Puyallup Avenue Corridor Conceptual Design

Tech Memo #3: Alternatives Evaluation Report

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NELSON
NYGAARD

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1 INTRODUCTION

The Puyallup Avenue Corridor Conceptual Design project developed multimodal concepts for the corridor that will enhance the experience for everyone, including pedestrians, cyclists, drivers, transit riders, and freight operators. This project focuses exclusively on Puyallup Avenue and excludes the parallel street of East 25th. Future planning efforts should include review and design of a broader corridor area, including parallel streets.

The alternatives presented in this plan are potential solutions for the corridor. The final layout will be based on number of factors, including:

- Sound Transit's Light Rail Extension
- Pierce Transit's High Capacity Transit Study
- Potential use of parallel corridors to accommodate specific travel modes
- Puyallup Avenue on-street parking analysis
- Additional public outreach

REPORT ORGANIZATION

This report summarizes the development and evaluation of alternatives for Puyallup Avenue in the following chapters:

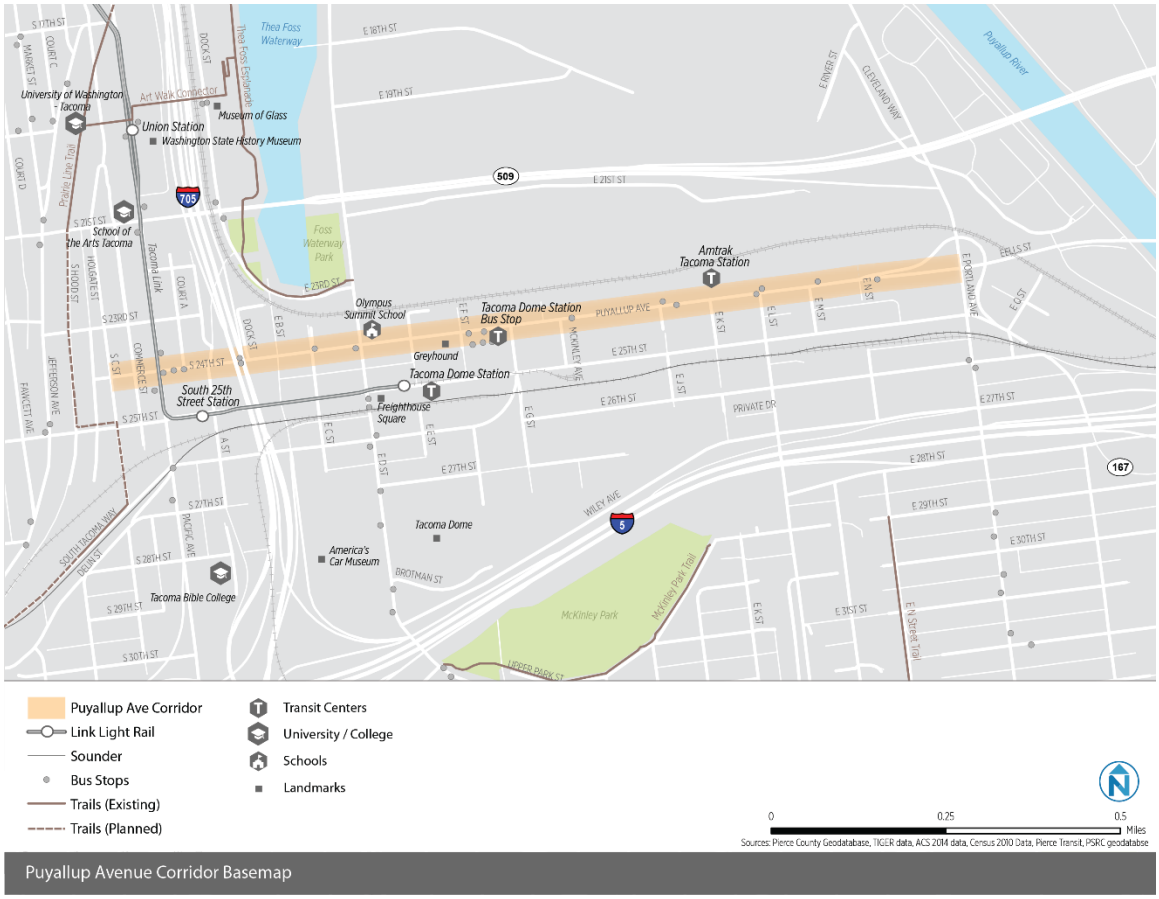
- **Chapter 2** provides an overview of the evaluation framework used to assess alternatives
- **Chapter 3** summarizes three preliminary alternatives developed for Puyallup Avenue
- **Chapter 4** presents a multimodal evaluation of the three preliminary alternatives
- **Chapter 5** summarizes the methodology and results of traffic volume forecasting and operations analysis for the corridor and the preliminary alternatives
- **Chapter 6** summarizes the key themes and findings from community outreach efforts regarding the preliminary alternatives
- **Chapter 7** presents a fourth alternative developed based on results from the multimodal evaluation, traffic forecasting and operations analysis, and public outreach, as well as a planning level cost estimate for that alternative

PROJECT STUDY AREA

The Puyallup Avenue study area is in South Downtown Tacoma and stretches from South C Street to the west to Portland Avenue to the east. In general, the corridor consists of two lanes per direction with a center turn lane. The street is home to one of the Puget Sound's most transit-rich hubs, Tacoma Dome Station. Previous visions for the corridor have included plans for bicycle facilities along the street, connections to Prairie Line Trail and the University of Washington

Campus, and relocation and redevelopment of the Amtrak Station (underway). Figure 1-1 provides an overview of the corridor.

Figure 1-1 Study Area Map



Puyallup Avenue Corridor Basemap

Because land uses and built form change along the corridor's length, this project created three districts within the corridor: Neighborhood, Transit-Oriented Development (TOD), and Industrial (see Figure 1-2) with different treatments based on context.

Figure 1-2 Study Area Districts

The goal of this project is to create a safe and pleasant multimodal environment while also preserving access and mobility for motorists and the street's many active freight users.

2 EVALUATION FRAMEWORK

The following terms are used in this chapter to describe "measures of effectiveness," or the measures that were used to evaluate the preliminary alternatives for Puyallup Avenue:

- **Objectives:** Overarching goals
- **Measures:** The approach to quantifying the objectives
- **Metrics:** Quantitative or qualitative benchmarks used to assess progress toward measures

This evaluation framework is one tool—tied to the project's goals and objectives—to help illustrate differences between alternatives. It is not intended to "pit" the alternatives against one another but rather to illustrate the strengths and weaknesses of the different alternatives across a range of measures to support decision making.

MEASURES OF EFFECTIVENESS

Objectives

Design of a street must be based upon community goals and objectives; there is no one "right" way to design a complete street. Early in this project, performance measures and evaluation criteria that matter to the community were defined to ensure that this framework can be used to evaluate the outcomes for each design alternative. Primary objectives for the design of the Puyallup Avenue corridor have been defined as the following:

- Develop a complete street that safely accommodates walking, bicycling, transit, driving, and freight
- Support travel times for freight, transit, and motor vehicles
- Create an inviting destination

Measures and Metrics

To quantify the objectives, measures were developed that support each one. Metrics associated with each measure provide a standardized way to evaluate each alternative's outcomes. For each metric, a scoring system was developed to express how well each alternative achieves the metric, from low (🔴) to medium (🟡) to high (🟢). A description of each measure and metric is provided below and summarized in Figure 2-1.

Objective 1: Develop a complete street that safely accommodates walking, bicycling, transit, driving, and freight

Bicycle Accommodation

Community and stakeholder input made it clear that accommodating bicycles on the corridor is a high priority. In each of the alternatives, the ease of accessing destinations on the corridor and connecting to the existing and planned network by bicycle was evaluated in two ways:

- The level of separation of the bicycle facility from traffic (e.g., a striped bike lane is scored lower than a shared-use path).
- The percentage of connections that will be made to the existing and planned bicycle network, such as the Prairie Line Trail, Pipeline Trail, Trail to the Mountains, and Fife bike path.

Ease of Crossing and Access to Transit

The majority of transit riders are making a round trip, and will need to cross the street at some point during their journey. The ease of crossing the street to transit stops was measured by calculating the average distance from bus stops to the nearest marked crossing.

Transit Stop Amenities

Shelters and seating provide a pleasant environment for taking transit. Opportunities to accommodate transit stop amenities, such as benches, shelters, trash and recycling receptacles, and public art, were evaluated by measuring the average sidewalk space available for amenities at bus stops.

Consistent and Safe Driving Experience

Good street design is legible and intuitive for everyone traveling along the corridor. Design can also provide an environment that promotes consistent, safe speeds for drivers, contributing to the safety of the corridor for everyone. This metric is measured through an inventory of traffic calming elements such as widened sidewalks, median refuge islands, landscaping, on-street parking, and other treatments that keep vehicle speeds to the desired speed (speeding is prevalent today in the Industrial context).

Freight Access

Puyallup Avenue is an important corridor for freight vehicles and freight-related businesses. Access for freight vehicles traveling along or accessing destinations on the corridor was measured in two ways: 1) the presence of a two-way left turn lane, which is often used for staging freight vehicles along the corridor, and 2) a count of turn pockets, which facilitate turns.

Objective 2: Support travel times for freight, transit, and motor vehicles

Vehicle Travel Time

Vehicle travel time is measured by the total estimated travel time for the corridor, in minutes. This is an output from the SYNCHRO transportation model.

Freight Travel Time

Freight travel time is measured by the total estimated travel time for the corridor, in minutes, for freight vehicles. This is an estimate derived from the SYNCHRO transportation model.

Transit Speed and Reliability

Approximately 3,300 people board transit every day at Tacoma Dome Station.[1] Transit is a critical feature of the area's character as well as a key factor in corridor redevelopment opportunities. All alternatives strive to maintain or enhance transit speed and reliability along the corridor. Transit speed and reliability is measured by the total estimated transit travel time for the corridor, in minutes. This is an estimate derived from the SYNCHRO transportation model.

Objective 3: Create an inviting destination

Supports Transit-Oriented and Neighborhood Development

Supporting transit-oriented and neighborhood development is a key aspect of creating an inviting destination along the corridor. This metric was measured in two ways:

- Opportunity for new private developments to benefit from an enhanced public realm (i.e., right-of-way available for places people can sit, stand, eat, and otherwise enjoy the street), measured as the combined width of the sidewalk and landscaping, minus a 7' clear zone for pedestrians; and
- Availability of on-street parking, measured as the percentage of existing on-street parking spaces retained.

Pedestrian Comfort

Pedestrian comfort is also important in creating a Puyallup Avenue that is an inviting destination. Pedestrian comfort is measured based on the following criteria:

- Sidewalk and landscaping width, evaluated based on the range of widths along the corridor, in feet;
- Speed of adjacent traffic, measured on average for the corridor, as an output from the SYNCHRO model;
- Buffers from adjacent traffic, such as on-street parking, landscaping, and bike lanes, between the sidewalk and travel lanes, evaluated based on the range of widths along the corridor in feet; and
- Shorter pedestrian crossings, as measured by the average width of the roadway at pedestrian crossings, in feet.

Creates Place

Finally, the corridor concepts were evaluated on the extent to which they create place, using two metrics:

- Opportunities to provide street trees, which require a minimum 6' of landscaping per city guidelines; and
- A count of curb bulbs, median islands, and other locations that can support placemaking elements. Potential placemaking elements that can be included in these spaces are inclusion of a gateway treatment to provide a sense of arrival to Tacoma, public art, or locally-relevant green features such as landscaping, trees, or green stormwater infrastructure elements.

[1] PSRC https://www.psrc.org/sites/default/files/tacomadometransitaccesscasestudy20160125.pdf

EVALUATION SCORING MATRIX

The following table summarizes the measures of effectiveness scoring used to evaluate alternatives. For each metric, a scoring methodology was developed to express how well each alternative achieves the metric, from low (🔴) to medium (🟡) to high (🟢). Metrics were evaluated in both qualitative (e.g., "low", "medium", or "high") and quantitative (e.g., "less than 4") terms. For example, the score an alternative received on the Driving measure was based on the estimated vehicle travel time from one end of the corridor to the other. For this metric, a vehicle travel time of less than 6 minutes was given a "high" score while a vehicle travel time of 7 minutes or more was given a "low" score.

Figure 2-1 Measures of Effectiveness Scoring

Objective	Measure	Metric	Low 🔴	Medium 🟡	High 🟢
Develop a complete street that safely accommodates walking, bicycling, transit, driving, and freight	Bicycle accommodation	Level of separation of bicycle facility	Low	Medium	High
		Points of connection to the existing and planned bicycle network	Low	Medium	High
	Ease of crossing and access to transit	Ease of crossing the street to/from transit stops	Low	Medium	High
	Transit	Opportunities to accommodate transit stop amenities	Low	Medium	High
	Driving	Provides a continuous contextual experience along the corridor that promotes consistent, safe speeds	Low	Medium	High
	Freight access	Presence of a two-way left-turn lane	No	N/A	Yes
		Presence of turn pockets	Less than 4	4 to 7	More than 7
Support travel times for	Driving	Estimated vehicle travel time (LOS)	LOS F	LOS E	LOS D or Better

Objective	Measure	Metric	Low 🔴	Medium 🟡	High 🟢
freight, transit, and motor vehicles	Freight	Estimated freight vehicle travel time	6 minutes or more	6 to 7 minutes	Less than 6 minutes
	Transit speed and reliability	Estimated transit travel time	6 minutes or more	6 to 7 minutes	Less than 6 minutes
Create an inviting destination	Supports transit-oriented and neighborhood development	Width of pedestrian realm	Low	Medium	High
		% on-street parking spaces retained	Less than 75%	75-100%	100%
	Pedestrian comfort	Sidewalk and landscaping width	Less than 7'	7 to 10'	11' or more
		Speed of adjacent traffic	Over 15 mph	12-15 mph	Under 12 mph
		Buffers from adjacent traffic	Low	Medium	High
		Shorter pedestrian crossings	Low	Medium	High
	Creates “place”	Opportunities for street trees	Low	Medium	High
		Curb bulbs, median islands, or other locations for public art, gateway treatments, landscaping, and placemaking elements	Low	Medium	High

3 PRELIMINARY ALTERNATIVES

Three unique options were developed for Puyallup Avenue to meet different community desires. These preliminary alternatives were refined with City of Tacoma staff in January 2017. The alternatives feature different layouts for the corridor, including a transit and high-occupancy vehicle (HOV) lane, a two-way bike path, and removal of the center turn lane. These variations allow for evaluation of outcomes at a concept level.

The team created three conceptual cross-sections of the street for each alternative at three places along the corridor: between South C Street and Pacific Avenue in the Neighborhood District, between East D Street and East E Street in the TOD District, and between East J and East L Streets in the Industrial District. One plan view was also produced for each alternative.

EXISTING

Puyallup Avenue is currently a four-lane roadway with a center turn lane and sidewalks on both sides. East of Pacific Avenue, the right-of-way measures 100'. The curb-to-curb width varies but is generally around 70'. West of Pacific Avenue the right-of-way narrows to 80' and the layout includes two general purpose travel lanes (one in each direction). There is on-street parking on Puyallup Avenue in many places along the corridor, ranging from 8 to 12 feet wide.

Figure 3-1 Neighborhood District Conceptual Cross-Section – Existing

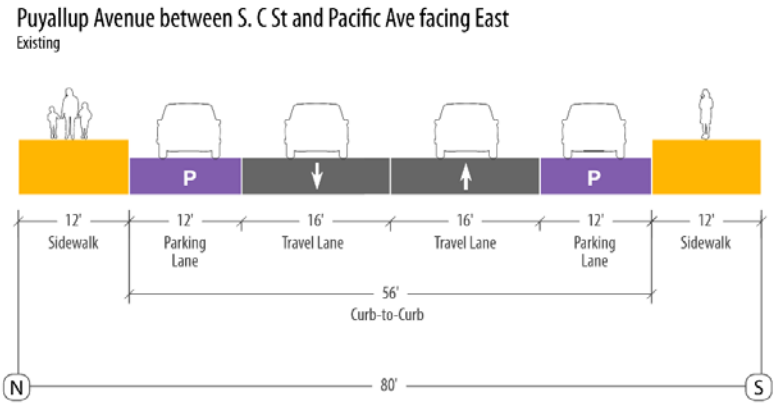


Figure 3-2 TOD District Conceptual Cross-Section – Existing

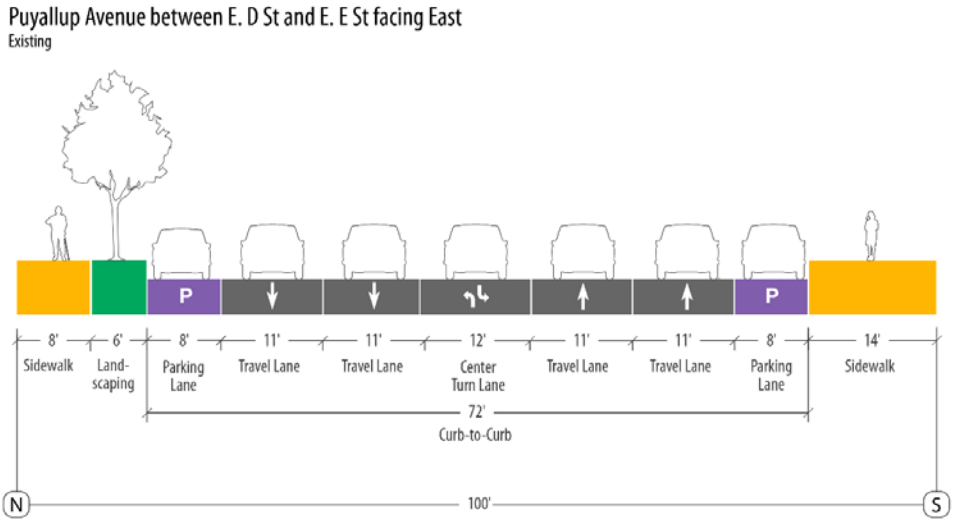
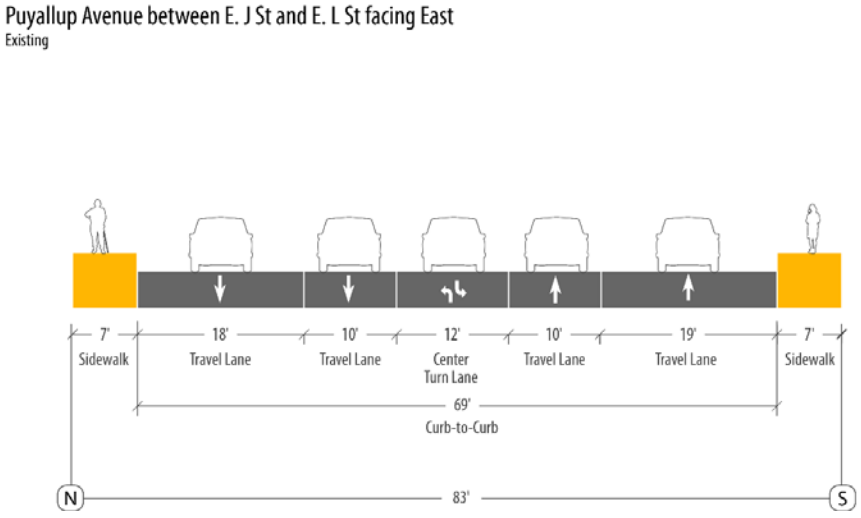


Figure 3-3 Industrial District Conceptual Cross-Section – Existing



ALTERNATIVE 1

Bike Path, Transit/HOV Lane, Two General Purpose Lanes, and Center Turn Lane

This alternative includes a single general purpose lane in each direction separated by a center turn lane and an eastbound transit/HOV lane. Eastbound buses would stop in the exclusive transit/HOV lane and westbound buses would stop in the westbound general purpose lane at bus bulbs.

Alternative 1 includes a two-way bike path on the north side of Puyallup Avenue between Pacific Avenue and L Street before transitioning to the south side of Puyallup Avenue east of L Street. Bike signals, pedestrian signal heads, and Leading Pedestrian Intervals are included at certain intersections.

The proposed sidewalk width varies depending on existing sidewalk dimensions—it is widest in the Neighborhood District, and narrower in the Industrial District. On-street parking is provided throughout the corridor, with exceptions where bus bulbs or curb extensions are needed.

Cross-Sections

Alternative 1 is illustrated in the following conceptual cross-sections.

Figure 3-4 Neighborhood District Conceptual Cross-Section – Alternative 1

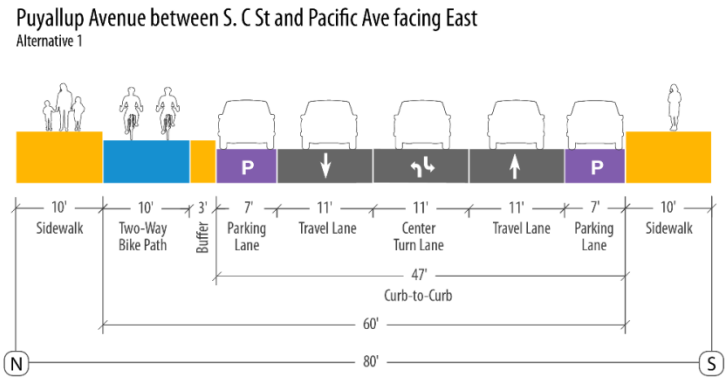


Figure 3-5 TOD District Conceptual Cross-Section – Alternative 1

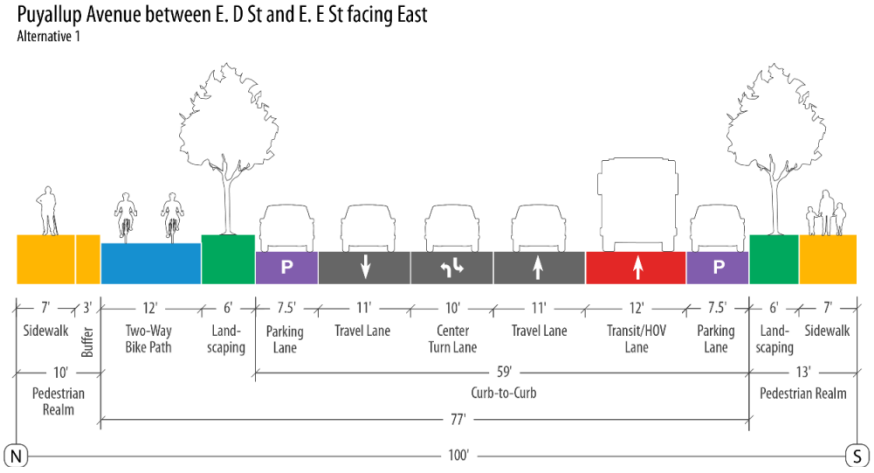
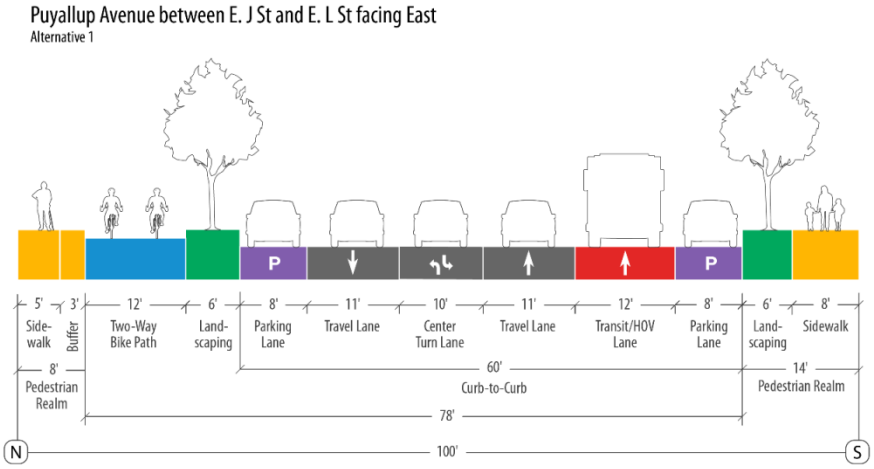


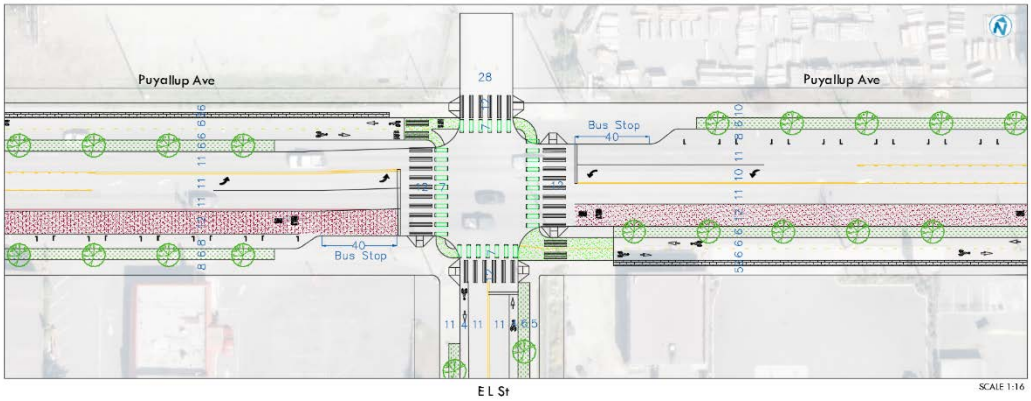
Figure 3-6 Industrial District Conceptual Cross-Section – Alternative 1



Plan View

The intersection of L Street was laid out to illustrate how the bicycle path would transition from the north to the south side of the street at this new signal to align with the Fife bike path.

Figure 3-7 Puyallup Avenue and East L Street Plan View – Alternative 1



Summary

Figure 3-8 summarizes what Alternative 1 means for people driving, walking, biking, taking transit, or operating freight.

Figure 3-8 Alternative 1 Modal Impacts

	PEDESTRIANS Pedestrian realm 8' to 14' wide Buffered from vehicle traffic by path (north side) Curb extensions possible
	BICYCLISTS Two-way path; highest level of separation among alternatives Bike signals added at signalized intersections Potential conflicts with driveways
	TRANSIT Transit/HOV lane eastbound Eastbound buses stop in Transit/HOV lane Westbound buses stop in general purpose lane Bus bulbs (widened sidewalk) replace parking at bus stops
	FREIGHT Two-way left turn lane provided Existing dedicated left turn lanes preserved at signals
	PLACEMAKING Street trees added to both sides in Industrial and TOD (Transit-Oriented Development) Districts
	DRIVERS Right turns allowed from Transit/HOV lane On-street parking on both sides HOV lane eastbound

ALTERNATIVE 2

Protected Bike Lanes with Four General Purpose Lanes

Alternative 2 removes the center turn lane and includes protected bike lanes on both sides of Puyallup Avenue with a bike signal at Pacific Avenue. This alternative provides two general purpose lanes in each direction with protected bike lanes on both sides of the corridor. Buses would stop in the general purpose lanes.

Similar to Alternative 1, an on-street parking/flex zone (can be swapped for bus bulbs or curb extensions) is proposed along the south side of the street throughout the corridor. On-street parking is also proposed on the north side of the street in the industrial section.

The sidewalk width varies depending on existing sidewalk dimensions, with the widest sidewalks in the Neighborhood District, and narrower sidewalks in the Industrial District.

Cross-Sections

Alternative 2 is illustrated in the following conceptual cross-sections.

Figure 3-9 Neighborhood District Conceptual Cross-Section – Alternative 2

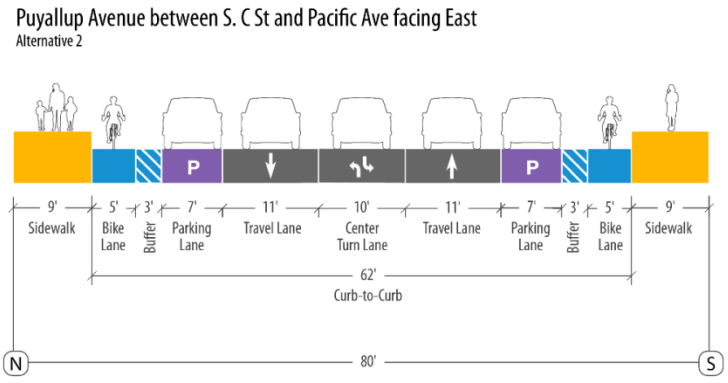


Figure 3-10 TOD District Conceptual Cross-Section – Alternative 2

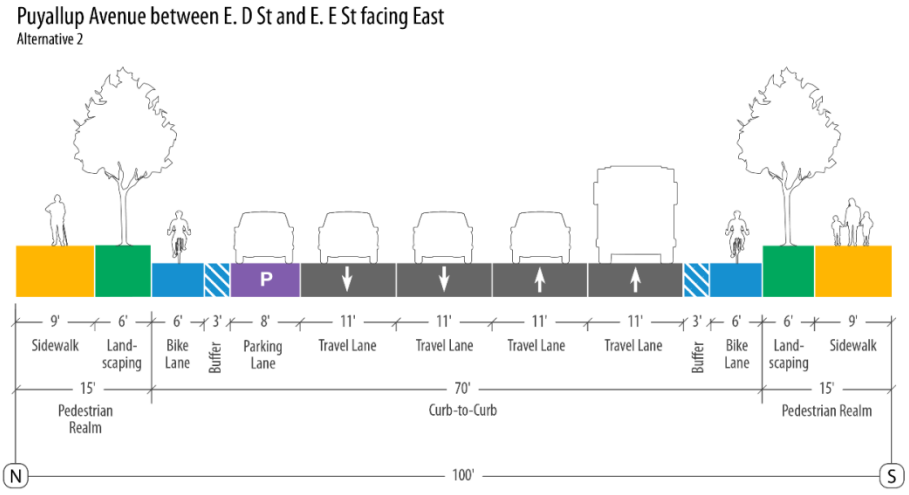
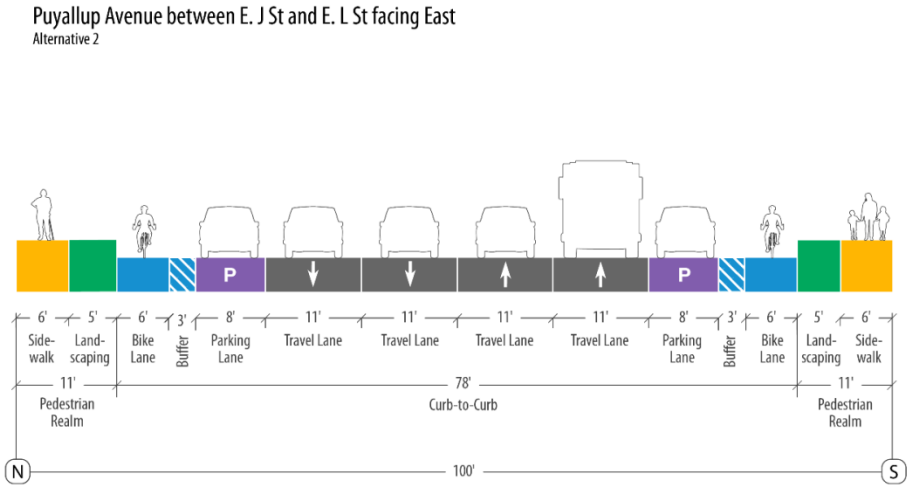


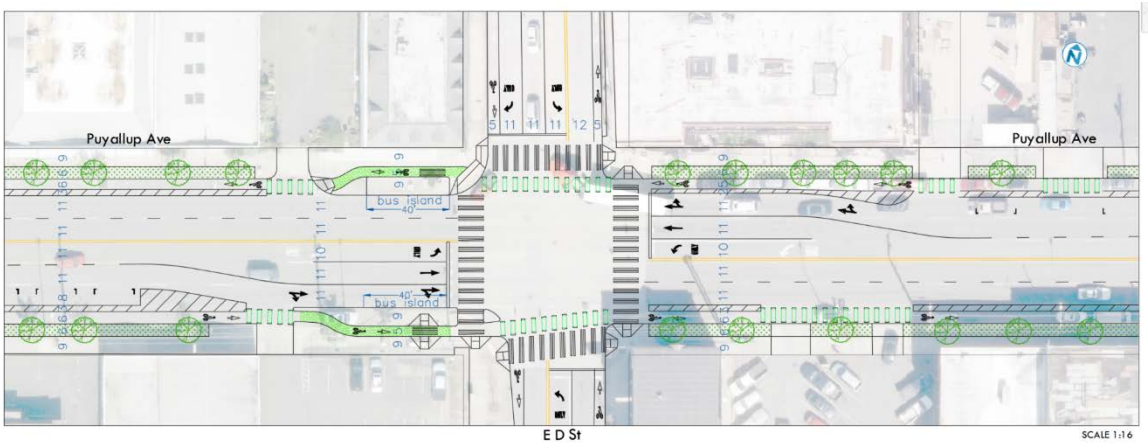
Figure 3-11 Industrial District Conceptual Cross-Section – Alternative 2



Plan View

The intersection of East D Street was laid out to illustrate how the protected bicycle lanes would wrap behind bus islands, and how on-street parking would drop at intersections to create room for left turn pockets.

Figure 3-12 Puyallup Avenue and East D Street Plan View – Alternative 2



Summary

Figure 3-13 summarizes what Alternative 2 means for people driving, walking, biking, taking transit, or operating freight.

Figure 3-13 Alternative 2 Modal Impacts

	PEDESTRIANS Pedestrian realm 9’ to 15’ wide
	BICYCLISTS Protected bicycle lane against curb
	TRANSIT Buses stop in general purpose lane Bus bulbs (widened sidewalk) replace parking at bus stops At East D Street, bikes route through 6’ landscaping area to go behind bus stop
	FREIGHT No two-way left turn lane Fewer left turn pockets
	PLACEMAKING Street trees added in TOD District on both sides
	DRIVERS Four travel lanes No two-way left turn lane Fewer left turn pockets On-street parking on both sides, except in TOD District

ALTERNATIVE 3

Buffered Bike Lanes with Two General Purpose Lanes and Center Turn Lane

Alternative 3 replaces an existing general purpose lane in each direction with buffered bike lanes in each direction. This alternative would provide one general purpose lane in each direction separated by a center turn lane and buffered bike lanes on both sides of the corridor. This alternative provides on-street parking on both sides of the street.

Unlike the previous alternatives, Alternative 3 maintains consistent widths for all elements (travel lanes, sidewalks, parking) throughout all sections of the corridor. Sidewalks are proposed at a consistent 16' east of Pacific Avenue.

Cross-Sections

Alternative 3 is illustrated in the following conceptual cross-sections.

Figure 3-14 Neighborhood District Conceptual Cross-Section – Alternative 3

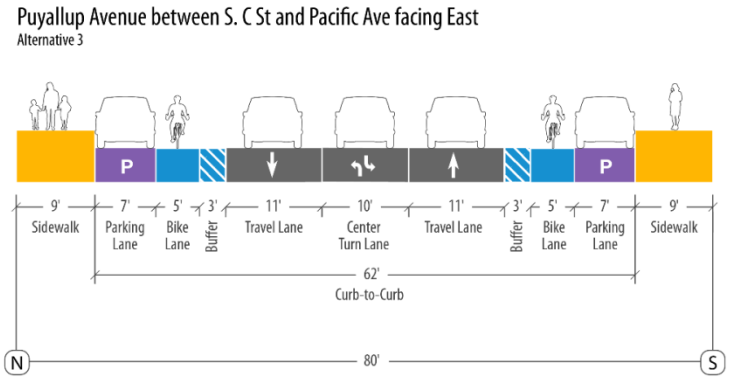


Figure 3-15 Neighborhood District Conceptual Cross-Section – Alternative 3

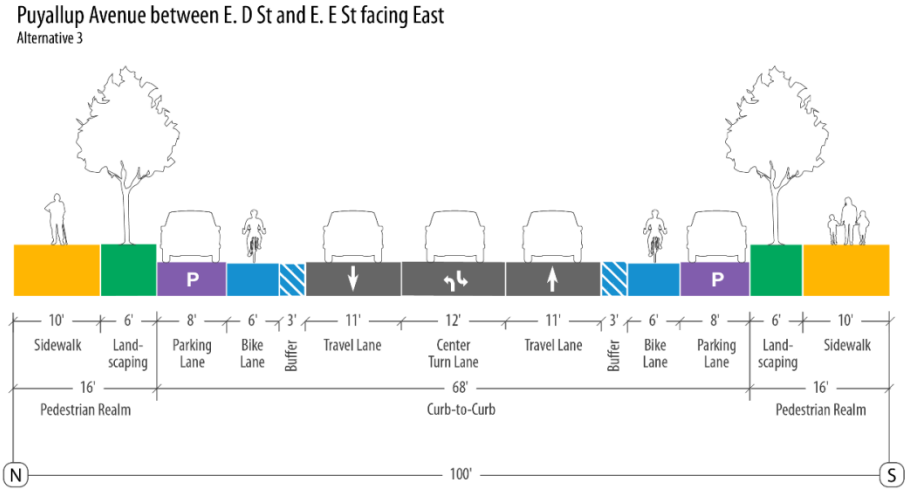
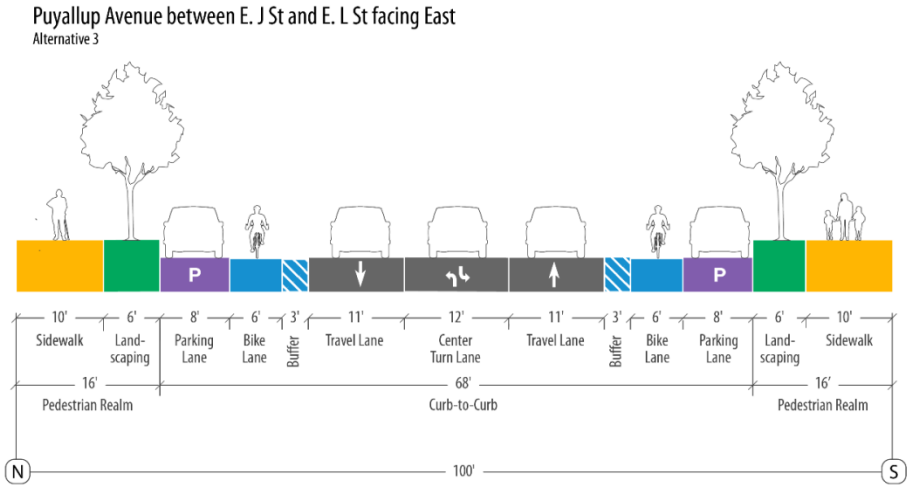


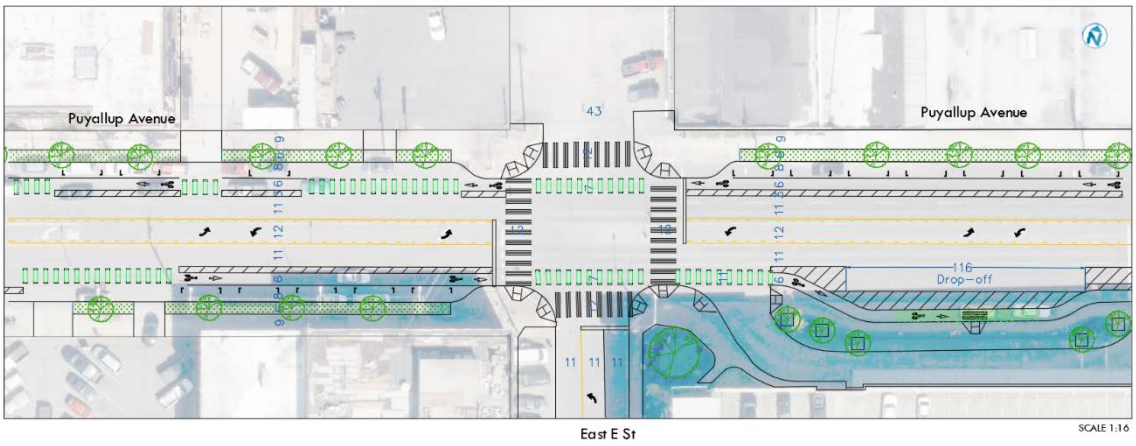
Figure 3-16 Neighborhood District Conceptual Cross-Section – Alternative 3



Plan View

The intersection of East E Street was laid out to illustrate how the buffered bicycle and on-street parking would interact, and how pick-ups and drop-offs at the Greyhound Station would be accommodated.

Figure 3-17 Puyallup Avenue and East E Street Plan View – Alternative 3



Summary

Figure 3-18 summarizes what Alternative 3 means for people driving, walking, biking, taking transit, or operating freight.

Figure 3-18 Alternative 3 Modal Impacts

	PEDESTRIANS Pedestrian realm 9' to 16' wide; widest of the alternatives Buffered from vehicle traffic by trees in Industrial and TOD Districts
	BICYCLISTS Buffered bike lanes next to parking
	TRANSIT Buses stop in general purpose lane Bus bulbs (widened sidewalk) replace parking at bus stops
	FREIGHT Two way left turn lane provided
	PLACEMAKING Street trees added in Industrial and TOD Districts on both sides
	DRIVERS One lane per direction Two way left turn lane provided On-street parking on both sides

Although the alternatives differ in significant ways, many elements are consistent in all three alternatives. Regardless of which alternative is selected for further development, a complete streets concept for Puyallup Avenue will feature the following elements:

Transit

- Bus stops will be consolidated at East D Street and East L and M Streets
- Current Tacoma Dome Station transit lanes between East E Street and East G Street will be maintained

Traffic Control

- A new traffic signal will be installed at East L Street
- Signals will be optimized

Channelization

- East D Street southbound approaching Puyallup Avenue will be rechannelized to three lanes instead of two, allowing right turns, through movement, and left turns, with bicycle lanes on both sides of the street.

Turning Movements

- Left turn pockets are maintained in Alternatives 1 and 3

4 PRELIMINARY ALTERNATIVES EVALUATION

The focus of preliminary alternatives evaluation was on identifying the ways unique elements of the alternatives meet the project's goals and community desires for the corridor. As noted in Chapter 2, the project evaluation framework is not intended as a tool for **scoring** the alternatives; rather, it is intended to help describe and communicate the **relative benefits and tradeoffs** of each alternative, illustrating the differences between them.

Preliminary evaluation is a way to help the project team and the public understand how the alternatives support the project's goals and how each performs against the metrics developed to express those goals. The results of the preliminary evaluation and feedback from the public help to illustrate what people like about each alternative and where there is room for improvement. This, then, informed the development of a fourth alternative, described in Chapter 7.

Evaluation results were communicated through a presentation and graphic boards during a public open house in June 2017 to help stakeholders and members of the public clearly understand the differences between alternatives.

Figure 4-1 presents the results of preliminary evaluation of the three alternatives. The results are as follows:

- **Existing** showed benefits for *Travel Times* metrics and challenges for *Creating an Inviting Destination.*
- **Alternative 1** performed solidly in the middle of the alternatives in all three categories.
- **Alternative 2** also had average benefits and tradeoffs for both *Complete Streets* and *Creating an Inviting Destination* metrics, but showed benefits relative to the other alternatives on *Travel Times.*
- **Alternative 3** showed the most benefits of the alternatives on *Complete Streets* and *Creating an Inviting Destination* metrics, and had the most tradeoffs on *Travel Times,* with the highest travel times of the alternatives.

The full scoring is provided in Appendix A.

Figure 4-1 Preliminary Alternatives Evaluation Results

Objective	Measure	Metric	Existing	Alt 1	Alt 2	Alt 3
Develop a complete street that safely accommodates walking, bicycling, transit, driving, and freight	Bicycle accommodation	Level of separation of bicycle facility	🔴	🟢	🟢	🟡
		Points of connection to the existing and planned bicycle network	🔴	🟢	🟢	🟢
	Ease of crossing and access to transit	Ease of crossing the street to/from transit stops	🔴	🟢	🟢	🟢
	Transit	Opportunities to accommodate transit stop amenities	🟡	🟡	🟢	🟢
	Driving	Provides a continuous contextual experience along the corridor that promotes consistent, safe speeds	🔴	🟡	🔴	🟢
	Freight access	Presence of a two-way left-turn lane	🟢	🟢	🔴	🟢
		Presence of turn pockets	🟢	🟢	🟡	🟢
Support travel times for freight, transit, and vehicles	Driving	Estimated vehicle travel time	🟢	🟡	🟢	🟡
	Freight	Estimated freight vehicle travel time	🟢	🟡	🟢	🟡
	Transit speed and reliability	Estimated transit travel time	🟢	🟢	🟢	🟡
Create an inviting destination	Supports transit-oriented and neighborhood development	Width of pedestrian realm	🟡	🟡	🟡	🟢
		% on-street parking spaces retained	🟢	🟡	🟡	🟢
	Pedestrian comfort	Sidewalk plus landscaping width	🔴	🟡	🟡	🟢
		Speed of adjacent traffic	🔴	🟢	🟡	🟢
		Buffers from adjacent traffic	🔴	🟢	🟡	🟡
		Shorter pedestrian crossings	🔴	🟡	🟡	🟢
	Creates “place”	Opportunities for street trees	🔴	🟢	🟡	🟢
		Curb bulbs, median islands, or other locations for public art, gateway treatments, landscaping, or placemaking elements	🔴	🟢	🟡	🟢

KEY 🔴 = Low Score 🟡 = Medium Score 🟢 = High Score

5 TRANSPORTATION FORECASTING AND OPERATIONS ANALYSIS

This chapter documents the traffic operations analysis assumptions, methodology, and findings comparing three potential multimodal improvement alternatives for the Puyallup Avenue Corridor between South C Street and Portland Avenue. This analysis evaluates four improvement conditions: one no-build condition and three build conditions. The No-Build condition would mostly maintain the existing lane configuration of the Puyallup Avenue corridor with no future improvements to Puyallup Avenue or pedestrian/bicycle facilities. Alternatives 1, 2, and 3 include modifications to convert Puyallup Avenue to a complete street configuration with a goal to serve people traveling by all modes.

TRAFFIC VOLUME FORECASTING

Overview

Traffic analysis for this project relies on a forecast of how many people will be traveling along Puyallup Avenue in the horizon year of 2040, and how they will be doing so. This section summarizes the methodology and results of traffic volume forecasting conducted by the City of Tacoma. Additional detail regarding the traffic forecasting process, methods, and results can be found in Appendix D.

A Tacoma citywide traffic forecasting model was developed, calibrated, and validated by a consultant in 2014. This model has been used to conduct and validate traffic operation assumptions for the City of Tacoma Transportation Master Plan in 2014 and the Tacoma Mall Neighborhood Subarea Plan in 2015-2016. The model performed well in these larger study areas; however, the model performance at a corridor level for the Puyallup Avenue study was determined to be unacceptable by City staff, and a more intensive land use and traffic data exercise was recommended.

Key inputs and assumptions used to generate the traffic forecast for Puyallup Avenue include: 2016 traffic volumes, major trip generators, land use, and mode split. Assumptions and results for each of these inputs are summarized in this section.

2016 Traffic Volumes

The City of Tacoma conducted 24-hour traffic counts along Puyallup Avenue in 2016 to establish a baseline level of motor vehicle traffic on the corridor. Traffic forecasts for 2040 are based on these counts. The traffic data also helped in identifying the key traffic generators and their relationship with Puyallup Avenue's overall traffic volumes and operation.

The current average daily traffic (ADT) on Puyallup between Pacific Avenue and Portland Avenue is approximately 15,000 vehicles. ADT near Tacoma Dome Station (TDS) is roughly 17,700, which

is nearly 3,000 more than the average daily traffic volumes on the rest of the corridor, highlighting the importance of TDS as a trip generator on the corridor.

Major Trip Generators

Tacoma Dome Station is a major multimodal hub for Puyallup Avenue and the region, with an average of 3,300 weekday boardings as of 2016. The parking garage at TDS is also a major generator of vehicle trips on Puyallup Avenue. The average rate of parking utilization at TDS park-and-ride was 97% in 2016, indicating that parking demand is higher than practical capacity (90%) and results in "cruising" for empty spaces. Additionally, nearly 93% of people arrive at the park-and-ride by car, whether driving alone, carpooling, or being picked up or dropped off.

Based on existing ridership at TDS and mode of arrival to the TDS park-and-ride, the City of Tacoma estimates that TDS generates approximately 6,000 daily driving trips, accounting for more than one-third of total motor vehicle traffic on Puyallup Avenue.

Land Use

A forecast of future land use was developed to estimate the number of people who will be living and working along the Puyallup Avenue corridor in 2040. These population and employment forecasts, in turn, are used to estimate the number of trips that people will be making along the corridor in the future.

Two different methodologies were used to produce land use forecasts for the project. The first methodology uses projected population and employment rates in traffic analysis zones (TAZs) as defined by the U.S. Census Bureau. The TAZ dataset represents growth allocation forecasts for population, households, and employment for the region as a whole. The second methodology, Build-Out, involves a land use analysis that identifies the potential residential and non-residential square footage that could be constructed under existing zoning regulations. The forecast from the Build-Out scenario represents the amount of growth that can be supported without changes to the existing land use code. Overall, the TAZ method for forecasting land use resulted in higher population and employment rates than the Build-Out method (see Appendix D for results of each methodology).

Using these two methods, the City developed a practical growth scenario for 2040 population and employment in the Puyallup Avenue corridor. This scenario predicts growth for Puyallup Avenue based on an understanding of development potential and trends along the corridor. For example, TAZ 3 is primarily an industrial zone with single-story buildings where the number of employees per square foot is expected to be lower, so smaller forecasts for population and employment were assumed. A similar exercise was completed to identify the appropriate growth for each TAZ in the corridor. A summary of the projected population and employment numbers for 2040 by TAZ is shown in Figure 5-1.

Figure 5-1 Puyallup Avenue Projected Population and Employment (2040)

Traffic Analysis Zone (TAZ)	2040 Population	2040 Employment
1	8,815	5,512
2	3,771	1,823
3	375	5,518
4	4,583	2,329

Mode Split

Mode split refers to the proportion of people using a mode of transportation—driving, taking transit, bicycling, walking, or carpooling. The City of Tacoma's 2015 Transportation Master Plan (TMP) proposes a reduction in single-occupancy vehicle (SOV) trips by more than 20% and an increase in high-occupancy vehicle (HOV) trips by 13% citywide by the year 2040. For this project, an alternate mode split is assumed that uses a more moderate change in SOV and HOV trips. Figure 5-2 summarizes the existing mode split, TMP target mode split, and the refined mode split used for this project. The refined mode split suggests a higher number of vehicles will be on the corridor in 2040 than the TMP mode split, but fewer than existing mode split.

Figure 5-2 Puyallup Avenue Corridor Study Proposed Mode Splits

Mode	Refined Mode Splits (%)	TMP Proposed Mode Splits (%)	Existing 2012 Mode Splits (%)
Single Occupancy Vehicle (SOV)	70	55	76
High Occupancy Vehicle (HOV)	12	23	10
Walk	3	8	5
Bicycle	5	4	
Transit	10	10	5

TRAFFIC OPERATIONS ANALYSIS

This section summarizes the methodology and results of the traffic operations analysis of the alternatives and No Build conditions conducted by the consultant team using the demand projections developed by the City of Tacoma. Additional detail regarding the modeling process, methods, and results along with model output tables can be found in Appendix E.

This traffic study evaluates the future (2040) traffic conditions within the project area including intersection level of service (LOS), approach LOS, arterial LOS, intersection delay, approach delay, queue length, and arterial travel time. Analysis of intersection and arterial traffic operations was conducted for No Build, Alternative 1, Alternative 2, and Alternative 3 conditions. Analysis of traffic operations at the intersection level is focused on performance metrics such as LOS, delays, and queueing. At the corridor level, the intent of this study is to evaluate traffic progression along Puyallup Avenue in terms of travel time, speeds, and overall corridor control delay. Traffic analysis is for the PM peak period.

It is important to note that this analysis can be used to understand how the alternatives compare relative to each other, but should not be taken as an actual estimate of delay or travel time on the corridor. A detailed peak period analysis using simulation models would provide a more accurate estimate of potential corridor operations.

Methodology and Results

This section provides an overview of the key metrics used to evaluate the traffic operations of the alternatives and No Build conditions. Future (2040) year traffic volumes were calculated by the City of Tacoma's travel demand model and provided to the consultant team for the traffic operations analysis. Future (2040) year traffic volumes were based on existing traffic volumes provided by the City of Tacoma. Traffic operations, including level of service, vehicle queueing,

and travel time, were determined using methods defined in the Highway Capacity Manual (HCM) and calculated using Synchro 9.1 traffic analysis software.

Vehicle Level of Service

Analysis of traffic operations is based on the concept of level of service (LOS). The LOS of an intersection is a qualitative measure used to describe operational conditions. LOS ranges from A (best), which represents minimal delay, to F (worst), which represents heavy delay and significant congestion. Intersection LOS for Puyallup Avenue was evaluated based on PM peak hour volumes.

The alternatives generally result in greater intersection delay and lower LOS than the No-Build condition because there is less vehicle capacity in the alternatives. Alternative 2 has the best operational performance of the alternatives because this alternative maintains two general purpose lanes in each direction, while Alternative 1 and Alternative 3 have a single general purpose lane in each direction resulting in decreased intersection LOS at some locations.

Vehicle Queuing

Vehicle queueing at intersections along Puyallup Avenue during peak periods was calculated by estimating the maximum queue length. This measure represents the maximum length of backup due to delays at intersections under the heaviest traffic conditions. During the PM peak period, traffic volumes are expected to result in backups equal to or greater than the maximum length of the queue. During the remaining 95% of rush hour (and during off-peak times), queue lengths are expected to be less than this maximum. Vehicle queueing was evaluated based on PM peak hour volumes.

Inputs for calculating this measure, including turn pocket storage lengths and distances between arterial intersections, were measured using Google Earth. Under Alternatives 1, 2, and 3, lane geometrics and storage lengths were based on conceptual drawings.

Under 2040 No-Build conditions, up to six arterial movements are expected to exceed the available storage length and result in vehicle queueing and delays. Alternatives 1, 2, and 3 are expected to experience similar delays except for the delays at East G Street. The alternatives are expected to result in delays for additional movements as well.

Travel Time

At the corridor level, this study evaluates arterial travel time along Puyallup Avenue. Travel time is measured for people traveling straight along the corridor between the west side of the intersection with Pacific Avenue and the east side of the intersection with Portland Avenue in the eastbound and westbound directions. Travel time figures reported here do not capture travel time improvements or delays for people making turns onto and off of the corridor. Estimated travel time is equal to the amount of time it takes to travel the corridor, plus expected signal delay at intersections. An estimate of traffic speeds along the corridor was also developed by dividing the distance of the corridor (1.2 miles) by the expected travel time. Analysis of corridor travel time was conducted using Synchro's arterial analysis, following HCM methodologies.

Synchro software was utilized to evaluate corridor performance along Puyallup Avenue for No-Build conditions and for each of the three alternatives. Compared to the No-Build scenario, travels times for Alternative 1 are 2.1 minutes longer in the eastbound direction and 2.2 minutes longer in the westbound direction. The exception to Alternative 1 travel times is the HOV lane in the eastbound direction. It is estimated that the HOV lane would provide an unimpeded travel

time for transit and carpool vehicles that would be similar to a No-Build configuration. The travel time range of the HOV lane is an estimate of the travel time for both transit and HOV vehicles. It is shown as a range to account for the variation in dwell time of transit vehicles.

The vehicle travel times for Alternative 2 are one minute longer in the eastbound direction and 12 seconds longer in the westbound direction compared to the No-Build scenario. Eastbound travel times are longer than westbound travel times in this alternative due to signal re-timing at Pacific Avenue that favors people turning left onto Puyallup Avenue from Pacific Avenue and people turning right onto Pacific Avenue from Puyallup Avenue. People making these two turning movements represent the majority of traffic volumes at this intersection and will experience better signal timing than in the No-Build scenario. However, this signal re-timing will result in longer signal delay for the limited numbers of vehicles traveling straight through the intersection.

Travel times for Alternative 3 are 2.3 minutes longer in the eastbound direction and 2.5 minutes longer in the westbound direction when compared to the No-Build scenario.

Additional Considerations and Model Limitations

Synchro has several limitations that prevent the software from performing a complete multimodal analysis of this corridor. It is important to recognize these limitations and understand that this traffic operations analysis is an analysis of the general purpose traffic and does not evaluate the pedestrians, bicyclists, and transit rider experience. Leading pedestrian intervals, leading bicycle intervals, transit signal priority, bus stops, and exclusive lanes are all elements that are not explicitly included in the model. Where possible, assumptions were built in to estimate the effects of these multimodal elements.

Consideration and balancing of the City's goals to enhance and promote high occupancy travel, multimodal connectivity, and experiential travel will be combined with the traffic operations information as the City moves forward with additional design for the corridor. The following are recommendations for any subsequent traffic analysis associated with a preferred alternative and recommended alternative refinements:

- Perform a re-calibration of the City of Tacoma travel demand model to allow for additional understanding about the dynamic land use effects on future traffic patterns.
- Maintain close coordination with Sound Transit to understand if they will seek to repurpose the Puyallup Avenue corridor into a light rail route for access to the Tacoma Dome Station.
- Synchronize the City of Tacoma travel demand model with the Dynameq and VISSIM model platforms to allow for further consideration of traffic impacts from future land use assumptions.
- Consider how event use will impact the corridor operation for all modes.

Summary

The following figures portray preliminary traffic modeling results—average eastbound and westbound travel times, intersection level of service, and expected queue length—for the 2040 No-Build scenario and for 2040 Alternatives 1, 2, and 3. The travel time range of the HOV lane in Alternative 1 is shown as a range to account for the variation in dwell time of transit vehicles.

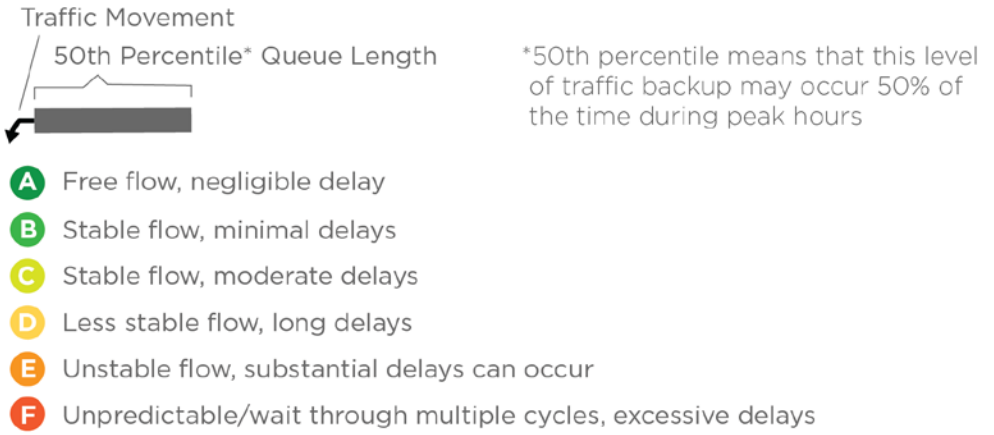


Figure 5-3 Peak Hour Traffic Operations Results – No Build

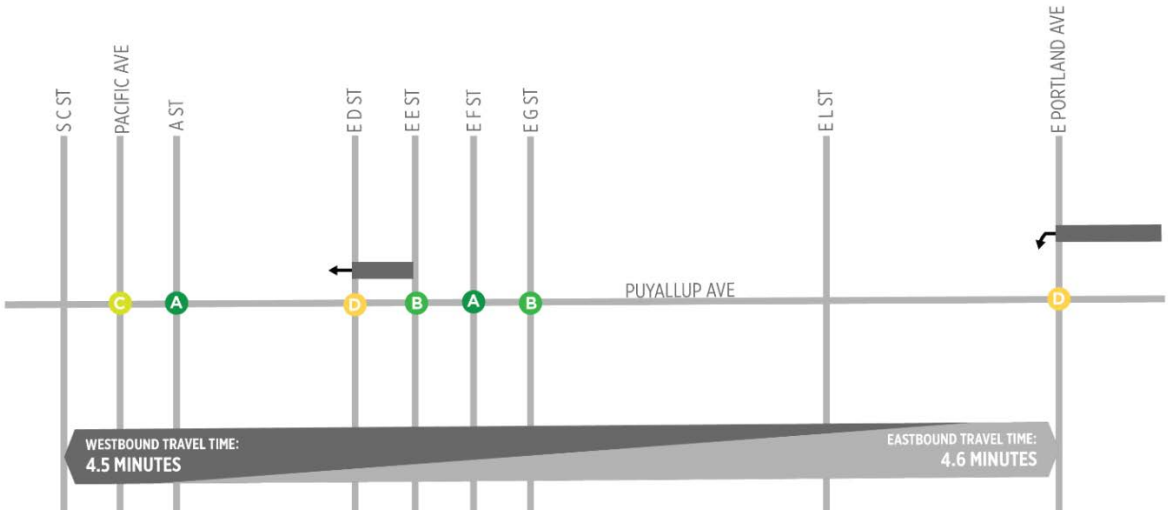


Figure 5-4 Peak Hour Traffic Operations Results – Alternative 1

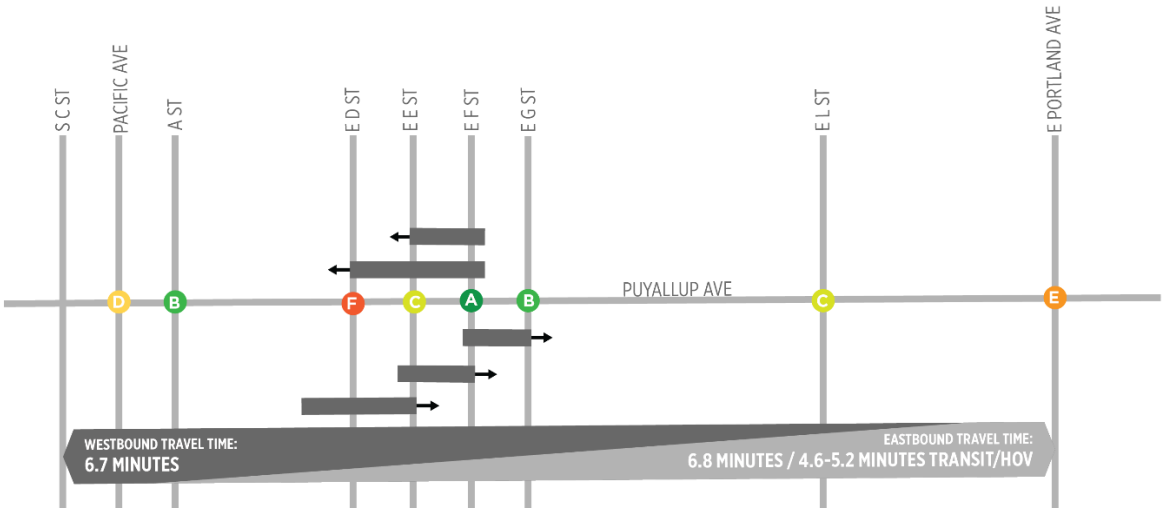


Figure 5-5 Peak Hour Traffic Operations Results – Alternative 2

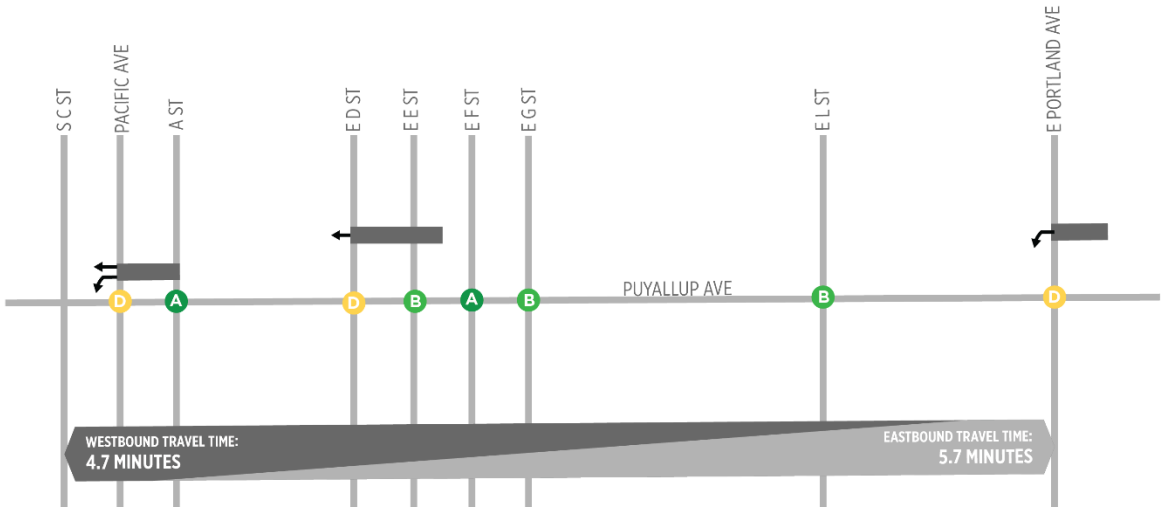
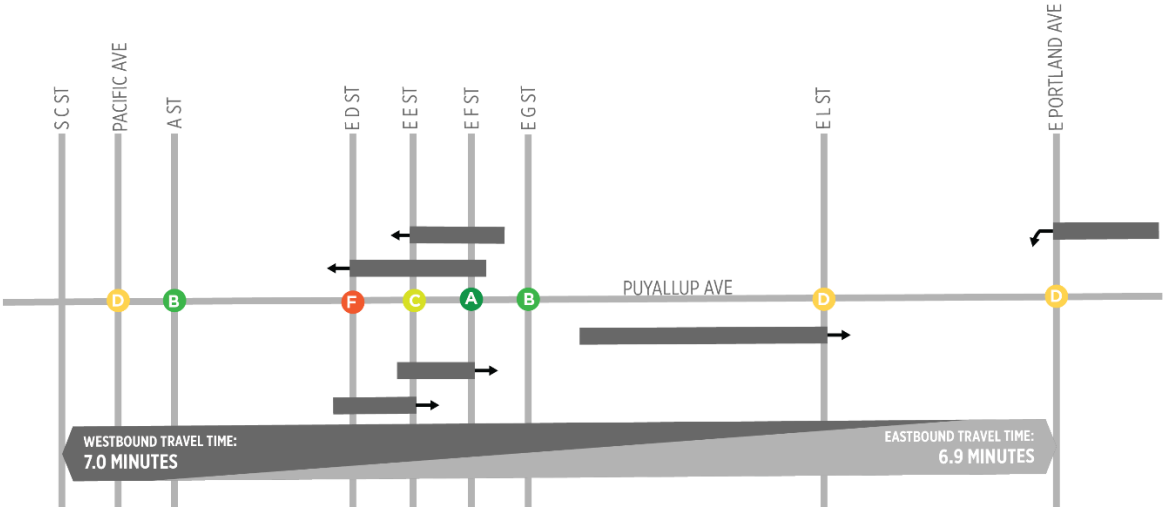


Figure 5-6 Peak Hour Traffic Operations Results – Alternative 3



6 ALTERNATIVES OUTREACH

This chapter summarizes the key themes and findings from community outreach efforts regarding the preliminary alternatives. Comments were received via a public open house held in June 2017, an online version of the open house that was available on the City of Tacoma's website through July 2017, and letters from the City of Tacoma Transportation Commission and Pierce Transit.

PUBLIC OPEN HOUSE

The City of Tacoma hosted a public open house to share information about three conceptual design alternatives for the Puyallup Avenue Corridor on June 5, 2017. The open house was held at the Summit Olympus Public School (409 Puyallup Avenue) from 5 to 7 p.m. with a short presentation at 5:30 p.m.

Meeting attendees were invited to identify aspects of each alternative that they liked or disliked. Approximately 20 people attended and provided more than 55 comments. Comments were also solicited via email on the project website through July 14, 2017, from people who were not able to attend the meeting.

Meeting attendees listen to a presentation about the three conceptual design alternatives.

Notification

Notice for the meeting was shared through the project website, e-mail to community stakeholders and the project listserv, and flyers and posters distributed to businesses and community destinations on and near the corridor.

A total of 20 posters were distributed at 11 locations (including multiple posters at places like Tacoma Dome Station), and flyers were also left at some locations like the Summit School. Locations for posters were:

- Elements of Sunshine (massage)
- Summit Olympus School
- Wingman Brewing
- Tacoma Dome bus station
- Dockside Donuts
- The Valley
- The ST Breezeway @ Freighthouse
- Friesenburgers
- New Frontier Bar
- Alfredo's
- Climb Tacoma

Public Comments

The following comments were summarized from notes written on the display boards by meeting participants. Participants also used dots and sticky notes to share their feedback by marking in one of two columns: "I like it!" and "I have concerns." Year 2040 traffic modeling results for the "No Build" scenario (if there are no changes to the corridor) and for each alternative were also presented, but this board received no comments. A verbatim list of comments received are listed in Appendix B, and the display boards used in the public meeting and online open house are shown in Appendix C.

Public Comments by Mode

Participants were invited to provide feedback on the three conceptual alternatives and what they mean for people traveling by different modes as well as individual project elements, including pedestrians, bicyclists, transit, freight, placemaking, and drivers. Figure 6-1 summarizes what people liked about each alternative, by mode. Overall, Alternative 1 garnered the most "I Like It" votes, followed by Alternative 3.

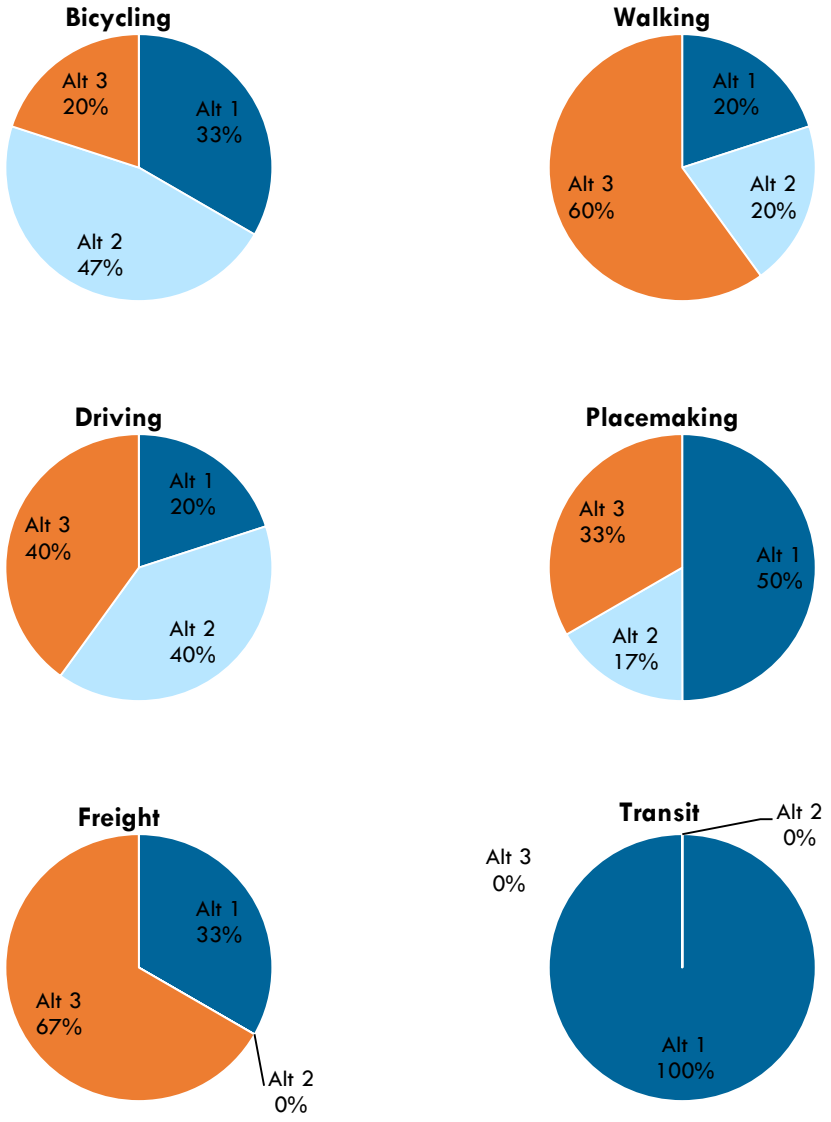
For **transit**, people preferred Alternative 1, which features a transit/HOV only lane, noting that the proposal communicates "*a strong message*" about the importance of transit. Other suggestions included:

> *"Consider managed westbound land with transit priority during peak hours"*
>
> *"Could you do this transit/HOV but have PBL?"*
>
> *"Tacoma Link extension to TCC needs eastbound couplet from East G to Pacific Avenue. Build out date is 2039. Please plan accordingly."*

For **bicycling**, people liked the options for presented in Alternative 2, which proposed parking protected bike lanes on both sides of the street. People liked the idea of parked cars buffering bikes from traffic, noting that with this option there is a "*boulevard feel created*." Additional suggestions for the buffered bike lanes included using planters as a delineator, and creating mountable curb separation or a mountable curb bike lane.

Alternative 3 received the most positive comments related to **walking**. One commenter noted that they like that pedestrians are also buffered from traffic by the protected bike lanes.

Figure 6-1 Alternative Preference by Mode



Across the three alternatives, people had the most concerns regarding bicycling. Four people noted that they have concerns about bicycling in Alternative 3, which proposes buffered bike lanes on both sides of the street. Comments regarding this option indicated a general preference for protected bicycle facilities along the corridor. Three people also noted concerns about bicycling in Alternative 1, which proposed a two-way shared use path along the north side of the

corridor that switches to the south side of the street at East L Street. People indicated a preference for bike lanes on both sides of the street and concerns about how the shared use path would connect to existing facilities at either end of the corridor. There were some concerns regarding driving in Alternative 1, with respondents noting that less on-street parking and more loading spaces for pick-ups and drop-offs are preferred.

Public Comments by District

Participants were also invited to comment on the conceptual alternatives within each specific sub-area of the Puyallup Avenue corridor, or district, that each have a different character and cross-section width. The three districts from west to east are:

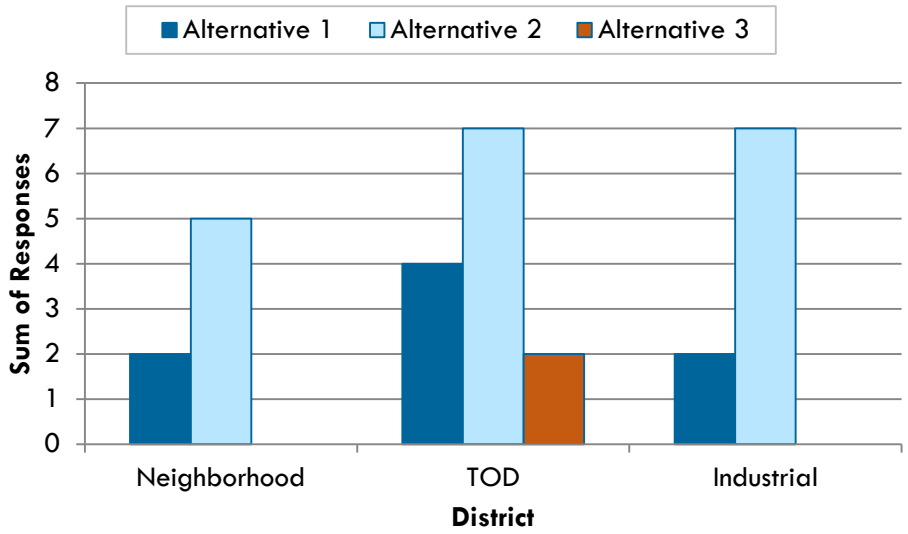
- **Neighborhood District:** South C Street to East D Street
- **TOD (Transit-Oriented Development) District:** East D Street to East G Street
- **Industrial District:** East G Street to Portland Avenue

For the **Neighborhood District**, people prefer Alternative 2, then Alternative 1. People liked the dedicated left turn onto Pacific Avenue southbound, the dedicated signals, and protected bike lanes on both sides of the street in this option. One respondent commented that Alternative 1 would be best for pedestrians, cyclists, local students, and creating community in the neighborhood district as density increases in the future.

People preferred Alternative 2 in the **TOD District** as well, followed by Alternative 1. Additional ideas provided for the TOD District included allowing cyclists in the HOV lane proposed in Alternative 1 and painting crosswalks near the school bright green.

In the **Industrial District**, people preferred Alternative 2, followed by Alternative 1. Several people commented in support of the protected bike lanes proposed by Alternative 2. Others noted that the Industrial District needs transit priority as lots of buses use that portion of the corridor.

Figure 6-2 Sum of "I Like It" Responses by District



Concerns with the alternatives were most prevalent for the TOD District. Although Alternative 2 was popular in all three districts, people noted the most concerns regarding Alternative 2 in the TOD District. In the TOD District, concerns centered on traffic, queue length for turning vehicles, creating a pedestrian- and bike-friendly environment, and sidewalk access.

In the Neighborhood District, people were concerned about managing on-street parking and protection for bicyclists under Alternative 3.

For both the Neighborhood and TOD Districts, people shared concerns related to consistency along the corridor as well as landscaping maintenance. In the TOD District, people expressed that left turns should be provided throughout. Some were concerned that two lanes would not be sufficient to handle traffic in the Industrial District, as proposed in Alternative 3.

Additional Public Comments

Community members provided written feedback at the open house or online via email regarding the alternatives. Key themes from those comments are as follows:

- Support for a cross-section with buffered bike lanes and one general-purpose vehicle lane in each direction with an intermittent center turn lane. Many support an eastbound bus-only lane in their preferred layout.
- Support for the shared use path proposed in Alternative 1. People supported a two-way cycle track as a way to provide bicycle access to Tacoma Dome Station, support transit, and send a message that the City of Tacoma is working to make cycling safe.
- There was support for narrowing and reducing the number of vehicle lanes and prioritizing space for pedestrians by widening sidewalks.
- People are seeking more details on several elements:
  - bike parking
  - potential width of bike buffer
  - new crossings for pedestrians
  - connections to existing and future bike lanes
  - plans for landscaping and/or planting strip maintenance
  - drop-off access to Tacoma Dome Station by Uber/Lyft or personal vehicle

CITY OF TACOMA TRANSPORTATION COMMISSION

The City of Tacoma Transportation Commission, with consultation from the Bicycle and Pedestrian Technical Advisory Group and Sustainable Tacoma Commission, offered comments and guidance on the Puyallup Avenue Corridor Conceptual Design in September 2017. The City of Tacoma Transportation Commission is comprised of 11 appointed and/or elected members, representing a range of perspectives and expertise from professional engineers, construction and private business, bike, pedestrian, and transit, planning and urban growth, environment and sustainability, ADA community, and general community sectors.

The Transportation Commission reviewed the three preliminary alternatives for Puyallup Avenue and provided feedback regarding the overall planning approach, on and off street parking, pedestrian and bicycle, transit, and freight components of the plan. They outlined six key recommendations for the corridor:

- Let this plan be the first of many drafting phases, including funding, with the City of Tacoma prioritizing a holistic review and design of the corridor to include East 25th Street.
- Remove on-street parking between Pacific and Portland Avenues to allow for safer and more effective and efficient pedestrian, bicycle, and transit level of service, and relocate, when applicable, to side streets.

- A bidirectional protected bicycle facility along the entire length of Puyallup Avenue (Alternative 1).
- Sidewalks and street plantings along the entire length of Puyallup Avenue and safer pedestrian crossings (included in all alternatives).
- An eastbound and westbound transit lane along the entire length of the Puyallup Avenue corridor between Pacific Avenue and Portland Avenue (Alternative 1 + new element).
- Eastbound Transit/HOV lane contained in Alternative 1; East D Street as a "Bus and Freight" lane.

Feedback from the Transportation Commission was used to develop an additional fourth "hybrid" alternative that incorporates the recommendations outlined in the letter. Detailed discussion of the fourth alternative is presented in the following chapter. The full text of the Transportation Commission's letter is provided in Appendix H.

PIERCE TRANSIT

Pierce Transit provided comment on the preliminary alternatives for Puyallup Avenue in August 2017. Pierce Transit indicated support for an eastbound transit only lane along Puyallup Avenue, indicating that transit lanes would be used by Pierce Transit, Sound Transit, and Intercity Transit. Together, these agencies operate over 500 trips per day in the vicinity of Tacoma Dome Station and along Puyallup Avenue, East D Street, and East 26th Street.

To support growing transit use along the corridor, Pierce Transit requested the inclusion of several additional transit-supportive elements on Puyallup Avenue, as illustrated in Figure 6-3.

Figure 6-3 Pierce Transit Proposed Puyallup Avenue Transit Treatments

Source: Pierce Transit, August 2017

Pierce Transit's proposed Puyallup Avenue transit treatments are:

- An eastbound transit lane along Puyallup Avenue from Pacific Avenue to Portland Avenue (presented in Alternative 1).
- Transit signal priority treatments at the intersections of Puyallup Avenue and Pacific Avenue, A Street, East D Street, East E Street, East G Street, and Portland Avenue.
- An eastbound queue jump at the intersection of Puyallup Avenue and East G Street.

- A westbound transit lane along 26th Street and G Street, connecting Pacific Avenue and Puyallup Avenue, along with transit signal priority at four westbound locations.

Analysis of these transit treatment benefits by Pierce Transit indicates that an eastbound BAT lane plus queue jumps and/or transit signal priority would result in travel time savings for transit vehicles and passengers of three minutes in the eastbound direction and nearly two minutes in the westbound direction.

Feedback from Pierce Transit was included in the recommendations outlined by the Transportation Commission as well as used to develop an additional fourth "hybrid" alternative. Communications and documentation of transit needs on Puyallup Avenue provided by Pierce Transit are compiled in Appendix I.

7 ALTERNATIVE 4 – INTERIM HYBRID

The project team developed a fourth alternative that incorporates results from the multimodal evaluation, traffic forecasting and operations analysis, and public outreach. This alternative was refined with City of Tacoma staff in September 2017. Alternative 4 is one potential solution for the corridor. The final design and layout for Puyallup Avenue will be based on number of factors, including the following:

- Sound Transit's Link Light Rail extension
- Pierce Transit's High Capacity Transit Study
- Potential use of parallel corridors to accommodate specific travel modes
- Puyallup Avenue on-street parking analysis
- Additional public outreach

DEVELOPMENT

The process of developing Alternative 4 began with a review of the evaluation results of the first three alternatives and the input received from the public. As described in Chapter 4, the preliminary evaluation results are a tool to help people understand the relative differences between the alternatives, highlighting the benefits and tradeoffs associated with the various facility types. The public engagement for the three alternatives was designed to solicit people's feedback on what elements of each alternative they liked and disliked, allowing the team to better understand what people hope a new design for Puyallup Avenue will achieve.

For example, members of the public expressed a desire for a protected bicycle facility along the corridor, and there was strong support for both a two-way multiuse path and for parking-protected bike lanes on both sides of the street. Alternative 4 includes parking-protected bike lanes because that facility type provides the greatest flexibility to support other public desires, such as wide sidewalks, landscaping, and on-street parking.

Members of the public and Pierce Transit supported a transit/HOV lane for the corridor to improve transit travel times, and that is included in Alternative 4. People also expressed a need for maintaining adequate vehicle capacity in some areas to ensure that important connections are maintained. Rather than providing two general purpose lanes in each direction throughout the length of the corridor—which would have eliminated the potential for transit/HOV lanes on the corridor and potentially impacted the type of biking facility—Alternative 4 generally includes three general-purpose lanes, with a fourth added near D Street to accommodate increased vehicle volumes and turning movements related to the transit center.

This approach to tailoring the corridor's design to meet different needs in different locations meets the project's goal of respecting and enhancing the character of the three distinct districts along the corridor.

It is fair to say that the preliminary evaluation results informed the public engagement, which was another key piece of information used to shape a hybrid alternative. More information about the specific elements included in Alternative 4 is provided in the following sections.

DESCRIPTION

Transit/HOV Lane and Travel Lanes

Although Alternative 2, with two general purpose lanes in each direction, was favored by members of the public, the elements of Alternative 2 that were most attractive to people were the parking protected bicycle lanes and overall access rather than the number of vehicle lanes. The public expressed concerns about speeds along the corridor and challenging pedestrian and bicyclist conditions resulting from maintain two general purpose lanes in each direction. In terms of travel lanes, public and stakeholder comments from the alternatives outreach showed strong support for a transit and high-occupancy vehicle-only lane in the eastbound direction. Traffic operations analysis of Alternative 1 showed travel time savings for eastbound travelers using the dedicated transit/HOV lane between 1.6 and 2.2 seconds.

To respond to the support for improved transit travel times, Alternative 4 proposes a single general purpose lane in each direction and an eastbound transit/HOV lane throughout the majority of the corridor. (Although Pierce Transit supports a transit/HOV lane in both directions, agency staff indicated that the eastbound direction is a higher priority given the concentration of buses moving toward the freeway in the morning.) Eastbound buses would stop in the exclusive transit/HOV lane and westbound buses would stop in the westbound general purpose lane. Bus bulbs would be provided at the following locations:

- Puyallup Avenue/Pacific Avenue eastbound
- Puyallup Avenue/I-705/Dock Street eastbound and westbound
- Puyallup Avenue/East D Street eastbound
- Puyallup Avenue/East C Street westbound
- Puyallup Avenue/McKinley Avenue eastbound
- Puyallup Avenue/East J Street eastbound and westbound
- Puyallup Avenue/East L Street eastbound and westbound

Traffic operations analysis suggested that traffic volumes and queue lengths would result in delays for westbound drivers in the TOD District of the corridor between East D Street and East G Street. Alternative 4 proposes two westbound travel lanes for this segment of the corridor, as well as left turn pockets at intersections.

Bicycle Lanes

For bicyclists, Alternative 4 includes parking-protected bike lanes on both sides of Puyallup Avenue for the entirety of the corridor, which was the solution most supported through public and stakeholder outreach. In general, the layout is a 9' protected bike lane (6' bike lane with 3' buffer) along the curb in each direction. The bike lanes are buffered by 8' parking lanes along both sides of the street, except at locations where parking is dropped to provide turn lanes.

The bicycle path routes onto the sidewalk behind transit stops in the TOD District of the corridor where two westbound travel lanes and a left turn lane are provided. The benefits of this configuration are that bus riders and bicyclists each have a dedicated space. The drawbacks of this configuration are the following: 1) There is only 8' of clear space remaining for pedestrians; 2)

There may be conflicts between pedestrians and bicycles; and 3) The amount of on-street parking is reduced. A treatment similar to that proposed in Alternative 4 has been used in Portland on the Portland State University campus at streetcar stations (see Figure 7-1). Additional treatments considered for this segment are included in Appendix G.

Although there was public support for a two-way multiuse path on the north side of the street, parking-protected bike lanes were selected for inclusion in Alternative 4 to reduced potential bicycle/vehicle turning conflicts, to connect to key corridor destinations (including Tacoma Dome Station), and to simplify signal timing at intersections.

Figure 7-1 Bicycles on Sidewalk in Portland, OR

Images from Nelson\Nygaard

Figure 7-2 Signage for Bicycles on Sidewalk in Portland, OR

Image from Nelson\Nygaard

Tacoma Dome Station

Several options were considered for including bicycle lanes along the south side of Puyallup Avenue adjacent to Tacoma Dome Station. Alternative 4 proposes a long-term solution: reconstructing the curb at TDS to allow bi-directional bus pick-ups and drop-offs at the station. Today, eastbound buses stop on the north side of island, but this option would bring eastbound buses into the bus bay. This option keeps the eastbound bicycle lane on the curb and allows HOV vehicles to have a continuous experience without weaving around cyclists. It is important to note that this option is conceptual and implementation would require careful coordination with transit agencies, community members, and stakeholders.

Pedestrian Crossings

High visibility striped crosswalks would be installed for all signalized intersections along the corridor, and an artistic crosswalk would be installed at East D Street. Pedestrian safety islands would be provided for the crossings at I-705, McKinley Avenue, East J Street, and Portland Avenue. Additionally, fixed pedestrian signal heads would be installed at Pacific Avenue, A Street, East D Street, East E Street, East F Street, and East G Street. Leading pedestrian intervals would be installed at all of those intersections with the exception of A Street. Potential signal changes at Portland Avenue would be determined during a later phase of design.

Other Improvements

Other improvements along the corridor would include pedestrian-scaled lighting, street trees with tree grates, public art, and street furniture such as trash and recycling receptacles, benches or other seating, and bicycle parking.

Variations

In some places along the corridor, the layout for Alternative 4 varies depending on specific conditions and constraints:

- **Westbound travel lanes.** Two westbound general purpose lanes are included between East D Street and East F Street to resolve queueing lengths identified during the traffic operations analysis. The lanes will likely continue past East C Street; final design of the taper in the remainder of the corridor will be developed in future phases.
- **Sidewalk width.** The proposed sidewalk width varies. In the Neighborhood and TOD Districts west of McKinley Street, sidewalks are 15' (9' through with 6' tree pits). In the Industrial District east of McKinley Street, sidewalks are 11' (5' through with 6' tree pits). Tree grates are included to provide additional walking space. Pedestrians are buffered from vehicle traffic throughout the corridor by trees, protected bicycle lanes, and parking.
- **Center turn lane.** In the Industrial District, the two-way center turn lane is maintained to support freight access and operations in this part of the corridor. In this segment, the protected bicycle lanes and sidewalk through areas are narrower than in the rest of the corridor, but still provide safe facilities for people walking and biking.
- **Turn pockets.** Where left turn lanes are provided at intersections, parking spaces are dropped to create room. At the intersection of Puyallup Avenue and Pacific Avenue, a westbound right turn pocket is provided in addition to a left turn lane. In the TOD District of the corridor between East D Street and East G Street, Alternative 4 proposes a center median with left turn pockets at intersections.
- **West of Pacific Avenue.** For the area west of Pacific Avenue where the right-of-way narrows to 80', sidewalks are 14' wide and there is one 11' general purpose lane in each direction. In this small segment west of Pacific Avenue, protected bike lanes are 8' (6' lane with 2' buffer), protected from traffic by 7' parking lanes.

The project team completed a high-level analysis of Alternative 4 to show how it compares to the original three alternatives. In general, Alternative 4 performs most similarly to Alternative 1, due to the transit/HOV lane and the high degree of separation for the bicycle facility.

Figure 7-3 Preliminary Alternatives Evaluation Results

Objective	Measure	Metric	Existing	Alt 1	Alt 2	Alt 3	Alt 4
Develop a complete street that safely accommodates walking, bicycling, transit, driving, and freight	Bicycle accommodation	Level of separation of bicycle facility	🔴	🟢	🟢	🟡	🟢
		Points of connection to the existing and planned bicycle network	🔴	🟢	🟢	🟢	🟢
	Ease of crossing and access to transit	Ease of crossing the street to/from transit stops	🔴	🟢	🟢	🟢	🟢
	Transit	Opportunities to accommodate transit stop amenities	🟡	🟡	🟢	🟢	🟢
	Driving	Provides a continuous contextual experience along the corridor that promotes consistent, safe speeds	🔴	🟡	🔴	🟢	🟡
	Freight access	Presence of a two-way left-turn lane	🟢	🟢	🔴	🟢	🟡
		Presence of turn pockets	🟢	🟢	🟡	🟢	🟢

Support travel times for freight, transit, and vehicles	Driving	Estimated vehicle travel time	🟢	🟡	🟢	🟡	🟡
	Freight	Estimated freight vehicle travel time	🟢	🟡	🟢	🟡	🟡
	Transit speed and reliability	Estimated transit travel time	🟢	🟢	🟢	🟡	🟢
Create an inviting destination	Supports transit-oriented and neighborhood development	Width of pedestrian realm	🟡	🟡	🟡	🟢	🟡
		% on-street parking spaces retained	🟢	🟡	🟡	🟢	🟡
	Pedestrian comfort	Sidewalk plus landscaping width	🔴	🟡	🟡	🟢	🟡
		Speed of adjacent traffic	🔴	🟢	🟡	🟢	🟢
		Buffers from adjacent traffic	🔴	🟢	🟡	🟡	🟢
		Shorter pedestrian crossings	🔴	🟡	🟡	🟢	🟡
	Creates "place"	Opportunities for street trees	🔴	🟢	🟡	🟢	🟢
		Curb bulbs, median islands, or other locations for public art, gateway treatments, landscaping, or placemaking elements	🔴	🟢	🟡	🟢	🟢

KEY 🔴 = Low Score 🟡 = Medium Score 🟢 = High Score

CROSS-SECTIONS

Alternative 4 is illustrated in the following conceptual cross-sections. Detailed plan views for the most complex areas of the corridor, from East D to East G Streets, are also provided below.

Figure 7-4 Neighborhood District Conceptual Cross-Section – Alternative 4

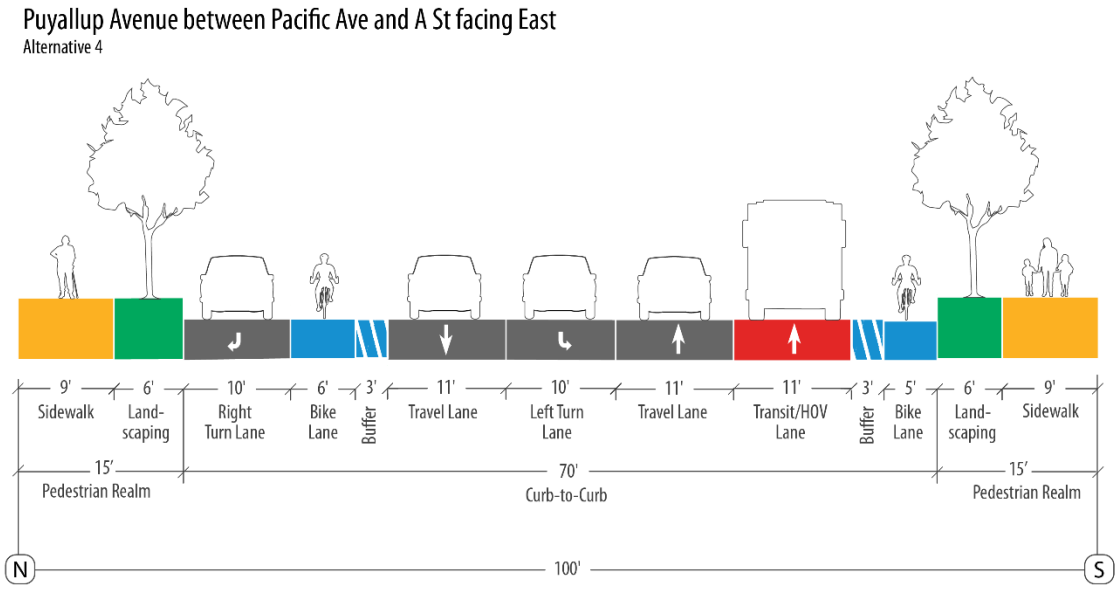


Figure 7-5 TOD District Conceptual Cross-Section – Alternative 4

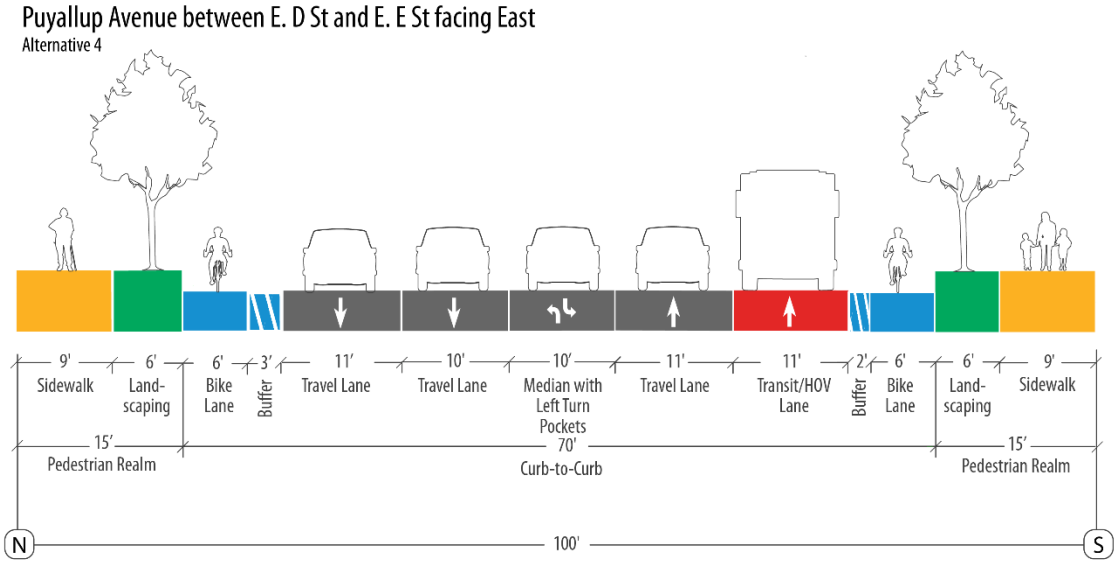
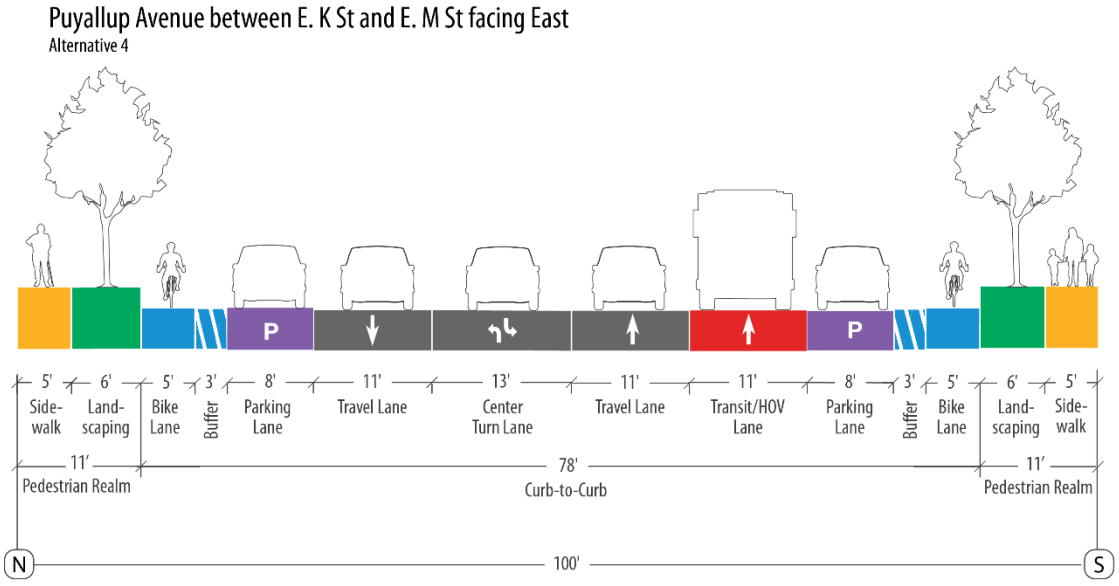


Figure 7-6 Industrial District Conceptual Cross-Section – Alternative 4



PLAN VIEWS

Figure 7-7 Puyallup Avenue from East C Street to East D Street Plan View – Alternative 4

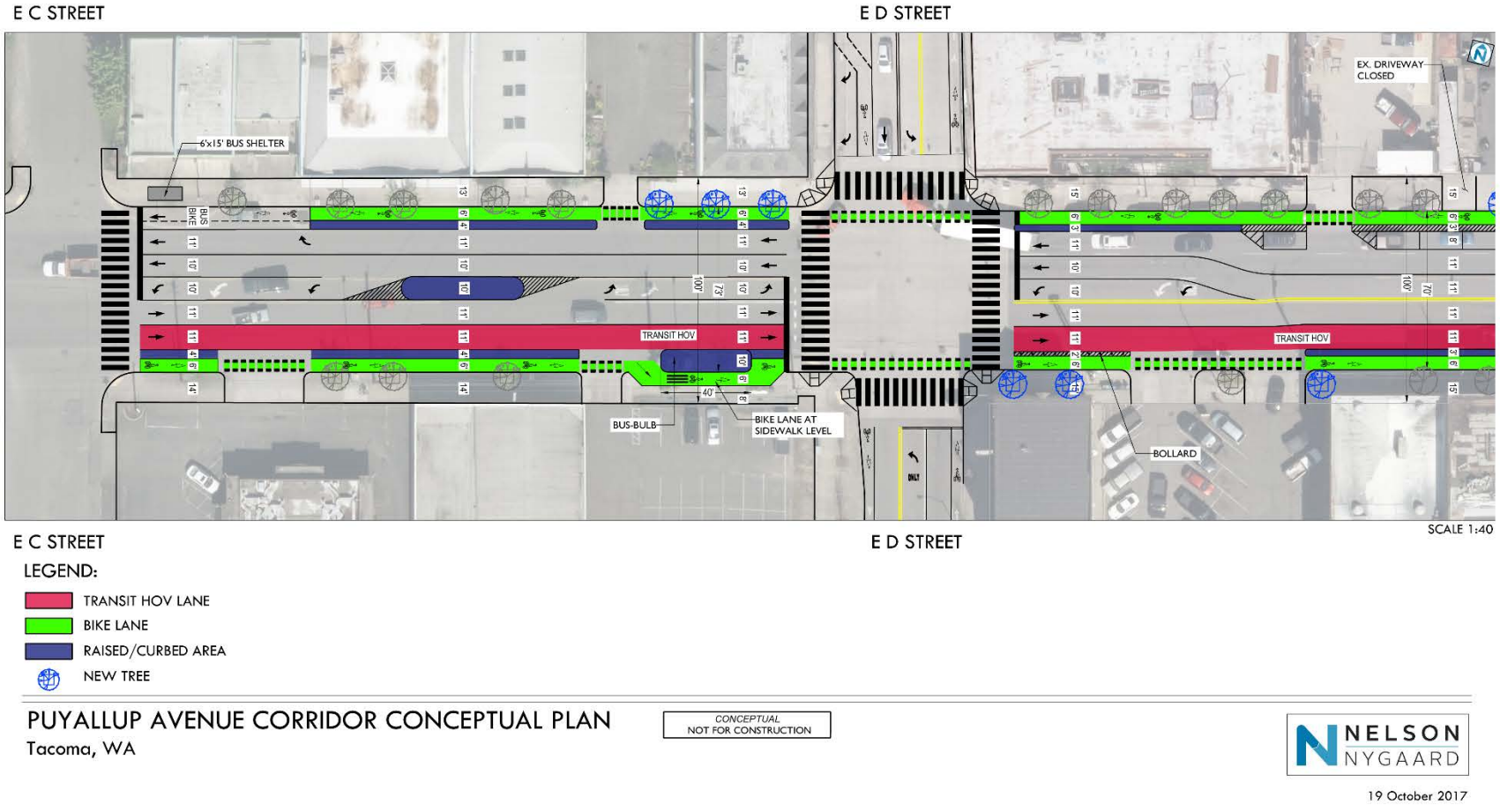


Figure 7-8 Puyallup Avenue from East D Street to East E Street Plan View – Alternative 4

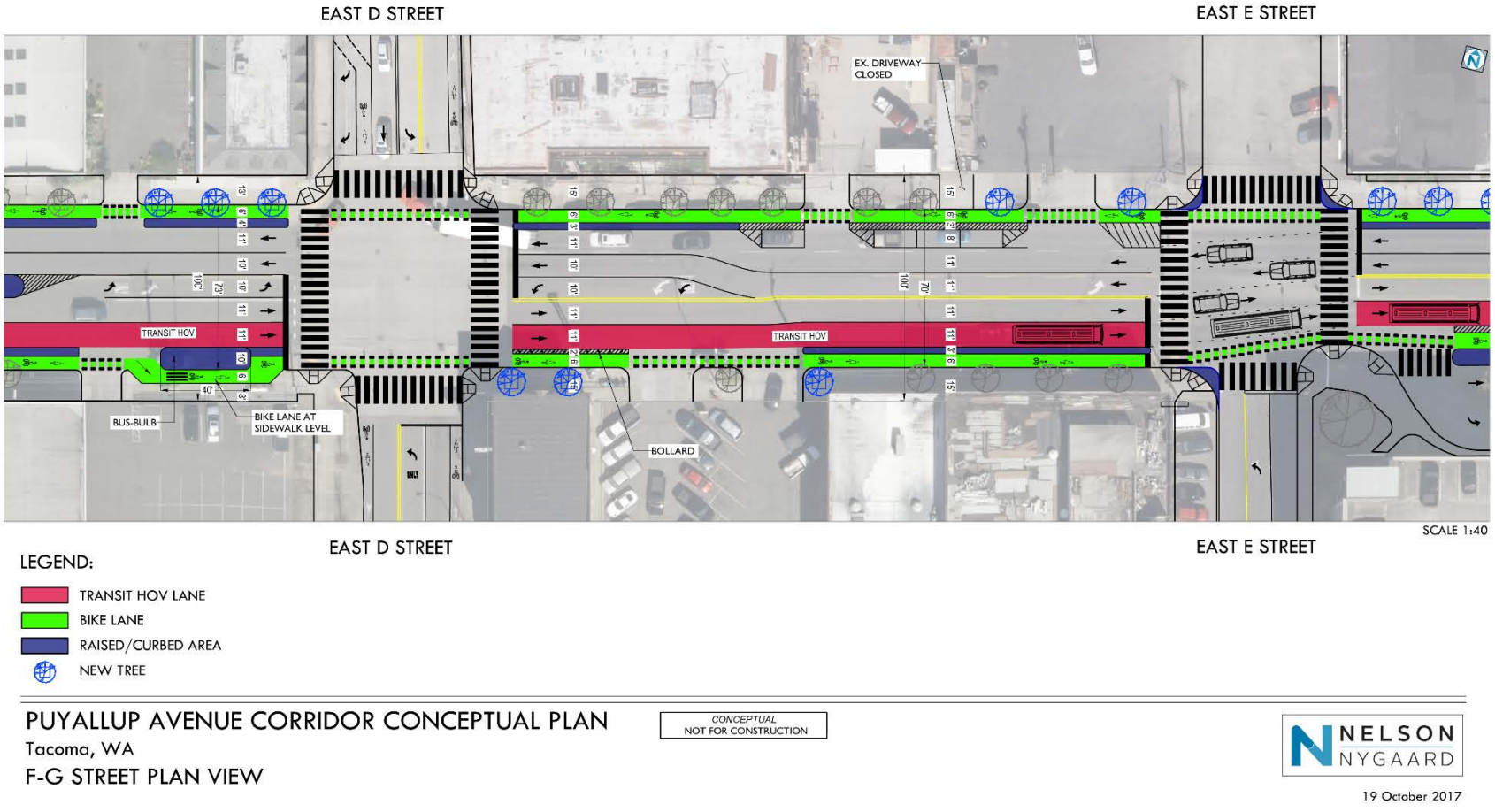


Figure 7-9 Puyallup Avenue from East E Street to East F Street Plan View – Alternative 4

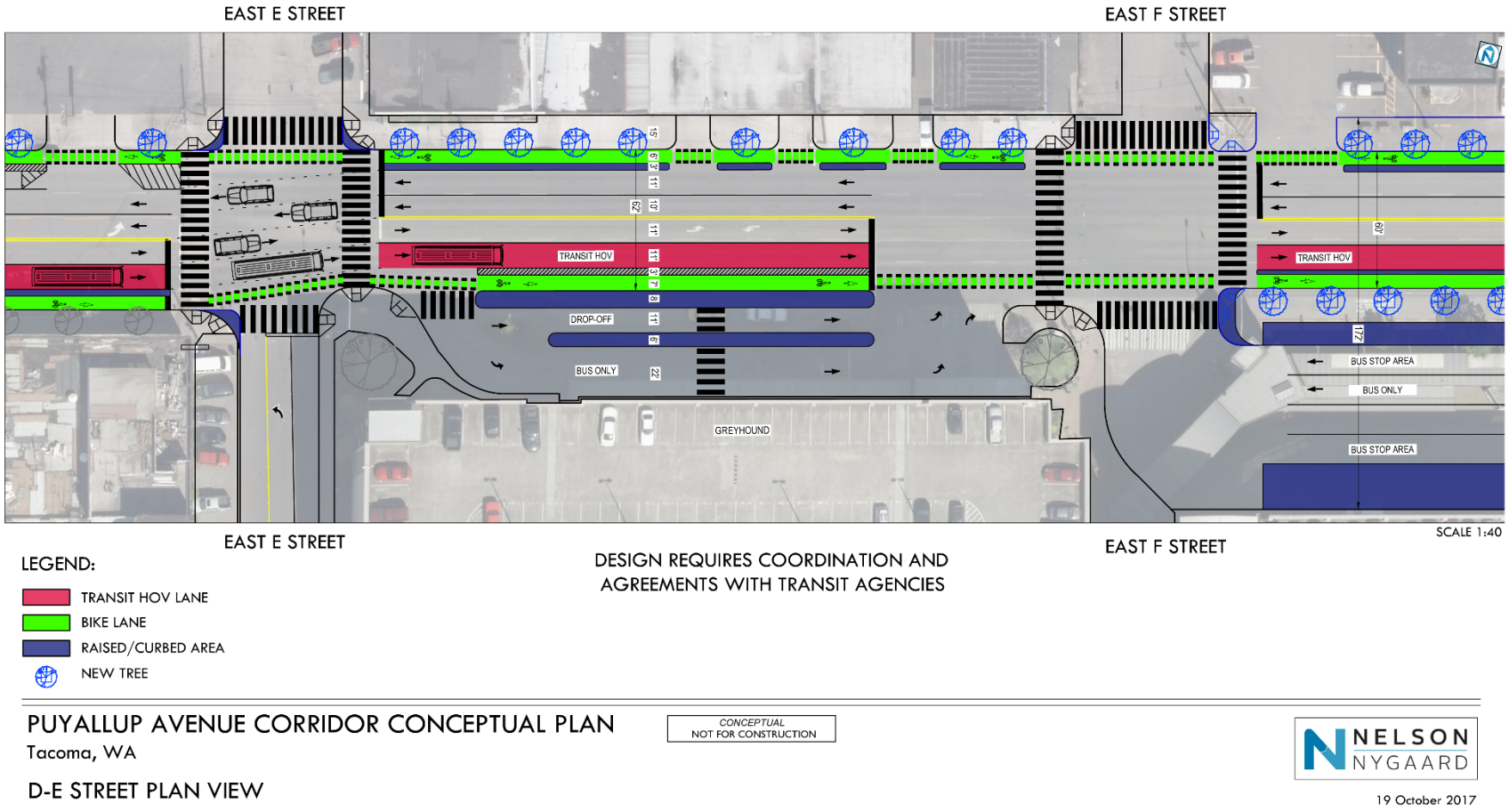
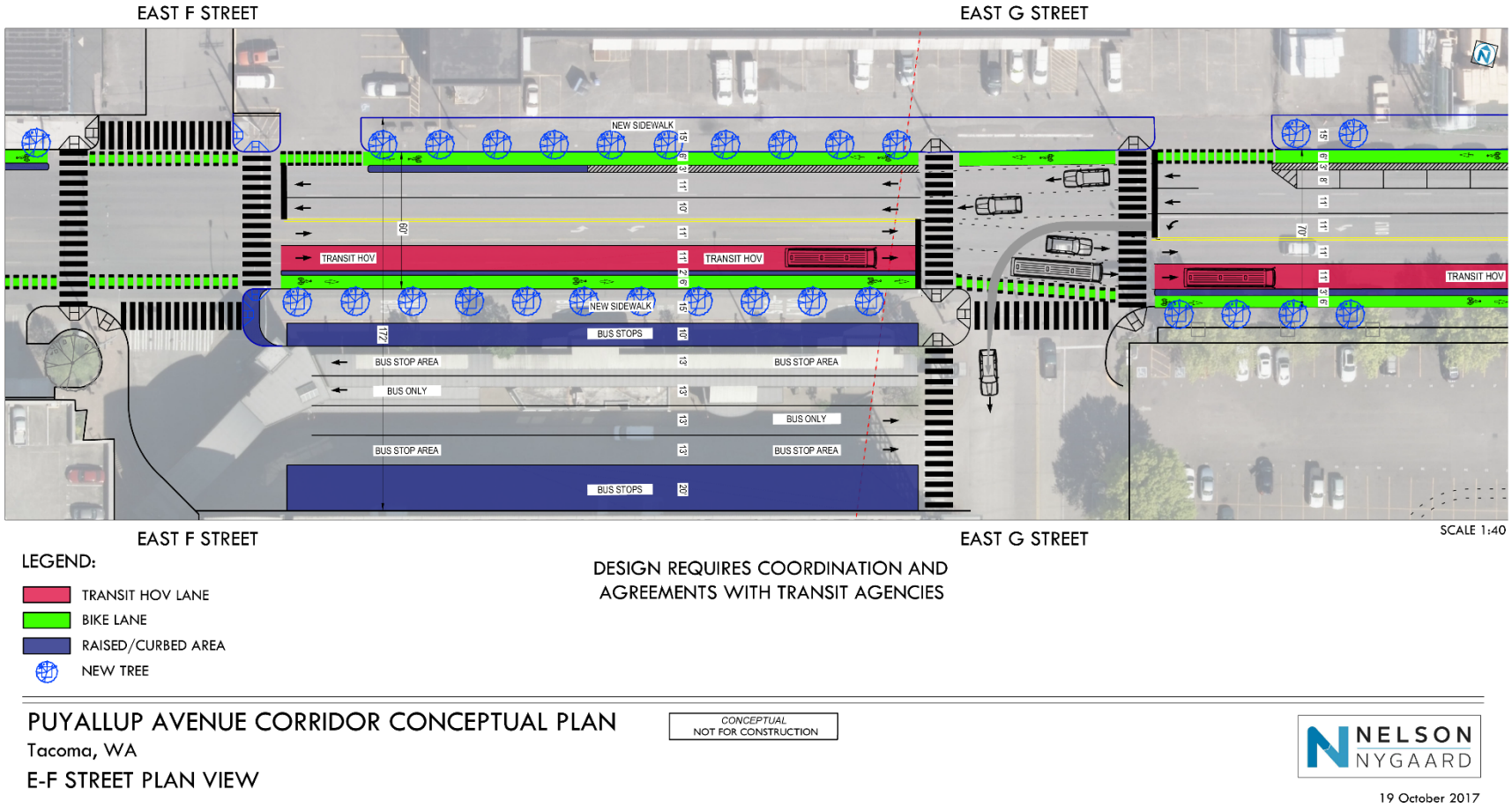


Figure 7-10 Puyallup Avenue from East F Street to East G Street Plan View – Alternative 4



SUMMARY

Figure 7-11 summarizes what Alternative 4 means for people driving, walking, biking, taking transit, operating freight, and experiencing the corridor.

Figure 7-11 Alternative 4 Modal Impacts

	PEDESTRIANS Pedestrian realm 11' to 15' wide Curb extensions possible Buffered from vehicle traffic by trees, protected bicycle lanes, and parking
	BICYCLISTS Protected bicycle lane against curb Buffered from vehicle traffic by parking
	TRANSIT Transit/HOV lane eastbound Eastbound buses stop in Transit/HOV lane Westbound buses stop in general purpose lane Bus bulbs (widened sidewalk) replace parking at bus stops
	FREIGHT Two-way left turn lane in Industrial District No two-way left turn lane in TOD and Neighborhood Districts
	PLACEMAKING Street trees added to both sides corridor-wide
	DRIVERS One travel lane per direction HOV lane eastbound Right turns allowed from Transit/HOV lane On-street parking on both sides Two westbound travel lanes in TOD District

COST ESTIMATE

The project team developed a planning-level cost estimate for the improvements to Puyallup Avenue proposed under Alternative 4. Where possible, City of Tacoma-provided costs and Washington Department of Transportation costs were used to provide a tailored cost estimate.

Assuming total roadway reconstruction, from right-of-way line to right-of-way line, the total cost to build Alternative 4 is estimated to be between $19.8 million and $38.3 million (2020 dollars). The wide range reflects the preliminary level of design as well as robust contingencies to account for project risks, the many unknowns associated with this alternative's final design, the year of construction, and the details of specific corridor elements. Additional detail regarding the costing process, methods, and results can be found in Appendix F.

Elements included in the cost estimate are the features of a full roadway rebuild, with the exception of drainage, stormwater detention, and stormwater treatment:

- **Concrete (10") roadway, curb and gutter, sidewalks, and ADA ramps at all intersection legs.** These costs include roadway striping as well; however, high-visibility crosswalk marking is priced separately.
- **Bus bulbs**. Ten 10-foot wide, 65-foot long bus bulbs are assumed along the corridor.
- **Pedestrian safety islands** are assumed at four intersections.
- **Striped, high-visibility crosswalks** are assumed at 25 locations.
- **Signals, including leading pedestrian intervals and fixed pedestrian heads** at all intersections.
- **Fiber interconnect and intelligent transportation system (ITS) improvements** along the corridor.
- **Gateway signage** is included at Portland Avenue.
- **Artistic crosswalks** are assumed for all four legs of the intersection of Puyallup Avenue at East D Street.
- **Street furniture** elements are included as a single generalized cost based on the individual prices of trash and recycling containers, benches, and bicycle parking.
- **Wayfinding** elements are included.
- **Public art.** The City of Tacoma Municipal Art Program dedicates 1% of construction costs from public capital projects to the creation of public art. This is included in the cost estimate.
- **Street trees** are assumed to be every 25 feet along the corridor where a 6-foot planting strip is available.
- **Roadway lighting** is assumed to be placed per AASHTO's roadway lighting design guide.
- **Pedestrian-scaled lighting** is assumed to be placed every 100 feet for ornamental lights per Backlight, Uplight, Glare (BUG) ratings. Lighting placement follows guidance of AASHTO's roadway lighting design guide. Lights should be placed 5 feet from driveways and 3 feet from curb faces.

Appendix A Alternatives Evaluation Matrix

Measures of Effectiveness			Scoring			Alternatives Detail				Scoring Summary				
Objective	Measure	Metric	1	2	3	Existing	Alt 1	Alt 2	Alt 3	Existing	Alt 1	Alt 2	Alt 3	Data/Source
Develop a complete street that safely accommodates walking, bicycling, transit, driving, and freight	Bicycle accommodation	Level of separation of bicycle facility	Low	Medium	High	No bicycle facility	12' two-way protected bike lane	6' parking protected bike lane on both sides of the street	6' buffered bike lane on both sides of the street					Alternatives Cross-Sections
		Points of connections to the existing and planned bicycle network	Low	Medium	High	None	4 direct connections - pipeline, trail to mountains, L bike lane, Fife bike path	4 direct connections - pipeline, trail to mountains, L bike lane, Fife bike path	4 direct connections - pipeline, trail to mountains, L bike lane, Fife bike path					Alternatives, future bike network map
	Ease of crossing and access to transit	Ease of crossing the street to/from transit stops (measured as distance to nearest crossing from transit stop in feet)	Low	Medium	High	0	913	67	67					Alternatives Layouts
	Transit	Opportunities to accommodate transit stop amenities	Low	Medium	High	0 to 7 feet	1 to 7 feet	2 to 8 feet	2 to 9 feet					Alternatives Cross-Sections
	Driving	Provides a continuous contextual experience along the corridor that promotes consistent, safe speeds (Index Score)	Low	Medium	High	14	221	34	46					Alternatives Cross-Sections and Layouts
		Average pedestrian zone (sq. ft.)				*14*	*22*	*22*	*32*					Alternatives Cross-Sections
		Count of Median Refuge Islands				*0*	*7*	*4*	*4*					Alternatives Layouts
		Average Width of Landscaped Buffer (min 6' required for street trees)				*Unknown*	*7*	*8*	*10*					Alternatives Cross-Sections
		On-Street Parking Spaces				*0*	*185*	*0*	*0*					Parking Stall Count Corridor Totals and Estimates
	Freight access	Presence of a two-way left-turn lane	No	N/A	Yes	Yes	Yes	No	Yes					Alternatives Layouts
		Presence of turn Pockets	Less than 4	4 to 7	More than 7	13	10	6	8					Alternatives Layouts
Support travel times for freight, transit, and motor vehicles	Driving	Estimated vehicle travel time (LOS)	LOS F	LOS E	LOS D or Better	D	E	D-E	E					SYNCHRO model - Average East and West Bound Travel Time in Seconds from Table 6 of Summary Tables+Arterial Analysis
	Freight	Estimated freight vehicle travel time (minutes)	6 minutes or more	6 to 7 minutes	Less than 6 minutes	4.6	6.8	5.2	7.0					SYNCHRO model - Average East and West Bound Travel Time in Seconds from Table 6 of Summary Tables+Arterial Analysis
	Transit speed and reliability	Estimated transit travel time (minutes)	6 minutes or more	6 to 7 minutes	Less than 6 minutes	4.6	4.6-5.2	5.2	7.0					SYNCHRO model - Average East and West Bound Travel Time in Seconds from Table 6 of Summary Tables+Arterial Analysis
Create an inviting destination	Supports transit-oriented and neighborhood development	Width of pedestrian realm (feet)	Low	Medium	High	8	8	9	13					Alternatives Cross-Sections
		% on-street parking spaces retained	Less than 75%	75-100%	100%	100%	86%	80%	102%					Parking Stall Count Corridor Totals and Estimates
	Pedestrian Comfort	Sidewalk + landscaping width	Less than 7'	7 to 10'	11' or more	7 - 14 feet	10 - 14 feet	9 - 15 feet	6 - 16 feet					Alternatives Cross-Sections
		Speed of adjacent traffic (mph)	Over 15 mph	12-15 mph	Under 12 mph	15.8	10.7	14.0	10.4					SYNCHRO model - Average East and West Bound arterial speed in mph from Table 6 of Summary Tables+Arterial Analysis
		Buffers from adjacent traffic	Low	Medium	High	0 to 10 feet	7 to 29 feet	15 to 23 feet	15 to 23 feet					Alternatives Cross-Sections
		Shorter pedestrian crossings (average width of travel lanes, in feet	Low	Medium	High	52	40	40	33					Alternatives Cross-Sections
	Creates "Place"	Opportunities for street trees	Low	Medium	High	Neighborhood District, North side only (except west of Pacific Ave)	Industrial, TOD, and Neighborhood Districts (except west of Pacific Ave)	TOD and Neighborhood Districts(except west of Pacific Ave)	Industrial, TOD, and Neighborhood Districts (except west of Pacific Ave)					Alternatives Layouts
		Curb bulbs, median islands, or other locations for public art, gateway treatments, etc.	Low	Medium	High	11	40	29	45					Alternatives Layouts

Appendix B Public Comments

The following comments were transcribed from notes written on the display boards by meeting participants. Participants also used dots and sticky notes to share their feedback by marking in one of two columns: "I like it!" and "I have concerns." The (+) and (-) signs by each comment in the tables below indicate which column the comment was written in, if applicable.

Figure A-8-1 Public Open House Comments by Alternative

Alternative	Comment is about…	Count of dots / comments		Comments
		I like it! (+)	I have concerns (-)	
1	Pedestrians	1	0	
	Bicyclists	5	3	▪ + separation of bike facility good job ▪ + keeps traveling cyclists from conflicting with transit as they merge into traffic from the transit center ▪ - bike lanes on both sides better ▪ - Bike lanes traveling in same direction as traffic feels safer to me as a cyclist. Driveway crossings & difficulty of leaving bike lane poses hazard ▪ - Curious about how bike lane connects to existing on either end
	Transit	7	0	▪ + HOV/transit lane communications the future – a strong message ▪ + Consider managed westbound land with transit priority during peak hours ▪ + Tacoma Link extension to TCC needs eastbound couplet from East G to Pacific Avenue. Build out date is 2039. Please plan accordingly. ▪ Could you do this transit/HOV but have PBL?
	Freight	1	0	
	Placemaking	3	0	
	Drivers	1	2	▪ - Lose the onstreet parking ▪ - Consider more loading spaces (drop-offs), less on-street parking, more creative solutions to surface parking
	General			▪ MV path in industrial area would work. Separate bike + ped approaching McKin.
2	Pedestrians	1	0	▪ + Pedestrians buffered by protected bike lanes
	Bicyclists	7	2	▪ + parked cars buffering bikes works – boulevard feel created ▪ + planters could be used as delineator ▪ + what about mountable curb separation? Or mountable curb bike lane?

				▪ - consider different paving + mountable curb instead of barrier ▪ - hard to make left turn unless bike boxes
	Transit	0	0	
	Freight	0	2	▪ - could follow part of Alt 3 to have 2 travel lanes & 2way left turn lane
	Placemaking	1	1	▪ What about columnar trees in pots [drawing] 5' area
	Drivers	2	0	
	General			▪ [Drawing: sidewalk – rounded – bike lane]
3	Pedestrians	3	0	
	Bicyclists	3	4	▪ - Don't like lack of protection ▪ - do not prefer parking having to cut across bike lane ▪ - Too many doors + bikes
	Transit	0	0	
	Freight	2	0	
	Placemaking	2	1	
	Drivers	2	0	

Figure A-8-2 Public Open House Comments by District

District	Comment is about…	Count of dots / comments		Comments
		I like it! (+)	I have concerns (-)	
Neighborhood	Alt. 1	2	1	▪ + Best for peds, cyclists, local students; creates more community; future increase in density will make this option most tenable ▪ - Concern about head-on collisions among cyclists
	Alt. 2	5	0	▪ + Dedicated L turn onto Pacific S Bound ▪ + Dedicated signals ▪ + Like bikes on both sides of street but protected!
	Alt. 3	0	1	▪ - Not enough protection for bikes & hard to manage parking
	General			▪ Landscaping is key but plant carefully ▪ Consistency along corridor is key, especially for bikes
TOD	Alt. 1	4	2	▪ + Transit priority is most equitable option. Safest option for most vulnerable ▪ + I like the HOV lane ▪ + Allow cyclists in HOV lane ▪ - Traffic ▪ - Truck back up from port (typical!)

	Alt. 2	7	4	▪ + Pave alley behind Summit Olympus parking lot / East F Street; L turn signal East F Street ▪ + Possibly painting crosswalks near school bright green! ▪ + "D" street left turn and Puyallup Ave for timing improvements ▪ - Turn queue for vehicles ▪ - TOD G to Pacific needs to have a ped/bike friendly feel more than industrial; bike safety needed G to Pacific ▪ - Mixed use sidewalk access consideration important ▪ - Consider transit / HOV for future use and general purpose off peak ▪ Left turns needed throughout
	Alt. 3	2	2	▪ + In TOD district especially, priority should be #1 Peds (FIRST) #2 Bicyclists #3 Transit users #4 Freight/delivery #5 Drivers (last) ▪ - This would be great if bike lanes protected
	General			▪ Landscaping is critical but must be maintained
Industrial	Alt. 1	2	1	▪ + Lots of buses use this corridor. Need priority right of way in both directions ▪ + Transit needs priority ▪ - Will not handle traffic
	Alt. 2	7	2	▪ + (R) HOV lane east bound during peak hours ▪ + Bollards +/- textured pavement divider for bike lane ▪ + Buffered, most protective bike facility ▪ - Need transit priority ▪ - Get rid of south side parking, add transit lane
	Alt. 3	0	1	▪ 2 lanes will not handle traffic

General Comments

Several community members provided written feedback at the open house or via email regarding the alternatives. Those comments are as follows:

Figure A-8-3 Online Public Open House Comments

Looking for more details on bike parking, TNC access, new crossings soon.
I think this hybrid approach (would be good). Comment includes a drawing of cross-section showing: sidewalk, bike lane, flexi bollard, parking, westbound lane, turn lane, eastbound lane, eastbound bus only lane, parking, flexi bollard, bike lane, sidewalk.
Connections to existing and future bike lanes- where/how do they cross over?
Where is the drop off for access to Tacoma Dome buses and trains by Uber/Lyft or personal vehicle?

I think a beautiful and pedestrian/shops-inviting plan would be the buffered bike lanes with one lane each direction and an intermittent center turn lane only at intersections turning into a central greenway divide between. More pleasing to the eye and sends a pedestrian friendly message to drivers.

The next step in getting people to use transit is giving them good options on how to get there. I think the two way cycle track would send a message that Tacoma is working hard to make cycling safe. We need to build structures for the 7 year old children and the beginning cyclists. The cycle track could be enough to persuade some folks to ride down to the bus station (or parents might let their kids ride to Summit high school) rather than take their car. I don't think the bike lanes will provide that perceived level of safety in this busy area. Experienced cyclists do have the option to ride in the street if they desire.

Just about every trip to the transit center is down hill and a safe bike parking area might increase ridership without impacting parking at the parking garage. We can learn how to build and use these structures and the public can learn how to use this infrastructure, but we have to be willing to take the first steps.

I prefer alternative 2, because as a former resident of both New York City and Amsterdam, I can assure you that protecting bike lanes, both from traffic AND car doors of parked cars, is necessary to encourage bikers to use the route.

ALTERNATIVE 1

- Bike lanes should be separate, one on each side. Both sides of street.
- Big trees, but no landscaping, develop area for tree roots to grow.
- Narrow car lanes, narrow lanes act to slow traffic; safer, fewer deaths, more pedestrian comfort, add to sidewalks.
- Add bike paths on both sides of the street.
- Who will maintain the planter strip?
- Less lanes. Make center turn lane less wide. Slow the traffic.
- What is the bike buffer, will it be more of a shy distance for cars so they will drive faster? Narrow down area for cars and they will slow down.

ALTERNATIVE 2

- 9-10' sidewalks not acceptable.
- As someone who actually lives and works and has tenants with storefronts on Puyallup Ave, do not take away our 15' (now 13' wide) sidewalk.
- Narrow lanes, less lanes and not bike path buffer will give us our full width of sidewalk.
- Must have trees, big trees, with room for roots.
- Narrow all lanes by 1', widen sidewalks. Do not reduce the size of our sidewalks.
- (Bicyclists Category Comment) Consider different paving and mountable curb instead of barrier separation.
- Less lanes, wider sidewalks.
- (Freight Comment) Could follow part of Alt. 3 to have two travel lanes and a two-way left turn lane.
- Who will take care of the planting strip.

ALTERNATIVE 3

- Who would take care of landscaping?
- This is the closest to ideal for Pacific Ave. to East. D Street.
- Make room for tree roots so we can have big trees for big avenue.
- Narrow lanes slow traffic make everyone safer.
- Make it urban. Not a planting strip, but street trees of a good size (3") in well covered (grates) with good soil.

TRAFFIC MODELING

- The Puyallup River Bridge will be completed someday and freight trucks will have little reason to use Puyallup Ave. to get to the Port or I-5, this changes the need for this street.

- Traffic count is not accurate because of I-5 construction. Hard to imagine the difference, but must be estimated if a useful design is wanted.
- Do not use peak times as the design parameter.

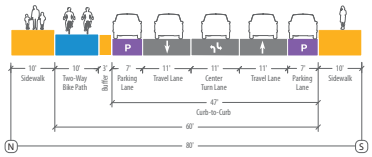
Appendix C Open House Boards

ALTERNATIVE 1

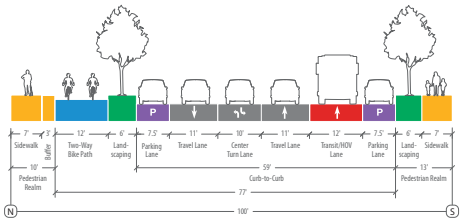
Bike Path, Transit/HOV Lane, 2 General Purpose Lanes + Center Turn Lane

CROSS SECTIONS

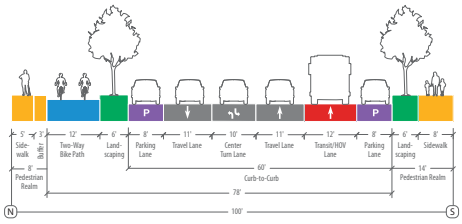
Puyallup Ave between S. C St and Pacific Ave (facing East)



Puyallup Ave between E. D St and E. E St (facing East)



Puyallup Ave between E. J St and E. L St (facing East)



WHAT IT MEANS FOR...

PEDESTRIANS

- Pedestrian realm 8' to 14' wide
- Buffered from vehicle traffic by path (north side)
- Curb extensions possible

BICYCLISTS

- Two-way path
- Bike signals added at signalized intersections
- Potential conflicts with driveways

TRANSIT

- Transit/HOV lane eastbound
- Eastbound buses stop in Transit/HOV lane
- Westbound buses stop in general purpose lane
- Bus bulbs (widened sidewalk) replace parking at bus stops

FREIGHT

- Two-way left turn lane provided

PLACEMAKING

- Street trees added to both sides in Industrial and TOD (Transit-Oriented Development) Districts

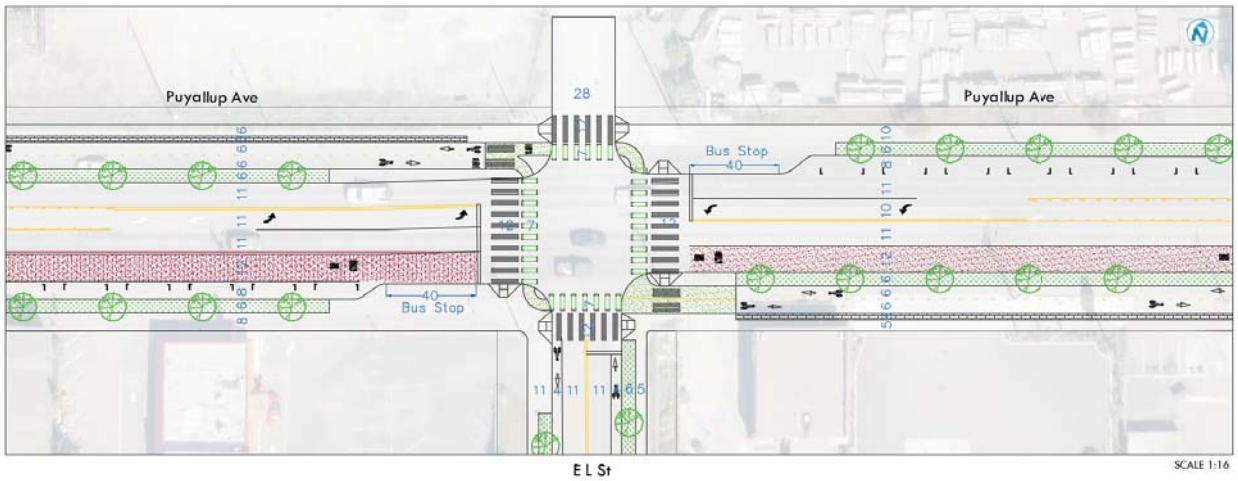
DRIVERS

- Right turns allowed from Transit/HOV lane
- On-street parking on both sides
- HOV lane eastbound

I LIKE IT!

I HAVE CONCERNS

PLAN VIEW - EAST L STREET

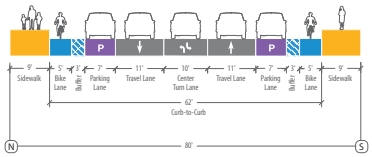


ALTERNATIVE 2

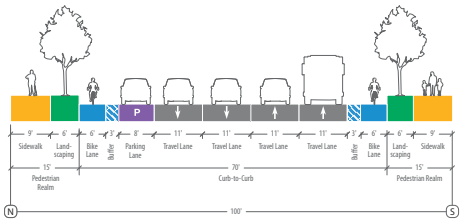
Protected Bike Lanes with 4 General Purpose Lanes

CROSS SECTIONS

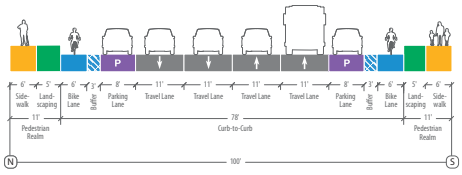
Puyallup Ave between S. C St and Pacific Ave (facing East)



Puyallup Ave between E. D St and E. E St (facing East)



Puyallup Ave between E. J St and E. L St (facing East)



WHAT IT MEANS FOR...

PEDESTRIANS

- Pedestrian realm 9' to 15' wide

BICYCLISTS

- Protected bicycle lane against curb

TRANSIT

- Buses stop in general purpose lane
- Bus bulbs (widened sidewalk) replace parking at bus stops
- At E. D Street, bikes route through 6' landscaping area to get around bus stop

FREIGHT

- No two-way left turn lane
- Fewer left turn pockets

PLACEMAKING

- Street trees added in TOD (Transit-Oriented Development) District on both sides

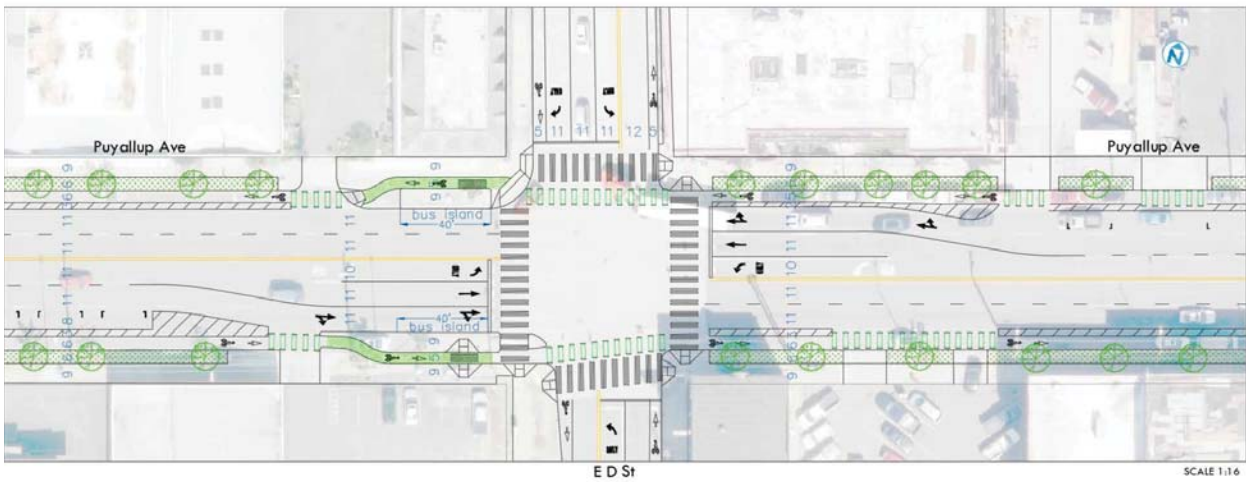
DRIVERS

- Four travel lanes
- No two-way left turn lane
- Fewer left turn pockets
- On-street parking on both sides, except in TOD District

I LIKE IT!

I HAVE CONCERNS

PLAN VIEW - EAST D STREET

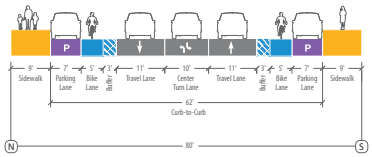


ALTERNATIVE 3

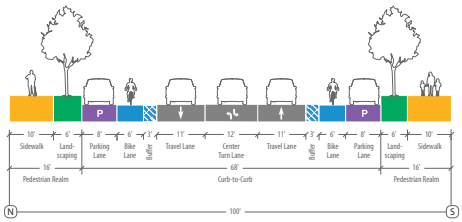
Buffered Bike Lanes with 2 General Purpose Lanes + Center Turn Lane

CROSS SECTIONS

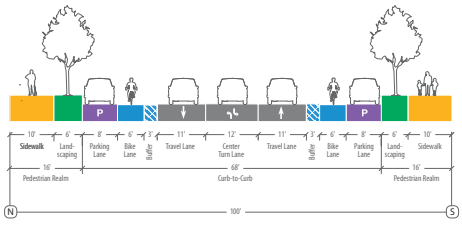
Puyallup Ave between S. C St and Pacific Ave (facing East)



Puyallup Ave between E. D St and E. E St (facing East)



Puyallup Ave between E. J St and E. L St (facing East)



WHAT IT MEANS FOR...

PEDESTRIANS

- Pedestrian realm 9' to 16' wide
- Buffered from vehicle traffic by trees in Industrial and TOD (Transit-Oriented Development) Districts

BICYCLISTS

- Buffered bike lanes next to parking

TRANSIT

- Buses stop in general purpose lane
- Bus bulbs (widened sidewalk) replace parking at bus stops

FREIGHT

- Two way left turn lane provided

PLACEMAKING

- Street trees added in Industrial and TOD (Transit-Oriented Development) Districts on both sides

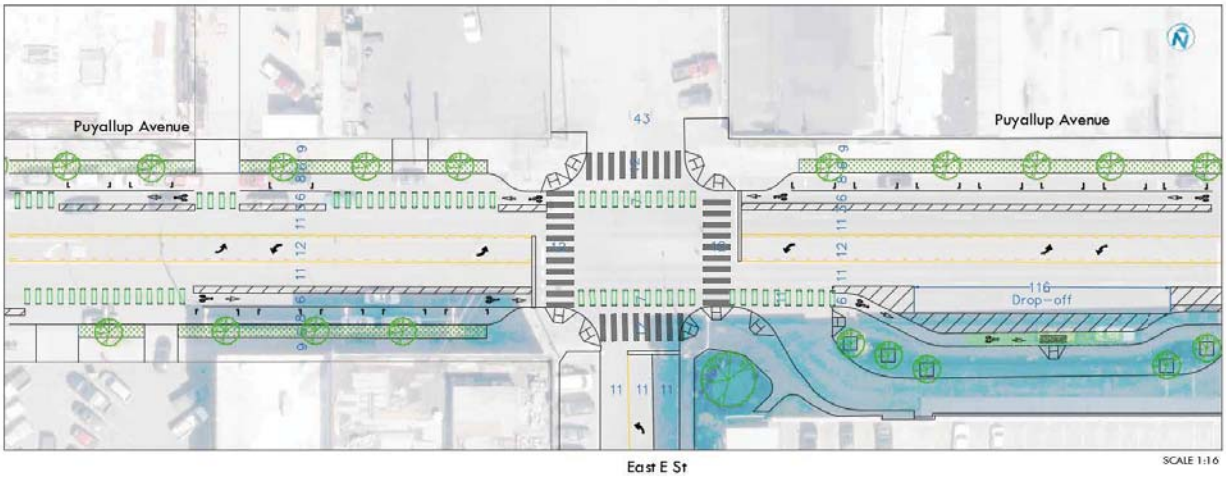
DRIVERS

- One lane per direction
- Two way left turn lane provided
- On-street parking on both sides

I LIKE IT!

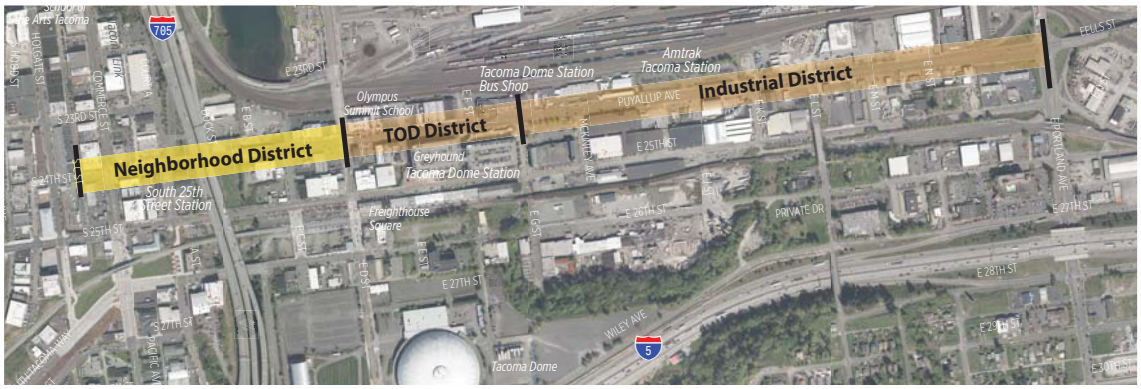
I HAVE CONCERNS

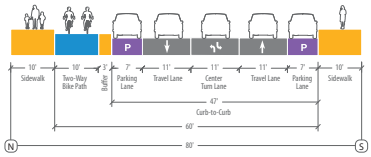
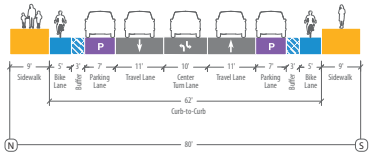
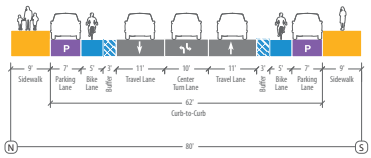
PLAN VIEW - EAST E STREET



NEIGHBORHOOD DISTRICT

S C Street to E D Street

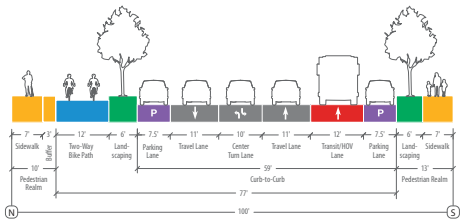
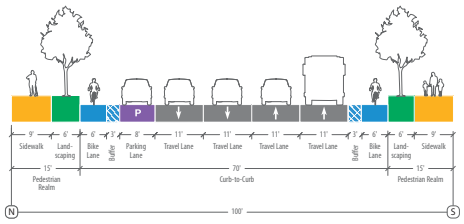
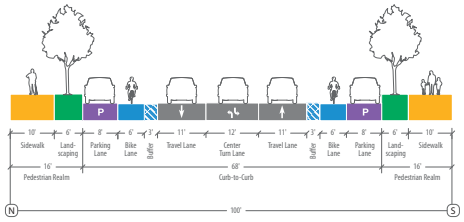


CROSS SECTIONS		I LIKE IT!	I HAVE CONCERNS
ALTERNATIVE 1 Bike Path, Transit/HOV Lane, 2 General Purpose Lanes + Center Turn Lane	Puyallup Ave between S. C St and Pacific Ave (facing East) 		
ALTERNATIVE 2 Protected Bike Lanes with 4 General Purpose Lanes	Puyallup Ave between S. C St and Pacific Ave (facing East) 		
ALTERNATIVE 3 Buffered Bike Lanes with 2 General Purpose Lanes + Center Turn Lane	Puyallup Ave between S. C St and Pacific Ave (facing East) 		

TOD DISTRICT

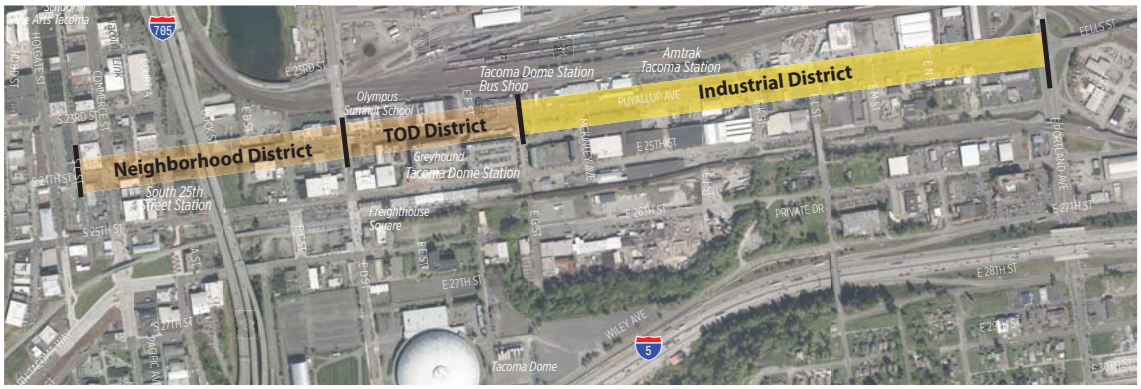
East D Street to East G Street

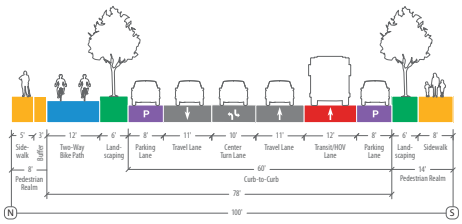
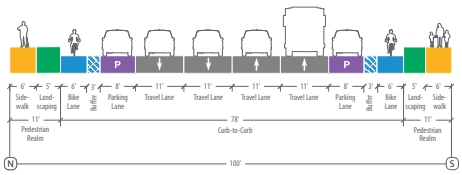
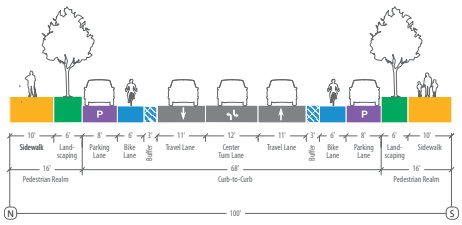
CROSS SECTIONS

		I LIKE IT!	I HAVE CONCERNS
ALTERNATIVE 1 Bike Path, Transit/HOV Lane, 2 General Purpose Lanes + Center Turn Lane	Puyallup Ave between E. D St and E. E St (facing East) 		
ALTERNATIVE 2 Protected Bike Lanes with 4 General Purpose Lanes	Puyallup Ave between E. D St and E. E St (facing East) 		
ALTERNATIVE 3 Buffered Bike Lanes with 2 General Purpose Lanes + Center Turn Lane	Puyallup Ave between E. D St and E. E St (facing East) 		

INDUSTRIAL DISTRICT

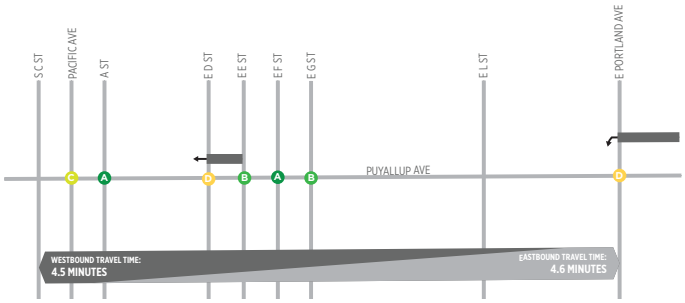
East G Street to Portland Avenue



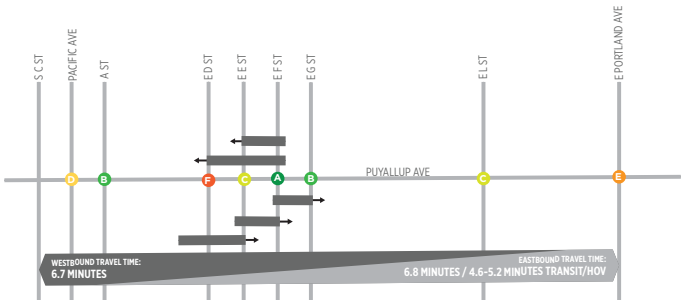
CROSS SECTIONS		I LIKE IT!	I HAVE CONCERNS
ALTERNATIVE 1 Bike Path, Transit/HOV Lane, 2 General Purpose Lanes + Center Turn Lane	Puyallup Ave between E. J St and E. L St (facing East) 		
ALTERNATIVE 2 Protected Bike Lanes with 4 General Purpose Lanes	Puyallup Ave between E. J St and E. L St (facing East) 		
ALTERNATIVE 3 Buffered Bike Lanes with 2 General Purpose Lanes + Center Turn Lane	Puyallup Ave between E. J St and E. L St (facing East) 		

TRAFFIC MODELING RESULTS

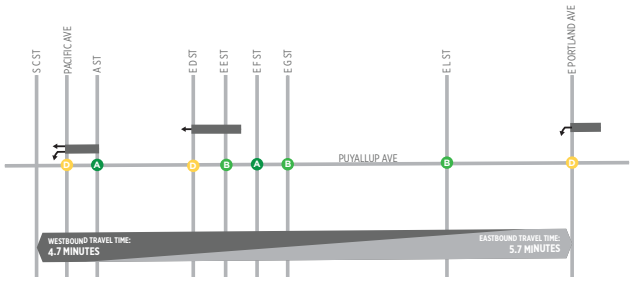
2040 NO BUILD



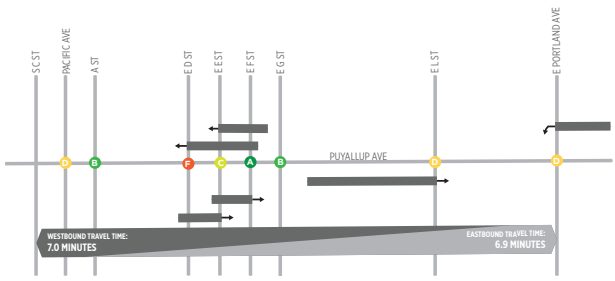
ALTERNATIVE 1



ALTERNATIVE 2



ALTERNATIVE 3



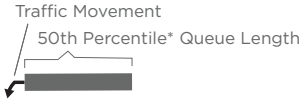
LEGEND

VEHICLE LEVEL OF SERVICE

Conditions during peak travel times only

- A Free flow, negligible delay
- B Stable flow, minimal delays
- C Stable flow, moderate delays
- D Less stable flow, long delays
- E Unstable flow, substantial delays can occur
- F Unpredictable/wait through multiple cycles, excessive delays

TRAFFIC QUEUE



*50th percentile means that this level of traffic backup may occur 50% of the time during peak hours

Appendix D 2040 Traffic Forecast

Tech Memo

Traffic Forecast (2040):
Puyallup Ave. Multimodal Corridor Study

Prepared for the

City of Tacoma

September 6, 2017

By ***Mazedur Hossain & Rachel Lindahl***

Table of Contents

Introduction:

The objective of this tech memo is to summarize the traffic and land use forecast methodologies and the steps needed for the Puyallup Ave. Multimodal Corridor Planning Study..

A Tacoma citywide traffic forecasting model (TFM) was developed, calibrated and validated by a consultant in 2014. This model was used to conduct and validate traffic operation assumptions for the City of Tacoma Transportation Master Plan in 2014. The same model was used for the Tacoma Mall Neighborhood Subarea Plan in 2015/16. The model performed well in these larger study areas however, the model performance at a corridor level for the Puyallup Ave study was determined to be unacceptable by City staff and therefore a more intensive land use and traffic data exercise was recommended.

Key Traffic Generator on Puyallup Avenue:

2016 Traffic Demand on Puyallup Ave.

Several 24-HR traffic counts were collected along Puyallup between Pacific and Portland in 2016 to assess the existing traffic demand. The traffic data helped in identifying the key traffic generators on Puyallup and the traffic relationship with the overall Puyallup Avenue's traffic demand and operation. The 24 HR traffic data is presented in *Figure 1: 2016 Average Daily Traffic on Puyallup Ave*. The average daily traffic (ADT) on Puyallup between Pacific and Portland Avenue is approximately 15,000. The ADT in the vicinity of the Tacoma Dome Station (TDS) on Puyallup is about 17,700 which is nearly 3,000 more than the average daily traffic demand on Puyallup. The highest traffic demand is at the TDS which demonstrates its significant influence on the Puyallup Avenue cooridor.

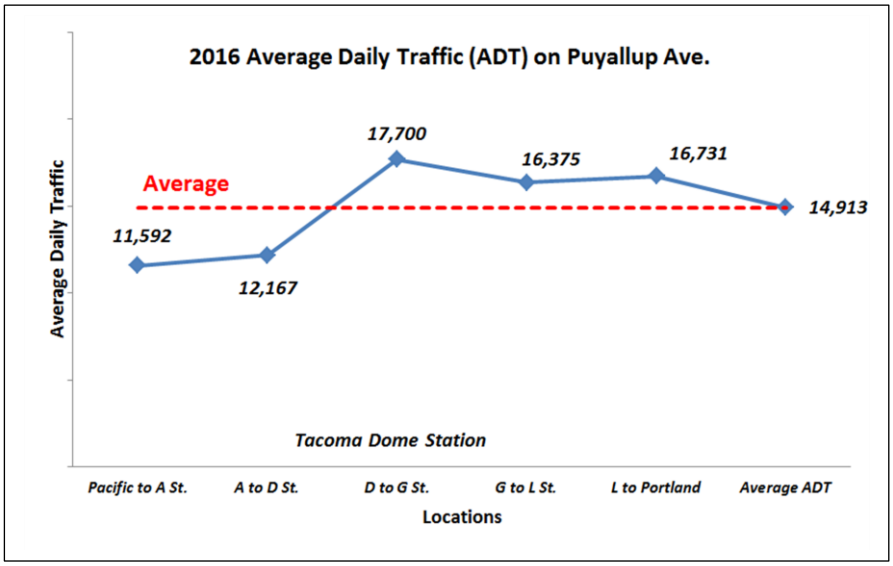


Figure 1: 2016 Average Daily Traffic on Puyallup Ave

A Regional Intermodal Facility:

The TDS is a major intermodal facility in the Puget Sound region serviced by three transit agencies operating three different transit modes and two nationwide transportation providers.

- Pierce Transit operates seven local bus routes.
- Sound Transit operates Tacoma Link light rail, Sounder Commuter rail, and four Regional Express bus routes.
- Intercity Transit operates three bus routes from the Olympia area (south).
- Greyhound and Amtrak services also have hubs located in the TDS area

The 24 HR traffic data alone did not convey the needed travel behavior/mode choices of TDS Park and Ride users. Therefore, the City of Tacoma requested the following information from the regional transit agencies to better understand how the travelers are using the TDS to complete their multimodal trip chains.

- Average parking utilization
- % of High Occupancy Vehicle (HOV) trips
- % of Single Occupancy Vehicle (SOV) trips
- % of Vanpool trips
- % of Bicycle trips
- % of Transit trips
- License plate study

Average Parking Utilization:

The average parking utilization at the TDS was 97% in 2016 and it was also very consistent in all four (4) quarters. See the *Table 1: 2016 Average Parking Utilization- Tacoma Dome* Station. The 97% average utilization (PSRC, Park-and-Ride Database, 2017) demonstrates that the parking demand is higher than practical capacity (90%) which creates "cruisng" for the few empty spaces. This regional intermodal facility has been serving the travelers to complete their multimodal trip chains, especially the commuter trips.

Tacoma Dome Station [1, 2]	***# of Stalls***	***1st Qr. 2016***		***2nd Qr. 2016***		***3rd Qr. 2016***		***4th Qr. 2016***		***2016 Total***	
		Avg. Use	% Use	Avg. Use	% Use	Avg. Use	% Use	Avg. Use	% Use	Avg. Use	% Use
	2337	2227	95%	2308	99%	2259	97%	2332	100%	2277	97%

Table 1: 2016 Average Parking Utilization- Tacoma Dome Station (PSRC, Park-and-Ride Database, 2017)

Estimated Average Daily Traffic (ADT):

The ADT on Puyallup Ave at the TDS is about 17,700 which is nearly 3,000 more than the average daily traffic demand on the remaining segments of Puyallup Ave (see the *Figure 1: 2016 Average Daily Traffic on Puyallup Ave).* Data collected by several regional agencies were used to estimate the average SOV trips generated by TDS. Washington State Department of Transportation funded a research study (Vikash V. Gayah, 2014) to analyze the travel behavior of Park and Ride users in the Puget Sound Region. The users of the TDS were asked several questions about how they currently utilize the TDS to complete their multimodal trip chains. A total of 262 TDS users completed this survey and the key findings from the travel survey provided the following information:

% of SOV trips: **84.11%**
% of HOV trips: 0.39+5.81+2.71 = **8.91%**
% of Bicycle trips: **1.16%**
% of Transit trips: 0.78+4.26 = **5.04%**
%of Vanpooled trips: **0.39%**

Question 9: "How did you get to this park and ride this morning?" (Vikash V. Gayah, 2014)

By Location	Drive Alone	Walked	Train	Vanpooled	Bicycled	Dropped off	Carpooled	Bus	Other
Tacoma Dome	84.11	0	0.78	0.39	1.16	5.81	2.71	4.26	0.78

Table 2 Survey Question 9

Question 10: "How will you leave this park and ride this morning?" (Vikash V. Gayah, 2014)

By Location	Drive Alone	Walked	Train	Vanpooled	Bicycled	Dropped off	Carpooled	Bus	Other
Tacoma Dome	1.16	5.04	15.12	0.78	0	0	0	75.19	2.71

Table 3 Survey Question 10

In addition, the Puget Sound Regional Council (PSRC) reported an average of 3,300 weekday boardings (PSRC, Transit Access Assessment, 2016) at the TDS in the "Transit Access Assessment" study. The information reported in the WSDOT's research study and PSRC's transit access assessment studies were used to estimate the average SOV trips generated by TDS. The estimation is calculated below:

Formula:

$$Estimated\ Average\ SOV\ Trips = Average\ weekday\ boardings * \%\ reduction\ for\ transfer\ trips * (\%\ of\ Single\ occupancy\ vehicle\ trips + \%\ of\ dropped\ of\ trips + \%\ of\ carpooled\ trips) * 2\ (Two - way)$$

$$Estimated\ Average\ SOV\ Trips = 3{,}300 * 0.95\% * (84.11\% + 2.71\% + 5.81\%) * 2 \approx 6{,}000$$

The average daily traffic on Puyallup is approximately 15,000 and the estimated average daily traffic generated from TDS is approximately 6,000. The numbers reveal that the TDS generates more than 1/3 of the total traffic demand on Puyallup Ave.

Land Use Forecast:

The Puyallup Ave. study area encompasses approximately 600 acres of historic industrial, commercial and residential property within the City's designated Brewery District, Dome District, and South Downtown and Lower Portland Avenue Mixed Use Centers. For the purpose of this study, this area was further divided into four subzones as shown on Figure 2. Subzones 1-3 are generally bordered by S. 21st Street/SR 509 to the north and the I-5 corridor to the south. Subzone 4 lies south of the I-5 corridor, extending to approximately E. 34th Street. A multi modal transit hub located in the southern portion of the study area provides some of the most comprehensive transit service in the State, including light rail and commuter rail service, and national, local and express bus service. Overall, the area has a diverse built environment, but is also characterized by a relatively high concentration of underutilized land and buildings.

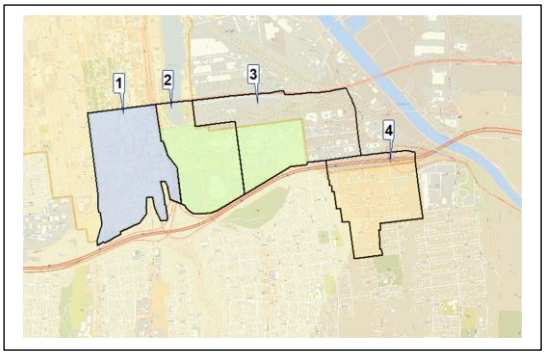


Figure 2 Subzones/Traffic Analysis Zones

To provide a reasonable forecast of future growth within the context of the Growth Management Act and at the county level, two different methodologies were used to calculate land use forecasts for the project. The first methodology involved utilizing projected population and employment rates from Traffic Analysis Zones (TAZ) as defined by the U.S. Census Bureau. The TAZ dataset represents growth allocation forecasts for population, households and employment for the region as a whole. The second methodology, Build-out involved conducting a land use analysis based on identifying the potential residential and non-residential square footage that could be constructed under existing zoning regulations. The forecast from the Build-Out scenario represents the amount of growth that can be supported without changes to the existing land use code.

TAZ 2040

TAZs are constructed using census block information to provide socioeconomic data for transportation planning projects. Variables utilized include characteristics of population, housing, household, group quarters and employment. The population and employment forecasts are generated at the county level using standard demographic techniques and employment patterns. This data is measured for the current year and is projected forward to understand the impact of the project in the future (year 2040 was chosen for the project). The projection assumes that population, employment rates and zoning are consistent with the goals of the Growth Management Act.

Methodology Overview:

Step 1 – Identify all TAZs that intersect with study area.
Step 2 – Categorize TAZs by subzone boundary.
Step 3 – Summarize projected 2040 data for population and employment rate by subzone.

Output:

Subzones/Traffic Analysis Zones	*TAZ 2040*	
	Population	*Employment*
1	12,328	9,511
2	2,596	4,640
3	1,074	5,518
4	3,282	1,940

Table 4 Subzones/ Population and Employment Rate per Build-Out Scenario

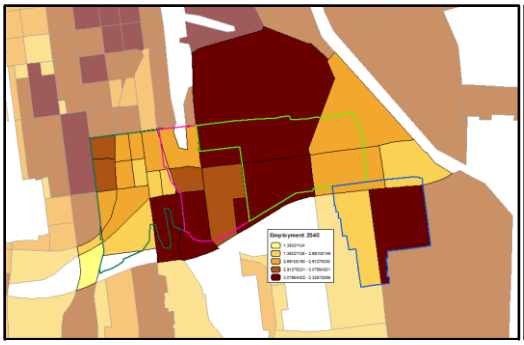


Figure 4 TAZs/ Employment 2040

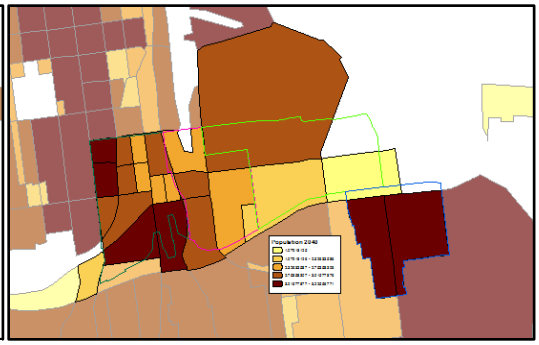


Figure 3 TAZs/ Population 2040

Build-out Scenario

Methodology Overview:

The land use Build-out analysis projects the maximum residential and commercial development allowed under current code in a given area. From these projections, population and employment rate can be estimated in the study area. Geographic Information System (GIS) methods were used to conduct the analysis. The GIS component of the study was undertaken in three phases.

Phase 1 –Determined developable parcels and categorize by zoning district
Phase 2 - Determined the maximum residential and non-residential square footage that could be built under existing 2016 zoning regulations
Phase 3 – Determined population and employment rate based on maximum land use capacity

Phases:

Phase 1- Determine developable parcels and categorize by zoning district.

Steps:

Step 1- Isolated all parcels that intersected with study boundary.
Step 2 - Categorized by study subzone boundary and land use zoning districts.
Step 3 - Delineate land that could not be developed due to constraints such as public ownership, deed restrictions and utility easements.

Parcels Removed:

- Parks
- Utilities
- Schools
- Right of Way
- Tax Exempt
- Parcels with an improvement to land value ratio greater than 2

Output

Baseline buildable parcel dataset for analysis

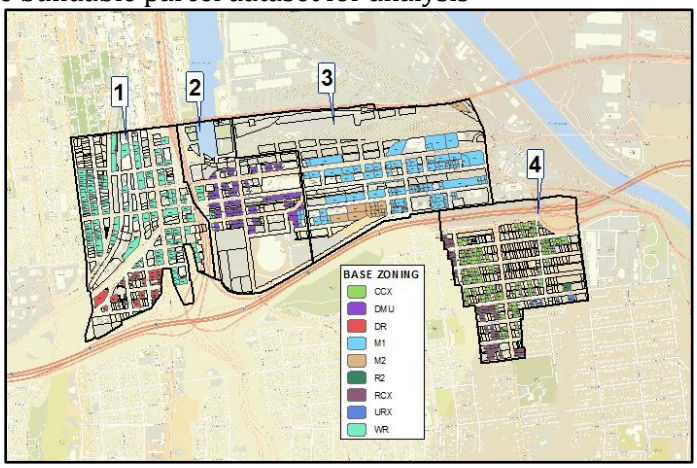


Figure 5 Subzones/Baseline Buildable parcels

Phase 2 - Determine maximum residential/non-residential square footage permitted under 2016 zoning regulations.

Steps:

Step 1-Reduce parcel area by setback requirements (per zoning district)

Formula

(Total Parcel Area) * (1- % Building Efficiency)

Output

Total buildable square footage by parcel

Step 2-Populate fields with residential and non-residential split ratio/mixed use, and maximum floors allowed

Stats

Zoning District	Building Efficiency	Max Floors	Unit Size	Residential %	Non-residential %
CCX	90%	6	1,100 sq ft	65%	35%
DMU	90%	6	1,000 sq ft	75%	25%
DR	90%	6	1,000 sq ft	75%	25%
M1	90%	4	1,250 sq ft	5%	95%
M2	70%	1	NA	NA	100%
R2	80%	2	12 DU/acre	97%	3%
RCX	80%	4	1,280 sq ft	95%	5%
URX	80%	3	1,280 sq ft	100%	NA
WR	80%	6	1,000 sq ft	65%	35%

Table 5 Baseline Zoning Requirements for Development

Output

Parcels auto populated with development requirements.

Step 3 – Calculate maximum buildable square footage with maximum height limits and residential/non-residential split ratio (mixed use buildings).

Formula

Total buildable square footage * Maximum height limit = Maximum buildable square footage
Maximum buildable square footage * (1- % Residential) = Total Maximum Residential
Maximum buildable square footage * (1- % Nonresidential) = Total Maximum Nonresidential

Output

Maximum residential and nonresidential buildable square footage

Phase 3 - Determine population and employment rate based on max capacity.

Step 1- Calculated Employment Rate

Formula

(Total non-residential buildable square footage / 375) * (1-.25)
Under staff direction, M2 zoning assumed as 50 employees per acre with 1 floor limit

Output

Employment rate per zoning district

Step 2- Determine Number of Residential Units

Formula

Total buildable square feet * % Residential ratio = Total buildable residential square footage
Total buildable residential square footage / Square footage unit size requirement

Output

Number of residential units

Step 3 – Determine Population rate

Formula

(Total number of units * 2.32) * (1-.25)

Output

Population rate per zoning district

Outlined below is a breakdown of the maximum possible population and employment rates that the Puyallup Ave can experience if the existing land use ordinances remain unchanged.

Subzones/Traffic Analysis Zones	*Build-Out Scenario*	
	Population	*Employment*
1	8,815	5,512
2	3,771	1,823
3	375	10,482
4	4,583	2,329

Table 6 Subzones/ Population and Employment per Build-Out Scenario

Conclusion:

With few exceptions the TAZ method for forecasting land use provided higher population and employment rates than the Build-Out Scenario method. See the ***Error! Reference source not found.***

Traffic Analysis Zones	*TAZ 2040*		*Build-Out Scenario*	
	Population	*Employment*	*Population*	*Employment*
1	12,328	9,511	8,815	5,512
2	2,596	4,640	3,771	1,823
3	1,074	5,518	375	10,482
4	3,282	1,940	4,583	2,329

Table 7 TAZ 2040 and Build-Out Scenario Land Uses

One possible reason for this is that the TAZ method took into account demographic data such as characteristics of population, housing, household, group quarters, employment, special traffic generator sites and school enrollment rates. The Build-Out Scenario, however, only included assumptions from land use and building codes. Additionally, TAZs are typically defined by census blocks or block groups and these boundaries did not always correspond well with the study's subzone boundaries. This misalignment could potentially account for the higher numbers projected for the population and employment rates.

Scenario Development:

Three (3) scenarios were developed based on the land uses and mode splits to forecast the Puyallup Avenue traffic.

Traffic Analysis Zones/Subzone:

The 1st step to forecast the traffic was to identify the traffic analysis zones (TAZ) that would contribute trips to Puyallup Avenue from Pacific to Portland avenues. Next, the study area was divided into four (4) zones to estimate the future lands uses (see the *Figure 6 Subzones/Traffic Analysis)*. Existing and future land uses, roadway connectivity, access to Puyallup, etc. were reviewed to define the boundary of the four (4) traffic analysis zones. The details of these TAZs/subzones are presented in section above: Land uses.

Figure 6 Subzones/Traffic Analysis Zones

Land use Forecast:

Two different land use forecasts were estimated based on two different methodologies and assumptions. See the ***Error! Reference source not found.***

TAZ 2040: The TAZ dataset represents growth allocation forecasts for population, households and employment for the region as a whole.

Build-Out Scenario: Build-out involved conducting a land use analysis based on identifying the potential residential and non-residential square footage that could be constructed under existing zoning regulations.

Refined Land use Forecast:

The TAZ 2040 and Build-Out Scenario represent different methodologies and assumptions. The land use forecasting exercise is both an art and a technical exercise. Several influencing factors such as economic uncertainty, political instability, technology evaluation, etc. impact the timing and size of future developments. Assessing and integrating impacts into land use forecasting is important. Therefore, City staff generated two possible growth scenarios by evaluating policies and other influencing factors to help increase the confidence of the land use forecasts used for this study.

Ultimate Growth: This scenario is for the maximum possible growth that the Puyallup Avenue can experience in the anticipated future. The highest population and employment information were chosen from "TAZ 2040" and "Build-Out Scenario" for each TAZ to develop the Ultimate Growth land use scenario as shown on *Table 8 Ultimate Growth Land Use Scenario*

Traffic Analysis Zones	Ultimate Growth	
	Population	Employment
1	12328	9511
2	3771	4640
3	1074	10482
4	4583	2329

Table 8 Ultimate Growth Land Use Scenario

Practical Growth: This scenario is for a reasonable growth that Puyallup Avenue will experience in the anticipated future. The above-mentioned forecasted population and employment were reviewed and identified the appropriate population and employment growth that each of these TAZs will reasonably experience. For example, for TAZ 3 the "Build-Out Scenario" forecasted 10,482 employees' vs. 5,518 employees in "TAZ 2040". The TAZ 3 mainly represents an industrial zone and the employee per square footage will be very minimal since the existing uses are mostly one-story buildings. Therefore, the TAZ 2040 forecast of 5,518 employees is more practical than is 10,482 employees. A similar exercise was completed to identify the appropriate growth for each TAZ to develop the Practical Growth land use scenario shown on *Table 9 Practical Growth Land Use Scenario*.

Traffic Analysis Zones	Practical Growth	
	Population	Employment
1	8815	5512
2	3771	1823
3	375	5518
4	4583	2329

Table 9 Practical Growth Land Use Scenario

Mode Splits/Choices:

Mode choices refer to the relative proportion of traffic using each mode of transportation, mainly auto, transit, bicycle, walking, etc.

TMP Mode Share: The City of Tacoma (COT) Transportation Master Plan (Peers, 2015) recommended that the SOV trips be reduced to 55%, which is more than 20% reduction as compared to today. See *Table 10 Mode Shares City of Tacoma Transportation Master Plan.* The project team recognized that the recommended, or targeted mode splits are achievable but more time and infrastructure is likely needed to shift from the heavy automobile oriented environment to multi-modal environment. Also, there was acknowledgement that the City does not manage and operate transit facilities and therefore the capital plans (including park and ride facilities) of the local/regional transit agencies may not be able to meet the City mode choice goals. Given these factors, the project team proposed an alternate mode split that is believed to be more consistent with Puyallup Avenue corridor and study area.

City of Tacoma Transportation Master Plan (Peers, 2015)		
Modes	**TMP Proposed Mode Splits (%)**	**Existing 2012 Mode Splits (%)**
SOV (Single Occupancy Vehicle)	55	76
HOV (High Occupancy Vehicle)	23	10
Walk	8	5
Bicycle	4	
Transit	10	5

Table 10 Mode Shares City of Tacoma Transportation Master Plan (Peers, 2015)

Refined Mode Share: The COT Transportation Master Plan recommended an increase of 13% HOV trips and a decrease of 21% SOV trips in future. The COT does not have designated HOV lanes. Transit and a few vanpooled services are the only facilities representing HOV trips. Therefore, the project team recognized that the TMP recommended HOV trip share is achievable but more time and infrastructure are required to meet the recommendation. A reasonable shift of both SOV and HOV trip shares have therefore been recommended for future. See the *Table 11 Mode Shares - Refined Mode Share Puyallup Avenue Corridor* Study.

Refined Mode Share (Puyallup Ave. Corridor Study)		
Modes	**Proposed Mode Splits (%)**	**Existing 2012 Mode Splits (%)**
SOV (Single Occupancy Vehicle)	70	76
HOV (High Occupancy Vehicle)	12	10
Walk	3	5
Bicycle	5	
Transit	10	5

Table 11 Mode Shares - Refined Mode Share Puyallup Avenue Corridor Study

Traffic Forecasting Scenarios:

Scenario planning defines a range of possible future conditions and includes an assessment of risk. Land uses and Mode splits were the two important and most uncertain factors. The project team carefully reviewed the land use and mode splits to develop a process that would lead to evaluation tools needed for the future design/operations of Puyallup Avenue corridor between Pacific and Portland avenues. The land use scenarios and the different mode splits presented above enabled the team to develop three (3) possible scenarios to forecast the future traffic. See the *Table 12 Traffic Forecasting Scenarios*

Land Use Scenarios	**Traffic Forecasting Scenarios**
Ultimate Growth	1. Ultimate growth with TMP Mode Share 2. Practical growth with TMP Model Share 3. Practical growth with Refined TMP Mode Share
Practical Growth	
Mode Share Scenarios	
TMP Mode Share	
Refined Mode Share	

Table 12 Traffic Forecasting Scenarios

Traffic Forecast:

Methodology Overview:

The City's existing traffic forecasting model was not used for the Puyallup Ave study due to its inability to replicate existing conditions at the corridor level. A higher quality and restructured traffic forecasting methodology was therefore developed with the following guidelines:

1. Meet the Puyallup Avenue project's goals and objectives
2. Comply with City's policies, goals, and objectives
3. Comply with City's Transportation Master Plan
4. Technically sound, defendable and transparent
5. Flexible enough to make quick refinements

The methodology defined below was used to forecast the 2040 total PM peak hour traffic for the three (3) different scenarios developed using a combination of different land uses and mode splits targets.

Steps:

Step 1-Estimate 24 –hour Person Trips:

This step was involved in estimating the 24-hour person trips in each TAZ using the trip rates available in the "*PSRC Travel Model Documentation*" Table 6.21: Trip Rates by Purposes (Systematics, 2007). The total person trips were estimated for each TAZ:

1. Brewery District,
2. Freight House Square
3. M2&M1 Zoning
4. Manufacturing and Portland Mixed Use Center.

Formula:

$$24-hour\ Population\ Trips\ = No.of\ Population * Trips\ per\ person$$
$$24-hour\ Employee\ Trips\ = No.of\ Employees * Trips\ per\ employee$$

Output:

Total person trips

Step 2-Estimate 24-hour Person Trips by Mode:

This step was involved in estimating the 24-hour person trips by mode using the estimated 24-hour person trips in Step 1. The mode splits recommended in the Transportation Master Plan and the refined mode splits were used to estimate the person trips by mode. See the *Table 13 Mode Splits*.

City of Tacoma Transportation Master Plan (Peers, 2015)		**Refined Mode Split**	
Modes	**Mode Splits (%)**	**Modes**	**Mode Splits (%)**
SOV (Single Occupancy Vehicle)	55	SOV (Single Occupancy Vehicle)	70
HOV (High Occupancy Vehicle)	23	HOV (High Occupancy Vehicle)	12
Walk	8	Walk	3
Bicycle	4	Bicycle	5
Transit	10	Transit	10

Table 13 Mode Splits

Formula:

$$24\ hour\ Trips\ By\ Mode = 24\ hour\ Person\ Trips * Mode\ Splits$$

Output:
Trips by mode

Step 3-Convert 24-hour HOV Person Trips to Vehicular Trips:

This step was needed to convert 24-hour high occupancy person trips estimated in Step 2 to the equivalent 24-hour single occupancy vehicular trips using vehicle occupancy rate (VOR). VOR depends on several factors such as geographical location, travel behavior, and the types of roadway facilities and services. Therefore, a more localized VOR was estimated using the information available in the research study funded by the Washington State Department of Transportation (Vikash V. Gayah, 2014). The estimated VOR was then compared with the VOR available in the National Household Travel Survey to identify an appropriate VOR for Puyallup Avenue corridor.

Vehicle Occupancy Rate:

The Puget Sound Regional Council (PSRC) reported an average of 3,300 weekday boardings (PSRC, Transit Access Assessment, 2016) at the TDS in the "Transit Access Assessment" study. Washington State Department of Transportation funded research study to analyze the travel behavior of Park and Ride users in the Puget Sound Region revealed the following key findings from the survey completed by 262 users. This information was compiled and used to estimate the VOR.

Question 9: "How did you get to this park and ride this morning?" (Vikash V. Gayah, 2014)

By Location	Drive Alone	Walked	Train	Vanpooled	Bicycled	Dropped off	Carpooled	Bus	Other
Tacoma Dome	**84.11**	0	0.78	0.39	1.16	**5.81**	**2.71**	4.26	0.78

Table 14 Survey Question 9

Estimated SOV:

$$\frac{3{,}300 * 0.95\ (5\%\ transfer) * (84.11\% + 2.71\% + 5.81\%)}{100}$$

$=2{,}903 \approx 3{,}000.$

Question 20: "Would you consider carpooling to this park and ride if carpools were guaranteed a space at no charge?" *(Vikash V. Gayah, 2014)*

By Location	Yes	No	I already carpool	I don't know
Tacoma Dome	28.84%	46.05%	3.72%	21.4%

Table 15 Survey Questions 20

The estimated SOV trips are approximately 3,000. According to the survey output from the question 20, it is evident that 28.84% of the existing travelers driving alone will consider carpooling ride if carpoolers were guaranteed a space at no charge. 3.72% of users already carpool. Therefore, a total of 32.56% (28.84%+3.72%) of the 3,000 SOV trips may consider carpooling in the future and the potential vehicle occupancy would be 2. Also, the Puget Sound Regional Council (PSRC) reported that 39 Vanpools are used at TDS with an average occupancy of 8.36 (PSRC, Transit Access Assessment, 2016). Weighted average vehicle occupancy rate was estimated below considering the data mentioned above:

Formula:

$$Weighted\ Average\ Vehicle\ Occupancy = SOV * (\%\ of\ future\ carpool\ users + existing\ carpool\ users) * Occupancy\ rate + nb\ of\ Vanpools * average\ valpool\ occupancy)/\ SOV * (\%\ of\ future\ carpool\ users + existing\ carpool\ users) + nb\ of\ Vanpools$$

$$Weighted\ Average\ Vehicle\ Occupancy = \frac{3000 * (28.84\% + 3.72\%) * 2 + 39 * 8.36}{3000 * (28.84\% + 3.72\%) + 39}$$

$\approx 2.24\ (VOR)$

2009 National Household Travel Survey (NHTS) reported that the average vehicle occupancy for all purpose trips is 1.67. The estimated 2.24 VOR is higher than the national average VOR. The existence of the largest regional intermodal facility on Puyallup and the potential multi-modal growth supports the estimated 2.24 VOR. The 2.24 VOR was used to convert high occupancy person trips estimated in Step 2 to equivalent single occupancy vehicular (SOV) trips.

Formula:

$$Equivalent\ 24\ hour\ SOV\ Trips = \frac{Total\ High\ Occupancy\ Person\ Trips}{2.24\ (VOR)}$$

Output:

Equivalent SOV and VOR

Step 4-Estimate the total 24-hour SOV Trips

This step was needed to estimate the total 24-hour SOV trips by adding the SOV trips estimated in STEP 2 with the equivalent SOV trips estimated in Step 3.

Formula:

$$24\ hour\ Total\ SOV\ Trips = SOV\ trips\ (Step\ 1) + Equivalent\ SOV\ trips\ (Step\ 3)$$

Output:

24 hour SOV trips

Step 5-Estimate 24-hour SOV Trips use Puyallup Ave.

This step was needed to estimate the 24-hour SOV trips that can reasonably access Puyallup for travel. TAZ characteristics such as existing and future land uses, available access to Puyallup Ave, number of other alternative access to and from each TAZ, existing and possible future traffic patterns, etc. were considered to determine the % of the total trips that will access Puyallup from each TAZ.

Formula:

$$24\ hour\ SOV\ Trips\ use\ Puyallup = 24\ hour\ Total\ SOV\ Trips * \%\ trips\ access\ Puyallup\ Ave.$$

Output:

24 hour SOV trips use Puyallup Ave.

Step 6-Estimate Total PM Peak Hour SOV Trips

This step was needed to estimate the PM peak hour SOV trips using the 24-hour SOV trips that can reasonably access Puyallup to travel. 24-hour traffic counts were conducted at several locations on

Puyallup. The 24-hour traffic counts were used to estimate the percentages of the 24-hour traffic travel during PM peak hour. 8% of the 24-hour traffic travel on Puyallup compared to 10% for the national standard. The national standard was used to model the more conservative scenario.

Formula:

$$Total\ PM\ Peak\ Hour\ SOV\ Trips = 24\ hour\ SOV\ Trips\ use\ Puyallup * \%\ of\ 24\ hour\ traffic\ travel\ during\ PM\ peak\ hour.$$

Output:

Total PM Peak hour SOV trips use Puyallup Ave.

Step 7-Estimate Directional Distribution

This step was needed to estimate the number of PM peak hour SOV trips generated from and attracted to each TAZ using the total PM peak hour SOV trips estimated in Step 6. The total trips generated from each TAZ consist of two trip legs, trip production, and attraction. The trips production and attraction percentages depend on the land use types (i.e. single vs. multi-family dwelling units, commercial, retail), the peak hours (PM vs. AM peak hours), and the trip purposes (i.e. Non-home-based trips, Home-based work trips, etc.). Each TAZ consists of different land use types and the trips production and attraction percentages differ for each land use type. Therefore, an average trip production and attraction rate/percentage were estimated and used to determine the number of PM peak hour SOV trips generated from and attracted to each TAZ.

Formula:

$$PM\ Peak\ Hour\ SOV\ Trip\ Production = Total\ PM\ Peak\ Hour\ SOV\ Trips * Average\ Trip\ Production\ Rate$$

$$PM\ Peak\ Hour\ SOV\ Trip\ Attraction = Total\ PM\ Peak\ Hour\ SOV\ Trips * Average\ Trip\ Attraction\ Rate$$

Output:

Trip production and attraction rates, production and attraction trips

Step 7-Trips Distribution and Assignment

The process of trip distribution determines where the trips end once they leave each TAZ, and the trip assignment determines what route or path trips will take in traveling from and to each TAZ. A MS Excel based trip distribution and assignment methodology was developed, and the estimated SOV PM Peak hour's trips were distributed and assigned considering the following factors:

1. Distances between the TAZs
2. Existing traffic demand and travel pattern
3. Key traffic generators and destinations
4. Land use types
5. Roadway access, major vs. minor

Truck Traffic Forecast:

The existing truck traffic, 2010 Tideflats Area Transportation Study (**TATS**) and ongoing and potential large development studies were reviewed to estimate future truck traffic on Puyallup Ave.

Existing Truck Traffic:

24 HR truck traffic counts were collected at several locations on Puyallup Ave in 2016 to assess the existing truck traffic demand. The truck traffic data helped in identifying the key truck traffic generators on Puyallup and their relationship with the overall Puyallup Avenue's truck traffic demand and operation.

The 24 HR truck traffic data is presented in *Figure 7 2016 Truck Percentages on Puyallup Ave*. The average daily truck traffic (ADTT) on Puyallup between Pacific and Portland Ave. is approximately 9.5%. The high truck traffic demand demonstrates the presence of industrial zone in Puyallup and the proximity of the Tideflats area. The ADTT between G and Portland on Puyallup is greater than ADTT on Puyallup and validates the presence of industrial zone.

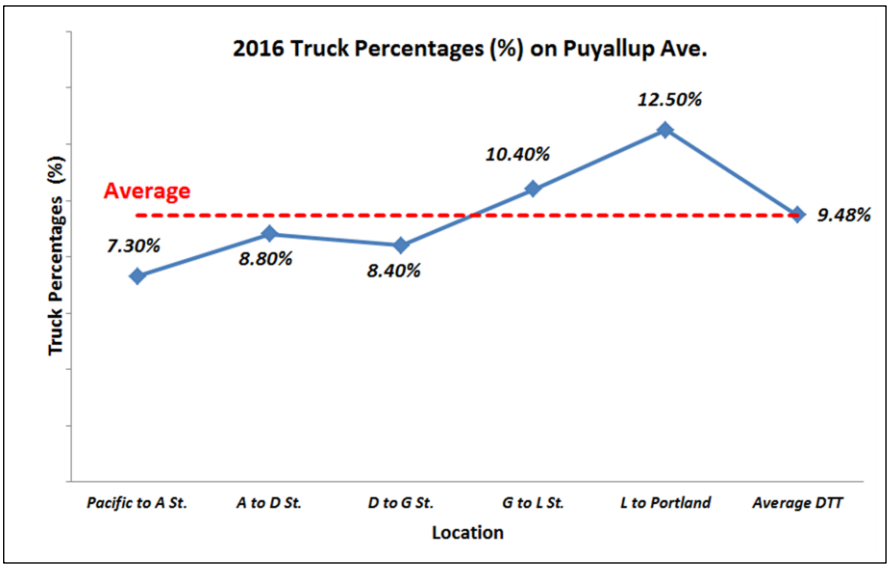


Figure 7 2016 Truck Percentages on Puyallup Ave

Tideflats Area Transportation Study (TATS):

The Truck Volume Forecasting section of the Tideflats Area Transportation Study (Marni C. Heffron, 2010) was reviewed. Comprehensive truck traffic forecasting efforts were undertaken in the TATS. The TATS (Marni C. Heffron, 2010) identified four (4) major industrial employment growth areas in Tacoma Tideflats and Fife. The truck traffic generated from three (3) areas has other alternative routes to access to and from the Tideflats area. The truck traffic generated from "Tacoma Tideflats- Southwest of Puyallup River" area will potentially access Puyallup to travel to and from the Tideflats area via Puyallup Ave/Portland Ave. intersection. TATS recommended a 0.7% (*CAGR-Compound Annual Growth Rate*) employment growth in the "Tacoma Tideflats-Southwest of Puyallup River" area. The following step by step procedure used the existing traffic counts, the total PM Peak Hour SOV Trips (*Ref: Traffic Forecast Section*), and TATS recommended 0.7% employment growth to estimate the 2040 truck traffic percentages.

Steps:

Step 1-Estimate 2040 Truck Traffic

This step was needed to estimate/validate the 2040 truck traffic using the TATS recommended 0.7% employment growth. *Based on PM peak hour intersection turning movement counts*, 25 truck traffic from the Tideflats area (***13% of the total traffic***) accesses Puyallup via Puyallup/Portland Ave. intersection

during the PM peak hour in 2016 compared to 30 vehicles?? in 2040. See the *Figure 8 2016 PM Peak Hour Truck Traffic*, and find the detail calculation below:

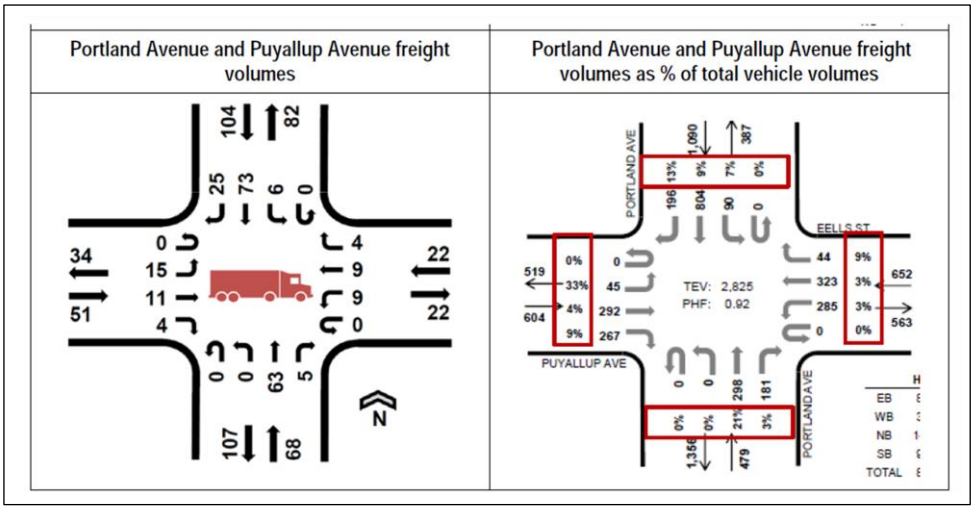


Figure 8 2016 PM Peak Hour Truck Traffic

Assumption:
The growth of truck traffic is proportional to the employment growth.

Formula:

$$2040\ Truck\ Traffic = Existing\ Truck\ Traffic * (1 + CAGR)^{Future\ Year - Existing\ Year}$$

$$2040\ Truck\ Traffic = 25 * (1 + 0.7\%)^{2040-2015} = 30$$

Output:
2040 truck traffic

Step 2-Estimate 2040 Truck Traffic Percentages

This step was needed to estimate the 2040 truck traffic percentages using the 2040 truck traffic estimated in Step 1 and the total 2040 PM Peak Hour SOV Trips (*Ref: Traffic Forecast Section*).

Formula:

$$2040\ Truck\ Traffic\ Percentages = \frac{2040\ Truck\ Traffic}{2040\ Total\ Traffic} = \frac{30}{291} = 10\%$$

Output:
2040 truck traffic percentages

The estimated 2040 truck traffic percentage is 10% compared to 13% in 2015. The estimated (following the TATS recommended growth rate) truck percentages are lower than the existing truck percentages.

Proposed Major Developments in the Tideflats Area:

Several large scale developments have been proposed in the Tideflats area. The proposed Interfor Port of Tacoma development (TENW, 2016) is located on 11th Street will mainly access Portland Avenue to travel to and from the Tideflats area and may have significant impacts at Puyallup/Portland Ave. intersection. Therefore, the traffic impacts study for the proposed Interfor Port of Tacoma development

was reviewed to understand the possible effects on Puyallup. The proposed project would consist of the development of up to 1,300,000 square feet of warehousing and/or high-cube warehouse/distribution center use(s), generating 62 PM Peak hour freight vehicles (TENW, 2016). The expected trip distribution showed that 5% (*12 trips*) of this PM Peak hour truck traffic would access Puyallup from the proposed development, with the majority of them using Portland, Lincoln, SR-509 and I-5 to access the proposed project site. Therefore, potential PM peak hour trips generated from the proposed developments in the tideflats area are insignificant compared to the 2040 forecasted traffic.

2040 Truck Traffic: (TENW, 2016)

The average truck traffic percentage on Puyallup is 9.5% based on 2016 24 HR truck traffic counts, see *Figure 7 2016 Truck Percentages on Puyallup Ave*. 12.5% is the highest truck traffic percentage observed in the industrial zone on Puyallup. 13% PM peak hour truck traffic was observed accessing Puyallup from the Tideflats area, see *Figure 8 2016 PM Peak Hour Truck Traffic*. However, the estimated PM peak hour (per the TATS recommended growth rate) truck percentages are lower than the current PM peak hour truck percentages. Also, the proposed Interfor Port of Tacoma development will have very minimal impact on Puyallup during PM peak hour. Traffic operational analysis uses the truck traffic percentages in estimating the intersection delay. Therefore, it is recommended to use existing truck traffic percentages in determining the PM peak hour intersection delay.

Preferred Scenario – Traffic Operational Analysis:

The step by step methodologies outlined in the "**Traffic Forecasting**" section were used to forecast the 2040 total PM peak hour traffic for the following three (3) scenarios. The estimated 2040 average daily traffic for the following three (3) scenarios is displayed in *Figure 9 2040 Average Daily Traffic.*

1. ***Ultimate growth with TMP Mode Share:*** *The estimated 2040 ADT is 20,000*
2. ***Practical growth with TMP Model Share:*** *The estimated 2040 ADT is 16,750*
3. ***Practical growth with Refined Mode Share:*** *The estimated 2040 ADT is 17,500*

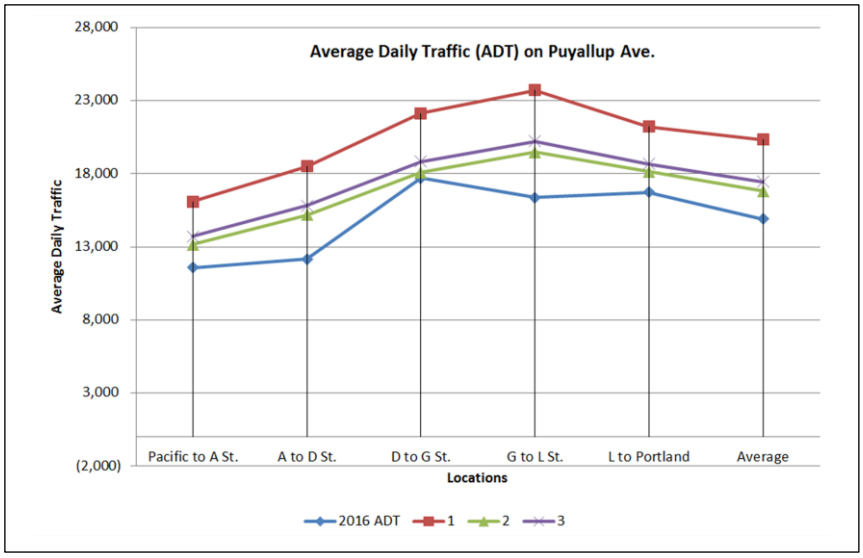


Figure 9 2040 Average Daily Traffic

1st, Ultimate growth with TMP mode shares scenario represents the maximum possible growth with the City adopted mode share. The estimated 2040 ADT will be approximately 20,000, which is 5,000 higher ADT than the current ADT.

2nd, The Practical growth with TMP and refined mode share scenarios represent the same land use growth, but different mode shares will experience almost same ADT in 2040. The practical growth with refined mode share scenario will experience higher ADT than practical growth with TMP mode share scenario.

Recommended Scenarios

Based on land uses, mode share, 2040 ADT, and other data/assumptions, City staff recommends the following two scenarios be used by the consultant to conduct the traffic operations analysis for the Puyallup Avenue Corridor Study.

1. **Ultimate growth with TMP Mode Share:** The estimated 2040 ADT is 20,000
2. **Practical growth with Refined Mode Share:** The estimated 2040 ADT is 17,500

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Appendix E Traffic Operations Analysis

Technical Memorandum

To: Jennifer Wieland

From: Laura Forinash, T.E.
Michael Horntvedt
Parsons

Date: June 19, 2017

RE: ***Puyallup Avenue Corridor Traffic Operations Analysis***

INTRODUCTION

This technical memorandum documents the traffic operations analysis assumptions, methodology, and findings comparing three potential multimodal improvement alternatives for the Puyallup Avenue Corridor between Pacific Avenue and Portland Avenue. This memorandum evaluates four improvement conditions: one no-build condition and three build conditions. The No-Build condition would mostly maintain the existing lane configuration of Puyallup Avenue Corridor with no future improvements to Puyallup Avenue or pedestrian/bicycle facilities. Alternatives 1, 2, and 3, include modifications to convert Puyallup Avenue Corridor to a complete street configuration with a goal to serve all users.

Project Location, Project Need and Project Study Area

Puyallup Avenue is in South Downtown Tacoma located in Pierce County, Washington. The corridor connects commuters, businesses, visitors, and industrial lands. Puyallup Avenue is a key part of the City of Tacoma's pedestrian, transit, freight, and bicycle networks and a future connection to the Prairie Line Trail. Residential and commercial development, the relocation of the Amtrak station, and the role of the Tacoma Dome as a regional draw support the need to examine Puyallup Avenue as a future multimodal complete street.

Currently, the Puyallup Avenue Corridor is a four-lane roadway with a center turn lane and pedestrian sidewalks. The study area encompasses Puyallup Avenue from Portland Avenue to Pacific Avenue. This study provides traffic operations analysis of intersections along Puyallup Avenue within the project limits. The following is a list of the study intersections:

1. Puyallup Avenue and Pacific Avenue;
2. Puyallup Avenue and A Street;
3. Puyallup Avenue and D Street;
4. Puyallup Avenue and E Street;
5. Puyallup Avenue and F Street;
6. Puyallup Avenue and G Street;
7. Puyallup Avenue and L Street; and
8. Puyallup Avenue and Portland Avenue.

Analysis Scenario

This traffic study evaluates the future (2040) traffic conditions within the project area including, intersection level of service (LOS), approach LOS, arterial LOS, intersection delay, approach delay, queue length, and arterial travel time. The analyses were conducted for the following conditions:

1. 2040 No-Build
2. 2040 Alternative 1;

3. 2040 Alternative 2; and
4. 2040 Alterative 3.

Project Alternatives Description

The Puyallup Avenue Corridor considers one no-build condition and three build alternative conditions. The No-Build alternative would maintain the existing lane configuration of Puyallup Avenue Corridor with no future improvements to the mainline or pedestrian/bicycle facilities. Alternatives 1, 2, and 3, include improvements to convert Puyallup Avenue to a complete street that serves all users.

2040 No-Build Condition

The No-Build condition would not result in any proposed project improvements. Puyallup Avenue is currently a four-lane roadway with a center turn lane and pedestrian sidewalks on either side of Puyallup Avenue.

2040 Alternative 1 Condition

Alternative 1 replaces an existing general purpose lane with an exclusive eastbound transit/HOV lane. This alternative would provide a single general purpose lane in each direction separated by a center turn lane and an eastbound transit/HOV lane. The eastbound buses would stop in the exclusive transit/HOV lane and the westbound buses would stop in the westbound general purpose lane. Alternative 1 also includes a two-way bike path on the north side of Puyallup Avenue between Pacific Avenue and L Street before transitioning to the south side of Puyallup Avenue east of L Street. Bike signals are installed at Pacific Avenue, A Street, D Street, and Portland Avenue. Lastly, fixed pedestrian signal heads are installed at Pacific Avenue, D Street, E Street, F Street, and G Street.

2040 Alternative 2 Condition

Alternative 2 removes the center turn lane and includes protected bike lanes on both sides of Puyallup Avenue with a bike signal at Pacific Avenue. This alternative would provide two general purpose lanes in each direction with protected bike lanes on both sides of Puyallup Avenue. Buses would stop in the general purpose lanes. Lastly, fixed pedestrian signal heads are installed at Pacific Avenue, A Street, D Street, E Street, F Street, G Street, and L Street.

2040 Alternative 3 Condition

Alternative 3 replaces an existing general purpose lane in each direction with buffered bike lanes in each direction. This alternative would provide one general purpose lane in each direction separated by a center turn lane and buffered bike lanes on both sides of Puyallup Avenue. Buses would stop in the general purpose lanes. Lastly, fixed pedestrian signal heads are installed at Pacific Avenue, A Street, D Street, E Street, F Street, G Street, and L Street.

METHODOLOGY

The analysis of intersection and arterial traffic operations was conducted for No-Build, Alternative 1, Alternative 2, and Alternative 3 conditions. Analysis of traffic operations at the intersection level is focused on performance metrics such as LOS, delays, and queueing. At the corridor level, the intent of this study is to evaluate traffic progression along Puyallup Avenue Corridor in terms of travel time, speeds, and overall corridor control delay. The following measures were used to evaluate intersection and arterial operations under No-Build, Alternative 1, Alternative 2, Alternative 3 conditions in 2040:

1. Approach LOS;
2. Approach delay;
3. Intersection LOS;
4. Intersection delay;
5. Intersection approach 95th percentile queue; and

6. Arterial travel time.

Levels of Service, delays, queuing, and travel time were determined used methods defined in the Highway Capacity Manual (HCM) as calculated using Synchro 9.1 traffic analysis software. Future (2040) year traffic volumes were calculated by Nelson\Nygaard's travel demand model and provided to Parsons for the traffic operations analysis. Future (2040) year traffic volumes were based on existing traffic volumes provided by the City of Tacoma. Synchro output worksheets for all analysis conditions are contained in **Attachment B.**

Level of Service (LOS) Analysis

Analysis of traffic operations is based on the concept of LOS. The LOS of an intersection is a qualitative measure used to describe operational conditions. LOS ranges from A (best), which represents minimal delay, to F (worst), which represents heavy delay and a facility that is operating with significant congestion. For unsignalized intersections, LOS is defined as a function of average control delay for each minor street approach movement. For signalized intersections, LOS is defined as a function of average control delay for the intersection as a whole. **Table 1** relates the operational characteristics associated with each LOS category for signalized and unsignalized intersections. The intersection LOS was determined using the Synchro 9.1 traffic analysis software which is based on the HCM. Nelson\Nygaard provided guidance on intersection coordination and turn types (i.e. protected, permitted, overlap, etc.). Intersections D, E, F, and G Street, are coordinated. Intersections Pacific Avenue, A Street, L Street, and Portland Avenue are not coordinated. Cycle lengths are optimized with cycle lengths ranging between 60 seconds and 150 seconds.

Table 1. Intersection LOS Criteria

LOS	Signalized Average Control Delay Per Vehicle (sec/veh)	Unsignalized Average Control Delay Per Vehicle (sec/veh)
A (minimal delay)	< 10	< 10
B (short delay)	> 10 and < 20	> 10 – 15
C (average delay)	> 20 and < 35	> 15 – 25
D (long delay)	> 35 and < 55	> 25 – 35
E (very long delay)	> 55 and < 80	> 35 – 50
F (extreme delay/jammed)	> 80	> 50

Source: Transportation Research Board, *Highway Capacity Manual 2000*, National Research Council, 2000.

Intersection Approach 95th Percentile Queue

The 95th percentile queue lengths were investigated to determine the adequacy of storage to accommodate expected queues of vehicles for intersections. The queueing analysis was conducted by Synchro 9.1 traffic analysis software. The 95th percentile queue length reported by Synchro is the maximum back of the queue with 95th percentile traffic volumes. This represents a condition where for 95% of the time during the peak period traffic volumes and related queueing will be at, or less than, the queue length indicated. The 95th percentile queue is compared to the storage length in the lane group. The No-Build turn pocket storage lengths and distances between arterial intersections were measured using Google Earth. Under Alternatives 1, 2, and 3, lane geometrics and storage lengths are based on the conceptual drawings provided by Nelson\Nygaard.

Arterial Travel Time

Analysis of corridor performance was analyzed using Synchro's arterial analysis which follows the HCM methodologies. The signal delay is the Synchro control delay for the through lane group. The travel time is equal to running time plus signal delay where running time is the link distance divided by the flow speed. The arterial speed is the distance divided travel time and arterial LOS is based on the speed.

Synchro Model Assumptions and Limitations

Synchro has several limitations which prevents the software from performing a complete multi-modal analysis of this corridor. It is important to recognize these limitations and understand that this traffic

operations analysis is an analysis of the general purpose traffic and does not evaluate the pedestrians, bicyclists, and transit rider experience. The following are Synchro limitations and assumptions relevant to this study.

Pedestrian and Bicycle Facilities

Alternative 1 recommends leading pedestrian intervals (LPI) and leading bicycle intervals (LBI) at intersections where pedestrian and bicycle signals are installed. A LPI or LBI provides pedestrians or bicycles a head start when entering an intersection with a corresponding green signal in the same direction of travel. The City of Tacoma recommends a 7 second LPI and did not provide guidance on the duration of LBIs. For this study, a 5 second LBI was assumed. At locations where both LPIs and LBIs are recommended, it was assumed that the LBI was included in the LPI and 7 seconds was used for the leading interval. Synchro does not have a specific LPI or LBI input; therefore, this study first optimized the cycle length and splits and then added the LPI or LBI interval to the appropriate phases' green time.

Transit Signal Priority and Bus Stops

Synchro is unable to model transit signal priority (TSP) and there is not an agreed upon industry standard on how best to deceive Synchro into running TSP. Therefore, TSP was not included in this traffic operations analysis. Typically, TSP is only in effect when the bus is behind schedule and should not occur often. Bus stops are not explicitly modeled in Synchro, but there is a bus blockage setting that accounts for the number of buses per hour that stop and block traffic. The eastbound bus stops in Alternative 1 were not modeled through bus blockages because the buses stop in the exclusive bus lane which is not included in the Synchro model.

Exclusive Transit/HOV Lanes

Synchro is unable to model vehicle specific lanes; therefore, the exclusive eastbound bus lane for Alternative 1 was not modeled except for assuming general purpose traffic would utilize the bus lane for eastbound right turns at intersections. This traffic operations analysis assumed a storage length of 150' for the eastbound right turns.

Analysis Results

Intersection Level of Service

Intersection traffic operations were evaluated for the No-Build condition and alternative conditions based on peak hour volumes. Results of this analysis are presented in **Table 2 (attached).** Under the No-Build condition, all intersections operate at LOS D or better during the peak hour. For Alternative 1, the intersection of D Street and Puyallup is expected to operate at LOS F during the peak hour. The intersection of Portland Avenue and Puyallup Avenue is expected to operate at LOS E. For Alternative 2, all intersections operate at LOS D of better during the peak hour. For Alternative 3, the intersection of D Street and Puyallup Avenue is expected to operate at LOS F during the peak hour.

As shown in **Table 2**, the alternative conditions generally result in worse operational performance in terms of delay and LOS compared to the No-Build condition because there is less capacity in the alternative conditions. Alternative 2 has the best operational performance out of the alternatives because this alternative maintains two general purpose lanes in each direction, while Alternative 1 and Alternative 3 have a single general purpose lane in each direction. Alternative 1 and 3 have similar LOS and delay results because the lane configurations are essentially identical because the Alternative 1 exclusive eastbound transit/HOV lane is omitted from the Synchro model due to software limitations previously discussed.

Vehicle Queuing

The 95th percentile queue is used as the benchmark for queuing impacts as a standard transportation engineering practice. For the purposes of this study, a potential queueing issue occurs under two events.

The first event occurs at an intersection where the estimated 95th percentile queue length in a dedicated turn lane is projected to exceed the storage limits of a turn pocket. The second event occurs at an intersection where the estimated 95th percentile queue length at a through movement is projected to exceed the upstream distance to the next intersection. Queue length results are presented in the attached **Tables 3**, **4**, **5**, and **6**, for the No-Build, Alternative 1, Alternative 2, and Alternative 3 conditions respectively. Locations where the 95th percentile queue length exceeds the storage length are highlighted in red.

As shown in **Table 3**, the following arterial movements are expected to exceed the available storage length under 2040 No-build conditions:

1. Southbound through movement at the Puyallup Avenue and Pacific Avenue;
2. Westbound left movement at Puyallup Avenue and Pacific Avenue;
3. Southbound left movement at Puyallup Avenue and D Street;
4. Northbound left movement at Puyallup Avenue and E Street;
5. Eastbound through movement at Puyallup Avenue and G Street; and
6. Westbound left movement at Puyallup Avenue and Portland Avenue.

As shown in **Table 4**, all 2040 No-build queue length violations are applicable to 2040 Alternative 1 except for the eastbound through movement at Puyallup Avenue and G Street. The following arterial movements are additional movements expected to exceed the available storage length under 2040 Alternative 1:

1. Westbound through movement at Puyallup Avenue and A Street;
2. Northbound through movement at Puyallup Avenue and D Street;
3. Southbound right movement at Puyallup Avenue and D Street;
4. Eastbound through movement at Puyallup Avenue and D Street;
5. Westbound through movement at Puyallup Avenue and D Street;
6. Southbound left movement at Puyallup Avenue and E Street;
7. Eastbound through movement at Puyallup Avenue and E Street;
8. Westbound through movement at Puyallup Avenue and E Street;
9. Northbound through movement at Puyallup Avenue and F Street;
10. Southbound through movement at Puyallup Avenue and F Street;
11. Northbound left movement at Puyallup Avenue and G Street;
12. Southbound through movement at Puyallup Avenue and L Street;
13. Eastbound left movement at Puyallup Avenue and L Street;
14. Eastbound through movement at Puyallup Avenue and L Street; and
15. Westbound left movement at Puyallup Avenue and L Street.

As shown in **Table 5**, all 2040 No-build queue length violations are applicable to 2040 Alternative 2 except for the eastbound through movement at Puyallup Avenue and G Street. The following arterial movements are additional movements expected to exceed the available storage length under 2040 Alternative 2:

1. Westbound right movement at Puyallup Avenue and Pacific Avenue;
2. Westbound right movement at Puyallup Avenue and Pacific Street;
3. Westbound through movement at Puyallup Avenue and D Street;
4. Northbound through movement at Puyallup Avenue and F Street;
5. Southbound through movement at Puyallup Avenue and L Street; and
6. Eastbound through movement at Puyallup Avenue and L Street.

As shown in **Table 6**, all 2040 No-build queue length violations are applicable to 2040 Alternative 3 except for the eastbound through movement at Puyallup Avenue and G Street. The following arterial movements are additional movements expected to exceed the available storage length under 2040 Alternative 3:

1. Westbound through movement at Puyallup Avenue and A Street;
2. Eastbound through movement at Puyallup Avenue and D Street;

3. Westbound through movement at Puyallup Avenue and D Street;
4. Southbound left movement at Puyallup Avenue and E Street;
5. Eastbound through movement at Puyallup Avenue and E Street;
6. Westbound through movement at Puyallup Avenue and E Street;
7. Northbound through movement at Puyallup Avenue and F Street;
8. Northbound left movement at Puyallup Avenue and G Street;
9. Westbound left movement at Puyallup Avenue and G Street;
10. Southbound through movement at Puyallup Avenue and L Street; and
11. Eastbound left movement at Puyallup Avenue and L Street;

Arterial Analysis

Synchro 9.1 analysis software was utilized to evaluate corridor performance along Puyallup Avenue for No-Build conditions and for each of the three alternatives. The peak hour Synchro models used for this evaluation include the1.2-mile segment of the Puyallup Avenue corridor from Pacific Avenue to Portland Avenue. **Table 7** below summarizes the projected average corridor travel time, speeds, delay, and arterial LOS along Puyallup Avenue under each condition.

Table 7. Arterial Analysis

Condition	Signal Delay, s	Travel Time, s	Arterial Speed, mph	Arterial LOS
EB Puyallup Avenue				
2040 No-Build	120.9	278.2	15.6	D
2040 Alternative 1	243.7	405.7	10.7	E
HOV Lane		280 – 305		
2040 Alternative 2	179.3	341.3	12.7	E
2040 Alternative 3	253.5	415.5	10.4	E
WB Puyallup Avenue				
2040 No-Build	115.5	272.8	15.9	D
2040 Alternative 1	242.5	404.5	10.7	E
2040 Alternative 2	122.7	284.7	15.2	D
2040 Alternative 3	258.4	420.4	10.3	E

As shown in **Table 7,** compared to the No-Build conditions, the travels times for Alternative 1 are 127.5 seconds longer in the eastbound direction and 131.7 seconds longer in the westbound direction. The exception to Alternative 1 travel times is the HOV lane in the eastbound direction. It is estimated that the HOV lane would provide an unimpeded travel time for transit and carpool vehicles that would be similar to a No Build configuration.

The travels times for Alternative 2 are 63.1 seconds longer in the eastbound direction and 11.9 seconds longer in the westbound direction when compared to the No-Build conditions. The travels times for Alternative 3 are 137.3 seconds longer in the eastbound direction and 147.6 seconds longer in the westbound direction when compared to the No-Build conditions.

Conclusions and Recommendations

Conclusions

This analysis illustrates that converting a general-purpose lane of traffic into and HOV lane and/or repurposing that space for non-motorized travel as assumed in Alternatives 1 and 3, would result in higher levels of delay for the general purpose traffic. Levels of congestion would be somewhat higher than reported in this analysis because of the intersections would have much more traffic demand than could be

processed during each signal cycle. This would likely also result in longer travel times than shown in the model output data. The analysis data can be used to understand how the alternatives compare relative to each other, but should not be taken as an actual estimate of delay or travel time on the corridor. A more detailed peak period analysis using simulation models would provide a more accurate estimate about corridor operations. It should be noted that the eastbound HOV lane would provide improved travel times for buses and HOV when compared to the general purpose travel. The eastbound transit and HOV traffic in Alternative 1 would operate like a No Build configuration.

Alternative 2 is shown travel times like No Build because it continues to provide the two general purpose lanes of travel along Puyallup Avenue. Buses would be required to stop in the lane and would result in some additional delay for the general-purpose traffic.

Recommendations

1. Because the selection of a preferred alternative is multi-faceted, with traffic operations only one part of the decision, this technical memorandum does not provide a recommendation for the preferred alternative. Consideration and balancing of the City's goals to enhance and promote high occupancy travel, multi-modal connectivity, and experiential travel will be combined with the traffic operations information to select a preferred alternative. The following recommendations are associated with any subsequent traffic analysis associated with the preferred alternative and recommended alternative refinements.Perform a re-calibration of the City of Tacoma travel demand model to allow for additional understanding about the dynamic land use effects on future traffic patterns
2. Maintain close coordination with Sound Transit to understand if they will seek to repurpose the Puyallup Avenue corridor into a light rail route for access to the Tacoma Dome park and ride
3. Synchronize the City of Tacoma travel demand model with the Dynameq and VISSIM model platforms to allow for further consideration traffic impacts from future land use assumptions
4. Consider how event use will impact the corridor operation for all modes

Attachment A: Tables 2 through 6

Table 2. Intersection and Approach Level of Service Summary

Intersection	Approach	2040 No-Build Conditions					2040 Alternative 1					2040 Alternative 2					2040 Alternative 3				
		Approach LOS	Approach delay, s	Intersection LOS	Intersection delay, s	Cycle Length, s	Approach LOS	Approach delay, s	Intersection LOS	Intersection delay, s	Cycle Length, s	Approach LOS	Approach delay, s	Intersection LOS	Intersection delay, s	Cycle Length, s	Approach LOS	Approach delay, s	Intersection LOS	Intersection delay, s	Cycle Length, s
Pacific Avenue & Puyallup Avenue	NB	C	28.2	C	29.2	85	D	47.9	D	41.4	135	E	60.9	D	48.0	135	E	58.4	D	42.9	130
	SB	C	33.9				D	53.9				D	47.5				D	42.7			
	EB	B	18.5				D	42.6				D	53.3				E	66.6			
	WB	C	26.5				C	26.7				D	42.5				C	33.8			
A Street & Puyallup Avenue	NB	B	10.4	A	8.6	65	C	31.6	B	16.9	105	B	10.4	A	8.6	65	C	22.3	B	11.9	90
	SB	B	10.8				C	33.1				B	10.7				C	23.1			
	EB	A	7.1				B	10.7				A	7.1				A	5.4			
	WB	A	9.0				B	17.8				A	9.1				B	13.5			
D Street & Puyallup Avenue	NB	B	19.0	D	39.3	75	F	115.8	F	88.8	150	D	46.2	D	39.5	105	C	34.5	F	82.0	140
	SB	E	58.7				F	131.2				E	79.5				F	88.2			
	EB	C	26.0				D	35.2				C	25.8				D	43.4			
	WB	D	44.4				F	90.2				C	26.8				F	115.2			
E Street & Puyallup Avenue	NB	C	34.0	B	11.1	75	E	68.9	C	31.5	135	D	49.3	B	19.0	105	E	63.4	C	30.2	125
	SB	C	20.1				D	38.6				C	29.1				D	35.5			
	EB	A	3.6				C	21.4				B	10.5				C	22.7			
	WB	A	7.0				C	24.3				B	12.5				C	22.6			
F Street & Puyallup Avenue	NB	C	27.8	A	6.8	75	E	60.1	A	9.1	135	D	43.7	A	6.3	105	D	54.8	A	8.9	125
	SB	C	27.7				E	58.8				D	43.1				D	53.6			
	EB	A	6.1				A	6.5				A	4.5				A	6.4			
	WB	A	4.4				A	4.5				A	2.7				A	4.9			
G Street & Puyallup Avenue	NB	C	31.5	B	12.2	75	F	80.5	B	15.0	135	D	48.1	B	11.0	105	F	84.3	B	16.4	125
	EB	B	15.1				A	6.6				A	9.1				A	7.1			
	WB	A	4.9				A	9.1				A	4.8				B	11.1			
L Street & Puyallup Avenue	NB	Unsignalized					D	45.6	C	30.1	100	C	27.7	B	14.6	80	F	114.9	D	41.7	150
	SB						D	38.6				C	26.7				E	76.8			
	EB						C	33.5				B	17.5				E	55.8			
	WB						C	21.9				A	7.0				A	6.3			
Portland Avenue & Puyallup Avenue	NB	C	29.6	D	40.4	90	C	29.2	E	67.8	95	C	29.6	D	40.7	90	C	29.5	D	40.5	90
	SB	D	44.7				E	78.7				D	44.7				D	44.6			
	EB	D	41.5				D	49.7				D	41.6				D	41.0			
	WB	D	38.9				F	95.0				D	40.4				D	40.4			

Table 3. 2040 No-Build Condition Intersection 95th Percentile Queue Summary

Intersection	Movement	Available Storage (feet)	95th Percentile Queue (feet)	Adequate?
Pacific Avenue & Puyallup Avenue	NBT	260	123	Yes
	SBT	300	401	**No**
	EBT	290	41	Yes
	WBL	310	330	**No**
	WBT	310	200	Yes
	WBR	115	68	Yes
A Street & Puyallup Avenue	NBT	270	14	Yes
	NBR	135	18	Yes
	SBT	80	34	Yes
	EBL	90	19	Yes
	EBT	310	91	Yes
	WBL	112	57	Yes
	WBT	720	216	Yes
D Street & Puyallup Avenue	NBL	150	51	Yes
	NBT	250	116	Yes
	SBL	150	297	**No**
	SBT	340	101	Yes
	SBR	100	40	Yes
	EBL	140	47	Yes
	EBT	280	180	Yes
	WBL	150	72	Yes
	WBT	290	251	Yes
E Street & Puyallup Avenue	NBL	100	139	**No**
	NBT	100	0	Yes
	SBL	50	33	Yes
	SBT	50	0	Yes
	EBL	100	5	Yes
	EBT	290	82	Yes
	WBT	300	75	Yes
F Street & Puyallup Avenue	NBT	50	47	Yes
	SBT	80	45	Yes
	EBL	50	7	Yes
	EBT	220	64	Yes
	WBT	290	108	Yes
G Street & Puyallup Avenue	NBL	260	116	Yes
	EBT	290	301	**No**
	WBL	150	49	Yes
	WBT	1,820	79	Yes
L Street & Puyallup Avenue	TWSC			
Portland Avenue & Puyallup Avenue	NBT	960	152	Yes
	NBR	150	57	Yes
	SBL	190	89	Yes
	SBT	570	460	Yes
	SBR	150	97	Yes
	EBL	150	44	Yes
	EBT	1,460	238	Yes
	EBR	560	294	Yes
	WBL	150	405	**No**
	WBT	3,000	147	Yes
	WBR	30	0	Yes

Table 4. 2040 Alternative 1 Intersection 95th Percentile Queue Summary

Intersection	Movement	Available Storage (feet)	95th Percentile Queue (feet)	Adequate?
Pacific Avenue & Puyallup Avenue	NBT	260	197	Yes
	SBT	300	558	**No**
	EBL	150	24	Yes
	EBT	290	124	Yes
	WBL	310	408	**No**
	WBT	310	258	Yes
	WBR	115	56	Yes
A Street & Puyallup Avenue	NBT	270	24	Yes
	NBR	135	16	Yes
	SBT	80	61	Yes
	EBL	90	38	Yes
	EBT	310	291	Yes
	EBR	150	0	Yes
	WBL	150 [1]	120	Yes
	WBT	720	926	**No**
	WBR	150	23	Yes
D Street & Puyallup Avenue	NBL	150	123	Yes
	NBT	250	320	**No**
	SBL	150	548	**No**
	SBT	340	227	Yes
	SBR	100	105	**No**
	EBL	140	74	Yes
	EBT	280	547	**No**
	EBR	150	6	Yes
	WBL	150	94	Yes
	WBT	290	1009	**No**
	WBR	150	83	Yes
E Street & Puyallup Avenue	NBL	100	256	**No**
	NBT	100	0	Yes
	SBL	50	59	**No**
	SBT	50	0	Yes
	EBL	100	34	Yes
	EBT	290	815	**No**
	EBR	150	10	Yes
	WBL	100	3	Yes
	WBT	300	879	**No**
F Street & Puyallup Avenue	NBT	50	97	**No**
	SBT	80	87	**No**
	EBL	50	7	Yes
	EBT	220	187	Yes
	WBT	290	202	Yes
G Street & Puyallup Avenue	NBL	260	270	**No**
	EBT	290	227	Yes
	EBR	150	1	Yes
	WBL	200 [2]	179	Yes
	WBT	1,820	296	Yes

[1] Extended WBL turn bay from 112' to 150'

[2] Extended WBL turn bay from 150' to 200'

Table 4. 2040 Alternative 1 Intersection 95th Percentile Queue Summary

Intersection	Movement	Available Storage (feet)	95th Percentile Queue (feet)	Adequate?
L Street & Puyallup Avenue	NBT	640	143	Yes
	SBT	50	114	**No**
	EBL	80	91	**No**
	EBT	340	997	**No**
	EBR	150	33	Yes
	WBL	80	87	**No**
	WBT	1,460	749	Yes
Portland Avenue & Puyallup Avenue	NBT	960	167	Yes
	NBR	150	46	Yes
	SBL	190	100	Yes
	SBT	570	525	Yes
	SBR	150	128	Yes
	EBL	150	90	Yes
	EBT	1,460	592	Yes
	EBR	560	267	Yes
	WBL	150	494	**No**
	WBT	3,000	158	Yes
	WBR	30	0	Yes

Table 5. 2040 Alternative 2 Intersection 95th Percentile Queue Summary

Intersection	Movement	Available Storage (feet)	95th Percentile Queue (feet)	Adequate?
Pacific Avenue & Puyallup Avenue	NBT	260	220	Yes
	SBT	300	572	**No**
	EBL	75	26	Yes
	EBT	290	123	Yes
	EBR	75	0	Yes
	WBL	310	399	**No**
	WBT	310	275	Yes
	WBR	115	196	**No**
A Street & Puyallup Avenue	NBT	270	14	Yes
	NBR	135	17	Yes
	SBT	80	34	Yes
	EBL	90	19	Yes
	EBT	310	91	Yes
	WBL	112	58	Yes
	WBT	720	217	Yes
D Street & Puyallup Avenue	NBL	150	56	Yes
	NBT	250	190	Yes
	SBL	150	303	**No**
	SBT	340	150	Yes
	SBR	100	52	Yes
	EBL	140	47	Yes
	EBT	280	242	Yes
	WBL	150	61	Yes
	WBT	290	424	**No**
E Street & Puyallup Avenue	NBL	100	193	**No**
	NBT	100	0	Yes
	SBL	50	45	Yes
	SBT	50	0	Yes
	EBT	290	176	Yes
	WBT	300	125	Yes
F Street & Puyallup Avenue	NBT	50	71	**No**
	SBT	80	64	Yes
	EBT	220	122	Yes
	WBT	290	80	Yes
G Street & Puyallup Avenue	NBL	260	160	Yes
	EBT	290	156	Yes
	WBL	150	63	Yes
	WBT	1,820	119	Yes
L Street & Puyallup Avenue	NBT	640	104	Yes
	SBT	50	82	**No**
	EBT	340	476	**No**
	WBL	80	71	Yes
	WBT	1,460	140	Yes

Table 5. 2040 Alternative 2 Intersection 95th Percentile Queue Summary

Intersection	Movement	Available Storage (feet)	95th Percentile Queue (feet)	Adequate?
Portland Avenue & Puyallup Avenue	NBT	960	152	Yes
	NBR	150	57	Yes
	SBL	190	89	Yes
	SBT	570	460	Yes
	SBR	150	97	Yes
	EBL	150	85	Yes
	EBT	1,460	238	Yes
	EBR	560	294	Yes
	WBL	150	405	**No**
	WBT	3,000	166	Yes
	WBR	30	0	Yes

Table 6. 2040 Alternative 3 Intersection 95th Percentile Queue Summary

Intersection	Movement	Available Storage (feet)	95th Percentile Queue (feet)	Adequate?
Pacific Avenue & Puyallup Avenue	NBT	260	212	Yes
	SBT	300	472	**No**
	EBT	290	141	Yes
	WBL	310	474	**No**
	WBT	310	240	Yes
	WBR	115	79	Yes
A Street & Puyallup Avenue	NBT	270	22	Yes
	NBR	135	26	Yes
	SBT	80	54	Yes
	EBL	90	19	Yes
	EBT	310	205	Yes
	WBL	112	52	Yes
	WBT	720	806	**No**
D Street & Puyallup Avenue	NBL	150	84	Yes
	NBT	250	222	Yes
	SBL	150	496	**No**
	SBT	340	170	Yes
	SBR	100	91	Yes
	EBL	140	61	Yes
	EBT	280	645	**No**
	WBL	150	111	Yes
	WBT	290	999	**No**
	WBR	150	109	Yes
E Street & Puyallup Avenue	NBL	100	237	**No**
	NBT	100	0	Yes
	SBL	50	55	**No**
	SBT	50	0	Yes
	EBL	100	35	Yes
	EBT	290	831	**No**
	WBL	100	4	Yes
	WBT	300	844	**No**
F Street & Puyallup Avenue	NBT	50	90	**No**
	SBT	80	79	Yes
	EBL	50	0	Yes
	EBT	220	140	Yes
	WBT	290	172	Yes
G Street & Puyallup Avenue	NBL	260	275	**No**
	EBT	290	51	Yes
	WBL	150	259	**No**
	WBT	1,820	251	Yes
L Street & Puyallup Avenue	NBT	640	284	Yes
	SBT	50	209	**No**
	EBT	340	1,614	**No**
	WBL	80	29	Yes
	WBT	1,460	395	Yes

Table 6. 2040 Alternative 3 Intersection 95th Percentile Queue Summary

Intersection	Movement	Available Storage (feet)	95th Percentile Queue (feet)	Adequate?
Portland Avenue & Puyallup Avenue	NBT	960	152	Yes
	NBR	150	57	Yes
	SBL	190	89	Yes
	SBT	570	460	Yes
	SBR	150	96	Yes
	EBL	150	85	Yes
	EBT	1,460	238	Yes
	EBR	560	288	Yes
	WBL	150	405	**No**
	WBT	3,000	166	Yes
	WBR	30	0	Yes

Attachment B: Synchro Analysis Worksheets

2040 No-Build Conditions

1. HCM LOS Analysis
2. Queue Analysis
3. Arterial Analysis

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	8	82	15	296	250	360	0	298	76	297	519	37
Future Volume (vph)	8	82	15	296	250	360	0	298	76	297	519	37
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0	5.0		5.0			5.0	
Lane Util. Factor		0.95		1.00	1.00	1.00		0.95			0.95	
Frpb, ped/bikes		1.00		1.00	1.00	1.00		1.00			1.00	
Flpb, ped/bikes		1.00		0.99	1.00	1.00		1.00			1.00	
Frt		0.98		1.00	1.00	0.85		0.97			0.99	
Flt Protected		1.00		0.95	1.00	1.00		1.00			0.98	
Satd. Flow (prot)		3507		1760	1900	1460		3318			3492	
Flt Permitted		0.93		0.68	1.00	1.00		1.00			0.98	
Satd. Flow (perm)		3270		1260	1900	1460		3318			3492	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	9	89	16	322	272	391	0	324	83	323	564	40
RTOR Reduction (vph)	0	11	0	0	0	272	0	31	0	0	4	0
Lane Group Flow (vph)	0	103	0	322	272	119	0	376	0	0	923	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Bus Blockages (#/hr)	24	0	4	4	0	24	0	24	0	0	4	0
Turn Type	Perm	NA		Perm	NA	Prot		NA		Split	NA	
Protected Phases		4			8	8	1	1		2	2	
Permitted Phases	4			8								
Actuated Green, G (s)		22.5		22.5	22.5	22.5		14.4			22.1	
Effective Green, g (s)		22.5		22.5	22.5	22.5		14.4			22.1	
Actuated g/C Ratio		0.30		0.30	0.30	0.30		0.19			0.30	
Clearance Time (s)		5.0		5.0	5.0	5.0		5.0			5.0	
Vehicle Extension (s)		2.5		2.5	2.5	2.5		2.5			2.5	
Lane Grp Cap (vph)		994		383	577	443		645			1042	
v/s Ratio Prot					0.14	0.08		c0.11			c0.26	
v/s Ratio Perm		0.03		c0.26								
v/c Ratio		0.10		0.84	0.47	0.27		0.58			0.89	
Uniform Delay, d1		18.5		24.1	20.9	19.5		27.1			24.8	
Progression Factor		1.00		1.00	1.00	1.00		1.00			1.00	
Incremental Delay, d2		0.0		15.0	0.4	0.2		1.1			9.2	
Delay (s)		18.5		39.1	21.4	19.8		28.2			33.9	
Level of Service		B		D	C	B		C			C	
Approach Delay (s)		18.5			26.5			28.2			33.9	
Approach LOS		B			C			C			C	

Intersection Summary			
HCM 2000 Control Delay	29.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	74.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	73.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	21	425	21	98	888	53	10	5	45	28	18	22
Future Volume (vph)	21	425	21	98	888	53	10	5	45	28	18	22
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0			5.0	5.0		5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	0.98		0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Frt	1.00	0.99		1.00	0.99			1.00	0.85		0.96	
Flt Protected	0.95	1.00		0.95	1.00			0.97	1.00		0.98	
Satd. Flow (prot)	1805	3527		1805	3522			1831	1537		1768	
Flt Permitted	0.21	1.00		0.48	1.00			0.85	1.00		0.90	
Satd. Flow (perm)	404	3527		903	3522			1606	1537		1614	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	23	462	23	107	965	58	11	5	49	30	20	24
RTOR Reduction (vph)	0	5	0	0	6	0	0	0	34	0	17	0
Lane Group Flow (vph)	23	480	0	107	1017	0	0	16	15	0	57	0
Confl. Peds. (#/hr)							10		10	10		10
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Bus Blockages (#/hr)	0	8	0	0	8	0	0	0	8	8	0	0
Turn Type	Perm	NA		Perm	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8		8	4		
Actuated Green, G (s)	19.5	19.5		19.5	19.5			12.7	12.7		12.7	
Effective Green, g (s)	19.5	19.5		19.5	19.5			12.7	12.7		12.7	
Actuated g/C Ratio	0.46	0.46		0.46	0.46			0.30	0.30		0.30	
Clearance Time (s)	5.0	5.0		5.0	5.0			5.0	5.0		5.0	
Vehicle Extension (s)	2.5	2.5		2.5	2.5			2.5	2.5		2.5	
Lane Grp Cap (vph)	186	1629		417	1627			483	462		485	
v/s Ratio Prot		0.14			c0.29							
v/s Ratio Perm	0.06			0.12				0.01	0.01		c0.04	
v/c Ratio	0.12	0.29		0.26	0.62			0.03	0.03		0.12	
Uniform Delay, d1	6.5	7.1		6.9	8.6			10.4	10.4		10.7	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.2	0.1		0.2	0.7			0.0	0.0		0.1	
Delay (s)	6.7	7.1		7.2	9.2			10.4	10.4		10.8	
Level of Service	A	A		A	A			B	B		B	
Approach Delay (s)		7.1			9.0			10.4			10.8	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM 2000 Control Delay	8.6	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	42.2	Sum of lost time (s)	10.0
Intersection Capacity Utilization	61.0%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	58	521	73	130	760	184	72	124	119	272	168	193
Future Volume (vph)	58	521	73	130	760	184	72	124	119	272	168	193
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	0.99		1.00	0.99		1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.99	1.00		0.99	1.00	1.00
Frt	1.00	0.98		1.00	0.97		1.00	0.93		1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1597	3382		1801	3329		1753	1690		1678	1863	1546
Flt Permitted	0.22	1.00		0.38	1.00		0.64	1.00		0.40	1.00	1.00
Satd. Flow (perm)	369	3382		714	3329		1186	1690		708	1863	1546
Peak-hour factor, PHF	0.82	0.82	0.82	0.73	0.73	0.73	0.67	0.67	0.67	0.96	0.96	0.96
Adj. Flow (vph)	71	635	89	178	1041	252	107	185	178	283	175	201
RTOR Reduction (vph)	0	15	0	0	27	0	0	46	0	0	0	129
Lane Group Flow (vph)	71	709	0	178	1266	0	107	317	0	283	175	72
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	13%	3%	0%	0%	3%	11%	2%	3%	3%	7%	2%	2%
Bus Blockages (#/hr)	0	8	0	0	0	0	0	0	0	0	0	0
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA		Perm	NA	Perm
Protected Phases	5	2		1	6			8			4	
Permitted Phases	2			6			8			4		4
Actuated Green, G (s)	23.0	23.0		28.2	28.2		27.0	27.0		27.0	27.0	27.0
Effective Green, g (s)	23.0	23.0		28.2	28.2		27.0	27.0		27.0	27.0	27.0
Actuated g/C Ratio	0.31	0.31		0.38	0.38		0.36	0.36		0.36	0.36	0.36
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5	2.5
Lane Grp Cap (vph)	191	1037		413	1251		426	608		254	670	556
v/s Ratio Prot	0.02	c0.21		0.06	c0.38			0.19			0.09	
v/s Ratio Perm	0.09			0.10			0.09			c0.40		0.05
v/c Ratio	0.37	0.68		0.43	1.01		0.25	0.52		1.11	0.26	0.13
Uniform Delay, d1	20.3	22.8		19.5	23.4		16.9	18.9		24.0	17.0	16.1
Progression Factor	1.00	1.00		0.86	0.91		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	0.9	3.7		0.5	26.7		0.2	0.6		90.6	0.2	0.1
Delay (s)	21.2	26.5		17.2	48.1		17.1	19.5		114.6	17.1	16.2
Level of Service	C	C		B	D		B	B		F	B	B
Approach Delay (s)		26.0			44.4			19.0			58.7	
Approach LOS		C			D			B			E	

Intersection Summary			
HCM 2000 Control Delay	39.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	79.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	32	859	16	10	819	40	209	0	72	49	0	42
Future Volume (vph)	32	859	16	10	819	40	209	0	72	49	0	42
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95			0.95		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00			1.00		1.00	0.98		1.00	0.97	
Flpb, ped/bikes	1.00	1.00			1.00		0.99	1.00		0.99	1.00	
Frt	1.00	1.00			0.99		1.00	0.85		1.00	0.85	
Flt Protected	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1799	3462			3417		1781	1577		1787	1572	
Flt Permitted	0.23	1.00			0.94		0.70	1.00		0.69	1.00	
Satd. Flow (perm)	441	3462			3223		1304	1577		1291	1572	
Peak-hour factor, PHF	0.90	0.90	0.90	0.87	0.87	0.87	0.66	0.66	0.66	0.44	0.44	0.44
Adj. Flow (vph)	36	954	18	11	941	46	317	0	109	111	0	95
RTOR Reduction (vph)	0	1	0	0	4	0	0	77	0	0	67	0
Lane Group Flow (vph)	36	971	0	0	994	0	317	32	0	111	28	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	0%	4%	0%	0%	4%	20%	0%	0%	0%	0%	0%	0%
Turn Type	Perm	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		2		1	6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	43.1	43.1			43.1		21.9	21.9		21.9	21.9	
Effective Green, g (s)	43.1	43.1			43.1		21.9	21.9		21.9	21.9	
Actuated g/C Ratio	0.57	0.57			0.57		0.29	0.29		0.29	0.29	
Clearance Time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.5	2.5			2.5		2.5	2.5		2.5	2.5	
Lane Grp Cap (vph)	253	1989			1852		380	460		376	459	
v/s Ratio Prot		0.28						0.02			0.02	
v/s Ratio Perm	0.08				c0.31		c0.24			0.09		
v/c Ratio	0.14	0.49			0.54		0.83	0.07		0.30	0.06	
Uniform Delay, d1	7.4	9.4			9.8		24.9	19.2		20.6	19.1	
Progression Factor	0.35	0.32			0.70		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.7	0.5			0.2		14.3	0.0		0.3	0.0	
Delay (s)	3.3	3.6			7.0		39.1	19.2		20.9	19.2	
Level of Service	A	A			A		D	B		C	B	
Approach Delay (s)		3.6			7.0			34.0			20.1	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM 2000 Control Delay	11.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	57.6%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	29	943	0	0	803	18	47	0	21	31	0	22
Future Volume (vph)	29	943	0	0	803	18	47	0	21	31	0	22
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0			5.0			5.0	
Lane Util. Factor	1.00	0.95			0.95			1.00			1.00	
Frpb, ped/bikes	1.00	1.00			1.00			0.99			0.99	
Flpb, ped/bikes	1.00	1.00			1.00			0.99			0.99	
Frt	1.00	1.00			1.00			0.96			0.94	
Flt Protected	0.95	1.00			1.00			0.97			0.97	
Satd. Flow (prot)	1797	3438			3460			1701			1716	
Flt Permitted	0.28	1.00			1.00			0.80			0.81	
Satd. Flow (perm)	536	3438			3460			1399			1426	
Peak-hour factor, PHF	0.89	0.89	0.92	0.92	0.87	0.87	0.92	0.92	0.92	0.75	0.92	0.75
Adj. Flow (vph)	33	1060	0	0	923	21	51	0	23	41	0	29
RTOR Reduction (vph)	0	0	0	0	1	0	0	24	0	0	24	0
Lane Group Flow (vph)	33	1060	0	0	943	0	0	50	0	0	46	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	0%	5%	2%	2%	4%	0%	2%	2%	2%	0%	2%	0%
Turn Type	Perm	NA			NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	53.0	53.0			53.0			12.0			12.0	
Effective Green, g (s)	53.0	53.0			53.0			12.0			12.0	
Actuated g/C Ratio	0.71	0.71			0.71			0.16			0.16	
Clearance Time (s)	5.0	5.0			5.0			5.0			5.0	
Vehicle Extension (s)	2.5	2.5			2.5			2.5			2.5	
Lane Grp Cap (vph)	378	2429			2445			223			228	
v/s Ratio Prot		c0.31			0.27							
v/s Ratio Perm	0.06							c0.04			0.03	
v/c Ratio	0.09	0.44			0.39			0.22			0.20	
Uniform Delay, d1	3.4	4.7			4.4			27.4			27.3	
Progression Factor	0.98	1.22			0.90			1.00			1.00	
Incremental Delay, d2	0.4	0.5			0.4			0.4			0.3	
Delay (s)	3.8	6.2			4.4			27.8			27.7	
Level of Service	A	A			A			C			C	
Approach Delay (s)		6.1			4.4			27.8			27.7	
Approach LOS		A			A			C			C	

Intersection Summary			
HCM 2000 Control Delay	6.8	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	45.1%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	896	72	175	702	69	151
Future Volume (vph)	896	72	175	702	69	151
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		5.0	5.0	5.0	
Lane Util. Factor	0.95		1.00	0.95	1.00	
Frpb, ped/bikes	1.00		1.00	1.00	0.98	
Flpb, ped/bikes	1.00		1.00	1.00	1.00	
Frt	0.99		1.00	1.00	0.91	
Flt Protected	1.00		0.95	1.00	0.98	
Satd. Flow (prot)	3413		1655	3539	1651	
Flt Permitted	1.00		0.17	1.00	0.98	
Satd. Flow (perm)	3413		293	3539	1651	
Peak-hour factor, PHF	0.89	0.89	0.84	0.84	0.95	0.95
Adj. Flow (vph)	1007	81	208	836	73	159
RTOR Reduction (vph)	6	0	0	0	106	0
Lane Group Flow (vph)	1082	0	208	836	126	0
Confl. Peds. (#/hr)		10	10		10	10
Heavy Vehicles (%)	4%	8%	9%	2%	0%	1%
Turn Type	NA		pm+pt	NA	Prot	
Protected Phases	2		1	6	8	
Permitted Phases			6			
Actuated Green, G (s)	40.2		54.2	54.2	10.8	
Effective Green, g (s)	40.2		54.2	54.2	10.8	
Actuated g/C Ratio	0.54		0.72	0.72	0.14	
Clearance Time (s)	5.0		5.0	5.0	5.0	
Vehicle Extension (s)	2.5		2.5	2.5	2.5	
Lane Grp Cap (vph)	1829		375	2557	237	
v/s Ratio Prot	c0.32		c0.07	0.24	c0.08	
v/s Ratio Perm			0.33			
v/c Ratio	0.59		0.55	0.33	0.53	
Uniform Delay, d1	11.8		6.5	3.8	29.8	
Progression Factor	1.24		1.00	1.00	1.00	
Incremental Delay, d2	0.4		1.4	0.3	1.8	
Delay (s)	15.1		7.9	4.1	31.5	
Level of Service	B		A	A	C	
Approach Delay (s)	15.1			4.9	31.5	
Approach LOS	B			A	C	

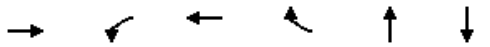
Intersection Summary			
HCM 2000 Control Delay	12.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	63.2%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	69	554	377	365	468	56	0	381	232	115	1029	284
Future Volume (vph)	69	554	377	365	468	56	0	381	232	115	1029	284
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	0.97	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	0.97		1.00	0.97	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	2633	3505	1444	1752	3539	1444		2983	1543	1700	3312	1405
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		1.00	1.00	0.34	1.00	1.00
Satd. Flow (perm)	2633	3505	1444	1752	3539	1444		2983	1543	610	3312	1405
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.95	0.95	0.95	0.86	0.86	0.86
Adj. Flow (vph)	78	622	424	410	526	63	0	401	244	134	1197	330
RTOR Reduction (vph)	0	0	159	0	0	37	0	0	185	0	0	148
Lane Group Flow (vph)	78	622	265	410	526	26	0	401	59	134	1197	182
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	33%	3%	9%	3%	2%	9%	0%	21%	2%	6%	9%	12%
Turn Type	Prot	NA	Perm	Prot	NA	Perm		NA	Perm	pm+pt	NA	Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases			2			6			8	4		4
Actuated Green, G (s)	4.8	20.9	20.9	22.0	38.1	38.1		22.0	22.0	33.0	33.0	33.0
Effective Green, g (s)	4.8	20.9	20.9	22.0	38.1	38.1		22.0	22.0	33.0	33.0	33.0
Actuated g/C Ratio	0.05	0.23	0.23	0.24	0.42	0.42		0.24	0.24	0.36	0.36	0.36
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	2.5	4.0	4.0	2.5	4.0	4.0		2.5	2.5	2.5	2.5	2.5
Lane Grp Cap (vph)	139	805	332	424	1483	605		721	373	293	1202	510
v/s Ratio Prot	0.03	0.18		c0.23	0.15			0.13		0.03	c0.36	
v/s Ratio Perm			c0.18			0.02			0.04	0.14		0.13
v/c Ratio	0.56	0.77	0.80	0.97	0.35	0.04		0.56	0.16	0.46	1.00	0.36
Uniform Delay, d1	42.0	32.8	33.0	34.1	18.0	15.6		30.2	27.2	20.6	28.9	21.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	4.2	4.9	13.3	34.8	0.2	0.0		0.7	0.1	0.8	24.8	0.3
Delay (s)	46.2	37.7	46.3	68.9	18.2	15.7		30.9	27.3	21.4	53.7	21.5
Level of Service	D	D	D	E	B	B		C	C	C	D	C
Approach Delay (s)		41.5			38.9			29.6			44.7	
Approach LOS		D			D			C			D	

Intersection Summary			
HCM 2000 Control Delay	40.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	90.9	Sum of lost time (s)	20.0
Intersection Capacity Utilization	85.5%	ICU Level of Service	E
Analysis Period (min)	15		

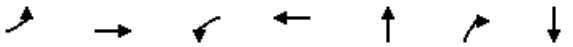
c Critical Lane Group



Lane Group	EBT	WBL	WBT	WBR	NBT	SBT
Lane Group Flow (vph)	114	322	272	391	407	927
v/c Ratio	0.11	0.85	0.47	0.55	0.60	0.89
Control Delay	17.6	47.8	25.4	6.0	28.3	38.0
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	17.6	47.8	25.4	6.0	28.3	38.0
Queue Length 50th (ft)	16	132	97	0	82	205
Queue Length 95th (ft)	41	#330	200	68	123	#401
Internal Link Dist (ft)	160		302		206	298
Turn Bay Length (ft)				115		
Base Capacity (vph)	1032	392	593	724	1150	1046
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.11	0.82	0.46	0.54	0.35	0.89

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.



Lane Group	EBL	EBT	WBL	WBT	NBT	NBR	SBT
Lane Group Flow (vph)	23	485	107	1023	16	49	74
v/c Ratio	0.12	0.30	0.26	0.64	0.03	0.10	0.15
Control Delay	10.1	8.2	10.1	11.4	12.1	5.1	9.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	10.1	8.2	10.1	11.4	12.1	5.1	9.9
Queue Length 50th (ft)	2	28	12	72	3	0	8
Queue Length 95th (ft)	19	91	57	216	14	18	34
Internal Link Dist (ft)		302		1077	208		187
Turn Bay Length (ft)	90		112			135	
Base Capacity (vph)	290	2533	648	2528	1031	1003	1044
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.08	0.19	0.17	0.40	0.02	0.05	0.07

Intersection Summary

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBR
Lane Group Flow (vph)	71	724	178	1293	107	363	283	175	201
v/c Ratio	0.33	0.66	0.44	0.98	0.25	0.56	1.11	0.26	0.29
Control Delay	22.6	24.7	21.3	41.9	18.9	19.0	118.2	18.3	4.0
Queue Delay	0.0	0.0	0.0	7.0	0.0	0.0	0.0	0.0	0.0
Total Delay	22.6	24.7	21.3	48.8	18.9	19.0	118.2	18.3	4.0
Queue Length 50th (ft)	23	146	63	~356	34	104	~154	56	0
Queue Length 95th (ft)	47	180	72	#251	51	116	#297	101	40
Internal Link Dist (ft)		1077		305		273		368	
Turn Bay Length (ft)	140		150		150		150		
Base Capacity (vph)	216	1097	408	1322	427	654	254	670	685
Starvation Cap Reductn	0	0	0	42	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.33	0.66	0.44	1.01	0.25	0.56	1.11	0.26	0.29

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	EBL	EBT	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	36	972	998	317	109	111	95
v/c Ratio	0.14	0.49	0.54	0.84	0.18	0.30	0.18
Control Delay	4.1	3.9	8.5	44.0	0.6	21.4	4.5
Queue Delay	0.0	0.1	0.6	0.0	0.0	0.0	0.0
Total Delay	4.1	4.0	9.1	44.0	0.6	21.4	4.5
Queue Length 50th (ft)	3	54	146	133	0	39	0
Queue Length 95th (ft)	m5	m82	75	139	0	33	0
Internal Link Dist (ft)		305	295		100		111
Turn Bay Length (ft)	100						
Base Capacity (vph)	253	1992	1857	451	689	447	611
Starvation Cap Reductn	0	174	128	0	0	0	0
Spillback Cap Reductn	0	0	437	0	0	0	13
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.14	0.53	0.70	0.70	0.16	0.25	0.16

Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

Lane Group	EBL	EBT	WBT	NBT	SBT
Lane Group Flow (vph)	33	1060	944	74	70
v/c Ratio	0.09	0.44	0.39	0.30	0.28
Control Delay	5.1	7.0	5.0	20.9	20.0
Queue Delay	0.0	0.1	0.3	0.0	0.0
Total Delay	5.1	7.1	5.2	20.9	20.0
Queue Length 50th (ft)	7	128	63	19	17
Queue Length 95th (ft)	m7	64	108	47	45
Internal Link Dist (ft)		295	292	136	111
Turn Bay Length (ft)	50				
Base Capacity (vph)	379	2429	2447	412	419
Starvation Cap Reductn	0	305	774	0	0
Spillback Cap Reductn	0	129	0	1	1
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.09	0.50	0.56	0.18	0.17

Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

Lane Group	EBT	WBL	WBT	NBL
Lane Group Flow (vph)	1088	208	836	232
v/c Ratio	0.59	0.55	0.33	0.67
Control Delay	17.2	10.3	4.3	25.1
Queue Delay	1.6	0.0	0.0	0.0
Total Delay	18.8	10.3	4.3	25.1
Queue Length 50th (ft)	199	23	56	47
Queue Length 95th (ft)	301	49	79	116
Internal Link Dist (ft)	292		1835	287
Turn Bay Length (ft)		150		85
Base Capacity (vph)	1833	611	2556	368
Starvation Cap Reductn	528	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.83	0.34	0.33	0.63

Intersection Summary

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	78	622	424	410	526	63	401	244	134	1197	330
v/c Ratio	0.45	0.80	0.88	0.96	0.35	0.09	0.55	0.43	0.45	0.99	0.50
Control Delay	48.9	42.3	39.1	69.7	19.0	0.2	33.0	6.5	25.2	52.0	9.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	48.9	42.3	39.1	69.7	19.0	0.2	33.0	6.5	25.2	52.0	9.6
Queue Length 50th (ft)	22	176	125	231	108	0	105	0	52	350	37
Queue Length 95th (ft)	44	#238	#294	#405	147	0	152	57	89	#460	97
Internal Link Dist (ft)		761			160		263			552	
Turn Bay Length (ft)	150		560	150		30		150	190		150
Base Capacity (vph)	175	779	481	428	1500	695	730	561	295	1215	662
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.45	0.80	0.88	0.96	0.35	0.09	0.55	0.43	0.45	0.99	0.50

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Arterial Level of Service: EB Puyallup Ave

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Pacific	III	30	7.0	17.6	24.6	0.05	6.7	F
A St	III	30	11.2	8.2	19.4	0.07	13.4	E
D St	III	30	27.8	24.7	52.5	0.22	15.0	D
E St	III	30	11.3	3.9	15.2	0.07	17.3	D
	III	30	11.0	7.0	18.0	0.07	14.2	D
G St	III	30	10.9	17.2	28.1	0.07	9.0	F
Portland	III	30	78.1	42.3	120.4	0.65	19.5	C
Total	III		157.3	120.9	278.2	1.20	15.6	D

Arterial Level of Service: WB Puyallup Ave

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Portland	III	30	7.0	19.0	26.0	0.05	6.3	F
G St	III	30	78.1	4.3	82.4	0.65	28.5	B
F St	III	30	10.9	5.0	15.9	0.07	16.0	D
E St	III	30	11.0	8.5	19.5	0.07	13.1	E
D St	III	30	11.3	41.9	53.2	0.07	4.9	F
A St	III	30	27.8	11.4	39.2	0.22	20.1	C
Pacific	III	30	11.2	25.4	36.6	0.07	7.1	F
Total	III		157.3	115.5	272.8	1.20	15.9	D

2040 Alternative 1 Conditions

1. HCM LOS Analysis
2. Queue Analysis
3. Arterial Analysis

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	8	82	15	296	250	360	0	298	76	297	519	37
Future Volume (vph)	8	82	15	296	250	360	0	298	76	297	519	37
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0		5.0			5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00		0.95			0.95	
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.99		0.99			1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00		1.00			1.00	
Frt	1.00	0.98		1.00	1.00	0.85		0.97			0.99	
Flt Protected	0.95	1.00		0.95	1.00	1.00		1.00			0.98	
Satd. Flow (prot)	1805	1790		1805	1900	1591		3470			3519	
Flt Permitted	0.95	1.00		0.95	1.00	1.00		1.00			0.98	
Satd. Flow (perm)	1805	1790		1805	1900	1591		3470			3519	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	9	89	16	322	272	391	0	324	83	323	564	40
RTOR Reduction (vph)	0	5	0	0	0	123	0	19	0	0	2	0
Lane Group Flow (vph)	9	100	0	322	272	268	0	388	0	0	925	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Bus Blockages (#/hr)	0	8	0	0	0	0	0	0	8	0	0	0
Turn Type	Prot	NA		Prot	NA	pm+ov		NA		Split	NA	
Protected Phases	5	2		1	6	4	8	8		4	4	
Permitted Phases						6						
Actuated Green, G (s)	1.7	16.9		24.2	39.4	69.7		16.8			30.3	
Effective Green, g (s)	1.7	16.9		24.2	39.4	69.7		16.8			30.3	
Actuated g/C Ratio	0.02	0.16		0.22	0.36	0.64		0.16			0.28	
Clearance Time (s)	5.0	5.0		5.0	5.0	5.0		5.0			5.0	
Vehicle Extension (s)	2.5	2.5		2.5	2.5	2.5		2.5			2.5	
Lane Grp Cap (vph)	28	279		403	691	1098		538			985	
v/s Ratio Prot	0.00	0.06		c0.18	c0.14	0.07		c0.11			c0.26	
v/s Ratio Perm						0.10						
v/c Ratio	0.32	0.36		0.80	0.39	0.24		0.72			0.94	
Uniform Delay, d1	52.7	40.8		39.7	25.5	8.1		43.5			38.0	
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00			1.00	
Incremental Delay, d2	4.8	0.6		10.3	0.3	0.1		4.5			15.8	
Delay (s)	57.5	41.4		50.0	25.8	8.2		47.9			53.9	
Level of Service	E	D		D	C	A		D			D	
Approach Delay (s)		42.6			26.7			47.9			53.9	
Approach LOS		D			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	41.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	108.2	Sum of lost time (s)	20.0
Intersection Capacity Utilization	73.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	21	425	21	98	888	53	10	5	45	28	18	22
Future Volume (vph)	21	425	21	98	888	53	10	5	45	28	18	22
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.96		1.00	0.96		0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00		0.99	1.00		0.99	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85		0.96	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		0.97	1.00		0.98	
Satd. Flow (prot)	1805	1900	1581	1805	1839	1508		1826	1558		1757	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		0.80	1.00		0.87	
Satd. Flow (perm)	1805	1900	1581	1805	1839	1508		1519	1558		1551	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	23	462	23	107	965	58	11	5	49	30	20	24
RTOR Reduction (vph)	0	0	9	0	0	51	0	0	43	0	20	0
Lane Group Flow (vph)	23	462	14	107	965	7	0	16	6	0	54	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Bus Blockages (#/hr)	0	0	0	0	8	8	0	0	0	0	0	0
Turn Type	Prot	NA	Perm	Prot	NA	custom	Perm	NA	Perm	Perm	NA	
Protected Phases	5	2		1	6			8			4	
Permitted Phases			2			4	8		8	4		
Actuated Green, G (s)	3.4	48.4	48.4	8.5	53.5	10.5		10.5	10.5		10.5	
Effective Green, g (s)	3.4	48.4	48.4	8.5	53.5	10.5		10.5	10.5		10.5	
Actuated g/C Ratio	0.04	0.59	0.59	0.10	0.65	0.13		0.13	0.13		0.13	
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	
Vehicle Extension (s)	2.5	2.5	2.5	2.5	2.5	2.5		2.5	2.5		2.5	
Lane Grp Cap (vph)	74	1116	928	186	1194	192		193	198		197	
v/s Ratio Prot	0.01	0.24		c0.06	c0.52							
v/s Ratio Perm			0.01			0.00		0.01	0.00		c0.03	
v/c Ratio	0.31	0.41	0.01	0.58	0.81	0.04		0.08	0.03		0.27	
Uniform Delay, d1	38.4	9.3	7.1	35.2	10.7	31.5		31.7	31.5		32.5	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	
Incremental Delay, d2	1.7	0.2	0.0	3.5	4.0	0.1		0.1	0.0		0.6	
Delay (s)	40.1	9.5	7.1	38.7	14.7	31.6		31.8	31.5		33.1	
Level of Service	D	A	A	D	B	C		C	C		C	
Approach Delay (s)		10.7			17.8			31.6			33.1	
Approach LOS		B			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	16.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	82.4	Sum of lost time (s)	15.0
Intersection Capacity Utilization	81.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	58	521	73	130	760	184	72	124	119	272	168	193
Future Volume (vph)	58	521	73	130	760	184	72	124	119	272	168	193
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.95	1.00	1.00	1.00	1.00	0.97		1.00	1.00	0.94
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.93		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1597	1845	1531	1805	1786	1455	1770	1663		1687	1863	1490
Flt Permitted	0.06	1.00	1.00	0.19	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	93	1845	1531	365	1786	1455	1770	1663		1687	1863	1490
Peak-hour factor, PHF	0.82	0.82	0.82	0.73	0.73	0.73	0.67	0.67	0.67	0.96	0.96	0.96
Adj. Flow (vph)	71	635	89	178	1041	252	107	185	178	283	175	201
RTOR Reduction (vph)	0	0	46	0	0	61	0	23	0	0	0	127
Lane Group Flow (vph)	71	635	43	178	1041	191	107	340	0	283	175	74
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	13%	3%	0%	0%	3%	11%	2%	3%	3%	7%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	8	0	0	0	0	0	0	0
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Prot	Prot	NA		Prot	NA	Perm
Protected Phases	5	2		1	6	6	3	8		7	4	
Permitted Phases	2		2	6								4
Actuated Green, G (s)	78.0	72.0	72.0	86.0	76.0	76.0	13.1	29.0		19.0	34.9	34.9
Effective Green, g (s)	78.0	72.0	72.0	86.0	76.0	76.0	13.1	29.0		19.0	34.9	34.9
Actuated g/C Ratio	0.52	0.48	0.48	0.57	0.51	0.51	0.09	0.19		0.13	0.23	0.23
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5
Lane Grp Cap (vph)	108	885	734	305	904	737	154	321		213	433	346
v/s Ratio Prot	0.03	0.34		c0.04	c0.58	0.13	0.06	c0.20		c0.17	0.09	
v/s Ratio Perm	0.31		0.03	0.30								0.05
v/c Ratio	0.66	0.72	0.06	0.58	1.15	0.26	0.69	1.06		1.33	0.40	0.21
Uniform Delay, d1	34.2	30.9	20.9	22.5	37.0	21.0	66.5	60.5		65.5	48.7	46.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	12.2	5.0	0.2	2.4	80.9	0.9	11.8	66.3		176.5	0.5	0.2
Delay (s)	46.3	35.9	21.0	24.9	117.9	21.9	78.3	126.8		242.0	49.2	46.7
Level of Service	D	D	C	C	F	C	E	F		F	D	D
Approach Delay (s)		35.2			90.2			115.8			131.2	
Approach LOS		D			F			F			F	

Intersection Summary			
HCM 2000 Control Delay	88.8	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.14		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	92.0%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	32	859	16	10	819	40	209	0	72	49	0	42
Future Volume (vph)	32	859	16	10	819	40	209	0	72	49	0	42
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00	0.95	1.00	1.00		1.00	0.95		1.00	0.95	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		0.97	1.00		0.98	1.00	
Frt	1.00	1.00	0.85	1.00	0.99		1.00	0.85		1.00	0.85	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1805	1827	1534	1805	1797		1757	1536		1761	1534	
Flt Permitted	0.13	1.00	1.00	0.15	1.00		0.69	1.00		0.66	1.00	
Satd. Flow (perm)	246	1827	1534	281	1797		1268	1536		1225	1534	
Peak-hour factor, PHF	0.90	0.90	0.90	0.87	0.87	0.87	0.66	0.66	0.66	0.44	0.44	0.44
Adj. Flow (vph)	36	954	18	11	941	46	317	0	109	111	0	95
RTOR Reduction (vph)	0	0	5	0	1	0	0	80	0	0	70	0
Lane Group Flow (vph)	36	954	13	11	986	0	317	29	0	111	25	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	0%	4%	0%	0%	4%	20%	0%	0%	0%	0%	0%	0%
Turn Type	Perm	NA	Perm	Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2		2	6			8			4		
Actuated Green, G (s)	88.8	88.8	88.8	88.8	88.8		36.2	36.2		36.2	36.2	
Effective Green, g (s)	88.8	88.8	88.8	88.8	88.8		36.2	36.2		36.2	36.2	
Actuated g/C Ratio	0.66	0.66	0.66	0.66	0.66		0.27	0.27		0.27	0.27	
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.5	2.5	2.5	2.5	2.5		2.5	2.5		2.5	2.5	
Lane Grp Cap (vph)	161	1201	1009	184	1182		340	411		328	411	
v/s Ratio Prot		0.52			c0.55			0.02			0.02	
v/s Ratio Perm	0.15		0.01	0.04			c0.25			0.09		
v/c Ratio	0.22	0.79	0.01	0.06	0.83		0.93	0.07		0.34	0.06	
Uniform Delay, d1	9.3	16.6	8.0	8.2	17.5		48.2	36.9		39.8	36.8	
Progression Factor	1.00	1.00	1.00	0.93	1.07		1.00	1.00		1.00	1.00	
Incremental Delay, d2	3.2	5.5	0.0	0.5	5.7		31.7	0.1		0.4	0.0	
Delay (s)	12.5	22.0	8.0	8.1	24.5		79.9	36.9		40.2	36.8	
Level of Service	B	C	A	A	C		E	D		D	D	
Approach Delay (s)		21.4			24.3			68.9			38.6	
Approach LOS		C			C			E			D	

Intersection Summary			
HCM 2000 Control Delay	31.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	29	943	0	0	803	18	47	0	21	31	0	22
Future Volume (vph)	29	943	0	0	803	18	47	0	21	31	0	22
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0			5.0			5.0	
Lane Util. Factor	1.00	1.00			1.00			1.00			1.00	
Frpb, ped/bikes	1.00	1.00			1.00			0.98			0.98	
Flpb, ped/bikes	1.00	1.00			1.00			0.98			0.98	
Frt	1.00	1.00			1.00			0.96			0.94	
Flt Protected	0.95	1.00			1.00			0.97			0.97	
Satd. Flow (prot)	1805	1810			1820			1665			1678	
Flt Permitted	0.26	1.00			1.00			0.76			0.80	
Satd. Flow (perm)	495	1810			1820			1300			1374	
Peak-hour factor, PHF	0.89	0.89	0.92	0.92	0.87	0.87	0.92	0.92	0.92	0.75	0.92	0.75
Adj. Flow (vph)	33	1060	0	0	923	21	51	0	23	41	0	29
RTOR Reduction (vph)	0	0	0	0	1	0	0	14	0	0	20	0
Lane Group Flow (vph)	33	1060	0	0	943	0	0	60	0	0	50	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	0%	5%	2%	2%	4%	0%	2%	2%	2%	0%	2%	0%
Turn Type	Perm	NA	Perm	Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2		2	6			8			4		
Actuated Green, G (s)	112.2	112.2			112.2			12.8			12.8	
Effective Green, g (s)	112.2	112.2			112.2			12.8			12.8	
Actuated g/C Ratio	0.83	0.83			0.83			0.09			0.09	
Clearance Time (s)	5.0	5.0			5.0			5.0			5.0	
Vehicle Extension (s)	2.5	2.5			2.5			2.5			2.5	
Lane Grp Cap (vph)	411	1504			1512			123			130	
v/s Ratio Prot		c0.59			0.52							
v/s Ratio Perm	0.07							c0.05			0.04	
v/c Ratio	0.08	0.70			0.62			0.48			0.39	
Uniform Delay, d1	2.1	4.6			4.0			58.0			57.4	
Progression Factor	1.12	1.00			0.71			1.00			1.00	
Incremental Delay, d2	0.3	2.0			1.6			2.2			1.4	
Delay (s)	2.6	6.7			4.5			60.1			58.8	
Level of Service	A	A			A			E			E	
Approach Delay (s)		6.5			4.5			60.1			58.8	
Approach LOS		A			A			E			E	

Intersection Summary			
HCM 2000 Control Delay	9.1	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	68.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	896	72	175	702	69	151
Future Volume (vph)	896	72	175	702	69	151
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	
Frpb, ped/bikes	1.00	0.95	1.00	1.00	0.95	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	0.85	1.00	1.00	0.91	
Flt Protected	1.00	1.00	0.95	1.00	0.98	
Satd. Flow (prot)	1827	1416	1656	1863	1599	
Flt Permitted	1.00	1.00	0.22	1.00	0.98	
Satd. Flow (perm)	1827	1416	376	1863	1599	
Peak-hour factor, PHF	0.89	0.89	0.84	0.84	0.95	0.95
Adj. Flow (vph)	1007	81	208	836	73	159
RTOR Reduction (vph)	0	14	0	0	59	0
Lane Group Flow (vph)	1007	67	208	836	173	0
Confl. Peds. (#/hr)		10	10		10	10
Heavy Vehicles (%)	4%	8%	9%	2%	0%	1%
Turn Type	NA	Perm	Perm	NA	Prot	
Protected Phases	2			6	8	
Permitted Phases		2	6			
Actuated Green, G (s)	107.4	107.4	107.4	107.4	17.6	
Effective Green, g (s)	107.4	107.4	107.4	107.4	17.6	
Actuated g/C Ratio	0.80	0.80	0.80	0.80	0.13	
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	
Vehicle Extension (s)	2.5	2.5	2.5	2.5	2.5	
Lane Grp Cap (vph)	1453	1126	299	1482	208	
v/s Ratio Prot	0.55			0.45	c0.11	
v/s Ratio Perm		0.05	c0.55			
v/c Ratio	0.69	0.06	0.70	0.56	0.83	
Uniform Delay, d1	6.3	3.0	6.3	5.1	57.3	
Progression Factor	0.78	0.87	1.00	1.00	1.00	
Incremental Delay, d2	2.0	0.1	12.6	1.6	23.3	
Delay (s)	6.9	2.7	18.9	6.7	80.5	
Level of Service	A	A	B	A	F	
Approach Delay (s)	6.6			9.1	80.5	
Approach LOS	A			A	F	

Intersection Summary			
HCM 2000 Control Delay	15.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	83.2%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

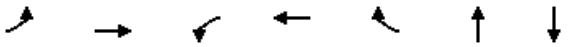
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	68	990	98	64	773	49	70	16	62	52	16	53
Future Volume (vph)	68	990	98	64	773	49	70	16	62	52	16	53
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0			5.0			5.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00			1.00			1.00	
Frpb, ped/bikes	1.00	1.00	0.96	1.00	1.00			0.98			0.98	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00			0.99			0.99	
Frt	1.00	1.00	0.85	1.00	0.99			0.94			0.94	
Flt Protected	0.95	1.00	1.00	0.95	1.00			0.98			0.98	
Satd. Flow (prot)	1770	1863	1515	1770	1841			1672			1672	
Flt Permitted	0.95	1.00	1.00	0.95	1.00			0.76			0.75	
Satd. Flow (perm)	1770	1863	1515	1770	1841			1294			1284	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	74	1076	107	70	840	53	76	17	67	57	17	58
RTOR Reduction (vph)	0	0	30	0	2	0	0	27	0	0	30	0
Lane Group Flow (vph)	74	1076	77	70	891	0	0	133	0	0	102	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Turn Type	Prot	NA	Perm	Prot	NA		Perm	NA		Perm	NA	
Protected Phases	5	2		1	6			8			4	
Permitted Phases			2				8			4		
Actuated Green, G (s)	7.8	56.8	56.8	7.8	56.8			14.3			14.3	
Effective Green, g (s)	7.8	56.8	56.8	7.8	56.8			14.3			14.3	
Actuated g/C Ratio	0.08	0.60	0.60	0.08	0.60			0.15			0.15	
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0			5.0			5.0	
Vehicle Extension (s)	2.5	2.5	2.5	2.5	2.5			2.5			2.5	
Lane Grp Cap (vph)	147	1126	916	147	1113			197			195	
v/s Ratio Prot	c0.04	c0.58		0.04	0.48							
v/s Ratio Perm			0.05					c0.10			0.08	
v/c Ratio	0.50	0.96	0.08	0.48	0.80			0.67			0.52	
Uniform Delay, d1	41.2	17.4	7.7	41.1	14.2			37.6			36.7	
Progression Factor	1.00	1.00	1.00	1.00	1.00			1.00			1.00	
Incremental Delay, d2	2.0	18.1	0.2	1.8	6.1			8.0			1.9	
Delay (s)	43.2	35.4	7.9	42.9	20.3			45.6			38.6	
Level of Service	D	D	A	D	C			D			D	
Approach Delay (s)		33.5			21.9			45.6			38.6	
Approach LOS		C			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	30.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	93.9	Sum of lost time (s)	15.0
Intersection Capacity Utilization	78.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	69	554	377	365	468	56	0	381	232	115	1029	284
Future Volume (vph)	69	554	377	365	468	56	0	381	232	115	1029	284
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	0.97		1.00	0.96	1.00	1.00	0.96
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1357	1845	1443	1752	3539	1443		2983	1514	1698	3312	1379
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		1.00	1.00	0.31	1.00	1.00
Satd. Flow (perm)	1357	1845	1443	1752	3539	1443		2983	1514	550	3312	1379
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.95	0.95	0.95	0.86	0.86	0.86
Adj. Flow (vph)	78	622	424	410	526	63	0	401	244	134	1197	330
RTOR Reduction (vph)	0	0	91	0	0	36	0	0	139	0	0	139
Lane Group Flow (vph)	78	622	333	410	526	27	0	401	105	134	1197	191
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	33%	3%	9%	3%	2%	9%	0%	21%	2%	6%	9%	12%
Turn Type	Prot	NA	Perm	Prot	NA	Perm		NA	custom	pm+pt	NA	Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases			2			6			6	4		4
Actuated Green, G (s)	8.5	33.0	33.0	17.0	41.5	41.5		20.0	41.5	31.0	31.0	31.0
Effective Green, g (s)	8.5	33.0	33.0	17.0	41.5	41.5		20.0	41.5	31.0	31.0	31.0
Actuated g/C Ratio	0.09	0.34	0.34	0.18	0.43	0.43		0.21	0.43	0.32	0.32	0.32
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	2.5	4.0	4.0	2.5	4.0	4.0		2.5	4.0	2.5	2.5	2.5
Lane Grp Cap (vph)	120	634	496	310	1529	623		621	654	249	1069	445
v/s Ratio Prot	0.06	c0.34		c0.23	0.15			0.13		0.03	c0.36	
v/s Ratio Perm			0.23			0.02			0.07	0.14		0.14
v/c Ratio	0.65	0.98	0.67	1.32	0.34	0.04		0.65	0.16	0.54	1.12	0.43
Uniform Delay, d1	42.3	31.2	26.9	39.5	18.2	15.8		34.8	16.6	24.5	32.5	25.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	10.7	30.9	3.9	166.0	0.2	0.0		2.0	0.2	1.7	66.6	0.5
Delay (s)	53.0	62.1	30.8	205.5	18.4	15.8		36.8	16.8	26.2	99.1	26.0
Level of Service	D	E	C	F	B	B		D	B	C	F	C
Approach Delay (s)		49.7			95.0			29.2			78.7	
Approach LOS		D			F			C			E	

Intersection Summary			
HCM 2000 Control Delay	67.8	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.18		
Actuated Cycle Length (s)	96.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	90.3%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	WBL	WBT	WBR	NBT	SBT
Lane Group Flow (vph)	9	105	322	272	391	407	927
v/c Ratio	0.05	0.47	0.77	0.38	0.33	0.70	0.91
Control Delay	48.5	48.1	52.3	27.3	2.2	46.5	49.9
Queue Delay	0.0	0.0	0.6	0.6	0.1	0.0	0.0
Total Delay	48.5	48.1	52.9	28.0	2.3	46.5	49.9
Queue Length 50th (ft)	5	62	192	122	6	126	301
Queue Length 95th (ft)	24	124	#408	258	56	197	#558
Internal Link Dist (ft)		160		302		206	298
Turn Bay Length (ft)	150				115		
Base Capacity (vph)	174	489	436	791	1176	1088	1024
Starvation Cap Reductn	0	0	14	250	163	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.05	0.21	0.76	0.50	0.39	0.37	0.91

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBT
Lane Group Flow (vph)	23	462	23	107	965	58	16	49	74
v/c Ratio	0.10	0.40	0.02	0.43	0.75	0.19	0.07	0.16	0.27
Control Delay	36.4	13.7	0.0	40.1	18.8	6.9	29.8	4.5	24.9
Queue Delay	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	36.4	13.8	0.0	40.1	18.8	6.9	29.8	4.5	24.9
Queue Length 50th (ft)	9	123	0	42	198	0	6	0	19
Queue Length 95th (ft)	38	291	0	120	#926	23	24	16	61
Internal Link Dist (ft)		302			1077		208		187
Turn Bay Length (ft)	90		150	150		150		135	
Base Capacity (vph)	235	1292	1095	282	1284	651	614	672	640
Starvation Cap Reductn	0	260	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.10	0.45	0.02	0.38	0.75	0.09	0.03	0.07	0.12

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT	SBR
Lane Group Flow (vph)	71	635	89	178	1041	252	107	363	283	175	201
v/c Ratio	0.65	0.72	0.11	0.58	1.15	0.32	0.69	1.06	1.33	0.40	0.42
Control Delay	49.5	36.6	1.4	22.9	115.6	11.6	89.1	115.8	224.5	52.7	14.2
Queue Delay	0.0	0.0	0.0	0.0	1.8	1.4	0.0	0.0	0.0	0.0	0.0
Total Delay	49.5	36.6	1.4	22.9	117.3	13.0	89.1	115.8	224.5	52.7	14.2
Queue Length 50th (ft)	29	484	0	78	~1194	67	103	~363	~357	148	28
Queue Length 95th (ft)	#74	547	6	94	#1009	83	123	#320	#548	227	105
Internal Link Dist (ft)		1077			305			273		368	
Turn Bay Length (ft)	140		150	150		150	150		150		
Base Capacity (vph)	109	885	799	305	904	798	177	344	213	433	473
Starvation Cap Reductn	0	0	0	0	233	361	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.65	0.72	0.11	0.58	1.55	0.58	0.60	1.06	1.33	0.40	0.42

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	36	954	18	11	987	317	109	111	95
v/c Ratio	0.22	0.79	0.02	0.06	0.83	0.94	0.21	0.34	0.18
Control Delay	14.7	23.7	4.2	9.5	26.3	82.6	3.0	42.1	1.5
Queue Delay	0.0	49.6	0.0	0.0	3.2	0.0	0.0	0.0	0.0
Total Delay	14.7	73.2	4.2	9.5	29.5	82.6	3.1	42.1	1.5
Queue Length 50th (ft)	13	597	1	4	676	264	0	76	0
Queue Length 95th (ft)	34	815	10	m3	879	256	0	59	0
Internal Link Dist (ft)		305			295		100		111
Turn Bay Length (ft)	100		150	100					
Base Capacity (vph)	161	1202	1015	185	1184	366	546	353	549
Starvation Cap Reductn	0	372	0	0	118	0	0	0	0
Spillback Cap Reductn	0	166	0	0	0	0	12	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.22	1.15	0.02	0.06	0.93	0.87	0.20	0.31	0.17

Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

Lane Group	EBL	EBT	WBT	NBT	SBT
Lane Group Flow (vph)	33	1060	944	74	70
v/c Ratio	0.08	0.70	0.62	0.54	0.47
Control Delay	3.3	7.7	5.0	59.0	49.8
Queue Delay	0.0	1.5	1.6	0.0	0.1
Total Delay	3.3	9.2	6.6	59.1	49.8
Queue Length 50th (ft)	6	452	170	50	41
Queue Length 95th (ft)	m7	187	202	97	87
Internal Link Dist (ft)		295	292	136	111
Turn Bay Length (ft)	50				
Base Capacity (vph)	410	1504	1513	206	222
Starvation Cap Reductn	0	254	116	0	0
Spillback Cap Reductn	0	164	368	2	4
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.08	0.85	0.82	0.36	0.32

Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

Lane Group	EBT	EBR	WBL	WBT	NBL
Lane Group Flow (vph)	1007	81	208	836	232
v/c Ratio	0.69	0.07	0.70	0.56	0.87
Control Delay	7.5	1.0	22.5	7.2	70.1
Queue Delay	0.9	0.0	0.0	0.0	0.0
Total Delay	8.4	1.0	22.5	7.2	70.1
Queue Length 50th (ft)	513	6	78	253	142
Queue Length 95th (ft)	227	m1	179	296	#270
Internal Link Dist (ft)	292			1835	287
Turn Bay Length (ft)		150	175		85
Base Capacity (vph)	1454	1140	298	1483	294
Starvation Cap Reductn	197	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.80	0.07	0.70	0.56	0.79

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Lane Group	EBL	EBT	EBR	WBL	WBT	NBT	SBT
Lane Group Flow (vph)	74	1076	107	70	893	160	132
v/c Ratio	0.39	0.94	0.11	0.37	0.79	0.71	0.58
Control Delay	47.2	36.8	4.2	46.7	22.6	47.4	37.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	47.2	36.8	4.2	46.7	22.6	47.4	37.6
Queue Length 50th (ft)	42	585	7	40	396	74	54
Queue Length 95th (ft)	91	#997	33	87	#749	143	114
Internal Link Dist (ft)		1835			604	981	346
Turn Bay Length (ft)	80		150	80			
Base Capacity (vph)	191	1139	955	191	1128	304	305
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.39	0.94	0.11	0.37	0.79	0.53	0.43

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	78	622	424	410	526	63	401	244	134	1197	330
v/c Ratio	0.57	1.00	0.73	1.31	0.34	0.09	0.64	0.31	0.53	1.11	0.56
Control Delay	55.8	69.6	27.2	194.5	19.7	0.2	39.5	3.7	32.4	93.8	13.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Total Delay	55.8	69.6	27.2	194.5	19.7	0.2	39.5	4.0	32.4	93.8	13.9
Queue Length 50th (ft)	45	~372	152	~320	113	0	116	0	59	~436	55
Queue Length 95th (ft)	90	#592	267	#494	158	0	167	46	100	#525	128
Internal Link Dist (ft)		761			160		263			552	
Turn Bay Length (ft)	150		560	150		30		150	190		150
Base Capacity (vph)	171	621	577	313	1545	707	628	799	251	1080	589
Starvation Cap Reductn	0	0	0	0	0	0	0	186	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.46	1.00	0.73	1.31	0.34	0.09	0.64	0.40	0.53	1.11	0.56

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Arterial Level of Service: EB Puyallup Ave

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Pacific	III	30	7.0	48.1	55.1	0.05	3.0	F
A St	III	30	11.2	13.7	24.9	0.07	10.5	E
D St	III	30	27.8	36.6	64.4	0.22	12.2	E
E St	III	30	11.3	23.7	35.0	0.07	7.5	F
	III	30	11.0	7.7	18.7	0.07	13.7	E
G St	III	30	10.9	7.5	18.4	0.07	13.8	E
E L ST	III	30	46.1	36.8	82.9	0.36	15.8	D
Portland	III	30	36.7	69.6	106.3	0.29	9.8	F
Total	III		162.0	243.7	405.7	1.20	10.7	E

Arterial Level of Service: WB Puyallup Ave

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Portland	III	30	7.0	19.7	26.7	0.05	6.1	F
	III	30	36.7	22.6	59.3	0.29	17.5	D
G St	III	30	46.1	7.2	53.3	0.36	24.5	B
F St	III	30	10.9	5.0	15.9	0.07	16.0	D
E St	III	30	11.0	26.3	37.3	0.07	6.9	F
D St	III	30	11.3	115.6	126.9	0.07	2.1	F
A St	III	30	27.8	18.8	46.6	0.22	16.9	D
Pacific	III	30	11.2	27.3	38.5	0.07	6.8	F
Total	III		162.0	242.5	404.5	1.20	10.7	E

2040 Alternative 2 Conditions

1. HCM LOS Analysis
2. Queue Analysis
3. Arterial Analysis

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	8	82	15	296	250	360	0	298	76	297	519	37
Future Volume (vph)	8	82	15	296	250	360	0	298	76	297	519	37
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0		5.0			5.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00		0.95			0.95	
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	1.00		0.99			1.00	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00		1.00			1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85		0.97			0.99	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		1.00			0.98	
Satd. Flow (prot)	1805	1900	1566	1805	1900	1615		3466			3518	
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		1.00			0.98	
Satd. Flow (perm)	1805	1900	1566	1805	1900	1615		3466			3518	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	9	89	16	322	272	391	0	324	83	323	564	40
RTOR Reduction (vph)	0	0	13	0	0	188	0	19	0	0	2	0
Lane Group Flow (vph)	9	89	3	322	272	203	0	388	0	0	925	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Prot	NA	Perm	Prot	NA	Over		NA		Split	NA	
Protected Phases	5	2		1	6	4	8	8		4	4	
Permitted Phases			2									
Actuated Green, G (s)	2.0	21.6	21.6	30.3	49.9	43.0		20.1			43.0	
Effective Green, g (s)	2.0	21.6	21.6	30.3	49.9	43.0		20.1			43.0	
Actuated g/C Ratio	0.01	0.16	0.16	0.22	0.37	0.32		0.15			0.32	
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0		5.0			5.0	
Vehicle Extension (s)	2.5	2.5	2.5	2.5	2.5	2.5		2.5			2.5	
Lane Grp Cap (vph)	26	304	250	405	702	514		516			1120	
v/s Ratio Prot	0.00	0.05		c0.18	c0.14	0.13		c0.11			c0.26	
v/s Ratio Perm			0.00									
v/c Ratio	0.35	0.29	0.01	0.80	0.39	0.39		0.75			0.83	
Uniform Delay, d1	65.9	50.0	47.7	49.4	31.3	35.9		55.1			42.5	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00			1.00	
Incremental Delay, d2	5.8	2.4	0.1	10.0	0.3	0.4		5.8			5.0	
Delay (s)	71.6	52.4	47.8	59.4	31.6	36.2		60.9			47.5	
Level of Service	E	D	D	E	C	D		E			D	
Approach Delay (s)		53.3			42.5			60.9			47.5	
Approach LOS		D			D			E			D	

Intersection Summary			
HCM 2000 Control Delay	48.0	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	135.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	73.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	21	425	21	98	888	53	10	5	45	28	18	22
Future Volume (vph)	21	425	21	98	888	53	10	5	45	28	18	22
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0			5.0	5.0		5.0	
Lane Util. Factor	1.00	0.95		1.00	0.95			1.00	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	0.98		0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Frt	1.00	0.99		1.00	0.99			1.00	0.85		0.96	
Flt Protected	0.95	1.00		0.95	1.00			0.97	1.00		0.98	
Satd. Flow (prot)	1802	3524		1801	3516			1831	1537		1768	
Flt Permitted	0.21	1.00		0.48	1.00			0.85	1.00		0.90	
Satd. Flow (perm)	403	3524		901	3516			1606	1537		1614	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	23	462	23	107	965	58	11	5	49	30	20	24
RTOR Reduction (vph)	0	5	0	0	6	0	0	0	34	0	17	0
Lane Group Flow (vph)	23	480	0	107	1017	0	0	16	15	0	57	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Bus Blockages (#/hr)	0	8	0	0	8	8	0	0	8	8	0	0
Turn Type	Perm	NA		Perm	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		4			8			6			2	
Permitted Phases	4			8			6		6	2		
Actuated Green, G (s)	19.4	19.4		19.4	19.4			12.7	12.7		12.7	
Effective Green, g (s)	19.4	19.4		19.4	19.4			12.7	12.7		12.7	
Actuated g/C Ratio	0.46	0.46		0.46	0.46			0.30	0.30		0.30	
Clearance Time (s)	5.0	5.0		5.0	5.0			5.0	5.0		5.0	
Vehicle Extension (s)	2.5	2.5		2.5	2.5			2.5	2.5		2.5	
Lane Grp Cap (vph)	185	1623		415	1620			484	463		486	
v/s Ratio Prot		0.14			c0.29							
v/s Ratio Perm	0.06			0.12				0.01	0.01		c0.04	
v/c Ratio	0.12	0.30		0.26	0.63			0.03	0.03		0.12	
Uniform Delay, d1	6.5	7.1		6.9	8.6			10.4	10.4		10.6	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.2	0.1		0.2	0.7			0.0	0.0		0.1	
Delay (s)	6.7	7.2		7.2	9.3			10.4	10.4		10.7	
Level of Service	A	A		A	A			B	B		B	
Approach Delay (s)		7.1			9.1			10.4			10.7	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM 2000 Control Delay	8.6	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	42.1	Sum of lost time (s)	10.0
Intersection Capacity Utilization	61.0%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	58	521	73	130	760	184	72	124	119	272	168	193
Future Volume (vph)	58	521	73	130	760	184	72	124	119	272	168	193
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	0.99		1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.99	1.00		1.00	1.00	1.00
Frt	1.00	0.98		1.00	0.97		1.00	0.93		1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1597	3380		1803	3271		1760	1688		1685	1863	1543
Flt Permitted	0.10	1.00		0.24	1.00		0.55	1.00		0.20	1.00	1.00
Satd. Flow (perm)	163	3380		464	3271		1018	1688		358	1863	1543
Peak-hour factor, PHF	0.82	0.82	0.82	0.73	0.73	0.73	0.67	0.67	0.67	0.96	0.96	0.96
Adj. Flow (vph)	71	635	89	178	1041	252	107	185	178	283	175	201
RTOR Reduction (vph)	0	10	0	0	18	0	0	36	0	0	0	154
Lane Group Flow (vph)	71	714	0	178	1275	0	107	327	0	283	175	47
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	13%	3%	0%	0%	3%	11%	2%	3%	3%	7%	2%	2%
Bus Blockages (#/hr)	0	8	8	0	8	0	0	0	0	0	0	0
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2			6			8			4		4
Actuated Green, G (s)	46.9	41.3		54.3	45.0		34.4	24.4		34.4	24.4	24.4
Effective Green, g (s)	46.9	41.3		54.3	45.0		34.4	24.4		34.4	24.4	24.4
Actuated g/C Ratio	0.45	0.39		0.52	0.43		0.33	0.23		0.33	0.23	0.23
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5	2.5
Lane Grp Cap (vph)	149	1329		358	1401		404	392		243	432	358
v/s Ratio Prot	0.03	0.21		c0.04	c0.39		0.03	0.19		c0.11	0.09	
v/s Ratio Perm	0.19			0.21			0.06			c0.27		0.03
v/c Ratio	0.48	0.54		0.50	0.91		0.26	0.83		1.16	0.41	0.13
Uniform Delay, d1	21.1	24.5		15.2	28.1		25.3	38.4		31.5	34.1	31.9
Progression Factor	1.00	1.00		0.64	0.70		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	1.7	1.6		0.7	9.3		0.3	13.9		109.5	0.5	0.1
Delay (s)	22.9	26.1		10.4	29.1		25.6	52.3		141.1	34.6	32.0
Level of Service	C	C		B	C		C	D		F	C	C
Approach Delay (s)		25.8			26.8			46.2			79.5	
Approach LOS		C			C			D			E	

Intersection Summary			
HCM 2000 Control Delay	39.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	105.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	79.7%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	32	859	16	10	819	40	209	0	72	49	0	42
Future Volume (vph)	32	859	16	10	819	40	209	0	72	49	0	42
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frpb, ped/bikes		1.00			1.00		1.00	0.97		1.00	0.97	
Flpb, ped/bikes		1.00			1.00		0.98	1.00		0.99	1.00	
Frt		1.00			0.99		1.00	0.85		1.00	0.85	
Flt Protected		1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3460			3416		1772	1569		1779	1562	
Flt Permitted		0.88			0.94		0.70	1.00		0.69	1.00	
Satd. Flow (perm)		3047			3216		1297	1569		1286	1562	
Peak-hour factor, PHF	0.90	0.90	0.90	0.87	0.87	0.87	0.66	0.66	0.66	0.44	0.44	0.44
Adj. Flow (vph)	36	954	18	11	941	46	317	0	109	111	0	95
RTOR Reduction (vph)	0	1	0	0	2	0	0	79	0	0	68	0
Lane Group Flow (vph)	0	1007	0	0	996	0	317	30	0	111	27	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	0%	4%	0%	0%	4%	20%	0%	0%	0%	0%	0%	0%
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases	5	2		1	6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		65.7			65.7		29.3	29.3		29.3	29.3	
Effective Green, g (s)		65.7			65.7		29.3	29.3		29.3	29.3	
Actuated g/C Ratio		0.63			0.63		0.28	0.28		0.28	0.28	
Clearance Time (s)		5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)		2.5			2.5		2.5	2.5		2.5	2.5	
Lane Grp Cap (vph)		1906			2012		361	437		358	435	
v/s Ratio Prot								0.02			0.02	
v/s Ratio Perm		c0.33			0.31		c0.24			0.09		
v/c Ratio		0.53			0.49		0.88	0.07		0.31	0.06	
Uniform Delay, d1		11.0			10.7		36.1	27.8		29.9	27.8	
Progression Factor		0.95			1.16		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.1			0.1		20.5	0.0		0.4	0.0	
Delay (s)		10.5			12.5		56.7	27.9		30.2	27.8	
Level of Service		B			B		E	C		C	C	
Approach Delay (s)		10.5			12.5			49.3			29.1	
Approach LOS		B			B			D			C	

Intersection Summary			
HCM 2000 Control Delay	19.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	105.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	74.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	29	943	0	0	803	18	47	0	21	31	0	22
Future Volume (vph)	29	943	0	0	803	18	47	0	21	31	0	22
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0			5.0			5.0			5.0	
Lane Util. Factor		0.95			0.95			1.00			1.00	
Frpb, ped/bikes		1.00			1.00			0.99			0.99	
Flpb, ped/bikes		1.00			1.00			0.99			0.99	
Frt		1.00			1.00			0.96			0.94	
Flt Protected		1.00			1.00			0.97			0.97	
Satd. Flow (prot)		3437			3459			1695			1710	
Flt Permitted		0.90			1.00			0.78			0.81	
Satd. Flow (perm)		3089			3459			1375			1422	
Peak-hour factor, PHF	0.89	0.89	0.92	0.92	0.87	0.87	0.92	0.92	0.92	0.75	0.92	0.75
Adj. Flow (vph)	33	1060	0	0	923	21	51	0	23	41	0	29
RTOR Reduction (vph)	0	0	0	0	1	0	0	20	0	0	26	0
Lane Group Flow (vph)	0	1093	0	0	943	0	0	54	0	0	44	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	0%	5%	2%	2%	4%	0%	2%	2%	2%	0%	2%	0%
Turn Type	Perm	NA			NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		82.9			82.9			12.1			12.1	
Effective Green, g (s)		82.9			82.9			12.1			12.1	
Actuated g/C Ratio		0.79			0.79			0.12			0.12	
Clearance Time (s)		5.0			5.0			5.0			5.0	
Vehicle Extension (s)		2.5			2.5			2.5			2.5	
Lane Grp Cap (vph)		2438			2730			158			163	
v/s Ratio Prot					0.27							
v/s Ratio Perm		c0.35						c0.04			0.03	
v/c Ratio		0.45			0.35			0.34			0.27	
Uniform Delay, d1		3.6			3.2			42.8			42.4	
Progression Factor		1.09			0.75			1.00			1.00	
Incremental Delay, d2		0.5			0.3			0.9			0.7	
Delay (s)		4.5			2.7			43.7			43.1	
Level of Service		A			A			D			D	
Approach Delay (s)		4.5			2.7			43.7			43.1	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM 2000 Control Delay	6.3	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.43		
Actuated Cycle Length (s)	105.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	66.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	896	72	175	702	69	151
Future Volume (vph)	896	72	175	702	69	151
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		5.0	5.0	5.0	
Lane Util. Factor	0.95		1.00	0.95	1.00	
Frpb, ped/bikes	1.00		1.00	1.00	0.97	
Flpb, ped/bikes	1.00		1.00	1.00	1.00	
Frt	0.99		1.00	1.00	0.91	
Flt Protected	1.00		0.95	1.00	0.98	
Satd. Flow (prot)	3411		1655	3539	1642	
Flt Permitted	1.00		0.19	1.00	0.98	
Satd. Flow (perm)	3411		326	3539	1642	
Peak-hour factor, PHF	0.89	0.89	0.84	0.84	0.95	0.95
Adj. Flow (vph)	1007	81	208	836	73	159
RTOR Reduction (vph)	4	0	0	0	84	0
Lane Group Flow (vph)	1084	0	208	836	148	0
Confl. Peds. (#/hr)		10	10		10	10
Heavy Vehicles (%)	4%	8%	9%	2%	0%	1%
Turn Type	NA		pm+pt	NA	Prot	
Protected Phases	2		1	6	8	
Permitted Phases			6			
Actuated Green, G (s)	63.1		80.3	80.3	14.7	
Effective Green, g (s)	63.1		80.3	80.3	14.7	
Actuated g/C Ratio	0.60		0.76	0.76	0.14	
Clearance Time (s)	5.0		5.0	5.0	5.0	
Vehicle Extension (s)	2.5		2.5	2.5	2.5	
Lane Grp Cap (vph)	2049		403	2706	229	
v/s Ratio Prot	0.32		c0.06	0.24	c0.09	
v/s Ratio Perm			c0.33			
v/c Ratio	0.53		0.52	0.31	0.65	
Uniform Delay, d1	12.3		6.7	3.8	42.7	
Progression Factor	0.67		1.00	1.00	1.00	
Incremental Delay, d2	0.9		0.8	0.3	5.4	
Delay (s)	9.1		7.5	4.1	48.1	
Level of Service	A		A	A	D	
Approach Delay (s)	9.1			4.8	48.1	
Approach LOS	A			A	D	

Intersection Summary			
HCM 2000 Control Delay	11.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	105.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	63.2%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	68	990	98	64	773	49	70	16	62	52	16	53
Future Volume (vph)	68	990	98	64	773	49	70	16	62	52	16	53
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0			5.0			5.0	
Lane Util. Factor		0.95		1.00	0.95			1.00			1.00	
Frpb, ped/bikes		1.00		1.00	1.00			0.99			0.99	
Flpb, ped/bikes		1.00		1.00	1.00			1.00			1.00	
Frt		0.99		1.00	0.99			0.94			0.94	
Flt Protected		1.00		0.95	1.00			0.98			0.98	
Satd. Flow (prot)		3416		1770	3444			1694			1693	
Flt Permitted		0.83		0.95	1.00			0.80			0.79	
Satd. Flow (perm)		2850		1770	3444			1382			1359	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	74	1076	107	70	840	53	76	17	67	57	17	58
RTOR Reduction (vph)	0	7	0	0	5	0	0	35	0	0	39	0
Lane Group Flow (vph)	0	1250	0	70	888	0	0	125	0	0	93	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Bus Blockages (#/hr)	0	8	8	0	8	0	0	0	0	0	0	0
Turn Type	Perm	NA		Prot	NA		Perm	NA		Perm	NA	
Protected Phases		2		1	6			8			4	
Permitted Phases	2						8			4		
Actuated Green, G (s)		38.1		5.6	48.7			12.7			12.7	
Effective Green, g (s)		38.1		5.6	48.7			12.7			12.7	
Actuated g/C Ratio		0.53		0.08	0.68			0.18			0.18	
Clearance Time (s)		5.0		5.0	5.0			5.0			5.0	
Vehicle Extension (s)		2.5		2.5	2.5			2.5			2.5	
Lane Grp Cap (vph)		1520		138	2349			245			241	
v/s Ratio Prot				0.04	c0.26							
v/s Ratio Perm		c0.44						c0.09			0.07	
v/c Ratio		0.82		0.51	0.38			0.51			0.39	
Uniform Delay, d1		13.8		31.6	4.9			26.5			25.9	
Progression Factor		1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2		3.6		2.1	0.1			1.2			0.8	
Delay (s)		17.5		33.7	4.9			27.7			26.7	
Level of Service		B		C	A			C			C	
Approach Delay (s)		17.5			7.0			27.7			26.7	
Approach LOS		B			A			C			C	

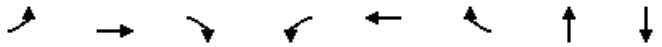
Intersection Summary			
HCM 2000 Control Delay	14.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	71.4	Sum of lost time (s)	15.0
Intersection Capacity Utilization	81.2%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	69	554	377	365	468	56	0	381	232	115	1029	284
Future Volume (vph)	69	554	377	365	468	56	0	381	232	115	1029	284
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.97	1.00	1.00	0.97		1.00	0.97	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1357	3505	1444	1752	3539	1444		2983	1543	1700	3312	1405
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		1.00	1.00	0.34	1.00	1.00
Satd. Flow (perm)	1357	3505	1444	1752	3539	1444		2983	1543	610	3312	1405
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.95	0.95	0.95	0.86	0.86	0.86
Adj. Flow (vph)	78	622	424	410	526	63	0	401	244	134	1197	330
RTOR Reduction (vph)	0	0	159	0	0	39	0	0	185	0	0	148
Lane Group Flow (vph)	78	622	265	410	526	24	0	401	59	134	1197	182
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	33%	3%	9%	3%	2%	9%	0%	21%	2%	6%	9%	12%
Turn Type	Prot	NA	Perm	Prot	NA	Perm		NA	Perm	pm+pt	NA	Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases			2			6			8	4		4
Actuated Green, G (s)	8.4	20.9	20.9	22.0	34.5	34.5		22.0	22.0	33.0	33.0	33.0
Effective Green, g (s)	8.4	20.9	20.9	22.0	34.5	34.5		22.0	22.0	33.0	33.0	33.0
Actuated g/C Ratio	0.09	0.23	0.23	0.24	0.38	0.38		0.24	0.24	0.36	0.36	0.36
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	2.5	4.0	4.0	2.5	4.0	4.0		2.5	2.5	2.5	2.5	2.5
Lane Grp Cap (vph)	125	805	332	424	1343	548		721	373	293	1202	510
v/s Ratio Prot	0.06	0.18		c0.23	0.15			0.13		0.03	c0.36	
v/s Ratio Perm			c0.18			0.02			0.04	0.14		0.13
v/c Ratio	0.62	0.77	0.80	0.97	0.39	0.04		0.56	0.16	0.46	1.00	0.36
Uniform Delay, d1	39.7	32.8	33.0	34.1	20.6	17.8		30.2	27.2	20.6	28.9	21.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	8.1	4.9	13.3	34.8	0.3	0.0		0.7	0.1	0.8	24.8	0.3
Delay (s)	47.8	37.7	46.3	68.9	20.8	17.8		30.9	27.3	21.4	53.7	21.5
Level of Service	D	D	D	E	C	B		C	C	C	D	C
Approach Delay (s)		41.6			40.4			29.6			44.7	
Approach LOS		D			D			C			D	

Intersection Summary			
HCM 2000 Control Delay	40.7	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	90.9	Sum of lost time (s)	20.0
Intersection Capacity Utilization	85.5%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBT	SBT
Lane Group Flow (vph)	9	89	16	322	272	391	407	927
v/c Ratio	0.07	0.29	0.04	0.80	0.36	0.56	0.76	0.83
Control Delay	59.5	53.5	0.2	64.4	31.1	15.1	61.5	50.3
Queue Delay	0.0	0.0	0.0	21.8	1.6	1.3	0.0	0.0
Total Delay	59.5	53.5	0.2	86.2	32.7	16.4	61.5	50.3
Queue Length 50th (ft)	8	73	0	264	168	71	173	375
Queue Length 95th (ft)	26	123	0	#399	275	196	220	#572
Internal Link Dist (ft)		160			149		206	298
Turn Bay Length (ft)	75		75			115		
Base Capacity (vph)	133	394	433	405	758	702	838	1123
Starvation Cap Reductn	0	0	0	82	320	147	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.07	0.23	0.04	1.00	0.62	0.70	0.49	0.83

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	EBL	EBT	WBL	WBT	NBT	NBR	SBT
Lane Group Flow (vph)	23	485	107	1023	16	49	74
v/c Ratio	0.13	0.30	0.26	0.64	0.03	0.10	0.15
Control Delay	10.2	8.3	10.2	11.5	11.9	5.0	9.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	10.2	8.3	10.2	11.5	11.9	5.0	9.7
Queue Length 50th (ft)	2	28	12	73	3	0	8
Queue Length 95th (ft)	19	91	58	217	14	17	34
Internal Link Dist (ft)		73		1077	208		187
Turn Bay Length (ft)	90		112			135	
Base Capacity (vph)	278	2447	625	2441	1073	1041	1085
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.08	0.20	0.17	0.42	0.01	0.05	0.07

Intersection Summary

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBR
Lane Group Flow (vph)	71	724	178	1293	107	363	283	175	201
v/c Ratio	0.43	0.54	0.50	0.89	0.27	0.85	1.16	0.40	0.39
Control Delay	23.0	27.2	13.8	30.0	22.2	51.2	135.6	35.7	6.5
Queue Delay	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0
Total Delay	23.0	27.2	13.8	31.7	22.2	51.2	135.6	35.7	6.5
Queue Length 50th (ft)	23	195	40	452	47	204	~162	99	0
Queue Length 95th (ft)	47	242	61	424	56	190	#303	150	52
Internal Link Dist (ft)		1077		305		273		368	
Turn Bay Length (ft)	140		175		150		150		
Base Capacity (vph)	167	1339	361	1450	403	531	243	550	597
Starvation Cap Reductn	0	0	0	63	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.43	0.54	0.49	0.93	0.27	0.68	1.16	0.32	0.34

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	EBT	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	1008	998	317	109	111	95
v/c Ratio	0.53	0.50	0.88	0.17	0.31	0.15
Control Delay	12.0	14.2	60.9	0.6	31.0	0.5
Queue Delay	0.1	0.4	0.0	0.0	0.0	0.0
Total Delay	12.1	14.6	60.9	0.6	31.0	0.5
Queue Length 50th (ft)	161	253	198	0	57	0
Queue Length 95th (ft)	m176	125	193	0	45	0
Internal Link Dist (ft)	305	295		100		111
Turn Bay Length (ft)						
Base Capacity (vph)	1907	2015	419	683	416	681
Starvation Cap Reductn	164	454	0	0	0	0
Spillback Cap Reductn	0	511	0	0	0	40
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.58	0.66	0.76	0.16	0.27	0.15

Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

Lane Group	EBT	WBT	NBT	SBT
Lane Group Flow (vph)	1093	944	74	70
v/c Ratio	0.45	0.35	0.41	0.37
Control Delay	5.0	3.0	37.2	32.1
Queue Delay	0.2	0.1	0.0	0.0
Total Delay	5.2	3.1	37.2	32.1
Queue Length 50th (ft)	118	49	33	26
Queue Length 95th (ft)	122	80	71	64
Internal Link Dist (ft)	295	292	136	111
Turn Bay Length (ft)				
Base Capacity (vph)	2436	2731	460	479
Starvation Cap Reductn	547	654	0	0
Spillback Cap Reductn	30	76	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.58	0.45	0.16	0.15

Intersection Summary

Lane Group	EBT	WBL	WBT	NBL
Lane Group Flow (vph)	1088	208	836	232
v/c Ratio	0.53	0.52	0.31	0.74
Control Delay	10.0	8.6	4.6	38.6
Queue Delay	0.2	0.0	0.0	0.0
Total Delay	10.2	8.6	4.6	38.6
Queue Length 50th (ft)	197	30	71	87
Queue Length 95th (ft)	156	63	119	160
Internal Link Dist (ft)	292		1835	287
Turn Bay Length (ft)		150		85
Base Capacity (vph)	2056	464	2706	465
Starvation Cap Reductn	287	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.62	0.45	0.31	0.50

Intersection Summary

Lane Group	EBT	WBL	WBT	NBT	SBT
Lane Group Flow (vph)	1257	70	893	160	132
v/c Ratio	0.80	0.27	0.39	0.56	0.46
Control Delay	21.0	31.9	5.9	27.0	22.7
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	21.0	31.9	5.9	27.0	22.7
Queue Length 50th (ft)	241	28	64	48	34
Queue Length 95th (ft)	#476	71	140	104	82
Internal Link Dist (ft)	1835		604	981	346
Turn Bay Length (ft)		80			
Base Capacity (vph)	1572	259	2591	435	431
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.80	0.27	0.34	0.37	0.31

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	78	622	424	410	526	63	401	244	134	1197	330
v/c Ratio	0.54	0.80	0.88	0.96	0.39	0.10	0.55	0.43	0.45	0.99	0.50
Control Delay	51.5	42.3	39.1	69.7	22.4	0.3	33.0	6.5	25.2	52.0	9.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	51.5	42.3	39.1	69.7	22.4	0.3	33.0	6.5	25.2	52.0	9.6
Queue Length 50th (ft)	43	176	125	231	117	0	105	0	52	350	37
Queue Length 95th (ft)	85	#238	#294	#405	166	0	152	57	89	#460	97
Internal Link Dist (ft)		761			160		263			552	
Turn Bay Length (ft)	150		560	150		30		150	190		150
Base Capacity (vph)	180	779	481	428	1359	643	730	561	295	1215	662
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.43	0.80	0.88	0.96	0.39	0.10	0.55	0.43	0.45	0.99	0.50

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Arterial Level of Service: EB Puyallup Ave

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Pacific	III	30	7.0	53.5	60.5	0.05	2.7	F
A St	III	30	11.2	8.3	19.5	0.07	13.4	E
D St	III	30	27.8	27.2	55.0	0.22	14.3	D
E St	III	30	11.3	12.0	23.3	0.07	11.3	E
	III	30	11.0	5.0	16.0	0.07	16.0	D
G St	III	30	10.9	10.0	20.9	0.07	12.1	E
E L ST	III	30	46.1	21.0	67.1	0.36	19.5	C
Portland	III	30	36.7	42.3	79.0	0.29	13.2	E
Total	III		162.0	179.3	341.3	1.20	12.7	E

Arterial Level of Service: WB Puyallup Ave

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Portland	III	30	7.0	22.4	29.4	0.05	5.6	F
	III	30	36.7	5.9	42.6	0.29	24.4	B
G St	III	30	46.1	4.6	50.7	0.36	25.8	B
F St	III	30	10.9	3.0	13.9	0.07	18.2	C
E St	III	30	11.0	14.2	25.2	0.07	10.1	E
D St	III	30	11.3	30.0	41.3	0.07	6.4	F
A St	III	30	27.8	11.5	39.3	0.22	20.1	C
Pacific	III	30	11.2	31.1	42.3	0.07	6.2	F
Total	III		162.0	122.7	284.7	1.20	15.2	D

2040 Alternative 3 Conditions

1. HCM LOS Analysis
2. Queue Analysis
3. Arterial Analysis

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	8	82	15	296	250	360	0	298	76	297	519	37
Future Volume (vph)	8	82	15	296	250	360	0	298	76	297	519	37
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0	5.0		5.0			5.0	
Lane Util. Factor		1.00		1.00	1.00	1.00		0.95			0.95	
Frpb, ped/bikes		1.00		1.00	1.00	0.97		0.99			1.00	
Flpb, ped/bikes		1.00		1.00	1.00	1.00		1.00			1.00	
Frt		0.98		1.00	1.00	0.85		0.97			0.99	
Flt Protected		1.00		0.95	1.00	1.00		1.00			0.98	
Satd. Flow (prot)		1847		1805	1900	1569		3466			3518	
Flt Permitted		0.96		0.95	1.00	1.00		1.00			0.98	
Satd. Flow (perm)		1775		1805	1900	1569		3466			3518	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	9	89	16	322	272	391	0	324	83	323	564	40
RTOR Reduction (vph)	0	5	0	0	0	223	0	20	0	0	2	0
Lane Group Flow (vph)	0	109	0	322	272	168	0	387	0	0	925	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm	NA		Prot	NA	Perm		NA		Split	NA	
Protected Phases		2		1	6		8	8		4	4	
Permitted Phases	2					6						
Actuated Green, G (s)		14.1		33.1	52.2	52.2		19.5			43.3	
Effective Green, g (s)		14.1		33.1	52.2	52.2		19.5			43.3	
Actuated g/C Ratio		0.11		0.25	0.40	0.40		0.15			0.33	
Clearance Time (s)		5.0		5.0	5.0	5.0		5.0			5.0	
Vehicle Extension (s)		2.5		2.5	2.5	2.5		2.5			2.5	
Lane Grp Cap (vph)		192		459	762	630		519			1171	
v/s Ratio Prot				c0.18	0.14			c0.11			c0.26	
v/s Ratio Perm		c0.06				0.11						
v/c Ratio		0.57		0.70	0.36	0.27		0.75			0.79	
Uniform Delay, d1		55.0		44.0	27.2	26.1		52.9			39.2	
Progression Factor		1.00		1.00	1.00	1.00		1.00			1.00	
Incremental Delay, d2		11.5		4.5	0.2	0.2		5.5			3.5	
Delay (s)		66.6		48.4	27.4	26.2		58.4			42.7	
Level of Service		E		D	C	C		E			D	
Approach Delay (s)		66.6			33.8			58.4			42.7	
Approach LOS		E			C			E			D	

Intersection Summary			
HCM 2000 Control Delay	42.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	73.0%	ICU Level of Service	C
Analysis Period (min)	15		

Description: Updated Timing - Do not optimize CL
3/1/1
NB/SB Split Phase -M
c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	21	425	21	98	888	53	10	5	45	28	18	22
Future Volume (vph)	21	425	21	98	888	53	10	5	45	28	18	22
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0			5.0	5.0		5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	0.97		0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	1.00		0.99	
Frt	1.00	0.99		1.00	0.99			1.00	0.85		0.96	
Flt Protected	0.95	1.00		0.95	1.00			0.97	1.00		0.98	
Satd. Flow (prot)	1802	1824		1798	1820			1828	1512		1760	
Flt Permitted	0.13	1.00		0.45	1.00			0.83	1.00		0.88	
Satd. Flow (perm)	245	1824		851	1820			1576	1512		1586	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	23	462	23	107	965	58	11	5	49	30	20	24
RTOR Reduction (vph)	0	2	0	0	2	0	0	0	40	0	19	0
Lane Group Flow (vph)	23	483	0	107	1021	0	0	16	9	0	55	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Bus Blockages (#/hr)	0	8	0	0	8	8	0	0	8	8	0	0
Turn Type	Perm	NA		Perm	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8		8	4		
Actuated Green, G (s)	44.6	44.6		44.6	44.6			12.8	12.8		12.8	
Effective Green, g (s)	44.6	44.6		44.6	44.6			12.8	12.8		12.8	
Actuated g/C Ratio	0.66	0.66		0.66	0.66			0.19	0.19		0.19	
Clearance Time (s)	5.0	5.0		5.0	5.0			5.0	5.0		5.0	
Vehicle Extension (s)	2.5	2.5		2.5	2.5			2.5	2.5		2.5	
Lane Grp Cap (vph)	162	1206		563	1204			299	287		301	
v/s Ratio Prot		0.26			c0.56							
v/s Ratio Perm	0.09			0.13				0.01	0.01		c0.03	
v/c Ratio	0.14	0.40		0.19	0.85			0.05	0.03		0.18	
Uniform Delay, d1	4.3	5.2		4.4	8.8			22.3	22.3		22.9	
Progression Factor	1.00	1.00		1.00	1.00			1.00	1.00		1.00	
Incremental Delay, d2	0.3	0.2		0.1	5.6			0.1	0.0		0.2	
Delay (s)	4.6	5.4		4.5	14.4			22.4	22.3		23.1	
Level of Service	A	A		A	B			C	C		C	
Approach Delay (s)		5.4			13.5			22.3			23.1	
Approach LOS		A			B			C			C	

Intersection Summary			
HCM 2000 Control Delay	11.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	67.4	Sum of lost time (s)	10.0
Intersection Capacity Utilization	84.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	58	521	73	130	760	184	72	124	119	272	168	193
Future Volume (vph)	58	521	73	130	760	184	72	124	119	272	168	193
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.99		1.00	1.00	1.00	1.00	0.97		1.00	1.00	0.94
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00	0.97	1.00		0.99	1.00	1.00
Frt	1.00	0.98		1.00	1.00	0.85	1.00	0.93		1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1597	1748		1805	1786	1455	1725	1665		1667	1863	1494
Flt Permitted	0.07	1.00		0.18	1.00	1.00	0.59	1.00		0.36	1.00	1.00
Satd. Flow (perm)	110	1748		339	1786	1455	1073	1665		639	1863	1494
Peak-hour factor, PHF	0.82	0.82	0.82	0.73	0.73	0.73	0.67	0.67	0.67	0.96	0.96	0.96
Adj. Flow (vph)	71	635	89	178	1041	252	107	185	178	283	175	201
RTOR Reduction (vph)	0	4	0	0	0	44	0	25	0	0	0	92
Lane Group Flow (vph)	71	720	0	178	1041	208	107	338	0	283	175	109
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	13%	3%	0%	0%	3%	11%	2%	3%	3%	7%	2%	2%
Bus Blockages (#/hr)	0	8	8	0	8	0	0	0	0	0	0	0
Turn Type	pm+pt	NA		pm+pt	NA	custom	Perm	NA		Perm	NA	Perm
Protected Phases	5	2		1	6	6		8			4	
Permitted Phases	2			6		6	8			4		4
Actuated Green, G (s)	67.0	67.0		67.0	67.0	67.0	52.0	52.0		52.0	52.0	52.0
Effective Green, g (s)	67.0	67.0		67.0	67.0	67.0	52.0	52.0		52.0	52.0	52.0
Actuated g/C Ratio	0.48	0.48		0.48	0.48	0.48	0.37	0.37		0.37	0.37	0.37
Clearance Time (s)	5.0	5.0		5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	2.5	2.5		2.5	2.5	2.5	2.5	2.5		2.5	2.5	2.5
Lane Grp Cap (vph)	116	836		225	854	696	398	618		237	691	554
v/s Ratio Prot	0.03	c0.41		0.03	c0.58	0.14		0.20			0.09	
v/s Ratio Perm	0.27			0.34			0.10			c0.44		0.07
v/c Ratio	0.61	0.86		0.79	1.22	0.30	0.27	0.55		1.19	0.25	0.20
Uniform Delay, d1	32.0	32.4		51.0	36.5	22.2	30.7	34.7		44.0	30.5	29.8
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	7.9	11.3		16.6	109.1	1.1	0.3	0.8		121.1	0.1	0.1
Delay (s)	39.9	43.7		67.6	145.6	23.3	31.0	35.5		165.1	30.7	30.0
Level of Service	D	D		E	F	C	C	D		F	C	C
Approach Delay (s)		43.4			115.2			34.5			88.2	
Approach LOS		D			F			C			F	

Intersection Summary			
HCM 2000 Control Delay	82.0	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.21		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	92.0%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	32	859	16	10	819	40	209	0	72	49	0	42
Future Volume (vph)	32	859	16	10	819	40	209	0	72	49	0	42
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.94	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.96	1.00		0.97	1.00	
Frt	1.00	1.00		1.00	0.99		1.00	0.85		1.00	0.85	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1805	1822		1805	1797		1739	1531		1755	1517	
Flt Permitted	0.12	1.00		0.13	1.00		0.69	1.00		0.67	1.00	
Satd. Flow (perm)	234	1822		250	1797		1270	1531		1236	1517	
Peak-hour factor, PHF	0.90	0.90	0.90	0.87	0.87	0.87	0.66	0.66	0.66	0.44	0.44	0.44
Adj. Flow (vph)	36	954	18	11	941	46	317	0	109	111	0	95
RTOR Reduction (vph)	0	0	0	0	1	0	0	79	0	0	69	0
Lane Group Flow (vph)	36	972	0	11	986	0	317	30	0	111	26	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	0%	4%	0%	0%	4%	20%	0%	0%	0%	0%	0%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	81.1	81.1		81.1	81.1		33.9	33.9		33.9	33.9	
Effective Green, g (s)	81.1	81.1		81.1	81.1		33.9	33.9		33.9	33.9	
Actuated g/C Ratio	0.65	0.65		0.65	0.65		0.27	0.27		0.27	0.27	
Clearance Time (s)	5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5	
Lane Grp Cap (vph)	151	1182		162	1165		344	415		335	411	
v/s Ratio Prot		0.53			c0.55			0.02			0.02	
v/s Ratio Perm	0.15			0.04			c0.25			0.09		
v/c Ratio	0.24	0.82		0.07	0.85		0.92	0.07		0.33	0.06	
Uniform Delay, d1	9.1	16.5		8.1	17.1		44.3	33.9		36.5	33.8	
Progression Factor	1.00	1.00		0.93	0.97		1.00	1.00		1.00	1.00	
Incremental Delay, d2	3.7	6.5		0.6	6.2		29.3	0.1		0.4	0.0	
Delay (s)	12.8	23.0		8.2	22.8		73.5	33.9		36.9	33.8	
Level of Service	B	C		A	C		E	C		D	C	
Approach Delay (s)		22.7			22.6			63.4			35.5	
Approach LOS		C			C			E			D	

Intersection Summary			
HCM 2000 Control Delay	30.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	125.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	72.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	29	943	0	0	803	18	47	0	21	31	0	22
Future Volume (vph)	29	943	0	0	803	18	47	0	21	31	0	22
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0			5.0			5.0			5.0	
Lane Util. Factor	1.00	1.00			1.00			1.00			1.00	
Frpb, ped/bikes	1.00	1.00			1.00			0.98			0.98	
Flpb, ped/bikes	1.00	1.00			1.00			0.98			0.99	
Frt	1.00	1.00			1.00			0.96			0.94	
Flt Protected	0.95	1.00			1.00			0.97			0.97	
Satd. Flow (prot)	1797	1810			1820			1668			1681	
Flt Permitted	0.26	1.00			1.00			0.76			0.80	
Satd. Flow (perm)	485	1810			1820			1318			1382	
Peak-hour factor, PHF	0.89	0.89	0.92	0.92	0.87	0.87	0.92	0.92	0.92	0.75	0.92	0.75
Adj. Flow (vph)	33	1060	0	0	923	21	51	0	23	41	0	29
RTOR Reduction (vph)	0	0	0	0	1	0	0	15	0	0	22	0
Lane Group Flow (vph)	33	1060	0	0	943	0	0	59	0	0	48	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Heavy Vehicles (%)	0%	5%	2%	2%	4%	0%	2%	2%	2%	0%	2%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)	102.5	102.5			102.5			12.5			12.5	
Effective Green, g (s)	102.5	102.5			102.5			12.5			12.5	
Actuated g/C Ratio	0.82	0.82			0.82			0.10			0.10	
Clearance Time (s)	5.0	5.0			5.0			5.0			5.0	
Vehicle Extension (s)	2.5	2.5			2.5			2.5			2.5	
Lane Grp Cap (vph)	397	1484			1492			131			138	
v/s Ratio Prot		c0.59			0.52							
v/s Ratio Perm	0.07							c0.04			0.04	
v/c Ratio	0.08	0.71			0.63			0.45			0.35	
Uniform Delay, d1	2.2	4.9			4.2			53.0			52.5	
Progression Factor	1.03	0.92			0.77			1.00			1.00	
Incremental Delay, d2	0.3	2.0			1.7			1.8			1.1	
Delay (s)	2.5	6.5			4.9			54.8			53.6	
Level of Service	A	A			A			D			D	
Approach Delay (s)		6.4			4.9			54.8			53.6	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM 2000 Control Delay	8.9	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	125.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	68.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	896	72	175	702	69	151
Future Volume (vph)	896	72	175	702	69	151
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0		5.0	5.0	5.0	
Lane Util. Factor	1.00		1.00	1.00	1.00	
Frpb, ped/bikes	1.00		1.00	1.00	0.95	
Flpb, ped/bikes	1.00		1.00	1.00	1.00	
Frt	0.99		1.00	1.00	0.91	
Flt Protected	1.00		0.95	1.00	0.98	
Satd. Flow (prot)	1797		1656	1863	1604	
Flt Permitted	1.00		0.18	1.00	0.98	
Satd. Flow (perm)	1797		321	1863	1604	
Peak-hour factor, PHF	0.89	0.89	0.84	0.84	0.95	0.95
Adj. Flow (vph)	1007	81	208	836	73	159
RTOR Reduction (vph)	2	0	0	0	63	0
Lane Group Flow (vph)	1086	0	208	836	169	0
Confl. Peds. (#/hr)		10	10		10	10
Heavy Vehicles (%)	4%	8%	9%	2%	0%	1%
Turn Type	NA		Perm	NA	Prot	
Protected Phases	2			6	8	
Permitted Phases			6			
Actuated Green, G (s)	99.8		99.8	99.8	15.2	
Effective Green, g (s)	99.8		99.8	99.8	15.2	
Actuated g/C Ratio	0.80		0.80	0.80	0.12	
Clearance Time (s)	5.0		5.0	5.0	5.0	
Vehicle Extension (s)	2.5		2.5	2.5	2.5	
Lane Grp Cap (vph)	1434		256	1487	195	
v/s Ratio Prot	0.60			0.45	c0.11	
v/s Ratio Perm			c0.65			
v/c Ratio	0.76		0.81	0.56	0.87	
Uniform Delay, d1	6.4		7.2	4.6	53.9	
Progression Factor	0.68		1.00	1.00	1.00	
Incremental Delay, d2	2.7		23.8	1.5	30.4	
Delay (s)	7.1		31.0	6.2	84.3	
Level of Service	A		C	A	F	
Approach Delay (s)	7.1			11.1	84.3	
Approach LOS	A			B	F	

Intersection Summary			
HCM 2000 Control Delay	16.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	125.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	114.9%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	68	990	98	64	773	49	70	16	62	52	16	53
Future Volume (vph)	68	990	98	64	773	49	70	16	62	52	16	53
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.0		5.0	5.0			5.0			5.0	
Lane Util. Factor		1.00		1.00	1.00			1.00			1.00	
Frpb, ped/bikes		1.00		1.00	1.00			0.98			0.98	
Flpb, ped/bikes		1.00		1.00	1.00			0.99			0.99	
Frt		0.99		1.00	0.99			0.94			0.94	
Flt Protected		1.00		0.95	1.00			0.98			0.98	
Satd. Flow (prot)		1769		1762	1781			1658			1658	
Flt Permitted		0.84		0.23	1.00			0.70			0.72	
Satd. Flow (perm)		1484		427	1781			1193			1214	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	74	1076	107	70	840	53	76	17	67	57	17	58
RTOR Reduction (vph)	0	2	0	0	2	0	0	17	0	0	19	0
Lane Group Flow (vph)	0	1255	0	70	891	0	0	143	0	0	113	0
Confl. Peds. (#/hr)	10		10	10		10	10		10	10		10
Bus Blockages (#/hr)	0	8	8	0	8	0	0	0	0	0	0	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8			4		
Actuated Green, G (s)		120.0		120.0	120.0			19.3			19.3	
Effective Green, g (s)		120.0		120.0	120.0			19.3			19.3	
Actuated g/C Ratio		0.80		0.80	0.80			0.13			0.13	
Clearance Time (s)		5.0		5.0	5.0			5.0			5.0	
Vehicle Extension (s)		2.5		2.5	2.5			2.5			2.5	
Lane Grp Cap (vph)		1192		343	1431			154			156	
v/s Ratio Prot					0.50							
v/s Ratio Perm		c0.85		0.16				c0.12			0.09	
v/c Ratio		1.05		0.20	0.62			0.93			0.72	
Uniform Delay, d1		14.7		3.4	5.8			64.3			62.4	
Progression Factor		1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2		41.1		0.2	0.7			50.6			14.4	
Delay (s)		55.8		3.7	6.5			114.9			76.8	
Level of Service		E		A	A			F			E	
Approach Delay (s)		55.8			6.3			114.9			76.8	
Approach LOS		E			A			F			E	

Intersection Summary			
HCM 2000 Control Delay	41.7	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.03		
Actuated Cycle Length (s)	149.3	Sum of lost time (s)	10.0
Intersection Capacity Utilization	131.2%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	69	554	377	365	468	56	0	381	232	115	1029	284
Future Volume (vph)	69	554	377	365	468	56	0	381	232	115	1029	284
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00		1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1357	3505	1482	1752	3539	1482		2983	1583	1703	3312	1442
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00		1.00	1.00	0.34	1.00	1.00
Satd. Flow (perm)	1357	3505	1482	1752	3539	1482		2983	1583	611	3312	1442
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.95	0.95	0.95	0.86	0.86	0.86
Adj. Flow (vph)	78	622	424	410	526	63	0	401	244	134	1197	330
RTOR Reduction (vph)	0	0	159	0	0	39	0	0	185	0	0	148
Lane Group Flow (vph)	78	622	265	410	526	24	0	401	59	134	1197	182
Heavy Vehicles (%)	33%	3%	9%	3%	2%	9%	0%	21%	2%	6%	9%	12%
Turn Type	Prot	NA	Perm	Prot	NA	Perm		NA	Perm	pm+pt	NA	Perm
Protected Phases	5	2		1	6			8		7	4	
Permitted Phases			2			6			8	4		4
Actuated Green, G (s)	8.4	20.9	20.9	22.0	34.5	34.5		22.0	22.0	33.0	33.0	33.0
Effective Green, g (s)	8.4	20.9	20.9	22.0	34.5	34.5		22.0	22.0	33.0	33.0	33.0
Actuated g/C Ratio	0.09	0.23	0.23	0.24	0.38	0.38		0.24	0.24	0.36	0.36	0.36
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	2.5	4.0	4.0	2.5	4.0	4.0		2.5	2.5	2.5	2.5	2.5
Lane Grp Cap (vph)	125	805	340	424	1343	562		721	383	293	1202	523
v/s Ratio Prot	0.06	0.18		c0.23	0.15			0.13		0.03	c0.36	
v/s Ratio Perm			c0.18			0.02			0.04	0.14		0.13
v/c Ratio	0.62	0.77	0.78	0.97	0.39	0.04		0.56	0.15	0.46	1.00	0.35
Uniform Delay, d1	39.7	32.8	32.8	34.1	20.6	17.8		30.2	27.1	20.6	28.9	21.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	8.1	4.9	11.7	34.8	0.3	0.0		0.7	0.1	0.8	24.8	0.3
Delay (s)	47.8	37.7	44.5	68.9	20.8	17.8		30.9	27.3	21.4	53.7	21.4
Level of Service	D	D	D	E	C	B		C	C	C	D	C
Approach Delay (s)		41.0			40.4			29.5			44.6	
Approach LOS		D			D			C			D	

Intersection Summary			
HCM 2000 Control Delay	40.5	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.99		
Actuated Cycle Length (s)	90.9	Sum of lost time (s)	20.0
Intersection Capacity Utilization	84.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBT	WBL	WBT	WBR	NBT	SBT
Lane Group Flow (vph)	114	322	272	391	407	927
v/c Ratio	0.58	0.70	0.36	0.46	0.76	0.79
Control Delay	62.8	54.7	29.5	5.3	58.9	45.1
Queue Delay	0.0	0.0	1.7	0.7	0.0	0.0
Total Delay	62.8	54.7	31.3	5.9	58.9	45.1
Queue Length 50th (ft)	89	244	159	10	165	369
Queue Length 95th (ft)	141	#474	240	79	212	472
Internal Link Dist (ft)	160		302		206	298
Turn Bay Length (ft)				115		
Base Capacity (vph)	400	459	782	864	817	1174
Starvation Cap Reductn	0	0	351	208	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.28	0.70	0.63	0.60	0.50	0.79

Intersection Summary

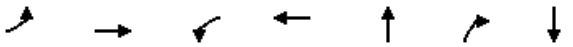
Description: Updated Timing - Do not optimize CL

3/1/1

NB/SB Split Phase -M

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.



Lane Group	EBL	EBT	WBL	WBT	NBT	NBR	SBT
Lane Group Flow (vph)	23	485	107	1023	16	49	74
v/c Ratio	0.14	0.40	0.19	0.85	0.05	0.15	0.23
Control Delay	8.2	7.1	6.4	19.1	25.5	9.3	20.7
Queue Delay	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Total Delay	8.2	7.4	6.4	19.1	25.5	9.3	20.7
Queue Length 50th (ft)	2	64	12	226	6	0	18
Queue Length 95th (ft)	19	205	52	#806	22	26	54
Internal Link Dist (ft)		302		1077	208		187
Turn Bay Length (ft)	90		112			135	
Base Capacity (vph)	199	1482	691	1478	628	630	645
Starvation Cap Reductn	0	442	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.12	0.47	0.15	0.69	0.03	0.08	0.11

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	EBL	EBT	WBL	WBT	WBR	NBL	NBT	SBL	SBT	SBR
Lane Group Flow (vph)	71	724	178	1041	252	107	363	283	175	201
v/c Ratio	0.61	0.86	0.79	1.22	0.34	0.27	0.57	1.19	0.25	0.31
Control Delay	43.7	44.2	64.9	142.5	16.1	33.1	35.1	160.0	31.8	10.5
Queue Delay	0.0	0.0	0.0	1.7	1.4	0.0	0.0	0.0	0.0	0.0
Total Delay	43.7	44.2	64.9	144.2	17.5	33.1	35.1	160.0	31.8	10.5
Queue Length 50th (ft)	35	569	92	~1160	90	68	234	~311	110	32
Queue Length 95th (ft)	61	645	111	#999	109	84	222	#496	170	91
Internal Link Dist (ft)		1077		305			273		368	
Turn Bay Length (ft)	140		150		150	150		150		
Base Capacity (vph)	116	840	224	854	740	398	642	237	691	647
Starvation Cap Reductn	0	0	0	206	311	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.61	0.86	0.79	1.61	0.59	0.27	0.57	1.19	0.25	0.31

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	36	972	11	987	317	109	111	95
v/c Ratio	0.24	0.82	0.07	0.85	0.92	0.21	0.33	0.18
Control Delay	15.2	25.0	9.8	24.7	76.2	3.4	38.4	2.0
Queue Delay	0.0	49.1	0.0	4.6	0.0	0.0	0.0	0.0
Total Delay	15.2	74.1	9.8	29.3	76.2	3.4	38.4	2.0
Queue Length 50th (ft)	12	593	3	698	240	0	69	0
Queue Length 95th (ft)	35	831	m4	844	237	0	55	0
Internal Link Dist (ft)		305		295		100		111
Turn Bay Length (ft)	100		100					
Base Capacity (vph)	151	1181	162	1166	375	551	365	550
Starvation Cap Reductn	0	338	0	123	0	0	0	0
Spillback Cap Reductn	0	183	0	0	0	14	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.24	1.15	0.07	0.95	0.85	0.20	0.30	0.17

Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

Lane Group	EBL	EBT	WBT	NBT	SBT
Lane Group Flow (vph)	33	1060	944	74	70
v/c Ratio	0.08	0.71	0.63	0.50	0.44
Control Delay	3.3	7.6	5.6	52.1	44.0
Queue Delay	0.0	2.5	2.4	0.0	0.0
Total Delay	3.3	10.1	8.0	52.1	44.0
Queue Length 50th (ft)	6	418	173	45	36
Queue Length 95th (ft)	m0	140	172	90	79
Internal Link Dist (ft)		295	292	136	111
Turn Bay Length (ft)	50				
Base Capacity (vph)	398	1483	1493	225	241
Starvation Cap Reductn	0	290	203	0	0
Spillback Cap Reductn	0	0	403	3	4
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.08	0.89	0.87	0.33	0.30

Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

Lane Group	EBT	WBL	WBT	NBL
Lane Group Flow (vph)	1088	208	836	232
v/c Ratio	0.76	0.81	0.56	0.90
Control Delay	7.5	35.6	6.5	72.8
Queue Delay	1.0	0.0	0.0	0.0
Total Delay	8.5	35.6	6.5	72.8
Queue Length 50th (ft)	151	82	211	130
Queue Length 95th (ft)	51	#259	251	#275
Internal Link Dist (ft)	292		1835	287
Turn Bay Length (ft)		175		85
Base Capacity (vph)	1438	256	1489	269
Starvation Cap Reductn	145	0	0	0
Spillback Cap Reductn	0	0	15	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.84	0.81	0.57	0.86

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	EBT	WBL	WBT	NBT	SBT
Lane Group Flow (vph)	1257	70	893	160	132
v/c Ratio	1.05	0.20	0.62	0.94	0.75
Control Delay	57.0	5.1	8.1	108.8	77.4
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	57.0	5.1	8.1	108.8	77.4
Queue Length 50th (ft)	~1342	14	296	138	105
Queue Length 95th (ft)	#1614	29	395	#284	#209
Internal Link Dist (ft)	1835		604	981	346
Turn Bay Length (ft)		80			
Base Capacity (vph)	1196	343	1433	177	182
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	1.05	0.20	0.62	0.90	0.73

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	78	622	424	410	526	63	401	244	134	1197	330
v/c Ratio	0.54	0.80	0.87	0.96	0.39	0.10	0.55	0.43	0.45	0.99	0.49
Control Delay	51.5	42.3	37.0	69.7	22.4	0.3	33.0	6.4	25.2	52.0	9.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	51.5	42.3	37.0	69.7	22.4	0.3	33.0	6.4	25.2	52.0	9.5
Queue Length 50th (ft)	43	176	124	231	117	0	105	0	52	350	37
Queue Length 95th (ft)	85	#238	#288	#405	166	0	152	57	89	#460	96
Internal Link Dist (ft)		761			160		263			552	
Turn Bay Length (ft)	150		560	150		30		150	190		150
Base Capacity (vph)	180	779	489	428	1359	658	730	571	296	1215	675
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.43	0.80	0.87	0.96	0.39	0.10	0.55	0.43	0.45	0.99	0.49

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Arterial Level of Service: EB Puyallup Ave

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Pacific	III	30	7.0	62.8	69.8	0.05	2.3	F
A St	III	30	11.2	7.1	18.3	0.07	14.2	D
D St	III	30	27.8	44.2	72.0	0.22	11.0	E
E St	III	30	11.3	25.0	36.3	0.07	7.2	F
	III	30	11.0	7.6	18.6	0.07	13.7	E
G St	III	30	10.9	7.5	18.4	0.07	13.8	E
E L ST	III	30	46.1	57.0	103.1	0.36	12.7	E
Portland	III	30	36.7	42.3	79.0	0.29	13.2	E
Total	III		162.0	253.5	415.5	1.20	10.4	E

Arterial Level of Service: WB Puyallup Ave

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Portland	III	30	7.0	22.4	29.4	0.05	5.6	F
	III	30	36.7	8.1	44.8	0.29	23.2	C
G St	III	30	46.1	6.5	52.6	0.36	24.8	B
F St	III	30	10.9	5.6	16.5	0.07	15.4	D
E St	III	30	11.0	24.7	35.7	0.07	7.2	F
D St	III	30	11.3	142.5	153.8	0.07	1.7	F
A St	III	30	27.8	19.1	46.9	0.22	16.8	D
Pacific	III	30	11.2	29.5	40.7	0.07	6.4	F
Total	III		162.0	258.4	420.4	1.20	10.3	E

Appendix F Cost Estimate

Planning Level Cost Estimate

Project: Puyallup Ave Improvements

Alternative 4

28-Feb-2018

Preliminary Engineering	10%	$	1,716,000
Right-Of-Way Acquisition		$	-
Construction/Preparation			
Mobilization:	8%	$	922,000
Utility Relocation:	5%	$	576,000
Grading/Site Prep:		$	1,255,000
Staging:	4%	$	461,000
Construction Engineering:	12%	$	2,059,000
Structures			
Bridge and Tunnels:		$	-
Retaining Walls:		$	-
Noise Walls:		$	-
Pavement		$	5,899,000

Environmental Mitigation			
Drainage:		$	-
Temp. Water Pollution Control:	3%	$	346,000
Traffic			
Traffic Services and Safety:		$	3,187,000
Workzone Traffic Control & Peds:	10%	$	1,152,000
Additional Items		$	1,183,000
Construction Contingency	6%	$	691,000
Sales Tax	9.5%	$	1,489,000
Total 2017 Cost =		**$**	**20,936,000**

Estimated Costs ($ Millions)

	YOE* 2017 Dollars	YOE 2020 Dollars (12% Const. Inflation)	Low (-20%) Dollars	Medium (+/- 0%) Dollars	High (+40%) Dollars
Estimated Cost =	**$ 20.94**	**$ 23.45**	**$18.76**	**$ 23.45**	**$ 32.83**

Risk Costs by Category			
YOE 2020 Dollars	**LOW ($mil)**	**MEDIUM ($mil)**	**HIGH ($mil)**
Land Acquisition	$ 0.25	$ 0.50	$ 1.00
Soil Conditions/Evironmental	$ 0.50	$ 1.00	$ 1.50
Utilties	$ 0.25	$ 0.50	$ 1.25
Construction Market	$ -	$ 0.50	$ 1.00
ADA Compliance	$ -	$ 0.25	$ 0.75
Risk Cost Range Sum	**$ 1.00**	**$ 2.75**	**$ 5.50**
Total Cost with Risk ($ Millions - YOE 2020)	**$19.76**	**$ 26.20**	**$ 38.33**

Note: Risk costs above added as the following: Low Risk + Los Cost, Med. Risk + Med Cost, High Risk + High Cost

* YOE -- Year of Expenditure

COST ESTIMATE
Strategic Analysis and Estimating Office

PIN NUMBER:	Oc	DESCRIPTION OF WORK	
SR, MP's:			28-Feb-2018
PROJECT TITLE: Puyallup Ave Improvements			
Puyallup Ave Improvments		Alternative 4: PLCE Costs for Roadway, Utilities, & Other Items.	
REGION:	Tacoma, WA		

Item Description		UOM	Unit Quan	Item Unit Cost	By Item Total	Group Total	Source of Costs	Notes
PREPARATION						$ 1,255,000		
REMOVING PAVEMENT		S.Y.	44,068	$ 20	$ 881,350		City of Tacoma Comparable Project	See Qty-Cost Backup, Item #16
REMOVE LIGHT POLE		EACH	-	8,000	$ -			N/A
REMOVE CURB AND GUTTER		L.F.	10,816	$ 10	$ 108,160		Unit Price per WSDOT Bid Tabs	See Qty-Cost Backup, Item #13
REMOVE CEMENT CONC. SIDEWALK		S.Y.	11,299	$ 16	$ 180,778		Unit Price per WSDOT Bid Tabs	See Qty-Cost Backup, Item #14
REMOVE TREE		EACH	18	$ 4,700	$ 84,600		Estimate	N/A
DRAINAGE, STORMWATER DETENTION AND TREATMENT						$ -		N/A - Conceptual plan is not at this level of detail
GRADING						$ -		N/A - Conceptual plan is not at this level of detail
STRUCTURES AND WALLS						$ -		N/A - Conceptual plan is not at this level of detail
CURBS, ASPHALT AND SURFACING						$ 5,899,000		
ASPHALT CONC. PAVEMENT		TON	-	$ 102.00	$ -		City of Tacoma Comparable Project	N/A
CRUSHED SURFACE BASE COURSE		TON	2,782	$ 52.00	$ 144,664		City of Tacoma Comparable Project	Quantity Estimates by Parsons
CEMENT CONCRETE PAVEMENT		SY	44,068	$ 80.00	$ 3,525,401		Unit cost per City of Tacoma	See Qty-Cost Backup, Item #16
6700 CEMENT CONC. TRAFFIC CURB AND GUTTER		L.F.	10,816	$ 30.00	$ 324,480		City of Tacoma Comparable Project	See Qty-Cost Backup, Item #13
DRIVEWAY RECONSTRUCTION OR MODIFICATION		S.Y.	484	$ 130.00	$ 62,920		City of Tacoma Comparable Project	N/A
7055 CEMENT CONC. SIDEWALK		S.Y.	15,927	$ 110.00	$ 1,751,932		City of Tacoma Comparable Project	See Qty-Cost Backup, Item #14
ADA RAMP		EACH	30	$ 3,000.00	$ 90,000		City of Tacoma Comparable Project	
WATERLINES AND SANITARY SEWERS						$ -		
TRAFFIC SERVICES AND SAFETY						$ 3,187,400		
SIGNING		L.S.	1	$ 10,000	$ 10,000		Estimate	L.S. is assuming minimal signing involved on the project
ITS		LS/LM	1	$ 3,000,000	$ 3,000,000		Lump Sum per City of Tacoma	N/A
NEW TRAFFIC SIGNAL SYSTEM		EACH	-	$ 201,780	$ -		Unit Price per PLCE database	All new signals
TRAFFIC SIGNAL MODIFICATIONS		EACH	-	$ 60,000	$ -		Estimate	No Mods, all new signals
TRAFFIC MARKINGS		L.F.	6417	$ 0.33	$ 2,118		Unit Price per PLCE database	Entire corridor would needing restriping
ILLUMINATION		EACH	29	6,000	$ 175,260		Estimate, For Local Streets	See Qty-Cost Backup, Item #12; Ped lighting only, existing lights to remain
ADDITIONAL ITEMS						$ 1,183,000		
ROADSIDE TREES		EACH	381	$ 740	$ 281,940		City of Tacoma Comparable Project	See Qty-Cost Backup, Item #11
SEEDING, FERTILIZING, AND MULCHING		ACRE	1	$ 6,000	$ 6,000		Unit Price per PLCE database	Tripled PLCE unit price
ROADSIDE RESTORATION		L.S.	1	$ 10,000	$ 10,000		Estimate	N/A
BUS BULB		EACH	10	$ 65,387	$ 653,873		Estimate	See Qty-Cost Backup, Item #1
PEDESTRIAN SAFETY ISLAND		EACH	4	$ 15,684	$ 62,736		Estimate	See Qty-Cost Backup, Item #2
NEW STRIPED HIGH-VIS CROSSWALK		EACH	25	$ 2,411	$ 60,276		Estimate	See Qty-Cost Backup, Item #3
GATEWAY SIGN		EACH	1	$ 20,487	$ 20,487		Estimate	See Qty-Cost Backup, Item #5
BOLLARDS		EACH	1	$ 909	$ 909		Estimate	See Qty-Cost Backup, Item #6
ENHANCED/ARTISTIC CROSSWALK		EACH	4	$ 3,609	$ 14,437		Estimate	See Qty-Cost Backup, Item #8
STREET FURNITURE		EACH	40	$ 1,507	$ 60,276		Estimate	See Qty-Cost Backup, Item #9
WAYFINDING		EACH	4	$ 3,000	$ 12,000		Estimate	
					CONSTRUCTION SUB-TOTAL	$ 11,524,000		
OTHER PARAMETRIC CONSTRUCTION COSTS						$ 4,149,000		
MOBILIZATION	8%	L.S.	1	921,920	$ 921,920		Raised Percent per PLCE	Raised from 6% using engineering judgement
MOT / TRAFFIC CONTROL / PED'S	10%	L.S.	1	1,152,400	$ 1,152,400		Raised Percent per PLCE	Raised 8% to 10% due to the expected business access challenges.
UTILITY RELOCATE	5%	L.S.	1	576,200	$ 576,200		Raised Percent per PLCE	3% standard per WSDOT PLCE- Increased to 5% due to local roadway.
CONSTRUCTION STAGING	4%	L.S.	1	460,960	$ 460,960		Percent per PLCE	
TEMP WATER POLLUTION CONTROL	3%	L.S.	1	345,720	$ 345,720		Percent per PLCE	
CONSTRUCTION CONTINGENCY	6%	L.S.	1	691,440	$ 691,440		Raised Percent per PLCE	Increased constuction contingency from 4% due to design level of the project
				SALES TAX	9.5%	$ 1,489,000		
					CONSTRUCTION TOTAL	$ 17,162,000		
						$ 3,775,000		
PRELIMINARY ENGINEER (PE)	10%	L.S.	1	1,716,000	$ 1,716,000		Percent per PLCE	
CONSTRUCTION ENGINEERING (CE)	12%	L.S.	1	2,059,440	$ 2,059,440		Percent per PLCE	
LAND ACQUISITION (Commercial)		ACRE		962,000	$ -		Unit Price per PLCE database	
LAND ACQUISITION (Residential)		ACRE		795,000	$ -		Unit Price per PLCE database	
LAND ACQUISITION (Vacant Land)		ACRE		70,000	$ -		Unit Price per PLCE database	
					$ -			
					$ -			
					$ -			
				TOTAL PLANNING LEVEL COST ESTIMATE		$ 20,937,000	Current Dollars	

Quantity - Cost Backup Information
Puyallup Ave Improvements
Alternative 4

28-Feb-18

ID	Pay Item	Description & Calculations	Qty
1	**Bus bulbs**	Assumed to be 10' wide, 65' long.	**10**
		Pacific Ave EB	1
		I-705/Dock St EB and WB	2
		East D St EB and WB	2
		McKinley Ave EB	1
		East J St EB and WB	2
		East L St EB and WB	2
2	**Pedestrian Safety Island**		**4**
		I-705	1
		McKinley Ave west leg	1
		East J St west leg	1
		Portland Ave west leg	1
3	**Striped Crosswalk - High-visibility**		**25**
		A St north and south legs	2
		East Dock St	1
		East C St north and south legs	2
		East E St all legs	4
		East F St east and west legs	2
		East G St south, east, and west legs	3
		McKinley Ave east and south legs	2
		East J St east and south legs	2
		East K St south leg	1
		East L St all legs	4
		East M St south leg	1
		Portland Ave west leg	1
4	**Leading Pedestrian/Bike Interval (New Signals)**		**7**
		Pacific Ave - fixed ped head; LPI (New Signal)	1
		A St - fixed ped head (New Signal)	1
		East D St - fixed ped head; LPI(New Signal)	1
		East E St - fixed ped head; LPI(New Signal)	1
		East F St - fixed ped head; LPI(New Signal)	1
		East G St - fixed ped head; LPI(New Signal)	1
		Portland Ave - LPI TBD (New Signal)	1
5	**Gateway Sign**		**1**
		Portland Ave	1
6	**Bollards**		**1**
		Between East D St and East E St before Alfred's drivewav	1
8	**Enhanced/Artistic Crosswalk**		**4**
		East D St all legs	4

ID	Pay Item	Description & Calculations	Qty	
9	**Street Furniture**		**40**	
		May include:		
		Trash and recycling receptacles	10	
		Benches or other seating	10	
		Bicycle parking	10	
		Tree grate	10	
10	**Public Art**		**1%**	**of capital costs**
		City of Tacoma Municipal Art Program dedicates 1% of construction costs from public capital projects to the creation of public art.		
11	**Roadside Trees**		**381**	
		Spacing assumed to be every 25 feet along corridor where 6' planting strip is available		

	Length of Segment (p	Count of Driveways	Linear feet of plan	Count of New Trees
South C Street to East C Street - Standard lighting	2384	11	2153	86
East C Street to East G Street - Decorative lighting (except TDS where lighting exists)	2040	21	1599	64
East G Street to Portland Ave - Standard lighting	6678	31	6027	241
Minus existing trees between East D Street and East E Street				-10

12	**Pedestrian-scaled Lighting**		**29**	
		Spacing assumed to be every 150 feet in residential areas, every 100 feet for ornamental lights per Backlight, Uplight, Glare (BUG) rating. Follows guidance of AASHTO's roadway lighting design guide, lights should be placed 5' from driveways and 3' from curb face.		

	Length of Segment	Count of Driveways	Linear feet of side	Count of lights
South C Street to East C Street - Standard lighting	2384	11	2109	14
East C Street to East G Street - Decorative lighting (except TDS where lighting exists)	2040	21	1515	15

13	**Curb Replaced**		**10,816**	**linear feet**

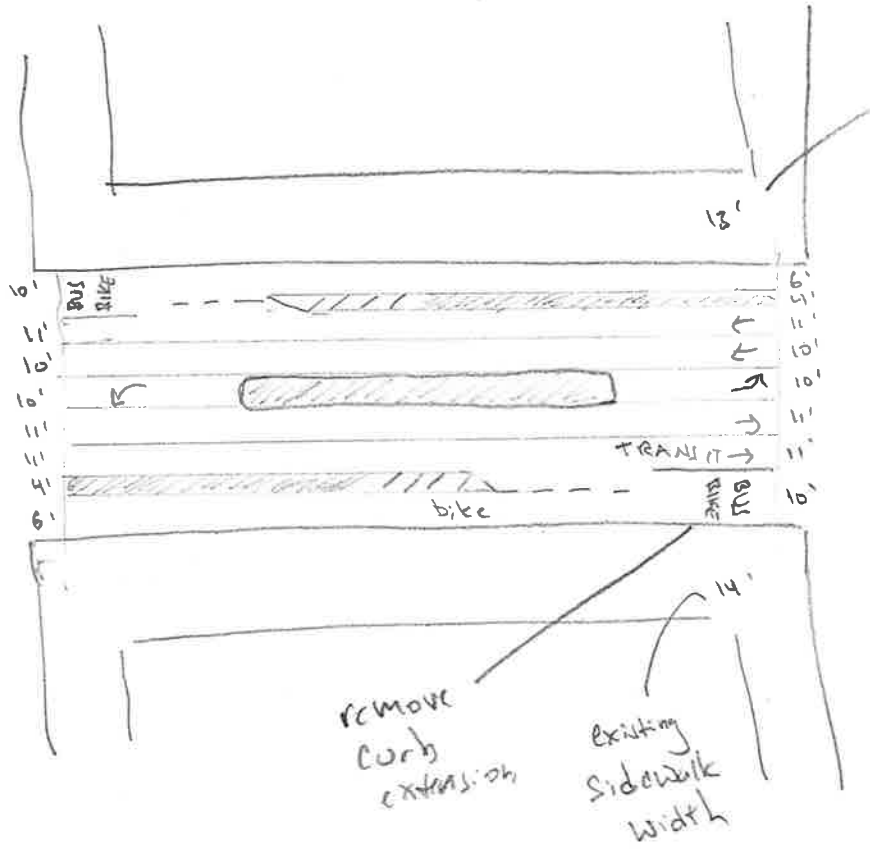
	Existing Width (ft)	Proposed Width (ft)	Change to Width	Length of Segmen	Both Side	Total Length (ft)
South C Street to Pacific Ave	56	56	0	238	yes	476
Pacific to East C Street	68	70	2	496	yes	992
East C Street to East D Street	73	70	-3	286	yes	572
East D Street to East E Street	72	70	-2	261	yes	522
East E Street to East F Street	67	62	-5	308	yes	616
East F Street to East G Street	74	74	0	330	yes	660
East G Street to McKinley Ave	69	70	1	304	yes	608
McKinley Ave to M Street	68	78	10	1942	yes	3884
M Street to Portland Ave	86	86	0	1093	yes	2186
Intersection islands bookending parking lane		7		150	yes	300

ID	Pay Item	Description & Calculations	Qty					
14	**Remove sidewalk**		**11,299**	**square yards**				
			Existing Width (ft)	Proposed Width (ft)	Change to Width	Length of Segmen	Both Side	Added Sidewalk (
		South C Street to Pacific Ave	12	0	-12	238	Yes	-5712
		Pacific to A Street	18	0	-18	291	Yes	-10476
		A Street to I-705	11	0	-11	205	Yes	-4510
		I-705 to East C Street	9	0	-9	458	Yes	-8244
		East C Street to East D Street	11	0	-11	286	Yes	-6292
		East D Street to East E Street	14	0	-14	261	Yes	-7308
		East E Street to East F Street	9.5	0	-9.5	308	No; Grey	-5852
		East F Street to East G Street	9	0	-9	330	No; TDS (	-5940
		East G Street to McKinley Ave	8	0	-8	304	Yes	-4864
		McKinley Ave to M Street	7	0	-7	1942	Yes	-27188
		M Street to Portland Ave	7	0	-7	1093	Yes	-15302
		Total				5716		
15	**Construct new sidewalk**		**15,927**	**square yards**				
			Existing Width (ft)	Proposed Width (ft)	Change to Width	Length of Segmen	Both Side	Added Sidewalk (
		South C Street to Pacific Ave	0	12	12	238	Yes	5712
		Pacific to A Street	0	15	15	291	Yes	8730
		A Street to I-705	0	15	15	205	Yes	6150
		I-705 to East C Street	0	15	15	458	Yes	13740
		East C Street to East D Street	0	15	15	286	Yes	8580
		East D Street to East E Street	0	15	15	261	Yes	7830
		East E Street to East F Street	0	15	15	308	Yes	9240
		East F Street to East G Street	0	15	15	330	Yes	9900
		East G Street to McKinley Ave	0	11	11	304	Yes	6688
		McKinley Ave to M Street	0	11	11	1942	Yes	42724
		M Street to Portland Ave	0	11	11	1093	Yes	24046
		Total				5716		
16	**Roadway Construction (10" PCC)**		**44,068**	**square yards**				
			Proposed Width (ft)	Length of Segment (ft)	Area of segment (sq ft)			
		South C Street to Pacific Ave	56	238	13328			
		Pacific to East C Street	70	496	34720			
		East C Street to East D Street	70	286	20020			
		East D Street to East E Street	70	261	18270			
		East E Street to East F Street	62	308	19096			
		East F Street to East G Street	74	330	24420			
		East G Street to McKinley Ave	70	304	21280			
		McKinley Ave to M Street	78	1942	151476			
		M Street to Portland Ave	86	1093	93998			

Infrastructure	Average cost (all states)
BOLLARD (EACH)	$ 909.01
BUS BULB-OUT (EACH)	$ 65,387.31
HIGH VISIBILITY CROSSWALK (EACH)	$ 2,411.04
PATTERNED CROSSWALK (EACH)	$ 3,609.31
GATEWAY SIGN (EACH)	$ 20,487.27
MEDIAN ISLAND (EACH)	$ 15,684.03
LEADING PEDESTRIAN/BICYCLE INTERVAL (EACH)	$ 1,268.29
STREET FURNITURE AVERAGE COST (BICYCLE RACK, BENCH, TRASH/RECYCLING, TREE GRATE, ETC.) (EACH	$ 1,506.89
PUBLIC ART (PER PROJECT)	
WAYFINDING SIGNAGE (EACH)	

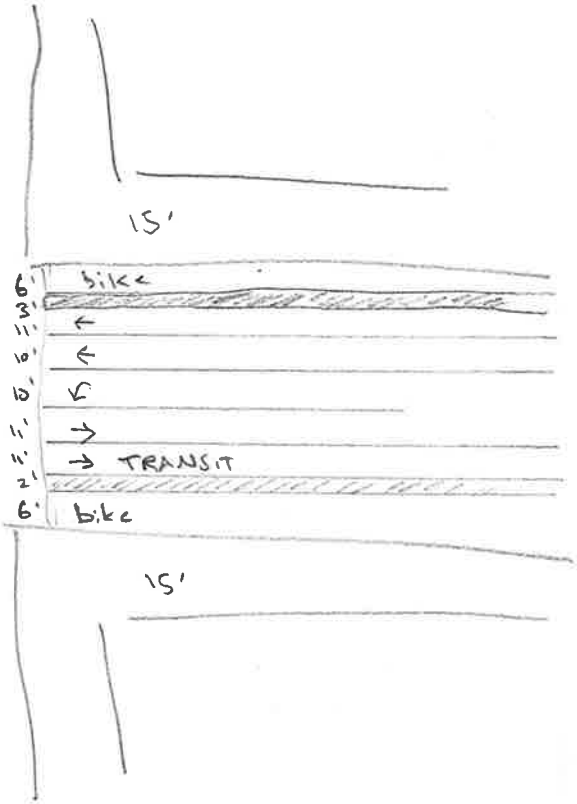
Appendix G Alternative 4 Sketches

(A) PBL



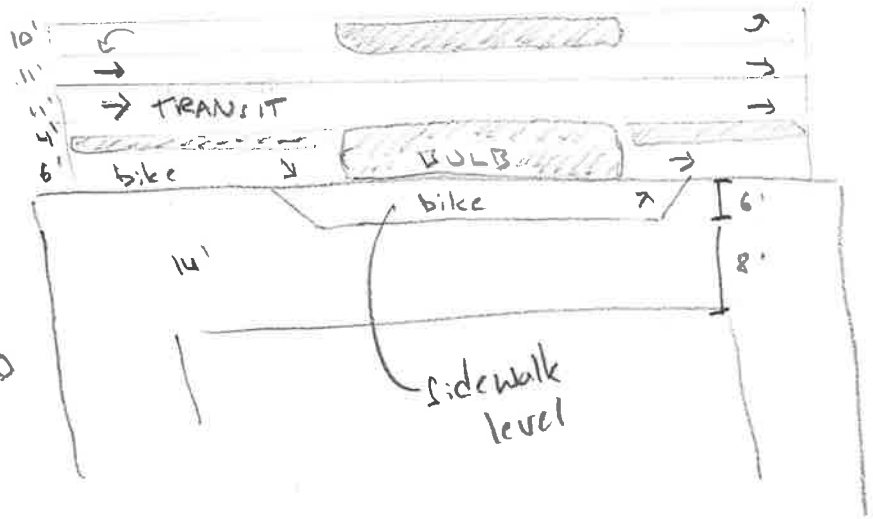
C

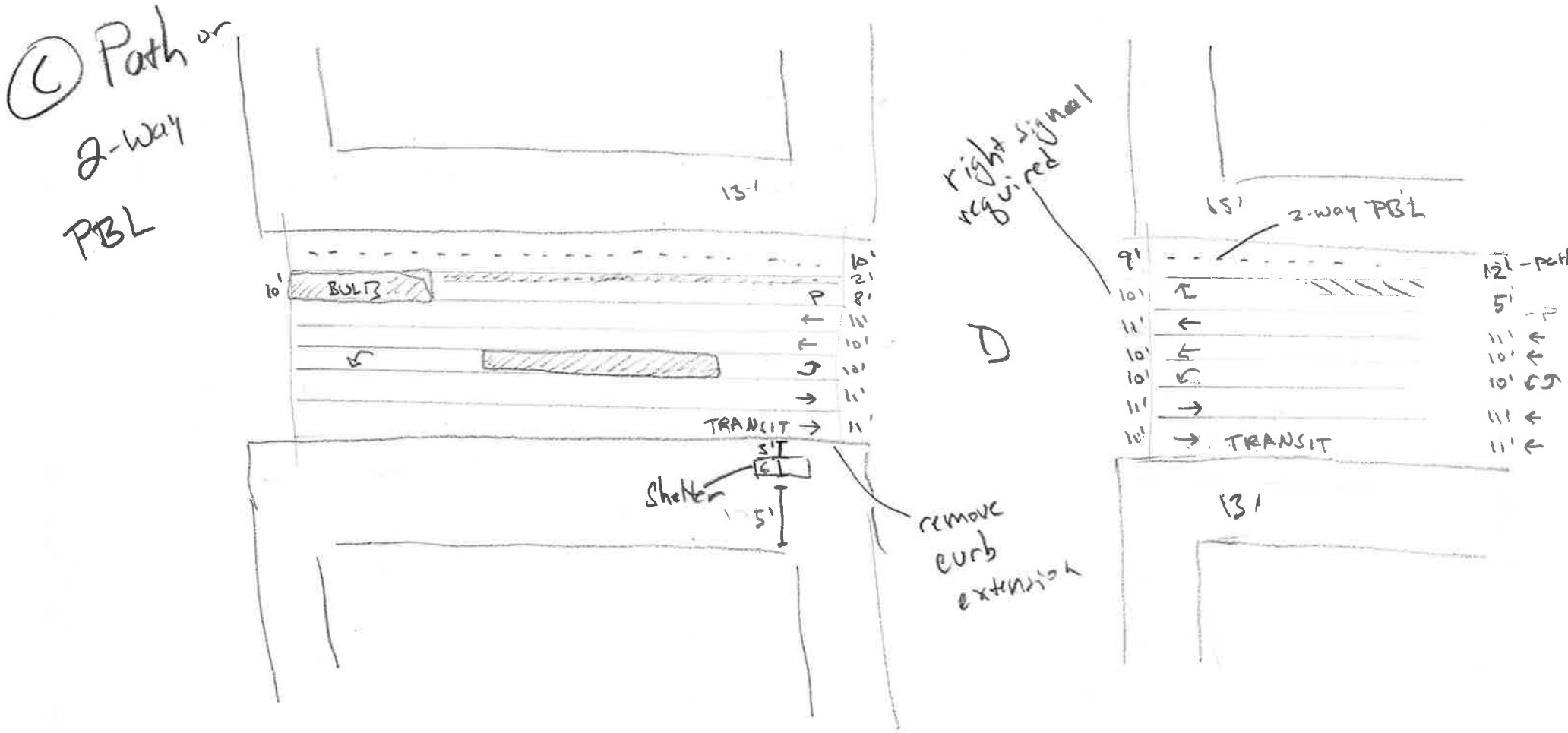
D



(B)

PBL - Sidewalk level past bus bulb




(C) Path or
2-way
PBL
13'
10'
BULB
10'
21'
8'
11'
10'
10'
11'
11'
TRANSIT
5'
6'
Shelter
5'
remove
curb
extension
right signal
required
15'
2-way PBL
9'
10'
11'
10'
10'
11'
11'
TRANSIT
12' - path
5'
11'
10'
10'
11'
11'
13'

Appendix H Transportation Commission Letter and Public Works Department Response

City of Tacoma
Transportation Commission

September 26, 2017

Mark D'Andrea
City of Tacoma
747 Market Street
Tacoma, WA 98402

Subject: Puyallup Avenue Corridor Conceptual Design

Thank you for the opportunity for the Transportation Commission (TC), with consultation from the Bicycle and Pedestrian Technical Advisory Group, and Sustainable Tacoma Commission (STC) to offer influential comments and staff guidance on the Puyallup Avenue Corridor Conceptual Design. This project is important because Puyallup Avenue serves as a gateway to our downtown core as well as the right of way for thousands of individuals coming and going from the Tacoma Dome Station (TDS) which is one of the largest multimodal hubs in the entire state of Washington. While this project on its face appears to be strictly a transportation project, it is truly a holistic planning effort which includes land use elements, open space and placemaking. These comments serve to not just influence the City of Tacoma's efforts on Transportation but compliments the plans that the City has fostered over the years including the South Downtown Subarea Plan (SDSP) and the Transportation Master Plan (TMP).

Overall Planning Approach

On Page 58 of the TMP the City identifies the modes of transportation in the following manner; Pedestrian, Bicycle, Transit, Freight and SOV. The TMP also identified the Puyallup Avenue Corridor as a "Conflicted Corridor" that needed further study. It is the opinion of the TC that this conceptual plan needs to be more holistic in its review and truly study and understand the needs of the various transportation modes not just today but in the future. Do note this also means taking into account the SDSP future vision for the corridor which includes density both in business and housing.

The plan lacks vision as it relates to the parallel street of East 25th, particularly between E. G Street and Portland Avenue. This is a severely underutilized street in this corridor and could serve to add capacity for all modes including emphasizing egress for freight to the industrial parts of the area between Puyallup Avenue and East 25th Street. In addition, as transit services increase as they will according to Pierce Transit and Sound Transit's long range plans, E 25th Street could serve as a future transit/freight only corridor.

Recommendation TC1: Let this plan be the first of many drafting phases, including funding, with the City prioritizing a holistic review and design of the corridor to include East 25th Street.

On and Off Street Parking

The Dome District has some of the highest concentrations of off street parking in the City including Pierce Transit's garage at TDS with over 2,000 parking stalls. With free parking and paid parking available, it is the opinion of the TC that this plan should de-emphasize on street parking between Pacific Avenue and Portland Avenue. By doing this, the plan then can allow for a greater use of Right of Way (ROW).

Recommendation TC2: Remove on-street parking between Pacific and Portland Avenues to allow for safer and more effective and efficient pedestrian, bicycle and transit LOS, and relocate, when applicable, to side streets.

Pedestrian & Bicycle

The TMP calls for a bicycle lane to be implemented on the entire corridor. All alternatives should include this facility and should be done so as to add elements for the safety of both the vehicular traffic and bicyclists when entering and using the corridor.

In the alternatives provided, the "Neighborhood" sections of the corridor lack proper trade off of modes. In order to continue to provide the Level of Service (LOS) needed for pedestrians, bicyclists and transit, parking and turn lanes need to give way for more right of way to emphasize these modes. While the TMP only calls for a bicycle lane, the opportunity of such a wide right of way could allow a cycle track or bike boulevard to be implemented between Pacific and Portland Avenues.

Recommendation TC3: A bidirectional protected bicycle facility along the entire length of Puyallup Avenue (Alternative 1)

Recommendation TC4: Sidewalks and street plantings along the entire length of Puyallup Avenue and safer pedestrian crossings (Included in all alternatives)

Transit

The importance of growing transit ridership as a greater share of mobility is key to reducing tailpipe emissions from transportation that are a majority of the City's adverse contribution to climate change. Further, high capacity feeder transit services and protected bicycle facilities will be necessary to provide access to regional light rail at Tacoma Dome Station in 2030. Additional single-use parking structures are not supported by the South Downtown Subarea Plan and EIS. We support the vision of South Downtown as a transit-oriented area with non-motorized access.

The point of this exercise is to plan for the future through 2040. Staff indicated that transit currently accounts for 3-4% of the 10,000 vehicles that travel on Puyallup Avenue per day, but did not translate those figures into the overall proportion of people moving along the corridor. 3,300 passengers per day board Sound Transit express bus services from Tacoma Dome Station, 500 per day from Pierce Transit board at Tacoma Dome. However, more passengers are using transit service on Puyallup Avenue as a

thoroughfare between Tacoma Dome Station and Downtown Tacoma and are not counted. Clearly transit vehicles are serving disproportionately more people per day than their vehicle counts are showing.

Recommendation TC5: An east and westbound transit lane along the entire length of the Puyallup Avenue corridor between Pacific Avenue and Portland Avenue. (Alternative 1 + new element)

Freight

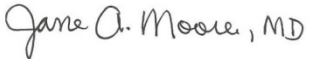
The 2015 Transportation Master Plan element of the Comprehensive Plan identified Puyallup Ave., between E. D St. and Portland Ave., as a Primary Street within Tacoma's Freight Priority Network, affirming its importance to the freight system of the City. East of E. G St., land use along the corridor is predominantly industrial. Both E. D St. and Portland Ave. serve as major access and egress routes to a part of the Tide Flats. With the corridor needing to serve multiple modes the TC feels it is important to continue to provide critical access to freight.

Recommendation TC6: Eastbound Transit/HOV lane contained in Alternative 1; E. D St as a "Bus and Freight" lane.

Overall this plan starts off on the right foot however the planning and design process is far from over. The Transportation Commission and Sustainable Tacoma Commission would like to see staff go back to the drawing table and develop an additional "Hybrid" alternative that incorporates the important and critical recommendations outlined in this letter. The Transportation Commission expects to be part of the conversation in developing the final design.

Sincerely,

Justin D. Leighton
Co-Chair
Transportation Commission



Dr. Jane Moore
Co-Chair
Transportation Commission

Alexandra Brewer
Chair
Sustainable Tacoma Commission

cc:
Mayor Marilyn Strickland
Tacoma City Councilmembers
Tacoma City Manager
Tacoma Public Works Director
Chelsea Levy, Sound Transit
Peter Stackpole, Pierce Transit
Bicycle & Pedestrian Technical Advisory Group

City of Tacoma
Public Works Department

November 7, 2017

City of Tacoma Transportation Commission

Subject: Puyallup Avenue Corridor Conceptual Design Comments, 9/26/17

Thank you for providing comments to our October 16, 2017, presentation on the Puyallup Avenue Conceptual Design project. As we move into this next phase, I wanted to provide a brief response to the Commission's recommendations to assure you we will be carrying these recommendations forward.

Recommendation TC1: Let this plan be the first of many drafting phases, including funding, with the City prioritizing a holistic review and design of the corridor to include East 25th Street.

Sound Transit has reported that "various alternatives for alignment and station siting will be developed and assessed over the next 16-18 months" for their light rail project. Pierce Transit's High Capacity Transit Study will identify its preferred option in 2018. Once the outcome of these studies are known, the use of Puyallup Avenue and E. 25th Street will be further reviewed with respect to optimizing travel for all modes.

Recommendation TC2: Remove on-street parking between Pacific and Portland Avenues to allow for safer and more effective and efficient pedestrian, bicycle and transit LOS, and relocate, when applicable, to side streets.

Removal and/or a reduction of on-street parking was a consistent comment during our public outreach. An evaluation of existing parking conditions will be reviewed, in conjunction with the Dome Business District and the South Downtown Subarea Plan, as part of the next phase of the project.

Recommendation TC3: A bidirectional protected bicycle facility along the entire length of Puyallup Avenue (Alternative 1)

Although more positive comments were received from our outreach for separated bike facilities, a two-way bicycle path on the north side of Puyallup Avenue will be reviewed as part of the next phase of the project.

Recommendation TC4: Sidewalks and street plantings along the entire length of Puyallup Avenue and safer pedestrian crossings (Included in all alternatives)

Sidewalks and street plantings are planned to run along the entire length of Puyallup Avenue on both sides of the street. Improving the pedestrian crossing experience/safety was identified as a high priority by stakeholders and the public during our recent outreach. Crossing improvements will be developed during the next phase of the project.

Recommendation TC5: An east and westbound transit lane along the entire length of the Puyallup Avenue corridor between Pacific Avenue and Portland Avenue. (Alternative 1 + new element)

The current project culminated in the development of an interim hybrid alternative based on feedback received through the outreach process. Elements of this interim hybrid alternative were presented to the Infrastructure, Planning and Sustainability Committee on October 25, 2017, and will be presented further in the project's final technical memo. This interim hybrid alternative does contain an eastbound transit lane from Portland Avenue to Pacific Avenue (as shown in Alternative 1). The transit agencies have requested a westbound transit lane on E. G St./E. 26th St. to Pacific Avenue. Although a westbound transit lane has not been included in the interim hybrid alternative along Puyallup Avenue, the final layout of the corridor will be developed in the next phase of the project in conjunction with the outcome of Pierce Transit's High Capacity Transit Study and Sound Transit's light rail alignment. At that time, the utility of a westbound transit lane along Puyallup Avenue will be reviewed with key stakeholders, such as the Transportation Commission and transit agencies.

Recommendation TC6: Eastbound Transit/HOV lane contained in Alternative 1; E. D St as a "Bus and Freight" lane.

An eastbound transit lane has been included in the interim hybrid alternative as described above in response to Recommendation TC5. This hybrid alternative will be carried into the next phase of the project for further development. The management of the transit lane regarding HOV use/hours of operation/freight use/etc. will be developed and reviewed with key stakeholders during the next phase of the project.

As discussed, an interim hybrid alternative has been developed based on the feedback received from our stakeholders, our Technical Advisory Committee, and via our public outreach process. This hybrid alternative is similar to Alternative 1 (with the exception of separated bike facilities in place of the two-way bike path) both east and west of the general transit area. In the vicinity of the transit area, however, the corridor is more similar to Alternative 2 with two travel lanes in each direction (one of which being an eastbound transit lane, and the addition of a center turn lane) to support the higher traffic volume associated with this area of the corridor. This interim hybrid alternative will be will be further developed and reviewed with key stakeholders during the next phase of the project.

Thank you for your recommendations on this project.

Sincerely,

Mark R. D'Andrea, P.E.
Project Manager

cc: Elizabeth A. Pauli, City Manager
Mayor Marilyn Strickland
Tacoma City Council Members
Kurtis D. Kingsolver, P.E., Public Works Director/City Engineer
Chelsea Levy, Sound Transit
Peter Stackpole, Pierce Transit
Bicycle & Pedestrian Technical Advisory Group

Appendix I Pierce Transit Letter

From: Peter Stackpole [mailto:pstackpole@piercetransit.org]
Sent: Thursday, August 17, 2017 8:57 AM
To: Justin D. Leighton
Cc: Kammerzell, Jennifer; Diekmann, Joshua; Jane Moore
Subject: RE: Transit Needs on Puyallup Ave.

Justin, et al:

Ideally, Pierce Transit would like to see the inclusion of an eastbound transit lane along Puyallup Avenue from Pacific Avenue to Portland Avenue, a westbound transit lane along 26th Street and G Street connecting Pacific Avenue and Puyallup Avenue, transit signal priority treatments, and queue jumps. Back in 2014 when the City sought support for the Puyallup Avenue Multimodal Corridor Project grant, Pierce Transit and Sound Transit requested these transit supportive elements be included as part of the project.

The lanes would be utilized by Pierce Transit, Sound Transit and Intercity Transit. I've attached the number of transit trips operating in the corridor. Additionally, the attached spreadsheet illustrates the potential delay savings by incorporating these transit supportive elements.

Please let me know if you have any questions.

Best,
Peter

Peter Stackpole, Service Planning Assistant Manager | T: 253.581.8131
3701 96th St. SW, Lakewood, WA 98499 | piercetransit.org

With more frequent service, more evening service, more direct service…
There's more to smile about!

From: Justin D. Leighton [mailto:justin.leighton17@gmail.com]
Sent: Wednesday, August 16, 2017 7:47 PM
To: Peter Stackpole
Cc: Kammerzell, Jennifer; Diekmann, Joshua; Jane Moore
Subject: Transit Needs on Puyallup Ave.

Good evening Peter,

I hope this email finds you well.

This evening the Transportation Commission heard a presentation on the Puyallup Avenue Corridor study and the 3 alternatives that are out there.

Several weeks ago I requested staff to specifically get in writing from PT what is wanted from the transit's in that corridor in terms of transit supportive elements. Specifically what does PT, ST and IT need when it relates to the re-design?

Our Co-Chair Jane Moore and I will be charged with drafting a comment letter on behalf of the commission on what we would like to see. Your direct input to us is what I seek and would be helpful in formulating our comments.

Could you please send me - reply all - an email on what you would like to see happen and any additional information.

It would also be great to know how any bus trips between Pacific and Portland and many avg daily boardings.

Thank you Peter

Justin D. Leighton
fighting for a progressive future
www.facebook.com/leighton253
253-677-9448

Puyallup Ave Transit Treatment Benefit Analysis

3-Lane Section				Transit Supportive Treatments - Alternative 1				Transit Supportive Treatments - Alternative 2				Delay Saving		% Increase	
Eastbound: 3-Lane Puyallup Ave				***Eastbound: BAT Lane on Puyallup Ave + Q-Jump***				***Eastbound: BAT Lane on Puyallup Ave + Q-Jump + TSP***				Alt 1	Alt 2	Alt 1	Alt 2
Intersection	Movement	LOS	Delay (sec)	Intersection	Movement	LOS	Delay (sec)	Intersection	Movement	LOS	Delay (sec)				
Pacific Ave/24th St	SBL	C	25.4	Pacific Ave/24th St	SBL	C	25.4	Pacific Ave/24th St	SBL	C	21.6	0.0	3.8		
Puyallup Ave/A St	EBT	A	2.2	Puyallup Ave/A St	EBT	A	1.4	Puyallup Ave/A St	EBT	A	1.4	0.8	0.8		
Puyallup Ave/D St	EBT	E	70.0	Puyallup Ave/D St	EBT	B	10.4	Puyallup Ave/D St	EBT	B	10.4	59.6	59.6		
Puyallup Ave/E St	EBT	B	14.1	Puyallup Ave/E St	EBT	A	9.6	Puyallup Ave/E St	EBT	A	9.6	4.5	4.5		
Puyallup Ave/F St	EBT	A	1.8	Puyallup Ave/F St	EBT	A	1.2	Puyallup Ave/F St	EBT	A	1.2	0.6	0.6		
Puyallup Ave/G St	EBT	E	70.0	Puyallup Ave/G St	EBT	A	3.0	Puyallup Ave/G St	EBT	A	3.0	67.0	67.0		
3 Pull-Out Stops	EBT	-	45.0	3 In-Lane Stops	EBT	-	0.0	3 In-Lane Stops	EBT	-	0.0	45.0	45.0		
Puyallup Ave/Portland Ave	EBT	D	44.0	Puyallup Ave/Portland Ave	EBT	D	44.0	Puyallup Ave/Portland Ave	EBT	D	37.4	0.0	6.6		
		Total Delay	***273***			**Total Delay**	***95***			**Total Delay**	***85***	***178***	***188***	***287%***	***322%***
Westbound: 3-Lane Puyallup Ave				***Westbound: BAT Lane on 26th St***				***Westbound: BAT Lane on 26th St + TSP***				Delay Saving		% Increase	
Intersection	Movement	LOS	Delay (sec)	Intersection	Movement	LOS	Delay (sec)	Intersection	Movement	LOS	Delay (sec)	Alt 1	Alt 2	Alt 1	Alt 2
Puyallup Ave/Portland Ave	WBT	C	22.0	Puyallup Ave/Portland Ave	WBT	C	22.0	Puyallup Ave/Portland Ave	WBT	C	18.7				
3 Pull-Out Stops	WBT	-	45.0	3 Pull-Out Stops	WBT	-	45.0	3 Pull-Out Stops	WBT	-	45.0				
Puyallup Ave/G St	WBL	A	4.4	Puyallup Ave/G St	WBL	B	14.0	Puyallup Ave/G St	WBL	B	11.9				
Puyallup Ave/F St	NBL	C	32.5	26th St/25th St	SBT	A	6.0	26th St/25th St	SBT	A	6.0				
Puyallup Ave/E St	WBT	B	14.5	26th St/D St	WBT	A	8.7	26th St/D St	WBT	A	8.7				
Puyallup Ave/D St	WBT	D	49.2	26th St/A St	WBT	A	2.4	26th St/A St	WBT	A	2.4				
1 Pull-Out Stop	WBT	-	15.0	Pacific Ave/26th St	WBT	C	32.1	Pacific Ave/26th St	WBT	C	27.3				
Puyallup Ave/A St	WBT	A	3.8												
Pacific Ave/24th St	WBT	D	51.0												
		Total Delay	***237***			**Total Delay**	***130***			**Total Delay**	***120***	***107***	***117***	***182%***	***198%***

	Re-entry delay because of the eastbound queue blocking the bus to merge to the adjacent lane.
	Queue Jump
	TSP

Puyallup Ave Transit Treatment Benefit Summary

Delay Summary (sec)

	3-Lane Section	Transit Treatment - Alt 1	Transit Treatment - Alt 2
Eastbound	*273*	*95*	*85*
Westbound	*237*	*130*	*120*

Delay Summary (min:sec)

	3-Lane Section	Transit Treatment - Alt 1	Transit Treatment - Alt 2
Eastbound	*4:33*	*1:35*	*1:25*
Westbound	*3:57*	*2:10*	*2:00*

Delay Saving Summary (sec)

	3-Lane Section	Transit Treatment - Alt 1	Transit Treatment - Alt 2
Eastbound	-	*178*	*188*
Westbound	-	*107*	*117*

Delay Saving Summary (min:sec)

	3-Lane Section	Transit Treatment - Alt 1	Transit Treatment - Alt 2
Eastbound	-	*2:58*	*3:08*
Westbound	-	*1:47*	*1:57*

Delay Increase Summary (%)

	3-Lane Section	Transit Treatment - Alt 1	Transit Treatment - Alt 2
Eastbound	-	*287%*	*322%*
Westbound	-	*182%*	*198%*

Route	Corridor Travelled Near Tacoma Dome Station	Route Destinations	Average Weekday Trips	Span of Bus Service
PT 13	Puyallup Avenue	Proctor MUC, Stadium MUC, Downtown, Dock Street, Tacoma Dome Station (TDS)	26	6 am - 6:30 pm
PT 14	Puyallup Avenue	Proctor MUC, UPS, Stadium MUC, Downtown, Dock Street, TDS	26	6 am - 7 pm
PT 41	Puyallup Avenue	Downtown, UWT, Lower Portland MUC, Salishan, 72nd & Portland MUC	47	5 am - 8:30 pm
PT 42	D Street Puyallup Avenue	Downtown, UWT, McKinley MUC, 72nd & Portland MUC	28	6 am - 8 pm
PT 102	Puyallup Avenue	Gig Harbor, TDS, UWT, Downtown, Martin Luther King MUC	9	5 am - 7 pm
PT 400	Puyallup Avenue	South Hill, Downtown Puyallup, TDS, UWT, Downtown	49	5 am - 9 pm
PT 500	Puyallup Avenue	Downtown, UWT, TDS, Fife, Federal Way	33	6 am - 10: 30 pm
PT 501	Puyallup Avenue	Downtown, UWT, TDS, Fife Industrial Area, Milton, Edgewood, Federal Way	30	6 am - 9 pm
ST 590	Puyallup Avenue	TDS, Downtown Seattle	97	4 am - 8 pm
ST 594	Puyallup Avenue	Lakewood Station, Downtown Tacoma, TDS, Downtown Seattle	59	5 am - 1 am
ST 574	Puyallup Avenue	SeaTac Airport, TDS, Lakewood	78	2 am - 1 am
ST 586	Puyallup Avenue	TDS, University of Washington-Seattle	19	6 am - 7 pm
IT 603/605/612	Puyallup Avenue 26th Street	Downtown, TDS, Lakewood Station, Lacey, Downtown Olympia	31	5 am - 10 pm

Transit Provider

PT = Pierce Transit

ST = Sound Transit

IT = Intercity Transit (Olympia/Thurston County)

Figure A: Study Corridor and Proposed Transit Treatments