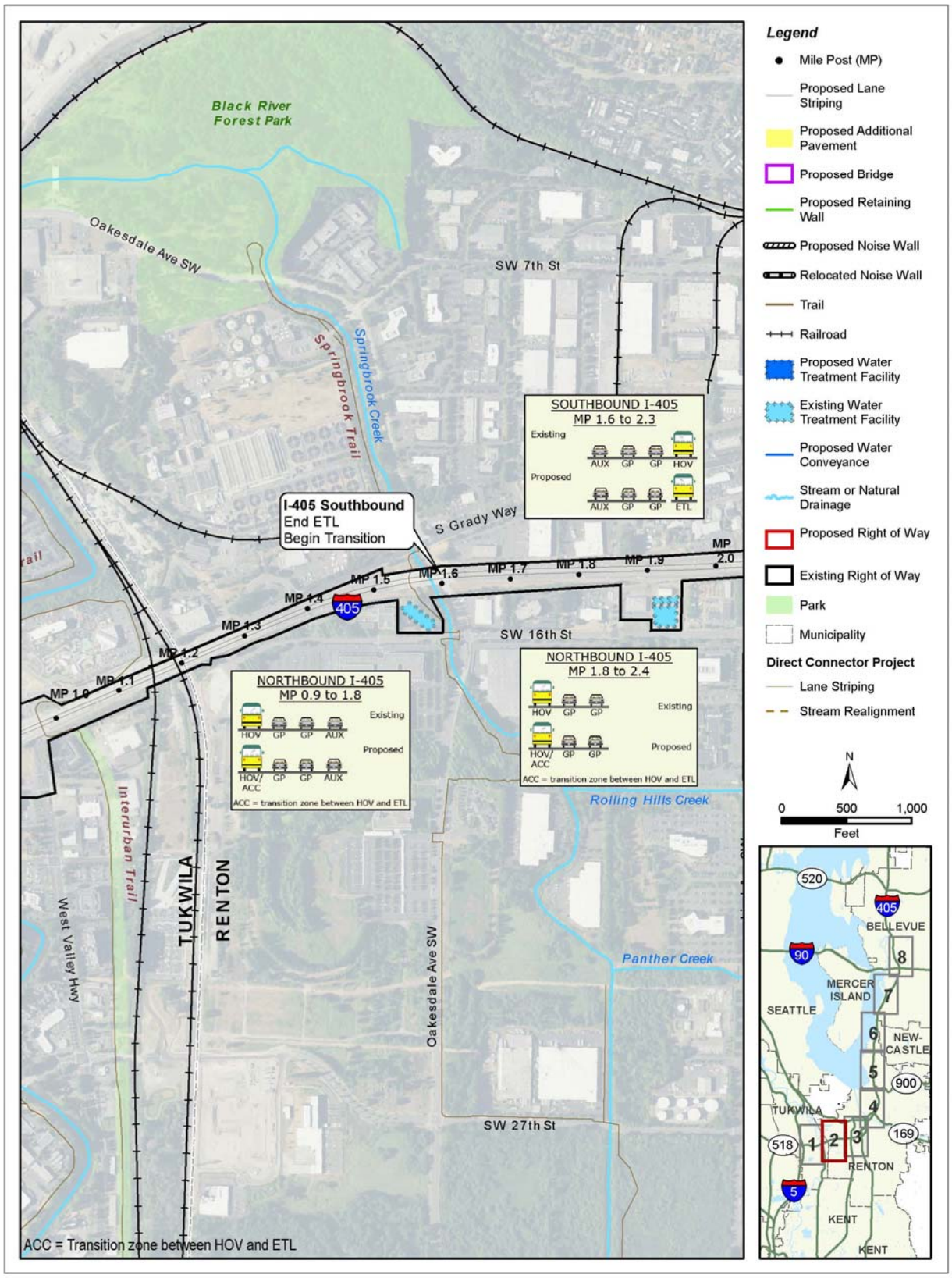


Exhibit 2-2. I-405, Tukwila to I-90 Vicinity Express Toll Lanes Project Improvements, Sheet 2 of 8



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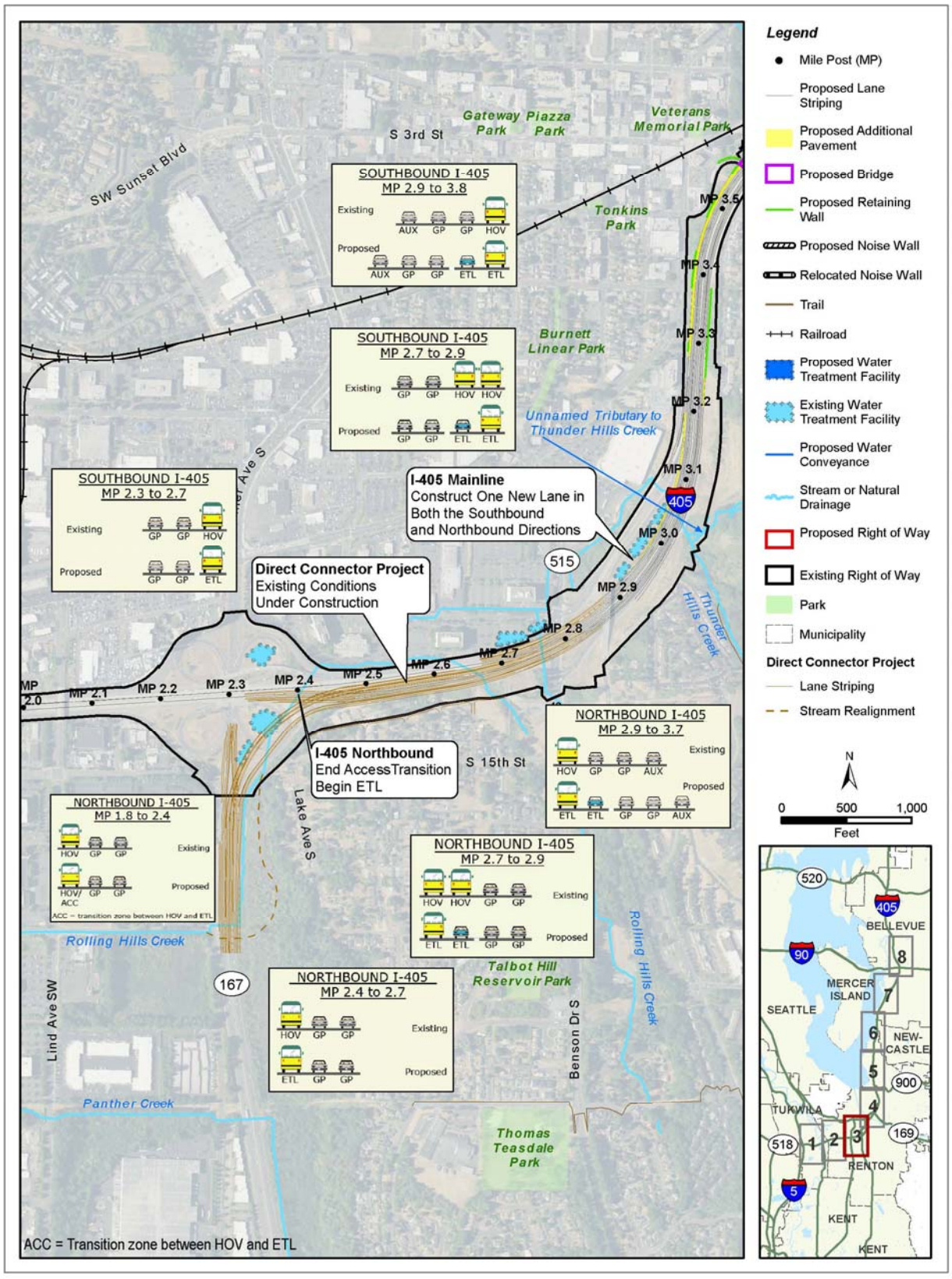

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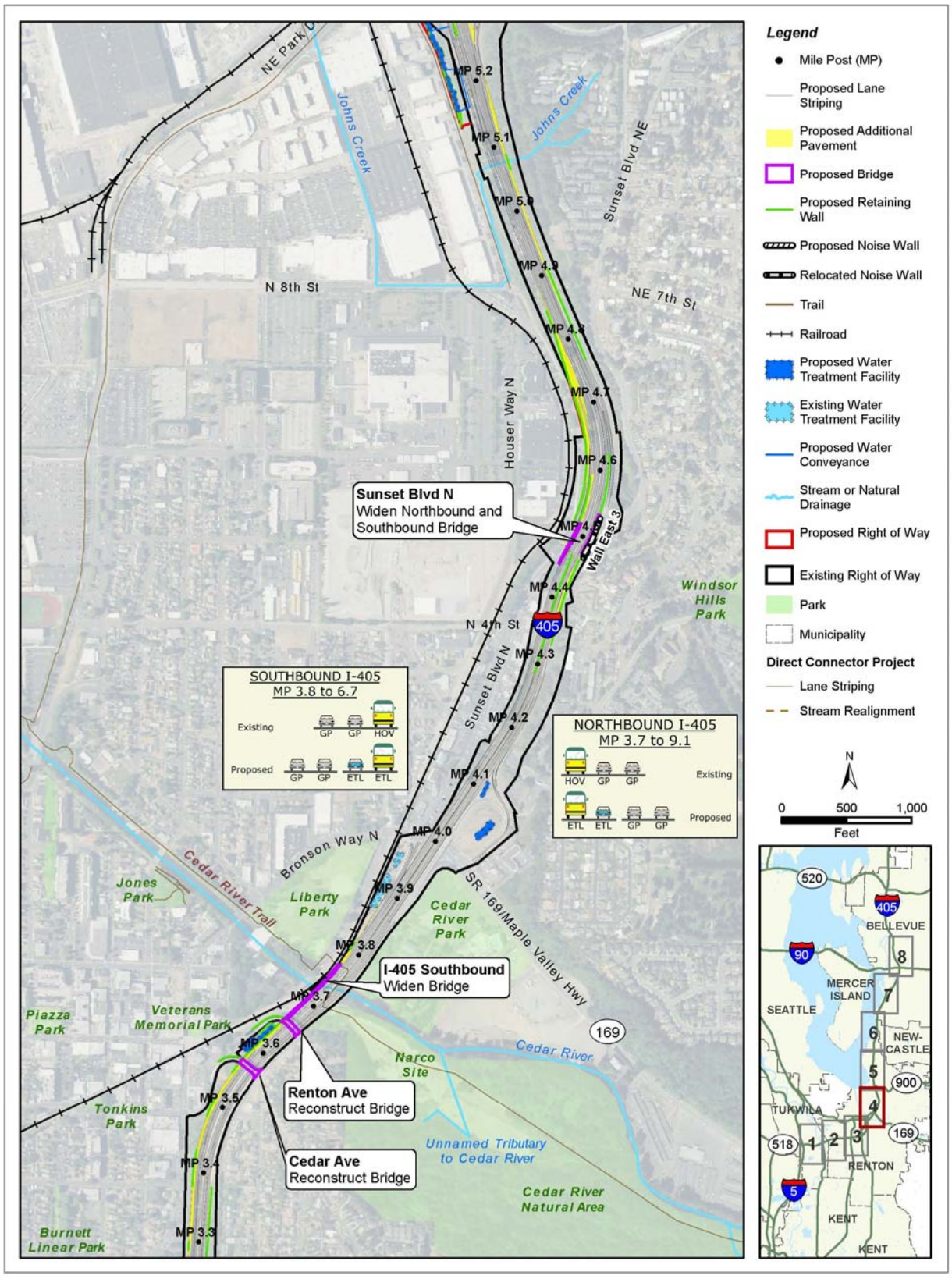
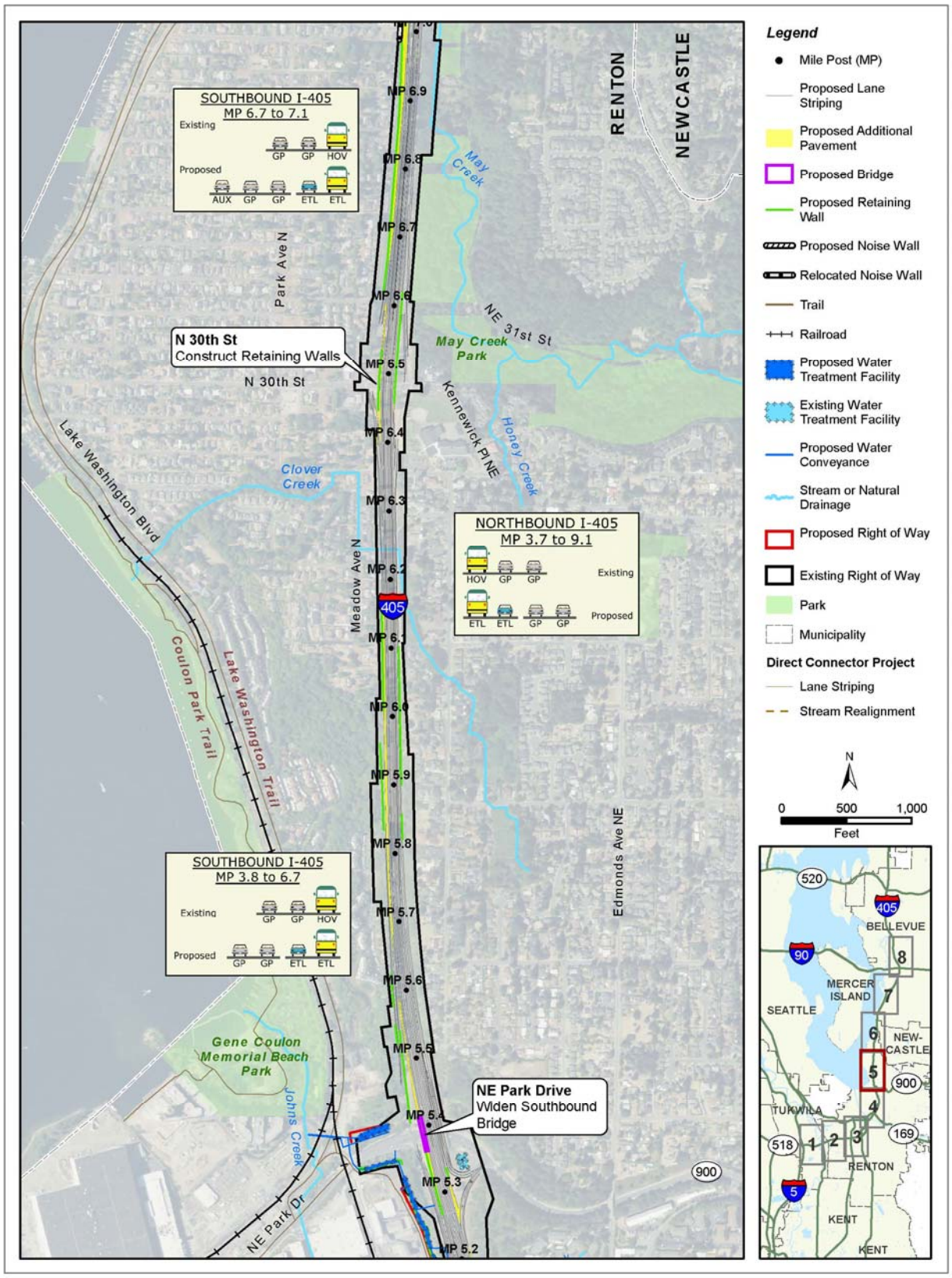


Exhibit 2-2. I-405, Tukwila to I-90 Vicinity Express Toll Lanes Project Improvements, Sheet 5 of 8



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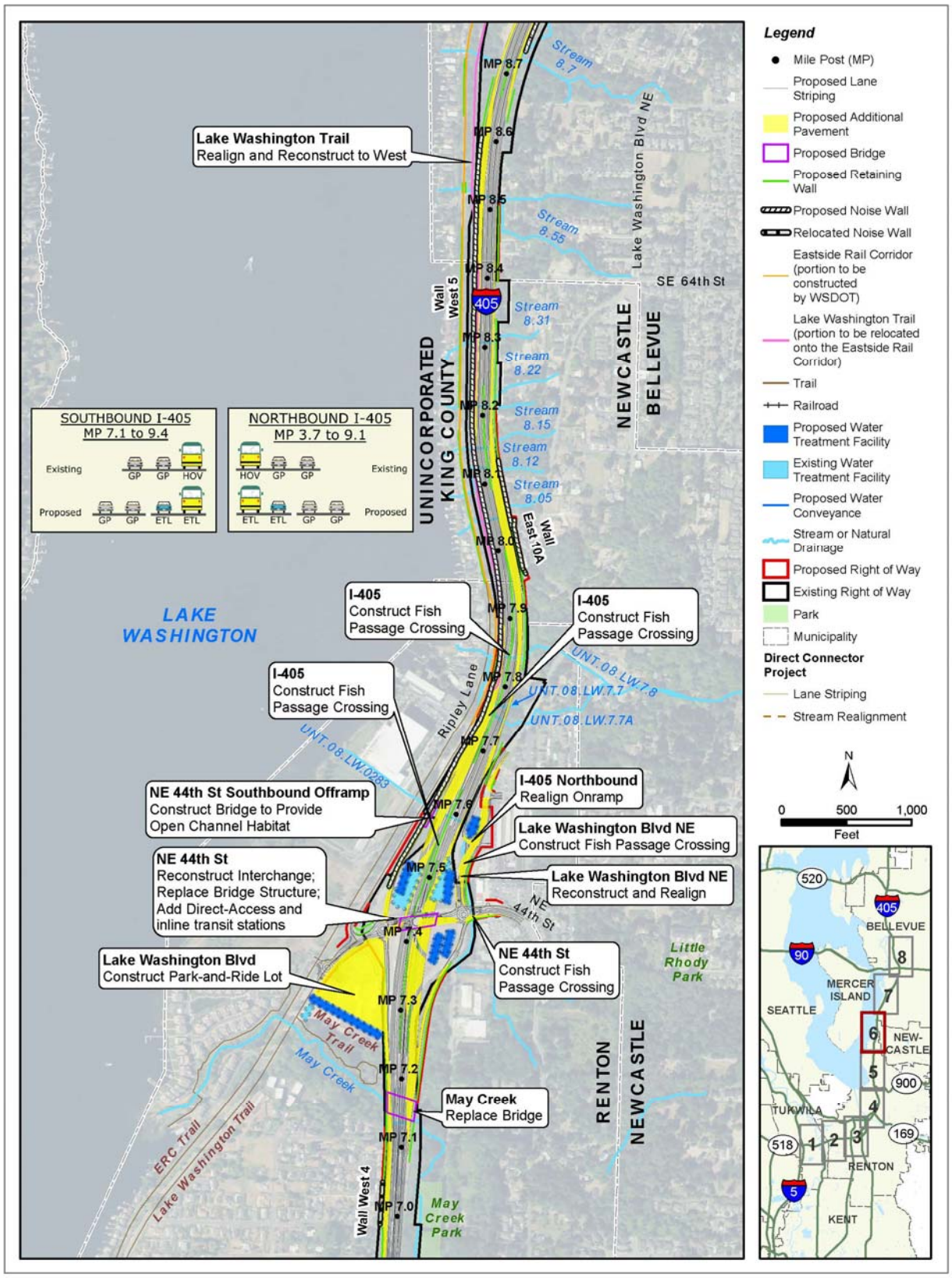


Exhibit 2-2. I-405, Tukwila to I-90 Vicinity Express Toll Lanes Project Improvements, Sheet 7 of 8

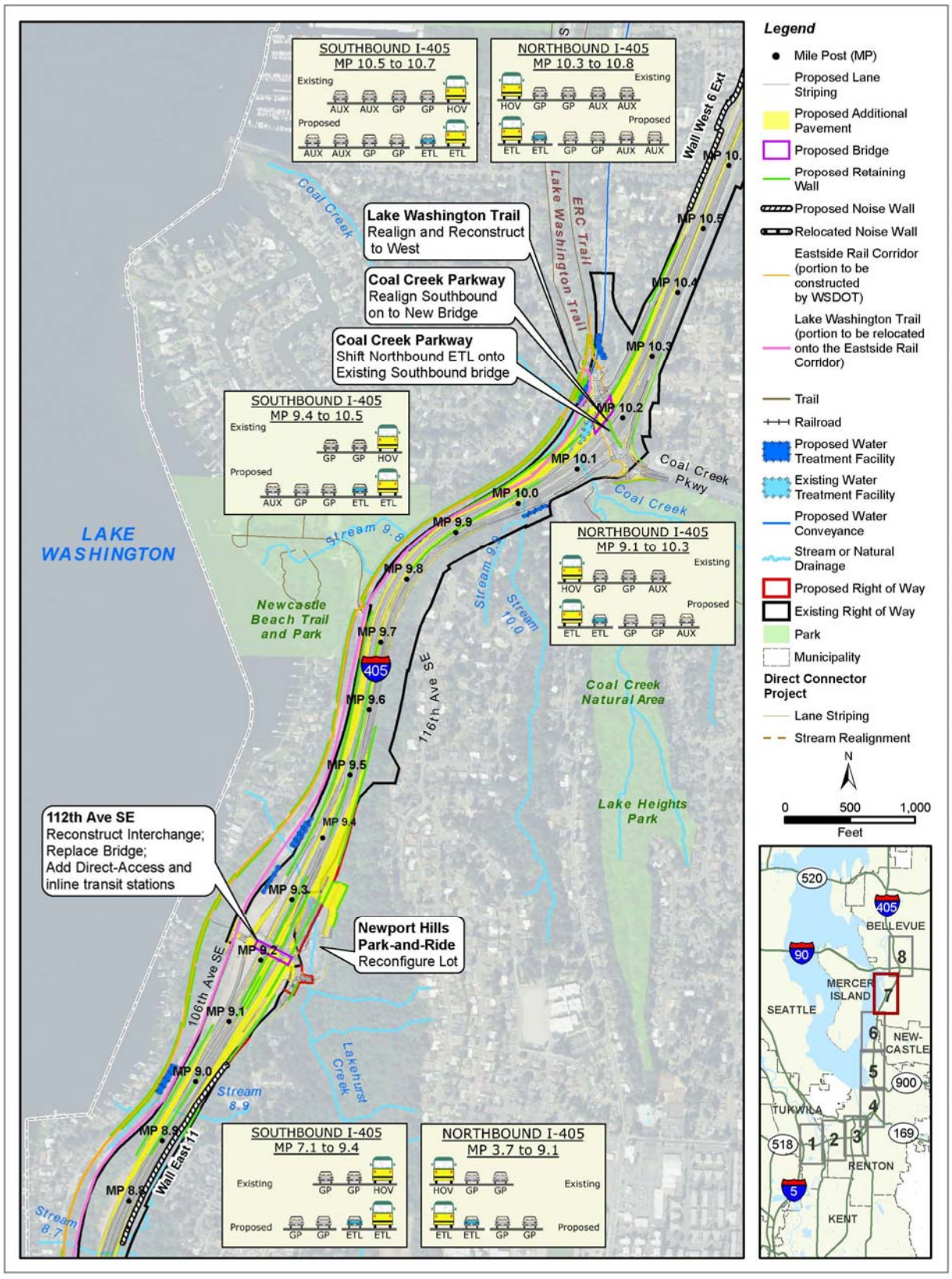
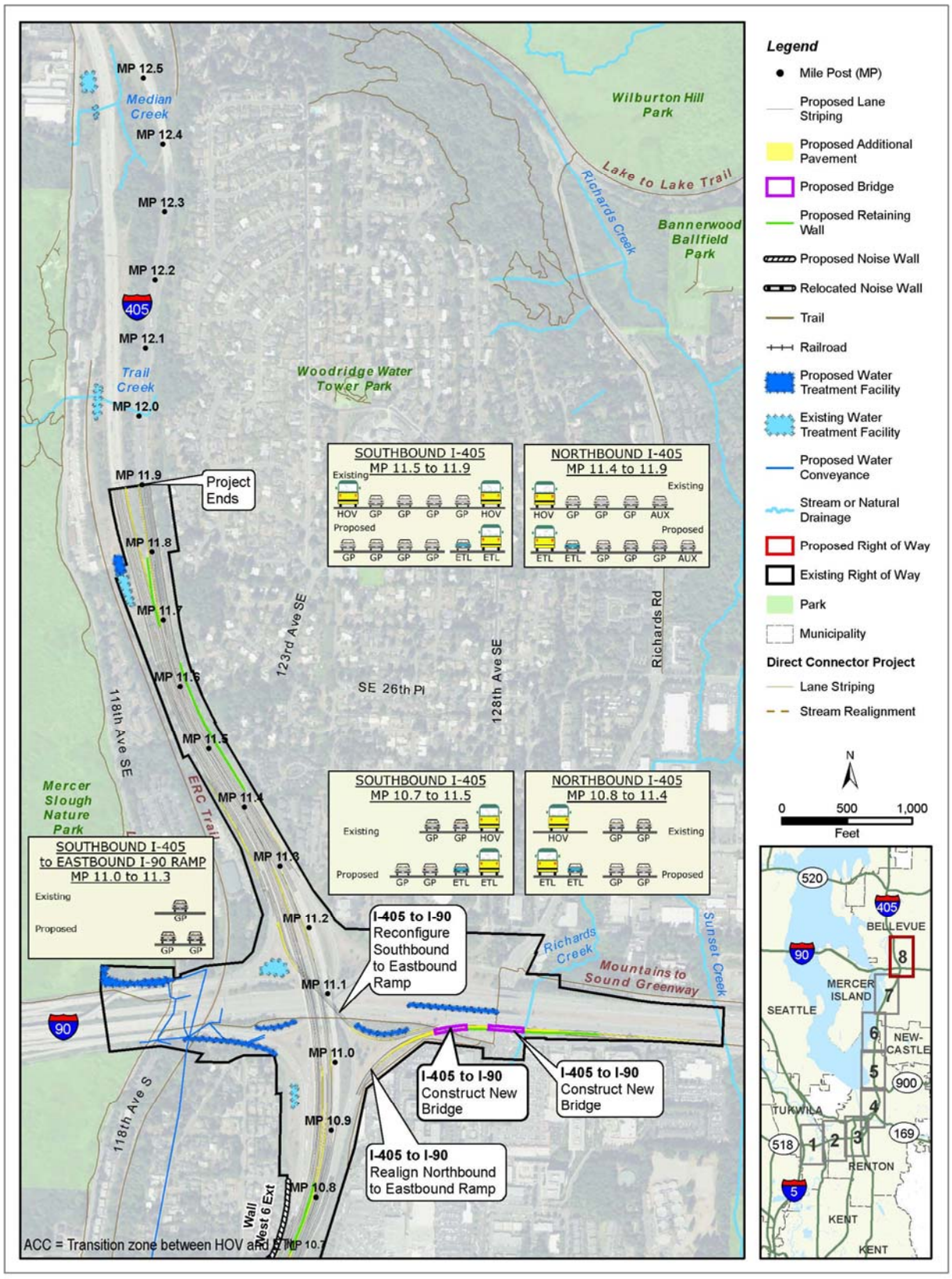


Exhibit 2-2. I-405, Tukwila to I-90 Vicinity Express Toll Lanes Project Improvements, Sheet 8 of 8



SECTION 3 STUDY APPROACH

What is the study area and how was it determined?

The study area for the geology, soils, and groundwater analysis includes the Project limits (e.g., from MP 0.0 to 11.9) and laterally to the area immediately adjacent to the roadway. Where appropriate, the study area also extended outside the Project limits to assess the relevant conditions.

What policies or regulations apply to determining effects on geology, soils, and groundwater?

For this report, the following WSDOT design standards were reviewed:

- *AASHTO LRFD Bridge Design Specifications* (American Association of State Highway and Transportation Officials 2015)
- *WSDOT Standard Specifications for Road, Bridge and Municipal Construction* (WSDOT 2018)
- *WSDOT Geotechnical Design Manual* (WSDOT 2015)
- *WSDOT Environmental Manual* (WSDOT 2017)

How did we collect information for this report?

WSDOT reviewed the preliminary design plans for the Project and relevant published geologic and groundwater information in preparation of this report. Section 8, References, provides a full list of sources.

How did we evaluate effects?

WSDOT considered the construction and long-term operation of both the Project and No Build Alternative. We reviewed WSDOT design and construction standards and conducted a visual examination of the available hazard maps to evaluate the existing site conditions and assess the appropriate construction/design activities to minimize effects to the environment.

SECTION 4 EXISTING CONDITIONS

What is the regional geology?

The Project is located along the west-facing slopes of a glacially carved trough that is occupied by Lake Washington. Several glacial periods within the past 2 million years have dominated the recent geologic history of the Puget Sound Lowland region. The most recent glacial advance to affect the central Puget Sound Lowland was the Vashon stade of the Fraser glaciation, which occurred approximately 20,000 years ago to around 12,000 years ago. This glacial advance is responsible for most of the present-day geologic and topographic conditions in the study area.

The Puget lobe of the Cordilleran ice sheet advanced southward from British Columbia and deposited a heterogeneous assemblage of proglacial lacustrine deposits, advance outwash, lodgement till, and recessional outwash on top of older pre-Vashon glacial and non-glacial deposits and Tertiary age (between 66 million to 2.6 million years ago) bedrock. As the glacier retreated northward, it uncovered a sculpted landscape of elongated uplands and intervening troughs or valleys, such as the Lake Washington and Lake Sammamish troughs. Post-glacial deposition has included alluvium along modern drainages; modern lacustrine deposits, including local accumulations of organic silts and peat; and landslide deposits. The geologic and soil conditions in the study area range from soft soil to dense and very dense glacial deposits.

What are the existing subsurface conditions and soil units in the study area?

Exhibit 4–1 illustrates the geologic conditions in and adjacent to the study area. The general geologic characteristics are described as Alluvium (Qa), which encompass a wide range of deposits from soft organic rich clayey silt, to very stiff sandy silt, to loose to dense sand and gravel. Areas of Tertiary sedimentary rocks are also expected to exist in the study area.

What are the existing conditions for groundwater in the study area?

Groundwater conditions in the study area can affect structural stability, settlement, dewatering subdrainage requirements, and earthwork in general. Groundwater levels are variable in the study area; as the groundwater increases in depth, discontinuous perched aquifers can be expected and are likely to exhibit seasonal fluctuations.

What is the seismic hazards in the study area?

The tectonic and seismic conditions of the Puget Lowland region are strongly influenced by convergent plate interaction along the Cascadia subduction zone, between the Juan de Fuca oceanic plate to the west and the North American crustal plate to the east (Stanley et al. 1999; Weaver and Shedlock 1996; Rogers et al. 1991; McCrumb et al. 1989). The Juan de Fuca plate is converging to the northeast with the North American plate. Consequently, the Juan de Fuca plate is being subducted under the North American plate along the Cascadia subduction zone (Rogers et al. 1991).

The Seattle Fault zone is the closest active crustal fault to the study area. The Seattle Fault zone is a broad 2.5-to-4-mile-wide, multi-trace, east-west-striking reverse-slip fault zone that extends more than 43 miles across central Puget Sound (Calvert et al. 2003; Nelson et al. 2003; Ten Brink et al. 2002; Johnson et al. 1999). Along the I-405 corridor, the southernmost mapped trace of the Seattle Fault zone crosses the corridor north of Exit 7 (NE 44th interchange), and the northernmost trace crosses the corridor near I-90 (Karlin et al. 2004; Blakely et al. 2002; Shannon and Wilson 2001; CH2M Hill 2001). Exhibit 4-2 shows the inferred location of the Seattle Fault zone.

The American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge design specifications would govern the seismic design criteria for the Project. These specifications are based on a hazard level of 5 percent probability of exceedances in 50 years and an approximate 1,000-year return.

Liquefaction and subsequently settlement and lateral spreading can occur during a seismic event in areas of loose saturated soils. Exhibit 4-3 identifies the liquefaction potential in the study area. With the anticipated groundwater levels and ground conditions described above, the liquefaction potential in the study area ranges from low and moderate to high.

Are there landslide hazards in the study area?

Exhibit 4-4 identifies the landslide hazards in the study area. Landslide hazard areas are defined by King County as areas with a combination of slopes steeper than 15 percent; impermeable soils, such as silt and clay frequently interbedded with granular soils such as sand and gravel, and springs or groundwater seepage. Also included in the landslide hazard classification are areas that have shown movement during the Holocene era (the last 10,000 years) or that are underlain by mass wastage debris from the Holocene, or areas potentially unstable as a result of rapid incision, streambank erosion, or undercutting by wave action. Potential landslide hazard areas have been identified between MP 7.0 and 10.0.

What is the erosion potential in the study area?

Most of the soils in and adjacent to the study area have been extensively modified by earlier construction activities. As these soils may be disturbed again during project construction activities such as brush clearing, setup of work sites, and other construction activities, the erosion potential may increase during execution of the Project. In addition, runoff from the construction area may increase the rate of surface erosion that could damage slopes and result in silt-laden runoff, which could degrade water quality.

Exhibit 4-1. Geologic Conditions in and adjacent to the Study Area

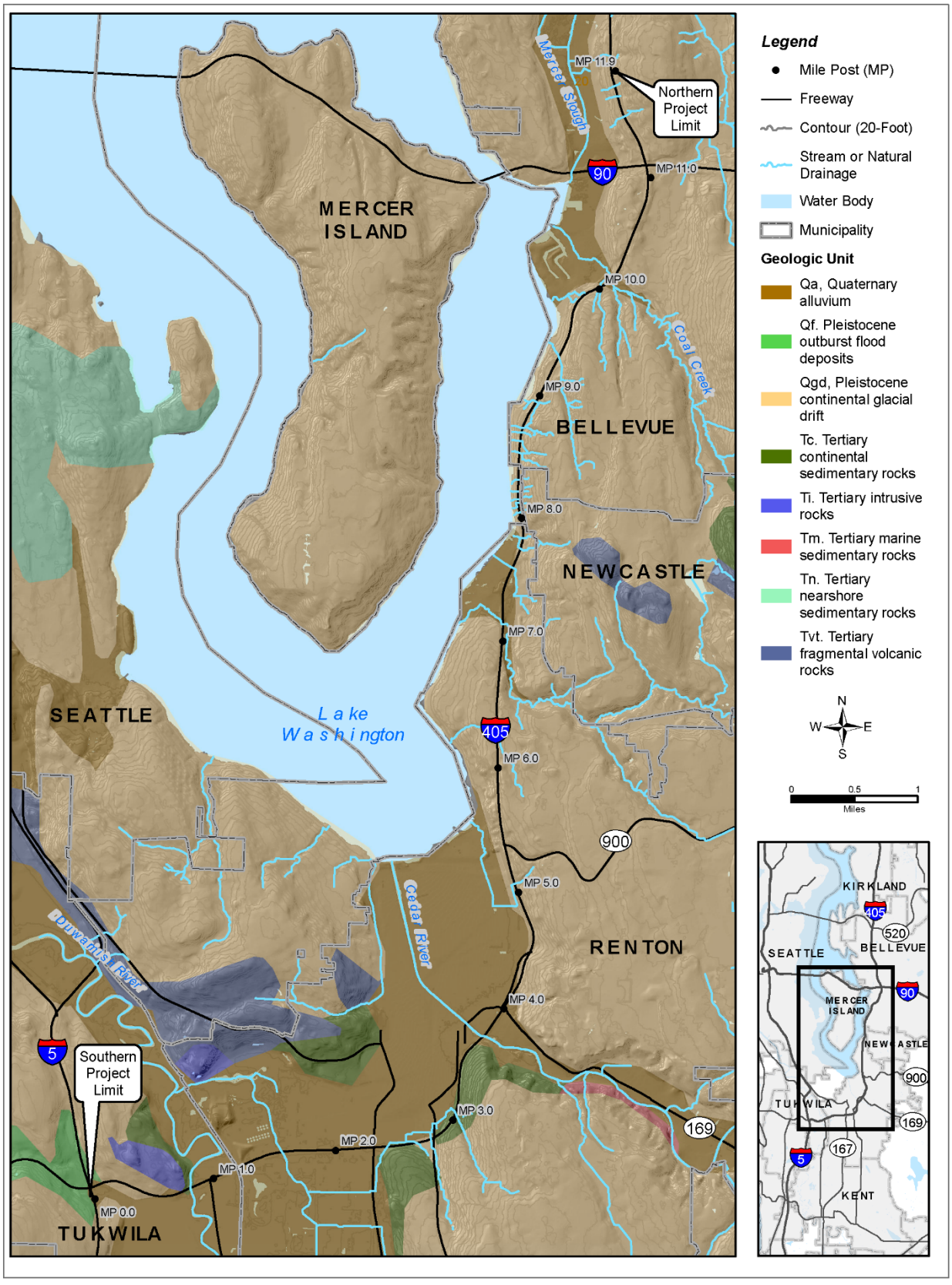


Exhibit 4-2. Inferred Location of the Seattle Fault Zone

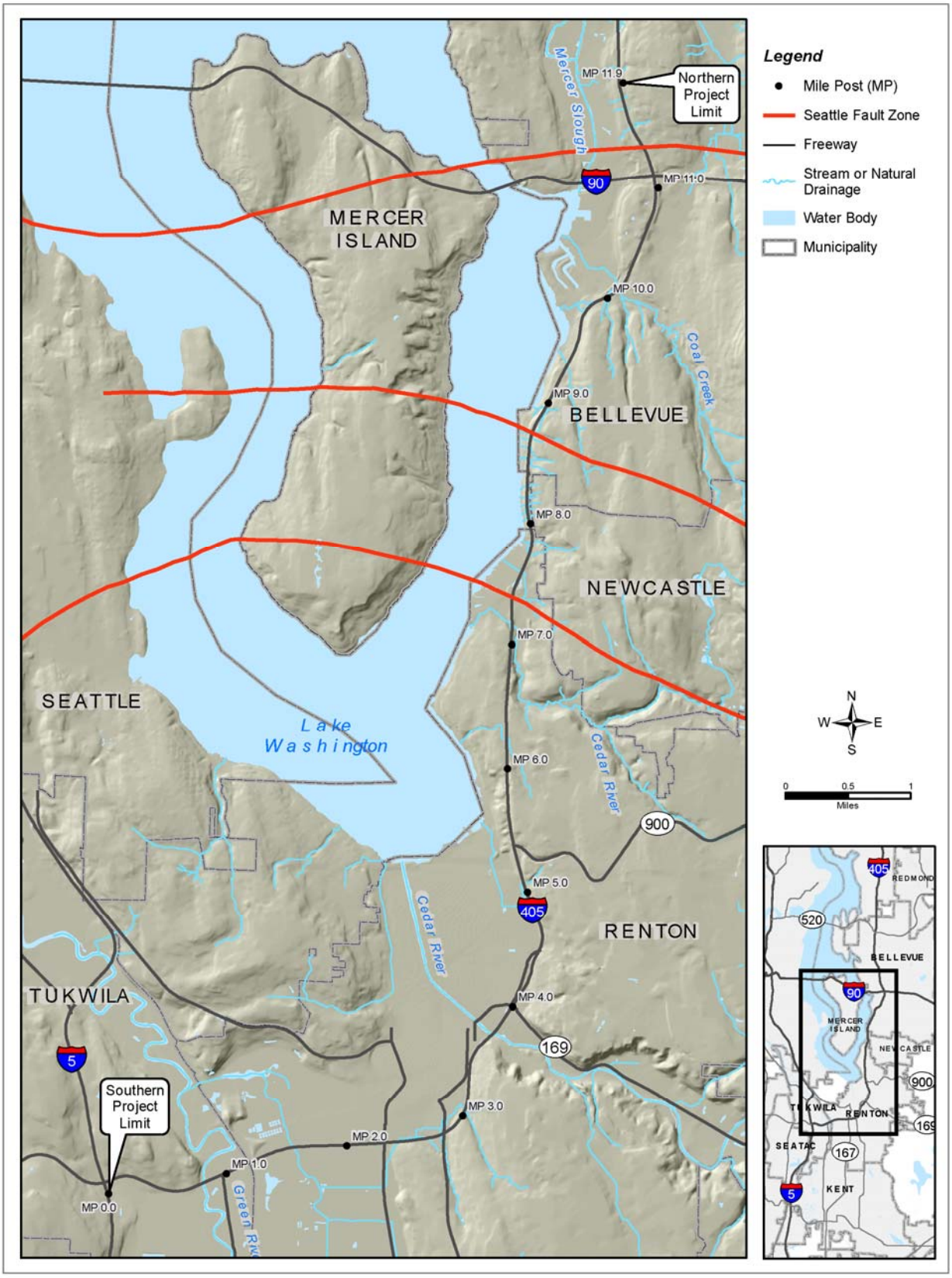


Exhibit 4-3. Liquefaction Potential in the Study Area

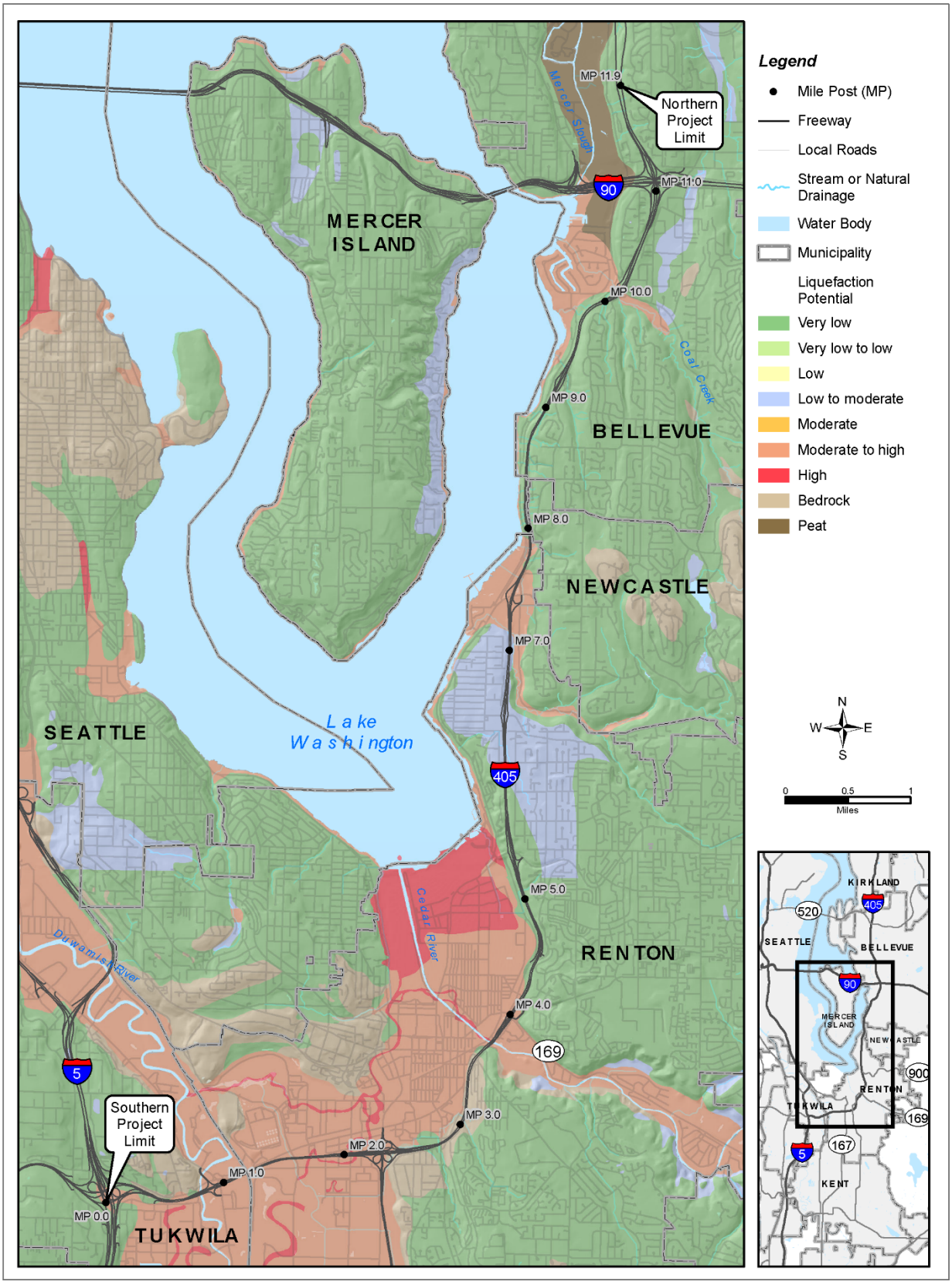
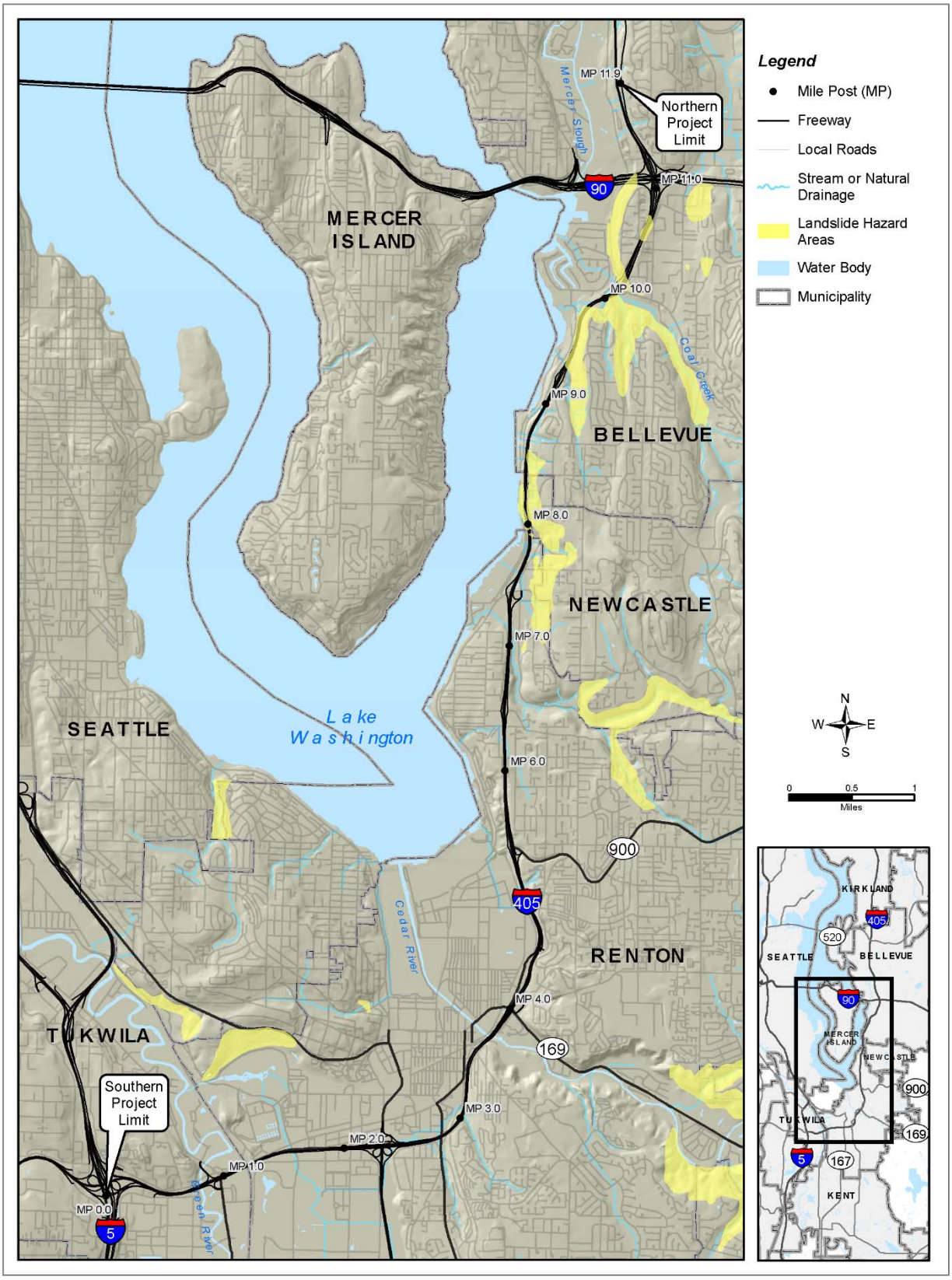


Exhibit 4-4. Landslide Hazards in the Study Area



SECTION 5 PROJECT EFFECTS

How would the Project affect geology, soils, and groundwater?

WSDOT has well-established design and construction practices for managing the types of geologic, soil, and groundwater conditions anticipated in the study area. An in-depth geotechnical site investigation (i.e., the combined efforts of WSDOT and the design-builder) will be performed to identify the subsurface conditions for final design and construction. With the implementation of normal WSDOT practices and activities to avoid effects on the environment, there would be minimal effects on geology, soils, and groundwater from the Project.

Highway design and construction through the type of soil and geologic conditions anticipated in the study area have been established based on extensive experience in completing similar projects. WSDOT is aware of the issues and would avoid or minimize potential effects through proper design, construction, and operational procedures.

What would be the Project effects during construction?

Erosion

Implementation of a temporary erosion and sedimentation control (TESC) plan would substantially reduce the volume of erosion and the potential for discharge of silt-laden runoff to nearby bodies of water. A TESC plan is typically oriented to a specific major storm event, such as the 2-year, 24-hour, or the 10-year, 24-hour storm event. A larger storm event could cause some silt to escape and be transported outside of the study area, thus, temporarily affecting nearby bodies of water. It is expected that these effects (if they occur) would be minor and of short duration.

Stormwater generated during construction is commonly turbid, with suspended solids in the runoff from disturbed and exposed soil surfaces. Stormwater containing elevated levels of turbidity and suspended solids generally do not affect groundwater quality because surface soils in which the stormwater must infiltrate to reach the aquifer usually filters and adequately removes turbidity.

Earthwork

Common to most large highway projects, project construction would involve substantial earthwork, including major cuts and fills. There would be areas where the excavated soils are unsuitable for reuse as fill, particularly during wet weather. It is anticipated that both off-site disposal of unsuitable soils and importing of fills would be required in the study area. This could result in truck traffic and associated effects, including traffic operations, noise, dust, mud, slope instability, and damage to roadways. General on-site earthwork activities would result in noise, vibration, and other relatively minor and short-term effects related to heavy construction equipment. Dry weather construction could result in dust and air quality problems.

What would be the Project effects during operation?

Seismic Hazards

The Seattle Fault crosses the study area. Should a rupture along the fault occur during the life of the Project, it could cause substantial damage to the roadway, utilities, and structures. The most recent large earthquake in the Seattle Fault zone was approximately 1,100 years ago. Five more major earthquakes are thought to have occurred in the Seattle Fault zone in the previous 12,000 years. Due to the long recurrence interval between major earthquakes and current WSDOT practices, the Project would not be designed to accommodate potential fault rupture because of the cost and difficulty in designing structures to avoid faults and the difficulty in locating active traces of the Seattle Fault zone.

Would the Project have indirect effects that may be delayed or distant from the Project?

Construction of the Project likely would not result in indirect effects on geology, soils, or groundwater.

What would happen if the Project were not built?

We evaluated a No Build Alternative to compare the effects of maintaining the status quo to the effects of the Build Alternative. With the No Build Alternative, only routine activities such as road maintenance, repair, and safety

performance improvements would take place over the next 20 years.

With the No Build Alternative, conditions would not change from the status quo. There would be no construction- or operations-related effects on geology, soils, or groundwater.

SECTION 6 MEASURES TO AVOID OR MINIMIZE EFFECTS

What measures will WSDOT take to mitigate geology, soils, and groundwater effects during construction?

WSDOT has well-established practices for managing design and construction issues associated with the types of geologic, soil, and groundwater conditions anticipated in the study area. Listed below are the measures that WSDOT will implement during construction of the Project to avoid or reduce such effects.

Seismicity

WSDOT will design project elements to AASHTO design standards and implement design methods that meet the AASHTO design event and limit susceptibility to collapse under an unlikely larger event.

Liquefaction-Prone Areas

WSDOT will identify Project areas where liquefaction-prone soils may be located. For structures underlain by liquefaction-prone soils, WSDOT will evaluate the potential effects on the structure from liquefaction. If liquefaction risks are determined to be unacceptable, WSDOT will use appropriate measures to reduce long-term liquefaction and lateral spreading risks. Such measures might include soil densification such as stone columns, vibratory compaction, compaction grouting, and dynamic compaction. Liquefaction potential along the project alignment is assessed as low and moderate to high.

Soft-Ground Areas

WSDOT will take appropriate measures to assess and reduce potential settlement problems associated with existing utilities or structures in areas underlain by soft, compressible soil. If deemed necessary, structures could be underpinned and utilities relocated or made more flexible. In cases where settlement exceeds WSDOT-allowable tolerances and the settlement is allowed, repairs as needed will be made after the settlement is complete. Where soft-ground areas are identified, WSDOT will conduct preconstruction surveys and monitor construction settlements.

WSDOT will assess the settlement potential for structures and embankments underlain by soft, compressible soil. If the potential settlement is unacceptable, WSDOT will design the structures and embankments to accommodate or avoid the settlement, such as deep foundations for structures or surcharge fills for embankments.

WSDOT will develop the means and methods to avoid or minimize settlement resulting from construction vibration in areas underlain by soft or loose soils.

Slope Stability and Landslide Areas

WSDOT will develop appropriate construction procedures to maintain or enhance slope stability in areas underlain by landslides or with landslide-prone geology. The design through these areas will include suitable wall types, such as soldier piles with tiebacks, possibly supplemented with enhanced drainage, such as improved surface drainage or horizontal drains.

WSDOT will drain suspected or observed seepage to reduce the risk of landslide and surface sloughing through the use of gravel drainage blankets, French drains, horizontal drains, placement of a surface rock facing, or other methods.

Dewatering

WSDOT will use properly designed, installed, and operated dewatering systems as dewatering for utility trenches can induce ground settlement in areas of soft compressible soils. This might include sheet pile cut-off shoring, recharge wells, a settlement and groundwater level monitoring system, and other procedures. We understand that complete elimination of settlement in proximity to excavations can be difficult, particularly if loose granular soils are densified by installing sheet piles.

WSDOT will control dewatering discharge to avoid adverse effects. If dewatering occurs in contaminated ground, discharge into storm drains or adjacent surface drainages could affect water quality. This condition is normally mitigated by disposing the discharge in a sanitary sewer or performing on-site treatment.

Erosion

WSDOT will prepare and implement a TESC plan to minimize erosion and protect water quality. WSDOT will take additional

action to minimize erosion, maintain water quality, and achieve the intended environmental performance, should any BMP or other operation not function as intended.

Earthwork

WSDOT will control dust through the use of a water truck or other dust-control measures (see Attachment B, *Air Quality Discipline Report*). WSDOT will also control soil tracked onto nearby surface streets from truck tires. WSDOT will place and maintain stockpiles properly to avoid erosion or slope stability problems. Proper traffic control and construction management procedures will be implemented to reduce truck-related construction effects. Erosion control of stockpiles will be included in the TESC plan.

Groundwater Quantity

WSDOT will avoid drawdown of nearby wells during construction. These effects can be avoided by the use of recharge wells and/or cut-off walls, if necessary. WSDOT will implement sound construction management, safety precautions, and safety enforcements to avoid construction-related traffic accidents, which could damage and disrupt these wells.

WSDOT will locate areas where permanent drainage will be required by site conditions for cut slopes. If local private groundwater users or downgradient wetlands and spring water right holders could become affected by drawdown of the groundwater table from these drain systems, these effects will be avoided on a site-specific basis by designing the permanent drainage system to recharge or replenish the downgradient water table.

SECTION 7 REFERENCES

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APPENDIX A ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
BMP	best management practice
EA	Environmental Assessment
EIS	Environmental Impact Statement
ETL	express toll lane
FHWA	Federal Highway Administration
GP	general purpose
HOV	high-occupancy vehicle
I-405	Interstate 405
I-5	Interstate 5
I-90	Interstate 90
LRFD	Load and Resistance Factor Design
MP	milepost
NEPA	National Environmental Policy Act
Qa	alluvium
OEO	Office of Equal Opportunity
ROD	Record of Decision
SOV	single-occupant vehicle
SR	State Route
TESC	temporary erosion and sediment control
UNT	unnamed tributary
WSDOT	Washington State Department of Transportation
WSTC	Washington State Transportation Commission

APPENDIX B GLOSSARY

Term	Meaning
Advance and recessional outwash	Sand and gravel deposited by an active glacier as it advances or retreats.
Alluvium	Alluvium is loose, unconsolidated soil or sediments that has been eroded, reshaped by water in some form, and redeposited in a non-marine setting.
Express toll lane	A limited-access freeway lane that is actively managed through a variable toll system to regulate its use and thereby maintain express travel speeds and reliability. Toll prices rise or rise in real time as the lane approaches capacity or becomes less used. This ensures that traffic in the express toll lane remains flowing at express travel speeds of 45 to 60 miles per hour. Transit and carpools do not pay a toll.
Glacial scour	Concentrated erosive action
Glaciofluvial	Deposits derived from stream flows from a glacier
Lacustrine deposits	Lacustrine deposits are sedimentary rock formations that formed in the bottom of ancient lakes.
Liquefaction	Phenomenon whereby a saturated soil loses its strength or stiffness
Lodgement till	A till characterized by particles oriented parallel to the movement of glacial ice.