Appendix A: Transportation Analysis Methods

TRANSPORTATION ANALYSIS METHODS

Traffic, Pedestrians, Bicycles, Freight, Parking

Introduction

This report describes the methods that will be used to collect data and conduct transportation analysis for people traveling in the Southwest Corridor in motor vehicles, by foot, and on bicycles, for goods moving in freight trucks and on railroads, and for motor vehicle parking for the Southwest Corridor Light Rail Project Draft Environmental Impact Statement (Draft EIS). This analysis will be developed to comply with the National Environmental Policy Act (NEPA); local and state policies, standards, and regulations; and to respond to community concerns raised through environmental scoping.

Planning for high capacity transit (HCT) improvements in the Southwest Corridor has been underway since 2009. The evaluation and refinement of HCT options in the corridor have included considerable technical analysis of traffic operations associated with the HCT options. The *Final SW Corridor Traffic Analysis and Operations Memorandum, July 2014*, prepared by DKS Associates, used Synchro traffic models to analyze the PM and AM peak hour operations at key intersections with HCT operating through the corridor.

That memo was followed by the *SW Corridor Supplemental Refinement Traffic Impact Analysis Executive Summary Traffic Report, March 2016*, also prepared by DKS Associates. This refinement memo focused on more detailed technical analysis in three target areas: SW Barbur Boulevard between SW 69th and SW Brier Place, SW Barbur Boulevard between SW Hamilton and SW Naito Parkway, and in the Interstate 5 (I-5)/Lower Boones Ferry Interchange area. This refinement analysis was used to test detailed design options and provide input into the preparation of light rail designs that are the basis for the Southwest Corridor Light Rail Project Environmental Impact Statement (EIS) analysis.

The models and analysis prepared for these memos will be used, as appropriate, in the traffic operations and impacts analysis for the EIS. The Draft EIS and Final EIS traffic analyses will be consistent with these methods. The Final EIS will include a more detailed analysis focused on the Preferred Alternative.

The Oregon Department of Transportation (ODOT) and the City of Portland are currently negotiating a potential jurisdictional transfer of the portions of SW Naito Parkway and SW Barbur Boulevard within the Portland city limits that are currently part of the state highway system designated as OR 99W. ODOT issued a letter to Metro and TriMet in January 2017 which clarified its expectations with regard to the acceptable forecast year for the traffic analysis for these portions of roadway in the Draft EIS. The letter clarifies that ODOT will accept 2035 forecast year analysis for SW Barbur Boulevard and SW Naito Parkway except for locations at freeway interchanges. ODOT further clarifies that if the jurisdictional transfer agreement is not concluded, that additional analysis using a 2045 forecast year for those state highway segments may be required.

Transportation methods range from system-wide measures developed through regional travel forecasts to focused analysis of intersection operations. Metro will analyze system-wide transportation impacts, but micro-level traffic impacts analysis will focus on identifying localized impacts. The local traffic analysis will identify and evaluate the long-term impacts of the project on the following:

- Volume-to-capacity (v/c) ratios or level of service (LOS) at study intersections affected by the alternatives and options
- Signal progression
- 95th percentile queueing at freeway off-ramps and mainline approaches for study intersections in Vissim model areas
- Property access and local traffic-flow changes caused by intersection reconfiguration, street closures and/or driveway consolidation, the addition of new traffic signals, and by at-grade rail crossings created by the proposed transit improvements
- Truck freight movement within the corridor, including loading dock access
- On-street parking impacts attributable to the alternatives and options
- Bicycle and pedestrian access and circulation
- Safety including high injury locations

Short-term impacts to vehicular, bicycle and pedestrian traffic resulting from construction activities will also be identified and evaluated.

Related Laws and Regulations

The following relevant laws, regulations, and policy direction established in the numerous transportation plans and policy documents adopted by jurisdictions within the corridor will be considered in the transportation analysis.

Federal

- National Environmental Policy Act of 1969
- Code of Federal Regulations (CFR), Title 49, Transportation **-** Part 213 Track Safety Standards
- CFR, Title 49, Transportation **-** Part 236 Rules, Standards and Instructions: Signal Systems

State

- Oregon Transportation Planning Rule (Oregon Administrative Rules [OAR] Chapter 660, Division 12) with its provisions for bicycle parking, and bicycle and pedestrian access to stations, and performance standard guidance
- OAR 340.20.129(1)(c) and OAR 340.20.129(1)(e) relating to the evaluation of park-and-ride lots as required by the Oregon Department of Environmental Quality (DEQ)
- OAR 734-020 and OAR 734-051 relating to traffic control and access spacing as required by the Oregon Highway Plan
- *Oregon Transportation Plan*, Oregon Department of Transportation (ODOT) (adopted September 20, 2006)
- *Oregon Highway Plan*, ODOT (1999, amended May 2015)

Local

- *Regional Transportation Plan*, Metro (2014)
- City and County Transportation System Plans (City of Portland, City of Tigard, City of Tualatin, City of Lake Oswego, and Washington County)
- Transportation impact study guidelines (City of Portland, City of Tigard, City of Tualatin, and Washington County)

Contacts and Coordination

Previous planning efforts in the Southwest Corridor have been coordinated by Metro and managed by a project Steering Committee that is chaired by two Metro Councilors, and has elected and appointed representatives from TriMet, ODOT, Washington County, and the cities of Portland, Tigard, Tualatin, Durham, King City, Beaverton, and Sherwood. A description of this planning process and resulting documentation can be found on Metro's website at http://www.oregonmetro.gov/public-projects/southwest-corridor-plan. Each of these agencies and jurisdictions is represented at the Southwest Corridor Project Technical Advisory Committee (TAC), which is composed of technical staff from each jurisdiction and agency. The transportation analysis team will report to the TAC as needed and as directed by the Metro project manager.

The jurisdictions and agencies listed below will be contacted as appropriate to provide information to assist with the transportation analysis. Typical thresholds or standards of significance used by these agencies (as documented later in this section) will be utilized, and any standard mitigation measures that would apply to the project are identified, including improvements already identified through prior planning in the corridor.

State Agencies

- ODOT: *Oregon Transportation Plan* (adopted September 20, 2006), *Oregon Highway Plan* (1999, amended May 2015), *Oregon Bicycle and Pedestrian Plan* (adopted May 19, 2016), and relevant policies related to access management and highway design/operation. ODOT is a full partner in the EIS and has responsibility over certain major transportation facilities in the corridor including I-5 (and exit and entrance ramps), OR 99W, Ross Island Bridge, OR 141 (SW Hall Boulevard), I-405, and OR 217. ODOT also has responsibility for roadways within interchange areas as well as for rail crossing safety, compliance with Federal Railroad Administration policies, regulating railroad clearances, and safety oversight of rail transit systems.
- DEQ: DEQ has responsibility for air and water quality and is included here due to its role in monitoring air quality impacts related to motor vehicle operations.

Regional Agencies

- Metro: *Urban Growth Management Functional Plan* (January 2016), the Congestion Management System, and the *Regional Transportation Plan* (2014). Metro is the project manager for the EIS, and is responsible for land use and transportation planning at a regional level.
- Tri-County Metropolitan Transportation District of Oregon (TriMet): TriMet is responsible for the design, construction, and operation of HCT facilities in its service area which includes

most of the urbanized areas of Washington County, Multnomah County and Clackamas County.

Counties

- Washington County: *Transportation System Plan (*November 2015). Washington County operates and maintains several roadways in the study area, and those facilities will be subject to county performance measures.

Cities

- City of Portland: *Transportation System Plan Update Stage 1 of the Comprehensive Plan* (adopted June 2016), the Transportation System Plan (adopted 2002, updated 2007), the Central City 2035 Proposed Draft (June 2016), and the Central City Transportation Management Plan (Adopted 1995).
- City of Tigard: *Transportation System Plan* (November 2010).
- City of Tualatin: *Transportation System Plan* (March 2014).
- City of Lake Oswego: *Transportation System Plan* (September 2014).

Data Collection

Study Area

The study area was defined during previous study phases. TriMet has developed conceptual designs illustrating the project alternatives, which are organized into three segments and serve as the basis for the EIS technical analysis. The results of the technical transportation analysis will be reported by segment, listed below, and will provide the basis for comparison among alignment options within each segment.

- Segment A – Inner Portland (SW Lincoln to SW Brier Place)
- Segment B – Outer Portland (SW Brier Place to SW 68th)
- Segment C – Tigard/Tualatin (SW 68th to Bridgeport Village)

The first two segments fall completely within the Portland City Limits, and the third segment includes two sub-areas that fall within the Cities of Tigard and Tualatin. There are four primary jurisdictions in the study area where the local traffic impacts within corridors are managed (Washington County, City of Portland, City of Tigard, and City of Tualatin), as well as the ODOT jurisdiction.

Overview of the Transportation Analysis Process

The following discussion provides an overview of the process for collecting data, analyzing existing conditions, preparing forecast volumes, preparing intersection analyses, assessing performance, and identifying mitigation. Further detail describing specific methodology and analysis is presented in subsequent sections of this report.

Affected Environment

Understanding the transportation-affected environment for the project requires collecting data on the existing transportation system and its performance for various modes of travel. The locations and type of data to be collected are described in the Affected Environment section of this report. The traffic count program described provides the basis for determining existing traffic volumes in the corridor.

The transportation analysis will focus on transportation operations at study area intersections and roadways using the *2010 Highway Capacity Manual* methodologies for unsignalized intersections and the *HCM 2000* methodology for signalized intersections (Transportation Research Board 2010). The analytical tools used to evaluate traffic operations at study area intersections will be Synchro, SimTraffic, and/or Vissim. The Affected Environment section will summarize data collected on pedestrian activity, bicycle activity, transit usage, on-street parking usage, freight truck activity, and safety data.

Future Traffic Volumes

After data for the affected environment has been summarized, forecasts for future volumes will be developed based on post-processing forecasts provided by Metro. The No-Build Alternative horizon year is 2035 (and 2045 for freeway ramp terminals). In addition to developing future volumes for the No-Build Alternative, future volumes will be developed for the build alternatives and alignment options for comparative purposes. These forecasts take into account future regional land uses including park-and-ride land uses, when applicable.

Impact Assessment – System-wide Analysis

Metro will prepare the system-wide analysis that will use the regional travel demand model to determine if the light rail project and associated facilities would cause changes in motor vehicle circulation or traffic patterns, including the potential for diversion of traffic through neighborhoods. This analysis will include quantification of link volumes from the travel demand model at key screenline locations (i.e., South Portland, mid-Barbur, Tigard), and comparison of link volumes across No-Build and build alternatives. Traffic diverted to regional through routes, such as freeways or other limited-access facilities, will be quantified using the regional travel demand model as a part of the system-wide traffic impact analysis. Volume difference plots will be produced to document changes in traffic patterns throughout the regional system.

Impact Assessment – Intersection Analysis

The tools utilized for future transportation operational analysis will focus on macroscopic (regional) and microscopic (intersection and corridor) levels of detail. The macroscopic analysis will be prepared by Metro utilizing its regional travel demand model. The microscopic analysis will be prepared by the consultant team and will focus on intersection/corridor performance using Vissim, SimTraffic, and the *Highway Capacity Manual* methodologies in Synchro. Vissim simulation will be utilized at three locations (SW 4th Avenue/I-405 interchange area, Ross Island Bridgehead, and the SW Terwilliger/Bertha/I-5 interchange area) identified at a traffic analysis methodology workshop with all participating project partner agencies. Microsimulation at these locations was determined to be necessary in order to fully understand the effects of oversaturated conditions and dynamic elements such as ramp queue dump operations, transit signal priority and pre-emption, and upstream/downstream effects of congestion.

Performance Measures and Mitigation

The final step in the transportation analysis process is to compare the alternatives, including the No-Build Alternative, to determine impacts to the transportation system resulting from the implementation of the proposed project. Potential mitigation measures will be developed at locations that do not meet specific performance standards and/or performance criteria thresholds (all of which are identified in more detail later in this report).

Background and Definitions

<u>Travel Demand Modeling</u>

Existing and projected population and employment are key factors in how the transportation system operates and how many vehicle trips are on the transportation network. Metro prepares population and employment estimates for the base year (2015) and for a range of forecast years. This study will use the base year and both a 2035 and a 2045 forecast year. Projected population and employment were developed for all areas within the study area consistent with the local jurisdiction comprehensive plans. These forecasts are consistent with the adopted Regional Transportation Plan (RTP). For purposes of the EIS analysis, Metro will prepare a 2035 forecast consistent with the RTP population and employment forecasts and a factoring approach to a 2045 forecast. Complete data sets will be developed for the following conditions:

- Existing base 2015
- Year 2035 forecast (AM and PM)[1]
- Year 2045 (PM only) forecast (for freeway ramp terminals only, factored from 2035).

The forecast year AM and PM peak-hour travel forecasts for each alternative and alignment option will be generated by Metro using the regional travel model. Regional travel demand forecasts will include hourly data and peak spreading.

The output from the regional travel models will be used to develop AM and PM peak-hour directional roadway volumes and intersection turning movements. These volumes will be derived using methodologies outlined in National Cooperative Highway Research Program Report 765, *Highway Traffic Data for Urbanized Area Project Planning and Design*. A post-processing application will facilitate the derivation of the forecast year AM and PM peak-hour turning movement volumes from actual count and model increment (growth) data.

Forecasting the amount of future traffic at the signalized and unsignalized intersections will be done by incorporating existing counts, base case travel demand model data (2015), and future travel demand model data (2035 and 2045). The growth rate in volumes will be determined between the base year model and the future year model, and the growth rate will be applied to the existing volume counts for 2015. This methodology minimizes the effects of model error by adding the increment of growth projected by the travel demand model to actual count data. Therefore, intersection approach and departure volumes used in the LOS calculations will reflect growth, but will not exactly match raw model volumes produced from the travel demand model.

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[1] Use of 2035 forecast year for analysis of OR 99W portions of SW Barbur Boulevard and SW Naito Parkway is dependent on the successful completion of proposed jurisdictional transfer between ODOT and the City of Portland.

Intersections

Traffic operations on surface streets are generally controlled by the intersections along any given route. For the purposes of the project's local traffic impact analyses, surface street intersections have been categorized into three basic groups: (1) signalized intersections, (2) unsignalized intersections and ramp merges, and (3) at-grade crossings of surface streets by light rail or railroad tracks. Some locations combine two of these elements; for instance, a signalized intersection with light rail tracks passing through the intersection. Through prior planning, EIS scoping, and the review of these methods, local agencies and ODOT have provided input into the intersections to be evaluated.

Measurement of Motor Vehicle Performance at Intersections

This section discusses the intersection operations for motor vehicles in the study area. LOS and the v/c ratio are two commonly used performance measures that provide a gauge of intersection operations. Agencies often incorporate these performance measures into their mobility standards. These performance measures are defined as follows:

- Level of Service (LOS): A "report card" rating (A through F) based on the average delay (seconds per vehicle) experienced by vehicles at the intersection. LOS A, B, and C indicate conditions where traffic moves without significant delays over periods of peak-hour travel demand. LOS D and E are progressively worse operating conditions. LOS F represents conditions where average vehicle delay has become excessive and demand is near or over capacity; this condition is typically evident in long vehicle queues.
- Volume-to-capacity (v/c) ratio: A decimal representation (typically between 0.00 and 1.00) of the proportion of capacity that is being used. The v/c ratio is determined by dividing the peak-hour traffic volumes by the hourly capacity of a given facility. A lower ratio indicates smooth operations and minimal delays. As the ratio approaches 1.00, congestion increases and performance is reduced. Above 1.00, demand is greater than capacity and the facility is oversaturated, resulting in longer queues and delays.

Highway Capacity Manual methods will be used to determine LOS and v/c ratio at signalized intersections. The LOS at signalized intersections is defined in terms of average delay. Capacity, delay, LOS, and v/c ratio are calculated for each traffic movement or group of traffic movements at an intersection. The weighted average delay across all traffic movements determines the overall LOS for a signalized intersection. Refined analysis in subsequent phases of the project may be necessary to account for the effects of transit priority measures, as measured in terms of additional delay that would be experienced by motorists.

LOS at an unsignalized intersection is also defined in terms of delay. Average total delay, or the total elapsed time from when a vehicle stops at the end of the queue until the vehicle enters the intersection from the stop-controlled or yield-controlled approach, is the controlling measure. While the analysis methodology is completely different for unsignalized intersections than for signalized intersections, the measures of effectiveness are similar (LOS delay). LOS definitions for signalized and unsignalized intersections are in Table 1.

Table 1. Level-of-Service Definitions

LOS	Signalized Intersection Stopped Delay per Vehicle (seconds per vehicle)	Unsignalized Intersection Average Total Delay (seconds per vehicle)
A	≤10.0	≤10.0
B	>10.1 and ≤20.0	>10.1 and ≤15.0
C	>20.1 and ≤35.0	>15.1 and ≤25.0
D	>35.1 and ≤55.0	>25.1 and ≤35.0
E	>55.1 and ≤80.0	>35.1 and ≤50.0
F	>80.0	>50.0

Source: Transportation Research Board – 2010 Highway Capacity Manual, Special Report 209, Fourth Edition.

In order to objectively evaluate roadways in Segment A with free-flow movements, metered movements, and ramp merges where v/c ratios and LOS cannot be measured, queuing, delay, throughput, and travel time will be measured for these locations. These are not specific mitigation criteria, but will be reported to provide complete information on the benefits and impacts of proposed changes to the roadway network.

Signal Timing Optimization

Often at intersections, motor vehicle, pedestrian, and bicycle movements are controlled by a traffic signal. The operation of traffic signals has an overall time allocated for all of the movements at the intersection (referred to as the cycle length), as well as an individual time within the cycle length given to movements (typically referred to as splits in the cycle). As volumes of users of all modes at an intersection grow over time, it is usually necessary to reallocate the existing cycle length time or develop a new cycle length time and allocation of time within that cycle, to better serve those movements.

Signal Progression Bandwidth

Signalized intersections are often coordinated along a corridor/roadway for maximizing operations of throughput on that corridor. The ability to coordinate these signals is predicated on the amount of green time given to the major through movement on the corridor, and the timing between the signals to progress users along the corridor. The "green time" (amount of time allocated to a movement at an intersection that is green) creates a band of time for users to travel along a corridor. This band of time is also referred to as a bandwidth for users. Signal progression takes into account this bandwidth of green time on a corridor and can try to optimize the ability for users to progress on a corridor.

Queuing

Queuing is when a line of vehicles is waiting to be served by a signalized or unsignalized intersection. The speed of vehicles serviced within the queue is determined by the rate of flow at the front of the queue. The queue (or backup) of traffic can affect the design of facilities to properly account for this storage activity. *Highway Capacity Manual* methodologies are limited in their ability to capture the effects of oversaturated conditions, queue spillback between intersections, storage bay spillback, or starvation. As such, simulation-based analysis will be performed using SimTraffic and/or Vissim to capture these effects. SimTraffic analysis will be performed according to ODOT's Analysis Procedures Manual, and Vissim analysis will be performed according to ODOT Vissim Protocol. For future year analysis, a peak-hour factor of 1.00 and an ideal saturation flow of 1,900 vehicles per hour per lane may be used to reflect realistic traffic patterns under highly congested conditions. The simulation analysis will report the 50th and 95th percentile queue lengths. The 95th percentile queue estimates that for any given cycle at a signalized intersection, the queue length calculated is representative of 95 percent of the peak 15-minute vehicular queues during the peak hour at that intersection.

Safety

Intersections will be identified based on their inclusion on local jurisdiction listings of high injury locations (or other collision reference). The local jurisdictions and ODOT will be asked to provide their prioritization and designations of high injury locations. Fatal and severe injury crashes (serious crashes) occurring in the most recent 5 years of data within 500 feet of the project alignment options will be documented. The locations of serious crashes will be identified and reviewed for apparent risk factors and compared to available documentation, such as the Barbur Road Safety Audit.

Evaluation Criteria for Traffic Operations

The methods used in the analysis of local traffic impacts will be consistently applied throughout the study area. However, because multiple agencies and jurisdictions are involved, there will be some differences in methodologies and impact thresholds depending upon the location within the corridor, the complexity of the issues, and the applicable laws and regulations.

In addition to the performance measures listed in Table 3, there are two special considerations for the City of Portland. The Portland Central City planning area has been designated a Multimodal Mixed-Use Area (MMA) by the city with concurrence from ODOT in June 2016. The MMA designation means that the City will not need to consider ODOT mobility standards when approving Comprehensive Plan or Zoning Map Amendments within the Central City portions of the corridor (north of I-405). The second consideration is a City policy that established a hierarchy for transportation modes that prioritizes pedestrian, bicycle, transit, freight and HOV/carshare vehicles over single occupant vehicles. While these policies do not directly affect the performance measures listed in Table 3, they will be considered during the evaluation of potential mitigation measures.

Local Jurisdiction Criteria

It is recognized that because multiple agencies and jurisdictions make up the study area, there will be some differences in performance measures depending upon the location of an intersection within the study area. The specific LOS threshold criteria for the supervising jurisdiction will be used at the study area intersections that fall within that jurisdiction and are summarized in Table 3.

Table 3. Acceptable Operating Standards / Performance Measures

Jurisdiction	Location	AM/PM Peak Two-Hour Period: First Hour	AM/PM Peak Two-Hour Period: Second Hour
Oregon Department of Transportation [A]	Barbur Boulevard (outside of Centers) Naito Parkway (outside of Centers)	0.99	0.99
	Ramp Terminals (signalized intersections at end of freeway off-ramps)	0.85	0.85
	Regional/Town Centers	1.1	0.99
Washington County [B]	Regional Centers Town Centers Main Streets Station Communities	0.99	0.99
	Other Urban Areas	0.99	0.9
City of Portland [C]	Central City Gateway Town Centers Neighborhood Centers Station Areas	1.1	0.99
	Barbur Boulevard and Other Principal Arterials	0.99	0.99
City of Tualatin [D]	Washington County facilities ODOT facilities	0.99	0.99
	Downtown Tualatin (Metro-designated Town Center)	1.1	0.99
	City facilities	LOS D or E	
City of Tigard	City of Tigard facilities	1.0	1.0
City of Lake Oswego	City of Lake Oswego facilities	LOS E	

Sources: A. Oregon Highway Plan (1999); B. Washington County Transportation System Plan (November 2015); C. City of Portland Comprehensive Plan, Transportation System Plan update (June 2016); D. Tualatin Transportation System Plan (February 2013).

Note: ODOT and the City of Portland are currently negotiating a possible jurisdictional transfer (JT) of the OR 99W portions of SW Naito Parkway and SW Barbur Boulevard. The Draft EIS will use ODOT criteria for those facilities to determine potential mitigation. It is anticipated that the JT issue will be resolved in 2017 and the Final EIS will use the appropriate jurisdictional criteria for determining final mitigation.

Affected Environment

Understanding the affected transportation environment requires gathering data on the existing transportation system and its performance for all modes of travel. The following discussion describes the collection of intersection count data that will capture the number and direction of bicyclists, pedestrians, and motor vehicles traveling through study area intersections. Counts are focused on signalized intersections and other locations where the project would change operation or geometry of the intersection. Figures 2-1 through 2-5 show the study area intersections and modeled intersections. Study area intersections are locations where performance measures will be reported. Modeled intersections are used to distribute traffic and to properly capture traffic operations at study intersections. Performance measures will not be reported at modeled intersections. This data includes the following:

- AM peak hour (7 to 9 AM) vehicle turn movement counts at up to 74 intersections. These counts will include the collection of pedestrian, bicycle, bus, and truck (medium/heavy) crossing counts at each intersection.
- PM peak hour (4 to 6 PM) vehicle turn movement counts at up to 105 intersections. These counts will include the collection of pedestrian, bicycle, bus, and truck (medium/heavy) crossing counts at each intersection.
- 24-hour bidirectional vehicle volume, speed, and classification counts at up to 8 locations (locations to be determined during field observations).
- AM and PM peak-hour one-hour driveway counts at up to 24 locations (locations to be determined during field observations).
- Video data collection at up to six locations (locations to be determined during field observations).
- Motor vehicle travel time surveys (using the floating car method) will be collected along up to four different routes in Segment A during the AM and PM peak hour (routes to be determined during field observations). It is assumed that survey data will be collected over two different days by two different vehicles.
- Vehicle queue length measurements at up 20 locations during both the AM and PM peak hours (locations to be determined during field observations).
- Lane utilization measurements at up to 10 different locations (locations to be determined during field observations) during both the AM and PM peak hours
- Survey of the existing physical characteristics of the existing street network, including travel lanes, lane geometry at intersections, signal timing and phasing at study area intersections, presence of sidewalks, presence of bike lanes, presence of crosswalks, presence of bus stops and/or bus zones.
- An on-street parking inventory will be collected for the entire project corridor to determine number of stalls impacted by the project.
- To supplement the number of stalls impacted by the project, parking occupancy counts will be collected on an hourly basis over an 8-hour period on up to 10 block faces in downtown Tigard.
- Crowd-sourced travel time data (i.e., TomTom, HERE, or similar) will be collected for segment A to support simulation model calibration.

Figure 2-1. Segment A Study Intersections

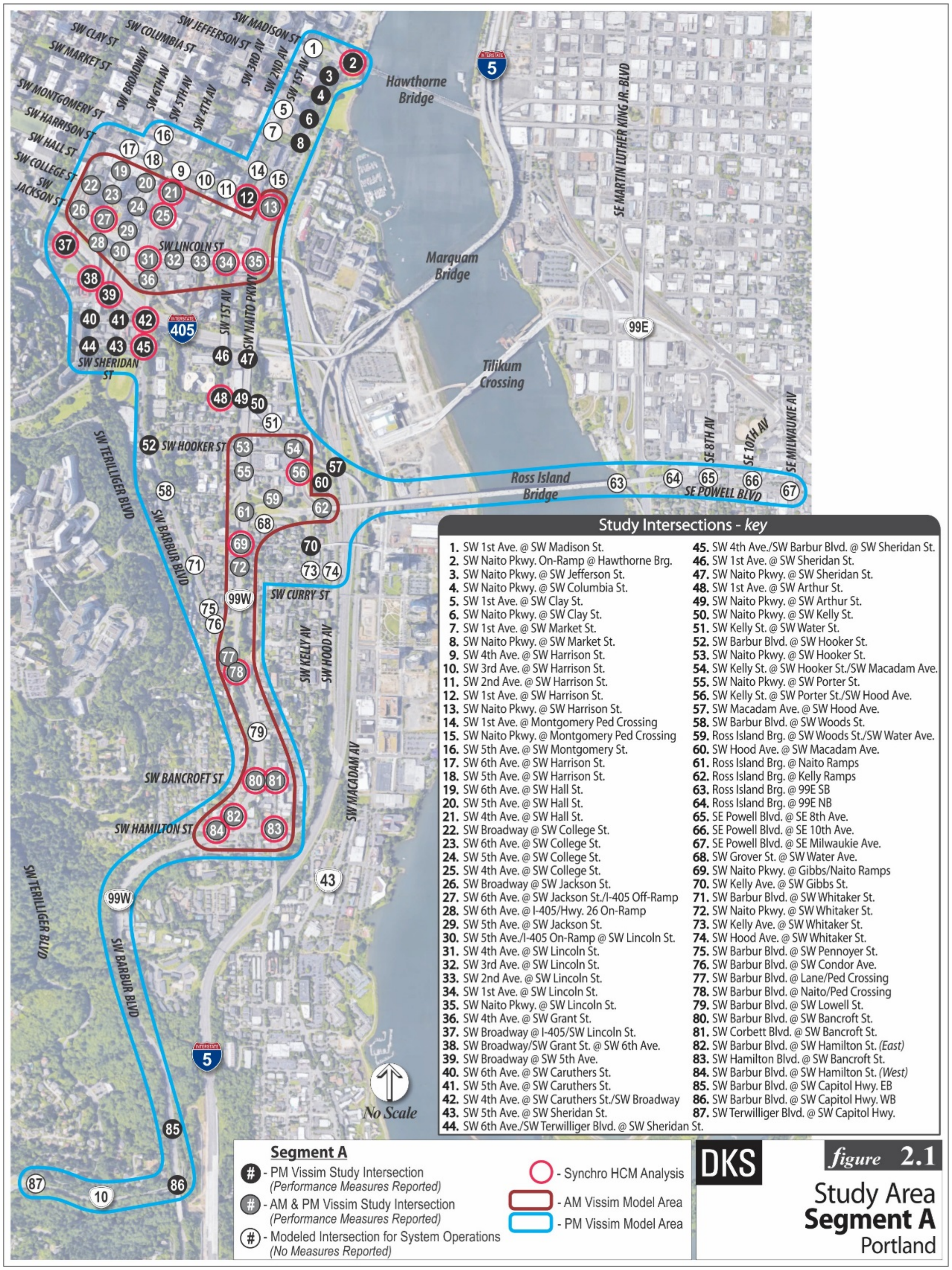


Figure 2-2. Segment B Study Intersections

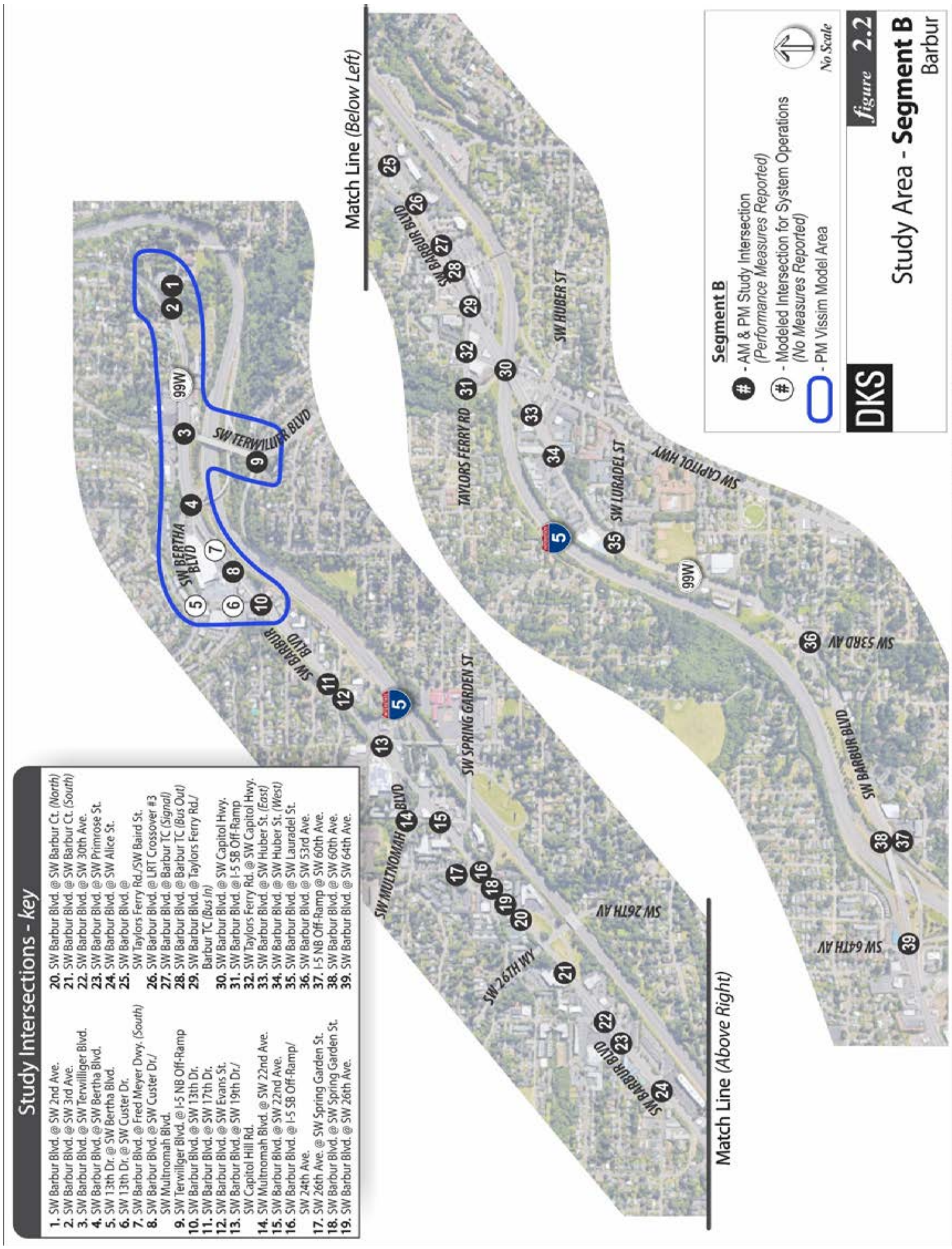


Figure 2-3. Segment C Study Intersections – Tigard

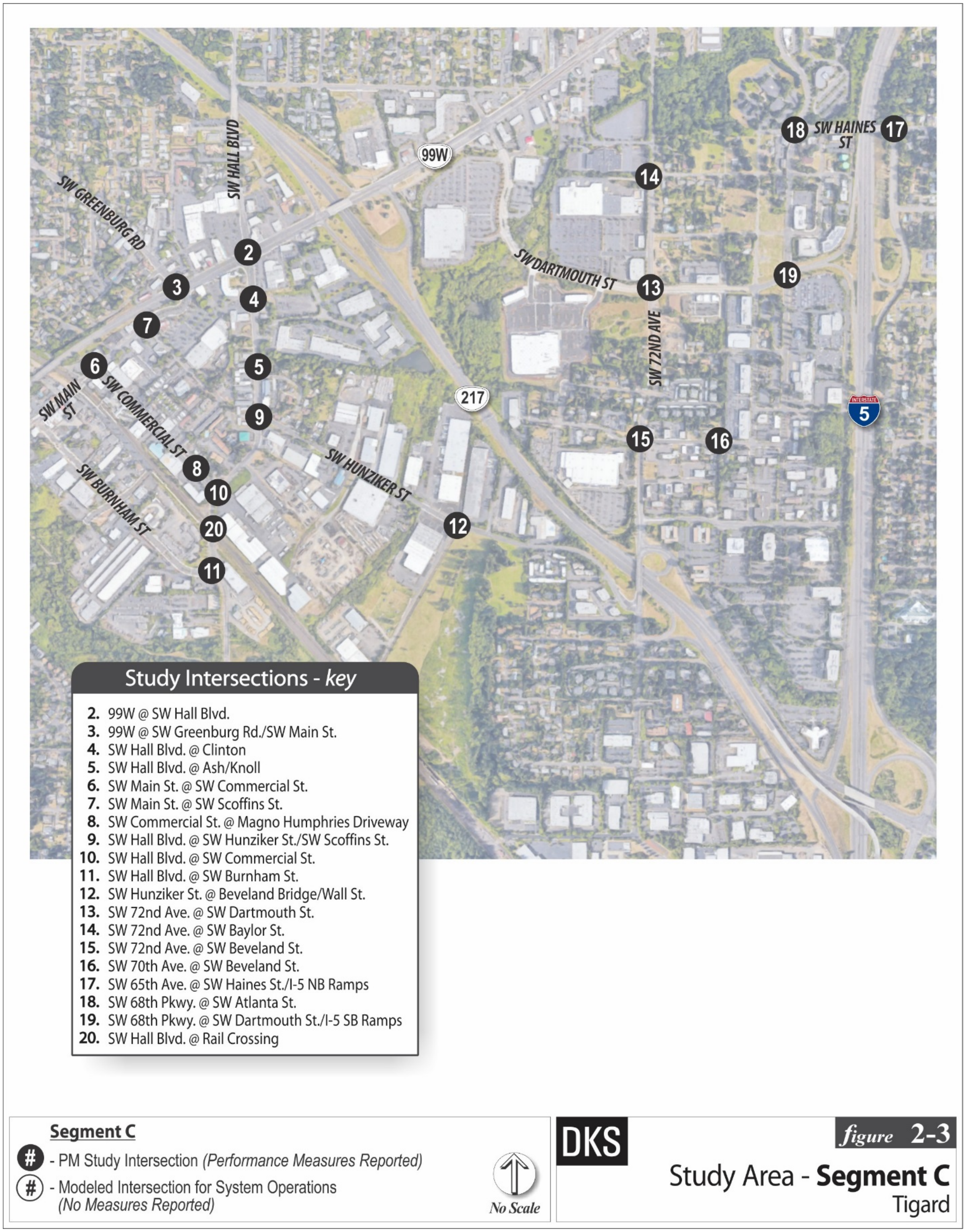


Figure 2-4. Segment C Study Intersections – Bonita and Carman/Upper Boones Ferry

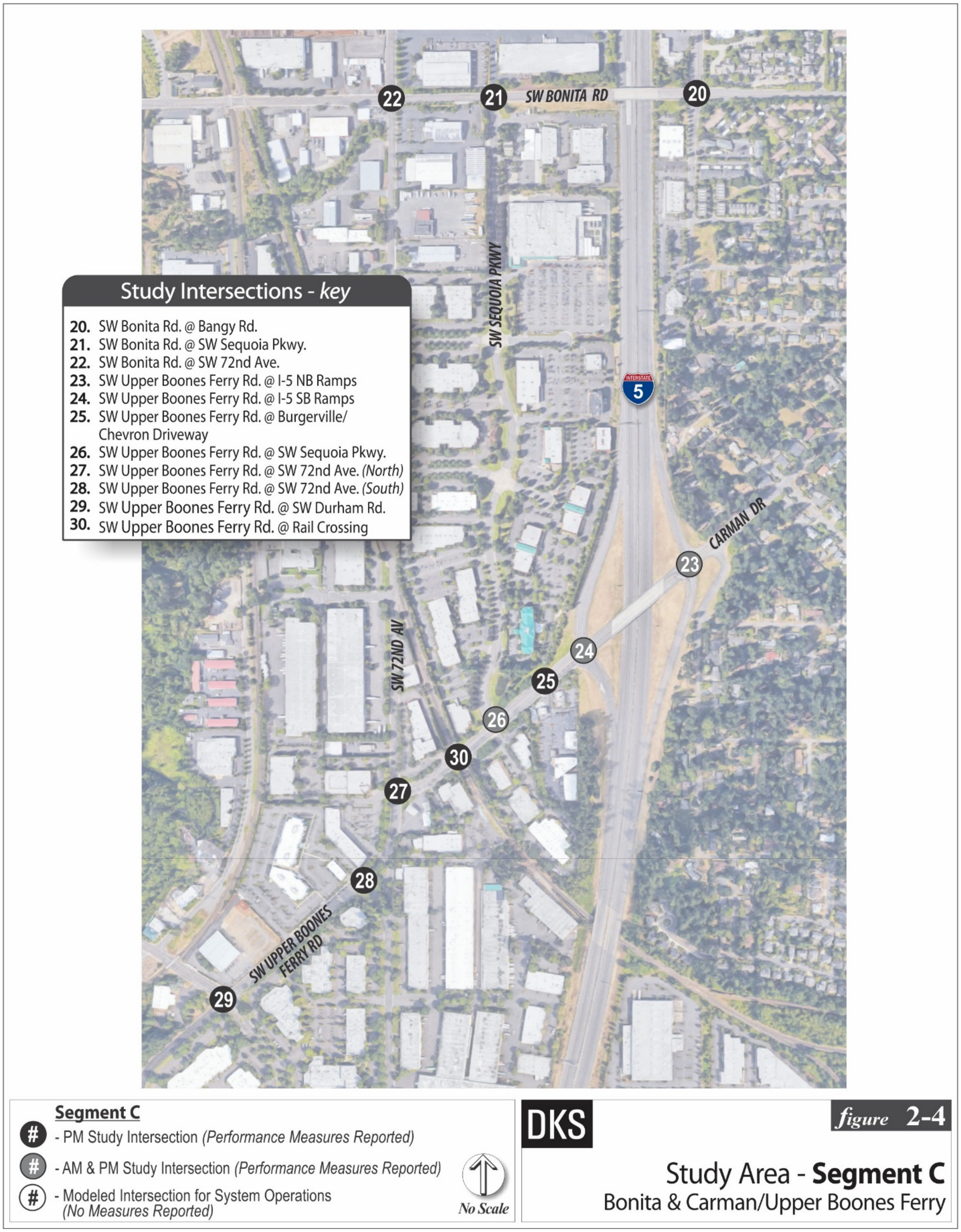
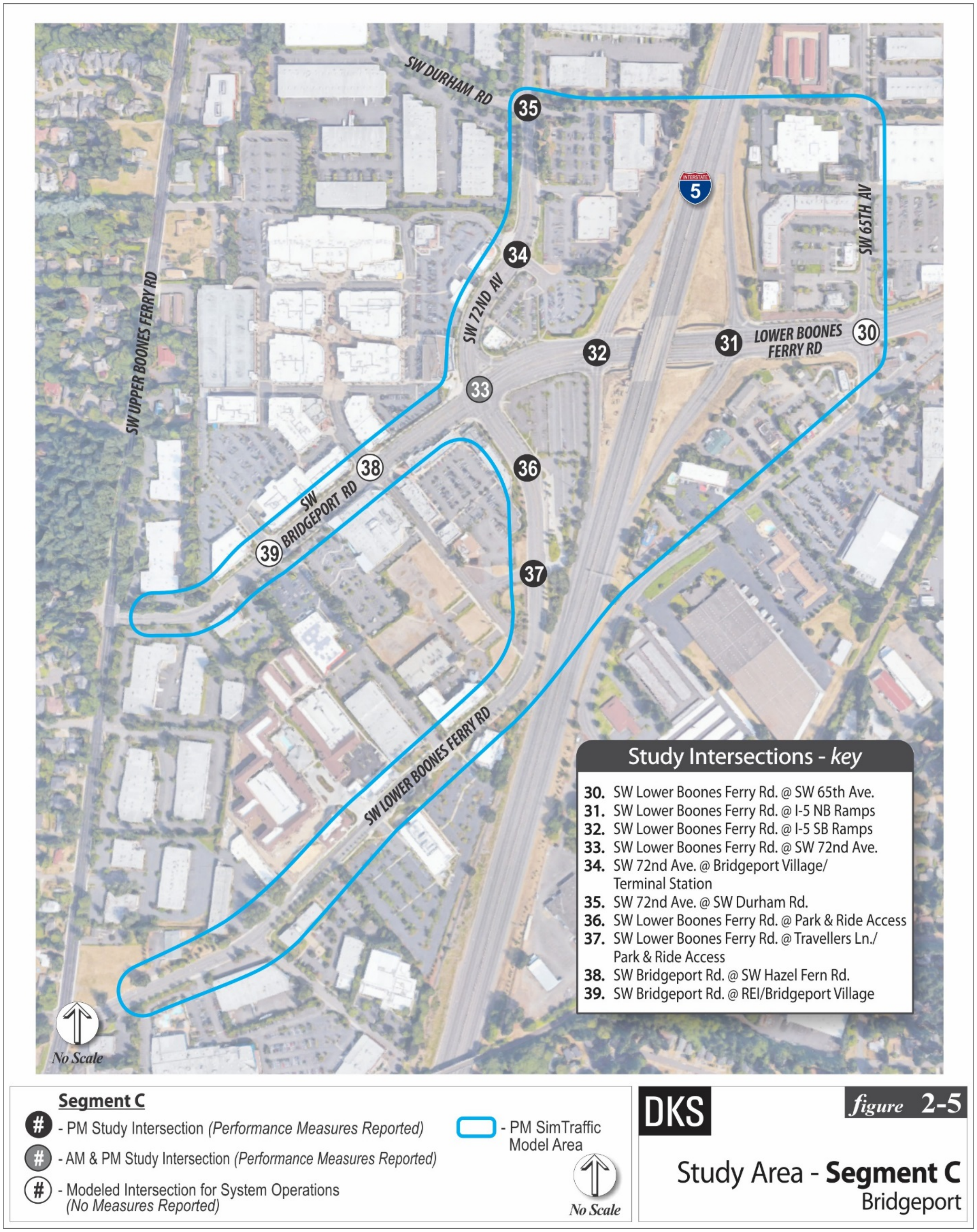


Figure 2-5. Segment C Study Intersections – Bridgeport



Impact Assessment and Mitigation

Long-Term Impacts

The following criteria will be used to evaluate all modes of travel within the study area. Both motorized and non-motorized modes will be evaluated, as well as additional criteria for parking and access.

Intersection Analysis

The evaluation of motor vehicle performance and identification of mitigation requirements for the project will be based on three primary criteria: v/c ratios, queuing, and safety. These three criteria will be compiled across all project alternatives (no build and build). To provide consistent evaluation criteria across the entire study area, project-based standards that have been mutually agreed upon by the partner agencies will be used. The project-based standards have been developed based on input from jurisdictional standards, but may or may not conform to these standards exactly. Each criterion will be evaluated separately to determine whether performance measures are met or not met when compared to the No-Build Alternative.

It is important to note that an alternative may not require mitigation using one performance measure, but may require mitigation using another performance measure. For example, a ramp terminal intersection may meet an intersection v/c mobility standard, but the 95th percentile queue on the ramp may exceed the safe stopping distance from back of queue to the freeway, thus requiring mitigation. Therefore, all performance measures will be applied, as appropriate, to study area intersections. These performance measures will be developed to help promote mobility and provide a safe and efficient transportation network. Figure 2-6 summarizes the overall process for evaluating impacts on study area intersections using the following performance measures.

The Draft EIS will include a preliminary signal warrant analysis at locations where the project includes installation of a traffic signal or where the project substantially impacts an unsignalized intersection. A full MUTCD traffic signal warrant analysis will be conducted during a future project phase.

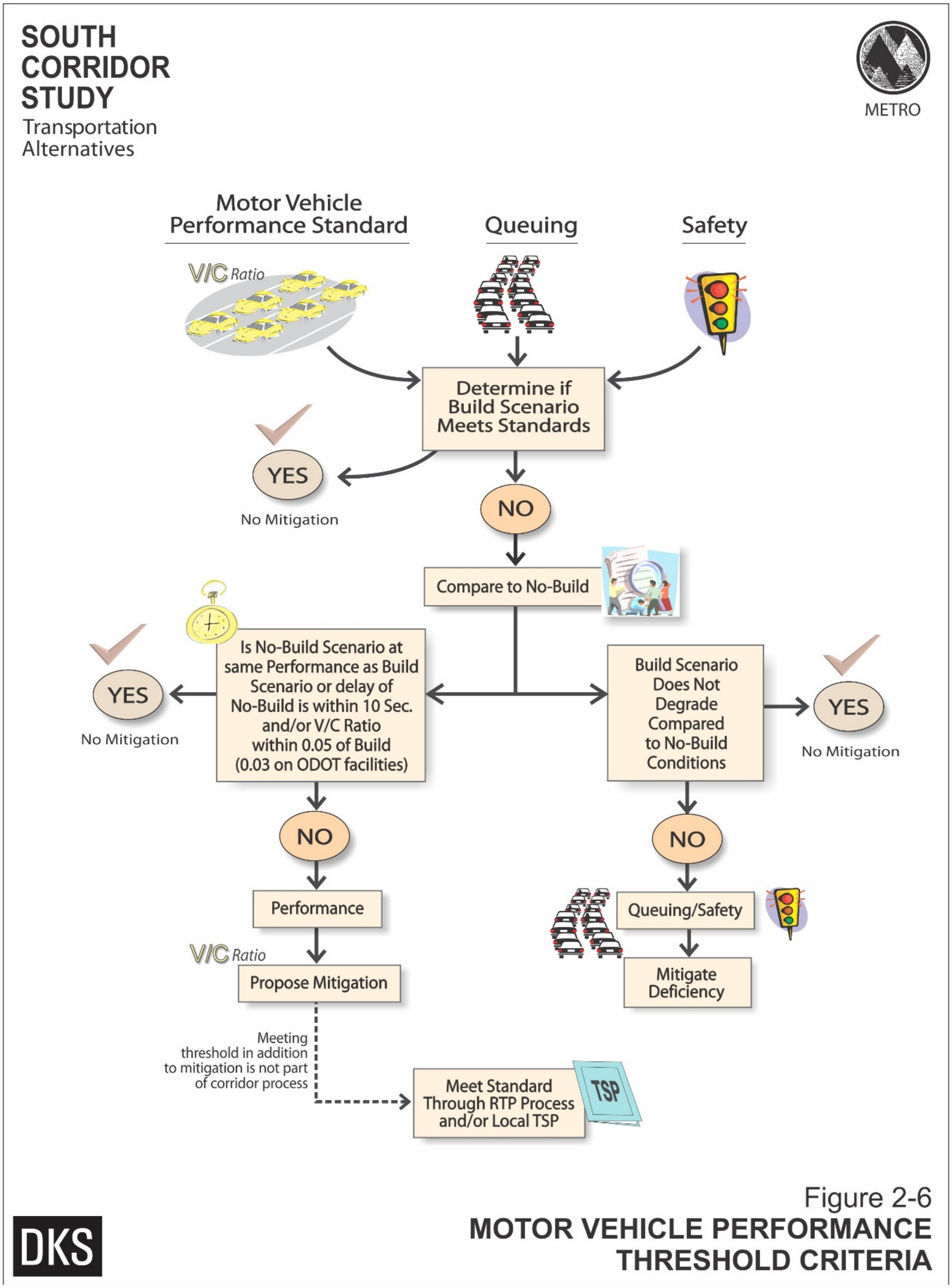
<u>Intersection Performance Measures</u>

The first performance measure is the v/c ratio. The build alternatives will be compared to the No-Build Alternative, which will lead to one of four different performance measure scenarios. The following is a list of the various performance measure scenarios for comparing alternatives; these performance measures apply to both unsignalized and signalized intersections.

Scenario 1: The No-Build Alternative and the build alternatives, with or without alignment/design options, **meet** jurisdiction standards. This scenario represents a condition where none of the alternatives create unacceptable traffic operations at study area intersections.

Scenario 2: The No-Build Alternative **meets** jurisdiction standards, and the build alternatives, with or without alignment/design options, **do not meet** jurisdiction standards and operate significantly worse (i.e., greater than 10 seconds of delay or greater than 0.05 v/c [except 0.03 for ODOT facilities]) than the No-Build Alternative. This scenario represents a condition where the build alternatives impact the transportation system and create unacceptable traffic operations.

Figure 2-6. Transportation Mitigation Criteria/Process



Scenario 3: The No-Build Alternative and the build alternatives, with or without alignment/design options, **do not meet** jurisdiction standards, and the build alternatives, with or without alignment/design options, operate either the same as or slightly worse (i.e., no more than 10 seconds of delay or 0.05 v/c [except 0.03 for ODOT facilities] more) than the No-Build Alternative. This scenario represents a preexisting condition where the No-Build Alternative has unacceptable traffic operations.

Scenario 4: The No-Build Alternative and the build alternatives, with or without alignment/design options, **do not meet** jurisdiction standards, and the build alternatives, with or without alignment/design options, operate significantly worse (i.e., greater than 10 seconds of delay or greater than 0.05 v/c [except 0.03 for ODOT facilities]) than the No-Build Alternative. This scenario represents a preexisting condition in which the No-Build Alternative has unacceptable traffic operations which would be worse with the build alternatives.

Each of the scenarios described above will have different mitigation associated with it based on the comparison of its performance to that of the No-Build Alternative. Scenario 1 would require no mitigation, because both the No-Build Alternative and the build alternatives, with or without alignment/design options, meet jurisdiction standards. Scenario 2 would require mitigation of the build alternatives, with or without alignment/design options. Due to the preexisting traffic operations under the No-Build Alternative for Scenarios 3 and 4, the following mitigation criteria was developed to determine when mitigation is necessary for either of these scenarios:

> ***Intersection Traffic Operations Mitigation:*** *No mitigation is necessary if there is less than or equal to 10 seconds of delay difference or 0.05 v/c (0.03 v/c for ODOT facilities) between the No-Build Alternative and the build alternatives. If there is greater than 10 seconds of delay or 0.05 v/c (0.03 v/c for ODOT facilities) between the No-Build Alternative and any of the build alternatives, and the build alternative does not meet the jurisdiction threshold criteria, then the build alternative would be mitigated to approximately the No-Build Alternative conditions (within 10 seconds of delay or 0.05, or 0.03 v/c difference). Use of either delay or v/c criteria is based on the operating standard of the owner of the roadway.*

Under Scenarios 2 and 4, the mitigation requested by the jurisdiction may exceed the minimum needed to achieve No-Build Alternative conditions. When this type of mitigation occurs, it is considered a betterment, and assumed to be the responsibility of the project to pay the proportionate share of the mitigation/betterment required to bring the study area intersection performance to match the no build.

With the mitigation commitments that will be included in the Final EIS, the proportionate share would be based either on the number of new vehicles introduced to the intersection that are related to the build alternatives compared to the total new volume with the No-Build Alternative (levels beyond existing conditions), or the increased delay associated with the build alternative compared to the No-Build Alternative. For mitigating to near No-Build Alternative conditions, the proportionate share approach would not apply as that would be the project's responsibility. The use of modifications to signal timing as mitigation would need to be approved by the managing jurisdiction of the facility.

In addition to the above-mentioned mitigation for Scenarios 2 and 4, additional mitigation may be identified that would be necessary to meet the threshold criteria of local jurisdictions. This betterment beyond the required mitigation would not be part of this project; however, it could be identified for possible inclusion in updates to the RTP Needs (Preferred or Strategic Plan) and local Transportation System Plans.

Queuing Analysis and Mitigation

The primary concern with queuing is whether or not ramp queues extend into the deceleration portion of the ramp or if turn pockets regularly overflow into the through lanes. Queuing results will be evaluated for the 95th percentile during the peak-hour conditions for both the No-Build Alternative and the build alternatives where indicated in the scope of work. These 95th percentile queues will then be evaluated to determine whether ramp queues extend or if turn pockets regularly overflow into the through lanes.

There are three potential queuing scenarios that could occur during this analysis:

Scenario 1: Neither the No-Build Alternative nor the build alternatives, with or without alignment/design options regularly have turn pockets that overflow into the adjacent through lanes, and/or produce queue spill back from freeway off-ramps to the safe stopping distance. This scenario represents a condition where none of the alternatives create unacceptable queuing.

Scenario 2: The No-Build Alternative queuing **does not regularly have turn pockets overflow** into the adjacent through lanes, and/or **does not produce queue spill back** from freeway off-ramps to the safe stopping distance, but queuing under the build alternatives, with or without alignment/design options, **does regularly have turn pockets overflow** into the adjacent through lanes, or **does produce queue spill back** from freeway off-ramps to the safe stopping distance, and is more than 25 feet longer than the vehicle queuing for the No-Build Alternative . This scenario represents a condition in which the build alternatives create unacceptable queuing impacts to the transportation network.

Scenario 3: Under the No-Build Alternative and the build alternatives, with or without alignment/design options, queuing **does regularly have turn pockets overflow** into the adjacent through lanes, and/or **does produce queue spill back** from freeway off-ramps to the safe stopping distance, and the vehicle queuing for the build alternatives, with or without alignment/design options, is not more than 25 feet longer than the vehicle queuing for the No-Build Alternative. This scenario represents conditions in which future volumes under the build alternatives have a preexisting queuing condition prior to implementation.

Scenario 4: Under the No-Build Alternative and the build alternatives, with or without alignment/design options, queuing **does regularly have turn pockets overflow** into the adjacent through lanes, and/or **does produce queue spill back** from freeway off-ramps to the safe stopping distance, and the vehicle queuing for the build alternatives, with or without alignment/design options, is more than 25 feet longer than the vehicle queuing for the No-Build Alternative. This scenario represents a condition in which the build alternatives create unacceptable queuing impacts to the transportation network.

Each of the scenarios described above has different mitigation associated with it based on the performance of the No-Build Alternative. Scenarios 1 and 3 would require no mitigation, because the build alternatives, with or without alignment/design options, either do not have queuing problems or do not worsen the issue. Both Scenario 2 and Scenario 4 would require mitigation. The following mitigation criteria were developed to address the type of mitigation necessary under these scenarios:

> ***Traffic Queuing Mitigation:*** *If queuing under the any build alternative, but not under the No-Build Alternative regularly has turn pockets overflow into the adjacent through lanes, or produces queue spill back from freeway off-ramps to the safe stopping distance, and is more than 25 feet longer than the vehicle queuing for the No-Build Alternative, then the build alternative, with or without alignment/design options, would be mitigated to conditions in which these queuing conditions are within 25 feet of the No-Build Alternative or to an appropriate condition. If queuing regularly has turn pockets overflow into the adjacent through lane or spill back from freeway off-ramps to the safe stopping distance under the build alternatives and the queuing is more than 25 feet longer than that of the No-Build Alternative, then potential mitigation strategies would be developed.*

Safety Analysis and Mitigation

Safety will be analyzed using ODOT's critical crash rate analysis method combined with a summary of information from existing crash lists, including ODOT's ARTS program, Washington County SPIS, and City of Portland's High-Crash Corridors.

There are a number of safety threshold criteria to evaluate for the No-Build Alternative and the light rail alternatives to determine if existing safety concerns are addressed by the project or if the project creates new safety concerns. The safety analysis will focus on serious injury and fatal crash history, and crash locations. If the No-Build Alternative does have intersections or other locations that are listed as high crash locations or that are on other preexisting crash lists in locations that may be altered by the light rail alternatives, then the project team will work with the agency with jurisdiction over the existing facility to identify reasonable measures that would likely result in safety conditions that would be the same or better than those of the No-Build Alternative.

Signal Warrant Review

Consultant will review peak one-hour traffic volumes for each intersection at which a new traffic signal is proposed and compare the volumes to a single hour of the 8- and 4-hour warrants from the Manual for Uniform Traffic Control Devices. The intent is not to complete a formal signal warrant analysis, which would be done in a future project phase, but to provide an indication of likelihood of meeting warrants with a future analysis. This comparison will be documented and reported as a percent of warrant met for the one hour considered.

Multimodal Impact Analysis and Mitigation

<u>Transit Impact Analysis</u>

Transit performance will be analyzed using Metro's regional travel demand model. The analysis will use a 2015 base year and 2035 horizon year. Future forecasts will be prepared for the No-Build Alternative and light rail alternatives that are anticipated to yield differentiating results. Most comparisons will be between the No-Build, a full-length through-routed alternative, a full-length branched route alternative, and a minimum-operable segment (MOS) alternative. Additional modeling will be performed to analyze changes to ridership as a result of geographic segment-level alternatives, including:

- Barbur (A1) and Naito (A2) in Segment A
- Barbur (B1), and adjacent to I-5 alternatives (B2, B3, and B4) in Segment B

- Ash (C1 and C5), Clinton (C3 and C4), and Wall (C6) in Segment C
- Adjacent to I-5 (C1 and C3) and Railroad (C2 and C4) in Segment C

Supplemental modeling may be performed to analyze park-and-ride capacity and PCC Sylvania shuttle options.

Performance measures will include:

- Service characteristics
  - Transit vehicle miles traveled
  - Transit vehicle hours traveled
- Travel Time
- Ridership
  - Light rail line ridership
  - System and corridor transit ridership
  - Peak load point
  - Station usage
  - Transit mode share
  - Change in transit productions
- Reliability

  Transit Mitigation: *TriMet and Metro will use the technical evaluation to determine if modifications are needed to the design or operation of the planned light rail alternatives or to the supporting bus network.*

<u>Pedestrian Impact Analysis</u>

The primary concerns for pedestrian activity are safety and accessibility to transit stations along the light rail alignments. Previous planning work in the corridor identified a range of pedestrian access projects within a broadly defined study area surrounding the transit corridor. These projects were extensively evaluated and those most supportive of the proposed light rail project were either integrated into the project design or identified as proposed non-integrated station access projects and included as separate items in the back of the plan drawing set.

The Draft Environmental Impact Statement (Draft EIS) analysis of impacts and mitigation will primarily focus on pedestrian safety and access issues. The non-integrated station access projects will be analyzed programmatically by segment. The Draft EIS will reference the development and purpose of the non-integrated projects and provide a qualitative description of impacts associated with potential modal conflicts (e.g., pedestrian/motor vehicle, pedestrian/bicycle, etc.) related to the design of sidewalk, pedestrian bridges, pedestrian crossings and other similar projects.

The Draft EIS will include a *Highway Capacity Manual*-based analysis of link-level Pedestrian Level of Service (PLOS) for roadway segments which would be significantly modified as part of a light rail alignment under any of the build scenarios.

The Draft EIS will include a description and inventory of pedestrian facilities included as integrated elements of the light rail project. Previous analysis identified gaps in the pedestrian network and will be used as a resource for evaluating the quality of pedestrian access to transit stations. The analysis will include an inventory of pedestrian crashes adjacent to the light rail alignment or within 500 feet of stations. The previous analysis and inventory will be used to identify impacts to pedestrian safety issues related to the introduction of the light rail project in the corridor.

> ***Pedestrian Mitigation:*** *Where pedestrian safety or station access impacts are identified including new gaps or barriers for existing or planned pedestrian facilities, potential mitigation measures will be identified. Examples of possible pedestrian safety impacts include locations where the design of the light rail could encourage jaywalking, where a pedestrian crossing or route is made substantially longer, or where light rail would close an existing pedestrian crossing.*

<u>Bicycle Impact Analysis</u>

Bicycle safety and access to transit stations will be evaluated in the Draft EIS. Previous planning work in the corridor identified a range of bicycle projects within a broadly defined study area surrounding the transit corridor. Bicycle projects most supportive of the proposed light rail project were either integrated into the project design or identified as proposed non-integrated station access projects and included as separate items in the back of the plan drawing set.

The Draft EIS analysis of impacts and mitigation will primarily focus on bicycle safety and access issues included in the light rail design sheets including projects that are considered as integrated in the design of the light rail project. The remaining non-integrated projects will be analyzed programmatically by segment. The Draft EIS will reference the development and purpose of the non-integrated projects and provide a qualitative description of impacts associated with potential modal conflicts (e.g. bicycle/motor vehicle, bicycle/pedestrian, etc.) related to the design of sidewalk, pedestrian bridges, pedestrian crossings and other similar projects.

The Draft EIS will include a *Highway Capacity Manual*-based analysis of link-level Bicycle Level of Service (BLOS) for roadway segments which would be significantly modified as part of a light rail alignment under any of the build scenarios.

The Draft EIS will include a description and inventory of bicycle facilities included as integrated elements of the light rail project. Previous analysis that identified gaps in the bicycle network will be used as a resource for evaluating the quality of bicycle access to transit stations. The Draft EIS analysis will include an inventory of bicycle crashes adjacent to the light rail alignment or within 500 feet of stations. The previous analysis and inventory will be used to identify impacts to bicycle safety issues related to the introduction of the light rail project in the corridor.

> ***Bicycle Mitigation:*** *Where bicycle safety or station access impacts are identified including new gaps or barriers for existing or planned bicycle facilities, potential mitigation measures will be identified. An examples of possible bicycle safety impacts include locations where bicycles would cross light rail tracks or are exposed to high conflicting (i.e. turning) vehicle volumes.*

Freight Mobility Impact Analysis

The role of major freight facilities in the study corridor will be characterized and documented with regard to local truck freight access and through travel as well as the role of rail freight operations in the corridor. This analysis will include the impact of the alternatives to truck movement and access adjacent to the alignment, including local truck access to businesses for loading and deliveries. Property access changes required by the build alternative, including consideration of access of heavy truck movements and the risk of truck traffic diverting to neighborhood streets, will be evaluated. Project impacts to rail freight operations will be identified.

> ***Freight Mitigation:*** *Locations where through movement of truck and rail freight is significantly impacted and impacts to specific site access will be identified, and a range of site-specific mitigation treatments will be identified.*

On-Street Parking Impact Analysis

Project plan sheets, on-line mapping tools, aerial mapping and site visits will be used to inventory existing on-street parking immediately adjacent to the light rail alignment. Metro and TriMet will provide the consultant with direction as to the locations where on-street parking spaces would be potentially be impacted by the light rail facility. The Draft EIS will include a summary and characterization of the demand for and the role of the impacted parking spaces.

> ***Parking Mitigation:*** *Based on the parking space inventory and a review of the conceptual drawings for each alternative, the loss of existing parking spaces will be calculated by location and type. The magnitude of any parking loss will be estimated using a simple parking utilization assessment, and mitigation strategies will be developed as appropriate, consistent with local policies.*

Operations and Maintenance (O&M) Facility Impact Analysis

The operation of the Southwest Corridor Light Rail Project would require additional O&M facility capacity. Two locations in Tigard have been identified as potential sites for a new operations and maintenance facilities to support the project: a site on SW Hunziker Street and a site on SW 72nd Avenue with two sub-options (one associated with a through-routed alignment and one with a branched alignment).

Traffic impacts associated with an O&M facility are typically minor and generally associated with employee and contractor access to and from the site. The EIS will determine whether traffic analysis is warranted by comparing the anticipated employment at the O&M facility with the current estimated employment on that site under existing conditions with the current land uses.

Both potential sites assume vehicle access at locations where driveways for vehicle access currently exist. If the employment associated with new O&M facility exceeds the current employment on the sites, the EIS will add the additional PM peak volumes to the analysis of adjacent intersections. If the O&M facility employment is no more than the existing, no adjustments will be made.

> ***O&M Facility Mitigation:*** *If traffic impacts are identified from the operation of the O&M facility, the traffic mitigation will be determined using methods consistent with the Traffic Queuing and Intersection Traffic Operations Measures described above.*

Park-and-Ride Lot Assessment

Areas where park-and-ride lots are proposed will also be evaluated for impacts to the street network. Existing vehicle trip generation data from similarly located and sized TriMet park-and-ride lots with a check using Institute of Transportation Engineers *Trip Generation,* will be utilized to estimate the number of vehicle trips during the peak period for transit park-and-ride lots. Park-and-ride trips already accounted for in the travel demand model results will be subtracted so that these trips are not double-counted in the analysis. The entrance to these lots and adjacent study intersections will be evaluated using the previously mentioned *Highway Capacity Manual* methodology.

The potential for park-and-ride spillover into neighborhoods will be assessed at locations where Metro's park-and-ride analysis indicates that the capacity provided at park-and-ride facilities is at risk for being inadequate. The analysis will consider the park-and-ride overflow risk at nearby commercial parking facilities and neighborhood on-street parking.

> ***Park-and-Ride Traffic Mitigation:*** *If traffic impacts are identified from the operation of the park-and-ride lots, the traffic mitigation will be determined using methods consistent with the Traffic Queuing and Intersection Traffic Operations Measures described in Figure 2-6. The mitigation assessment will also evaluate whether reducing the capacity of the park-and-ride facility would be a feasible strategy to minimize or avoid park-and-ride–related traffic impacts. Should reducing the capacity of a park-and-ride prove desirable, then adjusting capacity at other park-and-ride lots upstream or downstream could be considered as part of the refined project definition during preliminary engineering. Impacts associated with any park-and-ride capacity modifications would be evaluated in the Final EIS.*
>
> *Locations on the existing light rail system where neighborhood spillover park-and-ride activity has been identified, have been addressed on a case by case basis. Treatments implemented have included no-action, signage, enforcement, etc. If high spillover park-and-ride risk is identified, and it is determined that mitigation is desirable, those measures could include signage and active management and enforcement at commercial locations and time restrictions or resident permits at on-street locations.*

Alternatives to Mitigation

It is possible that the analysis will identify an impact for which no feasible or reasonable mitigation is available. In this case, the project team would work with the managing jurisdiction of the facility and the local land use authority to identify the appropriate course of action. The managing jurisdiction(s) could work with the project team to develop alternative mitigation strategies or could agree to accept the impact.

Construction (Short-term) Impacts

Two primary sources of construction impacts on local traffic will be considered from a generally qualitative standpoint:

- Impacts on traffic operations, property access, and parking supply related to potential road, sidewalk, bicycle, or other transportation facility restrictions and/or closures during construction; and
- Impacts of construction-related traffic on traffic operations.

The assessment of construction-related transportation impacts will focus primarily on arterials, on local streets that could be significantly affected by construction, and on I-5 at locations where structures would be built over or adjacent to the freeway or where freeway ramps would be modified. The transportation team will coordinate with Metro and TriMet to identify the construction activities that are likely to be most the most disruptive at locations along the light rail alignment(s).

Construction traffic analysis will consider the following:

- Identification of changes in roadway capacity including potential lane restrictions, parking restrictions, pedestrian or bicycle facility impacts, alignment shifts, areas of construction activity adjacent to travel lanes, or other reductions to capacity due to transit facility construction activity;
- Impacts on transit and emergency services;
- Impacts to transit bus stops and routing;
- Impacts on school transportation services during construction;
- Impacts to postal service routes and access;
- Impacts of construction-related activity on on-street parking supply;
- Identification of potential construction staging areas, including access and impact on roadway operations;
- Impact to freight delivery routes and truck size restrictions;
- Identification of potential construction access and truck routes and the impact of construction-related traffic on these routes, including reductions to overhead clearance; and
- Assessment of potential for neighborhood traffic intrusion related to road closure, detours or other construction related delays.
- Impacts to freight rail service and rail crossing locations;
- Estimation of construction truck traffic;
- Temporary delays or restrictions on truck routes during construction;
- Identification of areas that would require construction coordination between TriMet and other governmental agencies; and
- Development of mitigation measures.

The analysis will be summarized in a tabular format to identify the following:

- Impact location(s).
- Street characteristics.
- Type of construction activity including likely duration of impact.
- Level of construction traffic (characterized as high, moderate, or low).
- Full or partial road closures.
- Availability of detour routes.

- Potential for detoured traffic to affect a residential neighborhood. (This is characterized as high, medium, or low and is related to both potential for road closure and options for traffic detour.)
- Bus route detours and temporary bus stop locations.
- Loss of on-street parking. (This may be characterized as “yes” for parking loss and “no” for no parking loss. Additionally, there may be some temporary loss of off-street parking due to the location and operation of construction staging, as well as construction worker parking.)
- General comments highlighting key issues for each location related to construction traffic activity that do not fall into one of the above categories.

  Construction Mitigation: *A construction traffic management plan will be prepared that will address construction-related issues identified in the EIS analysis. The construction management plan will address potential construction staging locations, construction-related truck routes, motor vehicle, bicycle and pedestrian detours and other accommodations.*

Documentation

Existing transportation conditions, impacts and potential mitigation will be discussed in a Transportation Results Report and summarized in a Transportation section of the EIS. The EIS section will be summary-level, focused primarily on impacts but still identifying the long term and short term/construction period impacts of the project. The Transportation Results Report will include all background information, outputs from the traffic models, and other details of the analysis.

References

Transportation Research Board. 2010. *Highway Capacity Manual*, Special Report 209.

Institute of Transportation Engineers. 2012. *Trip Generation*, 9th Edition.