Everett Link Extension

EIS Technical Analysis Methods Report

October 2023

SOUNDTRANSIT

HOW TO USE THIS DOCUMENT

This Environmental Impact Statement (EIS) Technical Analysis Methods Report is a compilation of the technical analysis methodology memoranda that have been prepared for the Everett Link Extension (EVLE) Project. Sound Transit invites Tribes and agencies to review the technical analysis methodologies that are within their area of expertise. To facilitate navigation of this document, each technical analysis methodology memorandum is bookmarked on the left. Sound Transit requests that Tribes and agencies consolidate comments and record them in the comment form provided. Sound Transit will revise the methodology memoranda as appropriate based on the comments received and will make the final report available.

1 INTRODUCTION

The EVLE Project would extend Link light rail from the Lynnwood City Center Station to the Everett Station area in Snohomish County, Washington, and improve connections to the regional transit system and major activity centers. It would also include construction of a light rail operations and maintenance facility (OMF) in Snohomish County (OMF North) to support the regional Link light rail program, including EVLE. The project corridor is approximately 16 miles long and is part of the Sound Transit 3 (ST3) plan of regional transit system investments that voters approved funding for in 2016.

Sound Transit is the lead agency for the project under the Washington State Environmental Policy Act (SEPA) and has determined that the EVLE Project is likely to have a significant adverse impact on the environment. Sound Transit conducted SEPA EIS scoping in January-March 2023 and is beginning work on an EIS for the project now. Sound Transit is coordinating with FTA during their SEPA process and anticipates receiving future funding from FTA that would require environmental review under the National Environmental Policy Act (NEPA). A Notice of Intent under NEPA is anticipated to be issued at a later date, likely in mid-2025.

The enclosed technical analysis methodology memoranda have been prepared to address both NEPA and SEPA environmental review processes. Each technical analysis methodology includes information on guiding regulations, plans, and policies; data needs and sources; study area and area of effect; affected environment; environmental impact analysis; mitigation measures; proposed figures, maps, or other data; documentation; and data developed for use by other disciplines. Methodologies for the following are attached:

- Acquisitions, Displacements, and Relocations
- Air Quality
- Economics
- Ecosystems
- Electromagnetic Fields
- Energy
- Environmental Justice
- Geology and Soils
- Hazardous Materials

- Historic and Archaeological Resources
- Land Use
- Noise and Vibration
- Parks and Recreational Resources
- Public Services, Safety, and Security
- Section 4(f) Evaluation
- Section 6(f) and Recreation and Conservation Office Evaluation
- Social Resources, Community Facilities, and Neighborhoods
- Transportation
- Utilities
- Visual and Aesthetic Resources
- Water Resources

2 STUDY AREA

The study area around the proposed alternatives varies according to the potential range of effects for each particular resource.

3 ALTERNATIVES

3.1 Build Alternatives

In June 2023, Sound Transit identified Build Alternatives to study in the Draft EIS. The project alternatives being evaluated are in a corridor that generally parallels I-5 between Lynnwood City Center Station and Everett Station, with a curve to the west to serve the SW Everett Industrial Center. The alternatives being considered fully separate light rail from traffic and include six stations, plus a provisional (unfunded) station. The project also includes an operations and maintenance facility, OMF North. OMF North would be used to receive, commission, store, maintain, and deploy approximately 150 LRVs for daily service. The final number of LRVs maintained at this location will be determined in the Rail Fleet Management Plan updated, currently underway by Sound Transit. The alternatives to be studied in the Draft EIS are shown in Figure 3-1 and are described in the following sections by geographic segment: West Alderwood, Ash Way, Mariner, SR 99/Airport Road, SW Everett Industrial Center, SR 526/Evergreen Way, Broadway/I-5, and Everett Station, as well as OMF North.

3.1.1 West Alderwood

In the West Alderwood Segment, there are three proposed alternatives. ALD-D (preferred alternative) runs elevated west of I-5, turning north in the vicinity of 33rd Avenue W, turning east near 184th Street SW with an elevated station in the vicinity of 188th Street W and 33rd Avenue W. The second alternative, ALD-F, is on the same alignment as ALD-D, but with a station in the vicinity of 184th Street W and 33rd Ave W. The third alternative, ALD-B, runs elevated west of I-5, turning north in the vicinity of 33rd Avenue W, turning east near Alderwood Mall with an elevated station south of the mall.

3.1.2 Ash Way

In the Ash Way Segment, there are two proposed alternatives. ASH-A runs elevated on the west side of I-5 with an elevated station in the vicinity of Ash Way Park-and-Ride. The second alternative, ASH-D, crosses to the east side of I-5 north of the SR 405 interchange, with a below-grade station near 164th Street SW in the vicinity of Motor Place and continues elevated to the west side of I-5 in the vicinity of 134th Street SW. There is no preferred alternative identified for the Ash Way Segment.

3.1.3 Mariner

In the Mariner Segment, there are two proposed alternatives. MAR-B runs elevated on the west side of I-5 and turns west near 128th Street SW with an elevated station in the vicinity of 8th Avenue W; the guideway continues in the vicinity of 128th Street SW/Airport Road. The second alternative, MAR-D, runs elevated on the west side of I-5, east of 8th Avenue W with an elevated station in the vicinity of the Mariner Park-and-Ride; the guideway continues in the vicinity of 128th Street SW/Airport Road. There is no preferred alternative identified for the Mariner Segment.

3.1.4 SR 99/Airport Road

In the SR 99/Airport Road Segment, there are two proposed alternatives. AIR-A runs elevated generally on the east side of Airport Road with an elevated station near the intersection with SR 99. AIR-B runs elevated generally on the west side of Airport Road, crossing to the east side of Airport Road north of 112th Street SW, with an elevated station near Airport Road and SR 99. There is no preferred alternative identified for the SR 99/Airport Road Segment.

3.1.5 SW Everett Industrial Center

In the SW Everett Industrial Center Segment there are three proposed station alternatives on the same alignment. The SW Everett Industrial Center alignment runs elevated near Airport Road, curving east generally south of SR 526. SWI-A (preferred alternative) has an elevated station south of SR 526 near W Casino Road and west of Seaway Boulevard. SWI-B has an elevated station near Kasch Park Road. SWI-C has an elevated station near 94th Street SW.

3.1.6 SR 526/Evergreen Way

In the SR 526 Evergreen Way Segment there are three proposed alternatives. EGN-A runs at-grade generally on the north side of SR 526 with a station of Evergreen Way. EGN-B runs elevated generally on the south side of SR 526 with an elevated station west of Evergreen Way. EGN-E runs elevated generally on the south side of SR 526, transitioning to the south side of W Casino Road with an elevated station east of Evergreen Way. There is no preferred alternative identified for the SR 526/Evergreen Way Segment.

3.1.7 Broadway/I-5

In the Broadway/I-5 Segment there are two proposed alignment alternatives and no stations. I-5 (preferred alternative) is an alignment segment on the west side of I-5 from SR 526 to approximately 52nd Street SE. BRD is an alignment segment that runs parallel to Broadway from SR 526 to approximately 52nd Street SE.

3.1.8 Everett Station

In the Everett Station Segment, there are three proposed alternatives. EVT-C (preferred alternative) runs elevated west of I-5, turns north in the vicinity of McDougall Avenue with an elevated station near 32nd Street. EVT-D (preferred alternative) runs elevated west of I-5, turns north in the vicinity of McDougall Avenue with an elevated station near Hewitt Avenue. EVT-A runs elevated west of I-5 with a station near the existing Everett Station.

3.1.9 OMF North

There are three proposed alternative sites for the OMF North. Site B1/Site B2 would be located in the city of Everett generally between SR 526 and 75th Street SW, east of 16th Avenue W. Site E would be located primarily in the city of Everett generally between 100th Street SW and Holly Drive, east of Airport Road. Site F would be located in unincorporated Snohomish County generally southwest of Airport Road and northwest of SR 99/Evergreen Way. There is no preferred alternative for the OMF North sites.

3.2 No Build Alternative

The EIS will also evaluate a No Build Alternative. The No Build Alternative includes the transportation system and environment as they would exist in 2046 without the proposed project. The year 2046 is used as the analysis year because it is consistent with Sound Transit long-range planning and assumes the full build of Sound Transit’s ST3 system, including service to Everett Station in 2041 and parking facilities in place at the stations in 2046. This horizon year would utilize the Puget Sound Regional Council land use and roadway network assumptions.

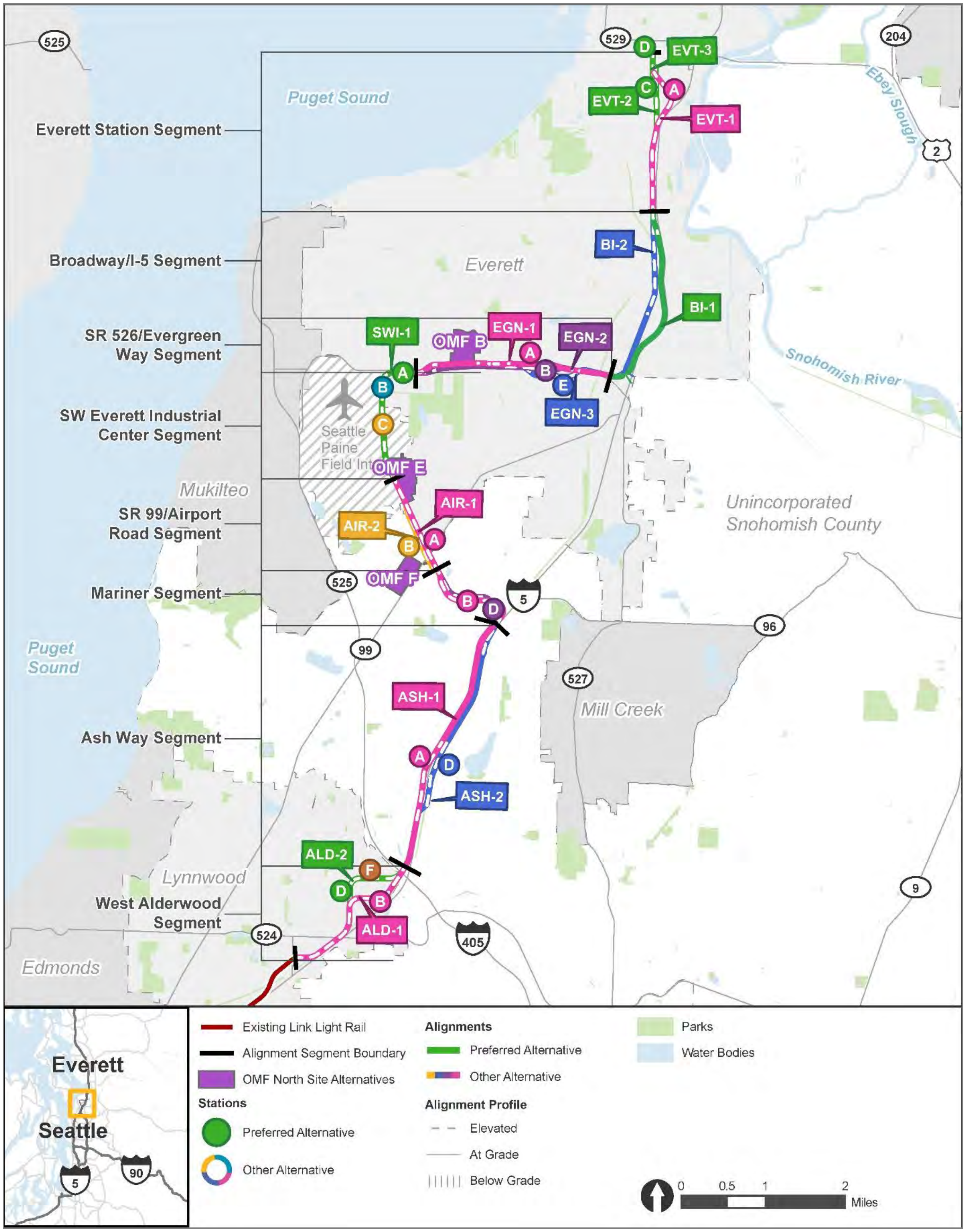

Figure 3-1 Draft EIS Alternatives

4 RELEVANT RESOURCES FOR ALL STUDIES

The following regulations, rules and guidelines will be considered in the environmental analyses:

- NEPA, United States Code (USC) Title 42 Section 4321
- Council on Environmental Quality (CEQ) NEPA Regulations, Code of Federal Regulations (CFR) Title 40 Section 1501-1508
- FTA NEPA regulations (23 CFR 771) and guidelines
- Fixing America's Surface Transportation (FAST) Act
- Presidential Executive Order 14008, Tackling the Environmental Crisis at Home and Abroad (EO 14008), January 27, 2021
- SEPA and rules for implementing SEPA, Chapter 197-11 of the Washington Administrative Code (WAC), in accordance with Revised Code of Washington (RCW) 43.21C and RCW 43.21C.030
- Washington State Growth Management Act (GMA) (RCW 36.70A)
- Sound Transit SEPA Rules (Board Resolution No. R2018-17)
- City of Lynnwood environmental policies and land use and zoning regulations
- City of Everett environmental policies and land use and zoning regulations
- Snohomish County environmental policies and land use and zoning regulations
- Sound Transit 3, the Regional Transit System Plan for Central Puget Sound (http://soundtransit3.org/)
- Sound Transit Environmental Policy (Board Resolution No. R2004-06)
- Sound Transit Sustainability Initiative (Board Resolution No. R2007-12)
- Sound Transit Executive Order No. 1 Establishing a Sustainability Initiative for Sound Transit (2007)
- Sound Transit Disparate Impact and Disproportionate Burden Policy (Board Resolution No. R2022-19)

Each resource methodology also describes relevant reference materials and regulations specific to the resource. Resource analyses will use applicable information from previous studies that have been conducted near the alternatives as well as past Sound Transit environmental documents. These documents are noted in the resource methodologies where applicable.

Everett Link Extension

Acquisitions, Displacements, and Relocations Technical Analysis Methodology

October 2023

SOUNDTRANSIT

1 INTRODUCTION

This technical analysis methodology memorandum describes the methods that will be used to analyze the impacts of property acquisitions, displacements, and relocations for the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS). The acquisitions technical report and EIS section will describe the property acquisitions and displacements and will present measures to mitigate potential impacts as well as a description of potential relocation opportunities in the project vicinity.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

In addition to the relevant regulations considered in all environmental analyses, the following will be considered:

- **Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970:** The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Code of Federal Regulations [CFR] Title 49, Part 24), as amended, is a federal requirement. The act and its amendments provide guidance on how federal agencies, or agencies receiving federal financial assistance for a project, will compensate for impacts on property owners or tenants who need to relocate if they are displaced by a project.
- **Sound Transit's Real Property Acquisition and Relocation Policy, Procedures, and Guidelines:** Sound Transit adopted the Real Property Acquisition and Relocation Policy, Procedures, and Guidelines to guide its compliance with Chapter 8.26 Revised Code of Washington and Chapter 468-100 Washington Administrative Code. Property acquisition will meet these laws and policies so that property owners are treated uniformly and equitably (Sound Transit, 2017).

3 DATA NEEDS AND SOURCES

Affected parcels and the type of property acquisition will be identified by the project design team and provided to the EIS team for summary in the EIS. Data will be provided in Microsoft Excel and/or geographic information system (GIS) data layer formats. Information summarized or obtained for the following sections will be used in this section:

- Land Use
- Social Resources, Community Facilities, and Neighborhoods
- Environmental Justice
- Public Services, Safety, and Security
- Utilities

Information from the Puget Sound Regional Council (PSRC) will also be accessed using their opportunity mapping tool (https://www.psrc.org/opportunity-mapping).

4 STUDY AREA AND AREA OF EFFECT

The study area for the property acquisitions impacts analysis will include the local jurisdictions and possibly the broader region for discussion of relocation opportunities and vacancy trends. The area of effect will be limited to the properties that are anticipated to require full or partial acquisition for each Build Alternative evaluated. The need for easements, such as subsurface easements, aerial easements, and temporary construction easements, will be described but specific properties will not generally be identified.

5 AFFECTED ENVIRONMENT

The affected environment is the land uses in the study area with a reference to the more detailed characterization in the Land Use section.

6 ENVIRONMENTAL IMPACT ANALYSIS

The analysis will assess the potential direct, indirect, and cumulative property acquisition impacts of the Build and No Build Alternatives. The No Build Alternative would not require any acquisitions, displacements, or relocations. The impacts of the Build Alternatives will be generally described for the estimated number of affected parcels and estimated displacements for the following categories:

- Residential units: includes buildings designated for permanent housing, including single-family and multi-family buildings
- Business units: includes retail, office, industrial, or any other type of commercial property
- Public/institutional: includes government facilities, schools, maintenance buildings, public utility properties, or other public or institutional properties

Impacts to properties that may provide emergency housing (motels, temporary shelters) will be discussed qualitatively.

Impacts to public right-of-way will be disclosed in a general manner but will not be quantified. Any future limitations to development in public right-of-way will also be discussed in a general manner.

6.1 Direct Impacts

The direct impacts of the project (long-term and short-term construction) will be primarily estimated using parcel data and ownership information from Snohomish County, other GIS data, conceptual design drawings, and field reconnaissance. Sound Transit will estimate partial and full acquisitions for each Build Alternative based on conceptual or preliminary design information. These estimates will consider property needed for related facilities, as known, such as power substations, major stormwater facilities, and areas that could be used for construction staging, maintenance and emergency access easements, or other elements. Information on partial and full acquisitions will be used to determine the total number of affected parcels and the number of displacements, but whether properties will be partial or full acquisitions will not be reported in the EIS due to the early stage of design.

The estimated number of affected parcels will be identified by segment (if applicable) and Build Alternative. Affected parcels includes both partial and full acquisitions and are presented together as a combined single number. Potentially acquired parcels will be further evaluated based on field investigations to identify parcel access impacts not readily identified through mapping. The impacts analysis will also identify the number of businesses, public/institutional facilities, and residential units that would be displaced by segment (if applicable) and Build Alternative, based on information available in assessor data and field verification when possible. The affected parcel and displacement information will be summarized in a table as appropriate. The EIS text can characterize the main features of the acquisitions and displacements as necessary. This analysis will emphasize and make clear the preliminary nature of the acquisition and displacement numbers and that these quantities will be refined as the project design and property acquisition process advance. Final determinations of right-of-way needs by parcel will not be made until after the Final EIS is complete and final design information is available.

6.2 Indirect Impacts

Indirect impacts are potential effects that would be caused at a later time or a farther distance but are still reasonably foreseeable. The potential for indirect property acquisitions and displacements due to project acquisitions and re-development projects by others will be addressed qualitatively.

6.3 Cumulative Impacts

If other recent past, current, or future projects with acquisitions or displacements are nearby, or if the project is displacing a use that has been relocated or altered due to previous projects, cumulative effects may be present. The analysis will review available information about past or current projects and the location of other proposals in the vicinity to determine the potential for cumulative impacts. The list of cumulative projects will be included as an appendix to the EIS.

7 RELOCATION OPPORTUNITIES

The analysis will also include a market-based review of available properties in the vicinity and regionally to determine the types of properties that might be used for relocating displaced uses. The assessment will consider availability by general type of use affected and in terms of the project's displacements and the market's balance of supply versus demand. Although individual property needs will not be assessed, the assessment will identify displaced properties with unique use or site requirements.

8 SOUND TRANSIT ACQUISITION AND RELOCATION POLICY SUMMARY

This section will summarize Sound Transit's acquisition and relocation requirements and policies, which are accepted as part of the project definition. These include the Federal Uniform Real Property Acquisition and Relocation Act, as amended, and Sound Transit's *Real Property Acquisitions and Relocation Policy, Procedures and Guidelines* (Revision 4, Sound Transit, 2017). Sound Transit's *Property Acquisition and Non-Residential Relocation Handbook* (Sound Transit, 2014a) and *Property Acquisition and Residential Relocation Handbook* (Sound Transit, 2014b) outline compensation and acquisition procedures in layman's terms and will be referenced as additional information.

Any removal of designated low-income or affordable housing must comply with the applicable local jurisdictional policies and regulations for replacing such housing, although such impacts will be discussed in more detail under the Social Resources, Community Facilities, and Neighborhoods section and the Environmental Justice section.

The types of assistance available to displaced residents and businesses will be described, including eligible compensation, relocation, and other assistance requirements.

9 MITIGATION MEASURES

Potential impacts will be controlled through project planning, design, and the application of required best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the Build Alternatives will be incorporated as appropriate. Where impacts cannot be avoided or minimized, mitigation measures will be developed.

Mitigation measures will be identified for property acquisition and displacement impacts. Design changes and alignment shifts, where appropriate, will be considered to minimize displacements. The mitigation discussion will refer to Sound Transit's acquisition and relocation requirements, policies, and procedures (Sound Transit, 2017) as part of the project definition and not considered as a mitigation measure.

10 PROPOSED FIGURES, MAPS, OR OTHER DATA

The technical report will include an appendix of affected parcels with a table listing potential property acquisitions and maps showing those acquisitions for each Build Alternative alignment, station, and maintenance facility location. The maps and tables will identify affected parcels by parcel number and address but will not differentiate between potential full or partial acquisitions.

11 DOCUMENTATION

For this resource, the following documentation will be developed:

- A technical report
- An EIS section

12 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

Data gathered on property acquisitions, displacements, and relocations will be used in the following analyses:

- Land Use
- Economics
- Social Resources, Community Facilities, and Neighborhoods
- Noise and Vibration
- Visual and Aesthetic Resources
- Hazardous Materials
- Public Services, Safety, and Security
- Historic and Archaeological Resources
- Parks and Recreational Resources
- Section 4(f) Evaluation
- Section 6(f) and Recreation and Conservation Office Evaluation
- Environmental Justice

13 REFERENCES

Sound Transit. 2014a. *Property Acquisition and Non-Residential Relocation Handbook*. October 2014. https://www.soundtransit.org/sites/default/files/Non-Residential_handbook_2014w.pdf.

Sound Transit. 2014b. *Property Acquisition and Residential Relocation Handbook*. October 2014. https://www.soundtransit.org/sites/default/files/documents/property-acquisition-and-residential-relocation-handbook.pdf.

Sound Transit. 2017. *Real Property Acquisition and Relocation Policy, Procedures, and Guidelines*. Resolution #R98-20-1. Revision 4. November 2017. https://www.soundtransit.org/sites/default/files/real-property-acquisition-relocation-policy-procedures-guidelines.pdf.

Everett Link Extension

Air Quality Technical Analysis Methodology

October 2023

SoundTransit

1 INTRODUCTION

This technical analysis methodology memorandum describes the methods that will be used to analyze the impacts to air quality, including greenhouse gas (GHG) emissions, for the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS). The air quality technical report and EIS section will address the air quality impacts of the No Build and Build Alternatives, discussing the following elements, and present potential mitigation measures for impacts, if needed:

- Existing air quality conditions in areas potentially affected by the alternatives
- Regulations and policies governing the evaluation of air quality impacts and mitigation
- Methodology used in the analysis
- Impacts of the alternatives (direct, indirect, and cumulative)
- Potential mitigation measures (if required)

The air quality analysis will address compliance with applicable federal, state, and local regulatory requirements based on the air quality classification within the project area, governing regulations for transportation projects of this type, and the types of pollutants emitted from construction and operational activities from the project and their effects on the existing environment. In addition, reviewing agencies have specific policies, protocols, and guidance documents that are relevant when evaluating air quality project impacts.

The following summarizes the requirements of the air quality analysis, separated into three criteria areas. The sections that follow address each of these criteria individually.

- The impacts of emissions generated from project operation for the No Build and Build Alternatives will be addressed qualitatively for areas in attainment for all criteria air pollutants.
- The impacts from mobile source air toxics (MSATs) will be addressed following Federal Highway Administration (FHWA) guidance based on project implications on traffic volumes and potential mitigation.
- The impacts on air quality during construction will be assessed qualitatively based on the expected construction activities and potential mitigation.

In addition, the technical report will include evaluation of:

- GHG emissions during construction and operations, which will be addressed quantitatively. The impacts of project operation on climate change will be assessed based on project implications on traffic volumes and potential mitigation.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

In addition to the relevant regulations considered for all environmental analyses, the following federal, state, and local laws, regulations, guidance, and policies are applicable to the air quality analysis for this project and will also be considered:

- Clean Air Act (42 United States Code [USC] 7401)
- Code of Federal Regulations (CFR) Title 40, Section 50 (40 CFR 50), U.S. Environmental Protection Agency (USEPA), National Primary and Secondary Air Quality Standards
- 40 CFR 86, Control of Emissions from New and In-Use Highway Vehicles and Engine
- 40 CFR 93, Determining Conformity of Federal Actions to State or Federal Implementation Plans
- Presidential Executive Order (EO) 13990, Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis, January 20, 2021
- Council on Environmental Quantity (CEQ), Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews, August 1, 2016
- CEQ, National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions and Climate Change, January 9, 2023
- FHWA, Updated Interim Guidance on Mobile Source Air Toxic Analysis in National Environmental Policy Act (NEPA) Documents, 2023
- Federal Transit Administration (FTA), Air Quality Conformity Guidance, 2017
- FTA, Greenhouse Gas Emissions from Transit Projects: Programmatic Assessment, 2017
- USEPA, Motor Vehicle Emission Simulator (MOVES) MOVES3 Technical Guidance, 2020
- USEPA, MOVES3 Policy Guidance, 2020
- Washington Clean Air Act (Revised Code of Washington [RCW] 70.94)
- Chapter 173-420 Washington Administrative Code (WAC), Conformity of Transportation Activities to Air Quality Implementation Plans
- Puget Sound Clean Air Agency (PSCAA) Regulation I, Article 9, Section 15, Fugitive Dust Control Measures
- Puget Sound Regional Council (PSRC), Regional Transportation Plan 2022-2050; Appendix G, Air Quality Conformity, 2022
- Washington State Department of Transportation (WSDOT) Guidance – Project Level Greenhouse Gas Evaluations under NEPA and State Environmental Policy Act (SEPA), 2018
- American Public Transportation Association (APTA) Recommended Practice for Quantifying Greenhouse Gas Emissions from Transit, 2009

3 DATA NEEDS AND SOURCES

The air quality and greenhouse gas analyses will use the following data from other EIS sections for the existing year as well as the 2037 opening year and 2042 horizon year. The analysis will draw on the forecasts for the No Build Alternative and the Build Alternatives that are being developed as part of the EIS transportation analysis.

3.1 Transportation Data

- Average daily vehicle miles traveled (VMT), daily vehicle hours traveled (VHT), and annual average daily traffic (AADT) for the project study area and the regional study area, summarized by roadway type (specific link data may be required for major arterials)
- Project-specific information from the design team, including miles of light rail, number of stations, supporting infrastructure (such as bus layover, parking, and maintenance facilities), and estimated daily and annual ridership

3.2 Energy Data

- Source(s) of energy for utility providing electricity to the project, for example: percent of renewable energy generation. Sound Transit and Puget Sound Energy (PSE) have entered into an agreement that all PSE electricity accounts related to the operations of Link light be sourced solely from renewable wind power via PSEs Green Direct program (see Board Motion No. M2017-11).
- Energy use by existing similar Sound Transit facilities in the Puget Sound region, such as light rail trains, stations, maintenance facilities and parking garages, requested from Sound Transit Maintenance Information.
- Maintenance schedule and anticipated activities associated with maintenance for the project. This includes schedule, type of equipment, general maintenance activities, and sequencing.

3.3 Construction Information

- Construction timeframe and sequencing
- Anticipated type and number of equipment used for construction
- Raw material use and placement

4 STUDY AREA AND AREA OF EFFECT

The project is expected to decrease regional VMT and associated emissions of air pollutants, resulting in an overall air quality benefit. The study area for air quality and GHG includes areas likely to be affected by changes in pollutant levels because of changes in traffic conditions resulting from the Build Alternatives. The study area will generally be the same as the regional study area used in the transportation analysis.

5 AFFECTED ENVIRONMENT

The EIS will discuss the air quality and GHG regulatory environment of the Puget Sound region and trends in the monitored ambient criteria pollutant concentration data. The regional air quality and meteorological data required for the analysis will be obtained from representative PSCAA or Washington Department of Ecology (Ecology) stations.

On a regional scale, the focus of the air quality analysis will encompass a wider range of pollutants. The following scenarios will be considered for the local and regional analysis:

- Existing conditions (2023)
- Future Opening Year (2037): This scenario represents the opening of the Operations and Maintenance Facility (OMF) North in 2034 and service to SW Everett Industrial Center in 2037. It does not include construction of parking facilities at the stations. This is consistent with the interim opening schedule identified by Sound Transit.
- Horizon year (2046): This is the proposed horizon analysis year consistent with regional planning. This horizon year is consistent with Sound Transit long-range planning and assumes the full build of Sound Transit's ST3 system, including service to Everett Station in 2041 and construction of parking facilities at the stations in 2046. This horizon year would utilize the PSRC land uses and roadway network assumptions.

The project area is in attainment for all criteria pollutants including carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter with aerodynamic diameter equal to or smaller than 2.5 micrometers ($PM_{2.5}$), particulate matter with aerodynamic diameter equal to or smaller than 10 micrometers (PM_{10}), sulfur dioxide (SO_2), and lead.

6 ENVIRONMENTAL IMPACT ANALYSIS

As described in Section 4 of the EIS Technical Analysis Methods Report Introduction, the Build Alternatives are divided into eight geographic segments. The difference in project effects related to air quality between the Build Alternatives are anticipated to be negligible, and a composite Build Alternative will be identified consisting of one alternative from each segment that reflects the greatest effect. The impact analysis will compare the composite Build Alternative to the No Build Alternative.

6.1 Direct Impacts

6.1.1 Long-Term

6.1.1.1 Criteria Pollutants

An analysis of potential effects associated with emissions of criteria air pollutants resulting from operations of the project No Build and Build Alternatives will be conducted qualitatively. As noted in Section 4, the project is anticipated to have an overall benefit to air quality in the region. The anticipated AADT and VMT for the No Build and Build Alternatives will be presented to show how the project would affect traffic volumes in the region. Long term impacts will also be analyzed under conformity analysis, which is further discussed in Section 6.2.

6.1.1.2 Mobile Source Air Toxics

Mobile source air toxic emissions generated from traffic in the project study area will be addressed following FHWA guidance (FHWA, 2023). The increase in AADT from the project No Build Alternative to the Build Alternatives will be used to determine if a qualitative or quantitative analysis would be required. If the increase in AADT from the No Build to the Build Alternatives is estimated to be less than the FHWA threshold of 140,000 AADT by the transportation forecast year, that would trigger a qualitative analysis. If a qualitative analysis is provided, the EIS will consider using Prototype Language for Qualitative Project-Level MSAT Analysis in the FHWA guidance, as appropriate. If review of the traffic data indicates that the threshold would be exceeded for any of the Build Alternatives, a quantitative analysis will be performed following FTA (2017) and FHWA (2023) guidance.

6.1.1.3 Greenhouse Gases

Changes in carbon dioxide equivalent (CO2e) emissions resulting from the alternatives will be calculated for the operational and construction phases of the project. The current approved version of the USEPA MOVES model for operational emissions will be used to estimate GHG emission factors resulting from fossil fuel consumption. The USEPA MOVES model will estimate overall fuel consumption factors based on national defaults and area-specific information for Snohomish County. The direct benefits of the reduction in VMT will also be quantified. The operational GHG analysis will be conducted using traffic data from the regional travel demand model, which includes vehicle volumes derived for each facility segment, producing VMT per roadway link.

The GHG emissions from energy (e.g., electricity or natural gas) used by the operating project will also be calculated, including power for the light rail, as well as fixed facilities such as stations and the Operations and Maintenance Facility (OMF) North. GHG emissions from electricity generation for the operation of light rail trains, stations, maintenance facilities, and parking facilities will be quantified based on the expected usage and the carbon intensity factor of the project region.

Following recommendations issued in the CEQ’s interim guidance on analyzing GHG under NEPA (CEQ, 2023), a social cost will be estimated based on the total CO2 emissions from the construction and operation of the Build and No Build Alternatives. The cost per ton of CO2e will be calculated based on the most up to date figures given by the current presidential administration. The 2020 average cost is quantified at $51 per metric ton of CO2.

6.1.2 Construction

To evaluate the potential effects during project-related construction, a qualitative analysis will be conducted of potential effects associated with the following:

- Emissions from dust-generating activities
- Operation of heavy-duty diesel equipment
- Trucking activities within major construction areas (including staging areas)

The construction analysis will quantify GHG emissions in terms of CO2e. Project-level construction emissions of GHG generated by construction activity for the project will be estimated using the FTA Transit Greenhouse Gas Emissions Estimator (GHG Estimator), which is recommended as the preferred model by Sound Transit Guidance (Environmental Science Associates, 2016). The model is based on the FHWA Infrastructure Carbon Estimator (ICE).

The construction impacts methodology will include life-cycle analysis such as the GHG emissions resulting from the manufacturing of light rail vehicles or cement production. The end result of the construction impacts analysis will be an estimated total amount of CO2e emissions for construction of the project.

6.2 Conformity Determination

Areas that are in nonattainment or maintenance for a pollutant are subject to conformity requirements. Transportation conformity rules require that transportation projects in maintenance areas conform to the State Implementation Plan (SIP). Regional conformity is demonstrated by inclusion of the project in the PSRC long-range transportation plan (e.g., Transportation 2050) and Transportation Improvement Program (TIP), which, as a program of transportation projects, has been analyzed for conformity with the SIP.

The Puget Sound region maintenance period for CO expired October 11, 2016. The USEPA confirmed the maintenance period is expired and CO transportation conformity analyses required under 40 CFR 93 no longer apply (Attachment A).

6.3 Indirect Impacts

Indirect impacts are potential effects that would be caused at a later time or a farther distance but are still reasonably foreseeable. The air quality analysis will be performed using projected traffic volumes for future years. Therefore, the air quality analysis will include the indirect effects of the project and other traffic growth that would be associated with the project. Indirect effects from embodied GHG associated with producing fuel will be accounted for by using the FHWA fuel cycle factor (0.27) in the direct analysis. The GHG benefits of reduction in congestion relief and land use multiplier will be quantified using MOVES, with some inputs developed using the APTA methodology (APTA, 2009) as part of the direct analysis and the benefit of land use densification around stations discussed qualitatively.

6.4 Cumulative Impacts

The cumulative impacts analysis will consider impacts on air quality and GHG emissions from other past, present, and reasonably foreseeable future actions, including other transportation or infrastructure projects, and other land use actions or developments in the study area. The PSRC Regional Transportation Plan will be used to develop a list of reasonably foreseeable transportation projects in the project area (PSRC, 2022).

The air quality analysis evaluates projected future traffic volumes and delays that incorporate anticipated traffic growth from planned development in the project area and in the region. Therefore, the air quality analysis already includes a general discussion of the cumulative effects of the project and other traffic growth that would be associated with the project. However, this section will address past trends and anticipated future trends in air quality and GHG emissions. Additionally, a review of potential cumulative impacts during construction will be evaluated and discussed qualitatively.

7 MITIGATION MEASURES

Potential impacts to air quality will be controlled through project planning, design, and the application of required best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the alternatives will be incorporated as appropriate. Where impacts cannot be avoided or minimized, mitigation measures will be developed. Based on the air quality analysis, specific BMPs for reducing air quality impacts from construction activities will be discussed to address air quality impacts per PSCAA and local construction policies. The Sound Transit sustainability program will be described in the Alternatives chapter of the EIS and referenced here.

8 PROPOSED FIGURES, MAPS, OR OTHER DATA

No figures, maps, or other data are proposed for the air quality EIS section.

9 DOCUMENTATION

For this resource, the following documentation will be developed:

- A technical report
- An EIS section

10 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

The result from this analysis may be incorporated into the following sections:

- Social Resources, Community Facilities, and Neighborhoods
- Environmental Justice
- Energy

11 REFERENCES

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U.S. Environmental Protection Agency (USEPA). 2020. MOVES3 Technical Guidance: Using Moves to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity. https://www.epa.gov/sites/default/files/2020-11/documents/420b20052.pdf.

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Washington State Department of Transportation (WSDOT). 2018. WSDOT Guidance – Project Level Greenhouse Gas Evaluations under NEPA and SEPA. https://wsdot.wa.gov/sites/default/files/2021-10/ENV-ANE-GHGGuidance.pdf.

ATTACHMENT A

USEPA Carbon Monoxide Maintenance Letter

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
AIR AND WASTE

DEC 16 2016

Puget Sound Transportation Conformity Air Quality Consultation Partners
c/o Mr. Josh Brown, Executive Director
Puget Sound Regional Council
1011 Western Avenue, Suite 500
Seattle, Washington 98104-1035

Dear Puget Sound Transportation Conformity Air Quality Consultation Partners:

Congratulations on reaching the end of the 20-year maintenance period for carbon monoxide!

The U.S. Environmental Protection Agency (EPA) is providing this letter in its consultative role to document that the transportation conformity requirements, under Clean Air Act (CAA) section 176(c), for the Seattle-Tacoma carbon monoxide (CO) area ended on October 11, 2016. This date marks 20 years from the effective date of redesignation of the area to attainment for the CO National Ambient Air Quality Standard (NAAQS). See 61 FR 53323 (October 11, 1996).

Under 40 CFR 93.102(b)(4) of the EPA's regulations, transportation conformity applies to maintenance areas through the 20-year maintenance planning period, unless the maintenance plan specifies that the transportation conformity requirements apply for a longer time period. Pursuant to CAA section 176(c)(5) and as explained in the preamble of the 1993 final rule, conformity applies to transportation related pollutants and their precursors for which an area is designated nonattainment or is subject to a maintenance plan approved under CAA section 175A for areas redesignated to attainment. The section 175A maintenance planning period is 20 years, unless the applicable implementation plan specifies a longer maintenance period, see 58 FR 62188, 62206 (November 24, 1993). The EPA further clarified this conformity provision in its January 24, 2008 final rule (73 FR 4434-5).

This letter documents that, because the approved maintenance plan for the Seattle-Tacoma CO area did not extend the maintenance period beyond 20 years from redesignation, transportation conformity requirements for CO ceased to apply after October 11, 2016 (i.e., 20 years after the effective date of the EPA's approval of the first 10-year maintenance plan and redesignation of the area to attainment for the CO NAAQS). As a result, the Puget Sound Regional Council may reference this letter to indicate that the transportation conformity requirements of 40 CFR Part 93 no longer apply for the CO NAAQS. In addition, project sponsors can reference this letter to indicate that as of October 11, 2016, transportation conformity requirements also no longer apply for the CO NAAQS for FHWA/FTA projects as defined in 40 CFR 93.101. Even though the conformity obligation for CO has ended, the terms of the maintenance plan remain in effect and all measures and requirements contained in the plan must be complied with until the state submits, and the EPA approves, a revision to the state plan, see *GM Corp. v. United States,* 496 U.S. 530 (June 14, 1990). Such a State Implementation Plan revision would have to comply with the anti-backsliding requirements of CAA section 110(1), and if applicable, CAA section 193, if the intent of the revision is to remove a control measure or to reduce its stringency.

The EPA notes that there is an approved limited maintenance plan in place for the Seattle-Tacoma PM_{10} area, see 79 FR 49239 (August 20, 2014). Although regional emissions analyses are not required for PM_{10} under the limited maintenance plan provisions in 40 CFR 93.109(e), conformity determinations for the PM_{10} NAAQS continue to be required for transportation improvement programs, and non-exempt FHWA/FTA projects, and all other transportation conformity requirements apply, see 79 FR 49239 (August 20, 2014). Similarly, the EPA notes that there is an approved maintenance plan in place for the Tacoma $PM_{2.5}$ area, see 80 FR 7347(February 10, 2015). Transportation conformity determinations for the $PM_{2.5}$ NAAQS continue to be required in this area, see 80 FR 7347 (February 10, 2015).

If you have questions about the transportation conformity requirements in the Seattle-Tacoma area, please contact Karl Pepple, of my staff, at (206) 553-1778 or pepple.karl@epa.gov.

Sincerely,

Tim Hamlin

Timothy B. Hamlin
Director

cc: Mr. Craig Kenworthy
Puget Sound Clean Air Agency

Mr. Stu Clark
Washington State Department of Ecology

Mr. Mike Boyer
Washington State Department of Ecology

Ms. Karin Landsberg
Washington State Department of Transportation

Mr. Cliff Hall
Washington State Department of Transportation

Ms. Sharleen Bakeman
Federal Highway Administration

Mr. Ned Conroy
Federal Transit Administration

Everett Link Extension

Economic Technical Analysis Methodology

October 2023

SoundTransit

1 INTRODUCTION

This technical analysis methodology memorandum describes the methods that will be used to analyze the impacts on economic conditions for the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS). The Economics technical report and EIS section will address the effects of the project on economic conditions in the region, including potential changes to government revenue, changes to business and employment activity as a result of property acquisition, and potential impacts to business and overall economic activity from construction spending and activities. This section will also present options to avoid, minimize, or mitigate potential impacts.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

In addition to the federal and state regulations, policies, and related resources that guide a major transit project EIS, the following will be considered in the assessment of economic effects:

- Title 42 United States Code (USC) Section 4601, Federal Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended
- Transit Cooperative Research Program (TCRP) Synthesis 128, Practices for Evaluating the Economic Impacts and Benefits of Transit (TCRP 2017)
- Economic Impact Case Study Tool for Transit (TCRP, 2016)

3 DATA NEEDS AND SOURCES

The following data will be collected to support the analysis of economic conditions:

- General descriptions of the economies of the affected cities and counties, and of the Puget Sound region, collected from a variety of federal, state, and local sources, including the following:
    - U.S. Census Bureau
    - U.S. Bureau of Economic Analysis
    - U.S. Bureau of Labor Statistics
    - U.S. Department of Energy
    - Washington State Office of Financial Management
    - Washington State Office of Trade and Economic Development
    - Washington State Department of Revenue
    - Washington State Employment Security Department, Labor Market and Economic Analysis Branch
    - Puget Sound Regional Council (PSRC)

- Existing and forecasted population, housing, and employment data from the PSRC, the Cities of Lynnwood and Everett, and Snohomish County. Information will be obtained for established PSRC transportation analysis zones (TAZs). Custom geography requests can also be made to PSRC.
- Locations of low-barrier providers of economic opportunities, including schools and low-barrier employers such as hotels.
- Assessed valuations and tax rates for properties that may be acquired because of the project from the Snohomish County Department of Property Taxes and Assessments.
- Taxable retail sales data from the Washington State Department of Revenue.
- Business and occupation tax data from the City of Everett and Snohomish County.[1]
- Comprehensive Plan for Snohomish County, Comprehensive and Subarea Plans for the City of Lynnwood, and Comprehensive and Subarea Plans for the City of Everett.
- Information about potential transportation effects of the project, including changes in parking, access, travel time, congestion, circulation, and freight movement from the transportation analysis.
- Current land use, zoning, and development proposals from the land use analysis; findings on acquisitions, displacements, and relocations from the acquisitions analysis; information on Tribal fisheries from the ecosystems analysis; and information about changes in air quality, visual, and noise and vibration from the respective analyses.
- Information about regional and local jurisdictions' land use and community development plans considering areas within a 0.5-mile radius of stations.
- Available information and publications from Sound Transit, the TCRP, the American Public Transportation Association, and others regarding the economic aspects of transit projects in North America, including transit-oriented development.
- The 2012 Washington Input-Output Model Report (January 2021) from the Washington State Office of Financial Management.

4 STUDY AREA AND AREA OF EFFECT

The economic analysis considers regional and local economic conditions. The regional study area encompasses the four-county Puget Sound region (King, Kitsap, Pierce, and Snohomish counties), and the local study area consists of the area within 0.5 mile of the Build Alternatives (city of Lynnwood, unincorporated Snohomish County, and city of Everett). The 4-county regional study area encompasses the economic unit for the region (used to measure regional changes to gross domestic product [GDP], employment, and other relevant metrics). The area of long-term operations effects is within either of these study areas. Long-term indirect and cumulative effects will also be determined using both the regional and local study areas.

[1] The City of Lynnwood does not levy any type of business and occupation taxes.

For short-term construction effects, the area of effect will encompass a geographic area approximately two blocks or a maximum of 1,000 feet from the edge of the anticipated construction zone. The 1,000-foot buffer around the construction zone is a reasonable area of influence for construction activity. Short-term indirect and cumulative effects will also be determined using this study area.

5 AFFECTED ENVIRONMENT

The affected environment will be the existing and projected economic setting within the study area. The analysis will identify major trends, covered in Washington State's long-term economic forecast to 2050, as well as PSRC's current estimates and 20-year projections of population, housing, household size, income, and employment projections for identified Forecast Analysis Zones. Major employment and designated regional planning centers (including manufacturing and industrial centers) that would be served by the project will be identified. Issues that affect economic opportunities in the study area will be summarized from existing neighborhood plans or other reports. To the extent that current market data are available in existing neighborhood plans, they will be incorporated in the analysis. This information will be coordinated with the transportation; acquisitions, displacements, and relocations; and social resources, community facilities, and neighborhoods analyses.

6 ENVIRONMENTAL IMPACT ANALYSIS

The impact analysis will assess the potential direct, indirect, and cumulative economic impacts of the Build and No Build Alternatives. The impacts analysis is divided into long-term operation impacts and short-term construction impacts. The impacts analysis will address potential changes to the regional economy (the four counties), as well as examine city/county-level tax revenue changes (such as effects from property acquisitions and development around transit stations), and site-specific economic characteristics within the study area and area of effect.

6.1 Direct Impacts

The analysis of direct impacts will include the long-term, ongoing impacts of transit operation and land acquisition on local and regional economic conditions, and the short-term impacts of construction.

6.1.1 Long-Term Operation

The discussion of long-term direct effects will be largely tied to government revenue and estimated changes associated with business displacements related to right-of-way acquisitions. Impacts will be evaluated quantitatively, except where noted, by considering:

- The changes in property tax revenue because of property acquisitions, in the context of the overall tax base for the local governments and statutory limitation of the property tax in Washington State will be qualitatively discussed.
- Business displacements and associated number of displaced employees due to property acquisition based upon the building size and the type of business activity using square-foot-

per-employee factors from the U.S. Energy Information Administration (2018) (or other planning sources).

- Broader changes to regional and industrial-sector level economic output resulting from potential displacement and relocation of businesses will be discussed qualitatively.
- Changes of revenue from other taxes associated with business displacements will be qualitatively discussed.
- Long-term impacts to Tribal fishing will be addressed qualitatively if potential effects to fisheries are identified.
- As the project converts properties for transportation purposes, some commercially zoned property would be removed from a city's developable land base, reducing that city's overall commercial development capacity, including sales tax, unless additional property is zoned for commercial uses or zoning regulations are amended to allow for more intense development. An assessment of how much of each city's commercially zoned land base would be fully acquired for each alternative would be calculated (as a percentage of the total commercially zoned land within each city) and analyzed.

Changes in property values near the project will be addressed qualitatively. Different areas along the project corridor may experience different changes in property values depending upon their proximity to station locations and land use context.

6.1.2 Short-Term Construction

The assessment of potential construction impacts will qualitatively examine changes in the business environment due to construction-related land use and transportation effects. Impacts will be evaluated by considering:

- Transportation impacts, including changes in access, parking, multimodal access, travel time, congestion, circulation, and freight movement.
- Business effects related to construction activities affecting transportation, air quality, noise/vibration, and visual conditions.
- Impacts to Tribal fishing will be addressed, if affected.

Project based spending (including design, right-of-way, and construction) will affect the state's economic sectors as well as the tax revenues of affected jurisdictions. The economic and tax effects of this spending will be estimated using different techniques. Direct and indirect/induced effects on business output, jobs, and wages will be calculated using the Washington State Input-Output Model developed by the Office of Financial Management.[2] Tax effects, primarily on construction spending and associated business income, are accounted for through the sales tax and business and occupation taxes and will be calculated using spreadsheet models.

[2] Numbers may be different than other Sound Transit reporting of project jobs supported by dollars spent on capital projects that is based on planning-level budgets. Both estimates use the Washington State Input-Output Model but may have different budget assumptions.

6.2 Indirect Impacts

Indirect impacts are potential effects that would be caused at a later time or a farther distance but are still reasonably foreseeable. Long-term indirect impacts related to the operation of the transit facility on the communities in the study area can be positive (such as economic development in disadvantaged areas) or negative (such as congestion, parking reduction, access, visibility, or other impacts that could disrupt business operations). The assessment of the potential for indirect economic impacts will consider the role of stations and other facilities where the project could alter key characteristics potentially affecting patterns of commerce and a communities' economic functions. The indirect impacts analysis will qualitatively consider:

- The potential for future development or redevelopment around stations, based in part on the results of the land use analysis for the EIS, related station area planning efforts, and information about local economic conditions and trends.
- The station area planning and related transit-oriented development assessments consider factors such as the effects of new transit access and activity around station areas; land use plans and zoning; general economic and business conditions in station areas; travel benefits such as anticipated daily boardings at each station and the mode of access (walk, transit, pick-up/drop off or drive and park, for example); and other benefits such as improved access to the station area from surrounding neighborhoods as well as other infrastructure investments.
- The potential for changes in property values (including rental rates and taxation) for different types of properties, depending upon their proximity to the project and station locations, and the related potential for residential or business economic displacement.
- Impacts of construction on individual businesses will be assessed in instances where there is potential for unique impacts to a business or where the business itself is unique.
- Changes to business production frontiers and the effects on industry sectors resulting from changes to transportation access, including roadway, rail, and water.
- Impacts from displacements of businesses that act as an anchor for other businesses.
- Level of accessible pedestrian connections to schools and low-barrier economic opportunities.
- The potential for areawide changes in existing businesses, employment, dwelling units, and population in station areas. The assessment will also consider published literature reviewing the effects of light rail transit on development patterns.
- The potential changes in local jurisdiction tax collections from marginal changes in development activity as they related to the property tax, sales tax, business and occupation tax, and utility taxes.
- Indirect economic effects related to other operations and maintenance facilities, development and redevelopment of properties along connecting transit routes, as well as the potential disposition of surplus properties required for project construction but not permanently needed for the operation of the project, consistent with Sound Transit's adopted policy.

Short-term indirect economic impacts can also result from the influx of capital construction funds. These will be estimated by applying an economic multiplier from the Washington State Input-Output Model Report to estimate the regional effect.

6.3 Cumulative Impacts

The assessment of cumulative economic effects will consider a list of past, present, and reasonably foreseeable transportation, land use, and major development projects that occur in the study area. The analysis will be qualitative and will consider the findings on cumulative effects in other topic areas including transportation and land use, including short-term construction effects and long-term operational impacts. The list of cumulative projects will be included as an appendix to the EIS.

7 MITIGATION MEASURES

Potential impacts to economics will be controlled through project planning, design, and the application of required best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the alternatives will be incorporated as appropriate. Where impacts cannot be avoided or minimized, mitigation measures will be developed.

Measures to avoid, minimize, or mitigate economic impacts will consider input from city, county, and agency staff, community leaders, business leaders, and individual citizens as part of the EIS development and public involvement process. They will reference environmental commitments and mitigation measures identified in other EIS sections, including acquisitions, displacements, and relocations; transportation; land use; visual; and other topics related to the built environment. Appropriate mitigation measures for construction and operation, such as maintaining access and minimizing impacts to businesses during construction, will be recommended should adverse economic impacts be identified. Consultation with the public outreach team will identify mitigation measures to nearby businesses, particularly during project construction.

8 PROPOSED FIGURES, MAPS, OR OTHER DATA

The following information is proposed in the economics technical report or EIS section:

- Maps of the Build Alternatives with the boundaries of adjacent business districts, transportation network and linkages, and key employment centers within the study area
- Tables of current and forecast population, housing, and jobs in the study area
- Summary tables showing estimated changes in parking spaces and changes in number of employers or total employment
- Tables of the changes in property tax by jurisdiction

9 DOCUMENTATION

For this resource, the following documentation will be developed:

- A technical report with summaries of detailed background calculations of economic impacts, including tax revenue changes, job creation, and other estimates
- An EIS section
- Model data, detailed calculations, and other input sources and analytical worksheets (to be kept on file with Sound Transit or referenced in support of the technical report)

10 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

Economic analysis data will be used in the following analyses:

- Social Resources, Community Facilities, and Neighborhoods
- Environmental Justice
- Historic and Archaeological Resources

11 REFERENCES

Transit Cooperative Research Program (TCRP). 2017. *TCRP Synthesis 128, Practices for Evaluating the Economic Impacts and Benefits of Transit*.

Transit Cooperative Research Program (TCRP). 2016. *Economic Impact Case Study Tool for Transit*.

U.S. Energy Information Administration. 2018. Commercial Buildings Energy Consumption Survey (CBECS). Table B1. Summary table: totals and means of floorspace, number of workers, and hours of operation. Revised December 21, 2022. https://www.eia.gov/consumption/commercial/data/2018/.

Everett Link Extension

Ecosystems Technical Analysis Methodology

October 2023

SOUNDTRANSIT

1 INTRODUCTION

This Ecosystems Technical Analysis Methodology memorandum briefly describes the methods that will be used to prepare the ecosystems element of the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS). The ecosystems analysis will identify and document potential long-term operational and short-term construction impacts to wetlands, threatened and endangered species, vegetation, wildlife habitat, wildlife, and aquatic species and habitat.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

In addition to the relevant regulations considered in all environmental analyses, the following will also be considered:

2.1 Federal

- Sections 404, 402, and 401 of the Clean Water Act (CWA)
- Section 7 of the Endangered Species Act (ESA)
- Magnuson-Stevens Fishery Conservation and Management Act (MSA)
- Bald and Golden Eagle Protection Act
- Migratory Bird Treaty Act (MBTA)
- Protection of Wetlands, Presidential Executive Order 11990
- Final Rule on Compensatory Mitigation for Losses of Aquatic Resources (2008 or as revised)
- U.S. Army Corps of Engineers Wetland Delineation Manual (1987)
- Regional Supplement to the U.S. Army Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region Version 2.0 (2010)
- Coastal Zone Management Act
- Standard Operating Procedure No. 22, Water Resources, Federal Transit Agency
- Standard Operating Procedure No. 23, Biological Resources, Federal Transit Agency
- Guidance for Federal Departments and Agencies on Ecological Connectivity and Wildlife Corridors, Council on Environmental Quality

2.2 State

- Hydraulic code (Washington Administrative Code [WAC] Chapter 220-110)

- Shoreline Management Act (SMA), 90.58 Revised Code of Washington (RCW)
- Protection of Wetlands, Governor's Executive Order (EO) 89-10
- Protection of Wetlands, EO 90-04
- Water Pollution Control Act, 90.48 RCW
- Wetland Mitigation in Washington State (Ecology et al., 2021)
- Roadside Policy Manual (Washington State Department of Transportation, 2022)

2.3 Local

- Critical Area Ordinances (CAOs)
  - City of Everett Municipal Code Chapter 19.37, Critical Areas
  - City of Lynnwood Municipal Code Chapter 17.10, Environmentally Critical Areas
  - Snohomish County Code Chapter 30.62A, Wetlands and Fish & Wildlife Habitat Conservation Areas
- Shoreline Master Programs
  - City of Everett, Shoreline Master Program (2019)
  - City of Lynnwood Municipal Code, Chapter 17.20, Shoreline Master Program
  - Snohomish County Code, Chapter 30.67 Shoreline Management Program
- Tree Protection Ordinances
  - City of Everett Municipal Code Chapter 8.40, Tree Management
  - City of Lynnwood Municipal Code Chapter 17.15, Tree Regulations
  - Tree Preservation and Protection Guidelines for the City of Lynnwood
  - Snohomish County Code Chapter 30.25.016, Tree Canopy Requirements
- Sound Transit Environmental Policy (2004)
- Sound Transit Executive Order Number 1: Establishing a Sustainable Initiative (2007)
- Sound Transit Climate Risk Reduction Project (Federal Transit Administration, 2013)
- Sound Transit Stream Assessment Guidelines (2016)
- Sound Transit Sustainability Plan Update (2019)

3 DATA NEEDS AND SOURCES

Data needs for this resource include information on ecosystems resources that will be affected by the construction and operation of the project, including the project footprint and mitigation sites. Data needs and sources that should be considered include:

- Natural Resources Conservation Service (NRCS) Web Soil Survey maps
- U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI)
- USFWS list of threatened and endangered species that may occur in proposed project location (obtained for project)
- National Oceanic and Atmospheric Administration (NOAA) Fisheries Endangered Species Act species lists
- Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species (PHS) data
- WDFW Fish Passage Web
- WDFW and Northwest Indian Fisheries Commission Statewide Washington Integrated Fish Distribution data
- Washington Natural Heritage Program rare plant database
- Washington State Department of Ecology 303(d) listed waters information
- Washington Department of Fisheries A catalog of Washington streams and salmon utilization (Williams et al., 1975)
- City of Everett Streams, Wetlands, and Recharge Sites, Critical Areas Map 1; Fish & Wildlife Habitat Conservation Areas, Critical Areas Map 6
- City of Lynnwood Environmentally Critical Areas Inventory, Wetlands Map, Streams Map
- Snohomish County PDS Map Portal data, including the Snohomish County wetland inventory; Planning and Development Services Wetland Inventory; Streams, Water Types, and Fish Distribution; and parcel data

4 STUDY AREA AND AREA OF EFFECT

The study area for ecosystem resources will vary according to the type of resource and will be measured from the project footprint and area used for construction.

- Wetlands: 300 feet from project limits.
- Vegetation: 200 feet from project limits.

- Wildlife and wildlife habitat: 200 feet from project limits. Also review documented occurrences of sensitive wildlife species within 0.25 mile of the project limits (0.5 mile if higher noise sources such as blasting or pile driving are proposed).
- Aquatic resources: Reconnaissance-level aquatic habitat surveys will be conducted for aquatic habitats 300 feet downstream, 100 feet upstream at each of the water body crossings, and the entire stretch of any water body paralleling the project within 200 feet from the edge of the project limits. The survey may extend to 300 feet upstream if channel configuration could result in stream buffers overlapping the project limits. For streams or water bodies with ESA listed species, the study area includes the segment of stream or water body through which underwater sound may travel (i.e., to first bend in the channel or where sound levels would dissipate to background levels).

5 AFFECTED ENVIRONMENT

5.1 Field Reconnaissance Survey Method

After collecting and reviewing existing information, the biologists will conduct a detailed field reconnaissance survey within the study area to identify and confirm ecosystem resources that could be affected by the project. Formal delineations (flagging and professional land surveying) of wetlands, ordinary high water mark (OHWM), and other ecosystem resources will only be conducted on a case-by-case basis.

5.1.1 Wetlands

A field survey will be conducted to identify, map, and describe wetlands and other surface waters within the study area. Field surveys will occur on publicly owned property and private properties, if accessible at the time fieldwork occurs. Vegetation, soil, and hydrology conditions will be documented at representative locations (sample plots) using methods outlined in the U.S. Army Corps of Engineers (Corps) Wetland Delineation Manual (Corps, 1987) and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region Version 2.0 (Corps, 2010). These sample plots will be identified in the field with labeled flagging and documented using a global positioning system (GPS) unit or survey techniques. Both wetland and upland sample plots will be documented. The wetland and upland sample plots need to be paired and within close proximity to each other. If a wetland contains multiple vegetation communities (e.g., forested and scrub/shrub), at least one wetland sample plot will be located in each vegetation community. A minimum of two wetland determination data forms will be developed for each wetland and then an additional data form for each additional wetland vegetation community in the study area. Observations of existing conditions and characteristics will be recorded for each wetland and associated buffer.

Wetlands will be classified according to the USFWS (Cowardin et al., 1979; FGDC, 2013) and hydrogeomorphic (Brinson, 1993) classification systems and rated according to local jurisdiction critical area ordinances and the Washington State Wetland Rating System for Western Washington 2014 Update (Hruby, 2014). Wetland functions will be evaluated through the use of the Washington State Wetland Rating System for Western Washington – 2014 Update.

Wetland assessments will provide estimates of extent for all wetlands and other surface waters in the study area, including those on properties lacking access, using remote sensing and best professional judgment. Vegetation and potential wetlands for areas where rights of entry have not been obtained will be identified based on field reconnaissance from public areas; current local, state, and federal habitat maps and reports; and the examination of aerial photographs. Potential wetlands will be rated using these same sources of information. Where specific information is not known (such as the hydrologic regime), preliminary assessments will be made using available information.

Those areas that appear to possess all three wetland indicators will be included in the EIS and technical report in order to provide a conservative estimate of potential impacts from each alternative. Documented wetlands from other projects or sources will be evaluated and, where appropriate, included in the wetland findings. Each wetland identified in the study area will receive a unique identifier that will be tracked in a GIS database. As new information is collected on project wetlands, data will be recorded in an Excel spreadsheet that will be linked to the GIS data. Wetland names will start with the letter “W” and the next two letters will be based on the jurisdiction they are located in (Lynnwood = LY; Everett = EV; Snohomish County = SC) followed by a number reflecting the order encountered in the field (1, 2, 3, etc.). For example, Wetland WEV4 would be the fourth field-identified wetland and located in Everett.

5.1.2 Aquatic Species and Habitat

The aquatic species and habitat assessment will focus on key habitats and aquatic features that may be impacted by the project and that are directly related to ecological functions that support aquatic ecosystems. Similar to wetlands, a detailed field reconnaissance survey will be conducted to identify, map, and describe aquatic species and habitat within public rights-of-way within the study area (e.g., Swamp Creek riparian corridor) and parcels where rights-of-entry have been obtained. These documented water bodies will be included in the EIS aquatic species and habitat findings. The descriptions will correlate with the Water Resources analysis.

Sound Transit’s Stream Habitat Assessment Guidelines (Sound Transit, 2016) (Attachment A) will be used to determine the level of information that should be collected for each identified stream. In accordance with the stream habitat assessment guidelines, research and field surveys will be conducted to identify, map, and describe aquatic species and habitats within the study area. This project will utilize the Phase 1 Project approach (planning level study) to provide analysis for State Environmental Policy Act (SEPA)/National Environmental Policy Act (NEPA) and ESA coordination. Within the Phase 1 approach, the project will use Track A methods for assessing riparian vegetation effects where property access is not granted. Track B methods will be used on properties where Sound Transit has acquired rights-of-entry and on Washington State Department of Transportation (WSDOT) and local agency right-of-way/easement areas. General information will be collected in the field and stream OHWM will be estimated and mapped using a GPS unit if possible. Biologists will collect information about the condition of in-stream and riparian habitats and identify the OHWM of streams.

Field assessment will be limited to areas accessible from public right-of-way, lands open to the public, and other lands where access is allowed (including private property where the property is accessible) for purposes of this survey. Aquatic habitats outside of public rights-of-way on properties lacking access will be identified based on field reconnaissance from public areas; current local, state, and federal habitat maps and reports; and the examination of aerial photographs. Those areas outside of public rights-of-way and which are not open to the public or accessible that appear to be aquatic habitat will be included in the EIS findings to provide a conservative estimate of the potential impacts for each alternative.

Background information about riparian vegetation, physical in-stream habitat, biological connectivity, water quality and quantity, stream typing, and fish presence and habitat use will be collected during the pre-field review phase. Additionally, aquatic species habitat will be described, when possible and applicable, in a sub-basin context. Habitat will be assessed with the assumption that anadromous fish may one day be able to access the area even if they cannot under present conditions where no natural barriers exist downstream. To the extent information is currently available or can be readily ascertained in the field, downstream fish passages, including any impediments to fish passage, will be evaluated for each identified aquatic habitat. Field observations will be limited to the study area; however, available information (like the WDFW Fish Passage Web App) would be used to evaluate downstream fish passage to the next fish-bearing stream.

Each stream identified in the study area will receive a unique identifier that will be tracked in a GIS database. As new information is collected on project streams, data will be recorded in an Excel spreadsheet that will be linked to the GIS data. If a stream already has a formal name, it will be used. Unnamed stream names will start with the letter “S” and the next two letters will be based on the jurisdiction they are located in (Lynnwood = LY; Everett = EV; Snohomish County = SC) followed by the order they are encountered in the field (1, 2, 3, etc.). For example, Stream SEV2 would be the second field-identified stream located in Everett. Other types of aquatic habitat (lakes, ponds, bays, waterways, etc.) will be identified by formal name, if available, or named in a system similar to the stream naming convention described above.

5.1.3 Vegetation, Wildlife, and Wildlife Habitat

To establish the basis for the analysis of effects on vegetation, wildlife, and wildlife habitat, the biologists will delineate and classify land cover on aerial photographs and visit a sample of these areas within the study area during the field reconnaissance survey. Information from existing land cover analyses, such as i-Tree, may be incorporated into the vegetation assessment if readily available. Major plant communities/habitat types will be identified and classified based on the structural categories defined in Wildlife-Habitat Relationships in Oregon and Washington (Johnson and O’Neil, 2001). Heritage trees as defined by the City of Lynnwood will be noted and included in the analysis within the city limits.

To support the analysis of effects on wildlife, the biologists will identify wildlife species that are associated with the land cover types in the study area, and with specific habitat elements within each cover type. Biologists will also assess locations of known ecologically sensitive areas and important wildlife occurrences that may be sensitive to disturbance from noise or human presence. This will include review of site-specific wildlife data, including bird surveys (e.g., eBird 2022). This information will be supplemented with data gathered during field visits.

Washington State Department of Natural Resources (DNR) Natural Heritage Program and WDFW publications will be used to identify important habitats and the wildlife species that use them. Vegetation data, including dominant plant species composition and relative abundance, will be gathered and classified by habitat type using field observation, aerial photographs, and pertinent literature. Maps will be developed showing plant communities/habitat types and special features, based on the habitat delineation exercise described above. Invasive species noted during fieldwork will be discussed qualitatively but will not be mapped. GIS data from the WDFW PHS program will be used to generate maps of the distribution of priority habitats and species, and other key ecological features needed to analyze impacts. DNR Natural Heritage

Program data will also be used to identify rare plant populations in the study area. Sensitive information regarding the locations of proposed, candidate, and listed species and habitats will be described but not mapped to protect the integrity of this information. Threatened and endangered species and critical habitat tables will be generated using the latest data provided on the USFWS and NOAA Fisheries websites.

6 ENVIRONMENTAL IMPACT ANALYSIS

The impact analysis will assess the potential direct, indirect, and cumulative ecosystem impacts of the Build and No Build Alternatives. The impacts analysis is divided into long-term operation impacts and short-term construction impacts. The impact analysis will describe the extent, magnitude, duration, and character of impacts on ecosystem resources for each alternative. Impacts will be quantified where appropriate and possible (e.g., area of wetland impacts).

6.1 Direct Impacts

Impacts on wetlands and buffers will be described based on direct impacts from both long-term effects (filling or other permanent displacement) and short-term construction-related effects (including effects associated with construction staging areas). If a contiguous wetland lies partially within the project limits, then best professional judgment will be used to determine any project effects, as defined by Wetland Mitigation in Washington State (Ecology et al., 2021), on the portion of the wetland outside of the project limits. If the remaining wetland is degraded by project construction or operation, then its acreage will be included in the impact table. The impact table will quantify the expected direct impacts on each wetland resulting from each alternative. Functional effects that extend beyond the area of direct wetland impacts will also be assessed as indirect effects.

Direct impacts on aquatic species habitat will be determined by evaluating the acreage and linear feet of each water body and riparian buffer that would be eliminated for each alternative. Direct impacts on aquatic species will be assessed qualitatively by considering such factors as the regional significance of the resident and anadromous fish species resource, fish habitat value (such as its role as a migration corridor or spawning), degree of connectivity and loss of habitat following project implementation, overall habitat quality, and potential for enhancing or restoring aquatic habitat or connectivity. Construction and operational impacts on aquatic species from water quality degradation, loss of habitat, shading, and habitat degradation will also be assessed.

Direct impacts on vegetation and wildlife habitat will be determined by evaluating the acreage of each dominant vegetation community that would be eliminated for each alternative. Impacts will also be assessed qualitatively by considering such factors as the regional significance of the resource, wildlife habitat value (such as its role as a wildlife movement corridor), degree of fragmentation and loss of the habitat following project implementation, overall habitat quality, and the potential for enhancing or restoring unique plant communities or wildlife habitat or connectivity. Construction and operational impacts on wildlife, including disturbances from increases in human access, noise, and light, will also be assessed. Direct impact on rare plant populations, if present, will be determined by evaluating acreage of these populations that would be eliminated for each alternative. Additionally, the biologists will analyze the potential for the project to cause the spread of noxious or invasive plant species.

Potential direct impacts to be considered for threatened and endangered species (aquatic and terrestrial) include direct mortality, disturbance and displacement effects, and loss or degradation of habitat. The Biological Assessment (BA) would be prepared for the preferred alternative. Consultation with NOAA Fisheries and USFWS will be coordinated through Sound Transit's ESA Coordinator throughout the environmental review process. Information received from the existing documents, field surveys, and agency consultation could identify habitats or areas to be avoided or protected. Impact avoidance is discussed in greater detail in the Mitigation Measures section.

6.2 Indirect Impacts

Indirect impacts are potential effects that would be caused at a later time or farther distance but are still reasonably foreseeable. These may include effects related to development that occurs by others as a result of proximity to station areas and could include things such as changes in the pattern of land use, population density, or water quality. The analysis will also include an assessment of the Build Alternatives' reasonably foreseeable effects on the environment due to climate change. Indirect impacts may also occur through the implementation of mitigation measures for other environmental impacts, or through supporting projects that are not yet defined or considered part of the Build Alternatives. Indirect impacts on ecosystem resources will be analyzed qualitatively based on information available at the time.

6.3 Cumulative Impacts

The total effects of the project on ecosystem resources will be determined by combining the project's impacts with other past, present, and reasonably foreseeable future actions. These actions include other transportation or infrastructure projects, or other planned or pending land use actions or developments in the study area.

7 MITIGATION MEASURES

Potential impacts to ecosystem resources will be controlled through project planning, design, and the application of required best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the alternatives will be incorporated as appropriate. Where impacts cannot be avoided or minimized, compensatory mitigation measures will be developed.

The project will use a mitigation sequencing approach based on a hierarchy of avoiding and minimizing adverse impacts through careful design, rectifying temporary impacts, and compensating for unavoidable adverse impacts. A listing of BMPs will be developed identifying measures that could be implemented to avoid or reduce adverse impacts on ecosystem resources during construction and operation. Potential mitigation will be identified and evaluated for project locations where adverse impacts could occur. Advanced mitigation, mitigation banks, and in-lieu fee programs that Sound Transit could propose to use for compensatory mitigation will also be included in the review of mitigation opportunities. Mitigation measures will include specific goals and objectives and will specify monitoring criteria against which proposed mitigation measures can be compared. Conceptual mitigation measures will be generally described in enough detail so that reviewing agencies can determine the likelihood of the proposed mitigation succeeding and meeting all stated objectives, including providing compensation for unavoidable impacts so there is no net loss of area and/or function.

The Final EIS will include a summary of conservation measures from the ESA consultation with the USFWS and NOAA Fisheries.

8 PROPOSED FIGURES, MAPS, OR OTHER DATA

Maps of vegetation land cover, wetlands, water bodies, and high-value habitat will be prepared.

9 DOCUMENTATION

An Ecosystems Technical Report will be prepared with chapters covering wetland resources, aquatic resources, wildlife, and vegetation.

The wetland chapter of the report will contain field data sheets and labeled photos that will be indexed on segment maps. Each photo will be catalogued with location and other basic information such as date and direction of view to assist Sound Transit in initiating preliminary consultation with Corps, Washington State Department of Ecology, and local jurisdictions for wetland permitting.

The aquatic resources chapter of the report will characterize existing aquatic conditions in streams within the study area, including Swamp Creek, and will detail elements for species and habitats of concern within the project area, including threatened and endangered species, critical habitat, and essential fish habitat (EFH) that would typically be addressed in the BA. The effects on these resources will be noted for each alternative and mapped (confidential if concerning threatened and endangered species). All official correspondence will be incorporated into an appendix.

The wildlife and vegetation chapter of the report will characterize existing terrestrial conditions and will also include species and habitats of concern, including threatened and endangered species that would typically be included in the BA.

An Ecosystem Resources EIS section will be prepared summarizing the Ecosystems Technical Report.

Unless required otherwise by the resource agencies, one BA will be prepared for the preferred alternative only. The BA will address species concerning both NOAA Fisheries and USFWS in one document. The BA will follow Sound Transit's Biological Assessment Template (current version) as well as ESA, USFWS, and NOAA Fisheries requirements. The BA will summarize the proposed action, describe the habitat requirements and life history of the listed species, evaluate whether suitable habitat exists at or near the site, present information regarding the actual occurrence of listed species at or near the site, and describe potential impacts of the proposed action (construction and operation) on listed species and habitats at or near the site. Proposed conservation measures intended to avoid or reduce potential impacts on listed species will be described in enough detail to enable USFWS and NOAA Fisheries to determine whether the proposed conservation measures will likely succeed and meet all stated objectives of avoiding and minimizing potential impacts. An effects determination will be made for each species and any designated critical habitat potentially affected by the project.

A separate wetland delineation report will be prepared for the preferred alternative during the Final EIS. It will include a list and map of properties that could not be delineated due to lack of property access.

10 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

Data gathered on ecosystems impacts may be used in the following analyses:

- Water Resources
- Land Use
- Visual and Aesthetic Resources
- Parks and Recreational Resources
- Environmental Justice

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ATTACHMENT A

Sound Transit Stream Habitat Assessment Guidelines

STREAM HABITAT ASSESSMENT GUIDELINES

January 2016

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SOUND TRANSIT STREAM HABITAT ASSESSMENT GUIDELINES

1. Introduction

Sound Transit projects often intersect with and affect streams. To comply with local, state, and federal rules and regulations, Sound Transit assesses stream conditions, determines stream impacts that will occur as a result of a project, and mitigates those impacts as appropriate. The analytical methodologies used and level of detail needed to meet these requirements depends on a variety of factors including: 1) the stage of project development and complexity of the project, 2) the extent to which Sound Transit has property access to streams, and 3) the magnitude of impact. Less detailed information is typically collected during planning and early design stages such as during SEPA/NEPA environmental review and preliminary engineering because rights-of-entry are not granted onto privately owned properties, thus restricting access to streams. Also, at this stage, multiple alternative alignments may be under consideration, making more labor-intensive field investigations less feasible from the standpoint of cost and time. At later stages of project development, once the project to be built is selected or final design is underway, more detailed analyses may be appropriate depending on access, the magnitude of potential impacts, and the types of environmental permits that may be necessary to construct the project.

Various methodologies exist on how to approach stream assessments in Washington and no one methodology is required, or is applicable to all projects or to all stages of project development. In addition, Native American tribes with fishing rights often request specific information about the effects of a project on both existing fish use and potential fish use of a stream. In this context, Sound Transit seeks to achieve greater consistency in how it approaches the assessment of streams at various stages of project development and under various conditions. The purpose of this document is to establish general guidelines for applying various stream assessment methods to Sound Transit projects based on the most commonly used methodologies in Washington. The information presented herein is for guidance only and is based on some of the most common scenarios encountered on Sound Transit projects. Sound Transit recognizes that other scenarios are possible and that professional judgment will be necessary when considering the best approach for specific projects. Proper application of professional judgment may reduce the collection of extraneous information, and reduce project effort and expense. The intent of these guidelines is to provide some level of consistency in Sound Transit's approach to assessing streams so that local, state, and federal regulators generally know what to expect during project reviews.

For the purposes of this document, project development is categorized into two phases: the initial environmental review and preliminary engineering phase (Phase 1) and the permitting/final design phase (Phase 2). These are further described below:

- **Phase 1 Projects –** Planning stage that includes environmental review under SEPA/NEPA and conceptual and preliminary design. At this stage, various alignments or sites may initially be under consideration, and Sound Transit may or may not have rights-of-entry to the properties being evaluated. In general, objectives at this stage of project development are to:
  1) Identify streams within the study area
  2) Characterize in-stream and riparian conditions (including fish use and barriers to fish use of the stream) based on readily available information and visual observations as possible

3) Determine potential impacts to streams for the alternative(s) under consideration during the environmental review process, and
4) Identify conceptual-level mitigation opportunities for impacts to streams (aquatic and riparian habitats).

Phase 1 projects may include Endangered Species Act consultation, with the overall objective of being able to make and support accurate effect determinations for federally listed aquatic species potentially occurring in affected streams. Phase 1 of Sound Transit's project development culminates with completion of the NEPA/SEPA environmental review process and Sound Transit's selection of a specific project alternative to build.

- **Phase 2 Projects** – Final project design stage that includes environmental permitting and detailed mitigation to address project-related impacts to streams. At this stage, full access is typically available for the project. The overall objective is to secure necessary environmental permits/approvals including but not limited to local critical areas permits, a Hydraulic Project Approval (HPA) from the Washington Department of Fish and Wildlife (WDFW), a Clean Water Act Section 404 permit from the United States Army Corps of Engineers (Corps), and a 401 Water Quality Certification or Coastal Zone Management Consistency Determination from the Washington State Department of Ecology (Ecology).

Section 2 of this guidance document, **Using the Stream Assessment Flowcharts**, helps guide the reader in determining the appropriate level of data collection during the two project phases described above. To do this, a flowchart has been created for Phase 1 and Phase 2 projects, taking into account various project variables. The flowcharts and overview of how to use them are provided in Section 2. The flowcharts in Section 2 are supported by additional tools and more detailed information on various methodologies described in **Section 3 - Data Collection for Key Aquatic Habitat Elements**. Both Section 2 and Section 3 are organized around five stream features, referred to as Key Aquatic Habitat Elements and described below.

General recommendations for the appropriate use of these guidelines, as well as a discussion of their limitations, are provided in **Section 4 - Considerations and Limitations**.

2. Using the Stream Assessment Flowcharts

The flowcharts should be used to determine the appropriate data needs and level of field assessment that will be required for a project. Working through the flowcharts with site specific information will require the collection of qualitative and/or quantitative information on various Key Aquatic Habitat Elements. These elements are the key habitats and stream features that may be impacted by a project and are directly related to ecological functions that support a stream ecosystem. The Key Aquatic Habitat Elements are:

- ***riparian vegetation,***
- ***physical in-stream habitat,***
- ***biological connectivity,***
- ***water quality and quantity, and***
- ***fish presence, fish habitat use, and stream typing.***

Information would be gathered during site visits or collected using specific survey techniques. The various “levels” of data collection for each Key Aquatic Habitat Element have been classified into one of three categories, or “Tracks”. Tracks A, B, and C represent an increasing level of detail for data collection and generally correlate to the phase of the project, the extent to which access is available, and/or the magnitude of stream impact.

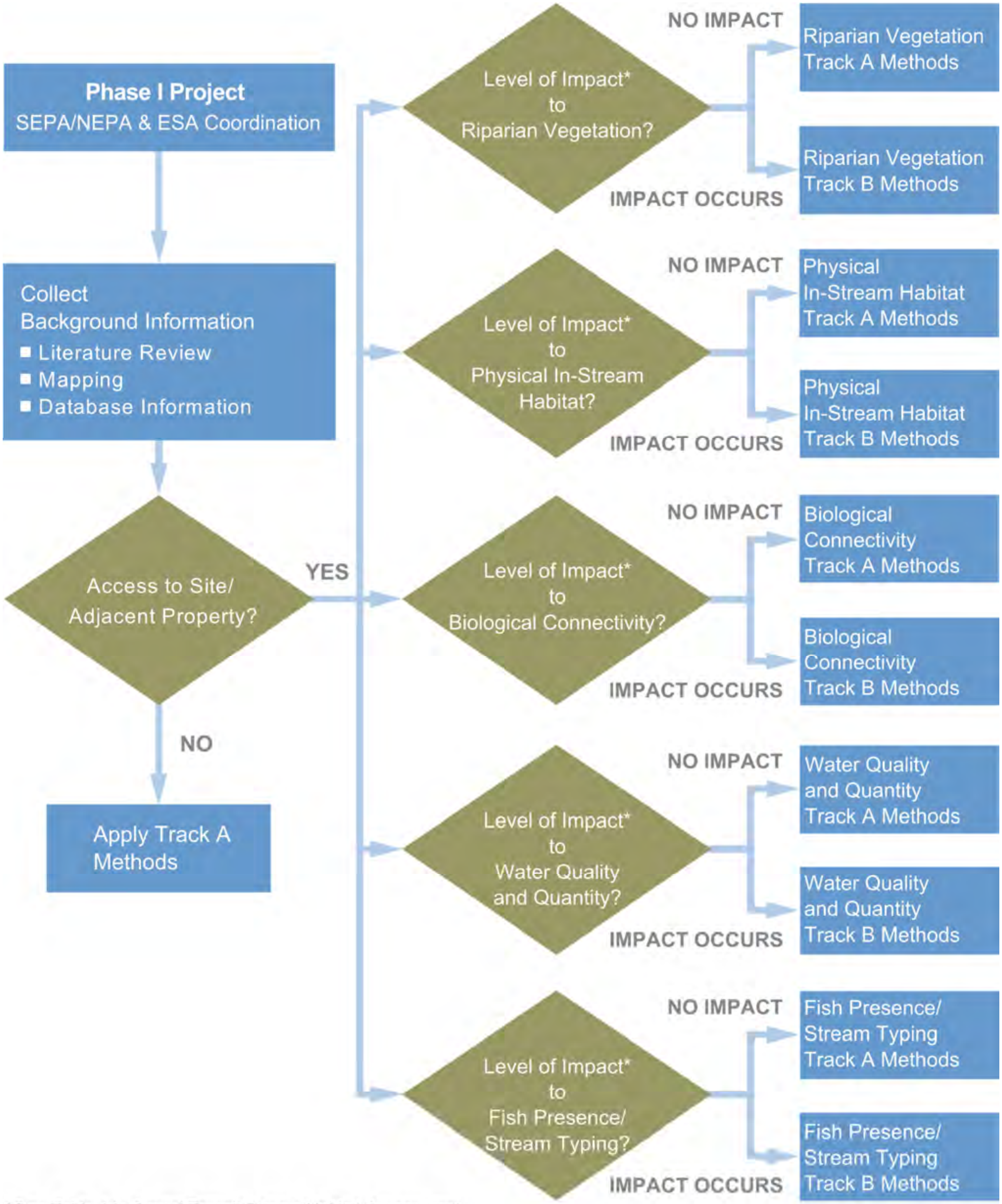
2.1 Phase I Projects

Figure 1 on page 4 is the stream assessment flowchart for planning-level projects. It shows the general process to follow when considering potential stream impacts associated with Phase 1 projects. For all Phase 1 projects that include stream habitats, regardless of access or impact level, the first step is to collect background information on each of the Key Aquatic Habitat Elements associated with each stream in the study area. To help guide these efforts, see **Section 3 – Data Collection for Key Aquatic Habitat Elements**. Section 3 includes more detailed information on specific data sources to consult when collecting this information. The information gathered will help form the basis of the *Existing Conditions* or *Affected Environment* section of the environmental document being prepared for the project.

After collecting background information, some level of data should also be collected in the field. The data collected and the stream assessment methods used will vary for Phase 1 projects depending on 1) whether or not impacts are anticipated impact, and 2) whether or not the project team has right-of-entry to parcels that contain streams.

If access is limited, Track A Methods should be used for each Key Aquatic Habitat Element to the extent feasible. Areas where access to streams is not limited include existing Sound Transit right-of-way, WSDOT right-of-way, or other publicly-owned rights-of-way such as parks. In these areas, the project team should consider the anticipated level of impact to each Key Aquatic Habitat Element. The level of analysis required for a given Key Aquatic Habitat Element should be commensurate with the potential for impacts at a given site. In order to appropriately size the analysis, the flowchart requires consideration of whether or not impacts are expected to occur within the stream environment, looking in turn at each of the Key Aquatic Habitat Elements. For Phase 1 projects, a simple determination of either “Impact” or “No Impact” should be made for each Key Aquatic Habitat Element as presented in Table 1 (see page 5). The results of this analysis will help determine the level of data collection and analysis appropriate for each ecological function. If impacts are anticipated, the project study team should coordinate with Sound Transit environmental staff before initiating Track B data collection efforts as the data may already have been gathered by others or a shift in the project footprint may occur that negates the need to do more detailed surveys.

Depending on the outcomes from using the stream assessment flowchart for Phase 1 projects, various levels of data collection (either Track A or Track B) will need to be conducted. For information on specific stream habitat assessment methods to use under Track A or Track B, refer to **Section 3 – Data Collection for Key Aquatic Habitat Elements.** Tables 3 and 4 in that section outline pertinent assessment methods for each Key Aquatic Habitat Element, including detailed information on specific analysis metrics and survey methods that may be appropriate under Tracks A and B.



*See Table 1 in *Sound Transit Stream Habitat Assessment Guidelines* document to assess level of impact

Figure 1
Stream Assessment Flowchart for Sound Transit Phase 1 Projects

Table 1 Impact Classification for Phase I Projects Based on Impacts to Key Aquatic Habitats

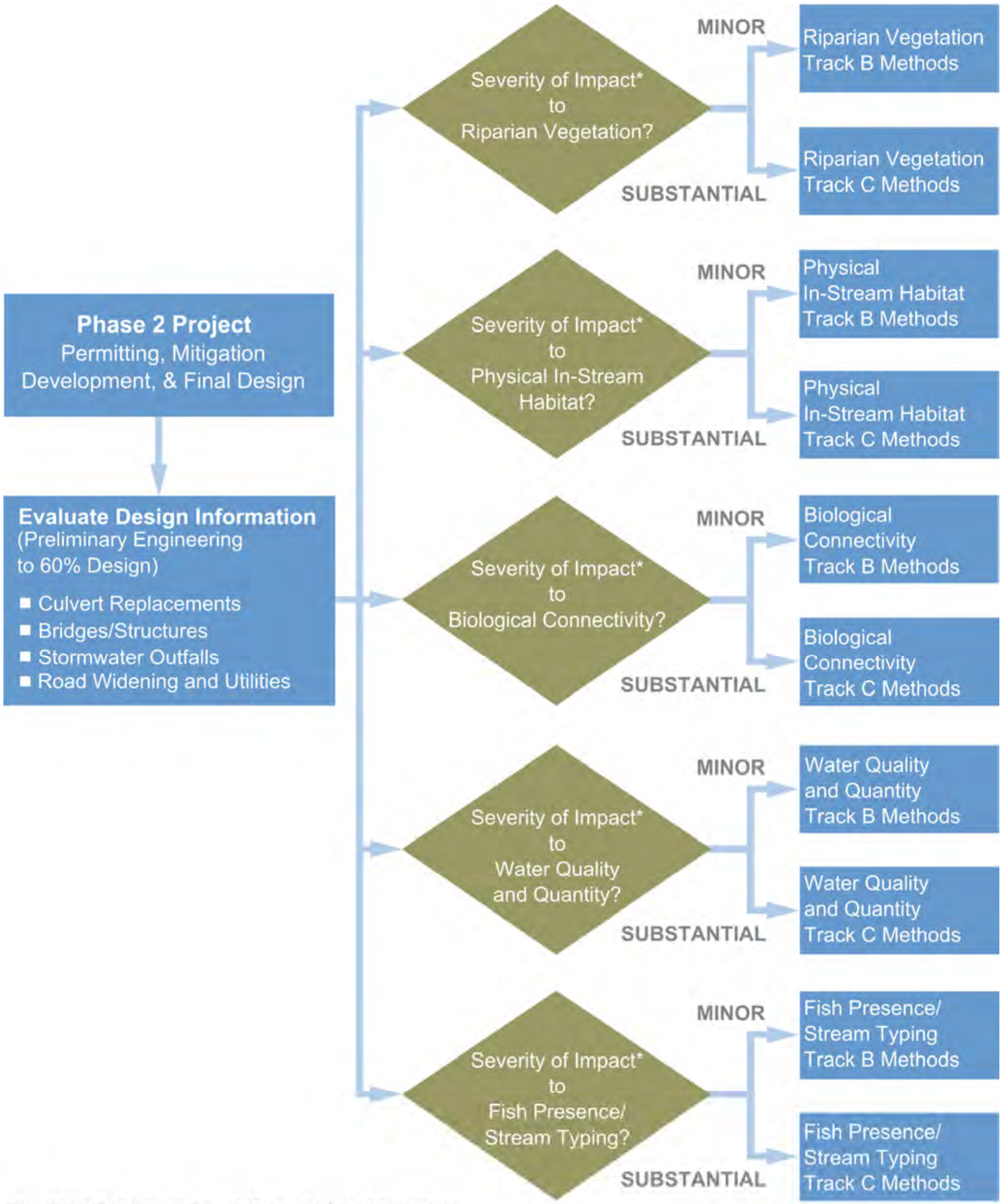
Key Aquatic Habitat Element	Impact Classification	
	No Impact	**Impact**
Riparian Vegetation	No clearing within riparian zone	Clearing riparian vegetation, OR Removing significant trees[1]
Physical In-Stream Habitat	No in-water work or disturbance to bed and streambank below OHWM[2]	Working in-water involving bank hardening, OR Installing fish habitat features (e.g., LWD[3] or boulders), OR Altering substrate
Biological Connectivity	No installation, removal, or alteration of culverts, bridges, weirs, or other potential passage barriers	Replacing or installing culverts, weirs, or bridges in non-fish bearing waters
Water Quality and Quantity	No new stormwater discharges or increases in impervious surface	Adding new stormwater discharges or increasing impervious surface
Fish Presence, Fish Habitat Use, and Stream Typing	No in-water or riparian impacts	In-water or riparian impacts occur

[1] Significant trees should be defined using the local jurisdiction's Critical Areas and/or Urban Forestry code sections. If significant trees are not defined by local code, assume significant trees are those trees 6-inches or greater dbh (diameter breast height).
[2] OHWM – ordinary high watermark
[3] LWD – large woody debris

2.2 Phase 2 Projects

Figure 2 on page 6 is the stream assessment flowchart for projects in final design. It shows the general process to follow when assessing streams in greater detail for Phase 2 projects that involve stream impacts. For Phase 2 projects, access to all riparian areas is assumed for purposes of conducting field work using either Track B or Track C methods. In the unusual event that access to all parcels is not available during Phase 2, Track A methods should be used to the extent feasible.

Using more detailed project design drawings, the level of data collection for Phase 2 projects will vary depending on the severity of impacts to Key Aquatic Habitat Elements. For each stream impact area, impacts should be classified as either a "Minor Impact" or "Substantial Impact". Table 2 on page 7 should be utilized to help classify potential Phase 2 project impacts on each Key Aquatic Habitat Element, based on specific project activities and quantification of expected impacts to each habitat element. However, it should be noted that the criteria may be adjusted based on the relative severity of project impacts within each project area. The project study team should coordinate with Sound Transit environmental staff to confirm the impact classification and intended data collection track before initiating data collection, as some or all of the data may already have been gathered by others, or a shift in alignment may occur that negates the need to do more detailed survey.



*See Table 2 in *Sound Transit Stream Habitat Assessment* Guidelines document to assess level of impact

Figure 2
Stream Assessment Flowchart for Sound Transit Phase 2 Projects

Table 2 Impact Classification for Phase 2 Projects Based on Impacts to Key Aquatic Habitats

Key Aquatic Habitat Element	Impact Classification	
	Minor Impact	**Substantial Impact**
Riparian Vegetation	Clearing less than 5,000 square feet of riparian vegetation, OR Removing 1 to 5 significant trees[a]	Clearing riparian vegetation in amounts exceeding minor impacts[1]
Physical In-Stream Habitat	In-water work involving bank hardening of <20 linear feet, OR Installing fish habitat features (e.g., LWD[2] or boulders), OR Altering substrate < 100 square feet	In-water work exceeding thresholds for minor impacts, OR stream straightening (meander loss) OR Site will be used as a compensatory mitigation site
Biological Connectivity	Replacing or installing culverts or weirs in non-fish bearing waters	Replacing or installing culverts, fishways, or weirs in fish-bearing waters
Water Quality and Quantity	Adding new stormwater discharges or increasing impervious surface where all stormwater is treated and detained and no 303(d) listed or TMDL[3] reaches	Adding new stormwater discharges or increasing impervious surfaces where discharge to 303(d)/TMDL[3] reach occurs, OR where full treatment and detention does not occur
Fish Presence, Fish Habitat Use, and Stream Typing	Minor impacts to one or more key aquatic habitats listed above	Substantial impacts to physical habitat or riparian vegetation aquatic habitat elements, OR project involves any changes (negative or positive) in fish passage conditions, OR where stream diversions/fish removal activities occur

[1] Significant trees should be defined using the local jurisdiction's Critical Areas and/or Urban Forestry code sections. If significant trees are not defined by local code, assume significant trees are those trees 6-inches or greater dbh (diameter breast height).
[2] LWD – large woody debris
[3] TMDL – total maximum daily load

Depending on the outcomes from using the stream assessment flowchart for Phase2 projects, various levels of data collection (either Track B or Track C) will need to be conducted for each Key Aquatic Habitat Element as appropriate. For information on specific stream habitat assessment methods to use under Track B or Track C, refer to **Section 3 - Data Collection for Key Aquatic Habitat Elements.** Tables 3 and 4 in that section outline pertinent assessment methods for each Key Aquatic Habitat Element, including detailed information on specific analysis metrics and survey methods that may be appropriate under Tracks B and C.

3. Data Collection For Key Aquatic Habitat Elements

Once the user has taken their Phase 1 or Phase 2 project through the appropriate flowchart in Section 2, Section 3 should be consulted to obtain more detailed information on specific data sources and stream assessment methodologies. Table 3 summarizes the recommended data to be collected for streams during all stages of project development. This includes background information, which should be collected in all cases, as well as field data collection for Tracks A, B, and C, which will depend on the anticipated level of impact to each Key Aquatic Habitat Element. The information in Table 3 is organized by Key Aquatic Habitat Element. Collection and assessment techniques for each Key Aquatic Habitat Element are described in more detail below. These data needs and assessment procedures have been selected to be generally applicable over the wide range of project types and permitting scenarios encountered by Sound Transit. During project development, the recommendations provided below may need to be adjusted based on project-specific input from regulatory agencies and Tribal entities.

3.1 Riparian Vegetation

For detailed information on specific riparian habitat assessment techniques and methods, see the *Oregon Riparian Assessment Framework* (Clarke, 2004) or Winward (2000). A common method for estimating canopy coverage is presented in (Daubenmire, 1959).

3.1.1 Background Information

1) Review existing literature –Reports or data sources that may contain information for reach or sub-basin scale riparian conditions include:

- The Washington State Conservation Commission Limiting Factors Analysis, organized by Water Resource Inventory area (http://scc.wa.gov/directory/ or http://www.eopugetsound.org/articles/water-resource-inventory-areas-puget-sound)
- Information on rare plants distribution from the Washington Department of Natural Resources Natural Heritage Program Database at: http://www.dnr.wa.gov/ResearchScience/HowTo/ConservationRestoration/Pages/amp_nh_data_instructions.aspx
- Local watershed analysis or stream assessment reports
- Local Shoreline Master Program Inventory reports Shoreline Master Program Inventory reports http://www.ecy.wa.gov/programs/sea/shorelines/smp/citizen.html

2) Review aerial photographs and any available site photos.

- Google Earth – also view past riparian conditions using historic photos on site
- Bing Maps – Birds Eye View feature is useful for assessing riparian conditions
- Digital or hardcopy orthophotos

3) Based on the results of steps 1) and 2) above, summarize the following:

- General vegetation type (forested, shrub, herbaceous, none (bare earth/built)),
- Tree canopy type (deciduous, coniferous, or mixed)
- Approximate density of vegetation types (dense or sparse),
- Approximate width of buffer on each streambank at project site (based on aerial photos), and
- Estimated average riparian buffer width upstream and downstream of project site.

Table 3. Overview of Data Collection Needs For Key Aquatic Habitat Elements

<table>
<tr><th>Key Aquatic Habitat Element[1]</th><th>Background Information[2]</th><th>Track A[3] – Limited Site Access or No Impact</th><th>Track B – Site Access and Minor Impacts</th><th>Track C – Site Access and Substantial Impacts OR Site to be Used as Compensatory Mitigation</th></tr>
<tr><td>Riparian Vegetation</td><td>1) Review existing literature
2) Review aerial photographs and existing site photos
3) Characterization should include:
• vegetation type (i.e., forested, shrub, herbaceous, built, coniferous, deciduous, genus and species if possible),
• relative vegetation densities</td><td>1) Site visit with qualitative description of riparian conditions:
• vegetation type, height, and relative density
• width/length of riparian zone
• presence of overhanging or fallen vegetation/stream cover
• presence of invasive plant species (estimate percent cover if possible)</td><td>1) Collect qualitative and quantitative field data from riparian zone including:
• approximate height for each vegetation layer
• approximate tree/shrub densities
• identify invasive species and observed snags/dead and down trees
• width, length, and area of functioning riparian zone
• stream banks vegetation type, height, and density
• percent vegetation that covers the stream
• qualitative evaluation of known limiting riparian factors such LWD[3] or shade limitations</td><td>Collect Track B data, supplemented by tree counts, GPS survey, or professional land survey within forested riparian impact area to include:
• tree species
• tree diameters
• estimated tree heights
• locations of snags/dead and down</td></tr>
<tr><td>Physical In-Stream Habitat</td><td>1) Review existing literature
2) Review aerial photographs, topographic maps and site photos
3) Characterization should include:
• stream width
• dominant in-stream sediment
• LWD[4] presence
• channel morphology
• streambank condition</td><td>1) Site visit to qualitatively assess the following through visual observations:
• stream width
• LWD presence
• general channel morphology
• general bank condition
• dominant stream substrate
• relative amount of instream cover and refuge

ALSO SEE TABLE 4 FOR MORE DETAILS</td><td>1) Site visit to quantitatively assess the following conditions within, upstream, and downstream of project site:
• wetted and OHWM[5] stream width
• LWD size, location, and type
• channel morphology - pool, riffle, run, glide
• bank condition - stability/armoring
• stream substrate - dominant/subdominant and particle distribution

ALSO SEE TABLE 4 FOR MORE DETAILS</td><td>Same as Track B, but specific habitat impacts or intended use for mitigation may require:
1) Track B data collection over a wider area
2) GPS/professional survey of habitat elements delineated in Track B, or
3) detailed quantitative analysis of habitat elements (e.g., bulk substrate analysis, micro-channel morphology)

ALSO SEE TABLE 4 FOR MORE DETAILS</td></tr>
<tr><td>Biological Connectivity</td><td>1) Review existing literature on existing fish passage conditions/barriers and check the WDFW Fish Passage Barrier Map
2) If no barriers are recorded online, Track B/C methods may be required regardless of impact level
3) Review aerial photographs to identify potential barriers at site, upstream, or downstream
4) Review topographic maps and watershed analyses</td><td>1) Site visit to qualitatively assess the following information on man-made fish passage structures:
• type/material of structure
• approximate size/configuration of structure
• condition of structure (i.e. wear, damage, etc.)</td><td>1) Site visit to quantitatively assess man-made structures:
• relative inlet and outlet elevations
• stream channel bankfull width

2) If necessary, conduct WDFW Level A Culvert analysis per WDFW (2009) to assess status as fish passage barrier. Check with WDFW prior to conducting the analysis; they may already have that information, particularly if the culvert is on WSDOT right-of-way</td><td>Same as Track B, but in some cases coordination with design team on conducting a WDFW Level B culvert analysis per WDFW (2009) may be necessary to accurately assess barrier status</td></tr>
<tr><td>Water Quality and Quantity</td><td>1) Review existing literature/databases for information on:
• water quality/contaminants,
• stream temperatures,
• flow data
• water quality/quantity limiting factors</td><td>1) Site visit with qualitative description of:
• type/material of outfall/drainage structure
• approximate size/configuration/condition of outfall/drainage structure
• visual estimate of streamflow and stream velocity
• stream temperature
• presence of septic systems within the project area
• Water source (stormwater, other?)</td><td>No additional effort</td><td>No additional effort</td></tr>
<tr><td>Fish Presence,
Fish Habitat Use, and
Stream Typing</td><td>1) Review existing literature/databases for information on:
• fish presence and fish habitat use
• stream typing
• contributing basin area
• natural/manmade barriers downstream</td><td>If result of background information does not provide complete or definitive results, conduct site visit and make preliminary determination based on WAC 222-16-031. Qualitatively assess the following:
• stream width/OHWM,
• flow conditions,
• fish observations</td><td>If result of background information does not provide complete or definitive results proceed with one or more of the following options, as appropriate:
1) Request government/Tribal fish use/stream typing assistance
2) Utilize a qualified biologist to estimate fish presence/absence based on habitat conditions within, upstream, and downstream of site
Conduct reconnaissance site visit to identify natural downstream barriers</td><td>Same as Track B, but in extraordinary circumstances, fish sampling by a qualified biologist may be appropriate[6]. Sampling techniques could potentially include:
• snorkel surveys
• minnow traps
• electrofishing</td></tr>
</table>

[1] See text in Section 3 – Data Collection for Key Aquatic Habitat Elements for more specific information on each habitat element
[2] Background information should be compiled regardless of access situation or level of impacts
[3] If lack of access, the information for Track A should be collected in the field from adjacent publicly accessible properties or right of way to the extent possible/practical
[4] LWD – large woody debris
[5] OHWM – ordinary high water mark
[6] If information collected as part of Track A or Track B does not provide the required level of certainty on fish presence and stream typing, and no natural barrier exists downstream, generally assume fish presence and consult with ST environmental staff. These activities will require a Scientific Collection Permit from WDFW, and in accordance with WAC 220-20-045. Electrofishing, per requirements in WAC 220-20-045, should only be used to assess fish presence under extraordinary circumstances where such actions are pre-approved by ST (e.g., this information is tied to a permit condition or the information is crucial for design of a substantial design element such as road or culvert)

3.1.2 Track A Information

After collecting and synthesizing relevant background information on riparian vegetation conditions within the project area, conduct a reconnaissance-level site visit within existing Sound Transit or public right-of-way/easement areas. Provide qualitative description of riparian conditions including the following:

- Note buffer vegetation type – e.g., forested, shrub, herbaceous, none (bare earth/built). Identify shrub and/or tree species if possible, including any observed invasive species.
- Note relative buffer vegetation density (e.g., sparse, moderately dense, dense) and approximate height of each vegetation layer, particularly the tree layer
- Note observable width/length of riparian zone
- Note extent and type of overhanging vegetation and any observed any observed LWD originating in riparian zone. Estimate percent overhead cover in stream thalweg.
- Note and describe extent of vegetation overhanging stream channel, fallen vegetation
- Qualitative evaluation of potential limiting riparian factors such (LWD or shade limitations)

3.1.3 Track B Information

Collect similar information as listed in Track A; however site access will allow for on-site evaluation of the riparian condition based on qualitative and quantitative field data gathered from within the riparian zone.

- Identify shrub or tree species within the riparian zone, including any observed invasive species.
- Estimate or measure canopy cover and ground cover within the riparian zone (Daubenmire, 1959) for dominant species. If measuring, use plots or intercept along a measuring tape.
- Approximate average diameter (diameter breast height – DBH) of trees within riparian zone using representative measurements
- Width and length of functioning riparian zone and
- Riparian interaction with stream banks (e.g., overhanging vegetation, bank stabilization by roots),
- Measure average in-stream riparian cover in the stream thalweg using a densitometer (average riparian cover measured facing upstream, downstream, left bank, and right bank).
- Observations or qualitative evaluation of reach or basin scale limiting riparian factors (such as large-scale LWD or shade limitations).

3.1.4 Track C Information

If the project involves substantial impacts to the riparian corridor, particularly forested riparian areas, it may be necessary to supplement the data collection efforts from above with a more accurate tree survey conducted with GPS survey or professional land survey. Within forested buffer impact areas, detailed survey of the following parameters may be appropriate:

- Tree locations
- Tree species
- Tree diameters
- Estimated tree heights
- Locations of snags and dead/ down woody debris

3.2 Physical In-Stream Habitat

There are literally hundreds of formal assessment protocols prepared for the evaluation of stream environments and habitats. Assessment methods to assess physical in-stream habitat for Pacific Northwest streams are also numerous (e.g. Overton et al. 1997, Pleus and Schuett-Hames 1998, Barbour et al. 1999). In addition, several agencies in the region have developed their own protocols that use unique suites of channel features and channel feature definitions. These protocols generally address measurement of the same in-stream habitat parameters (e.g., woody debris, channel morphology, streambank condition) with varying levels of detail. In order to cover the range of data requirements for both Phase 1 and Phase 2 Sound Transit projects, the discussion of field methods (Tracks A, B and C) for an assessment of this Key Aquatic Habitat Element is focused on these in-stream habitat parameters. Table 4 on page 13 details the specific metrics/measurements that may be applicable for each parameter under Tracks A, B, and C, with recommendations for specific methods or protocols, where appropriate. Table 5 summarizes the methodological references noted in Table 4 for various in-stream habitat parameters.

In addition, other authors have compared and contrasted various protocols and assessments from a nation-wide perspective (Somerville, 2010), with a focus on those assessments prepared for application in the Pacific Northwest region (Johnson et al., 2001; Stolnack et al. 2005). These review documents are excellent sources to consult prior to undertaking a detailed physical habitat assessment, especially in cases where the assessment is focused on specific in-stream habitat parameters.

3.2.1 Background Information

1) Review existing literature on physical in-stream habitat conditions, including stream size (width), presence of LWD and complex habitat features, approximate stream gradient/channel morphology, stream substrate and sediment condition, and bank condition. Reports that may contain information reach or sub-basin scale physical conditions include:
    - The Washington State Conservation Commission Limiting Factors Analysis, organized by Water Resource Inventory area (http://scc.wa.gov/directory/ or http://www.eopugetsound.org/articles/water-resource-inventory-areas-puget-sound)
    - Salmon recovery plans – Puget Sound: http://www.psp.wa.gov/SR_map.php King County: http://www.kingcounty.gov/environment/animalsAndPlants/salmon-and-trout.aspx
    - Shoreline Master Program Inventory reports for local jurisdictions http://www.ecy.wa.gov/programs/sea/shorelines/smp/citizen.html
    - Williams et al. (1975)
    - Local watershed analysis or stream assessment reports

2) Review aerial photographs, topographic maps, and any available site photos.
    - Google Earth – also view past stream habitat conditions using historic photos on site
    - Bing Maps – Birds Eye View feature is useful for assessing some in-stream conditions
    - Digital or hardcopy orthophotos
    - Topographic maps (LIDAR data if available) to determine stream gradients. LIDAR data can be obtained from the Puget Sound LIDAR Consortium at http://pugetsoundlidar.ess.washington.edu/

3) Use the results of 1) and 2) above to describe the following in-stream habitat conditions at the site/stream reach to the extent feasible:
    - general horizontal and vertical channel form (stream gradient and channel morphology) including the presence and quality of pools and riffles and channel confinement/entrenchment
    - dominant in-stream substrates (cobble, gravel, fines, etc.) and general sediment transport dynamics (source, transport, or response reach),
    - presence/absence of LWD, or frequency of LWD (if available),
    - streambanks condition, including bank stability and presence of bank hardening/revetments

3.2.2 Track A Information

After collecting and synthesizing relevant background information on in-stream physical habitat conditions within the project area, conduct a site visit within existing Sound Transit or public right-of-way/easement areas. Provide qualitative descriptions, based on visual observations, of on-site in-stream habitat conditions as detailed in Table 4 on the following page. The primary Channel Geomorphological Units (CGU) used for the assessment will likely be limited to fast/slow habitat types, as the evaluation will be based on visual observations only.

3.2.3 Track B Information

Collect similar information as listed in Track A; however site access will allow for better evaluation of in-stream physical habitat conditions, based on qualitative and quantitative field data gathered from within the stream. Information on specific recommended measurements, including appropriate references, is presented in Table 4. The primary Channel Geomorphological Units (CGU) used for the assessment will likely include a moderate detail (pools, riffles, and runs/glides at a minimum). Pools may be further classified into the type of pool (e.g., lateral scour, medial scour, boulder-formed pocket pool).

3.2.4 Track C Information

If the project involves substantial impacts to in-stream habitat, particularly impacts to the stream bed, stream banks, or local hydraulics, or if the site is to be used for compensatory mitigation, it may be necessary to supplement the data collection efforts from above with more detailed measurements as listed in Table 4.

Table 4. Specific Metrics for Assessment of Physical In-Stream Habitat Parameters

Parameter	Metric/Measurement	Track A – Limited Site Access and Low Impact	Track B – Site Access and Moderate Impacts	Track C– Site Access and Substantial Impacts OR Site to be Used as Compensatory Mitigation
Channel Form and Profile	Macrohabitat - habitat type	Visual characterization of Channel Geomorphological Units (CGUs) into slow/fast water habitats.	Classify and measure macrohabitat unit length using classification including pools, riffles, runs, and/or glides. Depending on specific impacts, additional detail may be appropriate (Arend 1999).	Same as Track B. If substantial alteration of stream hydraulics, may be useful to classify and measure CGUs using detailed classification system (Arend 1999).
	Macrohabitat - pool characteristics	Visual observation of water depths of slow/fast water habitat approximate depth.	Measure maximum pool depths and residual pool depths. Classifying pools based on minimum functional pool width/depth (Pleus et al., 1999).	Same as Track B
	Stream Reach Classification	N/A	N/A	If substantial alteration of stream hydraulics, may be useful to use existing geomorphic classification system to classify project reach - Montgomery and Buffington (1998).
	Stream Slope	Estimate stream slope using topographic maps or LIDAR data if available.	Measure using clinometer or auto-level.	Same as Track B. If substantial alteration of stream hydraulics, may be useful to conduct longitudinal profile study.
	Stream Patterns	Visual observation of channel patterns (e.g., sinuous versus straight channel).	Visual observation of channel patterns (e.g., sinuous versus straight channel).	Same as Track B. If substantial alteration of stream hydraulics, may be useful to measure meander length, radius of curvature, sinuosity, and meander belt width.
	Confinement	Visual assessment of channel confinement and entrenchment.	Measure channel confinement/entrenchment. The entrenchment ratio is the ratio of the width of the flood-prone area to the surface width of the bankfull channel. The flood-prone area width is measured at the elevation that corresponds to twice the maximum depth of the bankfull channel.	Same as Track B. If substantial alteration of stream hydraulics, may be useful to survey complete stream cross-section.
	Channel Dimension/Shape	Visual estimation of bankfull width.	Measure average bankfull width and depth in project area.	Same as Track B. If substantial alteration of stream hydraulics, may be useful to survey complete stream cross-section.
Streambank Condition	Stability	Visual observation of nature and extent of unstable banks.	Measure extent of and location of unstable banks with type of instability (slide, slump, slough, etc.).	Same as Track B. If substantial specific impact to this habitat element or the element is crucial to a key design feature, may be useful to use GPS or PLS to survey location of features.
	Bank Hardening/Revetments	Visual observation of nature and extent of bank hardening/revetments.	Measure extent and location of bank hardening/revetments with type of hardening (riprap, earthen, structural, etc.).	Same as Track B. If substantial specific impact to this habitat element or the element is crucial to a key design feature, may be useful to use GPS or PLS to survey location of features.
Substrate/Sediment	Particle Frequency	Visual estimate of dominant and subdominant substrate over project area.	Visually estimate dominant and subdominant substrate within each CGU. Supplement data with pebble counts at representative pool tail outs (Bunte and Abt 2001).	Same as Track B. If substantial alteration of stream hydraulics, may be useful to use grid surface sampling or sub-surface volumetric sampling (Bunte and Abt 2001).
	Percentage of Fine Sediments/Embeddedness	Visual estimate of amount of surface fines in pools.	Visually estimate percentage of surface fines in each pool CGU. Estimate substrate embeddedness in riffles and pools.	Same as Track B. If substantial alteration of stream hydraulics, may be useful to use grid surface sampling or sub-surface volumetric sampling (Bunte and Abt 2001).
Large Woody Debris	LWD Presence, Frequency, and Location	Visual count of observed pieces of woody debris (>6 feet in length and 0.5 feet in diameter).	Measure location and presence of each piece of LWD (>6 feet in length and 0.5 feet in diameter) and debris jams. Relative position of LWD (thalweg center, thalweg edge, bankfull, bankfull edge).	Same as Track B. If substantial alteration of stream hydraulics or LWD composition, may be useful to measure additional parameters, including mapping/GPS of LWD orientation.
	Debris Jams	Visual observations of presence/absence of LWD jams, including approximate location and size of jam.	Measure location and orientation of each LWD jam, including number of pieces of debris in jam.	Same as Track B. If substantial specific impact to this habitat element or the element is crucial to a key design feature, may be useful to use GPS or PLS to survey location of features.
	LWD Size	Visual estimate of LWD size (length and width).	Measure LWD size (length and width) for each piece of LWD.	Same as Track B. If substantial specific impact to this habitat element or the element is crucial to a key design feature, may be useful to use GPS or PLS to survey location of features.
	Age and Type	Visual estimate of LWD age and composition (deciduous or coniferous).	Measure LWD species (coniferous, deciduous, or unknown) and LWD age class (Shuett-Hames et.al., 1999a).	Same as Track B. If substantial specific impact to this habitat element or the element is crucial to a key design feature, may be useful to use GPS or PLS to survey location of features.
Cover and Refuge	Pool quality	Visual observation of relative pool size, location, depth, and cover.	Assess pool quality using a Pool Quality Index (Platts et al. 1983).	Same as Track B
	Undercut banks	Visual observations of presence/absence of undercut banks.	Measure location and presence of undercut banks.	Same as Track B. If substantial specific impact to this habitat element or the element is crucial to a key design feature, may be useful to use GPS or PLS to survey location of features.
	Off-channel/side-channel habitat	Visual observations of presence/absence of off-channel/side-channel habitat, including associated wetlands. Indicate presence of beaver dams or beaver activity within project area.	Include side-channel habitat in channel form and profile, LWD, streambank condition, and sediment measurements. Measure location, area, and water depth of off-channel areas. Record features of beaver dams and associated habitat.	Same as Track B. If substantial specific impact to this habitat element or the element is crucial to a key design feature, may be useful to use GPS or PLS to survey location of features.
	In-stream cover/protection	Visual observation of aquatic macrophytes, habitat boulders, and other in-stream structures providing cover.	Measure location and presence of aquatic macrophytes, habitat boulders, and other in-stream structures providing cover.	Same as Track B

Table 5 below summarizes the methodologies Sound Transit recommends for assessing in-stream habitat parameters.

Table 5. Methodological References for Physical In-Stream Habitat Parameters

Metric/Measurement	**Methodology Reference**
Habitat Unit Classification and Measurement	Arend, K.K. 1999. Macrohabitat Identification. Pages 75-93 *in* M.B. Bain and N.J. Stevenson, editors. Aquatic habitat assessment; common methods. American Fisheries Society. Bethesda, Maryland.
Pool Characteristics • measurement of maximum pool depths and residual pool depths • classification of pools based on minimum functional pool width/depth	Pleus, A. E., D. Shuett-Hames, and L. Bullchild. 1999. TFW Monitoring Program method manual for the habitat unit survey. Prepared for the WA State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-99-003. DNR #105. June. 31 pp.
Stream Reach Classification	Montgomery DR, Buffington JM. 1998. Channel Processes, Classification and Response. *In* Naiman, R. and Bilby, R. (Eds) River Ecology and Management: Lessons from the Pacific Coastal Ecoregion, New York, NY: Springer-Verlag.
Sediment Characteristics • Particle Frequency • Percentage of Fine Sediments/Embeddedness	Bunte, K. and Abt. S.R. 2001. Sampling surface and subsurface particle size distributions in wadeable gravel and cobble bed streams for analyses in sediment transport, hydraulics and streambed monitoring. General Technical Report RMRS-GRT-74. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 428 pp.
Large Woody Debris • LWD Presence, Frequency, and Location • Location, orientation, and number of pieces in each LWD jam • LWD size (length and diameter) • LWD species and age class	Shuett-Hames, D., A. E. Pleus, J. Ward, M. Fox, and J. Light. 1999a. TFW Monitoring Program method manual for the large woody debris survey. Prepared for the Washington State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-99-004. DNR #106. March. 33 pp.
Pool Quality Index	Platts, W. S., W. F. Megahan, and G. W Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. Gen. Tech. Rep. INT-138. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 70 p. http://www.fs.fed.us/rm/pubs_int/int_gtr138.pdf

3.3 Biological Connectivity

An analysis of biological connectivity and associated fish passage conditions may be a key element of Sound Transit projects, particularly for the creation, reconstruction, or removal of stream crossings (roads or bridges). Fish passage structures are regulated under the Washington State Hydraulic Code (WAC 220-110-170). Therefore, where such actions may occur, it is important to have early coordination with the project design team to determine and coordinate on overall project design and permitting needs.

Any definitive evaluation of fish passage conditions should be conducted using the *Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual* (WDFW, 2009). Likewise, design of stream crossings should utilize the standards and procedures in the WDFW *Water Crossing Design Guidelines* document (Barnard, et al. 2013).

3.3.1 Background Information

Review existing literature on biological connectivity and fish passage conditions, including the presence of any known or potential man-made or natural barriers to fish passage, including type, size, and location of such features. Data sources that may contain information reach or sub-basin scale biological connectivity and fish passage conditions include:

- WDFW Fish Passage Program: Data and Maps
  http://wdfw.wa.gov/conservation/habitat/fish_passage/data_maps.html

- WSDOT Fish Passage Reports
  http://www.wsdot.wa.gov/environment/biology/fp/fishpassage.htm#reports
- Topographic maps of stream for assessment of steep downstream reach gradients /natural barriers
- Local watershed analysis or stream assessment reports

3.3.2 Track A Information

After collecting and synthesizing relevant background information on biological connectivity habitat conditions within the project area, conduct a site visit within existing Sound Transit or public right-of-way/easement areas. Provide qualitative descriptions, based on visual observations, of biological connectivity habitat and fish passage conditions, including the following:

- Location and approximate dimensions of structures including length, width, and height
- Type of structures – Culvert, bridge, fishway, weir structure, etc.
- Material of structures - Concrete, stone/rip-rap, aluminum, PVC, etc. Note presence of culvert corrugation and liners
- Approximate size/configuration of structures – For culverts note type of structure (round, box, bottomless box, squash, arch, elliptical, etc.) and whether structure is countersunk
- Approximate condition of structure – Note any deterioration or damage to structure
- Presence of natural streambed material within culvert and estimate of percent of culvert opening affected by sedimentation
- Presence and relative extent of any backwater at culvert inlet
- Presence and height of any perch at culvert outlet
- Presence of any plunge pool at culvert outlet and estimated depth of pool

3.3.3 Track B Information

Collect similar information as listed in Track A, however site access will allow for better evaluation of connectivity and fish passage condition based on qualitative and quantitative field data gathered from within the stream. The use of the Level A Methodology and Field Form from WDFW (2009) is highly recommended for assessment purposes as it will ensure all essential information is captured. In addition to information collected in the Track A analysis on culvert shape, the following data should be recorded per WDFW (2009):

- Measure relative inlet and outlet elevations (preferable) or measured slope of culvert
- Measure culvert dimensions
- Measure stream channel width (bankfull width)
- Measure water surface drop at outfall
- Measure maximum plunge pool depth

3.3.4 Track C Information

If the project involves substantial impacts fish passage structures, particularly the alteration of an existing potential barrier and the Level A Analysis (WDFW, 2009) is not conclusive on barrier status (Level A does not provide conclusive barrier status in all cases), it may be necessary to coordinate with the design team to determine if a Level B analysis is required. This analysis is usually completed by a hydrologist, geomorphologist, or engineer and requires measurement of additional upstream and downstream parameters including channel width, depth, slope, and characterization of bed material. For specific methods, data requirements, and analysis tools, see WDFW (2009).

3.4 Water Quality and Quantity

3.4.1 Background Information

Review existing literature on water quality and flow conditions, including known impairments of water quality and temperature, and stream flow characteristics. Include any information on impairments or limiting factors from the literature or databases. Data sources that may contain information reach or sub-basin scale water quality and flow conditions include:

- Washington Streamflow Data - USGS
  Historic data = http://wa.water.usgs.gov/data/realtime/adr/interactive/
  Realtime data= http://waterdata.usgs.gov/wa/nwis/current?type=flow
- 303(d) list - Washington State Department of Ecology http://www.ecy.wa.gov/programs/wq/303d/
- King County Hydrologic Information Center
  http://green.kingcounty.gov/WLR/Waterres/hydrology/default.aspx
- Streams Water Quality Monitoring Data
  http://green.kingcounty.gov/WLR/Waterres/StreamsData/StreamList.aspx
- Local watershed analysis or stream assessment reports

3.4.2 Track A Information

After collecting and synthesizing relevant background information on water quality and quantity conditions within the project area, conduct a site visit within existing Sound Transit or public right-of-way/easement areas. Provide qualitative description of water quality and flow conditions including the following:

- Note any drainage outfalls, including type/size/location of structure, possible source and volume of outflow during time of site visit.
- Visually estimate streamflow (in cubic feet per second) and stream velocity (feet/second).

3.4.3 Track B and C Information

In almost all cases, the information gathered during the Background Information and Track A investigations will be sufficient to effectively characterize water quality and flow. However, in certain rare circumstances, additional site-specific water quality and flow measurements may be appropriate. As these circumstances are rare, and any such measurements should be tailored to specific project requirements (e.g., permit conditions), such additional measurements are not discussed in this document.

3.5 Fish Presence, Fish Habitat Use, and Stream Typing

There is a difference between fish presence and fish habitat use, and just because fish may not be present at a given time of the year does not mean that a particular stream or stream habitat is not used by fish. Fish presence may respond to seasonal use of a given stream or habitat type as well as a particular life stage of a given fish species. For these reasons, the general best approach is to assume fish habitat use wherever suitable fish habitat exists, and consult with Sound Transit environmental staff before collecting additional data on fish presence.

The determinations of fish habitat use, and the related element of stream typing, are key in determining the potential severity of project impacts, the width of regulated stream buffers, and the requirements for ensuring fish passage at crossing structures. Although for rivers and larger streams, extensive information exists on fish habitat use and stream type, this information is often times lacking for smaller first and second order tributary streams. The following methods utilize an extensive search of background information coupled with measurements of a stream's physical characteristics to evaluate the potential for fish habitat use based on the presence of suitable fish habitat.

3.5.1 Background Information

Review existing literature on fish habitat use and stream typing conditions, including any documented presence of fish species potentially or known to be present. It should also include documented or potentially present suitable fish habitat within the project area. Include any existing stream typing information from the literature or databases. Data sources that may contain information reach or sub-basin scale biological connectivity and fish passage conditions include:

- WDFW Priority Habitats and Species Online Mapper http://apps2.dfw.wa.gov/prodphsontheweb/viewer.aspx?auth=dchBC3QPoGho84hRndFNAyiX2awipVxGmK5mj/T0HbP429kXX73bzQ==
- WDFW SalmonScape Database http://apps.wdfw.wa.gov/salmonscape/
- DNR Water Typing Online Mapper http://www.dnr.wa.gov/businesspermits/topics/forestpracticesapplications/pages/fp_watertyping.aspx
- The Washington State Conservation Commission Limiting Factors Analysis, organized by Water Resource Inventory area (http://scc.wa.gov/directory/ or http://www.eopugetsound.org/articles/water-resource-inventory-areas-puget-sound)
- Wild Fish Conservancy Water Type Assessments and Interactive Maps http://wildfishconservancy.org/resources/maps
- Fish distribution in WRIA 8: http://www.govlink.org/watersheds/8/reports/fish-maps/default.aspx
- A Catalog of Washington Streams and Salmon Utilization (Williams et al., 1975)
- Local jurisdiction Critical/Sensitive Area maps
- Local watershed analysis or stream assessment reports

3.5.2 Track A Information

After collecting and synthesizing relevant background information on fish habitat use and stream typing within the project area, conduct a site visit within existing Sound Transit or public right-of-way/easement areas. Visually observe for the presence of fish. If the background information or visual observation does not clearly indicate fish use status of a particular stream, it may be difficult to determine fish use and therefore stream typing) at a site based upon the direct observation of salmonids. Due to poor visibility, low escapement levels, the existence of human-made barriers, or other factors, fish may not be observed during the field visit.

The Forest Practices Rule (WAC 222-16-031) is used to define water types. Based on the WAC, there are a number of methods to determine if a site has the potential to provide fish habitat. Satisfaction of one or more of the following criteria qualifies a water body as fish bearing or potential fish habitat:

- Watercourses shown by DNR as containing fish on DNR stream typing maps, the WDFW Priority Habitats and Species database, or the WDFW SalmonScape database.
- Watercourses with documented salmonid use determined by visual observation, electrofishing, or verification by local biologists.
- Estimate scour line width. Watercourses having average scour line widths (bankfull widths) in excess of 0.6 meters (2 feet) in Western Washington, provided the stream gradient is less than 20 percent.

Note that seasonally dry streams (ephemeral or intermittent) can provide fish habitat during periods of flow. When evaluating dry stream channels, consider the physical characteristics of the channel and proximity to known fish-bearing water. Also, consider the timing of fish presence for species in the area that may enter the habitat when flow is present. For example, chum salmon often use streams that may only flow for a few months out of the year; they will spawn in the channel during the fall when flow is present and fry will out-migrate in the spring immediately after emergence. In another example, off-channel rearing habitat and floodplain habitat may be used by juvenile salmonids during winter months, even though the channel is dry during the summer.

3.5.3 Track B Information

Better site access will allow for a more comprehensive analysis of evaluation of bankfull width, and greater opportunity to visually observe for fish presence. However, increased site access will not necessarily provide definitive results. If the result of background information and Track A does not provide complete or definitive results, the following options may be considered, as appropriate:

- Request fish use/stream typing assistance from WDFW, Tribal entities, or local government agencies. Assistance may consist of local knowledge of fish distribution or technical assistance with fish presence studies.

- Utilize a qualified fisheries biologist to estimate fish habitat use based on habitat conditions, within, upstream, and downstream of site, noting that absence of fish during a site investigation does not by itself confirm perennial absence.

- If background information indicates a potentially natural downstream fish barrier, conduct downstream reconnaissance to locate and assess natural barrier. Note that lack of fish access for anadromous species does not indicate absence of resident fish species (e.g., resident cutthroat trout or sculpin).

- Watercourses with documented salmonid use determined by visual observation, electrofishing, or verification by local biologists.

3.5.4 Track C Information

In extraordinary circumstances (e.g., this information is tied to a permit condition or the information is crucial for design of a substantial design element such as road or culvert), electrofishing, per the requirements in WAC 220-20-045 can be used to establish fish presence and stream typing. This pathway should only be used under careful consideration and in consultation with WDFW. Electrofishing, or other fish sampling methods, should be pre-approved by Sound Transit environmental staff and conducted by experienced fisheries biologists.

4. Considerations and Limitations

The purpose of this report, including associated flowcharts and tables, is to serve as a guide for assessing streams that are potentially affected by Sound Transit projects. Due to variation in the specific type and severity of project impacts, coupled with property access issues and the unique requirements of multiple regulatory agencies that are commonly involved, it is difficult to craft a “one size fits all” survey protocol. This difficulty is illustrated by an analysis of the stream assessment methods used by two large governmental agencies involved in transportation projects: the Washington State Department of Transportation and the King County Road Services Division. Neither of these agencies has specific stream assessment protocols for determining project impacts. This is also common for most local governments, as a sufficiently broad, detailed, and inclusive stream assessment survey protocol to cover all available project permitting and design needs would be inherently detailed. This in turn can lead to the potential collection of a substantial amount of information, extraneous to the needs of the project, resulting in an increase in project effort and expense.

Therefore, one should consider some project-specific elements prior to assessing streams. This will allow the user to specifically tailor the stream assessment methods in order to both “right size” the analysis methods and to ensure that information is collected in an efficient way that anticipates current and future information needs. These elements can be assessed by asking and answering the following project-specific questions:

- **Which specific habitat elements and sub-elements will be affected (e.g., in-stream substrate, stream banks, riparian zone width, etc.)?** Think carefully about the specific project impacts or mitigation needs and the information that should be collected to compare or assess these impacts or evaluate appropriate mitigation.

- **What project stage or stages is data from the stream assessment to be used -- programmatic planning, alternative comparison, initial permitting, project design, or mitigation design?** The stream assessment should be tailored to a level of detail that addressed the current project planning, design, or permitting phase and that will support the related documents and plans.

- **If the general purpose of the stream assessment is to help compare project options, is this comparison for programmatic options, many specific design alternatives, a small number of design alternatives, or is the purpose to compare a single alternative with a no-build option?** Based on the specific answer, the stream assessment should be tailored to allow for adequate analysis of impacts, without collecting extraneous information. Conversely, if only one site/alignment is being evaluated and access is not limited, collecting more detailed information early on may be beneficial in the long-term, especially if mitigation is necessary.

- **If the purpose of the stream assessment is to compare among a limited number of specific design options, do the alternatives impact stream habitats in similar manners and locations?** If impacts to streams from most or all of the alternatives will occur in the same geographic area(s), more robust initial stream assessment methods may be appropriate in order to minimize multiple assessments during the project lifecycle, thereby maximizing efficiency and limiting costs.

- **What is the project timeframe for alternative comparison, design, and permitting**? Expedited time-frames may require a more robust initial stream assessment method, in order to quickly advance design and permitting, or to avoid the risk of unexpected delay at a late stage of the project.

- **Are other project staff collecting similar or ancillary field data on stream conditions**? It is important to coordinate with other project staff on their data acquisition needs prior to selecting final assessment methods. For example, structural or civil engineers may be performing detailed hydraulic or hydrological analyses within the same stream reaches, and potentially eliminating the need for some channel morphology or sediment data collection during the stream assessment.

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Everett Link Extension

Electromagnetic Fields Technical Analysis Methodology

October 2023

SoundTransit

1 INTRODUCTION

This technical analysis methodology memorandum describes the methods that will be used to analyze the impacts on electromagnetic fields for the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS). The Electromagnetic Fields technical report and EIS section will address how the project affects electromagnetic field-sensitive receptors adjacent to the project, and will present measures to avoid, minimize, or mitigate potential impacts.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

The relevant regulations for all environmental analyses will be considered; however, there are no federal, state, or local regulations or policies governing electromagnetic fields, which are produced wherever electricity is used. The American Conference of Governmental Industrial Hygienists (ACGIH) and The International Commission on Non-Ionizing Radiation Protection have both established guidelines for human exposure to electromagnetic fields.

3 DATA NEEDS AND SOURCES

The project alignment, station, and OMF site alternatives will be reviewed to identify nearby facilities that might have receptors sensitive to electromagnetic fields. Sound Transit will consult with the managers of these facilities to determine what, if any, specific receptors might be sensitive to electromagnetic fields and the level of sensitivity for the receptors. Where relevant information is not obtained, either through lack of response from the facility manager or lack of available information, assumptions will be made based on previous experience with similar facilities.

Information on the presence of utilities sensitive to stray current will be obtained from the utilities analysis, including both point (e.g., radio masts) and linear (e.g., pipelines, power lines, telecoms lines) utilities.

The analysis will use any relevant information available from Sound Transit Operations or prior studies conducted for similar Sound Transit projects. Additionally, pertinent published literature regarding the current health effects research on electromagnetic fields will be summarized in a literature review.

4 STUDY AREA AND AREA OF EFFECT

The study area and potential area of effect will be the area within 300 feet of the Build Alternatives including alignments, stations, and OMF sites. This study area encompasses the locations that might be affected by electromagnetic fields associated with building and operating the project.

5 AFFECTED ENVIRONMENT

Existing facilities, buildings, and land uses within the study area will be reviewed to identify potential electromagnetic field-sensitive receptors such as medical and research facilities with specialized diagnostic equipment, or buildings with high-tech industrial or laboratory uses, and the level of sensitivity for the receptors. Electromagnetic field conditions (typical existing sources) will be described qualitatively. The presence of utilities or other structures potentially affected by stray current in the study area will also be mentioned.

6 ENVIRONMENTAL IMPACT ANALYSIS

The impact analysis will assess the potential direct, indirect, and cumulative electromagnetic field impacts of the No Build Alternative and a composite Build Alternative. Individual alignment alternatives or design options will not be separately analyzed unless they have the potential to be notably different (i.e., affecting transmission lines differently). Locations of proposed project electric power facilities will be reviewed to identify potential proximity effects on sensitive receptors.

6.1 Direct Impacts

Operational impacts on sensitive receptors will be described relative to any potential electromagnetic field-sensitive receptors. The analysis will be qualitative unless highly sensitive receptors are identified.

If highly sensitive receptors are present, the quantitative analysis will include conducting modeling of project-generated electromagnetic field levels at the sensitive receptors using information provided by Sound Transit on representative worst case traction system conductor currents and typical conductor geometry (cross-sections). If specific concerns are identified, Sound Transit will consult with the owner of the sensitive receptor to discuss specific needs and concerns over the electromagnetic field sensitivity. Stray current effects on utilities and design best management practices to address these effects will be described for the study area. Public health effects of electromagnetic field exposure will also be described. Note that the assessment will be uni-directional in that it will consider the impacts of the project on external facilities and assets and not vice versa.

An analysis of electromagnetic field impacts during construction is not expected because typical construction equipment generates negligible amounts of electromagnetic fields. However, if particularly sensitive facilities are identified where construction effects could be significant, this will also be assessed and reported.

6.2 Indirect Impacts

Indirect impacts are potential effects that would be caused at a later time or a farther distance but are still reasonably foreseeable. The indirect effects of new power sources and transmission from potential new development around stations, new operation and maintenance facilities, and other potential indirect affects to highly sensitive receptors, if present, will be discussed qualitatively.

6.3 Cumulative Impacts

If this project results in electromagnetic field impacts, the cumulative impacts analysis will consider past, present, and reasonably foreseeable future projects in the study area that have or could have electromagnetic field impacts. Trends and areas of combined (or overlapping) impacts will be identified and evaluated.

7 MITIGATION MEASURES

Potential impacts of electromagnetic fields will be controlled through project planning, design, and the application of required best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the alternatives will be incorporated as appropriate. Where impacts cannot be avoided or minimized, mitigation measures will be identified if there is a potential for electromagnetic field impacts on sensitive receptors. Stray current BMPs are considered part of the project design and not mitigation.

8 PROPOSED FIGURES, MAPS, OR OTHER DATA

No figures or maps need to be included in the technical report or EIS section unless electromagnetic field sensitive resources are identified in the study area. If sensitive resources are identified within the study area, the following will be included in the technical report:

- A table describing the facility, potentially sensitive equipment, distance from the track centerline, and anticipated disturbance
- Graphs illustrating the static magnetic field disruption caused by light rail vehicles relative to the lateral distance from the track centerline in worst-case conditions

9 DOCUMENTATION

For this resource, the following documentation will be developed:

- A technical report, including documentation of any modeling conducted for impacts to highly sensitive receptors
- An EIS section

10 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

Data gathered on electromagnetic fields may be used in the utility and energy analyses.

11 REFERENCES

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Everett Link Extension

Energy Technical Analysis Methodology

October 2023

SoundTransit

1 INTRODUCTION

This technical analysis methodology memorandum describes the methods that will be used to analyze the impacts on energy for the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS). The energy technical report and EIS section will address the magnitude of energy consumption associated with construction and operation of the Build and No Build Alternatives and will present measures to avoid, minimize, or mitigate any potential impacts.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

There are no federal, state, or local laws that specifically and quantitatively regulate energy consumption in the transportation sector. Many state, local, and regional transportation plans and policies identify goals for the efficient use of energy, energy conservation, and reduction goals, and targets occur at all levels of government.

In addition to the relevant regulations considered for all environmental analyses, the following will also be considered.

2.1 Federal

- Code of Federal Regulations (CFR) Title 49, Section 622.301, FTA Requirements for Energy Assessments - Buildings
- Energy Policy Act of 2005
- Clean Energy Act of 2007

2.2 State

- Engrossed Substitute Senate Bill 6508, Developing minimum renewable fuel content requirements and fuel quality standards in an alternative fuels market (2006)
- Revised Code of Washington (RCW) 47.01.440, Adoption of Statewide Goals to Reduce Annual Per Capita Vehicle Miles Traveled
- RCW 39.35, Energy Conservation in Design of Public Facilities
- Washington State Department of Transportation (WSDOT) *2016 Washington State Public Transportation Plan*
- Governor’s Executive Order 14-04: Washington Carbon Pollution Reduction and Clean Energy Action
- Governor’s Executive Order 07-02 and Senate Bill 6001
- Governor’s Executive Order 09-05
- Washington Transportation Commission Policy

- Washington State Energy Code (RCW 19.27A)
- Washington State Energy Independence Act, which requires large electric utilities to obtain 15 percent of their electricity from new renewable energy resources by 2020 and to undertake cost-effective energy conservation

2.3 Local

- Sound Transit Sustainability Plan Update (Sound Transit, 2019)

3 DATA NEEDS AND SOURCES

The following data will be used to describe the affected environment for energy:

- Annual trends of energy production and consumption by fuel type and statewide from the Energy Information Administration (EIA)
- Trends in energy demand and production for the state, from the Washington State Department of Commerce
- Distribution of primary energy sources used to generate electricity, from local utility providers

For the impact analysis, the anticipated data sources include the following:

- Vehicle miles travelled (VMT) per speed bin, roadway type, and vehicle type for each alternative, from the Puget Sound Regional Council (PSRC) regional travel demand model
- Fuel consumption rates per vehicle type
- Construction cost estimates for each alternative
- Number of miles of underground, elevated, or at-grade light rail track and stations
- Electrical utility provider percent of renewable energy generation. Sound Transit and Puget Sound Energy (PSE) have entered into an agreement that all PSE electricity accounts related to the operations of Link light rail be sourced solely from renewable wind power via PSEs Green Direct program (see Board Motion No. M2017-11, M2018-91, and M2020-65). In addition, Sound Transit is pursuing executing and amending new and existing Long Term Carbon-Free Energy Service Agreements with Sound Transit's utility service providers (see Board Motion M2021-09).
- Energy use by existing Sound Transit facilities

4 STUDY AREA AND AREA OF EFFECT

The study area for considering energy use for the project is regional, and covers the PSRC four-county region, including King, Pierce, Kitsap, and Snohomish counties. Consistent with PSRC's regional travel demand model, the analysis includes vehicular travel on all facilities, including freeways, ramps, collector-distributors, arterials, and collector streets. This scale of analysis is the most comprehensive and accounts for mode shifts between private vehicles and public transit; that is, this scale primarily illustrates the effects of travel demand.

5 AFFECTED ENVIRONMENT

This section will describe the national and local sources of energy to be used by the project, primarily electricity for operation and petroleum products for construction. State consumption trends will also be described.

6 ENVIRONMENTAL IMPACT ANALYSIS

The impact analysis will assess the potential direct, indirect, and cumulative energy impacts of the No Build Alternative and a composite Build Alternative reflecting the potential impacts of the project. The impacts analysis is divided into long-term operation impacts and short-term construction impacts (including impacts associated with construction staging areas).

6.1 Direct Impacts

The PSRC regional travel demand model will be used to categorize and estimate future No Build and Build Alternative VMT by vehicle type, road type, and speed. The direct impacts of the project would be illustrated by the change in regional energy consumption as a result of the project (i.e., mode shift and improved operations on roadways). It is likely that different Build Alternatives may not produce major differences that are noticeable at a regional level, so the analysis will assemble segment alternatives to represent the effects for a full corridor alignment, representing the highest- and lowest effect combinations that could be possible.

The energy analysis will use the FHWA Infrastructure Carbon Estimator (ICE) tool to estimate construction and operation impacts associated with the project, including the energy use that will occur at the Operations and Maintenance Facility (OMF) North. The tool improves upon previously available methods, which often require complex inputs or are based on outdated research. The ICE allows users to create ballpark estimates of energy emissions using limited data inputs.

Reduction of project energy consumption during construction and operation from Sound Transit's Sustainability Plan and design standards will be described.

6.2 Indirect Impacts

Indirect impacts are potential effects that would be caused at a later time or a farther distance but are still reasonably foreseeable. The potential for indirect impacts on energy use from potential transit-oriented development (TOD) described in the Land Use section will be qualitatively assessed.

6.3 Cumulative Impacts

Cumulative impacts to transportation-related energy use, which consider planned projects and policies within a geographical area, are also accounted for in the PSRC regional travel demand model, and, therefore, the analysis of direct impacts due to changes in transportation-related energy use will also be inherently cumulative in nature. While a more complex array of other factors affects the overall conditions for energy supply and demand at the regional level as well as nationally and globally, these types of changes are considered beyond the scope of the proposed project and are not proposed for additional detailed discussion. Brief additional text will be provided to explain the context for the regionally-based transportation-related energy demand effects, compared to larger-scale conditions in the energy marketplace.

7 MITIGATION MEASURES

There are currently no quantitative restrictions on energy use, and existing regulations lack quantifiable standards for assessing effects related to energy consumption. Potential impacts to energy use will be controlled through project planning, design, and the application of best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the alternatives will be incorporated as appropriate.

8 PROPOSED FIGURES, MAPS, OR OTHER DATA

Potential figures that may be used in the energy analysis include the following:

- Energy consumption per vehicle type
- Transit service area
- Distribution of primary energy sources used to generate electricity per utility provider
- Annual operational energy consumption, by OMF North alternative

9 DOCUMENTATION

For this resource, the following documentation will be developed:

- A technical report
- An EIS section

10 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

Data gathered on energy will be used in the following analyses:

- Air Quality
- Utilities

This analysis will coordinate with the analysis for air quality and greenhouse gases on the use of the FHWA ICE tool and its relevant outputs.

11 REFERENCES

Federal Highway Administration (FHWA). 2014. Infrastructure Carbon Estimator Tool. https://www.fhwa.dot.gov/environment/sustainability/energy/tools/carbon_estimator/.

Sound Transit. 2019. Sustainability Plan – 2019 Update. https://www.soundtransit.org/sites/default/files/documents/2019-sustainability-plan.pdf.

Washington State Department of Transportation (WSDOT). 2016. 2016 Washington State Public Transportation Plan. M3122. https://www.wsdot.wa.gov/publications/manuals/fulltext/M3122/WSPTP.pdf.

Everett Link Extension

Environmental Justice Technical Analysis Methodology

October 2023

SoundTransit

1 INTRODUCTION

This technical analysis memorandum describes the methods that will be used to analyze Environmental Justice effects for the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS). The analysis will address beneficial and adverse project affects to minority and/or low-income populations, identify measures to avoid, minimize, or mitigate potential adverse effects, and make a determination of whether the project has disproportionately high and adverse effects on these populations. It will also summarize outreach to minority and/or low-income populations for the project.

The project area lies within the homelands of Southern Coast Salish peoples enrolled in several federally recognized Tribes having treaty rights, cultural resources, and other interests in the study area. This analysis will assess potential impacts to these Tribal communities as well as Native Americans who are not enrolled in local Tribes but live in the region, which may be considered minority and/or low-income populations. Impacts to Tribal treaty-protected hunting, gathering, and fishing rights will be described in the Ecosystems Technical Report. Impacts to potentially affected archaeological, cultural, and traditional cultural properties will be included in the Historic and Archaeological Resources Technical Report.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

In addition to the relevant regulations considered for all environmental analyses, the Environmental Justice section will comply with the following requirements:

2.1 Federal

- Title 28 of the Code of Federal Regulations (CFR) Part 23, Nondiscrimination on the Basis of Disability in State and Local Government Services
- Title 49 of the Code of Federal Regulations (CFR) Part 21, Nondiscrimination in Federally Assisted Programs of the Department of Transportation, Effectuation of Title VI of the Civil Rights Act of 1964
- Title 23 of the United States Code (USC) Section 109(h), Federal Highway Administration Effectuation of Title VI of the Civil Rights Act of 1964
- Presidential Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (EO 12898), February 11, 1994
- Presidential Executive Order 13166, Improving Access to Services for Persons with Limited English Proficiency (EO 13166), August 11, 2000
- Presidential Executive Oder 14096, Revitalizing Our Nation’s Commitment to Environmental Justice for All (EO 14096), April 21, 2023
- U.S. Department of Transportation (USDOT) Order on Environmental Justice (DOT Order 5610.2(a) – Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, 77FR 27534 (May 10, 2012)

- Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 as amended. This act defines the federal regulations governing property acquisition and relocation for federally funded projects.
- USDOT Federal Transit Administration (FTA), Circular FTA C 4703.1, Environmental Justice Policy Guidance for Federal Transit Administration Recipients, August 15, 2012
- FTA, Circular FTA C 4702.1B, Title VI Requirements and Guidelines for Federal Transit Administration Recipients, October 1, 2012
- U.S. Environmental Protection Agency, *Promising Practices for EJ Methodologies in NEPA Reviews, Report of the Federal Interagency Working Group on Environmental Justice & NEPA Committee*, March 2016
- Federal Interagency Working Group on Environmental Justice & NEPA Committee, *Community Guide to Environmental Justice and NEPA Methods*, March 2019
- Council on Environmental Quality, Guidance for Federal Departments and Agencies on Indigenous Knowledge, November 2022

2.2 State/Region

- Sound Transit/Washington State Department of Transportation (WSDOT), Re-Alignment Issue Paper No. 36, Implementing Environmental Justice Pursuant to Executive Order 12898 and the Department of Transportation Order to Address Environmental Justice in Minority Populations and Low-Income Populations, October 4, 2001
- State of Washington Governor's Executive Order, 93-07, Affirming Commitment to Diversity and Equity in the Service Delivery and in the Communities of the State, September 27, 1993
- Washington State Law Against Discrimination, Revised Code of Washington (RCW) 49.60

3 DEFINITIONS

The definitions provided in this section for key terms are based on the United States Census Bureau's definitions of "minority." The definitions do not account for all non-White racial or ethnic groups, such as people with Middle Eastern origin who are categorized as White by the Census Bureau.

Minority persons include the following:

- Black: a person having origins in any of the Black racial groups of Africa.
- Hispanic or Latino: a person of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race.
- Asian: a person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent.

- American Indian and Alaskan Native: a person having origins in any of the original people of North America, South America (including Central America), and who maintains cultural identification through Tribal affiliation or community recognition.
- Native Hawaiian and Other Pacific Islander: people having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.

A minority population means any readily identifiable group or groups of minority persons who live in geographic proximity, and, if circumstances warrant, geographically dispersed/transient persons (such as migrant workers or Native Americans) who will be similarly affected by a proposed program, policy, or activity (FTA 2012). The term “minority” is used for consistency with Executive Order 12898.

A low-income person is identified as a person whose median household income is at or below two times the federal Health and Human Services poverty guideline; this is a local threshold that Sound Transit and other regional transit agencies have determined is appropriate for use in determining eligibility for reduced fare programs and reflects the increasingly high cost of living in the region. Two times the Department of Health and Human Services 2021 poverty guideline for a household of one is $25,760 annual income and for a household of four is $53,000 annual income (United States Department of Health and Human Services 2021). The use of a local threshold is consistent with FTA Circular 4703.1 (FTA 2012). Those individuals considered low-income will include persons living below these thresholds.

A low-income population means any readily identifiable group of low-income persons who live in geographic proximity and, if circumstances warrant, geographically dispersed/transient persons who will be similarly affected by a proposed program, policy, or activity (FTA 2012).

A person with limited English proficiency is defined as a person that speaks English “less than very well” by the United States Census Bureau (2021). People with limited English proficiency are not an environmental justice population as defined by FTA in Circular 4703.1, but they are considered in this analysis. Presidential Executive Order 13166 on Improving Access to Services for Persons with Limited English Proficiency directs each federal agency that is subject to its requirements to publish guidance for its representative recipients clarifying that obligation. The United States Department of Transportation published guidance in the *Federal Register* on December 14, 2005. The guidance defines a “safe harbor” for recipients to ensure that they comply with their obligation to provide written translations in languages other than English (United States Department of Transportation 2005). The guidance considers a recipient within the safe harbor if they provide the written translation of vital documents for each eligible language group that constitutes either 1,000 persons or 5 percent of the population of persons eligible to be served or likely to be affected or encountered (United States Department of Transportation 2005).

4 DATA NEEDS AND SOURCES

The Environmental Justice analysis will include a description of the demographic characteristics of populations in the study area. Impacts analysis will be largely based on a review of the potential adverse effects assessed for other elements of the environment addressed in the EIS and any proposed mitigation for those effects. The substantial effects and mitigation of other elements of the environment will be considered to assess the potential for high and adverse effects to minority and/or low-income populations. The analysis will involve close coordination with the development of other technical reports and EIS sections prepared for the project, including the following:

- Acquisitions, Displacements, and Relocations
- Social Resources, Community Facilities, and Neighborhoods
- Land Use
- Economics
- Transportation
- Air Quality
- Ecosystems
- Water Resources
- Public Services, Safety, and Security
- Noise and Vibration
- Visual and Aesthetic Resources
- Historic and Archaeological Resources
- Parks and Recreational Resources

The results of consultation with Tribal governments will be considered in the analysis. Input from public involvement efforts, particularly those representing minority and/or low-income populations, will also be reviewed and included in the analysis as required.

The following is a list of the key data that will be used as part of the Environmental Justice analysis:

- U.S. Census Bureau 2020 decennial census data on minority populations at the census block group level within the study area. The information will be shared with the public involvement team.
- U.S. Census Bureau American Community Survey 5-year estimate data on low-income populations, languages spoken at home, limited English proficiency, and the country of origin of persons born outside of the United States, for census block groups within the study area will be used to better understand minority populations. The information will be shared with the public involvement team.
- U.S. Environmental Protection Agency's Environmental Justice screening tool may be used to supplement U.S. Census data.
- Local demographic data and information, including data provided by the community or Tribes, may be used to supplement U.S. Census data. Anecdotal data will be validated for accuracy whenever possible.

- Washington State Office of Superintendent of Public Instruction demographic statistics for elementary schools with attendance boundaries located within the study area. This information will include the racial and ethnic minority population demographics and rates of participation in the free lunch and reduced lunch programs provided at the elementary schools. Available school district data on languages spoken by students will also be referenced.

- Washington State Department of Health's Health Disparities GIS mapping.

- Information from the public housing authorities operating in the study area, as collected through the analysis for the Social Resources, Community Facilities, and Neighborhoods EIS analysis. This information will support an analysis of the location of existing and planned public housing projects within the study area. This information will also include both public and private providers of public housing. Information on unsubsidized affordable housing and voucher holder data may be used if reliable data is available since these units are subject to change. Some of this information will be available from outreach activities compiled as part of the project's public involvement and communications program.

- Average travel time to the key regional destinations. This information will be based on the project's travel demand and traffic forecasting efforts, which are themselves derived from travel demand models developed by the Puget Sound Regional Council. This information will be provided by the transportation team.

- Location of community facilities and businesses serving low-income and minority populations. Some of this information is already available from work previously compiled by the project's public involvement staff for outreach activities and other analysis efforts for the project.

- Summaries of public involvement, communications, and outreach activities for the project, especially outreach activities for minority and/or low-income populations. This information will be obtained from the public involvement team. Key materials will be translated into multiple languages in accordance with the community engagement guide.

- Conceptual engineering drawings for the alternatives and options obtained from the engineering team.

5 STUDY AREA AND AREA OF EFFECT

The study area for the Environmental Justice analysis will encompass the area approximately 0.5 mile from the project footprint and area used for construction (including construction staging areas) for the Build Alternatives. While many of the other environmental topics consider smaller areas for assessing impacts, the 0.5-mile study area allows the project team to identify potentially affected populations or community resources that could be subject to project impacts. The 0.5-mile measure also represents the typical walking distance residents and workers might cover to access the proposed transit stations. This captures the majority of areas where nearby residents and communities would experience the benefits of improved access to transit as well as potential impacts to the built environment surrounding the project.

6 AFFECTED ENVIRONMENT

The discussion of the affected environment will rely on both qualitative and quantitative analysis. The discussion will focus on defining and describing the presence of minority and/or low-income populations within the study area.

Minority and/or low-income populations will be defined by the most recent Census boundaries used for the Environmental Justice analysis. U.S. Census Bureau data from the 2017–2021 American Community Survey, or the latest data set available, will be used for the demographic characteristics and maps will be prepared to present this information visually.

The Affected Environment section will identify Tribal resources in or near the study area.

The Affected Environment section will also discuss the businesses or employers, key community facilities (including public housing, service facilities) and community centers or institutions that provide services to minority and/or low-income populations. The description of neighborhoods in the Social Resources, Community Facilities, and Neighborhoods section will be referenced.

The American Community Survey information reports a 5-year average for very small sample surveys with potentially high margins of error; therefore, additional information will be presented to further document low-income populations in the study area. This information will include demographic information from local elementary schools because the attendance boundaries are smaller than middle and high-schools and tend to approximate the boundaries of the study area more precisely. The school district demographic information on student participation in the federal free lunch and reduced lunch program will help to document the potential for low-income populations in the study area.

Information obtained from the public involvement team will also be summarized and used as part of the Environmental Justice analysis. The information will explain the overall public involvement plan and approach, project EIS scoping efforts, and any targeted Environmental Justice outreach efforts for major phases of the project. The public involvement information may also help to identify additional minority or low-income populations, community resources, or communities to be described in the Affected Environment section. Comments or concerns from members of the community at large, and particularly any who identify as members of minority and/or low-income populations and communities, will be summarized. These comments may also include concerns from parties who require translation or other special assistance. The summary will note any recurrent comments or concerns.

7 ENVIRONMENTAL IMPACT ANALYSIS

The analysis of the potential for any disproportionately high and adverse effects on minority and/or low-income populations will present information for both the No Build Alternative and the Build Alternatives. Disproportionately high and adverse effects on minority and/or low-income populations are defined in DOT Order 5610.2(a) as follows:

- Effects that are predominantly borne by a minority population and/or a low-income population, or

- Effects that will be suffered by the minority population and/or low-income population and are appreciably more severe or greater in magnitude than the adverse effects that will be suffered by the non-minority population and/or non-low-income population.

Direct construction and operation effects, indirect effects, and cumulative effects will be examined for all elements of the environment no matter where the effects occur. The primary source for this analysis will be the technical reports and EIS sections prepared for the other elements of the environment. The analysis will also examine any offsetting benefits of the proposed project.

The first step in this analysis will be to review the assessments of environmental effects for each element of the environment and to determine if the alternatives would result in adverse effects, taking into account the proposed mitigation measures. Project impacts that would be effectively mitigated are not anticipated to result in disproportionately high and adverse effects on minority or low-income populations. A brief statement discussing those elements of the environment that would not result in substantial adverse effects will be included in the analysis discussion.

In determining whether the project could result in disproportionately high and adverse effects on minority and/or low-income populations, mitigation measures and project benefits will also be considered. A project benefit analysis will be conducted in cooperation with transportation and transit analysts to assess the following measures:

- Improved access to transit based on accessibility to stations
- Overall travel time savings and other transit factors such as improved reliability and service frequency from the project
- Representative travel times to the major job markets to reflect improved access to jobs and major health and education institutions in the study area

The demographic characteristics of the population around the alternative stations will be identified using previously noted sources. A qualitative analysis will then assess whether mitigation measures and project benefits would be likely to accrue to minority and/or low-income populations, and whether they would help offset any adverse impacts to those populations after all other mitigation measures are also considered. If potential adverse impacts are effectively mitigated, the benefits accruing to low-income and minority populations offset impacts, or both, the analysis may conclude that no disproportionately high and adverse effects would result.

To facilitate the discussion of potential disproportionately high and adverse effects on minority or low-income populations, tables will be included that depict the effects and mitigation for each element of the environment that affects these populations. To the extent that Native Americans have been included in the income and minority data used for this analysis, potentially disproportionate high and adverse effects will be assessed and reported in aggregate with the total Environmental Justice population in the study area, along with any appropriate description of transit benefits of the project. The analysis will also identify potential impacts on Tribes having treaty-protected rights, and on American Indian and Alaskan Native populations who maintain cultural identification through Tribal affiliation or community recognition, including describing potential disproportionately high and adverse effects to Usual and Accustomed Areas and known Tribal resources.

For substantial adverse effects that cannot be effectively mitigated or where a determination is made that benefits do not offset project impacts to low-income and minority populations or to Tribes, a more detailed analysis will be conducted to determine if the project would result in disproportionately high and adverse effects on minority and/or low-income populations and Tribes.

8 MITIGATION MEASURES

Potential impacts to minority and/or low-income populations will be controlled through project planning, design, and the application of required best management practices (BMPs) during construction and operation. The proposed mitigation measures for other elements of the environment may avoid potential disproportionately high and adverse effects on minority and/or low-income populations, especially considering project benefits. If disproportionately high and adverse effects cannot be avoided or minimized, mitigation measures will be developed.

9 PROPOSED FIGURES, MAPS, OR OTHER DATA

The following is a list of figures and tables that will be included in the Environmental Justice analysis:

- A map of the Build Alternatives and the minority composition of the population for census block groups within the study area. The percentage of the populations in each block group will be shown in quartiles. This map will also include the location of major community and social resources.
- A map of the Build Alternatives and the location of low-income populations in census block groups within the study area. The percentage of the population that is low income will be shown in quartiles. This map will also include the location of existing and proposed public housing in the study area.
- A table of adverse effects and potential benefits by environmental element where there is the potential for impacts to minority and/or low-income populations and corresponding mitigation for each element of the environment.

10 DOCUMENTATION

An Environmental Justice technical report will be prepared, and a summary of its findings will be incorporated in the Social Resources, Community Facilities, and Neighborhoods EIS section.

11 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

Information and related GIS mapping depicting the distribution of environmental justice populations and non-English speaking populations will be shared with the project's public involvement and communications team.

Information from the Environmental Justice analysis will also be used in the Social Resources, Community Facilities, and Neighborhoods section.

12 REFERENCES

City of Everett. 2019. Languages Spoken by Active English Learners in Everett Public Schools. https://www.everettwa.gov/DocumentCenter/View/19519/Languages-spoken-by-Els-in-EPS-October-2018.

Council on Environmental Quality. 2022. Guidance for Federal Departments and Agencies on Indigenous Knowledge. https://www.whitehouse.gov/wp-content/uploads/2022/12/OSTP-CEQ-IK-Guidance.pdf.

Federal Interagency Working Group on Environmental Justice & NEPA Committee. 2019. *Community Guide to Environmental Justice and NEPA Methods*. https://www.energy.gov/sites/default/files/2019/05/f63/NEPA%20Community%20Guide%202019.pdf.

Federal Transit Administration (FTA). 2012. *Environmental Justice Policy Guidance for Federal Transit Administration Recipients*. Circular FTA C4703.1.

Sound Transit. 2001. Re-Alignment Issue Paper No. 36: *Implementing Environmental Justice Pursuant to Executive Order 12898 and the Department of Transportation Order to Address Environmental Justice in Minority Populations and Low-Income Populations.*

U.S. Census Bureau. 2021. Frequently Asked Questions (FAQs) About Language Use. https://www.census.gov/topics/population/language-use/about/faqs.html.

U.S. Environmental Protection Agency. 2016. *Promising Practices for EJ Methodologies in NEPA Reviews, Report of the Federal Interagency Working Group on Environmental Justice & NEPA Committee*. https://www.epa.gov/sites/production/files/2016-08/documents/nepa_promising_practices_document_2016.pdf.

Everett Link Extension

Geology and Soils Technical Analysis Methodology

October 2023

SoundTransit

1 INTRODUCTION

This Geology and Soils Technical Analysis Methodology memo briefly describes the methods that will be used to prepare the Geology and Soils technical report and section of the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS). The purpose of the geotechnical analysis is to identify and assess potential EVLE construction and operations impacts on the environment.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

In addition to the relevant federal regulations considered in all environmental analyses, Washington State's Growth Management Act (GMA; Chapter 36.70A Revised Code of Washington [RCW]) requires all cities and counties to identify critical areas within their jurisdiction and develop regulations to protect them. Among the critical areas designated by the GMA are Geologically Hazardous Areas, which are defined as areas that, because of their susceptibility to erosion, landslides, earthquake-induced damage, or other geologic events, are not readily suited for development consistent with public health and safety concerns. The Build Alternatives are within Snohomish County, which includes geologically hazardous areas and other critical areas requirements in its Unified Development Code (Snohomish County Code, Subtitle 30.6). Portions of the Build Alternatives are within the city of Lynnwood, which includes geologically hazardous areas and other critical areas requirements in its Environment ordinance (Lynnwood Municipal Code, Title 17), and within the city of Everett, which includes geologically hazardous areas and other critical areas requirements in its Unified Development Code ordinance (Everett Municipal Code, Title 19).

3 DATA NEEDS AND SOURCES

The following information will be reviewed or collected, if available, on the geology and soils of the study area:

- Existing geological and geotechnical data, including summaries of previous geotechnical borings, readily available geotechnical reports, and published geologic data for the study area
- Results and recommendations from geotechnical borings completed for the project (note that borings are anticipated to be conducted for the purposes of obtaining geotechnical information and for archaeological survey and, where possible, boring locations will be chosen to serve both purposes)
- Geologic, topographic, and critical areas maps from federal, state, and local agencies as available, including the Washington State Department of Transportation (WSDOT), U.S. Geological Survey (USGS), Snohomish County, City of Lynnwood, and City of Everett

4 STUDY AREA AND AREA OF EFFECT

The study area will include the local jurisdictions and for some geologic categories, the region, for an understanding of broader geologic processes and to understand mechanisms related to site geology and sensitive and critical areas. The study area for each alternative is 100-feet from the project footprint and area used for construction. This area will be expanded if ground improvement, dewatering, or other subsurface treatments that extend beyond the 100-foot buffer are necessary. Potential impacts for any structures or facilities considered reasonably foreseeable for the cumulative impacts analysis would also be considered.

5 AFFECTED ENVIRONMENT

The affected environment section of the technical report will summarize the geology and soils information for the study area, including mapping, narrative discussion, and tables describing the topography and various geological features. Geologically sensitive, hazardous, and/or critical areas will also be identified and described.

6 ENVIRONMENTAL IMPACT ANALYSIS

The impact analysis will assess the potential direct, indirect, and cumulative geologic and soil impacts of the Build and No Build Alternatives. The impact analysis is divided into long-term operation impacts and short-term construction impacts. The factors to be evaluated include:

- Substantial structures for each alternative, including alignment profiles, stations, and other facilities within each segment, including their likely construction methods
- Proximity of project features and construction staging areas to sensitive and critical areas, noting potential conflicts and concerns
- Information from available maps, reports, and relevant geology, soils, and seismicity information, including geotechnical information developed as part of alternatives planning and engineering to help further delineate and characterize potential hazards
- Information from field reconnaissance

Based on the data review, field reconnaissance, and input from the design team, potential impacts will be evaluated for each alternative. The impact discussion will focus on the project's impact on geological conditions or features, rather than the engineering requirements posed by various conditions.

6.1 Direct Impacts

Direct impacts will be qualitatively evaluated based on both site-specific subsurface conditions and existing published geologic data. The effects discussion will consider the potential project impacts on areas of geologic concern. The evaluation will consider direct effects, such as:

- Potential for slope failures, liquefaction, lateral flow or spreading, and ground settlement, if an earthquake were to occur
- Potential for non-seismic landslides, erosion, and settlement and maintenance
- Undermining of non-project structures from soil erosion

- Impacts on structures from corrosive or expansive soils
- Modified groundwater flow from ground improvement, construction activities, or buried structures
- Modified groundwater flow from infiltration of surface water
- Excavation and disposal of excess or unsuitable soils
- Import of fill materials
- Excavation below groundwater level
- Ground improvement needed to complete construction
- Temporary construction dewatering

Engineering design standards and best management practices (BMPs) incorporated into the project design for purposes of mitigating or minimizing impacts will be described. For example, supporting structures on deep foundation systems is one of several proven techniques for addressing the potential impacts of locating a structure in an area that is susceptible to liquefaction during a seismic event.

6.2 Indirect Impacts

Indirect impacts are potential effects that would be caused at a later time or a farther distance but are still reasonably foreseeable. The evaluation will qualitatively address potential indirect effects, such as erosion-caused damage to drainage areas or water quality. The potential for indirect effects beyond the project footprint from ground improvement will also be considered. Potential impacts to regional aggregate (i.e., crushed stone) availability in the region will also be discussed, including estimated aggregate quantities needed for the project and potential sources and availability of aggregate in the project area.

6.3 Cumulative Impacts

Cumulative effects related to geology and soils will be evaluated by considering the potential longer-term impacts of this project and other past, present, and reasonably foreseeable actions that affected or would affect the geology and soils of the study area and/or region.

7 MITIGATION MEASURES

Potential impacts to geological resources will be controlled through project planning, design, and the application of required BMPs during construction and operation. Measures to avoid and minimize potential impacts of the alternatives will be incorporated as appropriate. Engineering design standards and BMPs incorporated in the project that avoid or minimize impacts will be differentiated from mitigation measures. Where impacts cannot be avoided or minimized, mitigation measures will be developed. For each identified impact, potential mitigation measures will be discussed. The range of mitigation will consider the type and magnitude of the impact on the affected environment and the type of construction planned for the area.

8 PROPOSED FIGURES, MAPS, OR OTHER DATA

The geology and soils technical report will include figures and tables as appropriate to supplement the report contents, and may include maps of local and regional geology, topography, potential geologic hazards, relevant soil types, study area fault zones, and groundwater tables, and estimated soil import and export quantity tables.

9 DOCUMENTATION

For this resource, the following documentation will be developed:

- A technical report including supporting maps and information
- An EIS section

References to other technical documents developed by Sound Transit for the geotechnical engineering elements of the project will also be provided, as appropriate.

10 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

The results from this analysis may be incorporated into the following sections:

- Ecosystems
- Water Resources
- Historic and Archaeological Resources
- Acquisitions, Displacements, and Relocations
- Transportation
- Visual and Aesthetic Resources
- Social Impacts, Community Facilities, and Neighborhoods

11 REFERENCES

City of Everett. 2022. Unified Development Code, Critical Areas. Everett Municipal Code Title 19, Chapter 19.37. https://everett.municipal.codes/EMC/19.

City of Lynnwood. 2022. Environmentally Critical Areas. Lynnwood Municipal Code Title 17, Chapter 17.10. https://www.codepublishing.com/WA/Lynnwood/html/Lynnwood17/Lynnwood1710.html#17.10.

Snohomish County. 2022. Wetlands and Fish & Wildlife Habitat Conservation Areas, Geologically Hazardous Areas, Critical Aquifer Recharge Areas. Snohomish County Municipal Code Subtitle 30.6, Chapters 30.62A, 30.62B, and 30.62C.

https://snohomish.county.codes/SCC/30. https://snohomish.county.codes/SCC/30

Washington State. 2022. Growth Management – Planning by Selected Counties and Cities. Revised Code of Washington Chapter 36.70A. https://apps.leg.wa.gov/rcw/default.aspx?cite=36.70a.

Everett Link Extension

Hazardous Materials Technical Analysis Methodology

October 2023

SoundTransit

1 INTRODUCTION

This technical analysis methodology memorandum briefly describes the methods that will be used to analyze the impacts on hazardous materials and waste for the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS).

Hazardous materials or substances, hazardous wastes, petroleum products and wastes, and contaminated environmental media (including soils, sediments, surface water, and groundwater) might be present within the study area and could potentially result in impacts to human health and the environment during construction activities or long-term operation activities. The following summarizes the work elements for describing the affected environment, evaluating potential impacts, and developing mitigation measures.

The hazardous materials analysis will identify properties in proximity to the Build Alternatives recognized to have hazardous materials issues associated with current or historical site activities or that might have documented releases to the environment. Types and locations of sites will be identified to evaluate potential impacts to construction, property ownership, and general public health and safety.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

In addition to the relevant regulations considered in all environmental analyses, the following will also be considered:

2.1 Federal

- Federal Transit Administration (FTA) Standard Operating Procedures No. 19, Consideration of Contaminated Properties including Brownfields, 2016
- Federal Highway Administration (FHWA) *Technical Advisory T6640.8A*, 1987
- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (42 United States Code [USC] 9601, et seq.)
- Superfund Amendment and Reauthorization Act
- Resource Conservation and Recovery Act of 1976 (RCRA), as amended (42 USC 6901, et seq.)
- Clean Water Act (33 USC Section 1251, et seq.)
- Toxic Substances Control Act (15 USC 2601-2629)

2.2 State

- Dangerous Waste Regulations (Washington Administrative Code [WAC] 173-303)
- Model Toxics Control Act (WAC 173-340)

- Underground Storage Tanks (USTs) (WAC 173-360)
- Sediment Management Standards (WAC 173-204)

2.3 Local

- Everett Municipal Code Title 14 – Water and Sewers
- Lynnwood Municipal Code Title 17 – Environment
- Snohomish County Code Chapter 7.35 – Solid Waste Disposal, Chapter 7.44 – Sewage Disposal Systems, and Chapter 7.53 – Water Pollution Control

3 DATA NEEDS AND SOURCES

Data needs for this resource include information on existing or relevant historical conditions or potential conditions of areas that will be affected by the physical improvements of the project, including station locations, staging areas, maintenance facilities, and alternatives. These data needs and sources are described in the following sections.

3.1 Regulatory Database Evaluation

The U.S. Environmental Protection Agency (USEPA) and Washington Department of Ecology (Ecology) develop and maintain databases to track the status of sites reported to have either a release of chemicals to the environment or a potential for release due to chemical handling activities. The databases identify each site location, the hazardous-material-related activity performed, and the status of regulatory follow-up performed to date. To complete the review of these records, the services of a professional environmental data retrieval service will be retained. The data sources will include the following environmental agency records:

- Federal National Priorities List Site List
- Superfund Program Comprehensive Environmental Response, Compensation, and Liability Act Information
- Federal RCRA Information System
- Washington State Confirmed and Suspected Contaminated Sites List
- Washington State Hazardous Sites List
- Washington State Independent Clean-up Reports List
- Washington State Landfill or Solid Waste Site List
- Washington State Leaking UST List
- Washington State Registered UST List

- Washington State Voluntary Cleanup Program Sites List
- Washington Petroleum Technical Assistance Program Site List

The database information report will be reviewed to identify erroneous output and to track down missing information (usually associated with addresses). Sites will be categorized into two categories: sites with documented release and sites with potential release.

Sites identified to potentially affect the Build Alternatives will be further evaluated and summarized by reviewing information included in the environmental database report provided by the database search service.

3.2 Historical Use

The objective of the historical use information review is to develop a history of the previous uses of properties within the study area and surrounding area that helps to identify the likelihood of past uses having led to environmental conditions that could potentially affect the environment or the project's construction. Analysts will research the historical land use of the study area and adjacent properties to evaluate historical uses that are known to be associated with potentially contaminated sites. Historical records reviewed may include Sanborn Fire Insurance maps, historical topographical maps, aerial photographs, and local street directories, as necessary and available.

3.3 Windshield Survey

A visual windshield survey of properties within the study area and the surrounding area will be conducted to identify properties where hazardous materials may be present. The site examination will consist of observing the areas immediately surrounding project construction locations, visiting representative areas of the project, and visually assessing the areas within the study area for evidence of hazardous materials. The survey will identify visual evidence of past or current practices that could lead to soil impacts, groundwater contamination, or both. The site reconnaissance will be conducted by driving and walking the length of the project and visually identifying evidence of chemical containers or drums, large spills and leaks, distressed vegetation, and USTs or other hazardous material storage containers, as appropriate. All observations will be conducted from public areas or rights-of-way.

4 STUDY AREA AND AREA OF EFFECT

For the analysis of hazardous materials, the study area will include the area within 0.125 mile (600 feet) of either side of the project footprint and area used for construction because potential impacts would likely be restricted to the immediate corridor of the Build Alternatives.

5 AFFECTED ENVIRONMENT

The Affected Environment section will characterize the existing conditions in the study area as affected by the known or suspected contaminated sites. The characterization will discuss the following topics:

- General land use history
- Physical environment characteristics that might impact the distribution, migration, and clean-up of contamination
- Known or suspected contaminated sites
- Summary of known or suspected contaminants and contaminated environmental media
- Clean-up status for contaminated sites
- Summary of possible presence of hazardous materials (e.g., asbestos, lead-based paint, and polychlorinated biphenyls [PCBs])
- Summary of conditions of former landfills located within the study area
- Summary of regulatory and cleanup status of Superfund sites located within the study area
- Map of locations of known or suspected contaminated sites in the study area

A regulatory database query for a large linear project is expected to yield many sites within the study area that have a history of hazardous materials use or release to the environment. Based on the information collected, sites will be categorized into one of four risk categories (high, medium, low, and minimal) to prioritize sites and determine the need for avoidance, remediation, or mitigation while considering associated impacts. The risk levels are defined as follows:

- **High:** Sites that involve substantial contamination of large areas, including soil and groundwater, and multiple contaminants. High-risk sites might represent higher risk of further releases of hazardous materials to people or the environment or would be likely to involve high levels of regulatory approvals, extensive or lengthy remediation activities that may create other impacts to the environment, or could pose major delays to the development of the project.
- **Medium:** Sites where the nature of potential contamination is known based on existing investigation data, the potential contaminants are not extremely toxic or difficult to treat, and probable remediation approaches are straightforward.
- **Low:** Sites where the nature of potential contamination is known based on existing investigation data and the sites are not expected to have notable impacts on the project due to their location, or sites where hazardous materials were used but had no or only very small reported releases.
- **Minimal:** Sites where it is unlikely that contamination is located within the project footprint and there is minimal risk to the overall project. An example of a minimal risk site is a typical single-family residence in a residential area.

Sites that are considered minimal risk will not be reviewed or further counted. Minimal risk sites include sites that had regulatory interactions not related to the potential release of hazardous materials to soil or groundwater (i.e., permitted air emissions) or sites with a small one-time spill that was reported as cleaned up.

These risk levels will be recorded in the hazardous materials sites database and included in the historical hazardous materials sites summary tables and maps. Phase I environmental site assessments will be conducted for all high-risk sites identified for acquisition along the Preferred Alternative as part of the Draft EIS. If the Preferred Alternative is changed after the Draft EIS, any new high-risk sites identified for acquisition along the modified Preferred Alternative will have Phase I environmental site assessments conducted during the Final EIS. Phase II environmental site assessments will be conducted where appropriate for the Preferred Alternative high-risk sites as part of the Final EIS where site access can be obtained.

6 ENVIRONMENTAL IMPACT ANALYSIS

The impact analysis will assess the potential direct, indirect, and cumulative hazardous material impacts of the Build and No Build Alternatives. The impacts analysis is divided into long-term operation impacts and short-term construction impacts. It will also address potential regulatory considerations as a result of the presence of hazardous materials, hazardous substances, hazardous wastes, or contaminated environmental media. The analysis will consider impacts to human health and the environment as a result of possible release of contaminants or alteration of contaminant migration pathways during construction activities, and effects of existing contaminated sites. The primary impacts of hazardous materials identified along the alternatives will affect construction, since potential releases might pose health and safety threats to the general public. The extent and type of contamination encountered at specific sites might help to determine project siting on a small scale to avoid potential long-term property ownership problems and avoid issues in construction staging areas. A general discussion of applicable regulatory requirements that result from hazardous materials issues will be provided.

Investigation into available information for each documented contaminated site will provide a technical basis for decision-making as to whether potential long-term liability is balanced by the benefits to the community and the project as a whole.

The impacts analysis would also include a discussion of the environmental benefits available if contaminated properties or brownfields are utilized by the project. Where an alternative would acquire contaminated sites requiring extensive remediation or cleanup measures (high risk sites), the major elements of the plan would be described and evaluated in the EIS. Any properties needing substantial remediation actions may have additional environmental impacts due to the remediation measures themselves, and these activities would be noted.

A qualitative discussion of hazardous materials used during operation for maintenance or other activities will be included.

Indirect impacts are potential effects that would be caused at a later time or a farther distance but are still reasonably foreseeable. The analysis of indirect effects will discuss the potential results of redevelopment in station areas where the Build Alternatives could encourage transit-oriented developments or station area development on sites that may have past contamination.

The analysis of cumulative effects will involve discussing trends as it pertains to hazardous materials and will review available information about past, present, and future projects to determine the potential for cumulative effects.

7 MITIGATION MEASURES

Potential impacts of hazardous materials will be controlled through project planning, design, and the application of required best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the alternatives will be incorporated as appropriate. Where impacts cannot be avoided or minimized, mitigation measures will be developed. BMPs including commitments to adhere to applicable regulations will be identified as part of the project. This includes measures for controlling hazardous materials planned for use within the context of constructing, operating, and maintaining the light rail system. The project action would also include measures called for in remediation plans for acquired properties with contamination.

The mitigation measures will describe potential mitigation for other identified impacts. The mitigation section will include the following:

- Measures to avoid or minimize potential environmental impacts due to further releases of hazardous materials on sites where contamination has been identified (e.g., modification of alternative)
- Measures to mitigate potential impacts to public health and the environment
- Measures to mitigate construction and operation impacts

8 PROPOSED FIGURES, MAPS, OR OTHER DATA

The following figures and tables are anticipated to be produced in support of the hazardous materials analysis for the EIS:

- Database hazardous material sites summary table
- Database hazardous material sites location map
- Historical hazardous material sites summary table
- Historical hazardous material sites location map
- Summary of potentially acquired properties identified as hazardous material sites (as background information for a technical memorandum)

9 DOCUMENTATION

For this resource, the following documentation will be developed:

- A technical report
- An EIS section

10 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

Potential remediation plans identified for contaminated properties would be evaluated by other EIS sections for other impacts to the environment.

11 REFERENCES

Federal Highway Administration (FHWA). 1987. *Technical Advisory T6640.8A, Guidance for Preparing and Processing Environmental and Section 4(f) Documents*.

Washington State Department of Transportation (WSDOT). 2022. Environmental Manual. M31-11.26.

Everett Link Extension

Historic and Archaeological Resources Technical Analysis Methodology

October 2023

SoundTransit

1 INTRODUCTION

This technical analysis methodology memorandum describes the methods that will be used to prepare the Historic and Archaeological Resources section of the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS).

Resources investigated in this environmental element include districts, sites, buildings, structures, objects, and landscapes significant in American history, the precontact period, architecture, archaeology, engineering, and culture. These resources are protected by a number of statutes and regulations at various government levels.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

In addition to the relevant regulations considered for all environmental analyses, the following regulations, plans, and policies will also be considered:

- National Historic Preservation Act of 1966 (NHPA), as amended
- Code of Federal Regulations (CFR) Title 36, Part 800, Protection of Historic Properties
- U.S. Department of Transportation Act of 1966, Section 4(f)
- American Indian Religious Freedom Act of 1978
- Presidential Executive Order 13007, Indian Sacred Sites (EO 13007), May 24, 1996 (access to and/or ceremonial use of sacred sites by Indian religious practitioner)
- Revised Code of Washington (RCW) 27.53 (archaeological sites), 27.44 (Indian graves), and 68.50 (human remains)
- Washington State Department of Archaeology and Historic Preservation (DAHP) survey and inventory standards
- City of Everett Historic Resource Ordinance (Everett Municipal Code [EMC] 19.28)
- City of Lynnwood Historic Preservation Ordinance (Lynnwood Municipal Code [LMC] 21.80)
- Snohomish County Code (SCC) Chapter 30.32D (Historic and Archaeological Resources)
- National Register of Historic Places (NRHP) program bulletins, preservation briefs, and other guidelines

Section 106 of the NHPA, as amended, states that any federal or federally assisted project or any project requiring federal licensing or permitting must consider the action's effects on historic properties listed in or eligible for listing in the NRHP. Regulations governing the Section 106 review process are contained in 36 CFR Part 800 "Protection of Historic Properties."

Historic properties include historic and precontact archaeological sites, districts, buildings, structures, and objects. Some historic properties can also be cultural landscapes or traditional cultural properties (TCPs) if they meet the applicable criteria in National Register Bulletins 18

(U.S. Department of the Interior, National Park Service, no date), 36 (U.S. Department of the Interior, National Park Service, 2000), or 38 (U.S. Department of the Interior, National Park Service, 1998). Section 106 regulations require consultation with the State Historic Preservation Officer (SHPO),[1] affected Tribes, other interested parties, and the public. The regulations also encourage coordination with the environmental review process required by other statutes, including the National Environmental Policy Act (NEPA) and Section 4(f) of the U.S. Department of Transportation Act of 1966.

Section 106 regulations require the federal agency (or agencies) to follow a five-step process for satisfying the Section 106 requirements:

- Determine that the project is an undertaking with the potential to affect historic properties
- Identify interested and affected Tribes and other interested parties
- Identify and evaluate cultural resources listed in or eligible for listing in the NRHP
- Assess whether the project will affect historic properties, and whether effects will be adverse
- Consult with affected Tribes, SHPO, and other interested parties to resolve adverse effects to NRHP-listed and -eligible historic properties

Historic properties are identified in consultation with the SHPO and other consulting parties and must qualify for listing in the NRHP by meeting specific criteria and standards of integrity (36 CFR 60.4).

Washington state laws include requirements related to archaeological sites. RCW 27.53 (Archaeological Sites and Resources) prohibits unpermitted disturbance of archaeological sites, defined as a geographic locality in Washington that contains archaeological objects. RCW 27.44 (Indian Graves and Records) and RCW 68.50 (Human Remains) require notification procedures and work stoppage in the event of a discovery of human remains.

At the local level, the Cultural Resources team will consider information in city and county codes related to historic resources.

3 DATA NEEDS AND SOURCES

Potential data needs and sources for this resource include:

- Federal and state lists and nomination forms of identified historic properties for the NRHP
- State and local lists and nomination forms of identified historic properties for the Washington Heritage Register (WHR), online register lists and local landmark or historic designations for Snohomish County, the City of Lynnwood and the City of Everett

[1] In Washington, the State Historic Preservation Officer is part of the Washington State Department of Archaeology and Historic Preservation.

- Mapping of buildings, structures, objects, sites, and districts in the area of potential effect (APE) by construction date from city directories, building permit files, and county tax assessor records
- Light detection and ranging (LiDAR) imagery
- Methods and results of cultural resource reports for previous surveys conducted within or near the APE
- Various sources and databases, including those maintained by DAHP and Tribal cultural resource departments, regarding existing archaeological and historic resources in the project APE, including historical maps, photographs, ethnographic literature, and local histories
- General Land Office Survey maps, and the files and site records of DAHP
- Fire insurance maps, historical maps and photographs, and oral histories, including those on record with local universities and public libraries
- Project design drawings of alignments, stations, and related facilities
- Models of archaeological potential, including DAHP's Statewide Predictive Model and any other applicable modeling
- Geotechnical information or other sources of information about subsurface conditions in the project area
- Consultation with affected Tribes and other interested parties such as local historic preservation groups and local governmental agencies
- Other technical reports prepared on behalf of the project, including, but not limited to, Noise and Vibration, Visual and Aesthetic Resources, and Geology and Soils

4 STUDY AREA AND AREA OF POTENTIAL EFFECT

The study area includes all areas where one or more of the alternatives could affect historic or archaeological resources. The Federal Transit Administration (FTA), in consultation with SHPO, affected Tribes, and other consulting parties, defines the Section 106 APE, which becomes the study area for historic and archaeological resources for the alternatives evaluated in the EIS. The APE for each alternative is anticipated to generally extend from elements of the project limits (e.g., guideway, stations, operations and maintenance facility, and construction staging areas) to the nearest tax parcel or a maximum of 200 feet where large tax parcels are adjacent to project elements.

Based on consultation, design, and/or information from other environmental disciplines, the definition of the APE may be expanded or reduced where a more detailed review of potential effects indicates that a smaller or larger study area is appropriate.

The APE vertical limit depth for precontact and historical archaeological resources consists of the area that will be disturbed in constructing the project up to the depth of sterile soils based on soil types, geologic setting, age of landforms, and modern disturbance.

5 AFFECTED ENVIRONMENT

The description of the affected environment will include the following:

- A description of the local and regional history to provide a context for understanding the development of the APE and for identifying historic properties.
- A list of historic properties that are currently listed or have previously been determined to be eligible for the NRHP or are listed on the WHR, the Snohomish County Register of Historic Places, the Everett Register of Historic Places, or the Lynnwood Register of Historic Landmarks.
- A list of properties that are recommended to meet the criteria of the NRHP or that could meet the criteria of the WHR, the Snohomish County Register of Historic Places, the Everett Register of Historic Places, or the Lynnwood Register of Historic Landmarks.
- A map and a list of identified archaeological sites within the APE. The mapping will be redacted from public or generally distributed versions of the documentation.
- A map or series of maps showing properties that are listed, determined eligible, or recommended eligible for listing in the NRHP and that are listed or recommended eligible for listing on state or local registers.

Information on cultural resources to be described in the Affected Environment section will be collected using the data sources described in Section 3.

5.1 Archival Research

To identify historic properties that had previously been identified as eligible, information will be collected on the developmental history of the area, the historic districts, and the individual buildings, using sources listed above in Section 3.

5.2 Historic Resource Field Surveys

5.2.1 National Register Eligibility

To identify historic resources that are potentially eligible for listing in the NRHP, the survey process will prepare DAHP Historic Property Inventory (HPI) forms for all properties within the APE that meet the NRHP criterion of being 50 years or older. This analysis assumes 2030 as the year of action because it is the year that construction is scheduled to begin. Based on this, the survey will consider all properties within the APE that were built in 1980 or earlier.

The surveys will consider information for any properties that have been previously recorded in the DAHP historic property inventory database (WISAARD). In general, previous eligibility determinations by others can be the basis for a determination of eligibility, but federal agencies may make their own assessments regarding eligibility for the NRHP, and they may also augment existing information by others. Field surveys, information from local building permit records, the county tax assessor records, city directories, and other archival information, as listed in Section 3, will be used to assess the historical integrity and significance of the properties. The newly evaluated properties will be added to the DAHP database with recommendations regarding their NRHP eligibility. Properties that were surveyed and inventoried over five years ago will be photographed, and the HPI entries will be updated and included in the survey. This information will be reviewed by Sound Transit and FTA. FTA will then make NRHP eligibility determinations, which will be transmitted to SHPO for concurrence. These determinations will also be shared with affected Tribes and Section 106 consulting parties as appropriate, and these entities will have the opportunity to comment on NRHP eligibility.

To determine the level of information to be contained in HPI forms used for NRHP determinations, Sound Transit and FTA will maintain ongoing coordination with SHPO and provide additional information as needed, such as project tours and photos.

Properties that are listed in or eligible for listing in the NRHP will be summarized in a table attached to the Historic and Archaeological Resources Technical Report.

5.2.2 State Register Eligibility

Any resource listed in the NRHP is automatically listed in the WHR. It can be assumed that any resource identified as NRHP-eligible would also be WHR-eligible. No additional evaluation will be completed for state eligibility.

5.2.3 Local Register Eligibility

Snohomish County, the City of Lynnwood, and the City of Everett maintain local historic resource registers.

Snohomish County has established the Snohomish County Register of Historic Places. Alterations to properties listed on the register require a certificate of appropriateness from the historic preservation commission. Demolition of a property listed on the register requires a waiver of a certificate of appropriateness prior to issuance of a demolition permit. There are no requirements to evaluate or otherwise review proposed demolition of or alterations to properties not listed on the register (SCC 30.32D.060).

The City of Lynnwood is in the process of developing the Lynnwood Register of Historic Landmarks. For the first 10 years a property is listed on the register, property owners and their successors are prohibited from altering listed properties in a way that would affect eligibility (LMC 21.80.400). There is no requirement to evaluate or otherwise review proposed demolition of or alterations to properties not listed on the register. No additional evaluation will be completed for Lynnwood Register of Historic Landmarks eligibility.

The City of Everett has established the Everett Register of Historic Places, and while they have requirements in place to review proposals to demolish or otherwise alter properties or districts listed on the register, there is no requirement to evaluate or otherwise review proposed demolition of or alterations to properties not listed on the register (EMC 19.28). No additional evaluation will be completed for Everett Register of Historic Places eligibility.

5.3 Archaeological Sensitivity Mapping

Research will be conducted to determine the soil types, geologic setting, and age of landforms involved, as well as the extent of modern disturbance. Ethnographic place names, specifically the geographical data that T.T. Waterman (Waterman 1920; Waterman et al. 2001) prepared for the Puget Sound area in the 1920s, will be included as part of the sensitivity mapping. The potential for encountering buried precontact, ethnographic, and historical archaeological sites will be established by this process to increase the likelihood that existing sites will be identified during reconnaissance. It is possible, however, that one or more subsurface sites might not be discovered before construction.

Archaeologists will map the potential for precontact and historical archaeological sites to occur in the APE. They will gather information about environmental features, ethnographic place names, known archaeological resources, the historical shoreline, and the patterns of precontact, ethnographic, and historic use of the area. They will also overlay LiDAR imagery to display the cut and fill limits within this heavily urbanized setting. They will then study maps of the project alignments and conduct a vehicle reconnaissance. DAHP's statewide archaeological probability map will be consulted, and a project-specific analysis of archaeological sensitivity will be developed to identify areas with a high potential for containing archaeological sites (known as high-sensitivity areas). Areas of apparent previous severe disturbance will be identified and classified as low-sensitivity areas. Examples of typical high-sensitivity areas include the following:

- Areas in the vicinity of water bodies, freshwater resources, and water body confluences, especially water bodies with anadromous fish runs
- Areas on higher ground such as terraces above water bodies
- High areas that provide protection, visibility, or both, such as bluff tops
- Areas on General Land Office plats or Sanborn Fire Insurance Maps that show historical land use with the potential to contact important archaeological deposits and features

In addition to consulting DAHP's statewide archaeological predictability map, Equinox Research and Consulting International (ERCI) also developed their own sensitivity model to examine the environmental, cultural, and historical contexts within and surrounding the project area. Data sourced from local and state agencies, departments, and scholarly works are collected and digitized for analysis to determine areas of high probability for encountering buried precontact, ethnographic, and historical sites.

5.3.1 ERCI Sensitivity Model

A project-specific analysis of archaeological sensitivity will be developed by ERCI to identify areas with a high potential for containing archaeological sites (known as high-sensitivity areas). The data for the sensitivity model will be based on its significance, context, and availability for the project area. Data surrounding the project area in a 1-mile buffer has been incorporated to showcase any outside influences that may have influenced the cultural context within the project area. The following is a list of variables that meet this criterion:

- Cemeteries and archaeological sites
- Historical data including the locations of buildings, trails, roads, bridges, and railroads
- Ethnographic place names, specifically the geographical data that T.T. Waterman prepared for the Puget Sound area in the 1920s (Waterman 1920; Waterman et al. 2001)
- Water bodies
- A terrain ruggedness index

The sensitivity model will be created using digitized data from DAHP and historical topographic maps from the United States Geological Survey (USGS) and Bureau of Land Management (BLM). The model also utilizes hydrography data from the Washington State Department of Natural Resources (DNR) and Washington State Department of Ecology, a Digital Elevation Model (DEM) from the USGS, and maps and written descriptions of ethnographic places by T.T. Waterman (1922).

5.3.2 DAHP Statewide Predictive Model

In 2009, DAHP had a similar notion about combining available environmental and archaeological data to predict areas of archaeological resources. The variables used for DAHP's model depended more so on availability and quality because they performed this analysis on a state-wide scale. The variables analyzed by the DAHP model include:

- Elevation
- Slope percent
- Aspect
- Distance to water
- Geology
- Soils
- Landforms
- Archaeological sites

The variables and their weightings are different in the Statewide Predictive Model and the ERCI Sensitivity Model, the biggest difference being that the ERCI model uses ethnographic place names. By referencing both models, more environmental, geologic, historic, and ethnographic variables are included in the analysis and the likelihood of representing risk to cultural materials is more accurate.

5.4 Archaeological Survey

FTA, Sound Transit, and the project archaeologists will coordinate with SHPO and affected Tribes to develop a preliminary archaeology survey plan that will select locations for field surveys, favoring locations with high sensitivity for containing archaeological sites based on the archaeological sensitivity mapping and expectations for where intact archaeological deposits are likely. The methodology and archaeological survey plan will be developed by Sound Transit in coordination with FTA, SHPO, and affected Tribes will have an opportunity for review and comment.

The size and urban nature of the APE presents many unusual challenges for archaeological survey, including property access and accessibility to archaeological deposits in a highly developed environment. The archaeological survey plan is intended to be comprehensive but flexible enough to adapt with developing project conditions. It is anticipated to contain four phases:

- Phase 1 – archaeological survey to support the Draft EIS
- Phase 2 – archaeological survey to support the Final EIS
- Phase 3 – archaeological survey to support the final design
- Phase 4 – archaeological support during construction

An Inadvertent Discovery Plan (IDP) will be prepared as part of the first phase to facilitate geotechnical investigations, ground water monitoring, and other early activities with a minimal ground disturbance footprint. The IDP will describe the protocols to be followed if intact archaeological resources or human remains are identified.

5.5 Identification of Traditional Cultural Properties

Consultation with Tribes and other communities and groups will be used to gather data pertinent to identifying TCPs within the APE. Another method consists of research into ethnographic sources that discuss Indian place names, especially the geographical data that T.T. Waterman prepared for the Puget Sound area in the 1920s (Hilbert et al. 2001; Waterman 1920).

5.6 Determination of NRHP Eligibility

Evaluation methods outlined in 36 CFR 800(c)(1) will be used to apply NRHP eligibility criteria to identified historic resources. To be considered a “historic property” (eligible for listing in the NRHP), a property must be at least 50 years of age (or meet the NRHP “Criteria Considerations” categories) and meet one or more of the NRHP criteria for evaluation (36 CFR 60.4), listed below. The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, or association, and

- that are associated with events that have made a significant contribution to the broad patterns of our history (Criterion A); or
- that are associated with the lives of persons significant in our past (Criterion B); or
- that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a

significant and distinguishable entity whose components may lack individual distinction (Criterion C); or

- that have yielded or may be likely to yield, information important in prehistory or history (Criterion D).

FTA will make a determination of NRHP eligibility for each property. Sound Transit and FTA will then submit inventory forms to SHPO with a request for concurrence with FTA's determinations on NRHP eligibility.

For archaeological sites, integrity of location, materials, and association are generally most crucial. To address important research topics, archaeological deposits usually must be in their original location, retain depositional integrity, contain adequate quantities and types of materials in suitable condition to address important research topics, and have a clear association. Associations may be defined at different social scales (e.g., an activity area, a household, or institution) and across various temporal spans (e.g., brief or longer term).

6 ENVIRONMENTAL IMPACT ANALYSIS

The impact analysis will assess the potential direct, indirect, and cumulative historic and archaeological impacts of the No Build and Build Alternatives. The impacts analysis is divided into long-term operation impacts and short-term construction impacts. The project would affect historic and archaeological resources if it changes the characteristics that qualify a historic property for inclusion in the NRHP or state or local registers. The first step in the analysis is to determine if any of the alternatives would have any effect, either permanently or during construction (including construction staging areas), on the property. The second step is to determine if the effect is adverse. An effect is adverse if it diminishes the integrity of the property's historically significant characteristics. Examples of adverse effects include, but are not limited to, the following:

- Demolition or alteration of the property
- Alteration of the property's setting
- Introduction of visual, audible, or atmospheric elements that are out of character with the setting of the historic property
- Physical encroachment upon an archaeological site

6.1 Direct Impacts

FTA will determine the anticipated adverse effects of project construction and operation on TCPs, ethnohistoric and archaeological sites, and properties eligible for the NRHP ("historic properties") as well as resources listed on the Snohomish County Register of Historic Places, the Everett Register of Historic Places, or the Lynnwood Register of Historic Landmarks; adverse effects include demolishing or altering the property or its setting, including disturbance of an archaeological site. To determine the direct effects on historic resources, the following information will be used:

- The location of project elements and proximity to historic properties

- Potential partial or complete acquisition and/or demolition of historic properties
- Construction methods and location
- Potential for vibration (short- or long-term) that could damage historic properties
- Potential for settlement that could damage historic properties
- Potential changes to the visual setting that adversely affect the historic setting

The extent to which these effects may alter the integrity of the historic properties will be analyzed based on experience with previous similar projects and activities. If possible, alternatives will be designed to avoid or minimize impacts on historic and archaeological resources. To minimize impacts, best management practices (BMPs) appropriate to the proposed construction activity will be initially defined and will be refined as the consultation process continues.

Under Section 106, FTA anticipates making a determination of effect for each resource and for each alternative or option. In addition to providing documentation of its analysis and findings, FTA will provide a written request to SHPO to review and comment on FTA's preliminary findings and will request the SHPO's concurrence with a potential determination of effect for the project. The SHPO may concur with the determination of effect, or, as provided in Section 106 regulations (36 CFR 800.5[b]), could suggest modifications or impose conditions so that adverse effects can be avoided and thus result in a "no adverse effect" determination. The lead federal agency will notify the Advisory Council on Historic Preservation (ACHP) in the case of an adverse effect and may also request their participation in the consultation process.

For the first 10 years that a property is listed on the Lynnwood Register of Historic Landmarks, property owners and their successors are prohibited from altering listed properties in a way that would affect eligibility (LMC 21.80.400).

The City of Everett requires review of proposals to demolish or otherwise alter properties listed on the Everett Register of Historic Places or located within a historic overlay zone. Proposed alterations to listed resources require a Certificate of Appropriateness, or, in the case of demolition, a waiver, to be issued by the Everett Historical Commission before work can begin (EMC 19.28.140). New construction within designated historic overlay zones is subject to review by the historical commission or City of Everett planning staff (EMC 19.28.080, EMC 19.28.090).

If an archaeological site eligible for listing on the NRHP is identified within the study area or APE, all efforts should be made to determine if the archaeological site can be avoided. Minimal archaeological investigations may be necessary to confirm the archaeological site boundary for proper avoidance (if it has not already been conducted). The project will have an adverse effect if archaeological sites that are eligible for the NRHP cannot be avoided by the project.

6.2 Indirect Impacts

Indirect effects are potential effects that would be caused at a later time or a farther distance but are still reasonably foreseeable. For indirect effects, broader changes (such as changes in land use) that the project may cause will be identified and analyzed qualitatively, based primarily on the effects seen from previous similar projects. This analysis would include activities related to the project but not directly part of the project or known at the time of the analysis. Examples include transit-oriented development projects, mitigation or permit compliance activities to respond to other kinds of environmental impacts or permitting requirements (such as for stormwater management), or complementary activities that may be taken by others, such as street or trail improvement projects that enhance connections or access to the light rail project.

6.3 Cumulative Impacts

Cumulative effects are effects that result from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions. The cumulative effects analysis will focus on the combined effects of the Build Alternatives with other projects that are anticipated to add to the effects on historic and archaeological resources in the study area. A listing of future anticipated projects will be developed as part of the general EIS documentation and will include other land development or transportation projects planned or programmed within the project vicinity.

7 MITIGATION MEASURES

Potential impacts to historical and archeological resources will be controlled through project planning, design, and the application of required BMPs during construction and operation. BMPs appropriate to the proposed construction activity will be initially defined, as well as refined, as the Section 106 consultation process continues. Where impacts cannot be avoided or minimized, mitigation measures will be developed. Typical mitigation measures that could be used include the following measures. Additional options can also be found on DAHP's webpage at https://dahp.wa.gov/project-review/mitigation-options.

- Modifying the undertaking through redesign, reorientation, or other similar changes
- Relocating the historic properties
- Documenting historic properties or resources that must be destroyed or substantially altered
- Installing interpretive/educational signage, or other options that provide a direct public benefit (e.g., exhibits, online history essays and informational websites, documentaries, historic property nominations, etc.)
- Implementing data recovery of archaeological or architectural information and materials
- Preparing a NRHP nomination for an archaeological site
- Preparing a comprehensive ethnographic study

Under Section 106, the product of consultation on effects and mitigation will be an agreement document (Memorandum of Agreement or Programmatic Agreement) that contains stipulations specifying measures to be implemented that will mitigate the adverse effects.

7.1 Tribal and Agency Consultation

Sound Transit and FTA will consult with affected Tribes, SHPO, the City of Lynnwood, the City of Everett, Snohomish County, and other interested parties (e.g., historic preservation groups) during the cultural resource investigations impact assessment, and mitigation development. FTA will lead consultation with SHPO and government-to-government consultation with federally recognized affected Tribes. Sound Transit will lead consultation with the county, cities, interested parties, and non-federally recognized affected Tribes.

Sound Transit and FTA will solicit information from the affected Tribes about the presence of any known archaeological sites and TCPs that might be affected by future construction of the project. During consultation, Sound Transit and FTA will discuss with the Tribal representatives protocols to protect culturally sensitive information from broad public distribution. If TCPs exist within the APE and affected Tribes are concerned about maintaining the confidentiality of culturally sensitive information, then Sound Transit and FTA will not place information specifically identifying the resource in the EIS.

8 PROPOSED FIGURES, MAPS, OR OTHER DATA

- Maps of the APE, historic resources or properties, and archaeological high-probability areas
- Current photos of historic resources and past photos when available
- Figures showing impacts and/or proposed mitigation, as appropriate

9 DOCUMENTATION

For this resource, the following documentation will be developed:

- A Cultural Resources Inventory and Survey Plan to define areas proposed for surveys
- A technical report, including sections on affected environment and impacts, with maps of the APE, maps of archaeological survey locations and probability areas; maps and tables of historic property locations and descriptions; maps, tables, and descriptions of properties reviewed for potential eligibility under the NRHP and local jurisdiction historic register or landmark criteria; and adverse effects evaluations for eligible properties
- An EIS section including a map of the APE, historic resources or properties, and archaeological high probability areas
- Archaeological Site, Isolate, or HPI forms (as submitted to DAHP’s database)
- Records of all correspondence with SHPO, affected Tribes, or other interested parties

10 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

Data and findings developed in this analysis will be used for the Section 4(f) evaluation.

11 REFERENCES

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Everett Link Extension

Land Use Technical Analysis Methodology

October 2023

SOUNDTRANSIT

1 INTRODUCTION

This Land Use Technical Analysis Methodology memorandum describes the methods that will be used to analyze land use impacts and mitigation for the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS).

Changes in transportation systems can influence changes in nearby land uses and local land use plans; these plans and their underlying zoning are regulated by local jurisdictions. The project can directly affect land use through property acquisition and conversion to a transportation use. Mobility improvements can also be a factor supporting greater levels of urban development. Regional plans and local jurisdiction plans identify the need to facilitate the efficient use of land by using transit to connect urban activity centers, with transit and other multimodal system improvements offering a sustainable approach to meeting growing transportation demand. Adopted regional policy calls for focusing future growth in compact, walkable and transit-oriented communities, and prioritizing transportation investments to support transit-oriented densities and development. Transit can act as a catalyst for development and/or redevelopment in station areas where jurisdictions have identified the need for greater density and a mix of land uses. The Land Use analysis will evaluate direct, indirect, and cumulative impacts to land use from operation and construction, and will present options to avoid, minimize, or mitigate potential adverse impacts. It will also review the project’s land use compatibility and conformance with existing land use plans and policies.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

The following adopted regulations, plans, and policies will be reviewed. This list will be revised as new plans are adopted.

2.1 Federal

- Federal Transit Administration (FTA) Circular C7050.1A, FTA Guidance on Joint Development, Rev. 1 (December 29, 2016)

2.2 State/Region

- Washington State Growth Management Act (GMA) (adopted 1990, as amended)
- Puget Sound Regional Council (PSRC) VISION 2050 (adopted 2020)
- PSRC Regional Transportation Plan (adopted May 2022)
- PSRC Regional Centers Framework Update (adopted March 2018)
- PSRC Growing Transit Communities Strategy (adopted October 2013)
- Sound Transit Regional Transit Long-Range Plan (adopted December 2014)
- Sound Transit 3, Regional Transit System Plan for Central Puget Sound (June 2016)

- Sound Transit Equitable Transit-Oriented Development (TOD) Policy (Board Resolution No. R2018-10) that addresses how the agency should consider potential for TOD development near transit facilities being planned and studied. The policy reflects requirements in Sound Transit 3 and Revised Code of Washington (RCW) 81.112.350 (the agency's enabling legislation)
- Sound Transit Real Property Excess, Surplus and Disposition Policy (Board Resolution No. R2013-30)

2.3 City and County Plans

- City of Everett, Everett Comprehensive Plan 2015-2035 (adopted 2015, updated 2021)
- City of Everett, Climate Action Plan (adopted 2020)
- City of Everett, Metro Everett Subarea plan (adopted 2018, amended 2020)
- City of Everett, Rethink Zoning (adopted 2020)
- City of Everett, Rethink Housing Action Plan (adopted 2021)
- City of Lynnwood, Comprehensive Plan (adopted 2015, amended 2021)
- City of Lynnwood, City Center Sub-Area Plan (adopted 2007)
- City of Lynnwood, Connect Lynnwood (adopted 2022)
- Snohomish County, Comprehensive Plan (adopted 2015, amended 2018)
- Snohomish County, Light Rail Communities: Station Area Planning (adopted 2020)

2.4 Other Plans

- Paine Field Airport Master Plan (adopted 2002; scheduled for adoption in 2023)

3 DATA NEEDS AND SOURCES

The following regional, city, and county governments will be the sources for the adopted, regional, city, and county land use plans, sub area or neighborhood plans (as applicable), zoning and development regulations, geographic information systems (GIS), and existing land use patterns near the project corridor, station locations, and OMF North alternatives:

- City of Lynnwood
- City of Everett
- Snohomish County

- Puget Sound Regional Council

Conceptual design drawings will be used, in combination with GIS maps, to display surrounding existing land uses and comprehensive plan land uses. The land use analysis will use information from other relevant EIS sections, such as Acquisitions, Displacements, and Relocations; Ecosystems; Parks and Recreation Resources; Social Resources, Community Facilities, and Neighborhoods; Economics; and Visual and Aesthetics Resources.

A portion of the indirect and cumulative impacts analysis will focus on the potential for station area development and TOD. Information from station area planning efforts being completed concurrent with the preparation of the project EIS, as well as analysis from the Alternatives Development phase of the project, may also be included where relevant.

4 STUDY AREA AND AREA OF EFFECT

The land use study area for the EIS has a regional context but is primarily local, encompassing the jurisdictions within 0.5-mile from each of the alternatives. The area of effect for each alternative is 0.5-mile from the project footprint and area used for construction.

5 AFFECTED ENVIRONMENT

The affected environment discussion will describe existing land use patterns, adopted comprehensive plan designations, notable zoning designations, and other plans and policies relevant to a jurisdiction’s land use, as well as in-process plans or subarea plans within the study area. It will note regional urban centers and other locally designated activity centers connected by the proposed project. Local comprehensive plan land use designations can vary, so therefore, all land uses will be generalized into dominant land use categories to be presented consistently. General land use categories will be categorized to include:

- Single-family Residential: This designation is consistent for all jurisdictions.
- Multi-family Residential: This designation will include all other types of residential uses except single family and zones explicitly designated as mixed use.
- Commercial: This designation will include retail, commercial, and office uses. There is no distinction between neighborhood-type commercial and larger retail (“big box”).
- Institutional/Public: This designation will include categorized institutions (such as hospitals and community colleges) and public facilities, except parks and open space.
- Mixed Use: This designation will include areas specifically zoned Mixed Use.
- Parks and Open Space: This designation is consistent for all jurisdictions.
- Industrial: This designation will include light and heavy industry.
- Vacant Land: This designation shows vacant land and will include the respective comprehensive plan designation for the property.

- Tribal Land: This designation will include Tribal reservations, Tribal properties, and Tribal trust lands.
- Other: Additional atypical designations may be included where they do not fit into the above categories, such as farmland.

To accompany the discussion of land use plans, existing land use patterns will be summarized based on a property inventory from county assessor records, review of recent aerial photographs, and field reconnaissance. Recent and future land use trends will also be briefly described, including noting areas where local land use plans call for development patterns notably different from existing land uses. Information provided by respective jurisdictions will describe pending major public and private development activities proximate to stations.

The affected environment discussion will also describe the adopted plans, policies, and development regulations that will be evaluated for consistency with the project. This will include acknowledging plans under consideration by local jurisdictions. This information will be briefly summarized for the major plans and policies. Plans that have not been adopted or those that are speculative in nature may be reviewed and noted in the affected environment, where appropriate, but will not be assessed in the impact section.

6 ENVIRONMENTAL IMPACT ANALYSIS

The impact analysis will assess the potential direct, indirect, and cumulative land use impacts of the Build and No Build Alternatives. The impacts analysis is divided into long-term operation impacts and short-term construction impacts. The analysis will also summarize the consistency of the No Build and Build Alternatives with state, regional, and local plans and policies.

The discussion of land use impacts will reference information provided in the Acquisitions, Displacements, and Relocations section regarding the potential conversion of land to a transportation use and will be closely coordinated with other EIS sections focused on the built environment such as Transportation; Economics; Visual and Aesthetic Resources; Social Resources, Community Facilities, and Neighborhoods; Noise and Vibration; and Public Services, Safety, and Security.

Joint development (a public transportation project that integrally relates to, and often collocates with commercial, residential, mixed-use, or other non-transit or transit development) will also be evaluated where included as part of the project. The level of analysis, and whether it is a direct or indirect impact, depends on the definition of the Build Alternatives including the specific circumstances of the joint development and information available at the time the EIS is prepared (see also FTA Circular C7050.1A). There may also be circumstances where a Draft EIS may consider joint development as a potential option, and by the Final EIS, a more detailed proposal or concept for joint development may emerge as part of the Preferred Alternative.

6.1 Direct Impacts

Direct impacts include the effects of acquisitions and the conversions of property for the project. The change in land use to a transportation use will be presented in acres for each Build Alternative and discussed qualitatively. The direct impacts analysis will qualitatively consider the scale of land use conversion in terms of the effect on existing land use patterns and consistency with land use plans, within the context of the overall jurisdiction and identified comprehensive plan areas. The direct impacts analysis will consider the land use effects of project construction and the physical and operational characteristics of the alternatives. The analysis will consider proximity impacts of improved mobility, changes in parking, and other changes in transportation conditions such as congestion or circulation. It will also consider factors such as visual, noise, and vibration impacts, to the extent that they would directly alter land use by impairing or preventing its primary function or a critical attribute.

The methods for assessing consistency with adopted plans, policies, and regulations are provided in a separate section below.

6.2 Indirect Impacts

Indirect impacts are potential effects that would be caused at a later time or a farther distance but are still reasonably foreseeable. Indirect impacts are potential changes in land use for reasons related to the project but not part of it, and that may occur separately or at another point in time. For a transit project, the most reasonably foreseeable source of change would be the potential development and/or redevelopment of land in the vicinity of stations. High-capacity transit has the potential to support higher density or mixed-use developments, including high-density residential, commercial, and office-related uses. The analysis will also address the later redevelopment of surplus properties, which may occur near stations and other areas near the project (such as construction staging areas).

The discussion of indirect impacts will reference station area planning efforts being conducted concurrent with the preparation of the Draft EIS. TOD potential in the station area will be addressed qualitatively. Station area planning efforts may also help define potential TOD or joint development opportunities; findings from these efforts will be included in the Final EIS or as an appendix to the Draft EIS.

Sound Transit is committed to affordable housing outcomes as outlined in the 2018 board-adopted Equitable Transit Oriented Development Policy (R2018-10). This is an element of Sound Transit’s policies on surplus property and will be assessed as potential TOD opportunities become better defined.

Potential indirect impacts on industrial land uses from siting of stations and OMFs as well as changes to transportation access, including roadway, rail, and water, will also be considered and will reference the Economics analysis.

6.3 Cumulative Impacts

The cumulative effects analysis will consider impacts on land use from other past, present, and reasonably foreseeable future actions, including other transportation or infrastructure projects and other land use actions or developments in the study area. Cumulative effects to land use in the study area could result from the following types of changes that may occur with or without the project:

- Reduced or increased traffic congestion, pedestrian or bicycle activity, transit use, or parking,
- A more urbanized character in the area,

- Increased likelihood of redevelopment for underdeveloped properties, or
- Increased demands for municipal public services and facilities.

7 LAND USE CONSISTENCY WITH ADOPTED PLANS, POLICIES, AND DEVELOPMENT REGULATIONS

This section provides information about the methods for assessing the project's consistency with existing land use plans and policies. The project's land use compatibility and consistency with existing land use plans and policies will be evaluated and compared to the plans listed in Section 2: Guiding Regulations, Plans, and Policies, focusing primarily on plans and policies that are directly related to the project and the area of potential effect. Compatibility will also be assessed against zoning codes referenced under the Relevant Resources for All Studies section. Details of the consistency evaluation will be presented in the Land Use technical report. The analysis will also discuss the status of regional transit projects as Essential Public Facilities, consistent with the definition of such facilities under the Growth Management Act. Where appropriate, the analysis will conclude with recommendations that could improve alternatives that would be inconsistent with regional and local plans, goals, and policies, which could include alternative refinements and further coordination with the local jurisdictions.

8 MITIGATION MEASURES

Potential impacts to land use will be controlled through project planning, design, and the application of required best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the alternatives will be incorporated as appropriate. Where impacts cannot be avoided or minimized, mitigation measures will be developed.

After considering mitigation measures presented in other chapters such as Transportation; Acquisitions, Displacements, and Relocations; Economics; Visual and Aesthetic Resources; and Noise and Vibration, the analysis will identify measures that could mitigate direct, indirect, or cumulative long-term or construction period land use impacts associated with the project.

9 PROPOSED FIGURES, MAPS, OR OTHER DATA

Tables:

- Potential land use conversion to transportation-related land use
- Tables of generalized comprehensive plan land use by type within the area of effect and at the jurisdictional level

Figures:

- Generalized comprehensive plan land use designations covering areas within the study area
- Maps of existing land uses

- Maps of future land uses

10 DOCUMENTATION

For this resource, the following documentation will be developed:

- A technical report
- An EIS section

11 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

The land use analysis will use GIS maps to display the existing land uses, zoning, and comprehensive plan designations of the study area, as drawn from the agencies with jurisdiction. This information will also support and use shared data sources with other analyses in the EIS such as Economics; Noise and Vibration; Social Resources, Community facilities, and Neighborhoods; Historic and Archaeological Resources; Parks and Recreational Resources; and Environmental Justice.

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Everett Link Extension

Noise and Vibration Technical Analysis Methodology

October 2023

SOUNDTRANSIT

1 INTRODUCTION

This technical analysis methodology memorandum describes the methods that will be used to analyze the impacts of project-generated noise and vibration for the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS). The Noise and Vibration technical report and EIS section will address how the project affects noise- and vibration-sensitive land uses and will present measures to avoid, minimize, or mitigate potential impacts related to construction and operation of the completed project.

Noise and vibration analysis is generally performed in four steps: define the existing conditions, predict future noise and ground-borne vibration levels that will be generated by the project, identify impacts based on the appropriate criteria, and identify noise and vibration mitigation measures where required and considered reasonable and feasible according to Sound Transit and Federal Transit Administration (FTA) policy and state and local codes, where applicable.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

In addition to the relevant regulations considered for all environmental analyses, the following will also be considered:

2.1 Federal

- FTA Transit Noise and Vibration Impact Assessment Manual (FTA Manual) (2018)
- Title 23 of the Code of Federal Regulations (CFR) Part 772, Procedures for Abatement of Highway Traffic Noise and Construction Noise

2.2 State

- Washington State Department of Transportation (WSDOT) *Traffic Noise Policy and Procedures* (2020)
- Maximum Environmental Noise Level, Chapter 173-60, Washington Administrative Code (WAC)

2.3 Local

- Sound Transit Link Light Rail Noise and Vibration Policy (2023) *[pending final approval by the Sound Transit Board – anticipated in July 2023]*
- Everett Municipal Code Chapter 20.08, Noise Control
- Lynwood Municipal Code Chapter 10.12, Noise
- Snohomish County Code Chapter 10.01, Noise Control

The FTA criteria found in the FTA Manual will be the primary noise and vibration criteria by which transit-related impacts are identified. The FTA Manual provides performance standards or thresholds for project elements, including light rail operations and associated ancillary and support elements, such as park and ride lots and operations and maintenance facilities. The FTA criteria should be used to consider highway elements of a transit project if:

1. FTA is the lead agency

2. The main purpose of the project is transit-related and not highway-related, and alternatives considered do not include reconstructing or widening an existing highway, and

3. No federal-aid highway funds are used for the project.

Additional tools are used to predict other transportation noise sources, particularly for traffic noise. Projected traffic noise levels will be calculated using the Federal Highway Administration (FHWA) Traffic Noise Model (TNM), version 3.1. The FHWA traffic noise impact criteria defined in 23 CFR 772, Procedures for Abatement of Highway Traffic Noise and Construction Noise, and also identified in WSDOT *Traffic Noise Analysis and Abatement Policy and Procedures* will be used to evaluate traffic-related noise.

For locations where potential noise or vibration impacts have been identified, mitigation measures will be considered and reviewed using Sound Transit’s Link Light Rail Noise and Vibration Policy. State and local regulations applicable in the analysis of the project are typically applicable for noise generated by project construction, operations and maintenance facilities, park-and-rides, traction power sub-stations and other facilities.

3 DATA NEEDS AND SOURCES

- FHWA TNM, version 3.1 (2021)
- Plan and profile drawings of the right-of-way showing the alignment, special track work (switches), stations, park-and-rides, ancillary facilities, and roadway revisions
- Geographic information system (GIS) data for land uses adjacent to the corridor – based on public sources of information on property type, supplemented by field reviews
- Light rail operations plan, including factors such as operating hours, frequencies, and number of cars running at any given period
- Traffic volumes and speeds for new and modified roadways under existing conditions, for the Build Alternatives and the No Build Alternative, and for project-related changes in traffic patterns in the vicinity of the stations – to be provided by the traffic analysis
- Vehicle speed profile – to be provided by Sound Transit
- Force density level data for the vehicles – based on data for the existing Sound Transit light rail vehicles
- Soil vibration propagation characteristics – to be measured at test locations adjacent to the right-of-way

4 STUDY AREA AND AREA OF EFFECT

The general study area for the noise and vibration analysis is defined in the FTA Manual by source type. Section 4 of the manual contains the screening distances for noise sources, and Section 6 contains the screening distances for vibration sources. The actual study area will be based on the maximum distance from the alignments where the potential for noise or vibration impacts exist based on a review of the proposed operational schedule, land use, and existing noise levels.

Traffic noise will be evaluated in areas with new or substantially modified roadways, as defined by FHWA in 23 CFR Part 772, that result from the project. The study area includes noise-sensitive property in areas that could experience a project-related increase in traffic noise levels as defined by WSDOT. The final selection of the traffic study area will be based on noise modeling of future conditions.

5 AFFECTED ENVIRONMENT

The project corridor will be inspected for areas where noise and vibration-sensitive uses have the potential for noise and vibration impacts from project operation or construction, including residences, hospitals, and institutional uses such as schools, libraries, and churches. The FTA Manual identifies the land uses that are considered noise or vibration sensitive for this analysis. Details on the FTA land use type categories are provided in Section 6. Most identified sensitive land uses will be sensitive to both noise and vibration. The exceptions include outdoor parks, which may be noise sensitive, depending on usage, but are not vibration sensitive, and vibration-sensitive equipment (such as MRI), which are not sensitive to airborne noise.

Existing noise levels for potentially affected areas will include field monitoring as well as a review of other recent studies within the corridor. This effort involves reviewing existing data from previous studies, including other projects that Sound Transit, WSDOT, and others have developed in or near the corridor and where noise analyses were conducted. In addition, long-term (approximately 24-hour or longer) and short-term (60 minutes) noise monitoring will be performed at representative locations along the corridor to establish ambient (background) conditions. All noise measurement procedures will comply with the methods defined by FTA, FHWA, and the American National Standards Institute (ANSI) S1.13-1983. All noise measurement equipment will meet the standards for an ANSI Type 1 sound measurement device and be capable of providing complete statistical analysis of the measured data. Photographs will be taken of all microphone placements during measurement periods. Local site characteristics affecting the transmission of noise will also be identified.

The vibration monitoring program will consist of surface vibration propagation testing and short-term ambient vibration measurements at representative locations with a priority given to where vibration-sensitive properties are proximate to the Build Alternatives. Propagation testing measures how efficiently vibration travels through the earth and consists of dropping a heavy weight on to the ground surface and measuring the force imparted into the ground and the vibration response at sensors at several distances from the weight.

Because existing environmental vibration is usually below human perception, a limited ambient vibration survey is sufficient even for a Detailed Analysis. Ambient vibration measurements will be completed at vibration-sensitive buildings such as research laboratories and near existing rail lines. Additional limited ambient vibration measurements will be completed during vibration propagation testing to provide an existing baseline of vibration levels in the area.

6 ENVIRONMENTAL IMPACT ANALYSIS

The impact analysis will assess the potential direct, indirect, and cumulative noise and vibration impacts of the Build and No Build Alternatives. The impacts analysis is divided into long-term operation impacts and short-term construction impacts.

6.1 Direct Impacts

Noise and vibration impacts from the operation and construction of the Build Alternatives will be determined through noise and vibration modeling using the methods from FTA and FHWA.

6.1.1 Operations

6.1.1.1 Transit Noise

Existing measured noise levels will be used to predict the Ldn and peak-hour Leq for receivers used in the noise and vibration analysis. The Ldn is a 24-hour energy average noise level used in determining impacts where nighttime sensitive land use exists, such as residences, hotels and motels, and hospitals. The peak-hour Leq is used to determine noise impacts for institutional land use, such as schools, libraries, or churches. All noise levels will be A-weighted to account for the hearing response of humans and referred to as sound levels in decibels (dBA).

The criteria in the FTA Manual are founded on well-documented research on community reaction to noise and are based on changes in noise exposure using a sliding scale. The amount of change in the overall noise environment that the transit project is allowed to make is reduced with increasing levels of existing noise. The FTA noise impact criteria group noise-sensitive land uses into the following three categories:

- **Category 1:** Tracts of land where quiet is an essential element in their intended purposes. This category includes lands set aside for serenity and quiet, and such land uses as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use. Also included are recording studios and concert halls.

- **Category 2:** Residences and buildings where people normally sleep. This category includes residences, hospitals, and hotels where nighttime sensitivity is assumed to be of utmost importance.

- **Category 3:** Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, theaters, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Places for meditation or study associated with cemeteries, monuments, museums, campgrounds, and recreational facilities can also be considered to be in this category. Certain historical sites and parks are also included.

The Ldn is used to characterize noise exposure for residential areas (Category 2), and the peak

1-hour Leq is used to evaluate effects from other noise-sensitive land uses such as schools, libraries, and other noise-sensitive daytime uses (Categories 1 and 3) during project operation. There are no FTA impact criteria for commercial uses, such as offices, retail, or restaurants.

There are two levels of impact included in the FTA criteria. The interpretations of these two levels of impact are summarized below:

- **Severe:** Project-generated noise in this range is likely to cause a high level of community annoyance. Noise mitigation must be considered for severe impacts unless there are extenuating circumstances that prevent mitigation.

- **Moderate:** Project-generated noise in this range is considered to cause impact at the threshold of measurable annoyance. Mitigation should be considered at this level of impact based on project specifics and details concerning the affected properties.

The FTA noise impact criteria are shown in Figure 1. The figure shows the existing noise exposure and the project noise exposure that would result in either a moderate or severe impact. The future noise exposure, which is not shown in the exhibit, would be the combination of the existing noise exposure and the additional noise exposure caused by the light rail project.

Noise from light rail operations will be modeled using the methods described in the FTA Manual. Input to the model will include the following:

- Measured reference noise levels of 79 dBA at 50 feet and 40 miles per hour (mph) on ballast and tie track for the Link light rail vehicles (based on measurements made in 2017).

- Digital terrain in 5-foot-elevation contour intervals.

- Plan and profile of the light rail alternatives and design options, including the locations of special track work, such as crossovers, where wheel impacts make a clicking noise. Measured data from similar switches and crossovers in Sound Transit's system will be used, including measurements taken before noise-reducing modifications were provided, as needed.

- Station locations, park-and-rides, and location of any at-grade gated crossing where warning bells would be used.

- Proposed maximum speeds along each of the alternatives and design option routes.

- Adjustments based on track type, including ballast and tie, embedded, retained cut, retained fill, and elevated.

- Light rail operating plan, including the length and number of trains throughout the daytime, evening, and nighttime hours.

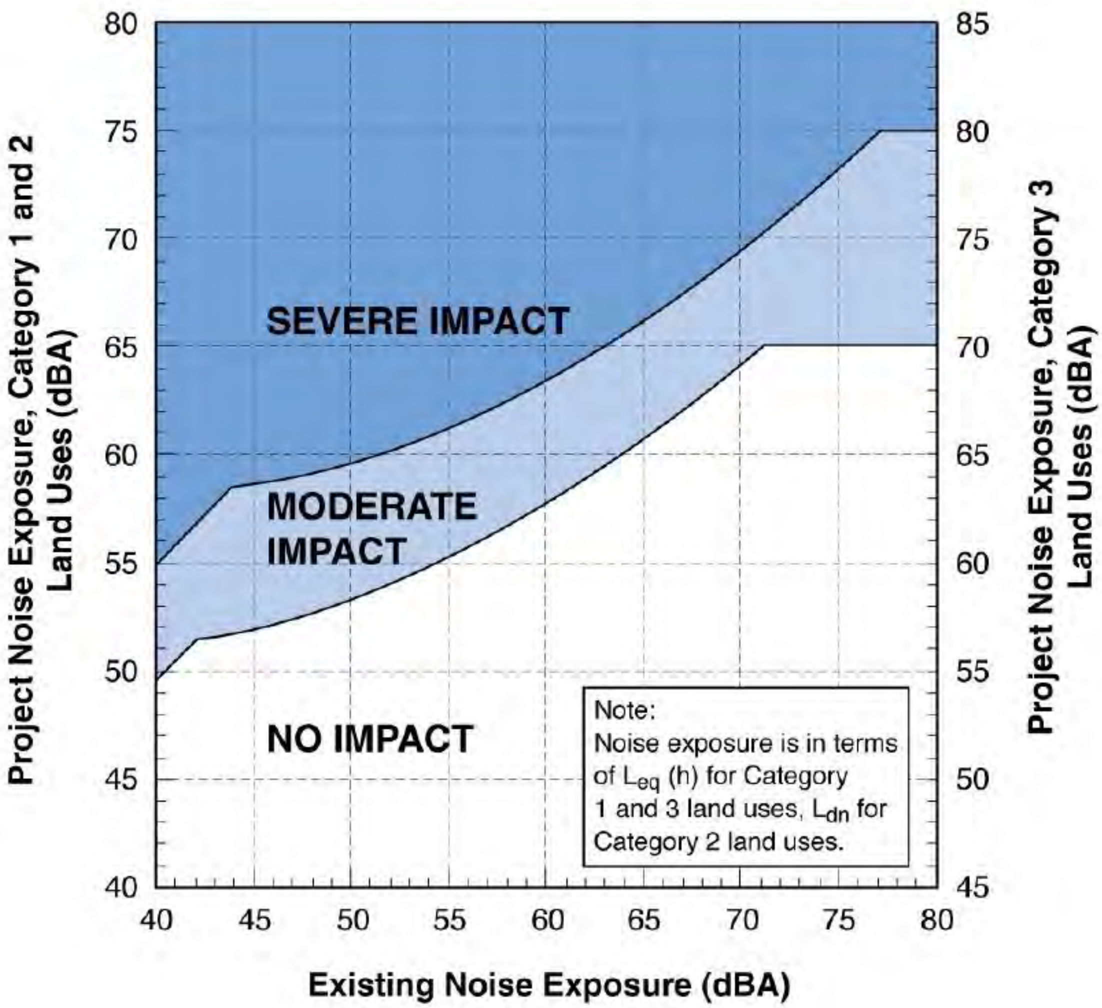

Figure 1 FTA Noise Impact Criteria

Wheel squeal is possible on curves with a radius of less than 600 to 1,000 feet depending on the speed and type of trackway. Wheel squeal is not included in the noise model because Sound Transit has committed to reducing any potential wheel squeal by installing wayside lubricators on all curves in noise-sensitive areas with a radius of less than 600 feet and preparing all curves for wayside lubricators that have a radius of between 600 to 1,000 feet.

For this analysis, attenuation for the noise-reducing effects of ground coverage will not be included and front-line receivers will be assumed to have a line-of-sight view of the light rail route unless the route is in a retained cut below grade, directly shielding the receptor from the tracks, resulting in a more conservative methodology. This method is consistent with the FTA Manual. The predicted project-generated noise exposure at each noise-sensitive site will be compared to the FTA noise impact criteria corresponding to the existing noise exposure and the current use of each site. This comparison will identify the locations where moderate and severe noise impacts will be caused by the project and where noise mitigation should be evaluated.

6.1.2 Traffic Noise

The traffic noise impact criteria against which the project traffic noise levels will be evaluated are taken from 23 CFR Part 772, Procedures for Abatement of Highway Traffic Noise and Construction Noise. The criterion applicable for residences, churches, schools, recreational uses, and similar areas is an exterior hourly equivalent sound level (Leq) that approaches or exceeds 67 dBA. The criterion applicable for other developed lands, such as commercial and industrial uses, is an exterior Leq that approaches or exceeds 72 dBA. FHWA states that a substantial increase in traffic noise levels can also result in a noise impact. Finally, FHWA allows the state departments of transportation to define the terms “approach” and “substantial increase” in their local regulations.

WSDOT is responsible for implementing the FHWA regulations in Washington state. Under WSDOT policy, a traffic noise impact occurs if projected noise levels approach within 1 dB of the FHWA criteria; therefore, a residential impact occurs at 66 dBA Leq and a commercial impact occurs at 71 dBA Leq. WSDOT also considers a 10-dB increase in noise a substantial increase impact, regardless of the existing noise level. A summary of the FHWA and WSDOT noise regulations is provided in Table 1.

Table 1 Noise Abatement Criteria (NAC) by Land Use Category

Activity Category	Activity Criteria in hourly Leq (dBA) FHWA NAC	Activity Criteria in hourly Leq (dBA) WSDOT NAC	Evaluation Location	Activity Description
A	57	56	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose
B[a]	67	66	Exterior	Residential (single- and multi-family units)
C[a]	67	66	Exterior	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or non-profit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails, and trail crossings
D	52	51	Interior	Auditoriums, day-care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or non-profit institutional structures, radio studios, recording studios, schools, and television studios
E[a]	72	71	Exterior	Hotels, motels, offices, restaurants/bars, and other developed lands, properties, or

Activity Category	Activity Criteria in hourly Leq (dBA) FHWA NAC	Activity Criteria in hourly Leq (dBA) WSDOT NAC	Evaluation Location	Activity Description
				activities not included in Activity Category A to D or F
F	--	--	--	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing
G	--	--	--	Undeveloped lands that are not permitted

[a] Includes undeveloped lands permitted for this activity category.

6.1.3 Vibration

The FTA vibration impact criteria are based on the maximum vibration level as a train passes. The FTA vibration thresholds do not specifically account for existing vibration because it is very rare that even substantial volumes of vehicular traffic including trucks and buses would generate perceptible ground vibration unless there are irregularities in the roadway surface such as potholes or wide expansion joints. For locations where there are existing trains or transit vehicles in the corridor, or portions of the corridor, the project will utilize the flowchart in Section 6 of the FTA Manual to determine the effect of the existing vibration on the impact assessment.

The FTA Manual provides two sets of criteria: one based on the overall vibration velocity level for use in a General Vibration Impact Assessment and one based on the maximum vibration level in any 1/3-octave band (the band maximum level) for use with a Detailed Vibration Assessment. This analysis will apply the Detailed Vibration Assessment criteria. The thresholds for use with the Detailed Vibration Assessments are shown in Figure 2. For the Detailed Assessment, the predicted vibration levels in terms of the 1/3 octave band spectra are compared to the curves shown in Figure 2 to determine whether there is impact and the frequency range over which vibration mitigation should be evaluated. Predicted impact occurs when any predicted spectral values exceed the applicable curve.

The FTA interpretation of the curves presented in Figure 2 is given in Table 2. The VC-A through VC-E curves are used to specify acceptable vibration limits for sensitive equipment such as electron microscopes. The “Residential (Day)” curve is applied to institutional land uses, such as churches and schools, and the “Residential (Night)” curve is applied to residential land uses.

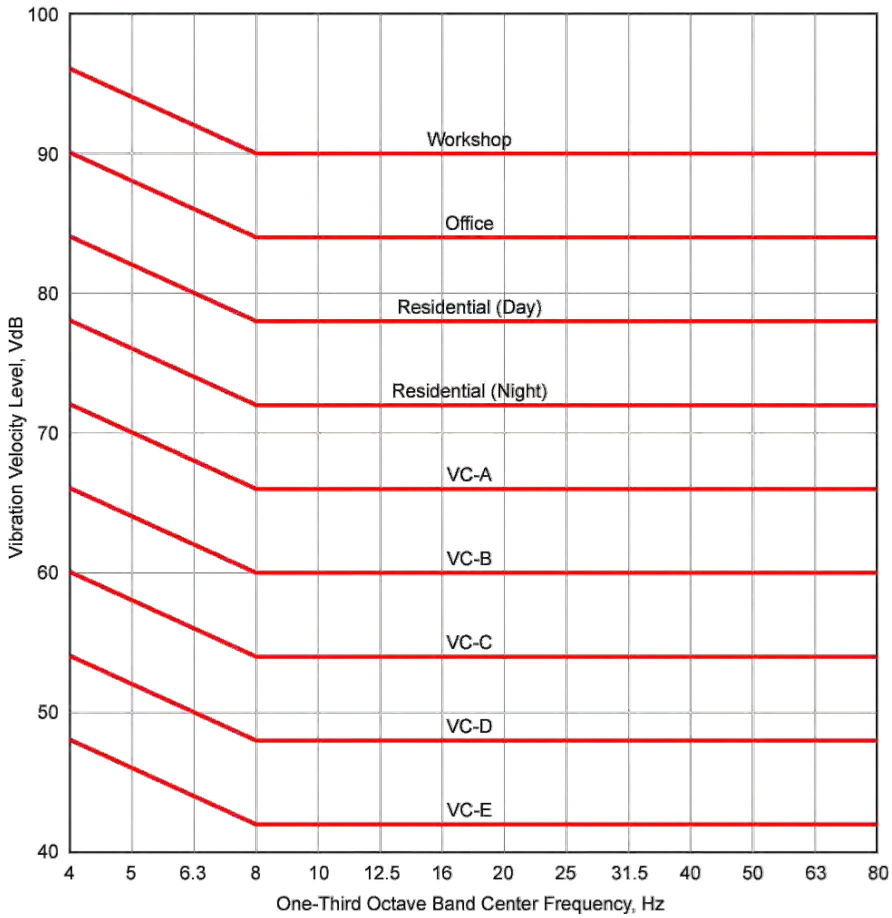

Figure 2 FTA Vibration Criteria for Detailed Assessment

Table 2 Vibration Criteria for Detailed Analysis

Criterion Curve	Maximum Lv (VdB)[a]	Description of Use
Workshop	90	Distinctly detectable vibration; appropriate to workshops and non-sensitive areas
Office	84	Detectable vibration; appropriate to offices and non-sensitive areas
Residential day	78	Barely detectable vibration; adequate for computer equipment and low-power optical microscopes (up to 20X)
Residential night, operating rooms/ sensitive hospital equipment	72	Vibration not detectable, but ground-borne noise might be audible inside quiet rooms; suitable for medium-power optical microscopes (100X) and other equipment of low sensitivity
VC-A	66	Adequate for medium- to high-power optical microscopes (400X), microbalances, optical balances, and similar specialized equipment

Criterion Curve	Maximum Lv (VdB)[a]	Description of Use
VC-B	60	Adequate for high-power optical microscopes (1,000X) and inspection and lithography equipment up to 3 micron-line widths
VC-C	54	Appropriate for most lithography and inspection equipment to 1 micron detail size
VC-D	48	Suitable in most instances for the most demanding equipment, including electron microscopes operating to the limits of their capability
VC-E	42	The most demanding criterion for extremely vibration-sensitive equipment

[a] As measured in one-third-octave bands of frequency over the frequency range of 8 to 80 Hz.

Some buildings, such as concert halls, recording studios, and theaters, can be particularly sensitive to vibration. Because of their sensitivity, these buildings usually warrant special attention during the impact assessment. Table 3 gives criteria for acceptable levels of ground-borne vibration and ground-borne noise for various types of special buildings.

Table 3 Ground-Borne Vibration and Noise Impact Criteria for Special Buildings

Type of Building or Room[a]	Ground-borne Vibration Impact Levels for Frequent Events[b] (VdB re 1 micro-inch/sec)	Ground-borne Noise Impact Levels for Frequent Events[b] (dB re 20 micro-Pascals)
Concert Halls	65 VdB	25 dBA
TV Studios	65 VdB	25 dBA
Recording Studios	65 VdB	25 dBA
Auditoriums	72 VdB	30 dBA
Theaters	72 VdB	35 dBA

[a] If the building will rarely be occupied when trains are operating, then there is no need to consider impact. As an example, consider locating a commuter rail line next to a concert hall; if no commuter trains will operate after 7 p.m., then trains would rarely interfere with the use of the hall.

[b] "Frequent Events" are defined as more than 70 vibration events per day; most transit projects fall into this category.

Table 4 presents the ground-borne noise impact criteria for three different land use types. Category 1 land uses are buildings where low ambient vibrations are essential for interior operations, such as laboratories. These spaces are generally not sensitive to ground-borne noise and therefore no ground-borne noise criteria is applicable to these spaces. Limits for spaces particularly sensitive to ground-borne noise are covered in Table 3.

Table 4 Ground-Borne Noise Impact Criteria for Frequent Events

Land Use Category	Ground-borne Noise Impact for Frequent Events[a] (d re 20 micro-Pascals)
Category 1: Buildings where low ambient vibration is essential for interior operations	N/A[b]
Category 2: Residences and buildings where people normally sleep	35 dBA
Category 3: Institutional land uses with primarily daytime use	40 dBA

[a] "Frequent Events" are defined as more than 70 vibration events of the same source per day; most rapid transit projects fall into this category.

[b] N/A = not applicable. Vibration-sensitive equipment is generally not sensitive to ground-borne noise.

6.2 Park-and-Rides, Maintenance Facilities, and Ancillary Facilities

Noise related to fixed facilities, such as operations and maintenance facilities, noise from transit operations within park-and-rides, and noise from other project-related ancillary facilities such as power stations, is evaluated using both the FTA criteria and the local noise control ordinance, as applicable. Applicable local noise ordinances include the WAC and the City of Everett, the City of Lynnwood, and Snohomish County noise ordinances. Most local jurisdictions have adopted the WAC noise regulations or have more stringent regulations. WAC noise regulations also apply when no local regulations exist. In addition, noise related to project construction will also be governed by the local jurisdictions or the WAC, depending on where the construction is taking place and which criteria are most stringent.

6.3 Washington State Noise Control Ordinance

The WAC noise regulations are taken from Chapter 173-60, WAC, Maximum Environmental Noise Levels, 2000 (WAC, 2000). This noise control ordinance provides three different Environmental Designations for Noise Abatement (EDNA) based on land use, which can be summarized as residential, commercial, and industrial for the purpose of this study. The ordinance is then written to define the maximum allowable noise level from one EDNA to another EDNA. For example, the noise caused by an industrial use, like the proposed project, must be less than 60 dBA at the closest residential property line, 65 dBA at the closest commercial use, and 70 dBA at the closest industrial use. Table 5 provides the property line noise standards provided in the WAC.

Table 5 Washington State Noise Control Regulation

Source of Noise	Maximum Allowable Sound Level (dBA[a]) Residential Receiver	Maximum Allowable Sound Level (dBA[a]) Commercial Receiver	Maximum Allowable Sound Level (dBA[a]) Industrial Receiver
Residential	55	57	60
Commercial	57	60	65
Industrial	60	65	70

[a] Between 10:00 p.m. and 7:00 a.m., the levels given above are reduced by 10 dBA for residential receiving property.

In addition to the property-line noise standards listed in Table 5, there are exemptions for short-term noise exceedance, including those outlined in Table 6, that are based on the minutes per hour that the noise limit is exceeded.

Table 6 Washington State Exemptions for Short-Term Noise Exceedances

Minutes Per Hour	Ln Value	Adjustment to Maximum Sound Level
15	L_{25}	+5 dBA
5	$L_{8.3}$	+10 dBA
1.5	$L_{1.5}$	+15 dBA

6.4 Everett Noise Control Ordinances

The Everett Municipal Code noise regulations are taken from Chapter 20.08, Noise Control. This noise control ordinance provides three different land use districts, defined by the receptor's land use zone in accordance with the Everett zoning code:

- District I – includes all residential zones
- District II – includes all business and commercially zoned districts
- District III – includes all agricultural and manufacturing zoned districts, all other nonresidential, nonbusiness, and noncommercially zoned districts

The ordinance defines maximum allowable exterior sound levels between properties based on the noise district of the source and receiving properties. For example, noise generated within District III must be less than 60 dBA at any District I property line, 65 dBA at District II, and 70 dBA at District III. Table 7 provides property line sound level limits defined in the Everett Noise Ordinance.

Table 7 Everett Municipal Code

District Sound Source	Receiving Property District I (dBA)	Receiving Property District II (dBA)	Receiving Property District III (dBA)
I	55	57	60
II	57	60	65
III	60	65	70

The Everett Noise Ordinance provides modifications to the exterior sound level limits outlined in Table 7, based on the time of day the source is active and quality of the sound generated:

- Between the hours of 10 p.m. and 7 a.m. during weekdays, and between 10 p.m. and 9 a.m. on weekends and legal holidays, the exterior sound level limits are reduced by 10 dBA where the receiving property lies within District I of the city of Everett.

- At any hour of the day or night, for any source of sound which is of short duration, the levels established are increased by:
  - 5 dBA for a total of 15 minutes in any one-hour period; or
  - 10 dBA for a total of 5 minutes in any one-hour period; or
  - 15 dBA for a total of 1.5 minutes in any one-hour period.

6.5 Lynnwood Noise Control Ordinances

The Lynnwood Municipal Code noise regulations are taken from Chapter 10.12, Noise. This noise control ordinance provides three different environmental designations for noise abatement (EDNA), defined by the receptor's land use:

- Class A EDNA – includes lands where human beings reside and sleep
- Class B EDNA – includes lands involving uses requiring protection against noise interference with speech
- Class C EDN – includes lands involving economic activities of such a nature that higher noise levels than experienced in other areas are normally to be anticipated

The ordinance defines maximum allowable exterior sound levels between properties based on the noise district of the source and receiving properties. For example, noise generated within Class C must be less than 60 dBA at any Class A property line, 65 dBA at Class B, and 70 dBA at Class C. Table 8 provides property line sound level limits defined in the Lynnwood Noise Ordinance.

Table 8 Lynnwood Municipal Code

EDNA of Noise Source	Receiving Property Class A (dBA)	Receiving Property Class B (dBA)	Receiving Property Class C (dBA)
Class A	55	57	60
Class B	57	60	65
Class C	60	65	70

The Lynnwood Noise Ordinance provides modifications to the exterior sound level limits outlined in Table 8, based on the time of day the source is active and quality of the sound generated:

- Between the hours of 10 p.m. and 7 a.m., the exterior sound level limits are reduced by 10 dBA where the receiving property lies within Class A EDNAs.
- At any hour of the day or night, for any source of sound which is of short duration, the levels established are increased by:
  - 5 dBA for a total of 15 minutes in any one-hour period; or
  - 10 dBA for a total of 5 minutes in any one-hour period; or

- o 15 dBA for a total of 1.5 minutes in any one-hour period.

6.6 Snohomish County Noise Control Ordinances

The Snohomish County Code noise regulations are taken from Chapter 10.01, Noise Control. This noise control ordinance provides four different land use districts, defined by the receptor's land use zone in accordance with the Snohomish County zoning code:

- Rural District – includes rural, agricultural and forestry land use zoned as RRT-10, R-5, RC, RU, SA-1, F, F & R, A-10, and RD
- Residential District – includes all residential land use zoned as R-20,000; R-12,5000; R-9,600; R-8,400; R-7,200; WFB; T; LDMR; and MR
- Commercial District – includes all commercial land use zoned as FS, NB, PCB, CB, RFS, RB, CRC, and GC
- Industrial District – includes all industrial land use zoned as BP, LI, HI, IP, MC, RI, and all parcels of land possessing a valid conditional use permit for mineral extraction

The ordinance defines maximum allowable exterior sound levels between properties based on the noise district of the source and receiving properties. Table 9 provides property line sound level limits defined in the Snohomish County Noise Ordinance.

Table 9 Snohomish County Code

District of Receiving Property	Receiving Property Rural Maximum Noise Level (dBA)	Receiving Property Residential Maximum Noise Level (dBA)	Receiving Property Commercial Maximum Noise Level (dBA)	Receiving Property Industrial Maximum Noise Level (dBA)
Rural	49	52	55	57
Residential	52	55	57	60
Commercial	55	57	60	65
Industrial	57	60	65	70

The Snohomish County Ordinance provides modifications to the exterior sound level limits outlined in Table 9, based on the time of day the source is active and quality of the sound generated:

- Between the hours of 10 p.m. and 7 a.m., the exterior sound level limits are reduced by 10 dBA where the receiving property lies within a rural or residential district.
- At any hour of the day or night, for any source of sound which is of short duration, the levels established are increased by:
  - o 5 dBA for a total of 15 minutes in any one-hour period; or
  - o 10 dBA for a total of 5 minutes in any one-hour period; or

- o 15 dBA for a total of 1.5 minutes in any one-hour period.
- For any source of sound which is periodic, has a pure tone component, or is impulsive, the maximum permissible sound levels are reduced by 5 dBA at night.

6.7 Construction

A general assessment of construction noise and vibration levels will be performed as described in Section 7, Noise and Vibration during Construction, of the FTA Manual. Note that Everett, Lynwood, and Snohomish County have general exemptions for construction during daytime hours of 7:00 a.m. to 10:00 p.m. Vibration will be evaluated using the FTA recommended limits for construction vibration.

The Build Alternatives and areas surrounding construction staging areas and stations will be investigated for noise- and vibration-sensitive land uses. Potential noise and vibration levels of commonly used construction equipment will be predicted and compared to local regulations, ordinances, and guidelines governing hours and levels of construction noise and vibration. The noise and vibration prediction methods will follow the general assessment methods for construction analysis given in the FTA Manual with noise metrics that can be used to compare with the WAC noise control ordinance. The potential noise and vibration impacts will be identified based on local regulations, ordinances, and FTA guidelines.

Existing noise and vibration levels will be characterized at potentially sensitive receivers, or at representative receivers along the alignment, to provide a point of comparison with the noise and vibration levels that may be experienced during construction.

6.7.1 Noise

Construction noise is exempt from the WAC noise limits, except at residential land uses during nighttime hours (10 p.m. to 7 a.m.). If construction is performed during nighttime hours, the contractor must still meet the WAC noise level requirements presented in Table 5 and Table 6 or obtain a noise variance from the governing jurisdiction.

Maximum permissible sound levels for haul trucks on public roadways are limited to 86 dBA for speeds of 35 mph or less, and 90 dBA for speeds over 35 mph when measured at 50 feet (Chapter 173-62, WAC).

Sounds created by backup alarms are exempt, except between 10 p.m. and 7 a.m. when “beep-beep” backup alarms are essentially prohibited by the WAC in urban areas and would be replaced with smart back-up alarms, which automatically adjust the alarm level based on the background level or switch off back-up alarms and replace with spotters. This criterion is included because, just like noise from construction activities, noise from backup beepers would exceed the WAC nighttime criteria, even with the allowable exceedance, at large distances from the construction site.

6.7.2 Vibration

Construction vibration will be analyzed for both potential damage to structures and annoyance. For potential vibration effects during construction, FTA’s recommendation on vibration levels is used because there are no state, county, or city vibration regulations.

The parameter normally used to assess potential construction vibration effects to structures is the peak particle velocity (PPV), which is the maximum velocity recorded during a particular event, such as from a jackhammer. FTA's recommended limits for construction vibration for four building categories are:

- Reinforced concrete, steel, or timber: 0.5 inches per second (in./sec) PPV
- Engineered concrete and masonry: 0.3 in./sec PPV
- Nonengineered timber and masonry buildings: 0.2 in./sec PPV
- Buildings extremely susceptible to vibration damage: 0.12 in./sec PPV

Annoyance from ground-borne noise and vibration is generally not an issue because of the short-term duration of most construction activities. However, potential annoyance or interference with sensitive activities from ground-borne noise and vibration due to construction will be evaluated generally applying the criteria for operations in Table 2, Table 3, and Table 4. Ground-borne noise and vibration from tunnel muck and support trains shall meet the FTA criteria for operations. The type of land use, nature of construction activities, time of day and period of exposure (short term vs. long term) for other construction ground-borne noise and vibration will also be considered in the impact analysis.

6.8 Indirect Impacts

Indirect impacts are potential effects that would be caused at a later time or a farther distance but are still reasonably foreseeable. Typical project sources for noise or vibration will be addressed through the direct long-term or construction impacts analysis, but the indirect impact assessment will qualitatively assess station area transit-oriented developments or street/transit system improvements that others may undertake in support of the light rail project.

6.9 Cumulative Impacts

For noise, the long-term impact analysis is already cumulative in nature because it considers the existing noise levels when determining the noise impact threshold for each receiver. This approach takes into account the noise from existing surrounding facilities, such as highways or local streets. The development of future projects, including future transportation facilities or services independent of the proposed light rail project, would have the potential to alter cumulative noise levels. As a result, the noise analysis will examine area trends as it relates to noise and other potential projects occurring in the vicinity of the proposed project to qualitatively evaluate the potential for cumulative long-term noise impacts.

Cumulative construction noise impacts could also occur if the light rail project and other construction projects occur at the same time. A qualitative analysis will address other projects that could result in cumulative construction noise impacts.

For vibration, if existing vibration levels are negligible, cumulative impacts are expected to be represented by the direct impact of light rail project operation. There are likely few opportunities for other projects or activities to result in cumulative vibration effects. However, the analysis will qualitatively discuss and evaluate the possibility of cumulative impacts.

7 MITIGATION MEASURES

Potential impacts to resources due to noise and vibration will be controlled through project planning, design, and the application of required best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the alternatives will be incorporated as appropriate. Where impacts cannot be avoided or minimized, mitigation measures will be developed.

The Link Light Rail Noise and Vibration Policy (Resolution No. R2023-15, anticipated to be adopted in July 2023) was designed to guide the assessment and mitigation, as appropriate, of noise and vibration impacts associated with construction and operation of Sound Transit light rail projects. Mitigation measures to address noise and vibration impacts from light rail construction and operations will follow Sound Transit mitigation policy. General specifications for each of the recommended operational mitigation measures will be presented and the resulting reduction in noise or vibration levels will be predicted. Mitigation measures at the source will be the preferred means of mitigation. After the implementation of source treatment measures, the use of path measures (between the source and receiver), such as noise walls, will be the preferred method of mitigating noise impacts. For locations where the construction of the proposed project results in modifications to highway features that are currently providing noise reduction for nearby communities (e.g., noise walls or earthen berms), an FHWA-type analysis will be conducted to determine potential impacts and analyze noise abatement, where appropriate. Receiver mitigation will be the final method implemented. Under the Link Light Rail Noise and Vibration Policy, mitigation measures will be considered for all noise or vibration impacts.

It is also important to note that during final design, all impacts and mitigation measures will be reviewed to verify predictions. If at that time it is discovered that mitigation can be achieved by a less costly means or that the noise impact would not occur even without mitigation, then the mitigation measure may be modified or eliminated.

Sound Transit has employed several operational measures to minimize noise and vibration levels. The analysis will list the measures that Sound Transit already practices as part of the project.

Some mitigation measures for vibration can affect the noise generated by the light rail vehicles operating on an at-grade track or aerial structure. Therefore, the recommendations for vibration mitigation will be coordinated with the noise analysis so that such effects can either be avoided or accounted for.

Mitigation measures for addressing potential noise and vibration impacts from project construction will also be described.

8 PROPOSED FIGURES, MAPS, OR OTHER DATA

The technical report and/or EIS section will include maps indicating the affected noise and vibration-sensitive receivers and the locations where recommended mitigation measures will be provided.

9 DOCUMENTATION

For this resource, the following documentation will be developed:

- A technical report, which will include tables and maps of noise and vibration-sensitive receivers identified by description, alignment, and civil station number. The tables will provide predicted noise and vibration levels from the project, indicate levels of impacts, recommend mitigation for each affected receiver, and show predicted noise and vibration levels after mitigation.
- An EIS section

10 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

Data gathered on noise and vibration will be used in the following analyses:

- Section 4(f) Evaluation
- Section 6(f) and Recreation and Conservation Office Evaluation
- Historic and Archaeological Resources
- Parks and Recreational Resources
- Environmental Justice
- Land Use
- Social Resources, Community Facilities, and Neighborhoods
- Ecosystems

11 REFERENCES

Federal Highway Administration (FHWA). 2022. Traffic Noise Model and Tools. https://www.fhwa.dot.gov/environment/noise/traffic_noise_model/.

Federal Transit Administration (FTA). 2018. *Transit Noise and Vibration Impact Assessment Manual* (FTA Manual). FTA Report No. 0123. Office of Planning and Environment. https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/research-innovation/118131/transit-noise-and-vibration-impact-assessment-manual-fta-report-no-0123_0.pdf.

Sound Transit. 2023. Link Light Rail Noise and Vibration Policy. Resolution No. R2023-15. *[pending final approval by the Sound Transit Board – anticipated in July 2023]*

Title 23 of the Code of Federal Regulations (CFR) Part 772, Procedures for Abatement of Highway Traffic Noise and Construction Noise. https://www.ecfr.gov/current/title-23/chapter-I/subchapter-H/part-772.

Washington State Department of Transportation (WSDOT). 2020. *Traffic Noise Policy and Procedures.* https://wsdot.wa.gov/sites/default/files/2021-10/ENV-ANE-NoisePolicy2020.pdf.

Everett Link Extension

Parks and Recreational Resources Technical Analysis Methodology

October 2023

SoundTransit

1 INTRODUCTION

This Parks and Recreational Resources Technical Analysis Methodology memorandum details the methods for completing the Parks and Recreational Resources element of the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS). For the purposes of this analysis, parks and recreational resources will be defined to include the following facilities:

- Federal, state, Snohomish County, City of Everett, and City of Lynnwood parks, playgrounds, recreation centers, and other public recreation facilities, such as golf courses and pools
- Designated public open spaces, greenbelts, and street open space corridors
- Pedestrian and bicycle trails

2 GUIDING REGULATIONS, PLANS, AND POLICIES

Regulations, plans, and policies that will be followed for this resource include the following:

- Section 4(f) of the U.S. Department of Transportation Act of 1966 (23 Code of Federal Regulations [CFR] 774)
- Federal Highway Administration Section 4(f) Policy Paper, 2012
- Section 6(f) of the 1965 Land and Water Conservation Fund Act (36 CFR 59)
- Washington State Recreation and Conservation Office (RCO) Grant Manual
- Federal Transit Administration (FTA) Standard Operating Procedures (SOP) No. 18: Section 4(f) Evaluations (August 2016)

Comprehensive plans, park plans, or equivalent planning policy/documents for local jurisdictions including:

- City of Everett Comprehensive Plan, Parks and Recreation Element (City of Everett, 2021)
- City of Everett Parks, Recreation and Open Space Plan (City of Everett, 2022)
- City of Lynnwood Comprehensive Plan, Parks, Recreation and Open Space Element (City of Lynnwood, 2021)
- City of Lynnwood Parks, Arts, Recreation and Conservation (PARC) Comprehensive Plan (City of Lynnwood, 2022)
- Snohomish County Comprehensive Plan, Park and Recreation Element (Snohomish County, 2021)

3 DATA NEEDS AND SOURCES

Data will be collected from the City of Everett, the City of Lynnwood, Snohomish County, Washington State Parks, RCO, and the National Park Service. The following information will be collected for each resource, as available:

- Name and owner
- Mapped boundaries
- Site acreages
- Amenities
- Physical layout of the facilities (location of specific uses and activities)
- Resource type and function
- Level of use of the facility
- Primary facility users
- Unique features, characteristics, or values of the facility
- Access to the site
- Funding sources for purchase of the site or development of the facilities
- GIS parks and recreation maps from local jurisdictions and from county assessor's data
- GIS trails mapping

In addition to this site-specific information, current park and trail plans will be collected and reviewed to identify plans for proposed new park development or existing facility expansions or improvements.

The initial data collection task will be supplemented by a site reconnaissance of each facility to field-confirm the data collected and to photograph relevant features, and follow-up discussions with City of Everett, City of Lynnwood, and Snohomish County Parks and Recreation staff to collect additional pertinent information.

The analysis will also use conceptual design and construction plans for the proposed alternatives necessary to define the project footprint, construction area, and possible proximity effects.

The project team will coordinate with other environmental impacts analyses conducted for the EIS. The Parks and Recreational Resources section in the EIS will include information from Acquisitions, Displacements and Relocations; Visual Resources; Noise and Vibration; Land Use; Transportation; Ecosystems; Section 4(f) Evaluation; and Section 6(f) and RCO Evaluation to develop the analysis of potential impacts.

4 STUDY AREA AND AREA OF EFFECT

The primary study area will include the areas within the ownership boundaries of existing and planned parks, trails, recreation sites, dedicated open space areas, and adjacent public rights-of-way used for access to these facilities within 250 feet (about one block) of the project footprint and area used for construction, 0.5 mile from each station, and 0.25 mile from the potential construction limits for the OMF sites. It is possible that parks and recreation resources outside of the study area may experience effects, and these factors would be considered in the Parks and Recreational Resources section based on the findings for other topic areas such as Transportation, Land Use, Noise and Vibration, Visual and Aesthetic Resources, or Ecosystems.

5 AFFECTED ENVIRONMENT

The Affected Environment section will summarize the inventory information, including mapping, limited narrative discussion of the resource, and tables describing the characteristics of each of the parks and recreation facilities identified in the study area. Proposed or planned parks or recreational facilities will be described if specific locations are identified in a jurisdiction's or agency's park or recreation plan, or if a specific property has been purchased for park or recreational development. Aspects of recreation areas that will be described include the nearest EVLE segment and station(s), the size of the site, recreational facilities and uses, location of recreational uses within the site, access locations for the site, and any unique characteristics of the site that enhance its use or experience as a recreational site. The Affected Environment discussion will also note funding sources for resources if they include restrictions on conversion such as Land and Water Conservation Fund (Section 6(f)) or RCO. Section 4(f), Section 6(f), and RCO considerations will be discussed in a separate section. Cross-references will be made as necessary to the Section 4(f) Evaluation and the Section 6(f) and RCO Evaluation sections.

6 ENVIRONMENTAL IMPACT ANALYSIS

The impact analysis will assess the potential direct, indirect, and cumulative parks and recreation impacts of the Build and No Build Alternatives. The impacts analysis is divided into long-term operation impacts and short-term construction impacts. The impacts analysis will evaluate all aspects of the project that will likely affect the use or enjoyment of existing and planned parks and recreation resources. Impact information will describe any impacts to parklands and may be presented in a table.

6.1 Direct Impacts

Direct impacts are primarily where the project footprint, construction, or operation impacts parks and recreation resources, including the resource's features, access, or functions. Direct impacts will be characterized by long term impacts, which include permanent changes to the resources resulting from the development of the light rail project or its operations, and temporary construction impacts.

Long term direct impacts would include any parks and recreation land permanently converted to project use and changes to the amenities, activities, and experiences for the resource, such as from changes in noise levels, visual conditions, parking, or access. Construction or temporary effects would include potential short-term effects to park or recreational properties, such as construction easements, construction staging areas, access, or other construction vicinity effects that may physically alter the resources or impact their functions.

6.2 Indirect Impacts

Indirect impacts are potential effects that would be caused at a later time or farther distance but are still reasonably foreseeable. Examples of such impacts include changes in surrounding land uses and resulting increases in noise, air pollution, or visual quality that could substantially diminish or affect the specific park or recreational facility, its access or character. Benefits to parks and recreational resources could also occur if the project would provide better access to these resources. The indirect impacts analysis will consider the indirect impact findings from other environmental topic areas of the EIS.

6.3 Cumulative Impacts

This analysis will review potential cumulative effects on parks and recreation resources resulting from other past, present, or reasonably foreseeable future actions that could impact the resources, either directly or indirectly. This could include other transportation projects or other planned developments or land use changes occurring in the area. The list of cumulative projects will be included as an appendix to the EIS.

6.4 Section 4(f) Evaluation

Section 4(f) will be discussed in a separate evaluation. The Parks and Recreational Resources section will cross-reference the Section 4(f) Evaluation section, briefly note any potential impacts, and include a brief summary of the evaluation.

6.5 Section 6(f) and RCO Evaluation

Section 6(f) and RCO impacts will be discussed in a separate Section 6(f) and RCO evaluation section. The Parks and Recreational Resources section will cross-reference the Section 6(f) and RCO section, briefly note any potential impacts, and include a brief summary of the evaluation. RCO impacts will be coordinated with the local jurisdiction and RCO's compliance specialist.

7 MITIGATION MEASURES

Potential impacts to parks and recreation resources will be controlled through project planning, design, and the application of required best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the alternatives will be incorporated as appropriate. Where impacts cannot be avoided or minimized, mitigation measures will be developed.

Potential mitigation measures will be developed in conjunction with the owner of the resource and could include replacement park or recreational property, replacement or new park or recreational facilities, financial compensation, or measures identified for resources in other EIS sections (e.g., Visual and Aesthetic Resources, Air Quality, Ecosystems, Noise and Vibration, and Transportation).

8 PROPOSED FIGURES, MAPS, OR OTHER DATA

The Parks and Recreational Resources analysis will include maps showing existing and planned park, open space, and recreational resources in the study area. The maps will also show the alternatives and will identify temporary and permanent impact areas.

9 DOCUMENTATION

For this resource, the following documentation will be developed:

- A technical report
- An EIS section

10 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

Data gathered on park features, funding, and description of park impacts will be used in the Section 4(f) Evaluation and Section 6(f) and RCO Evaluation sections. Information on potential park impacts will also be used to inform development of the Environmental Justice; Social Resources, Community Facilities, and Neighborhoods; Noise and Vibration; and Visual and Aesthetic Resources sections.

11 REFERENCES

City of Everett. 2021. *City of Everett Comprehensive Plan.* Amended 2021.

City of Everett. 2022. *Everett Parks, Recreation and Open Space Plan.* Adopted February 2022.

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Everett Link Extension

Public Services, Safety, and Security Technical Analysis Methodology

October 2023

SOUNDTRANSIT

1 INTRODUCTION

This technical analysis methodology memo briefly describes the methods that will be used to prepare the Public Services, Safety, and Security analysis for the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS).

The technical report and EIS section will identify and document potentially significant impacts of the Build and No Build Alternatives on public service facilities or service areas, including the potential to impact facilities, services, and response routes, the ability of service providers to deliver services, and the ability of the public to reach them. Public services include law enforcement, fire and emergency services, solid waste, schools, hospitals, public works, and other public service facilities or service providers.

The analysis will also include a discussion of safety and security, including safety issues, design measures to increase safety and prevent crime, and Sound Transit's security procedures for light rail, including at stations and parking facilities, on board light rail trains, or related to emergencies involving the system.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

Regulations, plans, and policies that will be followed for this resource include applicable national, state, and local codes, as well as Sound Transit's Agency Safety and Security Management Plan.

3 DATA NEEDS AND SOURCES

Agencies, groups, and individuals will be contacted for information on project area public services as well as recent crime statistics as available. Sources of information include the following:

- City of Everett fire and police department, City of Lynnwood police department, South Snohomish County Fire & Rescue, Snohomish Regional Fire & Rescue, Washington State Patrol, and the Snohomish County Sheriff's Office
- Municipal and Tribal planning and/or neighborhood departments, and housing and human services departments
- Snohomish County Solid Waste Division and Public Works, City of Everett and City of Lynnwood public works, and representatives of commercial and residential solid waste haulers
- Representatives of study area hospitals and health care facilities
- Edmonds School District, Mukilteo School District, and Everett School District
- Snohomish County Health Department
- Project analysis for the transportation, acquisitions and relocations, energy, noise and vibration, social and community facilities, utilities, and land use disciplines

3.1 Mapping

Geographic information system (GIS) data layers using information compiled from study area jurisdictions will be used to map facilities that are within the study area. Facilities to be mapped include:

- Federal facilities and state and local court buildings
- School district properties and schools
- Private schools
- School district bus routes
- School district walking/biking routes
- Community colleges and universities
- Emergency operations centers
- Fire stations
- Hospital and medical center locations
- Primary police precincts and stations
- Sanitary landfill and transfer station locations
- Other government facilities such as post offices, detention centers, extreme heat cooling centers, and cold weather shelters

3.2 Use of Existing Documentation and Information

Existing documentation and information, including those listed below, will be used to help prepare the Public Services, Safety, and Security analysis. In a number of cases, data may only be available at the city or county boundaries or by service districts, rather than only within the project's study area. Anticipated documents to be reviewed include:

- Local comprehensive and neighborhood plans (in coordination with Land Use and Social Resources, Community Facilities, and Neighborhoods technical analysis efforts)
- Strategic plans, master plans, and capital facility plans for local public school districts, colleges and universities and other public educational facilities. This would include a listing of their facilities and adopted plans such as safe routes to schools.
- Hospital and health care facility master plans
- Other environmental documentation (e.g., EIS, Environmental Assessment [EA], and SEPA checklists) for recently proposed or completed projects along or near the Build Alternatives

- A summary of annual crime statistics according to the National Uniform Crime Reporting Program, by project segment and existing park-and-ride and transit centers, supplemented by crime statistics from local police precincts within the study area
- Emergency response times for emergency service providers, as available

3.3 Field Reconnaissance

After examining maps, collecting and reviewing existing data sources, and contacting local agencies and other individuals, the analysts will conduct field visits within the study area to identify and confirm public services facilities that might be affected temporarily during construction or permanently by the project. The list of potentially affected properties will be developed as part of the analysis of acquisitions and displacements.

4 STUDY AREA AND AREA OF EFFECT

The study area will be the area within 0.5 mile from the project footprint and area used for construction. The area of effect may vary depending on the type of public services involved and on other impacts but is typically within or immediately adjacent to the Build Alternatives' footprint.

5 AFFECTED ENVIRONMENT

The affected environment discussion will map and describe the public service providers, indicate the type of service for each provider, its approximate service areas, and the primary characteristics or activities performed within the study area.

6 ENVIRONMENTAL IMPACT ANALYSIS

The analysis will assess the potential direct, indirect, and cumulative public service impacts of the Build and No Build Alternatives. The impacts analysis is divided into long-term operation impacts and short-term construction impacts. Factors evaluated for public services, safety, and security include the following:

- Medical, police, and fire protection access and emergency response times
- Solid waste pick-up and disposal (e.g., substantially delaying or altering pick up or routes), especially during construction
- School bus and walk/bike routes
- Effects such as displacement or change in access to other government facilities such as postal service and detention centers
- Demand for public services

The analysis will also provide a qualitative assessment of safety and security trends. As applicable, the assessment will include potential safety and security concerns related to crime rates for the existing area and population, and the extent of serious crimes by type. Locations of facilities with unique security concerns, such as government buildings and large public gathering spaces, will be identified.

Other environmental conditions identified through parallel project technical analyses and reports (e.g., Utilities; Transportation; Air Quality; Energy; Social Resources, Community Facilities, and Neighborhoods; and Acquisitions, Displacements, and Relocations) will also be used to analyze potential impacts to public services.

6.1 Direct Impacts

The assessment of potential direct impacts during construction and operation will focus primarily on where the development of the project will alter properties or facilities related to the provision of public services, or where the project would alter safety conditions. This analysis would also:

- Identify locations where Build Alternatives would physically or functionally modify access to public facilities, such as schools and other community facilities, or routes used for the delivery of medical, fire, and police emergency services, solid waste pickup and disposal, and postal delivery.
- Assess safety and security issues and operating procedures during construction and operation for the light rail alternatives, which includes safety and security in the station areas, along the alignment, in and around park-and-ride facilities, and for passengers at the stations and on the trains.
- Identify whether there would be a notable change in demand for services as a result of the project.
- Examine areas where the EIS transportation analysis indicates the potential for substantial delay or congestion on major public service or emergency response routes because of increased traffic due to the project.

6.2 Indirect Impacts

Indirect impacts are potential effects that would be caused at a later time or farther distance from the project but are still reasonably foreseeable. The discussion of indirect impacts will be qualitative. For example, many of the areas where station alternatives are proposed already have local plans encouraging higher density mixed use development than currently exists. Local jurisdictions may choose to alter zoning or create opportunities for increased density within station areas, which would result in an increased need for public services.

6.3 Cumulative Impacts

Cumulative impacts to public services, safety, and security will be identified in qualitative form, based on a review of past, present, and reasonably foreseeable future actions, including other transportation or infrastructure projects, and other land use actions or developments in the study area. The analysis will review available transportation information to qualitatively assess if future actions, in combination with the project, have the potential to result in additional impacts to public services or public safety.

7 MITIGATION MEASURES

Potential impacts to public services, safety, and security will be controlled through project planning, design, and the application of required best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the alternatives will be incorporated as appropriate. Where impacts cannot be avoided or minimized, mitigation measures will be developed.

After analyzing potential impacts, the Public Services analyst will work with the project team and service providers to identify measures to minimize or mitigate direct and indirect impacts on affected public services. Measures to minimize security issues will be described.

The EIS analysis will list these features included as part of the project, followed by a listing of any potential mitigation measures to address impacts that may not be addressed through existing best practices alone.

8 PROPOSED FIGURES, MAPS, OR OTHER DATA

Maps of the Build Alternatives with public facility locations will be included.

9 DOCUMENTATION

For this resource, the following documentation will be developed:

- A technical report
- An EIS section

10 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

Data gathered for public services that help low-income or minority populations, or serve a particular component of the community, may be used by the Social Resources, Community Facilities, and Neighborhoods or Environmental Justice sections.

11 REFERENCES

None.

Everett Link Extension

Section 4(f) Evaluation Technical Analysis Methodology

October 2023

Sound Transit

1 INTRODUCTION

This Section 4(f) Evaluation Technical Analysis Methodology memorandum describes the methods that will be used to prepare the Section 4(f) evaluation for the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS).

2 GUIDING REGULATIONS, PLANS, AND POLICIES

In addition to general National Environmental Policy Act (NEPA) regulations, guidelines, and policies applicable to all EIS topics, the Section 4(f) analysis will comply with the following requirements of 23 Code of Federal Regulations (CFR) Part 774.

The purpose of 23 CFR Part 774 is to implement 23 United States Code (U.S.C.) 138 and 49 U.S.C. 303, which were originally enacted as Section 4(f) of the Department of Transportation Act of 1966 and are still commonly referred to as “Section 4(f).” The regulation states that U.S. Department of Transportation (USDOT) agencies, including the Federal Transit Administration (FTA) and the Federal Highway Administration (FHWA), may not approve the use of:

> … a significant publicly-owned park, recreation area or wildlife and waterfowl refuge or any significant historic site, unless there is no feasible and prudent alternative to the use of land from the property and the action includes all possible planning to minimize harm to the property resulting from the use.

In accordance with 23 CFR 774.13, there are exceptions to this requirement for the following:

- Historic transportation facilities in certain circumstances
- Archeological sites that are on or eligible for the National Register of Historic Places (NRHP) when important chiefly because of what can be learned by data recovery
- Designations of Section 4(f) properties that are made, or determinations of significance that are changed, late in project development
- Temporary occupancies of land that are so minimal as to not constitute a use within the meaning of Section 4(f)
- Projects for the federal lands transportation facilities described in 23 USC 101(a)(8)
- Certain trails, paths, bikeways, and sidewalks
- Certain transportation enhancement activities, transportation alternatives projects, and mitigation activities

A Section 4(f) property must be open to the public and owned by a public entity, unless it is a historic property. Historic properties generally must be eligible for listing in the NRHP.

A use is generally defined as a transportation activity that permanently or temporarily acquires land from a Section 4(f) property, or that substantially impairs the important activities, features, or attributes that qualify the property as a Section 4(f) resource. The types of uses include:

- Permanent use – when a Section 4(f) property is acquired outright for a transportation project.
- Temporary occupancy – when there is temporary use of property that is adverse in terms of Section 4(f)'s preservationist purpose.
- Constructive use – when the proximity impacts of a transportation project on a Section 4(f) property, even without acquisition of the property, are so great that the activities, features, and attributes of the property are substantially impaired.

FHWA issued a “Section 4(f) Policy Paper” (July 2012) providing guidance on Section 4(f) that the FTA generally follows. In August 2016, FTA’s Office of Environmental Programs issued standard operating procedure (SOP) No. 18, Section 4(f) Evaluations, which provides guidance to clarify FTA roles and responsibilities, recommends timing of Section 4(f) processes in conjunction with NEPA, and improves understanding of the Section 4(f) process. The SOP outlines a series of steps in the Section 4(f) process, acknowledging that there may be circumstances where a step-wise procedure is not followed, in order to allow flexibility and efficiency in the process. The steps are as follows:

- Identify Section 4(f) properties in the vicinity of the project.
- Identify the official(s) with jurisdiction for the Section 4(f) properties.
- Determine whether there is a use of a Section 4(f) property.
- Determine whether the physical incorporation of Section 4(f) land into the transportation project qualifies as a *de minimis* impact.
- Determine whether a Section 4(f) exemption applies.
- Identify whether there are feasible and prudent avoidance alternatives to each use of a Section 4(f) property.
- If there are no feasible and prudent avoidance alternatives, (1) identify all possible planning to minimize harm and (2) conduct a least overall harm analysis.
- Review by U.S. Department of the Interior (USDOI) and/or any federal agency with an encumbrance. USDOI agencies with an interest include National Park Service (NPS) (for parks and National Historic Landmarks) and U.S. Fish and Wildlife Service (USFWS) (for wildlife refuges).
- Legal sufficiency review.
- Approval of Section 4(f) analysis.

3 DATA NEEDS AND SOURCES

The Section 4(f) evaluation will coordinate with the findings of the Section 106 process (which identifies NRHP-eligible historic properties and assesses project effects to them), and data gathered during the Parks and Recreational Resources analysis. The evaluation of Section 4(f) resources requires coordination with the official with jurisdiction[1] over the property to discuss the significance of the property and probable effects. If the official determines that a site is not significant for purposes of Section 4(f), Sound Transit will request written documentation to that effect from the official, and the documentation will be included in the Section 4(f) evaluation. Sites that are not significant are not Section 4(f) properties. For sites that are significant, further analysis to determine whether there will be a Section 4(f) use will be completed.

The Section 106 process, including its related documentation, coordination, and agreements, will be used to support the Section 4(f) evaluation of potential uses of historic resources, including historic buildings, archaeological sites, or traditional cultural properties. Findings of effect through the Section 106 process will also inform findings regarding the type of use that could occur. This includes coordination with the State Historic Preservation Officer (SHPO) at the Washington State Department of Archaeology and Historic Preservation (DAHP), as well as Tribal governments, the federal Advisory Council on Historic Preservation (ACHP), and other parties who may choose to participate in the Section 106 process, such as local historic preservation officers.

Public agencies (including schools) can also own or operate Section 4(f) properties. Correspondence will be solicited from these agencies and summarized in the Section 4(f) evaluation and provided in an appendix.

Agencies that may be contacted or require coordination for the parks, recreation, and wildlife/nature refuges element of the Section 4(f) evaluation include:

- Federal agencies
    - USDOI
        - USFWS
        - NPS
    - National Oceanic and Atmospheric Administration (NOAA) Fisheries
    - ACHP
- Affected Tribes
- State agencies
    - Washington State Parks and Recreation Commission
    - DAHP
    - Washington Department of Fish and Wildlife (WDFW)

[1] The officials with jurisdiction for historic sites are the State Historic Preservation Officer (SHPO) or, if the property is located on Tribal land, the Tribal Historic Preservation Officer (THPO). The Advisory Council on Historic Preservation (ACHP) can also be involved in consultation; the officials with jurisdiction for public parks, recreation areas, and wildlife and waterfowl refuges are the officials of the agency or agencies that own or administer the property.

- Washington Department of Natural Resources (DNR)
- Washington Recreation and Conservation Office (RCO)
- Washington State Department of Social and Health Services (DSHS)

- Local jurisdictions and agencies
  - Snohomish County
  - City of Everett
  - City of Lynnwood
  - Edmonds School District
  - Mukilteo School District
  - Everett Public Schools

4 STUDY AREA AND AREA OF EFFECT

The study area for the Section 4(f) evaluation includes both:

- The Area of Potential Effects for cultural and archaeological resources established by the Section 106 process; and
- The direct impact study area that is used for the Parks and Recreational Resources analysis (250 feet around alternatives, construction staging areas, and ancillary facilities).

5 IMPACTS ON SECTION 4(F) RESOURCES

The analysis will assess the potential Section 4(f) uses of the Build and No Build Alternatives. Under Section 4(f), a use can be permanent, temporary, or constructive.

Permanent use would acquire or incorporate all or part of a Section 4(f) property as part of the transportation facility.

Temporary use occurs, according to Section 4(f), when the project temporarily occupies any portion of the resource (typically during construction), and it substantially impairs the resource. FTA can allow a Section 4(f) exception under the following conditions:

- Duration must be temporary, i.e., less than the time needed for construction of the project, and there should be no change in ownership of the land;
- Scope of the work must be minor, i.e., both the nature and the magnitude of the changes to the Section 4(f) property are minimal;

- There are no anticipated permanent adverse physical impacts, nor will there be interference with the protected activities, features, or attributes of the property, on either a temporary or permanent basis;
- The land being used must be fully restored, i.e., the property must be returned to a condition which is at least as good as that which existed prior to the project; and
- There must be documented agreement of the official(s) with jurisdiction over the Section 4(f) resource regarding the above conditions (23 CFR 774.13).

Constructive, or indirect, use can occur when the project is near the Section 4(f) resource and has effects that substantially impair the protected activities, features, or attributes of a property. For example, a park property that is primarily a scenic viewpoint could have a constructive use if a transportation project blocks views from the park.

Direct and temporary use impacts will be based primarily on the findings of the Parks and Recreational Resources and Historic and Archaeological Resources elements of the EIS. Constructive use will be based on the findings of a number of relevant elements of the EIS, including the following:

- Acquisitions, Displacements, and Relocations
- Land Use
- Noise and Vibration
- Air Quality
- Transportation
- Visual and Aesthetic Resource
- Parks and Recreational Resources
- Historic and Archaeological Resources

If applicable, the net benefit to Section 4(f) resources will be considered where improved access and/or fulfilling local recreational development plans or enhancing the historical context of the resources outweigh the relative impacts of the project.

5.1 De minimis Section 4(f) Impact

FTA can approve a *de minimis* impact of a Section 4(f) property if, after considering any measures to minimize harm, it results in either:

- A Section 106 finding of no adverse effect or no historic properties affected on a historic property, or
- A determination that the project would not adversely affect the activities, features, or attributes qualifying a park, recreation area, or refuge for protection under Section 4(f).

A *de minimis* impact finding takes into account any mitigation or enhancement measures that would be implemented, including design measures to avoid or reduce impacts.

For public parks or recreation properties, a *de minimis* impact finding requires written concurrence from the agency with jurisdiction over the property, such as a city or county parks department. There must also be an opportunity for public notice and comment. For historic and archaeological sites, a *de minimis* impact finding requires FTA to determine that there will be “no adverse effect” to an NRHP-eligible property during the Section 106 process. Before making a *de minimis* finding on a historic or archaeological site, FTA must send a written notice to the SHPO. If the SHPO concurs or does not object, FTA may proceed with a *de minimis* finding. The Section 106 process includes public review and consultation with Tribes and other interested parties.

5.2 Procedures and Documentation for Potential Use of a Section 4(f) Resource

When a project’s Section 4(f) impact would be greater than *de minimis*, FTA must consider whether there are feasible and prudent alternatives that would avoid the impact. As defined in the Section 4(f) regulation, an alternative is feasible if it can be built as a matter of sound engineering judgment. An alternative is prudent if:

- It meets the project purpose and need and does not compromise the project to a degree that makes it unreasonable to proceed in light of its stated purpose and need;
- It does not cause extraordinary operational or safety problems;
- It causes no other unique problems or severe economic or environmental impacts;
- It would not cause extraordinary community disruption;
- It does not have construction costs of an extraordinary magnitude; and
- There are no other factors that collectively have adverse impacts that present unique problems or reach extraordinary magnitudes.

These findings, and the supporting coordination and analyses considering the relative importance of the Section 4(f) resources, must be included in a Section 4(f) evaluation. The evaluation identifies all properties with a use, as well as all properties where FTA is considering the application of exceptions such as for temporary uses or for archaeological resources that do not require protection in place, or for findings of *de minimis* impacts. The evaluation and its accompanying documentation must also demonstrate that the agency has consulted with other agencies with jurisdiction over the affected resources. The Section 4(f) regulations require that these findings and the record of coordination be presented first in a Draft Section 4(f) Evaluation (to be published with the Draft EIS), which is provided to the NPS, other agencies, and the public for comment. After considering the comments, FTA can issue a Final Section 4(f) Evaluation, which will be published with the Final EIS.

If FTA is considering a temporary use exception, an exception for certain kinds of archaeological sites, or a *de minimis* finding, a review of feasible and prudent avoidance alternatives is not required. Each of these other procedures for meeting Section 4(f) requirements can incorporate impact avoidance, minimization, and mitigation or enhancement measures. A *de minimis* finding and a temporary use exception both require agreement in writing from agencies with jurisdiction over the resource, and other exceptions typically require consultations and either agreement in writing or a lack of objection.

5.3 Least Overall Harm Analysis

Section 4(f) requires that if no feasible or prudent alternative to avoid use of Section 4(f) resources is found, then the action must include all possible planning to minimize harm to the property as defined in 23 CFR 774.17, and the Administration may approve only the alternative that causes the least overall harm [23 CFR 774.3(c)(1)].

Measures to minimize harm will be based on the impact's nature, location, and severity. Measures could include replacement of land or facilities, monetary compensation, improved access, screening (such as walls or landscaping) to improve noise attenuation and visual quality, mitigation measures implemented in accordance with the historic resource consultation process under 36 CFR Part 800, or special construction techniques to reduce noise, dust, or vibration. In evaluating the reasonableness of these measures, the views of the officials with jurisdiction, cost of the measures in light of the adverse impacts and benefits of the measures, and benefits of the measures to communities or environmental resources outside of the Section 4(f) resource will be considered.

There are seven factors to consider when determining which alternative would cause the least overall harm [23 CFR 774.3(c)(1)], including:

1. Ability to mitigate adverse impacts to each Section 4(f) resource (including any measures that would result in benefits for the resource);
2. Relative severity of the remaining harm, after mitigation, to the protected activities, attributes, or features that qualify each Section 4(f) resource for protection;
3. Relative significance of each Section 4(f) resource;
4. Views of the officials with jurisdiction over each section 4(f) resource;
5. Degree to which each alternative meets the purpose and need for the project;
6. After reasonable mitigation, the magnitude of any adverse impacts on resources not protected by Section 4(f);
7. Substantial differences in cost among alternatives.

6 PROPOSED FIGURES, MAPS, OR OTHER DATA

The text will be supplemented by maps that show each resource and potential uses by the Build Alternatives.

7 DOCUMENTATION

The Draft Section 4(f) Evaluation will include descriptions of individual Section 4(f) resources, and the evaluation will be coordinated with information from the Section 106 process and the analysis of potential effects to park and recreational resources noted above. Descriptions will include information on type of resource, size, use(s), existing and proposed activities, access, unique or significant characteristics. Descriptions of historic properties will also include information on attributes that qualify the property for inclusion in the NRHP. References may be made to the Historic and Archaeological Resources and Parks and Recreational Resources elements of the EIS, as necessary. A summary of the Section 4(f) evaluation will be included in the EIS and the Section 4(f) & 6(f) Evaluation Report will be included as a technical report in the appendix.

A draft Section 4(f) Evaluation will be included with the Draft EIS. The evaluation will have attachments that include a chronology of coordination and consultation activities with agencies having jurisdiction over affected resources, as well as copies of correspondence from those agencies regarding attributes and significance of affected resources and agreement with the findings of the analysis and the appropriateness of the proposed mitigation measures.

A final Section 4(f) Evaluation focusing on the Preferred Alternative will be prepared and submitted to the appropriate agencies for the Final EIS.

8 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

The results of this analysis will be referenced in the Parks and Recreational Resources Technical Report and EIS summary section and the Historic and Archaeological Resources Technical Report and EIS summary section.

9 REFERENCES

Federal Highway Administration (FHWA). 2012. Section 4(f) Policy Paper. Fed. Reg. Vol. 77, No. 140. http://environment.fhwa.dot.gov/4f/4fpolicy.asp.

Federal Transit Administration (FTA). 2016. Environmental Standard Operating Procedures. SOP No. 18, Section 4(f) Evaluations. https://www.transit.dot.gov/regulations-and-guidance/environmental-programs/section-4f-evaluations.

Everett Link Extension

Section 6(f) and Recreation and Conservation Office Evaluation Technical Analysis Methodology

October 2023

SoundTransit

1 INTRODUCTION

This Section 6(f) and Recreation and Conservation Office (RCO) Evaluation Technical Analysis Methodology memorandum describes the methods that will be used to prepare the Section 6(f) evaluation for the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS).

2 GUIDING REGULATIONS, PLANS, AND POLICIES

In addition to general National Environmental Policy Act regulations, guidelines, and policies applicable to all EIS topics, the Section 6(f) and RCO Evaluation will comply with the requirements of Section 6(f) of the federal Land and Water Conservation Fund (LWCF) Act of 1965 (54 United States Code [USC] 200305 et seq.). Under this law, there may be recreational properties funded through federal and state funding sources that have special provisions for converting land purchased using the funds to non-recreational uses.

Section 6(f) requires that recreational properties acquired or developed with grant funds be replaced in the event of permanent, non-recreation uses of those properties. Replacement land must be of at least equivalent property and recreation value. The National Park Service (NPS) is the agency that approves any LWCF conversion. There are two types of LWCF conversions (36 Code of Federal Regulations [CFR] Part 59):

- Full Conversion – when the use of or access to an entire LWCF resource property would be changed from recreation to another use for longer than six months.
- Partial Conversion – when the use of a portion of an LWCF property would be changed from recreation to another use for longer than six months.

An evaluation is required for any proposed full or partial conversion of an LWCF property to a non-recreation use. The Washington State RCO administers Section 6(f) on behalf of NPS and provides guidance.[1] Ultimately, the NPS conducts the final review and approval, taking into account recommendations from the RCO Board.

Grants directly from RCO state funding require similar treatments to Section 6(f) properties if they are impacted. As a result, any effects to RCO-funded resources will also be included as a separate discussion in the same subsection as the Section 6(f) evaluation.

The process for conversion of a resource that was funded by the RCO is similar to a Section 6(f) conversion, but the NPS is not involved. The major impacts to RCO resources are characterized as the following:

- Non-compliance: Conversion – where the property is converted to a use that is not part of the original agreement.
- Non-compliance: Element Change – when there is a minor or major element change as a result of the project where at least one element of a project does not meet the original agreement.

[1] https://rco.wa.gov/wp-content/uploads/2019/07/Manual7.pdf

Similar to the procedures for Section 6(f) compliance, documentation and consultation is required for RCO to approve the conversion or element change.

3 DATA NEEDS AND SOURCES

In Washington state, administration of the LWCF program and grants is conducted by the RCO on behalf of NPS. RCO's GIS-based PRISM database will be searched to determine if there are lands in the project vicinity that were purchased or developed using LWCF or RCO funds and that may be protected under Section 6(f) or RCO requirements. Projects and properties shown in the PRISM database do not always have easily identified geographic boundaries or clear funding sources. Therefore, if this search of the public database is inconclusive, coordination directly with the regional RCO staff is required to clarify what specific properties may be considered protected under Section 6(f) or RCO.

4 STUDY AREA AND AREA OF EFFECT

The study area for the Section 6(f) and RCO evaluation includes the direct impact study area used for the Parks and Recreational Resources analysis (250 feet around alternatives, construction staging areas, and ancillary facilities).

5 IMPACTS ON SECTION 6(F) AND RCO RESOURCES

The analysis will assess the potential Section 6(f) and RCO uses of the Build and No Build Alternatives.

5.1 Section 6(f) and RCO Impacts

Impacts to Section 6(f) properties and RCO grant recipient lands are considered direct uses when land is acquired permanently or is temporarily used for more than 180 consecutive days. Coordination with the local jurisdiction (RCO project sponsor) and RCO's compliance specialist would occur during the consultation and review of potential impacts. Under the LWCF regulations (36 CFR Part 59), conversion of parkland may be approved only if NPS finds that the following criteria have been met:

1. All practical alternatives to the proposed conversion have been evaluated;

2. The fair market value of the park property to be converted has been established, and the property proposed for substitution is of at least equal fair market value, as established by an approved appraisal in accordance with the Uniform Appraisal Standards for Federal Land Acquisitions, excluding the value of structures or facilities that will not serve recreational purposes;

3. The proposed replacement property is of reasonably equivalent usefulness and location as the converted property;

4. The property proposed for substitution meets the eligibility requirements for LWCF-assisted acquisition;

5. For properties that are proposed to be partially rather than wholly converted, the impact of the converted portion on the remainder must be considered, and the unconverted area must remain recreationally viable or be replaced as well;
6. All necessary coordination with other federal agencies has been satisfactorily accomplished;
7. The guidelines for environmental evaluation have been satisfactorily completed and considered by the NPS during its review of the conversion proposal; and
8. The proposed conversion is in accordance with the applicable Statewide Comprehensive Outdoor Recreation Plan and/or equivalent recreational plans.

For RCO-funded properties, nearly identical procedures are to be followed, but RCO approval is required rather than the NPS.

5.2 Procedures and Documentation for Potential Use of a Section 6(f) or RCO Resource

The process for converting an LWCF property (36 CFR Part 59) to a non-recreation use is described below.

1. **Determine if a LWCF resource is present in or near the project area.** The NPS and officials with jurisdiction, including Snohomish County and the Cities of Lynnwood and Everett, keep records of all properties that have received LWCF grants.
2. **Determine the boundary area submitted in the original LWCF application.** The boundary area can be a small area within the park, the whole park, a trail, or an area that traverses through the park. The boundary is determined based on what area is considered to be park property at the time of the final LWCF payment.
3. **Evaluate avoidance and minimization measures.** All practical alternatives that would avoid the LWCF conversion need to be evaluated and then rejected only if there is a sound basis for doing so. In addition, efforts to minimize the LWCF conversion should be evaluated and documented.
4. **Coordinate with the NPS and officials with jurisdiction to identify potential replacement property.** The replacement property must be of at least equal fair market value as the original property, as determined by a state-approved appraisal that follows the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970. The property must also have reasonably equivalent usefulness and location as the property being converted, but it does not need to be adjacent.
5. **Send NPS a formal request for regulatory approval to convert an LWCF property to a use other than a public outdoor recreation use.** The request will identify the LWCF property, summarize the alternatives analysis, describe the commitment to mitigation, and demonstrate support from the officials with jurisdiction.

6. **Acquire the land being converted and the replacement property.**[2] The properties will be acquired utilizing the Sound Transit right of way process. The replacement property should be deeded to the land manager and added to the properties subject to LWCF requirements.

7. **Close out the LWCF conversion process.** Before project completion, a formal LWCF conversion proposal must be submitted to the NPS for final approval. This step closes the process.

RCO-funded properties would have two levels of documentation depending on whether the impact is an element change or conversion. An element change requires a shorter document that describes the change and provides justification that includes alternatives that have been evaluated. The documentation should also include any replacement properties or remediation. The RCO project sponsor must acquire the replacement property in compliance with RCO policies and in compliance with Washington Administrative Code Sections 286-13-160, 286-13-170, and 286-13-180 for state-funded areas that are converted. Impacts to RCO-funded properties would also include public input, which is not required for Section 6(f).

6 PROPOSED FIGURES, MAPS, OR OTHER DATA

The text will be supplemented by maps that show each resource and potential uses by the Build Alternatives.

7 DOCUMENTATION

The Draft Section 6(f) and RCO Evaluation will include descriptions of individual Section 6(f) and RCO resources, and the evaluation will be coordinated with the analysis of potential effects to park and recreational resources noted above. Descriptions will include information on type of resource, size, use(s), existing and proposed activities, access, and unique or significant characteristics. References may be made to the Parks and Recreational Resources element of the EIS, as necessary. A summary of the Section 6(f) and RCO Evaluation will be included in the EIS and the Section 4(f) & 6(f) Evaluation Report will be included as a technical report in the appendix.

A final Section 6(f) and RCO Evaluation focusing on the Preferred Alternative will be prepared and submitted to the appropriate agencies for the Final EIS. The evaluation will have attachments that include a chronology of coordination and consultation activities with agencies having jurisdiction over affected resources, as well as copies of correspondence from those agencies regarding attributes and significance of affected resources and agreement with the findings of the analysis and the appropriateness of the proposed mitigation measures.

[2] The project proponent can acquire the land being converted and replacement property with written permission from NPS.

8 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

The results of this analysis will be referenced in the Parks and Recreational Resources EIS section and in the Parks and Recreational Resources Technical Report.

Everett Link Extension

Social Resources, Community Facilities, and Neighborhoods Technical Analysis Methodology

October 2023

SoundTransit

1 INTRODUCTION

This technical analysis memorandum describes the methods that will be used to analyze impacts to social resources, including community facilities and neighborhoods, for the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS). The Social Resources, Community Facilities, and Neighborhoods analysis will address how the project will affect people and their quality of life as a result of the proposed project. The analysis also will present measures to avoid, minimize, or mitigate potential impacts.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

The following is a list of regulations and guidance for the assessment of social resources, community facilities, and neighborhood effects:

2.1 Federal

- Title VI of the Civil Rights Act of 1964
- Americans with Disabilities Act of 1990
- 49 Code of Federal Regulations (CFR) 21, Nondiscrimination in Federally Assisted Programs of the Department of Transportation, Effectuation of Title VI of the Civil Rights Act of 1964
- Presidential Executive Order 13166, Improving Access to Services for Persons with Limited English Proficiency (EO 13166), August 11, 2000
- Presidential EO 13045, Protection of Children from Environmental Health Risks and Safety Risks (EO 13045), April 23, 1997
- Federal Highway Administration (FHWA), Community Impact Assessment: A Quick Reference for Transportation, Publication No. FHWA-HEP-18-055 (2018)
- Federal Transit Administration (FTA), Circular FTA C 4702.1B, Title VI Requirements and Guidelines for Federal Transit Administration Recipients (October 1, 2012)

2.2 State

- Governor’s EO 93-07, Affirming Commitment to Diversity and Equity in the Service Delivery and in the Communities of the State

2.3 Local

- Sound Transit’s Real Property Acquisitions and Relocation Policy, Procedures, and Guidelines (Revision 4, November 2017), adopted to guide compliance with Chapter 8.26 Revised Code of Washington and Chapter 468-100 Washington Administrative Code
- Sound Transit’s Equity and Inclusion Policy (December 2019)

3 DATA NEEDS AND SOURCES

Local jurisdictions, agencies, groups, and individuals will be contacted primarily through the public involvement team, for information on the study area neighborhoods, historic development, demographics, and community character and facilities. This information will serve to identify community values, needs, and key activity centers. This input will help identify solutions to avoid, minimize, and/or mitigate potential effects.

Existing documentation will be used to develop the discussion of the study area affected environment. Much of this information will be obtained from local, state, and federal agency web pages. The following is a list of the key data that will be analyzed for the Social Resources, Community Facilities, and Neighborhoods analysis:

- U.S. Census Bureau 2020 Census and American Community Survey 5-year estimate data on demographic characteristics within 0.5-mile of the Build Alternative alignments, stations, and operations and maintenance facility (OMF) sites. Demographic characteristics include census data on minority populations, age, household type, languages spoken at home, limited English proficiency, country of origin of persons born outside of the United States, disability, transit dependency, and vulnerable and low-income populations for census block groups within 0.5 mile of the Build Alternatives, as available. As needed, this information will be included in the Environmental Justice analysis.

- Federal tools to determine disadvantaged community status, such as the Climate & Economic Justice Screening Tool and Equitable Transportation Community Explorer (U.S. DOT, 2023).

- Information about existing and planned low-income housing projects within the study area. Public housing authorities providing services in the study area will be identified and contacted, as needed. Information on unsubsidized affordable housing and voucher holder data may be used if reliable data is available since these units are subject to change. Transitional housing provided by public and private social service organizations, such as shelters and transitional housing, also will be inventoried. This information will be included in the Environmental Justice analysis.

- Locations of community facilities within the study area boundaries will be collected and mapped, and neighborhood boundaries will be mapped based on boundaries verified by local jurisdiction staff and through public engagement activities. Community facilities for the project, including community, senior, and youth centers; food banks; sports venues; cultural institutions (e.g., libraries, museums, theaters, and landmarks); religious institutions (e.g., churches, temples, and mosques); cemeteries; medical services, stand-alone day care facilities; and government offices will be collected and mapped. Home day care facilities will not be included given that verification can be difficult for these types of facilities. This information will be obtained from local government web pages, other Internet sites, and through field reconnaissance, as appropriate. Social service providers and grocery stores (and other readily available locations of healthy food options such as farmers markets) within the area of effect will be identified. Park and recreation information, as well as schools and other public services information (such as hospitals and public safety) will be obtained from the authors of those respective sections of the EIS.

- Evidence of interaction between people in adjacent neighborhoods will be obtained from the public involvement and outreach team.

- Conceptual engineering drawings for the alternatives and options will be evaluated to determine if project operation would result in impacts such as division or bisection of a neighborhood.

Community outreach conducted for the EIS will also be a source of data for the analysis. Community outreach for the EIS is anticipated to include community briefings, door-to-door conversations, tabling events, listening sessions, social service provider interviews, and neighborhood forums, workshops, and open houses.

Applicable data from the Puget Sound Regional Council (PSRC) will also be accessed, such as the displacement risk tool (https://www.psrc.org/displacement-risk-mapping). Information will be obtained from the other technical analysts involved in the preparation of technical reports and text for the EIS, particularly Transportation; Land Use; Acquisitions, Displacements, and Relocations; Economics; Public Services, Safety, and Security; Utilities; Visual and Aesthetic Resources; Air Quality; Noise and Vibration; Ecosystems; Parks and Recreational Resources; Water Resources; Hazardous Materials; Historic and Archaeological Resources; and Environmental Justice. In recognition that some data needs for the Social Resources, Community Facilities, and Neighborhoods element will overlap with some other elements of the environment, it will be coordinated with these other analysts to avoid duplicative efforts and ensure consistency of data and results.

4 STUDY AREA AND AREA OF EFFECT

Consistent with Community Impact Assessment: A Quick Reference for Transportation (FHWA, 2018), the first step in the assessment of community impacts is definition of the study area. For the analysis of Social Resources, Community Facilities, and Neighborhood effects, a general study area around the alternatives will be evaluated. These areas of effect depend on the type of impact and are consistent with areas of effect used in the Environmental Justice analysis.

The study area will encompass all neighborhoods that fall within 0.5 mile from the project footprint and area used for construction for the Build Alternatives. While the area of effect is expected to be limited to a smaller geography, the 0.5-mile study area primarily reflects the distance residents and workers could easily walk to the proposed transit stations or the areas that would be affected by the construction and development of light rail and maintenance facilities.

5 AFFECTED ENVIRONMENT

The discussion of the affected environment will rely on both qualitative and quantitative analysis. Consistent with Community Impact Assessment: A Quick Reference for Transportation (FHWA, 2018), the focus of the discussion of the affected environment will be to present a community profile of the affected area. Identifying affected neighborhoods and determining boundaries of these affected neighborhoods is the first step. Information from the public involvement team will help to identify community interaction, linkages, and values.

The statistics used to describe the residents of adjacent neighborhoods will be largely quantitative, whereas information describing historic and current community land use character and community facilities will be largely qualitative. The discussion will focus on describing the residents and businesses and the qualities of all adjacent neighborhoods within the study area. For each, the neighborhood boundaries, general land use characteristics, and demographics will be described. Neighborhood cohesion will be evaluated in terms of transportation network and services, linkages to community facilities and activity centers, patronage of businesses and cultural institutions, interaction of people, and neighborhood uniqueness.

Much of the information used in this analysis will be collected for the Environmental Justice analysis or for other sections of the EIS. Text references to the appropriate technical report or EIS section will be included. The information will be summarized, and the reader will be encouraged to review the other sections of the EIS for more detailed information.

6 ENVIRONMENTAL IMPACT ANALYSIS

The impact analysis will assess the potential direct, indirect, and cumulative social resources, community facilities, and neighborhood impacts of the Build and No Build Alternatives. The impacts analysis is divided into long-term operation impacts and short-term construction impacts. The analysis will be consistent with the Community Impact Assessment: A Quick Reference for Transportation (FHWA, 2018). Both adverse and beneficial effects will be discussed. The EIS section will rely on tables for presenting information and will be supplemented with brief text description as appropriate. The approach to the analysis for each potential type of impact is described in the following sections.

Sound Transit has piloted a Racial Equity Toolkit (RET) to support Sound Transit's equity policy, which in turn will support Social Resources, Community Facilities, and Neighborhoods and Environmental Justice analysis for the project. Additional racial equity activities, including community workshops to establish and evaluate equity goals, will be conducted in parallel with the development of the EIS. The Social Resources, Community Facilities, and Neighborhoods section of the EIS will incorporate analysis from the RET and outcomes of these racial equity workshops and discuss potential benefits and/or burdens from operation and construction of the project within specific neighborhoods.

6.1 Direct Impacts

The assessment of potential direct impacts during construction and operation will examine changes in the neighborhood – its residents, businesses, parks, community resources/facilities, neighborhood cohesion, economy, land use and neighborhood character, transportation linkages, multi-modal access and mobility, drive-through traffic, visual changes, and interaction of people. The temporary construction effects discussion will focus on changes in neighborhood character, quality of life, and health and safety, as a result of temporary impacts to access, mobility, air quality, noise and vibration, and light and glare.

The discussion of long-term direct effects will be largely tied to neighborhood changes related to required right-of-way acquisition and the extent that this change would divide or bisect an existing neighborhood. The connection and access of the community to neighborhood resources/facilities and parks will also be discussed. Acquisitions and displacements could result in changes in the number or demographic character of residents, businesses, and the business district. Changes in multi-modal access and circulation, drive-through traffic, linkages to community facilities and services, transportation mobility and level of service for all modes, aesthetics, noise and vibration, and neighborhood quality of life and safety also will be discussed. Potential barriers, isolation, and enhancements to social interaction, including changes that would remove or alter social relationships and patterns or cultural institutions, will be analyzed. Quantifiable attributes (i.e., displacements and traffic/access changes) marking these changes will be presented in tabular format.

6.2 Indirect impacts

The analysis of potential indirect effects of social resources, community facilities, and neighborhoods will assess if the project could result in indirect impacts. Indirect impacts are potential effects that would be caused at a later time or farther distance but are still reasonably foreseeable. The project may have the potential to encourage redevelopment in station areas, which would be separate projects that would go through their own environmental review. Local comprehensive plan policies and zoning would guide the types of development that could occur in a given location through the redevelopment actions of others, but a major transportation infrastructure investment could affect such plans and zoning decisions over time. The project may encourage the completion of missing transportation links, such as bicycle facilities, sidewalks, or trails, which may not be a direct action of the project but could be implemented by others to support the project. These improvements could occur independently and have the potential to affect adjacent neighborhoods as an indirect effect of the project. The analysis of indirect effects due to transit-oriented development will be coordinated with the analysis of land use and economic conditions, and the analysis of future transportation or mobility projects linking to the light rail facility will be coordinated with the transportation analysis.

6.3 Cumulative Impacts

The cumulative effects analysis will include trends related to social resources, community facilities, and neighborhoods and reviewing available information about past, present, and future projects to determine the potential for cumulative effects. This includes other transportation or infrastructure projects or other planned or pending land use actions or developments in the study area, focusing on those that may occur with or without the project.

7 MITIGATION MEASURES

Potential social resources, community facilities, and neighborhood impacts will be addressed through project planning, design, and the application of required best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the alternatives will be incorporated as appropriate. Where impacts cannot be avoided or minimized, mitigation measures will be developed.

Applicable mitigation for neighborhood impacts, such as measures addressing traffic congestion and parking loss, noise and vibration, changes in land use, and visual or physical intrusion identified in other EIS sections will be referenced.

8 PROPOSED FIGURES, MAPS, OR OTHER DATA

Maps of the Build Alternatives and the boundaries of adjacent neighborhoods, transportation network and linkages, public housing, and community facilities within the study area will be included.

9 DOCUMENTATION

For this resource, the following documentation will be developed:

- A technical report
- An EIS section

10 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

Data gathered on social impacts will be used in the Environmental Justice analysis.

11 REFERENCES

Federal Highway Administration (FHWA). 2018. *Community Impact Assessment: A Quick Reference for Transportation*, Publication No. FHWA-HEP-18-055. 2018 Update.

Federal Transit Administration (FTA). 2012. Circular FTA C 4702.1B, *Title VI Requirements and Guidelines for Federal Transit Administration Recipients*. October 1, 2012.

Sound Transit and Washington State Department of Transportation (WSDOT). 2001. *Re-Alignment Issue Paper No. 36, Implementing Environmental Justice Pursuant to Executive Order 12898 and the Department of Transportation Order to Address Environmental Justice in Minority Populations and Low-Income Populations*. October 4, 2001.

U.S. Department of Transportation. 2023. Federal Tools to Determine Disadvantaged Community Status. https://www.transportation.gov/grants/dot-navigator/federal-tools-determine-disadvantaged-community-status.

Everett Link Extension

Transportation Technical Analysis Methodology

October 2023

SOUNDTRANSIT

1 INTRODUCTION

This technical analysis methodology memo for the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS) describes the methods that will be used to analyze project effects on local, corridor, and regional transportation system elements. The analysis results will be documented in the Transportation chapter of the EIS and the Transportation Technical Report.

The intent of the Transportation Technical Report is to inform the public about the potential transportation effects of the Build and No Build Alternatives (defined in the Introduction to the EIS Technical Analysis Methods Report), provide an appropriate level of analysis to make informed decisions, and identify areas in which mitigation might be necessary to reduce potential project impacts. With EVLE, the environmental analysis will proceed in parallel to a variety of other project development efforts, including but not limited to further refinement of the Build Alternatives, including conceptual construction plans, as part of concept design; refinement of the transit integration plans between the relevant transit agencies; and station area planning to integrate the project within the surrounding community. These efforts provide additional opportunities for collaboration between Sound Transit, partner agencies, and the community.

This transportation analysis will identify and evaluate the Build and No Build Alternatives potential impacts for the following transportation elements during both operations and construction:

- Regional transportation, including vehicle miles of travel, vehicle hours of travel, vehicle hours of delay, and mode share
- Transit services, including regional and local services, corridor and station ridership, and transit operations
- Arterial and local street system, including corridor analysis, intersection level of service (LOS), property access and local traffic circulation
- Parking, including the loss of parking due to the alignments and potential hide-and-ride parking impacts near stations
- Non-motorized facilities (bicycle and pedestrian) around stations and on major bicycle or pedestrian trails affected by the alignment(s)
- Safety (all modes)
- Aviation
- Freight (truck, rail, and water)

2 GUIDING REGULATIONS, PLANS, AND POLICIES

In addition to the relevant regulations, plans, and policies considered in all environmental analyses, the transportation analysis will be guided by the following laws and regulations:

- 23 Code of Federal Regulations (CFR) Part 450 (implementing 23 United States Code [USC] Section 111, which requires the U.S. Secretary of Transportation to approve access revisions to the Interstate System)
- 23 CFR Part 710 (Right-of-Way Regulations for Federally Assisted Transportation Programs)
- Revised Code of Washington (RCW) Chapter 47.06 (Statewide Transportation Planning) and 47.24 (City Streets as Part of State Highways)
- Snohomish County Code Chapter 30.66.B (Concurrency and Road Impact Mitigation)
- City of Everett Code Chapter 19.51 (Transportation Mitigation)
- City of Lynnwood Municipal Code Title 11 (Traffic)

Analysis of local transportation impacts will also be guided by the policy direction established in the numerous plans and policy documents adopted within the project corridor,[1] including the following:

- *2016 Washington State Public Transportation Plan* (Washington State Department of Transportation [WSDOT] 2016)
- *Washington State Freight System Plan* (WSDOT 2022b)
- *2022 Washington Statewide Human Services Transportation Plan* (WSDOT 2022c)
- *Regional Transportation Plan 2022-2050* (Puget Sound Regional Council [PSRC] 2022)
- *2023-2028 Transit Development Plan* (Community Transit 2023)
- *Long Range Transit Plan* (Community Transit 2011)
- *Everett Transit Long Range Plan* (Everett Transit 2018)
- *Transit Development Plan: 2022-2027* (Everett Transit 2022)
- *Connect Lynnwood: Active and Accessible Transportation Plan* (Lynnwood 2022)
- Comprehensive and/or transportation plans for the Cities of Lynnwood and Everett as well as Snohomish County
- Six-Year Capital Improvement Program for the Cities of Lynnwood and Everett as well as Snohomish County, including modal plans, such as the Everett Bicycle Master Plan
- WSDOT Synchro and SimTraffic Protocol
- WSDOT Traffic Analysis Guidebook

[1] Dates are for most recently adopted document. Any adopted updates will be used in the development of technical analysis.

- WSDOT Design Manual
- Level of service standards for the City of Lynnwood (Comprehensive Plan, Chapter 5), City of Everett (Comprehensive Plan, Chapter 5), Snohomish County (Comprehensive Plan, Transportation Element), and Washington State Highways (RCW 47.06.140(2))

3 DATA NEEDS AND SOURCES

A variety of data will be assembled to analyze the transportation-related effects of the Build and No Build Alternatives, including the following:

- Adopted PSRC Regional Land Use Forecast targets
- PSRC based regional travel demand model to calculate regional and project area traffic volume growth and other associated traffic metrics
- The Sound Transit Incremental Ridership Model to produce transit ridership forecasts
- City and county travel demand models, if applicable
- Existing transportation information from state and local jurisdictions such as WSDOT, Lynnwood, Everett, and Snohomish County, including:
    - Traffic counts
    - Physical roadway characteristics
    - Freight volumes and facilities existing and planned
    - Existing truck routes, over-dimension routes, and any truck restrictions
    - Pedestrian and bicycle volumes and existing and planned facilities
    - Crash data
    - Public parking information
- Existing transit route information in the study subareas from the local and regional transit agencies, and the Transit Integration Plan for future transit service prepared by Sound Transit and local transit providers
- Trip generation estimates from Link Light Rail Extension mode of access survey (2019) and/or Bay Area Rapid Transit (BART) Station Profile Study (BART 2015)
- Transportation facilities plans and other “committed” improvements assumed for the No Build Alternative, including:
    - WSDOT’s *Connecting Washington Package, Move Ahead Washington, and Washington State Highway System Plan* (WSDOT expected 2023)

- WSDOT's *Washington State Active Transportation Plan 2020 and Beyond* (WSDOT 2020)
- PSRC's *Regional Transportation Plan 2022-2050* (PSRC 2022)
- Sound Transit's ST2 and ST3 Programs (Sound Transit 2008, 2016)
- Regional capital and/or transportation improvement plans (CIPs/TIPs) for Snohomish County, City of Lynnwood, and City of Everett

Certain data sets may be analyzed at the corridor level or at a subarea level as detailed below.

4 STUDY AREA AND AREA OF EFFECT

4.1 Regional Transportation

Analysis of system-wide traffic impacts will address the Build and No Build Alternatives' regional effects within Sound Transit's district boundaries and the project-specific regional study subareas shown in Figure 4-1.

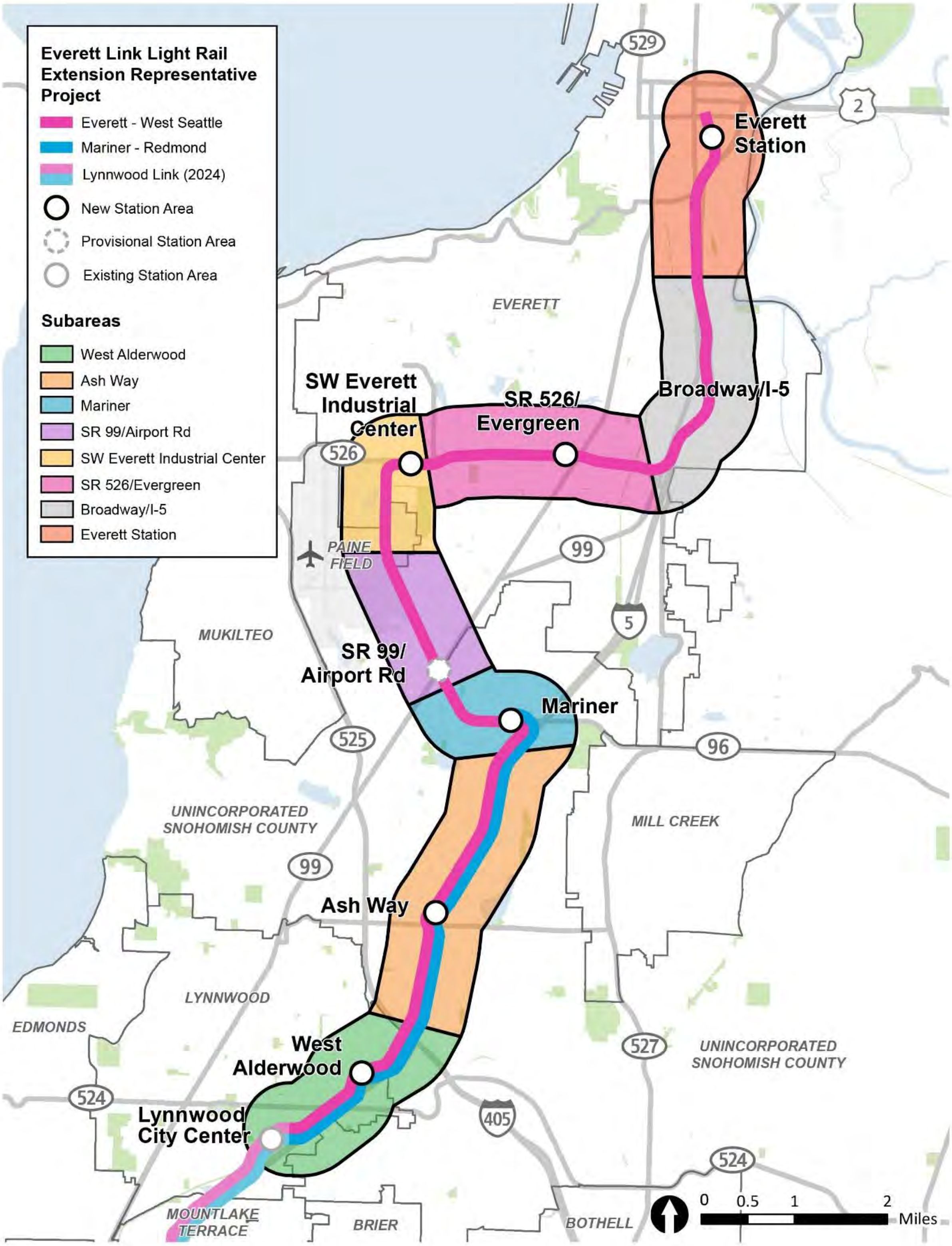


Figure 4-1 Study Area Subareas

4.2 Transit

The transit analysis study area for each subarea is generally the area within 0.5 miles of stations identified in the Build Alternatives. Transit connectivity with the Build Alternatives is addressed in the Transit Integration Technical Memorandum, included as Appendix A, developed by Sound Transit along with Community Transit and Everett Transit, and including Skagit Transit and Island Transit service. Pick-up/drop-off space for shuttle services to be provided by others at key station areas (e.g., SWI and MAR stations) will be defined, to the extent possible, and incorporated into the Transit Integration methodology and ridership forecasting efforts. For more broadly defined transit measures, the study subareas expand to the relevant regional transit system.

4.3 Arterials and Local Streets

The arterial and local street analysis study subareas will focus on locations affected by the light rail alternatives. The intersections that will be analyzed are those directly affected, such as by a change in channelization or intersection control, and those indirectly affected by changes in volume as a result of project trips accessing the system, including intersections and roadways surrounding transit stations and passenger pick-up and drop-off activity locations. Study intersections are listed in Table 4-1 through Table 4-8 and shown in Figure 4-2 through Figure 4-9. These study intersections were identified based on the alternatives in the Alternatives Development phase of the project as well as professional judgement. This list is preliminary based on expected direct and indirect impacts of the various alternatives identified by the Sound Transit Board to be studied in the EIS. AM and PM peak period level of service (LOS) analysis will be conducted at all study intersections. As needed, times outside of traditional weekday AM and PM peak periods will be added to the analysis based on identified local travel patterns. Final confirmation of intersections to be studied will be documented in the Transportation Technical Report and EIS chapter.

Figure 4-2 West Alderwood Station Subarea Intersections

Table 4-1 West Alderwood Station Subarea Intersections

ID	Intersection Location	Intersections to be Analyzed		
		ALD-B	ALD-D	ALD-F
100	Mall Access Rd/29th Ave	X		
101	Mall Access Rd/ALD-B Station Access	X		
102	Mall Access Rd/28th Ave	X		
103	Alderwood Mall Blvd/28th Ave	X		
104	188th St/33rd Ave		X	
105	33rd Ave/ALD-D Station transit access		X	
106	Mall Access Rd/188th St	X	X	
107	184th St/Mall Access Rd			X
108	184th St/33rd Ave			X
109	188th St SW/36th Ave W	X	X	
110	Alderwood Mall Blvd/33rd Ave W	X	X	
111	196th St SW/33rd Ave W/Poplar Way Bridge	X		X

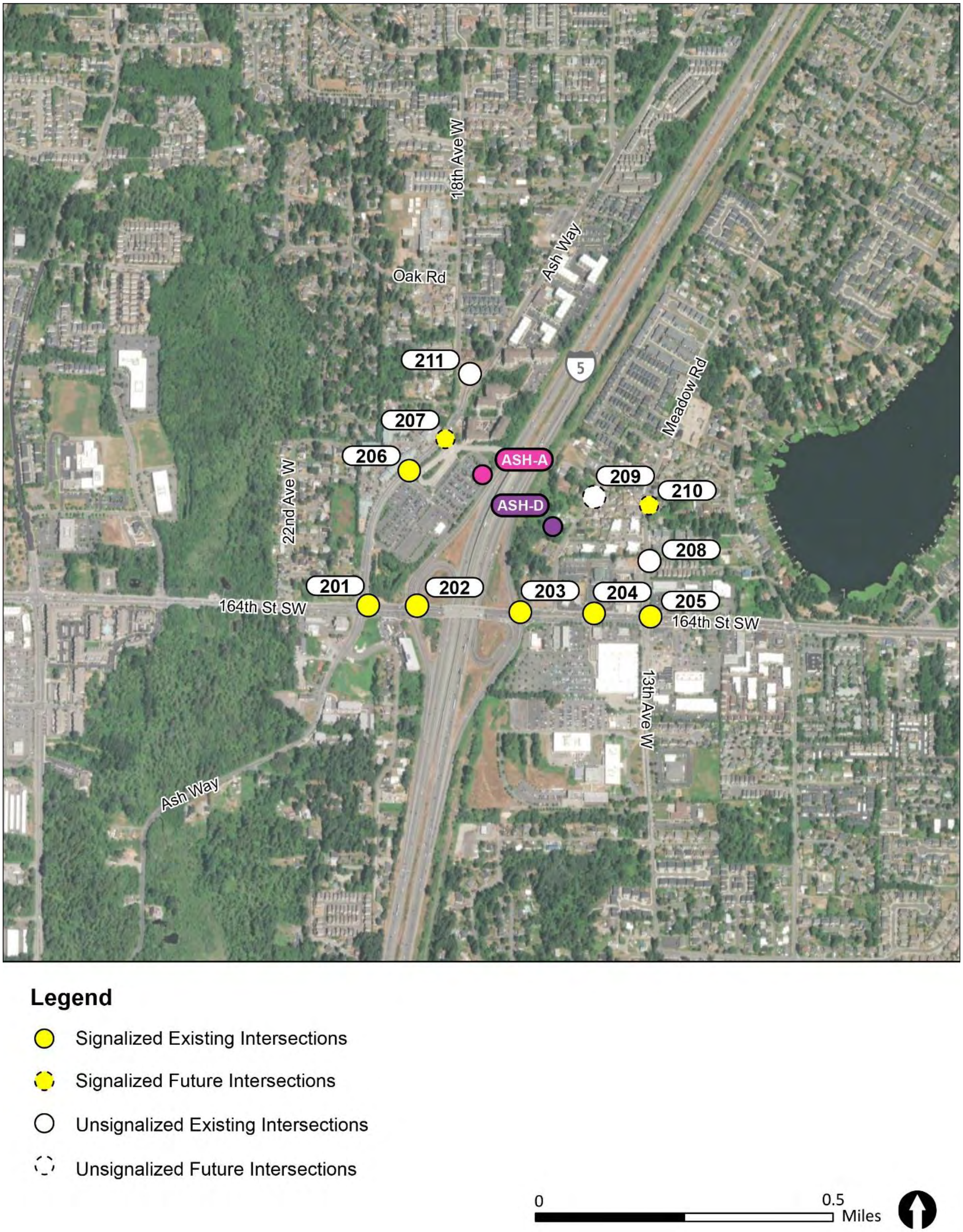


Figure 4-3 Ash Way Station Subarea Intersections

Table 4-2 Ash Way Station Subarea Intersections

ID	Intersection Location	Intersections to be Analyzed	
		ASH-A	ASH-D
201	Ash Way/164th St	X	
202	164th St/I-5 SB Ramps	X	X
203	164th St/I-5 NB Ramps	X	X
204	164th St/14th Pl		X
205	164th St/13th Ave/Meadow Rd		X
206	Ash Way/ASH-A Park & Ride Access	X	
207	Ash Way/ASH-A Transit Access	X	
208	Meadow Rd/ASH-D Transit Access		X
209	Motor Pl/Bridge over I-5	X	X
210	Meadow Road/161st St	X	X
211	Ash Way/18th Ave W	X	

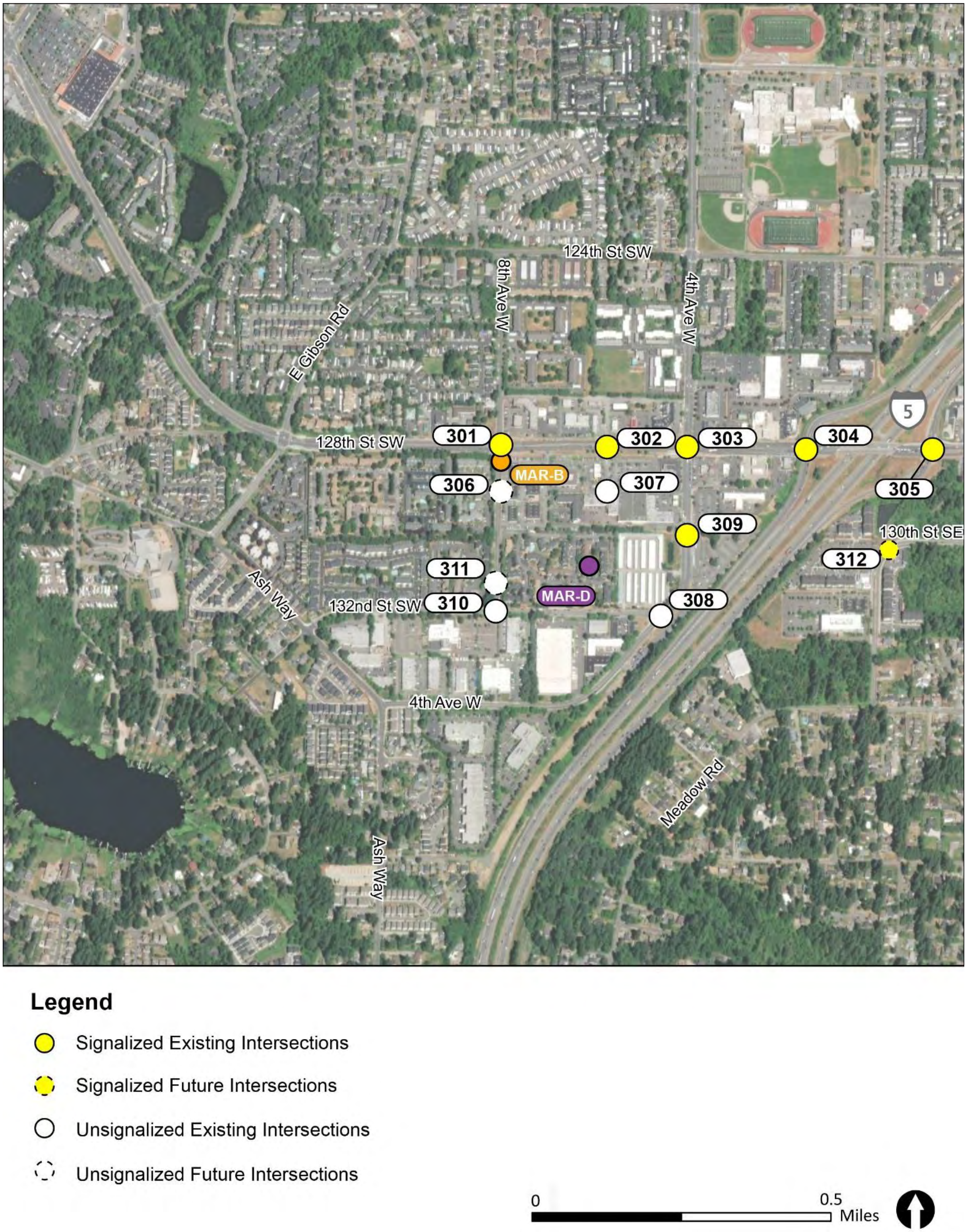


Figure 4-4 Mariner Station Subarea Intersections

Table 4-3 Mariner Station Subarea Intersections

ID	Intersection Location	Intersections to be Analyzed	
		MAR-B	MAR-D
301	128th St/8th Ave	X	
302	128th St/5th Pl	X	
303	128th St/4th Ave	X	X
304	128th St/I-5 SB Ramps	X	X
305	128th St/I-5 NB Ramps	X	X
306	8th Ave/MAR-B Transit Access	X	
307	5th Pl/MAR-B Transit Access	X	
308	132nd St/4th Ave		X
309	130th St/4th Ave		X
310	132nd St/8th Ave		X
311	5th Ave/MAR-D Station parking lot access		X
312	130th St/Meridian Ave		X

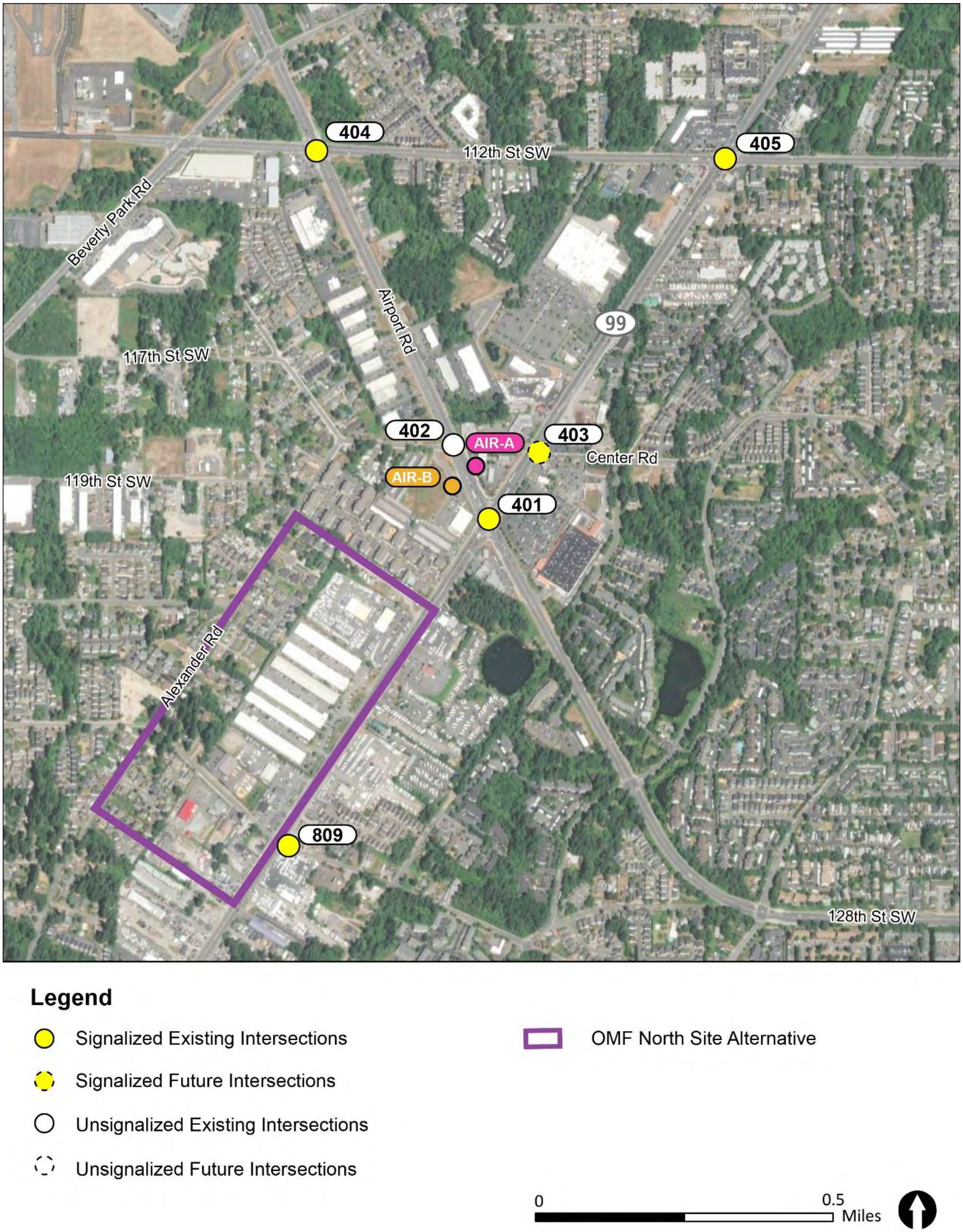


Figure 4-5 SR 99/Airport Road Station and SR 99 & Gibson Road OMF Site Subarea Intersections

Table 4-4 SR 99/Airport Road Station and SR 99 & Gibson Road OMF Site Subarea Intersections

ID	Intersection Location	Intersections to be Analyzed		
		AIR-A	AIR-B	SR 99 & Gibson Road OMF Site
401	Airport Rd/SR 99	X	X	X
402	Airport Rd/Center Rd	X	X	X
403	SR 99/Center Rd	X	X	
404	Airport Rd/112th St	X	X	
405	SR 99/112th St	X	X	
809	SR 99/Evergreen Way/Gibson Rd			X

Figure 4-6 SW Everett Industrial Center Station and Airport Road & 100th Street SW OMF Site Subarea Intersections

Table 4-5 SW Everett Industrial Center Station and Airport Road & 100th Street SW OMF Site Subarea Intersections

ID	Intersection Location	Intersections to be Analyzed			
		SWI-A	SWI-B	SWI-C	Airport Road & 100th Street SW OMF Site
501	Airport Rd/Kasch Pk Rd	X	X	X	
502	Airport Rd/Casino Rd	X	X	X	
503	Airport Rd/Boeing Fwy	X	X	X	
504	Casino Rd/SWI-A Transit access	X			
505	Casino Rd/SWI-A Station access	X			
506	Casino Rd/SWI-B Station access		X		
507	Kasch Pk Rd/SWI-B Station access		X		
508	Airport Rd/94th St			X	
509	94th St/SWI-C Station Access			X	
510	Airport Rd/SWI-C Station access			X	
805	Airport Rd/100th St				X
806	Airport Rd/106th St				X
807	Airport Rd/Holly Rd				X

Figure 4-7 SR 526/Evergreen Way Station Subarea Intersections

Table 4-6 SR 526/Evergreen Way Station Subarea Intersections

ID	Intersection Location	Intersections to be Analyzed		
		EGN-A	EGN-B	EGN-E
601	Evergreen Way/Casino Rd	X	X	X
602	Evergreen Way/SR526 EB Ramps	X	X	X
603	Evergreen Way/SR526 WB Ramps	X	X	X
604	Evergreen Way/79th Pl	X		
605	Casino Rd/EGN-B Station access/EGN-D Station access		X	
606	Casino Rd/EGN-C Station access/EGN-E Station access			X
607	Beverly Lane/79th Pl	X		
608	Casino Rd/5th Ave W		X	X
609	Evergreen Way/Holly Dr		X	X
610	7th Ave SE/Casino Rd/84th St SE			X

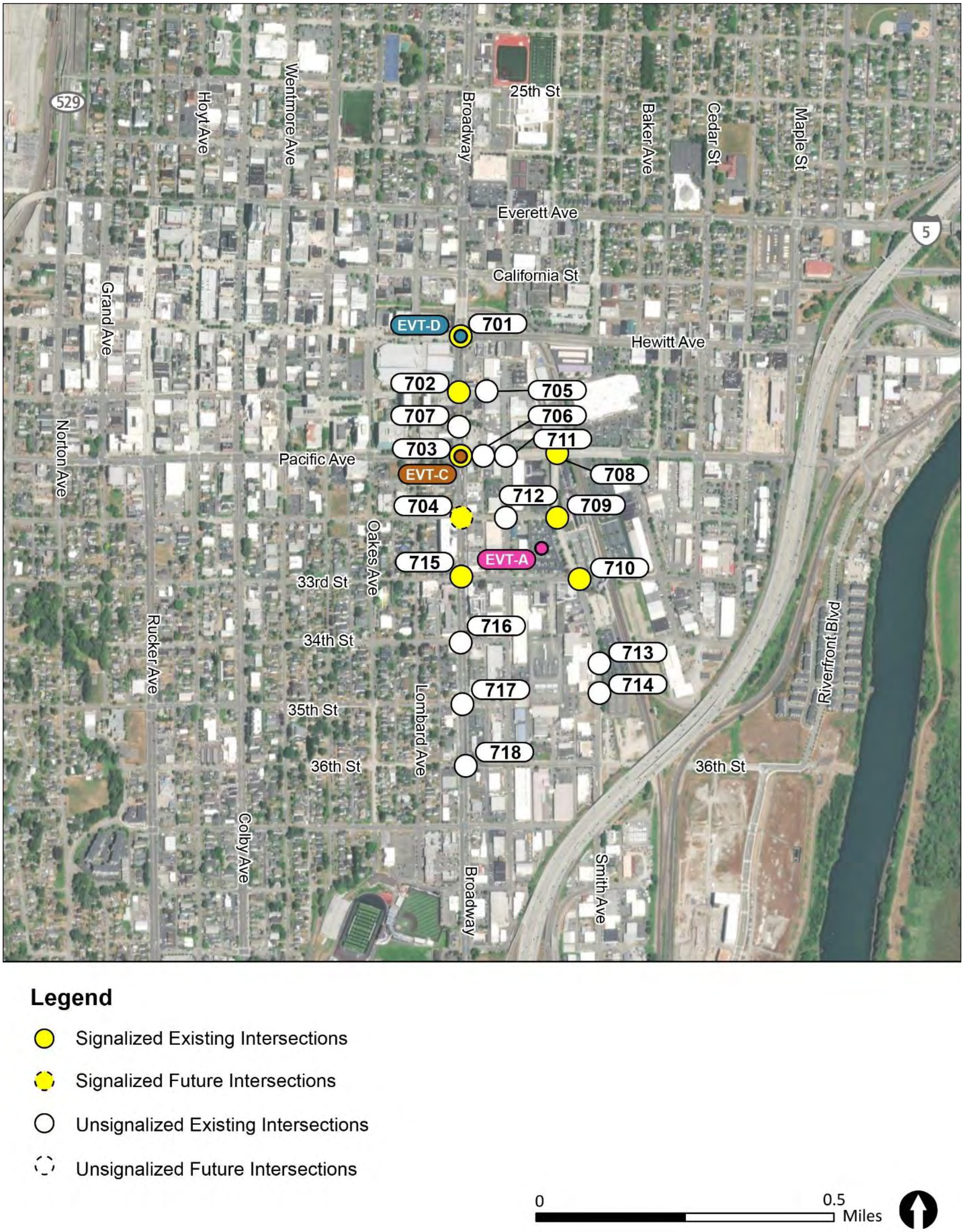


Figure 4-8 Everett Station Subarea Intersections

Table 4-7 Everett Station Subarea Intersections

ID	Intersection Location	Intersections to be Analyzed		
		EVT-A	EVT-C	EVT-D
701	Broadway Ave/Hewitt Ave			X
702	Broadway Ave/Wall St			X
703	Broadway Ave/Pacific Ave		X	X
704	Broadway Ave/32nd St		X	
705	Wall St/EVT-D Station Access			X
706	Pacific Ave/EVT-D Station Access			X
707	Broadway Ave/EVT-D Station Access			X
708	Smith Ave/Pacific Ave	X		
709	Smith Ave/32nd St	X		
710	Smith Ave/33rd St	X		
711	McDougall Ave/Pacific Ave		X	X
712	McDougall Ave/32nd St		X	
713	Smith Ave/EVT-A Station Access	X		
714	Smith Ave/EVT-A Transit Access	X		
715	Broadway Ave/33rd St		X	
716	Broadway Ave/34th St	X		
717	Broadway Ave/35th St	X		
718	Broadway Ave/36th St	X		

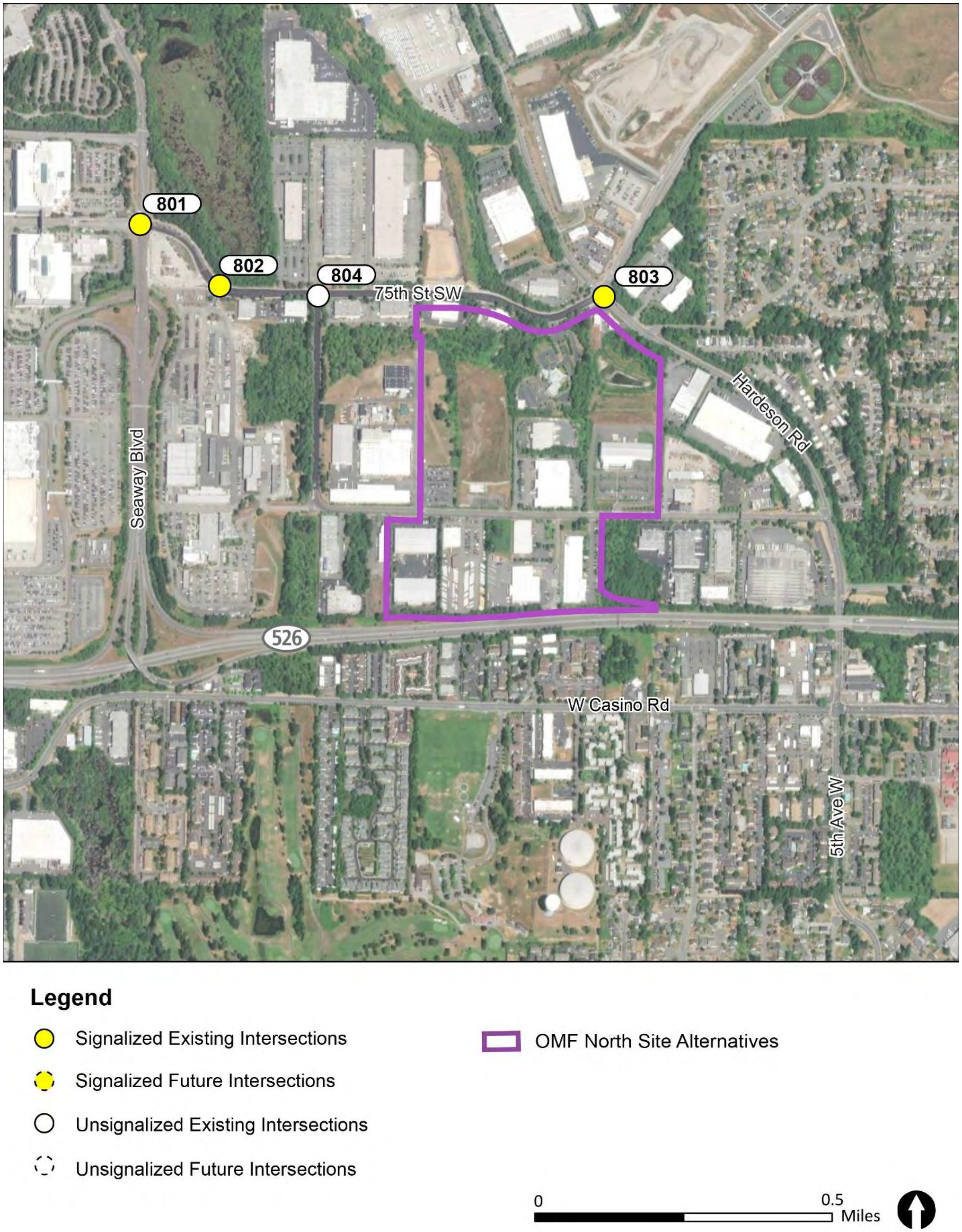


Figure 4-9 SR 526 & 16th Avenue and 75th Street SW & 16th Avenue OMF Site Subarea Intersections

Table 4-8 SR 526 & 16th Avenue and 75th Street SW & 16th Avenue OMF Site Subarea Intersections

ID	Intersection Location	Intersections to be Analyzed	
		SR 526 & 16th Avenue OMF Site	75th Street SW & 16th Avenue OMF Site
801	75th St/Seaway Blvd	X	X
802	75th St/Snohomish PUD	X	X
803	75th St/Hardeson Rd	X	X
804	75th St/Site Access	X	

4.4 Freight

The methodology will identify freight volumes in study subareas, as applicable. The study subareas for freight will be the same as for regional and local roadways. Truck freight will be classified into two vehicle types: small/medium trucks and large trucks (the remaining percentage of total vehicles would consist of passenger vehicles). As part of this analysis, attention will be paid to freight facilities, freight operations, and freight movements in the SW Everett Industrial Center.

4.5 Nonmotorized

The study area and area of effect for non-motorized facilities will be within 0.5 mile of each station for pedestrian facilities and within 1.5 miles of each station for bicycle facilities as measured along the network. Pedestrian facilities include sidewalks, trails, and other pedestrian facilities such as grade-separated crossings. Bicycle facilities include bicycle lanes, bicycle routes, and shared use paths. Analysis may identify existing and planned barriers to non-motorized connectivity.

4.6 Safety

The safety analysis will consider all modes of transportation and therefore the study subareas and areas of effect will be the same as described for each mode above.

4.7 Parking

The study will evaluate the availability of publicly accessible parking including public on-street and off-street parking in an area limited to one block on either side of the project footprint, the area used for construction, and the area within a 0.25-mile walking distance of each station. Off-street parking services provided by Sound Transit will be evaluated as well. The supply (capacity for vehicle parking) and regulation (including time limits, loading zone restrictions, paid parking areas, and no parking zones) of public curb space and off-street public parking within these areas will be inventoried based on available information from the appropriate jurisdictions and review of aerial photography. Off-street public parking is defined as parking that is available for public use and not privately owned (i.e., pay lots by private companies will not be inventoried). Data will be collected and reported by parking type/regulation (e.g., time-limited parking, unrestricted parking, paid parking, and loading zone) and location (e.g., block face) in areas likely to be accessible to passengers and subject to spillover parking or areas to be impacted by project construction. Private parking impacts will be assessed in the Acquisitions, Displacements, and Relocations section of the Draft EIS.

4.8 Aviation

The study area for aviation impacts will be defined by the requirements of the Federal Aviation Administration (FAA) Obstruction Evaluation/Airport Airspace Analysis.

5 ANALYSIS ASSUMPTIONS AND TOOLS

5.1 Transportation Analysis Years and Period

Based on the project's schedule and available traffic forecasting data, the traffic analysis will focus on three analysis horizons:

- Existing Year – 2023
- Future Opening Year – 2037. This scenario represents the opening of the Operations and Maintenance Facility (OMF) North in 2034 and serving all planned stations between the West Alderwood and SW Everett Industrial Center stations in 2037. It does not include construction of parking facilities at the stations. This is consistent with the interim opening schedule identified by Sound Transit.
- Future Horizon Year – 2046. This is the proposed horizon analysis year consistent with regional planning. This horizon year is consistent with Sound Transit long-range planning and assumes the full build-out of Sound Transit's ST3 system, including service to Everett Station in 2041 and construction of parking facilities at the stations in 2046. This horizon year would utilize the PSRC land uses and roadway network assumptions.

In the existing and horizon year analysis, the AM and PM peak periods will be evaluated with the focus on the impact analysis during the peak hour. The intersections that will be evaluated under each time period are identified in Table 4-1 through Table 4-8. The AM peak period is between 6:00 a.m. and 9:00 a.m. and the PM peak period is between 3:00 p.m. and 6:00 p.m., although both peak periods will be confirmed through historical daily counts. These peak periods are considered the timeframes when traffic impacts are the highest; therefore, the analysis will be of the worst-case scenario for overall traffic conditions. Common peak hours will be determined for each study subarea as opposed to individual intersection peak hours.

5.2 EIS Analysis Conditions

5.2.1 Analysis Conditions

The EIS analysis will be developed for the conditions listed in Table 5-1. The existing and No Build conditions will provide a point of comparison against the Build and construction conditions. This comparison determines project benefits and impacts based on the measures described in Section 7 of this report.

Table 5-1 EIS Evaluated Conditions

Condition	Existing Year (2023)	Opening Year (2037)	Horizon Year (2046)	Notes
Existing	X			Includes land use, roadway, and transit network conditions for the year 2023.
No Build Alternative		X	X	Based on travel demand forecasts and an assumed list of constructed background projects and transit service modifications.
Build Alternatives		X		The opening year condition assumes the project is constructed and operating as far as SW Everett Industrial Center station, but no structured parking facilities are constructed.
Build Alternatives			X	The horizon year condition assumes the full-length project is constructed and operating including structured parking facilities.

5.2.2 Background Project Identification

The future year conditions will include state, regional, and local agency projects that are reasonably foreseeable, are in an officially adopted plan, have completed environmental review, or are funded or permitted. These projects are assumed to be built and in place before the EVLE Project is completed. The list of background projects will provide valuable insight into how the transportation system within and surrounding the project's study area will change from existing conditions. These projects may directly affect transportation conditions, such as by altering travel patterns, affecting roadway operations and safety, and influencing non-motorized access and connections. The sources for developing the background project list will include the following:

- WSDOT Connecting Washington and Move Ahead Washington funding packages and *Washington State Highway System Plan* (WSDOT expected 2023)
- *2022 Washington State Freight System Plan* (WSDOT 2022b)
- *Regional Transportation Plan 2022-2050* (PSRC 2022)
- City of Everett Comprehensive Plan (2021)
- City of Lynnwood Comprehensive Plan (2021)
- Snohomish County Comprehensive Plan (2018)
- Sound Transit's ST2 and ST3 Programs (Sound Transit 2008, 2016)
- *Long Range Transit Plan* (Community Transit 2011)
- *Everett Transit Long Range Plan* (Everett Transit 2018)

- EVLE Transit Service Integration Technical Memorandum (Sound Transit in progress)
- Relevant local agency CIPs/TIPs

5.3 Analysis Tools and Processes

This section describes the analysis tools and modeling process that will be used to conduct the transportation analysis for the EIS.

5.3.1 Travel Demand Forecasting Models and Process

The transportation analysis will use the following regional travel demand models to support the assessment of future conditions:

- The Sound Transit Incremental Ridership Model, to produce transit ridership forecasts
- A PSRC-based regional travel demand model, to calculate regional and project area traffic volume growth and other associated traffic metrics

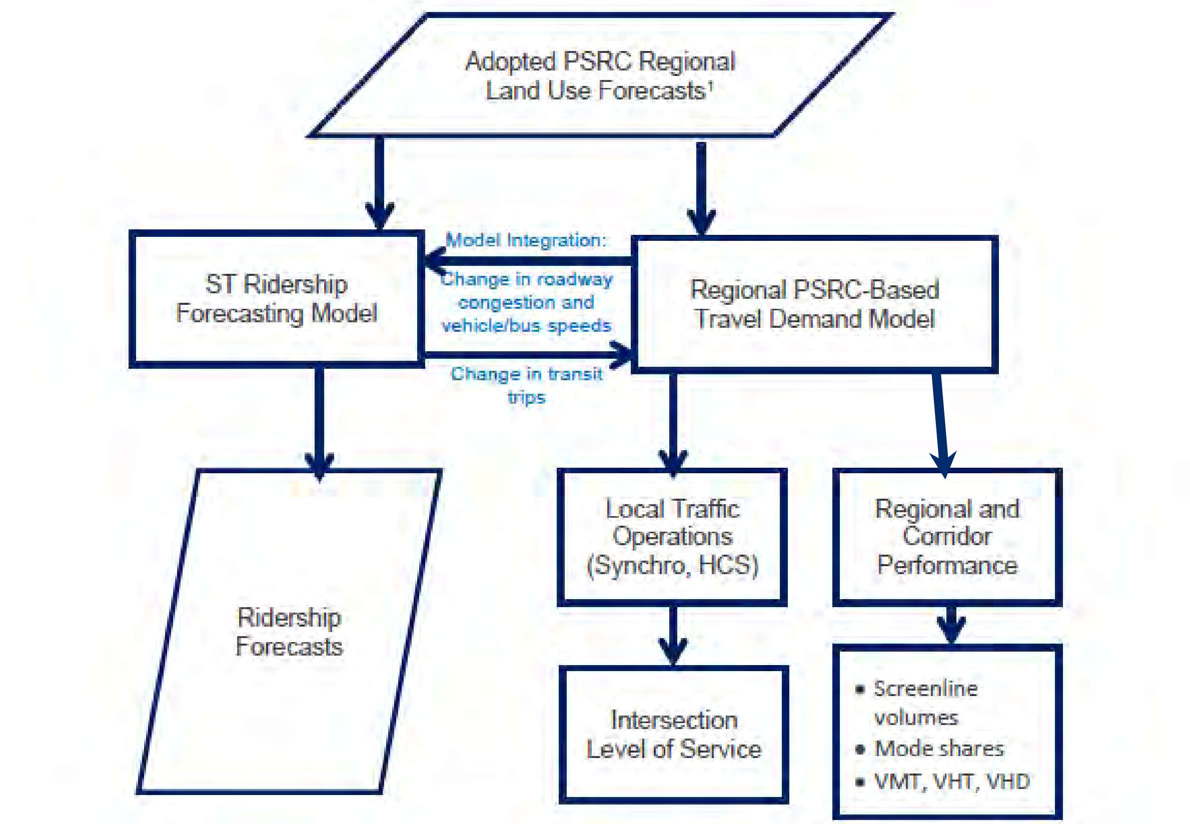
These models provide data included in the regional measures, transit system and local and arterial traffic operations analysis, as well as for a variety of other environmental analyses.

While the transit ridership and travel demand models will be run independently of one another, they use many of the same data sources, including land use, costs, and transit networks. Figure 5-1 illustrates the relationship between the two demand models. The Sound Transit Incremental Ridership Model is discussed in more detail in Appendix B.

5.3.1.1 Sound Transit Incremental Ridership Model

The current version of the Sound Transit Incremental Ridership Model uses analytical ridership forecasting procedures developed over three decades of incremental methods applications. During this period, the methods have been subjected to substantial external review, including three independent expert review panels and four cycles of review by the FTA over the course of New Starts grant applications for Link light rail projects (FTA 2013). As previously noted, the Sound Transit and PSRC modeling procedures are the foundation of the transportation technical analysis and are interrelated and complementary. The Sound Transit ridership model uses data from the PSRC modeling process to establish measures of change in external factors, including population and economic growth, and highway congestion. For more detailed information about the Sound Transit Incremental Ridership Model, see Appendix B, Sound Transit's Transit Ridership Forecasting Methodology Report.

The Sound Transit model will be used to produce rail and bus ridership forecasts for use in the EIS and will be part of a post-processing step to provide adjustments to the regional traffic model.



1 This model will be updated to reflect the latest adopted PSRC land use forecasts available at the beginning of the EIS process. It is assumed this will be PSRC's "Land Use Vision – Implemented Targets" released in 2023.

Figure 5-1 Sound Transit Ridership Forecasting Model and PSRC Based Regional Model Relationship

Transit Ridership Forecasting Process

The Sound Transit Incremental Ridership Model will be used to perform the transit ridership (bus and rail) forecasts for the future horizon year of 2046 (or other land use forecast available from PSRC at the time of the analysis) and any interim opening year analysis. The transit ridership output from this model is used to analyze transit impacts as well as provide information used to analyze the regional system, traffic and roadway conditions, station areas, and nonmotorized system. The existing transit system and future transit system, which includes the planned Sound Transit system and a reasonably foreseeable future bus network, will be documented through a transit integration plan developed with Community Transit and Everett Transit. This transit integration plan will be used to code the transit services/networks for the Build and No Build Alternatives in the ridership model. The Sound Transit ridership model will then be run for the Build and No Build Alternatives to prepare transit forecasts for analysis in the EIS. For the 2046 horizon year, the Sound Transit ridership model is run to estimate a range of future ridership reflecting uncertainty about future assumptions, while maintaining a consistent transit network between the three scenarios. This is similar to the way the ridership forecasts were prepared for ST3: The Regional Transit System Plan, where forecasts were presented as ranges rather than a single number (Sound Transit 2016).

PSRC-Based Four-County Regional Travel Demand Model

The regional travel demand model that will be used in this analysis has been developed specifically for the four county PSRC area as a refinement of the PSRC trip-based travel demand model. The model is rooted in the latest PSRC model and includes enhancements to trip generation, trip distribution, and assignment methodologies to reflect localized conditions within the project corridor.

The land use inputs used in the regional travel demand model will be consistent with those used for the Sound Transit ridership model. While the official control totals (at the city level) are used for regional consistency, land use distribution modifications have been made in the regional model based on specific data provided by PSRC jurisdictions (Seattle, Bellevue, Redmond, Tacoma, Issaquah, Tukwila, Federal Way, Kent, Des Moines, King County, Snohomish County) that have utilized the model for other recent projects.

Regional Travel Demand Model Process

Future No Build (Baseline) Travel Demand Conditions

For the future No Build conditions, the regional traffic demand model will be run and trip tables assigned to networks by time of day. Differences in traffic volumes from the model assignments will be applied to the observed traffic volume counts to develop estimated future PM peak hour and daily traffic forecasts. In addition, volumes will be post-processed in the vicinity of major planned development and redevelopment projects to ensure traffic effects of these developments are adequately represented.

Future Build Travel Demand Conditions

The regional travel demand model will be used to generate traffic volumes for the Build Alternatives based on the integration of transit ridership forecasts developed for the Build Alternatives from the Sound Transit Incremental Ridership Model. The projected changes to transit demand associated with the Build Alternatives will be incorporated into the regional travel demand model to reflect travel pattern and volume effects from changes in transit ridership. This process is illustrated in Figure 5-1. This process will only be used to produce traffic volumes for the Build Alternatives at the regional, corridor, and subarea system levels (e.g., vehicle miles traveled [VMT], vehicle hours traveled [VHT], vehicle hours of delay [VHD], and screenline data).

To develop traffic volumes for the Build condition used in the arterial and local street analysis, the traffic volumes developed for the No Build condition will be used as a base, with additional volumes added to reflect the vehicle traffic anticipated to be generated by the project. This is explained further in Section 7. In the forecasting integration process, the goal is to supplement the transit demand forecasts generated by the PSRC model with the data from Sound Transit's Incremental model to ensure consistency in the forecasts between the two models. This is accomplished by supplying future roadway congestion and vehicle speed information from the PSRC model to the Sound Transit model to develop the future transit ridership forecasts. The transit ridership forecasts from the Sound Transit model are then input into the PSRC regional travel demand model to develop the traffic forecasts for the Build Alternatives.

Trip Generation (General)

Trip generation at transit stations or other Sound Transit facilities will be developed for various modes of travel, including:

- Park-and-rides and other public parking facilities
- Auto trips: drop-off/pick-up, including private vehicles and transportation network company trips such as Uber and Lyft
- Transit trips: number of buses serving a station
- Walk/bike trips: bus transfers and walk/bike trips

Trip generation estimates for all modes listed above will be based on several sources. One consideration is the Sound Transit mode of access survey for the Link Light Rail Extension collected in spring 2019. The mode of access survey collected data for the full length of the light rail line from the University of Washington Station to the Angle Lake Station. Additionally, national data sources such as data from the BART Station Profile Study (BART 2015) will be considered. The BART study is a comprehensive mode of access and egress survey of BART rail users in the San Francisco Bay area. Available research and data related to transportation network company trips to and from transit stations will also be considered.

Trip generation at park-and-rides will assume the parking supply is fully utilized and will be based on the maximum capacity of the parking facility and not forecasted demand. Trip generation will be calculated based on a per space rate, which will be developed from several sources including the latest ITE Trip Generation Manual (Land Use Code 090 Park-and-Ride with Bus or Light Rail Service), relevant Sound Transit mode of access data, and available traffic counts at park-and-ride driveways. Trip generation for other Sound Transit facilities (e.g., maintenance facility parking) will be based on maximum parking capacity or projected use, as appropriate.

Information on bus service for each station will be developed by Sound Transit, Community Transit, and Everett Transit service planners as part of the planning-level transit service integration plan. This plan includes changes in local transit circulation to and from the station area, which will be incorporated into the overall trip generation.
The vehicle and nonmotorized (pedestrian and bicycle) trips associated with the light rail station ridership forecasts for the alternative with the highest ridership at that station will be used for evaluating the station area effects. Exceptions may be made at locations with substantial differences between alternatives (e.g., one has bus transfer opportunities, and one does not). In these cases, two trip-generation scenarios may be developed. Trips will be assigned to the nonmotorized and vehicular networks around the station locations based on existing and anticipated future circulation patterns.

Trip Generation (OMF North)

Information on opening year and 2046 trip generation for the OMF North facility will reflect employee ingress and egress and deliveries. These traffic volumes will be added to the future No Build Alternative traffic volumes as the basis on which to analyze the Build Alternatives. In locations where the facility will replace an existing land use that generates trips, the Institute of Transportation Engineers Trip Generation Manual will be used to estimate the change in peak trips for the existing land use.

5.3.2 Traffic Operations Analysis Tools

The traffic operations analysis will be consistent with WSDOT protocols. The Synchro/SimTraffic 11 studio suite combines the modeling capabilities of Synchro and the micro simulation and animation capabilities of SimTraffic. Synchro is a macroscopic analysis and optimization software application that supports the Highway Capacity Manual's (HCM) 7th Edition (Transportation Research Board 2022), 2010 and 2000 for signalized intersections and unsignalized intersections. Synchro's signal optimization routine allows users to weight specific phases, thus providing more options when developing signal timing plans. SimTraffic is a powerful, easy-to-use traffic simulation software application. With SimTraffic, individual vehicles are modeled and displayed traversing a street network. The study subarea intersection operations and 95th percentile queuing results will be evaluated and compared based on SimTraffic models to understand the true impact of traffic congestion and closely spaced intersection interactions. At locations where queue analysis is needed, SimTraffic will be used.

Synchro/SimTraffic models will be developed for the existing year (2023), opening year (2037), and future year (2046) Build and No Build Alternatives. Existing signal timing plans will be obtained from local agencies and used in the existing Synchro/SimTraffic models. SIDRA (version 9 or later) will be used to analyze study subarea intersections that either currently operate as, or are anticipated to operate as, roundabouts consistent with WSDOT protocols.

5.3.3 Other Tools

Mode-of-access tools including geographic information system (GIS)-based software will be utilized to define the walk, bicycle, and automobile "access sheds" in study subareas described previously. As existing travel behaviors continue to change and travel behaviors emerge that provide mobility options and choices for travelers, such as rideshare vehicles, additional analysis software and/or tools may be developed to provide support for evaluation measures related to these behaviors.

6 AFFECTED ENVIRONMENT

The affected environment for transportation will document existing conditions in year 2023 for each element of the transportation system evaluated within the study area. These elements include Regional and Corridor Traffic, Transit, Arterials and Local Streets, Freight, Nonmotorized, Safety, Parking, and Aviation. Particular focus for these modes will be on transportation facilities in the vicinity of proposed transit stations because these will be the primary site-specific traffic generators.

The detailed means for documenting the existing conditions for these transportation elements are discussed in Section 5 because the methods and measures to assess the existing conditions, No Build Alternative, and Build Alternatives are largely the same. Existing conditions information will be both quantitative and qualitative and will be displayed both graphically and in a tabular format as appropriate.

7 TRANSPORTATION RESOURCE ANALYSIS AND MEASURES

This section discusses the transportation analysis and measures that will be documented in the EIS to understand the affected environment and the direct impacts of the Build and No Build Alternatives. Direct impacts include measures to assess the long-term operation impacts as well as short-term construction impacts. This section also includes the analysis and measures used to determine indirect and cumulative impacts on the transportation system.

7.1 Assessment Methods and Analysis Thresholds

The analysis and measures in this section are presented by the specific transportation element that will be documented in the Transportation Technical Report and Transportation chapter of the EIS. The transportation analysis will be performed at three assessment levels, depending on transportation element: regional, corridor and subarea, and local.

Regional measures are defined as within the project area and beyond, and are considered region-wide (e.g., Snohomish County and beyond). Measures at the corridor and subarea level are intended to provide information for the project area or a segment within the project area. Measures at the local level would provide information specific to a certain location, transit route, or transportation facility. Table 7-1 summarizes the transportation analysis measures. Measures for assessing these transportation elements, discussed in the following sections, will be both quantitative and qualitative, and results will be displayed both graphically and in a tabular format as appropriate.

Table 7-1 Transportation Measures by Transportation Element

Transportation Element	Assessment Level	Measures
Regional and Corridor Traffic	Regional	Growth rate, VMT, VHT, VHD
	Corridor and subarea	Growth rate, vehicle volumes, volume to capacity (v/c) ratio/LOS, person trips, mode share
Transit	Regional	System-wide daily transit trips and boardings, total daily light rail boardings, total daily Sounder boardings
	Corridor and subarea	Project-wide daily trips on project, project-wide daily trips on project by transit-dependent population, station area boardings, travel times
	Local	Effects on local transit patterns and access and circulation to proposed station locations
Arterials and Local Streets	Local	Traffic patterns, street closures, property access modifications
		Intersection LOS, delay, and queue lengths
Freight	Local	Identify truck and rail freight routes and impacts, as well as impacts to business loading zones and access
Non-motorized Facilities and Modes	Local	Pedestrian and bicycle access, circulation and facility gaps surrounding stations, Americans with Disabilities Act (ADA) accessibility barriers immediately adjacent to project infrastructure, school walk route impacts, and bicycle parking at stations

Transportation Element	Assessment Level	Measures
Safety	Local	Historical intersection and roadway collision type and frequency. Safety assessment of effects on auto, freight, transit, and nonmotorized modes.
Parking	Local	Parking availability, restrictions, and utilization near stations, including off-street parking provided by the project, off-street parking spaces and/or curb space capacity removed as a result of the project, and on-street spaces; estimated access and parking demand; and assessment of drop-off/pick-up area needs based on estimated station access and rideshare forecasts
Aviation	Local	Obstruction Evaluation/Airport Airspace Analysis

7.2 Regional and Corridor Traffic

7.2.1 Operations

7.2.1.1 Regional Traffic

Evaluation Measures

Information from the regional model developed for this study will be the key data source for this analysis. The following types of data will be produced for opening year and horizon year 2046 to analyze the effect of the Build and No Build Alternatives on regional or system-wide traffic characteristics:

- Traffic growth rate – the annual growth rate for vehicle traffic in the region
- VMT – Total average daily vehicle miles traveled on the regional highway system
- VHT – Total average daily vehicle hours traveled on the regional highway system
- VHD – Total average daily vehicle hours of delay on the regional highway system, which indicates the total level of congestion on the highway system

Evaluation Approach

Information from the regional model will be used to generate the Build and No Build Alternatives VMT, VHT, and VHD data for the long-term conditions. This model will be run in an iterative process with the Sound Transit Incremental Ridership Model, with highway traffic volumes reflecting changes in transit ridership as described in Section 5. Matrices of vehicle trips and travel times on an origin-destination pair level from the model will be used to quantify estimated VHT, and matrices of vehicle trips and hours of delay per trip will be used to quantify the impact of the Build and No Build Alternatives on VHD.

Short-term changes in regional traffic during construction will not be assessed unless there are direct construction impacts on a regional facility, such as state highways.

7.2.1.2 Corridor Traffic

Evaluation Measures

- Growth rate – Vehicle traffic demand within the EVLE project area will be forecasted and presented as an annual growth rate.

Additional measures used to evaluate effects within a corridor and/or subarea of the study area will be based on a screenline-level analysis for the PM peak hour. Screenlines are imaginary lines drawn across one or more roadways to compare aggregate changes in traffic conditions. The following data will be included for each screenline:

- Vehicle volumes
- Vehicle v/c ratio/LOS
- Person trips – The number of person trips across screenlines
- Mode share – The proportion of vehicle and person trips at screenlines taken by transit (bus and rail) versus personal auto

Evaluation Approach

The analysis of traffic impacts in various segments of the corridor will involve comparing traffic conditions on the highway and local street system at selected screenlines for each alternative, with the exception of the growth rate measure, which is an area measure based on transportation analysis zones (TAZs) within the study area.

The screenline comparisons will provide a snapshot of traffic operations along each corridor. A map and table will be used to present data at screenline locations.

Information for each screenline will be generated from the project's regional model and Sound Transit's ridership model and will include PM peak hour and daily values. The v/c ratio at the screenlines may be expressed as a generalized facility-based LOS.

7.2.2 Construction

Construction impacts will be qualitatively and quantitatively assessed to determine if the project's construction would have any impact on the regional and corridor traffic measures. This analysis may include factors such as long-term closures or reductions in capacity to regionally significant roadways, extended diversions of transit trips, or other disruptions to regional and corridor traffic as a result of construction activities.

7.3 Transit

7.3.1 Operations

7.3.1.1 Regional Transit

Evaluation Measures

The following measures will be considered for assessing effects of the project on system-wide bus and rail transit for the horizon year (2046):

- Annual transit ridership (linked trips)
- Daily transit ridership (linked trips)
- Annual Link light rail boardings
- Daily Link light rail boardings

Evaluation Approach

As described earlier, the Sound Transit ridership model will be used to produce data related to regional transit forecasts associated with the alternatives. The network will be coded to reflect the Build and No Build Alternatives, and then the model will be run to produce transit forecasts for each alternative. Ridership forecast results will be provided as direct outputs from the ridership model.

7.3.1.2 Corridor Subarea Transit

This section describes the corridor and subarea analyses that will evaluate projected changes to transit services (light rail and bus) resulting from the Build Alternatives.

Evaluation Measures

The following evaluation measures will be considered to understand the corridor and subarea effects on transit service for horizon year 2046:

- Daily project ridership – Daily trips on project by project alternative. For the No Build Alternative, when no rail service will be present, corridor daily bus ridership will be estimated for bus routes in the general project area to provide consistency with the Build Alternatives.
- Station area boardings – Daily and PM peak period station boardings by project alternative will be produced from the Sound Transit Incremental Ridership Model. Each alternative will have a specific transit integration plan and parking capacity developed, along with transit travel times (light rail and bus) within the EVLE corridor and other key areas.

Evaluation Approach

As described earlier, the Sound Transit Incremental Ridership Model will be used to produce ridership data related to the project subarea transit forecasts with the Build Alternatives. Ridership will be forecast for both the PM peak and daily periods.

7.3.1.3 Local Transit

The transit quality of service assessment will analyze the expected project effects on the existing and future bus and light rail services within the EVLE study area using both qualitative and quantitative information. The approach will follow the methodology and guidelines presented in the Transit Capacity and Quality of Service Manual (Transportation Research Board 2017). Transit quality of service information will be reported at station areas within the EVLE study area.

Evaluation Measures

The evaluation will document the transit service effects for existing conditions, No Build Alternative, and Build Alternatives. This will include:

- Transit access and circulation, including any changes in travel times for buses accessing stations
- Walk time for transferring passengers from Swift BRT service to Link platforms

Evaluation Approach

Expected changes in transit service and routing with the Build Alternatives will be identified and compared to the transit service and routing under No Build conditions. These changes will be developed in conjunction with Community Transit, Everett Transit, and Sound Transit service planners as part of the project's transit integration plan. The comparison will focus on changes in coverage area and potential effects on travel time based on existing information from the transit agencies, traffic operations results, and/or other traffic analysis data. Passenger load data will be provided from the Sound Transit Incremental Ridership Model.

7.3.2 Construction

This analysis will evaluate the potential short-term impacts to regional, corridor, and local transit combined. Transit impacts during construction will be closely coordinated with the following sections: Regional and Corridor Traffic, Arterials and Local Streets, and Nonmotorized. Construction impacts to transit will consider both the transit service and transit rider. This assessment will evaluate the potential modifications to roadway capacity and operations during construction of transit service and the ability to access transit as a result of the project construction activities. This would include construction activities that could prohibit access to transit stops or activities that would close transit stops and require riders to relocate to another transit route or stop.

7.4 Arterials and Local Streets

7.4.1 Operations

7.4.1.1 Property Access and Local Circulation

This evaluation will assess permanent local area traffic circulation impacts including access to properties affected by the Build Alternatives. Refer to Section 7.4.2 for construction impacts to property access and local circulation.

Evaluation Measures

The evaluation will document any physical change to the traffic patterns and movements along with changes in property access. This will evaluate only vehicle movements; refer to Section 7.3 and Section 7.6 for how transit and nonmotorized modes will be evaluated for the project.

Evaluation Approach

This assessment will include such factors as:

- Effect of potential street closures on localized traffic movement
- Loss of access (such as left turns) to and from driveways
- Changes in property access

7.4.1.2 Intersection Operations (Including Station Area Traffic Analysis)

Evaluation Measures

Effects on intersection operations will be evaluated based on the opening year and horizon year 2046 peak hour intersection LOS. LOS measures the quality of traffic operations at an intersection. As described in Table 7-2, LOS ratings range from “A” to “F.” LOS A represents the best operation and LOS F the poorest operation. Queue lengths will be reported at intersections that operate at or below (failing) the agency’s LOS threshold.

Table 7-2 Level of Service Definitions for Signalized and Unsignalized Intersections

LOS	Average Control Delay (seconds per vehicle)		Traffic Flow Characteristics
	Signalized Intersections	Unsignalized Intersections	
A	≤ 10	≤ 10	Virtually free flow; completely unimpeded.
B	> 10 and ≤ 20	> 10 and ≤ 15	Stable flow with slight delays; less freedom to maneuver.
C	> 20 and ≤ 35	> 15 and ≤ 25	Stable flow with delays; less freedom to maneuver.
D	> 35 and ≤ 55	> 25 and ≤ 35	High density but stable flow.
E	> 55 and ≤ 80	> 35 and ≤ 50	Operating conditions at or near capacity; unstable flow.
F	> 80	> 50	Forced flow; breakdown conditions.

Source: Transportation Research Board 2022.

Agency transportation goals and LOS standards are developed as part of each agency’s comprehensive planning efforts. Although agencies accept different levels of congestion, a delay-based intersection LOS analysis is typically conducted for impacts analyses and is proposed for this project. Delay is expressed in terms of average delay (in seconds) per vehicle as a result of the intersection operations.

Although intersections may be located along a state route or state facility, the intersection operations standard may be under the jurisdiction of the local municipality as opposed to WSDOT. Specific agency thresholds and relation to intersection operations will be assessed in the Transportation Technical Report.

Evaluation Approach

Synchro (version 11) software will be used to determine the projected peak hour LOS for the analysis years identified in Table 5-1 at the intersections identified in Section 4.3. The HCM report from the Synchro software will be used to summarize average intersection delay, LOS, and v/c ratios (HCM 2022 7th Edition will be used unless unavailable for the configuration under study, in which case HCM 2000 will be used). The signalized intersections' LOS will be defined in terms of average intersection delay. The LOS at an unsignalized intersection is also defined in terms of delay, but only for the worst operating movement, which is typically on the minor street (i.e., stop) approaches. For unsignalized intersections that are stop-controlled on each approach, the average intersection delay is reported. Vehicle queue lengths will be reported from SimTraffic for intersections not meeting agency LOS standards, tightly spaced intersections, or intersections with direct physical project impacts, as agreed to with the relevant jurisdictions, to understand if the Build Alternatives impact vehicle queues beyond the storage length. The impacts of special events would be described qualitatively, with descriptions of when and how frequently they would occur and assessments of congestion levels during those periods.

Default assumption values for the analysis will be developed for intersections where actual values are not available. These will include assumptions with respect to saturation flow rates, geometry, traffic, and signalization conditions. Table 7-3 provides assumptions for existing, opening year, and future horizon year (Build and No Build Alternatives) input values and assumptions when data are not available.

Table 7-3 Default Synchro Parameters and Assumptions[a]

Arterial Intersection Parameter	Existing Year (2023)	Opening Year (2037) and Horizon Year (2046)
Peak Hour Factor	From count and for entire intersection; otherwise: If total entering vehicles ≥1000, 0.92. If total entering vehicles <1000, 0.90.	Use 0.95 for all intersections except where existing peak hour factor (PHF) is greater than 0.95 or less than 0.80. Use existing PHF in cases where the PHF is greater than 0.95. If existing PHF is less than 0.80, then use peak 15-minute volumes multiplied by a factor of 4.
Conflicting Cyclists and Pedestrians per Hour	From traffic count, otherwise assume 10 pedestrians/cyclists in both AM and PM periods.	For the No Build Alternative, apply growth rate from adjacent street to existing volumes. For the Build Alternatives, add the number of pedestrians based on the station ridership and mode of access forecasts.
Area Type	"Other" for all areas.	Same as existing.

Arterial Intersection Parameter	Existing Year (2023)	Opening Year (2037) and Horizon Year (2046)
Ideal Saturation Flow (for all movements)	1,750 vehicles per hour for urban areas;1,900 vehicles per hour for rural.	Same as existing.
Lane Utilization	Default software assumptions unless data/engineering judgment suggests otherwise.	Same as existing.
Lane Width	Existing lane widths. Assume 11 feet if no information available.	Same as existing, unless improvements proposed; then use agency standards/plans.
Percent Heavy Vehicles	From count, otherwise 3%.	Same as existing.
Percent Grade[b]	Flat approach = 0%. Moderate grade on approach = 3%. Steep grade on approach = 6% or from field/elevation data.	Same as existing.
Parking Maneuvers per Hour	Based on parking regulations. For less than 15-minute parking, assume 4 maneuvers per hour; otherwise, assume 1 maneuver per hour, unless data/information gathered or provided from agencies suggest otherwise.	Same as existing. For new parking, assume existing assumptions for maneuvers based on parking durations.
Bus Blockages	Headway information provided by transit agencies.	Use future service assumptions developed by Community Transit, Everett Transit, and Sound Transit as part of the Transit Service Integration Technical Memorandum.
Intersection Signal Phasing and Coordination	From agency signal phasing sheets or their existing analysis files.	Splits, offsets, and cycle lengths optimized between existing and no-build conditions. Signal timings kept consistent between Build and No Build Alternatives, but splits and offsets optimized. For timing adjustments: Left turns, if permitted in existing, will be examined for a protected phase based on LOS, access/geometry, safety, and agency guidance. For Build and No Build Alternatives: Any left turn conflict with at-grade light rail will include a separate lane and have protected phasing. Left turns will be restricted (or protected with a gate or similar treatment) at unsignalized intersections. For elevated light rail, mid-block left turns will be restricted. Signal warrant analysis will be completed at unsignalized intersections that are proposed or considered for new traffic signals.

Arterial Intersection Parameter	Existing Year (2023)	Opening Year (2037) and Horizon Year (2046)
Intersection Signal Timing Optimization Limits	Not applicable.	Between 60 and maximum of 180 seconds.
Minimum Green Time	Per signal timing cards.	Based on pedestrian times (minimum of 7 seconds walk time and 3.5 feet per second for flashing don't walk clearance). If no crosswalk: 10 seconds.
Yellow and All Red Time	Per signal timing cards.	New signals: Yellow = 4 seconds, and All Red = 1 second. Consider clearance times longer than 1.0 seconds for larger intersections (DDI, SPUI)
High-occupancy Vehicle (HOV) Lanes	Lane Utilization Method[c]	Same as existing.
Right Turn on Red	Allow (unless signed otherwise).	Same as existing.
Right Turn Overlaps	Per signal timing cards.	Identify if used.
Vehicle Queue Lengths	Based on 25 feet per vehicle.	Same as existing.

a Synchro parameters will be adjusted to meet jurisdictional standards, where applicable. An appendix detailing any changes from "default" parameters will be provided, with an explanation of these changes.
b Percent grade assumed for at-grade intersections only.
c This methodology assumes intersection lane designations will be coded exactly as shown in the field. Shared through (HOV) and right turn lanes will be coded as a general-purpose traffic lane because Synchro does not have a special method for HOV lane analysis. To account for lower HOV lane volumes, the lane utilization factors will be adjusted to reflect this condition. In instances of congested intersections with HOV lanes, adjusting the lane utilization factor may not assist in replicating the congested conditions. In this case, other Synchro parameters (such as the Saturation Flow Rates and Headway Factors) will be adjusted in the model.

7.4.2 Construction

The assessment of construction-related transportation impacts on local and arterial streets will focus primarily on corridors near light rail alignment or on streets that could be substantially affected by construction of any of the Build Alternatives. For the purposes of impact assessment on local and arterial streets, the construction phase considered to be most disruptive to traffic operations in the corridor will be the one assessed in the most detail. This phase will be identified in coordination with Sound Transit staff and staff from local jurisdictions, as appropriate. The construction analysis on local and arterial streets will consider the following:

- Changes in roadway capacity including potential lane closures, parking restrictions, roadway modifications, areas of construction activity adjacent to travel lanes, or other reductions to capacity as a result of project construction activity
- Identification of access and impacts from potential construction staging areas on roadway operations
- Assessment of potential for neighborhood traffic intrusion related to road closures, and options for traffic detours
- Estimation of construction truck traffic

The analysis will be summarized in a tabular format to identify the following:

- Impact location(s)
- Street characteristics
- Type of construction activity, including likely duration of impact to roadways (characterized as full or partial closures for short-term or long-term periods) on local and arterial roadways
- Level of construction traffic (characterized as high, moderate, or low). High truck traffic is generally associated with major fill, excavation, and concrete work.
- Availability and identification of potential detour routes. Potential for detoured traffic to affect a residential neighborhood. (This is characterized as high, medium, or low and is related to both potential for road closures and options for traffic detour.)

7.5 Freight

7.5.1 Operations

7.5.1.1 Evaluation Measures

Evaluation measures will include the following:

- Truck volumes – Change in truck volumes and/or percentages between existing and future conditions
- Truck operations – Change in congestion levels and/or travel speeds along identified freight facilities/routes
- Truck access – Physical impacts on truck routes, loading zones, or access to local businesses
- Freight rail impact – Physical impacts to freight rail corridors or port intermodal facilities

Evaluation Approach

Impacts of the Build Alternatives on freight movements will be qualitatively assessed. This assessment will focus on truck movement and truck routing impacts as well as the potential impact to freight rail corridors and facilities and port intermodal support facilities. The assessment of truck issues will focus on designated major truck routes and truck service areas, access to these facilities and areas, and loss of on-street loading zones and/or modifications of truck access to local businesses. The assessment of freight rail impacts will focus on physical changes proposed within, above, or below railroad right-of-way.

7.5.2 Construction

The assessment of freight impact during construction will include analysis of freight trucks and freight rail. The construction impacts will consider the impacts on freight routes, load ratings along routes, and intermodal and port terminal facilities, including access and circulation. This assessment will be coordinated with the construction impacts identified in the Arterials and Local Streets section.

7.6 Nonmotorized

7.6.1 Operations

7.6.1.1 Evaluation Measures

The Nonmotorized section will evaluate pedestrian and bicycle access, circulation and facility gaps surrounding stations, barriers, ADA accessibility, and school walk route impacts. The assessment of future nonmotorized (pedestrian and bicycle) facilities will address the following issues:

- Pedestrian access and circulation within 0.5 miles of the proposed stations in relation to the forecasted ridership
- Identification of short-term and long-term bicycle parking near the proposed stations
- Direct (physical) effects on pedestrian and bicycle facilities along the alignment of each alternative. This would include identifying any barriers to nonmotorized movements the Build Alternatives might create and any ADA accessibility barriers immediately adjacent to proposed station and OMF locations or other project infrastructure.
- Identification of existing physical barriers for nonmotorized pedestrian movements accessing proposed stations within 0.5 miles of the stations
- Identification of currently missing and funded new sidewalk sections for city arterials within 0.5 miles of the stations
- Impacts on designated school walk routes
- Identification of deficiencies in the existing and funded regional bicycle paths and routes within 1.5 miles of proposed station locations

7.6.1.2 Evaluation Approach

The evaluation of nonmotorized facilities and modes will be conducted through an inventory of the existing and planned future nonmotorized facilities surrounding each proposed station and OMF location as identified in the evaluation measures. This will identify existing and future gaps in the nonmotorized network. In coordination with the regional travel demand and transit ridership forecasts, future estimated pedestrian and bicycle volumes will be generated for each station and assigned to the nonmotorized facilities within the station nonmotorized study subareas. This will be conducted for both the Build and No Build Alternatives. This assignment of the pedestrian and bicycle forecasts will identify any physical barriers limiting access to the stations.

A quantitative pedestrian LOS analysis will be conducted for sidewalks at intersections within one block (approximately 300 feet) of proposed station entrances with substantial pedestrian ridership projections (the study area may exceed one block or 300 feet from the station depending on the location of transfer points, major key intersections for pedestrian connections, or nearby pedestrian generators). The Transit Capacity and Quality of Service Manual (Transportation Research Board 2017) and HCM methodology for determining sidewalk LOS will be used for this analysis. This methodology produces a score that indicates the pedestrian's perception of the travel experience and is based on the average pedestrian space and average flow rate.

7.6.2 Construction

Nonmotorized construction analysis will be coordinated with the local and arterial traffic analysis considering the potential pedestrian or bicycle facility impacts on roadways or nonmotorized facilities as a result of project construction activity that could close or modify these facilities. This analysis will summarize the impact location, type of facility, and construction activity, including likely duration of impact (short-term versus long-term).

7.7 Safety

7.7.1 Operations

Potential effects of the project on safety will be assessed qualitatively, and where appropriate, quantitatively, for all modes within the study subareas, including general traffic, transit, freight, bicycle, and pedestrian modes.

7.7.1.1 Evaluation Measures

Evaluation measures will include the following:

- Intersection and roadway collision histories (type, severity, and frequency).
- Qualitative effects on general-purpose traffic, transit, freight, and nonmotorized safety.

7.7.1.2 Evaluation Approach

A safety analysis will be used to assess historical collisions/crashes within the project limits in terms of type, severity, and frequency. Collision data from the latest three years will be compiled and summarized to identify any current safety deficiencies. Unique collision patterns (e.g., high frequency of a specific pattern) will be noted. The collision data will be collected for any directly affected study intersections and roadways.

A safety assessment of the intersection and roadway design will be conducted only where the Build Alternatives are proposed to be either at-grade in semi-exclusive right-of-way or elevated within the road right-of-way, predicted to substantially increase volumes of one or more modes, or will result in a physical change to the roadway geometrics or channelization. Along these streets, a qualitative discussion of how the project may directly affect the existing collision type and frequency will be developed and documented.

Safety effects on general vehicle traffic and truck freight travel due to station trip activities will be qualitatively assessed based on projected changes in traffic volumes and critical queue lengths, modal conflicts, and proposed roadway design.

Safety effects on bicycle and pedestrian travel will also be qualitatively assessed based on changes in the number of conflicts with motorized modes and changes in facilities provided for their travel. This assessment will consider school walk routes and school bus zones.

7.7.2 Construction

Construction impacts will be qualitatively assessed to determine if the project's construction would have any impact on the safety of the transportation system. This will include assessing the safety of transit riders, arterial and local streets, nonmotorized modes (pedestrians and bicyclists), and freight travel.

7.8 Parking

7.8.1 Operations

Demand for parking will likely vary depending on location throughout the study subareas. An assessment of drop-off/pick-up activity and informal parking near station areas will be conducted through analysis of existing mode-of-access survey information and data from Sound Transit for similar station areas. This data will be used to estimate the impact of driving and/or parking for stations along the corridor.

If station park-and-ride (surface or garage) facilities are included in the project, the project will estimate the demand for station parking for the length of the project. While the station parking analysis will estimate the demand compared to the proposed parking to be provided, the traffic analysis will assume that station parking facilities are full in order to analyze the worst-case condition.

7.8.1.1 Evaluation Measures

Analysis of the impacts of the project on existing on-street and off-street public parking will consider roads where permanent facilities would be located in the right-of-way and roadways around stations. The analysis will consider the loss of existing public on-street and off-street parking supply and the potential for hide-and-ride parking.

7.8.1.2 Evaluation Approach

The evaluation of parking impacts will include an inventory of parking supply, regulation, and pricing of publicly accessible on- and off-street parking in the area within a 0.25-mile radius of stations (and within one block of the project and the area impacted by construction). This information will be compared to the potential changes to the availability of parking in the station area under each of the Build and No Build Alternatives, including the potential for use of public parking on-street by people seeking to access Link stations. For selected locations, if parking inventory and/or travel demand indicates the potential for effects to publicly accessible parking availability, parking utilization for select block faces will be collected for peak utilization periods (11:00 AM-2:00 PM) plus alternative time windows associated with local patterns of demand if needed. Field data related to station access via auto modes will be used to assess the impact these modes may have in and around station areas along the alignment.

Along the alignment, the assessment of potential changes to the availability of publicly accessible parking will be based on review of the inventory of the supply, regulation, and pricing of parking in the station area, available data on the utilization and availability of such public parking during periods of peak demand for access to transit, and an evaluation of the conceptual drawings for the Build Alternatives. Comparison between existing supply, regulation, and utilization, and the projected supply remaining after construction of the Build Alternatives will form the basis for identifying recommendations for changes to parking regulation or management and potential changes to parking availability likely to be attributable to parking by transit passengers in association with each Build Alternative. This comparison will also consider possible mitigation strategies. The potential change to parking availability, if any, will be presented by both location (block face and facility) and type of curb space and/or parking space regulation (e.g., time limited, paid parking, load zones, or no parking zones). Off-street parking lots will be considered in the analysis as additional supply for the loss of on-street parking. In station areas, the potential for transit passengers to park in publicly available on-street parking areas surrounding the station will be estimated based on ridership forecasts, existing parking restrictions, the availability of other transit access alternatives, and the potential walkshed of the station.

7.8.2 Construction

The assessment of construction-related parking impacts will consider the following:

- Changes in roadway supply, parking restrictions, regulations, utilization, and availability
- Impacts to on- and off-street public parking supply, management, utilization, and availability
- Additionally, there may be some temporary loss of off-street parking supply and/or availability as a result of the location and operation of construction staging, as well as construction worker parking

7.9 Aviation

7.9.1 Operations

Potential effects of the project on aviation facilities in the project corridor and FAA requirements will be studied, including potential effects on the following: Design Criteria, Airspace (Part 77 Surfaces), and Land Release.

7.9.1.1 Evaluation Measures

If necessary, project elements will be summarized through an Obstruction Evaluation/Airport Airspace Analysis, documented through a Form FAA 7460-1, and presented to FAA and Snohomish County.

7.9.1.2 Evaluation Approach

Project elements will be reviewed with FAA and Snohomish County to determine if there are potential aviation impacts.

7.9.2 Construction

Proposed construction elements in proximity to aviation facilities in the project corridor will be summarized along with potential aviation impacts.

7.10 Indirect Effects

Indirect impacts are potential effects that would be caused at a later time or farther distance but are still reasonably foreseeable. Typical indirect transportation effects are those associated with changes in land use over time. The land use changes will be described in the Land Use technical report and EIS section, and the associated potential impacts to transportation will be discussed qualitatively.

7.11 Cumulative Effects

The cumulative transportation effects of the project are already generally analyzed through traffic modeling and ridership modeling that incorporates past and reasonably foreseeable future actions and projected growth.

A qualitative assessment will address additional cumulative transportation effects for specific reasonably foreseeable future plans or proposals that have not completed environmental review or are not fully funded for construction (and therefore are not directly accounted for in the modeling) but could foreseeably be built by the horizon year. These may include, but are not limited to, consideration of effects from actions such as the following:

- Highway/lane management, such as from the implementation of tolls on state and/or local facilities, that could further alter travel behavior in the corridor
- Construction activities from other transportation projects that could affect or be influenced by the project construction activities
- Local developments and public infrastructure projects that could contribute to cumulative traffic delays on local arterial streets over the construction period

8 MITIGATION MEASURES

Potential impacts to transportation will be controlled through project planning, design, and the application of required best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the alternatives will be incorporated as appropriate. Where impacts cannot be avoided or minimized, mitigation measures will be developed.

The development of potential mitigation measures will be coordinated with the relevant federal, state, and local agencies and jurisdictions to identify strategies that may already be under consideration but that could benefit the project.

8.1 Regional Transportation

Mitigation would be determined if any impacts to the measures evaluated within the Regional and Corridor Traffic section during operations or construction were identified.

8.2 Transit

The performance of the transit system will be assessed under the Build, No Build, and construction conditions using analysis results as stated in Section 7.3. The objective of the transit service integration plan collaboratively developed between Community Transit, Everett Transit, and Sound Transit is to be cost neutral, therefore potential mitigation for transit service hours or fleet is not expected with the project. Project-related operational delays, facility impacts, and mitigation identified as part of the traffic analysis conducted near the station areas and alignments will be reviewed to determine if there are needed transit improvements to maintain transit speed and reliability through these impacted locations (see Section 8.3).

At these locations, impacts will be reviewed and potential mitigation, design changes, and/or service revisions will be determined collaboratively by Community Transit, Everett Transit, and Sound Transit.

8.3 Arterials and Local Streets

Mitigation to property access and local circulation will be developed to address impacts to the roadway system and/or individual properties caused by the project. This could include project impacts that create substantial out-of-direction travel or would substantially limit access to areas or properties through road closures or direct barriers the project creates. Local circulation mitigation could also be determined if the project shifts traffic and causes intersections to operate with an unacceptable LOS based on the LOS standards established in this section.

For intersection operations, if the intersection LOS is equal to or better than the jurisdictional agency's LOS standard with the Build Alternatives, then that intersection is considered to meet the jurisdictional agency's standard and does not require mitigation. In situations where the intersection already operates worse than the jurisdictional agency's LOS standard (e.g., LOS F) in the No Build Alternative, then mitigation is only required if the overall intersection delay and/or LOS noticeably degrades (greater than a 15-second increase in the delay) with the project alternatives. In these situations, the project is only obligated to bring the operating condition back to the overall intersection delay levels in the No Build condition. Additionally, depending on the agreement with the relevant jurisdictions, potential mitigation may be needed if the project extends queue lengths further than those in the No Build Alternative and beyond the storage provided. Potential mitigation might include operational changes to signal phasing and physical modification such as restriping, extending, or adding turn lanes. Potential mitigation will also be reviewed against the nonmotorized conditions evaluated under Section 7.6 and safety conditions evaluated under Section 7.7, as well as any mitigation identified under Section 8.5 or Section 8.6. Potential mitigation measures that are found to have adverse effects on nonmotorized conditions or safety will be reviewed with relevant jurisdictions for resolution.

Mitigation measures, if necessary, will be developed to address construction impacts on the local and arterial roadway system with respect to property access and circulation, and arterial and local roadway operations.

8.4 Freight

Potential improvements will be identified to mitigate potential direct (long-term and construction) impacts from the Build Alternatives on freight. This will consider degradation of freight operations access and circulation impacts along affected roadways, commercial loading zones, and rail.

8.5 Nonmotorized

Potential improvements will be identified to mitigate potential direct (long-term and construction) impacts from the Build Alternatives on the nonmotorized system. This will consider degradation of pedestrian and bicycle conditions surrounding station areas, and any identified direct impacts to the pedestrian and bicycle facilities.

8.6 Safety

Potential improvements will be identified to mitigate potential direct (long-term and construction) impacts from the Build Alternatives on the safety of the transportation system. This will consider degradation of safety to transit riders, arterial and local streets, nonmotorized modes (pedestrians and bicyclists), and freight travel. The Federal Highway Administration Crash Modification Factor Clearinghouse will be used to identify safety countermeasures, if needed.

8.7 Parking

Potential parking mitigation will be considered where the project permanently or temporarily (e.g., during construction) removes public parking, including loading zones, or, where parking utilization by transit passengers is projected to result in a substantial change to the availability of public parking within a local sub-area or block face (e.g., more than 50% of parking is removed for the project or used by transit passengers), resulting in a condition where less than 15% of the capacity of the facility or area is available during periods of peak demand. Areas with a high potential for a significant change to parking availability due to transit passenger demand will be identified, with recommendations for changes to local parking regulation and management as mitigation strategies to reduce the likelihood of this activity. Potential changes to the availability of private parking would be addressed as a property acquisition impact.

8.8 Aviation

Any mitigation measures identified in the Obstruction Evaluation/Airport Airspace Analysis necessary to address impacts to aviation during operations or construction will be identified.

9 PROPOSED FIGURES, MAPS, OR OTHER DATA

Potential figures include:

- Study subareas
- Screenlines
- Freight routes and facilities
- Study intersection volumes

- Intersection LOS
- Walksheds and bikesheds
- Existing and future nonmotorized facilities
- Existing and future transit networks

Potential tables and graphs include:

- Roadway v/c ratio
- Station mode of access
- Station ridership

10 DOCUMENTATION

For the EVLE EIS, the transportation discipline will develop the following documentation:

- Transportation Technical Report
- EIS chapter

11 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

Specific types of transportation data will also be developed for use in analyzing project impacts on other environmental resources.

11.1 Air Quality

To support the Air Quality impact analysis, the following types of data will be produced:

- Daily VMT estimates by speeds for two areas: EVLE study area and regional system. These estimates will be provided in a tabular format for greenhouse gas analyses.

The above information will be provided for existing conditions (2023) and the horizon year (2046).

11.2 Noise and Vibration

To support the Noise and Vibration impact analysis, the following types of data will be produced:

- Existing (2023) and horizon year (2046) PM peak hour Synchro model files and general system-wide vehicle classification information (i.e., heavy vehicle percentage)

11.3 Energy

To determine operational energy impacts, the following types of data for year 2046 will be produced:

- Daily regional VMT and VHT
- Daily light rail transit VMT

11.4 Economics

To support the Economics analysis, the following information will be provided:

- Changes in access
- Parking impacts
- Construction detour routes
- Long term effects on general and freight mobility
- Temporary construction impacts to freight routes or loading zones

11.5 Environmental Justice and Social Resources, Community Facilities, and Neighborhoods

To support the Environmental Justice and Social Resources, Community Facilities, and Neighborhoods analysis, a variety of data will be produced, including the following:

- Estimated travelsheds as determined by using the travel demand model to identify transportation analysis zones relevant to the Environmental Justice and Social Resources, Community Facilities, and Neighborhoods analysis
- Estimated travel times to selected destinations for use in the analysis of access to employment centers, educational institutions, and medical services for environmental justice populations
- Analysis of temporary or permanent impacts on ADA parking or designated parking at social services, as well as percentage of parking spaces temporarily or permanently lost in designated commercial shopping districts
- Permanent and temporary changes in transit and traffic operations, circulation, and access on corridor roadways and potential mitigation

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13 APPENDICES

Appendix A: Transit Integration Technical Memorandum

Appendix B: Sound Transit’s Transit Ridership Forecasting Methodology Report

APPENDIX A

Transit Integration Technical Memorandum

Everett Link Extension

Transit Integration Technical Memorandum

December 2022

SOUNDTRANSIT

Revision History

Version	Title	Date	Notes, As Required
Draft 1	Transit Integration Technical Memorandum	10/7/2022	Draft 1 for Sound Transit review
Draft 2	Transit Integration Technical Memorandum	12/19/2022	Revised per Sound Transit comments

Table of Contents

Figures

Tables

Acronyms

EIS	Environmental Impact Statement
EVLE	Everett Link Extension
OMF	Operations and Maintenance Facility
ST3	Sound Transit 3 Plan

1 INTRODUCTION

1.1 Overview

The Everett Link Extension (EVLE), referred to in this memo as “the EVLE Project” or “the project,” will extend the Link light rail 16 miles from the Lynnwood City Center Link light rail station to the Everett Station area, adding six new stations and considering one provisional (or unfunded) station. The project is part of the Sound Transit 3 Plan (ST3) approved by voters in 2016. ST3 included a description of the “representative project” which identified the mode, station locations and related features, such as an Operations and Maintenance Facility (OMF). This formed the basis for the scope, schedule and budget assumed for the expansion of light rail to Everett. The ST3 representative project itself is the result of extensive, multi-year planning and public involvement work.

A map of the ST3 representative project showing the extension and planned station areas is shown in Figure 1-1 (Everett Link Extension Representative Project). The EVLE Project will extend the Lynnwood Link Extension, currently under construction, and will provide fast, reliable, frequent transit service to communities in Lynnwood, Snohomish County, and Everett. The EVLE Project provides important north/south connections to major employment, population, and activity centers, and connects to other local and regional transit services including Community Transit, Everett Transit, Community Transit *Swift* bus rapid transit (BRT) lines, and Sounder commuter rail service.

Sound Transit is leading the Alternatives Development phase (Phase I) of the EVLE Project planning process. Agency partners, the public, and other stakeholders were involved throughout this process. The Alternatives Development phase identifies, evaluates, and narrows down a wide range of alternatives. The information generated during this phase, as well as feedback from the public and stakeholders, will assist the Sound Transit Board in identifying a Preferred Alternative to study in a future Environmental Impact Statement (EIS). During the Alternatives Development phase, Sound Transit initiated agency coordination and robust public engagement to identify potential alternatives for light rail routes and profiles, as well as potential station and OMF North locations. Alternatives were analyzed through evaluation criteria based on the EVLE Project’s purpose and need statement. Consideration was also given to Sound Transit’s System Expansion Implementation Plan and federal funding program requirements.

Based on feedback received and the results of the alternatives evaluation, the Sound Transit Board is expected to identify a Preferred Alternative and other alternatives to advance into the next planning phase: Draft EIS and Conceptual Engineering (Phase II). Figure 1-2 (EVLE Project Overview) provides an overview of the project planning process.

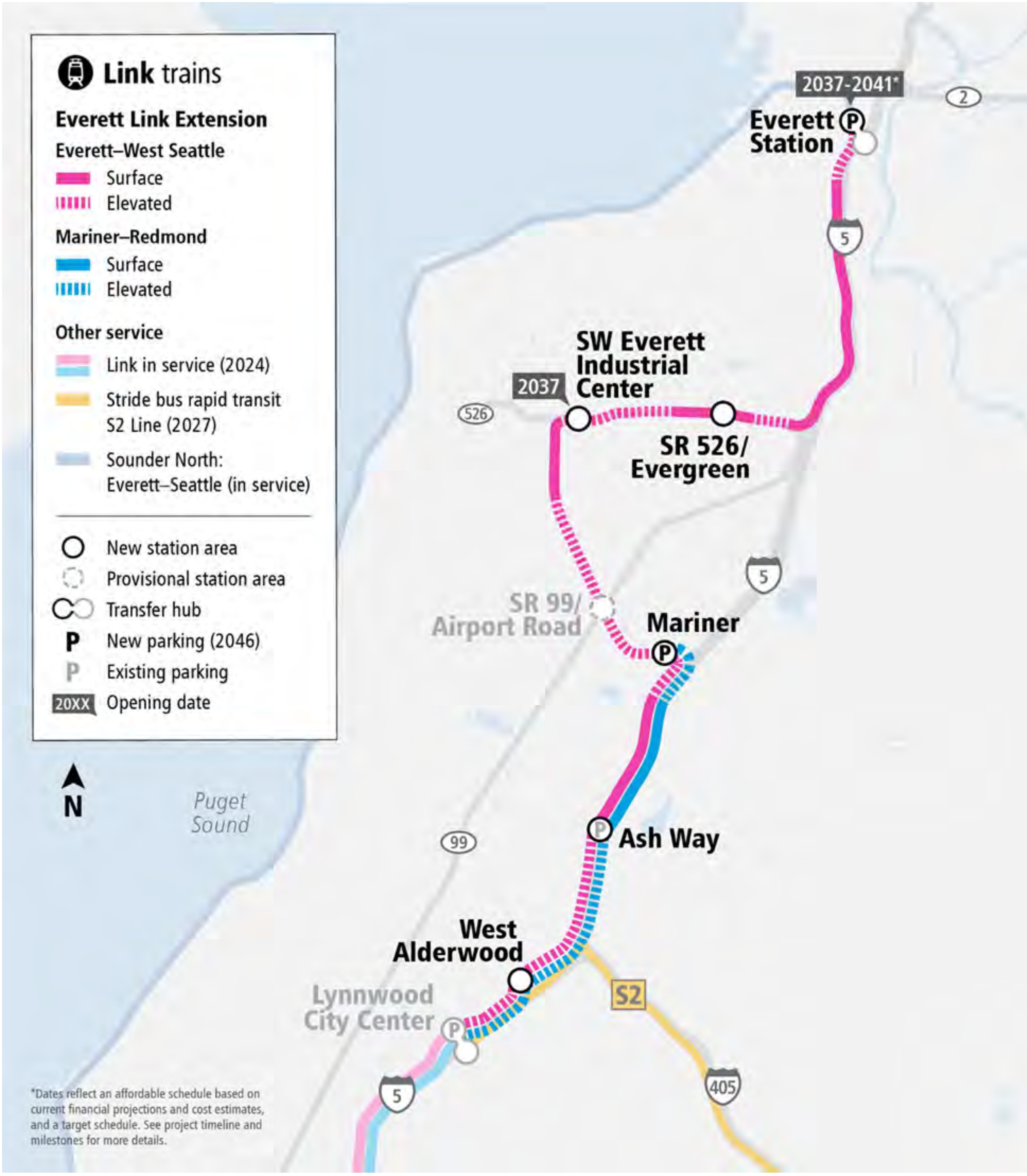


Figure 1-1 Everett Link Extension Representative Project

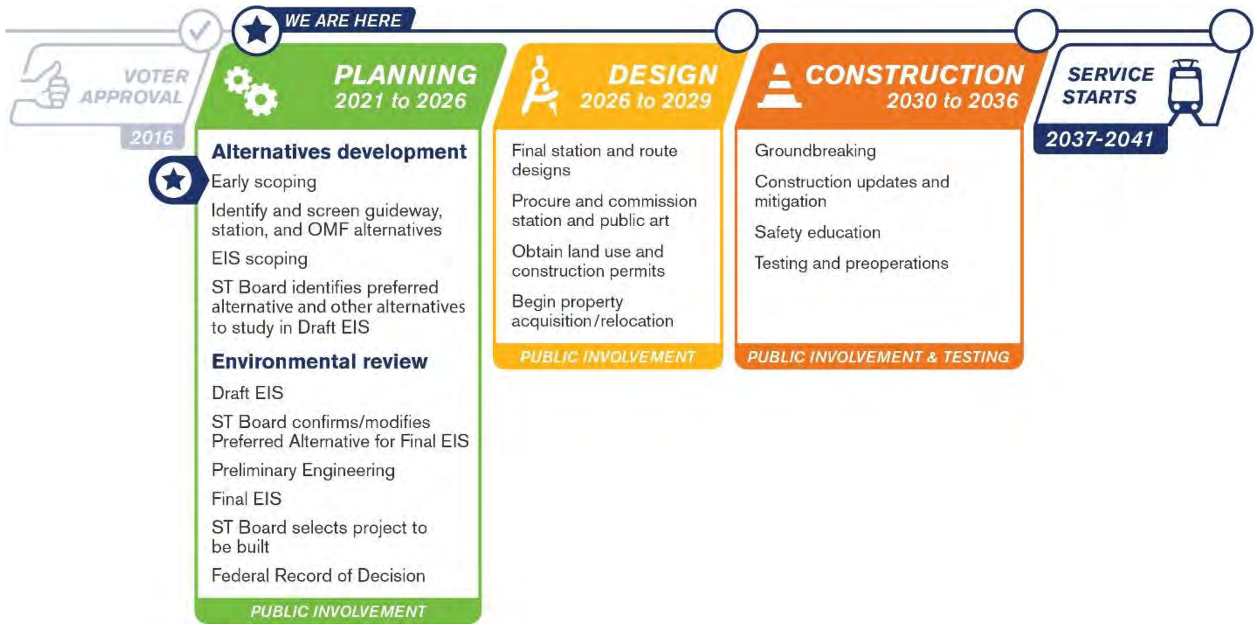


Figure 1-2 EVLE Project Overview

1.2 Purpose of Report

This technical memorandum describes the process of evaluating transit integration during Phase I of the EVLE Project. This process includes a multi-level evaluation approach that eliminates lower-performing alternatives and analyzes remaining alternatives in more detail as the evaluation progresses. Each level considers evaluation criteria and measures consistent with the preliminary purpose and need for the EVLE Project. The alternatives evaluation process will inform the Sound Transit Board's identification of a Preferred Alternative and any other alternatives to advance into the Draft EIS and Conceptual Engineering phase.

2 OVERVIEW OF LEVEL 1 AND LEVEL 2 ANALYSES

During Phase I, possible alternatives were identified through gathering data on existing conditions and local and regional plans, as well as through collaboration with partner agencies, tribes, and the public. The process began with 56 potential station location alternatives across the seven station areas. Through each level of evaluation, the analysis became more detailed and rigorous as data was gathered and conceptual design advanced, and low-performing alternatives were eliminated from consideration to arrive at a smaller number of the most promising alternatives. The initial 56 station location alternatives were screened down to 29 alternatives for the Level 1 evaluation and 20 alternatives for the Level 2 evaluation covered in more detail in this memo.

The initial screening process determined if the identified alternatives met the project purpose and need and rated alternatives based on their ability to satisfy the evaluation criteria relative to the ST3 representative project. The alternatives development process measured the performance of each station area alternative relative to other alternatives in the same station area.

The Alternatives Development process will result in the Sound Transit Board identifying a Preferred Alternative and other alternatives to advance to the Draft EIS for further evaluation. The evaluation process consisted of three levels to identify the alternatives that best meet the preliminary purpose and need for the EVLE Project. The first two evaluation levels (Screening and Level 1) reviewed alternatives by specific station areas or study sections. The final evaluation level, Level 2, added an end-to-end corridor analysis of alternatives.

3 TRANSIT INTEGRATION ANALYSIS

This transit integration analysis was part of a broad set of evaluation criteria in the Level 1 evaluation and Level 2 evaluation and was necessary to assess the performance of station alternatives within the context of existing and proposed transit service. A new transit investment with accessible stations that are well-connected to existing transit service is more likely to meet the needs of current and future transit riders. Understanding potential transit service levels at each station alternative also helps to determine facility needs, such as layover space and active bus bays. Station locations were identified in the Screening evaluation and further refined as part of the Level 1 evaluation. For the Level 2 evaluation, several advancements were made for each station alternative progressed to that level. One example is station areas in Level 2 were further defined, including early conceptual station concept layouts that sized and configured station features such as rail platforms, pick-up/drop-off areas, and bus bays. Secondly, bus service networks and frequencies were developed for the surrounding bus network. These elements are depicted in the conceptual site plans and bus circulation graphics associated with each station alternative. Station concept layouts and transit integration networks were vetted with the Interagency Group (IAG), which included local transit operators.

The Level 1 transit integration evaluation included an assessment of connections between the station and both high-capacity transit and other bus transit services. Transit integration analysis for the Level 2 evaluation allowed for a more in-depth analysis associated with the further definition of station access facilities and transit integration networks. The evaluation included an assessment of the quality of transfers to planned bus services, a specific focus on connections to high-capacity transit, implications to bus routing and efficiency for station connections, and amount of planned bus connectivity. Similar to the Level 1 evaluation, alternatives within the same station area were compared to each other during Level 2. For transfer quality and connectivity to high-capacity transit, the analysis looked at whether bus routes served the station directly or indirectly, transfer distance to make bus-rail connections, potential barriers along transfer walking paths, and service connectivity to *Swift* BRT lines. For connecting transit service and operations, the project team examined potential diversions from existing or optimal bus routing. The amount of planned bus activity was based on the planned number of buses per hour serving the station. A score range of 1 to 5 was assigned to each station alternative, with 1 being poor performance and 5 being excellent performance.

A detailed overview of transit integration measures and methods for both the Level 1 and Level 2 evaluation is provided in Tables 3-1 (Level 1 Evaluation Measures and Methods for Transit Integration) and 3-2 (Level 2 Evaluation Methods and Measures for Transit Integration).

Table 3-1 Level 1 Evaluation Measures and Methods for Transit Integration

Category	Criteria	Measure	Methods
Increase Transit Connectivity and Capacity Improve regional mobility by increasing connectivity and capacity in the EVLE corridor from the Lynnwood Transit Center to the Everett Station area to meet projected transit demand.	Modal Integration	**Quality and capacity of transfers**	**Assessment of quality of bus-rail transfers based on distance and barriers between bus drop-off and station entrance and capacity to integrate bus transfers based on proximity to existing transit centers/park-and-rides, and/or capacity to accommodate direct drop-off or on-street transfers.**
		Connectivity to high-capacity transit	**Evaluation of ease of connections to existing and planned high-capacity transit stations and corridors, including *Swift* BRT at station alternatives.**

*Measures and methods in **bold** were changed/added from the Screening to Level 1 evaluation.*

Table 3-2 Level 2 Evaluation Measures and Methods for Transit Integration

Category	Criteria	Measure	Methods
Increase Transit Connectivity and Capacity Improve regional mobility by increasing connectivity and capacity in the EVLE corridor from the Lynnwood Transit Center to the Everett Station area to meet projected transit demand.	Modal Integration	Quality and capacity of bus-rail transfers*	Quality of bus-rail transfers based on distance from stop locations and barriers to walking transfers. Capacity to integrate bus transfers based on proximity to existing and/or funded transit centers, and capacity to accommodate direct drop-off or on-street transfers.
		Quality of potential access for transit vehicles	**Assessment of quick and reliable bus access to station alternatives based on the roadway network, barriers, and available Community Transit, Everett Transit, and ST Express network assumptions.**
		Planned level of bus service and connectivity	**Planned total level of bus service to station alternatives.**
		Connectivity to high-capacity transit*	Evaluation of ease of connections to existing and planned high-capacity transit stations and corridors, including *Swift* BRT at station alternatives.

*Measures and methods in **bold** were changed/added from the Level 1 to Level 2 evaluation.* ** - Measure is refined or revisited.*

4 TRANSIT SERVICE INTEGRATION ASSUMPTIONS

The planned future with project bus networks were developed based on information from the local transit operators and partner agencies - Community Transit and Everett Transit – as well as from future plans for Sound Transit bus route service. The project included close coordination with both local transit operators throughout Phase I to develop and refine transit integration networks, bus facilities, and circulation shown in station concept layouts. Prior to the project team developing bus integration networks, Community Transit and Everett Transit jointly provided a 2036 route network that represented the current projection of a combined service network - - integrated with completion of the EVLE Project. That was accompanied by a table indicating station assignments for specific bus routes at each of the planned EVLE stations. The project team continued to collaborate with Community Transit and Everett Transit during the process of adjusting that network to reflect both short-term transit network changes being planned by Community Transit for a 2024 implementation ("Transit in 2024") that would have corresponding modifications to the 2036 network and to modify the network to reflect the varying EVLE Project station locations being analyzed in the Level 2 evaluation. These agencies also provided design requirements for bus bays and bus circulation at EVLE Project stations. Refined bus networks reflecting specific Level 2 station alternatives and transit operator-defined bus bay quantity and sizing requirements were then used to define the number of active and layover bus bays needed at each station.

See Figure 4-1 and Figure 4-2 for the existing bus service networks for Community Transit and Everett Transit, respectively. See Figure 4-3 for the proposed refined bus service network developed for the EVLE Level 2 evaluation.

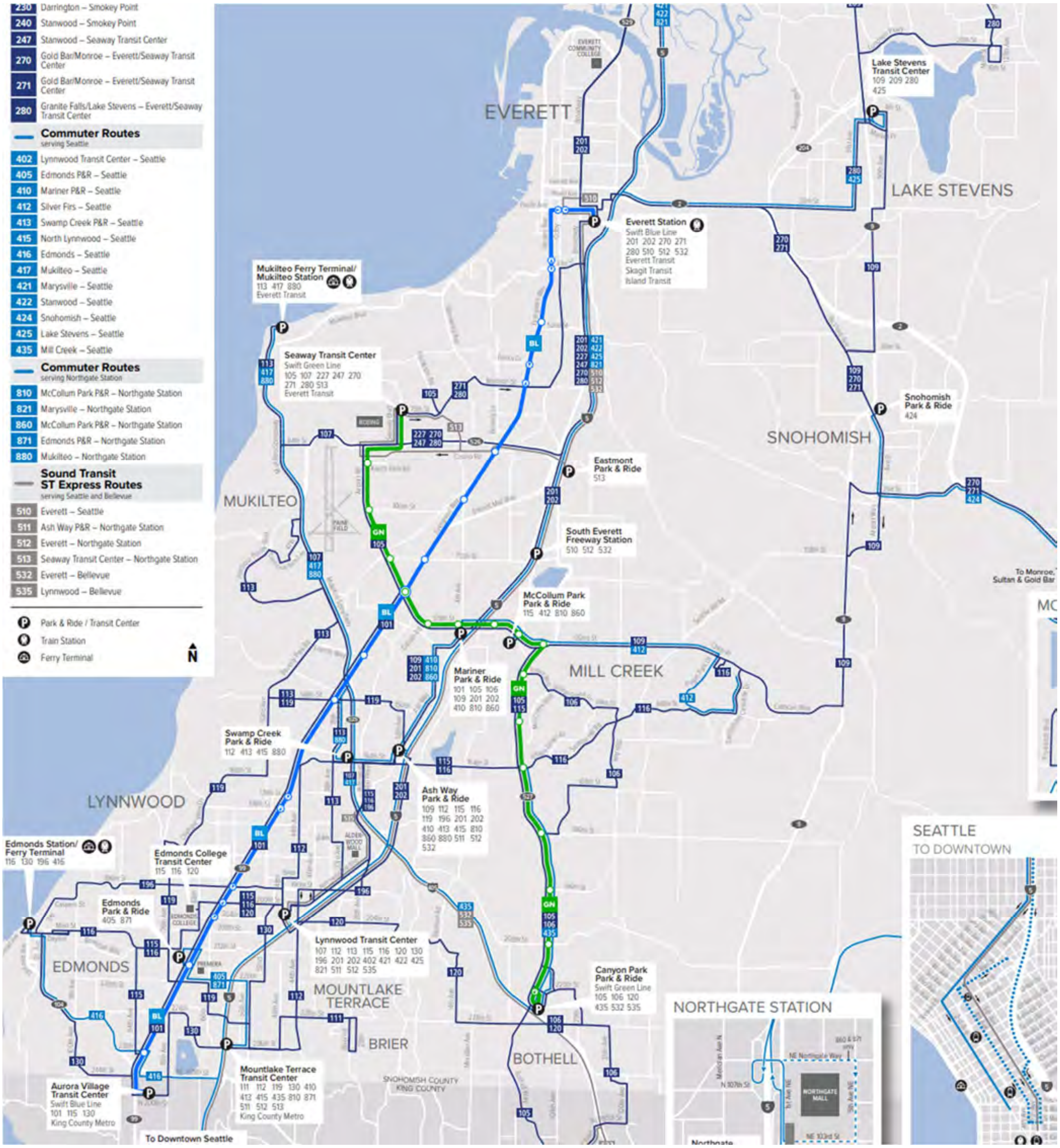


Figure 4-1 Existing Service, Community Transit

Figure 4-2 Existing Service, Everett Transit

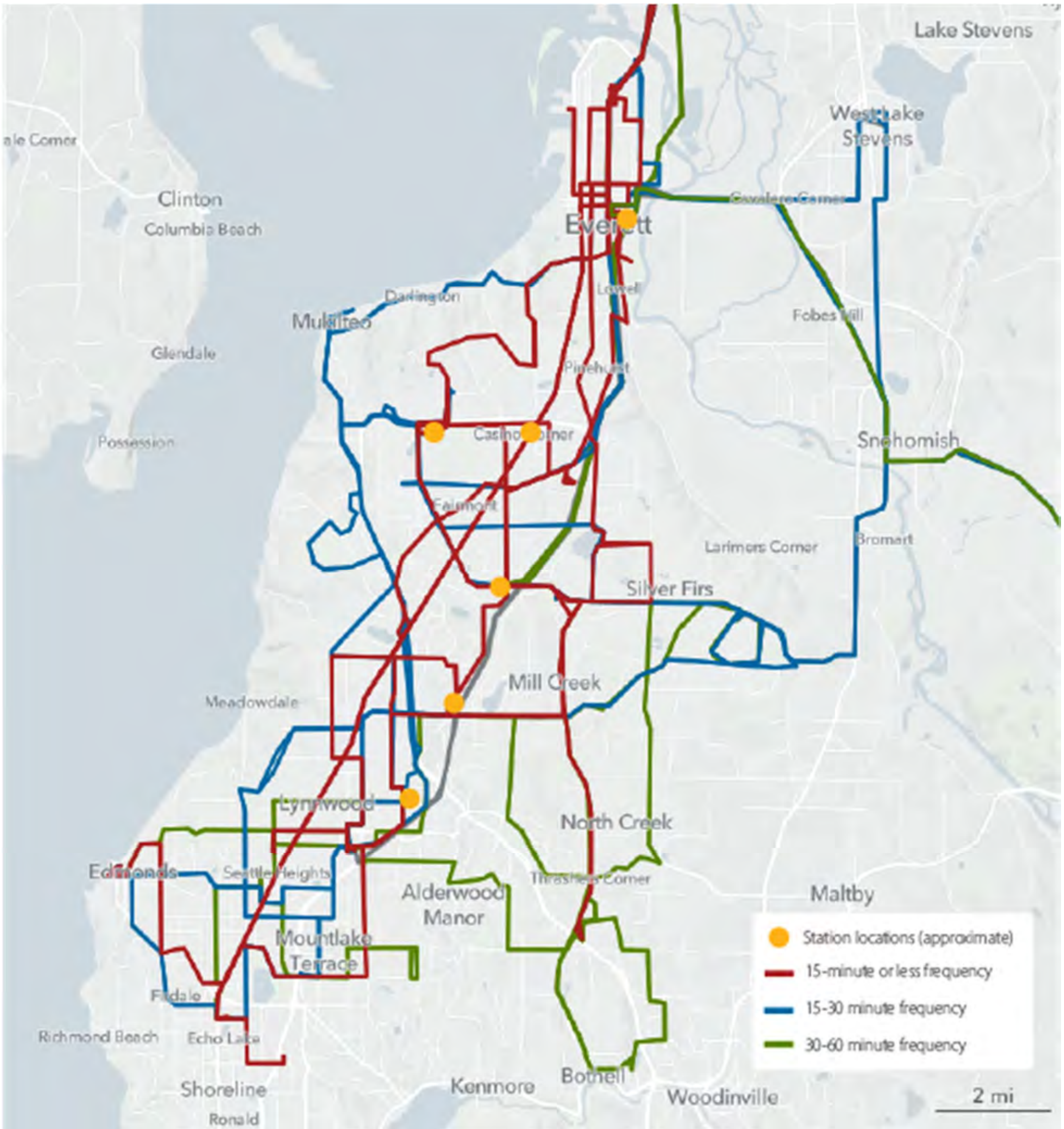


Figure 4-3 Proposed Transit Service

4.1 Service

Table 4-1 (Buses per Hour by Station Area) documents the number of buses on each route per hour that will serve each EVLE station. Note that the table sums the number of buses traveling in each direction per route, so that a 15-minute frequency bi-directional through route would generate 8 buses per hour at a station. Routing information for each station area can be found in Chapter 5 (Conceptual Transit Integration by Station Alternative). It is anticipated that bus network assumptions will be refined for any alternatives that advance to future project phases, which may change the routes and frequencies identified in this table.

Table 4-1 Buses per Hour by Station Area

Route	Buses per Hour at Peak Frequency (includes both directions)						
	West Alderwood	Ash Way	Mariner	SR 99/Airport Road (Provisional)	SW Everett Industrial Center	SR 526/ Evergreen	Everett Station
3/12					8	8	8
4							4
5							8
8			8				8
13	8						
14		8	8		8		
18							4
19			6	6			
29			8				8
70					4		
90X (Skagit)							2
101				8		8	
103	4				4		
104		8					
105			4				
111	4						
112		6					
116		4					
119		4					
121		4					
132			4				
166		4					
201							4
202							4
271							4
280							4
412 (Island)							3
Eastmont			6		6		

Route	Buses per Hour at Peak Frequency (includes both directions)						
	West Alderwood	Ash Way	Mariner	SR 99/Airport Road (Provisional)	SW Everett Industrial Center	SR 526/ Evergreen	Everett Station
701 (Blue)				12		12	12
702 (Green)			12	12	12		
703 (Orange)	12	12					
704 (Gold)							12
901			4				
902	4						
903			8				
904			8				
905			4				
Total	**32**	**50**	**80**	**38**	**42**	**28**	**85**

4.2 Active Bays and Layover Space

The numbers of active bays and layover bays required at each station were calculated based on the number of buses at the station per hour and a conversion rate of frequency to bays provided by the local transit operators. The resulting numbers of active bays and layover bays are documented in Table 4-2 (Bays and Layover Space Needs by Station Alternative). It is anticipated that bus network assumptions will be refined for any alternatives that advance to future project phases, which may change the space needs identified in this table.

Table 4-2 Bays and Layover Space Needs by Station Alternative

Station Area	On-Street Bays	Off-Street Bays	Layover Spaces
West Alderwood			
ALD-B	0	4	2
ALD-D	4	2	2
ALD-F	0	4	2
Ash Way			
ASH-A	0	10	9
ASH-D	0	10	8
Mariner			
MAR-A	2	19	7
MAR-B	2	19	7
MAR-D	2	15	28*

Station Area	On-Street Bays	Off-Street Bays	Layover Spaces
SR 99/Airport Road			
AIR-A	8	0	0
AIR-B	8	0	0
SW Everett Industrial Center			
SWI-A	0	8	2
SWI-B	2	8	2
SWI-C	2	6	2
SR 526/Evergreen			
EGN-A	6	0	0
EGN-C	6	0	0
EGN-D	6	0	0
EGN-E	6	0	0
Everett Station			
EVT-A	2	12	21*
EVT-C	17	0	0
EVT-D	17	0	0

**Totals include layover spaces that may be provided at the existing transit facilities.*
Note: Minor inconsistency between bay requirements in Table 4-2 and station concept layouts will be addressed along with further refinement of bus network assumptions in Phase 2. The bay requirements shown in Table 4-2 are current as of the preparation of this memo and reflect assumptions used in Phase 1 ridership modeling.

Additional station access facility design standards provided by the local transit operators include:

- Paratransit locations with clear path to elevator.
- Each active or layover bay should allow for independent arrival and departure for an over-the-road 60’ coach (most conservative vehicle type).
- *Swift* BRT stations are separate from local bus stops with distinctive station design requirements.
- *Swift* BRT coaches must have the ability to align all doors to boarding areas at *Swift* BRT stations.
- Dedicated space for TNC/Microtransit drop-off and pick-up is required at all stations.
- Avoid curb cuts and protruding objects such as signs and trees in vicinity of bus bays and layover.
- *For Mariner and SR 99/Airport Road*: Separate layover for two standby buses needed. This layover request is not included in Table 4-2. Provision for this layover space will need to be further considered in Phase 2.

- Sound Transit's Station Experience Design Guidelines provide additional station design guidance and principles to facilitate transit integration and access for vehicles and transit passengers.

5 CONCEPTUAL TRANSIT INTEGRATION BY STATION ALTERNATIVE

For each station alternative, conceptual routing and station area site plans were developed to define, for the purposes of the Level 2 evaluation, the location of active and layover bays, potential barriers and walking distances for bus-rail transfers, bus routing and access constraints and strategies, and the sizing and implications needed to accommodate the defined bus bay needs. As part of the Level 2 evaluation discussed previously, station location alternatives were compared to each other and given a rating on the basis of transfers, connectivity, and access. It is anticipated that both station layout concepts and transit integration networks will continue to be refined in Phase 2. The figures and associated findings for each station are provided in sections 5.1 through 5.7.

Station access facility concepts depict proposed on-street and off-street bus bays, including the location of existing *Swift* BRT stations and other bus bays that will remain. Potential layover bay spaces are depicted as well. General bus circulation flows and the relationship to planned pick-up/drop-off spaces are included.

Bus routing maps depict the planned transit integration network associated with each station alternative. Routes that would directly serve off-street transit centers are depicted as such on the graphics.

5.1 West Alderwood

5.1.1 ALD-B

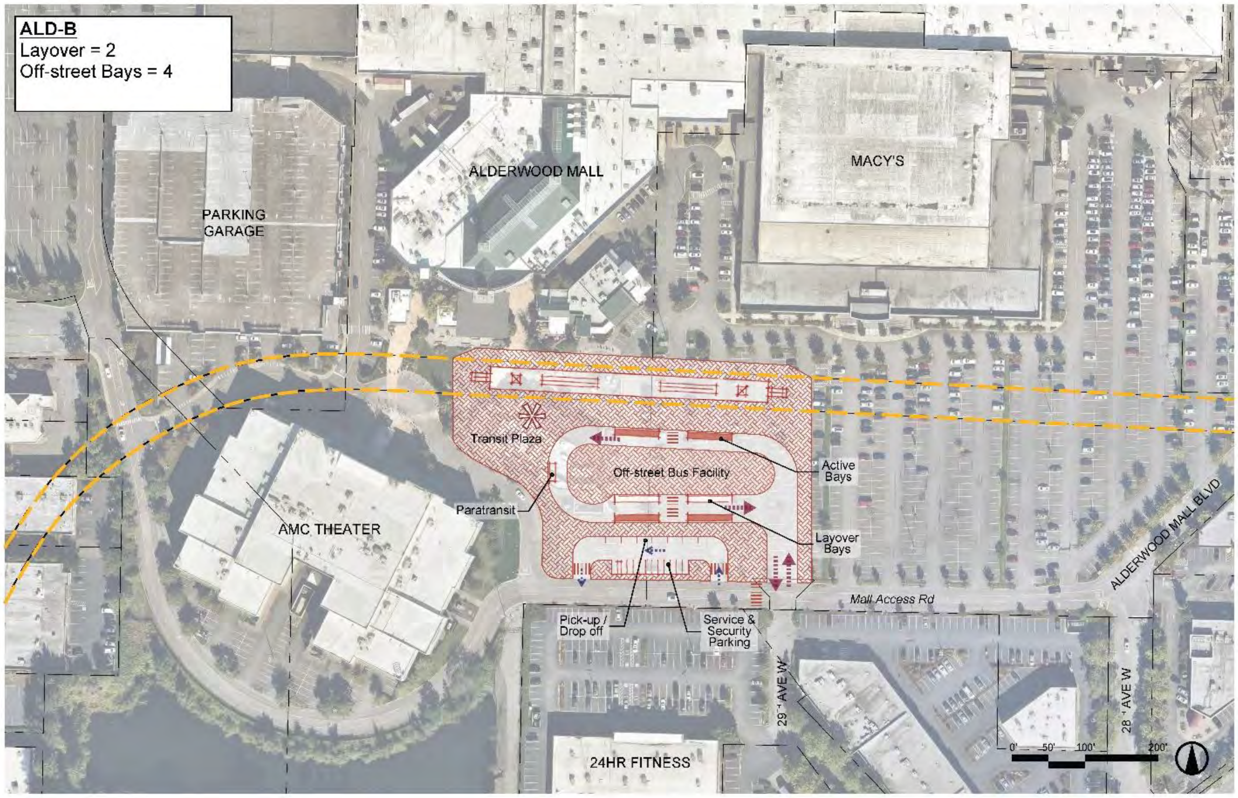


Figure 5-1 ALD-B Station Access Facility Concept Map

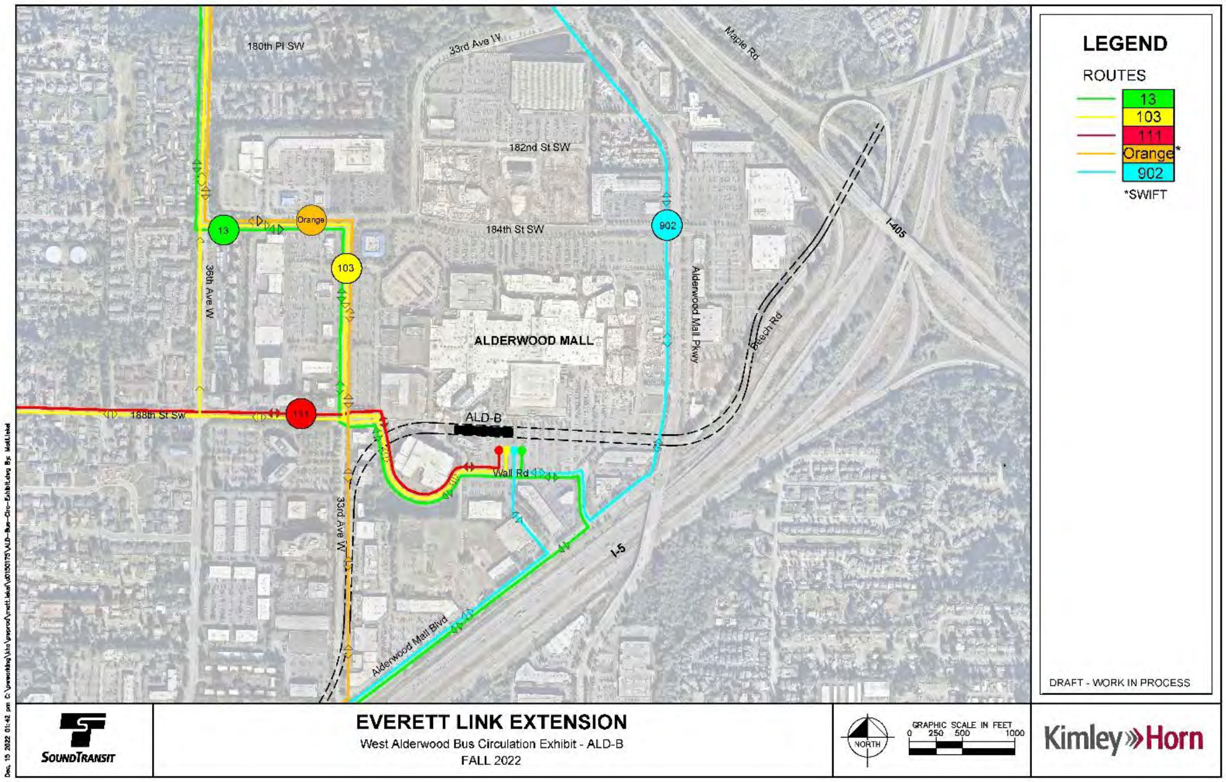


Figure 5-2 ALD-B Bus Routing Map

Quality and capacity of transfers

- Four routes serve this station alternative directly at an off-street transit center.

Connectivity to high-capacity transit

- Long transfer distance to the *Swift* BRT Orange Line, which remains on 33rd Avenue W at 188th Street SW.

Quality of access for transit vehicles

- Diversion from baseline routing.
- Diversion occurs along mall roads susceptible to congestion and lower speeds, impacting travel times.

Planned level of bus service

- Peak 18 buses/hour (weekday).

5.1.2 ALD-D

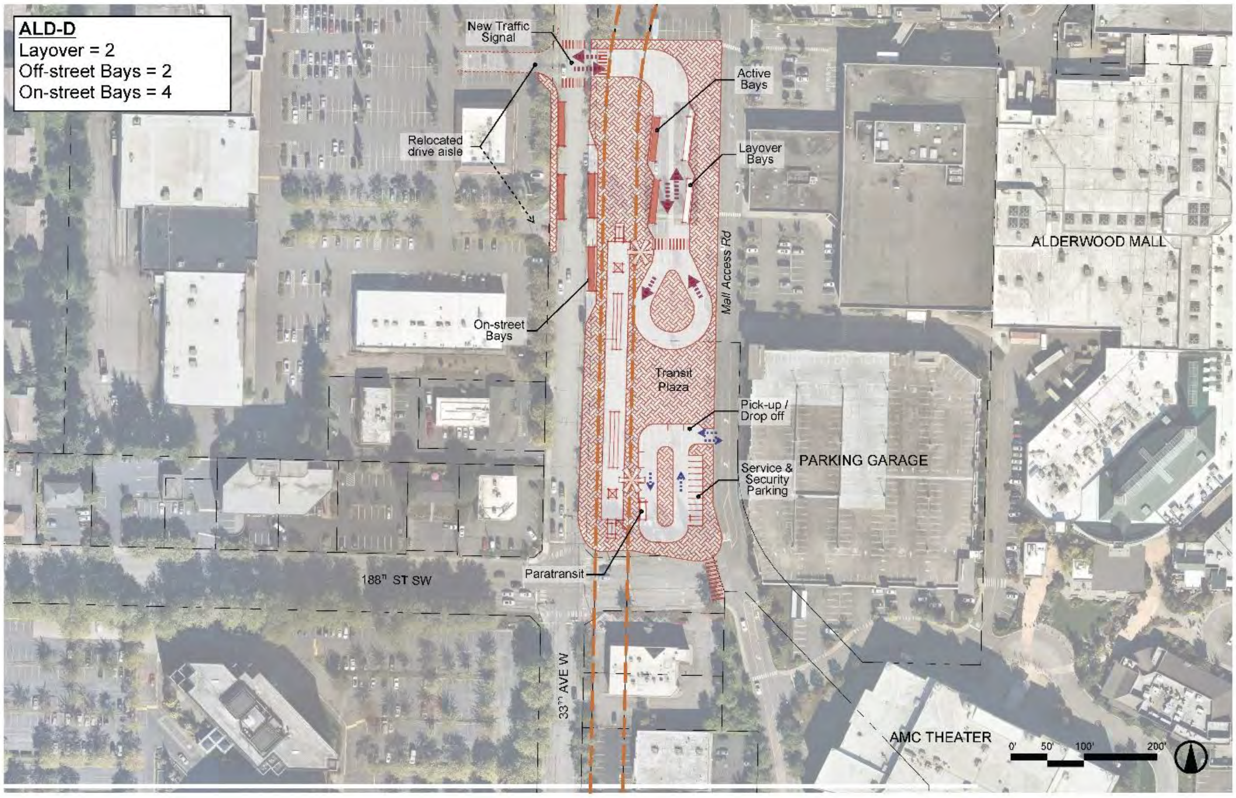


Figure 5-3 ALD-D Station Access Facility Concept Map

Figure 5-4 ALD-D Bus Routing Map

Quality and capacity of transfers

- Four routes serve this station alternative directly, with some accessed by passengers via bus stops on 33rd Avenue W and some within an off-street transit center facility.

Connectivity to high-capacity transit

- Direct connection to the *Swift* BRT Orange Line.
- Some transfers may require crossing 33rd Avenue W.

Quality of access for transit vehicles

- Minimal diversion for buses.
- On-street stops on 33rd Avenue W allow for no travel time penalty to access station for some routes.

Planned level of bus service

- Peak 26 buses/hour (weekday).

5.1.3 ALD-F

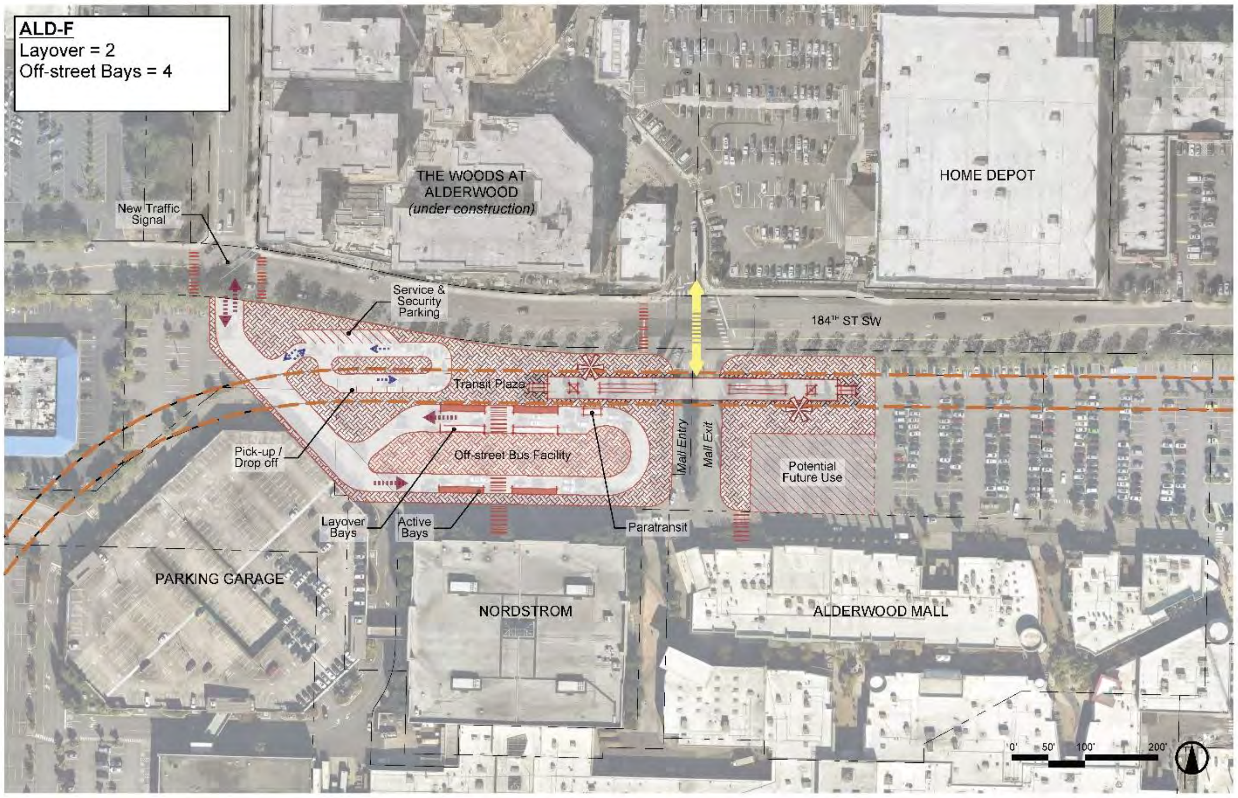


Figure 5-5 ALD-F Station Access Facility Concept Map

Figure 5-6 ALD-F Bus Routing Map

Quality and capacity of transfers

- Four routes serve this station alternative directly to an off-street transit center.

Connectivity to high-capacity transit

- Long transfer distance to the *Swift* BRT Orange Line, which remains on 33rd Avenue W at 188th Street SW.

Quality of access for transit vehicles

- Some diversion from baseline routing.

Planned level of bus service

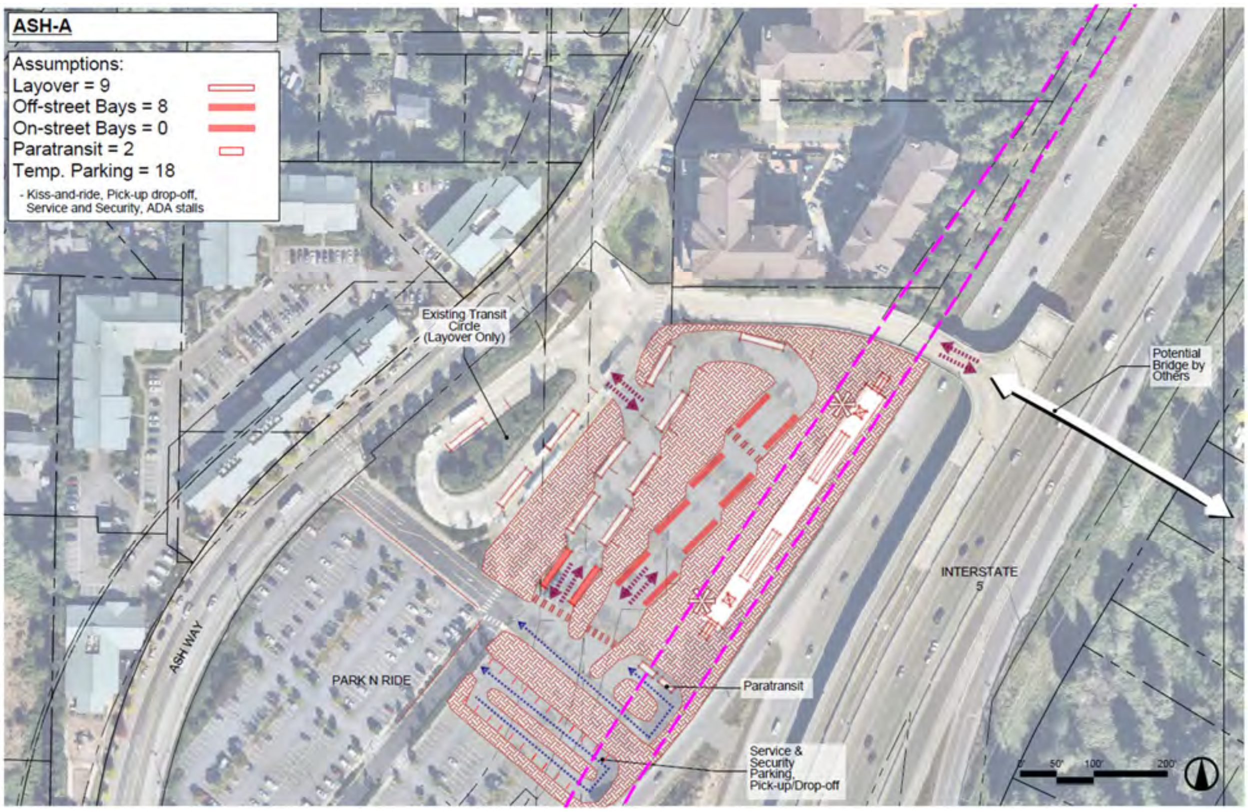
- Peak 18 buses/hour (weekday).

5.2 Ash Way

The two Ash Way station alternatives were both evaluated under two different background network scenarios. The “Without” background improvements scenario assumes the existing roadway network in the vicinity of the station. The “With” background improvements scenario assumes the addition of a new multimodal bridge crossing over I-5 to the north of 164th Street SW between Ash Way Park-and-Ride and Meadow Road.

5.2.1 ASH-A

The quality of transit integration with the ASH-A alternative would not fundamentally change between the “With” and the “Without” networks. While the new I-5 overcrossing would modify walksheds and bikesheds, transit routing and transfer patterns would generally be unchanged. The evaluation notes listed in this section would apply to both the “With” and “Without” networks.



Note: Minor inconsistency between bay requirements in Table 4-2 and concept will be addressed along with further refinement of bus network assumptions if the alternative is advanced to Phase 2.

Figure 5-7 ASH-A Station Access Facility Concept Map

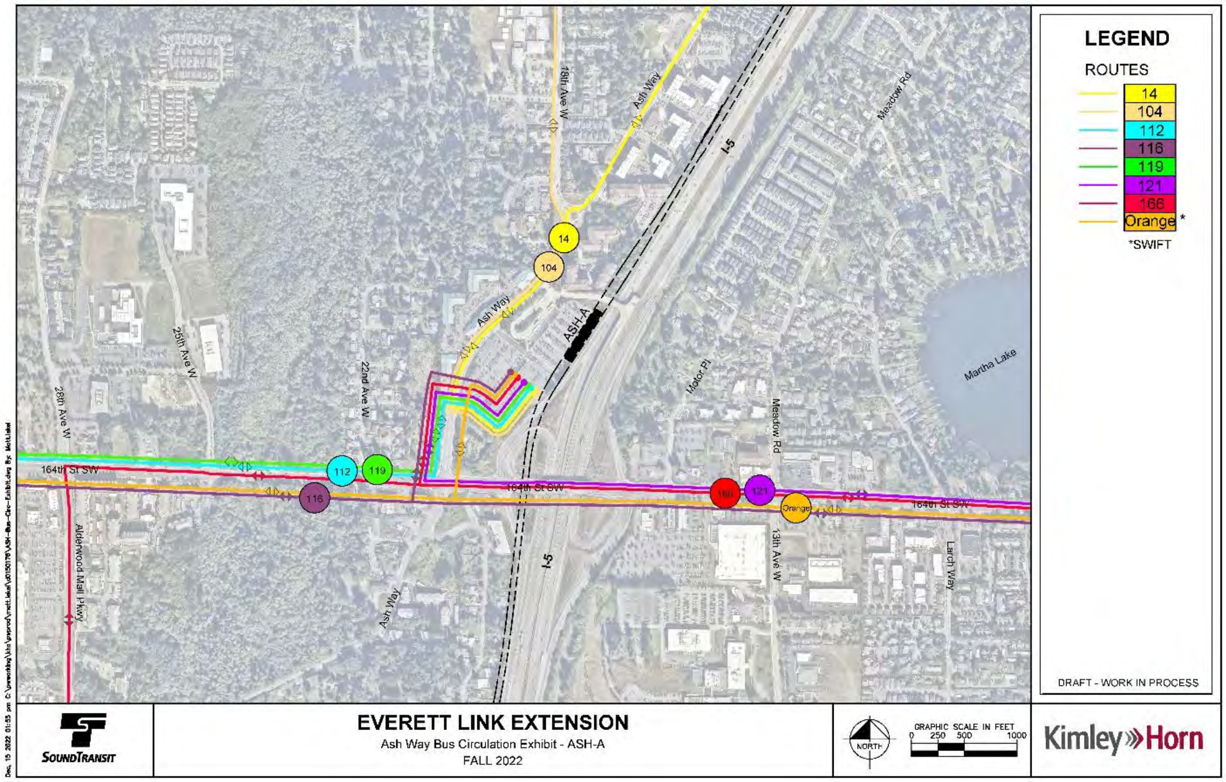


Figure 5-8 ASH-A Bus Routing Map

Quality and capacity of transfers

- Direct service from eight routes to off-street transit center.

Connectivity to high-capacity transit

- Direct connection to *Swift* BRT Orange Line.

Quality of access for transit vehicles

- Existing park-and-ride infrastructure with new transit signal being installed with the *Swift* BRT Orange Line at the transit loop entrance/exit to Ash Way allows buses to navigate easily.

Planned level of bus service

- Peak 43 buses/hour (weekdays).

5.2.2 ASH-D

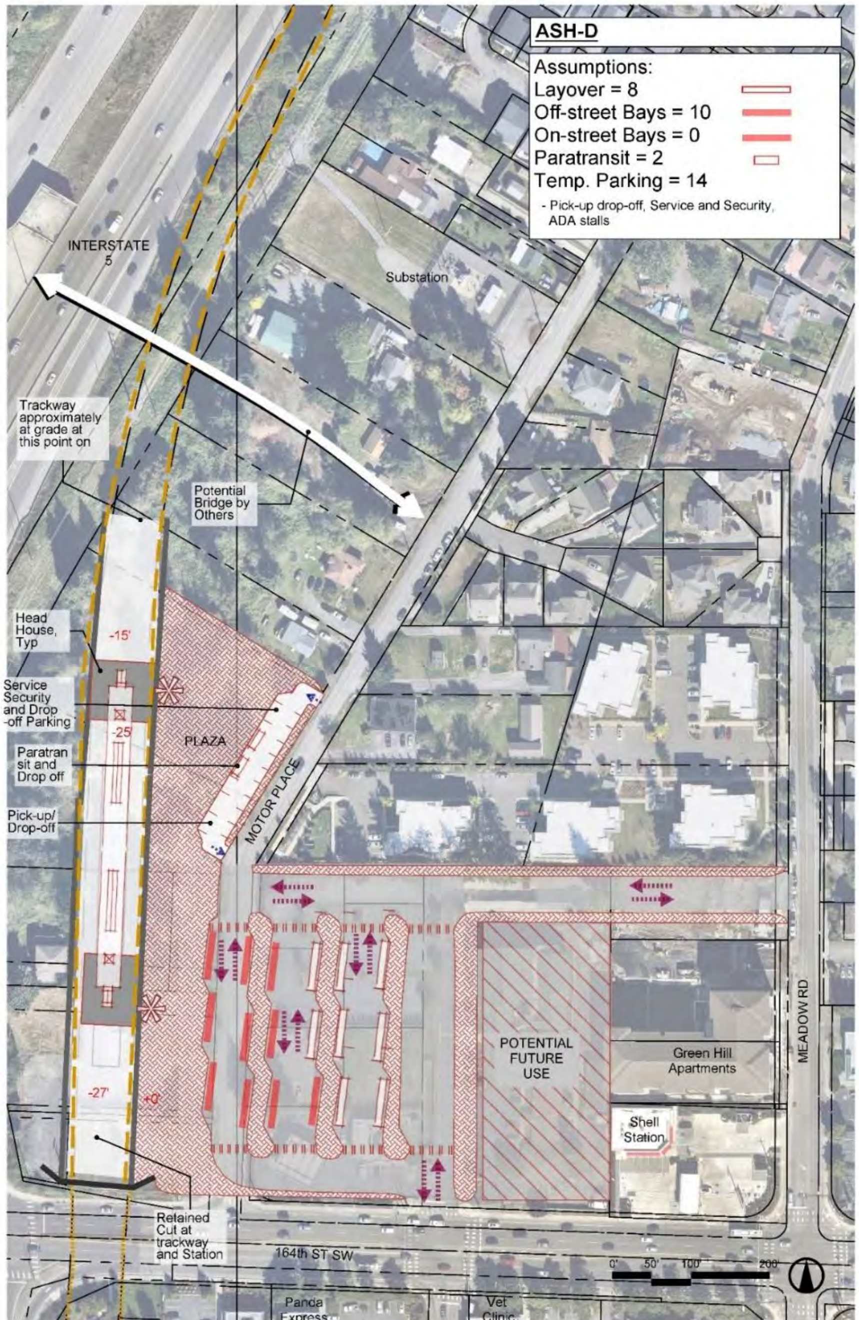


Figure 5-9 ASH-D Station Access Facility Concept Map

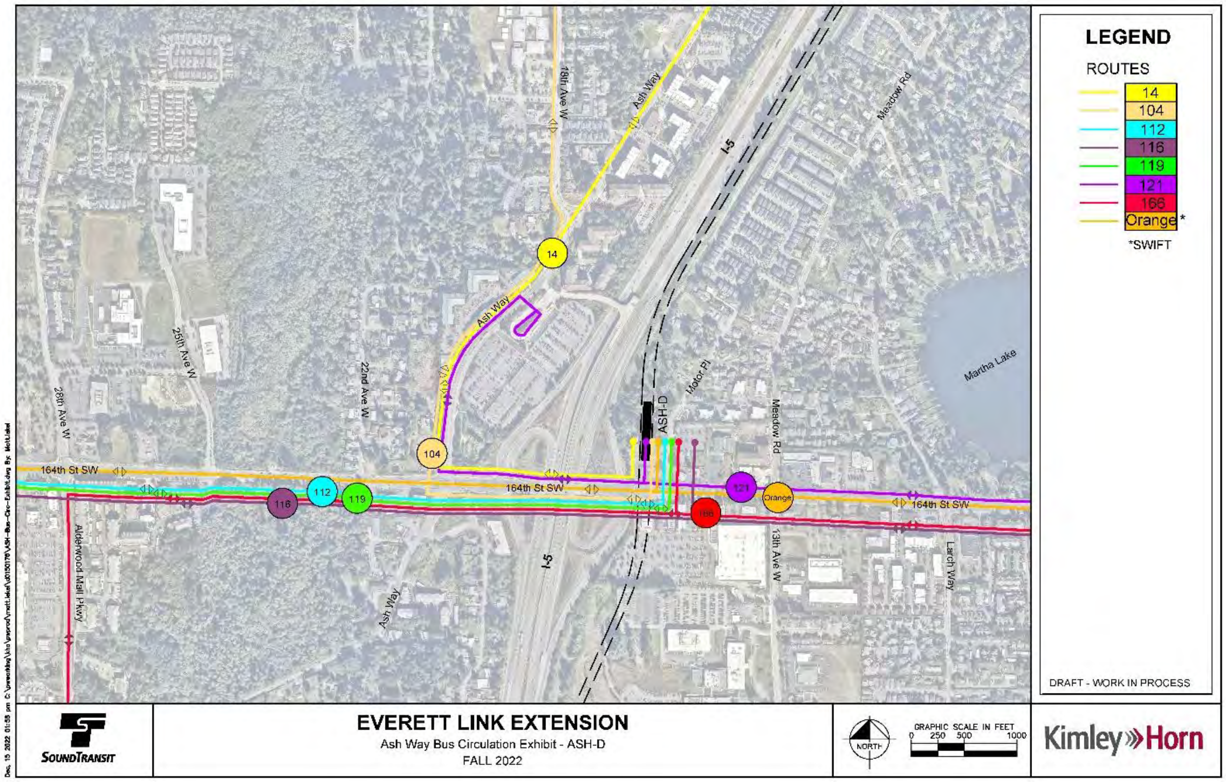


Figure 5-10 ASH-D (Without) Bus Routing Map

5.2.3 ASH-D (Without)

Quality and capacity of transfers

- Direct service from eight routes to off-street transit center.

Connectivity to high-capacity transit

- Direct connection to *Swift* BRT Orange Line.

Quality of access for transit vehicles

- Inefficient bus routing as some routes would need to serve both existing park-and-ride on the west side of I-5 and a new station on the east side.
- Several routes would be required to extend across interchange to reach terminus.

Planned level of bus service

- Peak 45 buses/hour (weekdays).

5.2.4 ASH-D (With)

The "With" background improvements scenario assumes the addition of a new multimodal bridge crossing over I-5 to the north of 164th Street SW between Ash Way Park-and-Ride and Meadow Road. This would provide buses traveling between the existing park-and-ride and the new station a more direct and less congested connection, allowing them to bypass congestion on 164th Street SW.

Quality and capacity of transfers

- Direct service from eight routes to off-street transit center.

Connectivity to high-capacity transit

- Direct connection to modified *Swift* BRT Orange Line.

Quality of access for transit vehicles

- Transit connection across I-5 assumed to facilitate access for buses to both existing and new transit centers.
- Longer route and additional stops are still required for some routes.

Planned level of bus service

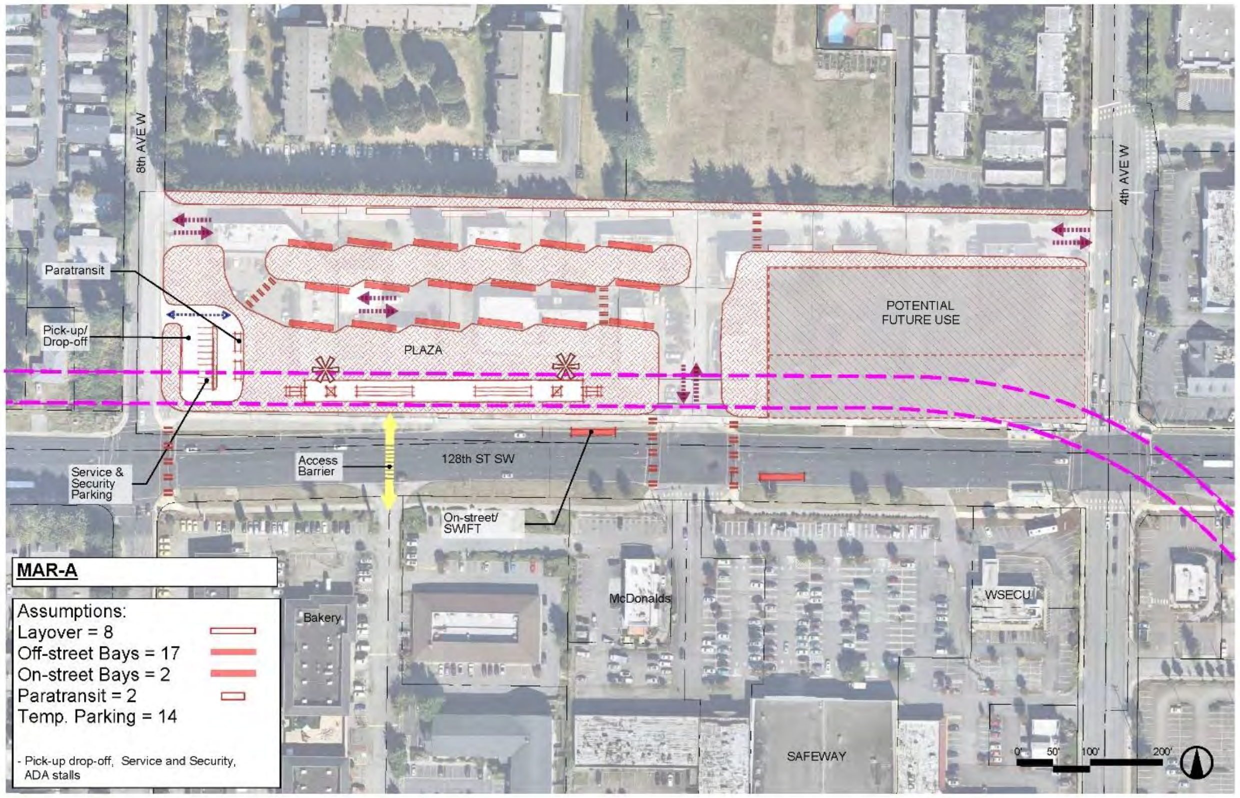
- Peak 45 buses/hour (weekdays).

5.3 Mariner

The three Mariner station alternatives were both evaluated under two different background network scenarios. The "Without" background improvements scenario assumes the existing roadway network in the vicinity of the station. The "With" background improvements scenario assumes the addition of a new multimodal bridge crossing over I-5 to the south of 128th Street SW to extend 130th Street SW to 8th Avenue W.

5.3.1 MAR-A

The quality of transit integration with the MAR-A alternative would not fundamentally change between the "With" and the "Without" networks. While the new I-5 overcrossing would modify walksheds and bikesheds, transit routing and transfer patterns would generally be unchanged. The evaluation notes listed in this section would apply to both the "With" and "Without" networks.



Note: Minor inconsistency between bay requirements in Table 4-2 and concept will be addressed along with further refinement of bus network assumptions if the alternative is advanced to Phase 2.

Figure 5-11 MAR-A Station Access Facility Concept Map

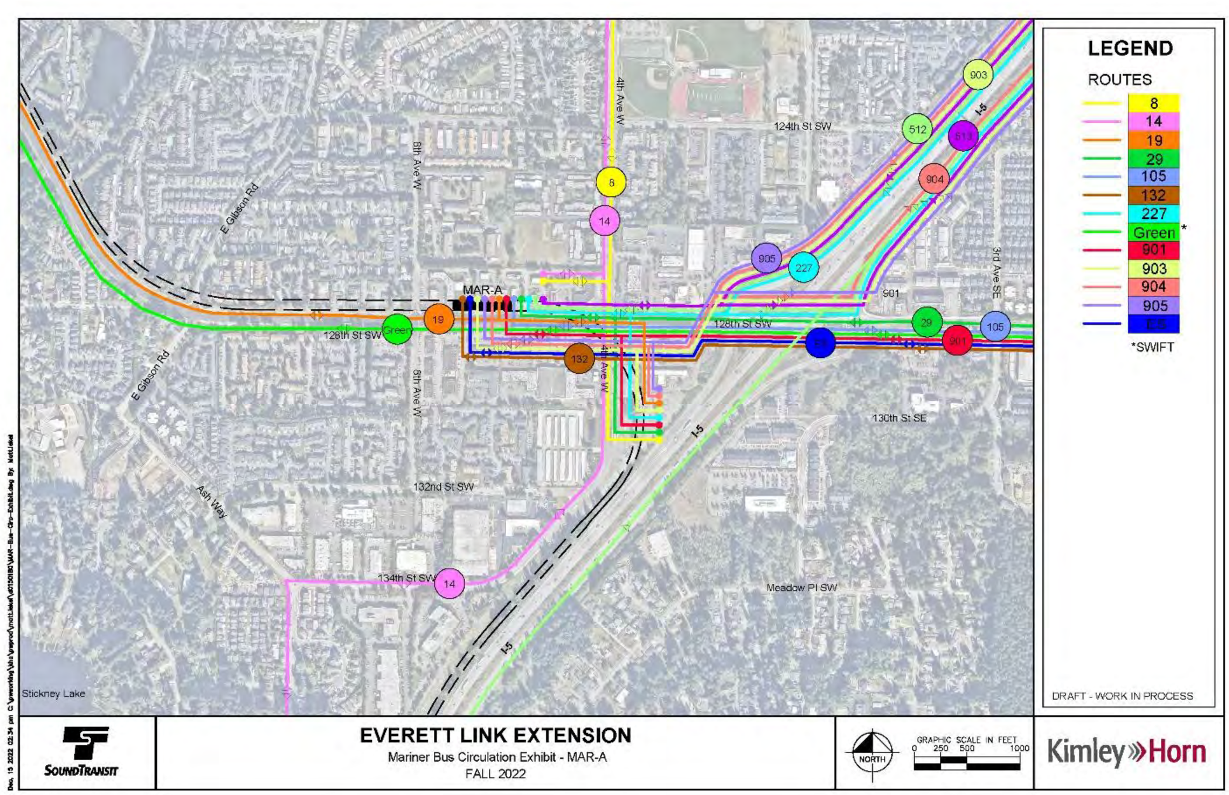


Figure 5-12 MAR-A Bus Routing Map

Quality and capacity of transfers

- All routes serve the station directly.
- All but *Swift* BRT Green Line are accessed via an off-street transit center.

Connectivity to high-capacity transit

- Transfers to *Swift* BRT Green are on-street.
- Some transfers may require crossing 128th Street SW.

Quality of access for transit vehicles

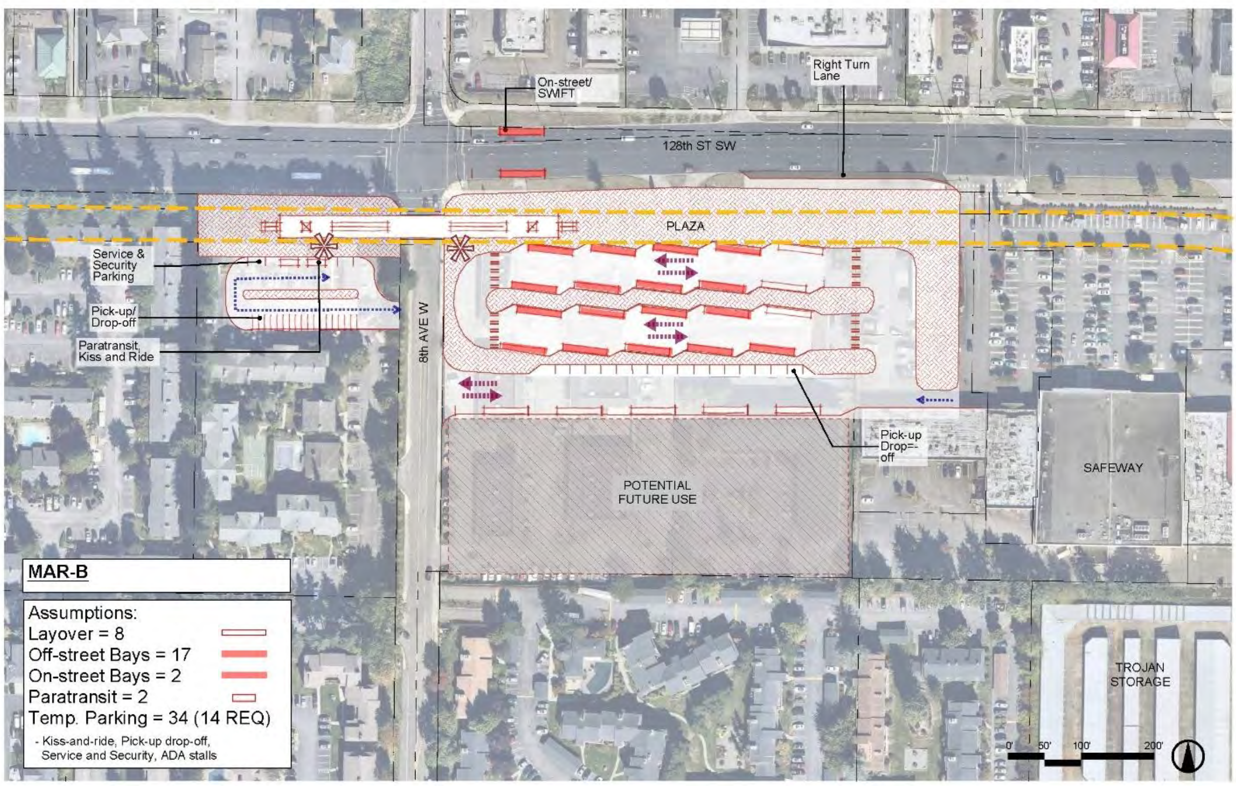
- Most routes have minimal to no diversion to access transit center, although many routes will experience longer route to back-track to layover at existing Mariner Park-and-Ride.
- Access for two routes to/from 4th Ave W may be inefficient.
- Transit center located approximately one-quarter mile west of the interchange used by many routes.

Planned level of bus service

- Peak 88 buses/hour (weekday).

5.3.2 MAR-B

The quality of transit integration with the MAR-B alternative would not fundamentally change between the "With" and the "Without" networks. While the new I-5 overcrossing would modify walksheds and bikesheds, transit routing and transfer patterns would generally be unchanged. The evaluation notes listed above would apply to both the "With" and "Without" networks.



Note: Minor inconsistency between bay requirements in Table 4-2 and concept will be addressed along with further refinement of bus network assumptions if the alternative is advanced to Phase 2.

Figure 5-13 MAR-B Station Access Facility Concept Map

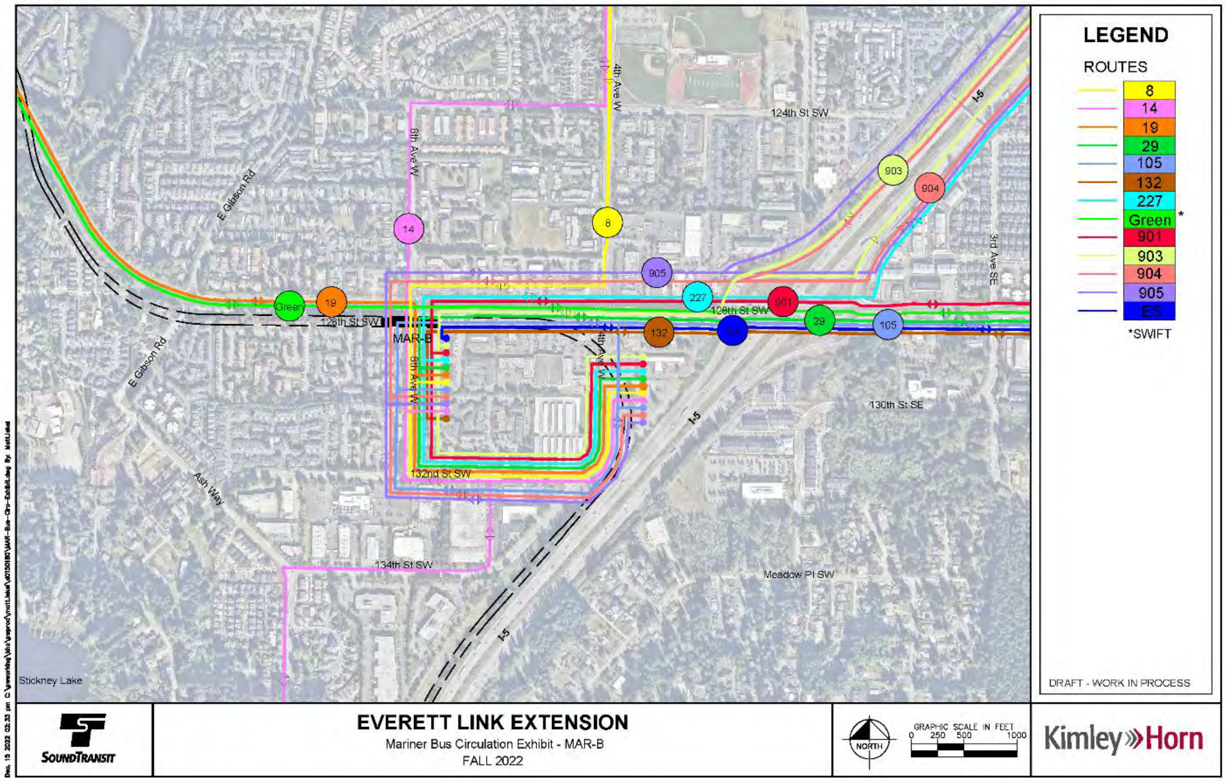


Figure 5-14 MAR-B Bus Routing Map

Quality and capacity of transfers

- All routes serve the station directly.
- All but *Swift* BRT Green Line are accessed via an off-street transit center.

Connectivity to high-capacity transit

- Transfers to *Swift* BRT Green Line are on-street.
- Some transfers may require crossing 128th Street SW.

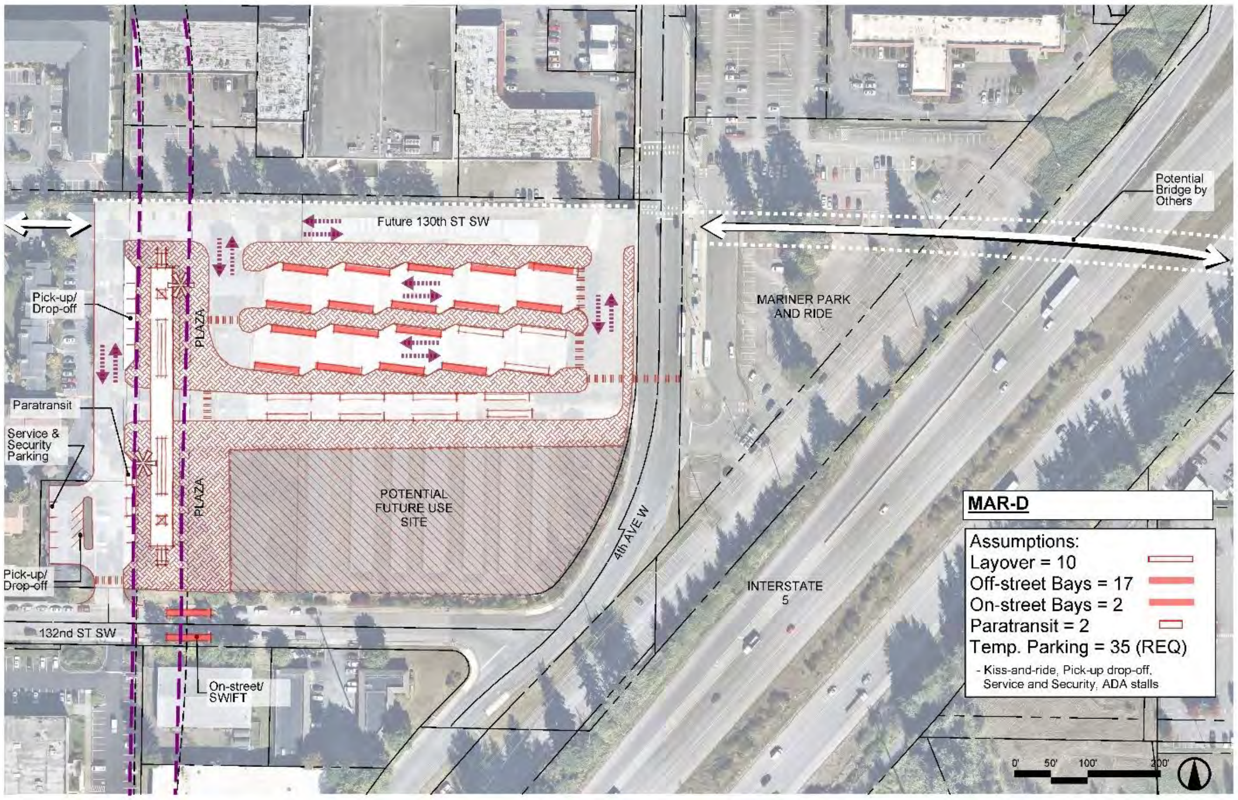
Quality of access for transit vehicles

- Most routes have minor diversion to access transit center, as there is no direct access for buses from 128th Street SW.
- Many routes will experience longer route to back-track to layover at Mariner Park-and-Ride.
- Transit center located approximately a half mile west of the interchange, used by many routes.

Planned level of bus service

- Peak 88 buses/hour (weekday).

5.3.3 MAR-D



Note: Minor inconsistency between bay requirements in Table 4-2 and concept will be addressed along with further refinement of bus network assumptions if the alternative is advanced to Phase 2.

Figure 5-15 MAR-D Station Access Facility Concept Map

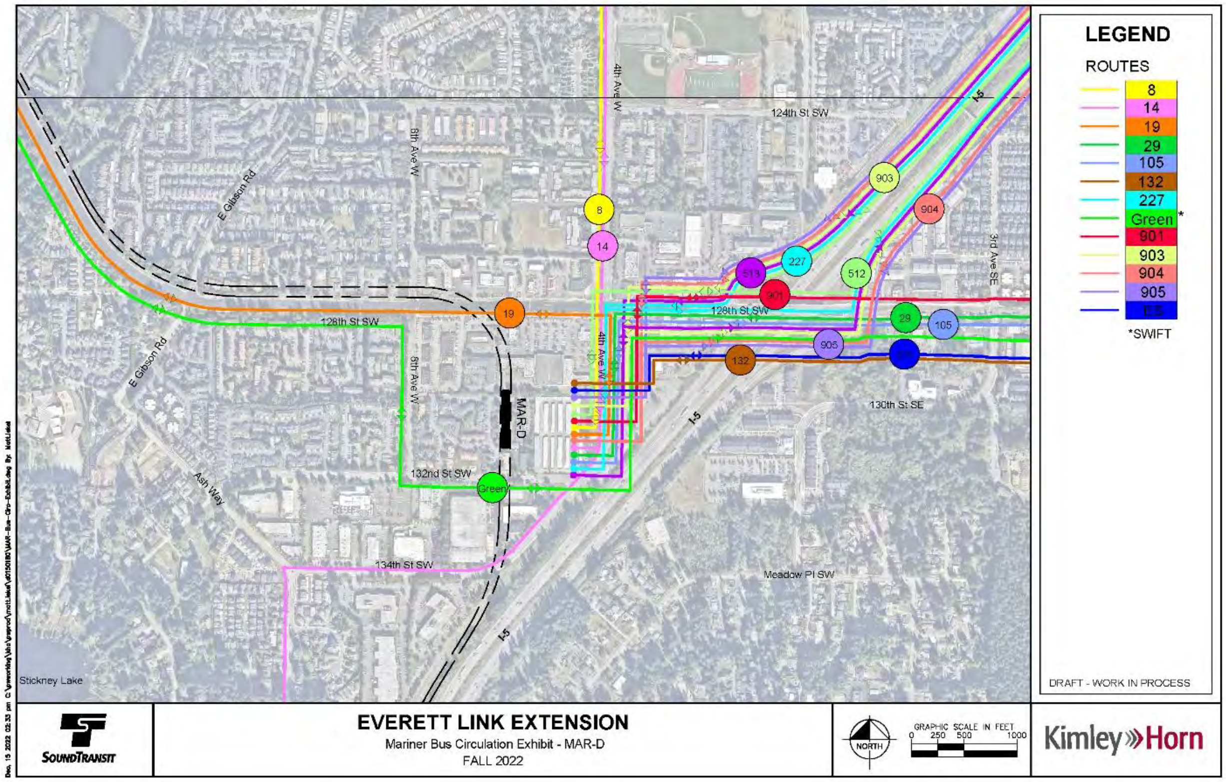


Figure 5-16 MAR-D (Without) Bus Routing Map

5.3.4 MAR-D (Without)

Quality and capacity of transfers.

- All routes serve station directly.
- All but *Swift* BRT Green Line are accessed via an off-street transit center.

Connectivity to high-capacity transit

- Transfers to modified *Swift* BRT Green Line on-street.
- Some transfers may require crossing 132nd Street SW.

Quality of access for transit vehicles

- Most routes have moderate diversion down 4th Avenue W to access transit center. Significant diversion for *Swift* BRT Green Line off 128th Street SW to 132nd Street SW.
- Proximity of park-and-ride allows for efficient layover access.
- Transit center is located approximately a third of a mile southwest of the interchange, used by many routes.

Planned level of bus service

- Peak 88 buses/hour (weekday).

5.3.5 MAR-D (With)

The "With" background improvements scenario assumes the addition of a new multimodal bridge crossing over I-5 to the south of 128th Street SW to extend 130th Street SW to 8th Avenue W. This new connection would be utilized by bus routes traveling between the station and east of I-5, allowing buses to bypass congestion on 128th Street SW at the I-5 interchange.

Quality and capacity of transfers

- All routes serve station directly.
- All but *Swift* BRT Green Line are accessed via an off-street transit center.

Connectivity to high-capacity transit

- Transfers to modified *Swift* BRT Green Line on-street. Some transfers may require crossing 132nd Street SW.

Quality of access for transit vehicles

- Most routes have moderate diversion down 4th Ave W to access transit center. *Swift* BRT Green Line may be able to efficiently serve station by using 130th Street and continuing on new bridge across I-5.
- Proximity of park-and-ride allows for efficient layover access.
- Transit center located approximately a third of a mile southwest of the interchange, used by many routes.

Planned level of bus service

- Peak 88 buses/hour (weekday).

5.4 SR 99/Airport Road

5.4.1 AIR-A

Figure 5-17 AIR-A Station Access Facility Concept Map

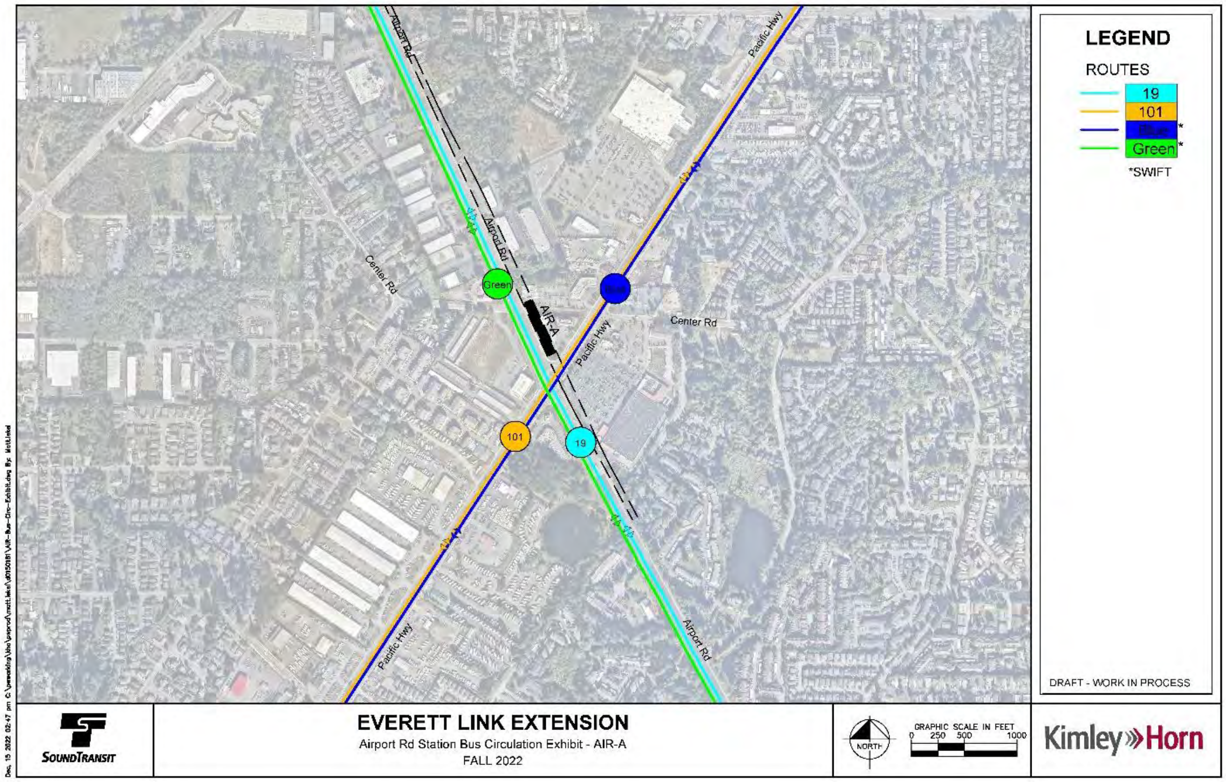


Figure 5-18 AIR-A Bus Routing Map

Quality and capacity of transfers

- Allows for connections to routes on both Airport Road and SR 99. Requires transfers across Airport Road or SR 99 for one direction of travel for all routes. No transfers require crossing both streets.
- Both arterial roadways are major barriers to access with long crossing distances.

Connectivity to high-capacity transit

- Direct connection to *Swift* BRT Green Line traveling northbound.
- Transfer for *Swift* BRT Green Line traveling southbound requires crossing SR 99 and Airport Road.
- Direct connection to *Swift* BRT Blue Line traveling southbound via relocated station, but northbound connections require crossing SR 99.

Quality of access for transit vehicles

- No deviation required.
- Stop placement impacted by intersection geometry.

Planned level of bus service

- Peak 38 buses/hour (weekday).

5.4.2 AIR-B

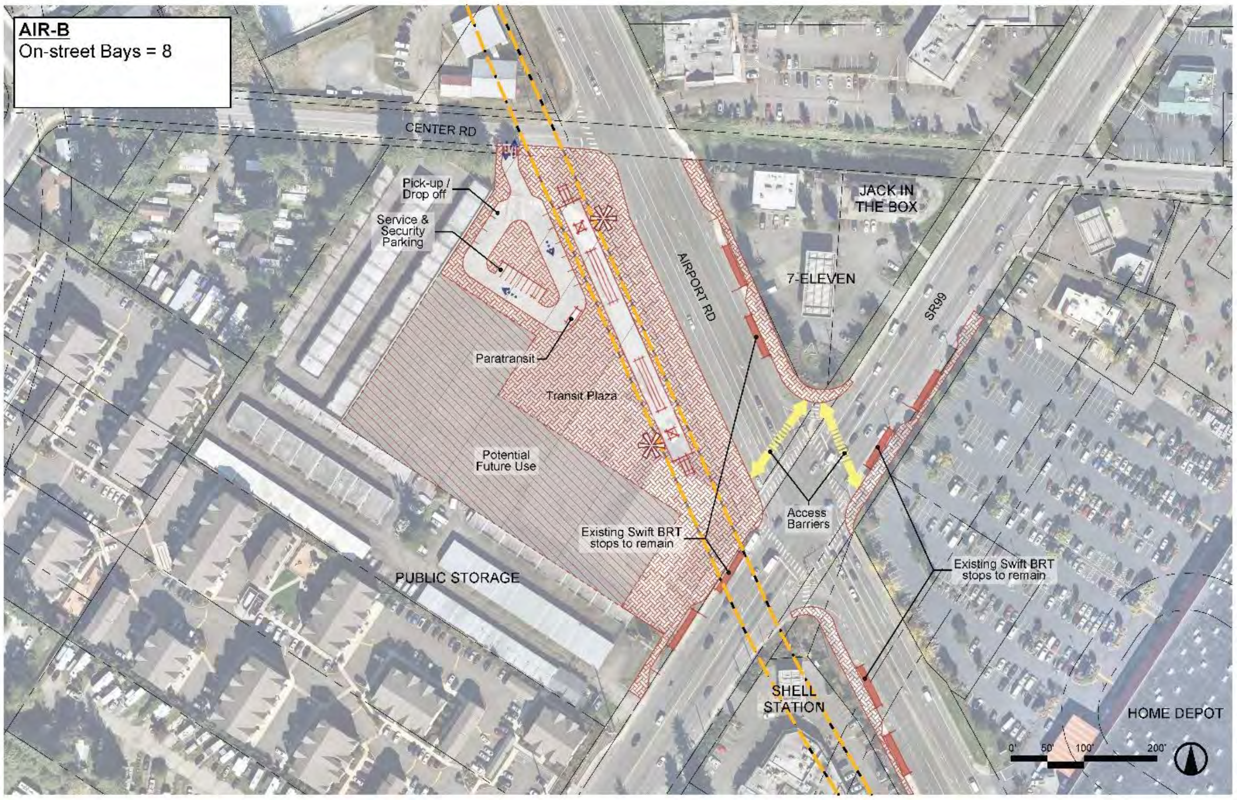


Figure 5-19 AIR-B Station Access Facility Concept Map

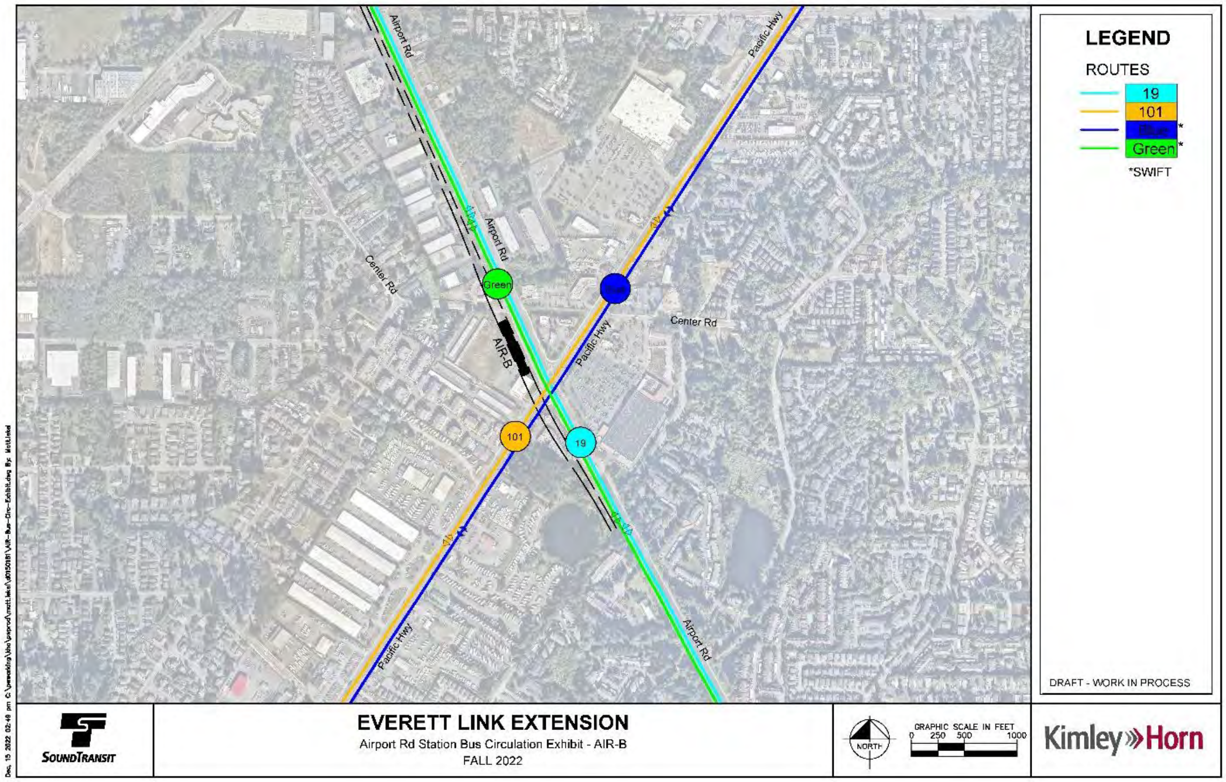


Figure 5-20 AIR-B Bus Routing Map

Quality and capacity of transfers

- Allows for connections to routes on both Airport Road and SR 99.
- Requires transfers across Airport Road and/or SR 99 for one direction of travel for all routes.
- Both arterial roadways are major barriers to access with long crossing distances.

Connectivity to high-capacity transit

- Transfer for *Swift* BRT Green Line traveling southbound requires crossing SR 99.
- Transfer to *Swift* BRT Green Line traveling northbound requires crossing Airport Road. Direct connection to *Swift* BRT Blue Line traveling southbound, but northbound connections require crossing Airport Road and SR 99.

Quality of access for transit vehicles

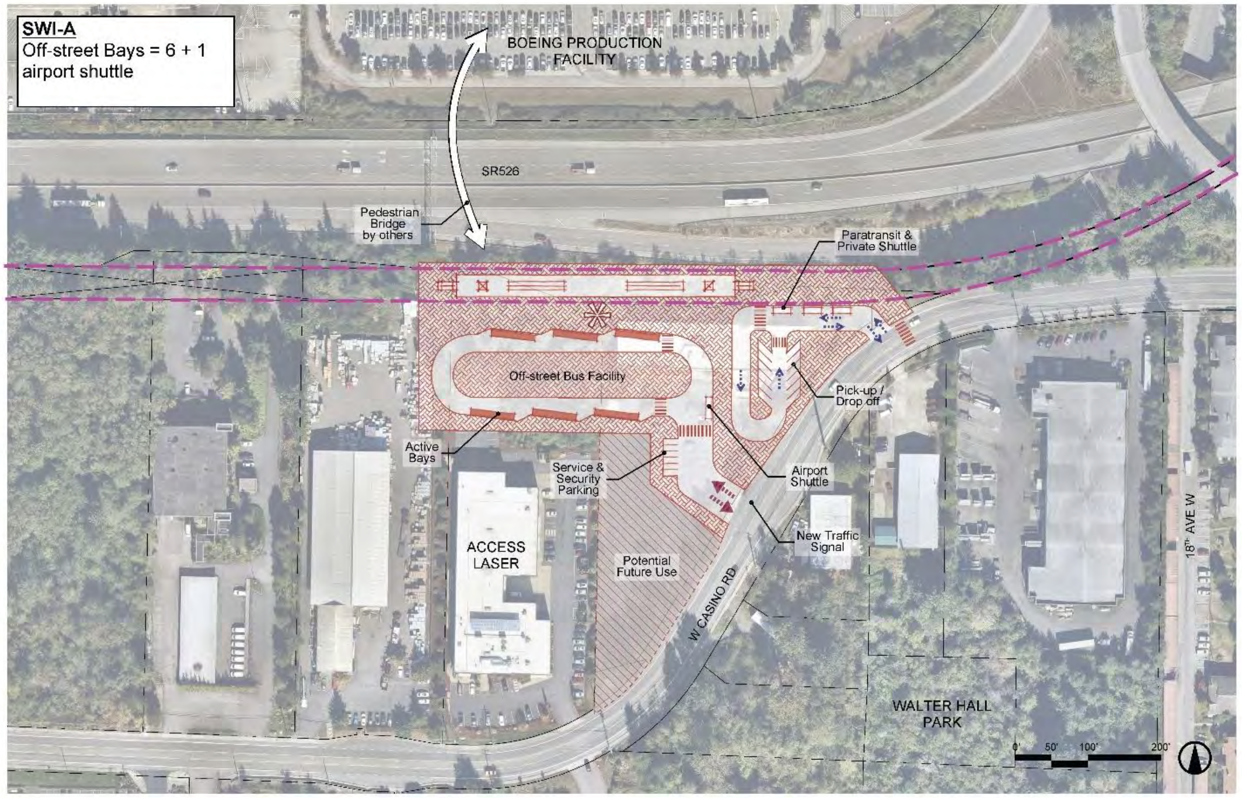
- No deviation required.

Planned level of bus service

- Peak 38 buses/hour (weekday).

5.5 SW Everett Industrial Center

5.5.1 SWI-A



Note: Minor inconsistency between bay requirements in Table 4-2 and concept will be addressed along with further refinement of bus network assumptions if the alternative is advanced to Phase 2.

Figure 5-21 SWI-A Station Access Facility Concept Map

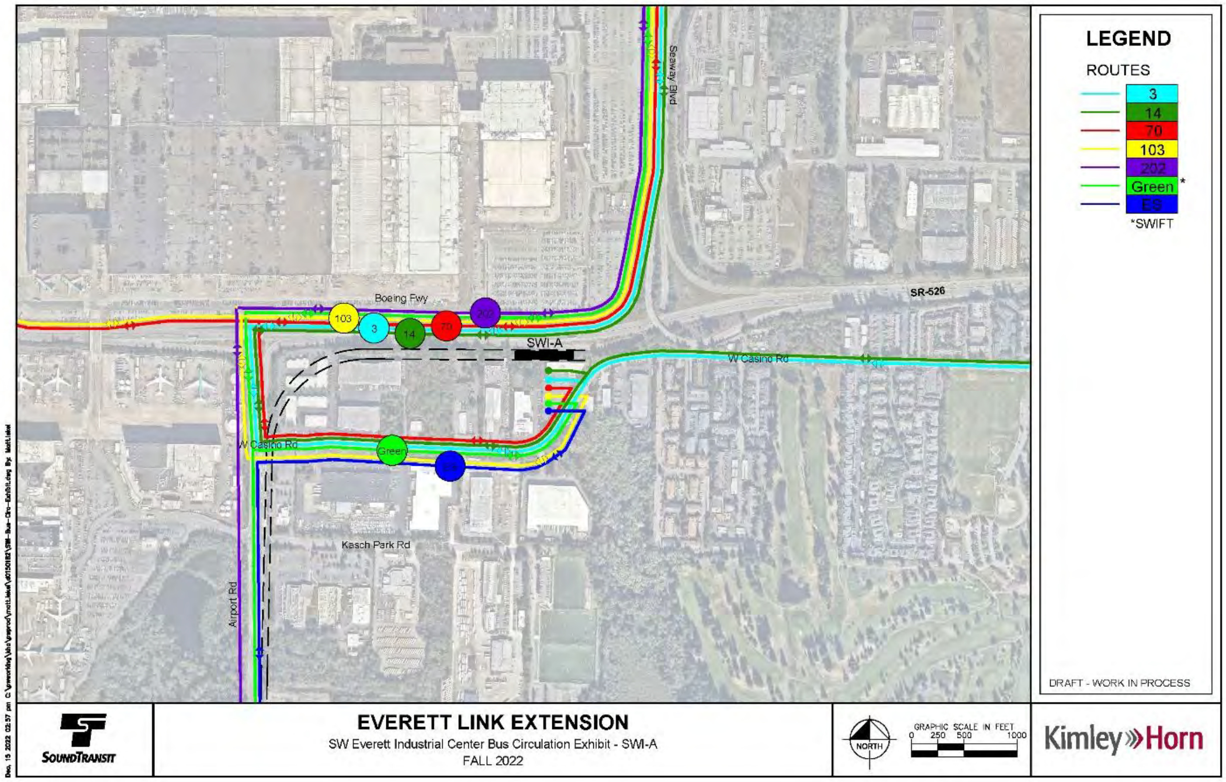


Figure 5-22 SWI-A Bus Routing Map

Quality and capacity of transfers

- Six routes serve station directly via an off-street transit center facility.

Connectivity to high-capacity transit

- Direct connection to modified *Swift* BRT Green Line service.

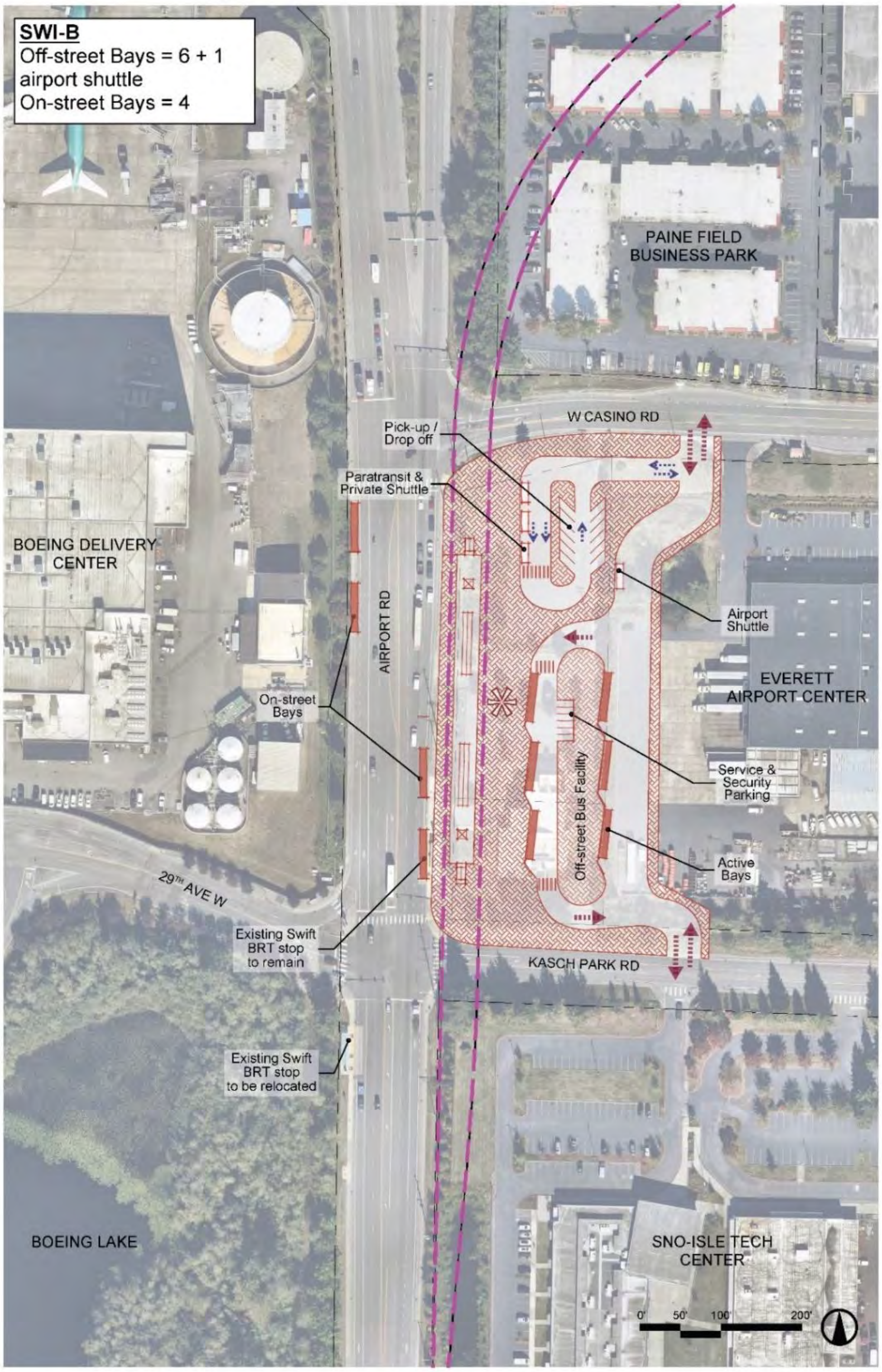
Quality of access for transit vehicles

- Significant diversion for most routes, including *Swift* BRT Green Line, from baseline to access station.
- Inefficient routing to access both this station and Seaway Transit Center.

Planned level of bus service

- Peak 39 buses/hour (weekdays) (excluding Boeing shuttles).

5.5.2 SWI-B



Note: Minor inconsistency between bay requirements in Table 4-2 and concept will be addressed along with further refinement of bus network assumptions if the alternative is advanced to Phase 2.

Figure 5-23 SWI-B Station Access Facility Concept Map

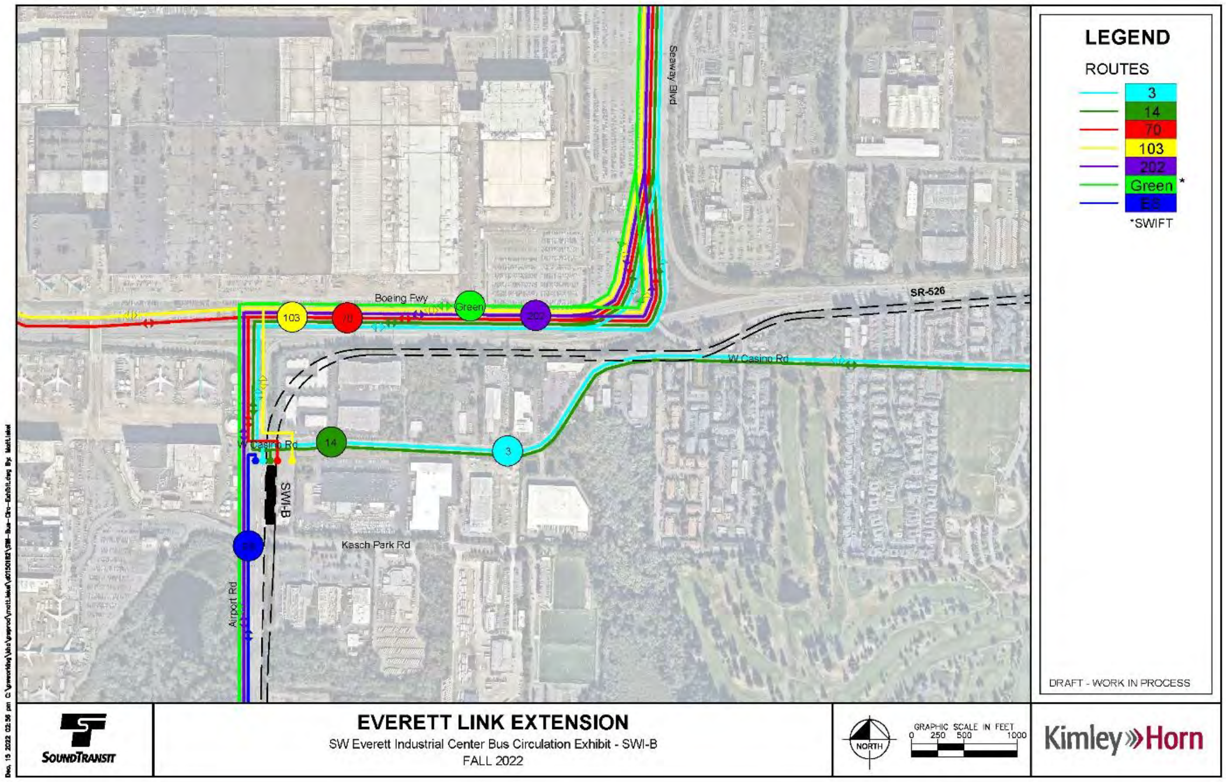


Figure 5-24 SWI-B Bus Routing Map

Quality and capacity of transfers

- Seven routes serve the station directly via an off-street transit center facility.

Connectivity to high-capacity transit

- Direct connection to *Swift* BRT Green Line service. Some transfers may require crossing Airport Road.

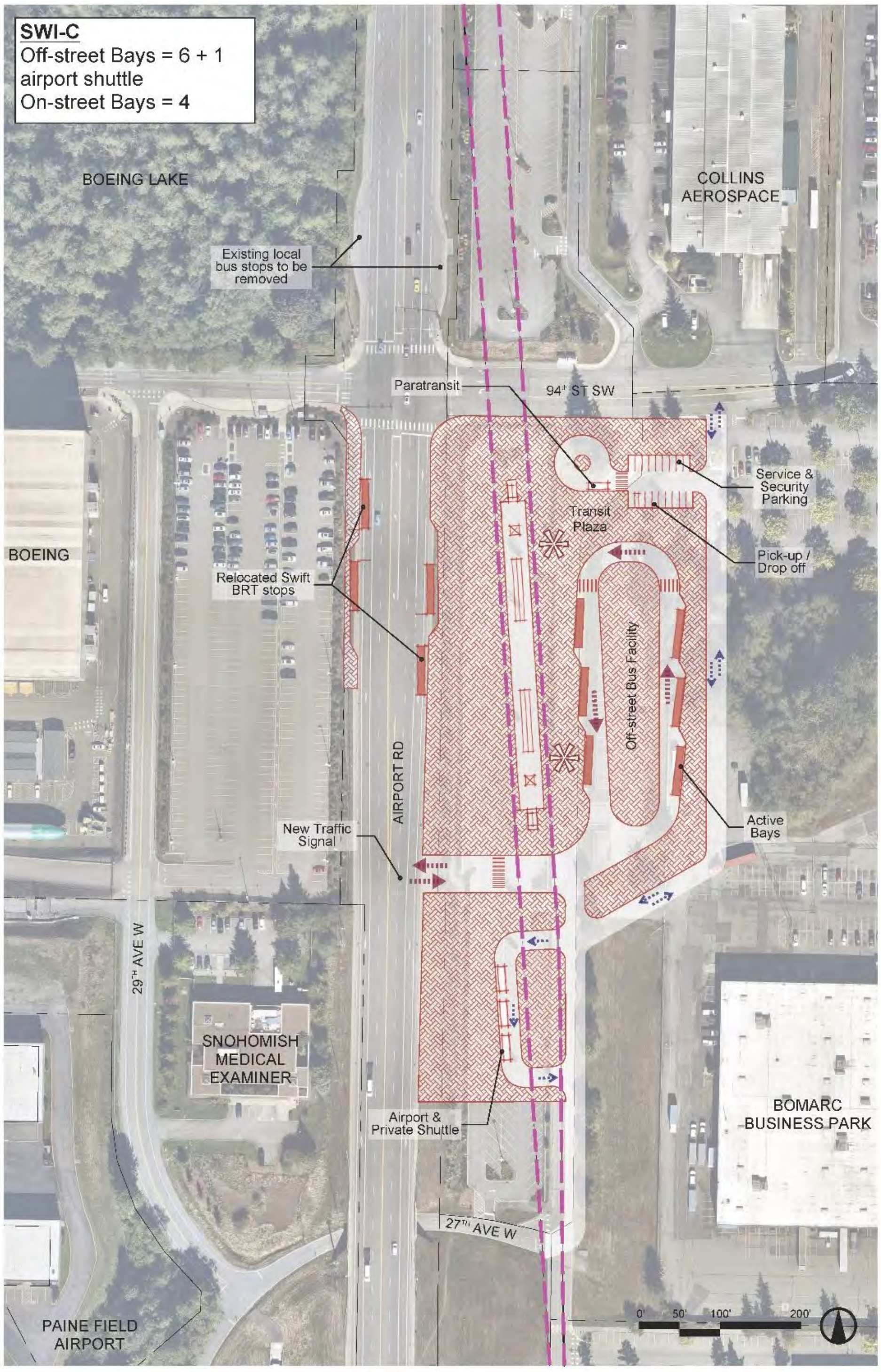
Quality of access for transit vehicles

- Moderate diversion for two routes from baseline to access station.
- Some routes could remain on Airport Road to minimize time penalty for serving station.

Planned level of bus service

- Peak 43 buses/hour (weekdays) (excluding Boeing shuttles).

5.5.3 SWI-C



Note: Minor inconsistency between bay requirements in Table 4-2 and concept will be addressed along with further refinement of bus network assumptions if the alternative is advanced to Phase 2.

Figure 5-25 SWI-C Station Access Facility Concept Map

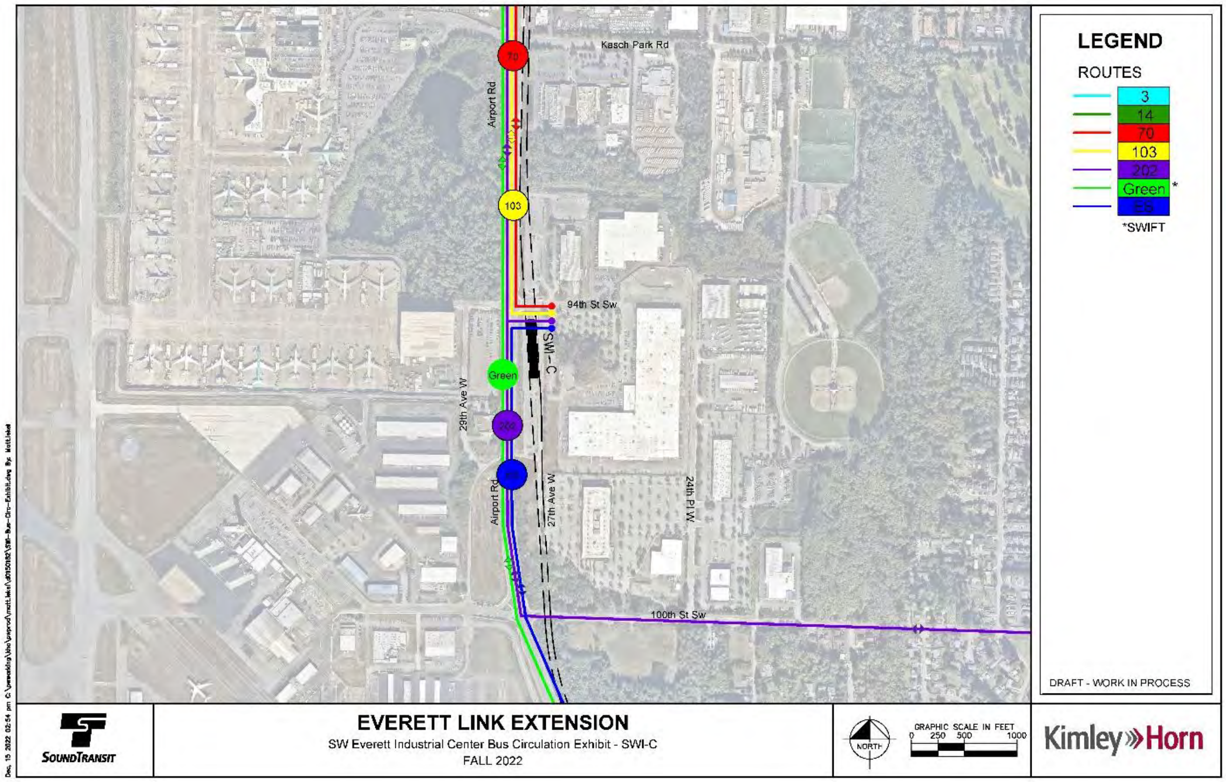


Figure 5-26 SWI-C Bus Routing Map

Quality and capacity of transfers

- Five routes serve station directly via an off-street transit center.

Connectivity to high-capacity transit

- Direct connection to *Swift* BRT Green Line service. Some transfers may require crossing Airport Road.

Quality of access for transit vehicles

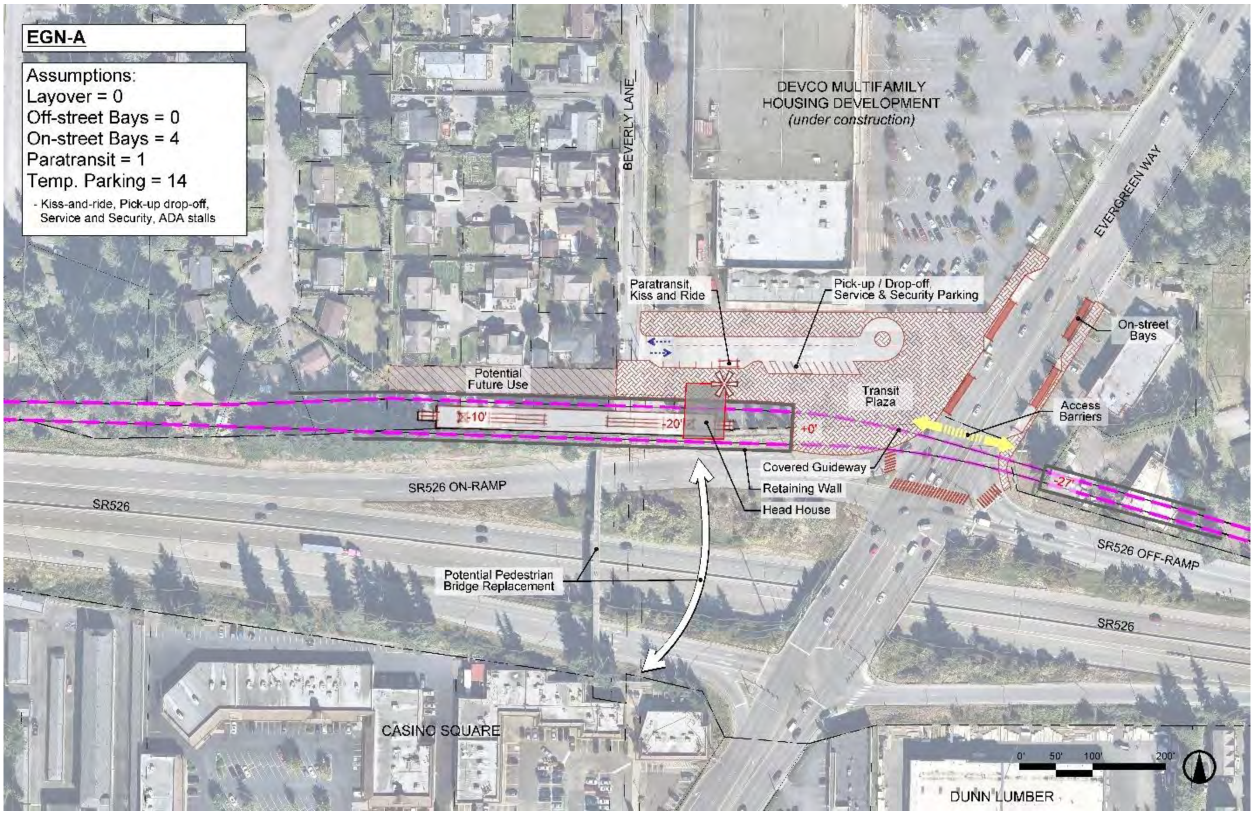
- Significant diversion for two routes from baseline to access station.
- Some routes could remain on Airport Road to minimize time penalty for serving station.

Planned level of bus service

- Peak 27 buses/hour (weekdays) (excluding Boeing shuttles).

5.6 SR 526/Evergreen

5.6.1 EGN-A



Note: Additional bus bays (not depicted within figure viewport) along Casino Road
Minor inconsistency between bay requirements in Table 4-2 and concept will be addressed along with further refinement of bus network assumptions if the alternative is advanced to Phase 2.

Figure 5-27 EGN-A Station Access Facility Concept Map

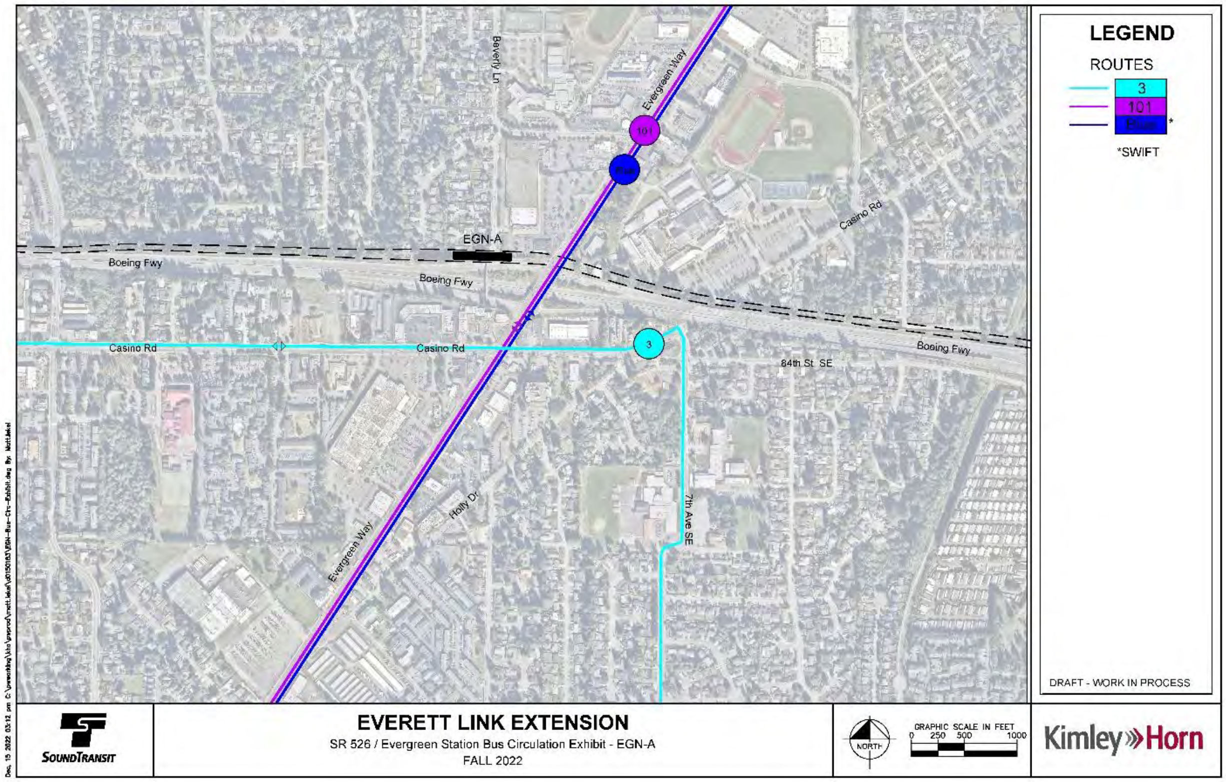


Figure 5-28 EGN-A Bus Routing Map

Quality and capacity of transfers

- Transfers to all routes require moderate to long walking distance.
- Some transfers require crossing SR 526 via pedestrian overcrossing.
- Evergreen Way is a major barrier to accessing northbound bus stops, including *Swift* BRT Blue Line.

Connectivity to high-capacity transit

- Connection to *Swift* BRT Blue Line on Evergreen Way.
- Requires crossing Evergreen Way to access northbound *Swift* BRT *Blue Line* station.

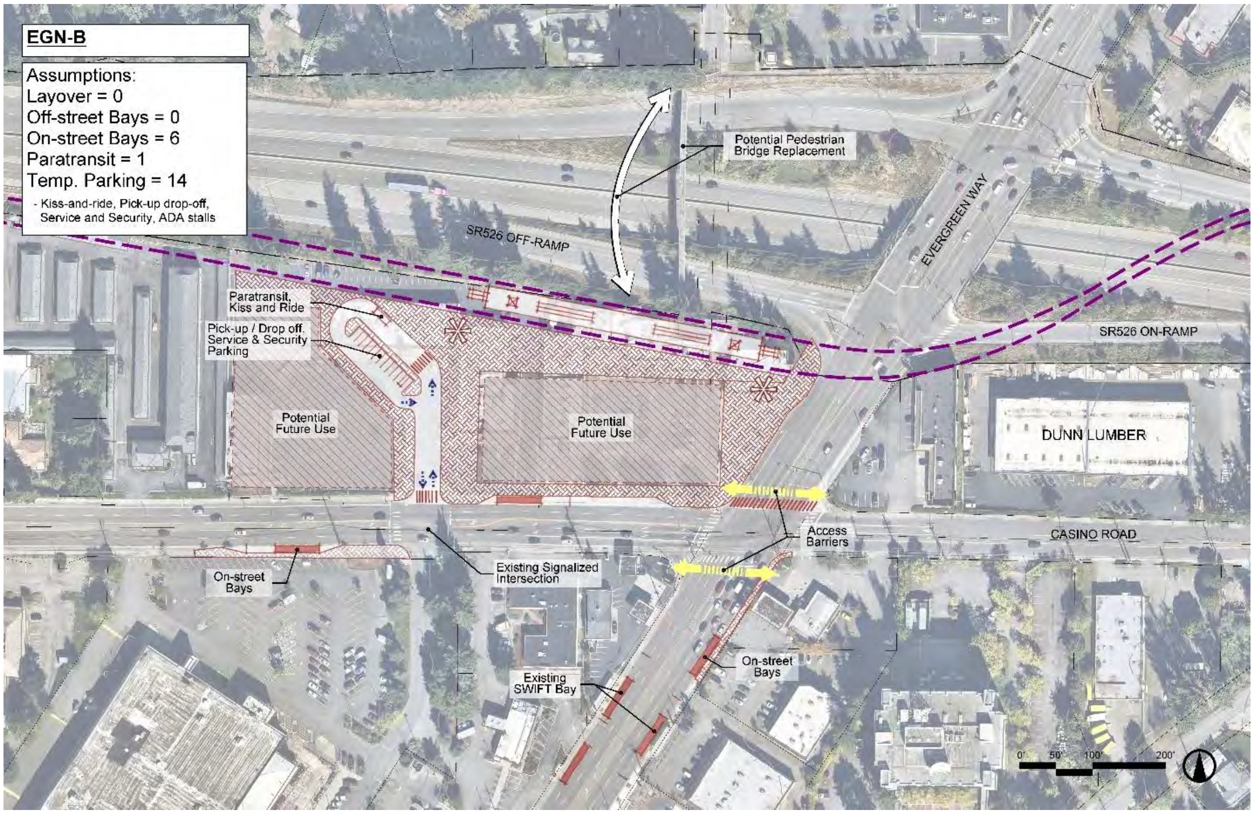
Quality of access for transit vehicles

- No route diversion proposed.
- Some stops would be relocated north of SR 526 to accommodate transfers.

Planned level of bus service

- Peak 28 buses/hour (weekday), including longer transfer distances.

5.6.2 EGN-B



Note: Minor inconsistency between bay requirements in Table 4-2 and concept will be addressed along with further refinement of bus network assumptions if the alternative is advanced to Phase 2.

Figure 5-29 EGN-B Station Access Facility Concept Map

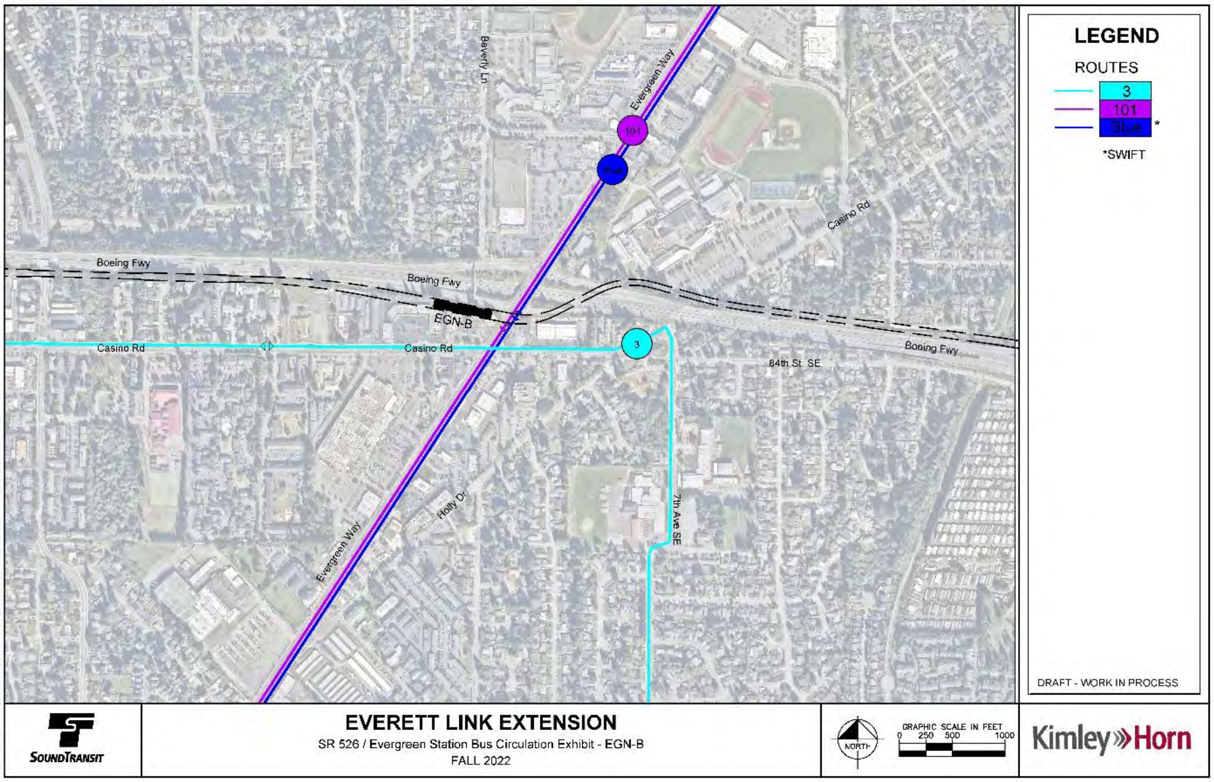


Figure 5-30 EGN-B Bus Routing Map

Quality and capacity of transfers

- Transfers to all routes on Evergreen Way require crossing Casino Road.
- Evergreen Way is a major barrier to accessing northbound bus stops, including *Swift* BRT Blue Line.

Connectivity to high-capacity transit

- Connection to *Swift* BRT Blue Line on Evergreen Way.
- Requires crossing Evergreen Way and Casino Road to access northbound *Swift* BRT Blue Line station and crossing Casino Road to access southbound *Swift* BRT Blue Line station.

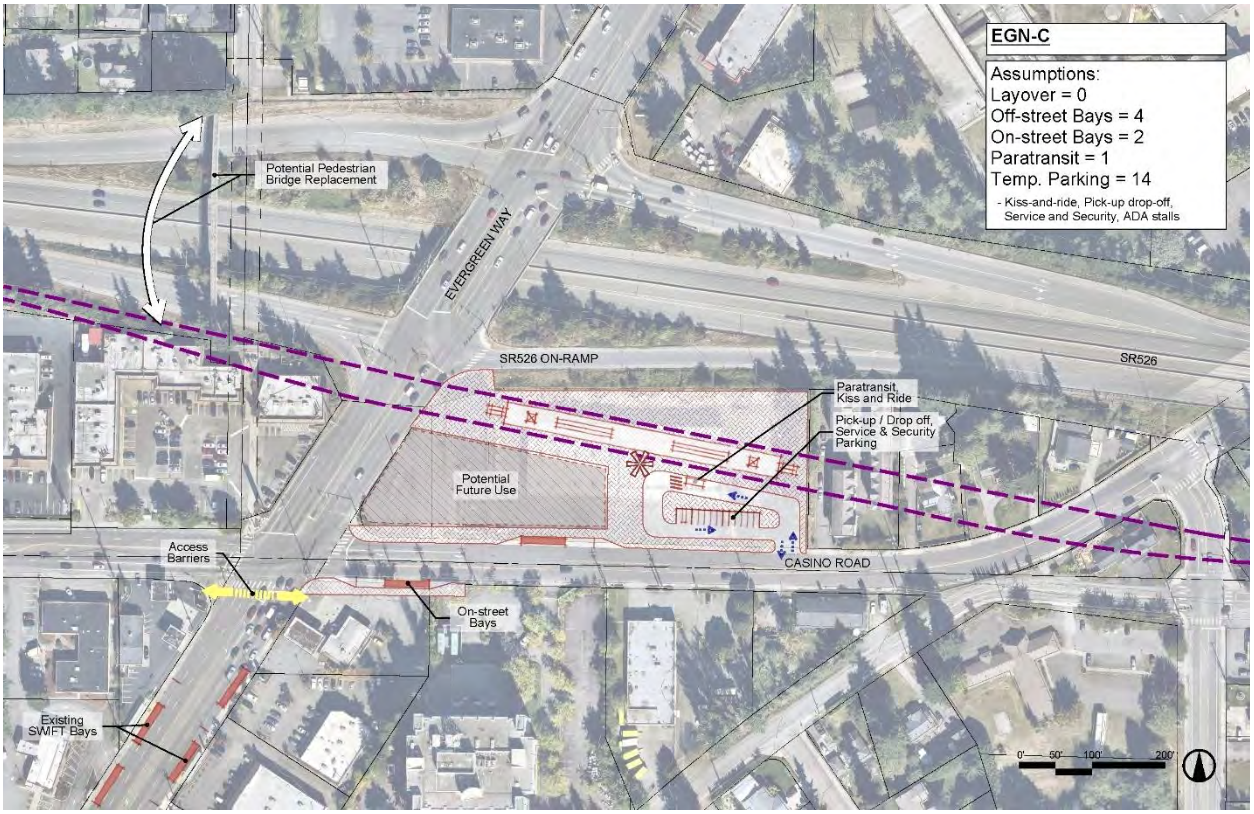
Quality of access for transit vehicles

- No route diversion proposed.
- No stop relocations.

Planned level of bus service

- Peak 28 buses/hour (weekday).

5.6.3 EGN-C



Note: Minor inconsistency between bay requirements in Table 4-2 and concept will be addressed along with further refinement of bus network assumptions if the alternative is advanced to Phase 2.

Figure 5-31 EGN-C Station Access Facility Concept Map

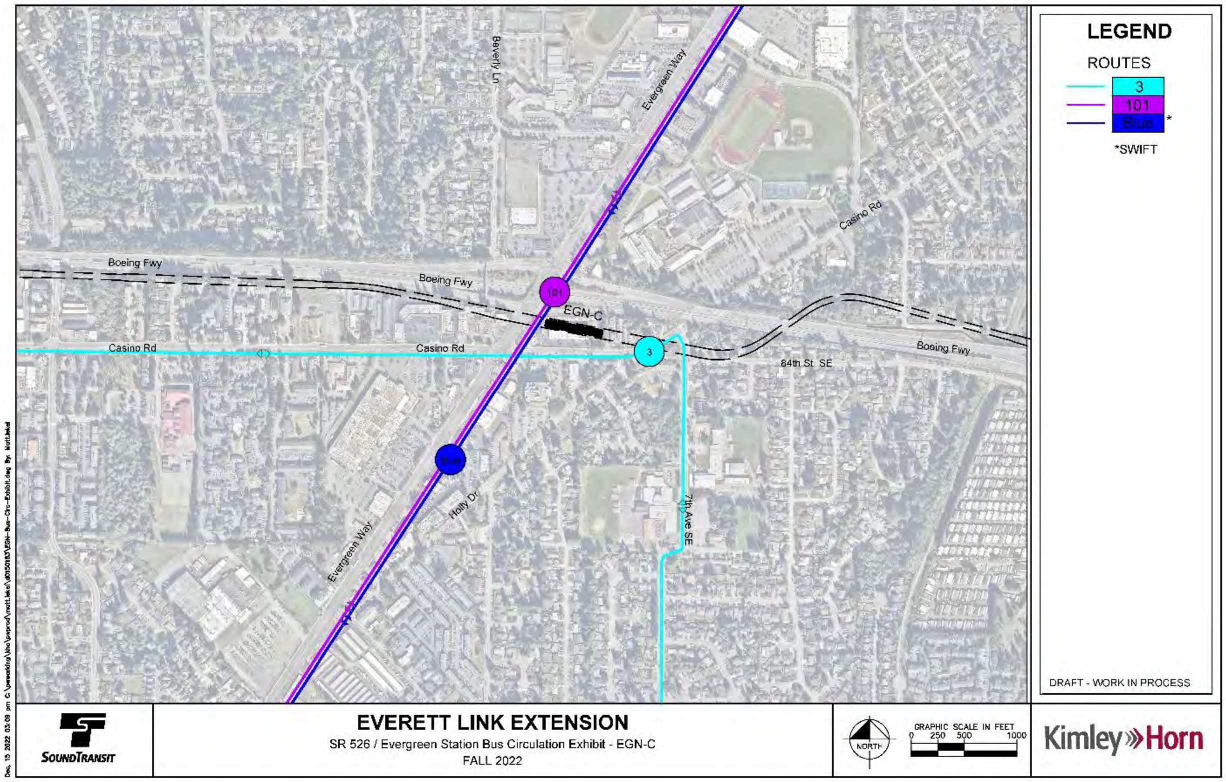


Figure 5-32 EGN-C Bus Routing Map

Quality and capacity of transfers

- Transfers to all routes on Evergreen require crossing Casino Road.
- Evergreen Way is a major barrier to accessing southbound bus stops, including *Swift* BRT Blue Line.

Connectivity to high-capacity transit

- Connection to *Swift* BRT Blue Line on Evergreen Way.
- Requires crossing Evergreen Way and Casino Road to access southbound *Swift* BRT Blue Line station and crossing Casino Road to access northbound *Swift* BRT Blue Line station.

Quality of access for transit vehicles

- No route diversion proposed.
- No stop relocations.

Planned level of bus service

- Peak 28 buses/hour (weekday).

5.6.4 EGN-D

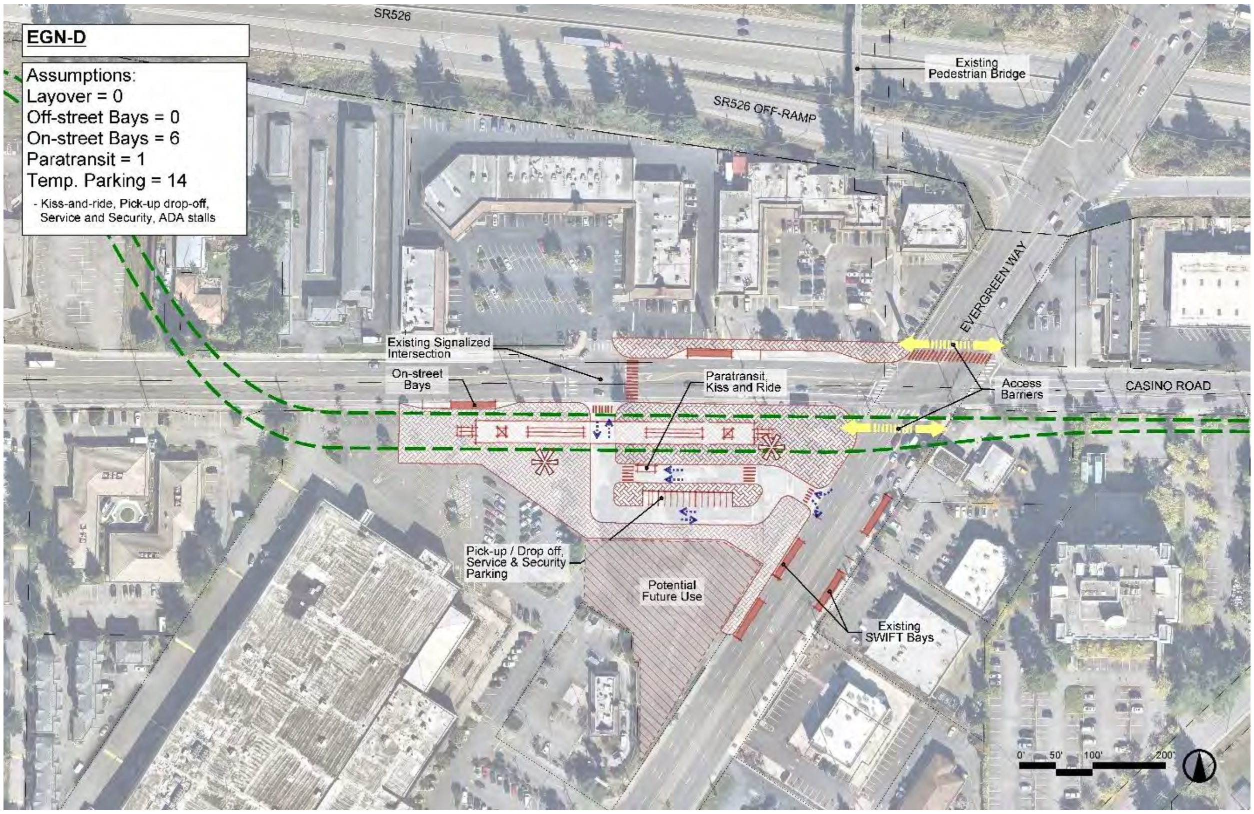


Figure 5-33 EGN-D Station Access Facility Concept Map

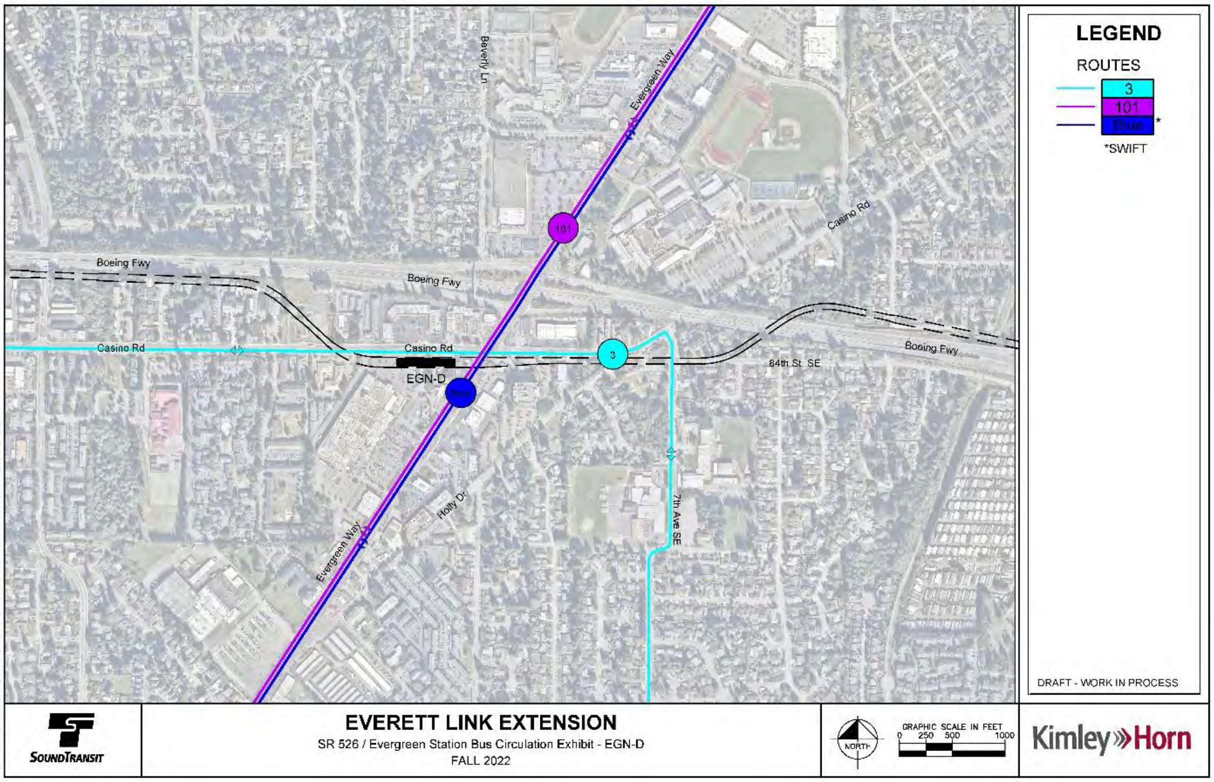


Figure 5-34 EGN-D Bus Routing Map

Quality and capacity of transfers

- Evergreen Way is a major barrier to accessing northbound bus stops, including *Swift* BRT Blue Line

Connectivity to high-capacity transit

- Connection to *Swift* BRT Blue Line on Evergreen Way.
- Requires crossing Evergreen Way to access northbound *Swift* BRT Blue Line station.

Quality of access for transit vehicles

- No route diversion proposed.
- No stop relocations.

Planned level of bus service

- Peak 28 buses/hour (weekday).

5.6.5 EGN-E

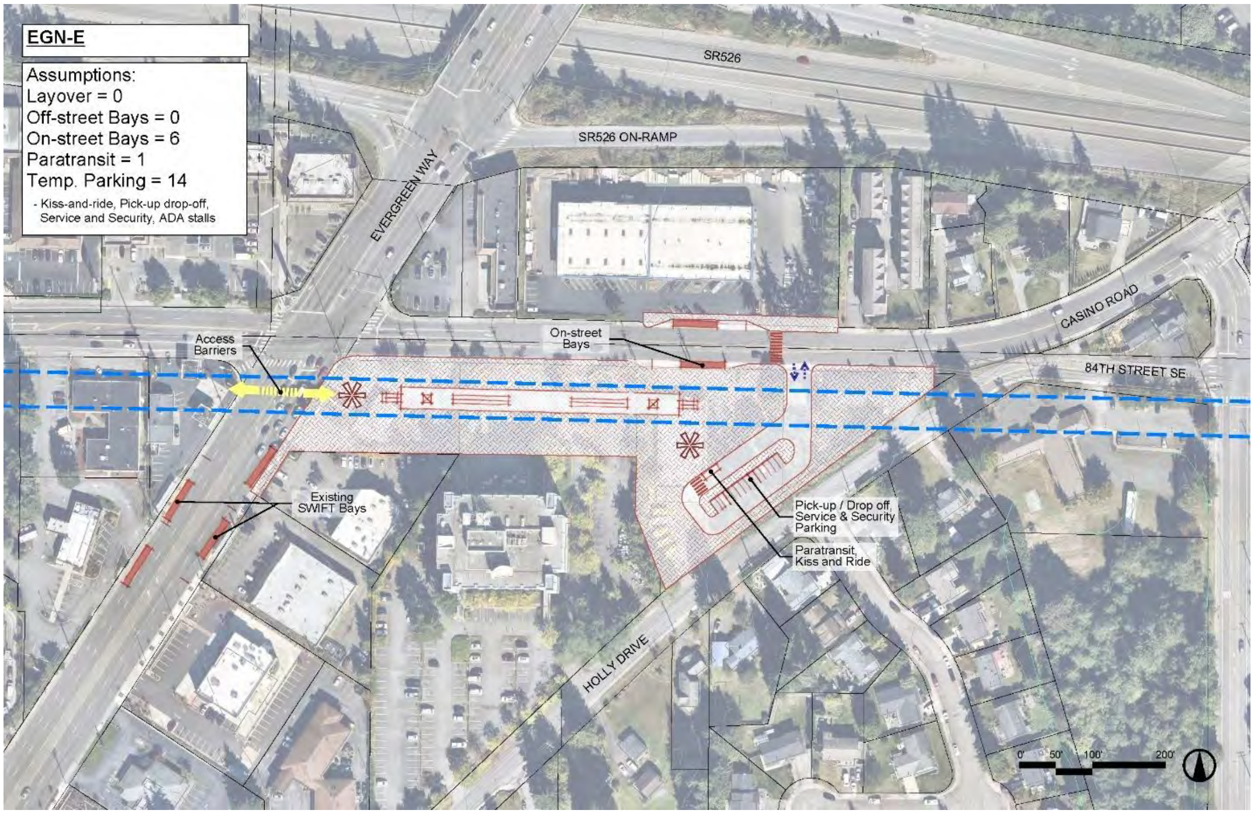


Figure 5-35 EGN-E Station Access Facility Concept Map

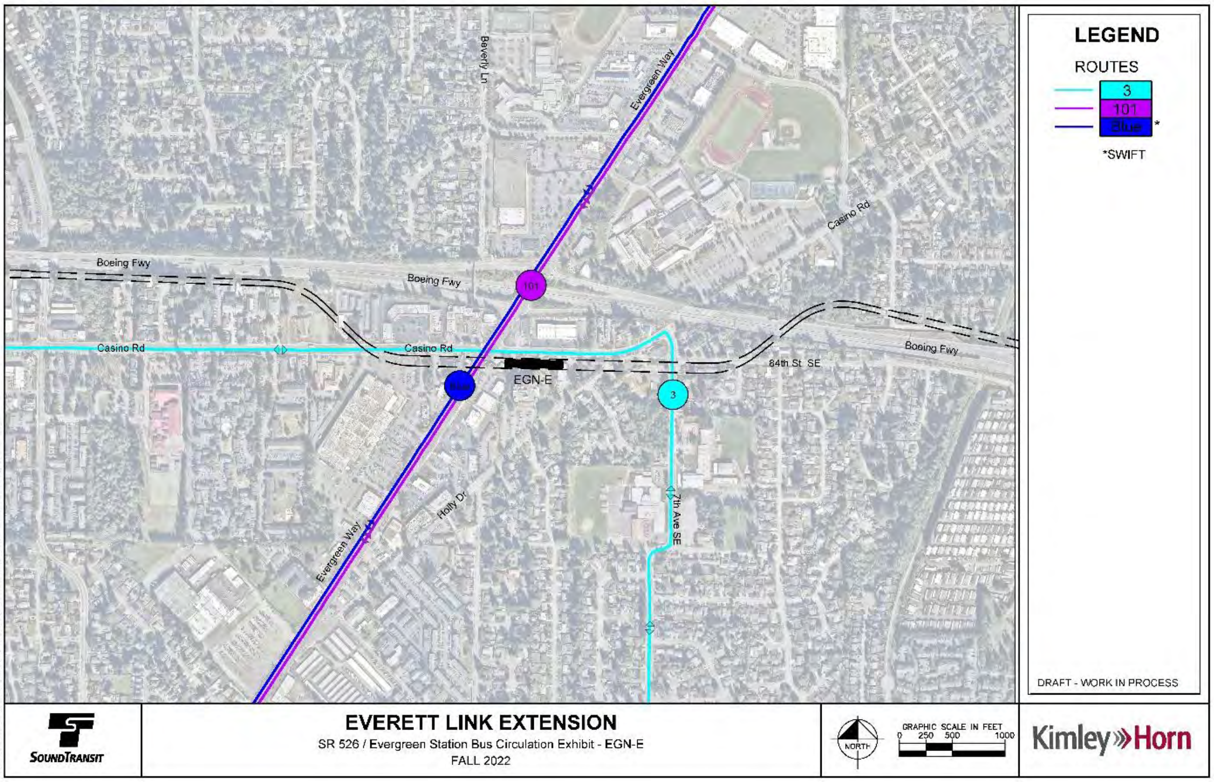


Figure 5-36 EGN-E Bus Routing Map

Quality and capacity of transfers

- Evergreen Way is a major barrier to accessing southbound bus stops, including *Swift* BRT Blue Line.

Connectivity to high-capacity transit

- Connection to *Swift* BRT Blue Line on Evergreen Way.
- Requires crossing Evergreen Way to access southbound *Swift* BRT station.

Quality of access for transit vehicles

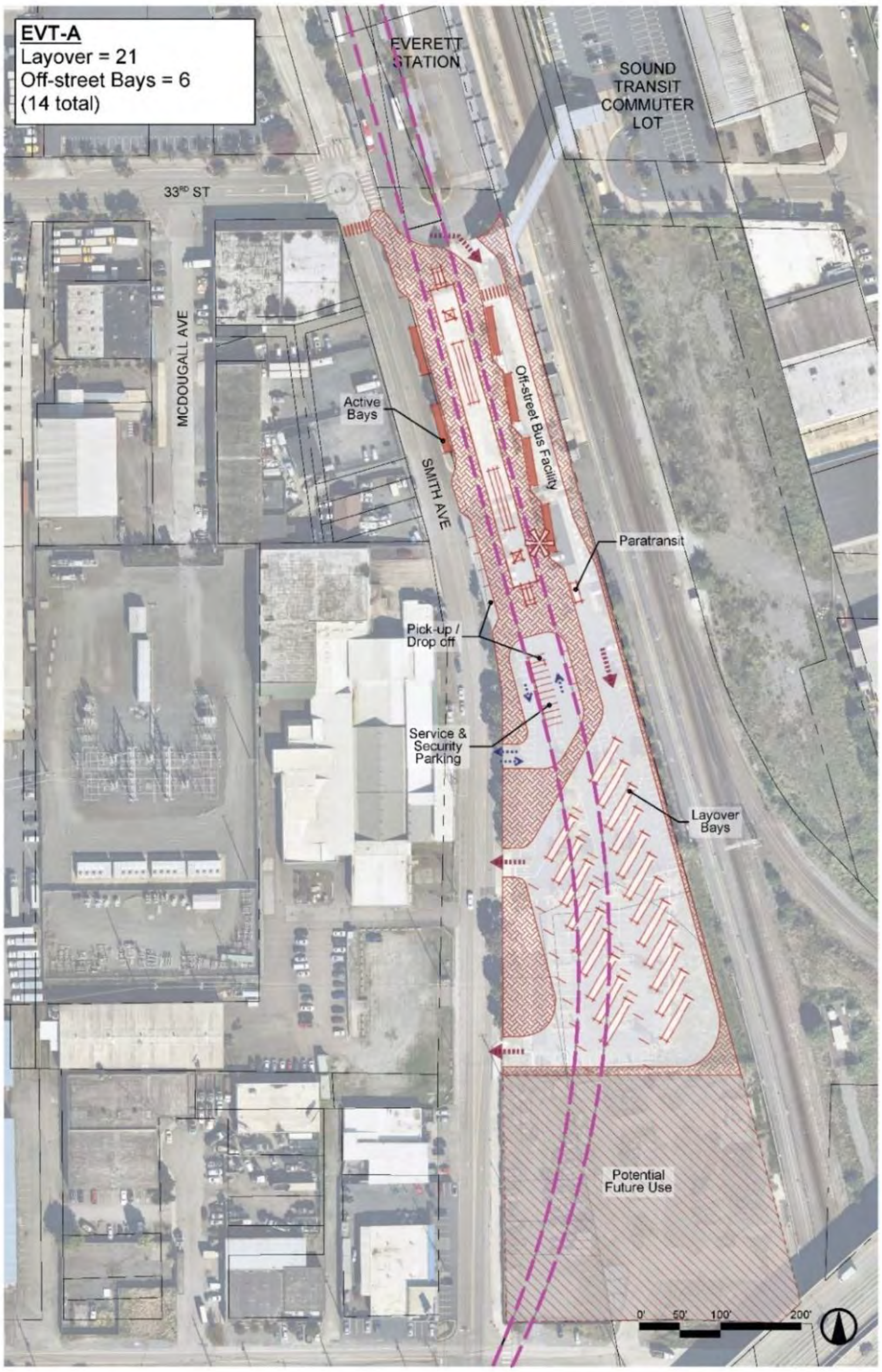
- No route diversion proposed.
- No stop relocations.

Planned level of bus service

- Peak 28 buses/hour (weekday).

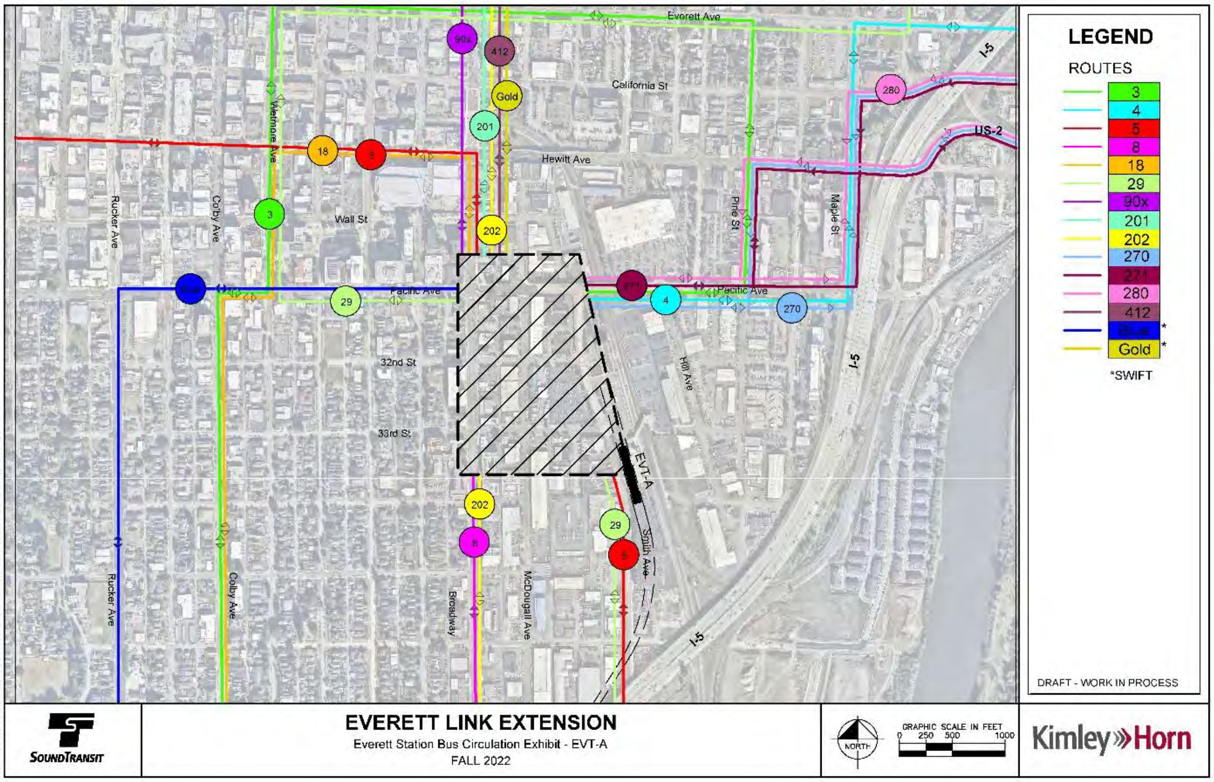
5.7 Everett Station

5.7.1 EVT-A



Note: Minor inconsistency between bay requirements in Table 4-2 and concept will be addressed along with further refinement of bus network assumptions if the alternative is advanced to Phase 2.

Figure 5-37 EVT-A Station Access Facility Concept Map



Note: Hatched area represents immediate station vicinity where bus routing is dependent on specific bay assignment, which is not yet determined

Figure 5-38 EVT-A Bus Routing Map

Quality and capacity of transfers

- All routes would stop at adjacent off-street transit center or adjacent on-street bays.
- Additional bus bay capacity would be added to existing facilities.

Connectivity to high-capacity transit

- Direct connection to the *Swift* BRT Blue Line and planned *Swift* BRT Gold Line.
- Direct connection to Sounder and Amtrak at Everett Station.

Quality of access for transit vehicles

- Similar to the existing bus terminal at Everett Station with no new diversions.
- Existing bus terminal access at Everett Station allows for easy access and circulation for transit vehicles.

Planned level of bus service

- Peak 49 buses/hour (weekday).

5.7.2 EVT-C

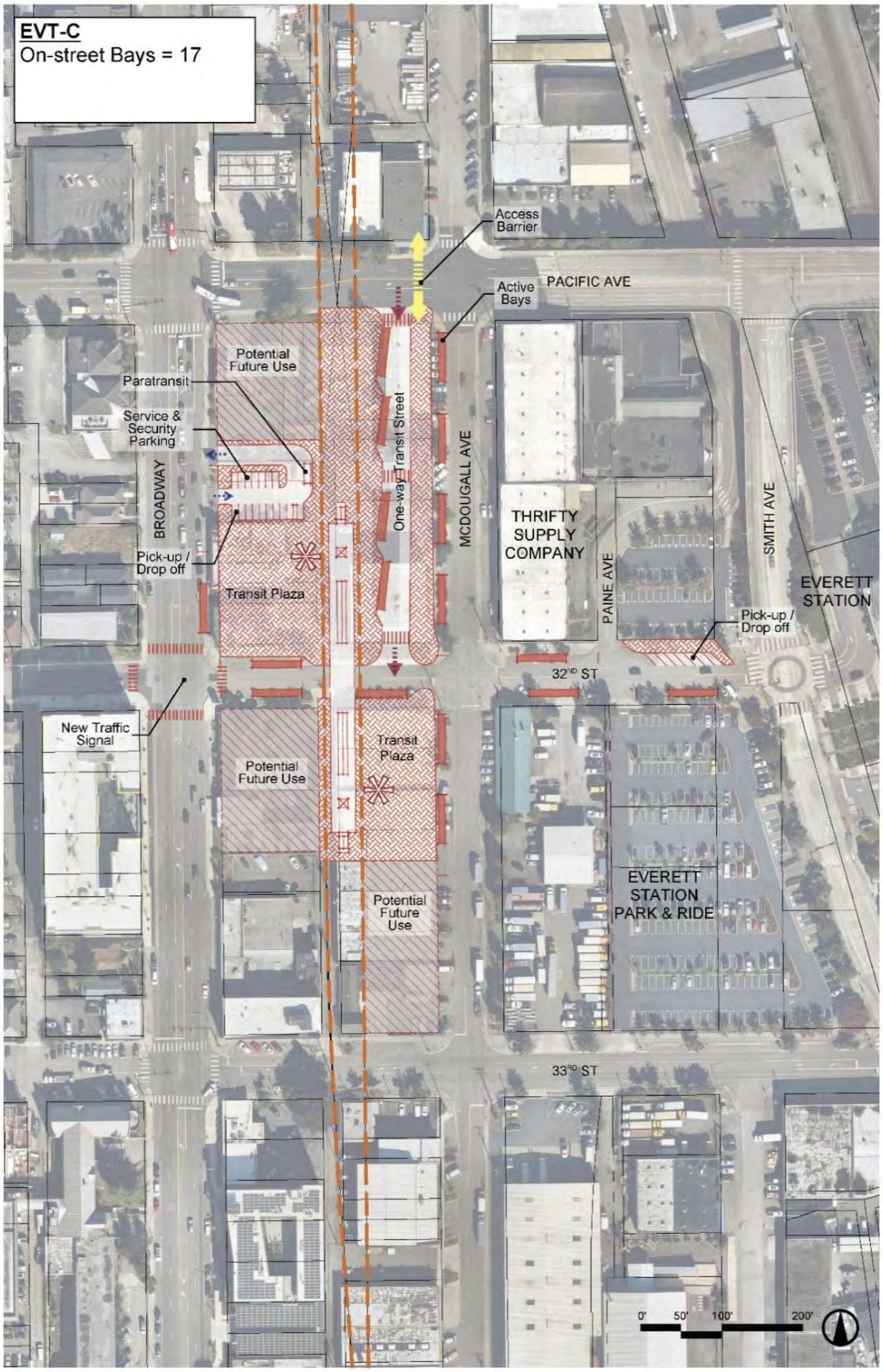
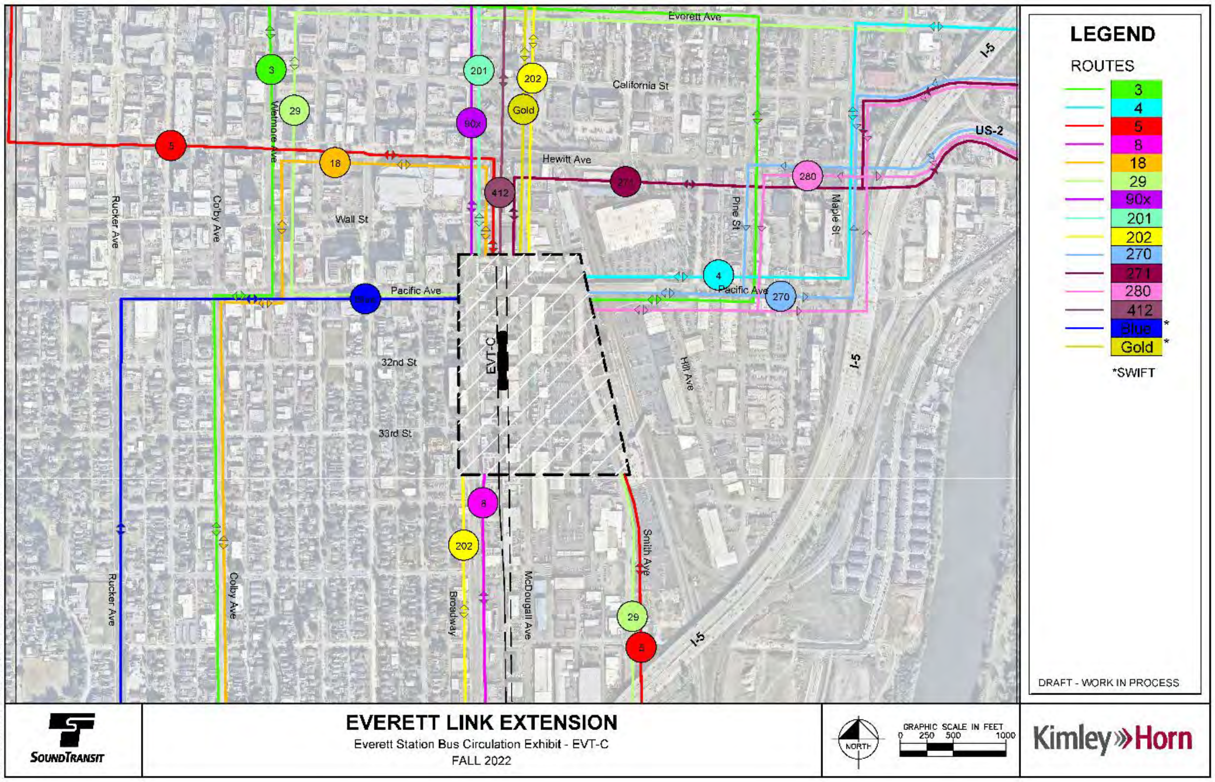


Figure 5-39

EVT-C Station Access Facility Concept Map



Note: Hatched area represents immediate station vicinity where bus routing is dependent on specific bay assignment, which is not yet determined

Figure 5-40 EVT-C Bus Routing Map

Quality and capacity of transfers

- Routes would stop at nearby bus stops located on-street or at nearby curbside bays.
- Many transfers would need to cross local streets, such as McDougall Avenue and/or 32nd Street.

Connectivity to high-capacity transit

- Direct connection to the *Swift* BRT Blue Line and planned *Swift* BRT Gold Line.
- 750 ft walk to Sounder and Amtrak at Everett Station.

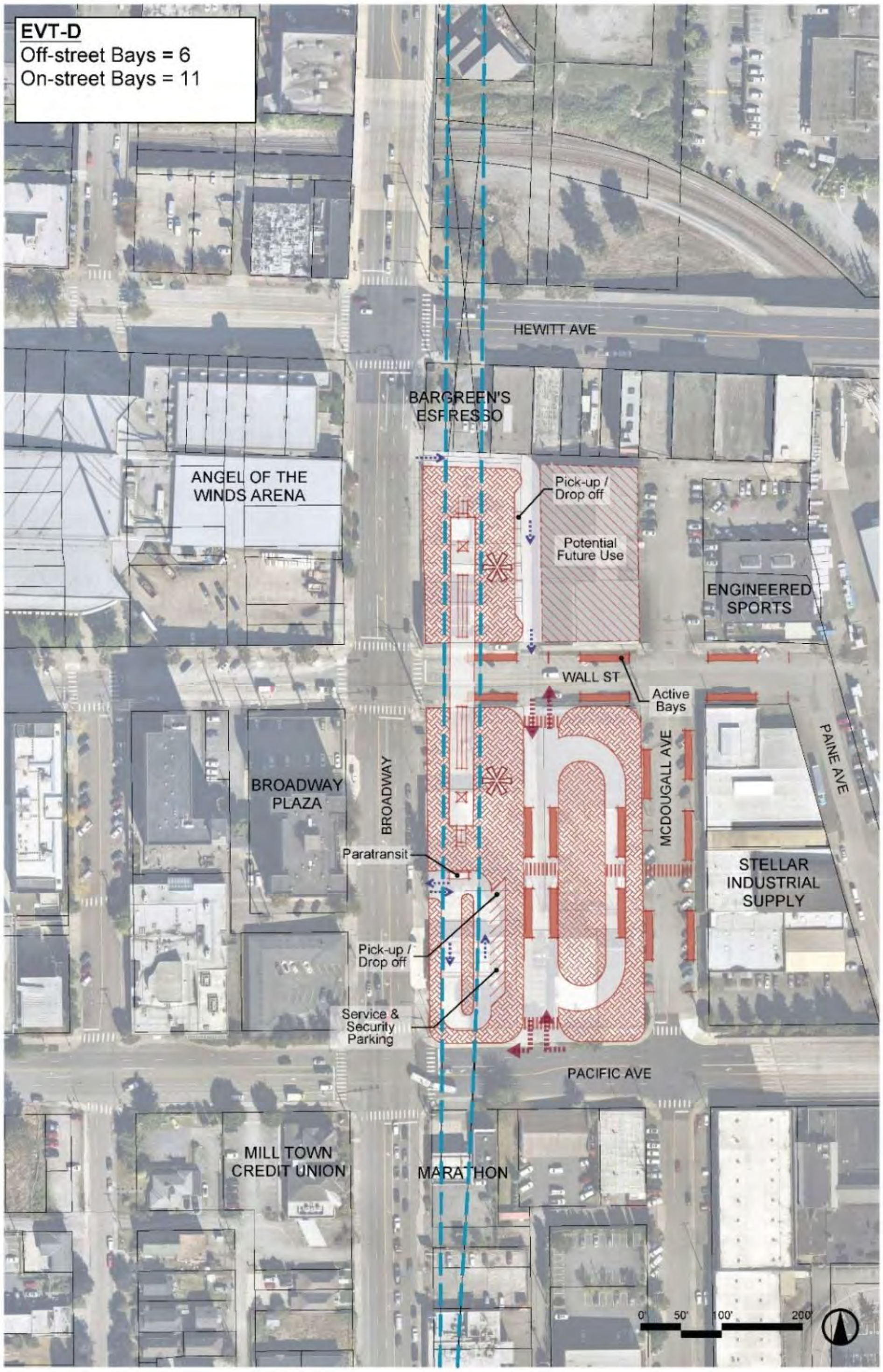
Quality of access for transit vehicles

- May be complex routing for most routes to serve both station alternative EVT-C and existing Everett Station.
- No layover bays planned at station. Layover assumed to occur at Everett Station.

Planned level of bus service

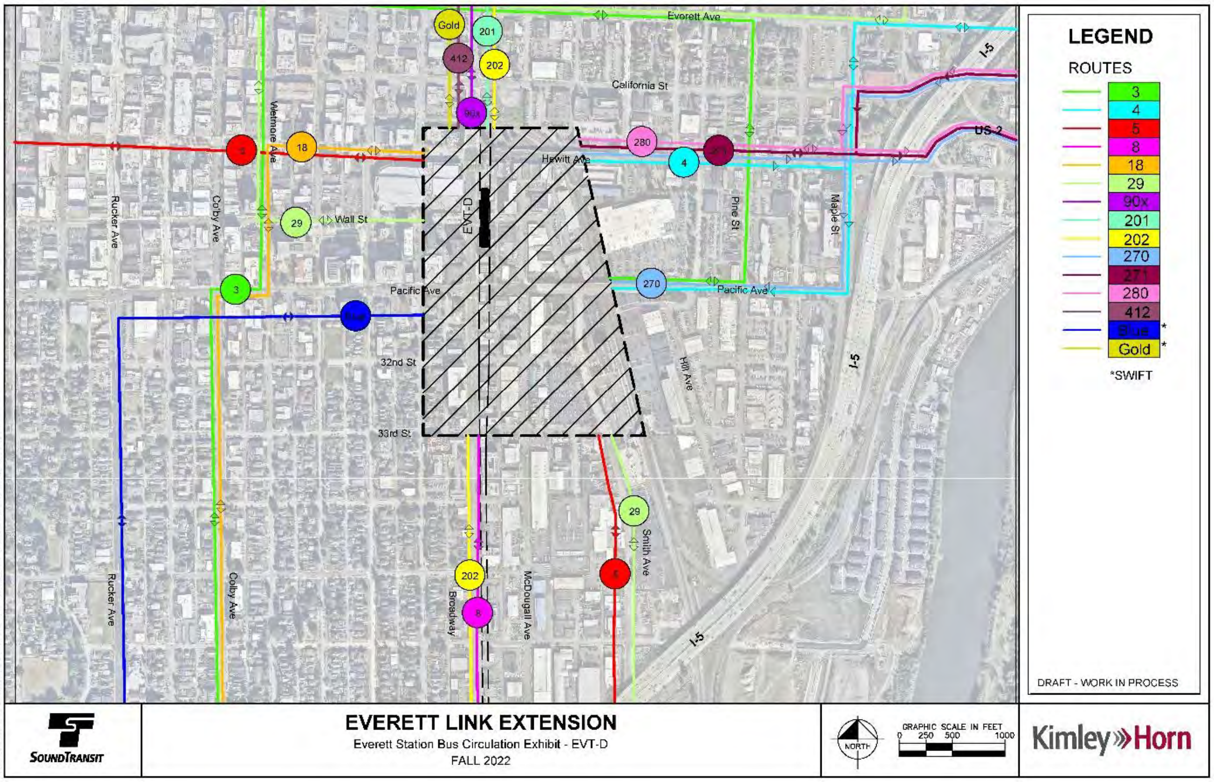
- Peak 89 buses/hour (weekday) (additional buses associated with bi-directional, non-terminal service).

5.7.3 EVT-D



Note: Minor inconsistency between bay requirements in Table 4-2 and concept will be addressed along with further refinement of bus network assumptions if the alternative is advanced to Phase 2.

Figure 5-41 EVT-D Station Access Facility Concept Map



Note: Hatched area represents immediate station vicinity where bus routing is dependent on specific bay assignment, which is not yet determined

Figure 5-42 EVT-D Bus Routing Map

Quality and capacity of transfers

- Routes would stop at nearby bus stops located on-street or at nearby curbside bays.
- Many transfers would need to cross local streets, such as McDougall Avenue and/or Wall Street.

Connectivity to high-capacity transit

- Direct connection to the *Swift* BRT Blue Line and planned *Swift* BRT Gold Line.
- 1500 ft walk to Sounder and Amtrak at Everett Station.

Quality of access for transit vehicles

- May be very complex and circuitous routing for most routes to serve both station alternative EVT-D and existing Everett Station.
- No layover bays planned. Layover at Everett Station assumed.

Planned level of bus service

- Peak 89 buses/hour (weekday) (additional buses associated with bi-directional, non-terminal service).

6 SUMMARY

During Phase 1 - Screening, Level 1, and Level 2, station area alternatives were assessed based on compatibility with project goals and performance relative to each other, with lower-performing alternatives removed at each step and higher-performing alternatives preserved for further analysis. Based on the transit integration assessment factors considered, each station area alternative was given a consolidated transit integration rating based on the assessment metrics and measures. These ratings are presented in Table 6-1 (Consolidated Ratings by Station Area Alternative).

The transit integration analysis is one piece of a larger alternatives analysis process with numerous other metrics and measures, including technical and engineering factors, ridership, bike and pedestrian access, demographic conditions, and equity considerations. While station area alternatives may have received a poor (1) or excellent (5) rating for other measures, none scored this low or this high for transit integration factors. This is generally considered an indication that there are fewer distinctive transit integration attributes that separate the station alternatives in the Level 2 evaluation. In combination with other analysis factors, these results will contribute to the future selection of a Preferred Alternative to move forward into the environmental and conceptual design process during Phase 2.

Table 6-1 Consolidated Ratings by Station Area Alternative

Station Area	Consolidated Rating
West Alderwood	
ALD-B	2
ALD-D	4
ALD-F	3
Ash Way	
ASH-A (without)	3
ASH-A (with)	3
ASH-D (without)	2
ASH-D (with)	3
Mariner	
MAR-A (without)	3
MAR-A (with)	3
MAR-B (without)	3
MAR-B (with)	3
MAR-D (without)	3
MAR-D (with)	4
SR 99/Airport Road	
AIR-A	3
AIR-B	2
SW Everett Industrial Center	
SWI-A	3
SWI-B	4
SWI-C	3
SR 526/Evergreen	
EGN-A	2
EGN-B	3
EGN-C	3
EGN-D	4
EGN-E	4
Everett Station	
EVT-A	4
EVT-C	3
EVT-D	2

APPENDIX B

Sound Transit's Transit Ridership Forecasting Methodology Report

Transit Ridership Forecasting Methodology Report

SOUND TRANSIT

401 South Jackson Street
Seattle, WA 98104-2826

March 2018

Contents

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Acronyms and Abbreviations

AAZ	Alternatives Analysis Zones
ACS	American Community Survey
APC	Automatic Passenger Count
AVL	Automatic Vehicle Locator
CT	Community Transit
CTR	Commute Trip Reduction
DRAM	Disaggregated Residential Model
EIS	Environmental Impact Statement
EMPAL	Employment Allocation Model
FAZ	Forecast Analysis Zone
FTA	Federal Transit Administration
IIA	independence from irrelevant alternatives
JTW	journey-to-work
KCM	King County Metro
PSRC	Puget Sound Regional Council
PT	Pierce Transit
RTA	Regional Transit Authority
RTP	Regional Transit Project
ST	Sound Transit
WSDOT	Washington Department of Transportation

1 Introduction

This report summarizes the methods used in the current Sound Transit (ST) incremental model to produce ridership forecasts in support of the ongoing project planning and development activities. It describes reliance on the new and emerging data that were not previously available. This includes data from the ORCA smart cards,[1] recent surveys, actual point-to-point speeds[2] and detailed ridership counts. The current model benefited profoundly from the new data - particularly, from the ORCA data which:

- Is rich and internally consistent with a statistically acceptable 30% representation of transit travel at origin-to-destination level and by time of day;
- Provides realistic transit trip length distribution as well as transfer rates for each time period; and
- Is a significantly improved alignment of the transit travel patterns (represented by the seed matrix) to the actual counts data that results in a more accurate Base Year transit demand.

The current (2017) version of the ST ridership model was developed using analytical ridership forecasting procedures refined over three decades of incremental methods applications. Over this time period, the methods have been subjected to substantial external review, including three independent Expert Review Panels, and four cycles of review by the Federal Transit Administration (FTA) over the course of New Starts grant applications for Link light rail projects. The fourth review cycle is still ongoing, in support of the proposed New Starts grant for the Federal Way Link Extension.

These reviews have included comments FTA provided with respect to the ST incremental modeling procedures and assumptions described in earlier versions of this report. This report incorporates changes reflecting all of FTA's comments. The following presents a brief history of ST transit ridership forecasting.

1.1 History of transit forecasting at Sound Transit

The history of transit forecasting analysis at ST began at Seattle Metro (now King County Metro) in 1986. Work by Brand and Benham[3] led to Metro's consideration of "a quick-responsive incremental travel demand forecasting method," based on the concept of staged forecasting analysis. In 1986, Metro developed and applied "logit mode-choice equations for pivot-point analysis"[4] (as described by Ben-Akiva and Atherton;[5] Koppelman;[6] Nickesen, Meyburg and Turnquist;[7] and many others) on EMME software. In 1988, Metro staff highlighted the relationship[8] between Metro's transit forecasting methods and the Puget Sound Council of Governments regional model.

The Regional Transit Project, incorporated as Sound Transit in 1993, further developed forecasting analysis procedures using incremental methods in the early 1990s, prior to the November 1996 voter

[1] ORCA smart card is the primary fare medium for all transit operators in the Puget Sound region.
[2] Actual Vehicle Locator (AVL) provides point-to-point actual speed data.
[3] Brand, D., and J.L. Benham, "Elasticity-Based Method for Forecasting Travel on Current Urban Transportation Alternatives," Transportation Research Record No. 895, 1982.
[4] Harvey, R., "Pivot-Point Analysis of Transit Demand Using EMME/2," an Internal Paper, Municipality of Metropolitan Seattle, May 1986.
[5] Ben-Akiva, M., and T. Atherton, "Methodology for Short-Range Travel Demand Predictions," Transportation Economics and Policy, v.7, 1977.
[6] Koppelman, F., "Predicting Transit Ridership in Response to Transit Service Changes," ASCE 109, 1983.
[7] Nickesen A., A. Meyburg, and M. Turnquist, "Ridership Estimation for Short-Range Transit Planning," Transportation Research B, v.17B, 1983.
[8] Harvey, R., "Comparison of Metro and PSCOG Modeling," a Memorandum to File, March 7, 1988.

approval of *Sound Move: The Ten-Year Regional Transit Plan*. An Expert Review Panel—formed in 1990 under the auspices of the Legislative Transportation Committee, the Secretary of Transportation, and the Governor—oversaw development of the first generation of the ST incremental model. This model is described in the November 1993 *Travel Forecasting Methodology Report* published by the Regional Transit Project.

The ST model was updated in the late 1990s in support of the Central Link Light Rail Transit Project Environmental Impact Statement (EIS) and the North Link Light Rail Transit Project Supplementary EIS, including respective Full Funding Grant Agreements with FTA. The underlying ST model procedures used to perform transit ridership forecasting analysis in support of the North Link Light Rail Projects were documented in the *Transit Ridership Forecasting Technical Report,* issued in November 2003 by ST. The ST model was further updated in the mid-2000s in support of the ST2 transit system expansion program and subsequently in 2012 for the EIS phases of the Lynnwood Link Extension and in 2014 for the ST3 system planning work.

The ST model has now been updated again in 2017 in support of the ST3 project planning and development activities and this report describes this latest update. Table 1-1 illustrates more clearly the historical development of the current model, showing refinements in both data sources and structure over the past two decades.

1.2 Report organization

This report contains three chapters and four appendixes. Chapter 1 summarizes the methods used to produce ridership forecasts for ST and discusses important methodological considerations. Chapter 2 describes the individual methods used for each step of the ridership forecasting process. Chapter 3 describes validation of the ST model to 2016 conditions. The current model validation exercise has two purposes: (1) to highlight problems with past forecasting process that might have otherwise been overlooked and (2) to incorporate changes that could improve the forecasting results.

1.3 Sound Transit incremental transit model

The ST incremental model has been updated to a new base year (2016). Development of the base-year transit-trip tables involved a rigorous analysis of actual ridership volumes along each transit route and a realistic simulation of observed transit service characteristics for peak and off-peak periods.

For future year forecasts, external changes in demographics, highway travel time, and costs are distinctly incorporated into the process in stages, prior to estimating the impacts of incremental changes in transit service. In the first stage of ridership forecasting analysis, only changes in Puget Sound Regional Council (PSRC) land use forecasts are considered. In the second stage, other external non-transit changes, such as highway travel time (congestion) and costs (including parking costs) are taken into consideration. For forecasts of external changes, the ST model relies on the version of the PSRC regional model in current use by the Washington State Department of Transportation (WSDOT) on major highway projects. The first two stages of ridership forecasting analysis result in a forecast of future year zone-to-zone transit trips within the Regional Transit Authority (RTA) district boundaries, absent any changes in the transit system itself. For current year analyses, these first two stages are not necessary.

Table 1-1. Sound Transit incremental models history

	Survey-based model (1992 to 2004)	Counts-based model (2005 to 2011)	Counts-based model (2012 to 2016)	Counts-based model (2017 to present)
Data Sources	▪ 1992 on-board surveys, collected by bus drivers on all transit lines – Lumpy 36% one-day sample of inbound trips (mostly AM), or about 18% of daily trips – Peak and off-peak line boardings control totals for survey expansion ▪ 1990 U.S. Census Journey-to-Work (JTW) used for base transit shares ▪ No reliable data for transfer rates, checked against 1992 surveys ▪ Sparse on-board survey data used for auto-access shares ▪ After 2000: 1992 survey demand adjusted with about 100 screen-line segment 1999 ridership counts on select locations around the region	▪ 1,700 line-segment ridership counts for each time period for all lines, mostly collected by validated Automatic Passenger Count (APC) systems (2004 average weekday) ▪ 2000 U.S. Census JTW for base transit shares ▪ 2004 ST on-board surveys ▪ PSRC modeled transit trip distribution to open additional non-zero cells ▪ Little reliable data for transfer rates, checked against 1992 and 2004 surveys ▪ Sparse on-board survey data for peak auto-access shares	▪ 1,800 line-segment ridership counts for each time period for most routes, collected by most transit agencies by validated APC systems (2011 average weekday) ▪ Washington Commute Trip Reduction Surveys (CTR) 2007 to 2014 data and American Communities Survey (ACS) 2010 data used for base transit shares ▪ 2009, 2011, and 2012 ST on-board surveys added to base year matrix development ▪ 2007 to 2014 CTR Survey transit trip patterns added to base year matrix development ▪ Transfer rate estimates validated against PSRC Travel Diary Survey (2006) and ST on-board surveys (2004–2012) ▪ Relied on segment counts near park-and-ride lots for peak auto-access shares	▪ 2,400 bus line-segment ridership counts for combined time periods and for all lines, collected by all transit agencies by validated APC systems (2016 average weekday) ▪ Stop-level boarding and alighting ridership counts for each period and for Link, Sounder and high ridership bus routes collected by all transit agencies by validated APC systems (2016 average weekday) ▪ 2016 ORCA smart card database data was primarily used to create peak and off-peak seed matrices. 2011-2016 ST on-board and CTR surveys were incrementally added to open new cells. ▪ 2011-2016 CTR Surveys data and most recent available American Communities Survey (ACS) data used for base transit shares ▪ 2016 ORCA smart card database provided actual transfer rates ▪ Relied on segment counts near park-and-ride lots for peak auto-access shares ▪ Actual Vehicle Locator (AVL) database was used to develop base year (2016 actual transit speed on each link for peak and off-peak

Table 1-1. Sound Transit incremental models history (continued)

	Survey-based model (1992 to 2004)	Counts-based model (2005 to 2011)	Counts-based model (2012 to 2016)	Counts-based model (2017 to present)
Structure	▪ 737 zones ▪ FAZ demographics from 2002 PSRC model DRAM/EMPAL + negotiation with locals ▪ Highway skims via blind adoption of PSRC matrices created with erroneous cost coefficient ▪ structural error ▪ Use of eight transit trip classes forced very thin demand matrices (not technically a structural error, but generally a poor practice) – PM time periods: 3-hour peak and ½ day off-peak – Trip purpose: commute and non-commute – Mode of access: walk and auto for peak and off-peak ▪ Transit Trip Tables – Base year demand derived directly from on-board surveys – Non-zero cells only 0.05% to 2% across the eight trip tables – After 2000: single-step Matrix Adjustment on non-zero cells of 0.5% to 3% for eight trip tables ▪ Fares in 2nd stage with auto-mode equation	▪ 780 zones (splits near rail stations) ▪ FAZ demographics from 2006 PSRC model DRAM/EMPAL ▪ Highway skims prepared directly by project team using a current PSRC model – Used a validated model that has been refined in major WSDOT projects – Aligned transit service levels in the PSRC model with those assumed in the ST model – Rigorous convergence criteria ▪ Use of only three transit trip classes allowed very robust demand matrices – Time periods: 6-hour peak and 18-hour off-peak with 24-hour daily counts as control totals – Mode of access: walk and auto for peak-period and walk only for off-peak ▪ Transit Trip Tables – Base year demand derived directly from detailed ridership counts by route segment, time-period, and direction – Single-step Matrix Estimation on non-zero cells of 15% for peak and 17% for off-peak ▪ Fares in 2nd stage with non-transit-mode equation	▪ 785 zones (splits for Ballard study) ▪ FAZ demographics from PSRC 2013 Land Use Targets and 2016 Vision I Forecasts ▪ Highway skims prepared directly by project team using a current PSRC model ▪ Used a recent model version refined and validated for major WSDOT projects ▪ Aligned transit service levels in the PSRC model with those assumed in the ST model ▪ Rigorous convergence criteria ▪ Use of only three transit trip classes allowed very robust demand matrices ▪ Time periods: 6-hour peak and 18-hour off-peak with 24-hour daily counts as control totals ▪ Mode of access: walk and auto for peak-period and walk only for off-peak ▪ Transit Trip Tables ▪ Base year demand derived directly from detailed ridership counts by route segment, time-period, and direction ▪ Five-step Matrix Estimation Fares in 3rd stage with transit-mode equation In transit assignment, used logit function on connectors to improve distribution of zone access.	▪ 807 zones (splits near Capitol Hill, SW Everett, Federal Way, Fife, Issaquah) ▪ FAZ demographics from PSRC 2017 Land Use Vision II Forecast ▪ Highway skims prepared directly by project team using a current PSRC trip-based model – Used a recent model version refined and validated for major WSDOT projects – Aligned transit service levels in the PSRC model with those assumed in the ST model – Rigorous convergence criteria ▪ Use of only three transit trip classes allowed very robust demand matrices – Time periods: 7-hour peak and 17-hour off-peak with 24-hour daily counts as control totals – Mode of access: walk and auto for peak-period and walk only for off-peak ▪ Transit Trip Tables – Base year demand derived directly from detailed ridership counts by route segment, time-period, and direction, plus stop-level boardings and alightings for major routes. – Six-step Matrix Estimation ▪ Fares in 3rd stage with transit-mode equation ▪ In transit assignment, used logit function on all connectors to improve distribution of zone access.

In the third and final stage, incremental changes in the transit level of service (e.g., access, wait, and ride travel times) and user costs (i.e., fares) are considered, resulting in final transit demand estimates for each transit network alternative under consideration.

Like all travel forecasting models, the ST model has some limitations. Because it uses average daily ridership, it is not particularly strong at assessing the effects of weekend special events, such as sporting events or major festivals. Furthermore, the ST model is ill-suited for analyzing structural changes in regional land use beyond those already included in PSRC demographic forecasts or for forecasting in outlying areas of the three-county region where there is minimal existing transit service.

1.4 Important considerations and constraints

This section discusses six important considerations and constraints in travel forecasting methods. Most of these are derived from many years of FTA guidelines on transit project planning that culminated in the current policy guidance.[9] The following considerations reemphasize the use of best professional practice:

- Careful standards for validation
- Consistent application of policy assumptions across alternatives
- Use of identical land use plans and constant overall travel demand patterns across alternatives
- Generic attributes of modes
- Analysis of service levels and travel forecasts for reasonableness
- Maximum possible reliance on detailed data rather than output from other models

1.4.1 Careful standards for validation

Validation is a vital component of any travel forecasting effort. It demonstrates that the forecasting procedures can replicate observed travel patterns in a region to support reliable forecasts of future travel patterns. The ST model primarily relies on the ORCA fare card data and detailed ridership counts to establish current transit travel patterns. In project planning, travel forecasting methods are expected to predict changes in travel patterns that are caused by general changes between the base year and a forecast year and by specific transit service changes introduced by each alternative.

1.4.2 Consistent policy assumptions across alternatives

A large number of inputs to the travel forecasting process are at least partially subject to the policy decisions of local and state agencies. To isolate the differences generated by a specific proposed project (e.g., a fixed guideway rail transit system), all conditions that are not directly attributable to the proposed project must be held constant. It is therefore required that the forecasts hold the policy setting constant across all alternatives evaluated. These policies include:

- Fare level and structure
- Levels of service provided by the background transit system
- Zoning policies
- Parking policies and prices

[9] Final Interim Policy Guidance—FTA Capital Investment Grant Program (June 2016).

This constraint means that forecasts prepared for FTA evaluation and EIS documentation should only contain differences between alternatives that are primarily caused by the transit alternatives themselves. For example, service levels on feeder buses should reflect a general service policy and investment level that is applied consistently across alternatives. Assumptions on all external inputs—land use, regional income, parking costs, and other external variables—should also be held constant.

1.4.3 Constant travel patterns across alternatives

Forecasts of the overall travel demand for which transit competes can involve confounding factors. The FTA guideline that land-use policies be consistently applied removes some sources of variability in population and employment forecasts. In basic forecasts for modes that have differing degrees of grade separation, it eliminates guessing about the extent to which a particular alternative might shift residential and commercial development. Note that the forecasts provided to FTA by ST hold travel patterns constant. Supplementary analyses external to the modeling process are used to address potential development changes related to the various transit investment proposals.

1.4.4 Generic attributes of modes

It is widely acknowledged that perceived differences between transit technologies, independent of travel time and cost, may contribute to choice of mode. These differences are often discussed in terms of comfort, security, reliability, legibility, and other characteristics that are difficult to quantify. Data to support direct inclusion of these variables in the analysis is limited. The ST model uses a conservative assumption and, for the most part, treats transit modes generically. Current FTA guidance on methods indicates that FTA will accept forecasts that account for measurable differences in some of these attributes, such as reliability between modes (e.g., bus and rail).

The ST model includes small quantified mode-specific variations in the perception factors (i.e., weights) for transit line boarding and waiting times (see Table 3-2 in Chapter 3).

1.4.5 Analysis of transit service levels and travel forecasts

The development of forecasts results in the production of a variety of additional types of information beyond ridership volumes. Examples include ridership changes in specific subareas, changes in roadway congestion levels, travel time savings created by new transit investments, and transit's share of various travel markets. All of these needs careful review for quality control purposes, as well as an understanding of what the forecasts reveal about changes between the present and the future and differences among the transit alternatives.

1.4.6 Reliance on data

This model version increases the reliance on detailed data by incorporating newly available data detail. Major new sources of data include ORCA fare card boarding and alighting data, Google highway travel time data, Automatic Vehicle Locator (AVL) data, and additional Automatic Passenger Count (APC) data on passenger activity at major stops. All of these data source additions reduce dependence on inputs from external models.

2 Procedures for Travel Forecasting

This chapter describes the methods and procedures used in the ST transit forecasting model, including the input data required by the ST model and its relationship to the PSRC model.

Section 2.1 describes the methodology used to develop transit forecasts, the data requirements, and the data available. Section 2.2 describes the relationships between the ST and PSRC models. For instance, this section provides an overview of the methodology used by PSRC to produce land use forecasts that are critical to any future year ridership forecasting analysis. The transportation analysis zone system is described in Section 2.3. The mode choice model structure, specification, and coefficients are presented in Section 2.4. Summary descriptions of the process used to develop base-year transit-trip tables are provided in Section 2.5. Possible changes in population and employment, highway congestion, and cost (i.e., the application of the staged build-up forecasting analysis) are discussed in Sections 2.6 and 2.7. A discussion on changes in transit service is included in Section 2.8.

2.1 Methodology

2.1.1 Incremental vs. synthetic methods

There are two different approaches to developing transit forecasts: synthetic methods and incremental methods. Synthetic methods estimate existing transit travel patterns by using separate sequential models to estimate

- An allocation of regional population and employment projections to zones
- The total number of trips to and from these zones
- The origin/destination patterns of these estimated trips
- The travel mode share likely for each estimated origin/destination pattern
- Which specific links and lines in the highway and transit systems are used by these synthesized trips

Incremental methods are simpler and more efficient for transit ridership forecasting and analysis because they

- Are directly based on observed (rather than estimated) baseline travel patterns of transit users
- Allow for concentrating efforts on transit network analysis, for studies whose primary goals are answering questions about alternative transit networks
- Are more conducive to the separate and transparent evaluation of population and employment changes, highway congestion and cost, and transit services through the three stages of the forecasting process
- Focus on direct comparisons related to specific changes rather than on complete simulations of travel behavior
- Are more usable for intermediate evaluation and error identification
- Eliminate the often laborious and time-consuming calibration of sub-choice models, since they do not require replication of base-year travel patterns for these markets.

The FTA guidelines on transit project planning have identified three strong characteristics of the incremental approach that make it attractive for many applications. According to FTA, the incremental method “is well grounded in the reality of baseline travel patterns; it deals only with marginal changes; and it focuses attention on the changes in land-use and transportation that drive the evolution of travel patterns over time.”[10]

One limitation that could render incremental methods less desirable in some situations is their weakness in estimating future transit markets in locations where there is no existing transit market from which to build estimates. This is not an issue within the ST RTA district, since both ridership and transit service coverage within the district are highly developed. The use of incremental methods would only have limitations if applied to exurban or rural areas beyond the district boundary.

Incremental methods rely on data collection, not travel demand theory, to describe base-year travel patterns. In recent years, data availability has increased dramatically, with large quantities of revealed preference data no longer requiring expensive surveys or special counts. The ORCA smart card data, coupled with the detailed route-level data by time-of-day from the ridership counts from each transit agency now available, provide complete observed baseline travel patterns within the RTA district.

In the incremental model approach, the coefficients and sensitivities are the same as in the synthetic approach. The incremental methods are mathematically derived from and parallel to the synthetic methods and are applied at the same level of network detail that would be used in a synthetic approach.

2.1.2 Data available for Sound Transit planning

The key sources of data available for ST planning include

- PSRC land use forecasts
- PSRC regional travel model version adopted by WSDOT for major highway projects
- Service levels and detailed route-level counts from transit operators in the three-county area—Sound Transit, King County Metro, Pierce Transit, Community Transit, and Everett Transit
- ORCA smart card database
- Automated Vehicle Locator (AVL) speed data
- Location-to-location highway travel time from the Google Distance Matrix database
- Sound Transit Surveys (2011–2016)
- Commute Trip Reduction surveys (2011–2016)
- Most recent available American Community Surveys
- The National Transit Database (2016)
- State and local agencies

[10] Procedures and Technical Methods for Transit Project Planning, Federal Transit Administration, 2004.

PSRC's land use forecasts are key input to the modeling effort for future years. The ST model uses the most current land use forecasts available from PSRC at the start of a project. The PSRC regional forecasting model, the version used by WSDOT for travel forecasting in support of major capital projects and tolling analysis, provides changes in highway travel times for past and future years. This WSDOT highway model also provides changes in traffic volumes on regional highway facilities for traffic impact analysis, and local jurisdictions provide traffic counts on local arterials for station impact analysis, as required.

The following sections discuss how these various databases were developed and include more detail on how they are being used.

2.2 Relationship to PSRC modeling

2.2.1 Summary comparisons of the PSRC travel demand model and the ST transit ridership model

PSRC maintains a four-step conventional synthetic travel-demand modeling system consisting of trip generation, trip distribution, mode choice, and trip assignment models.[11] Zonal trip ends are estimated using a set of trip rates classified by home-based work, home-based college, home-based shop, home-based other, home-based school, non-home-based work, non-home-based other, and three truck types. Trip distributions are estimated using a traditional "gravity" model. The PSRC mode-choice model structure is a logit-based model comprised of two transit modes, three auto modes, and two non-vehicle modes.

The ST and PSRC modeling procedures are closely inter-related and highly complementary. The ST model uses measures of regional change in travel demand and highway congestion derived from the PSRC model. Summary comparisons and interrelationships of the PSRC and ST modeling procedures are highlighted below:

- The PSRC model is a four-county synthetic modeling system comprising land use, trip generation, trip distribution, modal split, and assignment models. It also includes several feedback loops based on intra-regional accessibility.
- The ST model is a three-county, three-stage, fully incremental system purposely designed for detailed corridor-level transit planning and transit ridership forecasting.
- PSRC's regional population and employment forecasts are used to predict travel demand growth for future years.
- ST uses an incremental mode choice procedure that is consistent with PSRC's multinomial logit mode choice model.
- The current PSRC model version used by WSDOT for travel and toll forecasting in support of major highway projects is adopted for interface with the ST model. This highway model has been recently refined and validated for use on several WSDOT tolling analyses. Figure 2-1 highlights the relationship between the PSRC and ST models.

[11] Puget Sound Regional Council, 4K Travel Model Documentation, June 2015.

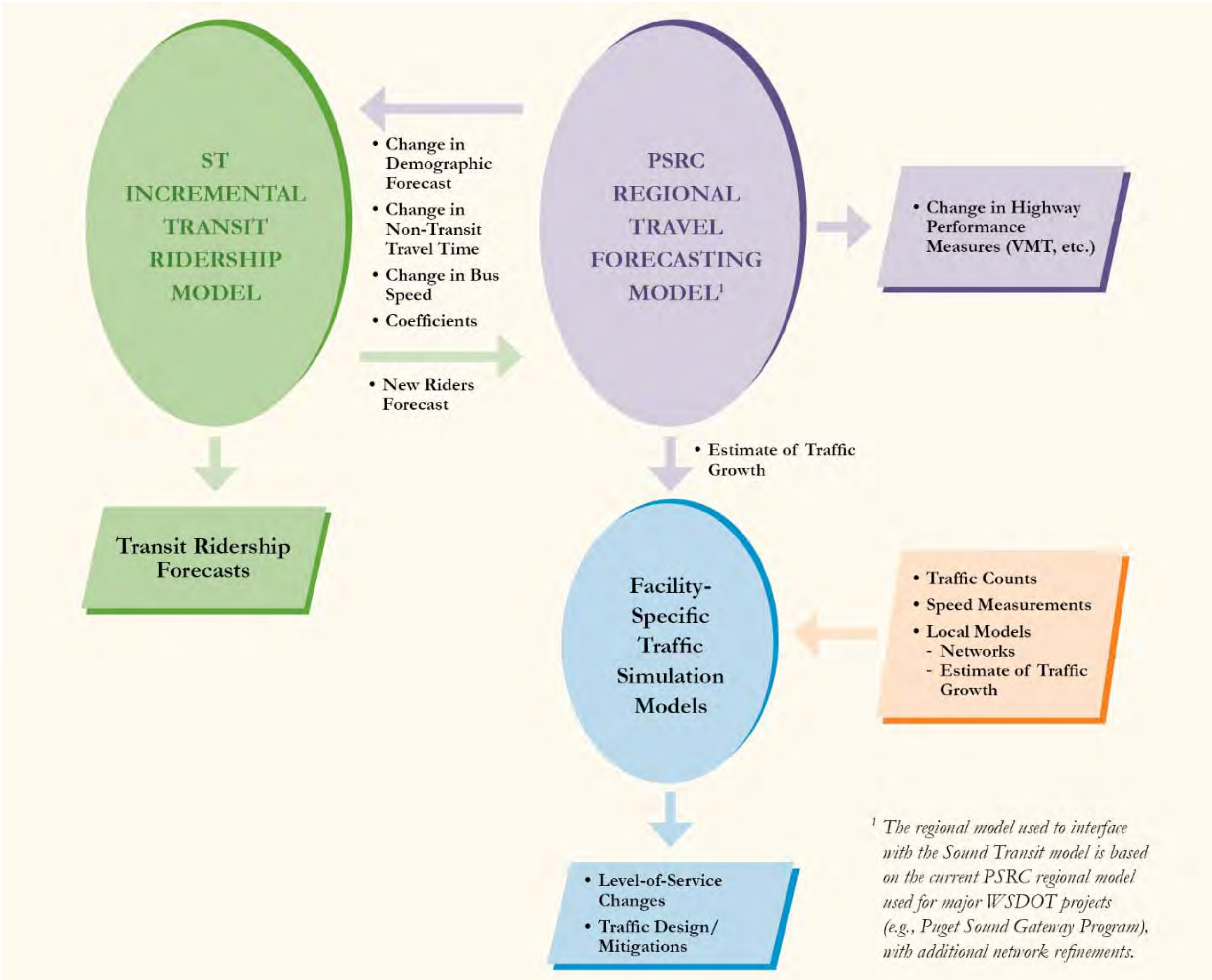

Figure 2-1. ST incremental transit ridership and PSRC regional models relationship

2.2.2 Preparation of demographic forecasts

This section summarizes the procedures used by PSRC to forecast regional population and employment. The current demographic forecasts are referred to as Land Use Vision (LUV). The development of demographic forecasts process is described by PSRC in the *Land Use Vision (LUV) Dataset Metadata Documentation (May 2017)*.

Land Use Vision Development Process

The LUV projects growth for places in the Central Puget Sound region in 5-year increments, 2015–2040. The process includes four general steps (Figure 2-2). The regional totals for population, households, and jobs come from the PSRC Regional Macroeconomic Forecast. PSRC has used numeric policy guidance from the VISION 2040 Regional Growth Strategy and adopted local growth targets to apportion the Regional Forecast to cities and unincorporated areas to create annual control totals. Resulting control totals are then used in the PSRC's land use simulation model, UrbanSim, to distribute projected growth on developable land.

Figure 2-2. Land use vision development process

The UrbanSim model results are reported at different geographies, including at the forecasting analysis zone (FAZ) level for review and consultation feedback by local jurisdictions. These forecasts are also circulated for review by a wide variety of public and private organizations. After the review process is completed, these forecasts and allocations are widely used by the state as well as by local governments, public agencies, and private organizations.

2.3 Development of zone and district systems

The ST travel forecasts are produced for an 807-zone system of Alternatives Analysis Zones (AAZ) developed specifically for the ST model but based directly upon PSRC's current zonal system. Summaries of inputs and forecasts are prepared using 26 summary districts or other levels of aggregation (e.g., by corridor or by county) as needed. Zone and district maps are shown in Appendix A.

2.3.1 Forecast analysis zone and traffic analysis zone systems

PSRC's FAZ structure is the basic land-use zone structure and consists of 219 FAZs that cover all the land area within the four-county region. It is usually at this level of detail that local jurisdictions, through PSRC, agree upon allocations of future population and employment throughout the region.

2.3.2 Alternatives analysis zone system

The AAZ system used to produce the ST travel forecasts is based on the zones maintained by PSRC for regional forecasts of travel demand within the four-county central Puget Sound region. The ST zone system differs from PSRC's system in two aspects.

Most importantly, the ST system does not have the same geographic boundary as the PSRC system. Whereas PSRC includes a four-county region (Snohomish, King, Kitsap, and Pierce Counties), the 1993 state-established RTA excludes the largely rural areas of North and Northeast Snohomish, South and Southeast Pierce, and East King Counties, as well as all of Kitsap County, Vashon Island, and the Gig Harbor peninsula. Areas outside the RTA district are external to the ST model. The 807-zone system includes smaller zones within transit corridors of interest, especially around potential station locations, as well as 17 external zones to represent highway connections outside the RTA boundaries.

Keeping the PSRC and ST zone structures as similar as possible reduces the level of data manipulation required for interface between the two models.

Summary districts were created from the AAZ system in order to

- Provide a consistent basis for aggregation of certain model inputs, when such aggregation is appropriate
- Calculate the modal shares required in the model validation and application phases
- Prepare summary reports on trip tables and travel time skims

These districts were carefully constructed to provide distinctive summary travel patterns by geographical area and corridor.

2.4 Sound Transit mode choice model methodology

2.4.1 Model structure

The ST mode-choice model structure, which is an incremental logit model, uses a pivot approach in the development of forecasts and uses the PSRC regional mode choice coefficients.

Incremental logit model

The incremental approach predicts changes in travel behavior based on existing travel behavior and changes in level of service. The incremental form of the logit model is derived from the standard logit formulation, which is[12]

(1) $$S_i = \frac{\exp(\mathrm{V_i})}{\mathrm{SUM_j}^{\mathrm{m}}\,[\exp(\mathrm{V_j})]}$$

Where

V_i = utility of mode i in choice set m (j=1,2,3, .., i, ..m)
Contains measurable components of transportation systems such as travel time and cost as well as socio-economic attributes of trip makers.

S_i = share of demand using mode i

[12] Domenich, T., and D. McFadden, "Urban Travel Demand—A Behavioral Analysis," North Holland, Amsterdam, 1975.

Ben-Akiva and Lerman indicate that "using elasticities is one way to predict changes due to modifications in the independent variables. For the linear-parameters multinomial logit model, there is a convenient form known as the incremental logit model which can be used to predict changes in behavior on the basis of the existing choice probabilities of the alternatives plus changes in the independent variables." The incremental form of the logit model is[13]

(2) $$S_i^f = \frac{S_i \text{ x } \exp(\text{DIFF } V_i)}{\text{SUM}_j{}^m \, [S_j \text{ x } \exp(\text{DIFF } V_j)]}$$

where

S_i	=	base-year observed probability of using mode i from choice set m
S_i^f	=	new share (i.e., forecast year) of using mode i (interzonal average)
DIFF V_i	=	change in utility of mode i (interzonal average)
	=	V_i^f—V_i = (DIFF CONST_i) + B_k x (DIFF $\text{VAR}_{i,k}$)

and

DIFF CONST_i	=	difference (future vs. base) in mode-specific constant for mode i,
B_k	=	coefficient for attribute k
DIFF $\text{VAR}_{i,k}$	=	difference in numeric variable VAR k of alternative i
f	=	variable with superscript "f" represents value in forecast year.

All transportation models, including the PSRC synthetic model, assume that the difference between the unmeasured attributes (e.g., comfort and image) between transportation systems in the base year and future years is negligible. As a result, the term representing the difference in mode-specific constants (i.e., DIFF CONST_i) falls out of the computations. The only terms remaining in Equation 2 pertain to those attributes (e.g., travel times and costs) for which a measured change might occur, as well as Equation 3:

(3) DIFF V_i = B_k x DIFF $\text{VAR}_{i,k}$

The mode-specific constants in a synthetic model theoretically represent the effects of unmeasured attributes and often account for over half of the explanatory power in synthetic mode choice models. In practice, these constants are quite large and compensate for all types of errors in synthetic models, even network coding idiosyncrasies. They are used as overall adjustment factors to move the base year model results closer to targeted base year totals. Mode-specific constants are not present in incremental logit equations.

[13] Ben-Akiva, M., and S.R. Lerman, "Discrete Choice Analysis Theory and Application to Travel Demand," The MIT Press, Cambridge, MA, 1985.

Nested logit model

According to the independence from irrelevant alternatives (IIA) assumption, logit models require that all of the modes defined in the choice set m (for travelers) be independent of one another. However, the IIA requirement is usually difficult to maintain in a simultaneous structure. In practice, a sequential (or nested) logit model that is less restrictive than the simultaneous form is often used. The nested logit model groups appropriate submodes under the primary modes (i.e., transit), as shown in Figure 2-3. For peak trips, the transit mode in the ST model, the sub-choice is between access to transit by walking or by automobile. Suggestions from FTA on the appropriateness of nesting can be found in the FTA presentation by Jim Ryan at the January 2004 Transportation Research Board Annual Meeting.[14]

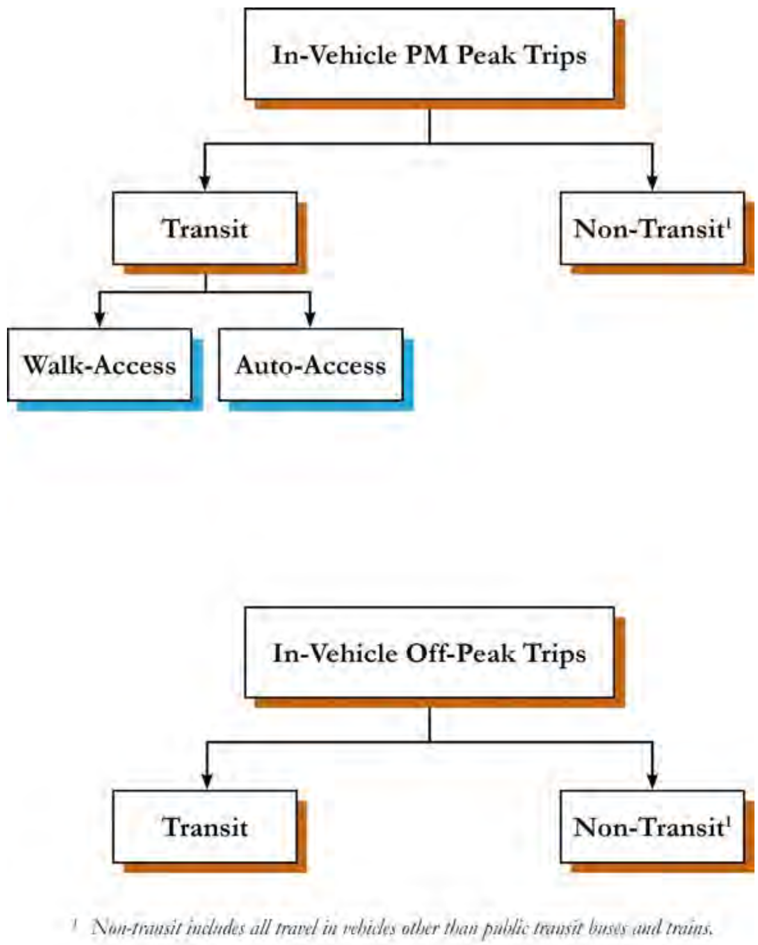

Figure 2-3. Incremental mode choice model structure

[14] Travel Forecasting for New Starts Projects, Transportation Research Board 83rd Annual Meeting, Session 501, January 13, 2004.

The natural logarithm of the denominator of a logit model (Equation 1) is a single "inclusive" index I_m[15] indicating the desirability of the main mode m and taking into account the attributes of access modes. This index is often called "LogSum" and calculated from

(4) $\text{LogSum} = \text{Ln}\ \{\text{SUM}_j^m\ [\exp(V_j)]\}$

where

V_j was defined before for Equation (1)

McFadden[16] has identified the coefficients K for the LogSum variable as indices of similarity among the sub-mode choices comprising the overall price or cost.

For the transit, lower level, the composite disutility of the sub-modes (walk- and auto-access) represents transit to the upper level choice. For transit mode t, the LogSum is

(5) $\text{LogSum}^t = \text{Ln}\ [\exp(V_{walk}) + \exp(V_{auto})]$

where

V_{auto} = utility of the auto-access mode
V_{walk} = utility of the walk-access mode

The structure for PM peak period shown in Figure 2-3 is fully incremental[17] because it uses the incremental logit model at both the lower-level and upper level nests. The incremental form is highly desirable because it relies on observed data that describes current conditions, rather than using models to estimate these current conditions.

Derivation of changes in LogSum variable

In the fully incremental ST mode choice model, the changes in ridership between future and base-year conditions are calculated based on the incremental logit formulation (Equation 2) both at the primary level of hierarchy (i.e., transit vs. non-transit) and at the lower level (i.e., mode of access).

Because the incremental model requires the difference in the values of LogSum variable (i.e., DIFF LogSum^t for the mode of access), the underlying components of this difference need to be spelled out first within the context of standard logit formulation (Equation 1). The derivation process starts by using the definition of difference in the LogSum values and ends up with a simple formula consisting of the logarithmic summation of the exponential difference in the utility of each mode (i.e., future minus base year), weighted by the respective base year observed share. The mathematical derivation is presented below.

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[15] McFadden,E., A. Talvities and Associates, "Demand Model Estimation and Validation, Urban Travel Demand Forecasting Project (UTDFP) Final Report," Vol. V, University of California, Berkeley, CA, 1977.
[16] McFadden,E., A. Talvities and Associates, "Demand Model Estimation and Validation, Urban Travel Demand Forecasting Project (UTDFP) Final Report," Vol. V, University of California, Berkeley, CA, 1977.
[17] Dehghani, Y., and R. Harvey, "A Fully Incremental Model for Transit Forecasting: Seattle Experience," Transportation Research Board, Record #1452, 1994.

Incremental change in $LogSum^t$ of Equation 5 can be represented by

(6) $$DIFF\ LogSum^t = Ln[exp(V^f_{walk}) + exp(V^f_{auto})] - Ln[exp(V^b_{walk}) + exp(V^b_{auto})]$$

Incremental change in LogSum for mode m (i.e., transit or auto), representing the upper-level of the nested logit structure, can be written as

(7) $$DIFF\ LogSum^m = Ln\ \{Sum^n_i[exp(V_i + DIFF\ V_i)]\} - Ln\ \{Sum^n_i\ [exp(V_i)]\}$$

or

$$= Ln\ \left[\frac{Sum^n_i\ [exp(V_i + DIFF\ V_i)]}{Sum^n_i\ [exp(V_i)]} \right]$$

$$= Ln\ \left[\frac{Sum^n_i\ [exp(V_i) \times exp(DIFF\ V_i)]}{Sum^n_i\ [exp(V_i)]} \right]$$

$$= Ln\ [Sum^n_i\ (S_i \times exp(DIFF\ V_i))]$$

where

$DIFF\ LogSum^t$	=	difference in LogSum term for transit mode t (future–base year)
V^f_{walk}, V^f_{auto}	=	the utility of walk and auto access modes in future
V^b_{walk}, V^b_{auto}	=	the utility of walk and auto access modes in the base year
$DIFF\ LogSum^m$	=	difference in LogSum term for mode m (e.g., auto or transit) in the upper level of the nested structure (future–base year)
V_i	=	the utility of submode i (e.g., walk or drive access attributes) under nest n (e.g., transit)
S_i	=	base-year observed share of using submode (e.g., walk or drive access) under nest n
$DIFF\ V_i$	=	difference in the utility (e.g., travel time) of submode i under nest n (future–base year).

The coefficients of variables (e.g., travel time) included in the utility of a sub-mode i are equal to comparable mode-choice coefficients from the upper-level nest for the same variables (e.g., travel time), scaled by the corresponding LogSum coefficient (K^i).

Values for DIFF LogSum variables resulting from Equation 7 are used in the incremental logit formulation (Equation 2) to estimate new interzonal modal shares. Nesting coefficients vary between 0.0 and 1.0 and measure the degree of similarity and dissimilarity of a group of sub-modes from other modes in the upper-level nest. For example, a nesting coefficient (K) of 1.0 on the transit nest of Figure 2-3 would indicate that auto- and walk-access sub-modes are dissimilar (independent) from each other, implying that they should have been structured simultaneously instead of within a nested form. In the absence of any information to inform the selection of a nesting coefficient, an assumption of 0.50 is neutral. This nesting coefficient of 0.50 is used for the PM peak mode-of-access nest in the ST model.

2.4.2 Model specification and coefficients

As indicated in the previous section, since the mode-choice model structure is fully incremental, the mode-specific constants fall out of the computations. Therefore, it is not necessary to estimate values for modal constants. The model includes

- Travel time and cost variables in the utilities of the transit sub-modes, walk and drive access (e.g., in-vehicle, out-of-vehicle times, transit fares)
- Travel time and cost variables in the utility of non-transit mode representing all travel in vehicles other than public transit buses and trains.

The travel time and cost coefficients used in the ST model include the following:

- -0.025 for in-vehicle travel time (which falls within the FTA's recommended range of -0.02 to -0.03 and is also used in the PSRC mode choice model) with a relative ratio of 1.5 for out-of-vehicle over in-vehicle transit travel times, as derived from the base year (2016) model validation analysis.
- -0.00075 for travel cost (in 2016 dollars).

These coefficients imply a value of in-vehicle time of $20 (in 2016 dollars), which is about two-thirds of average hourly wage rate for the Puget Sound Region. This value of travel time is also compatible with values used over the last decade for tolling analysis on major WSDOT projects such as SR 520,[18] SR 99, and Puget Sound Gateway.

2.4.3 Base year mode shares

Equation 2 illustrates the need for a reasonable estimate of S_i (the existing shares for transit relative to alternative modes), including existing mode-of-access shares. Development of these base shares, used in the ST incremental model, is described below.

Transit shares

For the 2017 ST model version, a combination of data from the Washington Commute Trip Reduction (CTR) Act surveys and the American Communities Survey (ACS) is used to establish base year transit shares.

The State of Washington passed the CTR Law in 1991 to encourage commuters to consider transportation alternatives to driving alone. Under this law, employers with 100 or more employees are required to conduct a survey once every two years to record the commute options used by their employees. The ACS is conducted on an on-going basis in order to provide up-to-date information for planning. Further information about the CTR surveys and the ACS is provided in Appendix B.

The CTR (2011-2016) surveys provide transit shares at the zonal level with some limitations. These limitations include an over-representation of transit users, related to employer size because the sample excludes small employers.

The ACS data also has some limitations as it represents a sample of residences—only about 1 in 40 households annually. The Census Bureau produces three ACS data series: *one-year, three-year, and*

[18] SR 520 Bridge Investment Grade—Traffic and Revenue Study Report, August 29, 2011.

five-year estimates. Five-year estimates of ACS home-to-work flow by mode are currently available at the County or Census Place geographies. To address the ACS data limitations, transit shares were aggregated at the 6-district level for maintaining statistical confidence in the share values.

A 6-district level summary comparison of transit shares in the ST service area indicated that

- As expected, CTR transit shares are higher than those obtained from the ACS
- Most recent available ACS shares are slightly higher than those obtained from the 2000 U.S. JTW data

Based on the findings from the above analysis, it is reasonable to adjust CTR transit shares relative to ACS shares in the following manner in order to retain the CTR geographic detail:

- Aggregate CTR 2011-2016 surveys to the 26 districts at the work ends and 26 districts at the home end and calculate transit shares accordingly. Calculating the shares at this level (i.e., 26-district to 26-district) preserves the variation in current mode-choice behavior for PM peak and, therefore, the elasticities in the incremental logit model.

Adjust 26-district-to-district base transit shares based on using the 6-district-to-6-district transit shares calculated from the most recent ACS five-year estimates as follows:

- Since the aggregated CTR shares are higher than the ACS shares at the 6-by-6-district level, reduce the CTR shares proportionately using the ratio of the ACS share to the aggregated CTR share.

For calculating off-peak base shares, a procedure similar to the one described above was used with the following exceptions:

- Aggregate CTR surveys at 26-district-to-26-district level and calculate shares accordingly
- Adjust CTR shares based on using 6-district level ACS shares similar to the method for peak shares.
- Balance the resulting 26-district-to-26-district share matrix by adding its transpose and dividing by 2
- Apply a factor of 0.5 to reflect the difference in base off-peak transit share relative to peak—this factor was calculated based on recent ST 2011 through 2016 small-sample transit on-board survey data.

Access shares

The 2017 ST model version relies on a matrix estimation process for the development of base-year trip tables that is based on using a seed matrix with a high number of non-zero cells. The process includes posting of ridership counts on appropriate segments and stops to capture existing demand at each park-and-ride facility. These considerations, together with the fact that existing park-and-ride facilities are adequately represented throughout the region provide a good database from which to calculate access shares. Steps used to estimate access shares are summarized below:

- Perform a select segment analysis on segments representing potential PM peak demand to park-and-ride facilities
- Aggregate the resulting demand matrix for PM peak auto-access trips and the total PM peak transit trip table at 26 districts (work ends) and 165 FAZs (home ends)

- Divide the aggregated trip tables to provide existing auto-access shares at a 26-district-to-165-FAZ aggregation level.

2.4.4 Discussion of staged build-up analysis application

For future year forecasts, the ST incremental ridership forecasting modeling procedures are applied in three distinct stages as highlighted in Figure 2-4. This application method explicitly recognizes a build-up approach to the ridership forecasts and encourages the analysis of intermediate results in the process as well as the checking of intermediate results for reasonableness. Specific contributions to changes in ridership at each stage are calculated and analyzed separately as they build on each other. The three stages are:

- Overall growth in travel related to population and employment growth
- Changes in ridership related to changes in highway congestion and costs
- Changes in ridership related to transit service changes, including transit fare changes, if any

By applying forecasting analysis in stages, the method also ensures that only those changes that are important to the study transit alternatives will be considered. For example, it is common in ridership forecasting (and preferred by the FTA) that only the changes in transit service be considered in the future year comparisons of transit ridership. Therefore, all demographics, such as land use, trip distributions, and gas and parking prices, are effectively held constant when comparing ridership on transit alternatives.

FTA now considers transit benefits measures related to economic development effects and to land use entirely separately from the ridership estimating process. Furthermore, by requiring current year ridership estimates, with future years optional, FTA is de-emphasizing future year forecasts in favor of simple network-based comparisons. As the FTA Policy Guidance points out, “Use of current year data increases the reliability of the projected future performance of the proposed project by avoiding reliance on future population, employment, and transit service levels that are themselves forecasts.”[19]

Staging the forecasts in an incremental model explicitly isolates sources of error, makes consistencies in the non-transit assumptions transparent, and reduces superfluous calculations. When only variations in the transit service are under consideration, Stage 3 of the incremental model is the only step needed to evaluate each proposed variation in transit service. This method does not preclude varying inputs other than the transit service (i.e., for sensitivity testing) but allows such variation to be addressed simply and specifically, rather than as a hidden piece of a very large and complex model.

2.5 Base-trip table development

The essential basis for incremental mode choice modeling analysis is the reliance on actual transit travel patterns. Capturing existing travel patterns is achieved in the ST model by using available, pertinent data that provide a complementary balance between origin-destination (O-D) data and detailed route-level transit ridership information by direction and time-of-day for the base year. Chapter 3 includes a detailed discussion of the process used to develop base year (2016) peak and off-peak transit-trip tables.

[19] Final Interim Policy Guidance—FTA Capital Investment Grant Program (June 2016).

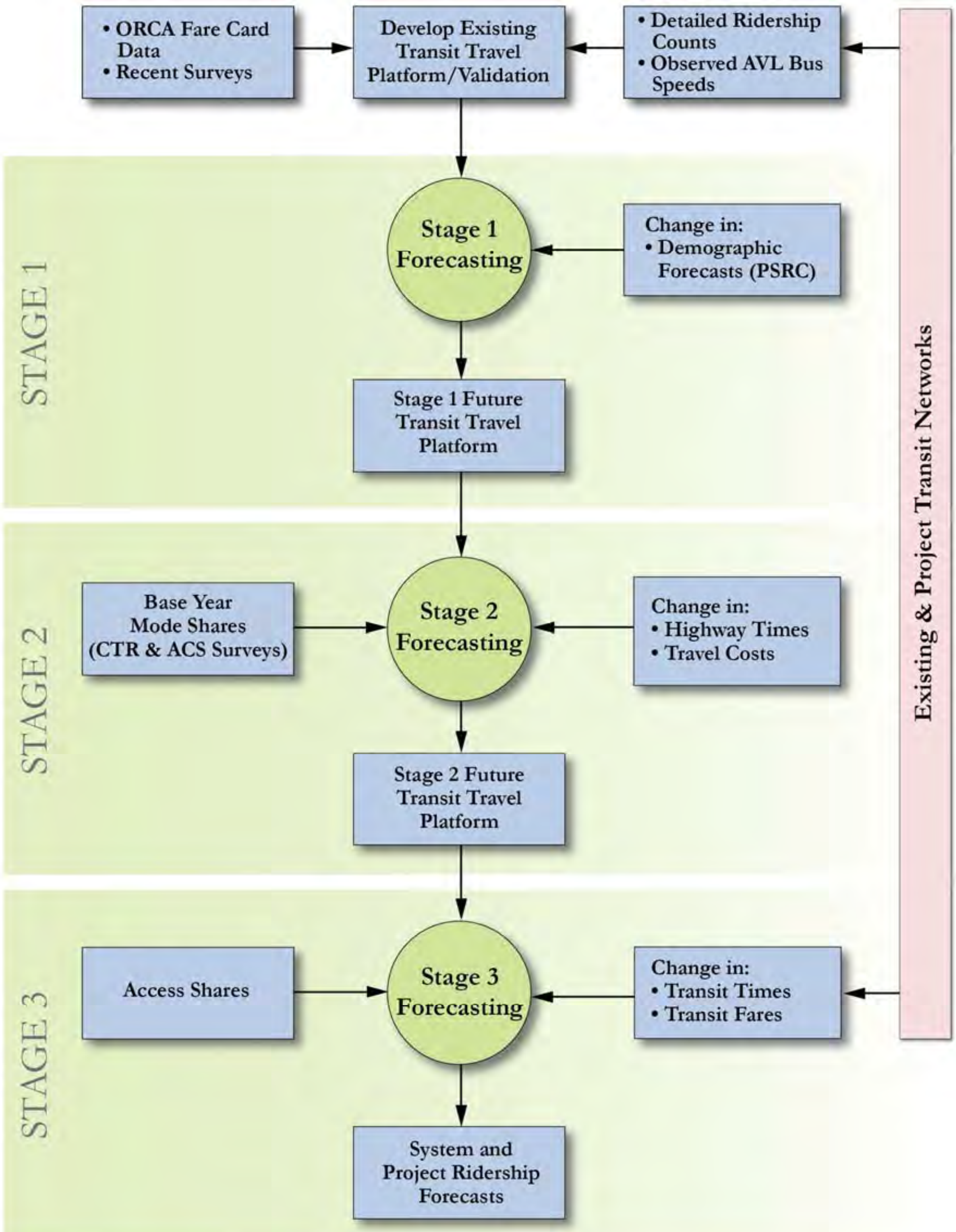

Figure 2-4. Staged ridership forecasting process

FTA now considers transit benefits measures related to economic development effects and to land use entirely separately from the ridership estimating process. Furthermore, by requiring current year ridership estimates, with future years optional, FTA is de-emphasizing future year forecasts in favor of simple network-based comparisons. As the FTA Policy Guidance points out, “Use of current year data increases the reliability of the projected future performance of the proposed project by avoiding reliance on future population, employment, and transit service levels that are themselves forecasts.”[20]

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2.6 Stage 1—Changes in demographics

2.6.1 Formulation of Stage 1 forecasting analysis

The ST ridership forecasting analysis depends on PSRC model databases for the overall growth in travel demand when performing future year forecasts. Growth estimates could either be derived from PSRC model trip distribution results or directly based on forecasts of demographics. Travel growth factors for the ST model are derived from published PSRC forecasts of households and employment growth.

Growth in total households and employment between 2016 and a future year is calculated at a FAZ level and applied to the base year (2016) transit-trip tables using a two-dimensional matrix balancing method (i.e., similar to a Fratar calculation). The results of the Stage 1 analysis are the estimated transit trips for a future year. The secondary impacts of growth on transit demand (e.g., increased highway congestion or costs) are not yet accounted for at the end of Stage 1.

A combination of households and employment is used in establishing the zonal growth factors applied at the origin and destination end of the base year (2016) trip tables.

- For the PM peak period, a combination of 20 percent households and 80 percent of employment is used to calculate the growth in PM peak transit origins and the reverse is used to calculate growth in PM peak transit destinations.
- For the off-peak period, a combination of 50 percent households and 50 percent employment is used to calculate growth for both origins and destinations.
- These factors are derived from ST on-board surveys conducted over the years 2011 through 2016.

[20] Final Interim Policy Guidance—FTA Capital Investment Grant Program (June 2016).

Because of earlier concerns about a supposed tendency of two-dimensional balancing to artificially increase trip lengths, an examination is performed to determine any alteration in average trip length for every application of the Stage 1 process. As highlighted in Figure 2-5, the balancing method has only slightly changed the underlying average trip length frequency distribution exhibited in the base year (2016) transit trip table. In fact, the average trip length and the standard deviation of the trip lengths increase slightly upon application of the two-dimensional balancing. While this check on trip lengths is performed for each new application of the Stage 1 balancing, the results of the checks have consistently shown the process to be neutral for trip lengths.

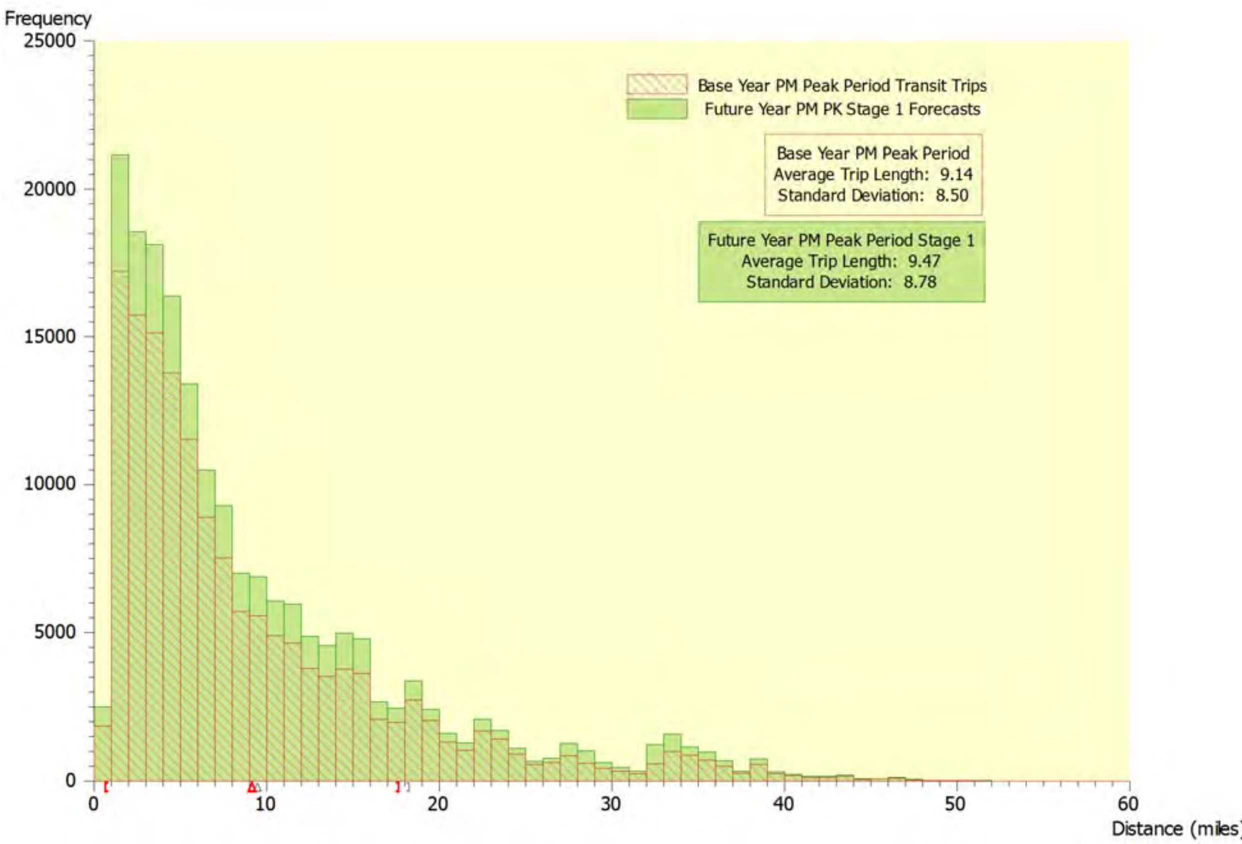

Figure 2-5. Average trip length frequency distribution comparison

2.7 Stage 2—Changes in highway congestion and cost

2.7.1 Formulation of Stage 2 forecasting analysis

Stage 2 considers how changes in highway congestion and auto costs (including parking, operating, and insurance) will influence mode choice.

The ST ridership forecasts use the PSRC model version, as adopted by WSDOT for travel forecasting in support of major highway projects, to estimate highway travel times. This highway model has been refined and validated in recent years for use on the SR 99 Alaskan Way Viaduct & Seawall Replacement project, the I-90 tolling analysis, Puget Sound Gateway project, the Lynnwood Link and Federal Way Link Extensions (see Appendix C). Base year (2016) zone-to-zone highway travel times are obtained directly from Google travel time data (see Appendix B). Rate of change in highway travel times is obtained using the PSRC model and applied to actual base year highway travel times to establish future year zone-to-zone highway travel times. This incremental process is executed on the FAZ-to-FAZ highway travel times.

When a transit alternative significantly affects the highway system (e.g., taking freeway lanes for transit facilities), additional analysis of future highway networks and congestion using the PSRC highway model is required. Likewise, when a Build alternative has significantly higher ridership in a corridor than the No Build alternative, an additional highway model application may be necessary to account for slightly higher highway volumes in a No Build alternative.

In the Puget Sound region, transit fares and auto costs (except parking costs) are usually assumed to increase only at the rate of overall inflation; therefore, they are usually immaterial to the ST model. The ST model, however, includes these variables for use in sensitivity tests that are not directly part of project planning ridership forecasts.

Stage 2 transit trip forecasts are calculated using the following incremental logit equation:

(8) $$\text{Stg2Trn} = \frac{\text{Stg1Trn}}{\text{S}_\text{t} + (1 - \text{S}_\text{t})\text{X}[\exp(\text{K} \times \text{DIFF LogSum}_\text{h})]}$$

where

Stg2Trn = Stage 2 transit trip forecasts

Stg1Trn = Stage 1 transit trip forecasts

S_t = the base year observed transit shares

K = nesting coefficient on the auto nest

DIFF $LogSum_h$ = Difference in the LogSum values due to changes in highway congestion and auto costs (future vs. base year).
Data from the ACS and CTR surveys (for the baseline share), highway skims, and auto costs are used in Equation 8 to estimate the DIFF $LogSum_h$ on the auto side.

Stage 2 transit-share forecasts (Stg2Shr) are also calculated as follows:

(9) $$\text{Stg2Shr} = \frac{\text{Stg2Trn} \times \text{S}_\text{t}}{\text{Stg1Trn}}$$

Resulting from the Stage 2 forecasting analysis are the transit trips for a future year, having accounted for factors external to the transit service itself. These results then serve as a platform for analysis of ridership on alternative transit networks. Note that bus speed degradations are used in the Stage 3 forecasting analysis. They are, however, based on changes in the level of highway congestion estimated using the Stage 2 PSRC model runs.

Note also that the final distance skim matrices from Stage 2 are saved for subsequent calculation of vehicle-miles traveled when estimating the environmental effects of various transit alternatives. This simple multiplication of a vehicle miles' matrix by a New Riders matrix is now incorporated in the FTA's Final Policy Guidance for estimating the environmental effects for New and Small Starts evaluations.[21]

In most project planning ridership forecasting, Stages 1 and 2 need not be calculated as often as Stage 3. It is only when a transit alternative is presumed to have a strong effect on external factors, such as the regional highway network, that the entire process would have to be cycled through. However, for the New Starts project rating purposes, FTA discourages forecasts that are based on different externalities for different alternatives.[22]

2.7.2 Estimation of parking costs

For the purpose of representing daily and hourly parking costs more accurately, a survey of parking costs scattered around the parts of the region that have paid parking was conducted in 2017. Based on the findings from this survey, base year daily parking costs were updated. This update compared target daily values with observed hourly parking rates, showing that the ratio of hourly-to-daily parking averaged around 25 to 30 percent, with a range from 10 percent in South Lake Union to 42 percent in downtown Seattle and around Seattle Center.

According to the limited historic information available, real parking costs have averaged an annual growth of approximately 1.5 percent since 1960. This is primarily attributable to changes in employment density, which has averaged similar growth over the last five decades. Forecast increases in employment density at the FAZ-level are used to estimate future year changes in real parking costs. This results in parking cost increases around the region varying between 0.5 and 2.0 percent per year between 2016 and 2040. The average for all zones for which there are parking cost increases is around 1.0 percent annually, with the weighted average being considerably lower.

2.7.3 Estimation of other costs and median income

Because auto operating costs in the Puget Sound region are usually assumed to increase only at the rate of overall inflation, they are less significant to ST models. Base-year (2016) and future auto operating costs are estimated at about $0.19 per mile (in 2016 dollars). Auto operating costs also include any relevant tolls or driving fees. The ST model assumes a conservative 0.5-percent annual (real) growth in income.

[21] Final Interim Policy Guidance—FTA Capital Investment Grant Program (June 2016).
[22] Final Interim Policy Guidance—FTA Capital Investment Grant Program (June 2016).

2.8 Stage 3—Changes in transit service

2.8.1 Formulation of Stage 3 forecasting analysis

In the third and final stage of the forecasting analysis, the incremental changes in the transit level of service, including transit fares, are considered. This change (as indicated in Section 2.4.1) is reflected in the resulting relative values of the $LogSum_t$ variable using the base-year and future transit networks.

The Stage 3 transit shares and ridership forecasts are calculated as follows:

$$(10) \quad P'ac = \frac{P_{ac} \times LOS_{ac}}{P_{ac} \times LOS_{ac} + (1 - P_{ac}) \times LOS_{wlk}}$$

and

$$(11) \quad Stg3Trn = \frac{Stg2Trn \times [\exp(K \times DIFF\ LogSum_t)]}{Stg2Shr \times [\exp(K \times DIFF\ LogSum_t)] + [1 - Stg2Shr]}$$

where

LOS_{ac} = Difference in (future vs. base year) utility of the park-and-ride access submode

LOS_{wlk} = Difference in (future vs. base year) utility of the walk-access submode

ac = Forecasted Stage 3 shares for the auto-access mode

P_{ac} = Base-year observed shares for the auto-access mode, derived from the base year trip table development process reflecting actual counts on park-and-ride facilities.

K = Nesting coefficient

DIFF $LogSum_t$ = Difference in the LogSum values due to changes in transit level-of service (future vs. base year)

Transit service that is taken into consideration in the ST model Stage 3 forecasting analysis is represented by means of a coded network. Details on transit network preparation are included in Appendix D. Treatment of bus speeds in the ST model includes the degradation of bus speeds due to roadway congestion, estimated by the PSRC model in a manner developed in consultation with the FTA.[23] Bus speed degradation is considered in Stage 3 forecasting analysis and held constant among alternatives. It is applied only to bus run time in mixed traffic (excluding high-occupancy vehicle lanes) and not to dwell and lay-over time components.

2.8.2 Transit fares

Any changes in transit fares are considered in Stage 3 of the ST model, along with changes in transit service. However, fares are always held constant among alternatives. Transit fare matrices were developed for the ST model and were assumed to be:

- The zone-to-zone averages in effect in 2016 (for the base year)
- The zone-to-zone averages in effect at the start of a project (for all future years)

[23] Billen, D., Sound Transit, "Updated Treatment of Bus Speeds in the Sound Transit Model," Memorandum to Eric Pihl of FTA, dated August 1, 2002. A copy of this memorandum is included in Appendix D.

- Independent of transit path choices

Independence from path choice is a reasonable approach to fares with the RTA District. The path-independent approach to transit fares also aligns with FTA's guidance to keep any fare-related utility differences between alternatives to a minimum. Upon the introduction of the ORCA smart card as the primary fare medium for all transit operators in the District, zonal fares are more appropriate than path-based fares. For most trips within the District, the fare implications of path choice and transfers have become less critical for forecasting. This is due to the very high market penetration of the regional employer pass programs, to the wide use of ORCA smart cards and to the refined agreements among the transit operators for assigning cash value to trips involving more than one transit vehicle or more than one transit agency.

3 Base Year Transit Trip Table Development and Validation

Before a model can be used for transit travel analysis, it must be validated. The process of validation involves comparing the performance of the model to the most recent observed data sources available to confirm that the model is accurately replicating current transit travel patterns.

An incremental approach, which is used in the ST model, generally reduces the need for validation because it relies not on travel behavior theory, but on current data. However, it is still useful to check the overall performance of the model against current known conditions.

This model version represents a departure from previous versions, primarily because of a significant increase in the amount of data available in the Puget Sound Region for describing current transit travel. The most significant of these is the availability of ORCA fare card transaction data, which removes the need for an ad hoc assembly of disparate seed matrix sources.

The availability of detailed and accurate system-wide peak and off-peak transit speed data from AVL systems enables a complete revision to previous methods for posting transit speeds. Of further significance, has been the increased detail and improved sample rates for the APC data, including stop-to-stop volumes and boarding and alighting details by stop.

This chapter is organized into three sections. Section 3.1 describes the data preparation, including network data, ridership count data, and seed matrix data. Section 3.2 describes the base year matrix estimation process. Section 3.3 describes the base year (2016) validation results and the final transit demand matrices.

3.1 Data preparation

3.1.1 Transit network

To facilitate translation of speeds and other geographic data to and from the model networks, all model networks are now converted to the XY coordinate base used in most local GIS and transportation applications (i.e., *Washington State Plane North* coordinates). Documentation of this shift of the coordinate system is provided in Appendix D.

Transit operating speeds are no longer estimated from posted schedules and spot data from terminus-to-terminus reliability reports, but directly from AVL systems managed by the transit operators. Thus, average speeds for every stop-to-stop segment within the RTA district boundaries are posted from the measured average speeds directly to the ST Model transit network. Documentation of this direct translation of operating data to model speeds is also provided in Appendix D.

Regional transit agencies currently implement two service changes each year, in late September and late March.

- This model version is constructed on a transit network base covering the winter 2016-2017 service levels (late September 2016 to late March 2017). We refer to this network as the 2016 Base Year network even though it spans six months over portions of two calendar years.

- The Base Year transit network thus includes the two recently opened Link light rail extensions—north to the University of Washington in March 2016 and south to Angle Lake in September 2016.
- The Base Year transit network also includes associated King County Metro (KCM) bus service changes implemented in response to those Link extensions.
- The Base Year transit network reflects all bus service as operated by all operators throughout the ST District for this winter 2016-2017 Base Year service period.
- Bus and rail headways are still obtained from agency posted schedules.
- Headway management data is now available stop-by-stop only for rail lines but are not available for bus lines. Such data may be useful in the future for adjusting model headways to data-driven perceived headways.
- All fixed-route fixed-schedule public transit services within the ST District are included, except for lines with fewer than six scheduled trips per weekday.
- Demand-response services, dial-a-ride services, employer provided services, and ferry services are omitted from the transit network.

3.1.2 Passenger counts data

Current passenger counting techniques have improved greatly, both in their accuracy and their level of available detail. This may be especially true here in the Puget Sound Region, although the technologies used are now widely available. The sampling rate for counts in this region is now over 25 percent on local bus lines, 30 percent on Link light rail, 50 percent on bus rapid transit lines, and 100 percent on commuter rail lines. Likewise, the detail available includes all stops, all segments, and all times of day by direction and vehicle trip.

The resulting data, averaged over a half year or over a quarter, should be considered perfectly reliable as a precise snapshot of current transit travel. Use of this level of existing detail resolves a significant portion of potential Base Year error. Detailed ridership counts were obtained from all transit operators within the RTA district boundaries. For the winter 2016-2017 service period described above, these operators are

- King County Metro
- Pierce Transit
- Community Transit
- Everett Transit
- Sound Transit

All the above operators supply complete ridership data from on-board APC systems. This data includes boardings and alightings by stop or station, by line, by direction, by trip, and by time of day. For use in the ST Model, the counts data is consolidated into segment volumes by line and by direction for peak and daily volumes and peak and daily boardings and alightings by stop or station. Off-peak counts are calculated from daily counts so that the daily counts remain control totals for all APC data. The consolidated counts data is processed directly into various stages of the matrix estimation process as described in Section 3.2.

- The PM peak period is defined as 3:00 p.m. to 6:30 p.m. for the partitioning and consolidation of the counts. This time-period allows specification of the peak-only services and peak-specific train and bus frequencies.
- For the ST model, an AM peak period is not defined or used directly in the model.
- Daily counts are consolidated into 24-hour totals for an average weekday within the six-month period described above.
- The daily counts always represent control totals for the boarding, alighting, and segment volume counts.
- Off-peak counts for use in the off-peak matrix estimation process are calculated as daily counts minus the PM peak counts minus the inverse of the PM counts, then balanced by direction.
- Detailed boarding and alighting counts by stop or station, line, direction, and time-period are retained for use in Matrix Estimation Quality Control (QC) exercises.
- QC methods include both machine error trapping and direct inspection of results on the model network.
- Further QC efforts are undertaken during the matrix estimation process as issues and inconsistencies arise in transit demand assignments produced over many iterations of matrix estimation.

The number of counts posted and the precise locations of the postings changes somewhat during the iterative matrix estimation process in response to issues arising in the QC process. Therefore, the number and types of posted counts are described in Section 3.2.

3.1.3 Data for seed matrices

Because of the difficulties inherent in attempting to accurately estimate or synthesize the shape of travel demand O-D matrices, the ST Model now uses primarily ORCA fare card data to construct the shape of the Base Year transit trip tables. This source substantially replaces the sparse and outdated rider O-D data from on-board surveys used in previous model versions.

- The widespread use of regional fare cards provides a very large sample of transit travel patterns (over 60 percent regionally and over 75 percent on ST rail and bus services). Not all of this ORCA data is directly usable for the seed matrices for a variety of reasons related to fare collection anomalies. However, the usable data sample remained very large, about 50 percent.
- Additional transit rider data from recent Washington CTR peak commute surveys and recent ST on-board rider surveys are also used, to the extent that they open new cells in the seed matrices.

The ORCA data has some specific advantages compared to sources of O-D patterns used in previous model versions. These include

- The data contains all types of transit trips, regardless of trip purpose, and is not skewed toward commute trips or long trips.
- The trip sample is so large that the potential response bias is minimal, compared to the sparse surveys used by ST over many years.
- The data is very detailed regarding time-of-day.
- The data is the first reliable large-sample information on transfer rates and transfer locations, now using a consistent regional definition of transfers.
- Because of its detailed information on transfer behavior, ORCA data provide data-driven rather than model-estimated totals of observed linked-trips for peak, off-peak, and daily transit travel, now using a consistent definition of what constitutes a linked-trip.

Data analysis and trip table preparation is a cooperative effort between ST and the Washington State Transportation Center (TRAC) at the University of Washington. Details of the ORCA data processing and geocoding to the ST Model 807-zone system are provided in Appendix B.

Some relevant basic information on the ORCA data details presented in Appendix B would include

- ORCA data is obtained for all transit operators on all lines operating within the ST District.
- The data chosen covers weekdays over a 9-week period from March 26, 2016, through May 28, 2016, after the University Link extension opened but prior to the Angle Lake station opening.
- Trips included in the resulting seed matrices account for 20.4 million weekday boardings, of which 4.9 million boardings involve transfers. This translates into an average weekday transfer rate of 1.32.
- The ORCA data comprises 97 percent of all trips in the two resulting (PM peak and off-peak) seed matrices and accounts for 90 percent of the O-D open cells. Total open cells amount to 29 percent of the available cells in the two 807-by-807 seed matrices.

3.2 Matrix estimation

Matrix Estimation (ME) in the ST transit model creates Base Year transit demand matrices, which replicate measured existing average weekday transit flows.[24] The methodology requires well-validated networks, precise ridership counts, and seed matrices of peak and off-peak transit demand in a zone structure tailored to the transit networks. The method uses an iterative gradient-reduction approach to minimize the differences between estimated and observed ridership counts posted at designated locations on the network.

The objectives of the ME process are to achieve a close match between estimated and actual peak and daily

- Transit volumes
- Boardings and alightings at all stations and at major BRT and high ridership bus stops

[24] The updated ST model was implemented in the current EMME Software (version 4.3.3). The Matrix Estimation process in the current EMME Software was used to develop base year (2016) demand matrices.

- Boardings by line
- Average trip length by operating agency and mode and by line for rail lines and BRT lines

3.2.1 Stepwise matrix estimation

It is possible to run ME in a single process which considers all routes at once and to achieve reasonable R-squared, slope, and intercept results for the major transit lines at their high-volume locations. The gradient-reduction measures with this method may indicate relative closure after about 25 iterations showing an apparent equilibrium between the lines and the matrices.

This apparent equilibrium is deceptive because closer examination of results of a single-step approach reveals that low-volume and medium volume lines and some low-volume segments on high-ridership lines may show serious mismatches in the resulting volumes. In the type of detailed analysis ST requires from this model, such relatively minor errors in the Base Year validation and in forecasting situations can seriously detract from the usefulness of the model.

Therefore, the ME is performed in a sequential and cumulative manner. Performing the ME in this manner mitigates the dominance of high-volume routes and allows better alignment of the counts data within subareas and within service types. The specification of the matrix estimation process in steps is shown in Table 3-1.

Table 3-1. Specification of matrix adjustment in steps

Step No.	Count Posting Type	Routes Considered
Step 1	Segments	Include segment counts from Pierce Transit, Everett Transit, Community Transit (excluding SWIFT line), and KCM 900 routes
	Boardings/Alightings	Bus boardings/alightings on RapidRides A/C/D, ST express bus, and KCM mid-town mid-range routes
Step 2	Segments	Step 1 + KCM local routes and street car + ST routes 541/556/566/596
	Boardings/Alightings	Same as Step 1
Step 3	Segments	Step 2 + KCM mid-town, mid-range routes
	Boardings/Alightings	Same as Step 1
Step 4	Segments	Step 3 + CT SWIFT + all ST and KCM routes excluding C/D/E/545/550/Sounder/Light Rail
	Boardings/Alightings	Same as Step 1
Step 5	Segments	Step 4 + RapidRides C/D/E + ST routes 545/550
	Boardings/Alightings	Step 4 + boardings/alightings for Sounder
Step 6	Segments	Same as step 5
	Boardings/Alightings	Step 5 + boardings/alightings for Light Rail

The segment counts are first grouped based on the markets and the service type. Then, the matrix adjustment is performed on each group by cumulatively including the segment loads from all the previous groups and using the previous result matrix as a new seed matrix. Such a step-wise matrix estimation process allows adjusting the transit-trip table for low volume segments before including the next level of higher volume segments. This allows the ME adjustment method an opportunity to adjust segments or stops with low volumes as well as segments with high volumes. The adjustments to low-volume segments or stops are not greatly modified as the higher-volume segments are brought in, so low-volume information is retained.

3.2.2 Calibration of path parameters

The approach to ME outlined above is complemented by an extensive and rigorous path analysis effort. This effort involves comparisons over many runs of ME against all available data, including agency data on line boarding and alighting locations, average trip lengths, route segment volumes, and other data available for the Base Year.

The parameters used in path-building are of critical importance in estimating path changes between an existing network and a proposed network, whether the proposed network postulates minor or major changes. These parameters include walking speeds, “escalator” link lengths, auto-access parking lot walk link lengths, boarding penalties, and weights or perception factors applied to the various components of out-of-vehicle time.

Previous ST model versions used a variety of weakly-calibrated assumptions, often postulated from external sources. The wealth of detail available for this model calibration enabled the first serious check of those postulated parameters. Since the parameters should be held constant through Matrix Estimation, Base Year assignments, mode choice skims, and final assignments, they are calibrated during the ME process.

The calibration involves many iterations through ME and final assignments. This requires constant checks against aggregate data, such as actual transfer rates, and detailed data, such as route-level and bus-stop-level boardings and alightings. An extensive analysis of outlier routes using scatterplots of estimated vs. actual boardings/route and average trip lengths is particularly productive in parameter calibration. These checks also provide as a byproduct, extensive QC checks on minor errors in the counts data and minor network coding errors. Table 3-2 shows the more important resulting path-building parameters.

The iterative check of assignment result details also includes review of important transfer locations, with emphasis on locations of existing rail transfers, and bus transfer activity at likely future rail transfer locations. Virtually all likely future rail transfer locations are on existing BRT or ST Express Bus lines.

Finally, the iterative ME calibration process allows adjustment of the count data posting locations, including moving or adding segment count locations to capture minor variations in the market profile along individual routes. For this model version, it allows posting boarding and alighting data at all rail stations and the major BRT and ST Express Bus stops. The final PM peak ME relied on posted actual ridership values at 1140 line segments and 180 stations or stops. The off-peak ME used about 80 percent of these, reduced by the presence of some having no off-peak service, e.g., Sounder Commuter Rail.

Table 3-2. Boarding penalty, wait time factor, and escalator link parameters

Description	Value
Regular Bus Stops	
Boarding penalty	4.0 minutes
Wait time factor	0.60
Escalator link	NA
Transit Centers[1]	
Boarding penalty	3.0 minutes
Wait time factor	0.50
Escalator link	NA
Downtown Bus Tunnel	
Boarding penalty	3.0 minutes
Wait time factor	0.50
Escalator link	1.4 minutes
Rail Stations (surface)	
Boarding penalty	1.5 minutes
Wait time factor	0.50
Escalator link	1.2 minutes
Rail Stations (tunnel or elevated, excluding Downtown Seattle Transit Tunnel stations under joint operations)	
Boarding penalty	1.5 minutes
Wait time factor	0.50
Escalator link	1.4–2.4 minutes

[1] List of Major Transit Centers (TC):

1) Bellevue TC
2) Federal Way TC
3) Northgate
4) Burien TC
5) Kent Station TC
6) Auburn Station TC
7) Kirkland v
8) Overlake TC
9) Aurora Village TC
10) Renton TC
11) Lynnwood TC
12) Tacoma Dome Station
13) Lakewood TC
14) Everett Station
15) Tacoma Community College
16) Tacoma Commerce St
17) Tukwila International Boulevard
18) Tukwila Station
19) Lakewood Station
20) Sumner Station
21) Puyallup Station
22) Issaquah TC
23) West Seattle
24) Ballard

Related Assumptions:

- Walk speed = 2.5 mph
- Weight factor on out-of-vehicle travel times = 1.5
- Weight factor on the auxiliary walk times on 1st, 2nd, 3rd and 4th Avenues in downtown Seattle leading to King Street Station = 1.0

3.2.3 Sensitivity test using ST3 build network

Understanding the performance of this model version compared to the previous version, i.e., the 2014 Base Year version used for the ST3 planning work, suggests applying a Current Year sensitivity test using the ST3 Build network. This requires a Current Year forecast using the new model version for comparison with the previous Current Year forecast for ST3 performed using the 2014 model version. Not only does this provide additional QC opportunities, especially on the network specifications, but it enables several checks on the model application to future networks, which include significant expansion of the rail system and realignment of the bus systems.

This is particularly important for understanding the relevance of unassigned trips. These trips are short trips which are in the seed matrix and therefore known to have occurred on transit, but which are assigned as walk-only paths. The trips therefore never appear as transit boardings or segment volumes.

The change in the transit path times between the Base Year network and a future network, such as the ST3 Plan network, results in some of these short trips having efficient paths using rail segments in the future network, even though they were erroneously assigned as walk-only trips in the Base Year network. Identification and analysis of unassigned trips is necessary to minimize discrepancies between the trip tables and the resulting transit network values.

3.2.4 Identification and removal of unassigned trips

Unassigned trips are analyzed by network analysis of the assignment results, especially network analysis of those trips assigned by themselves. Because EMME transit assignments are multi-path, unassigned trips in the ST model tend to be unassigned portions of trip values within certain O-D pairs, in particular closely adjacent zones.

Careful examination of the transit paths and fine-tuning of network elements in areas of dense transit demand and dense network structure enables the reduction of the total unassigned trips from 14,000 to 6,700, when correcting path elements on the Base Year network. In the application of the sensitivity test described above as a Current Year forecast on the ST3 Build network, the unassigned trips are reduced to 3,800. This includes the removal of 2,000 ferry trips double-counted upon the introduction of ORCA data as the primary source for transit travel patterns.

The final effect of the matrix estimation on the travel patterns in the initial seed matrix is summarized in the trip length frequency distribution comparison shown in Figure 3-1. This comparison is between the seed matrices at the start of ME and the resulting final Base Year demand matrices. Trip lengths in this figure are for entire zone-to-zone linked-trips. For consistency, the transit trip lengths for this comparison are based on a common neutral highway distance between zones.

As shown, the ME process has not impacted original shape exhibited in the seed matrix. It has only reduced the number of transit trips longer than 6 miles and increased the number of trips shorter than 6 miles. It has correspondingly reduced average transit trip length to 8.36 miles from almost 10 miles in earlier model versions.

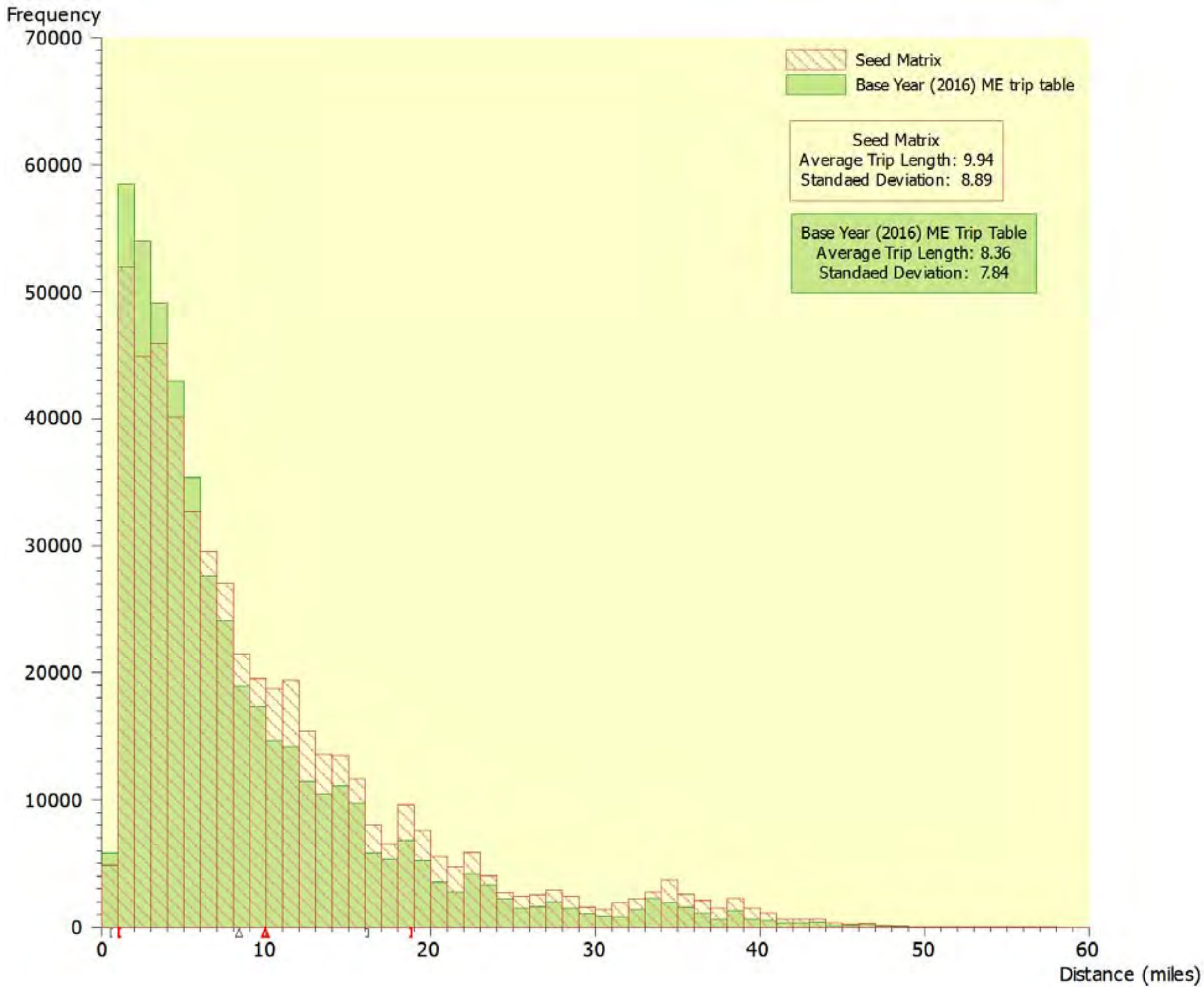

Figure 3-1. Average weekday (2016) trip length frequency distribution comparison: Seed matrix vs. matrix-estimated trip table

The validation analysis results for Base Year (2016) transit-trip table development are discussed below.

3.3 Base Year (2016) validation results

The validation analysis focuses on evaluating both the transit trip tables from the matrix estimation process and the accuracy of the assignment results. These are reflected in

- System-wide linked and unlinked trips and the system-wide transfer rate
- Transit boardings comparison by agency and mode
- Rail station boardings comparison for all existing stations
- Transit ridership volumes in locations relevant to major ST3 projects
- Average transit trip length comparison by operator
- Peak and daily boardings by transit line

Table 3-3 presents system-wide linked transit trips and unlinked transit trips by operator and mode. The estimated trips closely match the actual trips in all cases, reflecting the breadth and quality of the network inputs, the counts, and the seed matrix travel patterns from ORCA data.

Table 3-3. Systemwide 2016 linked and unlinked transit trips comparison: PM peak period and average weekday

	PM Peak Period (3:00–6:30 PM)			Average Weekday		
	Actual[1]	Estimated	Est/Act	Actual[1]	Estimated	Est/Act
Linked transit trips	145,500	151,900	1.04	467,000	466,900	1.00
Total Boardings by Operator						
KC Metro	119,500	122,200	1.02	397,000	384,200	0.97
Sound Transit	51,300	52,500	1.02	151,600	151,600	1.00
Pierce Transit	6,700	7,200	1.07	27,000	28,800	1.07
Community Transit	11,100	11,600	1.05	34,000	32,600	0.96
Everett Transit	2,000	1,900	0.95	7,000	7,000	1.00
Three-county total boardings	190,600	195,400	1.03	616,600	604,200	0.98
Systemwide transfer rate[2]	1.31	1.31	1.00	1.32	1.32	1.00
Rail and Regional Bus Boardings						
Central Link Light Rail	22,100	21,800	0.99	68,400	67,700	0.99
Tacoma Link Light Rail	900	900	1.00	3,600	3,100	0.86
Commuter Rail	8,500	8,400	0.99	16,600	16,900	1.02
ST Express Bus	19,800	21,500	1.09	63,000	63,900	1.01

[1] Actual boardings are the actual counts for the winter 2016/2017 obtained from transit agencies.
[2] Transfer rates are calculated by excluding unassigned trips.

The total estimated PM peak linked transit trips are 151,900, which is 32.5 percent of the total weekday 467,000 linked transit trips.

In this model version, the actual transfer rates of 1.32 for average weekday and 1.31 for PM peak are known for the first time, due to the availability of ORCA fare card data, as described above in Section 3.1.3. These observed transfer rates are also the basis of the 467,000 (for average weekday) and 145,500 (for PM peak) actual linked trips shown in the first row of Table 3-3 for the transit system. The definition of what exactly constitutes a linked trip is now closely tied to the regional agreement on fares and transfer policies, managed by Sound Transit and agreed upon with the other transit operators. The primary purpose of the regional agreement is revenue sharing among the operators, for which transfer information is an important input.

The close match between estimated and actual boardings by agency and mode is evident in Table 3-3. Both estimated and actual boardings reflect the same model Base Year period and bus service period, late September 2016 through late March 2017.

Table 3-4 and Table 3-5 show station-by-station comparisons of estimated versus actual station boardings for the same period. The closeness of the estimates to the counts at this level of detail is explained by the introduction of boarding and alighting counts, augmenting the segment line volume counts in the ME process.

Table 3-4. Average weekday (2016) light rail station boardings comparison

Station Name	Actual	Estimated	Est/Actual
UW	9,400	9,400	1.00
Capitol Hill	8,000	8,000	1.00
Westlake	10,200	9,900	0.97
University Street	5,300	5,200	0.98
Pioneer Square	4,100	3,900	0.95
International District	5,600	5,500	0.98
Stadium	1,300	1,400	1.08
SODO	1,900	2,000	1.05
Beacon Hill	2,900	2,900	1.00
Mount Baker	2,300	2,200	0.96
Columbia City	2,400	2,500	1.04
Othello	2,400	2,500	1.04
Rainier Beach	1,900	1,900	1.00
Tukwila International Blvd	2,900	2,800	0.97
Sea-Tac Airport	5,000	4,900	0.98
Angle Lake	2,900	2,700	0.93
Total Station Boardings	**68,500**	**67,700**	**0.99**

Table 3-5. Average weekday (2016) commuter rail station boardings comparison

Station Name	Actual	Estimated	Est/Actual
Everett	300	300	1.00
Mukilteo	200	200	1.00
Edmonds	400	400	1.00
King Street	6,800	7,000	1.03
Tukwila	1,000	1,000	1.00
Kent	1,900	2,000	1.05
Auburn	1,500	1,600	1.07
Sumner	1,200	1,200	1.00
Puyallup	1,500	1,500	1.00
Tacoma Dome	1,200	1,200	1.00
South Tacoma	200	200	1.00
Lakewood	400	300	0.75
Total Station Boardings	**16,600**	**16,900**	**1.02**

Table 3-6 compares estimated and actual bus ridership volumes at eight locations in major transit corridors. These locations are chosen for their relevance to major rail and BRT projects in the ST3 System Plan. The comparison illustrates that the existing base year volumes are closely approximated by the Base Year model in corridors which will be of interest over the term of this model version.

Table 3-6. Comparison of 2016 estimated and actual average weekday volumes—locations relevant to major ST3 Projects

ST3 Projects	Actual	Estimated
Link Extensions		
Everett Extension: Routes 510/512/513/532 & Sounder, north of Ashway	4,700	4,400
Tacoma Extension: Routes 574/586/590/592/594/595 & Sounder, at county line	14,600	14,600
Ballard: RapidRide D at Magnolia Bridge	6,700	7,100
West Seattle: RapidRide C at West Seattle Bridge	7,000	7,100
I-405/SR 522 BRT Projects		
I-405 BRT: Routes 532/535, at county line	2,500	2,500
I-405 BRT: Routes 560/566/567, at Coal Creek	2,300	2,200
I-405 BRT: Route 560 at Tukwila	900	800
SR 522 BRT: Route 522 at Kenmore	2,400	2,400

Table 3-7 and Table 3-8 contain summaries of the Base Year PM peak and daily trip tables at 10 x 10 districts. A map of the 10 districts is shown in Figure 3-2. Note that the totals for each of these matrices are the same as the totals presented in Table 3-3. These tables are the result of the matrix estimation process, representing a snapshot of the Base Year transit demand within the 3-county ST district. The matrices are the platform for subsequent work using the staged incremental transit demand model as described in Chapter 2.

Estimated and actual base year average in-vehicle trip lengths are compared in Table 3-9. Actual trip lengths shown are for the length of travel in each transit vehicle, derived from agency-reported total passenger-miles and boardings by mode. Thus, these trip lengths are not directly related to the overall zone-to-zone linked-trip lengths shown in Figure 3-1. The shorter average trip lengths on ST Express bus lines (8 percent low) are indicative of matrix estimation process estimating greater than actual rider turnover on some of the longer of these lines. The directional volumes on segments along these lines match the volume counts very closely.

Table 3-7. 10-district base year (2016) PM peak period transit trip table

ORIGIN \ DESTINATION		Everett	SW Snohomish	Shoreline	North Seattle	Seattle CBD	South Seattle	East King	South King	Tacoma	Pierce	Origin totals	Origin shares
		1	2	3	4	5	6	7	8	9	10		
Everett	1	1,700	300	100	100	–	–	100	100	–	–	2,400	1.6%
SW Snohomish	2	500	1,500	100	200	100	100	100	–	–	–	2,600	1.7%
Shoreline	3	100	200	200	400	100	100	100	–	–	–	1,200	0.8%
North Seattle	4	200	1,500	1,200	11,700	2,200	4,600	1,600	900	300	200	24,400	16.1%
Seattle CBD	5	900	4,000	1,200	10,200	2,100	17,900	7,100	7,000	1,200	1,300	52,900	34.8%
South Seattle	6	400	1,600	600	6,400	5,300	13,800	2,300	5,200	600	1,200	37,400	24.6%
East King	7	300	1,000	100	1,100	1,000	1,500	7,200	900	–	100	13,200	8.7%
South King	8	–	100	–	300	900	1,800	200	7,400	400	900	12,000	7.9%
Tacoma	9	–	–	–	–	–	100	–	200	2,600	1,100	4,000	2.6%
Pierce	10	–	–	–	–	–	–	–	100	800	900	1,800	1.2%
Destination totals		4,100	10,200	3,500	30,400	11,700	39,900	18,700	21,800	5,900	5,700	151,900	100.0%
Destination shares		2.7%	6.7%	2.3%	20.0%	7.7%	26.3%	12.3%	14.4%	3.9%	3.8%	100.0%	

Table 3-8. 10-district base year (2016) average weekday transit trip table

ORIGIN \ DESTINATION		Everett 1	SW Snohomish 2	Shoreline 3	North Seattle 4	Seattle CBD 5	South Seattle 6	East King 7	South King 8	Tacoma 9	Pierce 10	Origin totals	Origin shares
Everett	1	6,200	1,600	200	400	1,100	600	400	100	–	–	10,600	2.3%
SW Snohomish	2	1,600	6,100	700	2,100	4,600	1,800	1,300	100	–	–	18,300	3.9%
Shoreline	3	200	700	1,000	2,700	1,800	1,000	300	100	–	–	7,800	1.7%
North Seattle	4	400	2,100	2,700	38,500	17,900	16,200	4,300	1,900	400	200	84,600	18.1%
Seattle CBD	5	1,100	4,600	1,800	18,000	6,600	37,000	10,300	11,500	1,500	1,600	94,000	20.1%
South Seattle	6	600	1,800	1,000	16,200	37,000	46,100	5,400	11,000	900	1,400	121,400	26.0%
East King	7	400	1,300	300	4,300	10,300	5,400	22,400	1,700	–	100	46,200	9.9%
South King	8	100	100	100	1,900	11,500	11,000	1,700	25,900	1,100	1,300	54,700	11.7%
Tacoma	9	–	–	–	400	1,500	900	–	1,100	10,000	3,700	17,600	3.8%
Pierce	10	–	–	–	200	1,600	1,400	100	1,300	3,700	3,400	11,700	2.5%
Destination totals		10,600	18,300	7,800	84,700	93,900	121,400	46,200	54,700	17,600	11,700	466,900	100.0%
Destination shares		2.3%	3.9%	1.7%	18.1%	20.1%	26.0%	9.9%	11.7%	3.8%	2.5%	100.0%	

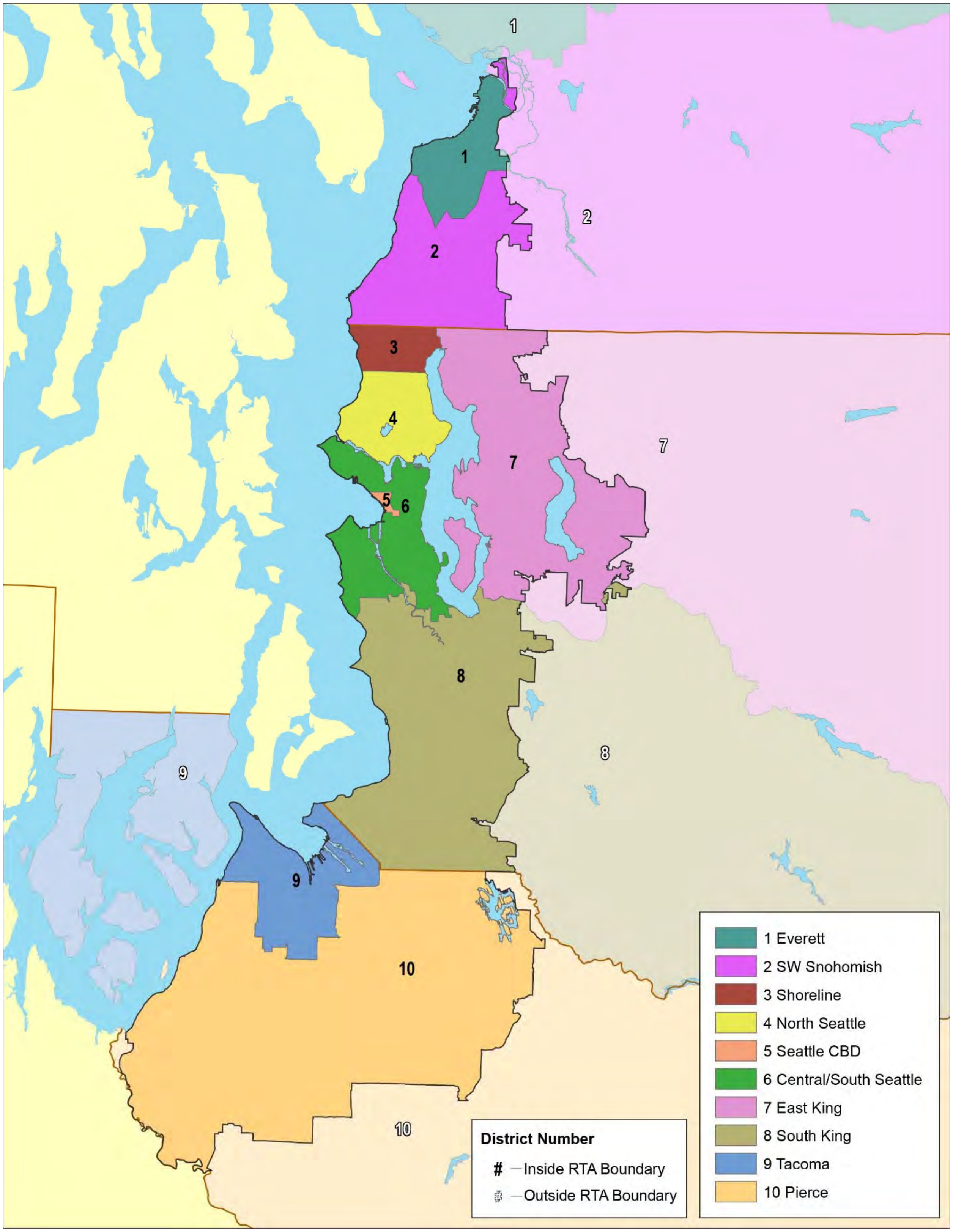

Figure 3-2. 10-district map

Table 3-9. Estimated and actual base year (2016) average weekday in-vehicle trip length comparison

Transit Operator	Actual[1]	Estimated	Est/Actual
King County Metro	4.3	4.1	0.95
Sound Transit Link	6.1	6.1	0.99
Sound Transit Sounder	24.8	24.0	0.97
Sound Transit Express Bus	14.3	13.1	0.92
Pierce Transit	4.1	4.0	0.98
Community Transit	9.3	8.5	0.91
Everett Transit	3.8	4.1	1.08
Systemwide	6.2	6.0	0.97

[1] Bus values are from 2016 National Transit Database; Rail values are from ST winter 2016/2017 counts

Figure 3-3a, Figure 3-3b, Figure 3-4a, Figure 3-4b and Figure 3-5 summarize comparisons of estimated to actual line boardings for every transit line in the region. These are more rigorous validation tests than a comparison of posted line segment volumes, since the matrix estimation process aims at precisely these segment matches. The process consistently returns R-squared values between 0.98 and 1.00. The comparisons of line boardings validates in greater detail the ability of the model estimates to replicate base year ridership profiles on a line-by-line basis.

Note that this attention to line detail is particularly important when a network-based model is to be used to estimate line volumes and station boardings for future rail line extensions. Validations against transit screenline counts do not provide sufficient confidence for forecasts of ridership on specific lines or line segments.

This line-by-line validation test assists the supplemental analysis of outlier bus lines, especially some mid-range ridership lines. The outlier analysis, including stop-level review of actual line profiles, provides strong additional QC on the networks and the counts.

Figure 3-3a and Figure 3-3b illustrates the PM peak line boardings comparisons, including and excluding the rail lines, with R-squared values of 1.00 and 0.98, respectively. Figure 3-4a and Figure 3-4b illustrates the average weekday line boardings comparisons, including and excluding the rail lines, with R-squared values of 1.00 and 0.99, respectively. The comparisons excluding the rail are necessary because of the dominance of Link ridership when it is included.

Finally, Figure 3-5 illustrates the average weekday boardings comparison for ST Express bus lines only, with an R-squared value of 0.98 and a slope of 0.99.

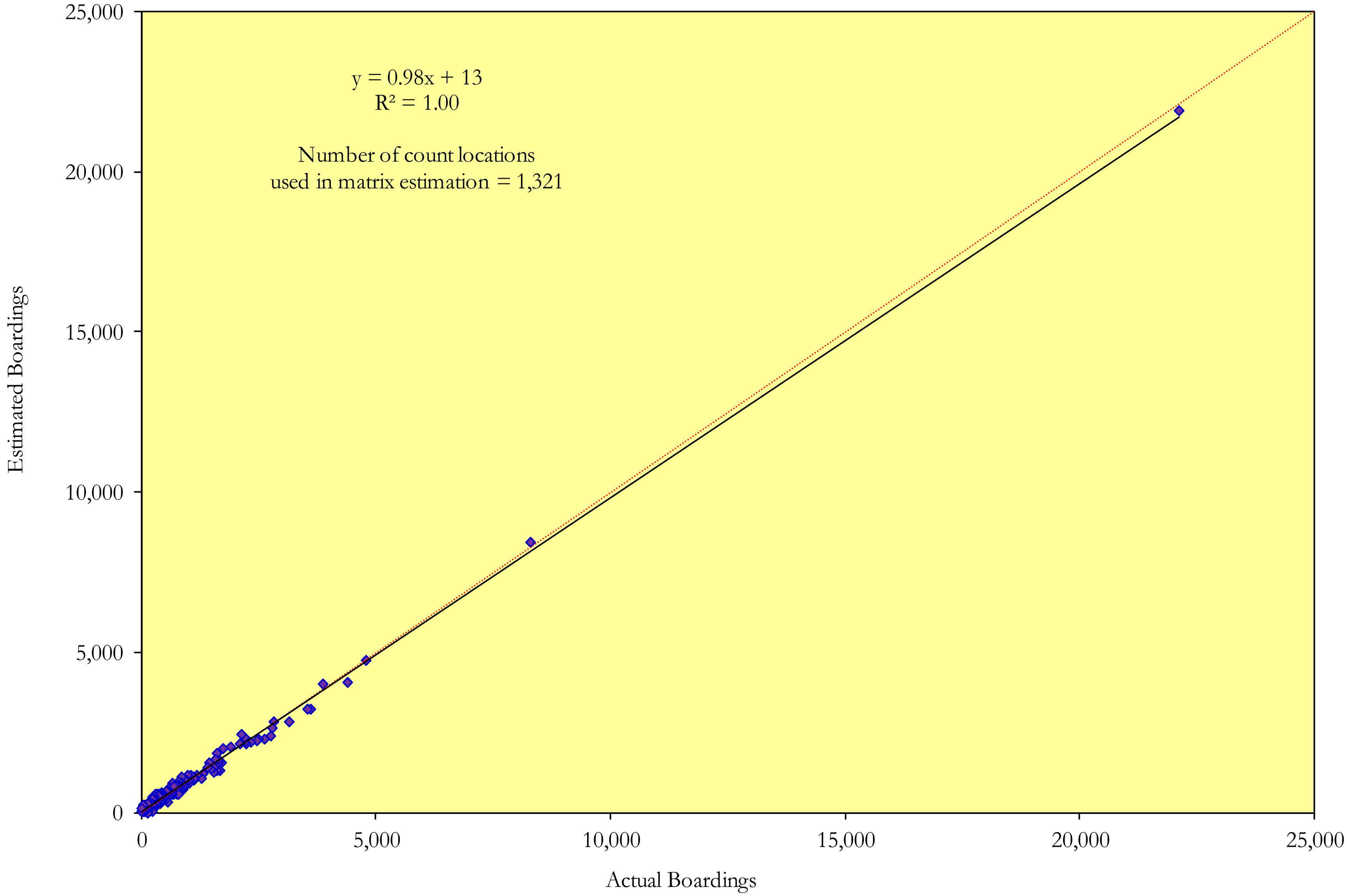

Figure 3-3a. Comparison of base year (2016) PM peak period transit line boardings (all agencies)

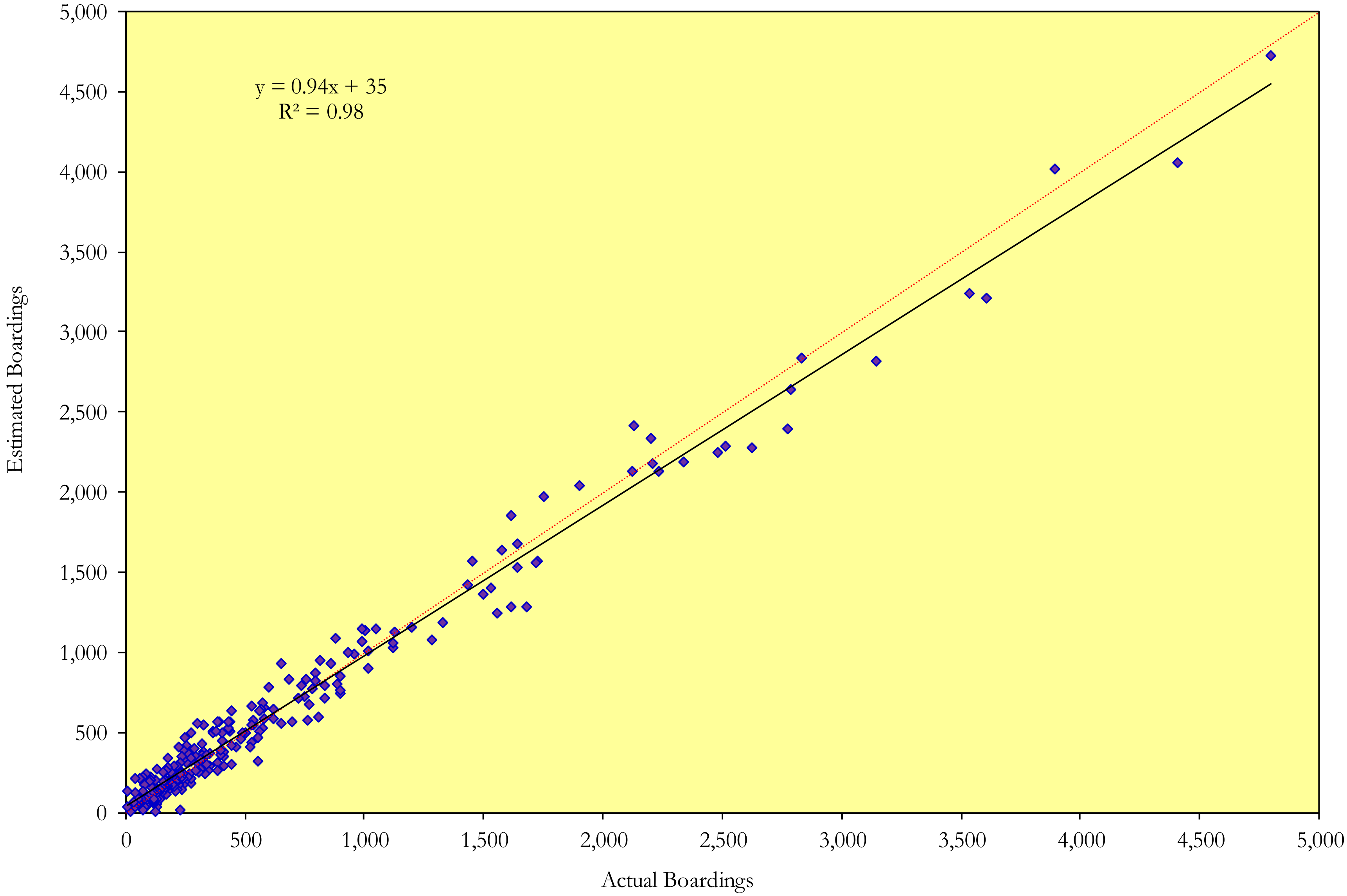

Figure 3-3b. Comparison of base year (2016) PM peak period transit line boardings (all agencies, but excluding light rail and commuter rail)

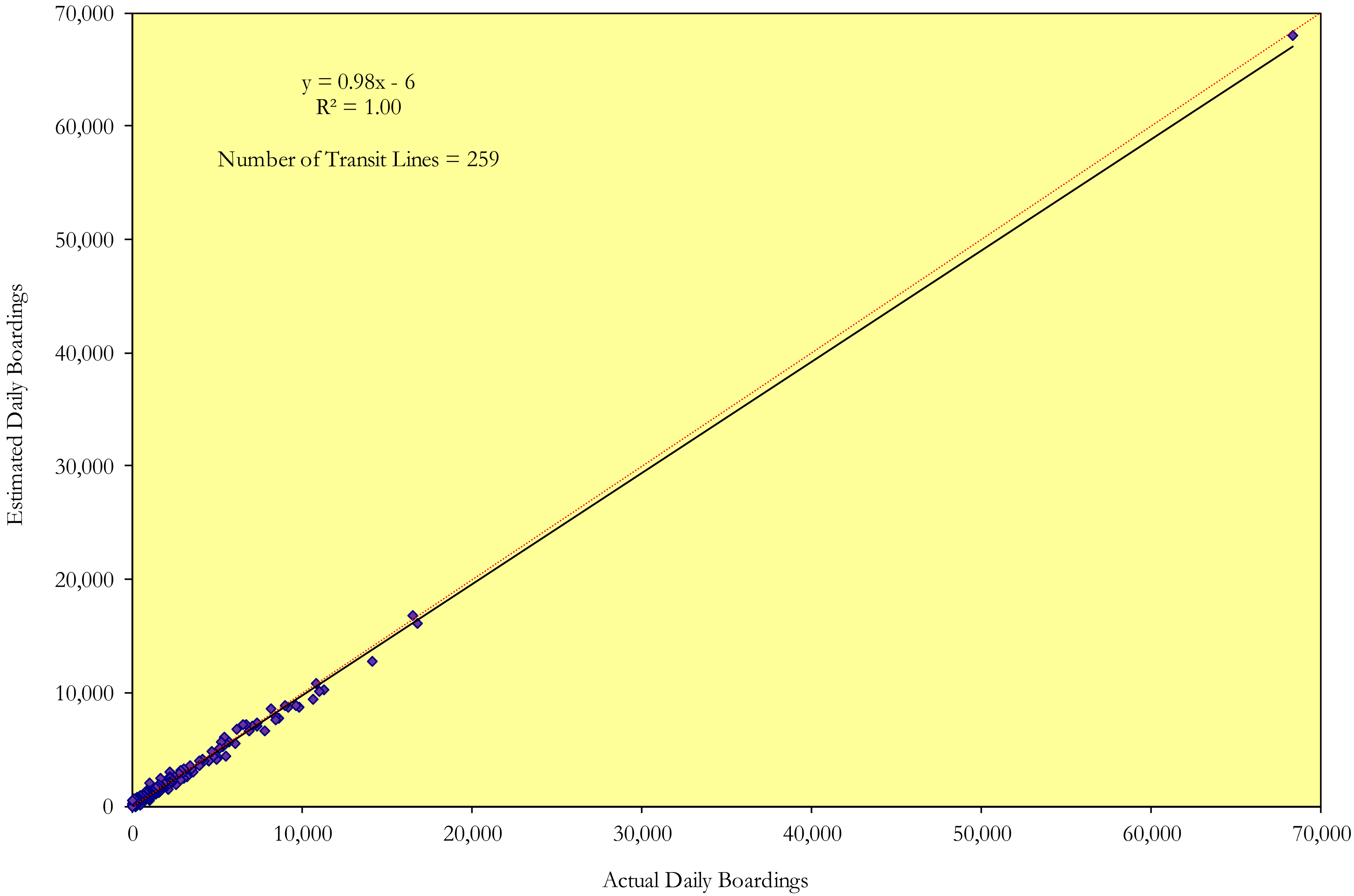

Figure 3-4a. Comparison of base year (2016) average weekday transit line boardings (all agencies)

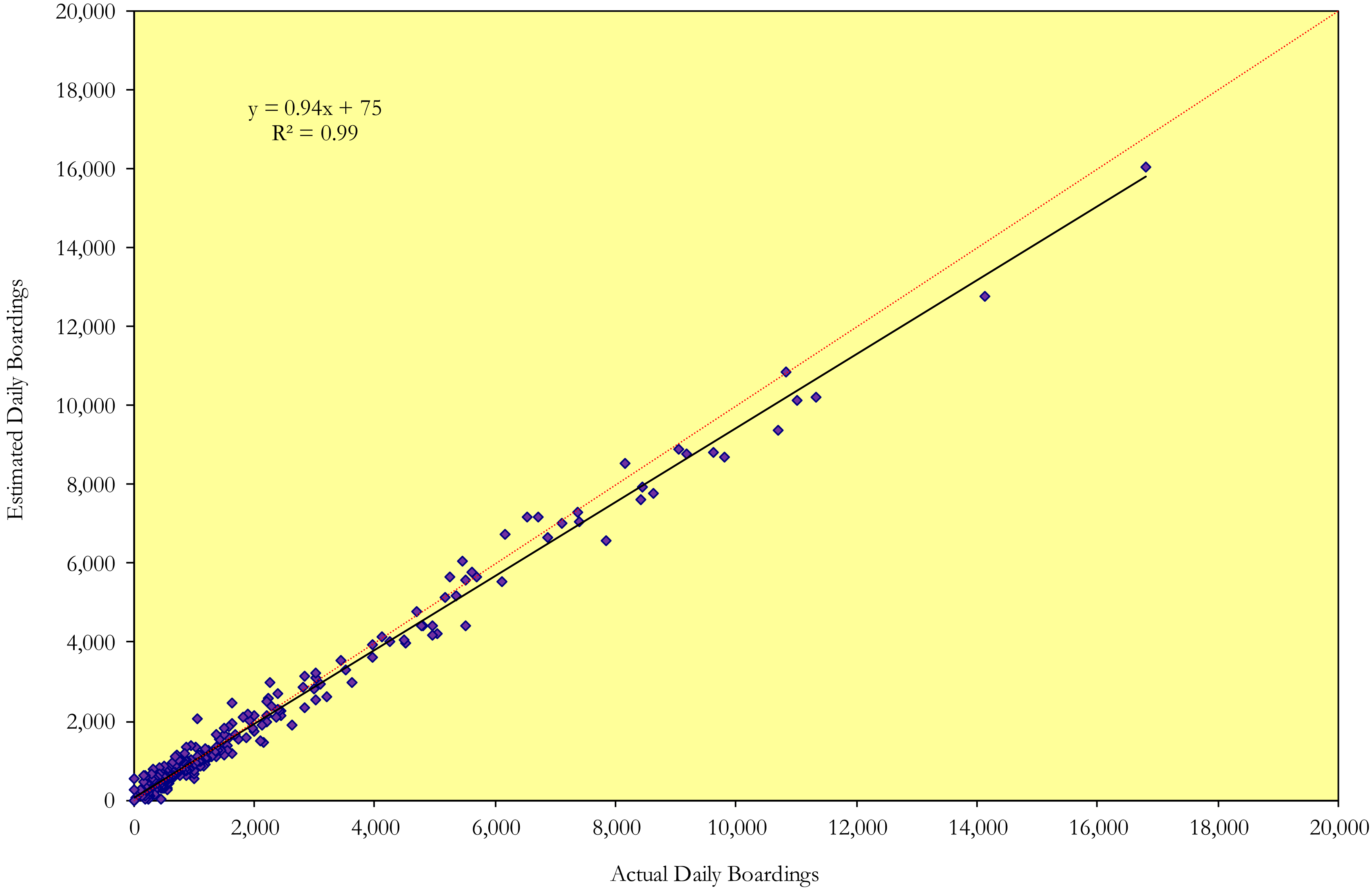

Figure 3-4b. Comparison of base year (2016) average weekday transit line boardings (all agencies, but excluding light rail and commuter rail)

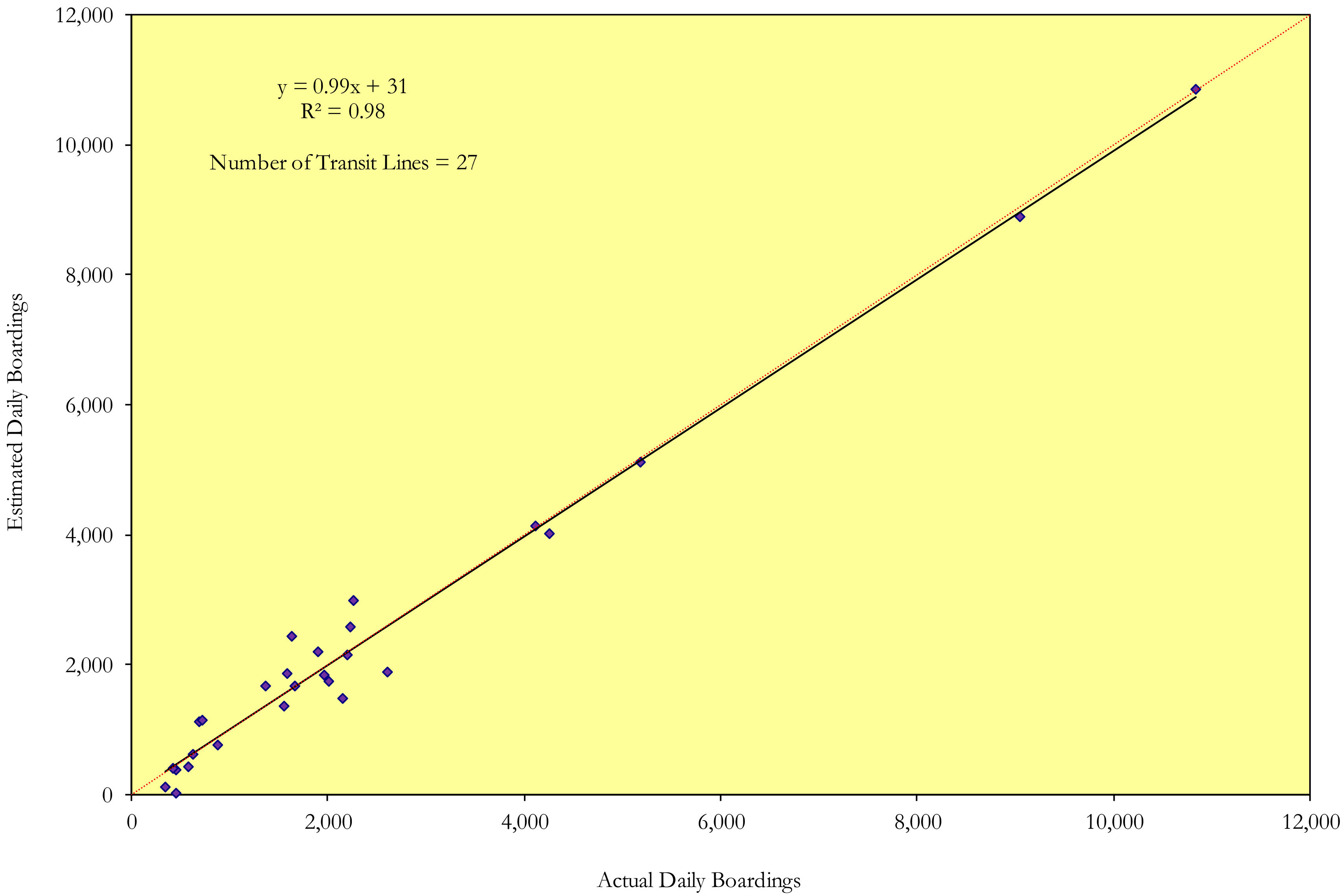

Figure 3-5. Comparison of base year (2016) average weekday transit line boardings (ST express bus only)

Appendix A: Maps

- *Forecasting Analysis Zones (FAZ)*
- *Alternative Analysis Zones (AAZ)*
- *10 and 26 Districts*

Figure A-1. PSRC FAZ Map—Snohomish County

Figure A-2. PSRC FAZ Map—King County

Figure A-3. PSRC FAZ Map—Pierce County

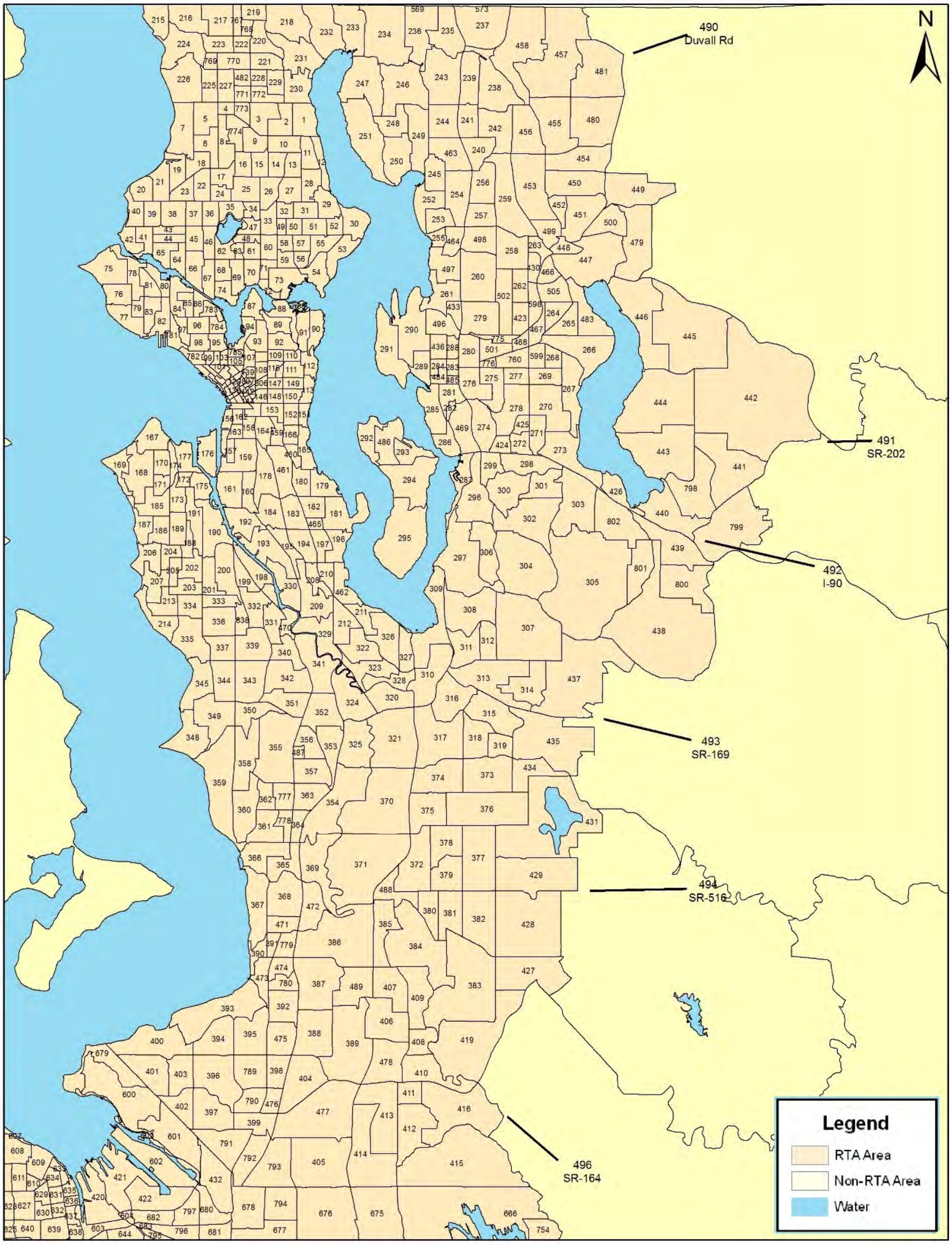

Figure A-4. 807 AAZ Map—King County

Figure A-4a. 807 AAZ Map—Central Seattle

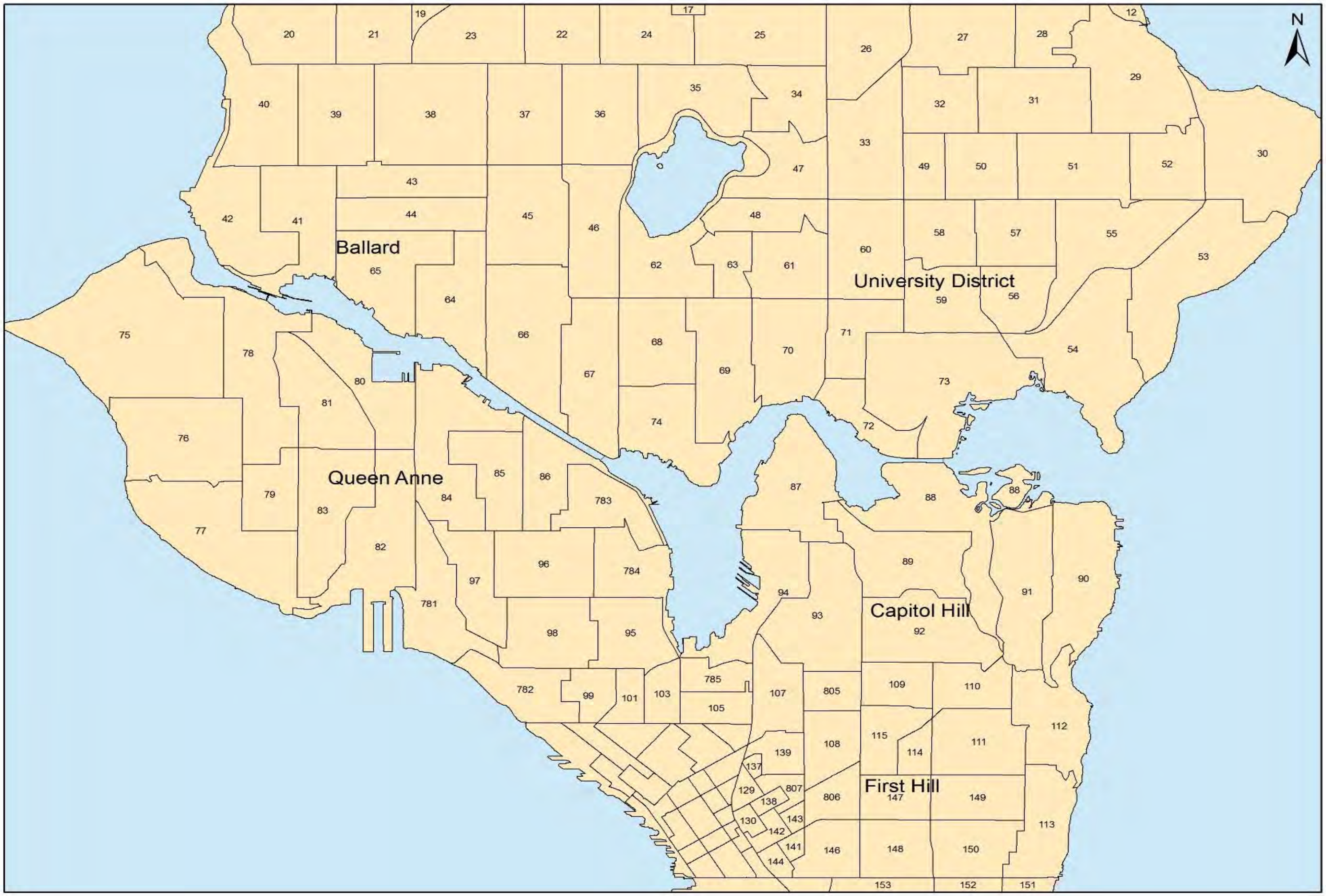

Figure A-4b. 807 AAZ Map—Capitol Hill, First Hill, Ballard & Queen Anne

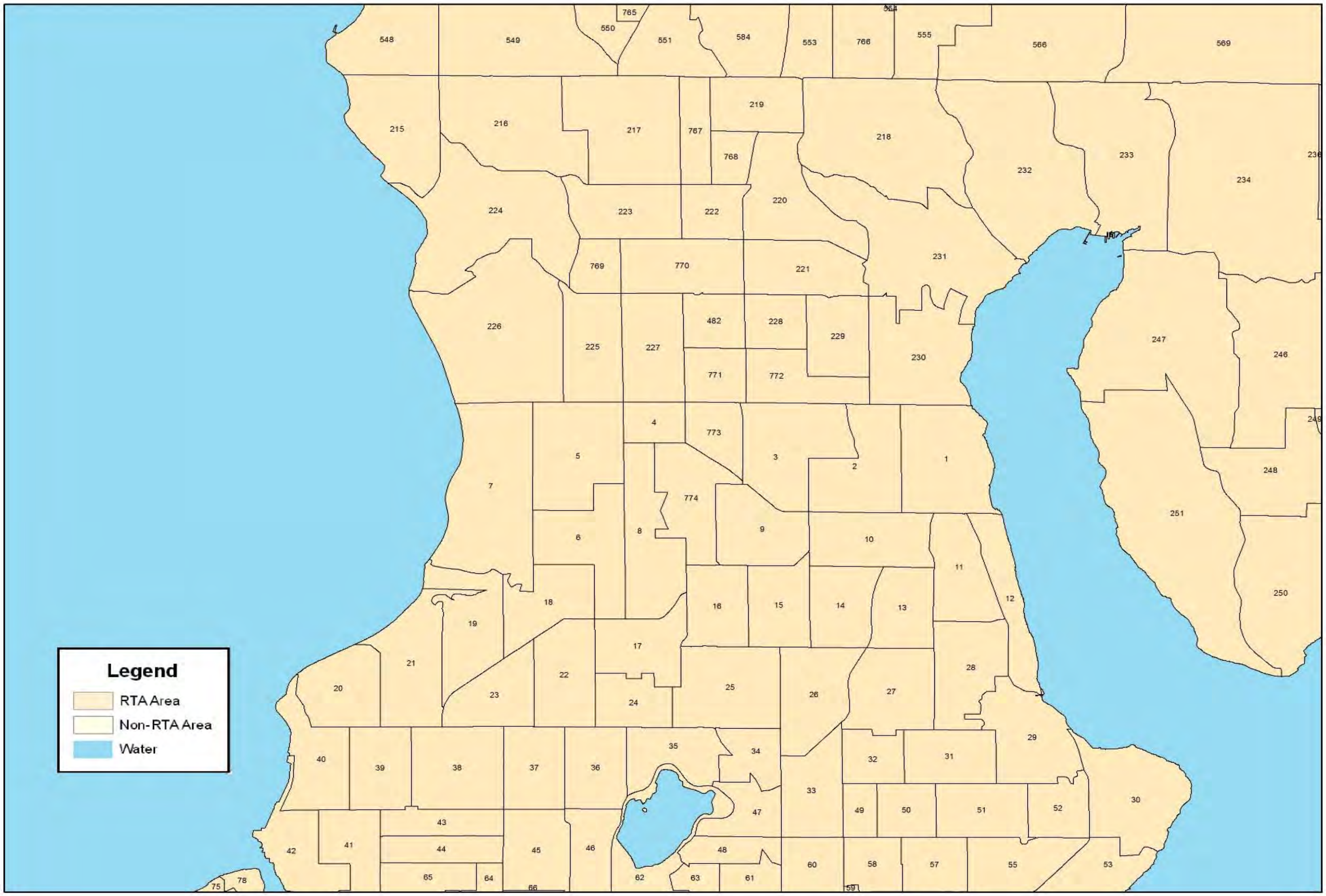

Figure A-4c. 807 AAZ Map—North Seattle

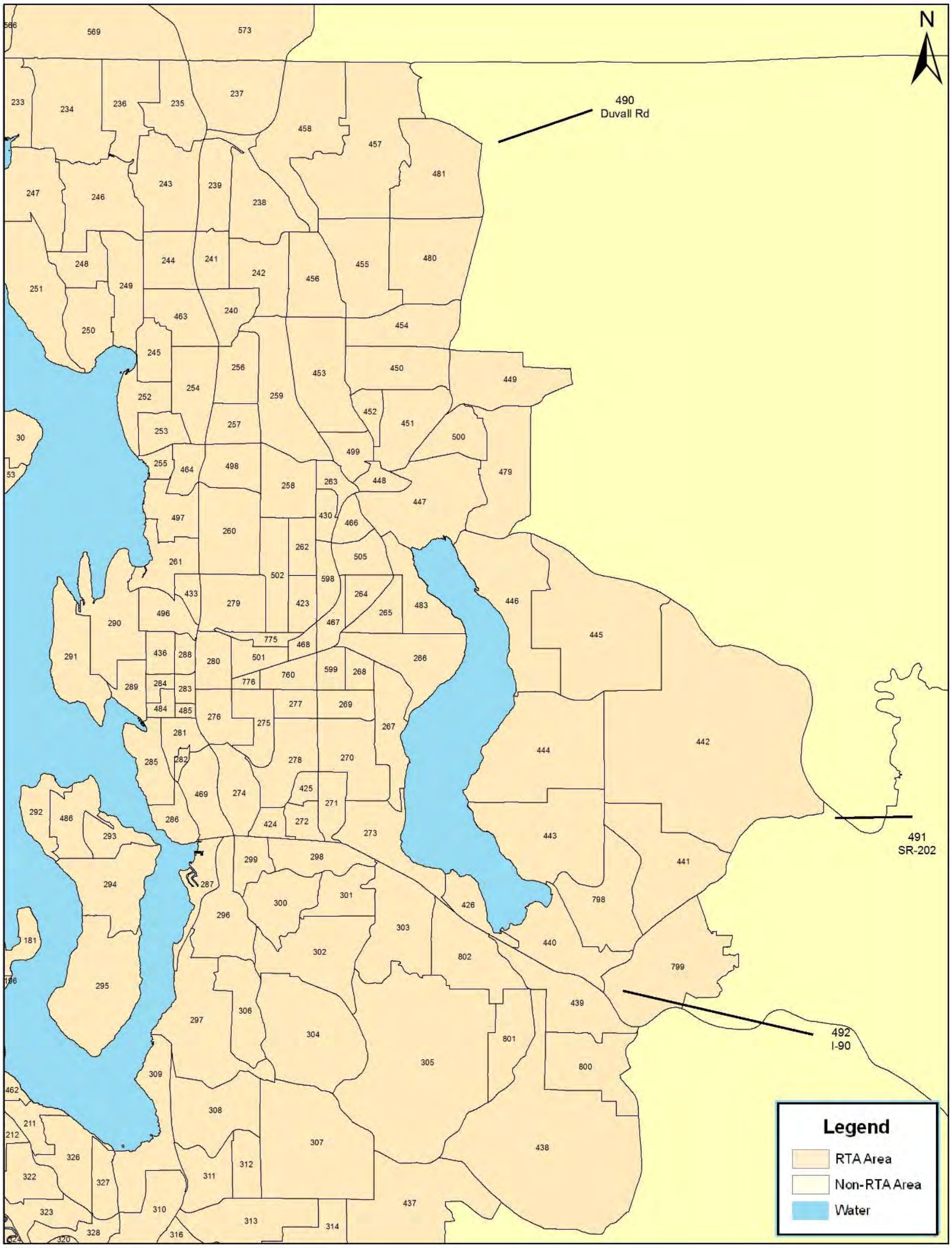

Figure A-4d. 807 AAZ Map—East King County

Figure A-4e. 807 AAZ Map—Southeast/West Seattle

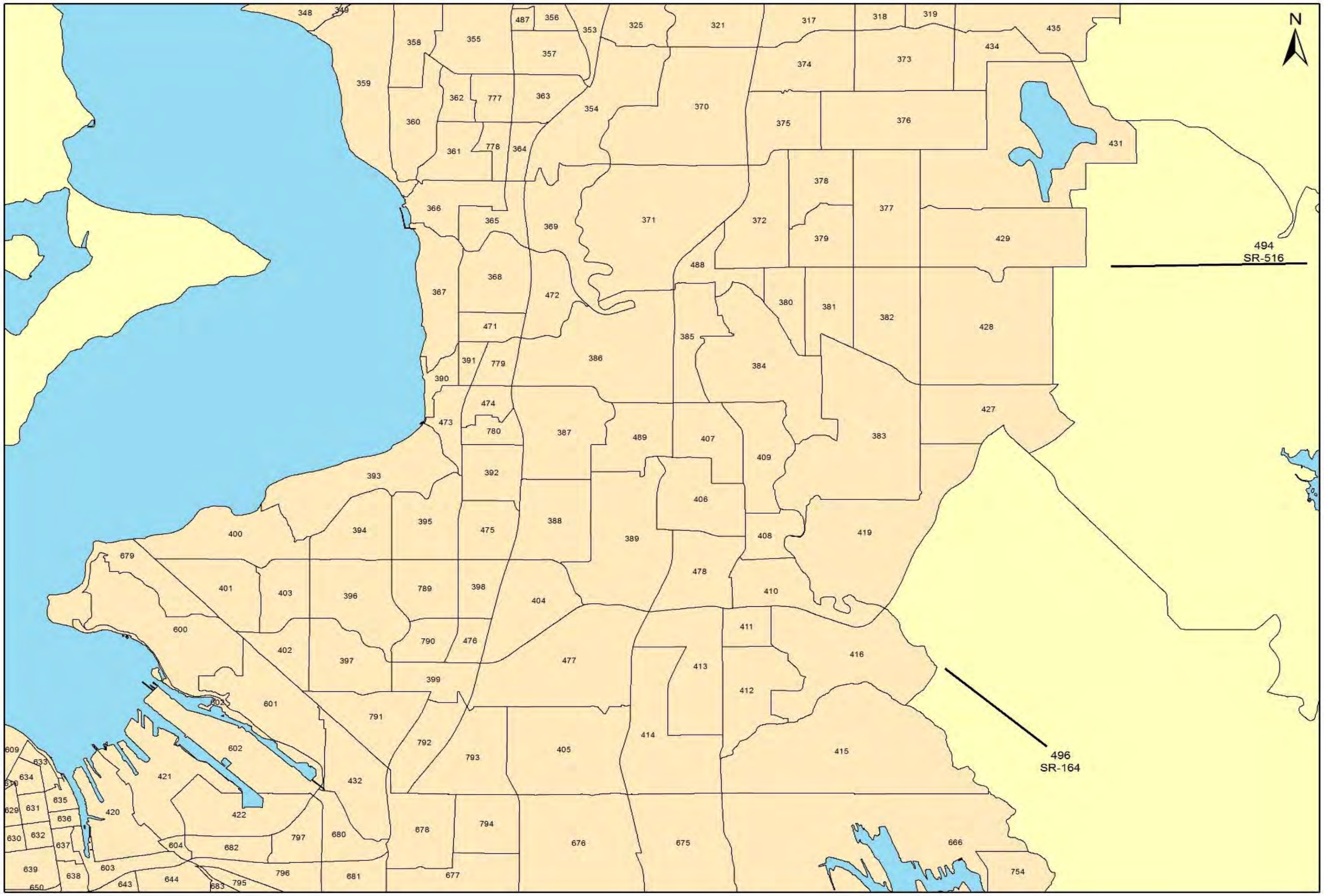

Figure A-4f. 807 AAZ Map—South King County

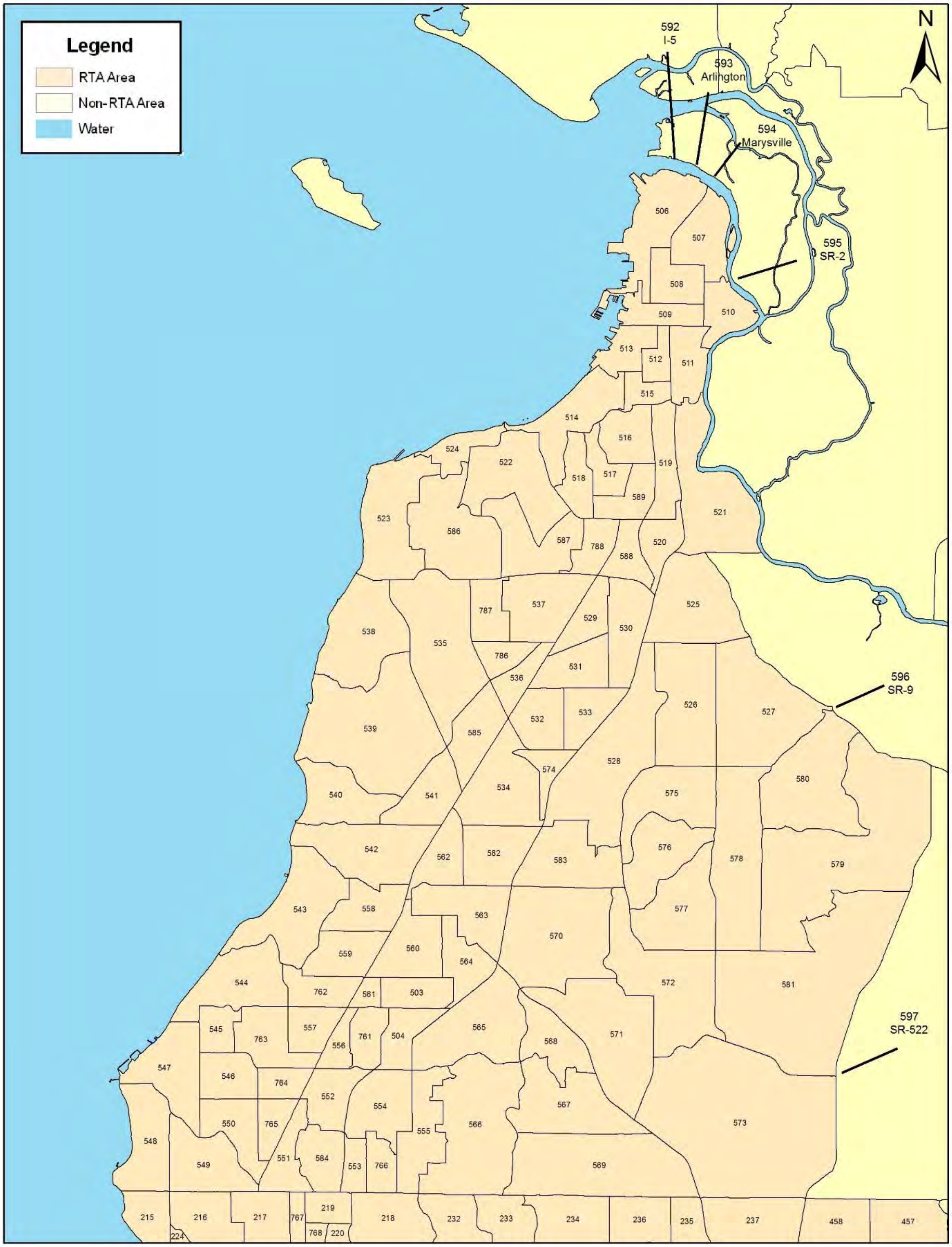

Figure A-5. 807 AAZ Map—Snohomish County

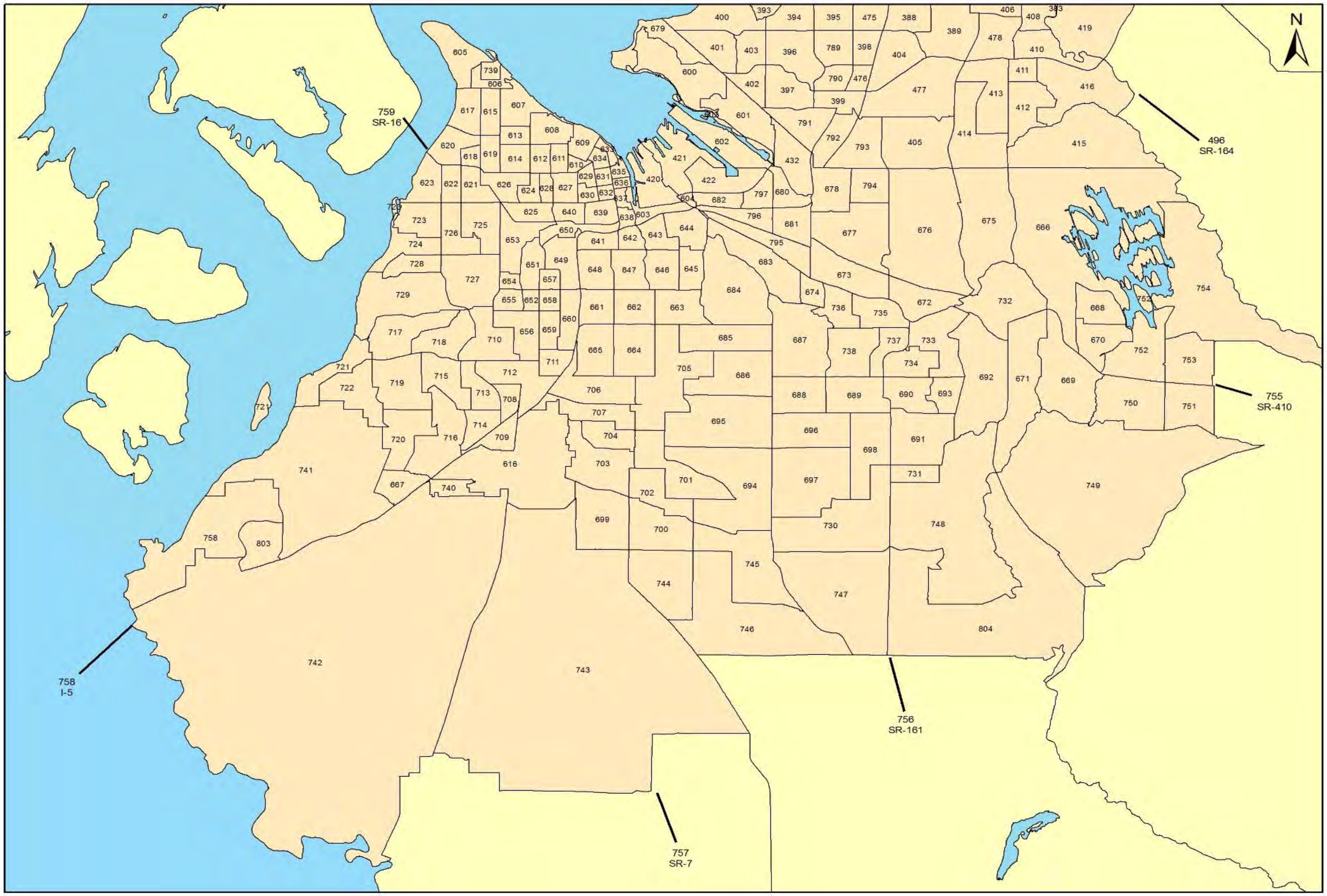

Figure A-6. 807 AAZ Map—Pierce County

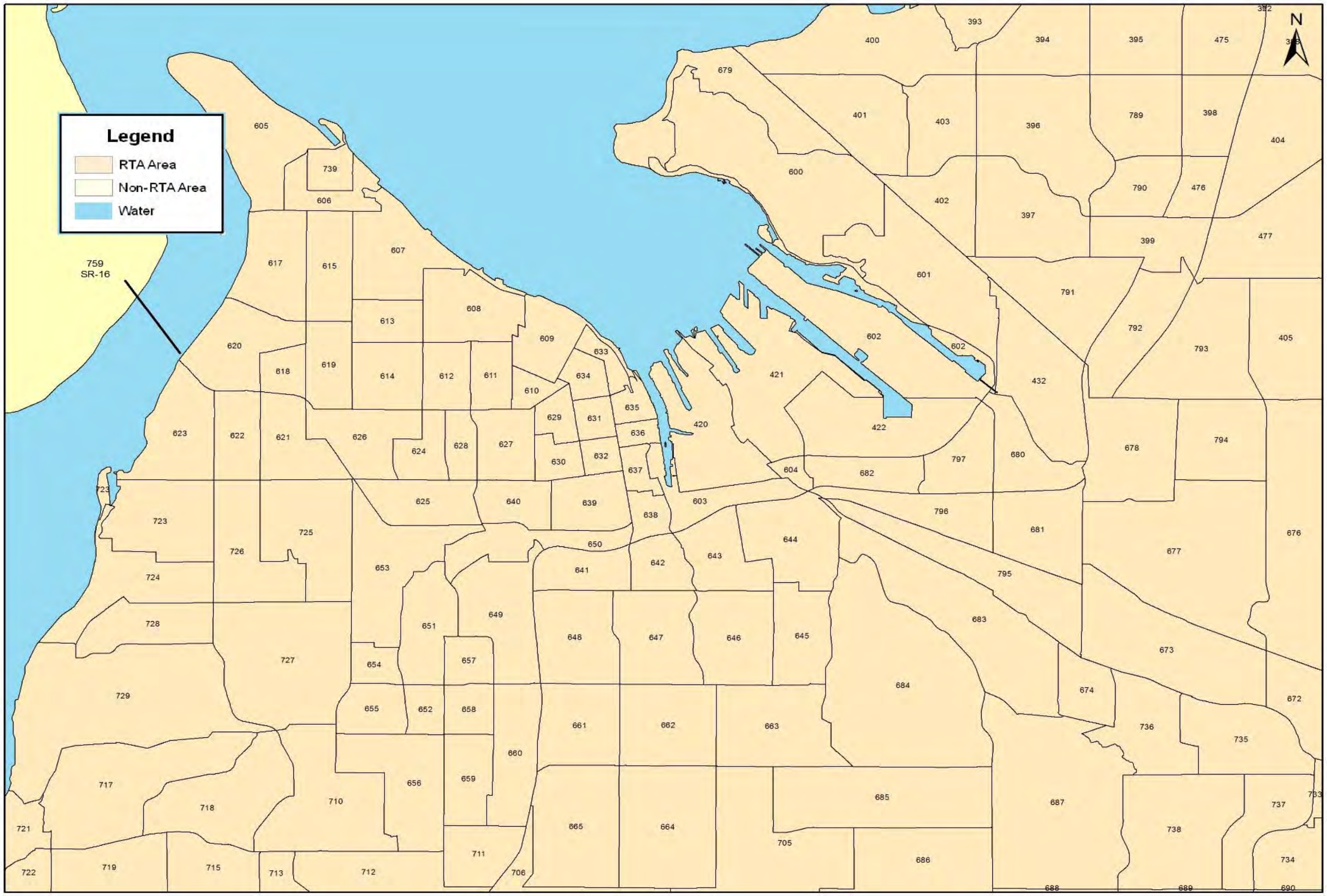

Figure A-6a. 807 AAZ Map—Tacoma

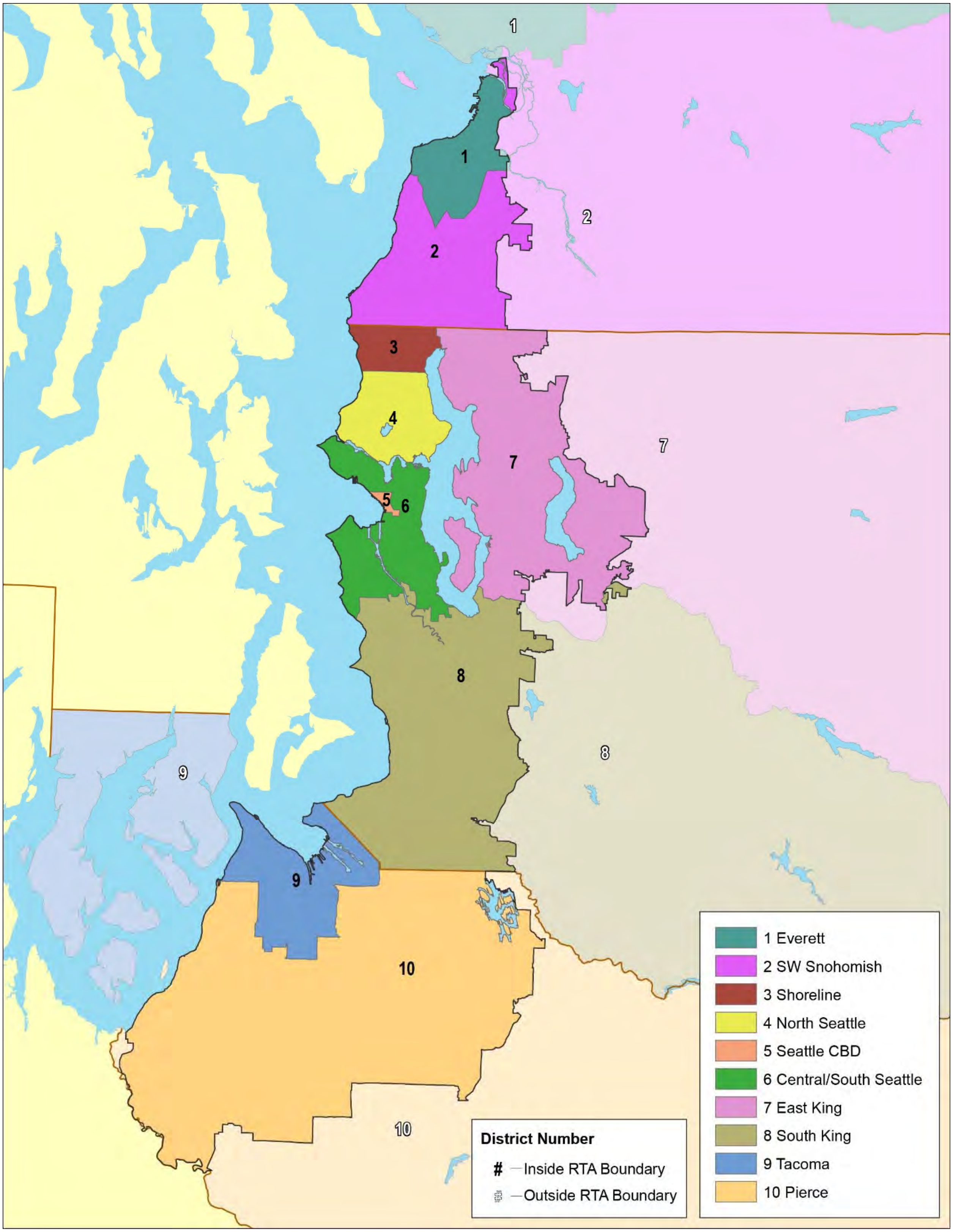

Figure A-7. 10-district map

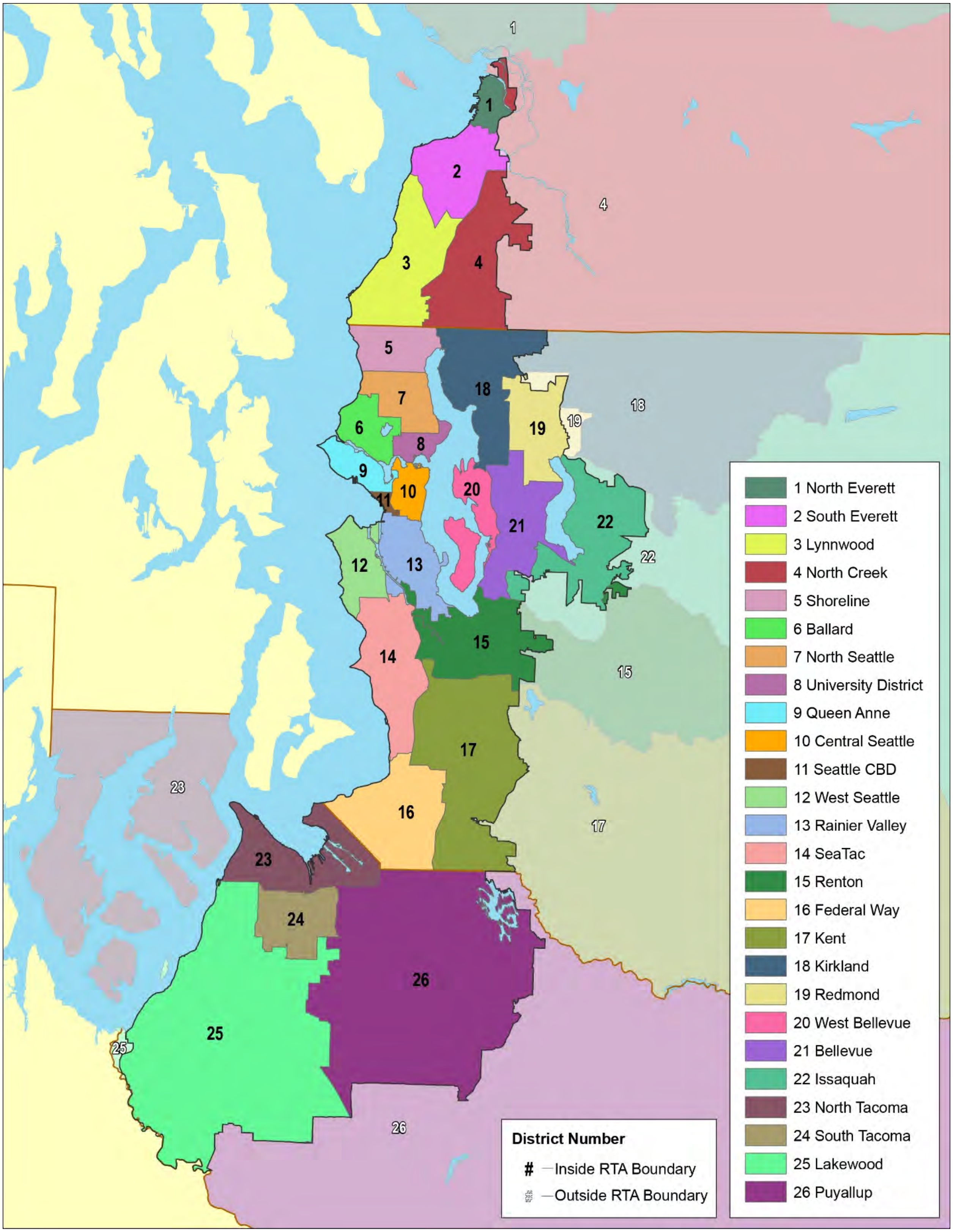

Figure A-8. 26-district map

Appendix B: ORCA, Surveys and Google Travel Time Data

Appendix B: ORCA and Surveys Data

This appendix includes a summary of the recent ORCA and surveys data used to update the 2017 version of the Sound Transit (ST) Ridership Model. This model version represents a departure from previous versions, primarily because of a significant increase in the amount of data available in the Puget Sound Region for describing current transit travel. The most significant of these is the availability of ORCA fare card transaction data used to create peak and off-peak seed matrices and provide a realistic estimate of transfer rates. ORCA data is now the primary source of shaping transit travel patterns. It constitutes opening 26 percent of (zone-to-zone) cells in the seed matrices with non-zero values. Commute trip reduction (CTR) and ST surveys open, respectively, an additional 3.0 and 0.3 percent of the cells.

B.1 ORCA Data

The ORCA card is a smart card technology to allow transit users to easily pay fares by tapping the card against an electronic card reader. The card enables seamless transfers between transit systems thanks to revenue-sharing agreements between transit agencies in the region. Transit users are incentivized to use the card instead of cash since they receive free or discounted transfers between agencies only if they use an ORCA card. The ORCA card allows for enhanced data collection as well, since the particular route, time of boarding, and transfers are logged; additionally, for rail, both the boarding and alighting locations are logged.

The ORCA data used to update the ST model is an outcome of previous work performed by the Washington State Transportation Center (TRAC) office at the University of Washington, designed to demonstrate the value of using ORCA transaction data for planning and operational purposes. The project is funded jointly by TRAC and Sound Transit, with staff support from the Puget Sound Regional Council.

The origin-destination data provided to Sound Transit and their consultants are developed from nine weeks of ORCA transaction data from March 26, 2016, to May 28, 2016, containing about 23 million boardings. On an average weekday during this period, 453,000 boardings were paid with ORCA cards. The number of true transfers, excluding round trips paid as transfers, was 109,600, yielding about 353,000 average weekday linked trips. This results in a transfer rate of 1.32. For the PM peak period, 148,200 boardings were paid for with ORCA cards. The number of true transfers, excluding round trips paid as transfers, was 35,400, yielding about 112,800 PM peak period linked trips. This results in a PM peak transfer rate of 1.31.

Trips on Kitsap Transit, Everett Transit, and Washington State Ferries were not geocoded and thus were not used in the estimation of the transfer rate.

Note that origins and destinations are assigned to specific transit stops and do not indicate the actual geographic origin (land use parcel or alternative analysis zone) or destination of that trip. An additional analysis used to allocate trips to zones for the matrix estimation seed matrix is described below.

B.1.1 ORCA data processing

The ORCA system supplies ORCA fare transaction records in two basic forms: on-board bus transactions (which include the date and time, bus number, route, and operating agency) and off-board transactions from rail and BRT services (which include the date and time, location of the card reader and, in some cases, where the rider exited the rail system).

The initial pre-processing step of the origin-destination process links the automatic vehicle location (AVL) records of each agency to the on-board ORCA fare transaction records. This allows the analysis process to geolocate a very high percentage of the ORCA transit boarding records. Next, a look-up table is used to identify the location of each off-board rail and BRT payment location. This allows the geolocation of the BRT and rail trips. For BRT trips, the vehicle location files are then used to identify which bus the rider boarded based on routes serving the indicated stationary card reader. Sometimes multiple tap records occur to account for fare reloads or covering additional required fare; therefore, these taps are removed from the dataset, as they are not records of boardings or alightings. The product of these basic pre-processing steps is the geolocated ORCA transactions file indicating when, where (bus stop or rail station), and which vehicle each rider boards.

B.1.2 Origin-destination processing

The input to the origin-destination estimation process is the geolocated transactions file described above. This file is sorted by hashed ORCA card number and then by date and time. Data processing then occurs for one hashed card ID at a time. (That is, all ORCA cards with a hashed card ID of “abc123” are processed together, and that processing occurs in date/time order, with the “oldest” record processed first.) While the process described below aims to determine origins and destinations, it focuses on destinations for transit trips that do not involve transfers; transfer processing is discussed in a later section.

Destination Estimation

Starting with the first record (Record J), the geolocated boarding location (Stop J) is assigned as the origin of the trip (Trip J). The next record (Record K) for that ORCA card ID is then examined. If Record K is a transfer,[1] then transfer processing (see the next major section) is performed. If Record K does not describe a transfer boarding, then the location of boarding for Record K is used as a potential indicator of the destination of Trip J.

A 1/3-mile circle is drawn around the boarding location described for Record K. If the transit route boarded for Record J (Route J) has a bus stop that falls within the 1/3-mile circle around the boarding location for Record K, then the stop closest to the boarding location shown for Record K (Stop K) that is served by Route J (Exitstop J) is assumed to be the destination for the trip with a defined origin at the boarding location for record J. The process then produces a record indicating the origin (Stop J) and destination (Exitstop J). An illustration of this process is shown in Figure B-1. If Route J does not pass within 1/3-mile of Stop K, then no destination can be assigned for Trip J and the trip is discarded for O-D purposes, as illustrated in Figure B-2. For rail trips where the person did “tap off,” this tap-off location is used as the destination, unless there is a transfer, in which case the process in the section below applies.

[1] ORCA records contain an indicator variable which indicates if the current boarding has occurred within 2 hours of a non-transfer boarding. If this boarding occurs within 2 hours of a non-transfer boarding, it is considered a transfer by ORCA.

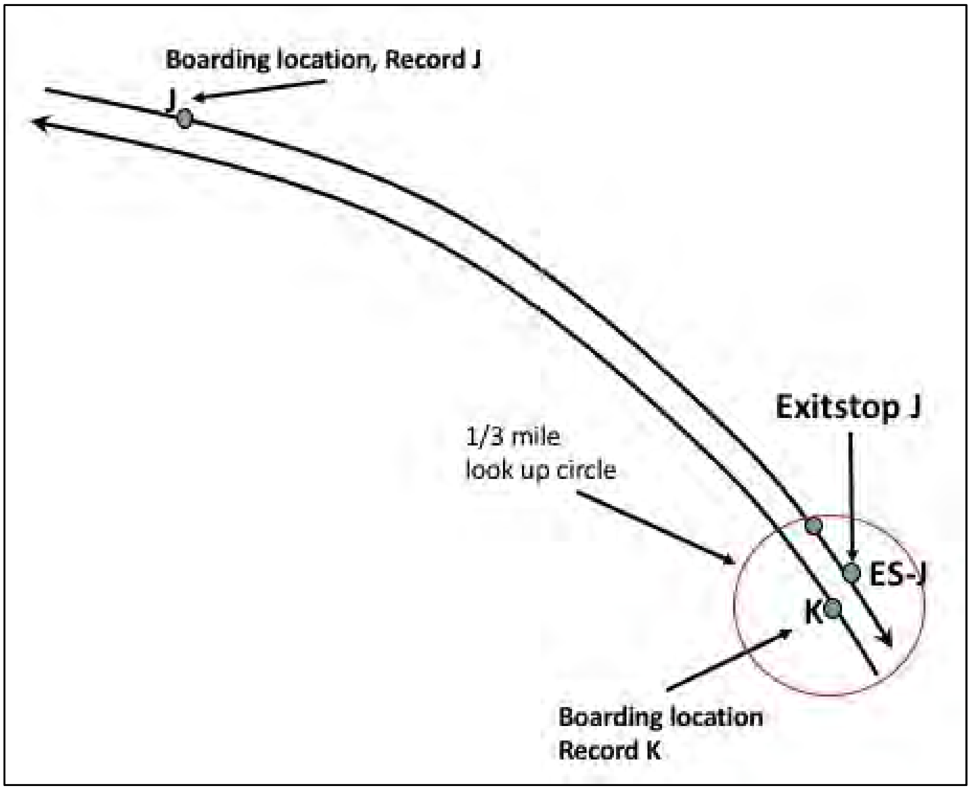

Figure B-1. The destination identification process

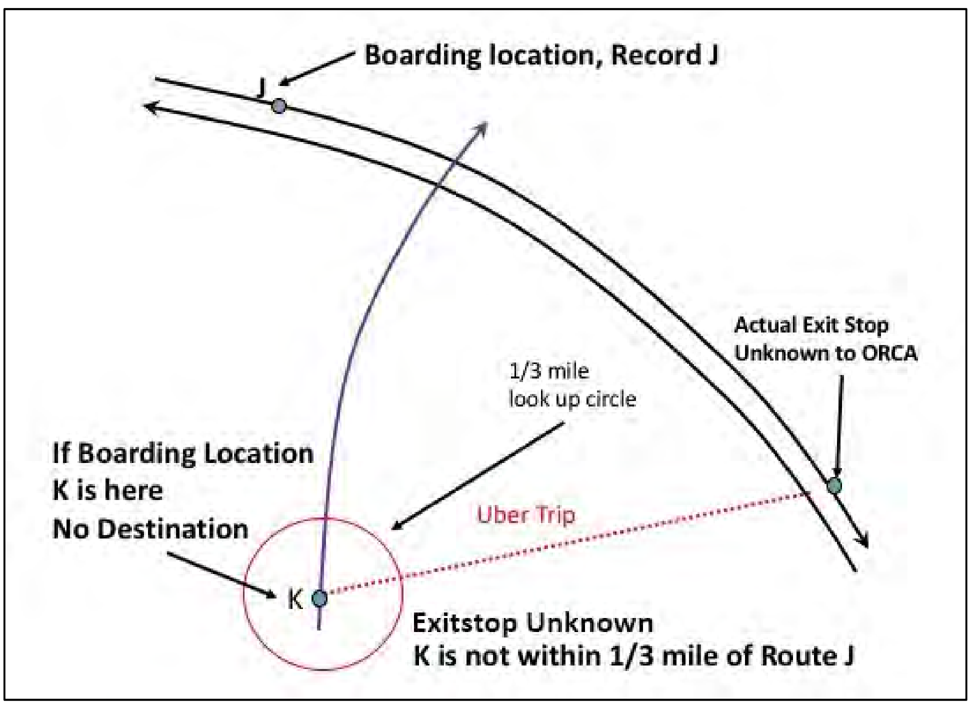

Figure B-2. The destination identification process, with no destination found

Transfer Handling

When a transfer is indicated by an ORCA record, the following steps are taken in place of the destination discovery steps described above. First, if the Route being boarded (i.e., the Route in Record K) is the same as the route being transferred from (Route J), then an activity is assumed to be taking place between the first boarding and the second boarding because no one gets off a bus to simply get right back on that bus. Consequently, if Route K = Route J, boarding stop K is the identifier of the logical destination for Trip J. Therefore, a 1/3-mile look-up is performed. Note that it is allowed to have boarding stop K as the destination for Trip J. This would be what is a termed a “pit stop”: the rider gets off at a bus stop, does an activity, and then re-boards that same route, going in the same direction, at the same stop. Alternatively, the rider may be involved in an “end point” transfer: where exit stop, J is essentially across the street from boarding stop K, and s/he is likely returning to the origin for Trip J, having completed an activity near exit stop J and boarding stop K.

If Route J is not equal to Route K, then the 1/3-mile check is created around the new boarding location (Stop K). If that look-up fails (the two routes are not close to each other), then it is assumed that some trip occurred between the first and second transit trips and, therefore, no destination can be found for Trip J and the trip is discarded for O-D purposes.

If the 1/3-mile look-up finds a stop, then the transfer is assumed to be valid. Route K is then used as the route for which a destination must be found. The next record (Record L) for this ORCA card number is then examined. If it is also a transfer, then the transfer process is repeated. If Record L is not a transfer, then the destination search process described above seeks a destination for Route K.

Rail Transfers

If Trip J occurs on a rail vehicle (Sounder or Link), an exit tap is made and a transfer occurs, then the validity of the transfer boarding is verified by checking the location of the transfer boarding (Stop K) against the exit station for the rail portion of the trip. If the new boarding is not within 1/3 mile of the exit rail station, then it is assumed that some trip occurred between the first and second transit trip, and the trip destination is assumed to be the rail station exit point. If the rider does not “tap off,” then the 1/3-mile computation takes into consideration the entire rail line in order both to determine the validity of the transfer and to identify the rail station that served as the exit point from the rail portion of the trip.

B.1.3 Apportioning ORCA flows to ST model zones

This data needs to be aggregated to the zonal level for use in the Sound Transit model. A naïve approach could be used where trips to or from a given stop are assigned entirely to the zone where the bus stop is located. However, this results in a number of issues:

- Stops along streets that are zone boundaries will have significant imbalances in daily flows
- Zones which have no stops will show no activity even if there are nearby stops

This document describes the process used to allocate flows from stop-to-stop to zone-to-zone.

Method for apportionment

Since the processed ORCA origin-destination flows represent linked trips (including transfers), the primary modes of access or egress from each stop are walking and biking, with auto access (drop off and parking) at park-and-ride locations. For walk/bike access, spreading trips over a reasonable access area was deemed appropriate. Historically, a 0.25-mile walk distance for bus and 0.5-mile for rail was considered typical. However, recent research, including the Sound Transit Before/After study for Initial Segment/Airport Link, indicated a willingness to walk longer distances, but extending the distance too far can result in unreasonably long access distances, given the large size of some zones. Table B-1 shows the distances used. For short trips, smaller distances were used to spread the flows since it makes sense that people will not walk as far for a short trip. For longer trips, 50 percent of trips were assigned to the area within half the walk access distance and the remaining 50 percent assigned to the outer ring of the distance as shown in Figure B-3. Whether for short trips or longer trips, the number of trips allocated to each zone is proportional to the area of the circle over each zone. Note that these distances were not used for the Downtown Seattle Transit Tunnel stations; for those stations, unique travelsheds were manually developed, reflecting station access, topography, zonal coverage, and likely use of each of the stations.

Table B-1. Walk access distances by stop type

Stop Type	Total Trip Length > 2 miles	Total Trip Length <= 2 miles
Link, Bus, & Streetcar	0.4 miles	0.2 miles
Sounder	0.6 miles	0.3 miles
Sounder at King Street Station	0.8 miles	N/A

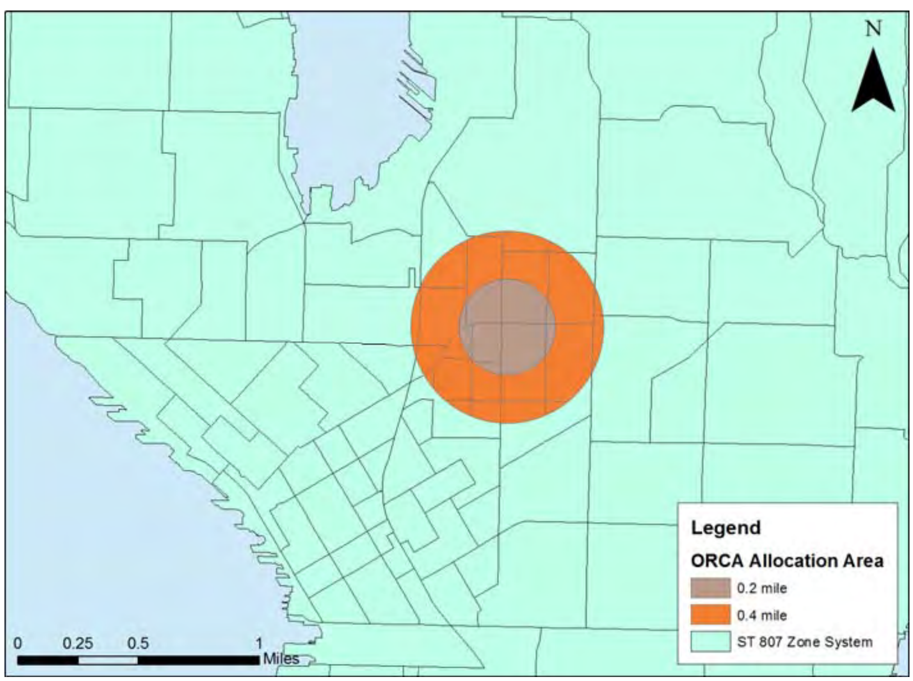

Figure B-3. Allocation area for walk/bike access at Capitol Hill Station

For stops at park-and-rides, the method above was used for walk access trips. However, for auto access, patterns of access tend to originate farther away from the destination (e.g., nobody drives from Mercer

Island to Bellevue to take a bus to Seattle). To apportion auto-access trips, park-and-ride-specific networks for automobiles to and from zones were used to apportion flows from an AM origin or PM destination stop (that serves commuter routes) over the zones this network connects to. These park-and-ride networks are reflective of the likely primary travelshed of auto access to each park-and-ride. The relative proportion of households was used to allocate between zones (e.g., zones with more households received a larger share of the flows from a stop). Finally, each stop was characterized as high (75 percent), medium (50 percent), or low (25 percent) auto access, representing the percent of trips that arrive/depart as auto access rather than walk or bike. This categorization of high, medium, and low recognizes that certain park-and-ride locations have much better walk accessibility for transit trip origins and destinations (e.g., Northgate).This results in smaller percentage of total boardings at that location to be allocated to auto-access than for other park-and-ride locations (e.g., Lakewood Station).

B.2 Surveys

In addition to ORCA data, relevant information from a number of recent surveys was also used in the ST model update. This included ST transit on-board surveys (2011-2016), CTR surveys (2011-2016), and American Community Survey. The ST and CTR surveys were used to open additional cells in the seed matrices. The American Community Survey was used to scale Base Year transit share matrix produced from the CTR survey. This was to neutralize the large-employer sample bias in the CTR data.

B.3 Google Travel Time Data

The Google Distance Matrix API (https://developers.google.com/maps/documentation/distance-matrix/) was used to establish Base Year non-transit travel times between each zone pair. The Distance Matrix API provides the network-based travel distance associated with the fastest travel time between two given points at a specified start time. Using a future date results in travel time estimates that represent typical travel times for that day of the week, including any recurring congestion, but without any delay from specific incidents that would result from using historical data. Representative points for each zone were selected by starting with the zone centroid, then adjusting the representative point as needed to reflect the center of travel activity for that zone. Representative points for some external ferry zones were chosen at the ferry terminal, meaning these travel times do not include ferry wait or travel times.

Travel times between points representing every zone pair (except intra-zonal pairs) for the following trip start times:

- Wednesday, June 7, 2017, at 12:15 p.m.
- Wednesday, June 7, 2017, at 5:15 p.m.

Collecting travel times between all zones for two start times resulted in over 1.3 million requests. The Google API limits the total number of requests to 100,000 per day per API key, the process was run the last week of May and first week of June, using the June 7 date for all travel time requests. The 12:15 p.m. time represents an off-peak hour, while 5:15 p.m. reflects the PM peak hour. Change in travel times from the ST highway model will be applied to the Google-based Base Year non-transit travel times to produce corresponding future year travel time inputs required in the ST model Stage 2 forecasting step.

Appendix C: Highway Model

- *Overview*
- *Network Refinements*
  - *Base Year*
  - *Future Baseline*
- *Model Results*

Appendix C: Highway Model

The Puget Sound Regional Council's (PSRC) 4K trip-based regional travel forecasting model[1] provides key inputs into the ST incremental transit ridership model. These include estimates of changes in (a) demographic growth, (b) non-transit travel times, and (c) bus speed degradation estimates. For the purpose of level-of-service and traffic design/mitigation analyses, it also provides estimates of changes in (a) performance measures (such as vehicle miles traveled) and (b) vehicular traffic as highlighted in Figure C-1. This figure shows the relationship between the ST incremental transit ridership model and the PSRC regional travel forecasting model, along with other related processes.

As illustrated in Figure C-1, the PSRC regional model is not meant to provide facility-specific traffic estimates at a level of detail adequate for use in analysis of impacts. It can only provide an overall estimate of generic growth factors when needed. Other locally detailed subarea traffic models, mesoscopic models, or micro-simulation models should be used for level-of-service and traffic design/mitigation analyses.

This appendix discusses the background of this highway model and highlights efforts to improve the results from the model to best reflect observed conditions and provide quality inputs into the ST model. This includes presentation of some Base Year model results.

C.1 Overview

The PSRC regional model used to support the ST incremental ridership model has benefited from the culmination of over two decades of experience from the application of PSRC regional model to major WSDOT projects, such as the SR 520, I-5 to Medina: Bridge Replacement and HOV Project, Alaskan Way Viaduct and Seawall Replacement Program, and Puget Sound Gateway Program. The observations and data regarding the operation of facilities in the ST area have provided insight to guide enhancements to the ST highway model.

As part of the analysis for the SR 99 tunnel toll traffic and revenue analysis, a Dynamic Traffic Assignment (DTA) model was created to analyze traffic and revenue that would be affected by tolling of the new tunnel. The mesoscopic DTA model provides a level of detail between a demand model and operational models, while still using the zonal system from the City of Seattle model. Likewise, a DTA model has been used to support evaluation of conceptual design scenarios for the Gateway project. For the purpose of preserving all the previous network changes and refinements, the original 1K zone system was adopted in conjunction with the current PSRC 4K model procedures.

Using the above model background information, the PSRC regional model incorporated network attributes and model procedures that would provide the best representation of travel conditions within the ST area. In addition to knowledge provided from these models, additional review of network attributes and existing roadway conditions was performed to provide additional updates that might not necessarily have been included in the focus of other recent modeling efforts.

[1] Puget Sound Regional Council, 4K Travel Model Documentation, June 2015.

Base Year and Future Year travel times from the PSRC regional model are not used in the ST transit model. Peak and off-peak non-transit travel times are taken directly from measured Google highway times, as described above in Appendix B, Section B.3. The PSRC regional model is used to estimate incremental changes in the measured non-transit times for use in Future Year transit ridership forecasts only.

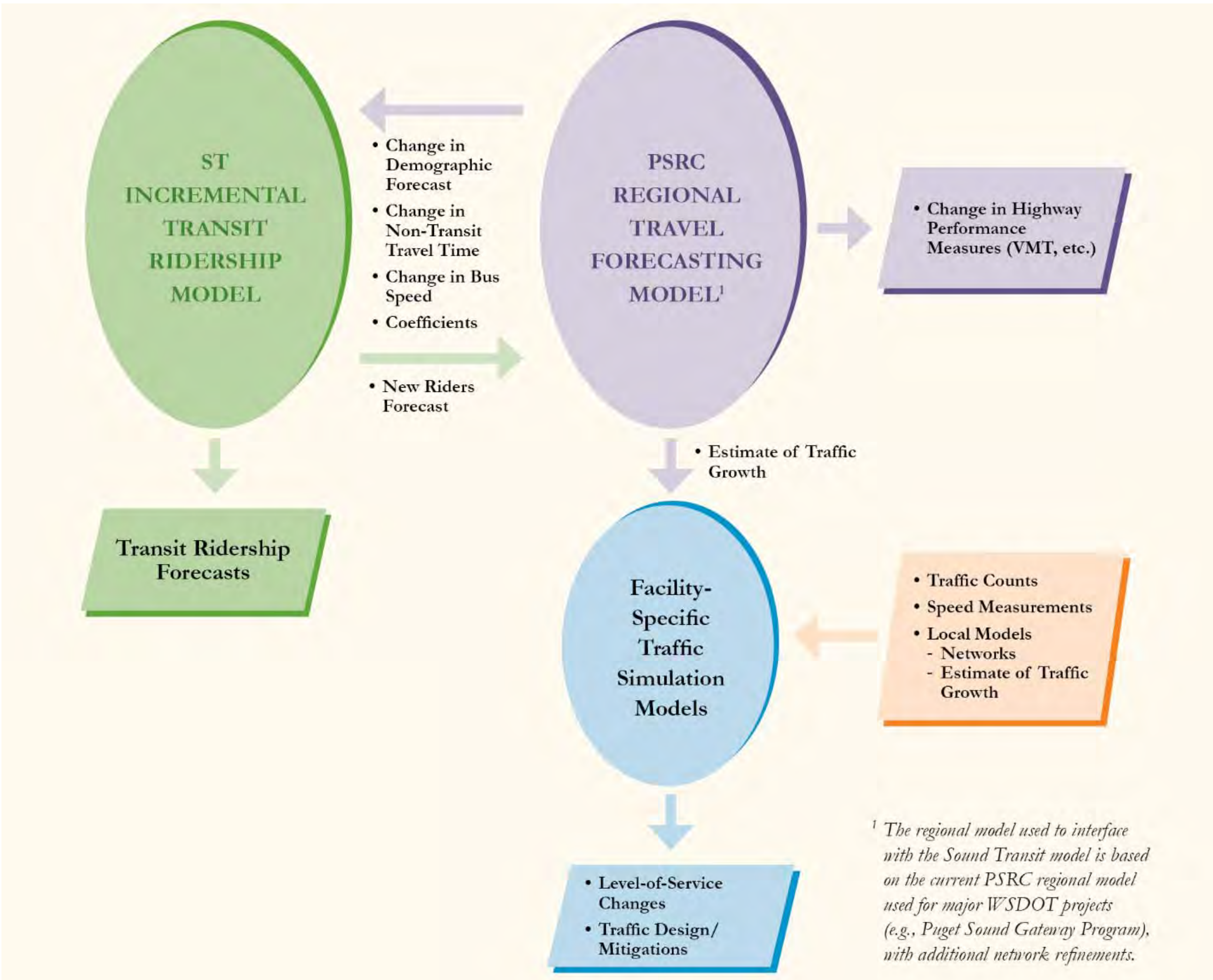

Figure C-1. ST incremental transit ridership and PSRC regional models relationship

Likewise, output from this model is not used to estimate Current Year or Future Year project-related changes in vehicle miles travelled. For vehicle-miles-travelled changes related to transit projects, the FTA preferred method, as described in recent FTA guidelines for the New Starts Capital Investment Grant Program, is used. This method requires only the transit new riders' estimates for Current Year and Future Year plus a generic highway distance matrix for the region.

C.2 Networks

C.2.1 Base Year

The Base Year (2016) highway network reflects existing conditions. To better reflect existing roadway configurations, the model link attributes were compared to actual conditions. Appropriate adjustments to speed, capacities, and congestion factors were made accordingly. The Base Year transit network in the ST ridership model was used as a guide to update the base transit network in the PSRC regional model. The path-builder parameters are similar to those used in the current ST incremental model.

C.2.2 Future baseline

Highway projects

The future baseline for the highway model includes several major and minor highway projects that were defined in PSRC's *Transportation 2040* Preferred Alternative (Constrained) network. This network, therefore, includes some projects that are planned but not funded. A single baseline network is used for the transit no-build and build alternatives since none of the build alternatives significantly affect the design of any roadways.

Transit projects

Transit changes significant enough to affect regional highway demand levels are also included in the 2040 PSRC regional model. The 2040 PSRC regional model assumes that the ST Link light rail network extends from Federal Way south to Lynnwood in the north and to Downtown Redmond in the east. Background transit assumptions for the PSRC model always include only transit projects with a Record of Decision and full funding. Bus routes and frequencies are adjusted to reflect updated connections to light rail service as well as King County's RapidRide arterial BRT service and Community Transit's Swift arterial BRT service.

Demographic forecasts

The PSRC regional model uses the Land Use Vision (LUV.2).

C.3 Bus speeds

Historically, the ST transit ridership model has used estimates of long-term speed degradation from the PSRC regional model in order to slightly reduce future bus speeds. This degradation typically has been in the 7- to 9-percent range per decade, depending on the location and type of highway segment used by the bus route. The historical justification for this approach included review of actual bus operating speeds over the four decades from about 1960 to 2016; long-term degradation of about 9 percent per decade was observed.

There is no reason to change this procedure in current applications of the ST transit model. After a period of very modest bus speed degradation from 2008 to 2013, there has been a steep decline in bus speeds from 2014 to 2017. The average decline over the past decade (i.e., combined for 2008-2017) has, in fact, been about 10 percent.

BRT routes, where freeway or arterial route segments are barrier-separated or grade-separated, are treated identically to rail lines in the ST transit model. That is, the speeds are entered directly on the links, with the addition of reasonable times for deceleration/dwell/acceleration at proposed stops. However, bus speed degradation is applied to routes that operate in congested high-occupancy vehicle lanes and which often require interaction with adjacent lanes, since recent history of measured bus speeds in these lanes exhibits continuing bus speed degradation in all major corridors.

A wide variety of existing BRT-type stop-spacing situations are available within the existing regional bus network for inference of new BRT travel times. While there is always a risk of over-optimism in the modeling of BRT operations for ridership estimation, careful reference to existing situational experience with actual bus speeds and station-to-station times reduces this risk.

C.4 PSRC regional model results

Although the primary purpose of this model is to provide estimates of future changes in non-transit travel times, a comparison of estimated and observed vehicle volumes at key screenlines provides a reasonableness check on model performance. Model-estimated vehicle volumes are compared to recent observed traffic counts on arterials and highways across a number of screenlines. The screenlines used are shown on the map in Figure C-2. As seen in Table C-1 through Table C-3 the estimated screenline total volumes are mostly within 10 percent of observed volumes during the peak hours and over the entire day.

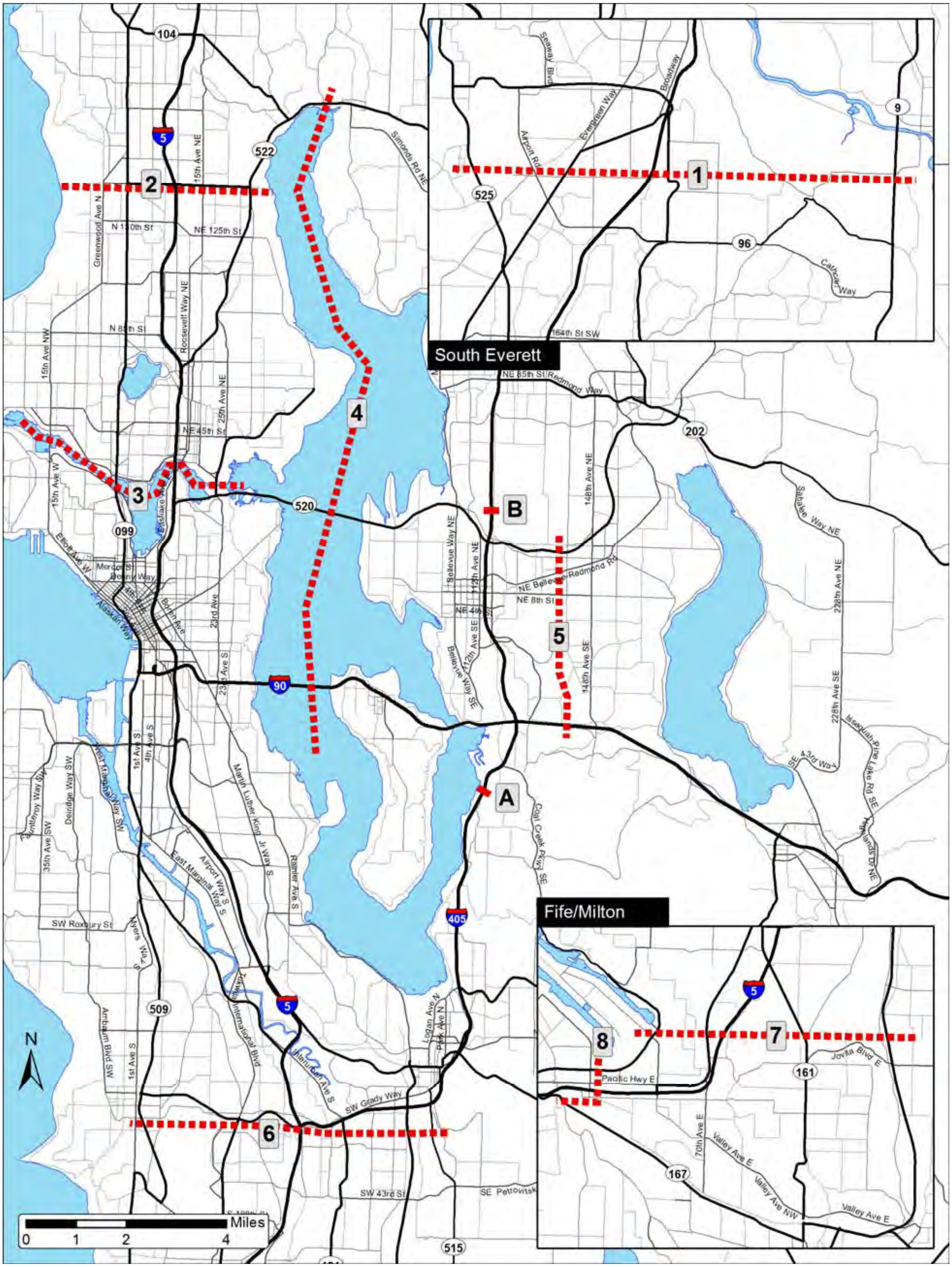

Figure C-2. Highway screenlines map

Table C-1. Base Year (2016) screenline total vehicle volume comparison (AM peak hour)

	Actual Volumes			Estimated Volumes			
	NB/EB	SB/WB	Total	NB/EB	SB/WB	Total	Est/Obs
Screenline 1 - North of 112th St SW							
Freeways	5,600	6,870	12,470	3,800	6,630	10,500	0.84
Arterials	3,840	5,040	8,880	4,230	4,510	8,800	0.99
Screenline Total	**9,440**	**11,910**	**21,350**	**8,030**	**11,140**	**19,300**	**0.90**
Screenline 2 - South of N 145th Street							
Freeways	5,010	8,070	13,080	4,870	7,980	12,900	0.99
Arterials	4,320	6,670	10,990	3,070	6,170	9,100	0.83
Screenline Total	**9,330**	**14,740**	**24,070**	**7,940**	**14,150**	**22,000**	**0.91**
Screenline 3 - Ship Canal							
Freeways	5,910	11,770	17,680	6,340	11,220	17,600	1.00
Arterials	3,880	5,670	9,550	3,670	4,920	8,700	0.91
Screenline Total	**9,790**	**17,440**	**27,230**	**10,010**	**16,140**	**26,300**	**0.97**
Screenline 4 - Midlake							
Freeways	8,720	10,700	19,420	8,010	8,170	16,300	0.84
Screenline Total	**8,720**	**10,700**	**19,420**	**8,010**	**8,170**	**16,300**	**0.84**
Screenline 5 - West of 140th Ave E							
Freeways	9,640	11,090	20,730	8,290	9,000	17,290	0.83
Screenline Total	**9,640**	**11,090**	**20,730**	**8,290**	**9,000**	**17,290**	**0.83**
Screenline 6 - South of SR 518/I-405							
Freeways	15,070	10,270	25,340	12,990	6,960	19,950	0.79
Arterials	3,610	4,800	8,410	3,390	3,590	7,000	0.83
Screenline Total	**18,680**	**15,070**	**33,750**	**16,380**	**10,550**	**26,990**	**0.80**
Screenline 7 - King/Pierce County Line							
Freeways	7,410	6,860	14,270	9,120	5,610	14,730	1.03
Arterials	5,100	3,250	8,350	5,480	3,250	8,700	1.04
Screenline Total	**12,510**	**10,110**	**22,620**	**14,600**	**8,860**	**23,350**	**1.03**
Screenline 8 - East of Port of Tacoma Rd							
Freeways	7,980	7,040	15,020	8,880	6,420	15,300	1.02
Arterials	2,230	3,360	5,590	1,760	2,010	3,700	0.66
Screenline Total	**10,210**	**10,400**	**20,610**	**10,640**	**8,430**	**19,050**	**0.92**
Point Locations - A & B							
I-405, South of Coal Creek Pkwy -- A	6,040	4,250	10,290	5,750	3,510	9,260	0.90
I-405, North of SR 520 -- B	4,980	7,960	12,940	4,680	7,430	12,110	0.94

Table C-2: Base Year (2016) screenline total vehicle volume comparison (PM peak hour)

	Actual Volumes			Estimated Volumes			
	NB/EB	SB/WB	Total	NB/EB	SB/WB	Total	Est/Obs
Screenline 1 - North of 112th St SW							
Freeways	7,240	6,290	13,530	7,800	4,400	12,200	0.90
Arterials	5,890	6,100	11,990	6,000	5,000	11,000	0.92
Screenline Total	**13,130**	**12,390**	**25,520**	**13,800**	**9,400**	**23,200**	**0.91**
Screenline 2 - South of N 145th Street							
Freeways	7,440	5,070	12,510	8,500	5,000	13,500	1.08
Arterials	7,990	7,190	15,180	9,200	5,600	14,800	0.97
Screenline Total	**15,430**	**12,260**	**27,690**	**17,700**	**10,600**	**28,300**	**1.02**
Screenline 3 - Ship Canal							
Freeways	10,560	4,660	15,220	11,900	6,900	18,800	1.24
Arterials	6,260	5,080	11,340	*6,700*	*6,200*	12,900	1.14
Screenline Total	**16,820**	**9,740**	**26,560**	**18,600**	**13,100**	**31,700**	**1.19**
Screenline 4 - Midlake							
Freeways	10,310	8,720	19,030	*10,700*	*9,300*	20,000	1.05
Screenline Total	**10,310**	**8,720**	**19,030**	**10,700**	**9,300**	**20,000**	**1.05**
Screenline 5 - West of 140th Ave E							
Freeways	11,140	8,580	19,720	*11,500*	*9,400*	20,900	1.06
Screenline Total	**11,140**	**8,580**	**19,720**	**11,500**	**9,400**	**20,900**	**1.06**
Screenline 6 - South of SR 518/I-405							
Freeways	12,590	15,080	27,670	*9,500*	*16,300*	25,800	0.93
Arterials	4,470	4,780	9,250	4,100	5,500	9,600	1.04
Screenline Total	**17,060**	**19,860**	**36,920**	**13,600**	**21,800**	**35,400**	**0.96**
Screenline 7 - King/Pierce County Line							
Freeways	7,090	8,200	15,290	*6,800*	*12,000*	18,800	1.23
Arterials	4,020	5,130	9,150	4,100	7,100	11,200	1.22
Screenline Total	**11,110**	**13,330**	**24,440**	**10,900**	**19,100**	**30,000**	**1.23**
Screenline 8 - East of Port of Tacoma Rd							
Freeways	8,010	8,580	16,590	*7,200*	*10,100*	17,300	1.04
Arterials	3,620	3,430	7,050	2,600	4,300	6,900	0.98
Screenline Total	**11,630**	**12,010**	**23,640**	**9,800**	**14,400**	**24,200**	**1.02**
Point Locations - A & B							
I-405, South of Coal Creek Pkwy -- A	4,970	4,820	9,790	4,300	6,200	10,500	1.07
I-405, North of SR 520 -- B	7,940	5,910	13,850	8,600	6,000	14,600	1.05

Table C-3: Base Year (2016) screenline total vehicle volume comparison (average weekday)

	Actual Volumes			Estimated Volumes			
	NB/EB	SB/WB	Total	NB/EB	SB/WB	Total	Est/Obs
Screenline 1 - North of 112th St SW							
Freeways	104,100	105,200	209,300	85,400	82,300	167,700	0.80
Arterials	69,100	76,900	173,300	88,900	86,600	175,500	1.01
Screenline Total	**173,200**	**182,100**	**382,600**	**174,300**	**168,900**	**343,200**	**0.90**
Screenline 2 - South of N 145th Street							
Freeways	101,300	102,300	203,600	110,400	107,300	217,700	1.07
Arterials	76,000	72,300	148,300	85,500	84,300	169,800	1.14
Screenline Total	**177,300**	**174,600**	**351,900**	**195,900**	**191,600**	**387,500**	**1.10**
Screenline 3 - Ship Canal							
Freeways	133,900	122,000	255,900	146,700	138,500	285,200	1.11
Arterials	62,100	63,500	269,300	*155,400*	*159,800*	315,200	1.17
Screenline Total	**196,000**	**185,500**	**525,200**	**302,100**	**298,300**	**600,400**	**1.14**
Screenline 4 - Midlake							
Freeways	120,400	120,000	240,400	135,600	126,400	262,000	1.09
Arterials	29,600	29,600	59,100	26,400	25,800	52,200	0.88
Screenline Total	**150,000**	**149,600**	**299,500**	**162,000**	**152,200**	**314,200**	**1.05**
Screenline 5 - West of 140th Ave E							
Freeways	136,600	132,700	269,300	147,800	136,000	283,800	1.05
Arterials	51,700	51,700	103,300	49,600	52,000	101,600	0.98
Screenline Total	**188,300**	**184,400**	**372,600**	**197,400**	**188,000**	**385,400**	**1.03**
Screenline 6 - South of SR 518/I-405							
Freeways	220,400	204,000	424,400	182,600	180,400	363,000	0.86
Arterials	76,100	81,300	157,400	61,300	70,900	132,200	0.84
Screenline Total	**296,500**	**285,300**	**581,800**	**243,900**	**251,300**	**495,200**	**0.85**
Screenline 7 - King/Pierce County Line							
Freeways	155,300	145,300	300,600	152,100	150,600	302,700	1.01
Arterials	41,800	45,200	87,000	52,000	55,300	107,300	1.23
Screenline Total	**197,100**	**190,500**	**387,600**	**204,100**	**205,900**	**410,000**	**1.06**
Screenline 8 - East of Port of Tacoma Rd							
Freeways	122,900	120,000	242,900	128,400	124,500	252,900	1.04
Arterials	41,600	47,200	88,800	34,300	40,300	74,600	0.84
Screenline Total	**164,500**	**167,200**	**331,700**	**162,700**	**164,800**	**327,500**	**0.99**
Point Locations - A & B							
I-405, South of Coal Creek Pkwy -- A	85,300	79,400	164,700	81,600	74,800	156,400	0.95
I-405, North of SR 520 -- B	105,200	99,600	204,800	100,400	99,800	200,200	0.98

Appendix D: Procedures for Transit Network Preparation

- *Development of the Base Network*
- *Coordinate System*
- *Bus Speed from AVL Data*
- *Bus Speed Degradation Procedures*

Appendix D: Procedures for Transit Network Preparation

Actual transit service is represented in a transit ridership forecasting model by means of a coded network. This service representation actually consists of two elements:

- A highway network, or “base network,” is coded to create a computerized representation of existing and planned roads, busways, and tracks in the study region.
- Transit service assumptions are overlaid on this base highway network.

Significantly, for Sound Transit (ST) studies, the base network does not vary among alternatives. A single base network is used for all alternatives—meaning that for each alternative, elements of the base network may exist on which no transit service is coded. For example, rail rights-of-way are coded in every network although rail service may not yet exist on many of these rights-of-way.

ST decided to construct a single base network for several reasons. One advantage of keeping the base network constant is that it eliminates spurious errors caused by roads or walkways which could accidentally be coded differently in different alternatives. A second reason for maintaining a single base network is that it minimizes differences in results due to accidental differences in access coding. Because a major aim of any forecasting effort is to capture differences among various alternatives, it is important that these differences are attributable to actual differences among the alternatives, rather than to coding inconsistencies.

In contrast to the base network, the transit service that operates on this network does vary, both by forecast year and by alternative. The transit service network created for each alternative is represented by a set of bus and rail transit routes operated by local transit agencies.

D.1 Development of the base network

The base network is coded within the ST boundary and consists of links and nodes that represent the road system on which transit and automobiles travel. As mentioned, exclusive rights-of-way for transit (e.g., busways and rail tracks) are also coded, although they may not be used in every alternative. Park-and-ride lots are also coded, although some of these may not be served by transit in every alternative.

Each of the links coded in the base network has a set of attributes consisting of the length, type, modes allowed, lanes, and speed. More detail on link attributes is presented below.

The network outside the study area is not coded, although the major roads leaving the study area are coded by means of external links. These links serve as a method of accounting for travel into the study area from areas beyond the study area boundaries.

D.1.1 Transit mode types

The following seven modes are specified on links within the base network:

Symbol	Mode represented
b	Bus
t	Trolley Bus
r	Rail (including streetcar)
a	Auto access/egress (directional link)
w	Walk access/egress (directional link)
p	General pedestrian link
x	Park-and-ride lot connection (directional link)

The access modes (i.e., modes “a,” “w,” “p,” and “x”) are an important aspect of the base network. Note that in a PM peak transit network, the conventional terms “auto access” and “walk access” would be more properly described as “auto egress” and “walk egress”. There is a minor variation in the way these access modes are used in the PM-peak and off-peak networks. In the peak networks, both auto access and walk access modes are allowed at the destination end of the transit trip, while in the off-peak, only walk access is allowed. At the origin end of the trip, the “p” mode enables all trips access to the network from an origin zone.

Walk-access links are coded with a speed of 2.5 miles per hour (mph). The “w” mode allows walking from the base network to a destination zone centroid. The specification of a “w” mode enables the analysis of auto-access-only paths by disallowing this mode for peak auto-access assignments. The “p” mode accommodates all other walking, including zonal walk access, sidewalks and pedestrian paths, and station escalators, elevators, and transfer paths.

The other two access modes (modes “a” and “x”) are associated with the use of park-and-ride lots to access transit. Mode “a” allows auto trips between park-and-ride lots and zone centroids, and mode “x” represents walking between platform and car.

Figures D-1a and D-1b illustrate this coding convention. For ease of understanding, only modes used in the path building at the destination end are shown. The network as used for the PM-peak path-building and calculations is shown in Figure D-1a. The network as used for the off-peak path-building and calculations is shown in Figure D-1b.

There are several reasons for including the x-links to represent park-and-ride access to transit. First, using such links allows for counting the number of trips that use park-and-ride locations to access transit. Second, the use of such links will allow for modeling the effect of charging fees at park-and-ride lots should this be desired. Third, there is a certain disutility associated with having to walk some distance between a bus or train platform and a parked car. Using x-links allows for the inclusion and variation of this disutility in the model.

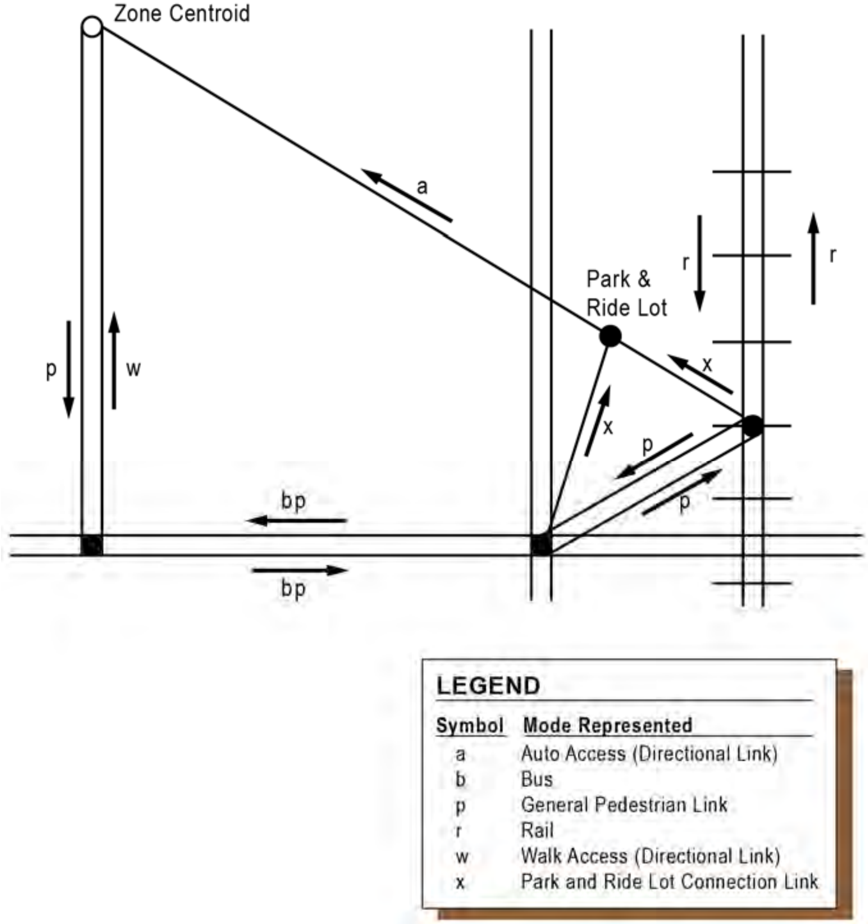

Figure D-1a. Sample mode coding on base network links (PM peak)

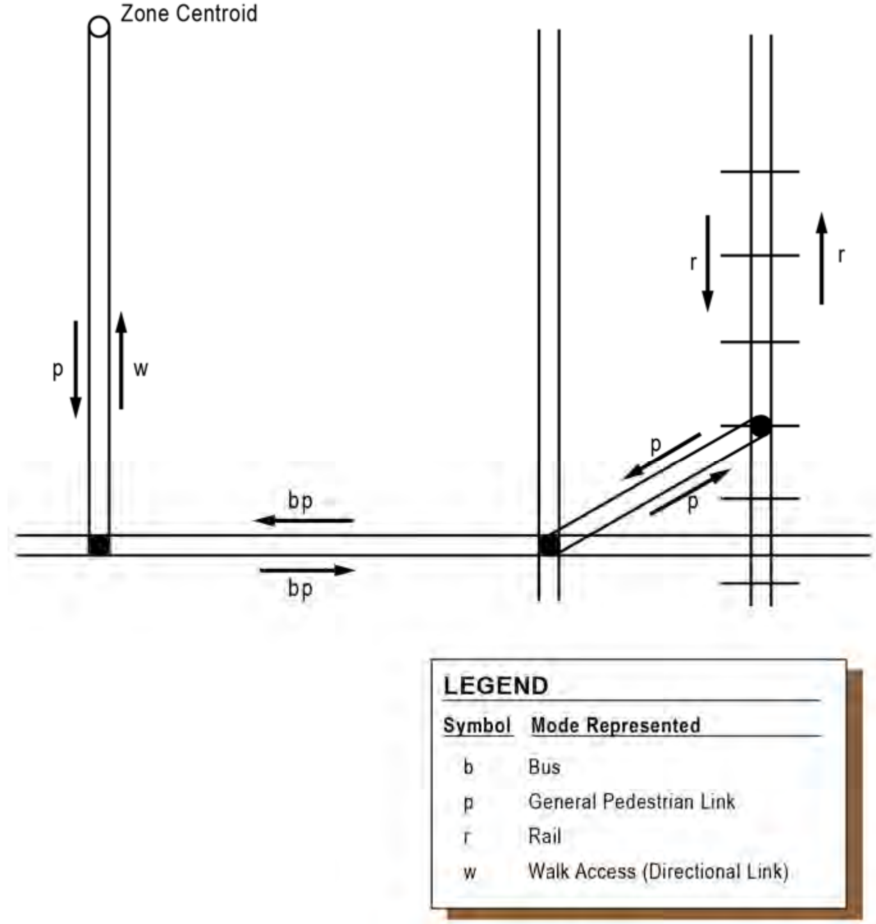

Figure D-1b. Sample mode coding on base network links (off-peak)

Finally, the use of x-links allows for a more even-handed comparison of park-and-ride access to transit between rail and non-rail alternatives. The use of x-links allows one to connect a single park-and-ride lot to both a bus stop and a rail station. This allows use of exactly the same park-and-ride location and auto-access by adjacent bus and rail stops.

All auxiliary transit modes have identical speeds in the peak network and the off-peak network. However, speeds on links used by bus and rail lines may vary between the peak and off-peak networks. Sources of bus and rail speeds are described below.

D.1.2 Development of the future transit service networks

Transit service networks are created to represent the transit service planned for each alternative and forecast year, as well as the service operated in the base years used to validate the model. Each service network is characterized by a unique set of routes, which includes rail lines, bus rapid transit (BRT) lines, express bus lines, and local bus lines. Each route is described by the nodes and links over which it travels, the travel time on each link, the locations where it stops, and its peak and off-peak headways. The characteristics are described in detail below.

Route patterns

Each route can be described by its route alignment, or the set of nodes and links over which it travels. The places where passengers are picked up and dropped off are coded by placing a dwell time on the nodes that represent bus stops for each particular route. All Sound Transit, King County Metro, Community Transit, Everett Transit, and Pierce Transit routes within the forecast study area are coded for each alternative and forecast year, with the exception of dial-a-ride services and routes that have less than six trips per day.

Route headways

Bus and rail headways are specified for each route in each transit service network, peak and off-peak. The headways in the PM peak network reflect the number of trips between 3:00 and 6:30 p.m., and the headways in the off-peak network reflect the base headways from 9:00 a.m. to 3:00 p.m. and 6:30 p.m. to 10:00 p.m. For the Base-Year network, headways are determined directly from the published operating schedules.

Future networks are developed according to the specific definition of alternatives as defined in appropriate Definition of Alternatives reports for Draft EIS, Final EIS, and PE projects as well as New Starts applications.

Rail speeds and bus speeds

For bus lines, peak and off-peak link speeds are obtained directly from AVL data as described below. For existing rail lines, all link speeds are obtained directly from ST operating data.

For future rail lines, link speeds are developed from operating plans supported by simulations. Future bus speeds are degraded according to the change in general roadway congestion level estimated by the PSRC model for arterial and freeway facilities and by geographic area. This procedure was developed and documented by ST staff in a memorandum to the FTA. A copy of this memorandum follows this section. Speeds of buses on busways, protected lanes are not affected and remain constant into the future.

D.2 Coordinate system

The ST model was previously projected in a variant of the WGS 1984 UTM Zone 10N coordinate system. This caused some network distortions that affected accurate plotting of the links and link distances. These issues were more pronounced farther from Seattle, such as in Everett and Tacoma. The coordinate system in the 2017 version of the ST model was updated to NAD 1983 HARN State Plane Washington North FIPS 4601. This update significantly reduced those distortions.

The following method was applied to update the coordinate system:

- Convert the existing nodes to State Plane North.
- Manually move nodes to more accurate locations.

This method preserves existing link and node numbers, allowing for preservation of the existing ST model transit network. The method is performed in a relatively short timeframe, and it limits possible unintended issues within the ST model.

The model nodes, with their existing identifiers and other values, are projected into State Plane North coordinates within ArcGIS. Then in ArcGIS, the nodes are manually moved to locations that best reflect the intersections that they represent in the model. This is an extensive process that spans the entire network coverage area (i.e., the RTA district boundaries).

To expedite the process and increase quality of node relocation, the nodes are typically snapped to a non-model GIS roadway network. An example of a completed area with nodes adjusted is shown in Figure D-2a. Additionally, the distortions in the network are greatly reduced, as exemplified by the change in scale and link locations in Everett shown in Figure D-2b.

D.3 Bus speed from AVL data

In previous model updates, bus speeds were hand-adjusted for major facilities and subareas of interest. This worked effectively in the past, partly because the changes to the seed matrices were modest. As the origin-destination seed matrices for this model version are now based on ORCA data instead of historical surveys, the actual speeds from Automatic Vehicle Locator (AVL) data should reflect the travel conditions that correspond directly to this origin-destination data.

King County Metro (KCM), Pierce Transit (PT), and Community Transit (CT) now have AVL equipment on their entire fleets and keep records of the AVL data. Sound Transit buses operated by these three agencies also have AVL equipment and associated data. As this data is more complete and readily available than for previous model updates, it is now used in the current 2017 ST model version.

The AVL data used in the ST model is received from the Washington State Transportation Center (TRAC) at the University of Washington and covers the same 9-week period in 2016 as the ORCA data. Each agency’s data is in a distinct format. KCM and CT provide stop-to-stop travel times, including dwell times if applicable. PT only provides stop-to-stop times where the bus door opened, which reduces the number of observed data points.

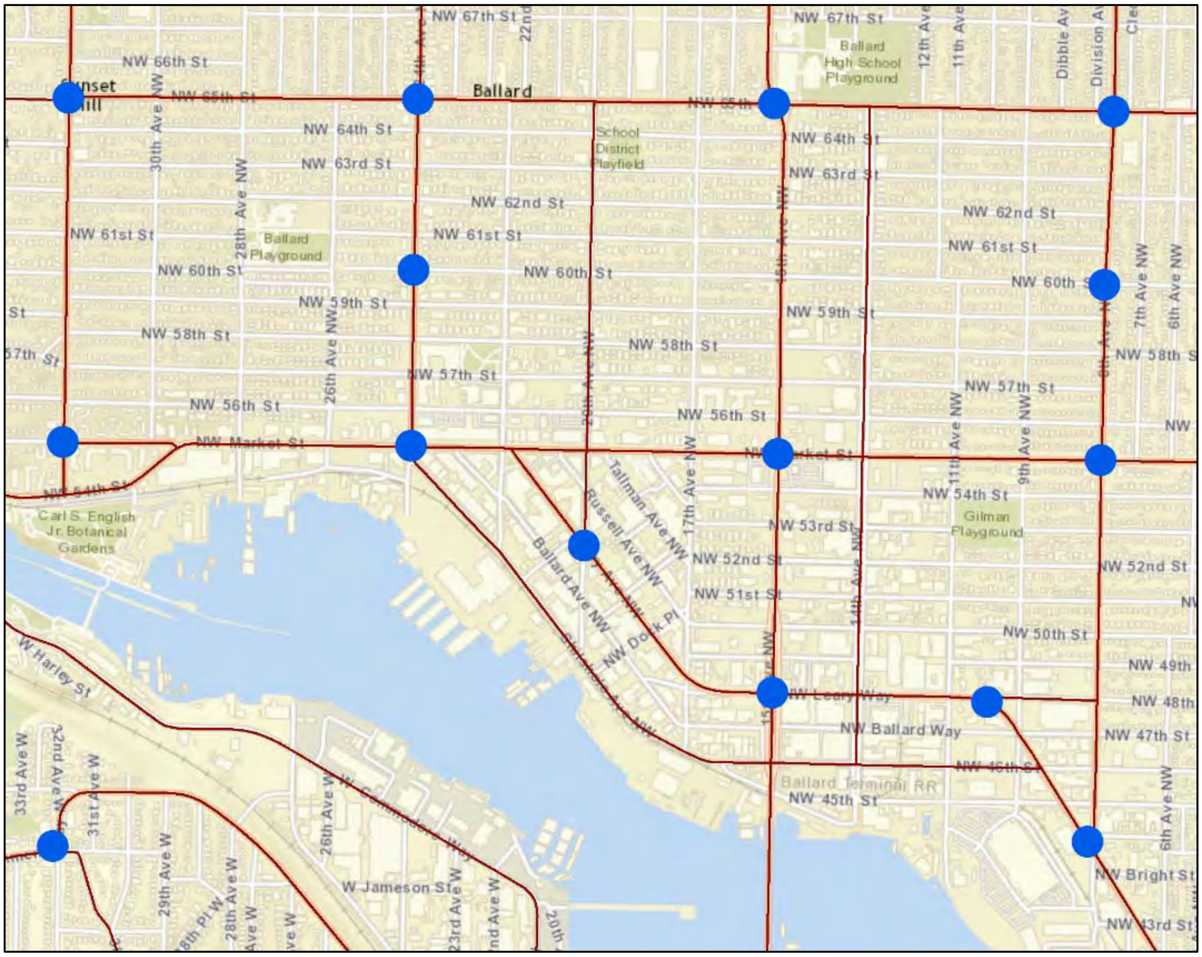

Figure D-2a. Updated nodes viewed in ArcGIS

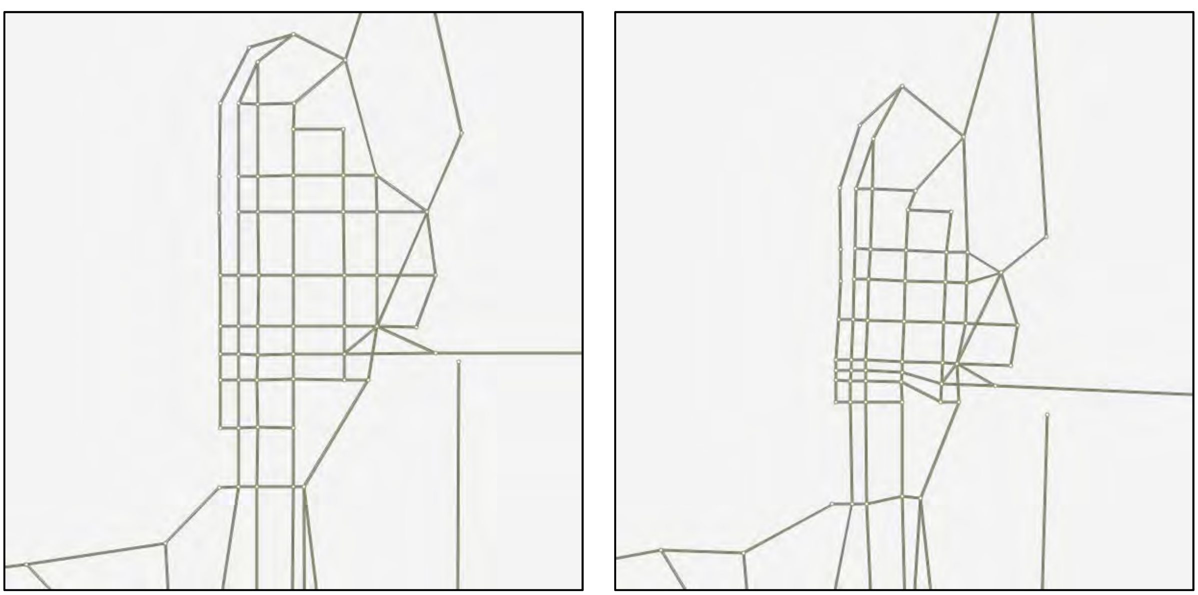

Figure D-2b. Model network before (left) and after (right) the update

AVL data processing

The process for attaching observed bus speeds to ST model links is described in this section.

In ArcGIS, each stop-to-stop travel time observation is imported as a line so that an average speed may be calculated. Both the hour-of-day and the bus route number associated with the line are saved as an attribute. The 11:00 a.m. and 5:00 p.m. hours are used to calculate off-peak and peak speeds, respectively. Over 3 million speed observations were used to prepare average link-level speed values.

A midpoint of each modeled bus link is selected and a buffer created around it. Buffers are used to account for any geometry mismatch between the observed stop-to-stop line and the model links, such as precise bus route turn locations or roadway curvature that is not in the model.

Then for each bus route, the speeds along each observed line are averaged to the midpoint buffers of model links that the route uses. Average speeds of each route are weighted by frequencies of those routes. Freeway and arterial speeds are calculated separately to account for multiple observed stop-to-stop line overlaps attributable to the typically long distances between stops along freeway routes.

After speeds are calculated for each agency and facility type, a summary table of average speeds on each link is created. In the few cases where a link is traversed by more than one transit agency, the KCM speed is given twice the weight of CT or PT speeds during the averaging process. Figure D-3 illustrates schematically the consolidation of average speeds from a mix of bus routes using a common link in the network, often with differing stopping patterns. A few examples of how AVL speeds would be attached to the links in Figure D-3 for a given time period are provided below:

- The buffer for the midpoint of model link 1 has both observed stop-to-stop travel times for routes A and B. At that location, the speed assigned to the link is the weighted averages of the speeds of the two routes at that point, even though one route is a local and the other is an express.
- For model link 2, the same calculation as link 1 applies, and the freeway route is ignored, even though the observed stop-to-stop line passes through it.
- The buffer for the midpoint of model link 3 has only route C passing through it, so the average stop-to-stop speed for that route at that location is attached to the link.

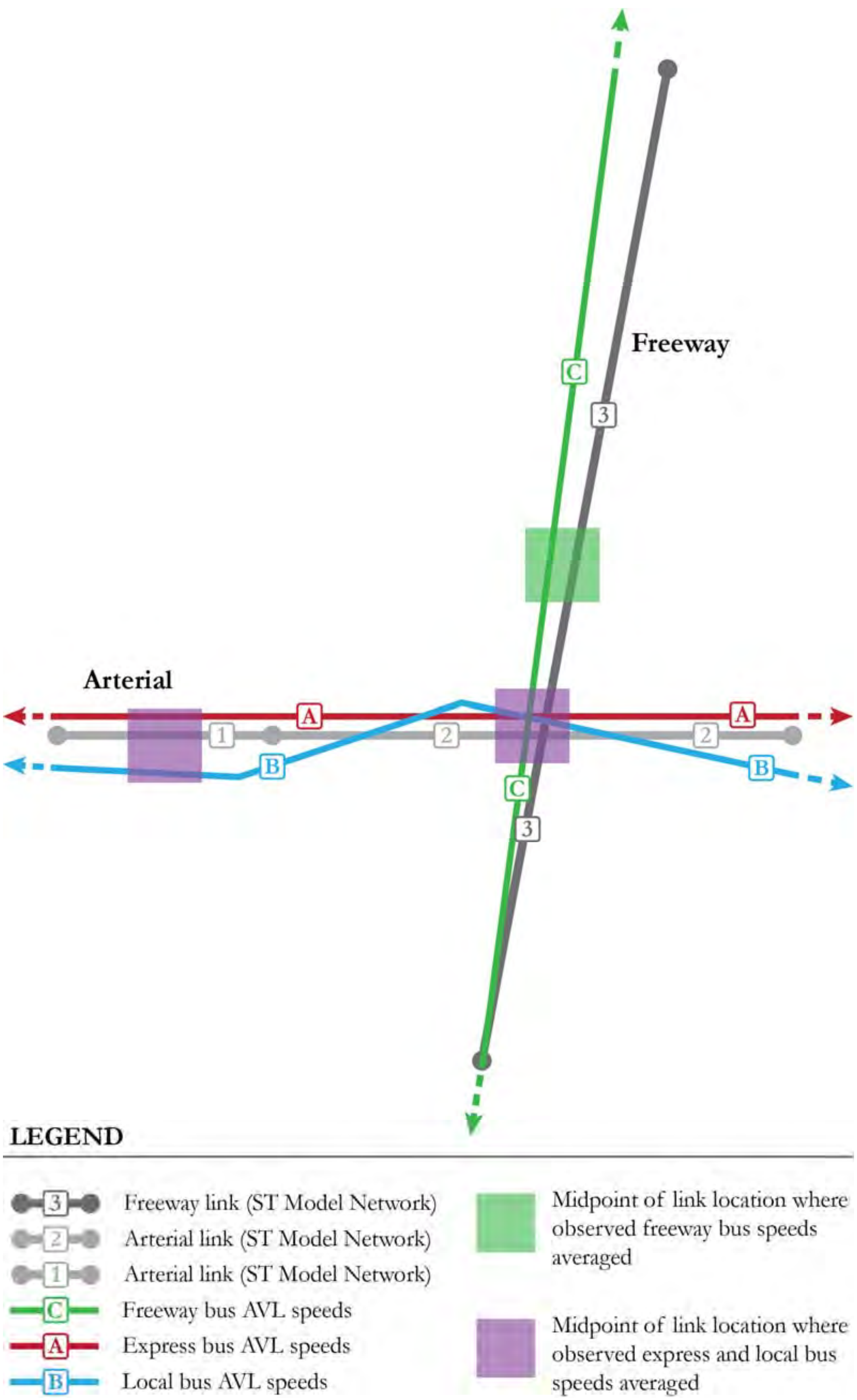

Figure D-3. Schematic representation of average speeds consolidation using AVL bus speeds and model link midpoint buffers

SOUNDTRANSIT

MEMO

August 1, 2002

TO: Eric Pihl

FROM: Don Billen

SUBJECT: Updated Treatment of Bus Speeds in the Sound Transit Model

This memorandum describes the updated procedures for treating bus speeds in Sound Transit's incremental ridership forecasting process. This is in response to your request that Sound Transit rely on output from the PSRC multi-modal model to estimate changes in bus speeds over time.

Sound Transit Incremental Ridership Model

Sound Transit uses an incremental model to forecast transit ridership consisting of three stages:

- Stage 1: Changes in demographics
- Stage 2: External changes in highway travel time (congestion) and costs (including parking costs), transit fares, and household income are taken into consideration.
- Stage 3: Incremental changes in the transit level-of-service (i.e. access, wait, and ride travel times) are taken into consideration.

The third stage of the forecasting process is where the effects of changes in bus speeds are captured. Base year link speeds in combination with transit travel time functions are used so that they result in network bus travel times equal to observed bus travel times. Individual transit routes are coded with transit travel time functions that account for acceleration/deceleration time, with bus speeds equal to the base year link speed for express portions of a route. Dwell time is similarly coded for individual transit routes, with zero dwell time for express portions of a route.

Future year link bus speeds are degraded relative to base year link speeds and according to the procedures described below. The transit travel time functions which account for acceleration/deceleration time are the same in the base year and future year. Dwell time similarly remains the same in the base and future year.

Since the model's development in the early 1990s by the Regional Transit Project, future year link speeds have been estimated using a constant degradation rate of seven to nine percent per decade. This degradation rate is consistent with historic trends in bus speeds. However, FTA staff have expressed concern about extrapolating historical trends into the future and suggested relating future bus speeds to road speeds in the PSRC multi-modal model.

SOUNDTRANSIT

MEMO

Updated Procedure for Estimating Future Bus Speeds

Sound Transit and its ridership consultant have investigated several methods for relating road speeds in the PSRC model to bus speeds in the Sound Transit model. After reviewing these methods with Puget Sound Regional Council and City of Seattle modeling staff, we have arrived at the following procedure.

For arterial bus speeds, weighted average auto travel time within the PSRC model is calculated at an intra-26-district level for the base year and forecast year in the PM peak and off-peak. The ratio between the base year and forecast year intra-district times is calculated. This change in intra-district auto travel times is used to estimate the change in bus speeds and is applied to the base year link speed values in the ST model for each geographic district. Table 1 shows the resulting PM peak bus degradation rates for each of the 26 districts for the period of 1998–2020.

Table 1. PM Peak Arterial Degradation Rates

Comparative Analysis of 1998 to 2020 Weighted Average Intra-District Travel Times

District		1998	2020	2020/1998 Ratio	Change Per Decade
North Everett	1	6.13	6.80	1.11	4.8%
South Everett	2	8.24	9.28	1.13	5.6%
Lynnwood	3	8.04	9.95	1.24	10.2%
North Creek	4	10.13	11.17	1.10	4.5%
Shorelin	5	6.47	6.79	1.05	2.2%
Ballard	6	6.32	6.79	1.07	3.3%
North Seattle	7	6.64	7.29	1.10	4.3%
University District	8	4.55	5.52	1.21	9.2%
Queen Anne	9	6.44	6.94	1.08	3.5%
Capitol Hill	10	4.86	5.07	1.04	1.9%
Seattle CBD	11	2.48	2.63	1.06	2.6%
W Seattle	12	7.28	8.63	1.19	8.1%
Rainier	13	9.17	9.92	1.08	3.6%
Sea-Tac	14	8.01	8.81	1.10	4.4%
Renton	15	10.00	11.58	1.16	6.9%
Federal Way	16	8.26	9.50	1.15	6.5%
Kent	17	9.99	11.16	1.12	5.2%
Kirkland	18	8.75	10.10	1.15	6.7%
Redmond	19	8.60	11.42	1.33	13.8%
West Bellevue	20	5.51	5.68	1.03	1.4%
Bellevue	21	8.85	9.69	1.10	4.3%
Issaquah	22	8.62	10.33	1.20	8.6%
North Tacoma	23	8.48	10.58	1.25	10.6%
South Tacoma	24	6.16	6.78	1.10	4.4%
Lakewood	25	8.30	9.72	1.17	7.4%
Puyallup	26	10.51	11.46	1.09	4.0%
External	27	16.97	19.70	1.16	7.0%
Destination Totals		19.33	22.34	1.16	6.8%

For freeway bus speeds, zone to zone travel times between major entry and exit points for buses along regional freeways are calculated for the base year and future year. As with arterial times, the ratio between the base year and forecast year times is calculated. This change in freeway auto travel times is used to estimate the change in bus speeds and is applied to the base year link speed in the ST model for each freeway segment. Table 2 shows the resulting bus degradation rates on two freeway segments in the light rail study area.

Table 2. PM peak freeway degradation rates

Comparative Analysis of 1998 to 2020 Freeway Travel Times					
Freeway Segment		1998	2020	2020/1998 Ratio	Change Per Decade
I-5: Seattle CBD to Northgate		15.50	18.07	1.17	7.2%
SR 520: Seattle to Overlake		22.15	25.12	1.13	5.9%

The resulting rates of degradation for both arterials and highways are somewhat lower than historic changes in bus speeds in the Central Puget Sound Region, so may underestimate actual degradation rates. However, the updated method offers the advantage of being sensitive to varying congestion rates over time and across geographic areas and to changes in these rates with alternative land use or highway network scenarios.

Alternate method investigated

Our ridership forecasting consultant originally proposed to simply average PSRC link speeds within a cross-classification of geography and facility type for a base and future year to estimate changes in bus speeds. (see Parsons Brinkerhoff memo of 12-2-01 from Youssef Dehghani to Don Billen).

Investigation of this method between 1998 and 2020 yielded results that varied greatly between geographic areas and on the aggregate showed changes in road times much lower than other analyses of PSRC model output. The average decline in speeds across all facilities was 1% per decade between 1998 and 2020 compared to previous analysis of zone-zone road skims that showed an average decline of 8% per decade (see Parsons Brinkerhoff memo of 11-19-01 from Youssef Dehghani to Don Billen). Furthermore, the change in arterial speeds in different geographic areas varied by factors as high as 16 to 23 times. For instance, major arterial speed degradation in the Eastside of King County was 17 times as high as in Snohomish County, even though both are high growth areas with very limited road expansion currently funded. (Table 3)

Upon review of these results with PSRC and City of Seattle modeling staff, we concluded that simple averaging of link speeds is inaccurate and that it would be better to rely on zone-zone skim times than link level times. The simple averaging of link speeds results in too much influence from low volume roadways and too little influence from highway volume roadways. Also, using link level rather than zone-zone travel time skims created the possibility for the results to be influenced by the density of road networks coded in a geographic area.

Table 3. Analysis of PM peak speed degradation in PSRC model by facility type and area type

(average change per decade from 1998 to 2020)

Facility Type		Area Type: All	Seattle CBD	Seattle	Eastside	Rest of King County	Snohomish County	Pierce County	Kitsap County
	All	1.5%	0.9%	0.7%	5.6%	3.0%	0.8%	1.8%	0.2%
	Freeway GP Lanes	6.3%	4.48%		8.8%	3.1%	14.4%	4.0%	6.1%
	Freeway HOV Lanes	1.2%	1.95%		4.2%	5.56%			
	Major Arterials	1.4%	3.4%	0.8%	6.8%	3.0%	0.4%	1.9%	0.2%
↓	Minor Arterials	1.8%	0.1%	0.2%	3.1%	2.7%	2.1%	0.3%	0.0%

Notes :- The data shown above represents the percentage speed degradation over a period of 22 years from 1998 to 2020.
- The percentage degradation in speed was obtained from the "slope" of the regression equation obtained from a linear regression analysis of PM peak link travel times for a particular facility type and area type.
- The regression analysis showed an R^2 of greater 0.9 for all the categories.
- Major arterials include all those arterials in the PSRC model that have a speed greater than 25 mph, e.g., MLK way, Rainier Avenue, NE 8th (in Bellevue etc.). Minor arterials are arterials with a speed less than 25 mph.

These concerns led PSRC and City of Seattle modeling staff to recommend the use of weighted average auto travel times from zone-zone travel time skims and to Sound Transit's development of the procedures described at the beginning of this memo.

CC: John Witmer, FTA Region X
Larry Blaine, Puget Sound Regional Council
Eric Tweit, City of Seattle
Tracy Reed, Ron Lewis, Mike Williams, Sound Transit

Everett Link Extension

Utilities Technical Analysis Methodology

October 2023

SoundTransit

1 INTRODUCTION

This technical analysis methodology memorandum briefly describes the methods that will be used to prepare the Utilities section of the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS). The Utilities section will identify and document potential significant impacts to utilities along and near the Build Alternatives. Utilities to be covered include electrical, sewer, water, natural gas, fuel oil, and telecommunications services and infrastructure. Information on stormwater infrastructure can be found in the Water Resources analysis.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

Federal, state, and local regulations, plans, and policies that apply to utilities include:

- Washington State Department of Transportation's (WSDOT's) Design Manual (M 22-01)
- WSDOT's Utility Manual (M 22-87) and Accommodation Policy (M 22-86)
- Applicable policies and procedures of the City of Everett, the City of Lynnwood, and Snohomish County
- Adopted City of Lynnwood, City of Everett, and Snohomish County comprehensive plans and policies related to utilities codes and engineering standards
- Applicable standards of the Sound Transit Design Criteria Manual, including Chapter 7, Utilities

3 DATA NEEDS AND SOURCES

The data needed will generally consist of available information from utility providers or owners regarding their service areas and existing and planned facilities in the vicinity of the Build Alternatives. A preliminary list of utility owners includes:

- City of Everett (water, stormwater, wastewater, lighting, Intelligent Transportation Systems)
- City of Lynnwood (water, stormwater, wastewater, Intelligent Transportation Systems)
- Alderwood Water and Wastewater District (water, wastewater)
- Snohomish County Public Works (stormwater, wastewater)
- Snohomish County Public Utilities District (SnoPUD) (water, electricity, lighting)
- Comcast, Wave, Lumen, and Frontier (telecommunications)
- Puget Sound Energy (natural gas)
- Williams (natural gas)

- WSDOT (stormwater, Intelligent Transportation Systems, traffic controls)

This utility information and mapping will be supplemented by planning and engineering information developed for the Build Alternatives, including:

- Franchise information from WSDOT on private telecommunication towers or fiber within the WSDOT right-of-way
- Information on WSDOT Intelligent Transportation Systems (ITS)
- Details on carrier facilities inside conduits, if known and/or available
- Additional field data in areas of potential conflicts, particularly interchanges, including detailed elevations of above-ground electrical transmission lines and related clearance requirements
- Information regarding, and copies of environmental documentation (EISs, Environmental Assessments [EAs], checklists) for recently proposed or completed projects along or near the proposed light rail alignment, stations, OMF sites, and related facilities

3.1 Field Reconnaissance

After examining maps, collecting and reviewing existing documents, and contacting utility providers and other individuals, the Utilities analysts will conduct field visits within the study area to identify and confirm utility facilities and infrastructure that may be affected. Some existing subsurface utilities may not be able to be confirmed during field visits, as they cannot be seen directly. The field team will pay particular attention to the location of overhead electrical transmission and distribution wires and towers, telephone lines, substations, and other utility structures that could interfere with or be compromised by the light rail system and OMF sites.

4 STUDY AREA AND AREA OF EFFECT

The study area for the impact analysis is within 100 feet on either side of the project footprint and area used for construction (including construction staging areas).

5 AFFECTED ENVIRONMENT

The EIS will describe the location, size (e.g., pipeline diameter), capacity, material (if known), and ownership of major utilities within the study area, including electrical, sewer, water, stormwater, natural gas, fuel oil, and telecommunications services and infrastructure. Planned utility upgrades will also be identified, if available. Impacts and benefits to smaller utilities will not be discussed separately but will be captured by the discussion of impacts and benefits to major utilities. Major utilities are defined as utilities of larger size such as:

- Water mains of 16-inch diameter or greater
- Sanitary sewer force mains and gravity sewers of 24-inch diameter or greater

- Stormwater drains of 36-inch diameter or greater and drainage ponds
- 115-kilovolt (kV) and greater electrical transmission lines
- Substations
- High-pressure gas mains of any diameter
- Intermediate-pressure gas lines with an 8-inch diameter or greater
- Telephone and fiber-optic duct banks with three or more conduits
- Petroleum product pipelines
- Steam pipelines of 12-inch diameter (carrier pipe diameter) or greater

6 ENVIRONMENTAL IMPACT ANALYSIS

The impact analysis will assess the potential direct, indirect, and cumulative utility services and infrastructure impacts of the Build and No Build Alternatives. The impacts analysis is divided into long-term operation impacts and short-term construction impacts.

6.1 Direct Impacts

Operational impacts to be addressed include stray currents and new utility infrastructure requirements to serve the project, particularly infrastructure upgrades and substations required to meet the electrical power demand, future accessibility to infrastructure, and potential conflicts with existing utilities. Operational effects will also include a discussion of the ability of SnoPUD to meet the demand for electricity to operate the project. Potential impacts will be compared to those of the No Build Alternative.

The construction impacts discussion will address the proposed project's major effects on existing overhead and below-grade utilities, such as utility crossings, utility service interruptions and revisions, utility relocations, street grades, and ability of existing facilities to withstand vibrations or settlement. The number of utility line crossings and length of utility infrastructure that could be affected by the alternatives will be quantified.

The Build Alternatives will be evaluated for their ability to avoid utility impacts while still meeting project objectives.

6.2 Indirect Impacts

Indirect impacts are potential effects that would be caused at a later time or a farther distance but are still reasonably foreseeable. The analysis of potential indirect impact of the project will be qualitative and will primarily consist of potential developments near stations, which could be encouraged by the availability of light rail service. This development would increase the demand for utility services.

6.3 Cumulative Impacts

Cumulative impacts result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions and include individually minor actions taking place over time. Accordingly, the cumulative impacts may include increased demand for electric, water, sewer, gas, petroleum, or communication utility services associated with planned land development proximate to light rail stations as identified by local jurisdictions. This will be a qualitative analysis.

7 MITIGATION MEASURES

Potential impacts to utilities will be controlled through project planning, design, and the application of required best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the Build Alternatives will be incorporated as appropriate. Where impacts cannot be avoided or minimized, mitigation measures will be developed.

The mitigation will consider the type and magnitude of the impact. The project will include measures to avoid or minimize impacts, such as preconstruction potholing and surveys, utility relocation, cathodic protection, engineering design measures, and BMPs. Sound Transit will coordinate with utility providers to minimize any potential service interruptions and perform outreach to notify the community of planned or potential service interruptions.

8 PROPOSED FIGURES, MAPS, OR OTHER DATA

The maps will show utility crossing conflicts and conflicts with nearby utilities using GIS.

9 DOCUMENTATION

For this resource, the following documentation will be prepared:

- A technical report
- An EIS section

10 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

There is overlap between the Utilities section and the Water Resources and Energy sections. The Utility team will coordinate with the Water Resources and Energy teams to reduce duplication of effort and ensure consistency.

11 REFERENCES

Washington State Department of Transportation (WSDOT). 2018. Utilities Accommodation Policy. M 22-86. http://www.wsdot.wa.gov/Publications/Manuals/M22-86.htm.

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Everett Link Extension

Visual and Aesthetic Resources Technical Analysis Methodology

October 2023

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1 INTRODUCTION

This technical analysis methodology memo describes the methods for preparing the Visual and Aesthetic Resources element of the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS). The objective of the Visual and Aesthetic Resources element is to identify existing aesthetic resources and evaluate visual and aesthetic impacts and potential mitigation, as appropriate. Key views of the Build Alternatives from and toward surrounding areas will be documented.

The analysis will examine and consider appropriate national, state, and local plans and policies that encourage protecting visual and aesthetic resources. Local jurisdiction requirements and plans and policies will be reviewed to determine to what extent visual quality and aesthetic resource impacts have been identified as important.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

The analysis will be based on the Federal Highway Administration (FHWA) guidance for visual impact assessment (FHWA, 1988 and FHWA, 2015). Local planning documents, ordinances, and codes will be reviewed to identify important visual resources and to determine whether local jurisdictions have established protections for visual resources such as protected view corridors and/or viewpoints. For projects along interstate highways, the analysis will also take into consideration areas subject to the Highway Beautification Act of 1965. Relevant guidance and regulatory documents that will be reviewed for the analysis include the following:

- Visual Impact Assessment for Highway Projects (FHWA, 1988)
- Guidelines for the Visual Impact Assessment of Highway Projects (FHWA, 2015)
- WSDOT Roadside Policy Manual (2022)
- WSDOT Utilities Accommodation Policy Manual (2016)
- City of Lynnwood City Center Design Guidelines (2019)
- Lynnwood Citywide Design Guidelines (2001)
- City of Lynnwood Transition Area Design Guidelines (2014)
- Snohomish County Code Chapter 30.34A, Urban Center Development
- City of Everett Municipal Code Chapter 19.12, Building Form and Design Standards
- City of Everett Comprehensive Plan 2015-2035, Urban Design & Historic Preservation Element (adopted 2015, updated 2021)

3 DATA NEEDS AND SOURCES

The data needed to describe the affected environment and determine visual impacts may consist of:

- Aerial imagery
- Engineering drawings (plan and profile)
- Engineering computer-aided design (CAD) data for developing photographic simulations
- KMZ files, or other GIS based tools for analysis, of Build Alternatives
- Local land use and management plans, regulations, and policies
- Field reconnaissance of visual environment and views
- Historic resources

4 STUDY AREA AND AREA OF EFFECT

The study area for each alternative is the viewshed from the project footprint and area used for construction (areas where the project would be visible to people). The study area also includes parcels adjacent to the project footprint whether the project would be seen from those parcels or not. The area of effect is the same as the study area.

The evaluation of the viewshed will generally focus on areas along routes that are within the foreground viewing distance (approximately 200 to 500 feet). The evaluation will consider views "of" the alternatives components from nearby areas and views. The study area also includes parcels adjacent to the project footprint, including ancillary facilities and staging areas.

5 AFFECTED ENVIRONMENT

Assessment of the affected environment will include several levels of analysis that will:

- Establish landscape units, determine viewsheds, and categorize the existing visual character and quality of views along the routes of the alternatives
- Identify visual resources (views, view corridors, scenic routes, etc.) established by federal, state, or local entities
- Identify affected populations
- Select key viewpoints

Existing conditions will be assessed in terms of:

- Visual character
- Visual quality
- Viewer location and type (residential, commercial, etc.)

5.1 Landscape Units and Viewsheds

Landscape units are used on visual assessments of large-scale linear transportation projects to break down the study area into smaller visually contiguous and uniform areas. A landscape unit may contain one or more viewsheds. Landscape units have common characteristics and features such as topography, land use, and viewer types that make them distinct. Specific visual resources within each landscape unit to be described include the following:

- The viewsheds within each landscape unit.
- Is this particular view common or memorable, or are parts of it? Visual character is an impartial description of the elements of the viewed landscape and is defined by the relationships between the existing visible natural and built landscape features. The description will consider and include topography, vegetation, land use patterns, community identity (aesthetics and image), neighborhood boundaries and edges, building scale and massing, and building/open space texture.
- Is it a pleasing composition (with a mixture of elements that seem to belong together) or not (with a mixture of elements that either do not belong together or contrast with the other elements in the surroundings)?
- The existing visual quality of views towards the proposed project from key views will be identified in text and illustrated in photographs (generally in the appendix that also contains photo-simulations of the proposed project). The overall visual quality will be categorized and displayed on maps as high, average, or low.
- Street grid, development characteristics, and open space patterns.
- Parks, pedestrian and bicycle routes, and other recreation areas.
- Special or protected views such as scenic routes identified in federal, state, or local jurisdiction plans, ordinances, or codes.
- Individual buildings, landmarks, designated historic buildings, or clusters of development that help define the visual character of an area.

5.2 Key Viewpoints

Key viewpoints will be identified and mapped within each landscape unit for each alternative. Scenic routes in the study area will be identified in accordance with the federal, state, or local entities. Some key viewpoints will be selected from important viewing locations such as parks or overlooks. Other viewpoints will be representative viewpoints that will be “typical” of common views, seen perhaps by nearby residents. The key viewpoints will be identified by consulting existing plans, ordinances, and codes, site reconnaissance, discussions with local jurisdiction staff, and comments made through the public participation process. The key viewpoints will become the views used to represent existing conditions and will be used to develop photographic simulations to depict what the proposed project will look like. The existing visual character and quality of the key viewpoints will be described so that changes associated with the proposed alternatives can be assessed in the impact analysis. The existing visual quality of the view from the key viewpoints will be categorized as either high, average, or low.

Photographs at key viewpoints for photographic simulations of the proposed project will be taken using a 35-millimeter digital single-lens reflex camera with a focal length equivalent to a photo taken with a 35-millimeter (mm) camera using a 50-mm lens. This setting is the generally accepted setting for visual assessment in that it captures views in a way that closely resemble what the human eye sees in a landscape. For each photograph the location of the photograph is established using geographic positioning system (GPS) data recorded at the time the photograph was taken. When using proposed project digital site plans and engineering data to produce 3-D views of the proposed project, 5 feet should be used as the assumed viewer eye-level.

5.3 Viewers and Viewer Sensitivity

Potential types of viewers will be identified within the study area by reviewing demographic data and existing traffic and land use studies, conducting site visits, viewing aerial photographs, discussions with local jurisdiction staff, and reviewing input from the public participation process. Types of viewers could include the following:

- Residents within the study area
- Individuals visiting public parks, trails, and viewpoints
- Commercial business staff and customers
- Motorists and cyclists traversing the study area
- Other sensitive viewers identified through the public participation process

The types of viewers and their activities influence their sensitivity to changes in the viewed environment. Viewer sensitivity to changes in the viewed landscape will be categorized as low, moderate, or high. People with low viewer sensitivity are not particularly concerned about the view or changes to it and/or see a view for brief periods of time (such as when driving along a highway). These types of viewers might include people working or shopping in an area that are engaged in their activities and not concerned with the condition of the visual setting. Moderate viewer sensitivity indicates that viewers have some concern and/or familiarity with a viewed landscape to a degree that is greater than those with low sensitivity, but less than viewers with high sensitivity. People with high viewer sensitivity are very aware of the existing viewed landscape and are concerned about changes to it. These viewers typically include residents, recreationists, or others for whom the viewed landscape is important. The impact assessment will focus on viewers with high viewer sensitivity. Transit riders are considered low sensitivity and are not evaluated.

6 ENVIRONMENTAL IMPACT ANALYSIS

The impact analysis will assess the potential direct, indirect, and cumulative visual impacts of the Build and No Build Alternatives. The impact analysis will be divided into long-term operation impacts and short-term construction impacts. The features incorporated in the project that reduce or avoid visual impact will be described.

6.1 Direct Impacts

The direct impact analysis will use photographic simulations to depict changes to the viewed landscape from the proposed project. Photographic simulations will be prepared to present the appearance of specific project components as viewed from key viewpoints. The visual simulations will present the appearance of project components associated with the various Build Alternatives so that they can be compared to the No Build Alternative and the other Build Alternatives. Project components depicted in the visual simulations might include stations, light rail guideway and trains, bridges and underpasses, vent shafts, overhead contact system poles and wires, traction power substations, an operation and maintenance facility, staging areas, and other components that could affect visual resources.

The locations chosen for developing photographic simulations will be coordinated with design, station area planning, and public involvement, as well as the Land Use, Historic and Archaeological Resources, Environmental Justice, and other EIS analyses as needed to ensure that the products produced will serve multiple functions in design, EIS preparation, and public presentations.

Direct project impacts to visual resources could include physical changes that would contrast with the existing visual character of a viewed landscape and impact the visual quality of the landscape. Proposed project components could displace existing landscape features and introduce other/new features that may be out of character with the surrounding landscape and impact visual quality. Shadow, light, and glare will also be analyzed in this effort.

The basis for describing changes to the visual character of each landscape unit and identifying potential impacts to visual quality will be an analysis of alternatives design in the field and on Google Earth, along with reviewing photographic simulations from key viewpoints. The changes and impacts to visual quality will relate to the following:

- The level of visual compatibility of project components with the existing visual character of the landscape within each landscape unit.
- Potential changes to the visual quality of views towards the proposed project from key viewpoints and along the routes of the alternatives, such as miles of areas along the alternative routes adjacent to sensitive viewers or approximate numbers of sensitive viewers where the existing visual quality category (high, average, or low) would change.

Key elements in the landscape that will be evaluated include the following:

- Elimination of natural and built environment elements
- Additional structures or reconstructed structures (including noise walls) and relationship to the built environment, including materials and color
- Effects of shadows
- Changes to foreground, middle ground, and background views
- Relationship of project components to the existing visual quality of key views and along the routes of the alternatives

- Relationship of project components to the scale, form, massing, materials, and color of the landscape and built environment elements
- Relationship of project components to the street and landscape grid, and the texture (block size) of built and open space areas
- Relationship of project components to distant views from public places
- Light and glare impacts such as the compatibility of project lighting to the surrounding landscape as well as motorists
- Viewer sensitivity to potential changes in visual character and quality

The level of change to the visual character within each landscape unit and key viewpoint will be described qualitatively. Impacts to the visual quality of each key viewpoint will be characterized as high, high average, average, low average, or low. Areas near viewers with high sensitivity where visual quality would change will be identified graphically, and linear distance of sensitive viewers affected will be calculated. This evaluation will be coordinated with the Land Use, Historic and Archaeological Resources, Noise and Vibration, Parks and Recreational Resources, and Social Resources, Community Facilities, and Neighborhoods analyses to ensure consistency.

Construction impacts will be described qualitatively with focus on temporary disruption of elements of the environment, staging areas, and other areas that will not be occupied by permanent facilities, but which may result in permanent change of the landscape.

6.2 Indirect Impacts

Indirect impacts are potential effects that would be caused at a later time or a farther distance but are still reasonably foreseeable. Indirect impacts will be assessed qualitatively and will include changes in visual quality that may occur through actions related to the project but not part of the project. These changes will include those due to local jurisdiction land use plans, assessment of areas with the potential for transit-oriented development in the vicinity of stations (as described in Land Use), and other types of indirect impacts identified in other EIS topics, including Transportation. Surplus property used during construction or acquired but not used for permanent facilities will also be discussed in terms of potential future development opportunities.

6.3 Cumulative Impacts

Cumulative impacts will be assessed qualitatively. The analysis will include discussing trends that may change existing visual conditions and will include reviewing available information related to past, present, and future projects to determine the potential for cumulative impacts.

7 MITIGATION MEASURES

Potential impacts to visual and aesthetic resources will be controlled through project planning, design, and the application of required best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the alternatives will be incorporated as appropriate. Where impacts cannot be avoided or minimized, mitigation measures will be developed. Mitigation concepts that reduce the impacts on the visual quality and enhance the visual characteristics of the alternatives will be identified through this analysis and further developed in coordination with design and engineering efforts as needed. Potential mitigation measures to be considered could include concepts that achieve the following:

- Alteration of the alignment (vertical and horizontal)
- Addition or change of design features to enhance relationships to the scale, form, massing, materials, color, or slope gradient of the landscape and built environment
- Screen views of the project (topographic and vegetation screening)

8 PROPOSED FIGURES, MAPS, OR OTHER DATA

Maps and figures used in the EIS and/or technical report will show:

- Landscape units
- Key viewpoints and scenic routes
- General locations of viewers with high visual sensitivity within the study area
- Park, recreation, and open space facilities
- Existing visual quality (high, average, low) of views within the study area
- Existing condition photographs in each landscape unit
- Existing condition and photographic simulations of key viewpoints

9 DOCUMENTATION

The following documentation will be developed:

- A technical report, including photographic simulations
- An EIS section

10 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

The results of this analysis will be incorporated into the analyses for Social Resources, Community Facilities, and Neighborhoods; Environmental Justice; Parks and Recreational Resources; and Historic and Archaeological Resources.

11 REFERENCES

City of Everett. 2021. *Everett Comprehensive Plan 2015-2035.* https://www.everettwa.gov/1395/2035-Comprehensive-Plan. Adopted 2015, updated 2021.

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City of Lynnwood. 2001. Lynnwood Citywide Design Guidelines. https://www.lynnwoodwa.gov/files/sharedassets/public/dbs/planning-amp-zoning/applications-and-checklists/5.-citywidedesignguidelinescomplete.pdf.

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Everett Link Extension

Water Resources Technical Analysis Methodology

October 2023

SoundTransit

1 INTRODUCTION

This technical analysis methodology memorandum describes the methods that will be used to analyze the impacts on water resources for the Everett Link Extension (EVLE) Project Environmental Impact Statement (EIS). The Water Resources technical report and EIS section will address how the project affects surface water, including streams, rivers and lakes, floodplains and floodways, groundwater (including critical aquifer recharge areas, sole source aquifers, and wellhead protection areas that may be present). It will present options to avoid, minimize, or mitigate potential impacts. Details regarding wetlands, aquatic species, and surface water habitat will be presented in the Ecosystems technical report and EIS section; details regarding geology, soils, and groundwater characteristics will be presented in the Geology and Soils technical report and EIS section; and details regarding potential groundwater contamination will be presented in the Hazardous Materials technical report and EIS section.

2 GUIDING REGULATIONS, PLANS, AND POLICIES

The federal, state, and local regulations that govern the protection or use of water resources that are applicable to the activities of this project are listed below. Local plans and/or policies that guide the use of water resources in the study area are also included. If a regulation, plan, or policy is updated to a newer version than that listed below, the most recent version that is legally applicable to the project will be referenced for the environmental analysis.

2.1 Federal

- Clean Water Act, 33 United States Code (USC) 1251 et seq., including Sections 401 – Water Quality Certification, 402 – National Pollutant Discharge Elimination System, and 404 – Permits for Dredge or Fill
- Coastal Zone Management Act, 16 U.S.C. 1451 et seq.
- Floodplain Management Presidential Executive Order 11988
- Safe Drinking Water Act, 42 U.S.C. 300 et seq., Chapter 6A
- Standard Operating Procedure No. 22, Water Resources, Federal Transit Agency
- Presidential Executive Order 13690, Federal Flood Risk Management Standard
- Presidential Executive Order 14030, Climate-Related Financial Risk

2.2 State

- Water Quality Standards for Surface Waters, Washington Administrative Code (WAC) 173-201A
- Water Quality Standards for Groundwater, WAC 173-200
- Flood Control Management Act, Revised Code of Washington (RCW) 86

- Water Pollution Control Act, RCW 90.48
- National Pollutant Discharge Elimination System (NPDES) Construction Stormwater General Permit (Washington State Department of Ecology [Ecology], 2020)
- Final 2019 Stormwater Management Manual for Western Washington (Ecology Manual) (Ecology, 2019a)
- NPDES Western Washington Phase I and Phase II Municipal Stormwater General Permits (Ecology, 2019b)
- Washington State Department of Transportation (WSDOT) Hydraulics Manual (WSDOT, 2023)
- Washington State Hydraulic Code (WAC 220-660)

2.3 Regional

- Sound Transit Link Design Criteria Manual, Rev. 5 (Sound Transit, 2021)
- 2022-2026 Action Agenda for Puget Sound (Puget Sound Partnership, 2022)
- Low Impact Development Technical Guidance Manual for Puget Sound (Puget Sound Partnership, 2012)

2.4 Local

- Drainage and Stormwater Technical Resources:
    - Snohomish County Drainage Manual (Snohomish County, 2021)
    - City of Everett 2022 Surface Water Comprehensive Plan (Everett, 2022)
    - City of Everett Stormwater Management Manual (Everett, 2023a)
    - City of Everett Design and Construction Standards for Development (Everett, 2023b)
    - City of Everett 2023 North Creek Stormwater Management Action Plan (Everett, 2023c)
- Stormwater Codes:
    - City of Everett Municipal Code, Title 14 Water and Sewers
    - City of Lynnwood Municipal Code, Title 13 Water
    - City of Lynnwood Municipal Code, Title 14 Sewers
    - Snohomish County Code, Title 25, Storm and Surface Water Management
    - Snohomish County Code, Title 36B, Land Disturbing Activities
- Critical Area Ordinances (CAOs):

- City of Everett Municipal Code, Chapter 19.30 Flood Damage Prevention
- City of Everett Municipal Code, Chapter 19.37 Critical Areas
- City of Lynnwood Municipal Code, Chapter 16.46 Flood Hazard Area Regulations
- City of Lynnwood Municipal Code, Chapter 17.10 Critical Areas
- Snohomish County Code, Chapter 30.62A – Wetlands and Fish & Wildlife Conservation Areas
- Snohomish County Code, Chapter 30.62C – Critical Aquifer Recharge Areas
- Snohomish County Code, Chapter 30.63A – Drainage
- Snohomish County Code, Chapter 30.65 – Special Flood Hazard Areas

- Shoreline Management Programs:
  - City of Everett, Shoreline Master Program (Everett, 2019)
  - City of Lynnwood Municipal Code, Chapter 17.20, Shoreline Master Program
  - Snohomish County Code, Chapter 30.67 Shoreline Management Program

3 DATA NEEDS AND SOURCES

Available data from municipal sources and regulatory agencies applicable to water resources in the study area will be collected and reviewed to evaluate the affected environment in the EIS Water Resources section. Data related to species or habitat are listed in the Ecosystems analysis, which will be coordinated with the Water Resources Analysis. Data sources will include the following:

- U.S. Environmental Protection Agency's (USEPA) Water Quality Data Portal
- U.S. Environmental Protection Agency's Sole Source Aquifer mapping
- U.S. Geological Survey (USGS) National Water Information System
- National Oceanographic and Atmospheric Administration (NOAA) Office for Coastal Management, Sea Level Rise Viewer
- Ecology's Water Quality Assessment 303(d) and 305(b) lists
- Stream inventories and water quality reports from local jurisdictions
- Flood Insurance Rate Maps (FIRMs) adopted by Federal Emergency Management Agency (FEMA) showing floodplains and floodways
- Flood mapping from local jurisdictions
- Water Resource Inventory Area 7 Snohomish and Area 8 Cedar-Sammamish map data

- Publicly available geographic information system (GIS) aerial mapping
- Stormwater and drainage infrastructure GIS data from local jurisdictions
- Critical areas GIS data available from local jurisdictions
- WSDOT stormwater management facility information
- County tax assessor GIS water resources data
- Snohomish County Planning & Development Services (PDS) Map Portal
- Sound Transit stream data collected for other projects
- Sound Transit conceptual design information

4 STUDY AREA AND AREA OF EFFECT

The project is located within parts of Lynnwood, Everett, and unincorporated Snohomish County, Washington, within Water Resource Inventory Areas 7 and 8: the Snohomish Basin and Cedar-Sammamish Basin.

The study area consists of the drainage basins where Build Alternatives will be located, including the specific water resources within these basins. The potential area of effect encompasses locations where water resources would be altered by the development and operation of the project, and where resources would likely receive direct runoff from the project during construction and/or in long-term operation. The detailed study area and potential impact area will be mapped based on reviews of existing aerial photography, GIS data, and technical reports for the vicinity of the study area from federal, state, county, and local jurisdictions, through coordination with these jurisdictions, and through field reviews.

5 AFFECTED ENVIRONMENT

Existing conditions will be identified within the study area to provide a baseline for the affected environment against which potential impacts from the alternatives will be discussed. The baseline will be formed by qualitatively evaluating water resources through field surveys, literature review, available GIS data, and a review of other EIS sections and technical reports. Mapped water resources will be approximate, and no detailed delineations will be made for this analysis. However, wetland delineation and stream survey information (gathered as part of the Ecosystems analysis) will be included in this section as appropriate. Field observations will be conducted from publicly accessible roads and rights of way. It is assumed that no new flow or water quality data will be collected.

5.1 Surface Water

The surface water baseline section will contain descriptions of the natural water bodies in the study area and will describe stormwater infrastructure, land use, and soils in the study area. The general description of the existing natural water bodies in the study area will be included, and fish-bearing waters or other streams, culverted streams, and waters with state-designated impaired water quality will be narratively identified and depicted on an exhibit. Stream drainage basins will also be shown on a map exhibit.

Discussion of existing stormwater infrastructure will include a qualitative review of existing stormwater management facilities, drainage infrastructure, and surface water discharge points. City of Lynnwood, City of Everett, Snohomish County, and WSDOT information will be used for this review, and if needed, interviews will be conducted with local agency staff. Information regarding water quality and stormwater problems will be collected, as well as up-to-date maps of the stormwater systems serving the study area. This information will be discussed in the technical report and shown on an exhibit for the study area in an appendix. Ditches and other surface-flowing stormwater features will be shown on the infrastructure exhibit where known.

The description of land use will include a quantitative estimate of existing pollution-generating impervious surface (PGIS) and non-pollution-generating impervious surface (NPGIS) within the project footprint, which is defined as the areas occupied by each alternative and any other modified areas, encompassing the guideway, stations, operations and maintenance facility, and other relevant facilities or improvements. Impervious surface data in tabular and graphic format will be based on the alternatives' design and GIS information and summarized in the technical report and EIS section.

Soil information will be presented as hydrologic soil groups and will be shown on an exhibit for the area of potential impact in an appendix to the technical report.

5.2 Shorelines

State shoreline designations will be reviewed to determine if any regulated shorelines exist within the study area, and they will be listed as a feature of the associated water resource and shown on an exhibit. Shoreline management plans, including shoreline designations, setbacks, and allowed uses, would be discussed under the Land Use section of the EIS. An exhibit showing the spatial extent of shoreline jurisdiction will be provided.

5.3 Floodplains and Floodways

FEMA flood zone maps depicting 100-year floodplain (one percent annual chance) and local flood hazard area designations within the study area will be reviewed. Findings will be narratively described and depicted on an exhibit including approval dates for FEMA maps. For channels at which a floodway boundary has not been mapped, it will be assumed that the floodway extends the entire width of the floodplain. Any floodplains with no base flood elevation provided by FEMA (e.g., Zone A) will be noted.

Areas susceptible to sea-level rise as mapped by NOAA will also be discussed.

5.4 Groundwater

The baseline for groundwater conditions will be established through review of federally designated sole-source aquifer areas and county- or city-designated critical aquifer recharge and/or the wellhead protection area for the 164th Street Artesian Well which occurs within the study area. These resources will be narratively described and depicted on an exhibit.

6 ENVIRONMENTAL IMPACT ANALYSIS

The impact analysis will assess the potential direct, indirect, and cumulative water resource impacts of the No Build and Build Alternatives. The impacts analysis is divided into long-term operation impacts and short-term construction impacts. The impact analysis will be generally based on regulatory guidance and similar past projects.

6.1 Direct Impacts

Direct impacts are effects that would potentially be caused by the alternatives and would occur at the same time and place as project construction or operation.

Potential direct impacts from construction activities (including construction staging areas) will be qualitatively evaluated based on the proximity of activities to surface water bodies and local drainage systems. Construction impacts will be assessed regarding the potential for erosion and sediment transport, concrete work, material handling and transport, hazardous material storage and use, shaft drilling, trenching, dewatering, and other construction-related activities that might affect water resources.

Potential direct impacts to water resources from project operation will be identified as follows:

- **Surface Water:** Changes in land use, including changes in PGIS, resulting from each alternative will be calculated and compared to existing conditions. Based on these calculations, potential impacts to drainage systems and receiving waters from changes in flow and water quality will be qualitatively discussed. The impact analysis will assume that stormwater management will meet applicable local or state stormwater design guidance, as appropriate, and follow relevant design and construction standards and specifications. The analysis will not include identification and/or recommendation of facilities by the EIS team. The analysis will be coordinated with the Ecosystems team regarding potential channel erosion and other potential impacts associated with streams, lakes, ponds, and wetlands affected by the proposed project. The Water Resources team will also provide any requested stormwater information to the Ecosystems team for their assessment of potential project stormwater effects to Endangered Species Act-listed fish species. A brief description of how the project is designed to account for climate change resilience from flooding and in stormwater facility design will be provided if applicable. The analysis will also cover construction activities and their potential to impact surface water by altering the water resource, by causing flooding or erosion, or through runoff from construction areas.

- **Shorelines:** Direct impacts to designated shorelines of the state, if any, will be qualitatively discussed based on potential alterations to shoreline areas. Impacts to shorelines of the state will include any impacts to associated wetlands, shoreline environments, and shoreline uses.

- **Floodplains/Floodways:** The proposed Build Alternatives will be reviewed to determine if any project element would place fill in the 100-year floodplain/floodway and/or alter existing water body crossings in a manner that would affect flood conveyance and/or cause storage volume displacements within the affected reach. The proximity of alternatives to areas susceptible to sea-level rise will be discussed qualitatively.

- **Groundwater:** Estimated changes in impervious surfaces and resulting effects on infiltration of surface water will be qualitatively evaluated for potential impacts to groundwater supply. Other impacts to groundwater quality will be identified based on potential alterations to groundwater flow or supply, including dewatering during construction or the placement of retaining walls, cuts, or deep foundations for project facilities.

6.2 Indirect Impacts

Indirect impacts are potential effects that would be caused at a later time or a farther distance but are still reasonably foreseeable. Indirect impacts to receiving waters will be qualitatively evaluated through consideration of each alternative's potential changes to land use and/or pollutant sources. For example, if the proposed project were expected to decrease vehicle use compared to the No Build Alternative, then an indirect impact would be a potential reduction in traffic-related pollutants in the watershed. Other indirect effects could result from station area developments by others (such as projects to improve access or connections to stations, or redevelopments by others to increase density in station areas), which could create new impervious surfaces as well as retrofit existing impervious surfaces with improved stormwater management facilities.

6.3 Cumulative Impacts

The analysis of cumulative effects will involve discussing trends related to water resources and reviewing available information about past, present, and future projects to determine the potential for cumulative impacts.

7 MITIGATION MEASURES

Potential risks to water resources will be controlled through project planning, design, and the application of required best management practices (BMPs) during construction and operation. Measures to avoid and minimize potential impacts of the alternatives will be incorporated as appropriate. Where impacts cannot be avoided or minimized, mitigation measures will be developed. Risks controlled by planning and design include avoidance and minimization of floodplain encroachment. Risks controlled by BMPs could include construction-related pollution and operational effects such as pollutant transport and/or changes in runoff volumes, frequencies, and/or durations.

The EIS development team will coordinate with the design team to identify potential project design elements and BMPs (for review and approval by Sound Transit) that will be implemented to control potential risks to water resources. Design elements and BMPs will most likely be taken from the local or state stormwater design guidance, as appropriate, local design and construction standards and specifications, WSDOT Hydraulics Manual, NPDES permit program documents, and other industry guidance.

Potential mitigation for direct, indirect, and/or cumulative impacts will be identified and evaluated within the study area where adverse effects would occur, such as downstream hydrologic impacts resulting from uncontrolled increases in flows, floodplain encroachment at water body crossings, or the cumulative effects of multiple construction projects occurring in an area at once. The analysis assumes that the proposed project would be expected to be controlled by permit-required BMPs and related conditions; any mitigation, if needed, would be for controls beyond that which would be normally required by applicable regulations and permit conditions. Similarly, in accordance with the Sound Transit Link Design Criteria Manual (Sound Transit, 2021), low-impact design features would be incorporated where appropriate. The Low Impact Development Technical Guidance Manual for Puget Sound (Puget Sound Partnership, 2012) will also be used. Mitigation strategies will consider combined mitigation identified with other jurisdictions.

8 PROPOSED FIGURES, MAPS, OR OTHER DATA

Figures for the technical report and EIS section will be developed to depict the existing surface waters, floodplains/floodways, shorelines of the state, and sensitive groundwater areas within the study area. Where possible, jurisdictional and stream basin boundaries will be included on the figures.

9 DOCUMENTATION

A Water Resources technical report will be prepared, detailing the information gathered on the affected environment and describing potential project effects on water resources. This information will be summarized in an EIS section.

Other documents may also be needed for the preferred alternative to address regulations and regarding consultations for the protection of water resources, including for consultation with the USEPA for sole source aquifers, and with local jurisdictions and FEMA for fill within floodplains.

10 DATA DEVELOPED FOR USE BY OTHER DISCIPLINES

Data gathered on water resources will be used in the following analyses:

- Ecosystems
- Geology and Soils
- Hazardous Materials
- Parks and Recreational Resources
- Land Use

11 REFERENCES

City of Everett. 2022. Surface Water Comprehensive Plan. https://www.everettwa.gov/876/Surface-Water-Comprehensive-Plan-SWCP

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