APPENDIX A:

MULTIMODAL LEVEL OF SERVICE ANALYSIS REPORT

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CHAPTER 1. INTRODUCTION

Fehr & Peers has completed a multimodal level of service (MMLOS) analysis for the City of Tukwila. As described in Deliverable #1 (attached as Attachment C), MMLOS summarizes the quality of the transportation system for autos, bicycles, and pedestrians based on the methodologies defined in NCHRP Project 3-70[1]. MMLOS is an advancement over traditional LOS techniques, which focus solely on automobile progression and delay to drivers.

This report summarizes the results of the MMLOS analysis for auto, bicycle, and pedestrian modes on roadway segments within the City of Tukwila. The results of the MMLOS analysis are followed by a list of preliminary recommendations for improving the LOS of poorly performing segments.

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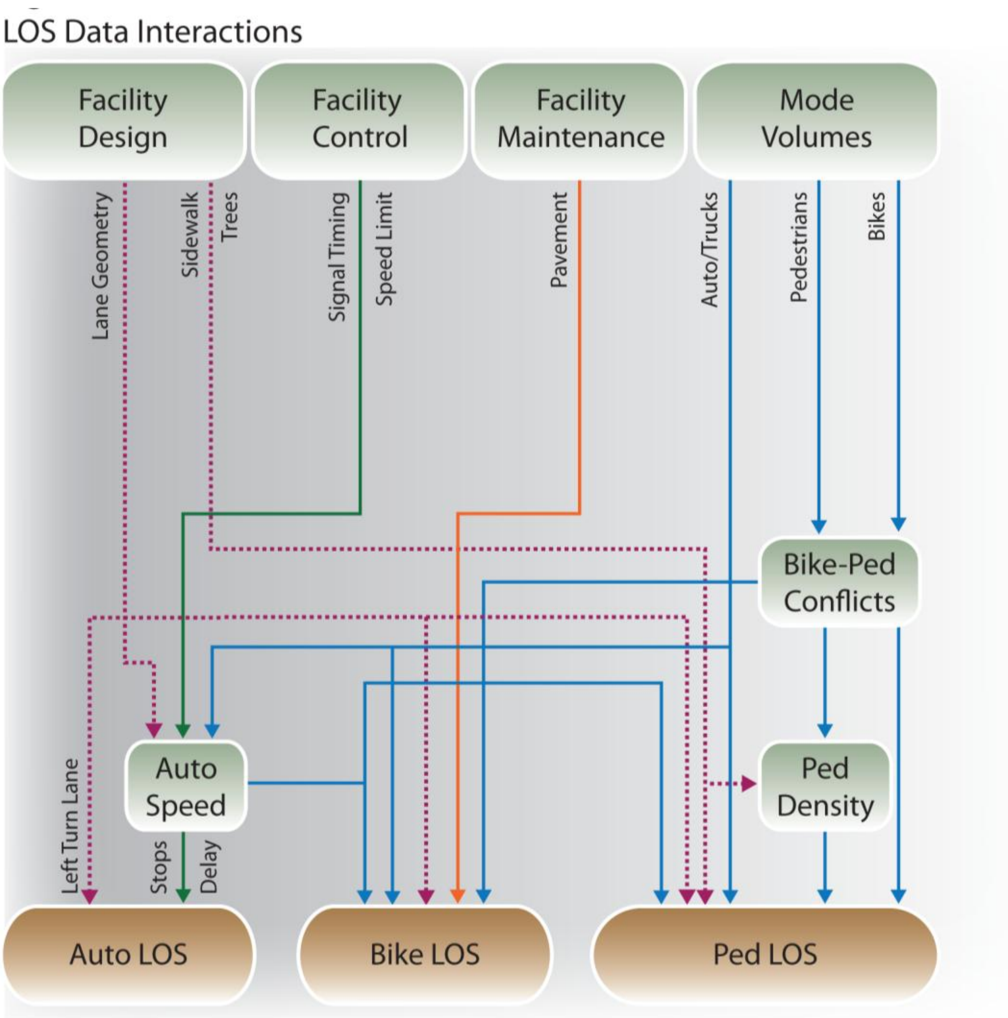
[1] These methodologies will also be included in the upcoming 2010 update to the *Highway Capacity Manual.*

CHAPTER 2. METHODOLOGY

A report by the National Cooperative Highway Research Program (NCHRP) Project 3-70 defines the methodologies to calculate MMLOS for auto, bicycle, transit, and pedestrian modes along roadway segments. These methods were applied to a set of major arterial roadways in the City of Tukwila to calculate LOS for pedestrian, bicycle, and auto modes. Although transit LOS is included in the MMLOS methodology, it was not calculated in this analysis as the City has no control over the transit service provided by King County Metro and Sound Transit. While LOS is determined independently for each mode, it is important to recognize variables that improve the LOS of one mode may worsen the LOS for another mode. For example, widening an intersection may improve auto LOS by reducing delay but worsen pedestrian and bicycle LOS by increasing crossing distances and exposure to conflicting vehicles. Thus balancing LOS by modes becomes a challenge, and in some cases it may be more appropriate to identify corridors that favor one mode over another to avoid creating a situation where all modes perform poorly. The diagram below highlights the interaction of the MMLOS data.



As described in Deliverable #1, the City of Tukwila identified 67 arterial study segments for MMLOS evaluation. In order to complete the MMLOS analysis for each mode, data were collected in both directions of the study segments. The data inputs for the MMLOS computation are summarized in Table 1. Due to construction activities and road closures, we were not able to collect data in the newly annexed southern portion of Tukwila, and these segments were not analyzed. In total, MMLOS was computed for 118 directional segments.

In accordance with MMLOS methodology, each segment must begin and end at a signalized intersection. While this was not the case for several of the designated segments, certain assumptions were made and are included in Attachment B. A summary of data sources that were used in the MMLOS calculations is provided in Attachment A.

TABLE 1 – MULTIMODAL LEVEL OF SERVICE DATA INPUT REQUIREMENTS

Data	Auto LOS	Bicycle LOS	Pedestrian LOS
Street Geometry			
Number of directional through lanes	X	X	X
Travel lane widths (feet)		X	X
Median width (if present, in feet)		X	
Bike lane width (if present, in feet)		X	X
Shoulder width (if present, in feet)		X	X
Planter strip width (if present, in feet)			X
Presence of barrier in planter strip (yes/no)			X
Sidewalk width (if present) (feet)			X
Presence of left hand turning lane(s) at intersections (yes/no)	X		
Length of analysis segment (feet)	X	X	X
Presence of right turn channelization islands at intersections (yes/no)			X
Number of cross-street through lanes at intersections			X
Cross-street curb to curb length (feet)		X	
Number of unsignalized intersections and driveways (per mile)	X	X	
Pavement condition (1-5 scale)		X	
Demand			
Intersection vehicle turning movements (vehicles per hour)	X	X	X
Vehicle right turn on red volume (vehicles per hour)			X
Vehicle peak hour factor (PHF)	X	X	X
Percent heavy vehicles		X	
Percent of on-street parking occupied		X	X
Intersection Control			
Saturation flow rate through lanes (vehicles per lane per hour)	X		
Green time per cycle for through movement (percentage)	X		X
Cycle length (seconds)	X		X
Quality of signal progression (1-5 scale)	X		
Speed limit (miles per hour)	X	X	X
Cross street speed limit (miles per hour)			X

Source: Fehr & Peers 2011

LOS DEFINITIONS

This section provides a qualitative description of how NCHRP Project 3-70 defines LOS for auto, bicycle, and pedestrian modes. The full equations necessary to compute MMLOS are complex and are not included in this report. Refer to the NCHRP documentation for additional details.

Auto LOS

Auto LOS is based on the average number of stops per mile and the presence of left turn lanes at signalized and unsignalized intersections along the roadway segment. Stops per mile are calculated using the volume to capacity (v/c) ratio and signal progression[2] of the through movement at the segment's downstream intersection. With the exception of the presence of left-turn lanes at unsignalized intersections along the segment, auto LOS is completely dependent on the characteristics of the intersection located at the downstream end of the roadway segment. Roadway characteristics such as lane width or presence of street trees are not included in the methodology.

Bicycle LOS

Bicycle LOS is a weighted average of study segment LOS and intersection LOS. Bicycle segment LOS is based on vehicle volume, vehicle speed, number of lanes, percent heavy vehicles, parking conditions, lane and shoulder widths, pavement quality, and number of unsignalized conflicts[3]. Bicycle intersection LOS is based on vehicle volumes, bicycle crossing distance, and lane geometries. Bicycle LOS is not influenced by grades or other factors that may increase the physical difficulty of bicycling.

Pedestrian LOS

Pedestrian LOS is influenced by vehicle speed and volume, parking conditions, sidewalk width, buffer and barrier presence[4], shoulder or bike lane width, sidewalk and intersection geometry, and cross street speed and volume. Similar to bicycle LOS, pedestrian LOS is based on a weighted average of the segment and intersection LOS. Due to the nature of different modes of travel, appropriate scale of segments for automobile and bicycle LOS may not coincide with that of pedestrian travel. For this reason, a set of smaller segments were created for pedestrian LOS analysis.

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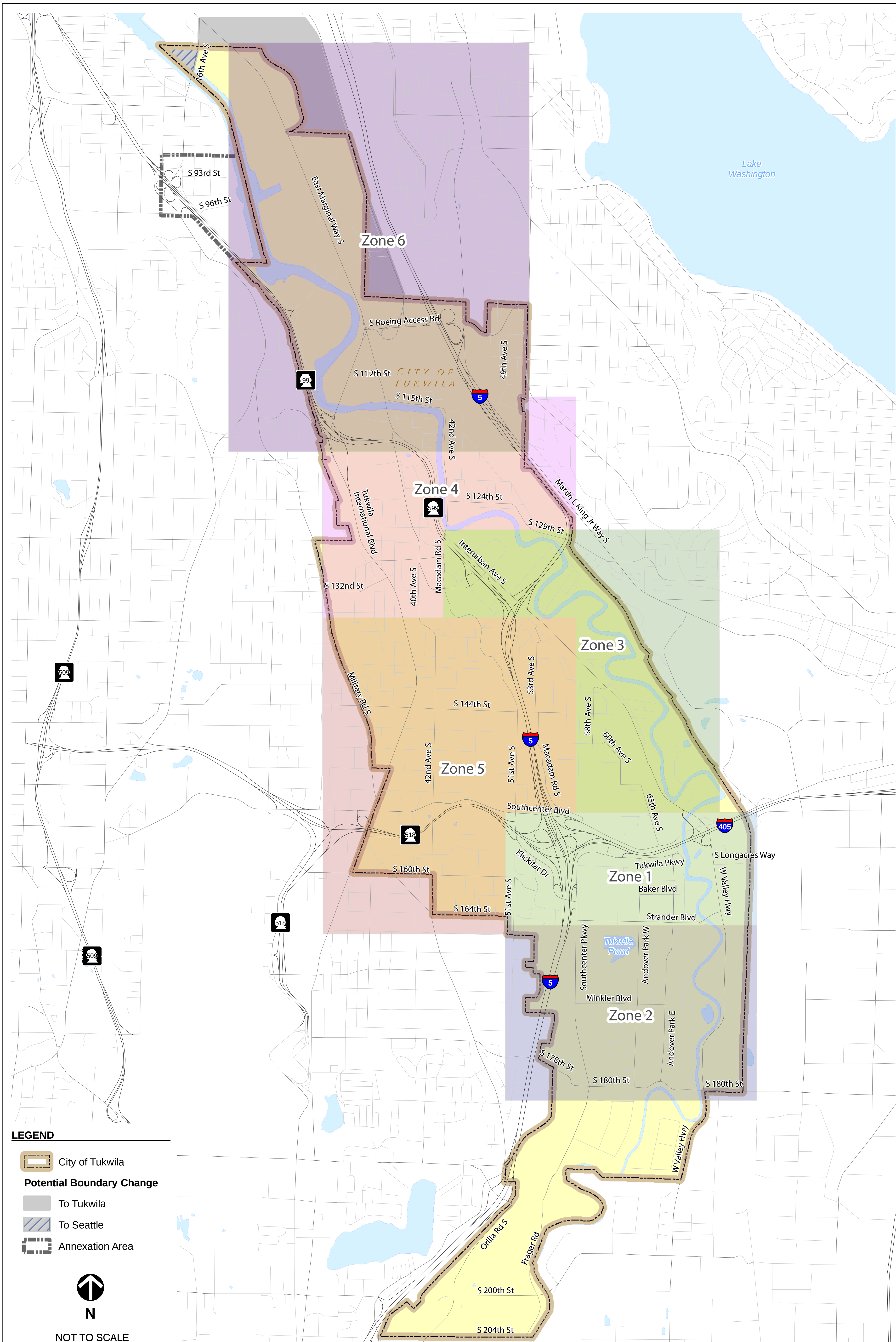
[2] Signal progression is a term from the Highway Capacity Manual, which describes the quality of signal coordination on a one to five scale. Signal progression of one represents very poor progression where vehicles are stopped by most traffic signals, while five represents exceptional progression where vehicles can proceed along a corridor with few stops or delays.

[3] Unsignalized conflicts are defined as unsignalized side street and driveway intersections.

[4] A buffer is an area (typically landscaped) between the edge of the sidewalk and the edge of the roadway. A barrier is a design feature that physically separates the pedestrians from the traffic stream. A barrier can be a railing, a low wall, or a row of closely spaced trees.

CHAPTER 3. RESULTS

Using the methodologies described above, MMLOS was determined for auto, bicycle, and pedestrian modes on the study segments in Tukwila. The study area was divided into six zones, as shown in Figure 1. The results are shown in Figures 2-7. Each figure number has three components-A showing auto LOS, B showing bicycle LOS, and C showing pedestrian LOS.



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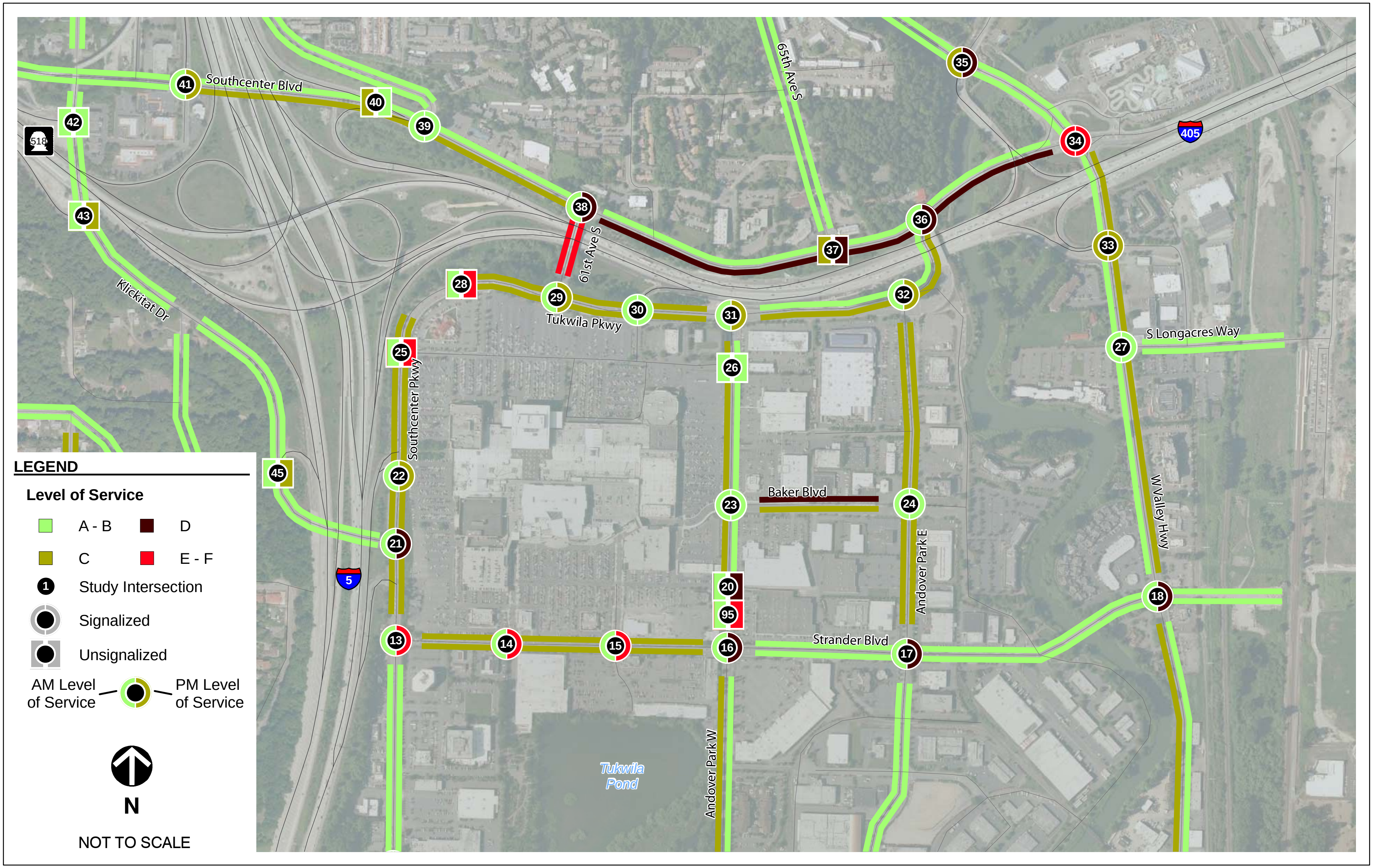
CITY OF TUKWILA - KEY MAP (ZONES)

FIGURE 1



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CITY OF TUKWILA - INTERSECTION AND ROADWAY AUTOMOBILE LEVEL OF SERVICE (ZONE 1)

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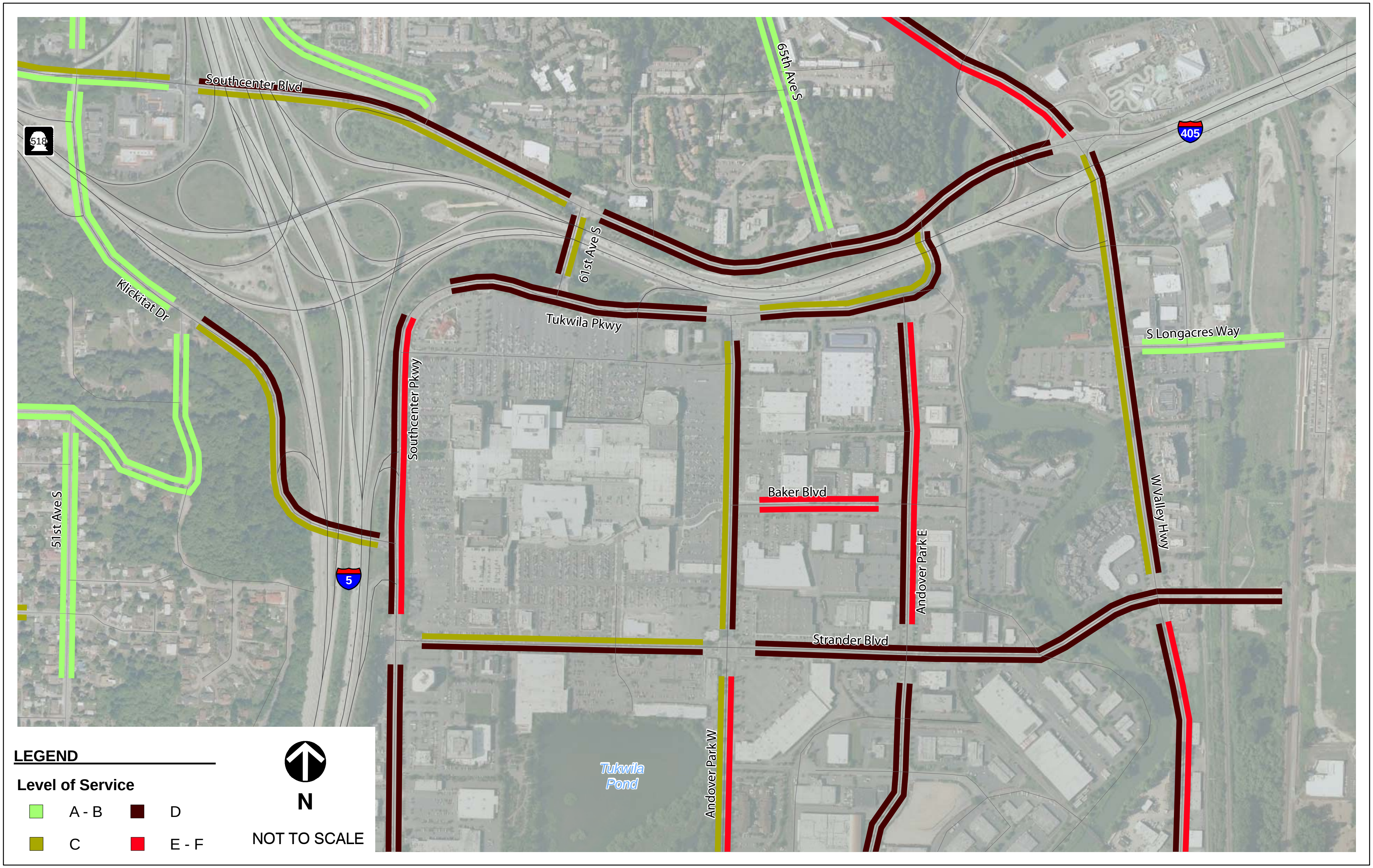
FIGURE 2A



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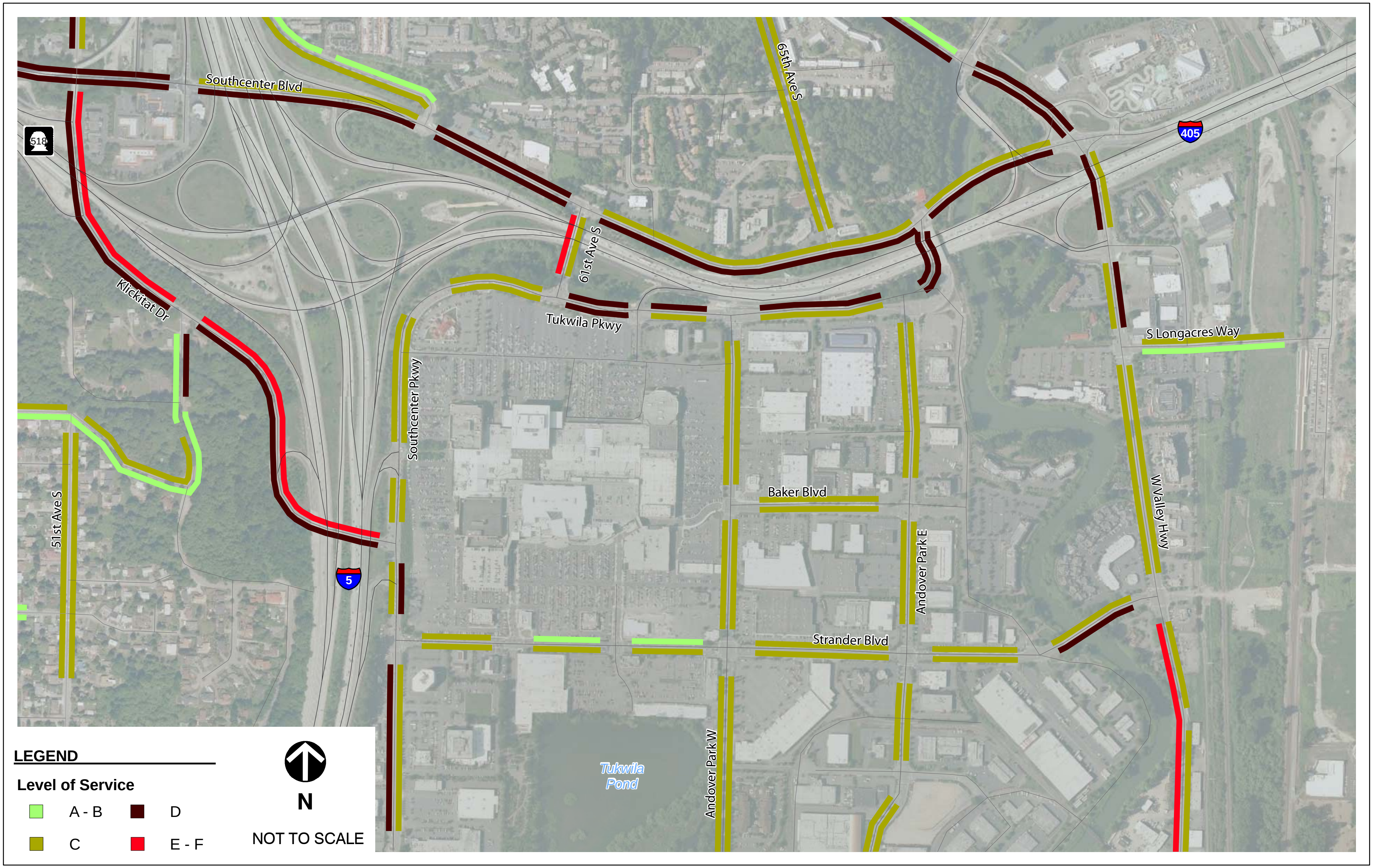
CITY OF TUKWILA - BICYCLE LEVEL OF SERVICE (ZONE 1)

FIGURE 2B



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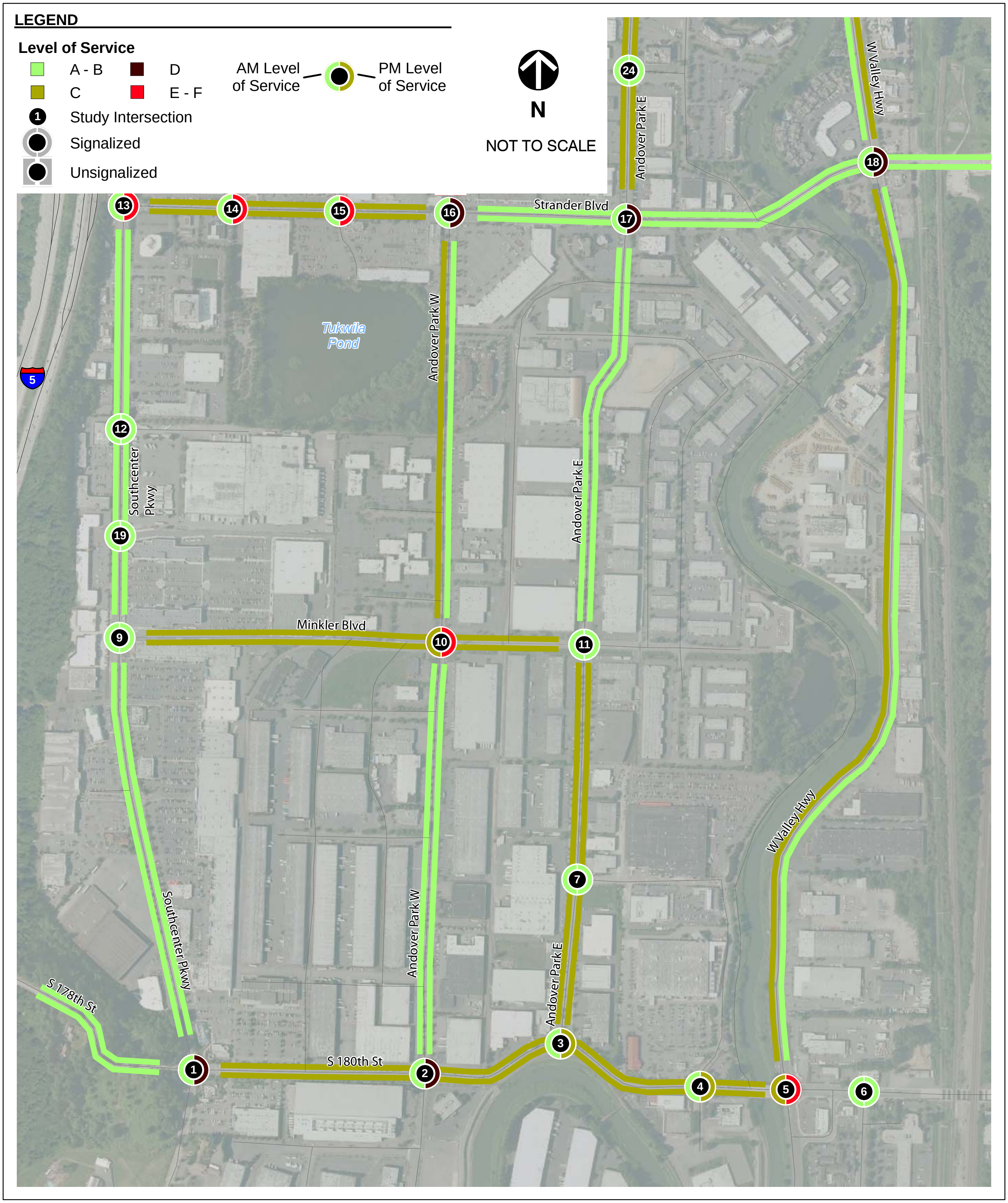
CITY OF TUKWILA - PEDESTRIAN LEVEL OF SERVICE (ZONE 1)

FIGURE 2C



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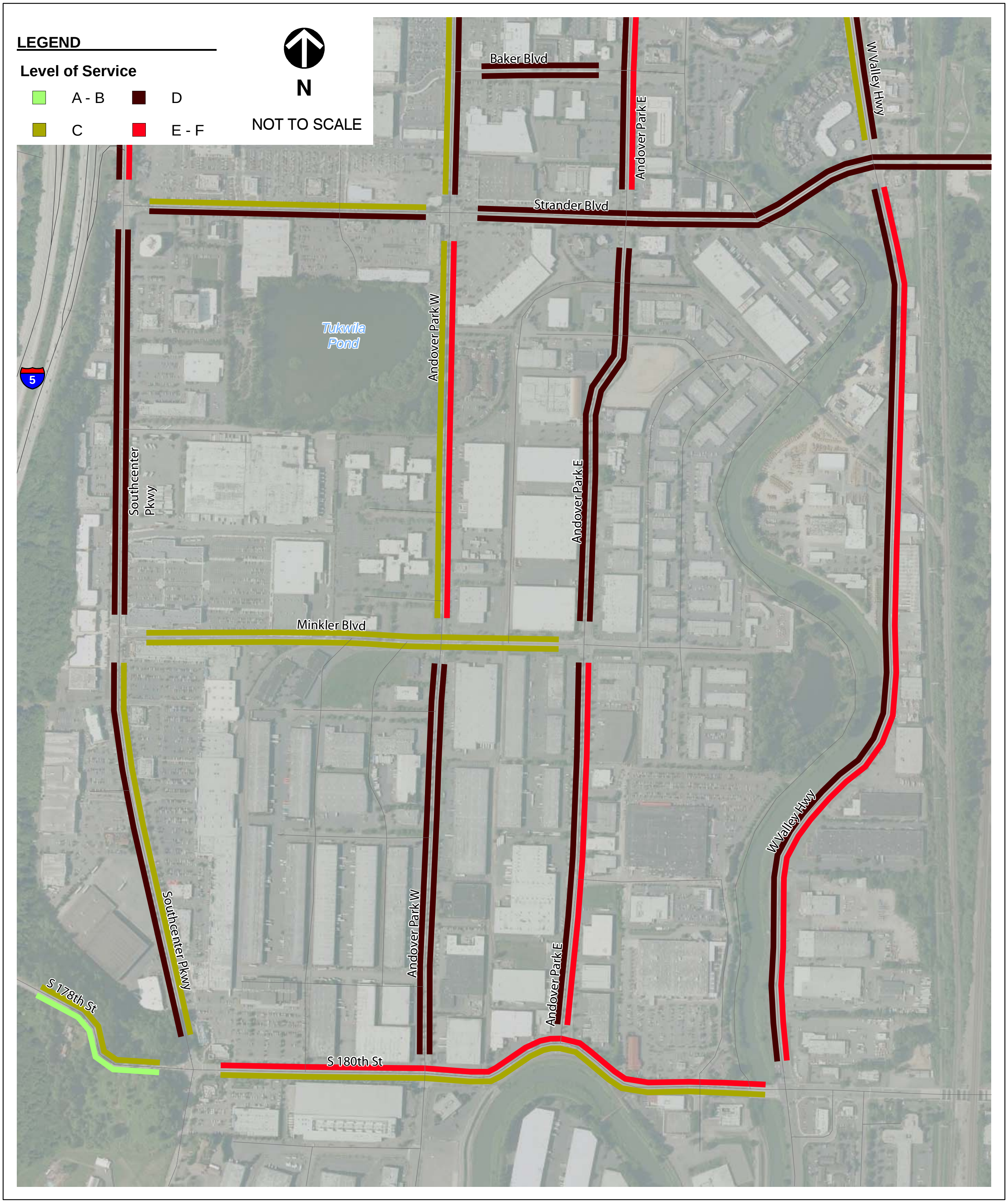
CITY OF TUKWILA - INTERSECTION AND ROADWAY AUTOMOBILE LEVEL OF SERVICE (ZONE 2)

FIGURE 3A



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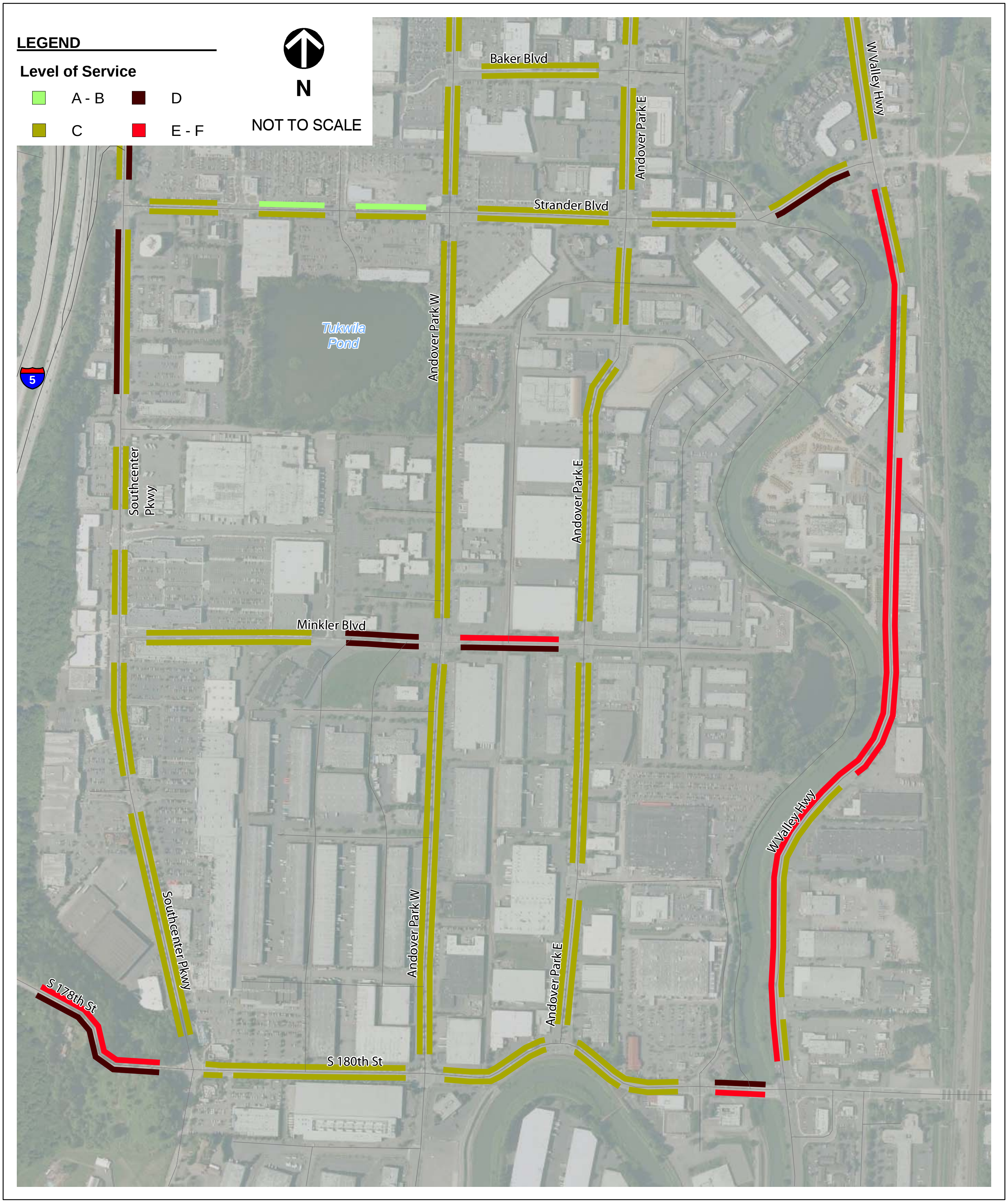
CITY OF TUKWILA - BICYCLE LEVEL OF SERVICE (ZONE 2)

FIGURE 3B



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CITY OF TUKWILA - PEDESTRIAN LEVEL OF SERVICE (ZONE 2)

FIGURE 3C

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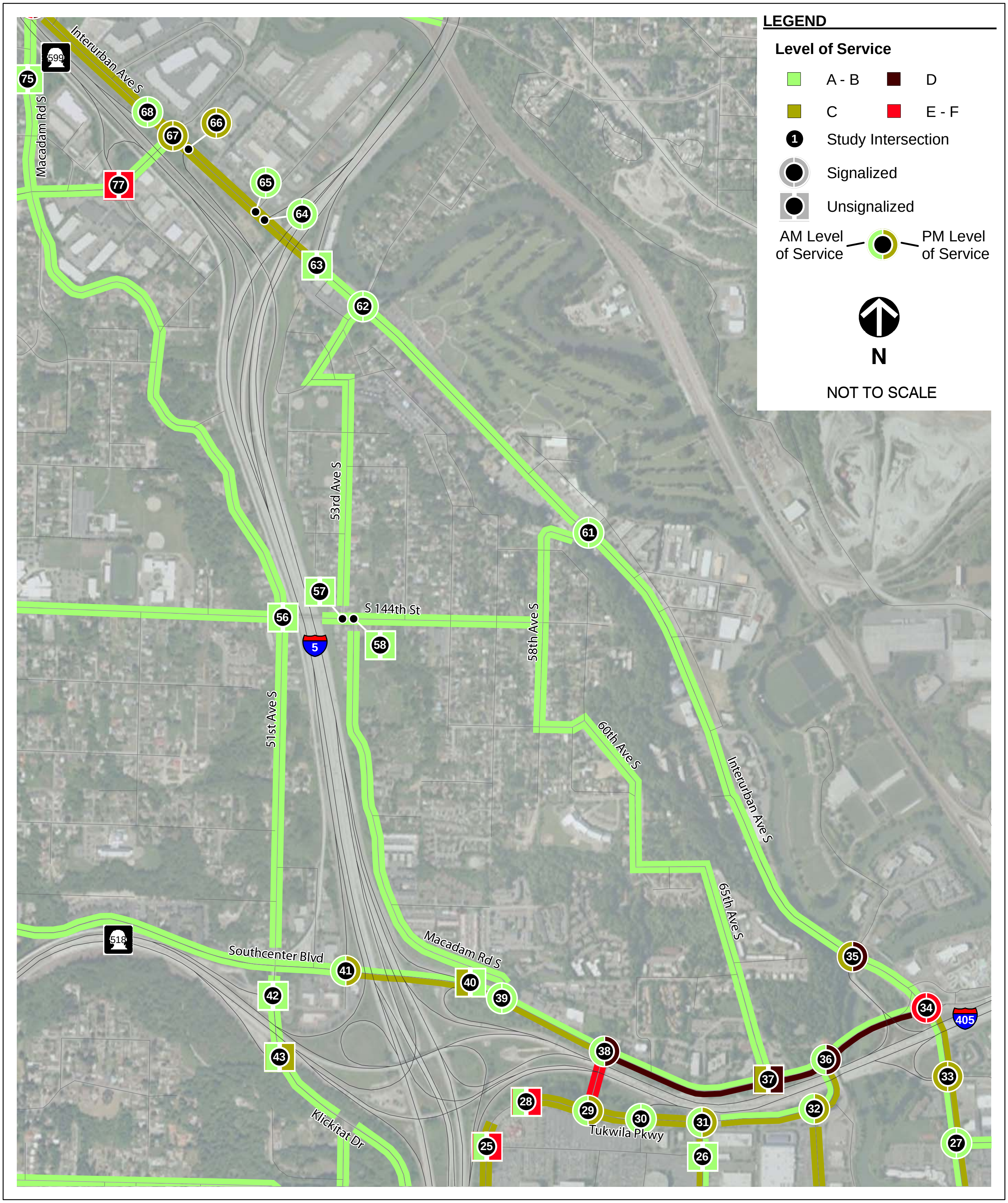

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CITY OF TUKWILA - INTERSECTION AND ROADWAY AUTOMOBILE LEVEL OF SERVICE (ZONE 3)

FIGURE 4A

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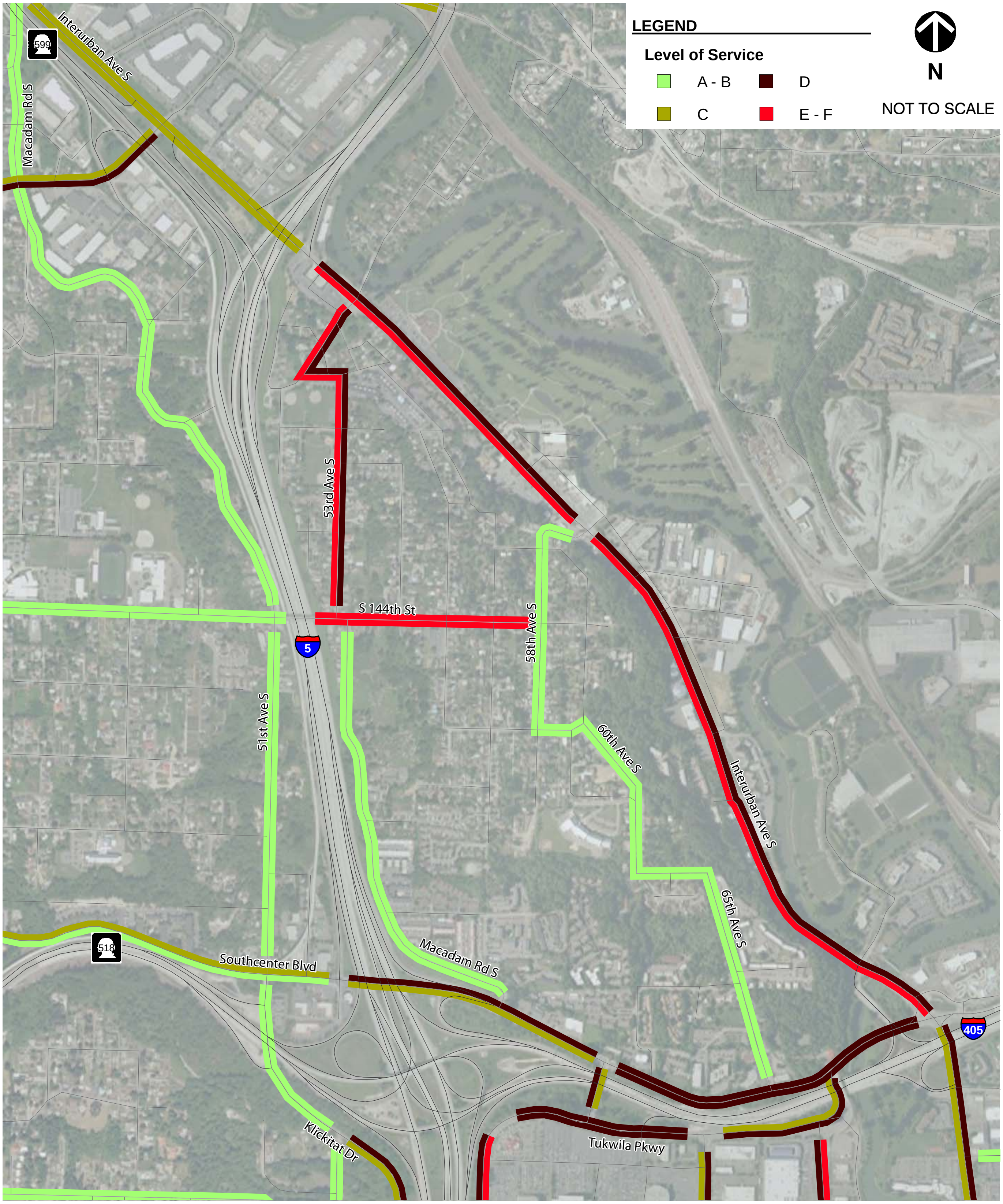

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CITY OF TUKWILA - BICYCLE LEVEL OF SERVICE (ZONE 3)

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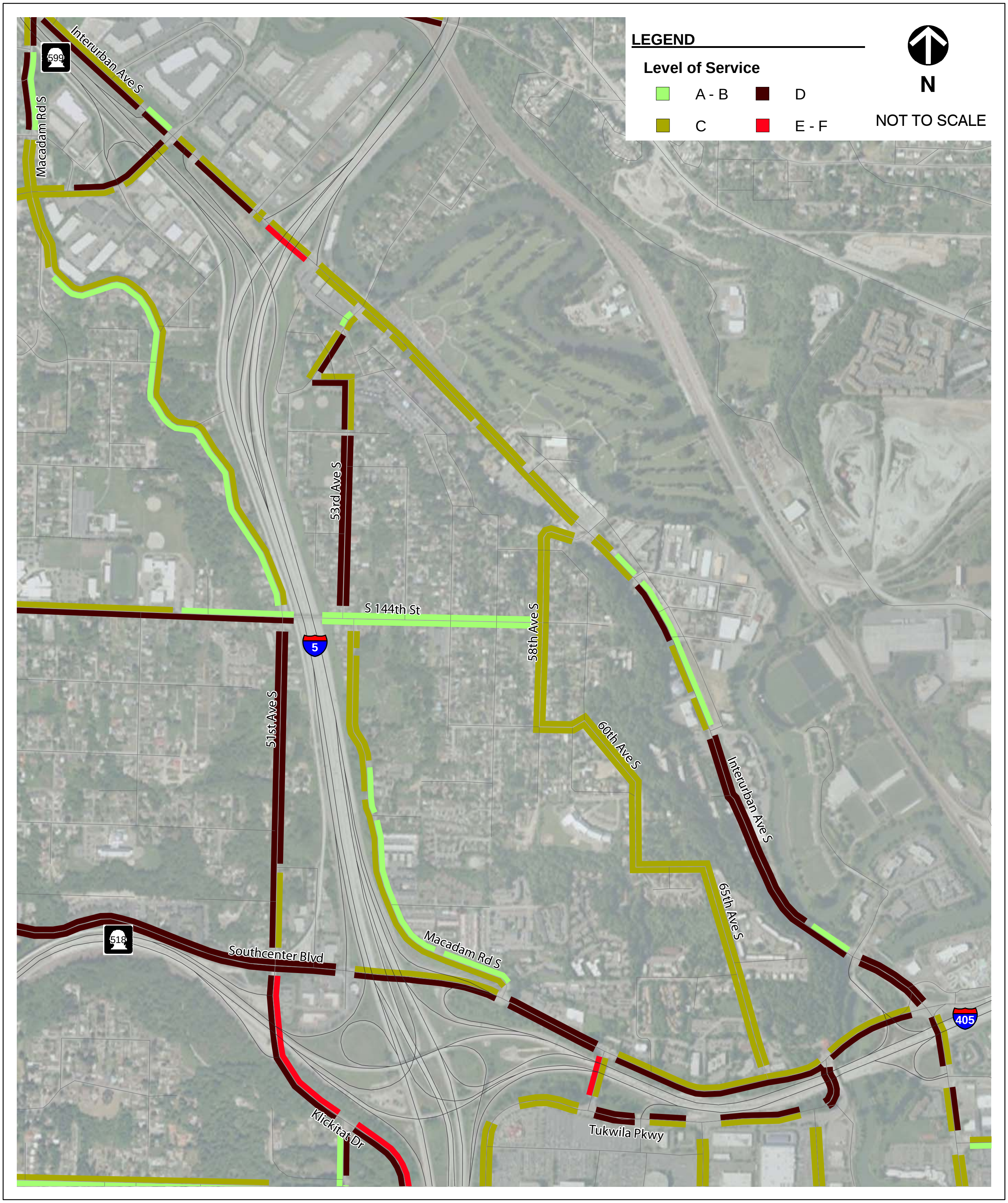
FIGURE 4B



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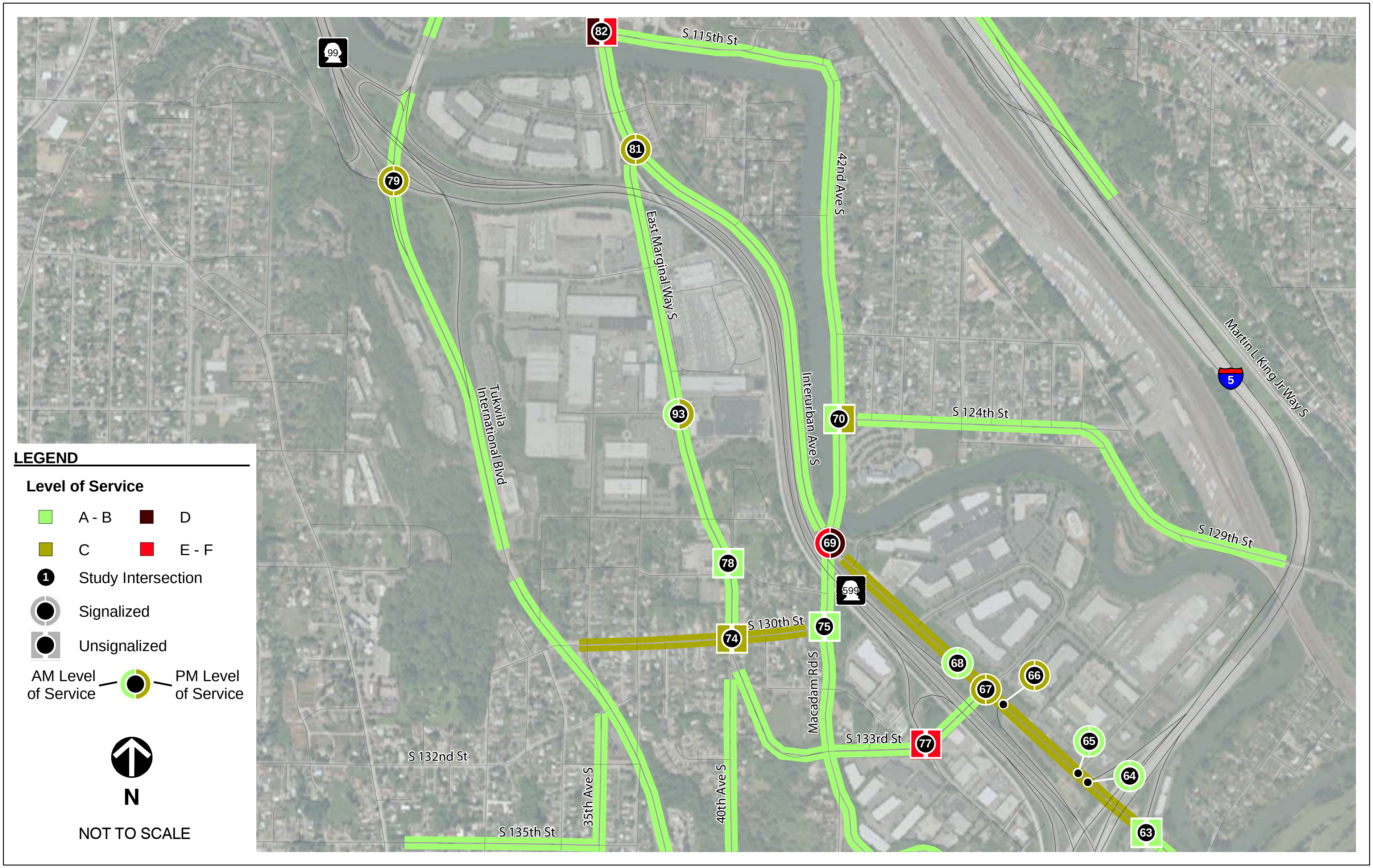
CITY OF TUKWILA - PEDESTRIAN LEVEL OF SERVICE (ZONE 3)

FIGURE 4C



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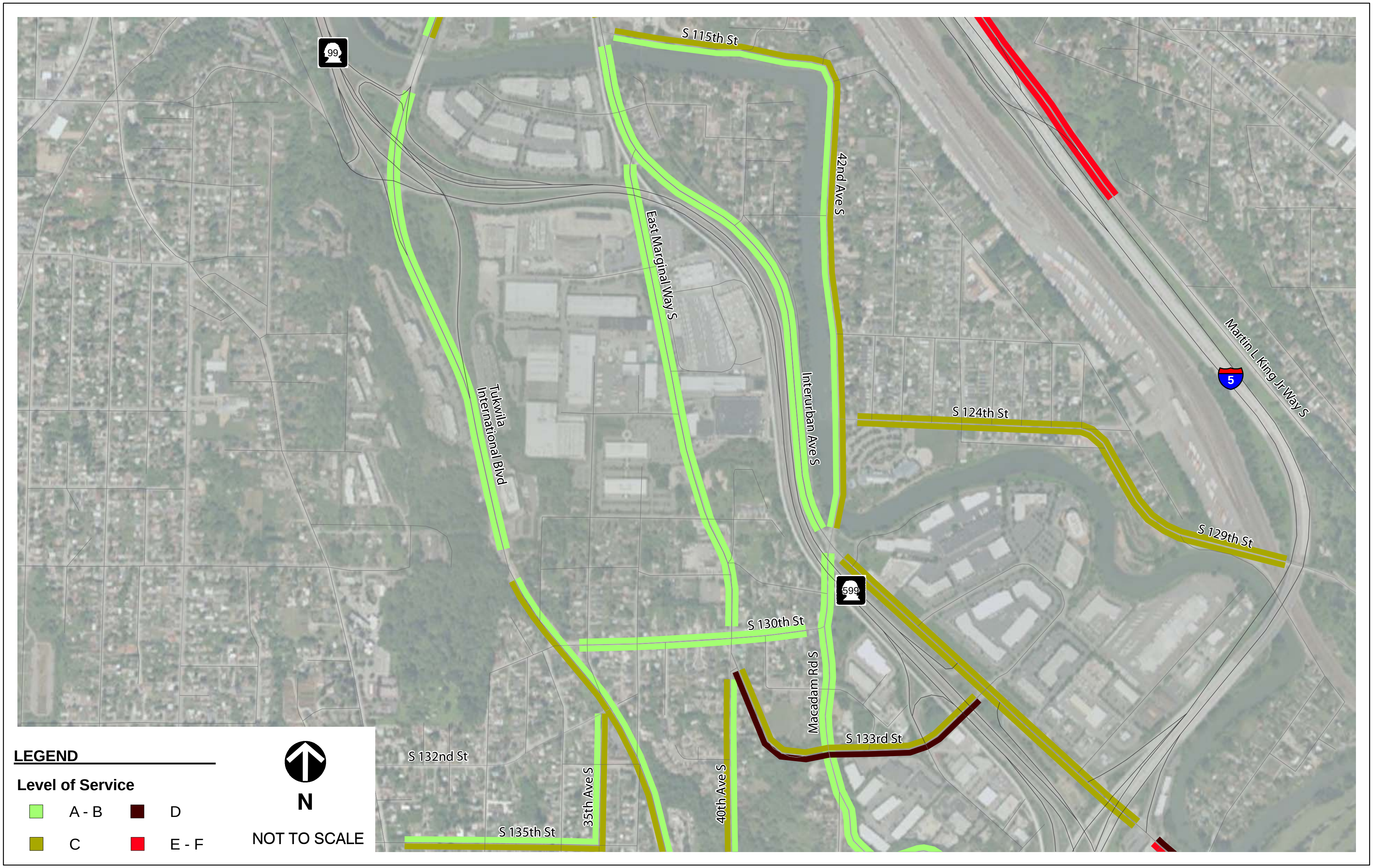
CITY OF TUKWILA - INTERSECTION AND ROADWAY AUTOMOBILE LEVEL OF SERVICE (ZONE 4)

FIGURE 5A



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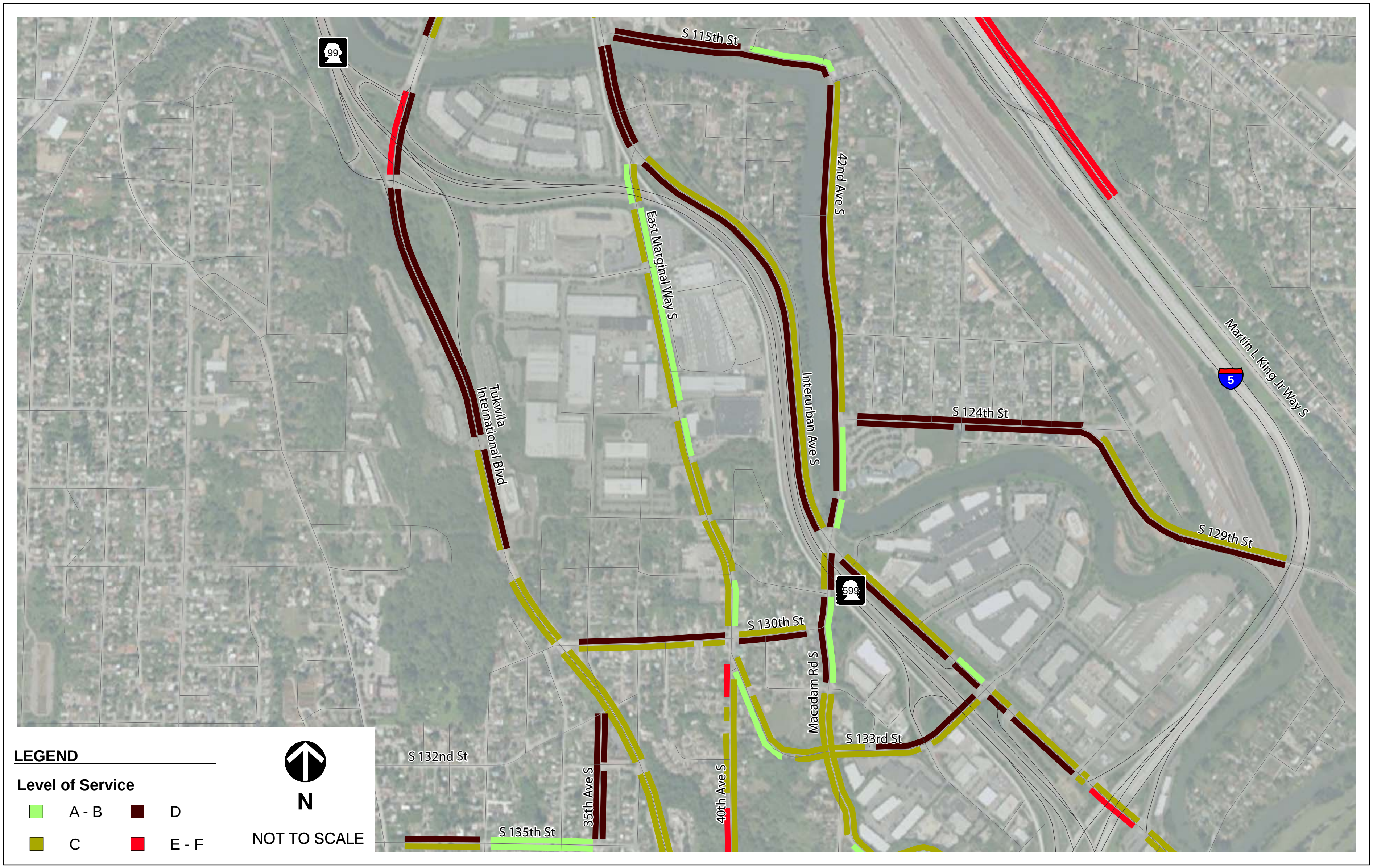
CITY OF TUKWILA - BICYCLE LEVEL OF SERVICE (ZONE 4)

FIGURE 5B



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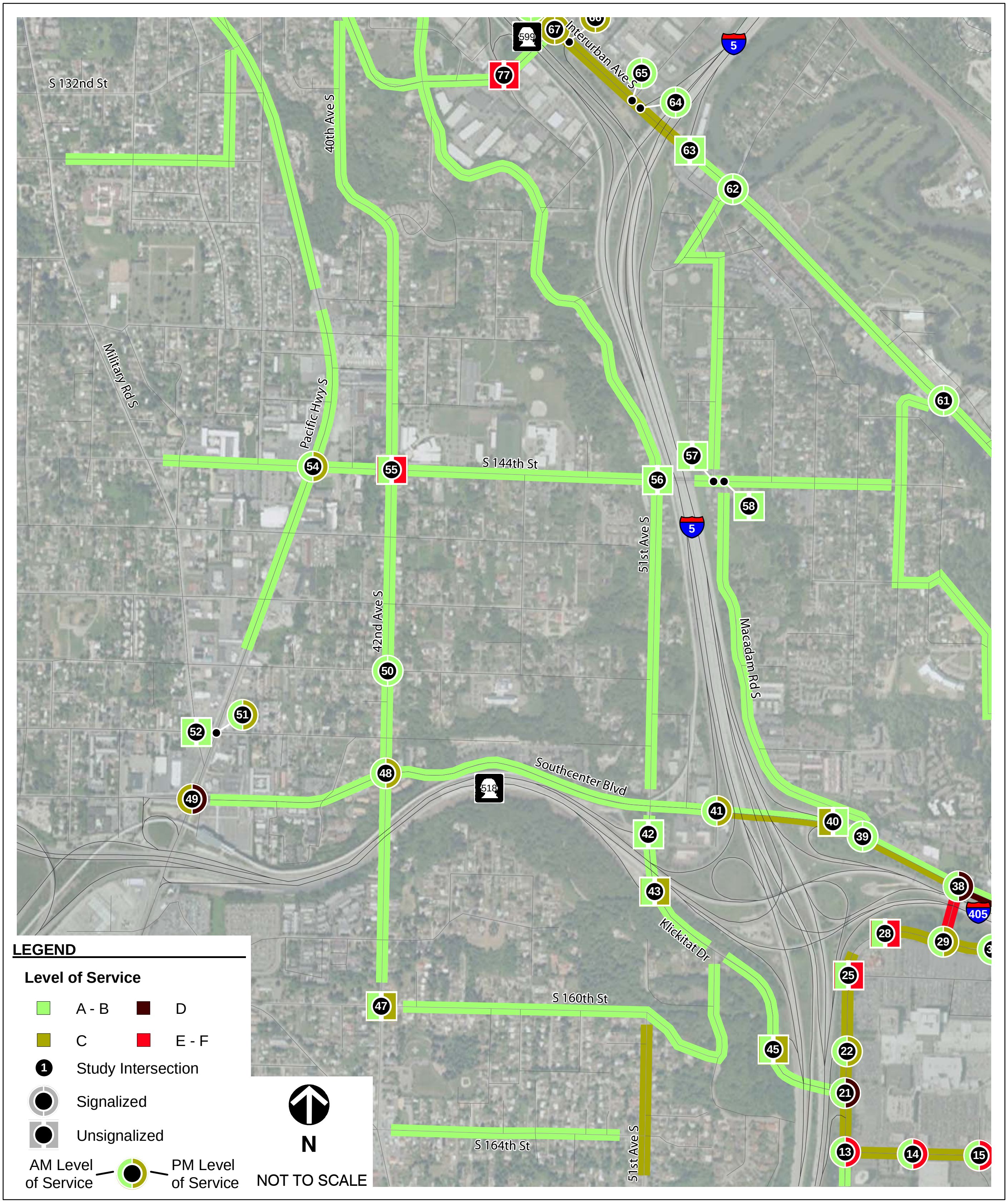
CITY OF TUKWILA - PEDESTRIAN LEVEL OF SERVICE (ZONE 4)

FIGURE 5C



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CITY OF TUKWILA - INTERSECTION AND ROADWAY AUTOMOBILE LEVEL OF SERVICE (ZONE 5)

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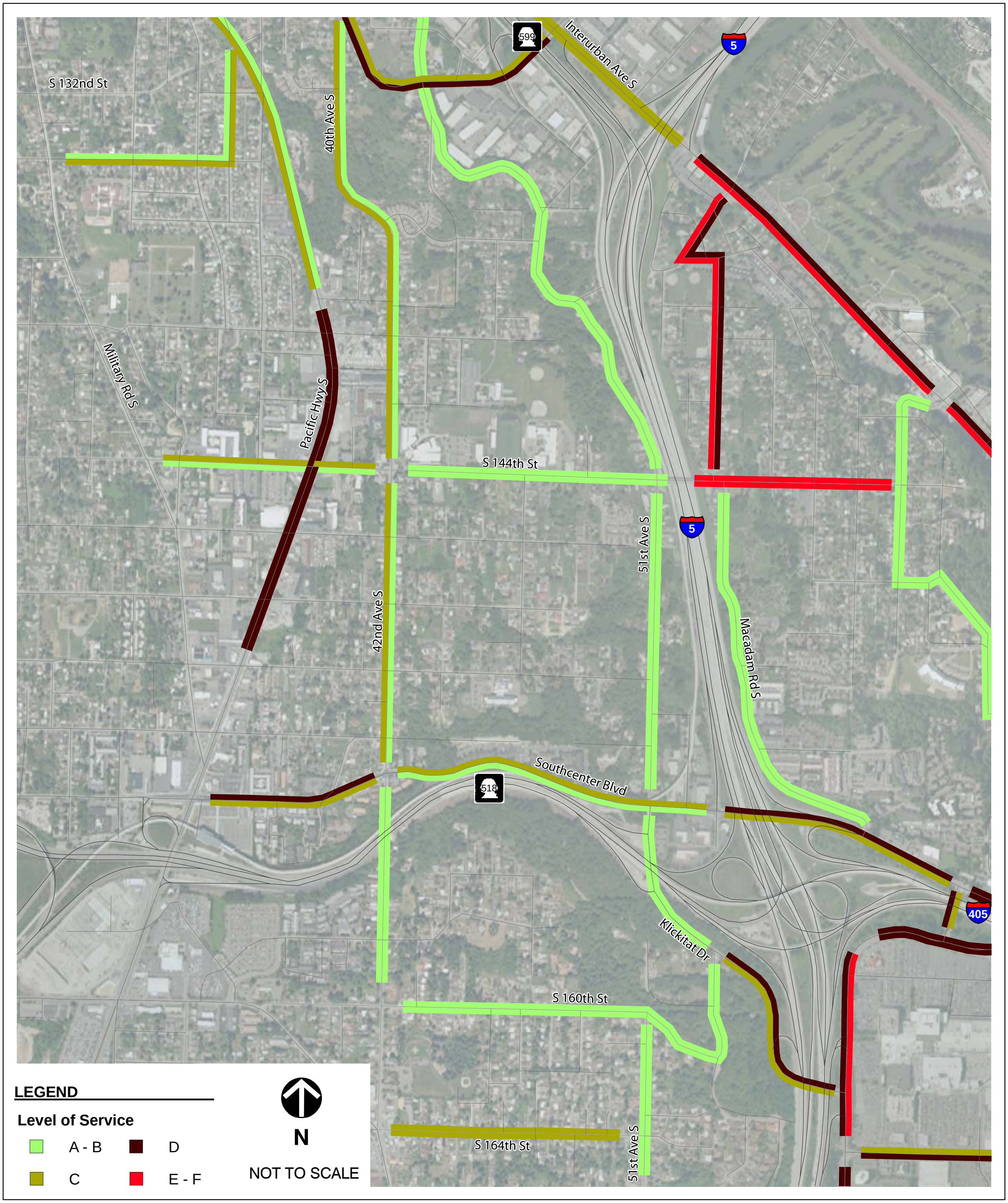
FIGURE 6A



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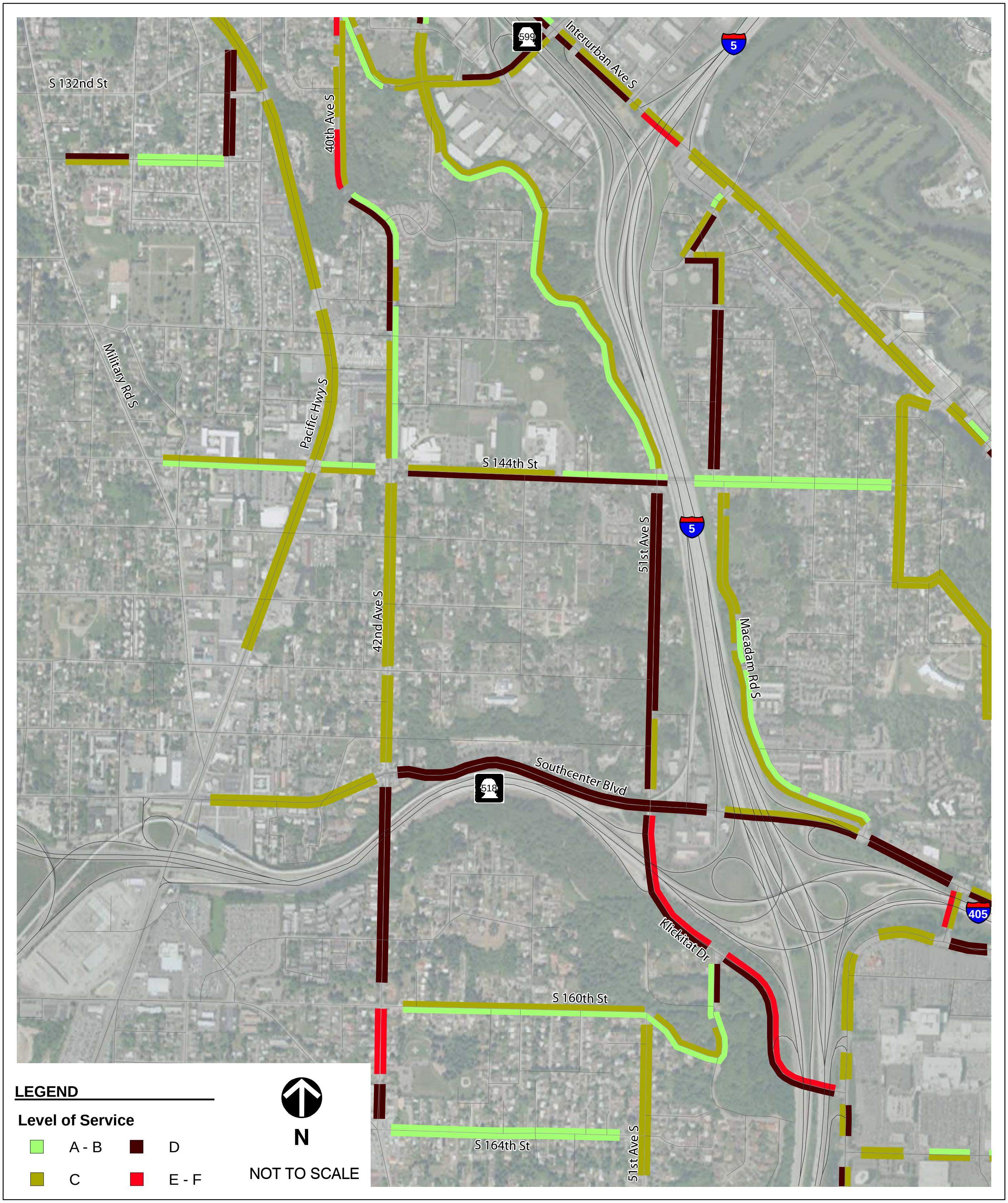
CITY OF TUKWILA - BICYCLE LEVEL OF SERVICE (ZONE 5)

FIGURE 6B



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CITY OF TUKWILA - PEDESTRIAN LEVEL OF SERVICE (ZONE 5)

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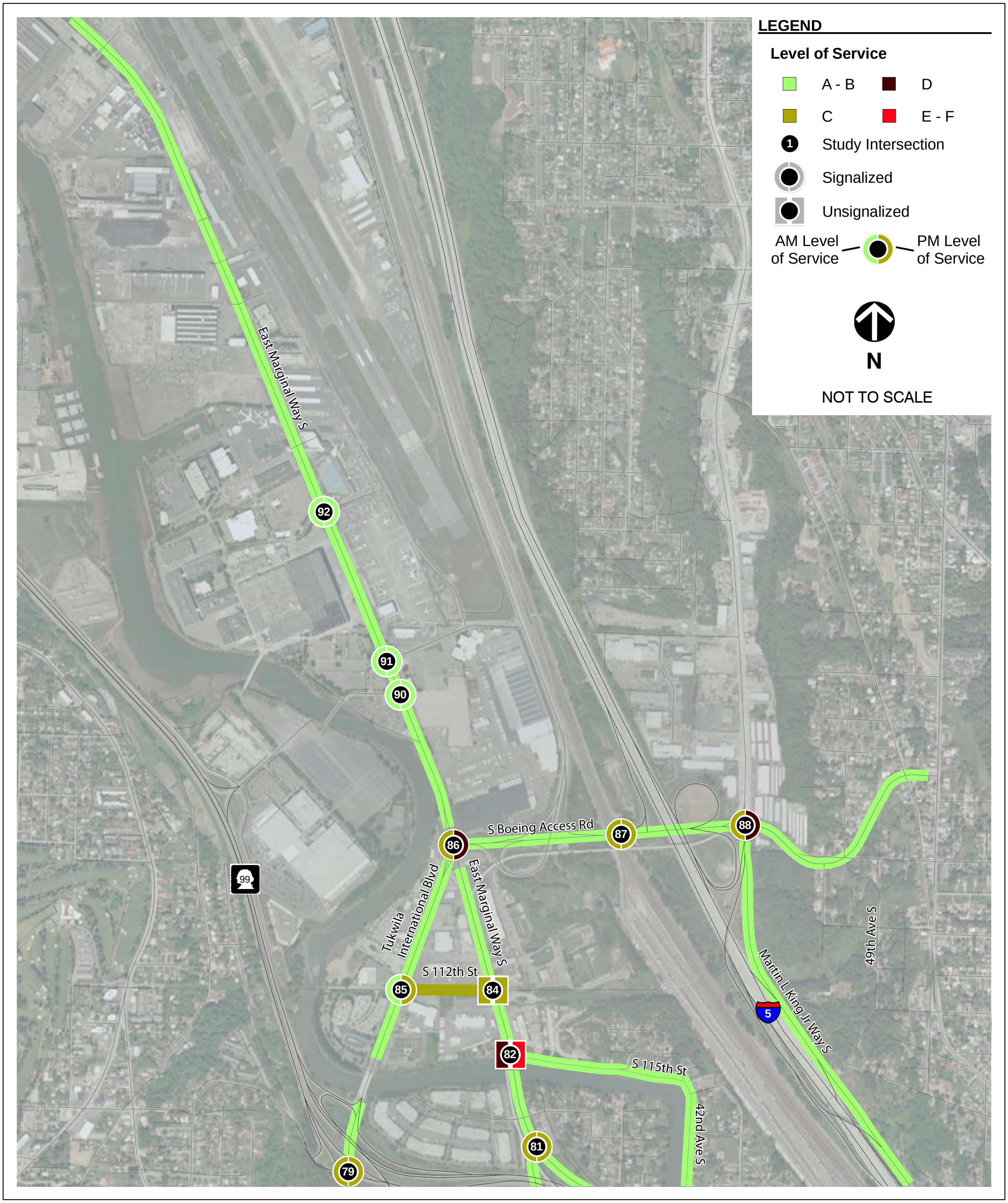
FIGURE 6C



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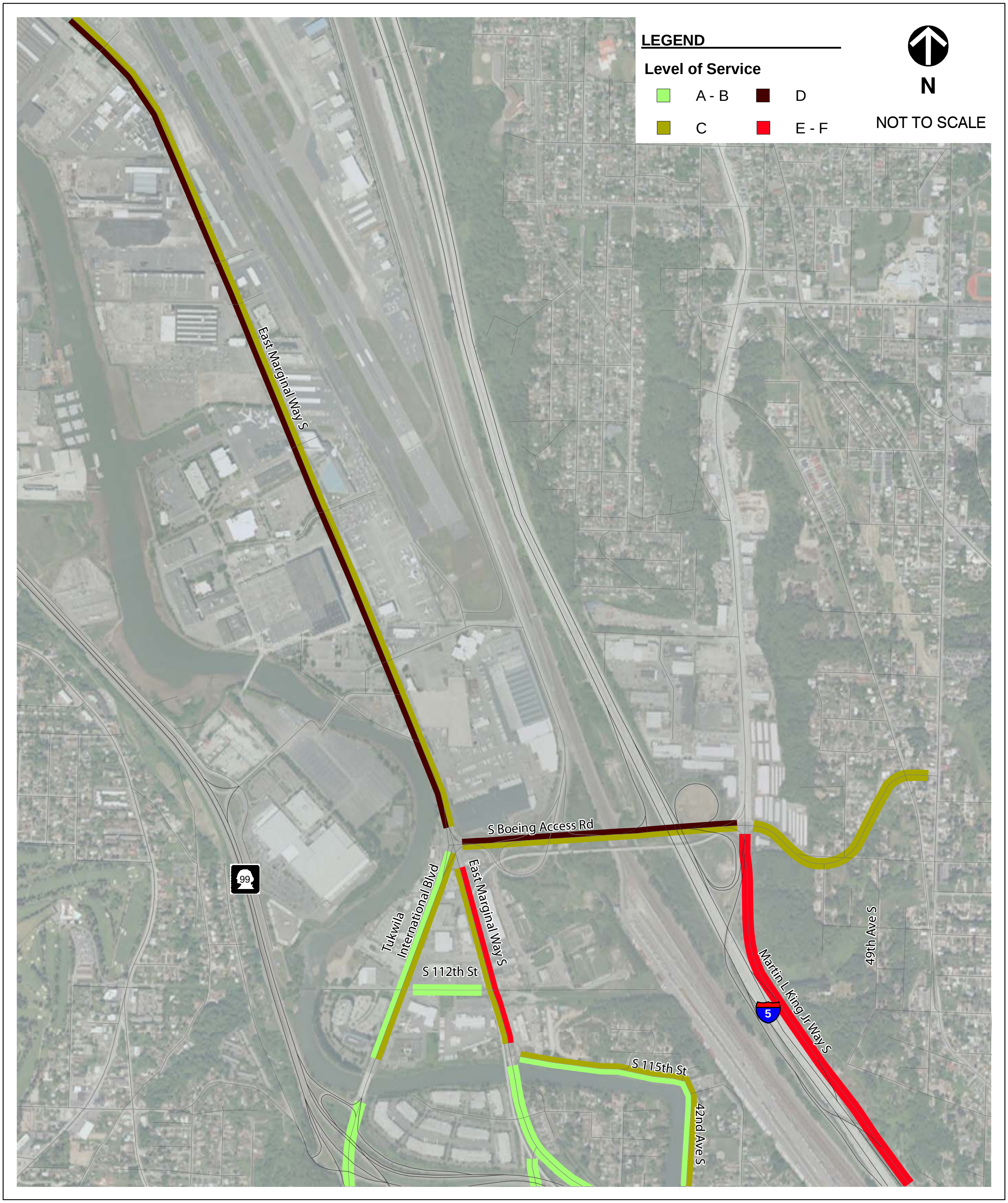
CITY OF TUKWILA - INTERSECTION AND ROADWAY AUTOMOBILE LEVEL OF SERVICE (ZONE 6)

FIGURE 7A



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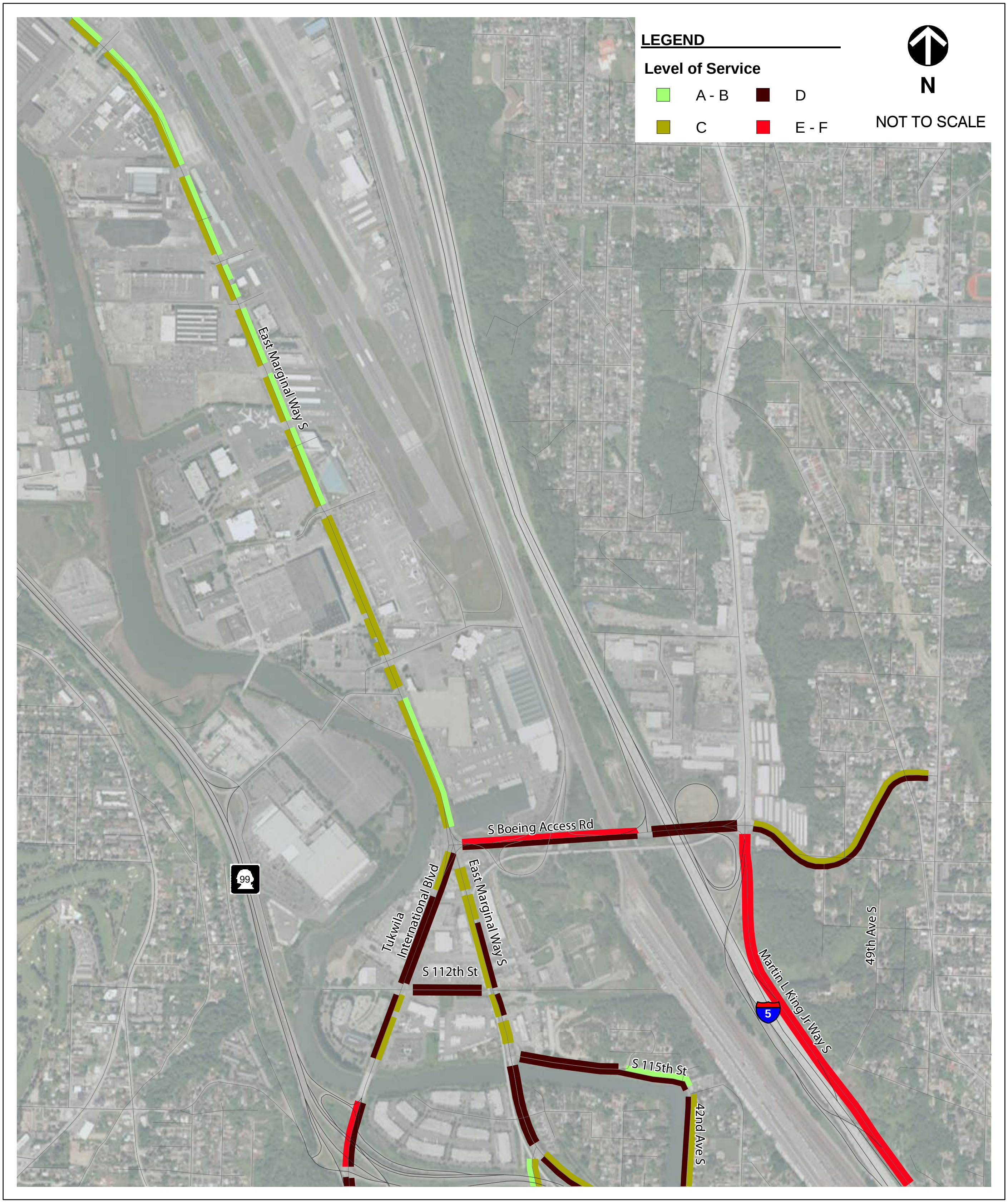
CITY OF TUKWILA - BICYCLE LEVEL OF SERVICE (ZONE 6)

FIGURE 7B



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CITY OF TUKWILA - PEDESTRIAN LEVEL OF SERVICE (ZONE 6)

FIGURE 7C

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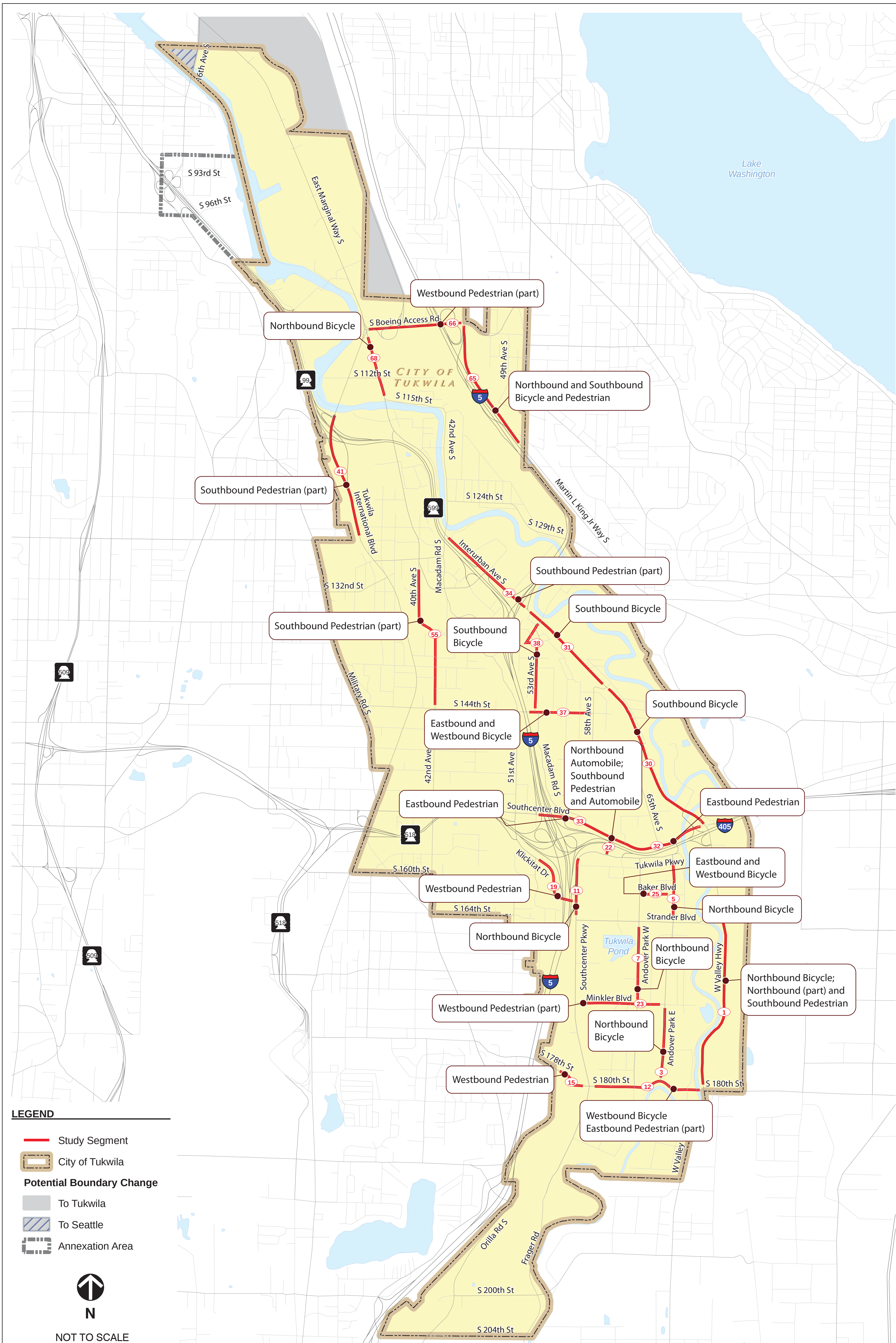
LOS E/F SEGMENTS

For the purposes of this study, segments in the City of Tukwila receiving an LOS of either E or F were considered to be performing poorly. The poorly performing segments and modes are summarized in Table 2 and shown in Figure 8.

TABLE 2 – LOS E/F SEGMENTS

Segment (Direction)	From	To	Auto LOS	Bike LOS	Pedestrian LOS
West Valley Highway (NB)	S 180th Street	Strander Boulevard		X	X
West Valley Highway (SB)	Strander Boulevard	S 180th Street			X
Andover Park East (NB)	S 180th Street	Minkler Boulevard		X	
Andover Park East (NB)	Strander Boulevard	Tukwila Parkway		X	
Andover Park West (NB)	Minkler Boulevard	Strander Boulevard		X	
Southcenter Parkway (NB)	Strander Boulevard	Northwest Mall Entrance		X	
S 180th Street (WB)	West Valley Highway	Southcenter Parkway		X	
S 180th Street (EB)	West Valley Highway	Southcenter Parkway			X
Klickitat Drive (EB)	53rd Avenue S	Southcenter Parkway			X
61st Avenue S (SB)	Southcenter Parkway	Southcenter Boulevard	X		
61st Avenue S (NB)	Southcenter Boulevard	Southcenter Parkway	X		X
Interurban Avenue S (SB)	58th Avenue S	Southcenter Boulevard		X	
Interurban Avenue S (SB)	I-5 NB On-Ramp	58th Avenue S		X	
Interurban Avenue S (SB)	Macadam Rd S	I-5 NB On-Ramp			X
Southcenter Boulevard (EB)	I-5 SB Off-Ramp	61st Avenue S			X
Southcenter Boulevard (EB)	61st Avenue S	West Valley Hwy			X
S 144th Street (EB & WB)	East End of I-5 Overpass	58th Avenue S		X	
53rd Avenue S/ 137th Street/52nd Avenue S (SB)	Interurban Avenue S	S 144th Street		X	
Martin Luther King Jr. Way (NB & SB)	East City Limit	North City Limit		X	X
40th Avenue S (SB)	East Marginal Way	42nd Avenue S			X
Baker Boulevard (EB & WB)	Andover Park West	Andover Park East		X	
Tukwila International Boulevard (SB)	Green River	SR-599 Ramp			X
S 178th Street (WB)	Southcenter Parkway	West City Limit			X
Boeing Access Road (WB)	Martin Luther King Jr. Way	East Marginal Way S			X
East Marginal Way S (NB)	S 115th Street	Boeing Access Road		X	

Source: Fehr & Peers, 2011



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CITY OF TUKWILA - STUDY SEGMENTS WITH A BICYCLE, PEDESTRIAN OR AUTOMOBILE LEVEL OF SERVICE OF 'E' OR 'F'

FIGURE 8

CHAPTER 4. RECOMMENDATIONS

Listed below are a series of preliminary improvement recommendations for each LOS E/F segment.

AUTO LOS E/F

Southbound 61st Avenue S from Southcenter Boulevard to Tukwila Parkway

Currently, the southbound segment of 61st Avenue S has an auto LOS of E. Due to the short distance of this segment and the traffic signal delay at the Tukwila Parkway / 61st Avenue S intersection, the segment has a relatively high number of stops per mile. The number of stops per mile is the most influential variable in calculating auto LOS, so this high value translates into poor auto LOS. Field observations confirm the poor auto LOS findings and indicate that heavy turning movements at the Southcenter Boulevard / 61st Avenue S and Tukwila Parkway / 61st Avenue S intersections cause long queues to form on eastbound Southcenter Boulevard and southbound 61st Avenue S.

In order to relieve some of the queuing that is forming along the southbound 61st Avenue S segment and improve traffic progression on this segment, the traffic signal timing could be improved to coordinate the eastbound right turn movement from Southcenter Boulevard and the southbound left turn movement from 61st Avenue S to Tukwila Parkway. By coordinating these two movements, the average number of stops per mile on the southbound 61st Avenue S segment would be reduced and the auto LOS would improve.

Since changing traffic signal timings could impact the progression on Southcenter Boulevard and Tukwila Parkway, a larger coordinated signal study focusing on both of these corridors should be conducted.

Northbound 61st Avenue S from Tukwila Parkway to Southcenter Boulevard

The auto LOS for the northbound segment of 61st Avenue S is E. Similar to the southbound segment, poor auto LOS is caused by heavy traffic volumes and closely spaced traffic signals that do not favor progression along 61st Avenue S. The auto LOS for this segment could be improved in one of two ways.

1) The 61st Avenue S Bridge could be widened to include three northbound lanes, which would increase the queue storage capacity of the northbound segment and increase the capacity of the Southcenter Boulevard / 61st Avenue S intersection.

2) Traffic signal coordination could be improved at the Southcenter Boulevard / 61st Avenue S and Tukwila Parkway / 61st Avenue intersections to favor northbound and southbound movements across the 61st Avenue S bridge. The progression for the movement along this segment is poor, as vehicles moving north through the Tukwila Parkway / 61st Avenue S intersection are usually met with a red signal at the Southcenter Boulevard / 61st Avenue S intersection. Coordinating this heavy movement could decrease delay through the segment and improve the auto LOS. As described above, any traffic signal coordination adjustments along 61st Avenue S would require a larger coordinated signal study focusing on the Southcenter Boulevard and Tukwila Parkway corridors.

BICYCLE LOS E/F

Northbound West Valley Highway from S 180th Street to Strander Boulevard

The bicycle LOS along this segment is E. The poor LOS can be attributed to relatively high vehicle speeds and high traffic volumes along with narrow travel lanes and a narrow shoulder. A relatively high percentage of heavy vehicles (16 percent) were also observed on the segment.

Given that West Valley Highway is a major north/south arterial through the City of Tukwila, carrying over 1,200 northbound vehicles during the PM peak hour, a reduction of vehicle capacity in order to accommodate bike lanes is not recommend. Providing additional bicycle capacity through right-of-way acquisition may be difficult as the Green River borders the segment to the west and several businesses border the segment to the east.

Therefore, we recommend that cyclists seeking a northbound or southbound route through this corridor be directed to the Interurban Trail or Green River Trail. Both trails are dedicated bike paths with no vehicular traffic. The Interurban Trail, located east of West Valley Highway is a direct and level route with very few vehicle conflicts. The Green River Trial, located west of West Valley Highway, meanders along the bank of its namesake river and provides a less direct but more scenic option than either West Valley Highway or the Interurban Trail. The Green River Trail is a good option for recreational cyclists who are less concerned with minimizing distance or travel time. No action is recommended for this segment as sufficient parallel bicycle routes exist.

Northbound Andover Park E from S 180th Street to Minkler Boulevard

The bicycle LOS for this segment is E. This poor bicycle LOS is a result of narrow vehicle lanes with no shoulders and a large number of unsignalized conflict points along the corridor. Field observations indicate that many on the businesses along the roadway have multiple driveways accessing Andover Park E.

Bicycle and pedestrian LOS could be improved along this corridor by reducing the number of lanes from four to three, which is commonly known as a “road diet.” The road would be restriped to include one through lane in each direction with a center two-way left turn lane. The remaining roadway width would be restriped to create a bicycle lane in each direction. With average daily traffic volumes along this segment under 10,000 vehicles per day, this three-lane configuration would provide adequate capacity to provide auto LOS of D or better.

In addition to the road diet, we also recommend that an access consolidation study be considered to determine the feasibility of reducing the number of driveways along the corridor. Fewer driveways will reduce the number of unsignalized conflicts, which will improve bicycle LOS. In addition, fewer driveways and a three-lane roadway configuration will provide the opportunity to create landscaped medians, improving the aesthetic quality of the roadway.

Northbound Andover Park E from Strander Boulevard to Tukwila Parkway

The bicycle LOS for this segment of Andover Park E is E. Along this segment, high vehicular volumes, the lack of a shoulder, and a large number of unsignalized conflicts cause the poor LOS.

Consolidating driveway access will lead to an improved bicycle LOS. Several businesses on the east side of the segment have multiple driveways. Reducing access points to one per business would improve the bicycle LOS from E to D.

Bicycle LOS on this corridor could also be improved from E to C with a road diet. However, the average daily traffic volume along this segment is over 13,000 vehicles per day, which could result in a negative impact on auto LOS unless additional lanes are provided at key intersections like at Baker Boulevard and Strander Boulevard. Although road diets along corridors with similar traffic volumes have been successfully implemented in other areas, further studies on this corridor should be considered prior to implementing a lane reduction.

Northbound Andover Park W from Minkler Boulevard to Strander Boulevard

Limited space for cyclists on this four-lane roadway with no shoulders and heavy traffic volumes results in a bicycle LOS of E. The segment also includes a large number of unsignalized conflicts that exacerbate the poor LOS.

Driveway consolidation could be considered as part of a bicycle LOS improvement plan for the corridor. Many businesses along the corridor have multiple access points that could potentially be removed; however an access study is recommended to determine the feasibility of reducing the number of driveways.

A road diet could also improve the bicycle LOS along the corridor. Although this segment serves a relatively high traffic volume (over 13,000 vehicles per day), benefits to pedestrians and cyclists along the corridor may outweigh any degradation in auto LOS. The City should consider further studying the impact of a road diet on this segment, potentially in conjunction with the road diet analysis for Andover Park E between S 180th Street and Tukwila Parkway.

Northbound Southcenter Parkway from Strander Boulevard to Northwest Southcenter Mall Entrance

The NCHRP 3-70 methodology does not accurately reflect the T-intersection geometry along this segment (see Attachment B). However, based on field observations, we estimate that this segment has a bicycle LOS of E. We based the poor LOS on the heavy traffic volumes, lack of shoulders or bike lanes, and the proportion of heavy vehicles traveling on the segment (8.2 percent).

As the Klickitat Drive / Southcenter Boulevard intersection will soon undergo reconstruction, we are recommending that no pedestrian or bicycle improvements be implemented along this segment. Cyclists should seek alternate routes such as Andover Park W.

Westbound S 180th Street from West Valley Highway to Southcenter Parkway

The bicycle LOS for westbound S 180th Street is currently E. High vehicle volumes along with the lack of bicycle facilities such as shoulders or bike lanes lead to the poor LOS.

The bicycle LOS could be improved along this segment by widening the street to provide bicycle lanes; however, businesses and the Green River levee could make any roadway widening costly and technically challenging. Heavy traffic volumes and complex geometric configurations (long crossing distances, dual right turn lanes) at the S 180th Street / Southcenter Parkway and S 180th Street / West Valley Highway intersections also limit the ability to improve bicycle LOS along this segment.

Given the proposed development in the Tukwila South Project area (along Southcenter Parkway, south of S 180th Street), future traffic volumes on S 180th Street will increase, which will further degrade the bicycle, pedestrian, and auto LOS of this corridor. To address the transportation challenges along this segment, a full multimodal access study should be prepared as part of the ongoing Transportation Element update. This multimodal study should consider a variety of enhancements including additional roadway capacity and the development of a parallel pedestrian and bicycle facility.

Southbound Interurban Avenue S from 58th Avenue S to Southcenter Boulevard

The Bicycle LOS for this segment is currently F. Heavy vehicle volumes, a high proportion of trucks, and narrow shoulders are the main factors leading to the poor LOS result. The two intersections analyzed for this segment (Southbound I-405 ramps and Grady Way/Southcenter Boulevard) also contributed to the poor LOS because of the long crossing distances.

Without increasing the width of the roadway, improving the bicycle LOS of the segment is not feasible in the near-term. Considering the high vehicle volumes, a road diet is not recommended in this location. While the Green River Trail parallels this segment, its circuitous routing may be unattractive to commuting cyclists. Cyclists traveling on this corridor increase their trip by over one mile when using the Green River Trail as an alternate route. As part of the Transportation Element update, the feasibility of a long-term strategy to add bike lanes and improve bicycle LOS on this facility should be explored.

Southbound Interurban Avenue S from I-5 NB On-ramp to 58th Avenue S

The bicycle LOS for this segment is currently E. As with the previous segment, high traffic volumes, a high percentage of heavy vehicles, and a lack of shoulders or bicycle lanes are the primary factors contributing to the poor LOS. The segment also has a high number of unsignalized driveways and intersections.

Without increasing the width of the roadway, improving the bicycle LOS of the segment is not feasible. However, the Green River Trail, a non-motorized recreational path, parallels Interurban Avenue along the east side of the road. Cyclists can use the Green River Trail as viable alternate route as it adds no additional distance to their route. To better direct southbound cyclists the Green River Trail, we recommend providing directional signs, potentially at the Interurban Avenue / 48th Avenue S intersection.

Eastbound and Westbound S 144th Street between the I-5 Overpass and 58th Avenue S

These eastbound and westbound segments have a bicycle LOS of E due to poor pavement quality. The city should consider repaving this street. With better pavement quality, these segments would have a bicycle LOS of B.

Southbound 53rd Avenue S / 137th Street / 52nd Avenue S from Interurban Avenue S to S 144th Street

This segment has a bicycle LOS of E due to poor pavement quality. The city should consider repaving this street. With better pavement quality, this segment would have a bicycle LOS of B.

Northbound and Southbound Martin Luther King Jr. Way between the East City Limit and the North City Limit

Martin Luther King Jr. Way has a deficient LOS in both directions for both bicycle and pedestrian modes. The segment, which is located between the Martin Luther King Jr. Way / Boeing Access Road intersection and Tukwila's east city limit, is a limited access highway designed with no bicycle or pedestrian amenities. Providing pedestrian and bicycle facilities along Martin Luther King Jr. Way would require coordination between municipalities. As no businesses or pedestrian or bicycle attractions exist along either side of this segment, no action is recommended at this time.

Northbound East Marginal Way S from S 115th Street to Boeing Access Rd

The bicycle LOS of northbound East Marginal Way between S 115th Street and Boeing Access Road is E. Although this segment has wide shoulders conducive to cyclists, the segment also has a large number of driveways conflicts. These driveway conflicts are responsible for the poor segment LOS.

The City should consider working with the business along the east side of the East Marginal Way to develop an access management strategy. The LOS of this segment would significantly improve with the consolidation of these driveways.

Eastbound and Westbound Baker Boulevard from Andover Park West to Andover Park East

Both eastbound and westbound Baker Boulevard received a Bicycle LOS of F. This poor LOS can be attributed to the lack of a shoulder or bike lane and a high unsignalized conflicts per mile value. With average daily traffic volume well below 10,000, the City should consider studying a 4 to 3 lane conversion or road diet. This would enable bicycle lanes to be placed on either side on the street, improving the bicycle LOS without significantly impacting traffic operations. The City should also consider driveway consolidation as part of their bicycle LOS improvement plan as businesses along the corridor have multiple access points.

PEDESTRIAN LOS E/F

Westbound Klickitat Drive from Southcenter Parkway to 53rd Avenue S

Westbound Klickitat Drive currently has a pedestrian LOS of E. The poor pedestrian LOS is related to the lack of sidewalks and relatively high traffic volumes. It is recommended that no action be taken on improving the pedestrian LOS for this segment as the parallel pedestrian walkway just south of the segment provides adequate pedestrian service.

Southbound 61st Avenue S from Southcenter Boulevard to Tukwila Parkway

The pedestrian LOS for this segment was determined to be E. No pedestrian facilities currently exist along this portion of 61st Avenue S. With no separation between the pedestrian and the travel lanes, along with heavy vehicle volumes, a lack of crosswalks, and multiple turning lanes, pedestrian travel on the west side of the 61st Avenue S bridge is difficult and potentially hazardous.

With heavy vehicle volumes along the segment, reconfiguring the roadway geometry to provide a sidewalk is impractical. In the near-term, pedestrians should be urged to use the sidewalk on the east side of the bridge. Without the modification of the bridge to provide sidewalks or the construction of a new, wider bridge, pedestrian LOS cannot be improved along this segment.

Eastbound Southcenter Boulevard from I-5 SB Off-ramp to West Valley Hwy

Calculations for the sub-segments along this section of roadway yield pedestrian LOS results of C and D. However, after further analyzing this portion of Southcenter Boulevard, engineering judgment leads us to believe this segment should fall into the E/F range. With heavy vehicle volumes along Southcenter Boulevard and no sidewalk present along the majority of the segment, little pedestrian service is provided. The pedestrian LOS could be improved by installing a sidewalk along the south side of Southcenter Boulevard. However, given the lack of businesses or other pedestrian attractions, and the proximity of I-405 on this side of the street, it is reasonable to direct pedestrians to use the sidewalk on the north side of Southcenter Boulevard. We also recommend that the narrow pedestrian path on the south side of Southcenter Boulevard between 61st Avenue S and 62nd Avenue S be rebuilt to meet City of Tukwila sidewalk standards. This improved sidewalk will provide better access to the eastbound bus stop located east of 61st Avenue S.

Westbound Boeing Access Rd from I-5 Off-ramp to East Marginal Way S

The pedestrian LOS along the westbound direction of Boeing Access Road is E. This segment has no sidewalk and requires pedestrians to cross five high-speed ramps accessing I-5, Airport Way, and East Marginal Way. The addition of sidewalks and crosswalks along this segment would improve pedestrian LOS. While the City's CIP address the replacement of the BNRR Bridge including sidewalks on both sides, it is being recommended that sidewalks also be placed along the entirety of the segment from the East Marginal Way intersection to the Martin Luther King Way intersection.

Northbound and Southbound Martin Luther King Jr. Way between the East City Limit and the North City Limit

Martin Luther King Jr. Way is a limited access highway designed solely for vehicle use. Pedestrians traveling along this corridor should seek alternate routes. As little to no pedestrian attractions, such as recreational areas or businesses, are located along this corridor, no action is being recommended.

Southbound Tukwila International Boulevard from Green River to SR 99 / SR 599 Ramps

Pedestrian LOS along this segment of Tukwila International Boulevard is E. Pedestrians traveling through this segment have no sidewalk and face relatively long crossing lengths at intersections due to the SR 99 / SR 599 ramp designs. Improvements at this location could include adding a sidewalk or reducing pedestrian crossing lengths by providing crosswalks perpendicular to the flow of traffic on ramps.

Southbound Interurban Avenue S from Macadam Rd to I-5 Northbound On-ramp (part)

A pedestrian LOS of E was calculated along this corridor. The segment contains no sidewalks as shrubs and trees occupy the side of the street, effectively prohibiting pedestrian travel. As no pedestrian attractions occupy this side of the street and the adjacent land serves as a drainage basin, widening the right-of-way for the placement of a sidewalk is unreasonable. Pedestrians should be advised to use the opposite side of the street. No action is recommended at this time.

Southbound 40th Avenue S from S 130th St to 42nd Avenue S (part)

This section of 40th Avenue S received a pedestrian LOS of E. Lack of continuous sidewalks and a narrow shoulder are responsible for the poor rating. As only a large shoulder is present on the opposite, northbound side of the street, it is recommended that the sidewalk on the southbound side of the street be extended northward to S 130th St creating a continuous pedestrian facility to serve the local residential neighborhood.

Westbound Minkler Boulevard from Andover Park East to Andover Park West

This section of Minkler Boulevard received a pedestrian LOS of E. Neither the north nor south sides of the street have sidewalks as the relatively heavy traffic volumes occupy the corridor. The north side of the street has several small sections of sidewalk, but the presence of the railroad tracks causes discontinuities at several locations. While a drainage basin occupies the southern side of the street, it is recommended that a continuous sidewalk be constructed on the north side to improve pedestrian LOS.

Northbound and Southbound West Valley Highway from Strander Boulevard to S 180th St

The entire southbound side of West Valley Highway from Strander Boulevard to S 180th St received a pedestrian LOS of E. Pedestrians on this side of the street are faced with high vehicular volumes and speeds without the safety of a sidewalk. As much of this section is bordered by the Green River and few pedestrian destinations, no action is being recommended for the southbound side of West Valley Highway. Pedestrians should be encouraged to use the opposite side of the street or either the Interurban Trail or Green River Trail which parallel the segment.

One section of the West Valley Highway northbound from S 180th to Strander Boulevard received a pedestrian LOS of E. This stretch, from approximately the businesses of Leavitt Machinery and Forklift Parts to SimpleFloors Seattle, is the single northbound section that does not have a sidewalk. It is recommended that a sidewalk be constructed for this section to provide a continuous pedestrian facility on one side of West Valley Highway.

Westbound S 178th St from Southcenter Parkway to West City Line

S 178th St westbound received an LOS of E. This calculation was based on the segment LOS rating only as no downstream intersection was present. The poor LOS can be attributed to the high vehicle volumes and lack of sidewalk. According to the methodology used for the LOS calculation, the segment also experienced high vehicular speeds. Because the methodology does not take into account grade and this segment has a severe slope, the average running speed may be overestimated. It is recommended that a sidewalk be considered for this corridor to increase pedestrian service. The speed limit could also be reduced to improve LOS.

Eastbound S 180th St from Sperry Drive to West Valley Highway

See recommendation for corridor in **Bicycle LOS E/F** section**.**

NEXT STEPS

In addition to this MMLOS analysis, we will work with staff to establish MMLOS policies to balance deficiencies and improvement measures for different modes. These MMLOS policies will establish clear guidance on which modes receive priority when improvement measures result in LOS degradation for different modes. These policy issues will be discussed as part of the Transportation Element Update.

ATTACHMENT A: SUMMARY OF DATA SOURCES

TRAFFIC DATA

Several pieces of data used in the MMLOS calculations were taken from turning movement counts collected at intersections throughout the City of Tukwila. These counts were taken on weekdays during June and July, 2010. Traffic data extracted from the turning movement counts included peak hour factor (PHF) and peak hour roadway segment volumes.

HEAVY VEHICLES

The heavy vehicle percentages used in the bicycle LOS calculation were taken from 2010 vehicle classification counts collected by the City along key corridors. In locations where vehicle classification counts were not available, heavy vehicle percentages were estimated from the turning movement counts described above. In locations where neither vehicle classification counts nor turning movement counts had been collected, heavy vehicle percentages from 2007 turning movement counts were used.

SYNCHRO DATA

The Synchro traffic LOS analysis software was used in several circumstances to calculate input data. These data included the volume-to-capacity ratio, the proportion of green time for an approach to an intersection, and the traffic signal vehicle control delay. The time-space diagram feature of Synchro was also used in determining the signal progression of several segments.

INTERSECTION AND ROADWAY GEOMETRIC FEATURES

Google Earth was used to measure the lengths and widths of the intersections and roadway segments. Although using Google Earth does not provide exact measurements, precise dimensions were not necessary for this methodology. Sensitivity tests completed on features such as sidewalk and lane width revealed the LOS for a given mode was insignificantly affected by increases or decreases of widths within a one-to-two foot range. Field observations at several locations were used to validate the Google Earth measurement approach.

PAVEMENT QUALITY

Data for the pavement quality of the study segments was provided by the City of Tukwila in the *Pavement Maintenance Management Program* report from 2008. In this report, city roadways were rated 0-100 based on the Pavement Engineers – Pavement Condition Rating (PE-PCR) system. As described earlier, the MMLOS methodology requires a 1-5 pavement rating system to calculate bicycle LOS. The 0-100 PE-PCR system was broken into five categories (0-20, 21-40, 41-60, 61-80, 81-100) which were simplified to the 1-5 MMLOS pavement quality rating scheme.

PERCENT OCCUPIED PARKING

The percentage of occupied parking was determined for segments with legal street parking. A field study was conducted where parked cars were counted along relevant study segments. We estimated the percentage of occupied parking using the following equation:

$$Percentage\ of\ occupied\ parking = \frac{(Number\ of\ parked\ cars\ on\ a\ segment * 20\ feet\ per\ parked\ car)}{Total\ length\ of\ parking\ area}$$

ATTACHMENT B: DESCRIPTION OF ASSUMPTIONS

ANALYZING T-INTERSECTIONS

The analysis of T-intersections is not addressed in the MMLOS methodology of NCHRP Project 3-70. While the methodology allows for the analysis of movements crossing the intersection, there is no provision for calculating the pedestrian or bicycle LOS on the “top of the T.” In other words, the NCHRP methodology does not give any guidance about the pedestrian or bicycle LOS for the side of the intersection with no roadway leg.

In these instances, the bicycle intersection crossing distance variable was given a value of 0 in the calculation. This approach basically rewards the intersection LOS for having no conflicting movements while continuing to analyze based on other variables. This approach was chosen because while the bicyclist is not faced with conflicting movements, there is still a negative impact to the cyclist’s level of service due to the presence of the intersection. For example the duration of time spent adjacent to vehicles and the decrease in comfort traveling through the intersection can all affect the bicycle LOS.

When analyzing pedestrian LOS through a signalized T intersection, an intersection LOS of A was assumed since the pedestrian faces no conflicts and the overall walking environment is similar to walking along the street between intersections. The LOS of A effectively removes the intersection from the pedestrian LOS calculation for segments with T intersections.

UNSIGNALIZED INTERSECTIONS

Unsignalized intersections are not addressed in the MMLOS methodology. The methodology used for bicycle and pedestrian intersection LOS is limited only to four-way signalized intersections. Therefore engineering judgment was used to describe the LOS for segments with unsignalized intersections; although these intersections were generally not considered to have any impact beyond the reduction in bicycle LOS associated with unsignalized conflict points.

RIGHT TURN ON RED (RTOR) VOLUMES

For the purposes of determining the pedestrian intersection LOS, several assumptions were made to determine the RTOR volume. For intersections where a right turning lane was present, 20 percent of the total right turning movement for the intersection was assumed to occur on the red light. For intersections where a shared through and right lane was present, 5 percent of the right turning volume was assumed to occur on the red light.

PERMITTED LEFT TURNS

In order to determine the permitted left turning volumes, which can conflict with the pedestrian movement, several assumptions were made. For protected only left turns (signals with red and green left turn arrows), a value of 0 percent was assumed. For approaches where left turns were permitted only, 100 percent of left turns were defined as potentially conflicting with pedestrian crossings. For approaches with permitted-protected left turn phasing (where a green arrow is initially given, followed by a permitted left turn phase), 20 percent of the total left turning movement was assumed to occur during the permitted (conflicting) phase.

PEDESTRIAN SUBSEGMENTS

In order to produce LOS results to the pedestrian scale, subsegments were created from the original segments. The MMLOS methodology was consequently broken as some of the subsegments did not begin and end at intersections. In these cases, the overall pedestrian LOS was determined solely by the segment LOS value and not a weighted average between segment and intersection LOS.

ATTACHMENT C:
NON-MOTORIZED CORRIDORS, EXISTING CONDITIONS

FEHR & PEERS
TRANSPORTATION CONSULTANTS

MEMORANDUM

Date: June 7, 2010 (Update)

To: Cyndy Knighton, City of Tukwila

From: Kendra Breiland and Tom Noguchi, Fehr & Peers

Subject: Deliverable #1: Non-Motorized Corridors, Existing Conditions, and Previously Identified Needs

SE08-0181

The City of Tukwila has contracted with Fehr & Peers to develop a process for evaluating operations of bicycle and pedestrian facilities in the City. This analysis, which is funded by an Energy Efficiency in Transportation Planning grant from the Washington State Department of Commerce, will include measuring bicycle and pedestrian level of service (LOS) on the City's roadway network according to the newest procedures described in the draft 2010 Highway Capacity Manual (HCM). Defining bicycle and pedestrian LOS on key corridors throughout the City will inform the City's Comprehensive Transportation Plan Update as to which sorts of projects would most benefit bicycle and pedestrian travel in the City.

This memorandum summarizes the following:

- The City's existing bicycle and pedestrian facilities
- Projects that are currently being planned and constructed, as reflected in the 2010-2015 Capital Improvement Program (CIP)
- The "Bicycle Friendly Routes" that are identified in the City's Walk and Roll Plan
- The corridors that have been selected for bicycle and pedestrian LOS evaluation
- The data needs to evaluate bicycle and pedestrian LOS on each of the selected corridors
- Connection with the Comprehensive Plan Update process

Existing Bicycle and Pedestrian Facilities

In 2009, the City published a Walk and Roll Plan, which is Tukwila's key non-motorized transportation plan. Fehr & Peers has reviewed the Plan and summarized Tukwila's existing transportation network, including bicycle and pedestrian facilities along arterial roadways. The following types of transportation facilities were identified as accommodating non-motorized travel:

- Sidewalks
- Bike lanes
- Paved shoulders

Figure 1 summarizes the existing non-motorized facilities on arterials within the City. It is worthwhile to note that this map does not include the components of the City's non-motorized transportation network that are outside of the arterial roadways. These facilities include sidewalks along non-arterial roadways, unpaved paths that are used by pedestrians, and local roadways that are shared by autos and bikes.

Future Bicycle and Pedestrian Facilities

Fehr & Peers has reviewed the City's 2010-2015 CIP to determine the sorts of non-motorized facilities planned for construction in the next five years. As shown in Figure 2, the City plans to construct new sidewalks on roadways throughout the City, as well as a bike-pedestrian bridge over the Green River. Not shown on Figure 2 are a number of intersection signal enhancements and crosswalks included in the CIP, which may also benefit bicycle and pedestrian travel.

Beyond the 2010-2015 CIP, the City's Walk and Roll Plan designates "Bicycle Friendly Routes" and provides guidance to ensure that major transportation infrastructure projects include bicycle and pedestrian elements that are consistent with City's ultimate non-motorized system. The Plan's Bicycle Friendly Routes are shown in Figure 3 and are intended to provide a coordinated City bikeway system that connects parks, schools, major employers, transportation centers, neighboring cities, and other activity centers.

Bicycle and Pedestrian Level of Service Evaluation

To refine the Walk and Roll Plan and inform the City's Comprehensive Transportation Planning process, Fehr & Peers will be evaluating bike and pedestrian LOS on several key corridors throughout the City. Figure 4 shows the corridors that were identified by City staff. In general, these corridors overlap with the Bicycle Friendly Routes identified in the Walk and Role Plan, but also include some additional locations (particularly near the Southcenter Mall) to ensure that major bicycle and pedestrian needs are considered.

Traditionally, LOS analysis has focused on a single mode – the auto. However, as jurisdictions like Tukwila attempt to plan for the travel experience of non-auto modes, a singular focus on automobile operations provides an incomplete picture. Thus, the City has identified the need to measure bicycle and pedestrian LOS. Below, we describe how LOS is measured for each mode:

- **Autos:** Auto operations have traditionally been measured by volume to capacity (V/C) ratios on roadways and by delay experienced by vehicles at intersections. The 2010 HCM guidelines may enhance these capacity and delay-based metrics to consider factors like speed and stops per mile.

- **Bicycles:** Bicycle operations will consider the experience of cyclists at intersections and on street segments between intersections. Bicycle experience at intersections is measured by the physical space available for bicycles and the number of conflicting vehicles using the intersection. Bicycle experience on roadway segments will consider a number of factors, including vehicle composition, speed and volume, pavement quality, physical space allotted to cyclists, the presence of on-street parking, and the number of conflicts (driveways and intersections) cyclists encounter per mile.

- **Pedestrians:** Pedestrian LOS can be measured either based on density or non-density factors. Since overutilization of pedestrian facilities is not presently a concern for Tukwila, we will use non-density factors to measure pedestrian LOS. These factors include physical separation of pedestrian and vehicle facilities (via on-street parking, bike lanes, planter strips, and other buffers), the speed of vehicle traffic, and the presence of sidewalks.

Measuring LOS for bicycles and pedestrians will require more data than analyses where vehicle operations are the sole focus. Below, we list the data required to reflect each mode:

- **Bicycle:** Bicycle operations analyses should include data on the number of conflicts cyclists face on a roadway segment (driveways and intersections), number of vehicle lanes, vehicle speeds, volumes and peaking characteristics, pavement quality, on-street parking utilization, the widths of the bicycle lane and outside vehicle lanes.

- **Pedestrian:** Pedestrian LOS analyses will assess the pedestrian environmental along roadway segments. Pedestrian segment LOS will require data on presence of sidewalks, width of outside vehicle lanes, barriers between pedestrians and vehicles (bike lanes, shoulders, on-street parking utilization, and other buffers), the continuity and width of sidewalks, vehicle speeds, volumes, and peaking factors.

The HCM 2010 guidelines will likely provide look-up tables and default values for many of the above data requirements. However, it is difficult to say the extent to which the default values would represent conditions in Tukwila. Thus, to accurately measure bicycle and pedestrian LOS on its transportation network, the City will begin collecting locally valid travel data for use in this analysis.

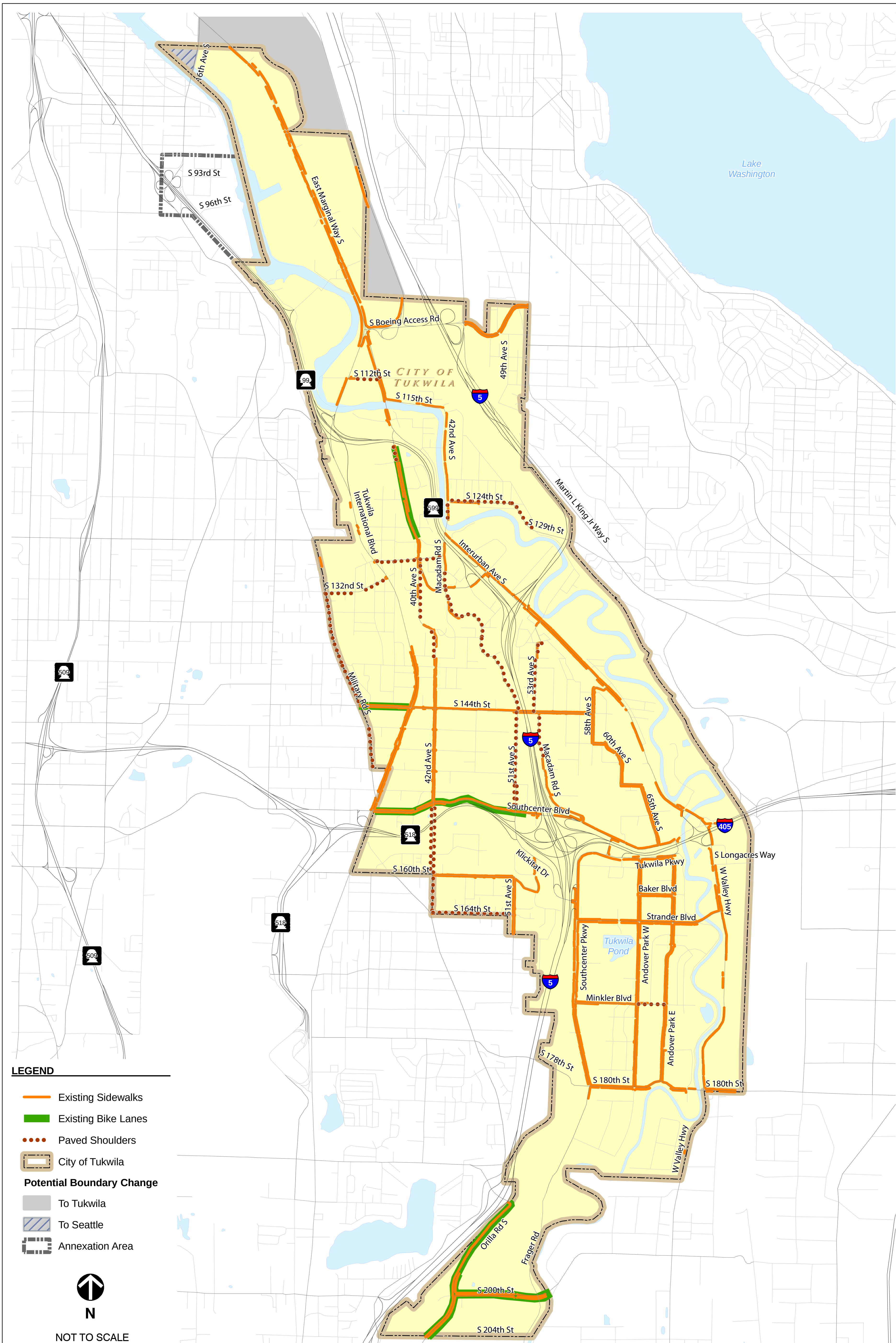
Connection with Comprehensive Plan Update Process

It is important to note that non-motorized travel is influenced by both the presence of bike and pedestrian facilities as well as the mix of adjacent land uses. Land use considerations include the type of land uses in place and whether they are conducive to non-motorized travel, as well as how close these land uses are to one another. As the City updates its Comprehensive Transportation Plan, we will be reviewing how the future land use plan will influence demand for non-motorized travel.

The work funded by this grant will provide the City with guidance as to how existing non-motorized facilities function. By pairing an understanding of the City's existing and planned land uses with how its current transportation system accommodates non-motorized modes, these efforts will provide the City with a better understanding of where bicycle and pedestrian facility improvements are needed.

Next Step

During the next phase, Fehr & Peers will collect the data and calculate auto, pedestrian, and bicycle levels of service for the arterial segments shown in Figure 4.



FEHR & PEERS
TRANSPORTATION CONSULTANTS

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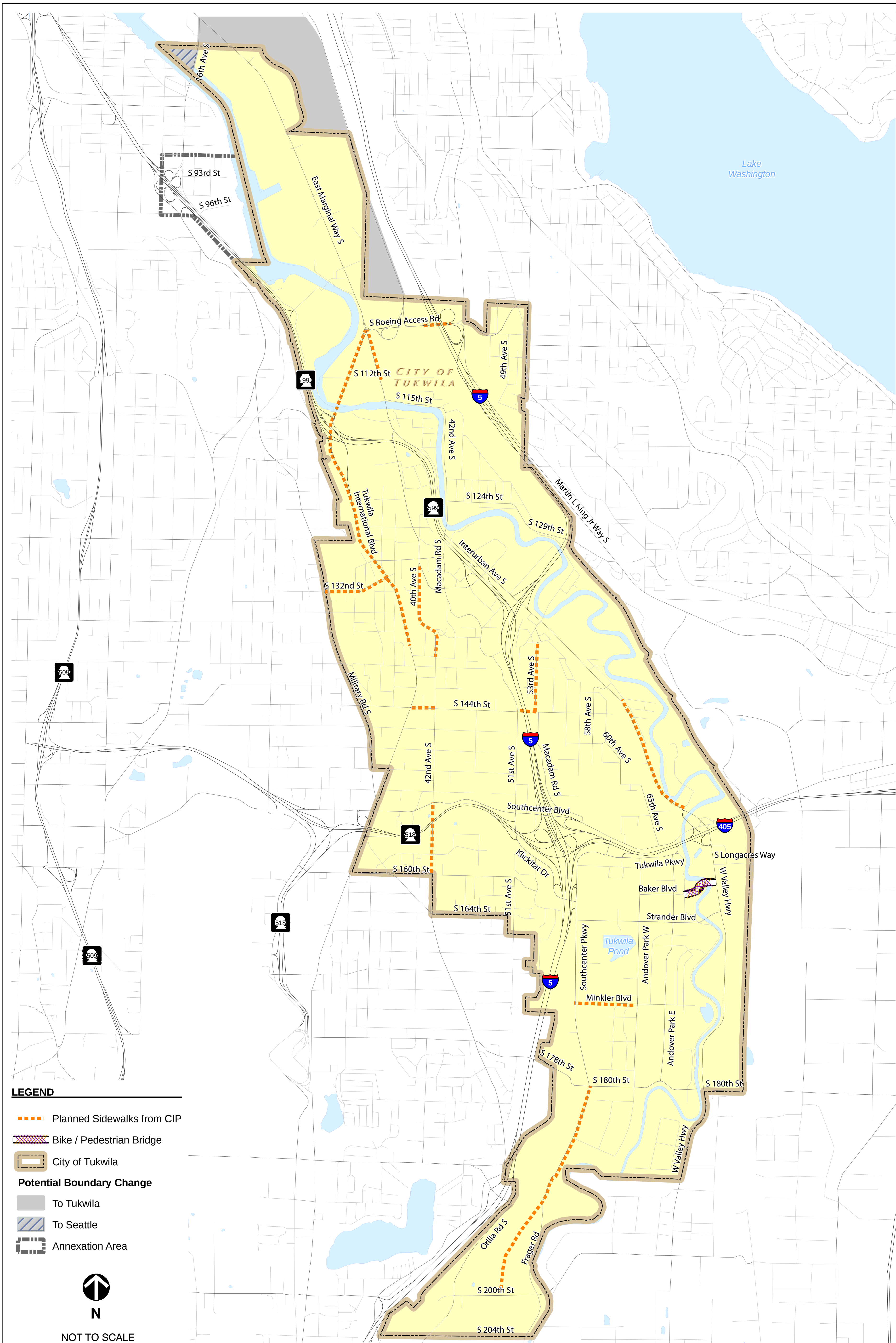
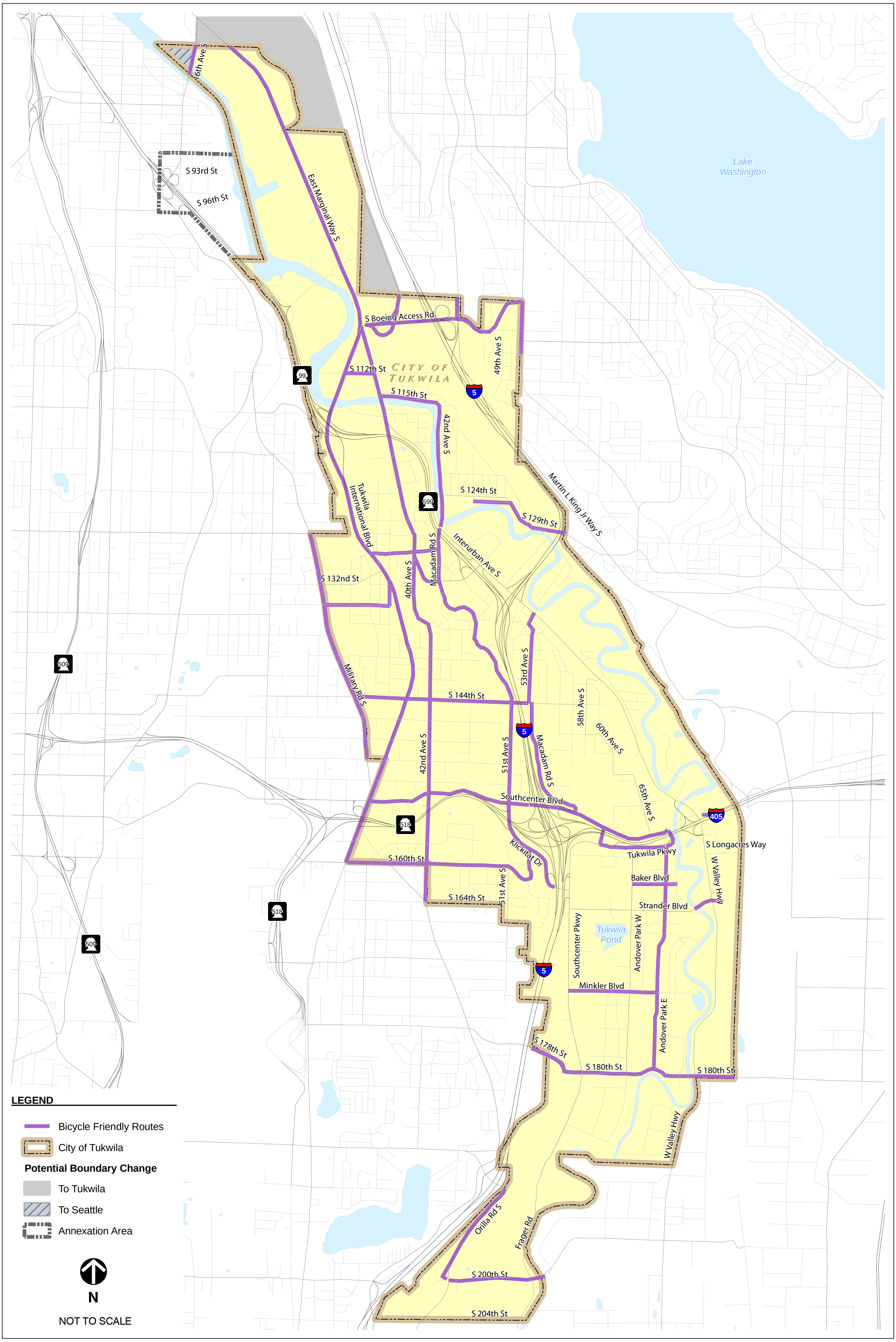
CITY OF TUKWILA - EXISTING PEDESTRIAN AND BICYCLE FACILITIES

FIGURE 1



CITY OF TUKWILA - PLANNED PEDESTRIAN FACILITIES
FIGURE 2



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CITY OF TUKWILA - BICYCLE FRIENDLY ROUTES

FIGURE 3

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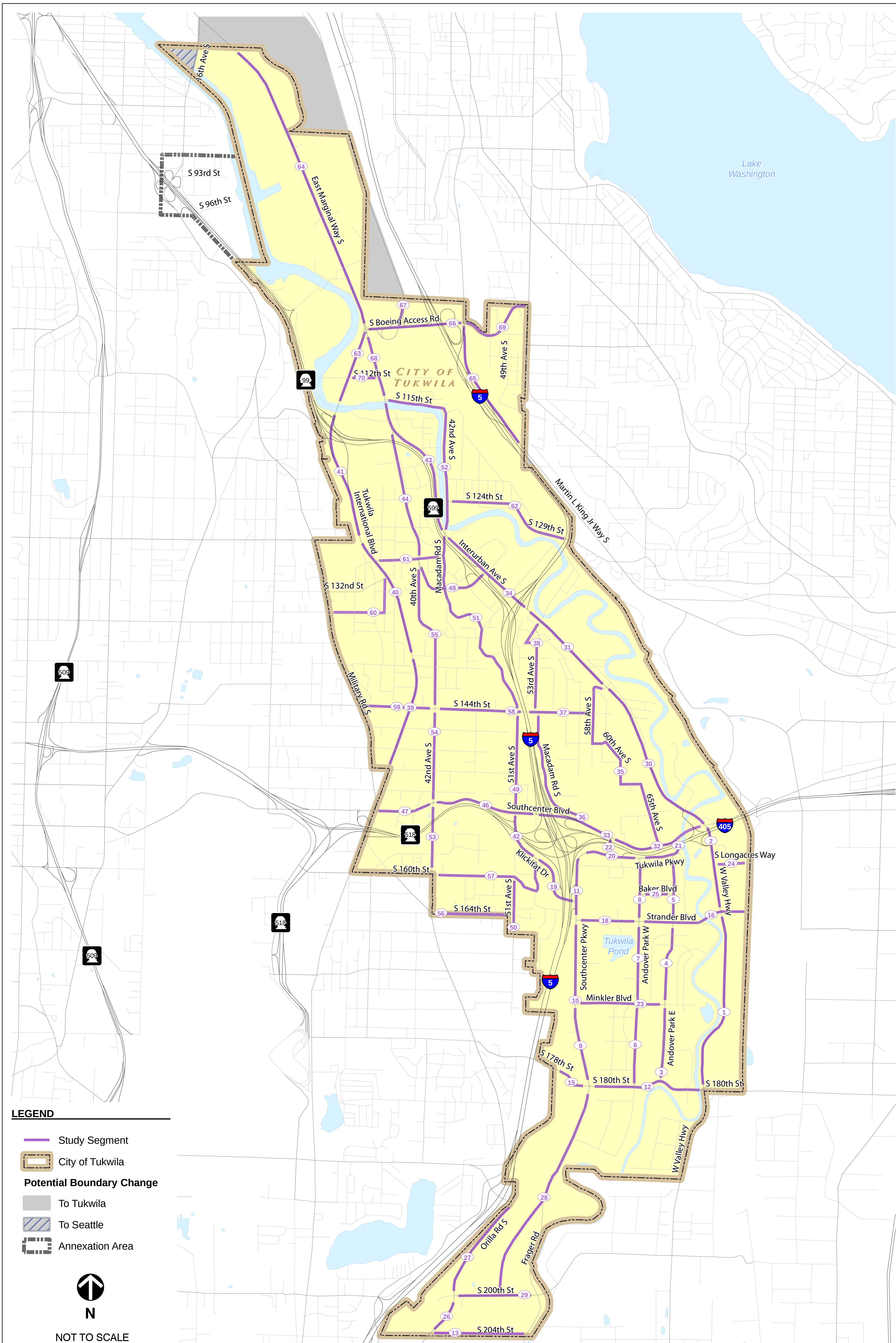

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CITY OF TUKWILA - STUDY SEGMENTS

FIGURE 4