3 EXISTING CONDITIONS

The existing transportation system was inventoried to identify its performance with a specific focus on measures important to freight movement using existing data from City of Seattle sources augmented with new data collected as part of this project. The measures for evaluating the freight network are tied to the project goals described in Chapter 1 and include:

- safety challenges;
- existing vehicle, truck, and rail volumes on select corridors;
- travel speeds for general traffic trucks;
- operational issues that are specific to truck travel;
- pavement and bridge conditions; and
- planning for modal overlap on shared streets.

Additionally, the FAP looked at the connectivity of the overall network serving truck-borne freight, including constraints of rail crossings that cause delay, and other limitations of the systems such as weight restrictions or height limits.

PERFORMANCE MEASURES

Mobility

- General traffic
- Truck volumes
- Speeds & congestion
- Reliability

Safety

- Truck collision history

Connectivity

- Access constraints (including over-legal limitations)
- Railroad crossings and bridge openings that cause delays
- Ease of movement (roadway geometric design to support trucks)

The following sections describe how previous planning efforts have influenced the current situation of freight and goods movement in the MICs. This chapter of the report documents the performance in key areas that align with the overall goals of the project noted in Chapter 1. These performance measures are summarized below and will be estimated for current (existing) conditions in this chapter. The same performance measures will be evaluated for future conditions in Chapter 4. Chapters 5 and 6 are devoted to establishing a priority of needs based on these conditions (Chapter 5) and defining a set of improvement solutions (Chapter 6).

While this project describes the policies and standards that shape freight needs, and solutions, it does not define changes or suggest recommendations to policy, programmatic, and technical issues which will be fully examined in the Seattle Freight Master Plan (FMP). The FMP will provide a city-wide comprehensive vision for freight transportation, as well as a strategy for implementing policies, and a prioritized package of project and program improvements.

3.1 Past Studies and Plans

There have been a number of significant planning efforts undertaken to study existing freight operations and mobility constraints, and gain an understanding and identification of project needs. The organization of this summary begins with plans for the City of Seattle and works outward to address the regional and statewide planning context.

3.1.1 City of Seattle

The City of Seattle has conducted a number of studies on freight mobility and industrial land uses to support truck and rail operations within the City limits. The third and most recent edition of the City's *Freight Mobility Strategic Action Plan*[1] identifies long-term goals and immediate action items to support industrial and maritime sector growth. In addition, the Seattle Department of Transportation developed the *Freight Segmentation Study*[2] in 2008 to provide strategies to improve truck mobility throughout the City.

The Department of Planning and Development's (DPD) *Future of Seattle's Industrial Lands*[3] provides recommendations to the land use code to support industrial uses in the Greater Duwamish MIC. The Seattle Comprehensive Plan includes a chapter specific to Port of Seattle activities titled the Container Port Element. Other relevant freight plans include the *Greater Duwamish Manufacturing and Industrial Center Plan*[4] , the *SoDo Action Agenda*[5], and *Access Duwamish: A Freight Mobility and Economic Strategy*[6].

Findings and Conclusions from the Governors Container Ports Initiative in 2009

The State's two major container ports operate within a complex system of marine terminal operations, truck and train transportation corridors, and industrial/warehousing support services. The operations of these facilities are increasingly affected by the conversion of traditionally-industrial properties into non-industrial commercial or even residential uses, driven by population growth, the economic pressures of the real estate market and trends in urban redevelopment, resulting in conditions that can:

- hinder the operations of existing marine terminal operations.
- limit key truck and train transportation corridors that move freight and cargo.
- convert nearby industrial support services (such as warehousing and cargo-logistics centers) on privately owned land into uses that are incompatible with industrial operations.

1 Freight Mobility Strategic Action Plan, Seattle, 2005
2 Freight Segmentation Study, Nelson/Nygaard, 2008
3 Future of Seattle's Industrial Lands, Seattle, 2003
4 Greater Duwamish Manufacturing and Industrial Center Plan, Greater Duwamish Committee, 1999
5 SoDo Action Agenda, City of Seattle, Manufacturing/Industrial Council, SoDo Business Association, AHBL, 2009
6 Access Duwamish: A Freight Mobility and Economic Strategy, SDOT, 2001

3.1.2 Port of Seattle

The Port of Seattle periodically conducts planning studies related to port operations and assesses local, regional, state, and national planning, programming and project development efforts as well as trends that impact the container terminals generating truck trips. The *Container Terminal Access Study* is currently undergoing an update expected to be issued in early 2015. The current plan (completed in 2003) includes container forecasts and truck volumes as related to Port activities.

In addition to carrying out its own analysis, the Port regularly reviews the efforts of partner agencies and private developers. In response to the proposal to construct a third arena, the port funded a report called *The Impact of SoDo Arena on Port of Seattle Operations.* This report documents the growth in export and import container volumes to the Port of Seattle and number of truck trips associated with that economic impact. The Governor's Container Ports Initiative also includes recommendations on the role of container shipments in the economic, land use, and transportation elements in the Greater Duwamish MIC.

3.1.3 Puget Sound Regional Council

As the Metropolitan Planning Organization (MPO) for the region, the Puget Sound Regional Council (PSRC) is responsible for land use and transportation planning in the four Puget Sound counties (King, Snohomish, Pierce, and Kitsap). The region-wide policy documents, including *Transportation 2040: Regional Freight Strategy*[7] and the *Urban Centers Report* shape policies related to freight movement for the area. PSRC evaluates and monitors the designated Manufacturing/ Industrial Centers and Regional Centers, and also reports on Industrial Lands. The latest evaluation of industrial lands is included in a draft dated December 2014[8]. PSRC staffs a regional partnership, Freight Action Strategy for Seattle/Tacoma (FAST)[9], which has planned and implemented several grade separations in the Greater Duwamish MIC. PSRC has also conducted an evaluation of the impacts of the Proposed Gateway Pacific Terminal[10].

3.1.4 Washington State Freight Mobility Plan

The Washington State Department of Transportation (WSDOT) recently (October 2014) published a Freight Mobility Plan that meets state law RCW 47.06.045 requires that

7 Transportation 2040 update, Appendix J Regional Freight Strategy, 2014
8 Industrial Lands Analysis for the Central Puget Sound Region, Discussion Draft for the Growth Management Policy Board, Community Attributes, 2014.
9 www.psrc.org/transportation/freight/fast
10 Economic Evaluation of Regional Impacts for the Proposed Gateway Pacific Terminal at Cherry Point, PSRC 2014

the Statewide Multimodal Transportation Plan include the State's interest in freight which assesses the transportation needs to ensure the safe, reliable, and efficient movement of goods within and through the state to ensure the state's economic vitality. *Moving Ahead for Progress in the 21st Century* (MAP - 21) also directs the United States Department of Transportation (US DOT) to encourage states to develop Freight Mobility Plans.

The Washington Freight Mobility Plan seeks to meet state and federal requirements for freight planning, and the national freight goals. Informed by research, data, analysis, and stakeholder input, this plan will improve Washington's ability to achieve these national freight goals:

- Improve the contribution of the freight transportation system to economic efficiency, productivity, and competitiveness.
- Reduce congestion on the freight transportation system.
- Improve the safety, security, and resilience of the freight transportation system.
- Improve the state of good repair of the freight transportation system.
- Use advanced technology, performance management, innovation, competition, and accountability in operating and maintaining the freight transportation system.
- Reduce adverse environmental and community impacts of the freight transportation system.

The plan was guided by these three objectives:

1. Develop an urban goods movement system that supports jobs, the economy, and clean air for all; and provides goods delivery to residents and businesses.
2. Maintain Washington's competitive position as a global gateway to the nation with intermodal freight corridors serving trade and international and interstate commerce, and the state and national Export Initiatives.
3. Support rural economies' farm-to-market, manufacturing, and resource industry sectors.

3.1.5 Other Organizations

The Greater Duwamish Transportation Management Association (TMA) has been actively studying transportation facilities in the vicinity of the Greater Duwamish MIC and has identified what it considers existing deficiencies and suggested recommendations for improvements. The *Workable SoDo Report (2013)* includes strategies and recommendations for freight safety, including multimodal improvements in the neighborhood. The Greater Duwamish TMA also developed a *Smart Street Study* identifying travel options for employees working in the Greater Duwamish MIC.

3.1.6 Construction Projects

The Alaskan Way Viaduct Replacement/Tunnel project is a major WSDOT project that consists of replacing the existing SR 99 viaduct with a 2-mile long bored tunnel beneath the downtown city-center. This project began construction in 2008 and is expected to continue through the end of 2017 when the new tunnel will be open to the public. Although the AWV replacement will be complete in 2017, there will be subsequent work that will take place as part of the other major projects to remove the viaduct and restore the Seattle waterfront as a result of the viaduct removal. This includes restoration of a surface

Alaskan Way roadway which will be completed by SDOT after the Viaduct is removed in 2018. When the new tunnel opens as SR 99, tolls will be implemented to offset the cost of construction and help maintain the facility. A separate but related project to reconstruct the central section of the Elliott Bay Seawall is also currently under construction by SDOT and should be complete by 2016.

3.2 Relevant City Policies and Guidelines

The City of Seattle evaluates transportation projects based on principles to improve the safety and mobility for all roadway users. Complete Street principles that encourage and enhance multimodal travel experiences are central to the current project development and evaluation process; while the *Right of Way Improvements Manual* (discussed below) provides engineers and designers with the design tools necessary to help implement these projects. This section of the report describes the current processes and policies supporting the City's evaluation of transportation projects.

3.2.1 Design Guidelines/Standards

The *Right-of-Way Improvements Manual*[11] (ROWIM) includes roadway designations, street types, and street standards for Seattle roadways. The cross-sections referenced in the manual specify the minimum and preferred requirements for typical street sections based on the functional street classifications designated in the *Transportation Strategic Plan* and adjacent land uses.

Design Guidelines are part of the City of Seattle's Design Review Program[12] and apply to all areas in the City except downtown. These guidelines provide a means for private development to achieve design excellence and open discussions with the public during the design review process.

The current design guidelines and standards provide context for development patterns and roadways. As related to transportation and street-

11 Seattle Right-of-Way Improvements Manual SDOT – Available at: www.seattle.gov/transportation/rowmanual/
12 Seattle Design Guidelines. City of Seattle – Department of Planning and Development. December 2013. Available at: www.seattle.gov/dpd/cs/groups/pan/@pan/documents/web_informational/p2083771.pdf

frontages, both the Seattle Design Guidelines and Right-of-Way Improvements Manual emphasize serving all modes of travel and planning ahead for freight, bicycle, pedestrian, and transit connections.

Section 3.3.4 of the ROWIM discusses over-legal constraints (those locations that are constrained for truck freight due to height, width, length or weight restrictions).

3.2.2 Complete Streets

"Complete Street" principles are applied to the entire street network to help ensure streets serve all roadway users. The focus of Complete Streets goes beyond the modal plans for transit, bicycles, and pedestrians to leverage multiple project elements and funding sources to plan and design streets that support and balance the needs of multiple users.

Seattle's Complete Streets policy, Ordinance # 122386[13], was adopted by the City Council in 2007. It was an important policy document because it was one of the first Complete Street ordinances in the country that clearly incorporated the goal to ensure freight mobility in applying complete street treatments on major truck freight facilities. Section 3 of the ordinance reads:

"Because freight is important to the basic economy of the City and has unique right-of-way needs to support that role, freight will be the major priority on streets classified as Major Truck Streets. Complete Street improvements that are consistent with freight mobility but also support other modes may be considered on these streets."

The Complete Streets Checklist[14] has been used to evaluate construction and maintenance projects within the City. The Complete Streets Checklist requires information on the roadway classifications for individual modes, adjacent land uses and zones, traffic volumes, and the existing and planned design elements for the roadway. The outcomes of this process include a prioritization of project elements that are preferred or should be considered.

13 clerk.ci.seattle.wa.us/~scripts/nph-brs.exe?d=CBOR&s1=115861.cbn.&Sect6=HITOFF&l=20&p=1&u=/~public/cbor2.htm&r=1&f=G

14 Complete Streets Checklist. City of Seattle. April 2011. Available at: www.seattle.gov/transportation/docs/ctac/2011_04_19Final%20Draft%20Checklist.pdf

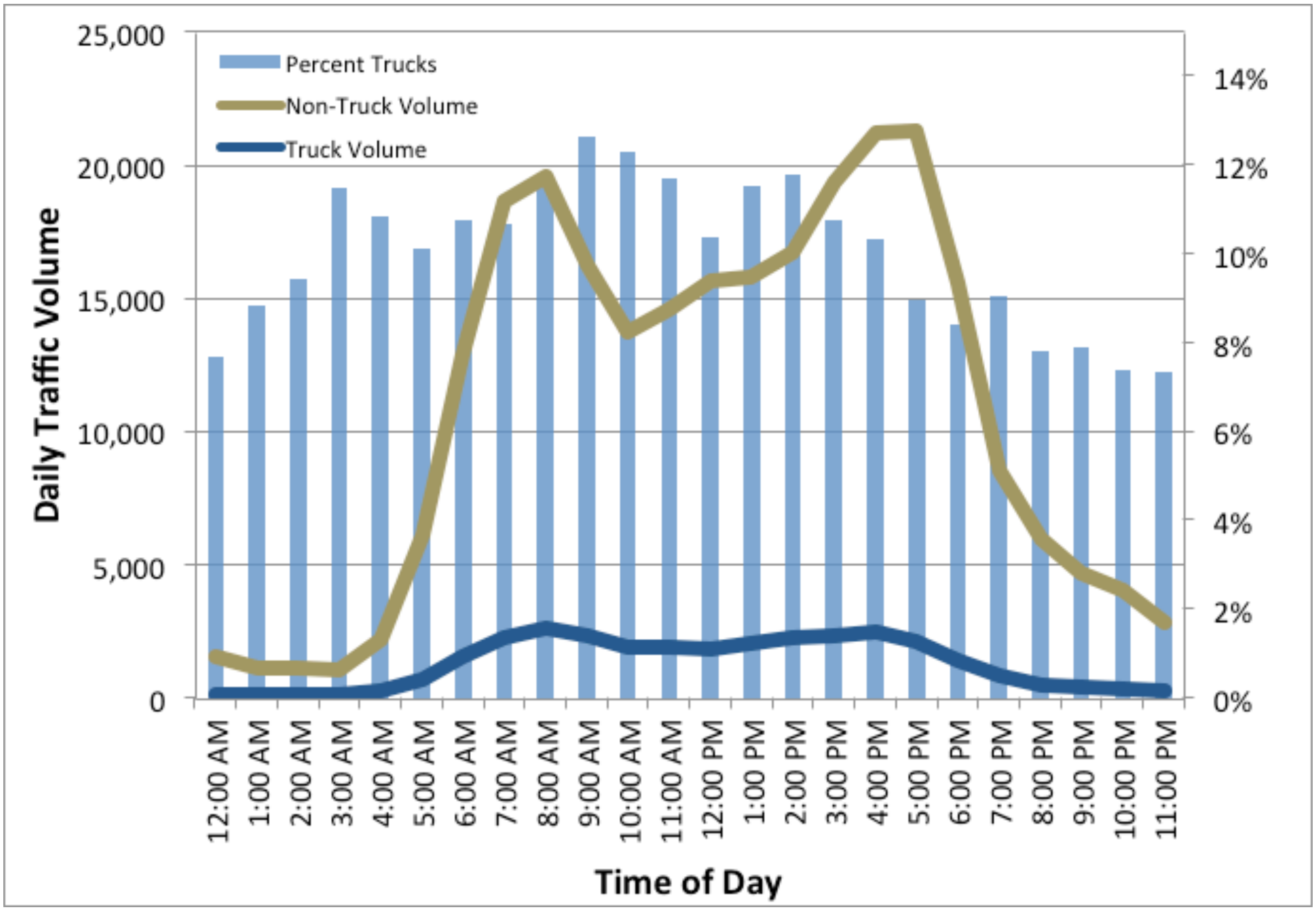


Figure 3.1 Daily Traffic Patterns (Source Transpo, IDAX)

3.3 Trucks

Trucks support local and regional markets by transporting freight on the roadway network. To understand the extent of truck travel on the roadways and within the City, this section covers the corridor truck volumes, roadway travel speeds, truck mobility issues, pavement and bridge conditions, and modal overlap. The Major Truck Streets are shown in Figure 3.2.

3.3.1 Corridor Volumes

Corridor volumes measure the amount of freight activity in the study area and are summarized by the existing truck volumes on the roadway network. Roadway volumes were inventoried based on a number of count sources, including 24-hour tube counts, intersection turning movement volumes, and volume summaries from other reports. Figure 3.1 illustrates truck, non-truck volumes and truck percentage on average for a weekday 24 hour period. This measure of system demand serves as a basis for establishing performance metrics, in addition to providing information on freight travel patterns.

Daily Truck Volumes

Daily traffic volumes show the magnitude of overall traffic activity on the freight network. Daily traffic volumes were drawn from recently conducted counts (January 2014) or from historical counts from SDOT and WSDOT. Figure 3.3 to Figure 3.5 show the average weekday daily and truck volumes on study roadways.
Daily truck volumes show the magnitude of

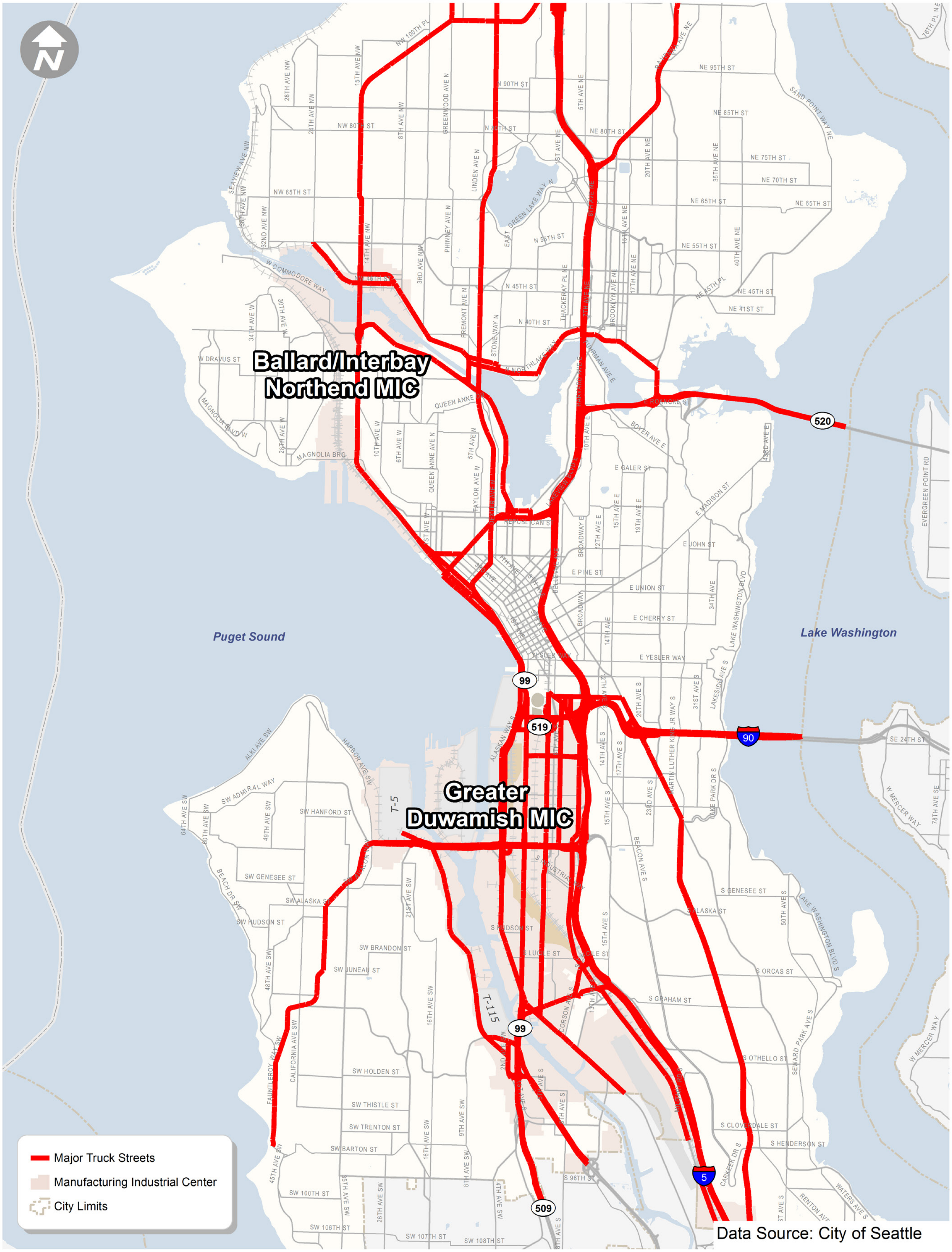


Figure 3.2 Major Truck Streets (Source Transpo, IDAX)

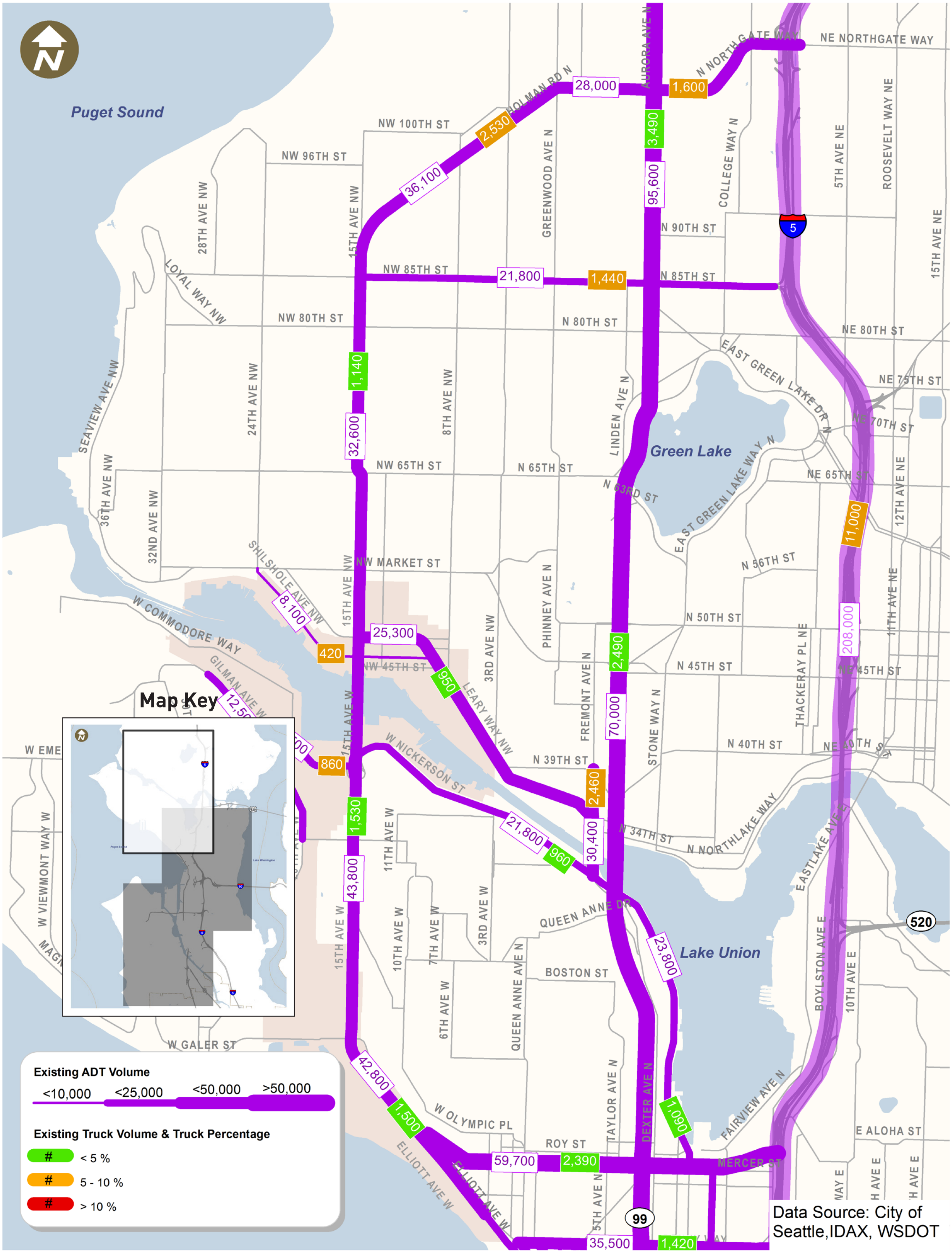


Figure 3.3 Daily Traffic Volumes – North Section (2014)

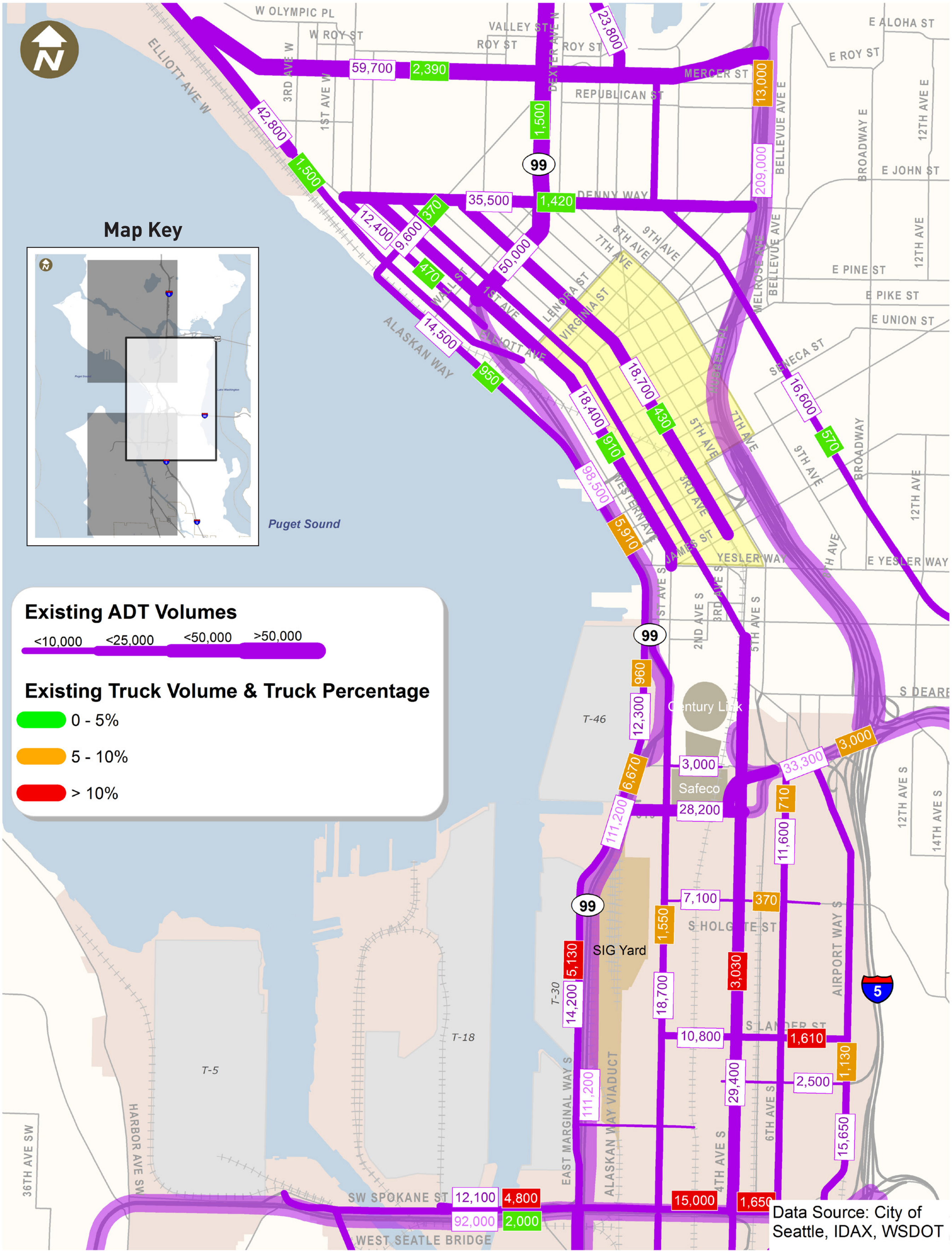


Figure 3.4 Daily Traffic Volumes – Central Section (2014)

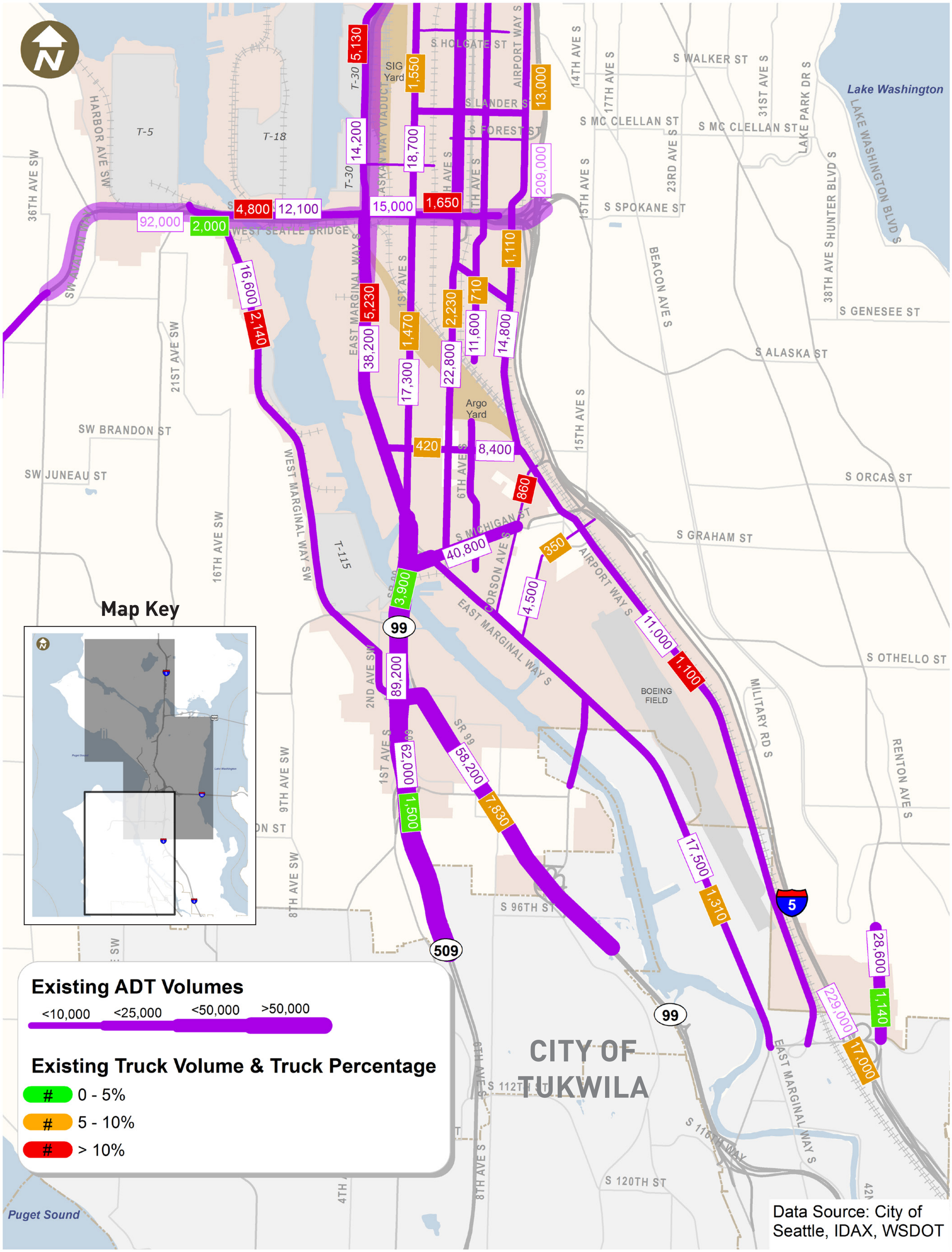


Figure 3.5 Daily Traffic Volumes – South Section (2014)

freight activity within the context of overall traffic demands. As part of the daily vehicle counts, vehicle classification counts were also conducted to determine the amount and size of trucks traveling on study roadways. Figure 3.3 to 3.5 also show the average weekday truck traffic volume as a percentage of total traffic volumes on the study roadways. In general, the highest daily volumes are along state routes, principal arterials, and intermodal yard connectors that are currently designated as local streets. In most cases, trucks represented between 8 to 12 percent of the total daily volumes on the corridors.

Truck Classifications

Truck corridor volumes were broken down to include light, medium, and heavy-duty trucks as defined in Chapter 2 of this report. These groups are related to the FHWA and gross vehicle weight (GVW) classification systems used for freight planning purposes. Figure 3.6 shows the light, medium, and heavy-duty truck classifications for the Greater Duwamish MIC and Ballard/Interbay Northend MIC (BINMIC).

As shown in the figure, both areas show similar ratios of light, medium, and heavy trucks, where light trucks comprise the largest portion of counts and heavy the smallest. The Greater Duwamish MIC has a higher overall percentage of trucks in the Average Daily Traffic (ADT) volumes. As a result, all classifications of trucks (light, medium,

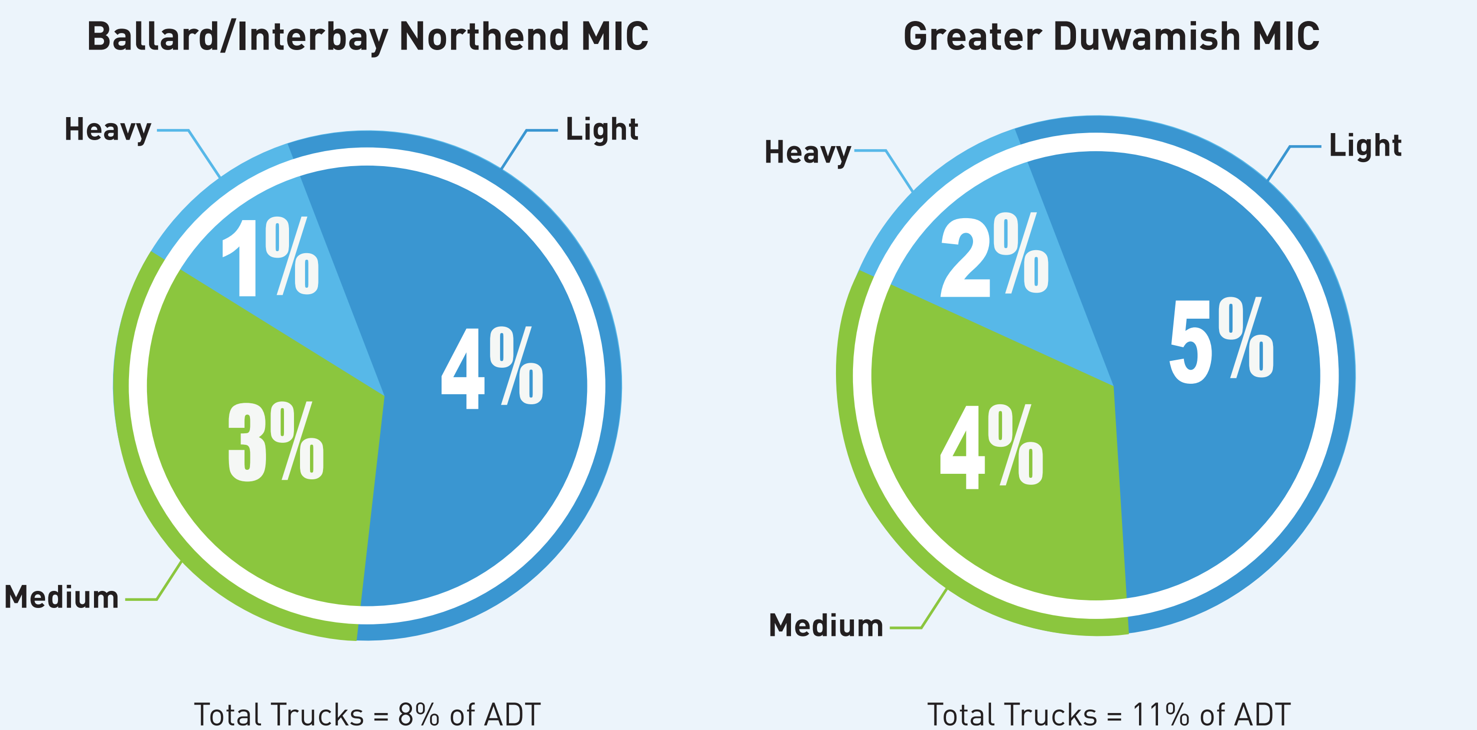


Figure 3.6 Light, Medium, and Heavy-Duty Trucks as Percentage of Total Traffic (source Transpo Group)

and heavy) comprise a slightly higher percentage of total traffic.

3.3.2 Corridor Travel Speeds

Speed, as a surrogate for travel time, provides an important performance measure for trucks as it influences reliability. Travel time for trucks is directly linked to the cost of providing goods and services. As travel time increases costs of goods can potentially increase for consumers. Existing general purpose travel speeds along study corridors were analyzed to understand the overall efficiency of freight corridors. System efficiency evaluates the prevailing speeds on corridors during peak traffic demands to measure the impact of roadway congestion on travel speeds for all vehicles on the roadway. The general purpose traffic data was used due to the more complete dataset that was available. Analysis of speeds in select locations found similar changes in general traffic efficiency and reliability as truck efficiency and reliability.

INRIX[15] speed data was collected for the major study roadways, though data was not available for all corridors. Information from the *WSDOT Mobility Report*[16] was included for regional highway locations that did not have available INRIX data. Morning and evening travel speeds were summarized in 2-hour windows to maintain consistency with previous FHWA studies and capture peak traffic periods for both passenger vehicles and trucks. Roadway congestion was defined based on the average speed of corridors as a percent of the posted speed for that roadway.

15 INRIX collects and disseminates traffic data to travelers and transportation professionals. Through a partnership with Transpo Group, one year of travel speed data was collected for this project
16 WSDOT Mobility Report. WSDOT. 2012

This approach uses thresholds consistent with the congestion levels defined in the WSDOT Handbook for Corridor Capacity Evaluation[17]:

- **Uncongested Flow -** Greater than 85 percent of posted speed.
- **Delayed Flow -** 70 to 85 percent of posted speed.

  Congested Flow - 60 to 70 percent of posted speed.

  Severely Congested Flow - Less than 60 percent of posted speed.

The historical speed data spans 12 months during 2013 and is summarized in 15-minute increments. Speed data from approximately 75 locations was filtered to remove weekend and holiday travel time periods. Corridor congestion experienced during the morning peak (7-9am) are shown in Figure 3.7 to 3.9.

As shown in the morning peak period average travel speeds, several roadways have travel speeds between 60 and 70 percent of the posted speed limit, and many others average speeds less than 60 percent of the posted speed limit. Congested roadways operating at speeds much lower than posted speeds are generally inbound (toward the Seattle Central Business District) in the peak commute direction. North of the downtown east-west arterials like Mercer Street and Denny Way are congested. In the Greater Duwamish MIC, both north-south and east-west arterials showed heavy congestion. WSDOT's *Corridor Capacity Report (2013)* documents congestion for freeways throughout the region. As noted in the report, during the morning commute

17 Handbook for Corridor Capacity Evaluation. WSDOT 2014

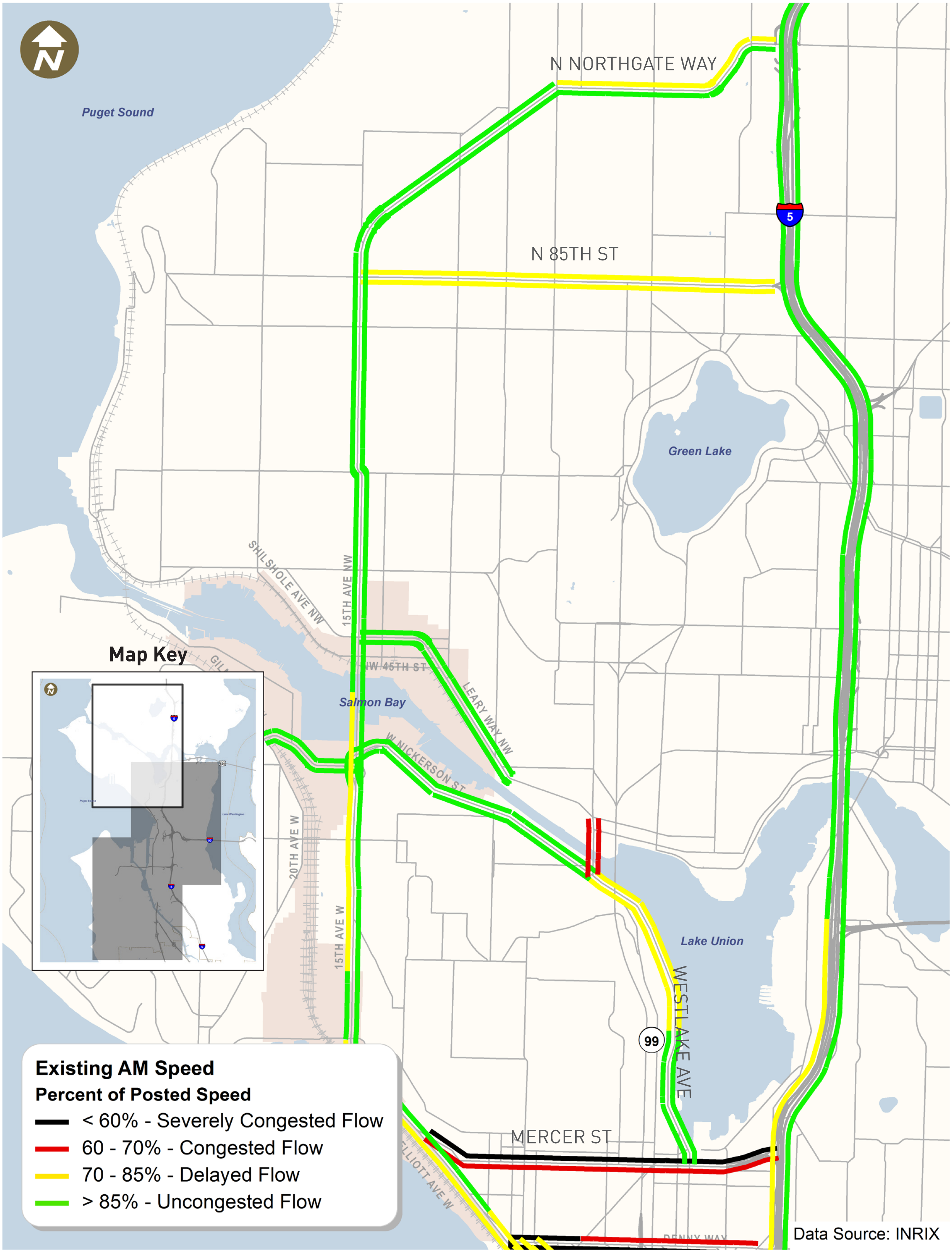


Figure 3.7 Existing (2013) AM Congestion Levels – North

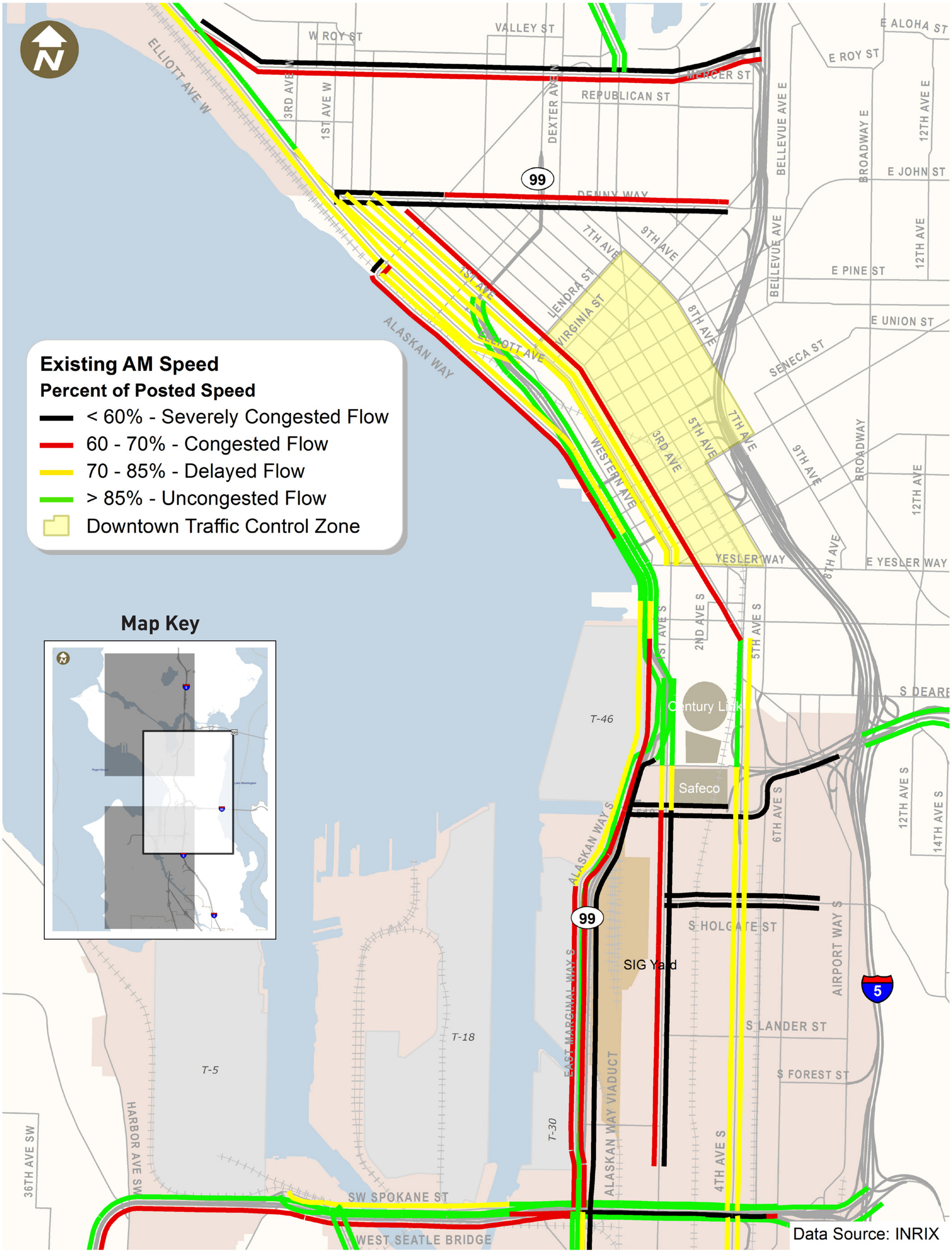


Figure 3.8 Existing (2013) AM Congestion Levels – Central

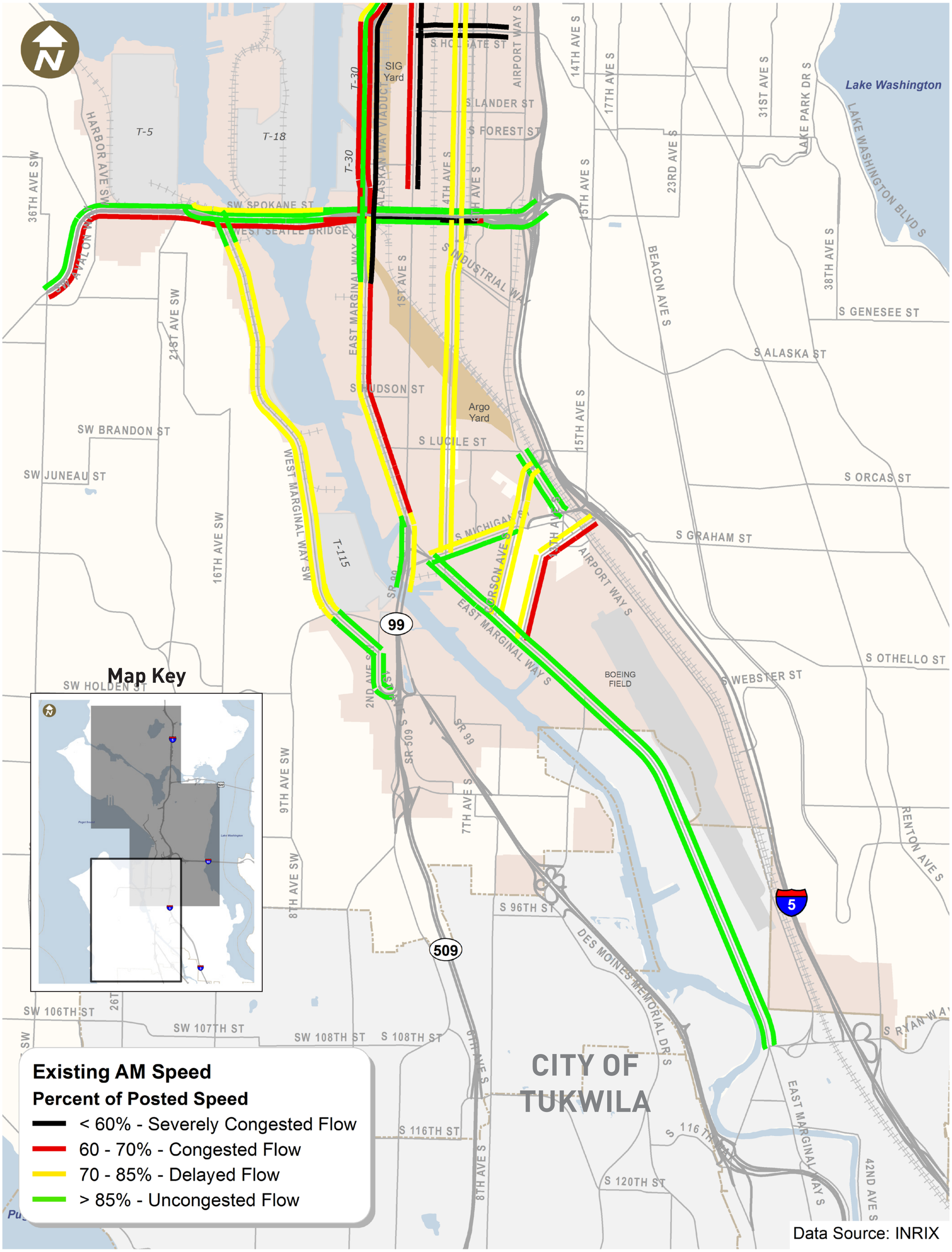


Figure 3.9 Existing (2013) AM Congestion Levels – South

period, travel times from Federal Way to Seattle via I-5 typically take twice as long as other times of the day (45 minutes versus 22 minutes). Similarly, travel times from Everett to Seattle take nearly twice as long via I-5 (44 minutes versus 24 minutes). The evening percent of posted travel speeds for the two-hour period from 3 to 5pm are shown in Figures 3.10 to 3.12.

As shown in the evening peak period average travel speeds, several roadways have average travel speeds less than 60 percent of the posted speed limit (very congested). Roadways with lower travel speeds are typically outbound in the peak commute direction (away from the Seattle Central Business District), but are generally more balanced than during the morning peak period. WSDOT's Corridor Capacity Report (2013) notes during the evening commute period, travel times from Seattle to Federal Way via I-5 typically take 10 minutes longer as during other times of the day (32 minutes versus 22 minutes), while travel times from Seattle to Everett take about 12 minutes longer via I-5 (38 minutes versus 24 minutes). In addition to using the Interstates, freight relies on several corridors with recurring congestion including SR 99, Spokane Street, Atlantic Street, Holgate Street and First and Fourth Avenues in the Greater Duwamish MIC. Freight also relies on the congested Mercer Street corridor north of downtown.

For both morning and evening peak periods, severely congested flow segments are those where traffic is traveling very slowly and travel times can easily double as compared to mid-day, non-peak times. These congested roadways are prone to higher collisions that can compound congestion.

Morning peak periods are slightly less congested and trucks often choose this time to make deliveries. Afternoon peak is generally worse than morning peak. Truck-borne freight operates in both peaks.

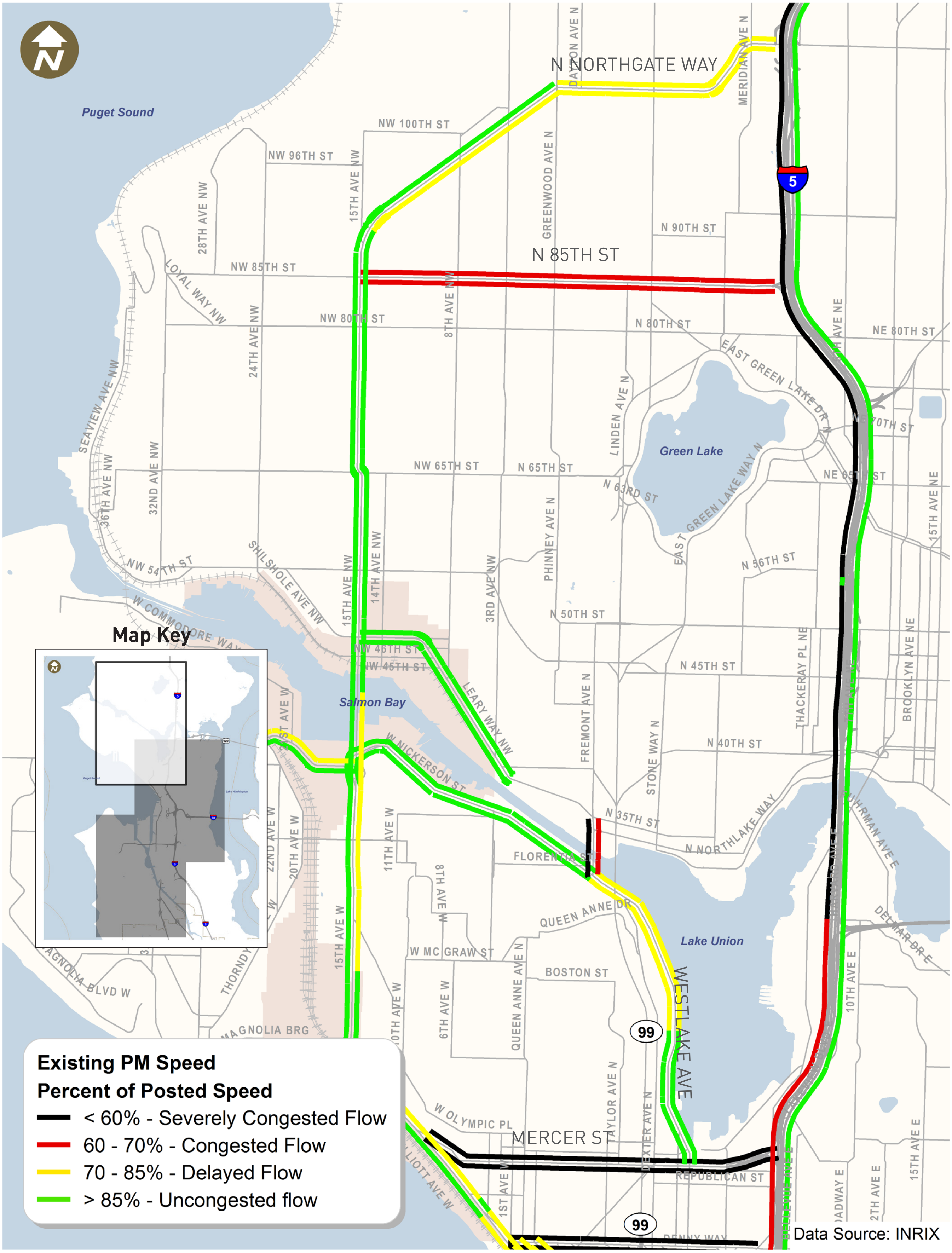


Figure 3.10 Existing (2013) PM Congestion Levels – North

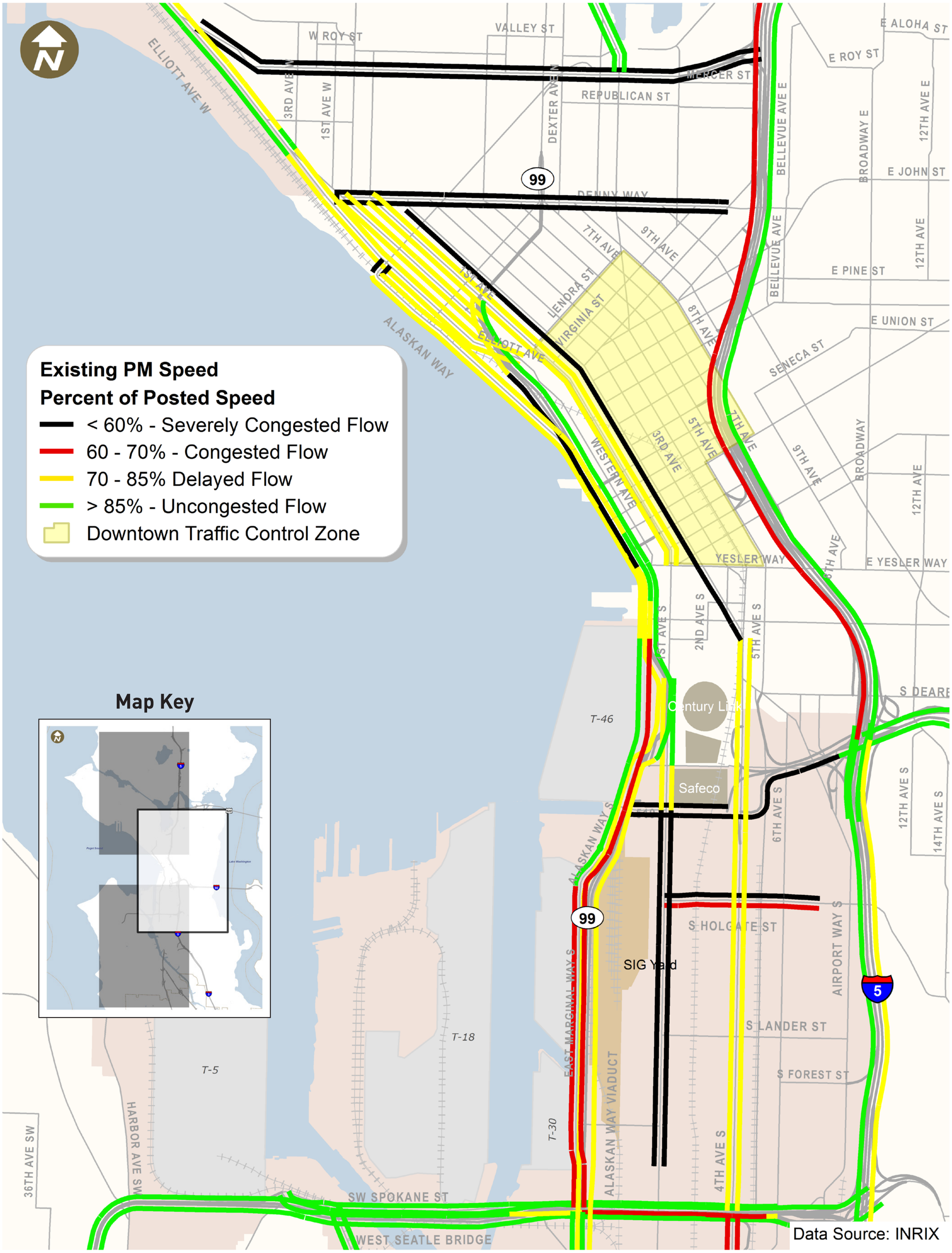


Figure 3.11 Existing (2013) PM Congestion Levels – Central

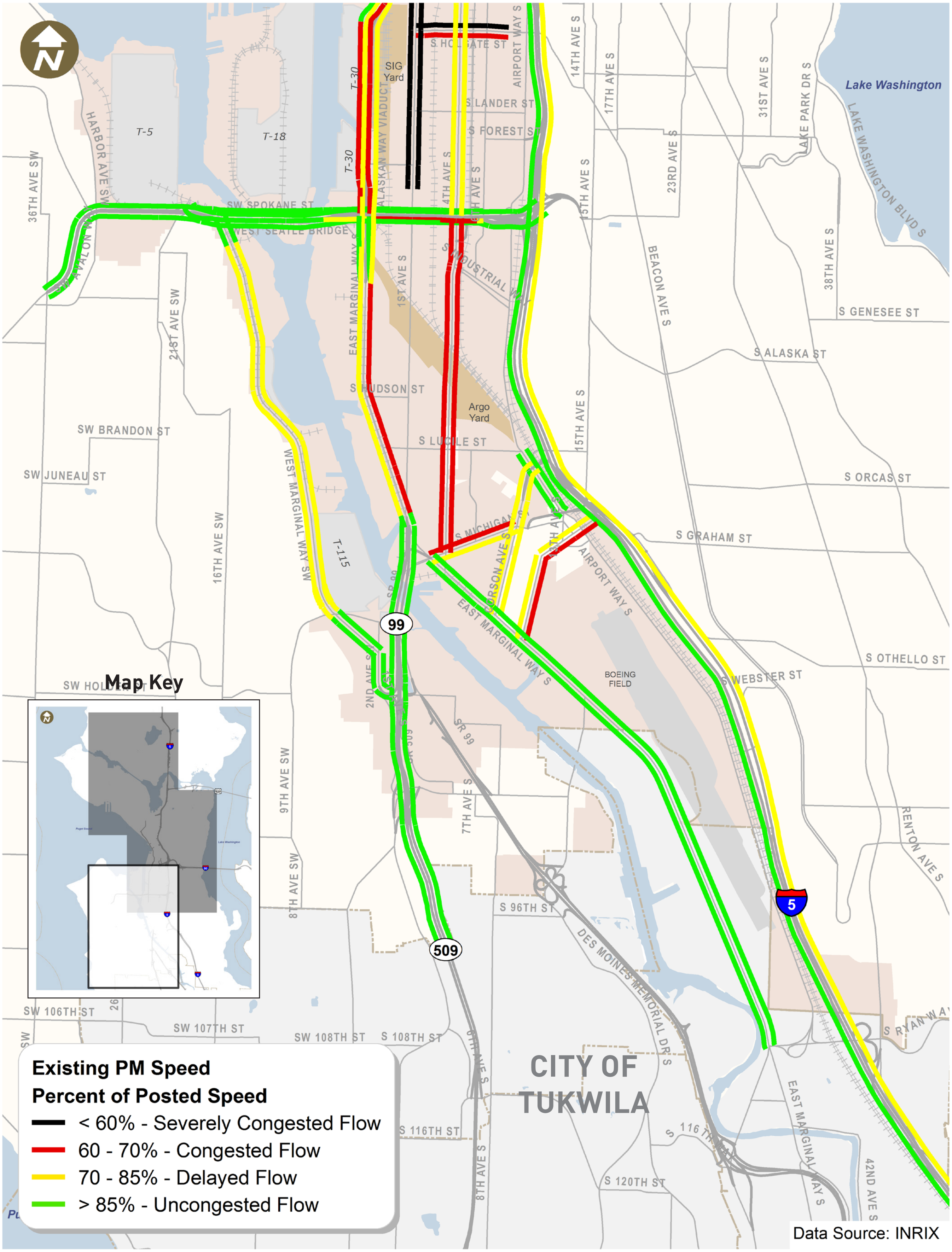


Figure 3.12 Existing (2013) PM Congestion Levels – South

3.3.3 Truck Safety

Truck and vehicle safety is included in the performance measures to evaluate the impact of truck-related collisions on City roadways. The metrics for this evaluation include the number and severity of freight collisions, and their impacts on people and cargo. Collision data was collected for all truck-involved incidents over the most recent available 5-year period for the areas within the MICs and connecting corridors. The number of truck collisions, including those where a pedestrian, cyclist, or passenger vehicle was involved, was used to assess the safety of roadways in the study area.

Truck Collisions

Five year collision data (January 1, 2009 through December 31, 2013) provided by SDOT was used to highlight truck collision history in the Ballard/Interbay Northend and Greater Duwamish MICs. In the BINMIC, there were 14 truck-involved collisions reported in the five years of available data. The majority of the collisions were collisions of trucks with other vehicles, and one was between a truck and a bicycle (truck/bike). None of the collisions resulted in fatalities, but there were 5 injury or serious injury collisions. No pedestrian collisions with trucks were reported within the BINMIC during the 5 years of data reviewed. Figure 3.13 illustrates locations of the collisions within the BINMIC.

In the Greater Duwamish MIC, there were 339 truck-involved recorded collisions over the five years of available collision reports. The majority of these truck/other collisions occurred along heavily used truck routes, such as S Spokane St, E Marginal Way S, and near the SIG Yard and Union Pacific Argo Yard entry points. There were 13 bike / truck collisions were recorded in the Greater Duwamish MIC, where one resulted in a fatality (at the E Marginal Way and Hanford Street intersection). No truck collisions with pedestrians were reported within the Greater Duwamish MIC. A map summarizing the locations of the truck collisions within the Greater Duwamish MIC is provided in Figure 3.14.

Figure 3.13 Truck Collisions in Ballard/Interbay Northend MIC

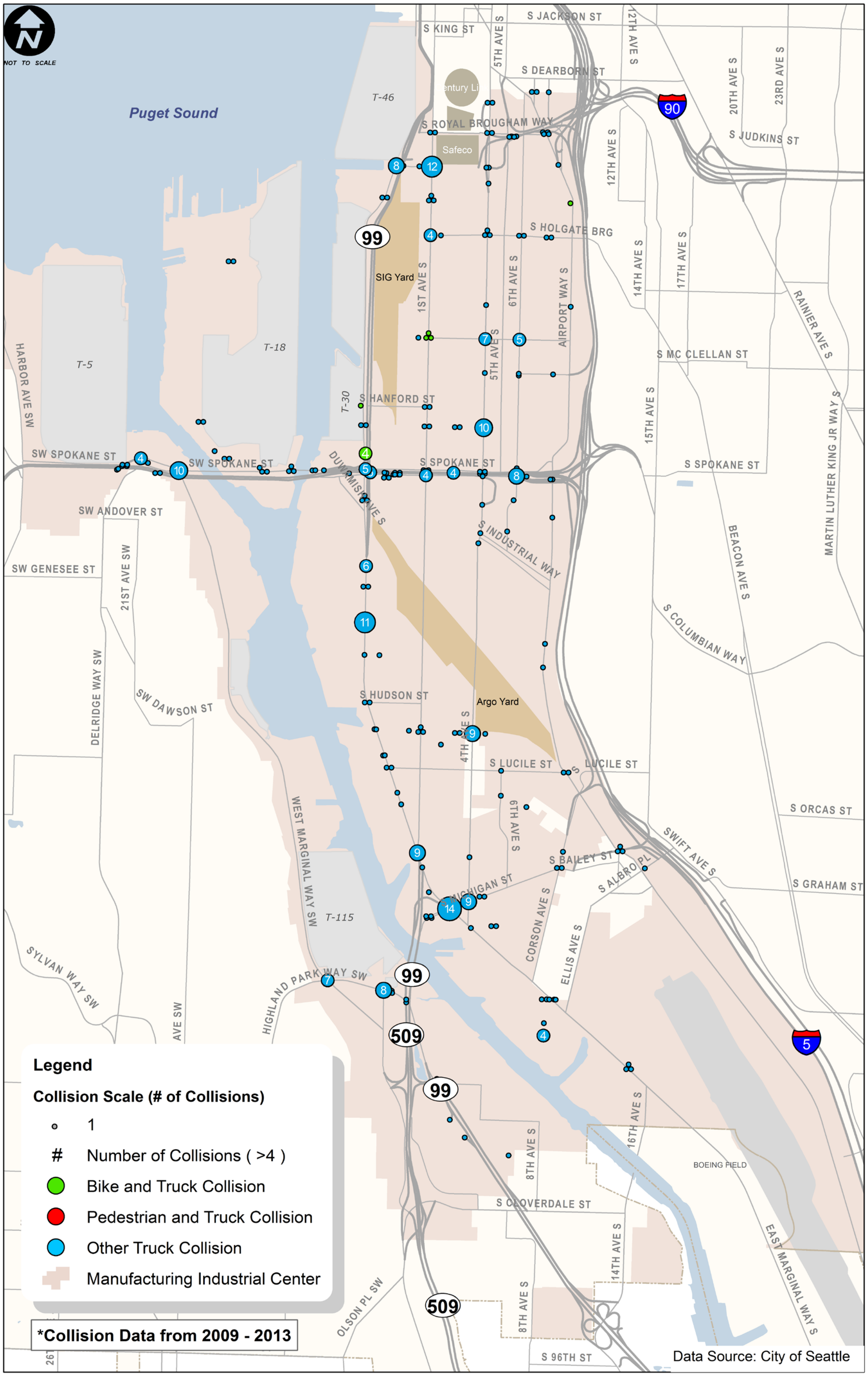


Figure 3.14 Truck Collisions in Greater Duwamish MIC

3.3.4 Truck Mobility Constraints

In order to address overall travel needs for trucks, it is important to inventory constraints on the roadway system that create bottlenecks or barriers for freight traffic. Mobility constraints include bottlenecks or barriers on the transportation network that impact freight access. Some of these constraints are locations that may delay the general traffic stream and therefore impact freight, while others are specific challenges for large trucks. Information on each mobility constraint was collected through SDOT GIS databases, a draft list of Truck Operational Problems in Response to Freight Community,[18] stakeholder comments, and site visits for field confirmation. The advantage of this approach is it can take into account a range of input from existing data sources and stakeholder comments.

One constraint that impacts overall mobility is the limited number of north-south arterials connecting the MICs. Specifically, the Downtown Traffic Control Zone, which is shown on the speed and volume maps, restricts truck access to outside of the downtown and further limits arterial connections that trucks can use between the MICs.

According to Seattle Municipal Code Ordinance 108200 Section 11.14.165, the "Downtown Traffic Control Zone" refers to the area within the downtown district where legal vehicles 30' long and longer may move with a permit from 9am - 3pm, and from 7pm - 6am without a permit. Curfews are in effect 6 - 9am and 3 - 7pm except Saturdays and Sundays.

Permits are required for legal vehicles 30' long and longer on Saturdays but curfews are not in effect.

These restrictions are not in effect on Sundays.

Another general mobility constraint was identified for east-west traffic crossing the railroad tracks in the Greater Duwamish MIC. The following mobility constraints were identified as potential causes of bottlenecks on the freight network:

- intersection and lane geometric constraints
- intersection operations
- at-grade railroad crossings
- over-height restrictions
- weight restrictions
- width restrictions
- roadway grades
- moveable bridges
- port/rail yard operations and security requirements

Improvements to address the mobility constraints are discussed in Chapter 6 – Freight System Improvements.

18 Truck Operational Problems in Response to Freight Community, Work in Progress. 2008-2009. SDOT.

CURB RADII AND LARGE OBJECTS, SUCH AS UTILITY POLES, OUTSIDE THE TRAVEL LANES ARE EXAMPLES OF INTERSECTION AND LANE GEOMETRY CONSTRAINTS.

SIGNAL OPERATIONS FOR FREIGHT INCLUDE COORDINATED SIGNALS AND LEFT-TURN PHASING TO INCLUDE PROTECTED-PERMITTED OPERATION.

Intersection and Lane Geometric Constraints
Due to their large size, trucks have unique needs at intersections and along roadways. The geometry of intersections, which includes the location of curbs, position of lanes, and proximity of objects outside the travel lanes such as poles and street trees, can be challenging for trucks executing turning movements. Wide turns through geometrically constrained intersections may include trucks crossing over road centerlines or mounting adjacent sidewalks or planting strips. Geometric constraints are a safety issue for all roadway users, and result in damage to sidewalks, planting strips, and signage.

Roadway lanes present a similar, but separate types of challenges for trucks. Narrow lanes (less than 12 feet in width) are challenging for trucks to navigate and result in slower speeds and encroachment into adjacent lanes. On-street parking along roadways with narrow lanes constrains available roadway width available for trucks. Signs and trees close to curbs may obstruct truck mirrors or vision for truck drivers. Regular maintenance can alleviate many of these issues, such as trimming and regularly pruning trees close to intersections at heights adequate for truck drivers.

Intersection Operations
The operations of an intersection are influenced by vehicle volumes, the peaking characteristics of traffic flows, and the number of heavy vehicles that travel through an intersection. Trucks have slower acceleration rates than smaller vehicles and require additional time to start from a red light or to traverse an intersection. As a result, signal timing plans that don't account for trucks can create bottlenecks or safety issues at intersections and along corridors with multiple signals.

Intersection operations are typically studied for an expected change in traffic conditions and in advance of any proposed changes to the lane configurations. Potential measures to better support freight mobility include:

- Adding yellow time at signals for trucks braking in advance of intersection.

AT-GRADE RAILROAD CROSSINGS CAN CREATE BLOCKAGES FOR STREETS CARRYING TRUCK TRAFFIC.

- Increasing left turn green times for trucks to complete the turn or add a protected-permitted phase
- Providing signal-interconnect and coordination set at a travel speed appropriate for truck traffic.

At-grade Railroad Crossings

At-grade railroad crossings pose safety issues and create delays for truck freight. Intersections with railroads may include several types of warning signs, gates or whistles, depending on the frequency of trains, amount of vehicle traffic, and location of the crossing. Truck delays are also influenced by the type and use of the rail lines, which determines the duration and frequency of crossing delays.

An inventory of at-grade railroad crossings was completed through comparison of Seattle GIS street and railroad shape files, review of aerial maps, and field verification. At-grade railroad crossings were primarily located on east-west streets in the Greater Duwamish MIC between SR 99 and I-5 and a concentration of crossings in close proximity to the interchange of SR 99 and Spokane Street Viaduct.

The impact on vehicular traffic of these at-grade railroad crossings depends on both the duration and frequency of train crossings as documented in the *Coal Train Traffic Impact Study*[19] for crossings in the Greater Duwamish MIC. Crossing times from this report are shown in table 3.1. Additionally, the type of crossing (mainline, tail or spur track) also affects the safety and delay of each crossing. Mainline crossings may close frequently throughout the day, while tail tracks could be occupied for long durations as longer

Table 3.1 At-Grade Rail Crossing Summary

Average Daily Totals (2012 weekday)	Greater Duwamish MIC		MIC connection
	Holgate Street	Lander Street	Broad Street
Train Crossings	107	87	52
Total Gate Down Time (hours)	3.6	3.7	2.8
Average Gate Down Time (min.)	2.0	2.5	3.3
Minimum/ Maximum Gate Down Time (min.)	0.3 – 8.2	0.5 – 8.1	1.1 – 11.6
Average Train Speed (mph)	7.4	8.1	6.7
Minimum/Maximum Train Speed (mph)	0.4 – 24.6	0.5 – 22.9	0.3 – 22.7
Observed gate closures AM Peak Period (6 – 9AM)	15	15	13
Observed gate closures PM Peak Period (3:30-6:30PM)	18	15	10

19 Coal Traffic Impact Study. Parametrix. 2012.

trains are being built. The introduction of LINK light rail on the SoDo Busway (5th Avenue South) also regularly blocks east-west traffic in the area. These delays are more frequent but have shorter duration due to the short length of LINK light rail vehicles.

The rail activity at the BNSF mainline rail crossings at S Holgate Street, S Lander Street, and S Broad Street blocked each roadway an average of 2.0 to 3.3 minutes per train. This equates to a total daily closure of 2.8 to 3.7 hours over a 24-hour period, and about 8.5 minutes during the PM peak hour.

Over-Height Restrictions
The presence of over-height restrictions on freight routes decreases system efficiency by requiring trucks to take a circuitous route with increased travel time. Clearances less than 14'0" can also result in property damage to both public bridges and freight vehicles. Major truck routes with over-height clearance of less than 14'0" were inventoried using Google Streetview, field verification and City data. Within the MICs there is only one height restriction located on Western Avenue at Bell Street.

Weight Restrictions
Bridge weight restrictions, like over-height restrictions, can decrease system efficiency by requiring trucks to take a circuitous route. A list of weight limited bridges on major trucks streets was developed based on a City-maintained list of bridges with posted vehicle weight restrictions and verified using Google Streetview. (Restrictions

OVER-HEIGHT NEEDS FOR TRUCKS MAY EXCEED RESTRICTIONS FOR OTHER ROADWAY USERS.

on non-legal loads were not captured in this review.) The structural condition of these bridges is discussed in a later section.

Hazardous Materials
The City of Seattle restricts the transport of hazardous materials on some routes to ensure public safety. Specifically, traffic code prohibits transport of hazardous materials through the SR 99 tunnel at all times. SDOT has posted signs to remind drivers that hazardous materials are restricted at all times in the SR 99 Battery Street Tunnel and on the Alaskan Way Viaduct during weekday peak travel periods. Weekday restrictions will continue on the Alaskan Way Viaduct between 7:00 and 9:00am and 4:00 to 6:00pm

Roadway Grades
Road segments with steep grades pose a challenge to heavy vehicles if they are required to stop and start on a steep grade or in traffic. Road segments with steep grades were identified using

WEIGHT RESTRICTIONS MAY REQUIRE OUT OF DIRECTION TRAVEL FOR OVER-LEGAL TRUCKS.

Seattle street centerline data. Within the project study area few road segments have steep grades although some routes to and from the project study area do have segments with steep grades. Table 3.2 identifies the ranges of street grades on Seattle streets and the uphill and downhill difficulties encountered for trucks.

Moveable Bridges

Moveable bridges open for waterway traffic, including waterborne freight, and are located on several of the major study roadways. Bridge lifts, when the roadway must close to open the bridge for boats to pass, may delay traffic for several minutes, potentially creating a bottleneck in the freight system.

The US Coast Guard controls the navigable waterways of the US, including those in the MIC. The movable bridges in the project are the Ballard Bridge and Fremont Bridge in the vicinity of the BINMIC, and the South Park Bridge, 1st Avenue S Bridge, and the Lower Spokane St. Swing Bridge in the Greater Duwamish MIC. Bridge openings along the Duwamish River are frequently needed by waterborne freight and other commercial traffic. Tidal influences make it difficult to adjust bridge openings to address roadway conditions without major impacts on waterborne freight. The opening of these bridges creates a mobility barrier for both truck freight and general vehicle traffic. Some of these bridges may open between

Grade Percent (%)	Truck Uphill Grade Difficulty	Truck Downhill Grade Difficulty
3% - 5%	None to manageable	None to manageable
5% - 8%	Manageable to moderately diffi-cult	Manageable to moderately difficult
8% - 12%	Difficult and not advised	Difficult and not advised
greater than 12%	Not advised; undesirable route	Not advised; undesirable route

Table 3.2 Roadway Grade Truck Difficulty Levels

Source: Freight Network: Seattle Arterials Street Grades. Seattle Department of Transportation. 2011.

Moveable Bridges

Seattle operates three movable bridges over the Lake Washington Ship Canal: Ballard, Fremont and University Bridges. WSDOT operates the Montlake Bridge. Each of these bridges takes 3-4 minutes to open and close for boat traffic.

There are three movable bridges over the Duwamish River that are regulated by the US Coast Guard – Seattle's southwest Spokane Street Swing Bridge, WSDOT's First Avenue South (SR 99) Bridge and King County's South Park Bridge (operated by SDOT). These bridges can take up to 11 minutes to open and close.

10 and 20 times each day[20], and while peak hour restrictions may apply not all openings can be predicted.

In 2012, the Fremont Bridge had an average of 16.6 vessels per day and an average of 14.8 bridge openings. The Ballard Bridge had an average of 14.6 vessels per day and an average of 11.6 bridge openings. From September 2008 to September 2009, the 1st Avenue S Bridge opened an average of 105 times per month. The South Park Bridge reopened in the summer of 2014. Prior to completion of the new bridge, the bridge had between 26 and 95 openings per month for marine vessels. The Lower Spokane Street swing bridge averages 150-200 openings per month.

Port/Rail Yard Operations and Security Requirements

Port and rail yard operations and security requirements determine the times during the day and the rate at which trucks enter terminals and yards. Table 3.3 provides access locations for the four major container terminals at the Port of Seattle. Currently, the railyards are open 24 hours a day, 7 days a week.

Table 3.3 Summary of Major Container Terminals at the Port of Seattle

Terminal	Access Point
T-5	W Marginal Way SW
T-18	SW Spokane St
T-25/30	E Marginal Way
T-46	Alaskan Way

Container terminal hours of operation vary to meet needs. Terminals add hoot-shifts (3-7am) on busy days or work on weekends to manage volume fluctuations. The typical pattern is for trucks to arrive before the gates open in the morning to get the earliest possible start. The busiest days are usually around large vessel arrivals as trucks are bringing goods to load and trucks discharge the imported containers. On occasions when terminal issues have slowed truck processing, it is possible for truck queues to overflow the holding area and extend onto access streets. The terminals all have substantial holding areas for trucks waiting for gate clearance and terminal operators will balance labor resources in the yard to enable it to function efficiently, and that also balances truck trips.

Figure 3.15 to Figure 3.17 show the mobility constraints that are currently identified in the study area. A list describing all of these mobility locations is provided in Table 3.4.

20 Ballard and Fremont Bridge Opening Analysis. SDOT 2012.

Table 3.4 Current Mobility Constraints

Mobility Constraint	Location
Geometric Constraints (G)	W Dravus Street / 15th Avenue Intersection
	15th Avenue NW / NW Market Street Intersection
	15th Avenue W / Emerson Street Intersection Improvement
	16th Avenue S / E Marginal Way S Intersection
	Airport Way S / Edmunds Street Intersection
	E Marginal Way S / Corson Street Intersection
	I-5 Ramps at S Corson Avenue / S Michigan Street
	I-5 Ramps at S Corson Avenue / S Michigan Street
	S Cloverdale on-ramp to SR 99
	S Dallas Street / 14th Avenue S Intersection
	S Michigan Street / S Bailey Street Intersection
Intersection Operations (S)	Airport Way S / Edmunds Street Intersection
	NW Leary Way Signal
	Terminal 46 New Signal & Intersection Improvements
	intersection at West Marginal Way / Chelan Street
	14th Avenue S
	E Marginal, Way, 8th Avenue / Myrtle Street
	Harrison Street between Queen Ann / 1st.
	1st Avenue S / Atlantic Street
	5th Avenue NE Signal
	Aurora Avenue N / 95th Street Signal
	NE Northgate Way Signal Optimization
	3rd Avenue NE Signalization
	8th Avenue NE Signal
	Airport Way S / Edmunds Street Intersection
	Meridian Avenue N Signal
	NW Leary Way Signal
	Terminal 46 New Signal & Intersection Improvements
Height Restriction	Western Avenue / Bell Street
(T) Weight Restriction	Airport Way overpass over Argo Yard
Moveable Bridges	15th Avenue Bridge (near Ballard)
	16th Avenue S Bridge (across Greater Duwamish)
	1st Avenue S Bridge (across Greater Duwamish)
	S Spokane Street (across Greater Duwamish)
	Fremont Avenue Bridge (across Lake Union)
At-Grade Rail Crossings (Mainline)	S Lander Street. (between 1st Avenue and 4th Avenue)
	S Holgate Street (between 1st Avenue and 4th Avenue)
	S Horton Street (between 1st Avenue and 4th Avenue)
	Lower Spokane (between 1st Avenue and 4th Avenue)
	Broad Street / Alaskan Way

Spur crossings and steep slopes are shown on the following maps.

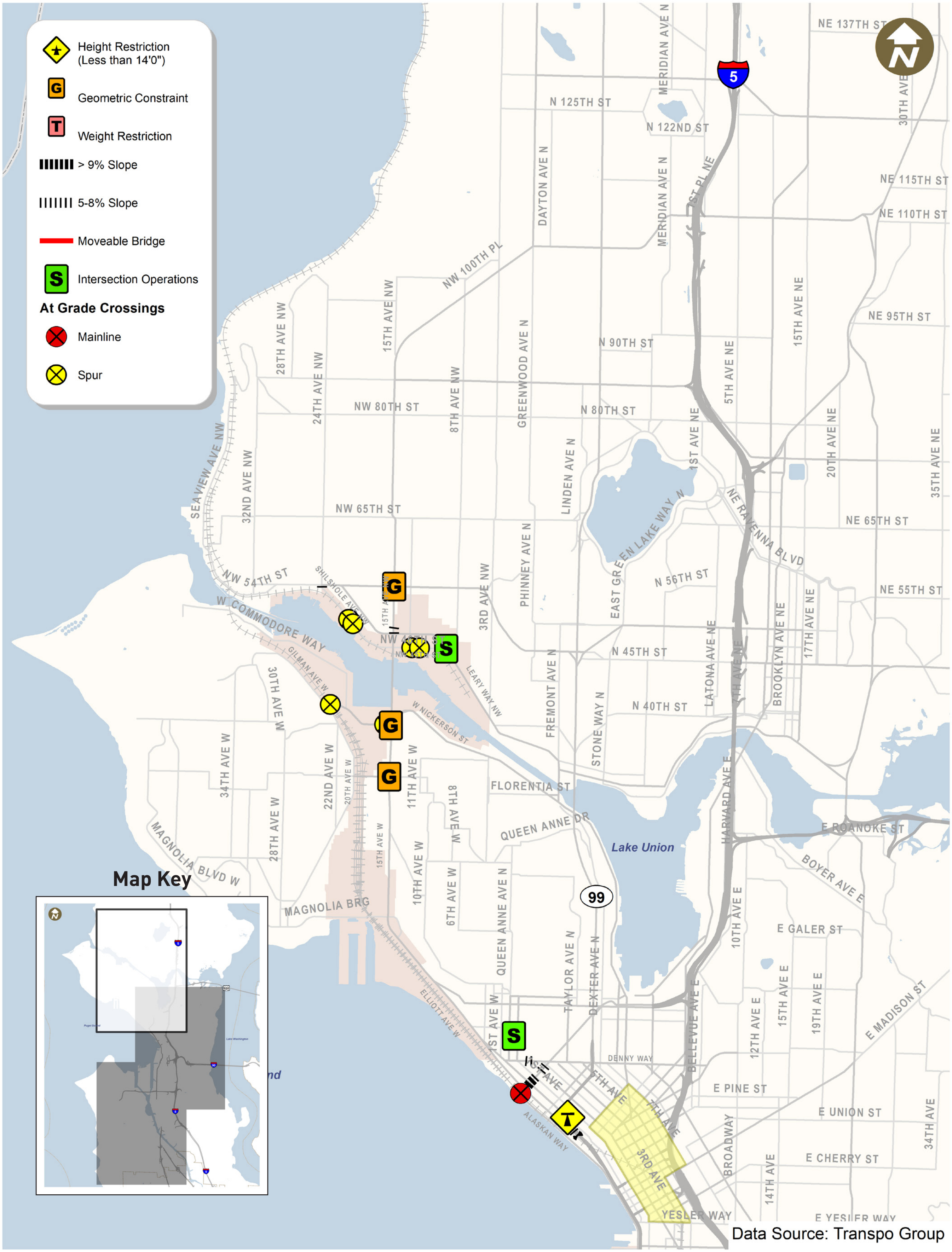


Figure 3.15 Existing Mobility Constraints – North Section

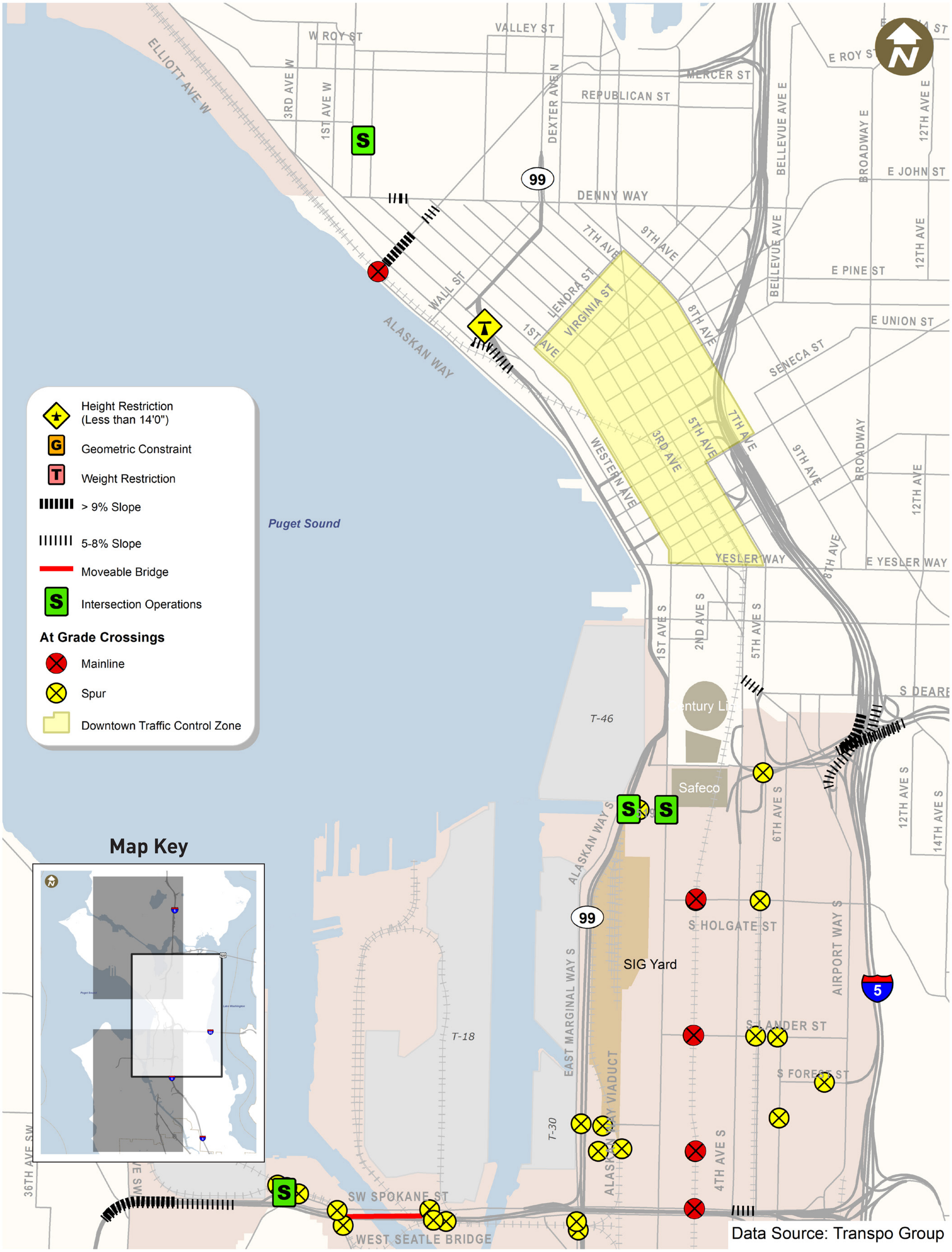


Figure 3.16 Existing Mobility Constraints – Central Section

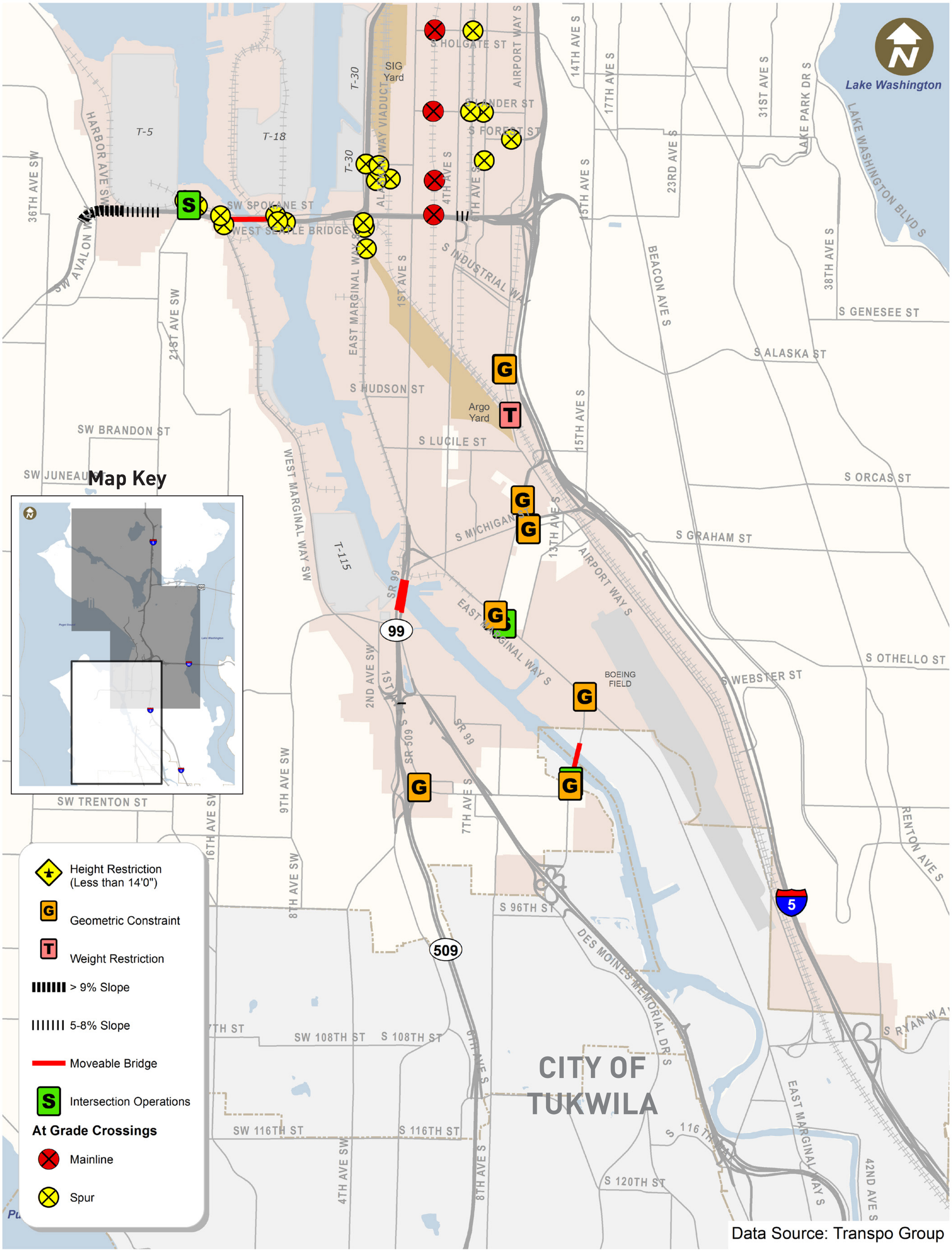


Figure 3.17 Existing Mobility Constraints – South Section

PAVEMENT RUTTING AND CRACKING ON A STUDY ROADWAY IN THE GREATER DUWAMISH MIC

3.3.5 Pavement and Bridge Conditions

Freight system condition measures provide information about the physical condition of freight transportation infrastructure, and can help inform system maintenance and preservation programs. Additionally, accounting for both pavement and bridge condition is a reporting requirement of *Moving Ahead for Progress in the 21st Century* (MAP-21). Most of the recommended freight condition performance measures for the highway system use data from well-established sources. NCFRP Report 10 *Performance Measures for Freight Transportation*[21] proposes several freight system condition measures, including monitoring National Highway System (NHS) pavement condition and NHS bridge conditions.

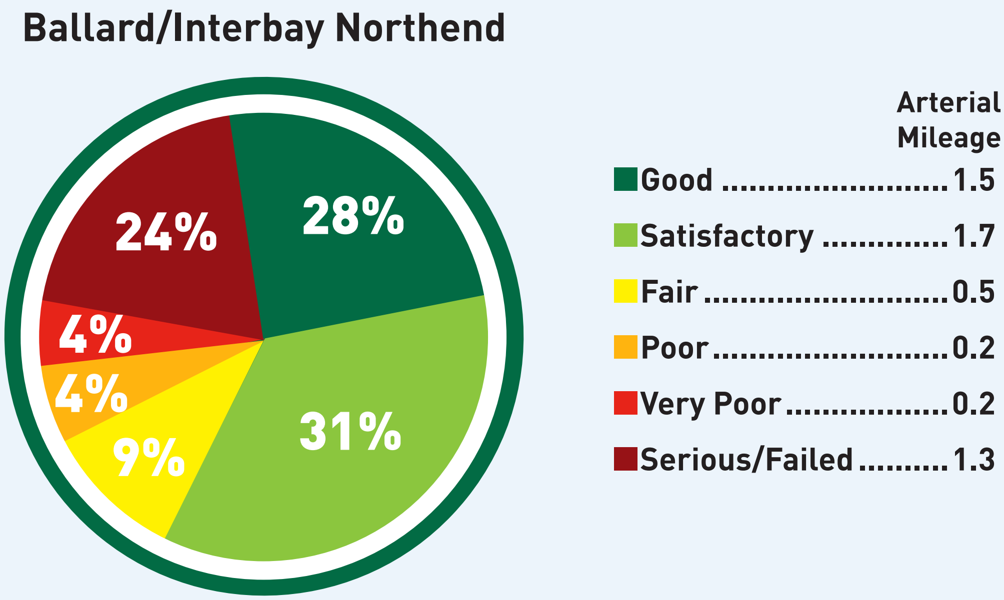
Pavement Condition Assessment

Keeping roadway pavement in a state of good repair decreases the risk of damage to trucks and cargo, and helps ensure a high level of service for freight. It is important to track this measure on critical freight routes including truck routes, intermodal connectors, and other "last mile" road segments.

The number of arterial roadway miles in good repair is maintained in the City Graphical Information System (GIS) database. The pavement condition rating for roadways is based on a 100-point scale, with excellent streets rated at 100 and failed streets rated at 0. This allows for better identification and tracking of the number of streets that only need minor repairs to maintain their high rating, the number of streets that are approaching their life expectancy and are in need of some type of resurfacing, and those streets that are past their life expectancy and are in need of substantial repair prior to resurfacing.

This Freight Access Project largely addresses arterial roadways; however some local streets with high truck volumes may also have very poor pavement conditions, though these streets are not currently being rated and mapped. As shown in Figure 3.18, there is a similar distribution of pavement index ratings for both MICs. The Greater Duwamish MIC has a higher number of roadway miles than BINMIC also highlighted in Figure 3.18. The breakdown of pavement conditions for the study area arterial streets are shown in Figures 3.19 to 3.21.

21 NCFRP Report 10 Performance Measures for Freight Transportation, Research Board, 2011



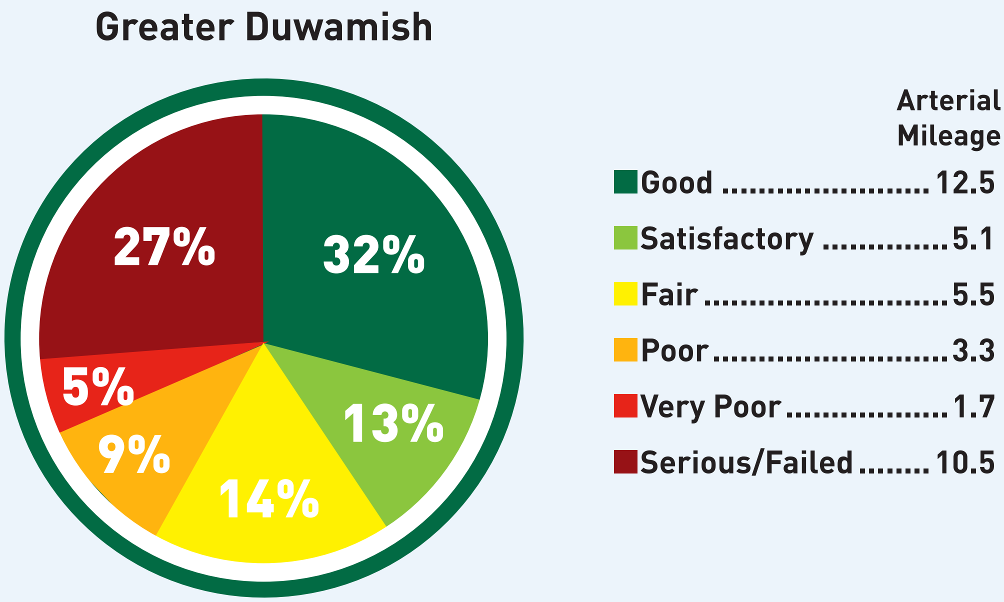


Figure 3.18 Breakdown of Arterial Pavement Conditions – Study Area Roadways (Source City of Seattle)

The best rated pavement categories (good and satisfactory) account for 59 percent of all pavement within the BINMIC while these categories account for only 45 percent of pavement in the Greater Duwamish MIC. Similarly, the worst rated categories (very poor and serious/failed) account for 28 percent of pavement in the BINMIC, while making up 31 percent in the Greater Duwamish MIC. This demonstrates that, generally speaking, the pavement is in better condition in the BINMIC than the Greater Duwamish MIC.

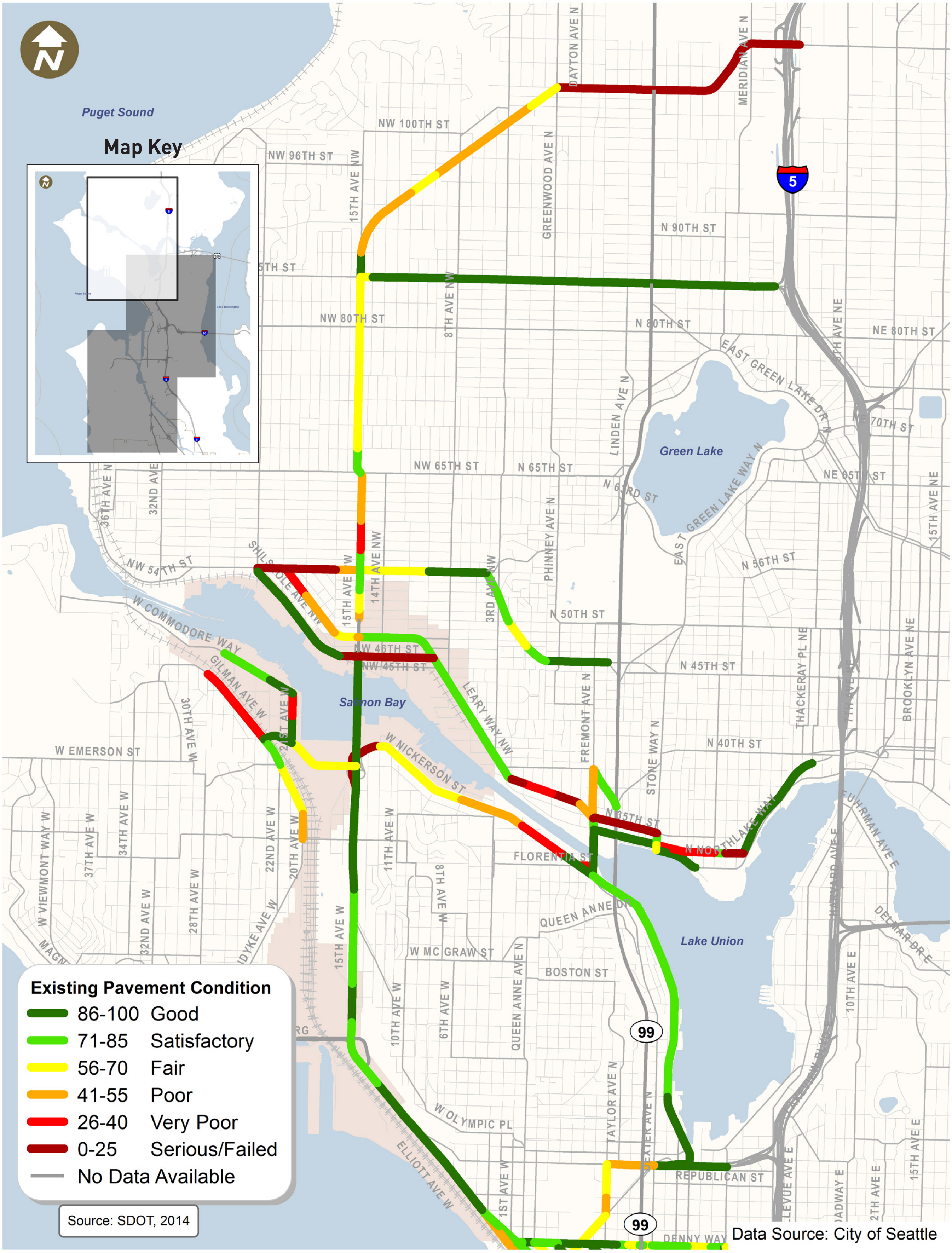


Figure 3.19 Pavement Conditions – North Section

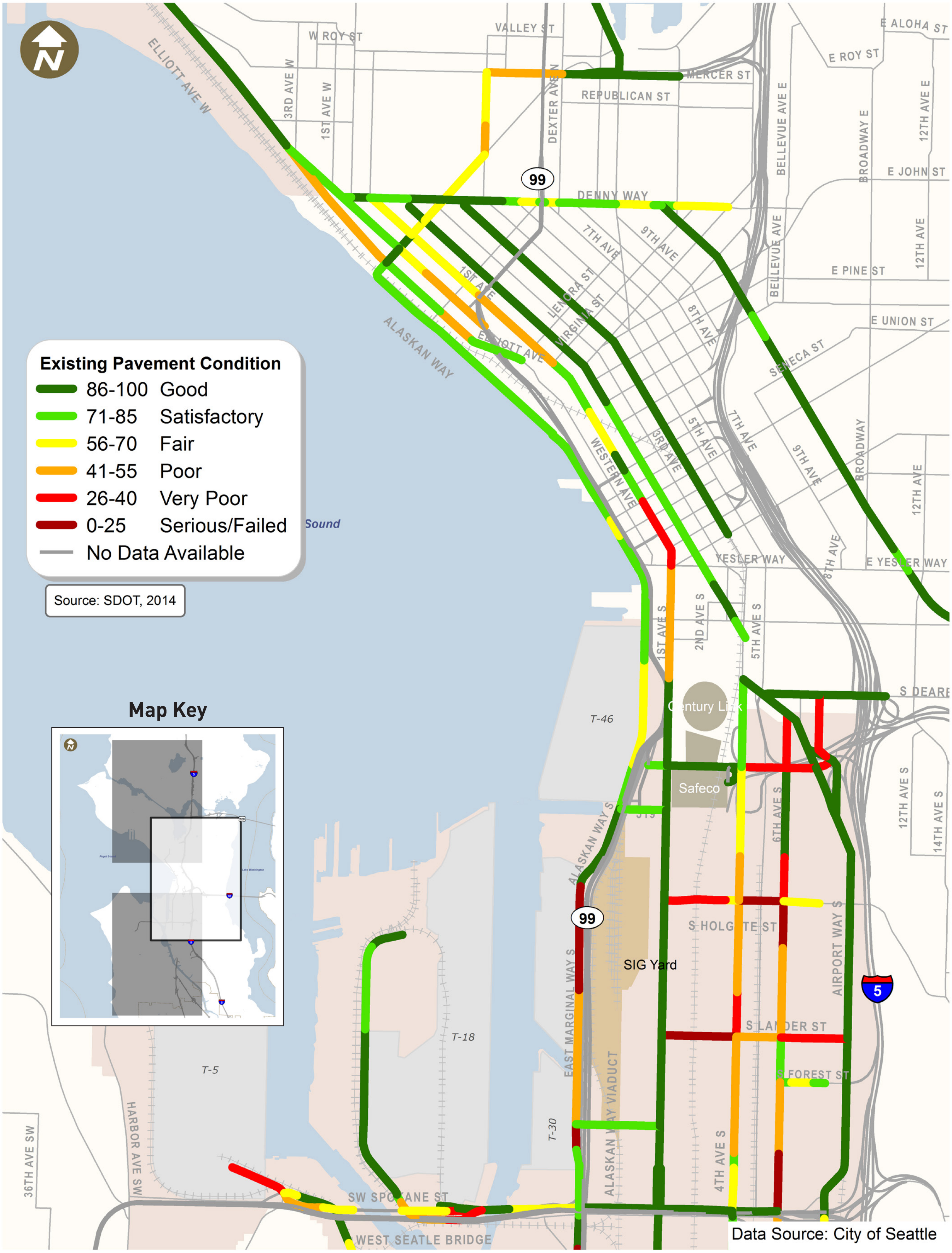


Figure 3.20 Pavement Conditions – Central Section

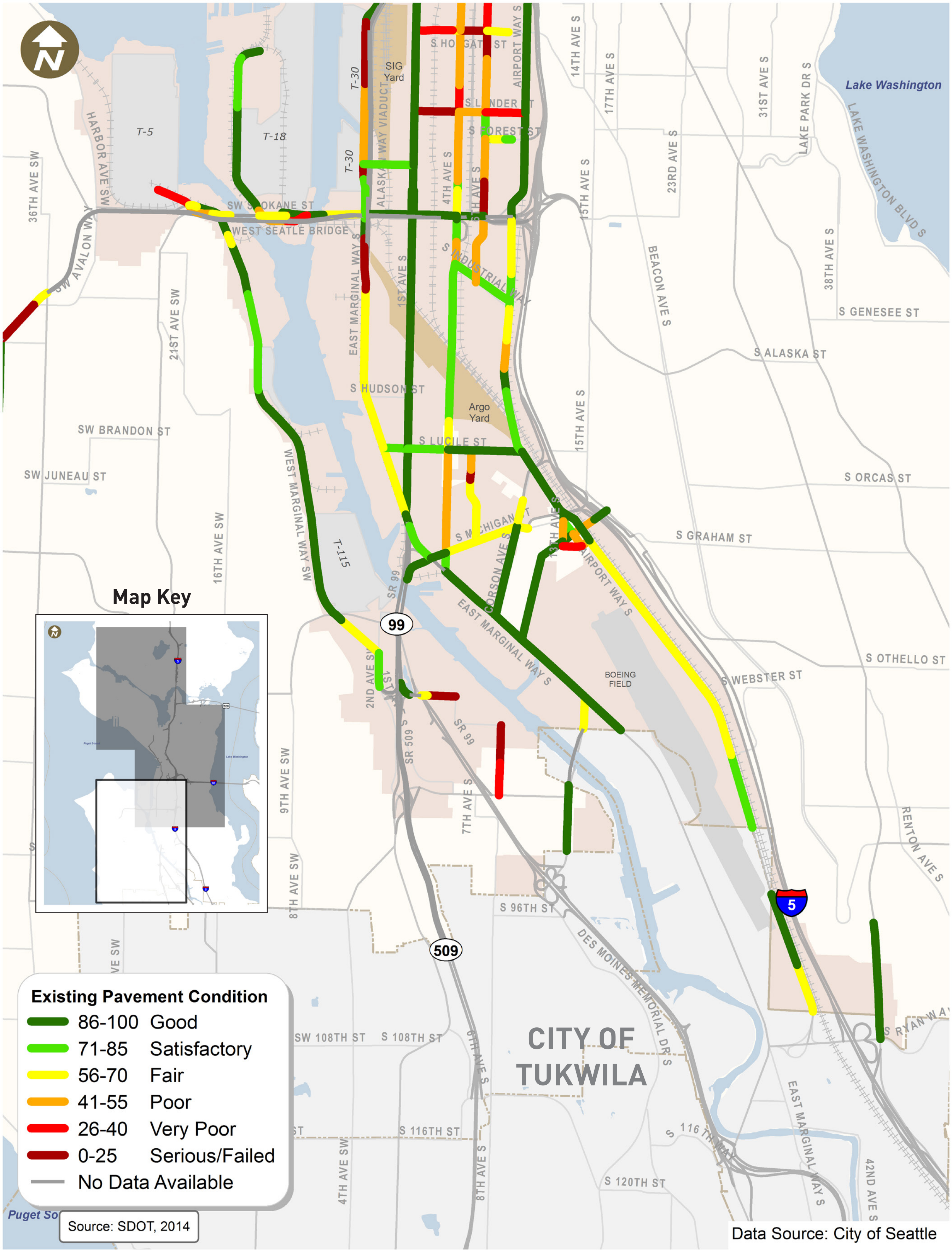


Figure 3.21 Pavement Conditions – South Section

Bridge Conditions

Bridges provide key connections for freight movements in the City of Seattle, allowing for trucks and other modes to cross the railroad tracks and waterways that exist within and connecting to the MICs. Bridges that open are called "moveable bridges" and create a unique set of challenges for freight reliability and movement. Moveable bridges may open at various times during the day to allow commercial boats to pass, creating a conflict between two different freight modes. Bridges in the project area include the Ballard and Fremont Bridges in the vicinity of the BINMIC, and the South Park Bridge, SR 99/1st Avenue South Bridge, and Spokane Street Swing Bridge in the Greater Duwamish MIC.

The City of Seattle's Roadway Structures Division has developed infrastructure standards related to structural condition of bridges within and connecting the MICs. Two categories were developed for the purposes of evaluating the existing condition of bridges[22]:

22 More information can be found at the SDOT freight mobility web page at: www.seattle.gov/transportation/freight.htm.

PHOTO CREDIT: SDOT

Bridges with Weight Restrictions

The legal maximum gross vehicle weight for truck and cargo in City of Seattle is 80,000 pounds, which applies to both trucks and their cargo. This information is posted on-line for trip planning purposes, as well as signs posted on the approaches to the structures to warn truck drivers. The existing bridges with weight restrictions in the City of Seattle within the MICs are listed below.

- Magnolia Bridge, Pier 91 Ramps
    - Center ramps to Port of Seattle on Magnolia Bridge
    - No trucks allowed
- Airport Way South Bridge over the Union Pacific Railroad (UP) Argo Yard
    - Airport Way South over the UP Argo Yard
    - Legal truck loads only, no overloads

Other bridges not in the MICs with weight restrictions are noted below:

- Southbound Fairview Avenue North Bridge
    - Fairview Avenue North between East Galer Street and East Prospect Street
    - Weight limit is 40 tons
- Post Alley
    - Post Alley between Columbia Street and Marion Street
    - Weight limit is limited to a two axle single unit truck, not to exceed 19 tons

Bridges Identified for Rehabilitation

The City also maintains a list of structures that have been identified as being desirable candidates for rehabilitation or other major improvements. These structures were built in the last century, and will eventually reach their useful service life. If future funds are not available for bridge replacement or rebuilding, truck weight and size restrictions may have to be posted in the future. Other bridges identified for rehabilitation include structures that are currently under construction, like the SR 99 structure over Mercer Street or will be rebuilt as part of the Alaskan Way Viaduct Project.

3.3.6 Modal Integration

Movement of both people and goods on the transportation system results in competing needs for a range of modes. The increasing urbanization of the City has resulted in reallocating space for transit, bicycles, and pedestrians within constrained right-of-ways with finite infrastructure. The City of Seattle has already implemented projects to reconfigure roadways on Nickerson Street (a Major Truck Street) and Stone Way to improve pedestrian safety and provide dedicated bicycle facilities[23] following guidance in the City's Complete Streets Ordinance (#122386).

The Seattle Department of Transportation (SDOT) will implement Complete Streets policy by designing, operating and maintaining the transportation network to improve travel conditions for bicyclists, pedestrians, transit and freight in a manner consistent with, and supportive of, the surrounding community.

23 As documented in the Nickerson Street Rechannelization Before and After Report and Stone Way N Rechannelization: Before and After Study (May 2010) by the City of Seattle.

PHOTO CREDIT: SDOT

"Freight will be the major priority on streets classified as Major Truck Streets. Complete Street improvements that are consistent with freight mobility but also support other modes may be considered on these streets."

The City is monitoring the performance of Complete Streets. The City is currently developing a multimodal corridors program as the next generation of complete streets. The Multimodal Corridor Program will focus on transforming a street or combination of streets into safer and healthier public spaces with predictable movement of people and goods with safety being the highest priority.

The available national guidance for providing safe, efficient infrastructure for freight vehicles sharing the transportation network with transit and non-motorized users generally promotes separation. However, as freight patterns change to accommodate future trends there will be an increasing need for delivery vehicles and other trucks to share roadways with other modes.

Locally, the Greater Duwamish Transportation Management Association (TMA) has attempted to developed recommendations for infrastructure and programmatic improvements[24]. In addition, the Freight Master Plan is addressing policies and programs related to design standards and roadway hierarchy as related to freight.

A multimodal system can include complementary benefits for competing modes in many situations, but this is not always the case. Individual modal plans[25] consider the needs and priorities of that particular mode, and therefore particular attention should be paid where multiple modes have been prioritized on the same street. Figures 3.22 to 3.24 show the locations of overlapping modal priorities contained in these modal plans to identify where transit, pedestrians, or cycling facilities are already present or have been prioritized by other planning work. The following sections discuss each of these modal overlaps in greater detail.

24 The Greater Duwamish TMA has provided recommendations in the Workable SoDo (November 2013) and Street Smart Study available at: www.Greater Duwamishtma.org/street-smart-study/
25 Including the Seattle Pedestrian Master Plan (September 2009), Transit Master Plan (April 2012), and Bicycle Master Plan (April 2014).

Transit

Transit streets identified in the Transit Master Plan as Transit Priority Corridors were used to compare locations that overlapped with Major Truck Streets. Transit service improvements may impact freight movements by dedicating a travel lane for bus or rail transit. Siting of stops and stations in locations where pedestrians and bicycles share the right-of-way with trucks may create bottlenecks for trucks when transit vehicles are stopped in the travel lane to pick up or discharge passengers. On the other hand better transit service may reduce auto demand and vehicle congestion thereby improving travel conditions for trucks.

Additionally, streets with existing and proposed Link Light Rail and Seattle Streetcar service were identified. Streetcars often share similar operating characteristics with buses. As compared to other modes included in this analysis across the City, the potential overlap with transit represented the highest proportion of the overall overlap.

Bicycle

The Bicycle Master Plan's guiding principle is to develop a bicycle network that facilitates travel to key destinations and provides substantial biking opportunities for all ages and abilities.

Streets with existing or proposed bicycle facilities, along with planned facilities in the Bicycle Master Plan were used to compare overlaps with Major Truck Streets. Bicycle facilities may reduce available roadway space for other modes or include shared-lane markings that promote bicycle use in the same lane as freight and other vehicles. Cyclists generally travel at slower speeds than other vehicles outside of the CBD and therefore impact the average speed and operations of vehicles on those roadways.

Streets with parallel or crossing bicycle paths should be a consideration if that path crosses access points or intersections frequently used by freight traffic. Stakeholders noted that corridors with overlapping priorities for freight and bikes were the most challenging, especially where modes operated in the same space without separation. Corridors identified as having both freight and pedestrian priorities include East Marginal Way, Lower Spokane Street, Airport Way, and 6th Avenue in the Greater Duwamish MIC, the Nickerson/Westlake Avenue corridor, Dearborn Way, Elliott Avenue, and Alaskan Way.

Pedestrian

City of Seattle policy as articulated in the Pedestrian Master Plan calls for ensuring safe pedestrian travel on all city streets.

Pedestrian overlay zones, including Urban Centers, Hub Urban Villages, and Residential Urban Villages, as identified in the Seattle's Comprehensive Plan were used to compare overlaps with Major Truck Streets. High pedestrian demand is generally localized near the CBD, the Stadium District, and higher-density neighborhoods adjacent to the BINMIC.

As compared to bicycle and transit modes, pedestrian demand had fewer modal overlaps. However, as pedestrian activity increases in certain areas of the city, this modal overlap could become a larger issue. In particular, Alaskan Way serves as a connector between the two MICs, and that role is more important with the bored tunnel configuration replacing the Viaduct. Thus, the development of the Central Waterfront could create a higher potential for conflicts between truck traffic and pedestrians crossing Alaskan Way.

Events at the stadiums with high pedestrian volumes result in closures of major truck corridors including Royal Brougham Way and Atlantic Street/Edgar Martinez Drive.

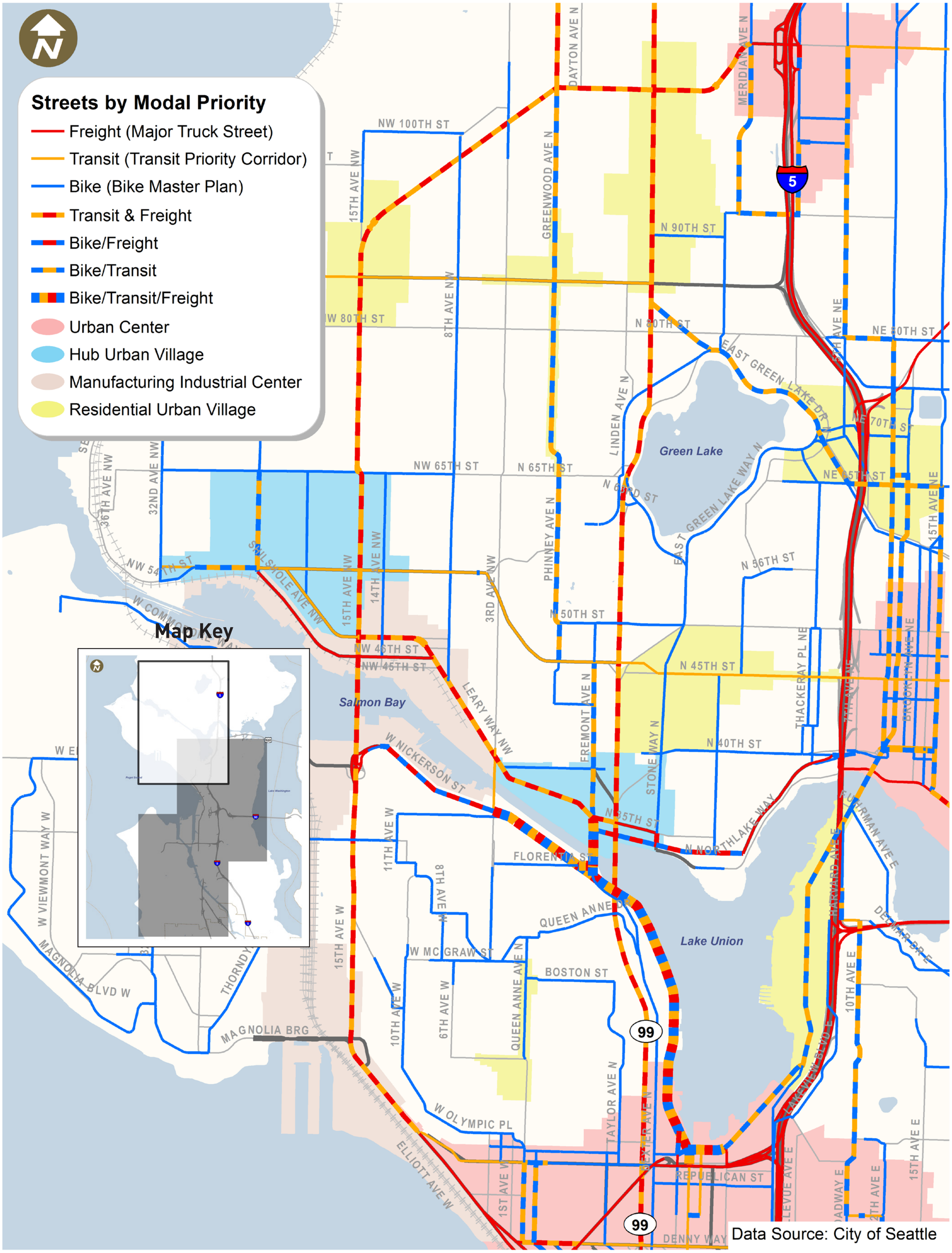


Figure 3.22 Modal Overlap – North Section

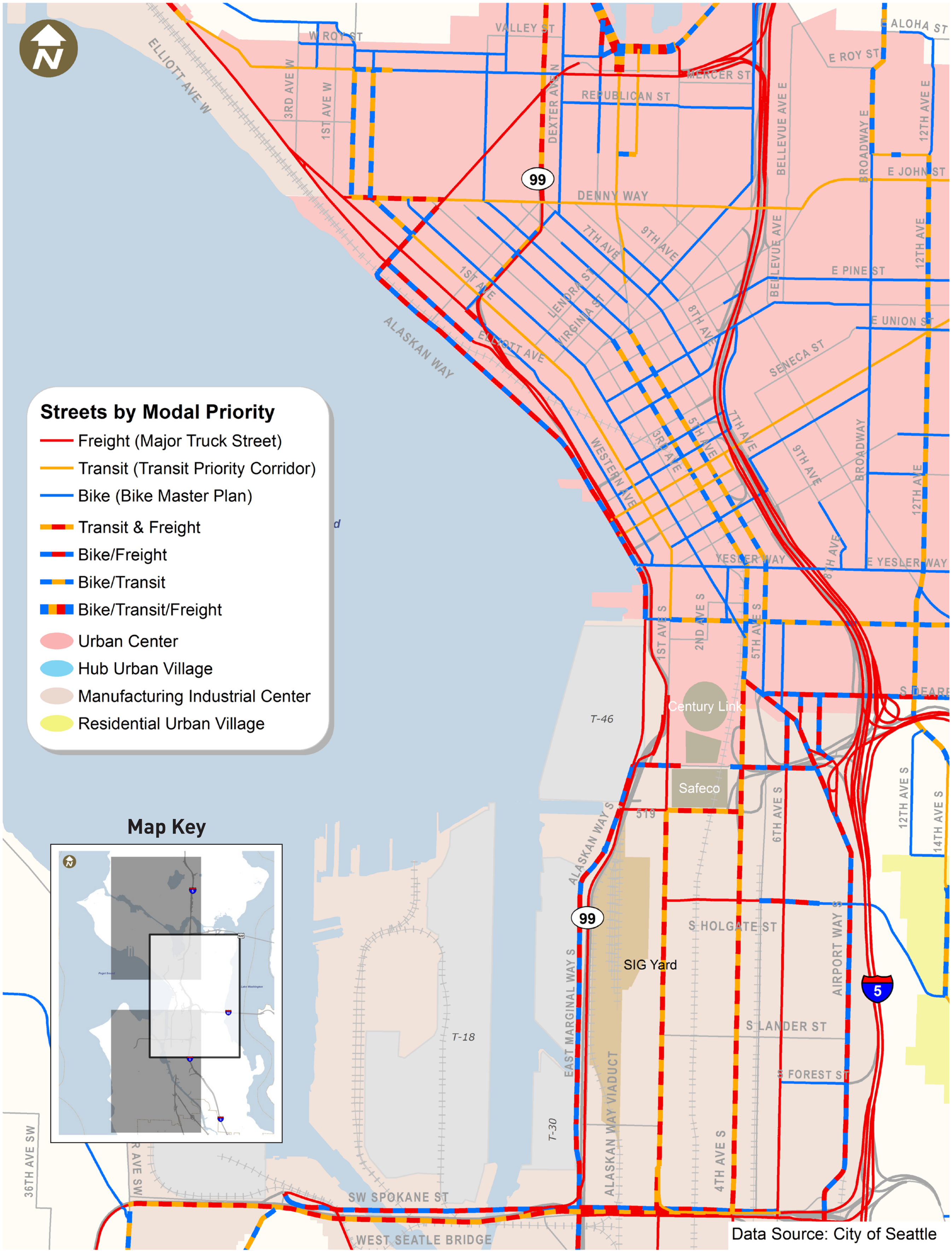


Figure 3.23 Modal Overlap – Central Section

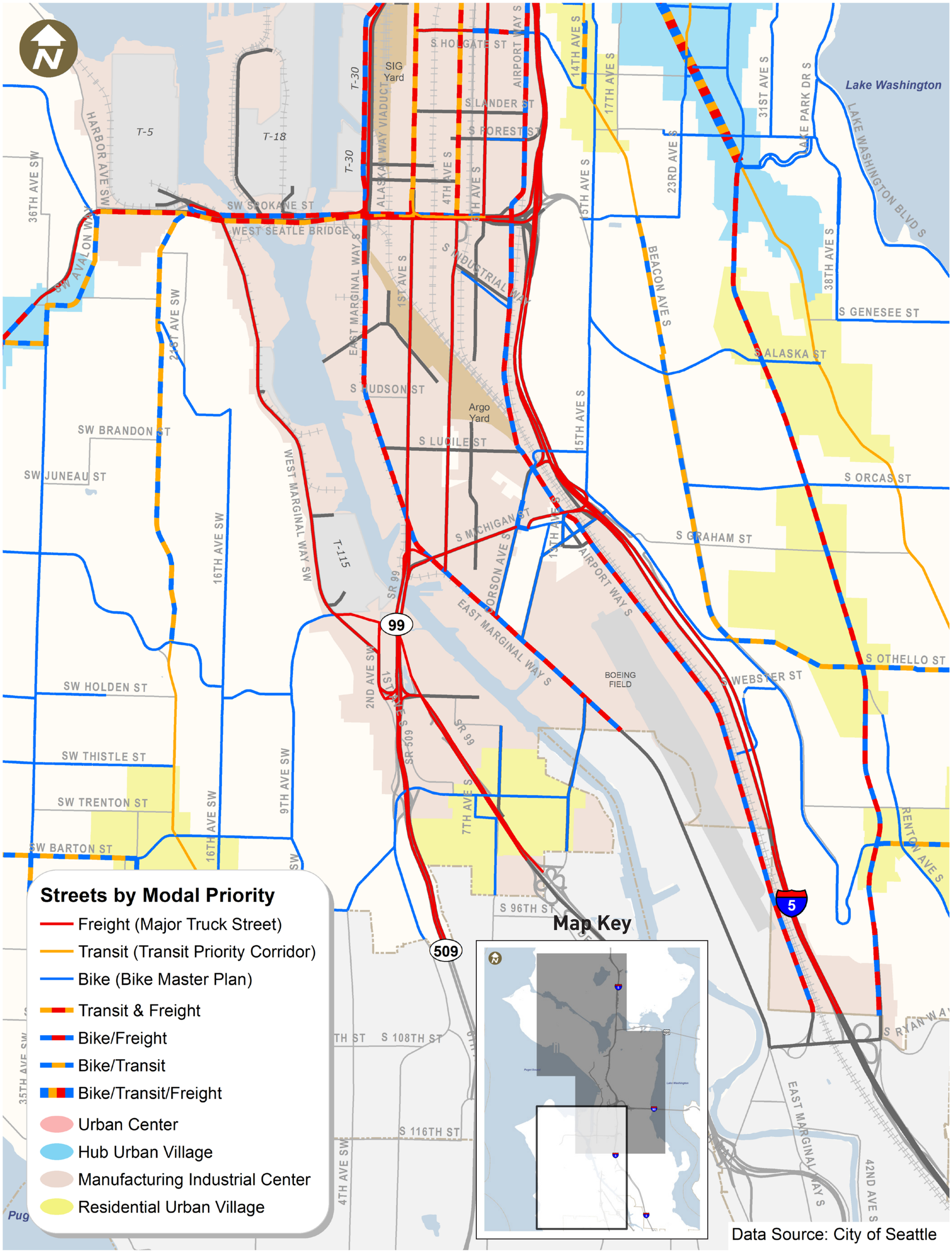


Figure 3.24 Modal Overlap – South Section

PHOTO CREDIT: SDOT

3.4 Rail Operations

For truck-borne freight, growth in rail traffic means that constraints at rail crossings will increase. This section describes the current rail operations affecting the MICs.

On a tonnage basis, half of all rail traffic with a Washington destination in 2010 came from out of state.

Commodity flows in the central Puget Sound move primarily through the ports of Seattle, Tacoma and Everett. Together, the ports of Seattle and Tacoma constitute the third largest container hub in North America with an estimated 60-70% moved by rail[26]. Rail freight volume has grown dramatically (81% growth in volume between 1991 and 2010) and is expected to continue to grow. A detailed summary of BNSF mainline rail traffic, including existing rail traffic observations, within the SoDo neighborhood is presented within the *Coal Traffic Impact Study*[27]. Within SoDo, between 65 and 85 rail movements occur each weekday at the BNSF mainline at-grade rail crossings with trains traveling at average speeds of approximately six to eight mph. Table 3.1 summarizes the average number and duration of train crossings at three of the at-grade mainline crossings in the Greater Duwamish MIC and connecting corridors.

Main line passenger rail service in the Puget Sound region is provided by Amtrak and Sound Transit. Amtrak is a federally chartered corporation that operates all intercity train services in the United States. In Seattle, Amtrak's service consists of Amtrak Cascades, and two long distance trains, the Empire Builder and Coast Starlight:

- Amtrak Cascades is a multiple frequency corridor service between Vancouver BC, Seattle, Portland, and Eugene, Oregon, that is administered and financially supported by Washington State DOT and Oregon DOT, in partnership with Amtrak.
- The Empire Builder operates daily along a northern route between Seattle, Spokane, Fargo ND, Minneapolis-St. Paul, and Chicago.

26 Economic Evaluation of Regional Impacts for the Proposed Gateway Pacific Terminal at Cherry Point, PSRC, 2014
27 Coal Traffic Impact Study. Parametrix. 2012.

- The Coast Starlight travels a route along the I-5 corridor between Seattle, Portland OR, Oakland CA, and Los Angeles, also on a daily basis.

The Empire Builder and Coast Starlight are national system trains, and thus are wholly managed and funded by Amtrak and the Federal Government.

Commuter rail service in the Seattle region is provided by Sound Transit and operated through a contract with BNSF and Amtrak, with the former providing operating personnel and the latter maintaining the equipment. Ten round trips are currently being provided on weekdays between Lakewood and Seattle, while four round trips are offered between Seattle and Everett.