CAPITAL ELEMENT BACKGROUND REPORT
VOLUME 1: SPEED & RELIABILITY

Bellevue Transit Master Plan

Draft

November 13, 2013

prepared for the
November 14, 2013 meeting of the
Transportation Commission

CITY OF BELLEVUE
November 2013

Transportation Department

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CONTENTS

INTRODUCTION

The Bellevue Transit Master Plan (TMP) will establish short- and long-term policies and projects that help foster a high-quality transit system that is more effective at connecting residents, employees, and visitors in Bellevue with the places they want to go. The *Transit Service Vision Report*, published in October 2013, has identified where and how frequently service will operate according to three funding scenarios (Growing, Stable, and Reduced) at three time horizons (2015, 2022, and 2030). The Capital Element of the TMP currently underway will recommend infrastructure investments that help the City realize its proposed 2030 Frequent Transit Network (FTN).

The Capital Element generally consists of two distinct components—roadway and signal investments that benefit transit speed and reliability, and improvements to passenger facilities—which are addressed in seperate volumes of the *Capital Element Background Report*. This volume examines congestion problems in Bellevue that compromise transit's efficiency, evaluates the trade-offs associated with different street design decisions on mode choice, traffic delay, person throughput, etc., and assesses roadway, signal system, and other rights-of-way improvements that could be made to support the Transit Service Vision. The forthcoming second volume of the *Capital Element Background Report* will assess where pedestrian access to bus stops is deficient, which bus stops warrant improved accommodations, and where opportunities exist to increase the supply of transit-oriented commuter parking through local partnerships.

The outcome of this process will be the Transit Capital Vision, which will identify locations and corridors that warrant speed and reliability treatments, non-motorized infrastructure enhancements, and pursuit of park-and-ride leasing partnerships that support efficient and effective transit operations, as well as their appropriate implementation period.

BACKGROUND

According to respondents of Bellevue's Transit Improvement Survey, improving service speed and reliability by investing in roadway and traffic signal infrastructure is the highest priority for municipal investment in transit among current transit users in Bellevue (see Figure 1). Building from an extensive market analysis, review of future growth patterns, and evaluation of transit needs, the City of Bellevue's Transit Master Plan (TMP) will detail specific capital projects that will improve transit speed and reliability in high ridership bus corridors. This task, identified as the Capital Element in the TMP scope of work, has three primary objectives:

1. Stimulate discussion on congestion in Bellevue that compromises transit's efficiency.
2. Evaluate the trade-offs associated with different street design decisions.
3. Assess roadway, signal system, and other right-of-way improvements that could be made to support the 2030 Frequent Transit Network outlined in the Service Vision Report.

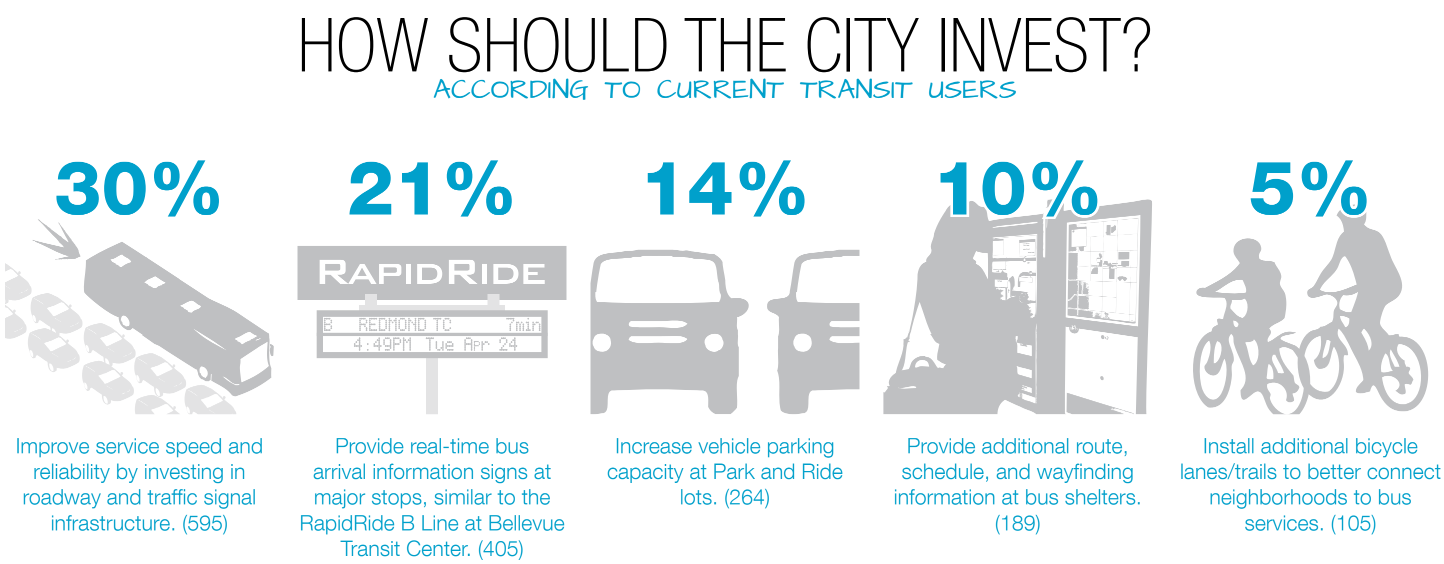


Figure 1 The most common way current transit users think the City should invest municipal resources to improve transit service in Bellevue is by "improving service speed and reliability by investing in roadway and traffic infrastructure" (30.3%; 595/1,962). The above are the five strategies most commonly selected by respondents to the 2012 Transit Improvement Survey. For full results, see the *Bellevue Transit Improvement Survey Report*.

For the purposes of assessing potential capital projects, the Capital Element references the 2030 Frequent Transit Network (FTN) as proposed in the *Transit Service Vision Report* (see Figure 2 and Figure 4). This network is comprised of all frequent services operating in the 2030 Growing Resources scenario, which increases service by approximately 47 percent from Spring 2012 levels to accommodate the projected near tripling of citywide transit demand by 2030. This is both the vision to which the City aspires and that with the greatest number of buses in operation—and hence that with the greatest need for capital investments to support fast and reliable service. The FTN supports Downtown growth, planned Bel-Red corridor redevelopment, and Bellevue's other activity centers with well-connected bus routes that seamlessly interface with East Link light rail. People traveling along FTN corridors can expect convenient, reliable, easy-to-use services that are so frequent, riders will not need to refer to a schedule when using these routes or connecting to East Link.

As part of the ongoing outreach supporting the TMP, the Transportation Department held the joint Board/Commission Capital and Policy Workshop on September 6, 2013. Workshop participants engaged in a discussion about the appropriate degree to which transit should be given priority over other modes—if at all—and in which situations. This was considered both in terms of the language used in City policies and in relation to transit priority treatments along Frequent Transit Network corridors. Although that workshop represented only an initial step in the capital planning process, the perspectives expressed and insights gleaned from it have assisted staff and consultants in compiling the preliminary list of potential capital projects reflected in this volume. (See the *Capital & Policy Workshop Report* for additional information.)

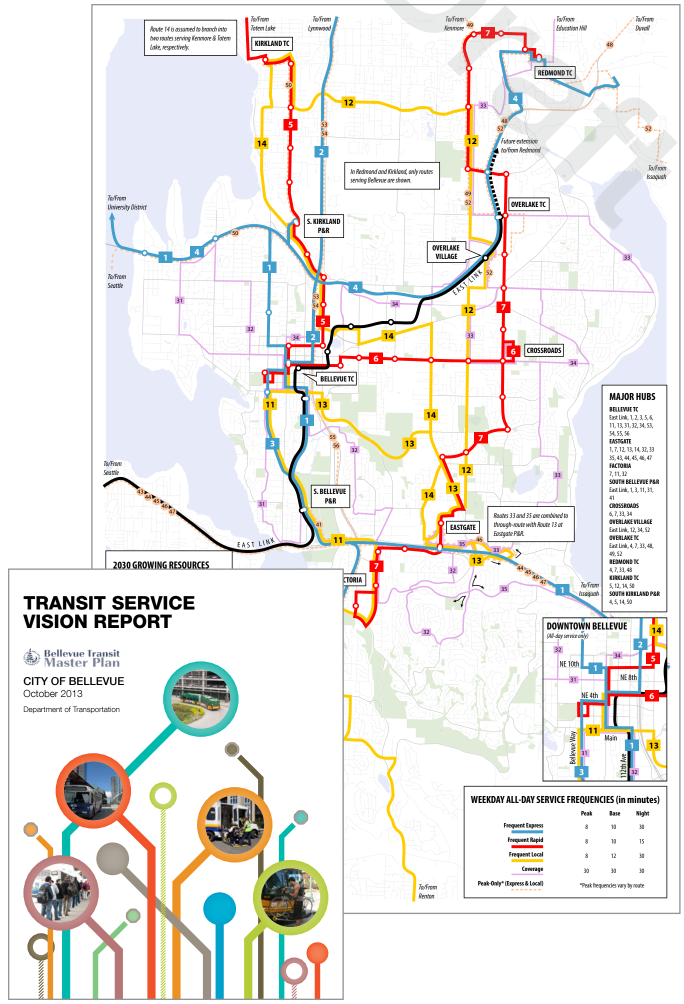


Figure 2 The *Transit Service Vision Report* presents route-level recommendations for transit in Bellevue that are responsive to three financial scenarios and attune to three time horizons. The 2030 Growing Resources Network (pictured above) is the most optimistic of the networks presented.

Figure 3 Boards and Commission members provide their perspective on potential transit priority policy language and treatment options.

This *Capital Background Report* focusing on speed and reliability issues represents an important reference document for the TMP process as work progresses in developing a Transit Capital Vision. This report is a compilation of the following processes undertaken in support of the TMP:

1. **Past Studies and Projects** – Summary of notable previous studies and transit speed and reliability projects implemented since the adoption of the 2003 Bellevue Transit Plan.
2. **Toolbox of Corridor Treatments** – A review of best practices compiled into a toolbox of speed and reliability treatments to guide capital improvements along FTN corridors.
3. **Speed & Reliability Issue Identification** – Description of the evaluation methodology used to determine where it might be appropriate for Bellevue to consider investing limited transit funding in capital projects along FTN corridors.
4. **Potential Improvements** – A preliminary list of potential speed and reliability improvements for each of the FTN corridors.

The final Transit Master Plan report will incorporate service- and capital-oriented strategies with short- and long-term projects that foster a transit system that is easier and more enjoyable to use for residents, employees, and visitors in Bellevue.

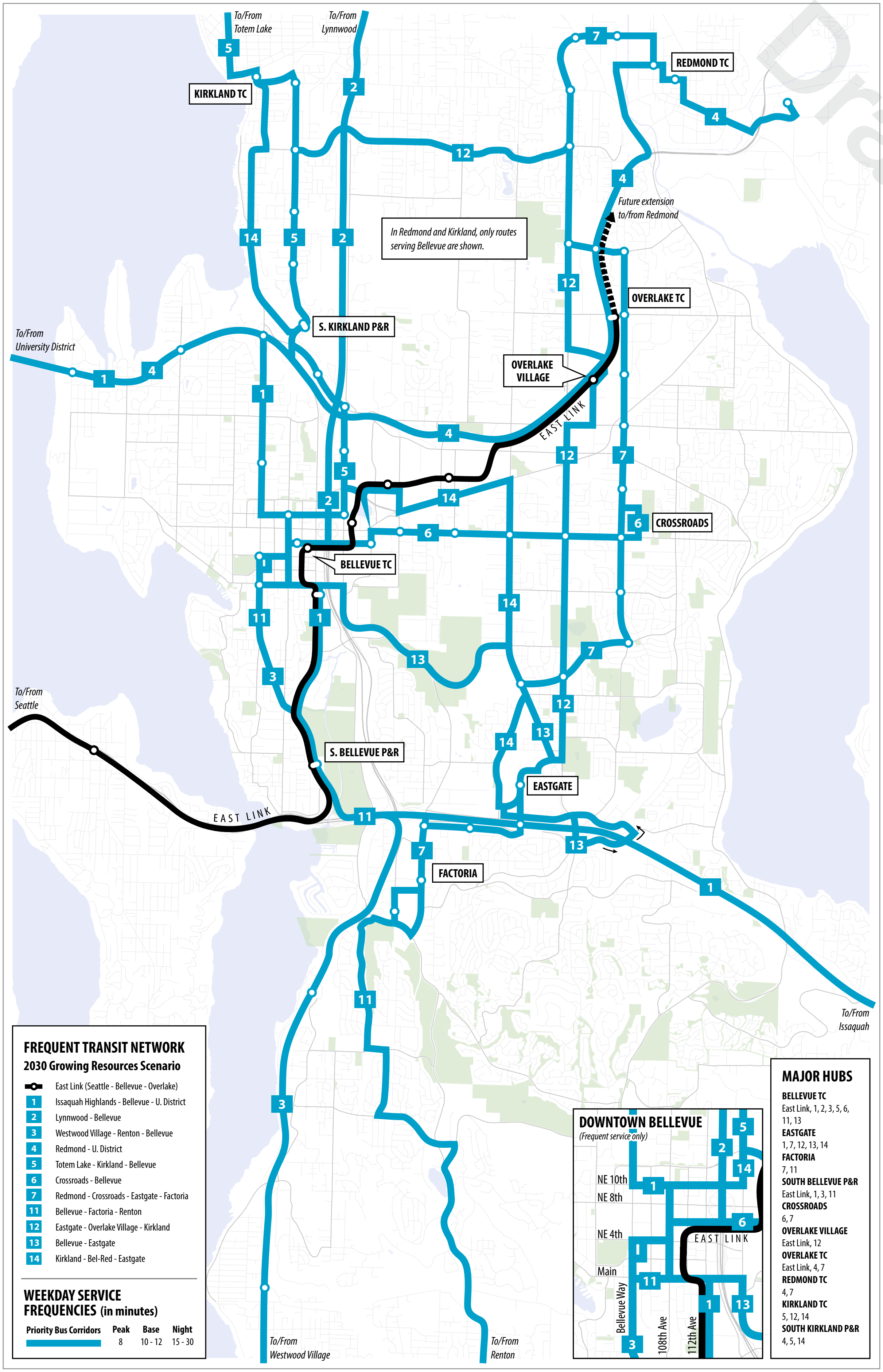


Figure 4 2030 Frequent Transit Network (FTN).

PAST STUDIES & PROJECTS

PAST STUDIES

The first task of the Capital Element was the documentation of previously identified transit and roadway improvements along the corridors served by the Frequent Transit Network (FTN). The following provides a brief summary of the reports referenced.

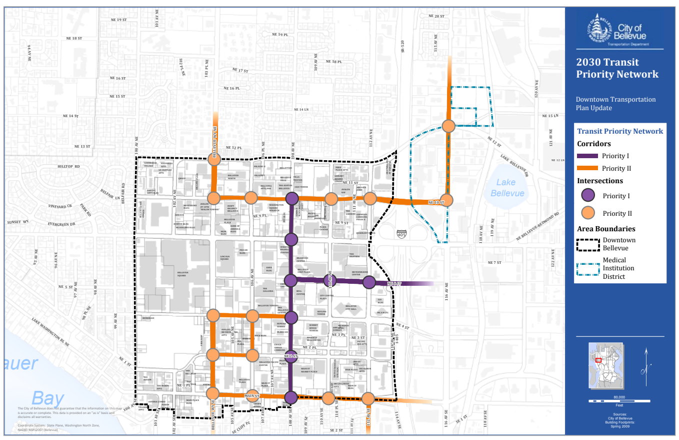
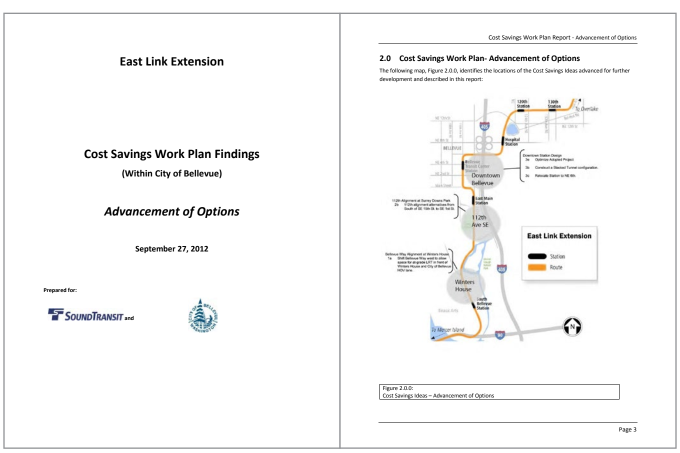


Figure 5 The 2030 Transit Priority Network from the *Downtown Transportation Plan Update*.

Downtown Transportation Plan Update (current) – This on-going project will be a focused update to the transportation portion of the Downtown Subarea Plan, which was adopted in 2004. The update will incorporate forecasted growth in population and employment through 2030 to ensure that the Downtown transportation system can function well and support this anticipated growth. A multimodal strategy is being pursued to accommodate both motorized and non-motorized transportation demand. The final report will include a revised list of system improvements to roadways, transit, pedestrian and bicycle facilities, and traffic signal operations. While still on-going, some early results of this effort relating to the Transit Master Plan include the establishment of future transit circulation patterns in Downtown, which are reflected in the networks proposed in the *Transit Service Vision Report*, and the consideration of projects such as the 108th Ave NE Bus Priority Corridor.


East Link Extension

Cost Savings Work Plan Findings
(Within City of Bellevue)

Advancement of Options

September 27, 2012

Prepared for:

Cost Savings Work Plan Report - Advancement of Options

2.0 Cost Savings Work Plan- Advancement of Options

The following map, Figure 2.0.0, identifies the locations of the Cost Savings Ideas advanced for further development and described in this report:

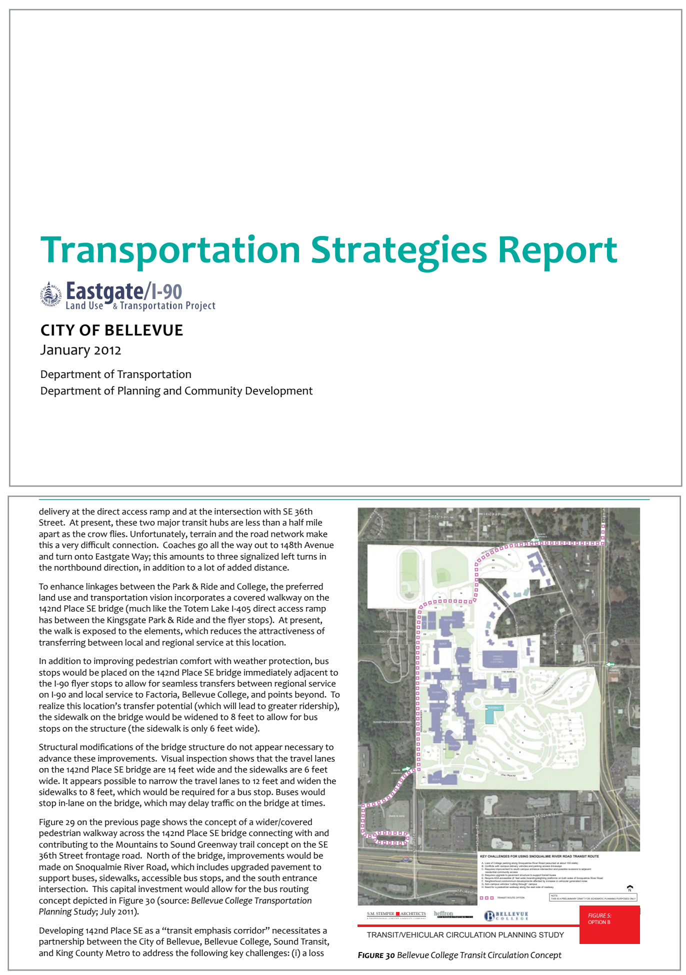
Figure 2.0.0: Cost Savings Ideas – Advancement of Options

Page 3

Figure 6 Map of the three areas with cost savings options advanced for further consideration, from the *East Link Extension Cost Savings Work Plan Findings.*

East Link Extension Cost Savings Work Plan Findings (2012) – Following the November 2011 execution of a Memorandum of Understanding (MOU) regarding funding and construction of East Link light rail, the City of Bellevue and Sound Transit analyzed cost savings concepts that have the potential to save at least $60 million in project costs while supporting the system's performance. This report summarizes the cost savings options advanced for further development, including alternative alignments for Bellevue Way and 112th Ave SE segments and several options for the Downtown Station design. The review of each of these includes anticipated cost savings, impacts to traffic, vehicle and pedestrian access, noise, visual appearance, and any impacts to adjacent properties, wetlands, and parks. Other projects associated with these concepts, including a southbound HOV lane along Bellevue Way SE between 112th Ave SE and South Bellevue Park-and-Ride.

Eastgate/I-90 Land Use and Transportation Project (2012) – The *Transportation Strategy Report* outines a vision that will guide public and private actions, investments, and capital project priorities to improve mobility for all travel modes in the Eastgate/I-90 corridor. Potential improvements advanced by the plan are oriented toward finding the best transportation solutions for the area that are affordable, supported by the community, and can be implemented in a reasonable time frame. The list includes projects that would improve traffic flow at critical intersections, enhance the pedestrian/bicycle environment, and increase the attractiveness of transit as a travel option. One of the transit improvements proposed is the development of 142nd Pl SE as a transit emphasis corridor, including upgrading Snoqualmie River Rd to support buses and accessible bus stops.


Transportation Strategies Report
Eastgate/I-90 Land Use & Transportation Project
CITY OF BELLEVUE
January 2012
Department of Transportation
Department of Planning and Community Development

delivery at the direct access ramp and at the intersection with SE 36th Street. At present, these two major transit hubs are less than a half mile apart as the crow flies. Unfortunately, terrain and the road network make this a very difficult connection. Coaches go all the way out to 148th Avenue and turn onto Eastgate Way; this amounts to three signalized left turns in the northbound direction, in addition to a lot of added distance.

To enhance linkages between the Park & Ride and College, the preferred land use and transportation vision incorporates a covered walkway on the 142nd Place SE bridge (much like the Totem Lake I-405 direct access ramp has between the Kingsgate Park & Ride and the flyer stops). At present, the walk is exposed to the elements, which reduces the attractiveness of transferring between local and regional service at this location.

In addition to improving pedestrian comfort with weather protection, bus stops would be placed on the 142nd Place SE bridge immediately adjacent to the I-90 flyer stops to allow for seamless transfers between regional service on I-90 and local service to Factoria, Bellevue College, and points beyond. To realize this location's transfer potential (which will lead to greater ridership), the sidewalk on the bridge would be widened to 8 feet to allow for bus stops on the structure (the sidewalk is only 6 feet wide).

Structural modifications of the bridge structure do not appear necessary to advance these improvements. Visual inspection shows that the travel lanes on the 142nd Place SE bridge are 14 feet wide and the sidewalks are 6 feet wide. It appears possible to narrow the travel lanes to 12 feet and widen the sidewalks to 8 feet, which would be required for a bus stop. Buses would stop in-lane on the bridge, which may delay traffic on the bridge at times.

Figure 29 on the previous page shows the concept of a wider/covered pedestrian walkway across the 142nd Place SE bridge connecting with and contributing to the Mountains to Sound Greenway trail concept on the SE 36th Street frontage road. North of the bridge, improvements would be made on Snoqualmie River Road, which includes upgraded pavement to support buses, sidewalks, accessible bus stops, and the south entrance intersection. This capital investment would allow for the bus routing concept depicted in Figure 30 (source: *Bellevue College Transportation Planning Study*; July 2011).

Developing 142nd Place SE as a "transit emphasis corridor" necessitates a partnership between the City of Bellevue, Bellevue College, Sound Transit, and King County Metro to address the following key challenges: (i) a loss

Figure 7 Proposed improvements and revised transit routing around Bellevue College along Snoqualmie River Rd, from the *Eastgate/I-90 Transportation Strategies Report*.

SR-520 High-Capacity Plan (2008) – The *SR-520 High Capacity Transit Plan* outlines a strategy for meeting the demand for cross-lake travel with an incremental implementation of bus rapid transit service that connects employment, residential areas, and activity centers on both sides of Lake Washington. The plan recommends how transit can build on capital investments identified for the SR-520 Corridor Program by substantially increasing service and improving off-corridor transit facilities to help meet future growth in travel. Of the plan's three major elements, that most relevant to the TMP is the near-term implementation of bus rapid transit service on SR-520 supported by HOV lanes and direct-access ramps, transit priority treatments at intersections, intelligent transportation systems (ITS), and improvements in fare collection systems and bus stations.

Figure 9 A map depicts the existing transit and HOV facilities on SR-520, from the *SR-520 High-Capacity Plan*.

I-405 Bus Rapid Transit Concept Reports – Several reports related to I-405 Corridor BRT planning were reviewed to help inform the TMP Capital Element, including *White Paper: I-405 Bus Rapid Transit Line Concept* (2003) and the *I-405 South Corridor Bus Rapid Transit Pre-Design Report* (2005). The former describes components of the proposed BRT line for the entire I-405 corridor, including HOV lanes, direct access ramps, BRT station locations and designs, fare collection, ITS, and other features. It also presents ridership forecasts for the corridor with and without implementation of the BRT line and estimates the cost of the various infrastructure investments considered by the plan. The latter report builds on earlier I-405 Corridor studies, focusing on the the southern portion of the corridor from Bellevue to Sea-Tac Airport. It assesses the overall feasibility of operating BRT along this section of the corridor in the short- (2014) and long-term (2030), considers current travel times and sources of delay, and identifies infrastructure needed to support BRT operations along with planning-level cost estimates.

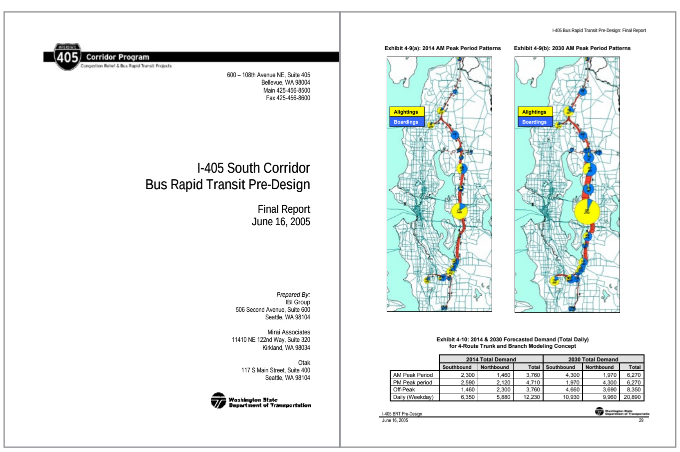


Figure 8 Maps depict I-405 BRT stop-level ridership forecasts for the AM peak period in 2014 and 2030, from the *I-405 Corridor Program: Bus Rapid Transit Line Concept.*

Bellevue Transit Improvement Analysis (2005) – In April of 2004, King County Metro, Sound Transit, and the City of Bellevue collaborated to consolidate all of the proposed transit improvements in Bellevue from various prior studies and to identify immediate transit needs. This report summarizes the results of the arterial improvement evaluation and TSP analysis. The goal was to identify routes and corridors with the greatest needs based on a qualitative review of headways, ridership, and historic delay problems. The primary corridors identified include NE 8th St, 156th Ave NE, Bellevue Way, Eastgate Way, and Factoria Blvd. King County Metro's TSP Interactive Model (TIM) was used to calculate the benefit-to-cost ratio of deploying TSP, wherein the value of the bus passenger's and transit operator's time saved is compared to the cost of furnishing, installing, and maintaining the equipment. Of the 81 signalized intersections originally assessed, most were removed from further consideration on the basis of negative benefit-to-cost ratios, leaving 28 eligible intersections. The fifteen highest ranked locations were estimated to cost $543,000 to furnish and install equipment.

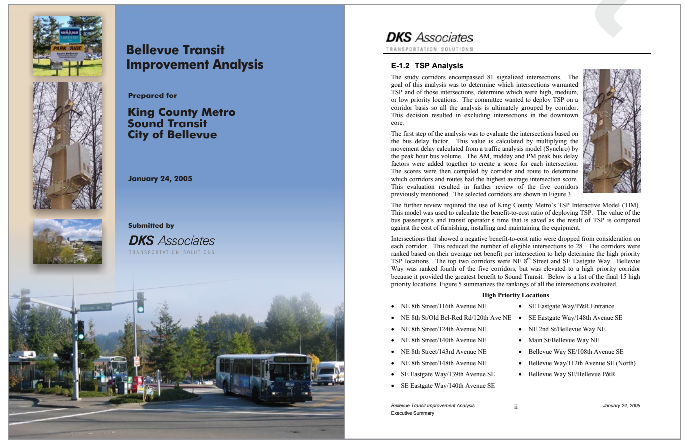


Figure 10 Summary of the TSP analysis process and the fifteen highest-ranked intersections prioritized for transit signal priority (TSP), from the *Bellevue Transit Improvement Analysis*.

ITS Master Plan (2004) – The Bellevue ITS Plan is a road map to implement an integrated system of transportation strategies based on a set of identified opportunities. The plan's purpose is to establish the need for ITS investments in the region, to identify relative priorities to direct ITS investment, to identify specific projects to be deployed to address identified needs, and to prioritize financial resources for ITS opportunities. The plan was coordinated with regional efforts to ensure that ITS strategies are integrated and complementary, which helps ensure that Bellevue is eligible for federal ITS funding. Among the projects identified is a collaborative evaluation with Metro of the potential to deploy TSP at up to 120 along six of Bellevue's most heavily traveled transit routes, which would be implemented over twenty years.

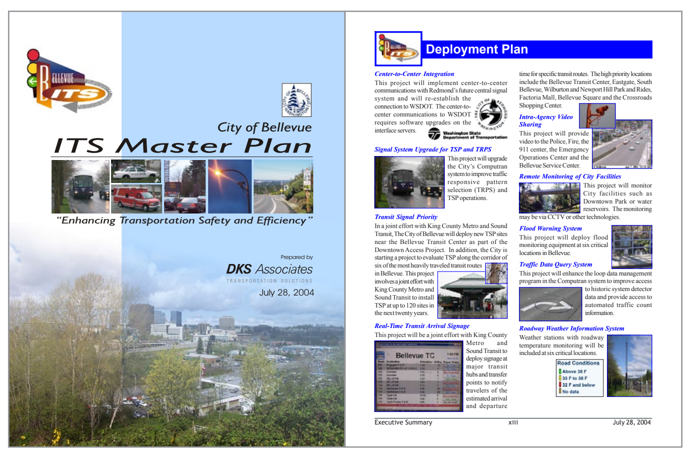


Figure 11 High priority projects identified by the *ITS Master Plan.*

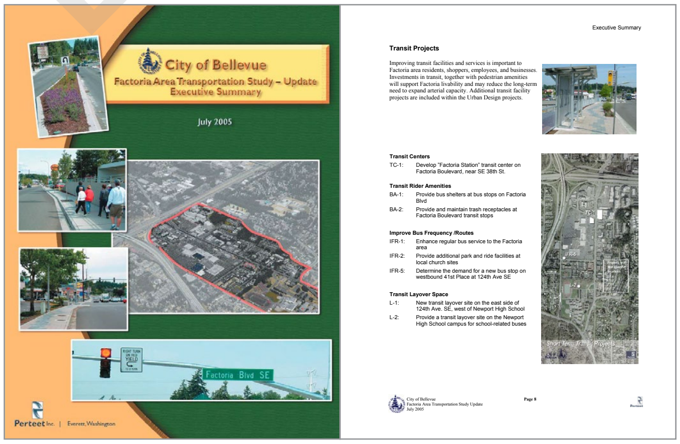


Figure 12 Transit facilities and service improvement projects identified by the *Factoria Area Transportation Study.*

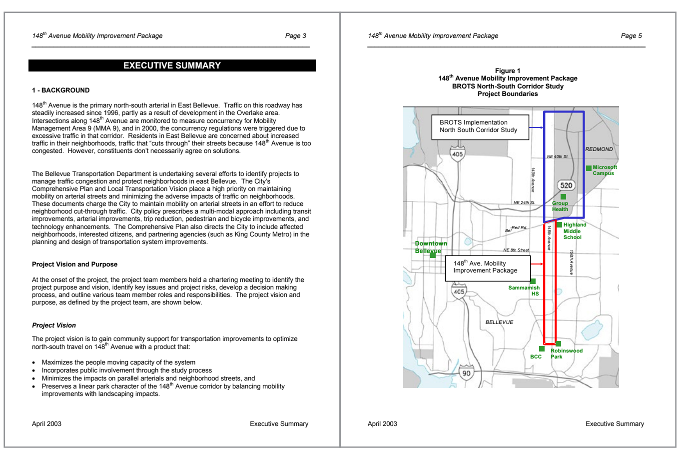


Figure 13 Project extents assessed by the *148th Avenue Mobility Improvement Package.*

Factoria Area Transportation Study Update (2005) –

This report is an update to the 1996 *Factoria Area Transportation Study*, which was completed three years after the area annexed to Bellevue. The update documents the transportation system capacity analysis that was conducted, addresses the needs of all modes of transportation within the area, and provides design guidance for private sector redevelopment along Factoria Blvd. Further, the update provides a strategy to achieve long-term mobility and safety for all transportation system users. It challenges the existing, disconnected suburban land use pattern, providing transportation and urban design recommendations embraced by the community that would create a well-integrated, transit supportive, pedestrian oriented, mixed-use urban neighborhood.

148th Avenue Mobility Improvement Package (2003)

– This study addresses the concerns of residents of East Bellevue neighborhoods, who were concerned that excessive traffic in the 148th Ave corridor was resulting in increased traffic on neighborhood streets. The project's vision is to gain community support for transportation improvements to optimize north-south travel on 148th Ave that maximizes the people-moving capacity of the system while minimizing the impacts on parallel arterials and neighborhood streets. The report identifies short- and mid-term projects to manage congestion problems and protect neighborhoods from cut-through traffic. Some transit projects recommended include TSP at slected locations along 148th Ave and a southbound queue jump at SE 24th St.

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Figure 14 Bellevue Transit Center.

Figure 15 Eastgate Park-and-Ride.

Figure 16 Downtown Bellevue HOV Access.

COMPLETED PROJECTS

Since the adoption of the 2003 *Bellevue Transit Plan*, hundreds of millions of dollars in HOV access ramps, transit centers, park-and-ride lots, and speed and reliability projects were completed in Bellevue in support of transit operations. Transit capital projects completed since 2003 include:

Bellevue Transit Center – In 2003, Sound Transit expanded the Bellevue Transit Center to include ten bus bays, shelter improvements, and rider amenities. Additional bus stops and roadway improvements on 108th Ave NE, 106th Ave NE and east of the transit center on NE 6th St have improved transit and traffic flow in Downtown Bellevue and enable more than 100 buses during peak periods to move efficiently through the transit center. *Total funding: $16 million.*

Eastgate Park-and-Ride Expansion – In 2004, King County expanded the Eastgate Park-and-Ride from a 696-stall facility to a structured complex that can accommodate 1,646 vehicles. In spite of the large number of parking spaces, the Eastgate Park-and-Ride is already at capacity with a utilization ratio of 97 percent (Q2 2012). *Total funding: $27 million.*

Downtown Bellevue HOV Access – Completed in 2005, the Bellevue HOV Access project makes it easier to travel in an out of Downtown Bellevue from the freeway. The project provides a new interchange on I-405 at NE 6th St for buses and carpools, giving buses direct access to the expanded Bellevue Transit Center. It improves freeway interchanges at NE 4th St, NE 8th St, and SE 8th St, including improvements to nearby city street intersections. *Total funding: $144 million.*

Eastgate Direct Access Ramp – WSDOT and Sound Transit partnered in 2006 to complete the Eastgate Transit Access project to connect the existing 142nd Pl SE bridge to I-90 HOV lanes. The addition of two ramps (one each on the east and west sides of I-90) allows a direct connection for bus and HOV users to 142nd Pl SE and the Eastgate Park-and-Ride without having to cross the general lanes to exit the highway. *Total funding: $19 million.*

Figure 17 Eastgate Direct Access Ramp.

I-90 Two-Way Transit & HOV Operations – WSDOT and Sound Transit are working together to improve on-time reliability and access for transit and HOVs on I-90. The project will provide full-time HOV lanes for eastbound and westbound traffic on the outer I-90 roadways and will retain the existing reversible lane operations in the center roadway until East Link light rail construction is ready to begin. HOV direct access on- and off-ramps will enable buses and carpools to access the HOV lanes without crossing other lanes of traffic. The project is being implemented in three stages: stages 1 and 2 were completed in 2008 and 2012, respectively; the third and final stage is in design with construction expected to be complete in. *Total funding: $188 million.*

Figure 18 I-90 Two-Way Transit & HOV Operations.

RapidRide B Line – King County Metro's RapidRide B Line started running between the Downtown Bellevue and Redmond Transit Centers via Crossroads and Overlake in 2011. Customers enjoy enhanced frequencies (service at least every 10 minutes during the busiest morning and evening travel hours and 15 minute service during off-peak periods), real-time bus arrival signs, well-lit shelters, and speed and reliability enhancements offered by transit signal priority (TSP). *Total funding for roadway improvements, communication network, stations and stops and associated amenities: $10 million.*

Figure 19 RapidRide B Line inauguration ceremony.

TRANSIT PRIORITY TOOLBOX

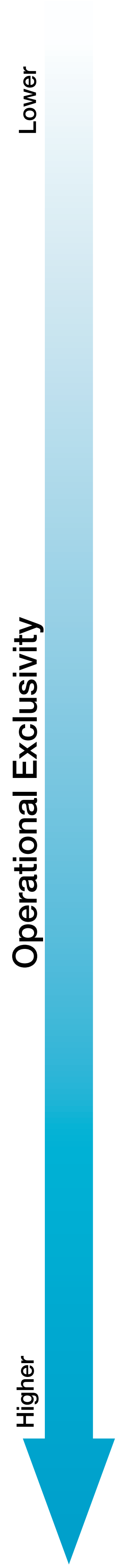
The Transit Priority Toolbox, developed for the Bellevue Transit Master Plan by project consultant Transpo Group, includes a range of transit priority treatments being considered for implementation on Bellevue's transit corridors by 2030. The purpose of the toolbox is to guide capital improvements on Frequent Transit Network (FTN) corridors that will improve the speed and reliability of these services—both to make them more attractive to the public, and to ensure they achieve operating speeds consistent with estimates in the *Transit Service Vision Report*.

Treatments considered in the Transit Priority Toolbox are generally divided into three categories:

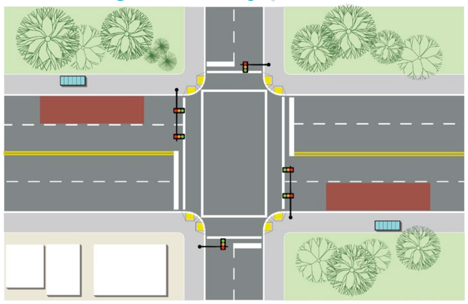
1. **Intersection treatments**, including TSP, queue jump lanes, and left turn restrictions;
2. **Bus stop treatments**, including in-lane stops, curb extensions, and transit islands; and
3. **Running way treatments**, including BAT lanes, arterial HOV lanes, transit-only lanes or streets, contra-flow bus lanes, and busways.

Each category includes strategies with different levels of financial investment, degrees of benefit to transit, and impacts to other travel modes. Some improvements are intended for discrete locations, while others are meant to be coordinated along entire corridors. Some locations or corridors may warrant multiple improvements based on existing configurations and level of transit priority deemed appropriate. Figure 7 provides a graphical summary of the treatment types organized according to the degree of transit operational exclusivity they provide. The following pages describe each of the treatments being considered, their advantages, disadvantages, and approximate cost, and include photographs of their application elsewhere in the Puget Sound region.

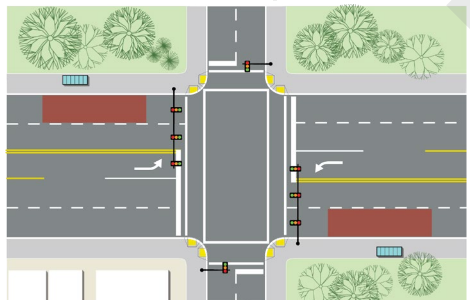
Figure 20 (opposite) Diagram of the level of operational exclusivity exhibited by the primary categories of treatments in the Transit Priority Toolbox.

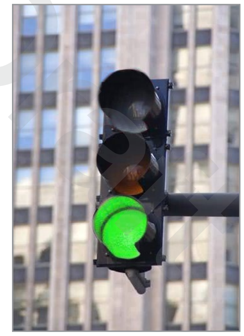


Signal Priority | 4-Lane

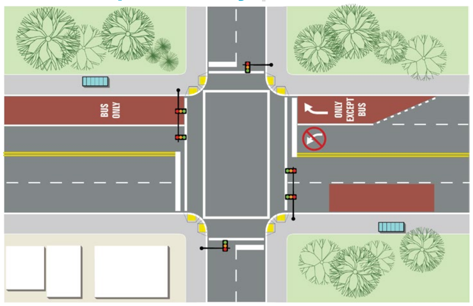


Signal Priority | 5-Lane

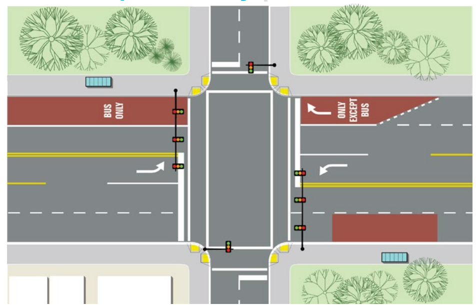




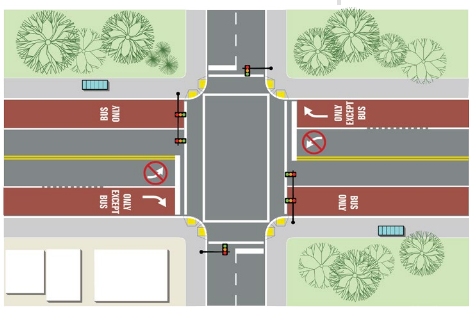
Spot Priority | 4-Lane



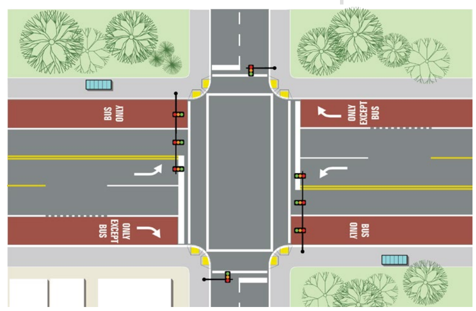
Spot Priority | 5-Lane



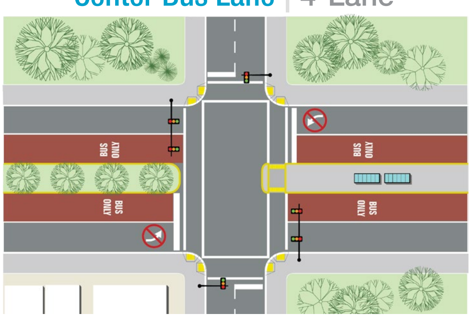
Curbside Bus/HOV Lanes | 4-Lane



Curbside Bus/HOV Lanes | 5-Lane

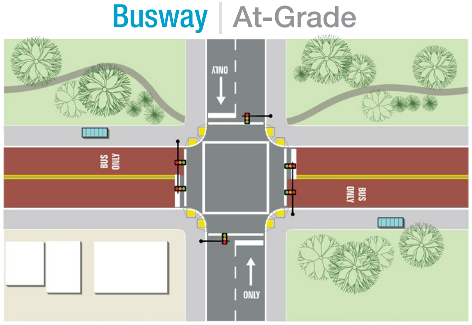


Center Bus Lane | 4-Lane

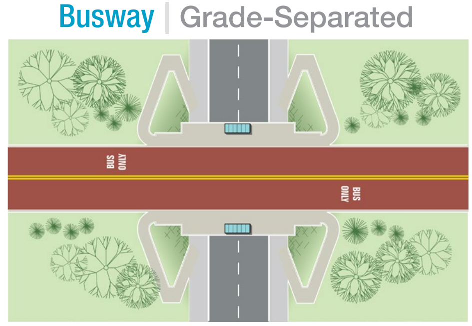


Source: CTA

Busway | At-Grade



Busway | Grade-Separated



INTERSECTION TREATMENTS

Transit Signal Priority

Description

Transit signal priority (TSP) is an operation that adjusts signal timing to prioritize transit vehicle movements along a corridor. There are several types of signal priority treatments, as shown at left, with green extension and early green used most commonly. Intersection context and city policy have a significant impact on the speed and reliability benefits that TSP can provide to transit. Arterials with medium levels of congestion and frequent signalized intersections are ideal for TSP. Many other priority treatments are paired with TSP to improve overall effectiveness.

Passive TSP strategies include signal timing coordination and the addition of a special signal phase. Active TSP offers the additional ability to give a bus priority conditionally based on one or more factors, including whether a bus is running late, the number of passengers on board, and how recently priority was given to another bus. Upgrades to signal controllers and fiber communication lines are often necessary for implementation of active TSP strategies.

Green Extension – This application keeps a signal green for an approaching bus until the bus has passed through an intersection.

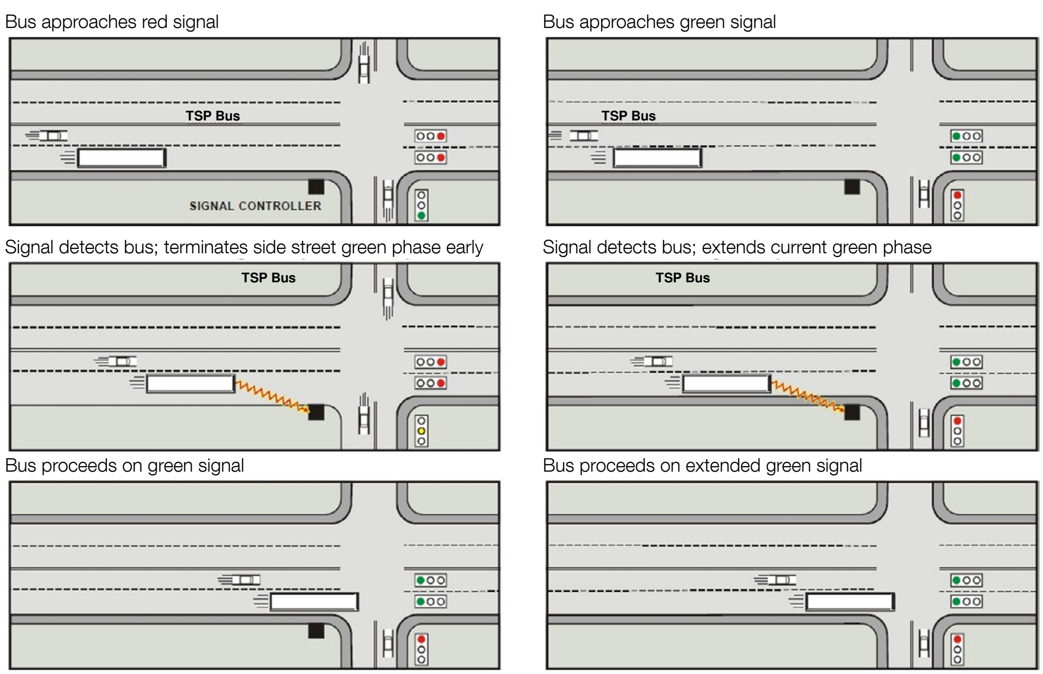
Early Green (Red Truncation) – This application reduces the amount of time a bus waits for a green light by shortening the amount of green time given to other traffic.

Phase Rotation – This application switches the sequence in which signals turn green, most commonly switching a left turn arrow with a through green for an approach.

Pre-emption – This application is typically used by emergency vehicles and at railroad crossings. Designated vehicles receive a green signal upon approaching an intersection or crossing.

Special Phase – This application is used to give a green light to a bus only signal when a bus is present. This type of application is typically used at or near transit centers when buses make unusual movements through an intersection.

Figure 21 Signal timing operations with early green (left) and green extension (right).



Source: URS for Pace Suburban Bus (2011).

Advantages

- Provides modest speed and reliability improvement
- Improves overall travel time between three to fifteen percent and can reduce signal delay for transit up to 75%
- No additional right-of-way required
- Produces a minimal overall impact to general traffic, depending on the level of priority assumed
- Can be implemented with other signal and transit enhancements

Considerations

- Performance depends on many factors including:
  - Number of intersections
  - Priority thresholds
  - Extent of priority
- TSP has limited impact when buses are on highly congested corridors
- May disturb the flow of a coordinated signal system
- Requires inter-jurisdiction coordination
- Side-street bus routes may experience additional delay when favored routes receive priority
- Not as effective with far side stops

Figure 22 Transit signal priority helps to ensure that buses can move along a corridor with minimal delay incurred by red lights.

Queue Jump Lanes

Figure 23 A bus approaches an intersection in a bus-only queue jump lane.

Figure 24 The bus-only queue jump lane (right signal) receives a green signal before general purpose traffic (left signal).

Description

Queue jumps allow buses to bypass congested choke points through a combination of a short bus-only lane and a dedicated bus signal, which gives buses a green light several seconds before other vehicles. This operation allows buses to enter the intersection ahead of general traffic. Queue jumps are primarily used when the right-of-way at a choke point is constrained, but roadways leading up to the choke point have sufficient space for a dedicated bus-only lane.

Benefits

- Allows buses to bypass congestion at critical locations
- Requires less right-of-way than treatments along a full corridor
- Can improve bus travel time by five to twenty-five percent and reduces delay

Considerations

- Impacts to general purpose traffic varies per improvement strategy (i.e. use of a right-turn lane or conversion of second thru-lane to a right-turn only lane with transit queue jump)
- Effectiveness will vary depending on location of intersection transit stop
- Will be less effective with high volume right-turn lanes

Left Turn Restrictions

Description

Turn restrictions are generally used to improve safety or reduce congestion by restricting left-turns during peak periods. In many cases, turn restrictions reduce delays caused by turning vehicles blocking traffic. This is primarily an issue at intersections without dedicated left-turn lanes, such as 2-lane and 4-lane corridors. Turn restrictions are also used in combination with transit priority treatments. A turn restriction maximizes the capacity of the remaining general purpose lanes or restricts unsafe movements that cross bus traffic. Turn restrictions may also give transit priority at locations with heavy traffic delays.

Benefits

- Improves traffic operations at intersections and along corridors where center turn lanes do not exist
- Can be implemented for specific time periods
- Provides priority for transit vehicles when turning left
- Improves travel time for transit

Considerations

- Can cause confusion for general traffic
- Reduces route options for general purpose traffic during peak periods
- Requires active enforcement
- May increase intersection delays caused by vehicle diversion, degrading intersection levels of service
- Can impact safety at adjacent intersections through the consolidation of left-turning traffic

Figure 25 Left turn restriction on general purpose traffic.

Figure 26 A bus turns during a protected phase.

BUS STOP TREATMENTS

In-Lane Bus Stops

Description

In-lane bus stops are locations where a bus stops in a travel lane to pick-up or drop-off passengers. This type of stop typically generates less delay for the bus as compared to bus pullouts, which require the bus to leave the traffic stream and re-enter after serving passengers. Merging back into the main travel lane can significantly delay buses because passenger vehicles often do not yield to a bus attempting to merge into traffic. This causes additional delay and increased potential for conflicts. In-lane stops reduce re-entry delay and increase safety for the bus and other vehicles. In-lane bus stops are particularly effective on roadways with few gaps in traffic.

Benefits

- Reduces re-entry delay after serving a bus stop
- Increases transit visibility

Considerations

- Increases vehicle delays for general traffic (may vary with one or two lane directional configurations)
- Can increase bike/transit conflicts

Figure 27 RapidRide bus at an in-lane bus stop.

Figure 28 Unlike bull pullt-outs, in-lane stops do not incur delay by requiring buses to re-enter the traffic stream.

Curb Extensions

Description

Curb extensions are locations where the sidewalk has been extended to allow buses to stop in-lane. This design reduces delays for buses by avoiding re-entry delay, with the added benefit of providing additional sidewalk space for waiting passengers and amenities. Curb extensions are typically used in locations were on-street parking is provided; buses experience delay when re-entering traffic; or additional sidewalk space is needed. Roadway capacity may be reduced, and conflicts between bikes and transit might occur in situations where bicycle lanes exist.

Figure 29 Curb extension on the far-side of an intersection.

Benefits

- Reduces re-entry delay after serving bus stop
- Allows for retention of on-street parking or load zones
- Increases pedestrian comfort by allowing for wider sidewalks and bus stop amenities
- Can improve pedestrian safety by reducing crossing distance if incorporated into a mid-block crosswalk or intersection treatment

Figure 30 Curb extension following a short parking lane.

Considerations

- Increases vehicle delays for general traffic (may vary with one or two lane directional configurations)
- Can increase bike/transit conflicts

Transit Boarding Islands

Description

Transit islands provide a bus stop in the road right-of-way separated from the curb through a variety of designs. This treatment enables a bus to travel and stop in a lane that is not adjacent to the curb while still providing amenities to the transit riders. For example, buses may use the left lane of a roadway because of a priority treatment or a necessary maneuver, and a transit island allows buses to serve a bus stop without changing lanes. Transit islands can also reduce bike and transit conflicts by routing the bicycle lane behind the transit island. Transit islands are built within the street right-of-way and often reduce effective crossing distances for pedestrians, which may improve pedestrian connectivity and safety.

Figure 31 Transit island with in-lane bus stop.

Benefits

- Integrates with locations configured with a left side transit lane
- Reduces transit vehicle re-entry delay after serving a bus stop
- Reduces bike/transit "leap-frog" conflicts
- Can be useful at intersections with significant parking activity and right turns

Figure 32 Transit island with bus-only lane.

Considerations

- Increases vehicle delays for general traffic, particularly if unable to pass the bus
- Requires space within standard street ROW
- Could create an unsignalized pedestrian crossing for riders to access the transit island, if configured mid-block

Business Access & Transit Lanes

Description

Business Access and Transit (BAT) Lanes restrict a curbside lane of a multilane arterial to transit and right-turning vehicles only. At intersections, all vehicles (including high occupancy vehicles) are required to turn right while transit can continue straight through the intersection. This preserves access to businesses and side-streets, but reduces vehicle volumes in the curbside lane such that transit speed and reliability are improved. BAT lanes may not benefit transit operations well in locations with frequent right-turn vehicle movements and heavy conflicting pedestrian volumes.

Figure 33 Transit island with in-lane bus stop.

Benefits

- Can result in significant transit speed and reliability improvements through congested corridors where standing queues from intersections increase congestion
- Works well in locations with infrequent right turn movements

Considerations

- Requires significant ROW to construct or conversion of travel or parking lane to BAT lane
- Can increase general purpose congestion through decreasing general purpose capacity
- Can be blocked by cyclist or turning/merging vehicles especially in highly congested locations or locations with high pedestrian volumes
- Effectiveness is limited along high volume commercial areas with high right-turn volumes

Figure 34 Transit island with bus-only lane.

Figure 35 Bus in an HOV lane.

Figure 36 Bus in an HOV lane at a signalized intersection.

Arterial HOV Lanes

Description

Arterial High-Occupancy Vehicle (HOV) Lanes have similar restrictions as freeway HOV lanes. Only transit, motorcycles, and carpools (2+ or 3+ occupants) are allowed to use the lanes. These lanes are typically located in areas with heavy reoccurring congestion and infrequent right-turns. Allowing carpools can increase the person capacity of the lane and works well in coordination with the freeway HOV system.

Benefits

- Speed and reliability improvement for transit and HOV vehicles in congested corridors
- Works well along road segments where transit volumes might not be high enough to justify an exclusive transit lane and HOV demand is high
- Works well in coordination with freeway HOV system and onramps

Considerations

- Can increase general purpose congestion
- Effectiveness is limited along high volume commercial areas with high right-turn volumes
- Requires on-going enforcement which is complicated by carpools

Transit-Only Lanes

Description

A transit-only lane reserves a lane for exclusive transit use along a corridor or through a choke point. This provides the highest level of transit priority on "local" streets and is often implemented along corridors with high bus volumes or with median bus rapid transit. Bus-only lanes can result in significant improvements to speed and reliability for transit, especially through choke points. Bus-only lanes can result in turn restrictions for general purpose traffic depending on the overall location and configuration of side streets.

Figure 37 Transit-only lane provides non-curb lane for buses.

Benefits

- Provides the highest level of transit priority of all arterial priority treatments
- Provides significant speed and reliability benefits in congested areas
- Ideal for locations with high bus volumes

Considerations

- Can increase general purpose congestion due to reduced capacity
- Can result in turn restrictions for general purpose traffic
- Generally the most difficult arterial running way treatment to implement
- Requires on-going enforcement

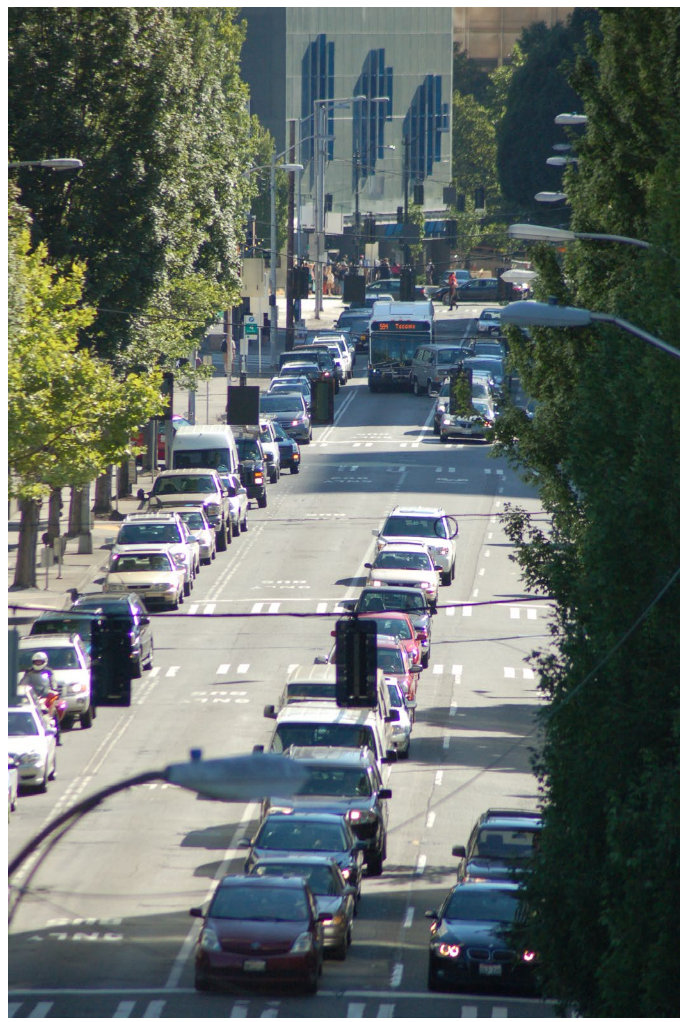


Figure 38 Personal vehicles cannot use a transit-only lane.

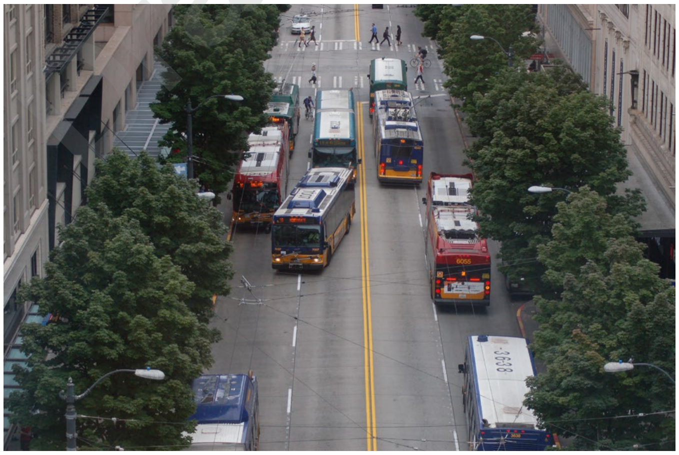


Figure 39 Transit-only streets provide additional maneuvering space for buses.

Figure 40 Transit-only street during peak hours.

Transit-Only Street

Description

A transit-only street is a street that is reserved for transit vehicles for part or all of the day. This designation is often implemented to increase transit capacity of a roadway especially in urban centers and to ensure that buses are insulated from general purpose traffic congestion. Transit-only streets also allow for transit service to be consolidated onto a single street, simplifying and improving frequency of service for riders and reducing the impact of transit on general purpose traffic on parallel corridors.

Benefits

- Improves speed and reliability of multiple transit routes
- Can reduce transit impacts on parallel streets

Considerations

- Restricts general purpose travel on street and can create confusion for general purpose traffic at the interface with multi-purpose roadways
- Impacts access for general purpose traffic to parking garages and business, but can be managed via signage and allowance for access to mid-block locations
- Can increase congestion on parallel streets due to traffic diversion

Busways

Description

Busways are similar to transit only streets, but are typically built in their own right-of-way, such as abandoned railroad right-of-way. Busways can be fully grade-separated, allowing buses to bypass cross-traffic using bridges or tunnels. Busways can also be at-grade with transit signal priority at intersections. A combination of the two is also possible. Busways offer the highest level of speed and reliability benefits, sometimes similar to light rail. Busways can be expensive to build, especially fully grade-separate ones, and conversion of right-of-way to bus use can be complex due to competing objectives for the corridor and concern from adjacent property owners.

Figure 41 Busways provide dedicated right-of-way for buses.

Benefits

- Separates buses from vehicles to a high degree, with either full grade-separation or transit signal priority for at-grade intersections.
- Provides a reliable corridor, where traffic can't impact bus travel
- Provides a high-capacity corridor for very frequent transit service
- Can allow for higher travel speeds than allowed on city streets
- Can result in transit service with similar speeds and frequency of light-rail

Figure 42 Busways may include grade-separated lanes for buses.

Considerations

- In most cases is only viable on unused utility or rail corridors
- Needs to incorporate grade separation into access locations or primary crossings
- Can have a significant cost if corridor needs to be acquired or grade-separated crossings are built
- Use of corridor often has competing objectives and potential opposition from adjacent property owners

Figure 43 Contraflow lanes provide critical connections for transit networks.

Contra-flow Bus Lanes

Description

Contra-flow bus lanes allow buses to travel against traffic on a one-way street, turning a one-way street into a two-way street for transit. Contra-flow lanes can vary in length and are generally used to address transit routing/access issues.

Benefits

- Facilitates direct, congestion-free routing for otherwise complex routing to important connecting facilities
- Bus lane is less likely to be blocked by parked or loading vehicles
- Two-way routing reduces rider confusion

Considerations

- Can increase congestion due to conversion of travel lane to transit only
- Depending on the circulation needs of transit, could reduce efficiency of one-way street because of signal timing

SPEED & RELIABILITY ISSUES IDENTIFICATION

When the efficiency of transit is reduced, so is its attractiveness to potential riders, and the many economic, social, and environmental benefits that transit provides are then also diminished. While the efficiency of transit service is affected by a variety of factors, the City of Bellevue has the ability to influence some of them, including the timing and coordination of traffic signals, the design of roadways, and the extent to which transit interacts with traffic congestion.

However, changing any of these factors from their current state requires difficult trade-offs to be made between competing interests. Whereas transit service trade-offs deal primarily with competing interests among different groups of transit users, capital investments in transit need to be balanced against the potential impacts on other modes of travel—namely private automobiles, but also bicycles and pedestrians. The extent to which the right-of-way is segmented in favor of any one mode necessarily reduces that available to other travel modes, so it is vital to carefully consider how alternative courses of action would affect all road users. Due to limitations imposed by financial resources, constrained rights-of-way, and the impacts that transit priority projects could have on other modes of travel, it is not possible to implement such projects everywhere that transit operates. Instead, attention should be directed to locations of particular concern, significance to the success of the overall network, and/or those capable of realizing notable improvement over existing operations.

The issue identification methodology presented here highlights locations in Bellevue where multiple factors related to transit speed and reliability—such

Figure 44 Staff, consultants, and local stakeholders took part in a field review of several corridors being considered for transit priority investments, including Snoqualmie River Rd on the Bellevue College campus, pictured here.

as congestion, transit use, bus volumes, and coach operator feedback—are troublesome or high. Potential transit priority treatments will be considered and assessed for selected locations, and following additional consultation with stakeholders, those deemed worth pursuing will be prioritized for implementation. While all or some of the issue identification measures will be used in later tasks to prioritize projects, these measures are only a subset of the factors that will be considered during the project prioritization process. Extensive field review, stakeholder feedback, and operational modeling of key locations will also be considered before specific projects are advanced from conceptual planning to adoption by the *Transit Master Plan* and ultimately inclusion in the *Transportation Facilities Plan.*

The following sections summarize the early stages of the Capital Element planning process. It must be emphasized that these analyses are only the first steps in a process that will include outreach to local stakeholders, transit agencies, and City boards and commissions.

DATA SOURCES

This section summarizes the data sources that have be used to identify the location and magnitude of transit speed and reliability issues as part of the Capital Element of the TMP. The data sources include multiple measures of existing and future roadway congestion, bus delays as tracked through GPS data from Metro, transit ridership, mode share, bus volumes, and bus operator feedback. Data sources selected for this analysis were considered for the following reasons:

- Data was available in a format that could be used in the analysis.
- Data was relevant to the speed and reliability of transit service in Bellevue.
- Data sources provide information on short- and long-term measurements.

The following provides an overview of each data source used, including a description, review of the data's significance, how it was generated and/or from whom it was obtained, and any limitations that exist. Appendix A summarizes this information.

Figure 47 Bellevue Way NE and NE 12th St facing south. A queue jump lane for northbound buses is among the transit priority projects being considered based on issues identified by the process described here.

Standing Delays

Over the last few years, King County Metro buses have been equipped with a GPS-based tracking system. Data from the GPS system and other instruments like door sensors and the speedometer are integrated and recorded by an onboard computer during every bus trip operated. Using this data, it is possible to estimate the amount of time that buses are stopped by traffic signals and congestion. Time when a bus is stopped to pick up or drop off passengers is not included in this measure, as that is a function of the boarding and exiting process and not related to street congestion.

This is a rich and highly applicable dataset because it is a direct measure of the delay experienced by transit vehicles on a day-to-day basis. Intersections and roadway segments that experience frequent standing delays are easily identified through graphical representation of the data. Standing delay data was provided by King County Metro and compiled by screening GPS data for instances when a bus stopped with its doors closed while not at a bus stop. The data used in this analysis was collected on weekdays between January 7 and February 15, 2013.

Transit Ridership

Transit ridership is measured in terms of the forecasted weekday count of passengers that use transit in both directions along a street segment. Daily transit ridership is critical for highlighting corridors where transit priority investments will benefit the largest number of riders. For example, while transit priority at one location might save five seconds for 1,000 riders, the same improvement on a heavily utilized corridor could save five seconds for 10,000 riders—a tenfold increase. By identifying corridors with strong ridership, high-impact transit priority projects can be identified to ensure greater return on investment.

Weekday ridership data for this measure reflects that realized in 2010 and forecasts for 2030 obtained from the Bellevue-Kirkland-Redmond (BKR) travel demand model (EMME version MP30r6.2). Figure 49 on page 34 and Figure 50 on page 35 depict these data sources. Because future transit ridership estimates are based on forecast assumptions, the results may ultimately vary due to real-world divergence from model assumptions.

Bus Volumes

Bus volumes are measured in terms of the number of buses operating each weekday in both directions along a street segment. Total weekday volumes are used—as opposed to volumes during a particular time of day—so that highlighted locations reflect those that exhibit high bus traffic over the course of an entire day, rather than a disproportionate surge exclusively during peak hours.

Bus volumes are an important measure when analyzing the efficiency of the bus network. As with transit ridership, focusing transit priority treatments where the most buses operate multiplies the benefits of transit priority, improving the return on investment. This is important for Metro and the City of Bellevue because each minute of travel, regardless of the number of passengers on-board, costs the same amount of money to operate and hence reflects the same share of total regional service hours allocated locally. The more efficiently transit service can operate within Bellevue, the more service Metro can provide with the same amount of resources. This is true in any circumstance, but it is particularly significant given Metro's continuing budget constraints.

The data used for analysis of bus volumes was compiled by the City staff and reflects transit services in Bellevue as operated by the Spring 2012 Baseline Network and consistent with the span and headways

Figure 49 Daily transit usage patterns on Bellevue's arterials in 2010 by transit passenger per day arterial categories.

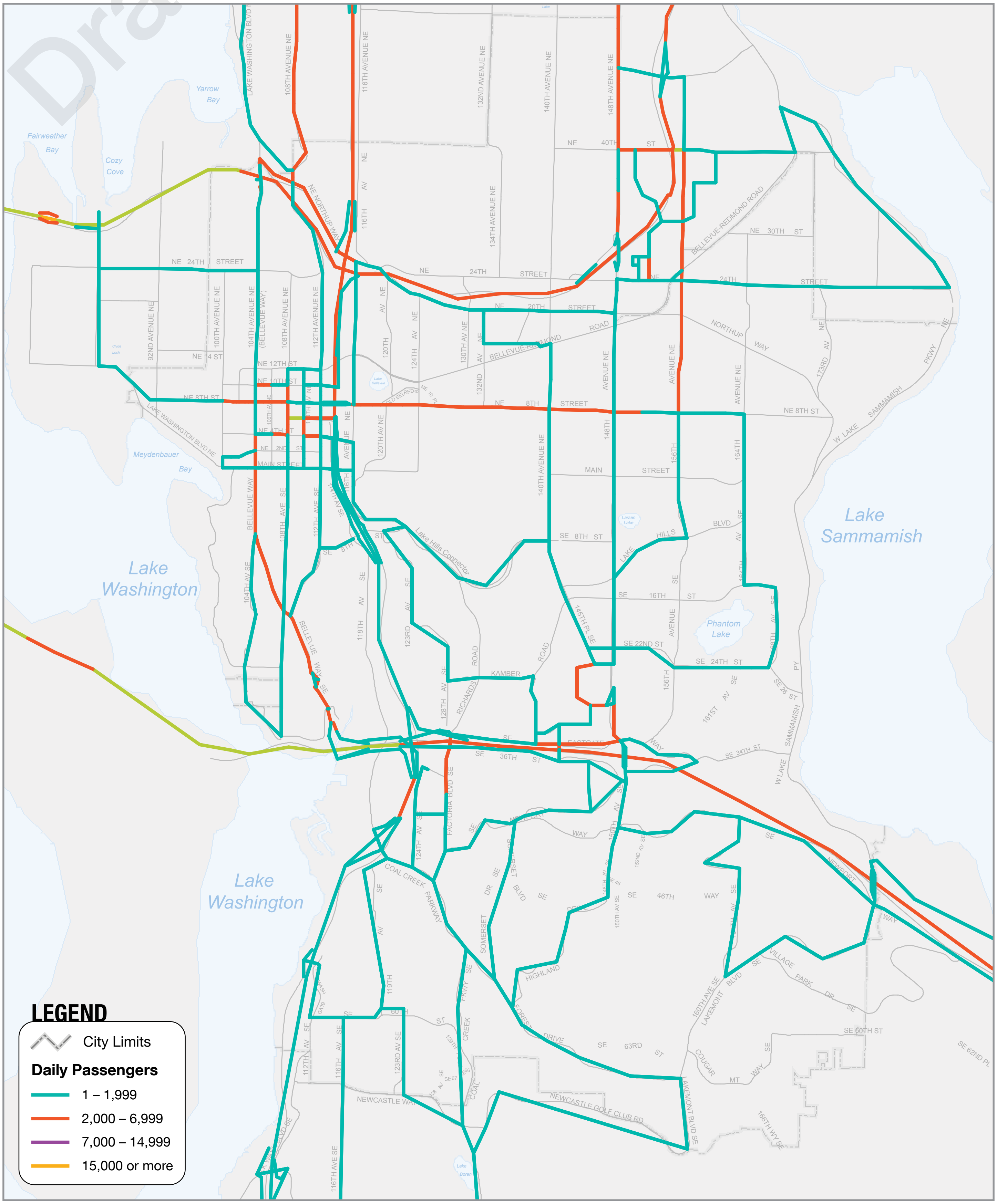


Figure 50 Daily transit usage patterns on Bellevue's arterials in 2030 by transit passenger per day arterial categories (derived from BKR model platform MP30r6.2 with transit routes defined in the 2010 *East Link Bus/Rail Integration Plan*).

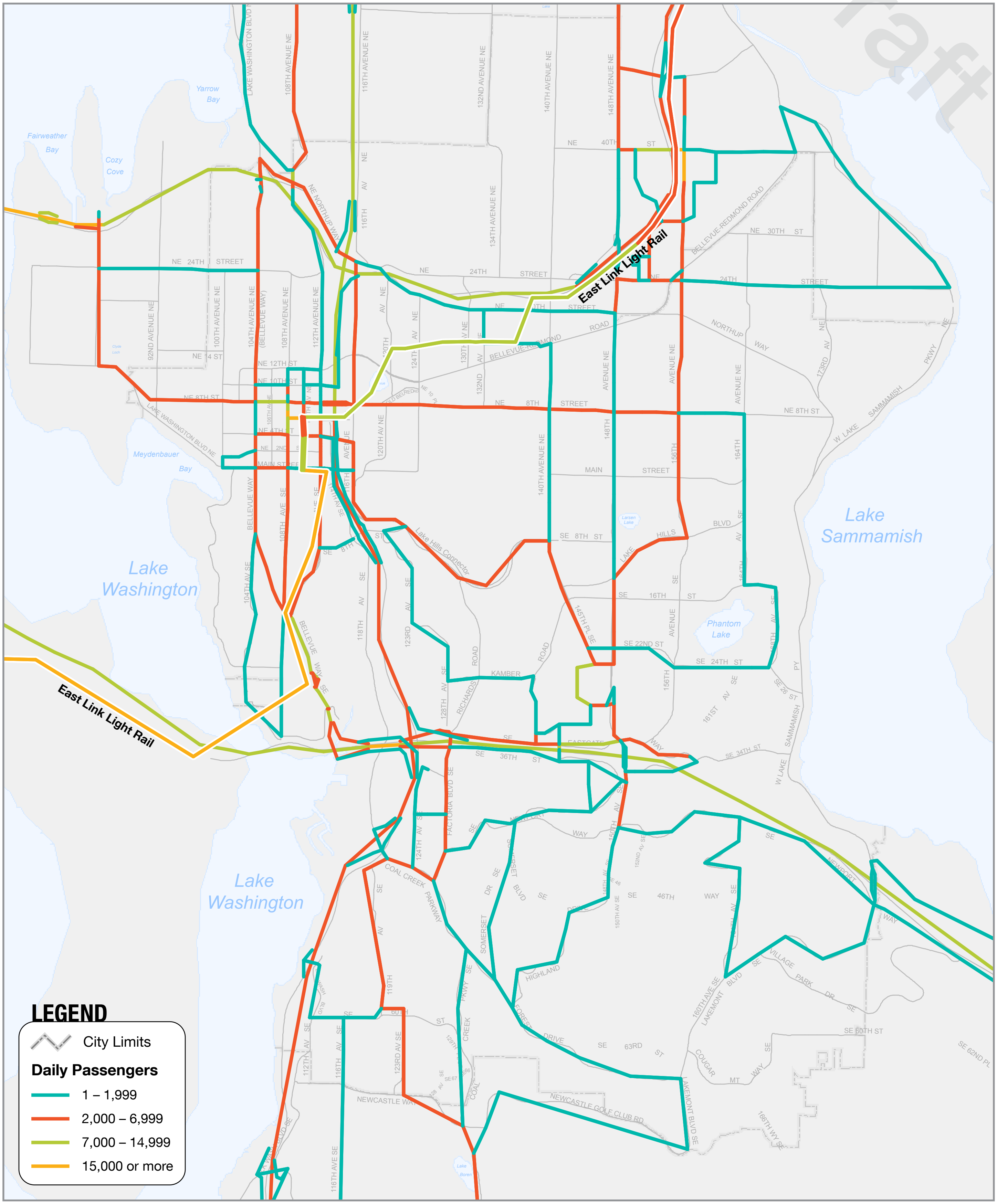


Figure 51 Bus trips operated daily, Spring 2012 Baseline Network.

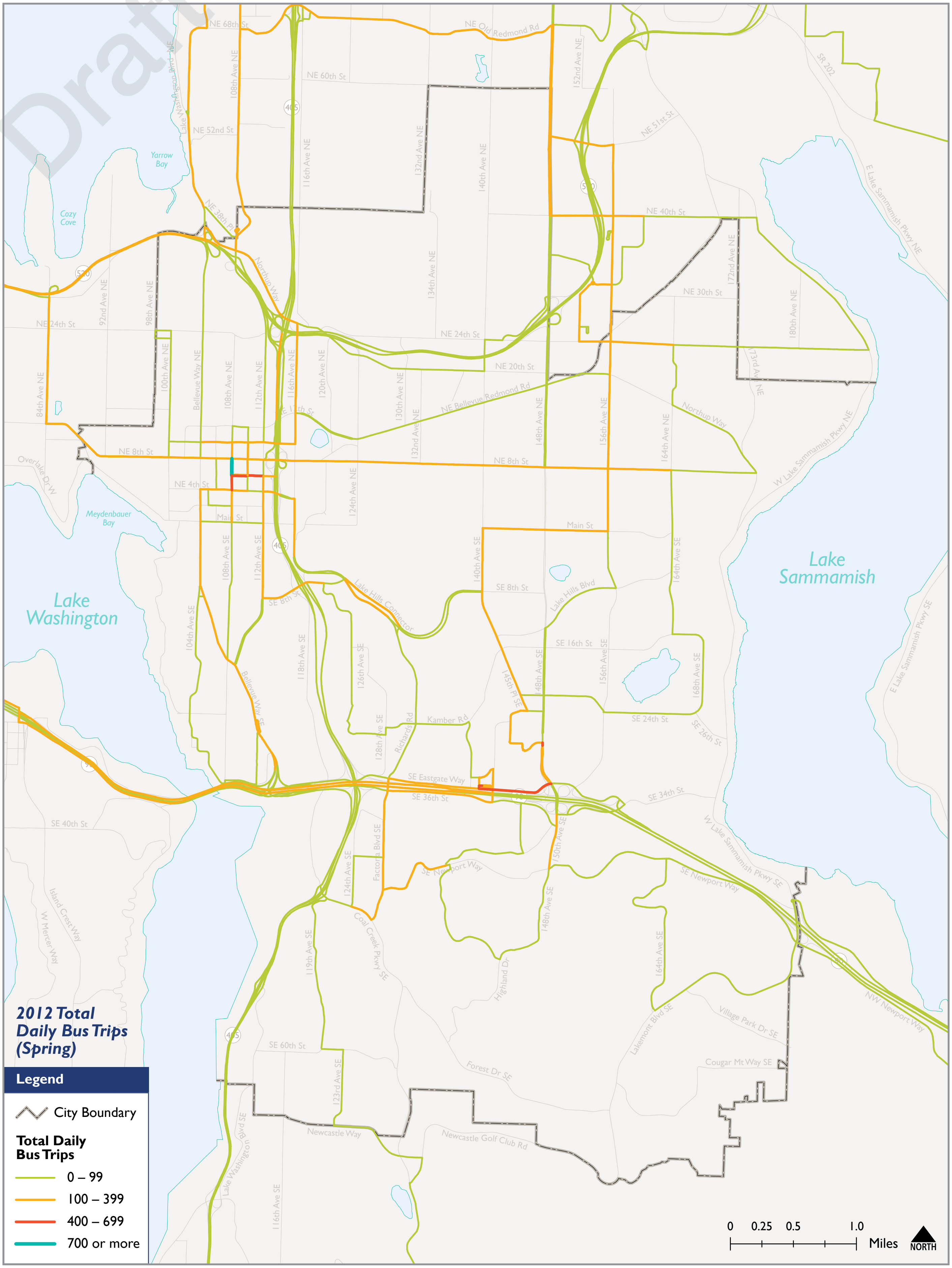
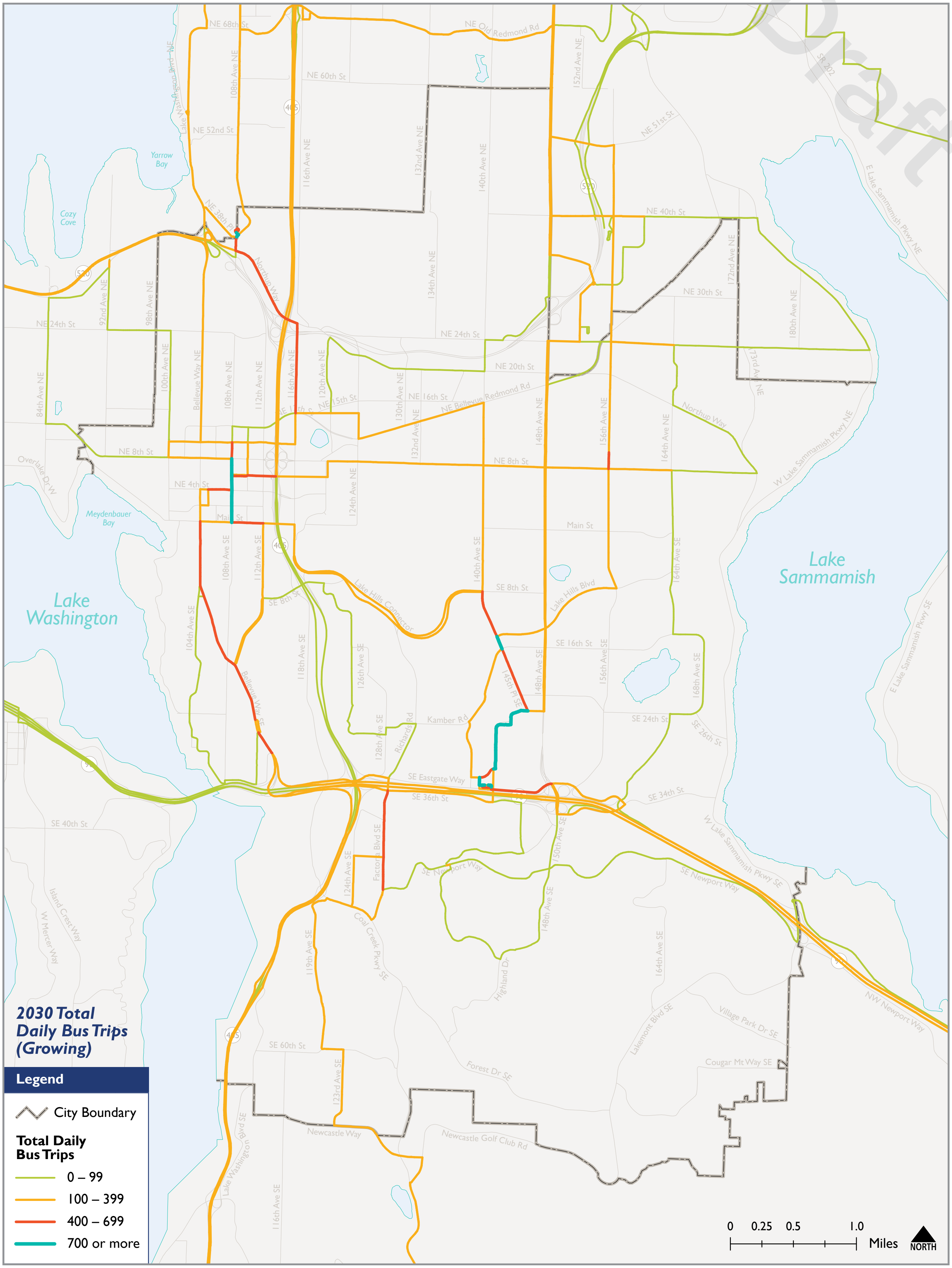


Figure 52 Bus trips operated daily, 2030 Growing Resources Network.



to be operated by the 2030 Growing Resources Network. (See the *Transit Service Vision Report* for details about each of these networks.) Figure 51 on page 36 and Figure 52 on page 37 compare the number of daily bus trips operated in 2012 and 2030, respectively. Among future networks, the bus volume analysis was completed only for the 2030 Growing Resources Network because that represents the maximum number of bus trips that will be operated per day within the TMP's implementation period. All routes were associated to the streets on which they operate, and the number of daily trips operated by each were aggregated for all overlapping segments.

Approach Delay

Delays experienced by vehicles on city streets are primarily the result of intersection related delays from traffic control devices like traffic signals. As vehicle volumes increase during peak periods and congestion builds, delays in the transportation network increase. This is particularly evident at signalized intersections. In congested and high-volume corridors, a single intersection can be a bottleneck for large parts of the network, creating significant delays to general purpose traffic and any buses traveling in general travel lanes.

The measure used in this analysis captures the sum of the average weekday, PM peak intersection approach delay, measured in seconds, along an analysis segment. City staff calculated approach delay for 2010 and 2030 using the Dynameq travel demand model. This model is more detailed than the City's travel demand model because it provides specific operational metrics at an intersection level. However, not all aspects of traffic are modeled, such as the impact of high pedestrian volumes on turning vehicle delays. Only intersection approaches served by bus routes that operate frequent headways were included in the analysis.

Approach Queue

The queue length is measured as the length of vehicles waiting to travel through an intersection. Intersection approach queues are summarized along an analysis segment. The approach queue experienced for an intersection approach is influenced by its signal timing (green time allocated to that approach), signal coordination, and traffic volumes.

Data for the approach queues was included in the TMP Capital Element analysis because it can identify approaches that are currently or expected to experience long vehicle queues, impacting the speed and reliability along key transit corridors. This information can help guide transit priority treatment, such as installation of queue jumps or bus-only lanes so that buses can bypass queued vehicles.

Forecasted average PM peak hour approach queue is reported for 2010 and 2030 in terms of the average length in feet (see Figure 53 on page 40 and Figure 54 on page 41, respectively). This data is based on the City of Bellevue's Dynameq travel demand model.

Intersection Level of Service

The performance of an intersection can be reported in many ways, but intersection level-of-service (LOS) is the measure most commonly used by traffic engineers. LOS uses the average delay experienced by a vehicle at an intersection and assigns a letter grade of A through F, with an intersection of LOS A experiencing little delay and an intersection of LOS F experiencing significant delay.

With respect to transit speed and reliability, intersection level-of-service has several implications. An intersection with a poor LOS indicates a location where transit likely experiences delays; however, it also indicates an intersection where transit priority treatments are likely more difficult to implement successfully due to impacts on other modes or physical limitations. In contrast, intersections with

Figure 53 Intersection level-of-service (LOS) and average queue length (in feet) in 2010.

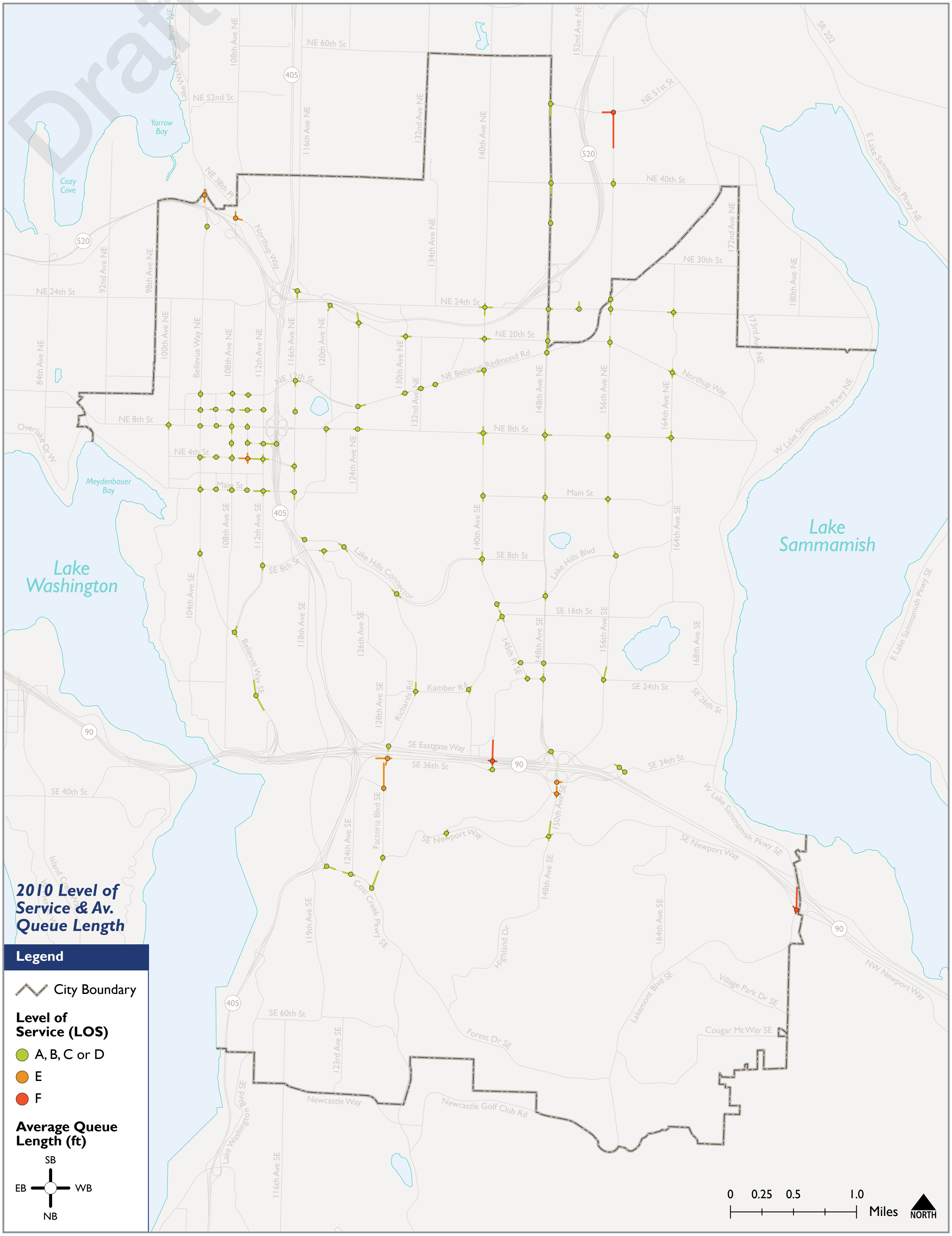
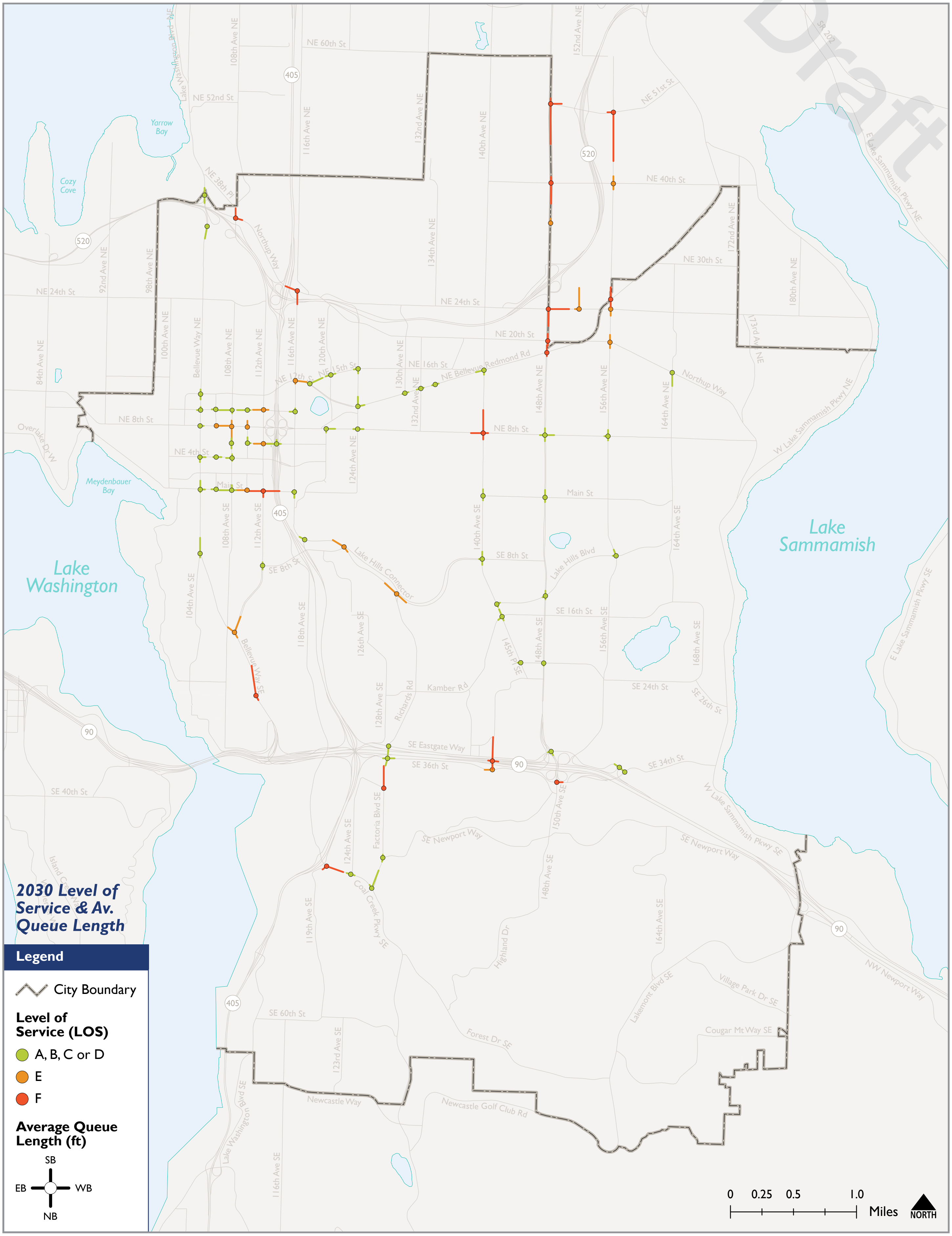


Figure 54 Intersection level-of-service (LOS) and average queue length (in feet) in 2030.



Safety – Safety is always a paramount concern for the City of Bellevue and Metro. Safety issue can result in slower and less reliability travel times as operators slow to ensure they are operating coaches safely.

Signal Failure – At some intersections it can take buses multiple green lights to get through an intersection, adding delay and travel time reliability issues. The cause of these delays vary depending on the location.

Signal Timing – Traffic lights are controlled in several ways and are generally timed in a way to minimize vehicle delay. Identifying locations or corridors where coach operators observed potentially unnecessary delay due to timing of the lights will help identify locations where various operational changes like revised traffic light timing could be made friendlier to transit.

Maneuver Delays – Metro coaches are some of the largest vehicles on many of the roads they serve. Locations which are hard for operators to negotiate can cause speed and reliability issues which can repeat hundreds of times a day. Intersections were coaches make a right turn can be particularly troublesome.

General Delays – While traffic models have been used to identify congestion related delays, there may be locations where, due to some local circumstance or roadway design, additional detail from coach operators could help more clearly understand the cause of delays and possible solutions. Locations with left turns are of particular concern as the models used are not sensitive to these delays.

medium or good LOS have less delay and are likely easier to implement transit priority because impacts on other modes are less significant. However, this also means that the benefits realized by any transit priority treatments implemented are more limited because the delays originally experienced are less substantial.

As with approach delay data, City staff generated intersection LOS data based on the 2010 and 2030 PM peak hour Dynameq travel demand model. Intersection LOS was summarized by analysis segment, using the worst intersection LOS along the segment (see Figure 53 on page 40 and Figure 54 on page 41 for 2010 and 2030 data, respectively).

Operator Feedback

Through their work and often years of experience, Metro coach operators learn traffic patterns in a way that most road users likely never will. They see how traffic changes during the day and over the course of a year, as well as how service changes affect interactions between transit and traffic. Coach operators can therefore provide significant insight into existing traffic congestion on Bellevue streets and help identify critical points in the network that could benefit from closer consideration by planners.

An optional survey was used to solicit feedback from coach operators about several general categories of issues related to transit speed and reliability, as shown at the right. This feedback was valuable because it helped to reaffirm some of the data provided by other sources and filled in the gaps left by those sources in some cases. Responses were collected by paper survey with questions, a map, and an area for written response (see the *Coach Operator Outreach Report*). The primary challenge with leveraging operator feedback is combining this more subjective feedback with the more objective measures used in other analyses.

DATA PROCESSING

Several data processing steps were necessary to convert the above mentioned data into information which could be used in the issues identification analysis. Data processing was completed using a mapping technology called Geographic Information Systems (GIS) due to the spatial nature of the data and analysis.

The City of Bellevue and King County Metro provided data in several formats, primarily GIS shapefiles. Most data sources were derived from a different source, therefore extensive discussion between the consultant the City and Metro occurred to ensure data was accurately mapped and used. Some format conversion, data integration and map modifications of the data were however required. Several files did not overlap other files when mapped, which required modification to ensure lines overlapped. No numeric data was modified with these changes.

Data analysis segments, or the unit at which the analysis was completed on, was also developed. Analysis segments were based off the street network, with segments primarily extending from one signalized intersection to another. Data from each source was summarized using these analysis segments. Appendix B contains maps of each data source displayed using the analysis segments. The sections below describe in detail the steps completed to prepare data for analysis.

Data Collection

Approach delay, approach queueing and LOS data were provided by the City of Bellevue in separate GIS shapefile and excel files which were joined and verified to ensure the two data sources were correctly joined. This process was completed in coordination with the City of Bellevue as City staff is intimately familiar with the data. Five batches of operator surveys were provided by Metro to the City and consultant. The location of applicable, specific and clear operator survey comments were recorded in GIS by the consultant.

Data Mapping

Once data was mapped in GIS, several of the data sources did not overlap. Overlap was necessary to combine data in later steps. To ensure that all files overlapped, the lines and points of the transit ridership and bus volume data layers were shifted to overlap with the other layers. These changes were generally minor and only involved moving the location of the lines and points; no changes were made to the numeric values of the data.

Analysis Segment Development

A single common analysis unit is required to compare the multiple data sources used in the issue identification. The following process, illustrated in Figure 55, was used to develop the analysis segments:

1. Street segment from the City of Bellevue's GIS street centerline shapefile which are used by the transit in the 2030 growing resources frequent transit network were identified a selected.
2. These street segments, of which each city block has its one, were grouped into analysis segments made up of one or more street segments. Signalized intersections were used as the primary break point between analysis segments, however some unsignalized intersections were used in locations where signalized intersections were infrequent.
3. Each analysis segment was then buffered by 40 feet in all directions, creating an 80 foot wide polygon slightly longer than the analysis segment. This polygon, referred to as the buffered analysis segment, was used in the remainder of the analysis to combine, analyze and display the issue identification data and composite scores.

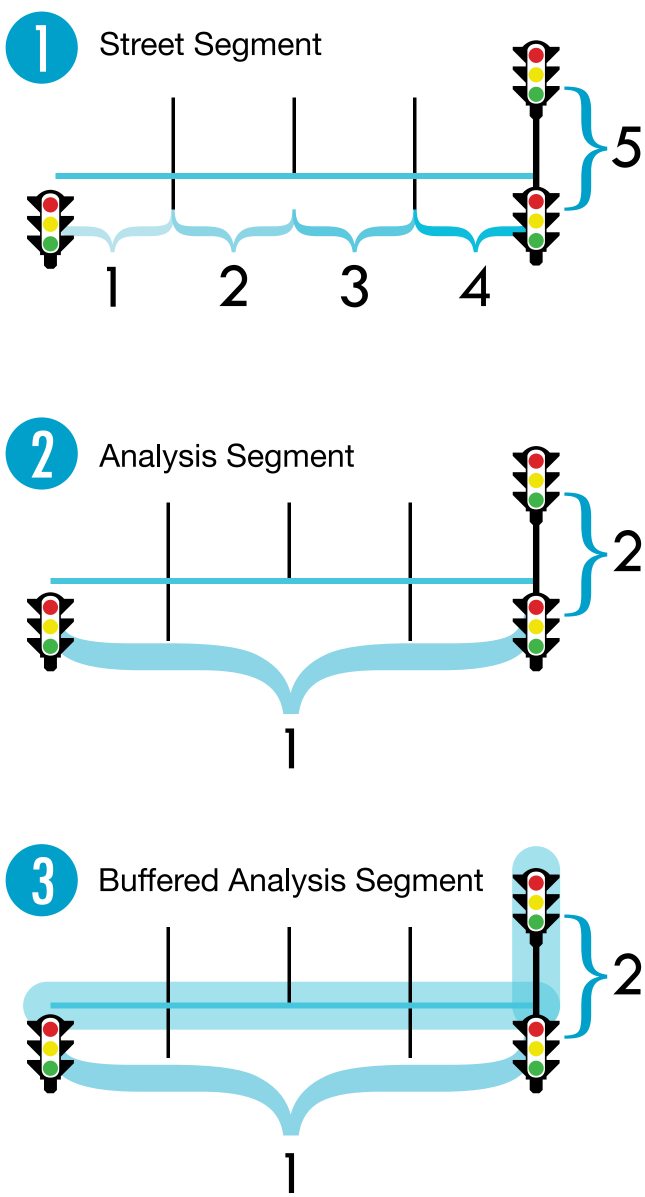


Figure 55 Analysis segment development.

Analysis Segment Data Transfer

Once the buffered analysis segment was developed, data from the various GIS data inputs was spatially joined to the buffered analysis segments. Bus volumes and ridership data was spatial joined to the buffered analysis segment using the line's mid-point to reduce overlap issues. GPS standing delays within the buffered analysis segment polygons were summed to compute the total delay which occurred inside the polygons. Operator feedback was manually added. Approach queue and approach delay for all intersections within each buffered analysis segment polygon were summed. Intersection LOS of A-F was assigned to the buffer analysis segment, using the worst intersection LOS of all intersections within the buffered analysis segment.

DATA ANALYSIS

The analysis steps outlined below brings multiple critical measures together into two composite scores focused at different time horizons, one for the short-term and another for the long-term. These composite scores help identify locations along the frequent transit network where multiple issues compound creating larger issues for transit speed and reliability.

The combination of multiple measures into the composite score facilitates comparison of the system. Using the analysis segments previously developed, issue identification was completed. This involved scoring, grouping and weighting of the various important measures. This approach was developed and modified with feedback from City and Metro staff.

Table 1 Quartile Scoring.

Quartile	Score
Fourth (Top 25%)	4
Third (Middle-Top 25%)	3
Second (Middle-Bottom 25%)	2
First (Bottom 25%)	1
None / No Data	0

Data Scoring

Each data source was grouped into four quartiles to evenly distribute data for each measure into four groups. Each data source was then assigned a score of 1 to 4 depending on the quartile in which the data was contained. Data with 2010 and 2030 data such as transit ridership and bus volumes were grouped by quartile using the 2030 results. Table 1 illustrates the scoring system.

Intersection LOS and operator comments, which have different scoring systems, were scored in accordance to Table 2. LOS is scored on a letter basis with A indicating little congestion and F indicating significant congestion. The low number of operator comments and general concentration of the comments received necessitated a unique scoring system.

Table 2 LOS and Operator Survey Scoring.

Level-of-Service (LOS)	Score
F	3
E	2
D	1
A, B, C	0

Operator Comments	Score
4-8	4
3	3
2	2
1	1

Composite Scores

The data analysis structure was designed to capture two key issues. The first issue, related to the time horizon, is addressed by developing two composite scores, one for the short-term and another for the long-term. Current and future needs may be different due to changes in the transit and transportation network or change in congestion. The solutions to short- or long-term problems can also vary, from small spot fixes for short-term issues to significant capital investments in locations with both short- and long-term issues.

Additionally, in the short-term, directly measured rather than modeled data is available. This is especially the case with bus GPS standing delays which are a direct measure of existing transit speed and reliability. The use of two composite measures more directly links each composite to a set of speed and reliability tools.

Short-Term Composite – This composite uses existing GPS bus delays, operator feedback, existing bus volumes and existing ridership volumes. This composite highlight locations where investments in speed and reliability will realize short-term benefits.

Long-Term Composite – This composite uses future bus volumes, future ridership volumes, and future modeled congestion. This is key for guiding capital investments to meet future transit needs and congestion.

Data Weighting

The second issue relates to the relative importance and combination of multiple data sources. When combining multiple measures into a composite score, the relative importance of each component needs to be asses. More important measures should be elevated, while less important measures should be lowered. These adjustments are done using weighting factors.

Approach delay, approach queue, intersection LOS and bus standing delay are all highly related measure. If one of these four measures is scores poorly, the remaining three are also likely to score poorly. To address the overlap of these data sources and respond to City and Metro comments, approach delay, approach queue and intersection LOS we removed from the short-term composite score.

Table 3 Composite Score Weighting.

Measure	Short-Term Composite		Long-Term Composite	
	Weight	Possible Points	Weight	Possible Points
Standing Delays	4x	16	-	-
Transit Ridership	2x	8	2x	8
Bus Volumes	1x	4	1x	4
Approach Delay	-	-	1x	4
Approach Queue	-	-	1x	4
Intersection LOS	-	-	1x	4
Operator Survey	1x	4	-	-
Total	8x	32	6x	24

Weighting of both short- and long-term composite scores were set such that delay or congestion related factors represent half of the overall composite scores.

Additionally, the Transit Master Planning effort has clearly identified transit ridership as the major driver behind investment in transit service. To account for the significant importance of this measure relative to other measures a weighting factor of 2x was assigned to transit ridership in both the short- and long-term composite.

Table 3 on page 47 contains the weighting factors used both in the short-term and long-term analysis as well as the total score possible for each composite. Four measures are used for the short-term composite, while five measures are used for the long-term composite. Although the two measures are related, they cannot be directly related because point allocations and totals are different.

RESULTS

Using the scoring, grouping, and weighting described above and summarized in Table 4, short- and long-term composite measure maps were developed (see). A map for each measure is also contained in the Appendices. As previously noted, these maps do not necessarily identify priorities; rather, they indicate locations where a confluence of issues is concentrated and more detailed analysis will be necessary. Buffered analysis segments with low composite scores have fewer issues while areas with higher scores have more compounding issues.

Table 4 Issue Identification: Sources, Measures, and Weighting.

Short-Term Composite Measure	Data Source	Description	Limitations	Metric	Weight
Standing Delays	AVL GPS Data	GPS-based AVL data for standing buses with their doors closed. Data is summarized by intersection.	Raw data had not yet been processed	Sum of weekday bus standing delays between 1/7 and 2/15 in minutes	4x
Transit Ridership	BKR Model	Estimated average daily transit ridership by model segment.		2010 average weekday transit ridership	2x
Bus Volumes	Spring 2013, 2030 BKR Model	Daily transit trips by road segment based on Spring 2012 service.		2013 average weekday bus volumes	1x
Safety Issues	Operator Survey	Safety issues identified by coach operators that impact speed or reliability.	Subjective	Comment	1x
Signal Failure	Operator Survey	Intersections identified by coach operators that consistently take multiple green lights to get through either due to insufficient green time or congestion.		Comment	1x
Signal Timing	Operator Survey	Signals or corridors identified by coach operators with little vehicle congestion and unnecessary delays due to poorly time signals or long signal cycles.	Subjective	Comment	1x
Maneuver Delay	Operator Survey	Locations identified by coach operators which impact speed and reliability due to difficult turning radii, required lane changes, or other roadway geometry issues.		Comment	1x
General Delay	Operator Survey	Consistent congestion-related delays identified by coach operators.	Subjective	Comment	1x
				Total Possible:	32

Long-Term Composite Measure	Data Source	Description	Limitations	Metric	Weight
Transit Ridership	BKR Model	Estimated average daily transit ridership by model segment.		2030 average weekday transit ridership	2x
Bus Volumes	Spring 2013, 2030 BKR Model	Daily transit trips by road segment based on the 2030 Growing Resources Frequent Transit Network (FTN).		2030 average weekday bus volumes	1x
Approach Delay	Dynameq Model	Estimated average PM peak hour delay in second by approach for signalized intersections in the 2030 Growing Resources Frequent Transit Network (FTN).		2030 sum of average weekday PM Peak hour approach delay (seconds of delay)	1x
Approach Queue	Dynameq Model	Estimated average PM peak hour queue length in feet by approach for signalized intersections in the 2030 Growing Resources Frequent Transit Network (FTN).	Determining meaningful threshold, related to approach delay	2030 sum of average weekday PM Peak hour approach queue length (in feet)	1x
Intersection LOS	Dynameq Model	Estimated PM peak hour LOS for signalized intersections in the 2030 Growing Resources Frequent Transit Network (FTN).		2030 intersection LOS	1x
				Total Possible:	24

Measures Considered But Not Used	Data Source	Description	Limitations
Street Congestion	BKR Model	Estimated PM peak hour vehicle volumes divided by estimated roadway capacity. Ratios near or above 1 indicate roadways with congestion.	Less accurate than Dynameq in areas with closely spaced signals and complex vehicle queues.
Mode Share	BKR Model	Estimated PM peak hour HOV person throughout divided by total roadway person throughput. Ratios closer to 1 indicate higher relative person HOV throughput.	Not available for all corridors
Scheduled Speed	TPI Travel Speed	Scheduled travel time by time of day divided by the distance between origin and destination time point.	Not available
Travel Time Variability	TPI Variability	Variation in travel time per TPI. High variation indicates TPIs with travel time reliability issues.	Not available

Figure 56 Short-term composite score.

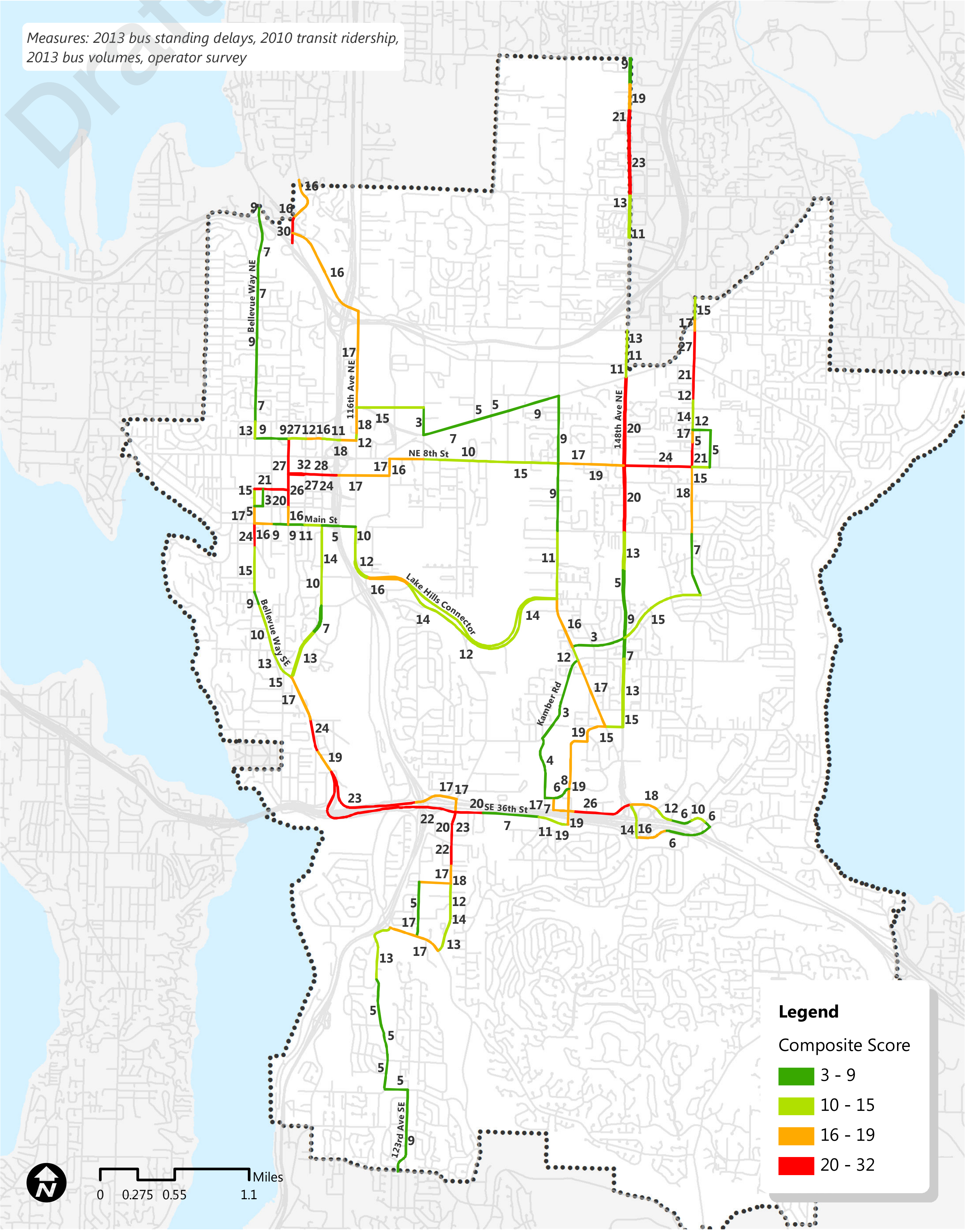
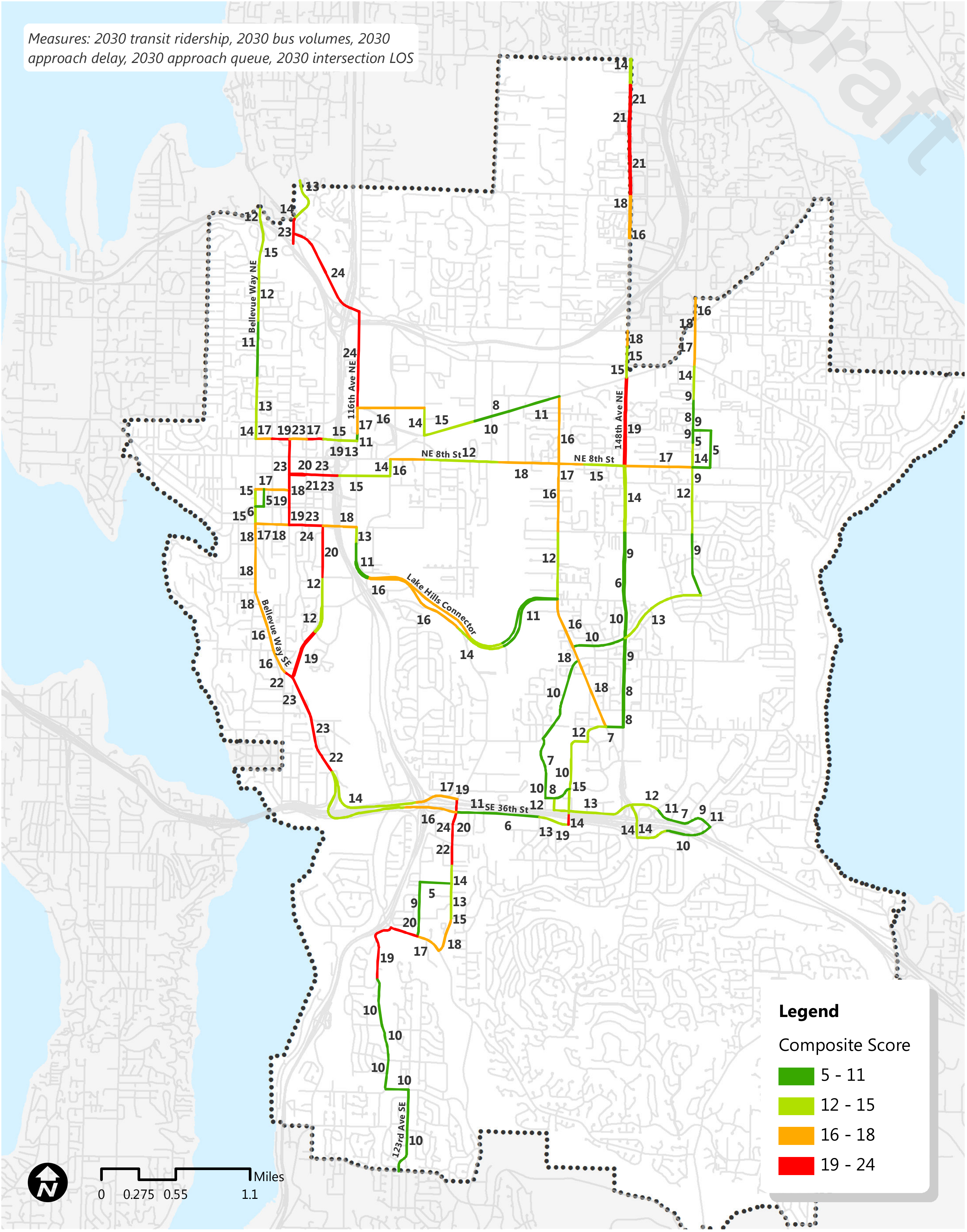


Figure 57 Long-term composite score.



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POTENTIAL IMPROVEMENTS

This section provides a preliminary list of all potential speed and reliability projects currently being considered as part of the TMP Capital Element. It includes sixty-eight discrete running way, spot improvement, or data collection projects, plus a yet to be determined number of potential transit signal priority (TSP) projects. Table 5 indicates the number of projects being considered of each type, and Figure 59 on page 55 depicts the location and/or general extent of each project.

This project list was developed by TMP consultant Transpo Group with consideration given to existing data, field investigation, and input from staff and transit agency representatives. The list will undergo various stages of development, review, and refinement, so that presented here should neither be interpreted as a comprehensive survey of all conceivable projects, nor as a finalized 'wish list'. Rather, this list includes all of the potentially beneficial projects that have not been eliminated from consideration following preliminary screening based on exceptional technical or contextual limitations. Project feasibility, costs, benefits, impacts, and implementation timeframes will all still be assessed, and some of the projects included here will not be retained in future revisions based on the findings of those analyses. Visualizations have been generated for some of the projects presented here to assist the communication of how a given type of project could be applied to specific situations. It must be emphasized that these visualizations are only conceptual and do not represent final designs or engineering-level detail.

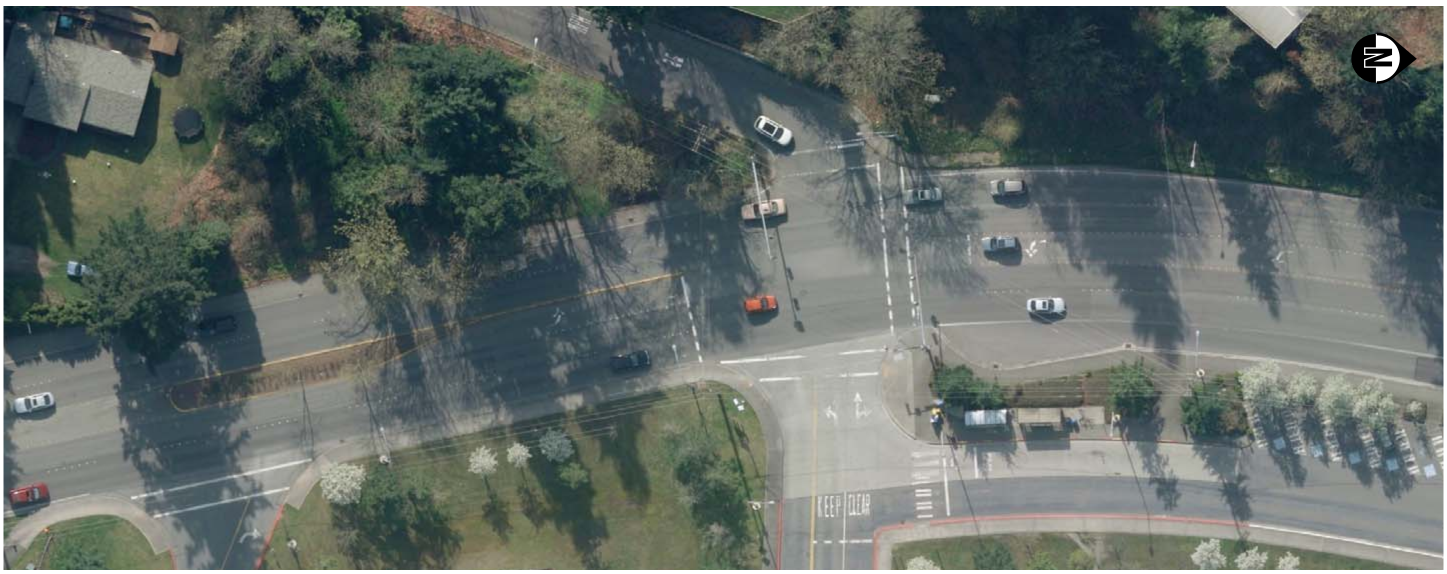
As noted in other sections, the projects identified here include only intersections and roads that are included in the 2030 Frequent Transit Network (FTN),

Table 5 Summary of potential projects by type.

Project Type	No. of Projects
Running Way Improvements	22
HOV Lanes	9
BAT Lanes	7
Roadway Construction	6
Spot Improvements	41
Queue Jump Lanes	18
Intersection and Roadway Improvements	13
Signalization Improvements	10
TSP Projects	Unspecified
Tracking & Additional Study	5
Total	68

a subset of the Growing Resources scenario. The issue identification results presented in the previous section were used to inform the development of this project list and direct attention to those locations with the most significant issues. Projects previously identified in past plans are also included in this list and have been identified as such. Refinements to the list of potential improvements were informed by the service characteristics of bus routes, transit ridership, and bus volumes by time of day; arterial traffic volume by direction; placement of bus stops, intersection geometry, turn movement counts/capacity, and safety considerations; pedestrian and bicycle impacts; and the overall scale of improvements in terms of roadway width and right-of-way.

Figure 58 Running Way Improvement Project L1: A southbound median HOV lane will be constructed on Bellevue Way SE between the South Bellevue Park-and-Ride and I-90 by Sound Transit as part of the East Link light rail extension project. This will be achieved by constructing a new lane, thereby maintaining all existing general purpose lanes. Aerial images depict roadway striping before and after construction.



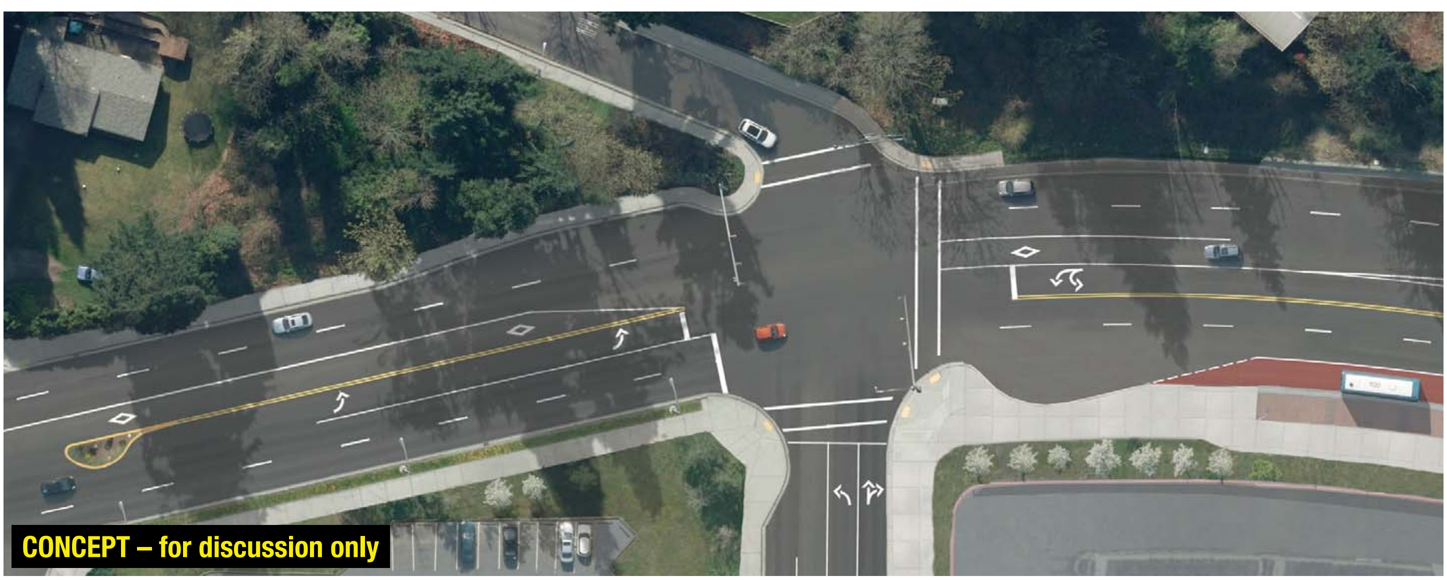
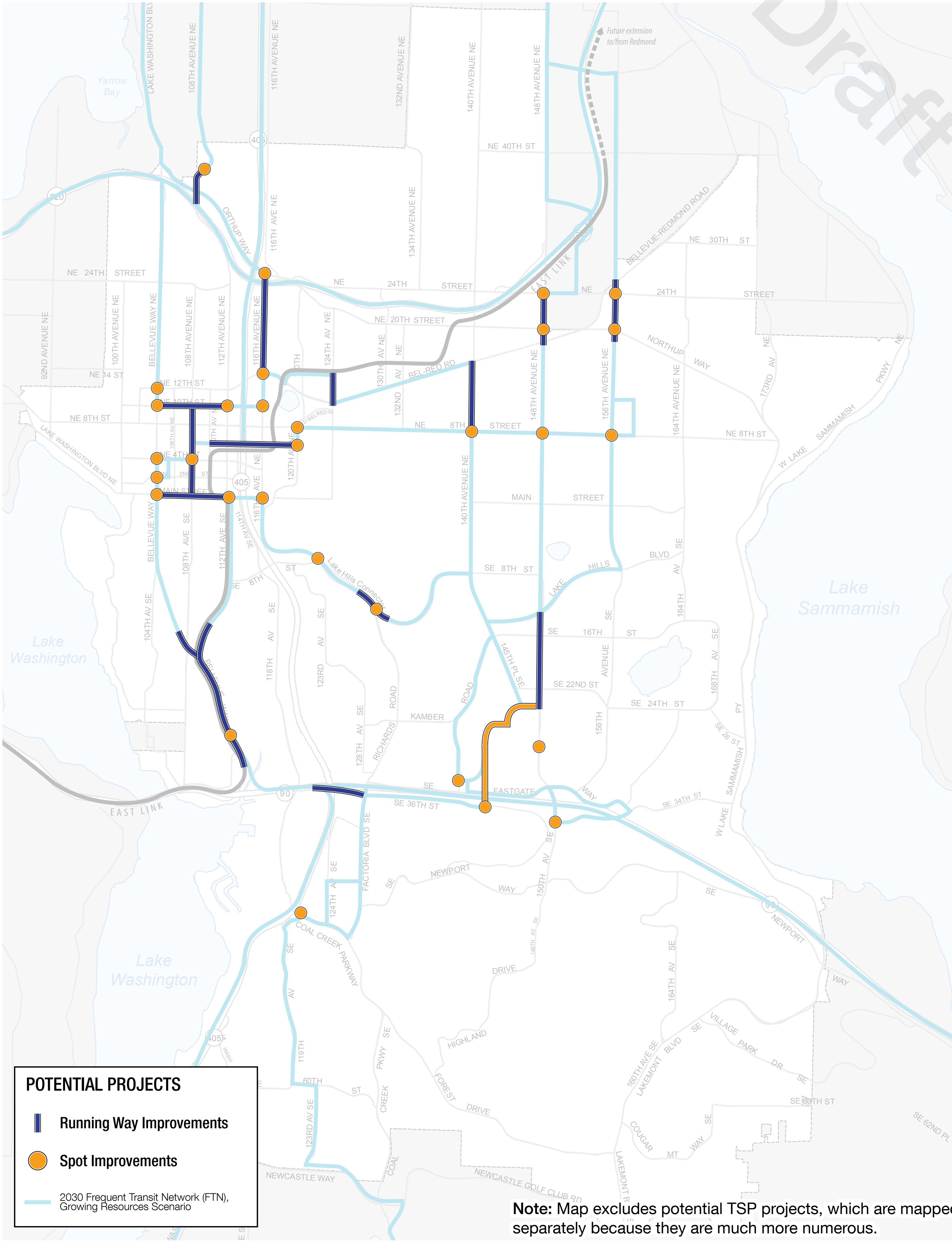


Figure 59 Potential spot and running-way improvement projects.



Note: Map excludes potential TSP projects, which are mapped separately because they are much more numerous.

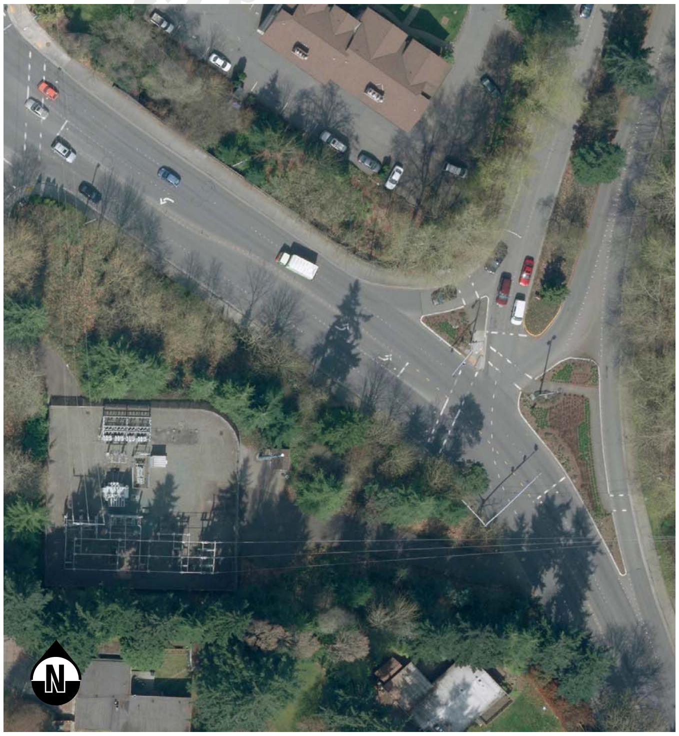


Figure 60 Running Way Improvement Projects L2, L3 and L4: Median HOV lanes on Bellevue Way SE and 112th Ave SE would improve the movement of transit vehicles through this congested Y-intersection southbound to South Bellevue Park-and-Ride. This would be achieved by constructing one lane on Bellevue Way SE and constructing a new median lane on 112th Ave SE. Aerial images depict roadway striping before and after lane reconfiguration. This concept maintains all existing general purpose travel lanes.

TRANSIT RUNNING WAY IMPROVEMENTS

Twenty-two projects relating to transit running ways are currently being considered, including the reconfiguration or restriction of general purpose travel lanes and the conversion or construction of new lanes for transit (see Figure 62 and Table 6 on the following pages). Potential improvements include High-Occupancy Vehicle (HOV) lanes and Business Access and Transit (BAT) lanes along several key corridors in the 2030 Frequent Transit Network (FTN). Some of the projects included may also be beneficial to consider in the short-term as 'early wins' in the Transit Master Plan's implementation.

Some notable projects include HOV lanes along several segments of Bellevue Way SE and 112th Ave SE (see Figure 60), BAT lanes along the 108th Ave NE Bus Priority Corridor in Downtown, HOV lanes along 110th Ave NE, Main St, and the NE 6th St Extension (see Figures 58 and 59), and an upgrade of Snoqualmie River Rd so that it can accommodate bus traffic. Two other projects that warrant specific mention because of their unique nature include a transit bypass lane on Lake Hills Connector at Richards Rd (see Figure 66) and roadway improvements to the eastbound I-90 off-ramp at Factoria Blvd.

Figure 60 depicts an early conceptual rendering of how three HOV lane projects (L2, L3, and L4) might be included in the street right-of-way along Bellevue Way SE and 112th Ave SE (see also Figure 61). These treatments are meant to improve travel time for southbound buses through this Y-intersection to the South Bellevue Park-and-Ride. Project L2 between the Y-intersection and the park-and-ride was included in Sound Transit's *East Link Extension Cost Savings Work Plan Findings* report in September 2012, but it has since been separated from any improvements being made for East Link by Sound Transit. This corridor ranks among those with the greatest need in both the short- and long-term based on the results of the issue identification process, but it remains a sensitive topic among some members of adjacent neighborhoods. Funding has already been secured for project L1 from the park-and-ride south to I-90, and it will be constructed by Sound Transit as part of the East Link project.

Figure 61 Running Way Improvement Projects L2: A southbound median HOV lane on Bellevue Way SE would improve the speed and reliability of transit vehicles between 112th Ave SE to South Bellevue Park-and-Ride. This would be achieved by constructing one lane on Bellevue Way SE, thereby maintaining all existing general purpose travel lanes. Aerial images depict roadway striping before and after construction.

Figure 62 Map of potential transit running way projects.

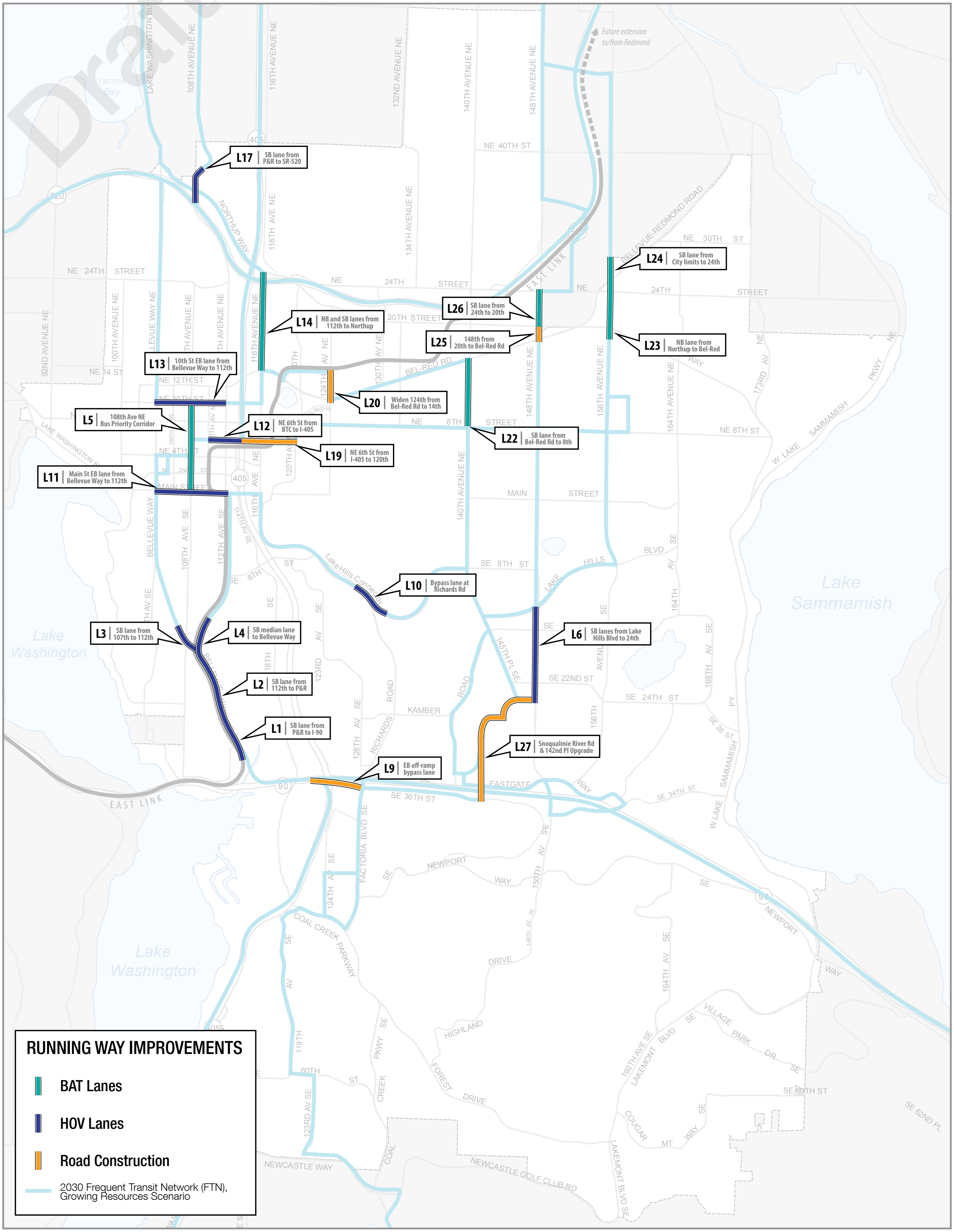


Table 6 Potential transit running way projects.

ID	Project	Type	FTN Service Routes	FTN Service Frequency (Peak/Base/Night)	Project Description	Composite Scores Short-Term	Composite Scores Long-Term	Project Need	Potential Issues
L1	Bellevue Way SE HOV Lane - South Bellevue P&R	Lane Construction	1, 3, 11	2-3 / 3-5 / 10-15	Construct a southbound HOV Lane on Bellevue Way SE between South Bellevue Park-and-Ride and I-90			Previously noted in multiple plans including East Link Cost Saving Negotiations, Bellevue Transit Plan, Bellevue Transit Improvement Analysis, and Transportation Facilities Plan. See TIP-54 and TFP-242.	
L2	Bellevue Way SE HOV Lane - South Bellevue P&R Extension	Lane Construction	1, 3, 11	2-3 / 3-5 / 10-15	Construct a southbound HOV lane on Bellevue Way SE between South Bellevue Park and Ride and Y intersection with 112th Ave			Previously noted in Bellevue plans. See TIP-55 and TFP-242.	
L3	Bellevue Way SE HOV Lane - 112th Ave SE Extension	Lane Conversion/ Restriction	3, 11	4 / 5-6 / 15	Construct a southbound median HOV Lane on Bellevue Way SE from 112th Ave SE to approximately 107th Ave SE.			Addresses operator feedback, 2030 LOS of E and 2030 queuing, and frequent service.	Property impacts on the west side of Bellevue Way SE at the intersection with 112th Ave SE.
L4	112th Ave SE HOV Lane	Lane Construction	1	8 / 10 / 30	Construct a southbound median HOV Lane on 112th Ave SE from Bellevue Way to slightly beyond end of intersection queue.			Addresses operator feedback, 2030 LOS of E and 2030 queuing.	Property impacts on the west side of Bellevue Way SE at the intersection with 112th Ave SE.
L5	108th Ave NE Bus Priority Corridor	Lane Restrictions	1, 2, 3, 5, 6, 11, 13	1 / 1 / 4	Construct or convert existing lanes along 108th Ave NE using BAT lanes as identified by the downtown transportation plan update from NE 10th st to Main St			Very high bus volumes, revised circulation patterns, increased bus layover needs, and higher passenger boarding/alighting volumes will require additional transit capacity. Previously noted in several plans including the Downtown Transportation Plan Update, Bellevue Transit Plan, and Bellevue Transit Improvement Analysis. See TIP-51 and TFP-230 .	
L6	148th Ave SE Improvements - Bellevue College	Lane Construction	12	8 / 12 / 30	Construct southbound HOV lane and transit queue jump lanes and TSP on 148th Ave SE between Lake Hills Blvd and SE 24th St			Previously noted in the Bellevue Transit Plan. See TIP-66.	
L9	I-90 Factoria Blvd Exit Expansion	General Purpose Lane Construction	11	8 / 12 / 30	In coordination with the Mountains to Sound Greenway relocate current trail undercrossing of ramp between I-405 and I-90 Eastbound to new bridge south of existing undercrossing and add second off-ramp lane to the current ramp undercrossing. Evaluation how best to stripe ramp to ensure reliable transit operations.			Addresses 2010 intersection LOS of E and queuing issues. Could be funded in coordination with TIP-35, CIP W/B-78, and TFP-243.	
L10	Lake Hills Connector Tee Intersection Bypass	Lane Construction	13	8 / 12 / 30	Construct westbound transit bypass lanes at T-intersections with Richards Rd.			Addresses 2030 intersection LOS of E and queuing issues.	Wetland easements surround the intersection of Lake Hills Connector and Richards Rd, limiting the available space for additional lanes.
L11	Main St HOV Lane	Lane Restriction	1, 13	4 / 5-6 / 15	Convert one eastbound lane to PM peak HOV lane from Bellevue Way to NE 112th Ave SE.			Addresses 2030 intersection LOS of E/F at multiple intersections as well as significant queuing issues.	
L13	NE 10th ST HOV Lane	Lane Restrictions	5	8 / 10 / 15	Convert eastbound PM peak HOV lane on NE 10th Street from Bellevue Way to NE 112th St.			Addresses LOS of E at one intersection and long queues at multiple intersections in 2030.	
L14	NE 116th Ave NE BAT Lanes	Lane Restrictions	5, 14	4 / 5-6 / 10-15	Convert TWLTL into southbound or northbound BAT lanes between NE 12th St and Northup Way when approaching intersections			Addresses LOS of F and long intersection queues at north end of corridor. Very frequent service on corridor.	
L17	108th Ave HOV Lanes	Lane Construction	4, 5, 14	2-3 / 3-4 / 8-10	Construct southbound lane for SR-520 westbound traffic and restrict 2nd lane for SR-520 eastbound and HOV traffic between SR-520 direct access ramps and South Kirkland Park and Ride.			Addresses current and future LOS issues (E and F respectively Very frequent service on this segment.	
L19	NE 6th St Extension	Road Extension	2, 6	4 / 5 / 10-15	Conduct pre-design analysis for the extension of NE 6th St from its current termini in the median of I-405 to the east over the northbound lanes of I-405 and 116th Ave NE to a new intersection with 120th Ave. Evaluate for additional transit improvements.			Addresses delay associated with signalized turns. Previously noted in the Bellevue Capital Investment Program and Transportation Facilities Plan. See TIP-14, CIP R-162, and TFP-211.	
L20	124th Ave NE - Bel-Red Road to NE 14th Street	Road Upgrade	14	8 / 12 / 30	Complete preliminary design for the widening of 124th Ave NE from Bel-Red to NE 14th (to 5 lanes). Coordinated with PW-R-166. Evaluate for additional transit improvements.			Addresses delay associated with signalized turns. Previously noted in the Bellevue Capital Investment Program and Transportation Facilities Plan. See TIP-18, CIP R-169, and TFP-213.	
L22	140th Ave NE BAT Lane	Lane Construction	14	8 / 12 / 30	Construct southbound BAT lane from Bel-Red Rd to NE 8th St.			Addresses future LOS of F as well as significant queuing.	
L23	156th Ave NE BAT Lane - Northbound	Lane Construction	7	8 / 10 / 15	Construct northbound BAT lane from south of Northup Way to just north of NE 24th St.			Addresses future LOS and queue length issues at multiple intersections.	

Table 6 continued.

ID	Project	Type	FTN Service		Project Description	Composite Scores		Project Need	Potential Issues
			Routes	Frequency (Peak/Base/Night)		Short-Term	Long-Term		
L24	156th Ave NE BAT Lane - Southbound	Lane Construction	7	8 / 10 / 15	Construct southbound BAT lane from City Limits to just south of 24th St.			Addresses future LOS and queue length issues at multiple intersections.	
L25	148th Avenue NE Master Plan Improvements	Road Upgrade	12	8 / 12 / 30	"Construct the following: - Third NB through lane on 148th Ave from 350 ft South of Bel-Red Road to east 520 on-ramp - NB right turn lane and EB/WB turn dual left turn lane at 148th and Bel-Red Rd - EB/WB dual left-turn lanes at NE 20th St & 148th Ave - Extend NB and WB right turn lanes at NE 24th and 148th Ave - EB and WB dual left-turn lanes at NE 24th St and 148th Ave NE - Configure the NB 3-lane approach on 148th Ave at the SR 520 EB on-ramp to right turn only"			Investigate how improvements can be implemented to prioritize HOV and transit. Previously noted in the Transportation Facilities Plan. See TIP-61 and TFP-250.	
L26	148th Ave NE BAT Lane - Overlake	Lane Construction/ Restriction	12	8 / 12 / 30	Convert and extend southbound right turn lane on NE 148th Ave between NE 24th and NE 20th St into a BAT lane.			Addresses future LOS of F for multiple intersections.	
L27	Snoqualmie River Road/142nd Pl SE Upgrade	Road Upgrade	14	8 / 12 / 30	Upgrade roadway surface and facilities to support very frequent transit service. Includes stronger road surface, sidewalks, bicycle facilities and bus stops and parking relocation components. Non-motorized improvements to the NE 142nd Pl SE bridge are also included.			Previously noted in the Eastgate/I-90 Land Use and Transportation Project. See TIP-63 and TFP-252.	

Consistent with the Downtown Transportation Plan Update, the *Transit Service Vision Report* proposes that many key routes follow 108th Ave NE through the length of Downtown, thereby forming a Bus Priority Corridor. BAT lanes are proposed for the curb lanes in both directions along 108th (Project L5) to accommodate the significant volume of services that will use this Downtown transit spine, which ranks among the corridors with the greatest long-term needs for speed and reliability investments based on projected ridership, bus volumes, approach delay, and queue length. As a complement to the Bus Priority Corridor, eastbound HOV lanes are being considered along NE 10th St and Main St between Bellevue Way and 112th Ave NE to address approach delay and queue length issues, as well as high bus volumes and projected ridership. Both HOV projects would be convert an existing travel lane during PM peak hours only.

Another important project assumed by the *Transit Service Vision Report* to be complete by 2030 is the NE 6th St HOV Extension, which is already included in Bellevue's Capital Investment Program (Project L19; see Figures 58 and 59 on page 61). This project will extend the existing NE 6th St HOV direct access ramp bridge from the center of I-405 east to 120th Ave NE. This would make it possible to remove all transit services from NE 8th St west of 120th Ave NE, thereby bypassing multiple intersections with long approach queues, delays, and poor level-of-service (LOS) associated with general purpose traffic entering and exiting I-405.

A final project specifically noted by the *Transit Service Vision Report*—and previously proposed by the *Eastgate/I-90 Transportation Strategies Report*—is an upgrade of Snoqualmie River Rd, which is a central factor in increasing service frequency and reliability through Bellevue College. This project (L27) involves improving the roadway surface to be capable of supporting very frequent bus service, new bus stops, and associated pedestrian/bicycle facilities. Without this improvement, long deviations would

Figure 63 View from NE 6th Street multi-use path looking northeast at BNSF regional trail.

Figure 64 Artist rendering of East Link integrated with the NE 6th St HOV Extension. This visualization was completed before the East Link alignment was shifted to the south side of NE 6th St.

continue to be required to serve both Bellevue College and the Eastgate Park-and-Ride, resulting in an unreasonable waste of limited transit resources and a likely need to reconsider the route structure in the Eastgate area.

In contrast to the projects addressed so far, which have either been previously proposed in some form by past studies or are related to such projects, the following two projects arose entirely out of the issue identification process addressed in the previous section. The Lake Hills Connector transit bypass lane (Project L10; see Figure 66) would address 2030 projected queuing and LOS 'E' issues by allowing northwest-bound transit to continue uninterupted through this T-intersection. A queue jump (Project Q11) would provide similar benefits to southeast-bound buses. However, wetland easements adjacent to the right-of-way may impact the potential for these projects to be pursued. Also being considered is a unique roadway project that would relocate a portion of the Mountains to Sound Greenway Trail and widen an overpass structure to expand the I-90 eastbound off-ramp roadway to two lanes (Project L9; Figure 65). Further study is required to determine how to best utilize this lane to address LOS 'E' and long queue length issues to the benefit of transit and other road users.

Although the Transit Priority Toolbox reviewed in an earlier section includes improvements that afford transit greater operational exclusivity—treatments like bus-only lanes and transit-only streets—no such projects are currently included in this list.

SPOT IMPROVEMENTS

Forty-one spot improvement projects are currently being considered, including eighteen queue jump lanes, thirteen intersection or roadway improvement projects, and ten signalization improvement projects. Intersection and roadway projects relate primarily to turning movements and include improvements to turn radii and the construction of new turning lanes. Signalization improvements relate primarily to adjusting signal timing to increase the amount of green time allocated to movements operated by FTN routes, but they also include some turn restrictions on general purpose traffic during peak hours and improvements to the responsiveness of existing TSP controllers.

Queue Jumps

Queue jumps can be implemented in one of three basic configurations, as shown in Figure 68. Which variant is pursued for any given project depends primarily on the amount of right-of-way available on the near and far sides of the intersection. Queue jumps require either a complimentary lane on the far-side of the intersection (right diagram) or TSP treatment to allow buses to advance through the intersection before general purpose traffic (left and center diagrams). Where permitted by the amount of right-of-way available, it is operationally preferable to use a designated queue jump lane with an advance green signal, as shown by the left and right diagrams. The alternative depicted by the center diagram involves restriction of the right lane so that only transit vehicles can continue through the intersection; for general purpose traffic, it becomes a right-turn only lane. This latter configuration is less desirable both because it removes a through-lane from general purpose traffic and because of the potential for buses to be caught behind a queue of right-turning vehicles, reducing the benefit afforded to transit by the queue jump.

Figure 66 Running Way Improvement Project L10 and Spot Improvement Project Q11: A shoulder transit-only bypass lane would eliminate signal and queuing delay for northwest-bound on this segment of Lake Hills Connector, and a queue jump lane would assist southeast-bound buses. Both projects would require new lanes to be constructed if implemented as shown, but all existing general purpose travel lanes would be maintained.

Figure 65 (opposite) Running Way Improvement Project L9: The eastbound I-90 off-ramp would be widened from one lane to two by modifying an overpass structure and relocating the Mountains to Sound Greenway Trail. This project would help reduce signal and queuing delay caused by the signal at Factoria Blvd, helping both transit and general purpose traffic.

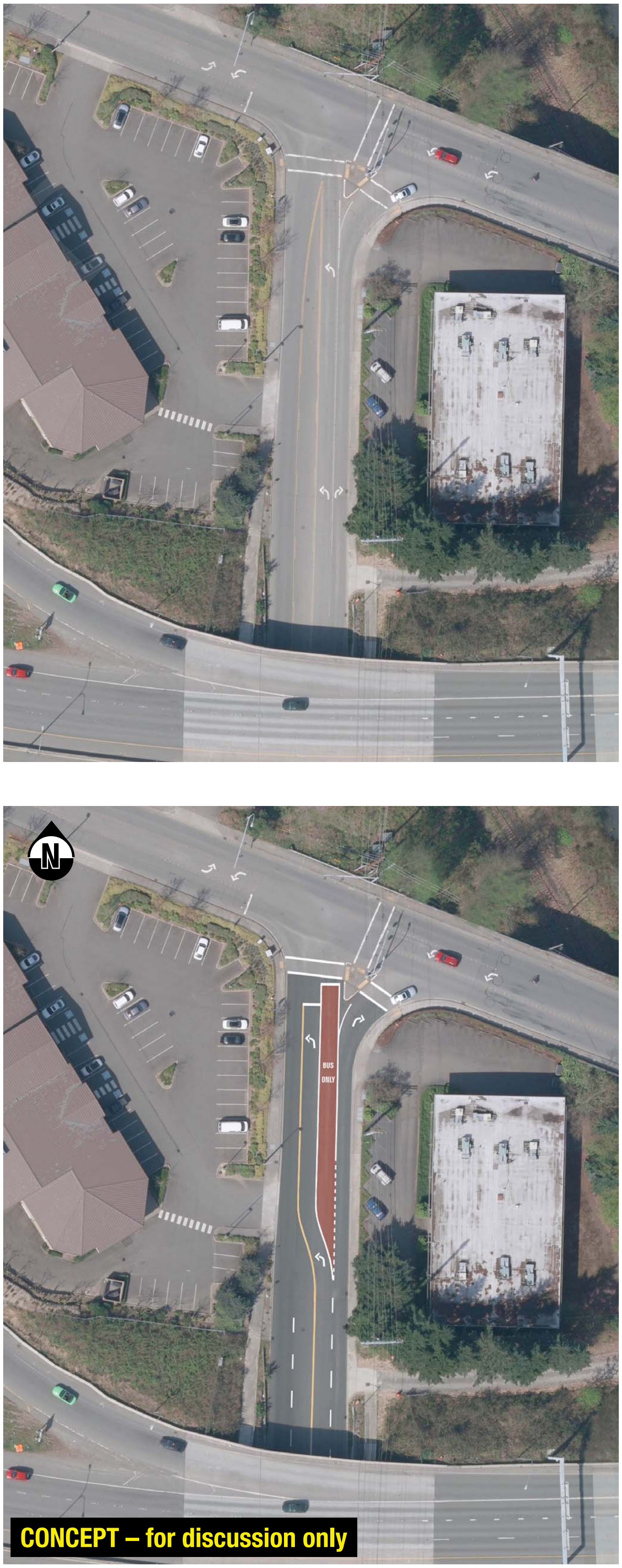


Figure 67 Spot Improvement Project Q5: Queue jump lane on NE 116th St for left turning, northeast-bound traffic at Northup Way. Aerial images depict roadway striping before and after lane reconfiguration. This concept maintains all general purpose travel lanes and requires no new lane construction—both suitable qualities for a potential 'quick win' project.

Although the conceptual visualizations presented here reflect one of these three configurations, this does not imply that there is only one way to implement a queue jump at a given location. Specific queue jump configurations have not yet been determined for any of the potential projects, but the conceptual renderings indicate one possibility. As queue jump projects are advanced through feasibility screening and project prioritzation, potential design strategies will be assessed based on signal operations, right-of-way availability, and constructability restrictions.

Some notable queue jump projects being considered include one on 116th Ave NE for northbound buses turning west (left) onto Northup Way (see Figure 67), one for northbound buses on 108th Ave NE at Northup Way, and two for nothbound traffic on Bellevue Way NE—one at Main St and another at NE 12th St. Three queue jumps are also being considered on Lake Hills Connector—one in each direction at SE 8th St and another at Richards Rd for southeast-bound buses (see Figure 66 on page 63 for the latter).

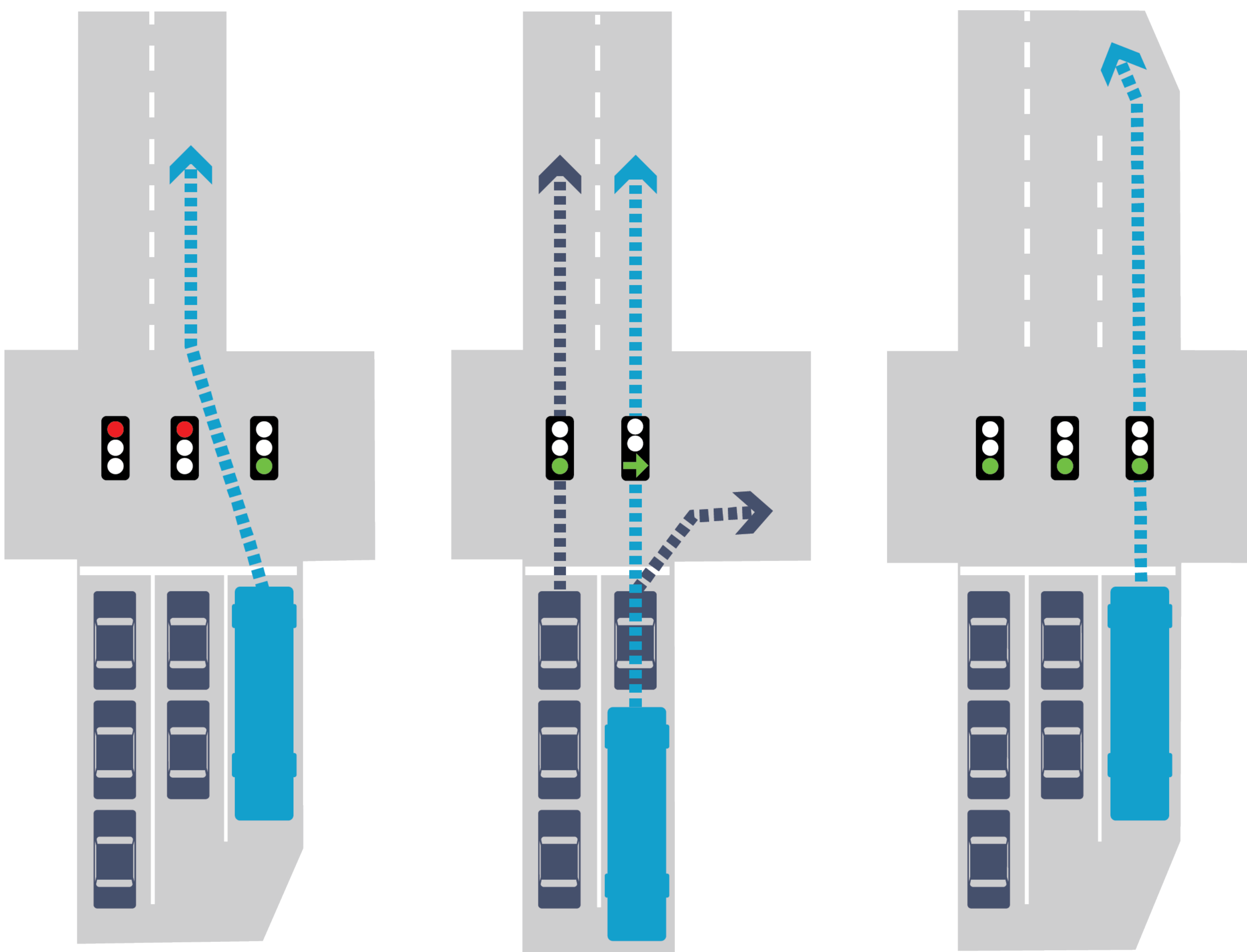
Intersection & Roadway Improvements

All but one of the potential intersection and roadway improvement projects deal with improving turn radii to better accommodate buses or adding new turn lanes to increase traffic flow and help buses pass through intersections more reliably in a single signal cycle. The only project that does not fall into these two categories (R14) simply seeks to improve the clarity of the existing channelization on NE 10th St. No negative impacts to general purpose traffic are anticipated from these improvements, as any right-of-way adjustments are lane additions, not conversions, and are not restricted to use by HOVs or buses.

Signalization Improvements

Signalization improvements relate primarily to extending the length of green phases associated with troublesome transit turning movements, either by adjusting normal signal timings or improving existing TSP controller responsiveness. New TSP implementation projects are categorized separately and are addressed in the following section. Two city-wide projects are also being considered—one to upgrade any non-SCATS traffic signals to that system, and another to coordinate with Metro to establish standards for TSP equipment and software.

Figure 68 Various configurations of queue jump lanes.



Queue Jump through
Advanced Green Signal

Queue Jump through
Transit Vehicle Exception

Queue Jump through
Transit Receiving/Merge Lane

Figure 69 Potential spot improvement projects.

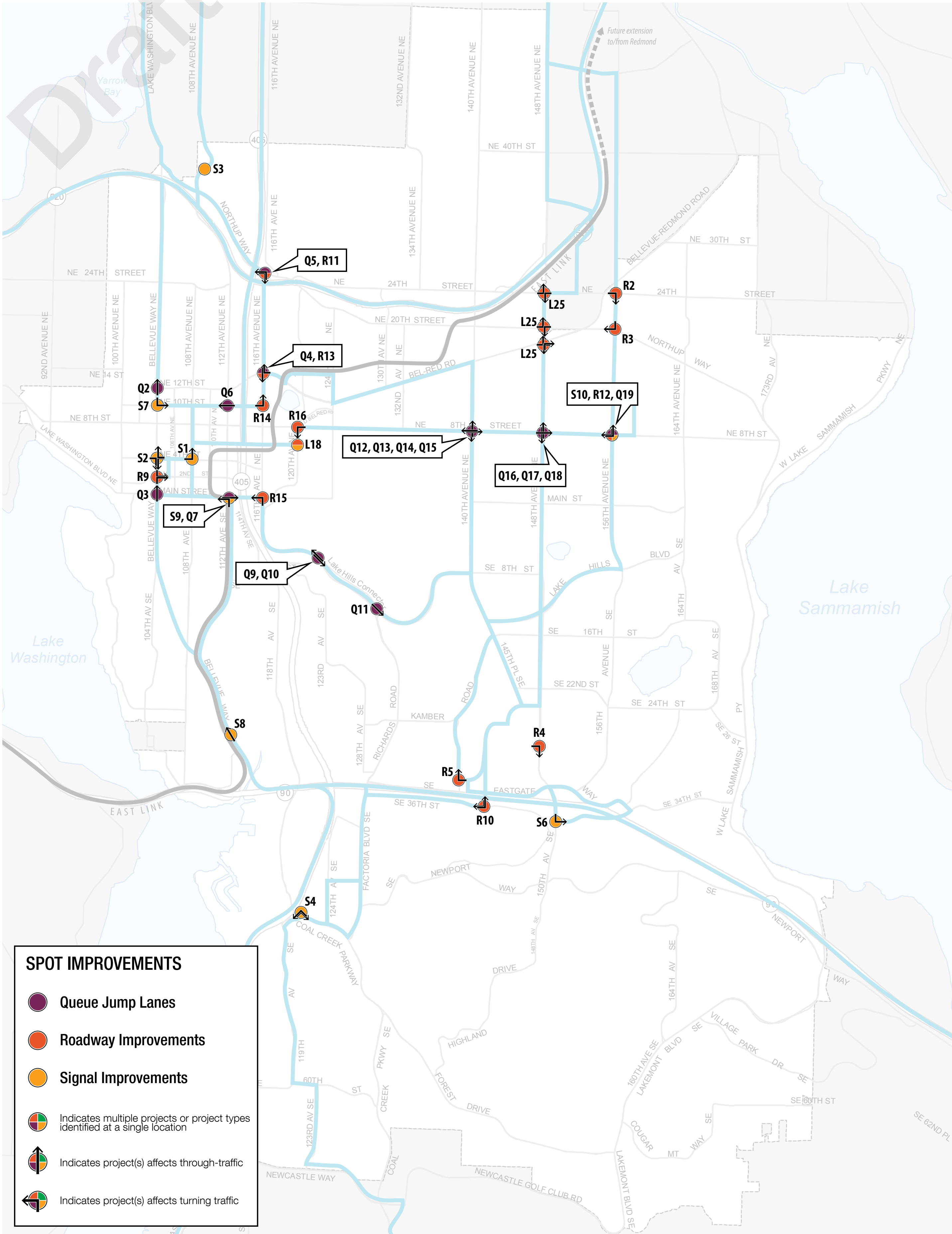


Table 7 Potential transit running way projects.

ID	Project	Type	FTN Service		Project Description	Composite Scores		Project Need	Potential Issues
			Routes	Frequency (Peak/Base/Night)		Short-Term	Long-Term		
Queue Jump Lanes									
Q2	Bellevue Way and NE 12th St - Northbound	Queue Jump	1	8 / 10 / 30	Add queue jump to northbound right turn lane.			High frequency transit service	
Q3	Bellevue Way and Main St - Northbound	Queue Jump	3, 11	4 / 5-6 / 15	Add queue jump through conversion of right lane to a right turn only lane.			Addresses operator comments and high bus volumes. Uses existing facilities to prioritize transit.	
Q4	Northup Way and 116th Ave NE - Northbound	Queue Jump	2, 5, 14	2-3 / 3-4 / 8-10	Add northbound to westbound queue jump lane.			Addresses future LOS and queuing issues, and very high bus volumes	
Q5	116th Ave NE and NE 12th St - Southbound	Queue Jump	5, 14	4 / 5-6 / 10 - 15	Add queue jump without far side lane to southbound approach in right turn only lane.			Addresses high bus volumes	
Q6	NE 10th St and 112th Ave NE - Westbound	Queue Jump	5	8 / 10 / 15	Add queue jump to westbound approach in right turn only lane.			Addresses future intersection LOS of E.	
Q7	Main St and 112th Ave NE - Westbound	Queue Jump	1, 13	4 / 5-6 / 15	Add queue jump to westbound approach in right turn only lane.			Addresses future intersection LOS of F and significant queuing.	
Q9	Lake Hills Connector and SE 8th St - Eastbound	Queue Jump	13	8 / 12 / 30	Add queue jump to eastbound approach in right turn only lane.			Addresses future intersection LOS of E and significant queuing.	
Q10	Lake Hills Connector and SE 8th St - Westbound	Queue Jump	13	8 / 12 / 30	Add queue jump to westbound approach in new queue jump lane.			Addresses future intersection LOS of E.	
Q11	Lake Hills Connector and Richards Rd - Eastbound	Queue Jump	13	8 / 12 / 30	Add queue jump to eastbound approach partially in of right turn lane and partially in new queue jump lane.			Addresses future intersection LOS of E and significant queuing.	Wetland easements surround the intersection of Lake Hills Connector and Richards Rd, limiting the available space for additional lanes.
Q12	NE 8th Street and 140th Ave NE - Eastbound	Queue Jump	6	8 / 10 / 15	Add queue jump to eastbound approach in right turn only lane.			Addresses future intersection LOS of E and queuing.	
Q13	NE 8th Street and 140th Ave NE - Northbound	Queue Jump	6, 14	4 / 5-6 / 10-15	Add queue jump to northbound approach in new queue jump lane.			Addresses future intersection LOS of E.	
Q14	NE 8th Street and 140th Ave NE - Westbound	Queue Jump	6, 14	4 / 5-6 / 10-15	Add queue jump to westbound approach in new queue jump lane.			Addresses future intersection LOS of E.	
Q15	NE 8th Street and 140th Ave NE - Southbound	Queue Jump	6, 14	4 / 5-6 / 10-15	Add queue jump to southbound approach in right turn only lane.			Addresses future intersection LOS and significant queuing issues.	
Q16	NE 8th St and 148th Ave NE - Eastbound	Queue Jump	6, 12	4 / 5-6 / 10-15	Add queue jump to eastbound approach in right turn only lane.			Addresses operator comments.	
Q17	NE 8th St and 148th Ave NE - Northbound	Queue Jump	6, 12	4 / 5-6 / 10-15	Add queue jump to northbound approach in right turn only lane.			Addresses operator comments.	
Q18	NE 8th St and 148th Ave NE - Southbound	Queue Jump	6, 12	4 / 5-6 / 10-15	Add queue jump to southbound approach in right turn only lane.			Addresses operator comments.	
Q19	NE 8th St and 156th Ave NE (NB)	Queue Jump	6, 7	4 / 5 / 7-8	Convert right lane of northbound approach into right turn only lane expect for transit.				
Intersection and Roadway Improvements									
R2	156th Ave NE and NE 24th St Turn Radii	Turn Radii	7	8 / 10 / 15	Improve turn radii for eastbound right-turn 156th Avenue at NE 24th Street			Previously noted in the Eastgate/I-90 Land Use and Transportation Project.	
R3	Northrup Way and 156th Ave NE Turn Radii	Turn Radii	7	8 / 10 / 15	Improve turn radii for the southbound right-turn at 156th.			Previously noted in the Bellevue Transit Plan and Bellevue Transit Improvement Analysis.	
R4	Landerholm Circle and 148th SE Radii Improvements	Turn Radii	7, 13	4 / 5-6 / 10-15	Improve turn radii for eastbound right-turn 148th Ave at Landerholm Circle			Previously noted in the Bellevue Transit Plan and Bellevue Transit Improvement Analysis.	
R5	SE 32nd St and 139th Ave SE Radii Improvement	Turn Radii	14	8 / 12 / 30	Improve turn radii for westbound right-turn 139th Ave SE at SE 32nd Street			Previously noted in the Bellevue Transit Plan and Bellevue Transit Improvement Analysis.	
R9	NE 2nd St and Bellevue Way Turn Improvement	Road Upgrade	3, 5, 6	2-3 / 3-4 / 8-10	Add a northbound right-turn lane and a second southbound left turn lane.			Previously noted in the Bellevue Transit Plan and Bellevue Transit Improvement Analysis.	
R10	SE 36th ST and 142nd Ave SE	Turn Lanes	7	8 / 10 / 15	Improve eastbound to northbound and southbound to westbound turn movement through construction of southbound right turn lane and northbound bus stop pullout.			Previously noted in the Eastgate/I-90 Land Use and Transportation Project.	

Table 7 continued.

ID	Project	Type	FTN Service Routes	FTN Service Frequency (Peak/Base/Night)	Project Description	Composite Scores Short-Term	Composite Scores Long-Term	Project Need	Potential Issues
Intersection and Roadway Improvements (cont.)									
R11	Northup Way and NE 116th St Turn Improvement	Turn Lanes	5, 14	4 / 5-6 / 10-15	Add a eastbound to southbound right turn lane.			Addresses future intersection LOS of F with queuing issues, high bus frequency.	
R12	NE 8th St and 156th Ave NE Turn Radii	Turn Radii	6, 7	4 / 5 / 7-8	Improve southbound to westbound turn radii.			Addresses operator comment.	
R13	NE 12th St and 116th Ave NE Turn Lane	Turn Lanes	5, 14	4 / 5-6 / 10-15	Add westbound to northbound right turn lane.			Addresses future intersection LOS of E and queuing issues.	
R14	NE 10th St and 116th Ave NE Channelization		5	8 / 10 / 15	Clarify channelization of eastbound approach such that right lane feeds into curb right-turn only lane and first left-turn only lane.			Prioritizes lane with transit at closely spaced intersection.	
R15	116th Ave SE and Main St Turn Lane	Turn Lanes	13	8 / 12 / 30	Add second northbound to westbound turn lane. Time of day ITS solutions might eliminate need for lane construction.			Addresses existing left turn queuing issues.	
R16	NE 8th St and 120th Ave NE Turn Lane	Turn Lane	6	8 / 12 / 15	Add second westbound to southbound turn lane and restrict to HOV and Transit.			Addresses existing left turn queuing issues.	
R18	NE 4th St and Bellevue Way Turn Improvement	Turn Improvement	3, 5, 6	2-3 / 3-4 / 8-10	Add a southbound right turn lane, a westbound right-turn lane, and a dual westbound left-turn lanes.			Previously noted in the Transportation Facilities Plan. See TIP-48 and TFP-222.	
Signalization Improvements									
Citywide-S1	Traffic Computer System Upgrade	ITS	NA	NA	Citywide replacement of traffic signal and software to upgrade to a SCATS traffic system.			SCATS implementation has shown to reduce travel times across, which will generally result in improved speed and reliability of transit service.	
Citywide-S2	Controller Equipment and Software Standards	Standards	NA	NA	Coordinate with King County Metro on equipment and software TSP standards for all new signal controllers.			Ensures TSP treatments can be easily implemented in the future with existing equipment and software	
S1	NE 4th St and 108th Ave Turn Improvement	Turn Improvement	3, 6	2 / 2-3 / 4-7	Improve eastbound left turn level of service for transit through increased time allocation or TSP. Explore strategies to reduce southbound right turn delays caused by pedestrians.			Addresses top operator comment location.	
S3	South Kirkland P&R Signalizations	Signalization	4, 5, 14	2-3 / 3-4 / 8-10	Signalize NE 108th South Kirkland Park and Ride entrance			Previously noted in the Bellevue Transit Plan and Bellevue Transit Improvement Analysis	
S4	Coal Creek Pkwy SE and 119th Ave SE Turn Improvement	Turn Improvement	11	8 / 12 / 30	Improve westbound to southbound and northbound to eastbound turn movements through timing prioritization and TSP.			Addresses future intersection LOS of F and queuing issues.	
S6	SE 37th St and 150th Ave SE Turn Restriction	Turn Restriction	13	8 / 12 / 30	Restrict southbound to eastbound turns during PM peak hours to HOV and transit to reduce volumes and ensure SE 37 St eastbound is not blocked by queuing traffic from I-90 eastbound.			Addresses existing and future LOS of E and F.	
S7	Bellevue Way and NE 10th St Turn Improvement	Turn Improvement	1	4 / 5 / 15	Improve southbound to eastbound turn movement through signal timing prioritization and TSP. Improve westbound to northbound movement through conversion on right through lane to right turn only lane.			Reduces intersection signal delay	
S8	Bellevue Way and South Bellevue Park and Ride TSP Improvement	TSP Improvement	1, 3, 11	2-3 / 3-4 / ~10	Improve responsiveness of northbound TSP operations			Addresses multiple operator comments that northbound TSP was not responsive enough	
S9	112th Ave NE and NE Main St Turn Improvement	Turn Improvement	1, 13	4 / 5-6 / 15	Improve northbound to westbound turn movement through timing prioritization and TSP.			Addresses future intersection LOS of F.	
S10	NE 8th St and 156th Ave NE Turn Improvement	Turn Improvement	6, 7	4 / 5 / 7-8	Improve eastbound to northbound left turn through timing prioritization and TSP. If not adequate consider construction of second left turn lane.			Addresses multiple operator comments.	

TRANSIT SIGNAL PRIORITY

The number of potential transit signal priority (TSP) projects has not yet been determined because early feasibility screening is still being completed. Figure 71 therefore depicts most of the traffic signals through which 2030 Frequent Transit Network routes will pass, including the direction of travel for which TSP would benefit transit operations. Only twelve potential signal projects have been eliminated from consideration to date based on known signal and/or roadway limitations.

If transit efficiency and reliability were the only two considerations necessary in determining where TSP should be deployed—that is, if cost were no object, impacts to other travel modes were deemed insignificant, and no technical limitations existed on where TSP could be deployed—then TSP might reasonably be pursued at all or most of these signals. However, this is of course not the case, as all of these other factors are also critical considerations in determining where transit priority can and should be implemented.

City planning staff and project consultants are currently working with traffic signal and engineering staff to formulate a TSP project screening methodology. This will help to identify a subset of the signals depicted here at which the viability and potential of TSP projects should be considered in greater detail. This methodology will consider where TSP projects (1) are technically feasibile, (2) exhibit significant potential to improve transit operations, and (3) limit adverse impacts to general purpose traffic, cross streets, and other transit operations. Some measures likely to factor into the TSP evaluation process include intersection LOS, traffic delay, bus volumes, and signal coordination patterns. Future reports will present the screening methodology that is ultimately adopted and the TSP projects that remain under consideration following its application.

Figure 70 Spot Improvement Project Q4: Queue jump lane on 108th Ave NE for northbound buses at Northup Way. Also pictured are Running Way Improvement Projects L15 and L17 along Northup Way and 108th Ave NE, respectively. Aerial images depict roadway striping before and after lane reconfiguration. This concept repurposes existing travel lanes.

Figure 71 Potential transit signal priority (TSP) projects.

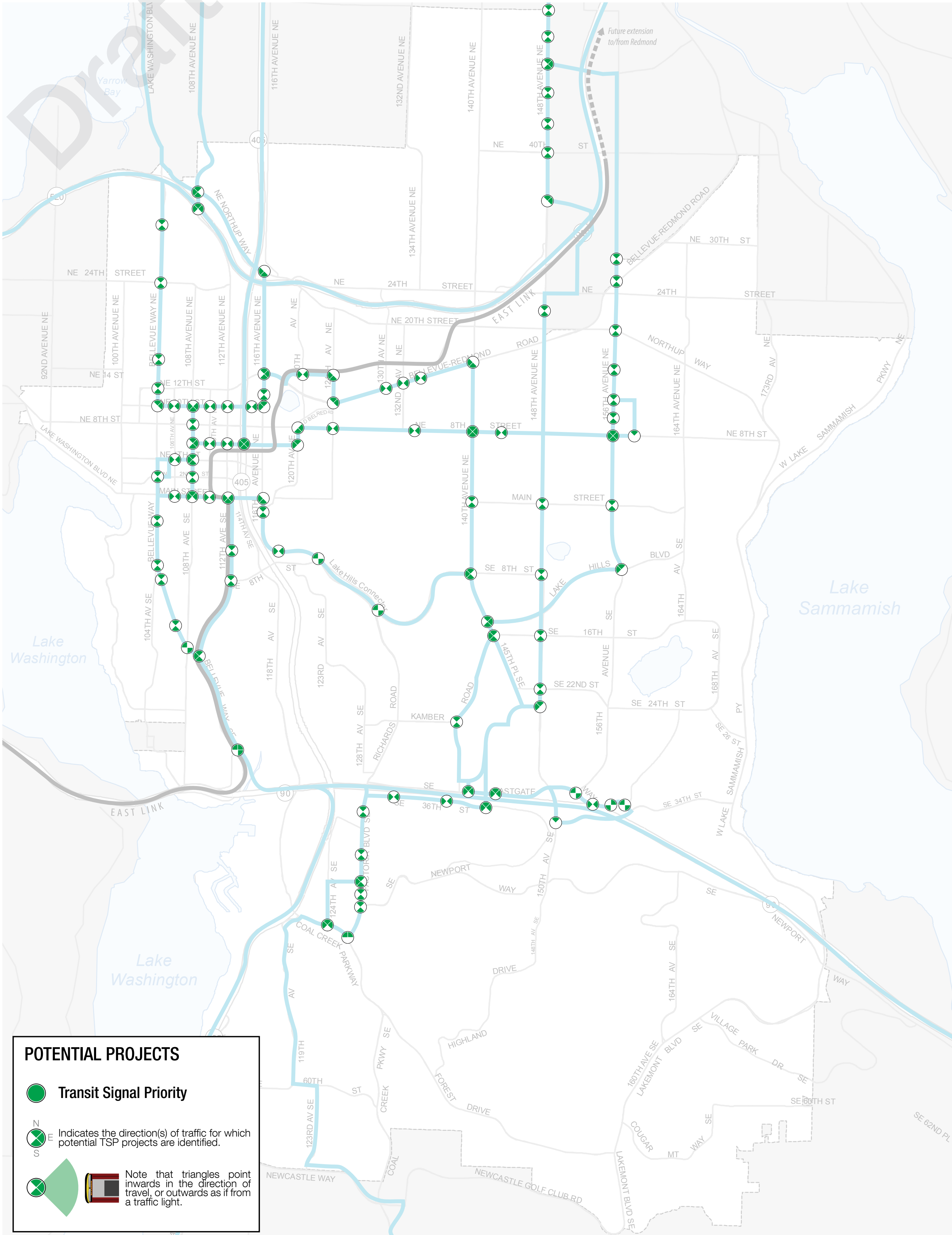


Table 8 Potential transit signal priority (TSP) projects.

Project ID	Intersection ID	Cross Streets	Direction (Approach)	FTN Service: Routes	FTN Service: Frequency (Peak/Base/Night)	Short-Term Composite	Long-Term Composite	Related TMP Project	Related TFP Project	Previous TSP Priority	Notes
TSP100-E	214	108th Ave & SR-520 DA Ramp	EB (W Approach)	5, 14	4/ 5-6 / 15	30	23	X			
TSP100-S	214	108th Ave & SR-520 DA Ramp	SB (N Approach)	4	8 / 10 / ~30	30	23	X			
TSP100-W	214	108th Ave & SR-520 DA Ramp	WB (E Approach)	4	8 / 10 / ~30	30	23	X			
TSP101-N	23	108th Ave & NE 2nd St	NB (S Approach)	1, 2, 3, 5, 6, 11, 13	2 / 2-3 / 5-6	16	19	X	X		
TSP101-S	23	108th Ave & NE 2nd St	SB (N Approach)	1, 2, 3, 5, 6, 11, 13	2 / 2-3 / 5-6	26	18	X	X		
TSP102-E	78	Northrup Way & 108th Ave	EB (W Approach)	4, 5, 14	2 / 3-4 / 8-10	16	24	X			
TSP102-N	78	Northrup Way & 108th Ave	NB (S Approach)	4, 5, 14	2 / 3-4 / 8-10	30	23	X			
TSP102-S	78	Northrup Way & 108th Ave	SB (N Approach)	4, 5, 14	2 / 3-4 / 8-10	30	23	X			
TSP103-E	114	Northrup Way & NE 116th Ave	EB (W Approach)	5, 14	4/ 5-6 / 10-15	16	24	X			
TSP103-N	114	Northrup Way & NE 116th Ave	NB (S Approach)	5, 14	4/ 5-6 / 10-15	17	24	X			
TSP104-E	19	Main St & 106th Ave	EB (W Approach)	11	8 / 12 / ~30	16	17				
TSP104-W	19	Main St & 106th Ave	WB (E Approach)	11	8 / 12 / ~30	9	18				
TSP105-E	24	Main St & 108th Ave NE	EB (W Approach)	13	8 / 12 / ~30	9	18	X	X		
TSP105-S	24	Main St & 108th Ave NE	SB (N Approach)	1, 11, 13	2 / 3-4 / 10-12	16	19	X	X		
TSP105-W	24	Main St & 108th Ave NE	WB (E Approach)	11	8 / 12 / ~30	9	24	X	X		
TSP106-E	36	Main St & 112th Ave NE	EB (W Approach)	13	8 / ~12 / 30	11	24	X			
TSP106-N	36	Main St & 112th Ave NE	NB (S Approach)	1	8 / 10 / ~30	14	20	X			
TSP106-W	36	Main St & 112th Ave NE	WB (E Approach)	13	8 / ~12 / 30	5	18	X			
TSP107-N	9	Main St & 104th Ave NE	NB (S Approach)	3	8 / 10 / ~30	24	18				
TSP107-S	9	Main St & 104th Ave NE	SB (N Approach)	3	8 / 10 / ~30	17	15				
TSP108-N	83	Main St & 156th Ave NE	NB (S Approach)	7	8 / 10 / ~15	7	8				
TSP108-S	83	Main St & 156th Ave NE	SB (N Approach)	7	8 / 10 / ~15	18	12				
TSP109-E	157	Main St & 110th Ave NE	EB (W Approach)	13	8 / ~12 / 30	9	19	X			
TSP109-W	157	Main St & 110th Ave NE	WB (E Approach)	13	8 / ~12 / 30	11	24	X			
TSP110-E	73	Main St & 116 Ave NE	EB (W Approach)	13	8 / ~12 / 30	5	18	X			
TSP110-N	73	Main St & 116 Ave NE	NB (S Approach)	13	8 / ~12 / 30	10	13	X			
TSP111-N	50	Main St & 148th	NB (S Approach)	12	8 / ~12 / 30	13	9				
TSP111-S	50	Main St & 148th	SB (N Approach)	12	8 / ~12 / 30	20	14				
TSP112-E	44	Lake Hills & 145th Pl SE	EB (W Approach)	7	8 / 10 /~15	14	11		X		
TSP112-N	44	Lake Hills & 145th Pl SE	NB (S Approach)	13, 14	4 / 6 / ~15	16	16		X		
TSP112-S	44	Lake Hills & 145th Pl SE	SB (N Approach)	13, 14	4 / 6 / ~15	11	12		X		
TSP113-E		Lake Hills & 156th Ave SE	EB (W Approach)	7	8 / 10 / ~15	15	13				
TSP113-S		Lake Hills & 156th Ave SE	SB (N Approach)	7	8 / 10 / ~15	7	9				
TSP114-E		Lake Hills & 148th	EB (W Approach)	7	8 / 10 / ~15	3	10	X			
TSP114-W		Lake Hills & 148th	WB (E Approach)	7	8 / 10 / ~15	15	13	X			
TSP115-E	315	Lake Hills Connector & 405 NB Off-ramp	EB (W Approach)	13	8 / 12 / ~30	16	16				
TSP115-W	315	Lake Hills Connector & 405 NB Off-ramp	WB (E Approach)	13	8 / 12 / ~30	12	11				
TSP116-E	134	Lake Hills Connector & Richards Rd	EB (W Approach)	13	8 / 12 / ~30	14	16	X			
TSP116-W	134	Lake Hills Connector & Richards Rd	WB (E Approach)	13	8 / 12 / ~30	12	14	X			
TSP117-NW	71	Lake Hills Connector & SE 8th St	NB (S Approach)	13, 14	4 / 6 / ~15	16	16		X		
TSP118-E	43	Lake Hills Connector & 140th Ave SE	EB (W Approach)	13	8 / 12 / ~30	14	11		X		
TSP118-N	43	Lake Hills Connector & 140th Ave SE	NB (S Approach)	13, 14	4 / 6 / ~15	16	16		X		
TSP118-S	43	Lake Hills Connector & 140th Ave SE	SB (N Approach)	14	8 / 12 / ~30	11	12		X		

Table 7 continued.

Project ID	Intersection ID	Cross Streets	Direction (Approach)	FTN Service		Short-Term Composite	Long-Term Composite	Related TMP Project	Related TFP Project	Previous TSP Priority	Notes
				Routes	Frequency (Peak/Base/Night)						
TSP119-NE	45	Kamber Rd & 145th Pl	NEB (SW Approach)	14	8 / 12 / ~30	3	10		X		
TSP119-NW	45	Kamber Rd & 145th Pl	NWB (SE Approach)	13	8 / 12 / ~30	17	18		X		
TSP119-SE	45	Kamber Rd & 145th Pl	SEB (NW Approach)	7	8 / 10 / ~30	12	18		X		
TSP120-N	280	Kamber Rd & 139th Ave	NB (S Approach)	14	8 / 12 / ~30	4	7				
TSP120-SW	280	Kamber Rd & 139th Ave	SWB (NE Approach)	14	8 / 12 / ~30	3	10				
TSP121-N	105	Eastgate Way & Richards Rd	NB (S Approach)	11	8 / 12 / ~30	17	19				
TSP122-E	327	Eastgate Way & 140th Ave	EB (W Approach)	13, 14	4 / 6 / ~15	17	12			X	
TSP122-S	327	Eastgate Way & 140th Ave	SB (N Approach)	7	8 / 10 / ~15	17	15			X	
TSP122-W	327	Eastgate Way & 140th Ave	WB (E Approach)	13, 14	4 / 6 / ~15	17	13			X	
TSP123-E		Eastgate Way & 148th Ave	EB (W Approach)	13	8 / 12 / ~30	26	13			X	
TSP123-W		Eastgate Way & 148th Ave	WB (E Approach)	13	8 / 12 / ~30	18	12			X	
TSP124-W	91	Eastgate Way & 160th Ave	WB (E Approach)	13	8 / 12 / ~30	10	9				
TSP125-W	92	Eastgate Way & 161st Ave	WB (E Approach)	13	8 / 12 / ~30	6	7				
TSP126-E	305	Eastgate Way & 139th Ave	EB (W Approach)	13, 14	4 / 6 ~ / 15	26	13			X	
TSP126-S	305	Eastgate Way & 139th Ave	SB (N Approach)	13	8 / 12 / ~30	7	12			X	
TSP126-W	305	Eastgate Way & 139th Ave	WB (E Approach)	13, 14	4 / 6 ~ / 15	19	14			X	
TSP127-E	284	Coal Creek Pkwy & 124th Ave	EB (W Approach)	7	8/ 10 / ~15	17	20				
TSP127-S	284	Coal Creek Pkwy & 124th Ave	SB (N Approach)	7	8/ 10 / ~15	5	9				
TSP127-W	284	Coal Creek Pkwy & 124th Ave	WB (E Approach)	7	8/ 10 / ~15	17	17				
TSP128-E	203	Coal Creek Pkwy & Factoria	EB (W Approach)	7, 11	4/ 5-6 / 10-15	17	17				
TSP128-S	203	Coal Creek Pkwy & Factoria	SB (N Approach)	7, 11	4/ 5-6 / 10-15	13	18				
TSP129-N	34	Bel-Red Rd & 124th	NB (S Approach)	14	8 / 12 / ~30	7	15	X	X		
TSP129-S	34	Bel-Red Rd & 124th	SB (N Approach)	14	8 / 12 / ~30	3	14	X	X		
TSP132-E	38	Bel-Red Rd & 132th	EB (W Approach)	14	8 / 12 / ~30	5	8				
TSP132-W	38	Bel-Red Rd & 132th	WB (E Approach)	14	8 / 12 / ~30	5	10				
TSP133-N	40	Bel-Red Rd & 140th Ave	NB (S Approach)	14	8 / 12 / ~30	9	16	X			
TSP133-W	40	Bel-Red Rd & 140th Ave	WB (E Approach)	14	8 / 12 / ~30	9	11	X			
TSP134-E	37	Bel-Red Rd & 130th Ave	EB (W Approach)	14	8 / 12 / ~30	5	10				
TSP134-W	37	Bel-Red Rd & 130th Ave	WB (E Approach)	14	8 / 12 / ~30	7	15				
TSP135-E	175	Bel-Red Rd & 134th Ave	EB (W Approach)	14	8 / 12 / ~30	9	11				
TSP135-W	175	Bel-Red Rd & 134th Ave	WB (E Approach)	14	8 / 12 / ~30	5	8				
TSP136-N	213	Bellevue Way & SR-520 SPUI	NB (S Approach)	1	8 / 10 / ~30	7	15	X			
TSP136-W	213	Bellevue Way & SR-520 SPUI	WB (E Approach)	1	8 / 10 / ~30	7	15	X			
TSP137-N	69	Bellevue Way & NE 24th Ave	NB (S Approach)	1	8 / 10 / ~30	9	11				
TSP137-S	69	Bellevue Way & NE 24th Ave	SB (N Approach)	1	8 / 10 / ~30	7	12				
TSP138-N	5	Bellevue Way & NE 12th Ave	NB (S Approach)	1	8 / 10 / ~30	13	14				
TSP138-S	5	Bellevue Way & NE 12th Ave	SB (N Approach)	1	8 / 10 / ~30	7	13				
TSP139-E	31	Bellevue Way & NE 2nd St	EB (W Approach)	5, 6	4 / 5 / 7-8	16	17	X	X	X	

Table 7 continued.

Project ID	Intersection ID	Cross Streets	Direction (Approach)	FTN Service		Short-Term Composite	Long-Term Composite	Related TMP Project	Related TFP Project	Previous TSP Priority	Notes
				Routes	Frequency (Peak/Base/Night)						
TSP139-N	31	Bellevue Way & NE 2nd St	NB (S Approach)	3	8 / 10 / ~30	24	18	X	X	X	
TSP139-S	31	Bellevue Way & NE 2nd St	SB (N Approach)	3	8 / 10 / ~30	17	15	X	X	X	
TSP139-W	31	Bellevue Way & NE 2nd St	WB (E Approach)	5, 6	4 / 5 / 7-8	5	6	X	X	X	
TSP140-N	10	Bellevue Way & SE Wolverine Way	NB (S Approach)	3, 11	4 / 5 -6 / 15	15	18				
TSP140-S	10	Bellevue Way & SE Wolverine Way	SB (N Approach)	3, 11	4 / 5 -6 / 15	24	18				
TSP141-N	12	Bellevue Way & SE 10th St	NB (S Approach)	3, 11	4 / 5 -6 / 15	10	16				
TSP141-S	12	Bellevue Way & SE 10th St	SB (N Approach)	3, 11	4 / 5 -6 / 15	9	18				
TSP142-E	13	Bellevue Way & 108th Ave Se	EB (W Approach)	3, 11	4 / 5 -6 / 15	13	16	X		X	
TSP142-N	13	Bellevue Way & 108th Ave Se	NB (S Approach)	3, 11	4 / 5 -6 / 15	15	22	X		X	
TSP142-S	13	Bellevue Way & 108th Ave Se	SB (N Approach)	3, 11	4 / 5 -6 / 15	13	16	X		X	
TSP142-W	13	Bellevue Way & 108th Ave Se	WB (E Approach)	3, 11	4 / 5 -6 / 15	15	22	X		X	
TSP143-E	108	Bellevue P&R Entrance	EB (W Approach)	1, 3, 11	2-3 / 3-4 / 10	23	14	X	X	X	
TSP143-N	108	Bellevue P&R Entrance	NB (S Approach)	1, 3, 11	2-3 / 3-4 / 10	19	22	X	X	X	
TSP143-S	108	Bellevue P&R Entrance	SB (N Approach)	1, 3, 11	2-3 / 3-4 / 10	23	14	X	X	X	
TSP143-W	108	Bellevue P&R Entrance	WB (E Approach)	1, 3, 11	2-3 / 3-4 / 10	19	22	X	X	X	
TSP144-N	136	Bellevue Way & 2900 Block Crosswalk	NB (S Approach)	1	8 / 10 / ~30	7	12				
TSP144-S	136	Bellevue Way & 2900 Block Crosswalk	SB (N Approach)	1	8 / 10 / ~30	7	15				
TSP145-N	137	Bellevue Way & 1700 Block Crosswalk	NB (S Approach)	1	8 / 10 / ~30	7	13				
TSP145-S	137	Bellevue Way & 1700 Block Crosswalk	SB (N Approach)	1	8 / 10 / ~30	9	11				
TSP146-S	6	Bellevue Way & NE 10th Ave	SB (N Approach)	1	8 / 10 / ~30	13	14	X			
TSP146-W	6	Bellevue Way & NE 10th Ave	WB (E Approach)	1	8 / 10 / ~30	9	17	X			
TSP147-N	11	Bellevue Way & SE 8th St	NB (S Approach)	3, 11	4 / 5 -6 / 15	9	18				
TSP147-S	11	Bellevue Way & SE 8th St	SB (N Approach)	3, 11	4 / 5 -6 / 15	15	18				
TSP148-N	135	Bellevue Way & SE 16th St	NB (S Approach)	3, 11	4 / 5 -6 / 15	13	16				
TSP148-S	135	Bellevue Way & SE 16th St	SB (N Approach)	3, 11	4 / 5 -6 / 15	10	16				
TSP149-E	14	Bellevue Way & 112th Ave SE	EB (W Approach)	3, 11	4 / 5 -6 / 15	17	22	X	X	X	
TSP149-N	14	Bellevue Way & 112th Ave SE	NB (S Approach)	3, 11	4 / 5 -6 / 15	17	23	X	X	X	
TSP149-S	14	Bellevue Way & 112th Ave SE	SB (N Approach)	1	8 / 10 / ~30	13	19	X	X	X	
TSP149-W	14	Bellevue Way & 112th Ave SE	WB (E Approach)	3, 11	4 / 5 -6 / 15	15	23	X	X	X	
TSP150-E		NE 15th st & 120th Ave NE	EB (W Approach)	14	8 / 12 / ~30	15	16				
TSP150-W		NE 15th st & 120th Ave NE	WB (E Approach)	14	8 / 12 / ~30	15	16				
TSP151-E		NE 15th st & 124th Ave NE	EB (W Approach)	14	8 / 12 / ~30	15	15				
TSP151-N		NE 15th st & 124th Ave NE	NB (S Approach)	14	8 / 12 / ~30	3	14				
TSP152-E	154	NE 10th St & 106th Ave NE	EB (W Approach)	1	8 / 10 / ~30	9	17	X			
TSP152-W	154	NE 10th St & 106th Ave NE	WB (E Approach)	1	8 / 10 / ~30	9	19	X			
TSP153-E	33	NE 10th St & Library Crosswalk	EB (W Approach)	5	8 / 10 / ~15	12	17	X			
TSP153-W	33	NE 10th St & Library Crosswalk	WB (E Approach)	5	8 / 10 / ~15	16	15	X			
TSP154-E	234	NE 10th St & 112th	EB (W Approach)	5	8 / 10 / ~15	16	17	X			
TSP154-W	234	NE 10th St & 112th	WB (E Approach)	5	8 / 10 / ~15	11	15	X			
TSP155-E	165	NE 10th St & 116th Ave	EB (W Approach)	5	8 / 10 / ~15	18	13	X			
TSP155-S	165	NE 10th St & 116th Ave	SB (N Approach)	5	8 / 10 / ~15	12	11	X			
TSP156-N	190	NE 10th St & 108th Ave	NB (S Approach)	1, 5	4 / 5 / 15-20	27	23	X	X		

Table 7 continued.

Project ID	Intersection ID	Cross Streets	Direction (Approach)	FTN Service		Short-Term Composite	Long-Term Composite	Related TMP Project	Related TFP Project	Previous TSP Priority	Notes
				Routes	Frequency (Peak/Base/Night)						
TSP156-N	190	NE 10th St & 108th Ave	NB (S Approach)	1, 5	4 / 5 / 15-20	27	23	X	X		
TSP156-W	190	NE 10th St & 108th Ave	WB (E Approach)	1	8 / 10 / ~30	12	19	X	X		
TSP157-E	332	NE 10th St & 110th Ave	EB (W Approach)	5	8 / 10 / ~15	16	23	X			
TSP158-E	259	NE 10th St & 405 Onramp	EB (W Approach)	5	8 / 10 / ~15	18	15				
TSP158-W	259	NE 10th St & 405 Onramp	WB (E Approach)	5	8 / 10 / ~15	11	13				
TSP159-N	21	NE 8th St & 108th	NB (S Approach)	1, 5	4 / 5 / 15-20	27	23	X	X		
TSP159-S	21	NE 8th St & 108th	SB (N Approach)	1, 5	4 / 5 / 15-20	27	23	X	X		
TSP160-E	35	NE 8th St & 124th Ave	EB (W Approach)	6	8 / 10 / ~15	16	16			X	
TSP160-W	35	NE 8th St & 124th Ave	WB (E Approach)	6	8 / 10 / ~15	10	12			X	
TSP161-E	41	NE 8th St & 140th Ave	EB (W Approach)	6	8 / 10 / ~15	15	18	X			
TSP161-N	41	NE 8th St & 140th Ave	NB (S Approach)	14	8 / 12 / ~30	9	16	X			
TSP161-S	41	NE 8th St & 140th Ave	SB (N Approach)	14	8 / 12 / ~30	9	16	X			
TSP161-W	41	NE 8th St & 140th Ave	WB (E Approach)	6	8 / 10 / ~15	17	17	X			
TSP162-E	63	NE 8th St & 156th Ave	EB (W Approach)	6	8 / 10 / ~15	24	17	X			
TSP162-N	63	NE 8th St & 156th Ave	NB (S Approach)	12	8 / 12 / ~30	18	12	X			
TSP162-S	63	NE 8th St & 156th Ave	SB (N Approach)	12	8 / 12 / ~30	21	14	X			
TSP162-W	63	NE 8th St & 156th Ave	WB (E Approach)	6	8 / 10 / ~15	15	9	X			
TSP163-N	33	NE 8th St & 120th Ave	NB (S Approach)	6	8 / 10 / ~15	17	14	X	X		
TSP163-W	33	NE 8th St & 120th Ave	WB (E Approach)	6	8 / 10 / ~15	16	16	X	X		
TSP164-E	288	NE 8th St & 13300 Block Crosswalk	EB (W Approach)	6	8 / 10 / ~15	10	12				
TSP164-W	288	NE 8th St & 13300 Block Crosswalk	WB (E Approach)	6	8 / 10 / ~15	15	18				
TSP165-E	46	NE 8th St & 143rd Ave	EB (W Approach)	6	8 / 10 / ~15	17	17			X	
TSP165-W	46	NE 8th St & 143rd Ave	WB (E Approach)	6	8 / 10 / ~15	19	15			X	
TSP166-E	299	NE 8th St & 160th Ave	EB (W Approach)	6	8 / 10 / ~15	5	5				
TSP166-W	299	NE8th St & 160th Ave	WB (E Approach)	6	8 / 10 / ~15	15	14				
TSP167-N	126	NE 6th St & 108th Ave	NB (S Approach)	1, 5	4 / 5 / 15-20	26	18	X	X		
TSP167-S	126	NE 6th St & 108th Ave	SB (N Approach)	1, 5	4 / 5 / 15-20	27	23	X	X		
TSP167-W	126	NE 6th St & 108th Ave	WB (E Approach)	2, 6	4 / 5 / 15-20	32	20	X	X		
TSP168-E	107	NE 6th St & 112th Ave	EB (W Approach)	2, 6	4 / 5 / 15-20	28	23	X			
TSP168-W	107	NE 6th St & 112th Ave	WB (E Approach)	2, 6	4 / 5 / 15-20	24	23	X			
TSP169-E		NE 6th St & 120th St	EB (W Approach)	6	8 / 10 / ~15	17	15	X	X		
TSP169-S		NE 6th St & 120th St	SB (N Approach)	6	8 / 10 / ~15	17	14	X	X		
TSP170-E	124	NE 6th St & 110th Ave	EB (W Approach)	2, 6	4 / 5 / 15-20	32	20	X			
TSP170-W	124	NE 6th St & 110th Ave	WB (E Approach)	2, 6	4 / 5 / 15-20	27	21	X			
TSP171-E	191	NE 6th St & 405 DA Ramp	EB (W Approach)	2, 6	4 / 5 / 15-20	24	23	X	X		
TSP171-N	191	NE 6th St & 405 DA Ramp	NB (S Approach)	2, 6	4 / 5 / 15-20	24	23	X	X		
TSP171-S	191	NE 6th St & 405 DA Ramp	SB (N Approach)	2, 6	4 / 5 / 15-20	17	15	X	X		
TSP171-W	191	NE 6th St & 405 DA Ramp	WB (E Approach)	2, 6	4 / 5 / 15-20	17	15	X	X		
TSP172-E	17	NE 4th St & 106th	EB (W Approach)	3, 5, 6	2-3 / 3-4 / 10-12	21	17				
TSP172-W	17	NE 4th St & 106th	WB (E Approach)	3, 5, 6	2-3 / 3-4 / 10-12	20	19				
TSP173-E	22	NE 4th St & 108th	EB (W Approach)	3, 5, 6	2-3 / 3-4 / 10-12	20	19	X	X		
TSP173-N	22	NE 4th St & 108th	NB (S Approach)	1, 11, 13	2-3 / 3-4 / ~10	26	18	X	X		

Table 7 continued.

Project ID	Intersection ID	Cross Streets	Direction (Approach)	FTN Service		Short-Term Composite	Long-Term Composite	Related TMP Project	Related TFP Project	Previous TSP Priority	Notes
				Routes	Frequency (Peak/Base/Night)						
TSP173-S	22	NE 4th St & 108th	SB (N Approach)	1, 11, 13	2-3 / 3-4 / ~10	26	18	X	X		
TSP174-N	285	Factoria Blvd & 3600 Block	NB (S Approach)	7, 11	4 / 5-6 / 15-20	20	20	X			
TSP175-E	282	Factoria Blvd & SE 41st	EB (W Approach)	7	8 / 10 / ~15	17	5				
TSP175-N	282	Factoria Blvd & SE 41st	NB (S Approach)	7, 11	4 / 5-6 / 15-20	12	13				
TSP176-N	301	Factoria Blvd & SE 44th St	NB (S Approach)	7, 11	6 / 5-6 / 15-20	14	15				
TSP177-S	301	Factoria Blvd & SE 44th St	SB (N Approach)	7, 11	7 / 5-6 / 15-20	12	13				
TSP178-N	318	Factoria Blvd & SE 40th Ln	NB (S Approach)	7, 11	8 / 5-6 / 15-20	17	14				
TSP178-S	318	Factoria Blvd & SE 40th Ln	SB (N Approach)	7, 11	9 / 5-6 / 15-20	22	22				
TSP179-N		Factoria Blvd & Newport	NB (S Approach)	7, 11	10 / 5-6 / 15-20	12	13				
TSP179-S		Factoria Blvd & Newport	SB (N Approach)	7, 11	11 / 5-6 / 15-20	14	15				
TSP180-N	202	Factoria Blvd & SE Newport Way	NB (S Approach)	7, 11	12 / 5-6 / 15-20	13	18				
TSP180-S	202	Factoria Blvd & SE Newport Way	SB (N Approach)	7, 11	13 / 5-6 / 15-20	14	15				
TSP181-E	291	SE 36th & 132nd Ave SE	WB (E Approach)	7	8 / 10 / ~15	7	6				
TSP181-W	291	SE 36th & 132nd Ave SE	EB (W Approach)	7	8 / 10 / ~15	23	20				
TSP182-E	171	SE 36th & 142nd Pl SE	EB (W Approach)	7	8 / 10 / ~15	19	19	X			
TSP182-S	171	SE 36th & 142nd Pl SE	SB (N Approach)	7	8 / 10 / ~15	19	14	X			
TSP182-W	171	SE 36th & 142nd Pl SE	WB (E Approach)	7	8 / 10 / ~15	11	13	X			
TSP183-E	305	SE 36th & 136th Pl SE	EB (W Approach)	7	8 / 10 / ~15	7	6				
TSP183-W	305	SE 36th & 136th Pl SE	WB (E Approach)	7	8 / 10 / ~15	11	13				
TSP184-E	54	SE 24th & 145th Pl	EB (W Approach)	7, 12, 13	2-3 / 3-4 / 10-12	19	12				
TSP184-S	54	SE 24th & 145th Pl	SB (N Approach)	7, 13	4 / 5-6 / 15-20	17	18				
TSP185-N	298	112th Ave & SE 6th St	NB (S Approach)	1	8 / 10 / ~30	10	12				
TSP185-S	298	112th Ave & SE 6th St	SB (N Approach)	1	8 / 10 / ~30	14	20				
TSP186-N	89	112th Ave & SE 8th St	NB (S Approach)	1	8 / 10 / ~30	7	12				
TSP186-S	89	112th Ave & SE 8th St	SB (N Approach)	1	8 / 10 / ~30	10	12				
TSP187-N	29	116th Ave & NE 12th St	NB (S Approach)	5	8 / 10 / ~15	18	17				
TSP187-S	29	116th Ave & NE 12th St	SB (N Approach)	5, 14	4 / 5-6 / 10-15	17	24				
TSP187-W	29	116th Ave & NE 12th St	WB (E Approach)	14	8 / 12 / ~30	15	16				
TSP188-N	131	116th Ave & SE 1st St	NB (S Approach)	13	8 / 12 / ~30	12	11				
TSP188-S	131	116th Ave & SE 1st St	SB (N Approach)	13	8 / 12 / ~30	10	13				
TSP189-N	165	116th Ave & Overlake Hospital	NB (S Approach)	5	8 / 10 / ~15	12	11	X			
TSP189-S	165	116th Ave & Overlake Hospital	SB (N Approach)	5	8 / 10 / ~15	18	17	X			
TSP190-N	287	148th Ave & NE 60th St	NB (S Approach)	7, 12	4 / 5-6 / 10-15	9	14				
TSP190-S	287	148th Ave & NE 60th St	SB (N Approach)	7, 12	4 / 5-6 / 10-15	9	14				
TSP191-N	249	148th Ave & NE 51st St	NB (S Approach)	7, 12	4 / 5-6 / 10-15	21	21	X			
TSP191-S	249	148th Ave & NE 51st St	SB (N Approach)	7, 12	4 / 5-6 / 10-15	19	21	X			
TSP191-W	249	148th Ave & NE 51st St	WB (E Approach)	7	8 / 10 / ~15	19	21	X			
TSP192-N	0	148th Ave & NE 4200 Block	NB (S Approach)	12	8 / 12 / ~30	13	18	X			
TSP192-S	0	148th Ave & NE 4200 Block	SB (N Approach)	12	8 / 12 / ~30	23	21	X			
TSP193-S	195	148th Ave & NE 36th St	SB (N Approach)	12	8 / 12 / ~30	13	18				
TSP193-W	195	148th Ave & NE 36th St	WB (E Approach)	12	8 / 12 / ~30	11	16				
TSP194-N	287	148th Ave & Trail Crosswalk	NB (S Approach)	12	8 / 12 / ~30	11	16				

Table 7 continued.

Project ID	Intersection ID	Cross Streets	Direction (Approach)	FTN Service		Short-Term Composite	Long-Term Composite	Related TMP Project	Related TFP Project	Previous TSP Priority	Notes
				Routes	Frequency (Peak/Base/Night)						
TSP194-S	287	148th Ave & Trail Crosswalk	SB (N Approach)	12	8 / 12 / ~30	11	16				
TSP195-N	52	148th Ave & SE 16th St	NB (S Approach)	12	8 / 12 / ~30	20	20				
TSP195-S	52	148th Ave & SE 16th St	SB (N Approach)	12	8 / 12 / ~30	20	20				
TSP196-E	55	148th Ave & SE 24th St	EB (W Approach)	12	8 / 12 / ~30	11	15	X			
TSP196-S	55	148th Ave & SE 24th St	SB (N Approach)	12	8 / 12 / ~30	13	15	X			
TSP197-N	0	148th Ave & NE 5600 Block	NB (S Approach)	7, 12	4 / 5-6 / 10-15	19	21				
TSP197-S	0	148th Ave & NE 5600 Block	SB (N Approach)	7, 12	4 / 5-6 / 10-15	9	14				
TSP198-N	0	148th Ave & NE 46th St	NB (S Approach)	12	8 / 12 / ~30	23	21	X			
TSP198-S	0	148th Ave & NE 46th St	SB (N Approach)	12	8 / 12 / ~30	21	21	X			
TSP199-N	79	148th Ave & NE 40th St	NB (S Approach)	12	8 / 12 / ~30	13	18	X			
TSP199-S	79	148th Ave & NE 40th St	SB (N Approach)	12	8 / 12 / ~30	23	21	X			
TSP200-N	268	148th Ave & NE 22nd St	NB (S Approach)	12	8 / 12 / ~30	20	19	X	X		
TSP200-S	268	148th Ave & NE 22nd St	SB (N Approach)	12	8 / 12 / ~30	20	19	X	X		
TSP201-N	65	148th St & SE 8th St	NB (S Approach)	12	8 / 12 / ~30	9	10				
TSP201-S	65	148th St & SE 8th St	SB (N Approach)	12	8 / 12 / ~30	5	6				
TSP202-N	53	148th St & SE 22nd St	NB (S Approach)	12	8 / 12 / ~30	15	8	X			
TSP202-S	53	148th St & SE 22nd St	SB (N Approach)	12	8 / 12 / ~30	13	8	X			
TSP203-S	227	150th Ave SE & SE 37th St	SB (N Approach)	13	8 / 12 / ~30	14	14	X			
TSP204-N	0	156th & NE 28th St	NB (S Approach)	7	8 / 10 / ~15	17	18	X			
TSP204-S	0	156th & NE 28th St	SB (N Approach)	7	8 / 10 / ~15	15	16	X			
TSP205-N	62	156th & Northrup Way	NB (S Approach)	7	8 / 10 / ~15	21	14	X			
TSP205-S	62	156th & Northrup Way	SB (N Approach)	7	8 / 10 / ~15	27	17	X			
TSP206-N	70	156th & NE 13th Way	NB (S Approach)	7	8 / 10 / ~15	14	8				
TSP206-S	70	156th & NE 13th Way	SB (N Approach)	7	8 / 10 / ~15	12	9				
TSP207-N	60	156th & Bel-Red Rd	NB (S Approach)	7	8 / 10 / ~15	17	18	X			
TSP207-S	60	156th & Bel-Red Rd	SB (N Approach)	7	8 / 10 / ~15	15	16	X			
TSP208-N	66	156th & NE 15th St	NB (S Approach)	6, 7	4 / 5 / 7-8	14	8				
TSP208-S	66	156th & NE 15th St	SB (N Approach)	6, 7	4 / 5 / 7-8	12	9				
TSP209-N	67	156th & NE 10th St	NB (S Approach)	7	8 / 10 / ~15	21	14				
TSP209-S	67	156th & NE 10th St	SB (N Approach)	7	8 / 10 / ~15	17	9				

TRACKING & FURTHER STUDY

In addition to the physical infrastructure improvement projects noted above, five projects dealing with performance tracking and further study have also been identified (Table 9). Though less visible than the 'brick-and-mortar' running way and spot improvement projects, and less immediately impactful to transit operations than transit signal priority projects, these tracking and study projects would provide valuable opportunities for the City to ensure that its investments in transit priority are functioning as intended and providing the greatest return on investment possible.

The tracking and study projects include two targeted projects and three city-wide projects. Project L12 would track the volumes of traffic between Bellevue Transit Center and the NE 6th St direct-access ramp to I-405 to ensure that speed and reliability do not decline over time, and Project R17 would study how speed and reliability could be improved for westbound buses from SR-520 to the South Kirkland Park-and-Ride. Citywide-R1 would track the adequacy of turn pocket lengths along FTN corridors and adjust signal timing as needed. Citywide-S3 and Citywide-S4 both deal with TSP performance. The former would develop TSP performance standards and track the resulting measures to ensure that TSP systems are functional and optimized, while the latter project would conduct a before-and-after study of the benefits provided to transit by TSP at selected intersections, as well as its impacts on general purpose traffic.

Table 9 Tracking projects and studies.

ID	Project	Type	FTN Service Routes	FTN Service Frequency (Peak/Base/Night)	Project Description	Project Need
L12	NE 6th St Bus Priority Corridor	Tracking	1, 2, 3, 5, 6, 11, 13	~1 / ~1 / ~4	Highlight transit priority over general purpose and HOV traffic on NE 6th St from BTC to I-405 direct access ramps. Track general purpose and HOV volumes to ensure they do not result in degradation of speed and reliably below existing levels and take steps to mitigate growing HOV volumes if needed.	Addresses very high bus volumes between BTC and I-405.
Citywide-R1	Transit Turn Priority	Tracking	NA	NA	Monitor right and left turn pockets used by Frequent Transit Network (FTN) routes for level of service and adequacy of pocket length. Using signal timing work to prioritize these movements to ensure fast and reliable transit service.	Turning moments at major intersections with long signal cycles can have a significant impact on speed and reliability of routes.
R17	SR-520 and 108th Ave NE Exit Transit Priority	Study	4	8 / 10 / 30	Improve speed and reliability of SR-520 westbound buses to South Kirkland Park-and-Ride through signal operations, striping or construction of bus facilities.	Addresses 2010 and 2030 intersection LOS of E and F.
Citywide-S3	TSP Performance Tracking and Optimization	Tracking	NA	NA	Develop TSP performance standards in coordination with King County Metro. Track performance and ensure that TSP is operational and optimized.	Develop shared goals of successful TSP implementation between the City of Bellevue and King County Metro.
Citywide-S4	TSP Before and After Study	Study	NA	NA	Complete before and after study at select intersections to assess the benefits of TSP to transit and the impacts on general purpose traffic. Use person throughput and person delay as performance measures.	Provides local example of the benefits and impacts on TSP implementation for staff and policy makers.

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PROJECTED OUTCOMES

This section summarizes the results of initial efforts to model the impacts of implementing some of the potential projects considered in this report. The results presented here were generated using Dynameq, a dynamic traffic simulaton application that is capable of assessing traffic patterns under congested conditions. This software models vehicles of multiple modes and captures lane-based effects and explicit signal timing, making it a useful tool for considering how HOV and BAT lane projects would affect transit and automobile travel time along the Frequent Transit Network (FTN) corridors of interest. Other project types like queue jumps and TSP cannot be modeled with this application and are therefore not considered in this analysis. It should be noted that at this level of study, the modeling is done on the set of potential projects as a group (identified as the HOV/BAT Lane scenario; see Table 6 on page 59). As plan implementation progresses, more detailed modeling will be done to assess the benefits of individual projects.

This Dynameq-based assessment suggests that implementation of every HOV and BAT lane project being considered will improve the average transit travel speed for each category of FTN service by roughly 1 mph (Table 10). This level of improvement represents approximately half of the total improvement needed for Frequent Local (FL) routes to achieve the operating speeds assumed in the *Transit Service Vision Report*. Frequent Rapid (FR) routes achieve about one-third of the improvement in average speed required, and Frequent Express (FX) routes about one-quarter.

That Frequent Express routes would realize less substantial improvements than Frequent Local routes

Table 10 Average transit and general purpose travel speeds by FTN service category before and after HOV and BAT lane implementation.

Scenario	Avg. Speed Along FTN Corridors by Service Type (mph)		
	FX	FR	FL
Transit			
Baseline	18	12	12
HOV/BAT Lane Projects	19	13	13
2030 Targets	22	15	14
General Purpose Traffic			
Baseline	20	13	13
HOV/BAT Lane Projects	21	14	14

Source: Dynameq model D30R1.0.3, for November 14, 2013 Transportation Commission meeting.

Table 11 Transit and general purpose travel time by FTN route before and after HOV and BAT lane implementation.

FTN Route	FTN Type	From / To	Dir.	Dist. (miles)	Baseline		HOV/BAT Lane Projects	
					Avg. Travel Time (min)	Avg. Speed (mph)	Avg. Travel Time (min)	Avg. Speed (mph)
Transit								
1	FX	Lakemond Interchange to NE 84th St	In	11.41	37.1	18.4	34.9	19.6
			Out	11.15	46.8	14.3	44.1	15.2
2	FX	NE 124th St Interchange to NE 102nd Ave	In	8.03	22.8	21.1	21.1	22.8
			Out	7.64	40.4	11.3	40.7	11.3
3	FX	Kennydale to Bellevue Transit Center	In	8.34	18.6	25.9	18.4	27.2
			Out	8.34	34.0	13.8	30.2	16.6
4	FX	Union Hill/SR520 to NE 84th Ave	In	10.05	24.2	24.9	20.8	28.9
			Out	8.91	20.5	26.1	21.4	25.0
5	FR	NE 124th St Interchange to Bellevue Transit Center	In	9.17	34.8	15.8	37.9	14.5
			Out	9.42	53.4	10.6	53.5	10.6
6	FR	Crossroads to Bellevue Way/NE 4th	In	3.62	23.3	9.3	22.5	9.6
			Out	3.55	20.8	10.2	19.5	10.7
7	FR	Town Square to Factoria Mall	In	12.55	57.3	13.1	55.8	13.5
			Out	11.97	54.5	13.2	48.8	14.6
11	FL	Newcastle Way to Bellevue Transit Center	In	7.94	34.4	13.9	35.6	13.5
			Out	7.99	47.0	10.2	41.8	11.3
12	FL	148th/Old Redmond Rd to Eastgate Park-and-Ride	In	7.20	32.3	13.4	32.5	13.3
			Out	7.20	40.0	10.8	33.0	13.1
13	FL	Bellevue Transit Center to Eastgate Park-and-Ride	In	7.89	39.4	12.0	38.3	12.4
			Out	7.95	36.3	13.1	31.5	15.1
14	FL	Eastgate Park-and-Ride to Lake Wash Blvd	In	7.91	37.2	12.7	32.9	14.4
			Out	7.88	39.6	11.9	38.4	12.3
General Purpose Traffic								
1	FX	Lakemond Interchange to NE 84th St	In	11.41	35.2	19.4	31.4	21.8
			Out	11.15	42.6	15.7	41.8	16.0
2	FX	NE 124th St Interchange to NE 102nd Ave	In	8.03	22.2	21.7	18.3	26.3
			Out	7.64	35.5	12.9	37.8	12.1
3	FX	Kennydale to Bellevue Transit Center	In	8.34	17.7	28.2	17.9	27.9
			Out	8.34	31.7	16.0	23.6	21.5
4	FX	Union Hill/SR520 to NE 84th Ave	In	10.05	22.0	27.4	20.2	29.8
			Out	8.91	18.1	29.5	18.1	29.5
5	FR	NE 124th St Interchange to Bellevue Transit Center	In	9.17	30.4	18.1	34.6	15.9
			Out	9.42	47.2	12.0	51.5	11.0
6	FR	Crossroads to Bellevue Way/NE 4th	In	3.62	21.5	10.1	17.4	12.5
			Out	3.55	20.5	10.4	21.1	10.1
7	FR	Town Square to Factoria Mall	In	12.55	51.5	14.6	51.2	14.7
			Out	11.97	53.1	13.5	46.4	15.5
11	FL	Newcastle Way to Bellevue Transit Center	In	7.94	28.6	16.6	30.2	15.8
			Out	7.99	42.2	11.4	39.7	12.1
12	FL	148th/Old Redmond Rd to Eastgate Park-and-Ride	In	7.20	28.8	15.0	29.4	14.7
			Out	7.20	40.4	10.7	31.6	13.7
13	FL	Bellevue Transit Center to Eastgate Park-and-Ride	In	7.89	39.5	12.0	39.7	11.9
			Out	7.95	37.7	12.7	33.4	14.3
14	FL	Eastgate Park-and-Ride to Lake Wash Blvd	In	7.91	29.4	16.2	30.0	15.8
			Out	7.88	33.5	14.1	32.0	14.8

Source: Dynameq model D30R1.0.3, for November 14, 2013 Transportation Commission meeting.
Notes: The above figures reflect only the length of each route operating either wholly within Bellevue or to the nearest bus stop outside of Bellevue city limits. For example, Route 3 terminates at Kennydale Park-and-Ride for the purposes of this modeling exercise. This is done to minimize the extent to which route segments outside of Bellevue's jurisdiction, which do not benefit from the HOV and BAT lane projects being considered in Bellevue, affect the average speeds and travel times realized as a result of these potential improvements.

stands to reason given the nature of these routes and the projects reflected in this analyis. Frequent Express routes operate long segments on highways, while all of the HOV and BAT lane projects assessed here are on local streets over which Bellevue has jurisdiction. To achieve additional improvement to Frequent Express travel times, some transit accommodations may be necessary on SR-520, I-90, and I-405, such as increasing HOV lane use requirements from 2+ to 3+ passengers, for example. By contrast, Frequent Local routes operate entirely on local arterial streets, so these running way projects are able to more directly target the range of issues affecting them.

Table 11 indicates that most routes would realize travel time improvements of two minutes or more in one or both travel directions, including Route 1FX, Route 3FX outbound, Route 4FX inbound, Route 5FR inbound, Route 7FR outbound, Route 11FL outbound, Route 12FL outbound, Route 13FL outbound, and Route 14FL inbound. Note that many potential HOV and BAT lane projects apply only to one direction of travel, hence the benefits are not realized equally by inbound and outbound trips. Outbound trips of Routes 7FR, 11FL, and 12FL would realize the largest improvements—roughly six minutes for each—which may suggest that Projects L1-L4, L6, L23, L4, and L26 are particularly effective in addressing the speed and reliability issues affecting transit on these corridors. However, because all projects are modeled simultaneously, as noted above, it is not clear from this analysis which of these projects has the greatest impact.

Table 12 reflects the systemwide impacts of implementing every potential HOV and BAT lane project currently being considered. Although the number of signalized intersections with an LOS of 'B' decreases and those rated 'C' increase, intersections with an LOS of 'D', 'E', and 'F' all decline, resulting in an overall improvement in citywide vehicle delay of 2 seconds.

Table 12 2030 PM peak hour signalized intersection LOS before and after HOV and BAT lane implementation.

LOS	Baseline	HOV/BAT Lane Projects
A	8	8
B	31	28
C	49	54
D	53	52
E	30	33
F	24	20
Citywide Avg. Vehicle Delay (sec)	49.9	47.9
Citywide LOS	D	D

Source: Dynameq model D30R1.0.3, for November 14, 2013 Transportation Commission meeting.

As only a portion of the potential transit priority projects can be modeled (i.e. HOV and BAT lanes), it can be expected that implementation of the entire package of improvements would result in a greater travel time savings than is reflected here. This is because HOV and BAT lanes are often paired with other improvements, such as queue jump lanes and/or TSP to help transit pass through problem intersections more efficiently. This assessment therefore only presents part of the picture—the degree of benefit achieved by HOV and BAT lanes in isolation of any other related transit priority projects—so the results presented in Table 10 should not be understood to mean that the City will be unable to achieve the target travel speeds assumed in the Transit Service Vision Report. The other types of priority projects being considered will also contribute to transit travel speed improvement—those investments would not be considered if this was not the case—but those projects' benefits will need to be assessed using more detailed applications.

After further review of the list of potential projects by staff, consultants, transit agency representatives, and the Transportation Commission, four projects of particular interest will be prioritized for additional in-depth analysis by project consultant Transpo Group. That analysis will use VISSIM modeling software to assess the benefits and impacts of the projects being considered in terms of transit and general purpose travel time, delay, and vehicle queuing, among other measures. Unlike the analysis presented here, the VISSIM analysis will not be limited to considering only HOV and BAT lane treatments, so the impacts of queue jumps, TSP, and other improvements will also be reflected and hence provide a more accurate depiction of the total benefit realized by the potential projects being considered.

APPENDICES

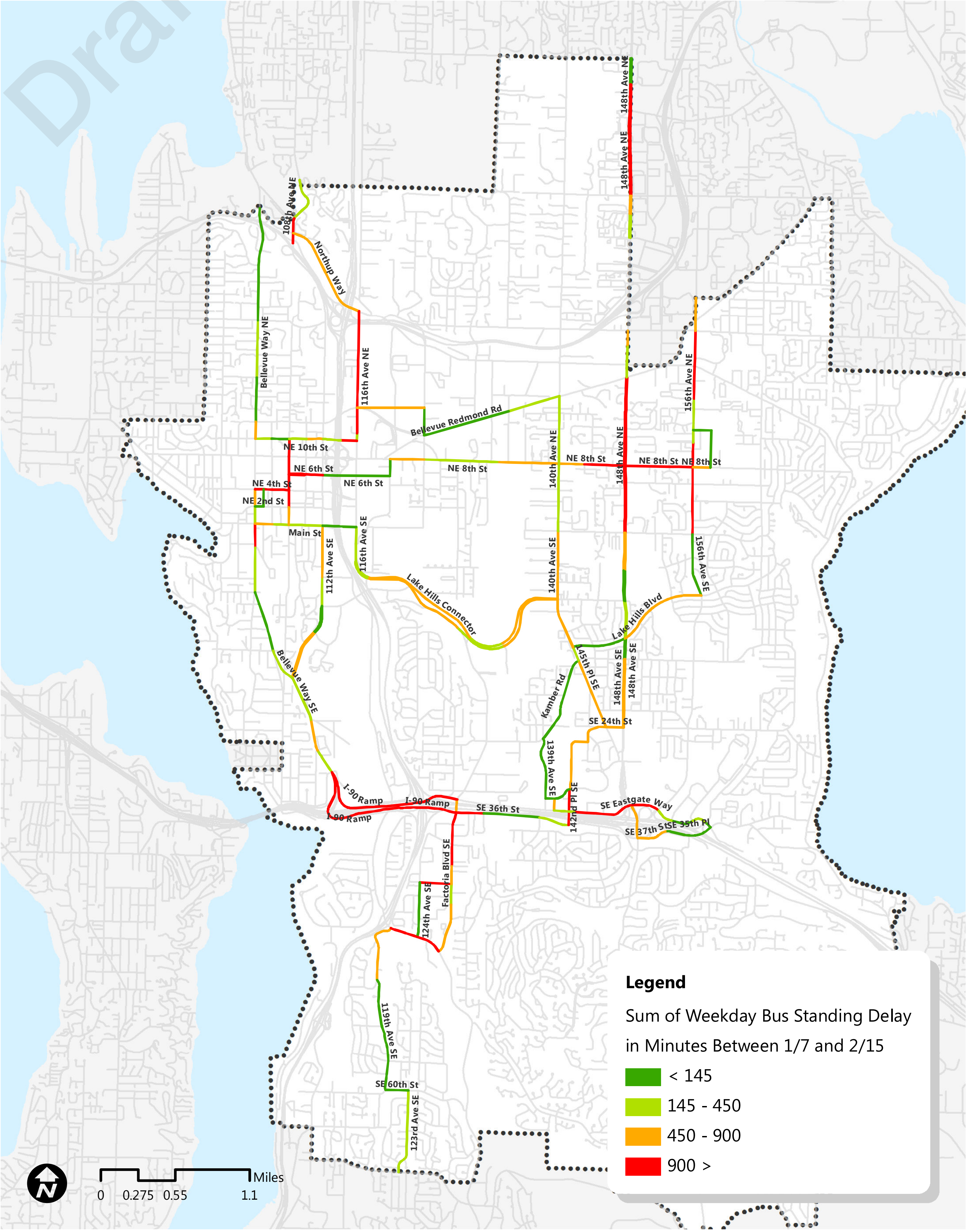
APPENDIX 1: ISSUE IDENTIFICATION MEASURE MAPS

The maps on the following pages present all of the measures used in the issue identification methodology described on pages 27-49. This includes the following measures:

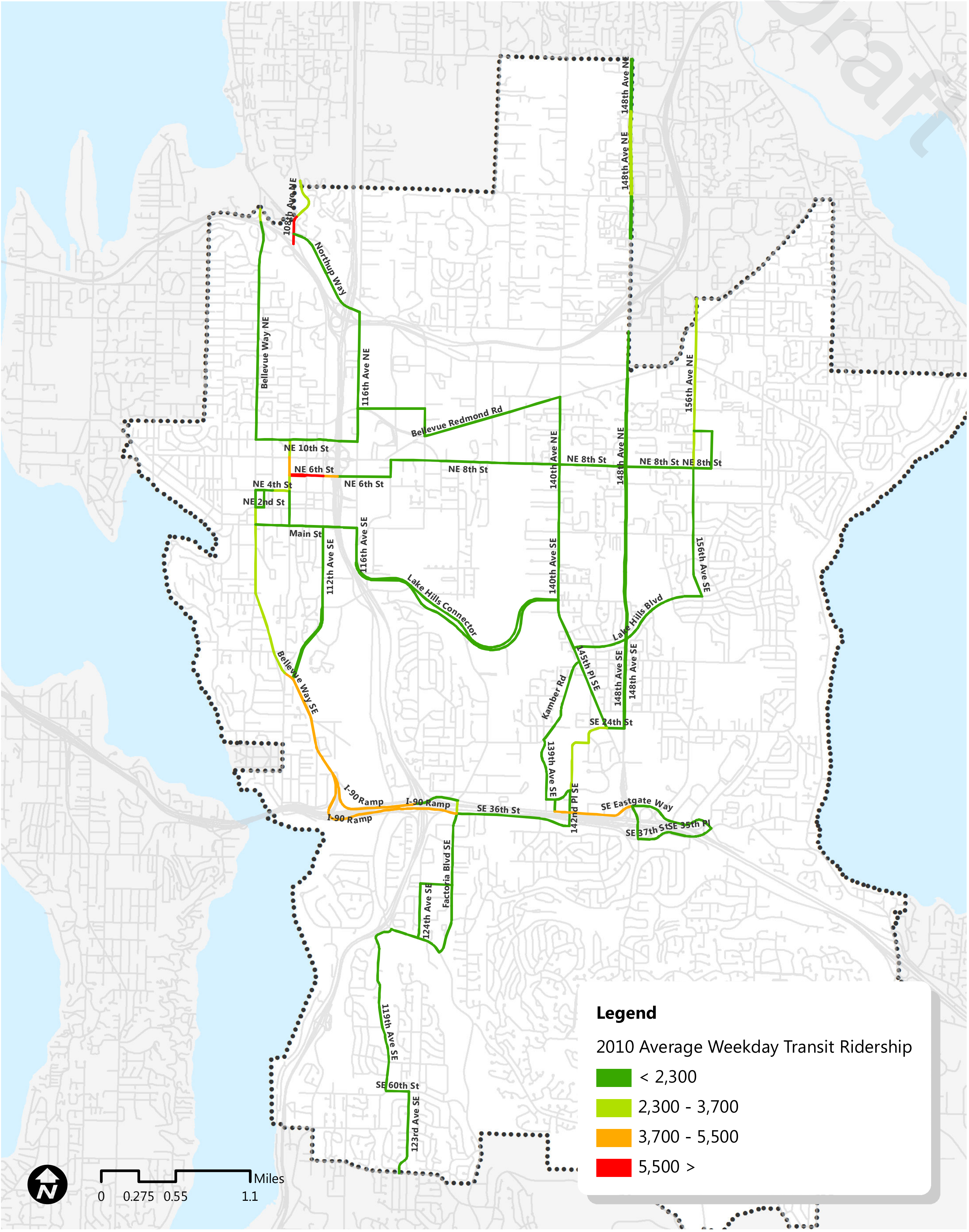
- Short Term Measures:
  - Weekday bus standing delay (in minutes)
  - 2010 average weekday transit ridership
  - 2013 weekday bus volumes
  - Coach operator survey comments

- Long-Term Measures:
  - 2030 projected average weekday transit ridership
  - 2030 planned weekday bus volumes
  - 2030 projected sum of average weekday PM peak approach delay (in seconds)
  - 2030 projected sum of average weekday PM peak approach queue length (in feet)
  - 2030 projected intersection level-of-service (LOS)

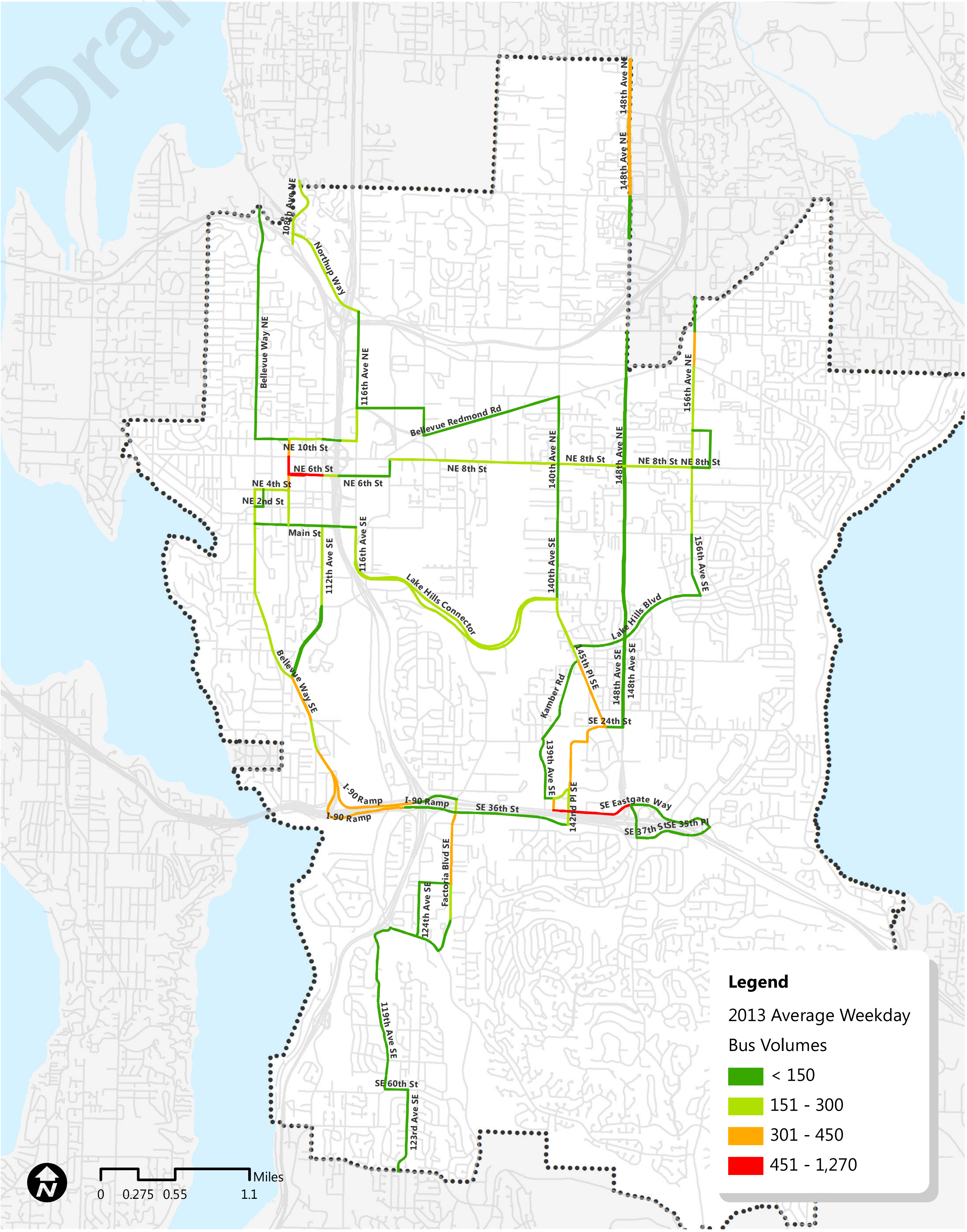
Appendix Figure 1 Short-Term: Weekday Bus Standing Delay.



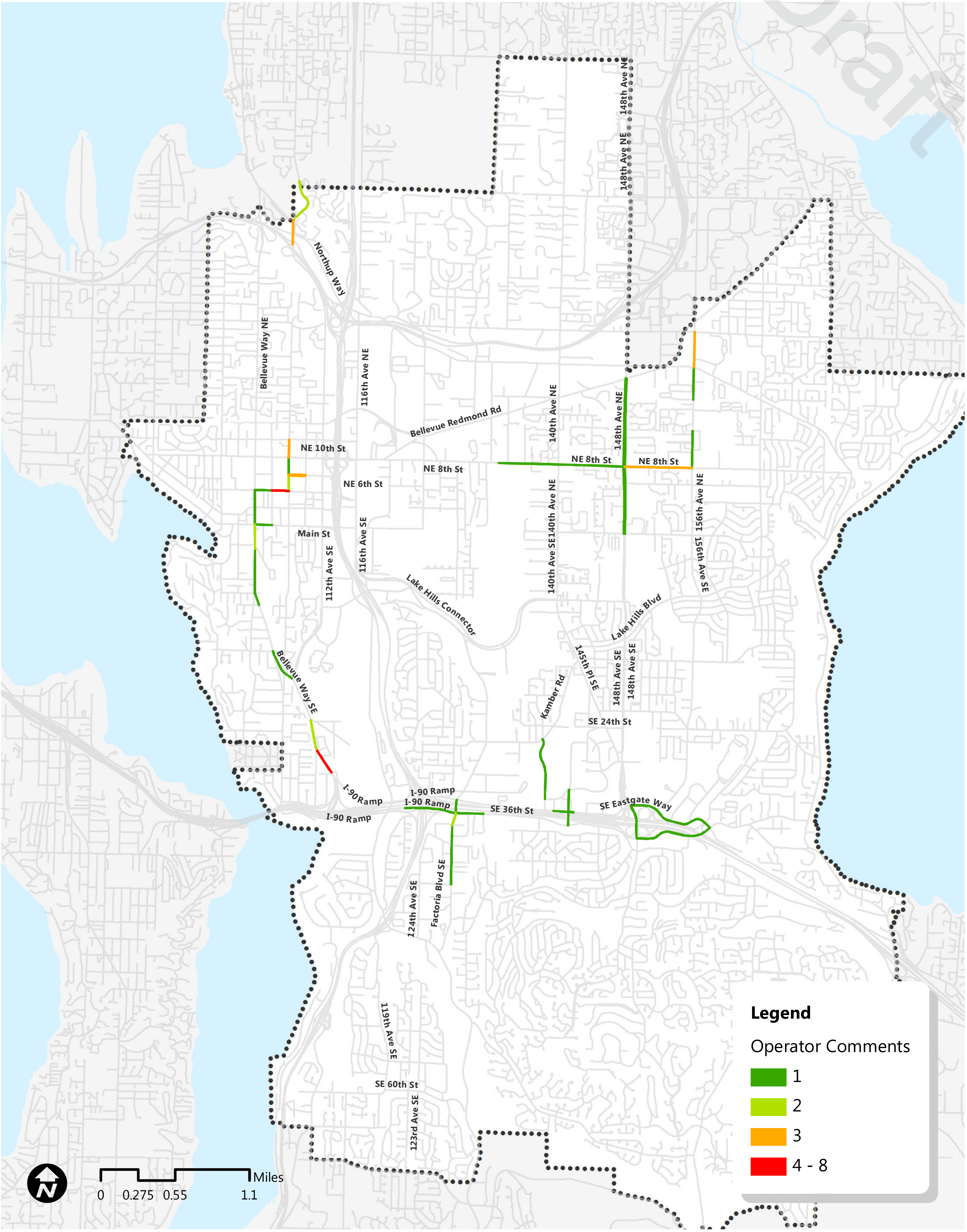
Appendix Figure 2 Short-Term: 2010 Average Weekday Transit Ridership.



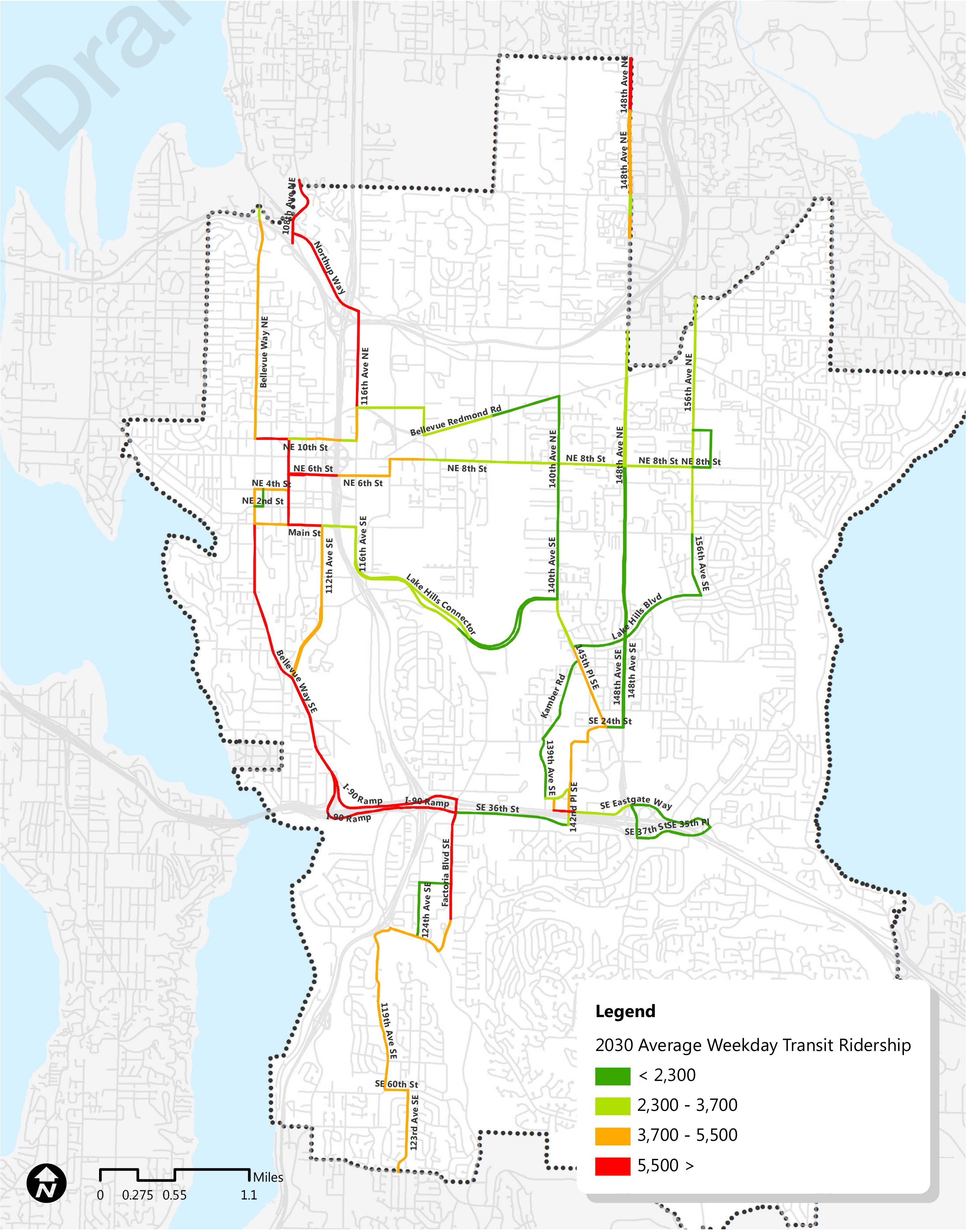
Appendix Figure 3 Short-Term: 2013 Weekday Bus Volumes.



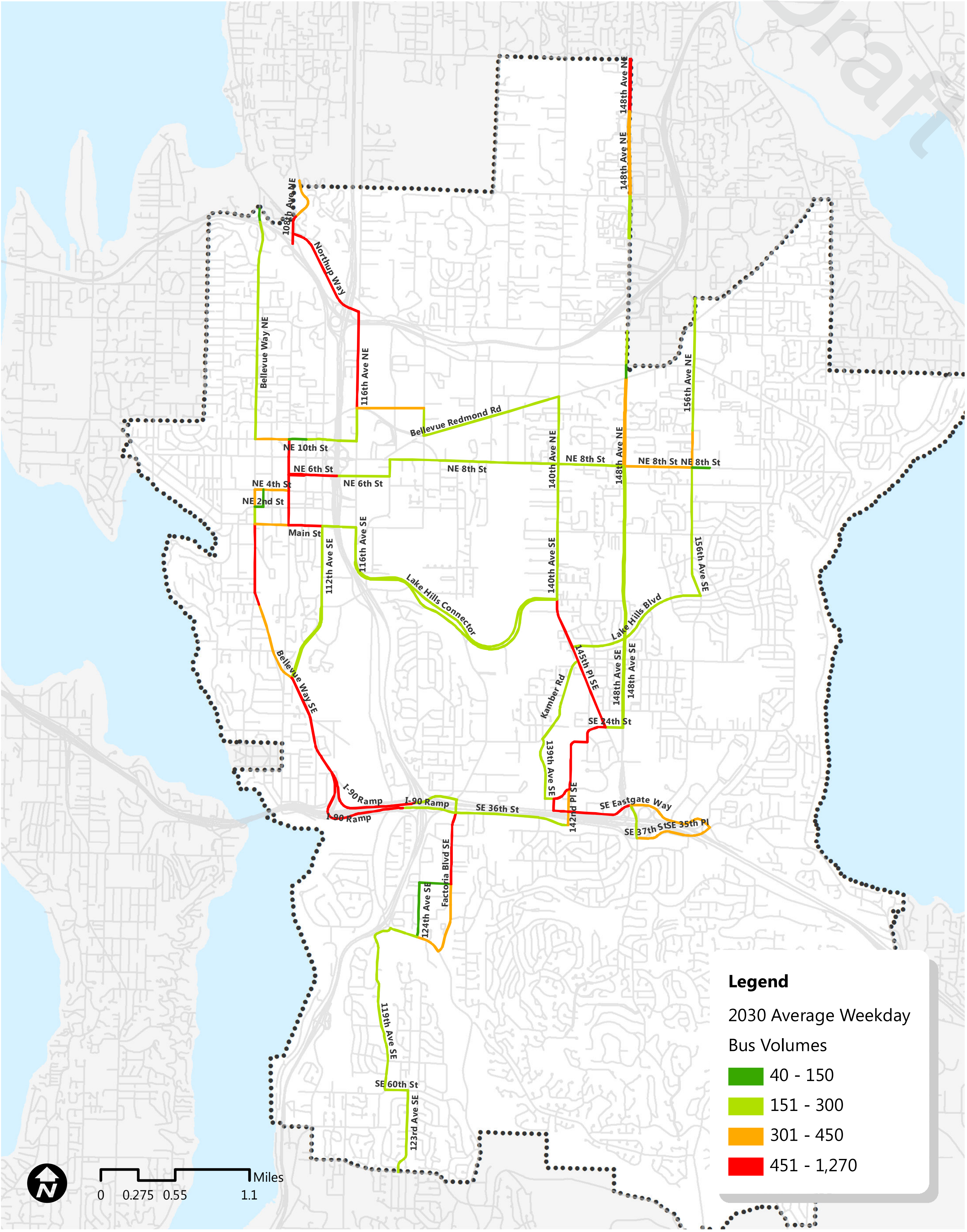
Appendix Figure 4 Short-Term: Operator Survey Comments.



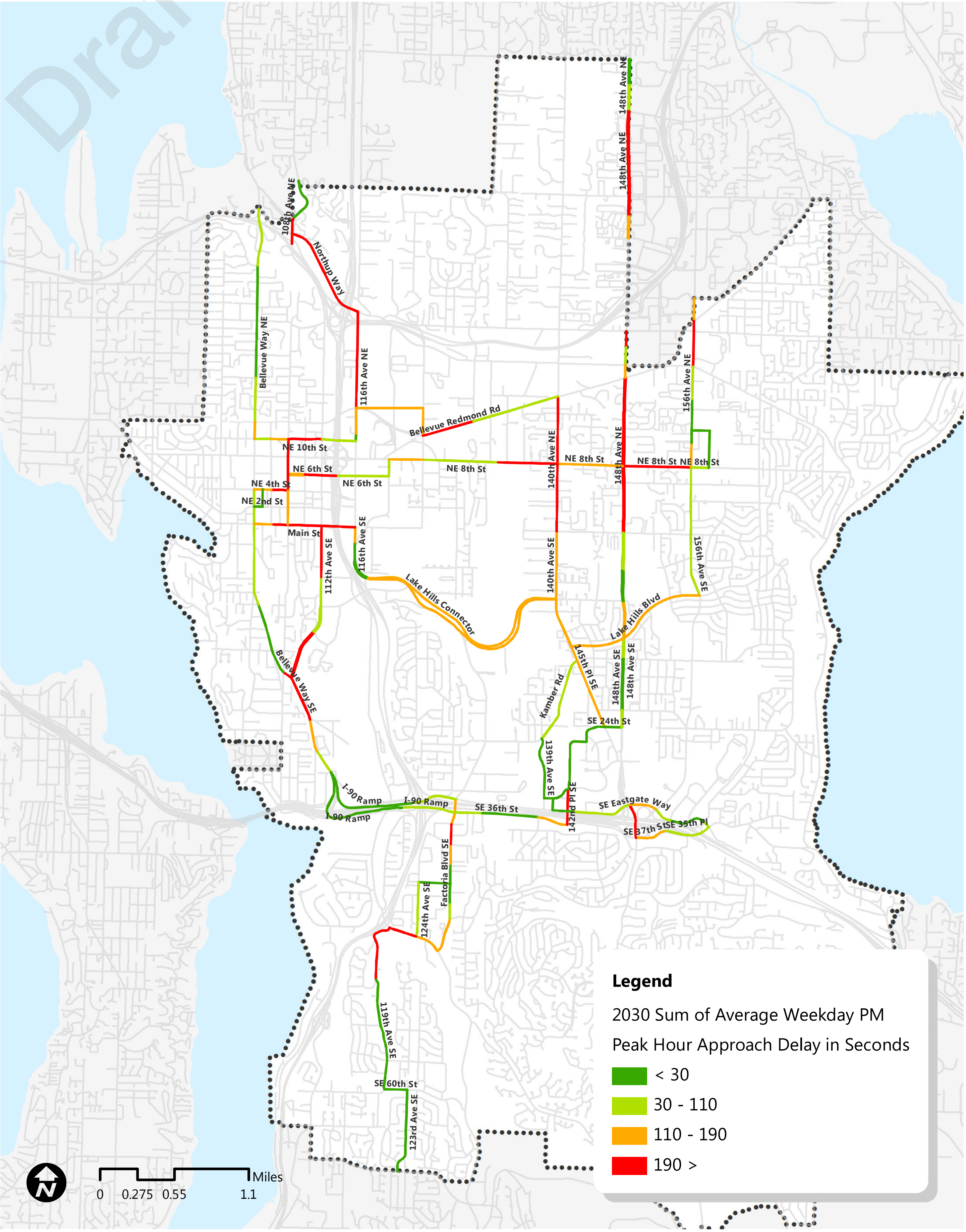
Appendix Figure 5 Long-Term: 2030 Average Weekday Transit Ridership.



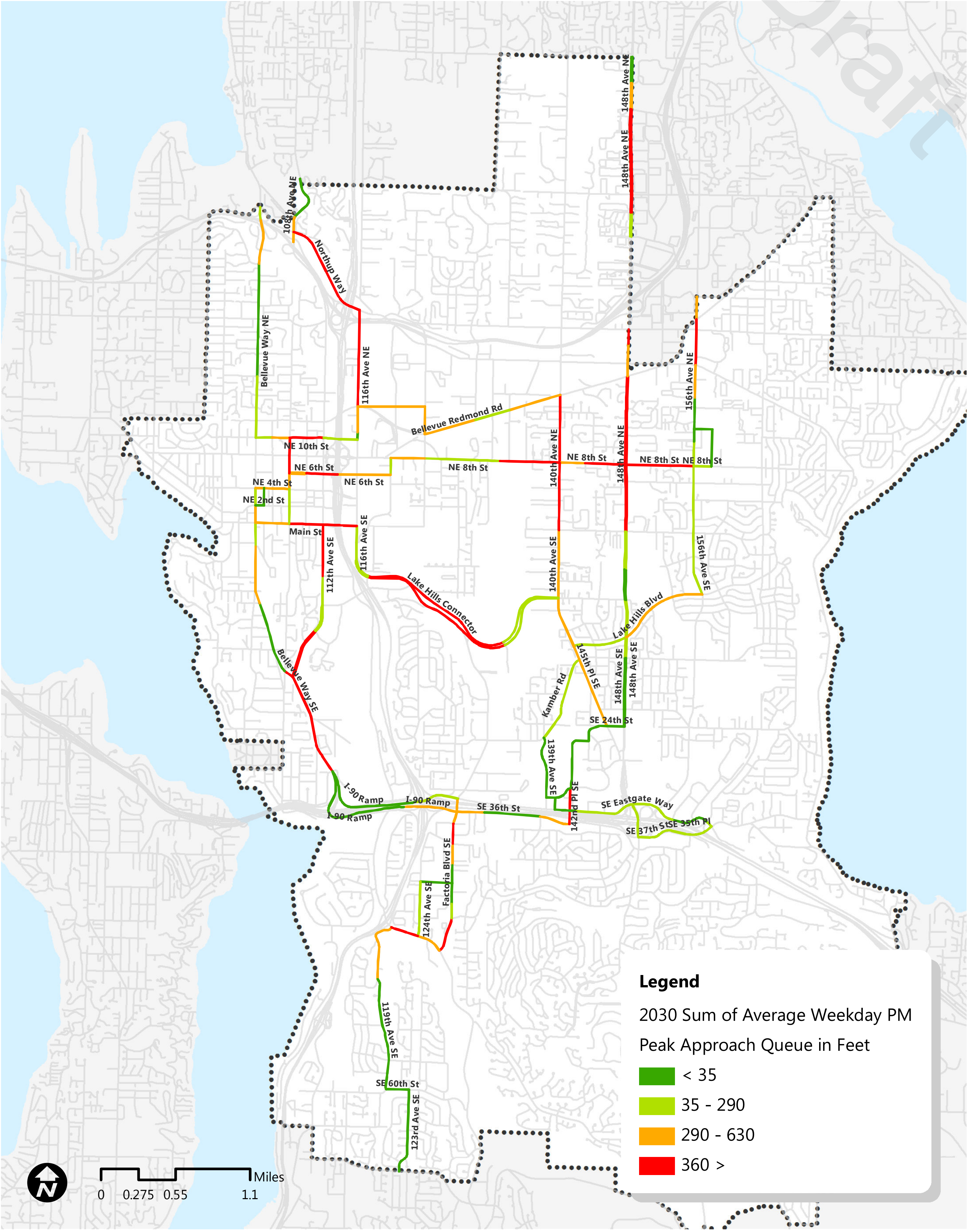
Appendix Figure 6 Long-Term: 2030 Weekday Bus Volumes.



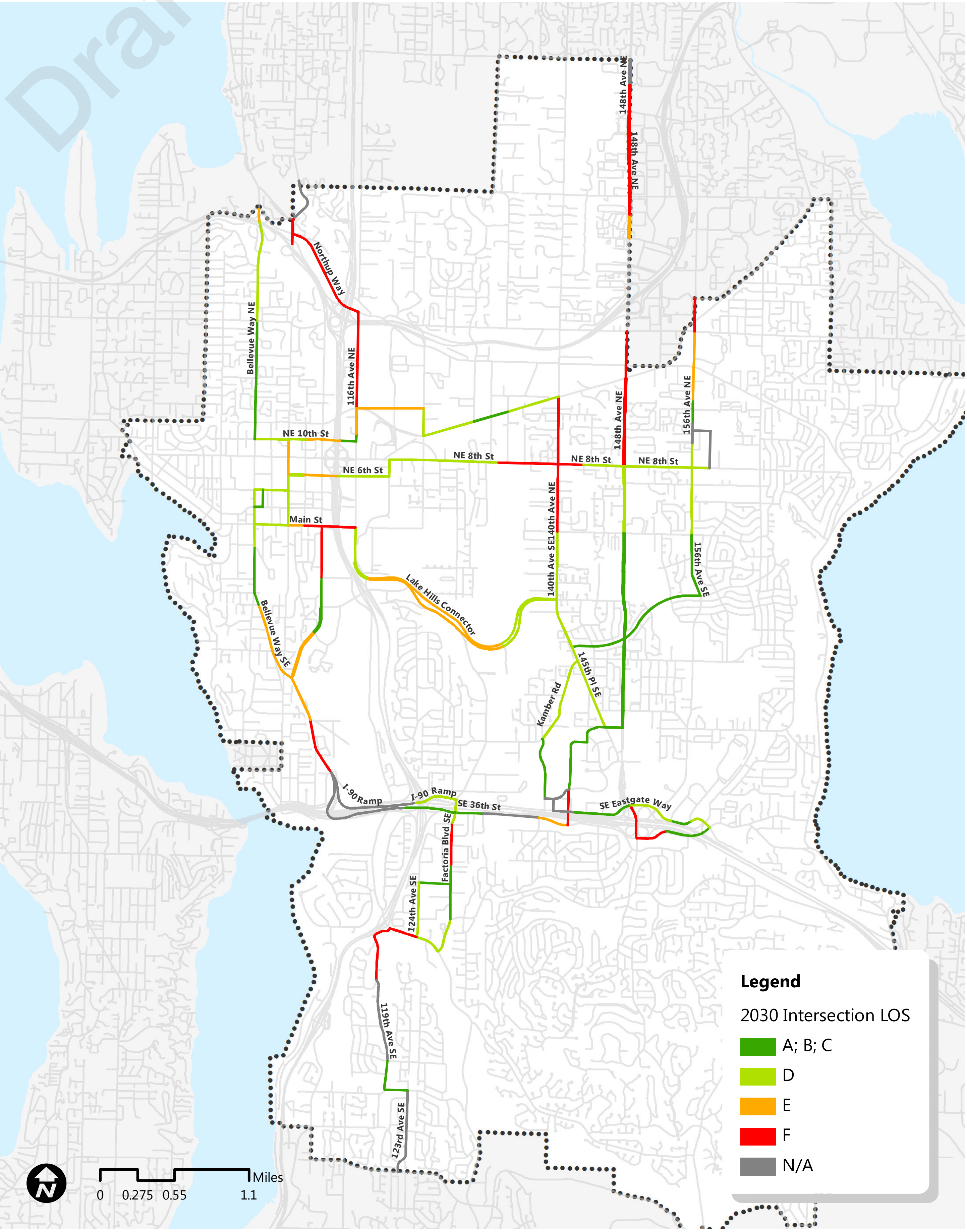
Appendix Figure 7 Long-Term: 2030 Average Weekday PM Peak Approach Delay.



Appendix Figure 8 Long-Term: 2030 Average Weekday PM Peak Approach Queue Length.



Appendix Figure 9 Long-Term: 2030 Intersection Level-of-Service (LOS).



APPENDIX 2: DATA SOURCES CONSIDERED BUT NOT USED

After additional review several data sources which were presented at the project kickoff meeting or discussed with staff will not be used. These data sources, while related to transit speed and reliability, had various issues which made them poorly fitted to the analysis, unavailable, tedious to use, or simply less useful than other similar data sources.

On-Time Performance

On-time performance is measured as the percent of trips which depart their respective time points less than two minutes early or five minutes late. For example, RapidRide B Line on-time performance is measured as the percent of trips within +/- three minute of that trip's scheduled headway. Multiple issues were identified with this data source:

1. The data is coarse, with data available only for an entire route or at some time points. Only some terminal time points can be used due to known issues with data when buses layover.
2. Delays from insufficient recovery time at route terminals can contribute to poor on-time performance.
3. On-time performance is calculated by comparing actual departure times against scheduled departure time. By adding time to a schedule, Metro planners can improve on-time performance without actually improving the speed and reliability of routes.
4. Delays occurring outside the city, especially on highways, are not directly relevant to this analysis, but their impact cannot be removed from the data.

Because of these issues and the more detailed data provided by bus GPS data, on-time performance is not used at this time.

Street Congestion

Congestion on road segments can be measured as the ratio of vehicles to roadway capacity. The closer vehicle volumes are to the capacity of the roadway, the more delay a road segment experiences. This measure was originally identified because it could help identify road segments where buses might experience delay when reentering traffic after stopping at an out-of-lane bus stop. However, because very few locations in Bellevue require buses to merge back into traffic and intersection delay is available from the more detailed Dynameq model, it was determined that this data was duplicative.

Travel Time Reliability

Reliability of travel time is highly important for transit systems. When transit travel times are unreliable the service operator must schedule extra time at the end of each trip to ensure the bus can depart on time for its next trip. This additional time, called recovery time, is necessary to operate a reliable transit system but also results in "wasted" service hours because buses are not carrying passengers during this time.

The reliability of travel time can be measured as the variation of travel time throughout the day from one time point to another. The lower the variability, the more reliable a time point interval is. While presented at the project kickoff meeting as a very important data point, further discussion with King County Metro revealed that Metro's database structure is set up in such a way that this measure could not be calculated. Alternative approaches to use this data were reviewed because of the value of this data but no good alternative was ultimately identified.

Scheduled Speed

The average scheduled travel speed between two time points can be calculated using the scheduled travel time and distance between the time points. The first reason this data was not used is due to the lack of detail with regards to time point intervals, the route between time points, which can be several miles long. The second, more practical reason, is because King County Metro doesn't have a shapefile which time point interval data can be joined to.

Mode Share

Mode share is a ratio that describes the relative use of a street by different modes of transportation such single occupant vehicles (SOVs), high occupancy vehicles (HOVs), buses, pedestrians, and bicyclists. Whereas low-density, auto-oriented areas have a high SOV mode share, areas like Downtown have a higher non-SOV mode share. The mode share of key transit corridors will be used to identify and prioritize the locations for transit priority treatments, but this data is not available for all areas served by the Frequent Transit Network (FTN).