Grand Mound Transportation Action Plan

Prepared for:
Thurston Regional Planning Council

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Introduction

The Grand Mound Transportation Action Plan was developed to support Thurston County's update of the Grand Mound Subarea Plan. Thurston Regional Planning Council (TRPC), in partnership with Thurston County, is leading the effort to develop the transportation plan for the Grand Mound area.

The goal of this study is to establish a vision for the transportation system in the Grand Mound Urban Growth Area (UGA) and identify improvements needed to realize that vision. Based on community input, the project team identified six overarching goals for Grand Mound's future transportation network:

Safety. Transportation infrastructure in Grand Mound provides safe options for all users.

Efficiency. Roadways and intersections have adequate capacity and function to avoid unacceptable levels of congestion for autos and freight, even as the region grows.

Character Transportation infrastructure contributes to Grand Mound's identity as a distinctive place with rural character.

Multi-Modal Connections. Grand Mound's transportation system accommodates walking and biking, including connections to regional trails, transit, and commercial land uses.

Economic Diversity & Tourism. Transportation facilities support economic growth in Grand Mound, including residential, commercial, and industrial development; jobs, and tourism.

Supported. Transportation infrastructure in Grand Mound reflects community input.

The technical assessment for this study began with an evaluation of existing conditions within Grand Mound, including understanding how the transportation system functions for all users today. This evaluation included an operational assessment to identify roadways and intersections operating with unacceptable levels of delay, an inventory of the bicycle and pedestrian infrastructure to identify areas with missing facilities or connections, and a review of collision data to determine locations with a high number of crashes.

Population and employment forecasts indicate Grand Mound will continue to grow significantly over the next 20 years. Transportation improvements must anticipate and accommodate this growth. Using land use forecasts and the travel demand model provided by TRPC, the study team developed traffic forecasts

for 2040 and evaluated transportation system operations to identify locations where future improvements will be needed to meet the needs of all users in Grand Mound.

Once existing and future needs were evaluated, the project team identified eight improvements that will advance the goals of this study. An operational assessment completed for each of the improvements identifies project benefits to vehicles, bicyclists, and pedestrians. The project team also developed conceptual layouts and cost estimates for each project. **Table 1** includes a brief project description, the estimated cost, and the goals advanced by the identified improvements.

In addition to the eight improvements fully evaluated, other potential projects that advance the goals of this study are also discussed.

Findings from this study will be incorporated into the Grand Mound Subarea Plan, Thurston County Road Standards, and relevant development codes.

Table 1. Summary of Transportation Actions

Project	Cost					
C1. 196th Avenue SW & Sargent Road SW Intersection Improvements: Construction of a single-lane roundabout at the intersection and widening of sidewalks to accommodate bicyclists and pedestrians.	$5.5M	√	√	√	√	√
C3.196th Avenue SW & Elderberry Street SW Intersection Improvements: Construction of a single-lane roundabout at the intersection, including converting the current driveway to provide access to potential development and widening of sidewalks to accommodate bicyclists and pedestrians.	$4.5M	√	√		√	√
C4.US 12/Old Highway 99/Elderberry Street SW Intersection Improvements: Construction of pedestrian refuge islands for pedestrians crossing the east, west, and south legs of the intersection.	$230,000	√	√	√	√	
C7. Old Highway 99 Improvements: Construction of a shared-use path on the west side of Old Highway 99 and connection of sidewalks on the east side and consolidation of access along Old Highway 99.	$8.2M	√	√		√	√
C8. Sargent Road Improvements: Construction of shared-use path on the south side of Sargent Road to accommodate bicyclists and pedestrians, with widening to provide left-turn storage lanes and sidewalks on the north side of the road.	$2.9M	√	√		√	√
C10.Sargent Road SW /201st Avenue SW/ Old Highway 99 Intersection Improvements: Reconfigure Sargent Road to allow right-in/right-out access only at Old Highway 99 and construct a single lane roundabout at 201st Avenue SW.	$5.0M	√		√		√
C11.Old Highway 9 & Old Highway 99 Intersection Improvements: Construction of a traffic signal at the existing intersection.	$879,900	√		√	√	
C13. Power Line Trail: Construction of a multi-use trail following the current power lines alignment for bicyclists and pedestrians.	$3.0M	√	√		√	

Notes: "√" indicates that the project was found to advance the goal.

Existing Conditions

This chapter documents the facilities evaluated as part of this study and the findings from the existing conditions assessment. For a more detailed discussion of the data, assumptions, and methodologies used to complete this assessment, see **Appendix A** for the Existing Conditions Analysis.

Study Area

This study evaluated roadway segments and intersections within the Grand Mound UGA and unincorporated areas bordering the UGA within Thurston County.

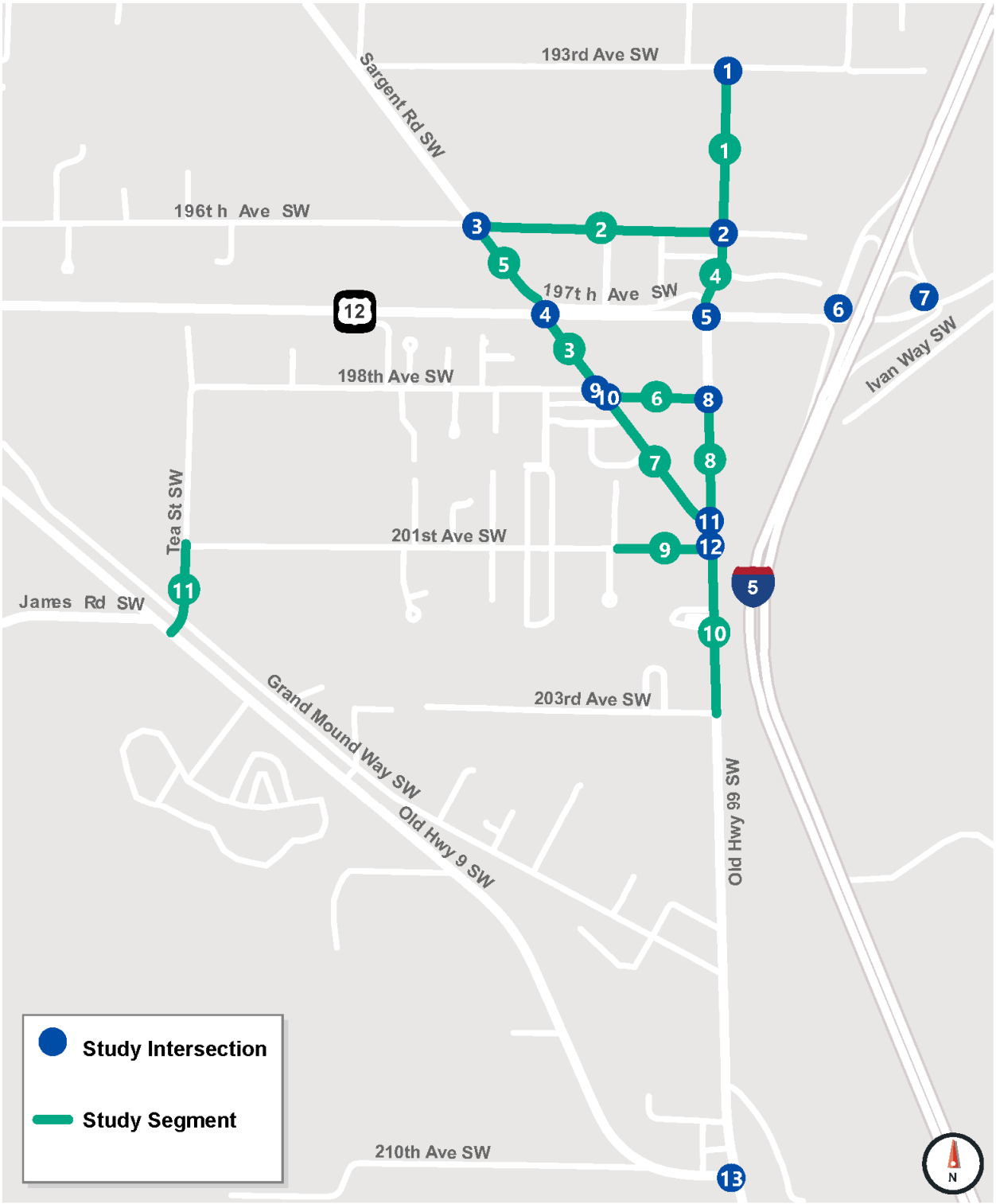
Roadway segments evaluated as part of this study are listed below and shown on **Figure 1**.

1. Elderberry Street SW between 196th Avenue SW and 193rd Avenue SW
2. 196th Avenue SW between Sargent Road SW and Elderberry Street SW
3. Sargent Road SW between US 12 and 196th Avenue SW
4. Elderberry Street SW between US 12 and 196th Avenue SW
5. Sargent Road SW between 198th Way SW and US 12
6. 198th Avenue SW between Sargent Road SW and Old Hwy 99
7. Sargent Roadd SW between Old Hwy 99 and 198th Way SW
8. Old Hwy 99 between 198th Avenue SW and Sargent Road
9. 201st Avenue SW between Tea Street SW and Old Highway 99
10. Old Hwy 99 between 201st Ave SW and Old Hwy 9

Intersections evaluated as part of this study are listed below and shown on **Figure 1.**

1. Elderberry Street SW and 193rd Avenue SW
2. Elderberry Street SW and 196th Avenue SW
3. Sargent Road SW and 196th Avenue SW
4. Sargent Road SW and US 12 (***intersection planned for construction in 2022***)
5. Old Highway99 and US 12
6. Southbound I-5 Ramp and US 12
7. Northbound I-5 Ramp and US 12
8. Old Highway 99 and 198th Avenue SW
9. Sargent Road SW and 198th Avenue SW (West)
10. Sargent Road SW and 198th Avenue SW (East)
11. Old Hwy 99 and Sargent Road SW
12. Old Hwy 99 and 201st Avenue SW
13. Old Hwy 99 and Old Highway 9

Figure 1. Project Study Area & Facilities



Findings

The existing conditions analysis considers the overall safety of the area's transportation system and conditions for driving, walking, and biking. Conditions for driving were measured based on where roadway segments and intersections met operational standards established by Thurston County. Conditions for walking and biking were assessed based on an inventory of existing pedestrian and bicycle facilities. The overall safety of the system was evaluated based on five years of crash data to determine locations with a high number of collisions and the contributing factors.

Study Intersections & Roadway Segments

The operations of roadway facilities are described with the term *level of service*. Level of Service (LOS) is a qualitative description of traffic flow based on factors including speed, travel time, delay, and freedom to maneuver. Six levels are defined from LOS A, the best operating conditions, to LOS F, the worst operating conditions. LOS E represents "at-capacity" operations. When traffic volumes exceed the capacity, stop-and-go conditions result, and operations are designated as LOS F. **Table 2** summarizes the relationship between the average control delay per vehicle and LOS.

Table 2. Level of Service Definitions

Level of Service	Description	Signalized Intersection Delay (seconds/vehicle)	Unsignalized Intersection Delay (seconds/vehicle)
A	Free-flowing Conditions	≤ 10	0-10
B	Stable Flow (slight delays)	>10-20	>10-15
C	Stable Flow (acceptable delays)	>20-35	>15-25
D	Approaching Unstable Flow (tolerable delay)	>35-55	>25-35
E	Unstable Flow (intolerable delay)	>55-80	>35-50
F	Forced Flow (congested and queues fail to clear)	>80	>50

All study intersections were evaluated to determine the average control delay experienced by drivers and corresponding LOS. For roadway segments the volume of vehicles utilizing the roadway was used to evaluate the volume-to-capacity ratio (V/C). Results for both the study intersections and roadway segments were compared to criteria found in the Thurston County Comprehensive Plan to determine if

the facilities currently operate acceptably. As shown in **Table 3** all study intersections and roadway segments are currently operating acceptably when compared to Thurston County's criteria.

Table 3. Existing Study Intersections & Roadways Operations

Location	Thurston County LOS Standard	Met/Not Met (PM Peak Hour LOS)[1]
Intersections		
193rd Ave & Elderberry St	D	Met (A)
196th Ave & Elderberry St	D	Met (A)
196th Ave & Sargent Rd	D	Met (B)
Sargent Rd & US-12	D	-
Old Hwy 99/Elderberry St & US-12	D	Met (D)
SB I-5 Ramp & US-12	D	Met (C)
NB I-5 Ramp & US-12	D	Met (C)
198th Ave & Old Hwy 99	D	Met (A)
198th Ave (West) & Sargent Rd	D	Met (A)
198th Ave (East) & Sargent Rd	D	Met (A)
Sargent Rd & Old Hwy 99	D	Met (B)
201st Ave & Old Hwy 99	D	Met (C)
Old Hwy 9 & Old Hwy 99	D	Met (B)
Roadway Segments		
Elderberry Street SW between 196th and 193rd Avenue SW	D	Met
196th Avenue SW between Sargent Rd SW and Elderberry Street SW	D	Met
Sargent Road SW between US 12 and 196th Avenue SW	D	Met

Table 3. Existing Study Intersections & Roadways Operations

Location	Thurston County LOS Standard	Met/Not Met (PM Peak Hour LOS)[1]
Elderberry Street SW between US 12 and 196th Street SW	D	Met
Sargent Road SW between 198th Way SW and US 12	D	Met
198th Avenue SW between Sargent Road SW and Old Hwy 99	D	Met
Sargent Road SW between Old Highway 99 and 198th Way SW	D	Met
Old Highway 99 between 198th Ave SW and Sargent Road	D	Met
201st Avenue SW between Tea Street and Old Highway 99	D	Met
Old Highway 99 between 201st Avenue SW and Old Highway 9	D	Met

Notes: [1] V/C Ratio less than or equal to 0.90 is considered acceptable for LOS D operations on study roadway segments.

Pedestrian and Bicycle Network

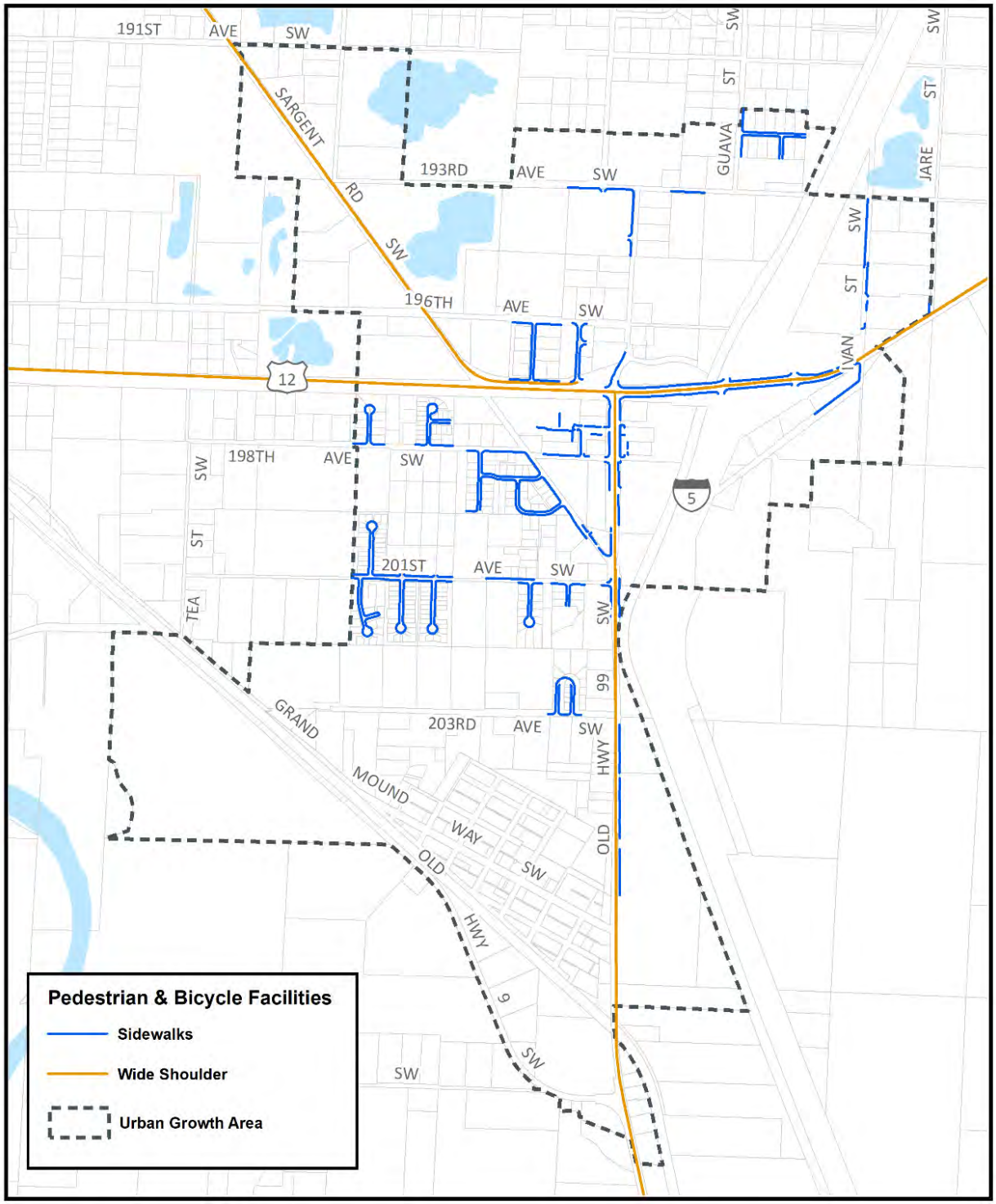
Pedestrian infrastructure exists on many of the residential local roads. However, on major connectors such as US 12 or Old Highway 99, the existing pedestrian and bicycle facilities were constructed as development occurred, resulting in spot improvements often lacking connectivity as described below.

- **US 12:** Bicycle and pedestrian facilities exist along US 12 from the intersection of US 12 with Old Highway 99 to just east of the Park and Ride on the east side of I-5. A wide shoulder that can accommodate bicyclists also exists from the intersection of US 12 with Pecan Street to the intersection of US 12 with Old Highway 99.
- **Elderberry Street/Old Highway 99:** A sidewalk exists on the west side of Elderberry Street just north of the intersection of Old Highway 99 and US 12. Bike lanes and sidewalks exist on the east and west side of Old Highway 99 from the intersection of Old Highway 99 and US 12 to just south of 198th Avenue SW. A wide shoulder and intermittent sidewalks continue until just south of 201st

Avenue SW. Additional sidewalk infrastructure also exists on Old Highway 99 adjacent to the Great Wolf Lodge.

A map of existing bicycle and pedestrian facilities is presented on **Figure 2**.

Figure 2. Existing Pedestrian & Bicycle Facilities



Safety

Based on safety data provided by WSDOT, between 2014 and 2018, 226 crashes occurred in the Grand Mound area. Nearly half of all crashes occurred at an intersection, the intersections with the highest number of crashes are summarized in **Table 4**. Collisions that occurred in the study area are mapped on **Figure 3**.

Table 4. Study Intersection Crash Summary

Study Intersection	Number of Crashes
US 12/Old Highway 99 SW	35
US 12/I-5 Ramps	17
Old Highway 99 SW/Old Highway 9 SW	7
Old Highway 99 SW/198th Street SW	6
Old Highway 9 SW/Tea Street SW	6
Old Highway 99 SW/Jare Street	4
Old Highway 9 SW/James Road SW	4
Elderberry St SW/196th Avenue SW	3
Sargent Rd SW/191st Avenue SW	2
Sargent Rd SW/196th Avenue SW	2
Sargent Road & Old Hwy 99	2

Of the 226 crashes, two fatal collisions and five crashes resulting in serious injuries occurred.

Crashes with Fatalities. Over the past five years, Grand Mound suffered two fatal crashes, both in 2017. The first occurred in May when a vehicle traveling at night on an unlit portion of Old Highway 9 SW hit a pedestrian, who was in the middle of the travel lane. The second crash occurred when a vehicle taking a left onto Old Highway 99 SW from Sargent Rd SW collided with a tractor-trailer headed southbound, killing the driver of the car. A third fatal crash in 2017 occurred along Old Highway 99 SW just south the study area, near the intersection with Oregon Trail Rd SW.

Crashes with Serious Injuries. Since 2014, five accidents in Grand Mound have caused suspected serious injuries.

- ***March 2016***: a head-on collision on Sargent Rd, when a pickup truck or van[1] crossed the center line in dry, daylight conditions. WSDOT identified driver distraction as a contributing factor.
- ***December 2016***: a pickup truck or van hit a pedestrian walking in their lane of traffic on Grand Mound Way SW, during dark, raining conditions.
- ***December 2016***: a pickup track or van headed north on Old Highway 99 SW hit a guardrail.
- ***April 2017***: a head-on collision on US 12, when a passenger car crossed the center line and hit a pickup truck or van in dark, but dry conditions. WSDOT identified driver distraction as a contributing factor.
- ***August 2018***: a motorcycle overturned on Elderberry St SW in dry, dark conditions. WSDOT noted excessive speed as a factor in the accident.

There were also three crashes involving pedestrians and three involving bicyclists.

Pedestrian-Involved Crashes. An overall lack of continuous sidewalks and pathways makes the Grand Mound study area challenging to navigate on foot, and travel in this area is typically done by auto. Over the past five years, there have been only three crashes that involved pedestrians, however all have resulted in injury to the pedestrian, including a fatality.

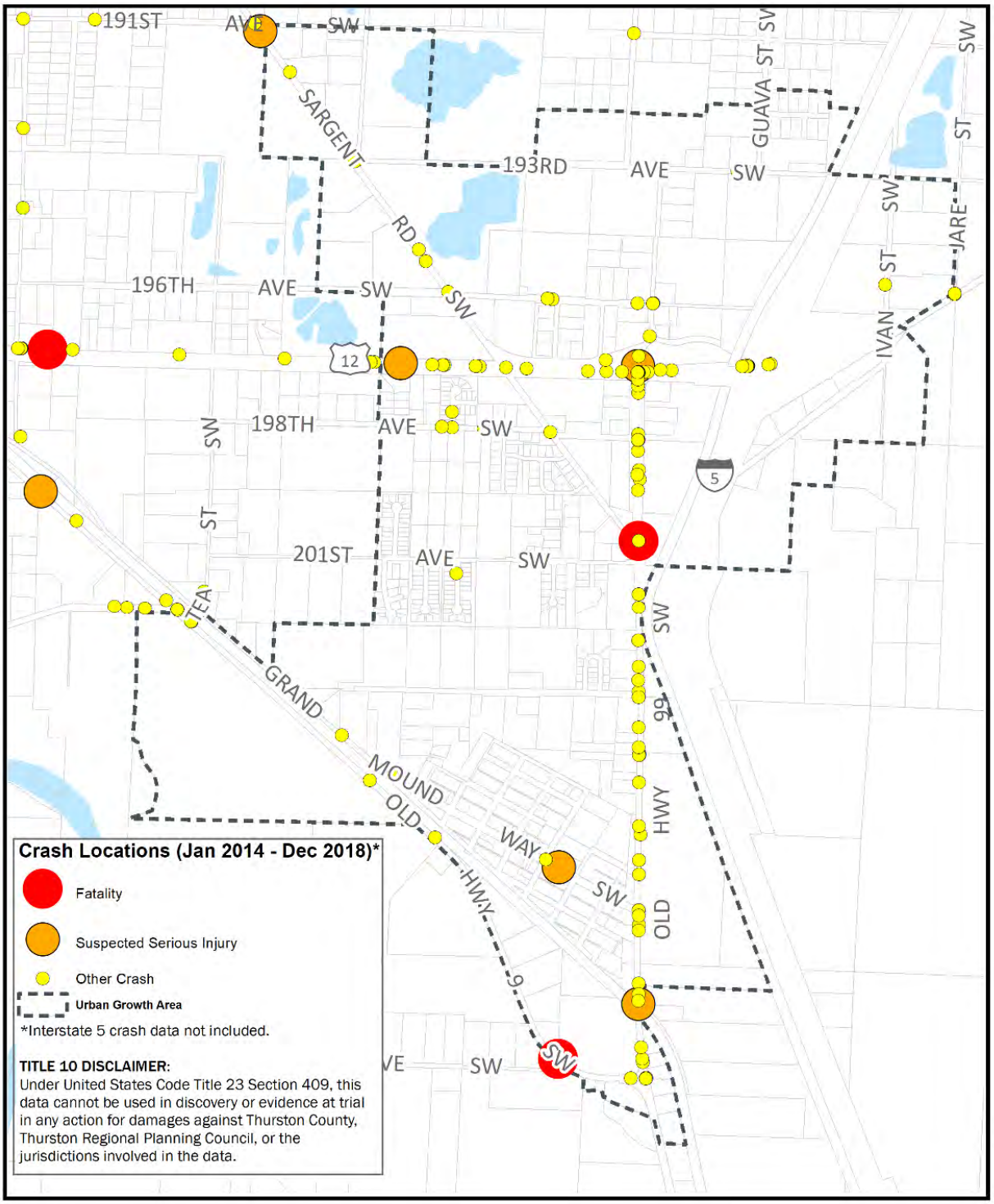
- ***December 2016***: a pickup truck or van hit and seriously injured a pedestrian walking in their lane of traffic on Grand Mound Way SW, during dark, raining conditions.
- ***May 2017***: a vehicle traveling at night on an unlit portion of Old Highway 9 SW hit and killed a pedestrian, who was in the middle of the travel lane.
- ***November 2018***: A pickup truck or van making a turn from Ivan Street SW into a driveway hit and injured a pedestrian, during dark, wet conditions in an area without streetlights.

Bicyclist-Involved Crashes. Similarly, the Grand Mound area can be challenging for cyclists, and there have been three accidents involving bicycles since 2014.

- ***March 2015***: A passenger car making a left turn from Old Highway 99 SW into a driveway hit a cyclist, leading to a minor injury.
- ***August 2016***: A pickup truck or van going straight on Sargent Rd SW near 196th Ave hit a cyclist in dry, daylight conditions, leading to a minor injury.
- ***May 2018***: A vehicle going straight on Old Highway 9 SW hit a cyclist in dry daylight conditions.

[1] WSDOT lumps small truck and vans into a single vehicle category called "Pickup Panel Truck or Vanette under 10000 lb."

Figure 3. Crash Locations



Future Conditions

This chapter describes baseline conditions for the year 2040 in the Grand Mound UGA. This scenario represents how the transportation network is expected to operate in 2040 given forecasted growth if the only funded improvements are implemented. Currently, the only funded improvement in the Grand Mound UGA is the construction of a roundabout that will create a new intersection on US 12 connecting Sargent Road across US 12. Findings from the operational analysis completed for this scenario were used to identify where additional transportation improvements will likely be needed by 2040 to maintain the County's level of service standards. For a more detailed discussion of future conditions, see **Appendix B**.

Study Intersections & Roadway Segments

Over the next 20 years, the volume of traffic in the Grand Mound area is expected to increase at a rate of 1.9 percent per year. While traffic in the study area is increasing overall, several locations will see a decrease in volume as a result of the new US 12/Sargent Road connection. Those locations include:

- Northbound left-turn at Elderberry Street/193rd Avenue SW
- Northbound and southbound through movements, northbound left-turn and eastbound right-turn at Elderberry Street/196th Avenue SW
- Southbound left-turn at Sargent Road/196th Avenue SW
- Northbound and southbound through movements, westbound right-turn, and southbound left-turn at Old Highway 99/US 12

By 2040, delay experienced by drivers at two study intersections, Old Highway 99/Elderberry Street & US 12 and Old Highway 99 & Old Highway 9, will exceed the acceptable levels of service, as shown in **Table 5** during the PM peak hour.

As growth occurs at intersections that are currently stop-controlled, it is important to understand if construction of a traffic signal should be considered. The Manual on Uniform Traffic Control Devices (MUTCD) has established eight criteria, referred to as warrants to evaluate the need for a traffic signal. These warrants consider vehicle volume using the intersection during different time periods, the number of pedestrians using crosswalks, and the crash rate at the intersection Two study intersections were found to meet the peak hour signal warrant by 2040, indicating strategies for intersection control should be considered as part of future improvements. The two intersections found to meet a peak hour signal warrant by 2040 were:

- 196th Avenue SW/Sargent Road
- Old Highway 9/Old Highway 99

Evaluation of the study roadway segments with growth expected to occur by 2040 indicates that all roadway segments will operate with adequate capacity as shown in **Table 5**.

Table 5. 2040 Study Intersection & Roadway Segment Operations

Location	Thurston County LOS Standard	Met/Not Met (PM Peak Hour LOS)[1]	
		Existing	2040
Intersections			
193rd Ave & Elderberry St	D	Met (A)	Met (B)
196th Ave & Elderberry St	D	Met (A)	Met (B)
196th Ave & Sargent Rd	D	Met (B)	Met (D)
Sargent Rd & US-12	D	-	Met (A)
Old Hwy 99/Elderberry St & US-12	D	Met (D)	**Not Met (F)**
SB I-5 Ramp & US-12	D	Met (C)	Met (D)
NB I-5 Ramp & US-12	D	Met (C)	Met (D)
198th Ave & Old Hwy 99	D	Met (A)	Met (A)
198th Ave (West) & Sargent Rd	D	Met (A)	Met (B)
198th Ave (East) & Sargent Rd	D	Met (A)	Met (B)
Sargent Rd & Old Hwy 99	D	Met (B)	Met (C)
201st Ave & Old Hwy 99	D	Met (C)	Met (D)
Old Hwy 9 & Old Hwy 99	D	Met (B)	**Not Met (F)**
Roadway Segments			
Elderberry Street SW between 196th and 193rd Avenue SW	D	Met	Met
196th Avenue SW between Sargent Rd SW and Elderberry Street SW	D	Met	Met
Sargent Road SW between US 12 and 196th Avenue SW	D	Met	Met
Elderberry Street SW between US 12 and 196th Street SW	D	Met	Met
Sargent Road SW between 198th Way SW and US 12	D	Met	Met

Location	Thurston County LOS Standard	Met/Not Met (PM Peak Hour LOS)[1]	
		Existing	2040
198th Avenue SW between Sargent Road SW and Old Hwy 99	D	Met	Met
Sargent Road SW between Old Highway 99 and 198th Way SW	D	Met	Met
Old Highway 99 between 198th Ave SW and Sargent Road	D	Met	Met
201st Avenue SW between Tea Street and Old Highway 99	D	Met	Met
Old Highway 99 between 201st Avenue SW and Old Highway 9	D	Met	Met

Notes: [1] V/C Ratio less than or equal to 0.90 is considered acceptable for LOS D operations on study roadway segments.

Project Selection

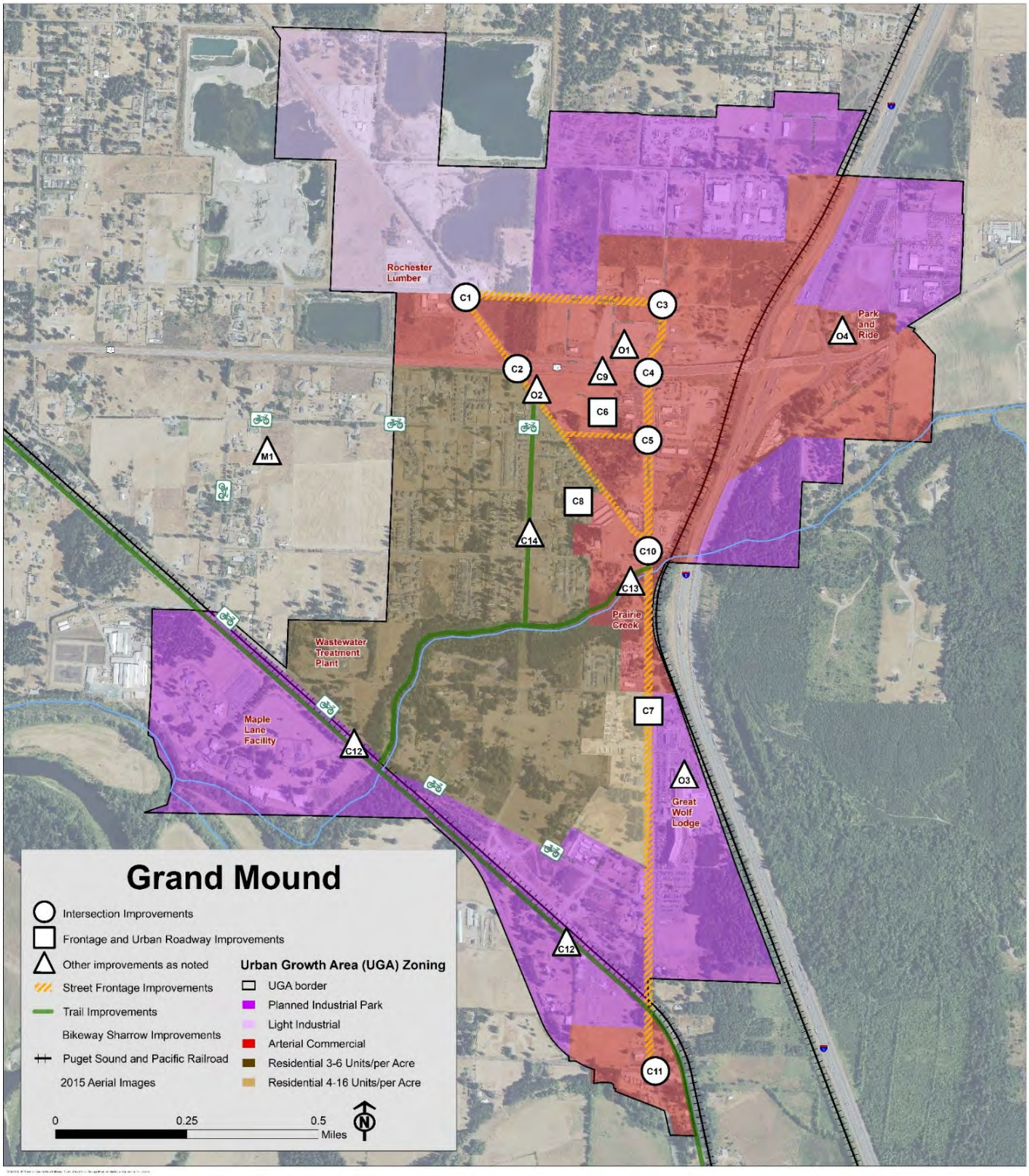
The project selection process for this study incorporated community input and considered how well projects advanced Grand Mound's transportation vision. Based on this, eight projects are recommended for implementation; four additional projects should be considered as part of future planning efforts.

Community Engagement

In an earlier phase of this study, TRPC and Thurston County administered a community survey in spring 2018 and hosted a community workshop in November 2018 to inform the Current Conditions Report for the Grand Mound area (November 2018). At the November workshop, residents identified locations where they experience transportation challenges and want to see improvements. The Project Team used this input to develop a list of Draft Transportation Actions for the Grand Mound UGA. The Draft Actions listed below and shown on **Figure 4** and served as the starting point for the list of projects evaluated as part of this study.

- C1: Intersection Improvements — 196th Avenue & Sargent Road
- C2: Intersection Improvements — US 12 & Sargent Road (Construction 2021)
- C3: Intersection Improvements — 196th Avenue & Elderberry Road
- C4: Intersection Improvements — US 12 & Elderberry Road/Old Highway 99
- C5: Intersection Improvements — 198th & Old Hwy 99 (Construction 2019)
- C6: Frontage Improvements — 198th Avenue
- C7: Urban Roadway Improvements — Old Hwy 99, from US 12 to Old Highway 9
- C8: Frontage Improvements — Sargent Road from 198th to Old Hwy 99
- C9: Pedestrian Crossing Improvements — US 12
- C10: Intersection Improvements — Sargent Road & Old Hwy 99 and Old Highway 99 & 201st
- C11: Intersection Improvements — Old Highway 9 and Old Highway 99
- C12: New Trail — Gate-Rochester-Grand Mound Trail
- C13: New Trail/Park —Old Highway 99 and Prairie Creek
- C14: New Trail — Along Powerlines, from 203rd to 198th
- O1: Stormwater Pond Improvements — US 12 & Elderberry/Old Highway 99
- O2: Gateway Signage — US 12 & Sargent Road
- O3: Transit — Bus Shelters & Stops in Grand Mound
- O4: Park-and-Ride Lot Improvements — Old Highway 99
- M1: Designated Bike Route — 198th Avenue, Tea Street & Grand Mound Way

Figure 4. Grand Mound UGA Draft Actions



The community survey asked participants to rank their level of concern regarding a wide range of transportation issues. Responses to the survey were used to inform the project goals established for this study.

Transportation Plan Goals

Input from project stakeholders and community members informed the development of six goals for the Grand Mound Transportation Plan.

	**Safety.** Transportation infrastructure in Grand Mound provides safe options for all users.
	**Efficiency.** Roadways and intersections have adequate capacity and function to avoid unacceptable levels of congestion for autos and freight, even as the region grows.
	**Character** Transportation infrastructure contributes to Grand Mound's identity as a distinctive place with rural character.
	**Multi-Modal Connections.** Grand Mound's transportation system accommodates walking and biking, including connections to regional trails, transit, and commercial land uses.
	**Economic Diversity & Tourism.** Transportation facilities support economic growth in Grand Mound, including residential, commercial, and industrial development; jobs, and tourism.
	**Supported.** Transportation infrastructure in Grand Mound reflects community input.

Project Evaluation

Selection of the top performing projects began with an evaluation matrix was used to identify how the 12 projects identified from the earlier phase aligned with the Transportation Plan goals The project evaluation matrix evaluated each of the projects using the metrics identified for Safety, Efficiency, Character, Multi-Modal Connections and Economic Diversity & Tourism. **Table 6** summarizes the project scores and rank for each of the evaluated projects. The complete project matrix and metrics used for evaluation can be found in **Appendix C**. The results of the project evaluation matrix were used to identify the eight highest performing projects based on the composite score to be evaluated in more detail, while the other projects could be considered by future studies.

Table 6. Project Evaluation Results

ID	Project Name	Total Project Cost	Safety	Efficiency	Character	Multi-Modal Connections	Economic Diversity & Tourism	Composite Score
C1	Intersection Improvements — 196th & Sargent	$5.15M	3	6	3	3	6	21
C3	Intersection Improvements — 196th & Elderberry	$4.51M	3	3	3	3	6	18
C4	Intersection Improvements — US 12 & Elderberry/Old Hwy 99	$230,000	3	6	6	3	3	21
C7	Urban Roadway Improvements — Old Hwy 99, from US 12 to Old Hwy 9	$8.24M	6	3	6	6	3	24
C8	Frontage Improvements — Sargent, from 198th to Old Hwy 99	$2.93M	0	3	6	6	6	21
C10	Intersection Improvements — Sargent & Old Hwy 99, and Old Hwy 99 & 201st	$3.5M	6	6	3	4	3	22
C11	Intersection Improvements — Old Hwy 9 and Old Hwy 99	$879,000	6	6	3	3	6	24
C13	New Trail — Along Power lines, from 203rd to 198th	$3M	0	0	6	6	6	18

Following the identification of the eight highest performing projects and project evaluation, additional input was collected from both project stakeholders in the form of one-on-one discussions and the broader community at an open house in March 2020. Stakeholder outreach included discussions with local business owners, the West Thurston Fire Authority, and the Chehalis Tribe to understand future development plans, infrastructure needs, and collect input on proposed projects.

At the March 2020 community workshop, participants were able to review the projects evaluated by this study and share any thoughts or concerns.

Overall, community members who attended the workshop confirmed the need for separating modes on Old Highway 99 and intersection improvements, specifically at the Old Highway 9/Old Highway 99

intersection. The projects were generally supported and only the proposed trail alignment received some questions regarding the need for that facility.

Input from stakeholders and community members was used to refine projects throughout, including selection of the preferred configuration at the Sargent Road/201st Avenue/Old Highway 99 based on impact to local business access and right-of-way.

Evaluated Projects

Each of the projects described below was evaluated to understand benefit to all modes, impact to the built and natural environment, and cost. A more detailed discussion of the travel demand forecasting and operational analysis for all projects can be found in **Appendix B**. Project layouts and cost estimates can be found in **Appendix D**.

The eight projects evaluated as part of this study, shown on **Figure 5**, are:

- **C1**. 196th Avenue SW & Sargent Road SW Intersection Improvements
- **C3**. 196th Avenue SW & Elderberry Street SW Intersection Improvements
- **C4**. US 12/Old Highway 99/Elderberry Street SW Intersection Improvements
- **C7**. Old Highway 99 Improvements
- **C8**. Sargent Road Improvements
- **C10**. Sargent Road SW /201st Avenue SW/ Old Highway 99 Intersection Improvements
- **C11**. Old Highway 9 & Old Highway 99 Intersection Improvements
- **C13**. Power Line Trail

Table 7 includes a summary of the evaluated projects, the goals advanced by each of the projects and the estimated cost of each project.

Table 7. Summary of Transportation Actions

Project	Cost					
C1. 196th Avenue SW & Sargent Road SW Intersection Improvements: Construction of a single-lane roundabout at the intersection and widening of sidewalks to accommodate bicyclists and pedestrians.	$5.5M	√	√	√	√	√
C3.196th Avenue SW & Elderberry Street SW Intersection Improvements: Construction of a single-lane roundabout at the intersection, including converting the current driveway to provide access to potential development and widening of sidewalks to accommodate bicyclists and pedestrians.	$4.5M	√	√		√	√
C4.US 12/Old Highway 99/Elderberry Street SW Intersection Improvements: Construction of pedestrian refuge islands for pedestrians crossing the east, west, and south legs of the intersection.	$230,000	√	√	√	√	
C7. Old Highway 99 Improvements: Construction of a shared-use path on the west side of Old Highway 99 and connection of sidewalks on the east side and consolidation of access along Old Highway 99.	$8.2M	√	√		√	√
C8. Sargent Road Improvements: Construction of shared-use path on the south side of Sargent Road to accommodate bicyclists and pedestrians, with widening to provide left-turn storage lanes and sidewalks on the north side of the road.	$2.9M	√	√		√	√
C10.Sargent Road SW /201st Avenue SW/ Old Highway 99 Intersection Improvements: Reconfigure Sargent Road to allow right-in/right-out access only at Old Highway 99 and construct a single lane roundabout at 201st Avenue SW.	$5.0M	√		√		√
C11.Old Highway 9 & Old Highway 99 Intersection Improvements: Construction of a traffic signal at the existing intersection.	$879,900	√		√	√	
C13. Power Line Trail: Construction of a multi-use trail following the current power lines alignment for bicyclists and pedestrians.	$3.0M	√	√		√	

Notes: "√" indicates that the project was found to advance the goal.

Figure 5. Evaluated Projects

C1. 196th Avenue SW & Sargent Road SW Intersection Improvements

This project involves constructing a single-lane roundabout at the intersection. Ten-foot wide sidewalks on all four legs of the roundabout will provide a safe and comfortable option for bicyclists and pedestrians to navigate the roundabout.

This project also includes a recommended cross-section for Sargent Road. The Thurston County Bike Map identifies Sargent Road as a route where bicyclists should use the shoulder. As shown on **Figure 7**, the recommended cross-section provides two travel lanes, sidewalks on both sides with a bioswale acting as a buffer, and paved shoulders for bicyclists.

Figure 6. 196th Avenue & Sargent Road Roundabout

The total estimated cost of this project is $5.15 million.

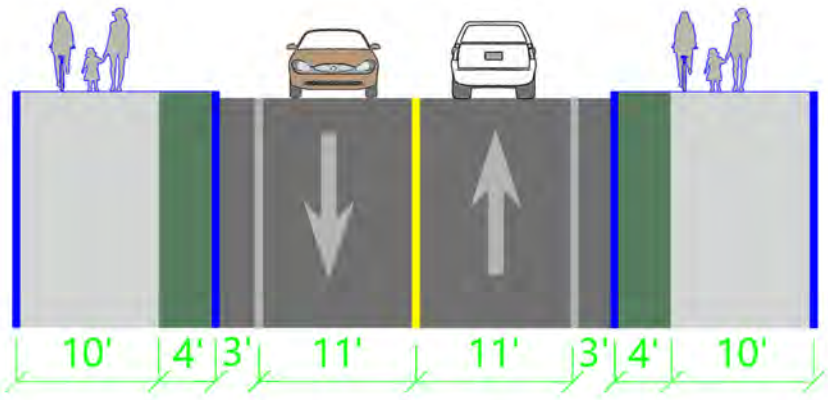


Figure 7. Recommended Sargent Road Cross-Section between US 12 and 196th Avenue

Benefits

This project advances all five metrics evaluated as part of the project selection process.

Safety

Between 2014 and 2018, only one crash occurred at this intersection. However, community members provided feedback at the November 2018 workshop that this intersection feels unsafe due to the traffic speeds on Sargent Road and the angle/skew of the east and west legs of the intersection.

Roundabout control will result in lower speeds as vehicles on Sargent Road enter the intersection and reduce the number of potential conflicts with vehicles turning onto Sargent Road. This configuration also

creates better alignment of the east and west legs without significant need for additional right-of-way acquisition.

Efficiency

With the planned connection of Sargent Road across US 12, traffic volume at this intersection is expected to increase significantly. Without improvements, this intersection is expected to operate at LOS D by 2040. Traffic is anticipated to increase to the point that the intersection will meet the warrant for a traffic signal.

Roundabout control at this intersection will improve the intersection's operations to LOS A in 2040 and minimize delay experienced by vehicles on 196th Avenue.

Character & Multimodal Connections

Today, bicyclists must use the unpaved shoulder on Sargent Road, and sidewalks do not exist near this intersection. These improvements will create consistent connections for all modes, while maintaining consistency with other plans for this area and Grand Mound's rural character. Roundabout control at this intersection will also maintain consistency with other planned and recommended roundabouts at US 12 and Sargent Road and 196th Avenue and Elderberry Street.

Economic Diversity & Tourism

The area along US 12 continues to see commercial growth, with more development north of US 12 anticipated. This intersection will serve as a connection for traffic from the west and from US 12 to development in this area. Improvements at this intersection will improve connections to the area for vehicles, bicyclists, and pedestrians, promoting economic growth in Grand Mound.

Additional Considerations

The roundabout and associated improvements will require right-of-way acquisition on the north, west, and east legs of the intersection. There will be no impact to existing buildings, but landscaped areas and parking areas will be impacted.

Signal control was also evaluated as a possible design solution for this intersection. However, while a traffic signal will operate efficiently, the intersection's proximity to the planned roundabout at US 12 and Sargent Road means a roundabout will result in the more efficient and safer configuration for the transportation system.

C3. 196th Avenue SW & Elderberry Street SW Intersection Improvements

This project involves constructing a single-lane roundabout at the intersection. The existing driveway that aligns with the intersection on the east side of Elderberry Street will be converted to a full leg and provide access to future development east of Elderberry Street. Sidewalks will be widened to 10 feet on all sides of the intersection to accommodate bicyclists.

This project will require the existing 197th Avenue SW access to Elderberry Street to be closed and consolidated with the access at 196th Avenue SW. The roundabout configuration will also require limiting access to development on the west side of Elderberry Street. Full access should be consolidated to a single driveway between US 12 and 196th Avenue; any additional driveways should be limited to right-in, right-out access only.

This project would maintain the existing three-lane cross-section to the south of 196th Avenue, as shown on **Figure 9**. To the north of 196th Avenue, the current two-lane cross-section would be maintained.

The estimated cost for this project is $4.51 million.

Figure 8. 196th Avenue & Elderberry Proposed Roundabout

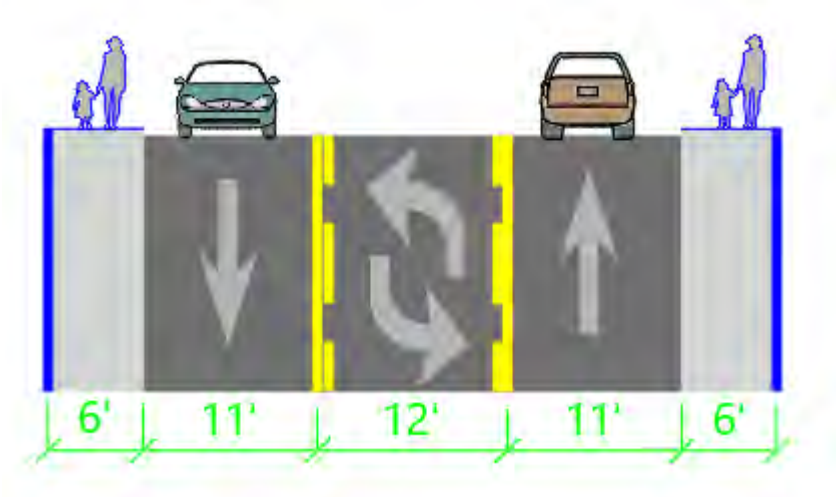


Figure 9. Proposed Elderberry Street Cross-Section

Benefits

This project advances all five of the metrics evaluated as part of the project selection process.

Safety

As traffic volumes increase on Elderberry Street, the opportunity for vehicles on 196th Avenue to safely enter the intersection will decrease. Exposure to conflicts for vehicles, bicyclists, and pedestrians will also increase. Implementing a roundabout configuration at this intersection will result in lower vehicle speeds and improve access for side-street traffic while providing marked crossings for bicyclists and pedestrians.

Efficiency

A roundabout control at this intersection is expected to operate with little delay for vehicles while accommodating increases in traffic volume as the area grows.

Character

These proposed improvements will create consistent connections for all modes and operate efficiently with other planned and recommended roundabouts at US 12 and Sargent Road and 196th Avenue and Sargent Road.

Multi-Modal Connections

This project will provide marked pedestrian crossings on all four legs, and sidewalks will be widened to 10 feet approaching the intersections. This will allow bicyclists to use the sidewalks to navigate the roundabout. Sidewalks will extend to the west on 196th Avenue and south on Elderberry Street providing continuous multi-modal connections to future development and destinations to the south and east of this intersection.

Economic Diversity & Tourism

Roundabout control will accommodate future growth while providing access to development east of Elderberry Street.

Additional Considerations

Right-of-way will need to be acquired on all four corners due to the footprint of the proposed roundabout. Acquisition of the needed right-of-way should occur with private development to the east and on the southwest corner.

The roundabout must also be designed to accommodate large trucks traveling north of US 12 on Elderberry Street.

C4. US 12/Old Highway 99/Elderberry Street SW Intersection Improvements

This project involves constructing pedestrian refuge islands on the east, west, and south legs of the intersection. Pedestrian islands will decrease crossing distances for pedestrians, resulting in decreased pedestrian exposure and more efficient signal operations.

Two new refuge islands on the south side of the intersection will shorten distances for pedestrians crossing the east, south, and west legs of the intersection. Pedestrian lead intervals are also included in the signal timing updates so that pedestrians crossing the right-turn lanes can do so before vehicles, limiting potential conflicts with vehicles.

The estimated cost for this project is $230,000.

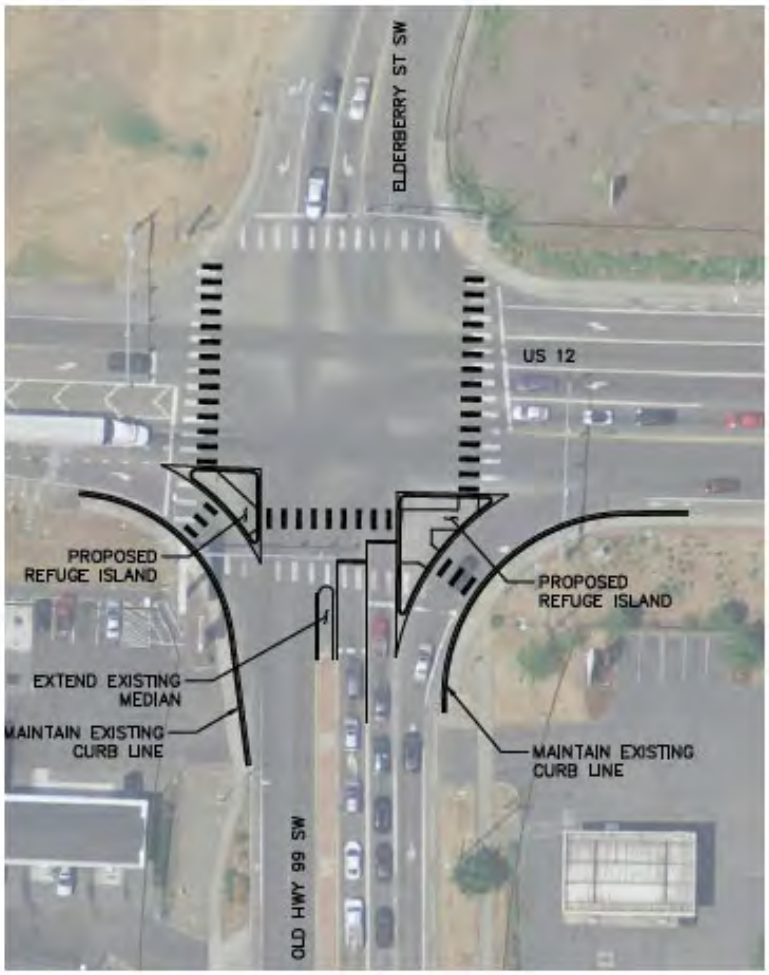


Figure 10. Proposed US 12 Pedestrian Islands

Benefits

This project improves four of the five metrics evaluated as part of the project selection process.

Safety

Pedestrian refuge-islands will shorten the distance pedestrians need to cross while being exposed to potentially high-speed vehicles on US 12. The refuge islands will also channelize right turns, which again create safer crossings for pedestrians.

Queueing, which can contribute to rear-end collisions, is also a concern on US 12. With improved signal timing, queueing at the intersection is reduced, resulting in increased safety for drivers.

Efficiency

Today, the length of the crosswalks and the time it takes pedestrians to cross US 12 controls how well the traffic signal operates. By shortening the crossing length, resulting in less time needed for pedestrians to cross US 12 more green time can be allocated to the busiest movements, reducing the delay experienced by drivers at the intersection.

Multi-Modal Connections

These improvements will improve existing pedestrian facilities and provide improved connections to key development areas in the Grand Mound UGA.

Economic Diversity & Tourism

Improvements at this intersection will reduce congestion experienced by drivers accessing development near the intersection and within the greater UGA area. This project also improves pedestrian connections to key destinations on both sides of US 12.

Additional Considerations

As development continues in this area and other improvements are constructed, opportunities to connect this intersection with Sargent Road via a multimodal path parallel to US 12 should be explored. Refuge-islands could be designed to accommodate bicyclists facilitating a connection across Old Highway 99 to existing bicycle lanes to the east of this intersection.

C7. Old Highway 99 Improvements

A major concern on Old Highway 99 today is the mix of users with little separation of modes. This project therefore focuses on accommodating all modes in dedicated spaces along Old Highway 99. The recommended cross-section for Old Highway 99 is shown on **Figure 12**.

First, consolidating business access along Old Highway 99 is recommended. At most, parcels should have one driveway with full access (allowing both left-and right-turns into and out of the driveway). If additional access points cannot be consolidated, they should be limited to right-in/right-out access only. With proposed and constructed roundabouts along the Old Highway 99 corridor, drivers that would typically be making a left-turn across traffic on Old Highway 99 from a driveway would be able make a right-turn then use the constructed and proposed roundabouts on Old Highway 99 to make a U-Turn. Opportunities to consolidate access between parcels should also be investigated. Consolidating driveway access along Old Highway 99 will decrease conflicts for bicyclists and pedestrians while also limiting locations where vehicles make uncontrolled left turns across oncoming traffic. Bicyclists will use a shared-use path on the west side of Old Highway 99.

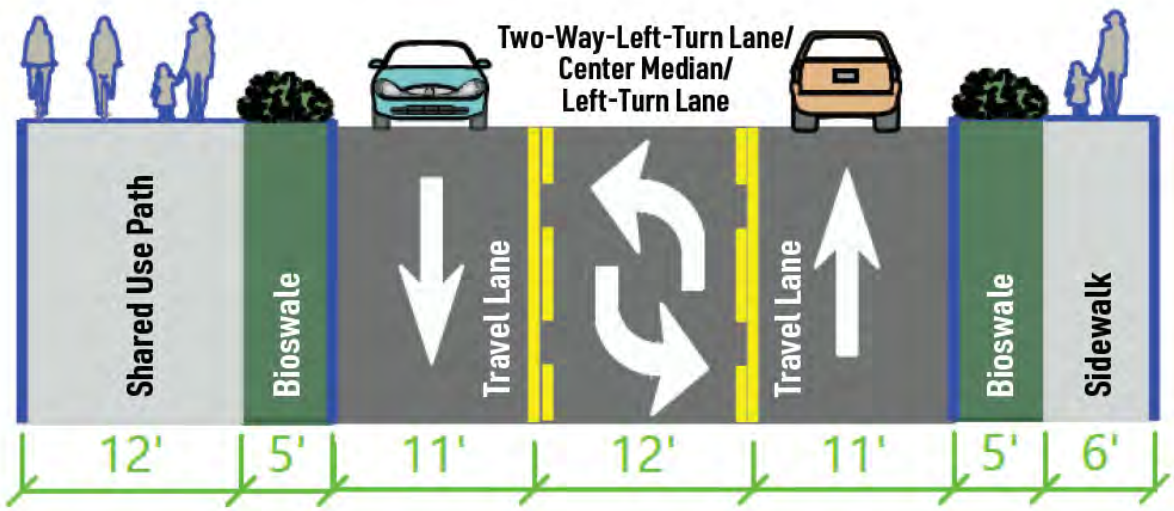
On the east side of Old Highway 99 existing sidewalks, which are intermittent along the corridor today, will be continuous between Old Highway 9 and 198th Avenue SW. The existing three-lane cross-section will be preserved. The center lane will transition between a two-way-left-turn-lane, left-turn pockets, and a median based on access requirements along the corridor.

Figure 11. Proposed Old Highway 99 Improvements

At least two mid-block crossings are recommended as part of these improvements. As development along the corridor occurs, specific locations should be identified to align with destinations for pedestrians crossing Old Highway 99.

This project is estimated to cost $8.24 million but can be implemented in phases as development occurs and funds are available.

Figure 12. Old Highway 99 Proposed Cross-Section



Benefits

This project improves four of the five metrics evaluated as part of the project selection process.

Safety

This project will provide pedestrian and bicycle facilities separated from vehicle traffic on both sides of Old Highway 99 and include two marked crossing locations. Separation will result in a better experience for all users while minimizing potential conflicts and exposure for the most vulnerable users.

The mix of passenger vehicles and heavy trucks on this corridor is also a concern. By limiting local access, the potential conflict between these modes will be reduced on Old Highway 99.

Character

These improvements will create a consistent cross-section for Old Highway 99, the key north-south route in the Grand Mound UGA for all modes.

Multi-Modal Connections

This project will provide new bicycle and pedestrian connections on the west side of Old Highway 99, while making the existing facilities on the east side continuous. This results in an accessible and direct north-south connection through the UGA for multimodal users that does not exist today.

Economic Diversity & Tourism

These improvements will facilitate connections to future development along Old Highway 99 while also providing connections for existing development. Connected sidewalks on the east side of Old Highway 99 and marked crosswalks along the corridor will allow pedestrians to safely walk between the Great Wolf Lodge and restaurants and commercial uses closer to US 12.

Additional Considerations

Planning documents for the Grand Mound area should be updated to include policy guidance that balances the needs of local businesses and property owners for sufficient access to the roadway system while creating a safe space for all users. An example of language that could be used in this update is provided below.

Policy: Provide access between private property and the public street system that is safe, convenient, and incorporates the following:

- *Limit and provide access to the street network in a manner consistent with the function and purpose of each roadway. Restrict number of driveways located along arterials. Coordinate with local businesses and property owners to consolidate access in commercial and residential areas.*
- *Require new development to consolidate and minimize access points along all state highways, principal arterials, and minor arterials.*
- *Design the street system so that the majority of direct residential access is provided via local streets.*

Incorporating such language into planning documents will help consolidate existing access points and provide direction as new development and street connections are considered in the future.

C8. Sargent Road Improvements

This project widens the existing Sargent Road cross-section to accommodate bicyclists and pedestrians in addition to vehicles. The proposed Sargent Road cross-section includes a two-lane roadway, widening at intersections to allow storage for left-turning vehicles. A shared use path on the south/west side of Sargent Road will ensure bicyclists of all ages and all abilities have a facility separated from vehicles. A sidewalk for pedestrians will be on the north/east side of Sargent Road.

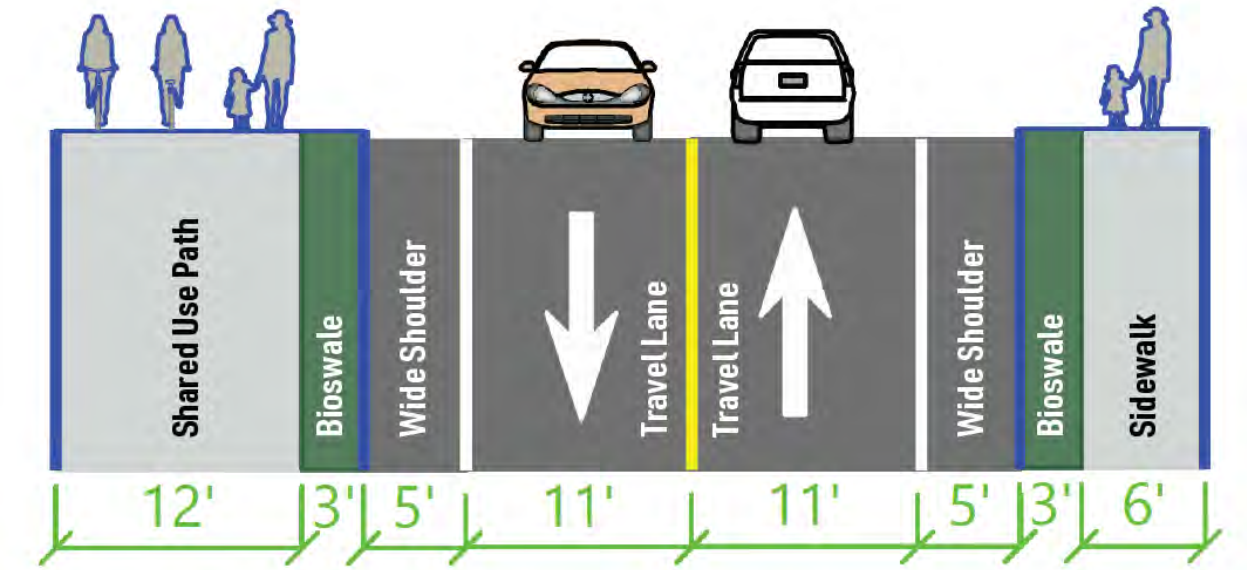
Consistent with the Thurston County Bike Plan, Sargent Road will also include wide shoulders for bicyclists who choose not to utilize the shared use path.

This project is estimated to cost $2.93 million, connecting the recent improvements installed on 198th Avenue Way and proposed improvements on Old Highway 99 as well as accommodate the additional traffic anticipated when the US12 and Sargent Road Roundabout is built.

The proposed Sargent Road Cross-Section is shown on **Figure 14**.

Figure 13. Proposed Sargent Road Improvements

Figure 14. Proposed Sargent Road Cross Section



Benefits

These improvements advance four of the five metrics evaluated as part of the project selection process.

Safety

The proposed cross-section and narrow lanes act as a traffic calming measure, keeping vehicle speeds low/reasonable? on Sargent Road, thereby improving safety for all users.

Character

These improvements are consistent with proposed improvements on Old Highway 99 and with proposed improvements for bicyclists on Sargent Road north of US 12.

Multi-Modal Connections

Existing facilities will be improved to provide options for users of all ages and abilities while offering separation for bicyclists and pedestrians from vehicles.

Economic Diversity & Tourism

These improvements create a more comfortable streetscape for all users that connects residential areas to commercial areas, identified as a desired improvement by community members throughout the engagement process.

Additional Considerations

One additional consideration for improvements on Sargent Road is the existing intersection at 198th Way. Several community members at the open house in November 2018 identified safety concerns for the existing intersection at Sargent Road and 198th Way, due to the skew between the east and west legs.

C10. Sargent Road SW/201st Avenue SW/Old Highway 99 Intersection Improvements

To address safety and operational concerns that result from the closely spaced Sargent Road and 201st Avenue intersections on Old Highway 99, this project reconfigures access at Sargent Road to only allow right turns and construct a single-lane roundabout at 201st Avenue. This will also accommodate the additional traffic anticipated to use Sargent Road when the US12 and Sargent Road Roundabout is built.

Drivers wanting to access Sargent Road from the south will need to travel north to 198th Way and either turn left or make a U-turn at the existing roundabout, head south, and turn right onto Sargent Road. Drivers attempting to access northbound Old Highway 99 from Sargent Road can either use 198th Way or the roundabout at 201st Avenue to make a U-turn before heading north.

This project is estimated to cost $3.5 million

Benefits

This project advances three of the five metrics evaluated as part of the project selection process.

Safety

This location has a history of crashes, including one fatal crash in YEAR. Limited access at the Sargent Road intersection will reduce potential conflict points for vehicles, bicyclists, and pedestrians crossing Sargent Road. Roundabouts have also been found to reduce serious injury crashes at intersections with stop-control or signal control due to lower speeds and one-way travel.

Figure 15. Old Highway 99 & 201st/Sargent Road Improvements

Efficiency

By 2040, the 201st Avenue intersection with Old Highway 99 is expected to operate at LOS D and drivers on 201st Avenue will experience more delays as fewer gaps in traffic on Old Highway 99 occur. The roundabout configuration will allow vehicles on 201st Avenue to safely enter the intersection without adding significant delay to the northbound and southbound traffic on Old Highway 99, improving operations to LOS A.

Character

Roundabout control at this location is consistent with the planned roundabout on US 12 and the existing roundabout at 198th Way. This configuration also accommodates the street and frontage improvements proposed for both Old Highway 99 and Sargent Road.

Additional Considerations

An alternate configuration was considered that combined the two intersections into one roundabout. Due to the significant amount right-of-way acquisition required, this alternative was screened from further consideration. While the proposed improvements will require some additional right-of-way acquisition on the west side of Old Highway 99, it is minimal compared to the alternative not recommended.

C11. Old Highway 9 & Old Highway 99 Intersection Improvements

This project constructs a traffic signal at the Old Highway 9 and Old Highway 99 intersection, including signalization of the driveway access on the east side of the intersection. The existing lane configuration will be maintained on all approaches.

This project is estimated to cost $879,900.

Benefits

This project advances three of the five metrics evaluated as part of the project selection process.

Safety

Over the five-year period analyzed, seven crashes occurred at this intersection including one with suspected serious injuries. Signal control can reduce the occurrence of certain crash types – such as right-angle crashes – while controlling vehicle movement through the intersection.

Traffic signal control also allows bicyclists and pedestrians to cross when potential vehicle conflicts are minimized.

Efficiency

Without improvements, this intersection is expected to operate at LOS F by 2040 due to high delay experienced by drivers on Old Highway 9. Traffic signal control at this intersection will reduce delay significantly resulting in LOS B.

Figure 16. Proposed Old Highway 99 & Old Highway 9 Improvements

Economic Diversity & Tourism

The Old Highway 9 and Old Highway 99 intersection provides access to the Maple Lane facility owned by the Washington State Department of Corrections, Rochester Primary School, and Grand Mound Elementary School. This intersection also provides access to industrial uses west of Old Highway 99 and is a key intersection in freight routes through the area.

Additional Considerations

Roundabout control was also evaluated at this intersection. While a roundabout would provide better intersection operations, significant right-of-way acquisition would be necessary. That, coupled with the impact to local business parking and access, resulted in the roundabout being screened from further consideration. A more in-depth design process is needed to fully evaluate R/W impacts.

C13. Power Line Trail

This project constructs a shared-use trail within an existing power lines easement. The trail creates a parallel route to Old Highway 99 for bicyclists and pedestrians from 198th Avenue SW to 203rd Avenue SW. The trail also serves as a connection to other trails and parks planned for the area such as the proposed Grand Mound-Rochester Trail.

Figure 17 and **Figure 18** show the proposed alignment and cross-section for the Power Line Trail.

This project is estimated to cost $3 million

Figure 17. Proposed Trail Alignment

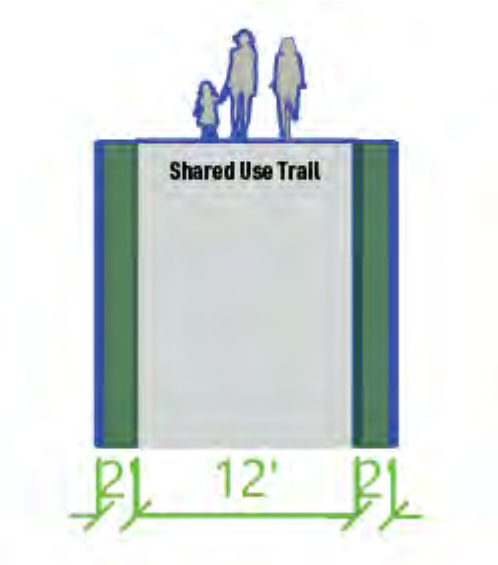


Figure 18. Shared Use Trail Cross-Section

Benefits

This project advances three of the five metrics evaluated as part of the project selection process.

Safety

The proposed shared use trail provides an alternative to using existing on-street options for bicyclists, including a parallel option to Old Highway 99, the corridor with the most crashes in the study area.

Multi-Modal Connections

The trail creates a direct north-south connection for bicyclists from Old Highway 9 to 198th Way SW. Today, bicyclists attempting to navigate between these locations must either use Old Highway 99 or utilize circuitous local streets that are narrow and do not provide dedicated space for bicyclists.

The trail also provides local connections to proposed trails in the area, creating better connections to recreational facilities throughout the Grand Mound area.

Economic Diversity & Tourism

As noted above, direct connections between residential areas to the south and existing commercial areas adjacent to US 12 are limited for multimodal users. This proposed trail provides a direct connection for all ages, all abilities users between residential areas south of 198th Way SW and commercial development concentrated along US 12.

Additional Considerations

This project requires coordination with PSE, the current owner of the right-of-away along the powerline's alignment. The project will also need to include wayfinding signage to direct bicyclists and pedestrians to and from the trail.

All crossings on local streets require additional treatment to create safe crossings for bicyclists and pedestrians using the trail. The following treatments are recommended for the crossings on two-lane, low-speed, residential streets:

Street Treatments

- Install the Combined Bicycle/Pedestrian Warning (W11-15) sign
- Paint a high-visibility crosswalk on the local road

Trail Improvements

- Install a No Motor Vehicles (R5-3) sign to discourage unauthorized access
- Paint a stop/yield line and pair with a Stop/Yield sign six feet from the crossing
- Install curb ramps to make the trail accessible for pedestrians of all abilities.

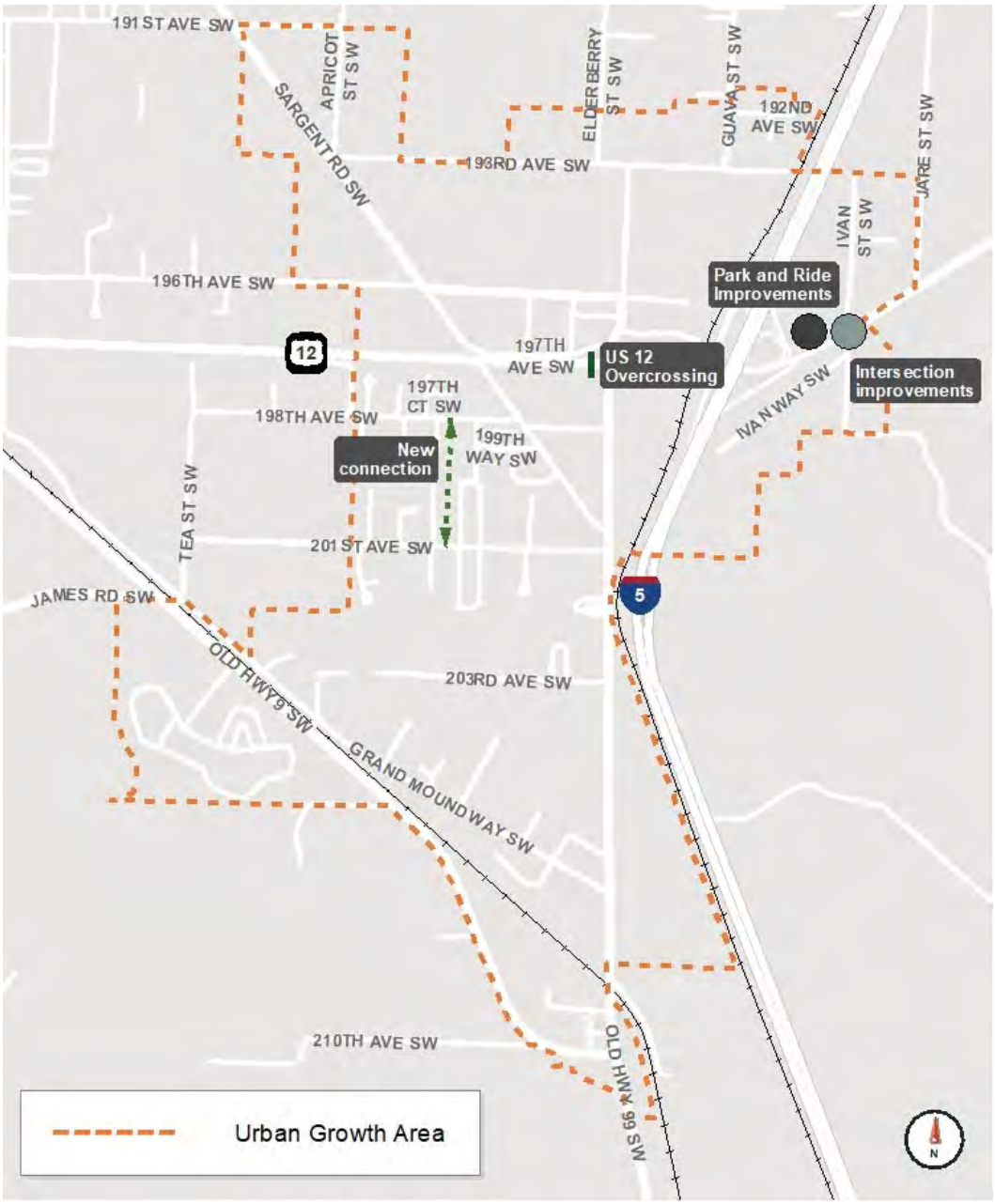
Example of W11-15 Sign
Source: MUTCD

Example of R5-3 Sign
Source: MUTCD

Projects for Future Consideration

Several additional projects identified on the Draft Actions list and throughout the development of this plan were identified as projects that advance the vision of the transportation system in the Grand Mound UGA. These projects, shown on **Figure 19** and described below should be considered in future studies and plans for the area.

Figure 19. Grand Mound Vision Projects



Ivan Way/Old Highway 99 Intersection Improvements

Over the course of this study, land to the east of I-5 emerged as a location of interest for potential higher intensity commercial and industrial development, both within the current UGA boundary and the area adjacent to the boundary. Should development occur in this area, the intersection of Ivan Way and Old Highway 99 will need to be analyzed to identify improvements to maintain safety and operations.

Park & Ride Improvements

As residential development and improvements to transit service in the Grand Mound area occur, improvements to the existing park and ride should be considered. This could include expanding the existing parking lot, providing improved amenities like bicycle parking and a shelter, and improved connections for bicyclists and pedestrians accessing the park and ride. The need for such improvements was identified by several participants at the community open house in November 2018.

Transit Feasibility Study

Community input gathered at the March 2020 Community Workshop indicated a desire by community members to see additional transit stops and more frequent transit service throughout the study area. As development occurs in the Grand Mound UGA creating more dense land uses, a transit feasibility study should be completed to determine potential ridership and identify the best locations for future transit stops.

New North-South Connection

Aside from Old Highway 99 and Sargent Road, Tea Street – which lies to the west of the Grand Mound UGA – is the only north-south connection between 198th Way and 201st Avenue. Consequently, circulation within the residential of Grand Mound area is limited with Old Highway 99 and Sargent Road acting as essential connectors between the north and south portions of the residential area. With construction of the roundabout at 201st Avenue, access to Sargent Road will be limited. Residents will need to use Tea Street or continue on Old Highway 99 to 198th Way to circulate within this area, the addition of a north-south route within the residential area will create a more direct connection for traffic.

Sargent Road/198th Way Intersection Improvements

With the planned Sargent Road connection to US 12 traffic using Sargent Road will increase in the future. While this intersection is expected to continue to operate acceptably in the future, the skew of the east and west legs of 198th Way create a safety concern for all modes. While the proposed Sargent Road cross-section could be extended to US 12, future analysis should be completed to evaluate options for realigning this intersection to improve safety for vehicles, pedestrians, and bicyclists.

US 12 Pedestrian Overcrossing

The area near US 12 and Old Highway 99 is currently experiencing significant commercial development. Due to the size of the intersection, the signal requires an extended green to accommodate pedestrians crossing the highway. While Project C4 will address some pedestrian safety concerns, it comes with a cost

to efficient operation of this major intersection. This project constructs a crossing over US 12 near the intersection, thereby creating a safer crossing for both pedestrians and drivers while also improving the intersection's efficiency. The overcrossing could be located west of the Old Highway 99 intersection and paired with a mixed-use bicycle and pedestrian path on the north side of US 12 creating a multi-modal gateway to the Grand Mound UGA.

Appendix A: Grand Mound Transportation Plan Existing Conditions Analysis

Grand Mound Transportation Plan
Existing Conditions Analysis

Prepared for:
Thurston Regional Planning Council

November 2019

SE19-0676

FEHR PEERS

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INTRODUCTION

Fehr & Peers has completed the existing conditions assessment as part of a transportation study for the Grand Mound Sub Area Plan. This report summarizes the methodology and findings of the analysis, which was based on data collected between August 2016 and November 2018.

This chapter outlines the transportation assessment, including a brief project description, the geographic extent of the study area, and the roadway segments and intersections identified as study locations.

Project Description

In November 2018, Thurston Regional Planning Council (TRPC) and Thurston County produced a comprehensive Transportation Current Conditions Report for the Grand Mound Urban Growth Area (UGA). The Current Conditions Report documents the findings of community outreach conducted in spring of 2018 and provides a qualitative assessment of transportation conditions, including identification of major issues and priorities by the community.

This transportation assessment includes technical analysis to supplement the November 2018 report, including detailed level of service analysis at study locations and safety analysis to both substantiate the report's findings and identify additional needs that might not have been identified as part of the qualitative assessment.

Study Area

The study area for this project includes roadway segments and intersections within the UGA defined for the Grand Mound area of Thurston County and unincorporated areas bordering the UGA limits.

As part of the existing conditions assessment, the following roadway segments, shown on **Figure 1**, were analyzed:

1. Elderberry St SW between 196th Ave SW and 193rd Ave SW
2. 196th Ave SW between Sargent Rd SW and Elderberry St SW

3. Sargent Rd SW between US-12 and 196th Ave SW
4. Elderberry St SW between US-12 and 196th St SW
5. Sargent Rd SW between 198th Way SW and US-12
6. 198th Ave SW between Sargent Rd SW and Old Hwy 99
7. Sargent Rd SW between Old Hwy 99 and 198th Way SW
8. Old Hwy 99 between 198th Ave SW and Sargent Rd
9. 201st Ave SW between Tea St SW and Old Hwy 99
10. Old Hwy 99 between 201st Ave SW and Old Hwy 9

The following intersections were also analyzed as part of the existing conditions assessment, and are shown on **Figure 1**:

1. Elderberry St SW and 193rd Ave SW
2. Elderberry St SW and 196th Ave SW
3. Sargent Rd SW and 196th Ave SW
4. Sargent Rd SW and US-12 (***future intersection***)
5. Old Hwy 99 and US-12
6. SB I-5 Ramp and US-12
7. NB I-5 Ramp and US-12
8. Old Hwy 99 and 198th Ave SW
9. Sargent Rd SW and 198th Ave SW (West)
10. Sargent Rd SW and 198th Ave SW (East)
11. Old Hwy 99 and Sargent Rd SW
12. Old Hwy 99 and 201st Ave SW
13. Old Hwy 99 and Old Hwy 9

It is important to note that the intersection of Sargent Road RW and US-12 does not currently exist but is expected to be complete by 2023 and is therefore included in all future analysis.

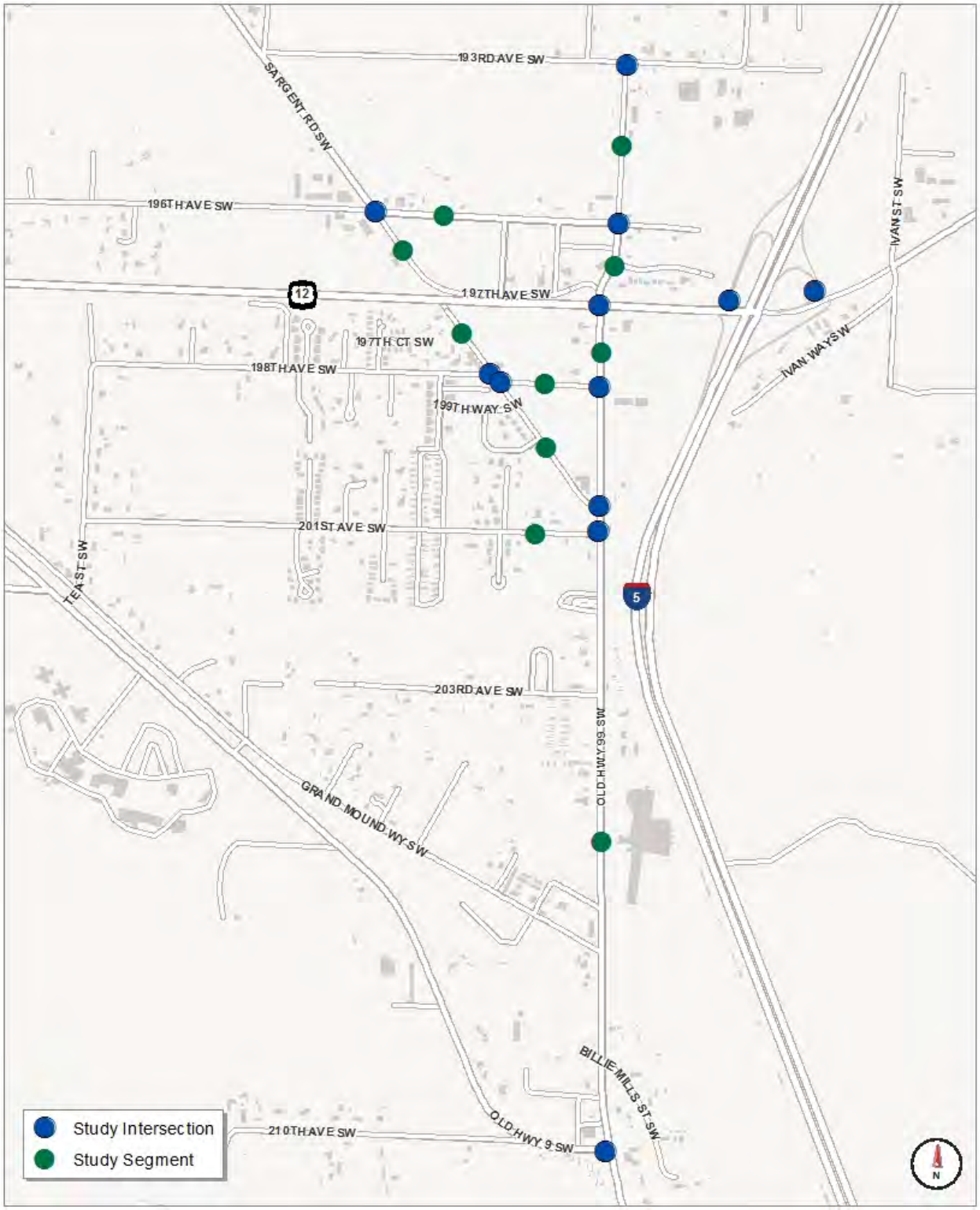

Figure 1. Study Intersections and Segments

ANALYSIS METHODOLOGIES

This section documents the analysis methodologies and assumptions used to evaluate the study segments and intersections.

Intersection Analysis

The operations of roadway facilities are described with the term *level of service*. Level of Service (LOS) is a qualitative description of traffic flow based on factors including speed, travel time, delay, and freedom to maneuver. Six levels are defined from LOS A, the best operating conditions, to LOS F, the worst operating conditions. LOS E represents "at-capacity" operations. When traffic volumes exceed the capacity, stop-and-go conditions result, and operations are designated as LOS F.

In order to evaluate how study intersections are performing, the Highway Capacity Manual, 6th Edition (HCM) (Transportation Research Board, 2016), methodology was applied using the Trafficware Synchro 10 software package. Synchro calculates vehicle delay and LOS based on procedures identified in Chapter 19 Section 3, Approach A. **Table 1** summarizes the relationship between the average control delay per vehicle and LOS, described above, for signalized intersections and unsignalized intersections. Per HCM 6th Edition methodology, LOS at signalized and all-way-stop control intersections is determined using the average delay experienced by all vehicles at the intersection. For side-street stop controlled intersections, the delay experience by vehicles at the highest-delay approach is considered.

SIDRA software and methodology consistent with Washington State Department of Transportation (WSDOT) guidelines for the analysis roundabouts was utilized to analyze the recently constructed roundabout at Old Highway 99 and 198th Avenue SW.

Table 1: Level of Service Definitions

Level of Service	Description	Signalized Intersection Delay (seconds/vehicle)	Unsignalized Intersection Delay (seconds/vehicle)
A	Free-flowing Conditions	≤ 10	0-10
B	Stable Flow (slight delays)	>10-20	>10-15
C	Stable Flow (acceptable delays)	>20-35	>15-25
D	Approaching Unstable Flow (tolerable delay)	>35-55	>25-35
E	Unstable Flow (intolerable delay)	>55-80	>35-50
F	Forced Flow (congested and queues fail to clear)	>80	>50

Roadway Segment Analysis

To evaluate the performance of county roadways, Fehr & Peers applied Thurston County's LOS standard for roadway segments.

The County's LOS policy associates daily traffic volumes with established capacity thresholds. The County's service threshold capacities are based on data established by neighboring Pierce County and the HCM. Generally, the County strives to provide LOS "C" operations in rural (unincorporated) areas and LOS "D" operations in UGAs. Thurston County roadway segment service threshold capacities relevant to the study area are shown in **Table 2**. Using these thresholds each roadway segment was evaluated to determine if it is operating acceptably.

Table 2: Roadway Segment Service Threshold Capacities

Classification	Travel Lanes (each directions)	Service Threshold Capacities (PM Peak 2-Hour)	
		≤ 40 MPH	≥ 45 MPH
Urban (LOS D)	1	1550	1600
	2	3150	3250
Rural (LOS C)	1	1400	1450
	2	2800	2900

Performance Criteria

Based on the Draft Thurston County Comprehensive Plan Update (November 2019) standards on traffic impact analyses, the following performance criteria were used to determine if existing facilities are sized appropriately:

- **Grand Mound Urban Growth Area:** As defined by the Comprehensive Plan, the Grand Mound UGA is designated as a non-rural urbanized area of Thurston County. LOS "D" is established as the minimum acceptable standard for county roads lying within the Grand Mound UGA.
- **Rural Strategy Corridors:** Rural strategy corridors are defined as roadways where the adopted LOS standard may be exceeded. Old Highway 99 is one such roadway and is considered "built-out" today. In lieu of road widening, alternatives such as intersection improvements, connections to regional trails, and extending/increasing transit service shall be applied to mitigate congestion.
- **Rural Unincorporated Thurston County:** Any rural unincorporated Thurston County roadways are defined as roadways lying outside of the current census urbanized area, including those roadways falling just outside of the Grand Mound Urban Growth Area. LOS "C" is established as the minimum acceptable standard for roadways lying within unincorporated Thurston County.

EXISTING CONDITIONS

Existing Roadway Facilities

Regional Roads

- **Interstate 5 Freeway (I-5):** I-5 is an interstate highway that runs in the north-south direction from San Diego, California at the southernmost end to the US-Canadian border in Washington at the northernmost end. I-5 is located at the eastern edge of the Grand Mound UGA and is a six-lane facility (three in each direction) at its junction with Old Highway 99/US-12. Access to I-5 within the study area exists only at US-12.
- **US-12:** US-12 is a federal highway that runs in the east-west direction from Aberdeen, WA in the west to I-5, where it runs in a north-south direction until Napavine, WA. US-12 cuts through the center of the Grand Mound UGA and is a two-lane facility (one lane in each direction) within the study area except between Old Highway 99 and the junction with I-5, where it is a four-lane facility (two lanes in each direction).
- **Old Highway 99:** Old Highway 99 is a regional highway that runs in the north-south direction from Fords Prairie, WA until it intersects with US-12 within the study area, at which point it runs in the east-west direction until Tenino, WA. Old Highway 99 cuts through the center of the Grand Mound UGA and is a two-lane facility (one lane in each direction) until Sargent Road SW, where it becomes a four-lane facility (two in each direction) until it crosses I-5 and reverts back to two lanes.

Local Roads

- **193rd Avenue SW:** 193rd Avenue SW is identified as a Local County Road in the Thurston County Comprehensive Plan. In the study area, it is a two-lane facility that runs between Sargent Road and I-5, along the north boundary of the Grand Mound UGA.
- **Elderberry Street SW:** Elderberry Street SW is identified as a Local County Road in the Thurston County Comprehensive Plan. In the study area, it is a two-lane facility that runs from the intersection of Old Highway 99 and US-12 until 193rd Avenue SW.

- **196th Avenue SW:** 196th Avenue SW is identified as a Local County Road in the Thurston County Comprehensive Plan. In the study area, it is a two-lane facility that runs from Sargent Road to just past Elderberry Street SW.
- **Sargent Road SW:** Sargent Road SW is identified as a Major Collector in the Thurston County Comprehensive Plan. In the study area, it is a two-lane facility that runs northwest-southeast from the northwest boundary of the Grand Mound UGA, dead-ends at US-12, then continues just south of US-12 until Old Highway 99.
- **198th Avenue SW:** 198th Avenue SW is identified as a Local County Road in the Thurston County Comprehensive Plan. In the study area, it is a two-lane facility that runs from Tea Street SW to Old Highway 99.
- **201st Avenue SW:** 201st Avenue SW is identified as a Local County Road in the Thurston County Comprehensive Plan. In the study area, it is a two-lane facility that runs from Tea Street SW to Old Highway 99.
- **Tea Street SW:** Tea Street SW is identified as a Local County Road in the Thurston County Comprehensive Plan. In the study area, it is a two-lane facility that runs from Old Highway 9 to 198th Avenue SW.
- **Grand Mound Way SW:** Grand Mound Way SW is identified as a Local County Road in the Thurston County Comprehensive Plan. In the study area, it is a two-lane facility that runs northwest-southeast from US-12 to Old Hwy 99.
- **Old Highway 9:** Old Highway 9 is identified as a Local County Road in the Thurston County Comprehensive Plan. In the study area, it is a two-lane facility that runs northwest-southeast from US-12 to Old Hwy 99.

Existing Transit

There is currently one Park and Ride within the limits of the Grand Mound UGA located just west of the interchange of I-5 with US-12/Old Highway 99. Service is provided "ruralTransit" (rT) managed by the Thurston Regional Planning Council, which operates two routes that stop weekdays at the Park and Ride. Route 3 runs along Highway 12 from Rochester, stopping at Pecan Street (outside study area) and the Grand Mound Park and Ride before taking I-5 north to Tumwater. Route 4 runs from Centralia, north on I-5 to the Grand Mound Park and Ride, then along Old Highway 99 toward Tenino. As of June 2019, Route 3 operated 12 routes per day (six northbound, six southbound), and Route 4 operated hourly from 6 am to 6 pm, Monday through Friday. This Park and Ride also is serviced by vanpool routes, facilitated by Intercity Transit, that go from Centralia to Olympia.

Existing and Proposed Pedestrian and Bicycle Facilities

Pedestrian infrastructure exists on many of the residential local roads. However, on major connectors such as US-12 or Old Highway 99, the existing pedestrian and bicycle facilities are provided as development occurs resulting in spot improvements often lacking connectivity. The following are current existing bicycle and pedestrian facilities on major roadways within the Grand Mound UGA. Existing facilities are shown in **Figure 2**.

- **US-12:** Bicycle and pedestrian facilities exist along US-12 from the intersection of US-12 with Old Highway 99 to just east of the Park and Ride on the east side of I-5. A wide shoulder that can accommodate bicyclists also exists from the intersection of US-12 with Pecan Street to the intersection of US-12 with Old Highway 99.
- **Elderberry Street/Old Highway 99:** Sidewalk exists on the west side of Elderberry Street just north of the intersection of Old Highway 99 and US-12. Additionally, bike lanes and sidewalks exist on the east and west side of Old Highway 99 from the intersection of Old Highway 99 and US-12 to just south of 198th Avenue SW. A wide shoulder and intermittent sidewalks continue until just south of 201st Avenue SW. Additional sidewalk infrastructure also exists on Old Highway 99 adjacent to the Great Wolf Lodge.

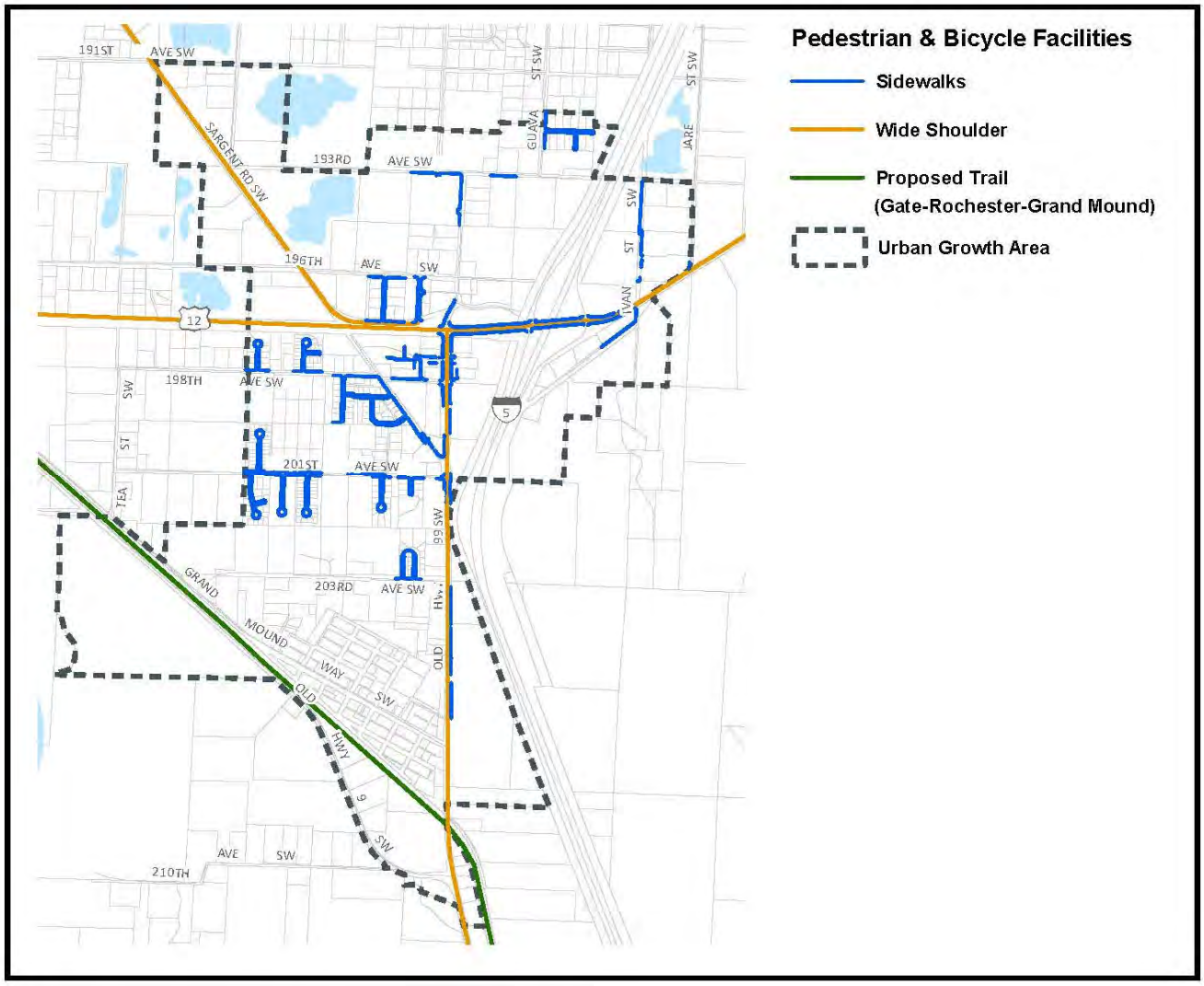

Figure 2. Existing Pedestrian and Bicycle Facilities

Traffic Volumes and Lane Configurations

Analysis for existing conditions was completed using data collected by TRPC and Thurston County within the study area between August 2016 and November 2018.

For the purpose of this assessment, analysis was completed for the PM peak hour. The peak hour was identified for the 12 study intersections and 11 roadway segments based on the PM peak period (4:00 to 6:00 PM) counts collected by TRPC and Thurston County. Existing PM peak hour volumes and lane configurations for the study intersections are summarized on **Figure 3**.

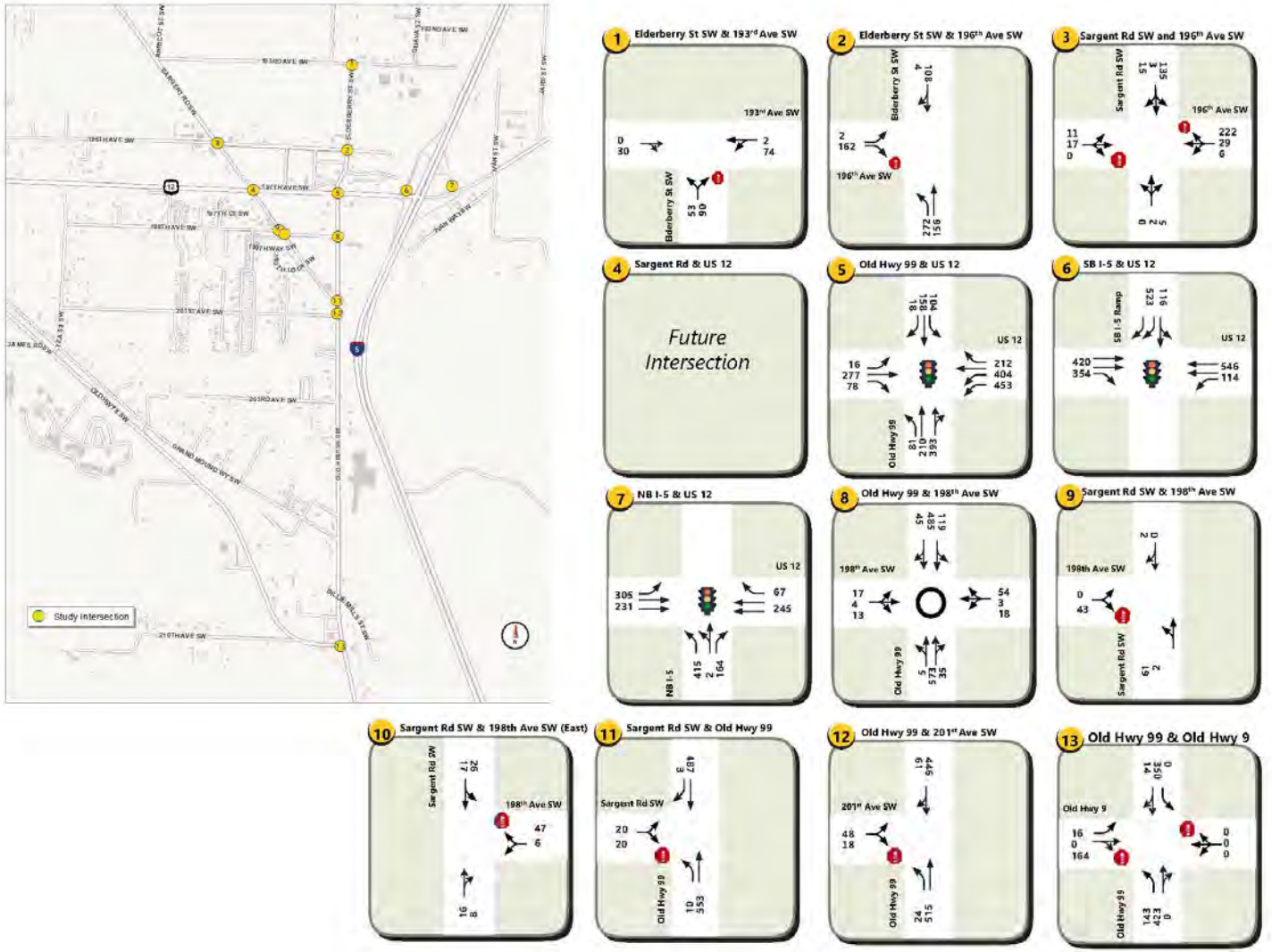

Figure 3. Existing PM Peak Hour Traffic Volume and Lane Configurations

Intersection and Roadway Segment Operations

Existing traffic volumes, lane configurations, and signal timings were used to calculate delay and LOS at the study intersections for existing PM peak hour conditions. **Figure 4** summarizes the results of the existing conditions assessment. The technical calculations are provided in **Appendix A**.

As shown on **Figure 4**, all intersections are operating at an acceptable level of service, based on the criteria presented in the Thurston County Comprehensive Plan.

Traffic volumes for the study segments during the two-hour PM peak period are summarized in **Table 3**. The LOS standard and calculated volume-to-capacity ratio (V/C) are also summarized in **Table 3**. All study segments are meeting the LOS standard consistent with the Thurston County Comprehensive Plan.

Table 3: Roadway Segment Operations

Project Location	Direction	PM Volume (2-hr)	LOS Standard	V/C Ratio	PM Pass/Fail
Elderberry Street SW between 196th and 193rd Avenue SW	NB	230	D	0.13	Pass
	SB	191	D	0.11	Pass
196th Avenue SW between Sargent Rd SW and Elderberry Street SW	EB	321	D	0.18	Pass
	WB	523	D	0.30	Pass
Sargent Road SW between US-12 and 196th Avenue SW	NB	14	D	0.01	Pass
	SB	64	D	0.04	Pass
Elderberry Street SW between US-12 and 196th Street SW	NB	634	D	0.36	Pass
	SB	448	D	0.25	Pass
Sargent Road SW between 198th Way SW and US-12	NB	-	D	0.00	Pass
	SB	4	D	0.00	Pass
198th Avenue SW between Sargent Road SW and Old Hwy 99	EB	44	D	0.03	Pass
	WB	93	D	0.05	Pass
Sargent Road SW between Old Highway 99 and 198th Way SW	NB	95	D	0.05	Pass
	SB	55	D	0.03	Pass
Old Highway 99 between 198th Ave SW and Sargent Road	NB	1,050	D	0.30	Pass
	SB	1,054	D	0.30	Pass
201st Avenue SW between Tea Street Old Highway 99	EB	143	D	0.08	Pass
	WB	194	D	0.11	Pass
Old Highway 99 between 201st Avenue SW and Old Highway 9	NB	912	D	0.52	Pass
	SB	842	D	0.48	Pass

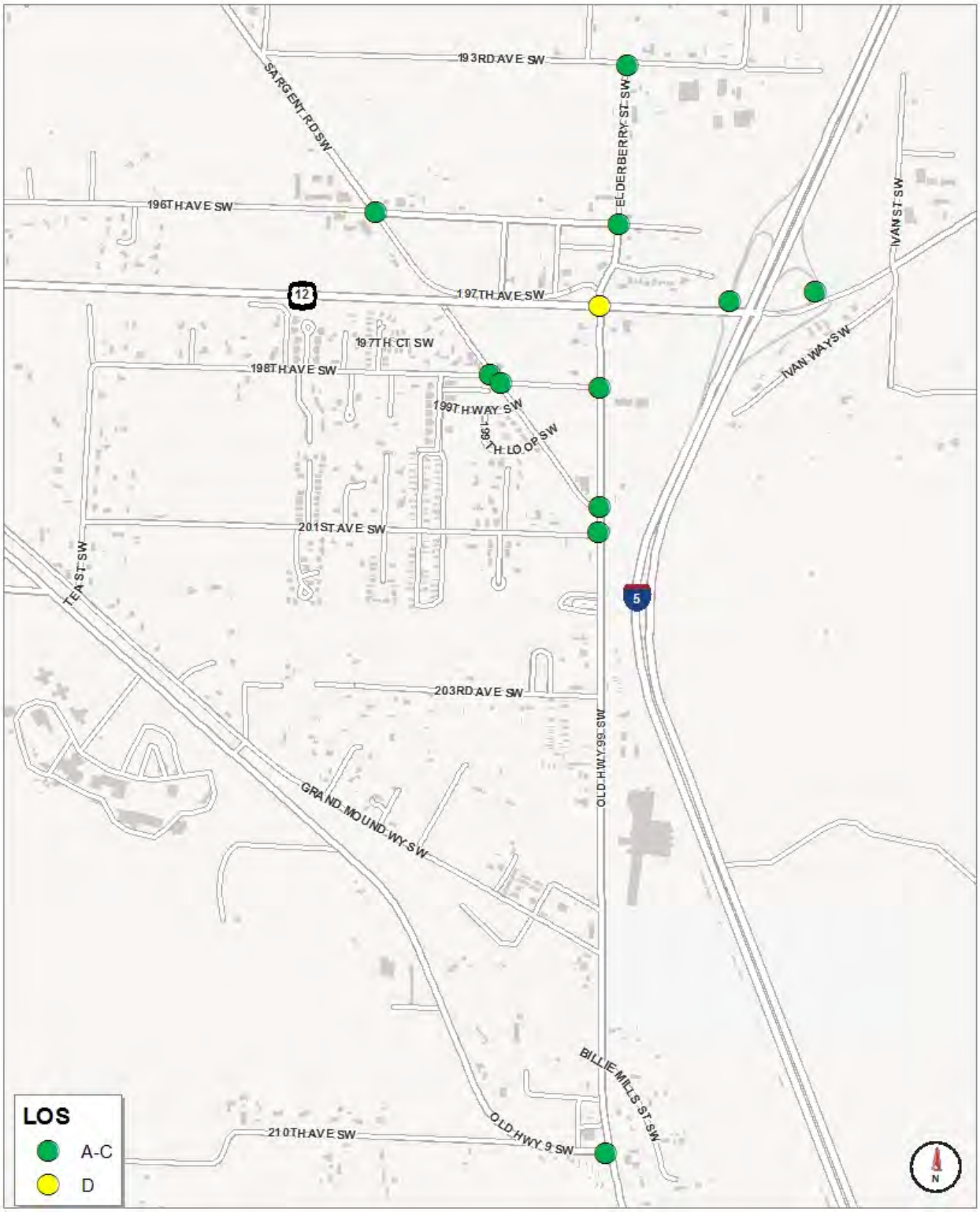

Figure 4. Intersection PM Peak Hour LOS – Existing Conditions

Safety Assessment

Grand Mound community members identified roadway safety as their greatest transportation-related concern during outreach events in 2018. Washington State has adopted Target Zero – a goal to reduce traffic fatalities and serious injuries on Washington's roadways to zero by the year 2030. Thurston County has proposed the same transportation safety goal for County roadways in its Comprehensive Plan (draft Policy T.1.A.1).

Figure 5 maps recent crashes in Grand Mound, using data collected by Washington State Department of Transportation (WSDOT). During the five-year period of 2014 through 2018, there were 226 recorded traffic accidents in Grand Mound area. Overall, 37 percent of these collisions resulted in a possible injury, including two fatalities and five suspected serious injuries. Most accidents occurred along either US 12 (78 crashes) or Old Highway 99 SW (76), and the greatest concentration of incidents occurred at or near the intersection of these two roads. However, the types of accidents on the two roads differ: on US 12 rear-end accidents were the most common type of collision, occurring in 42 percent of accidents; while on Old Highway 99, the greatest proportion of crashes (45%) occurred from vehicles entering at an angle.

Intersections. Nearly half of all crashes (45%) that occurred in Grand Mound over the past five years were characterized as being related to an intersection. Intersections with the greatest number of collisions include:

- US 12/Old Highway 99 SW: 35
- US 12/I-5 ramps: 17
- Old Highway 99 SW/Old Highway 9 SW: 7
- Old Highway 99 SW/198th St SW: 6
- Old Highway 9 SW/Tea St SW: 6
- Old Highway 99 SW/Jare St: 4
- Old Highway 9 SW/James Rd SW: 4
- Elderberry St SW/196th Ave SW: 3
- Sargent Rd SW/191st Ave SW: 2
- Sargent Rd SW/196th Ave SW: 2

Along Old Highway 99 SW, a substantial portion of crashes (17) were related to vehicles entering or exiting driveways, rather than another street. In addition, a single collision at the intersection of Old Highway 99 SW and Sargent Rd SW resulted in one of the two fatalities during this period.

Contributing Conditions. WSDOT identifies inattention as the most frequent driver contributing condition to crashes during this period, playing a role in about a quarter of accidents. Drivers not granting right-of-way contributed to 19 accidents, most commonly along Old Highway 99 SW (including six collisions at the intersection with 198th Ave SW where a roundabout is being installed) and US 12. Consumption of alcohol or drugs was a factor in 16 crashes.

Along US 12, disregarding stop lights, excessive speeding, not granting the right-of-way, improper turns, and following too closely were also listed as contributing factors in multiple crashes. These factors may contribute to the high proportion of rear-end collisions on this roadway.

Crashes with Fatalities. Over the past five years, Grand Mound suffered two fatal crashes, both in 2017. The first occurred in May when a vehicle traveling at night on an unlit portion of Old Highway 9 SW hit a pedestrian, who was in the middle of the travel lane. The second crash occurred when a vehicle taking a left onto Old Highway 99 SW from Sargent Rd SW collided with a tractor-trailer headed southbound, killing the driver of the car. A third fatal crash in 2017 occurred along Old Highway 99 SW just south the study area, near the intersection with Oregon Trail Rd SW.

Crashes with Serious Injuries. Since 2014, five accidents in Grand Mound have caused suspected serious injuries.

- ***March 2016***: a head-on collision on Sargent Rd, when a pickup truck or van[1] crossed the center line in dry, daylight conditions. WSDOT identified driver distraction as a contributing factor.
- ***December 2016***: a pickup truck or van hit a pedestrian walking in their lane of traffic on Grand Mound Way SW, during dark, raining conditions.
- ***December 2016***: a pickup track or van headed north on Old Highway 99 SW hit a guardrail.
- ***April 2017***: a head-on collision on US 12, when a passenger car crossed the center line and hit a pickup truck or van in dark, but dry conditions. WSDOT identified driver distraction as a contributing factor.
- ***August 2018***: a motorcycle overturned on Elderberry St SW in dry, dark conditions. WSDOT noted excessive speed as a factor in the accident.

[1] WSDOT lumps small truck and vans into a single vehicle category called "Pickup Panel Truck or Vanette under 10000 lb."

Pedestrian-Involved Crashes. An overall lack of continuous sidewalks and pathways makes the Grand Mound study area challenging to navigate on foot, and travel in this area is typically done by auto. Over the past five years, there have been only three crashes that involved pedestrians, however all have resulted in injury to the pedestrian, including a fatality.

- ***December 2016***: a pickup truck or van hit and seriously injured a pedestrian walking in their lane of traffic on Grand Mound Way SW, during dark, raining conditions.
- ***May 2017***: a vehicle traveling at night on an unlit portion of Old Highway 9 SW hit and killed a pedestrian, who was in the middle of the travel lane.
- ***November 2018***: A pickup truck or van making a turn from Ivan Street SW into a driveway hit and injured a pedestrian, during dark, wet conditions in an area without streetlights.

Bicyclist-Involved Crashes. Similarly, the Grand Mound area can be challenging for cyclists, and there have been three accidents involving bicycles since 2014.

- ***March 2015***: A passenger car making a left turn from Old Highway 99 SW into a driveway hit a cyclist, leading to a minor injury.
- ***August 2016***: A pickup truck or van going straight on Sargent Rd SW near 196th Ave hit a cyclist in dry, daylight conditions, leading to a minor injury.
- ***May 2018***: A vehicle going straight on Old Highway 9 SW hit a cyclist in dry daylight conditions.

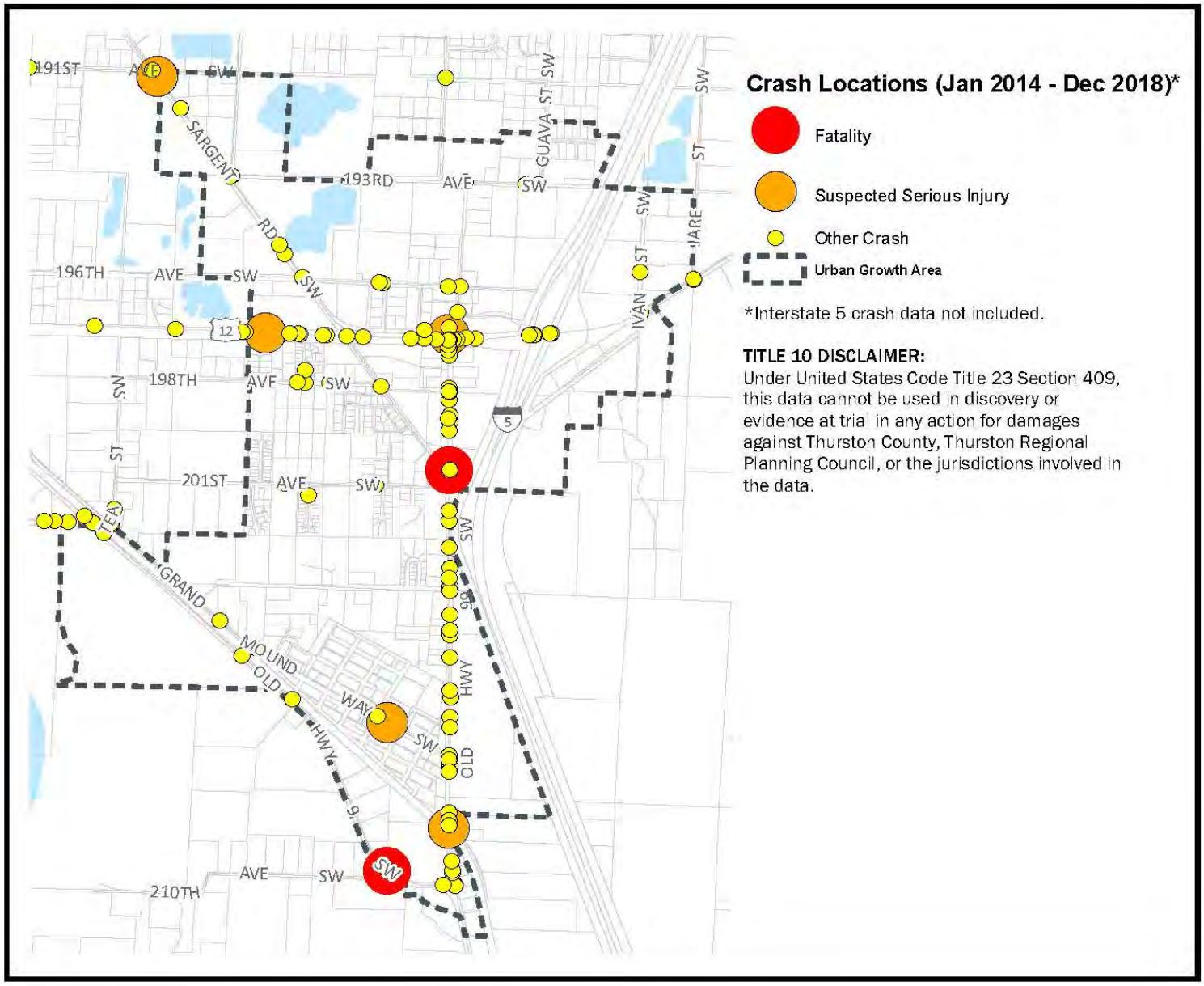

Figure 5. Grand Mound Crash Locations, 2014-2018

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Appendix A:
Intersection Level of Service Calculations

Existing Intersection LOS Summary

INT #	Intersection	Existing Control	Peak Hour	Existing	
				Delay	LOS
1	193rd Ave & Elderberry St	TWSC	PM	10	A
2	196th Ave & Elderberry St	TWSC	PM	10	A
3	196th Ave & Sargent Rd	TWSC	PM	14	B
5	Old Hwy 99/Elderberry St & US-12	Signalized	PM	48	D
6	SB I-5 Ramp & US-12	Signalized	PM	25	C
7	NB I-5 Ramp & US-12	Signalized	PM	28	C
8	198th Ave & Old Hwy 99	Roundabout[1]	PM	5	A
9	198th Ave (West) & Sargent Rd	TWSC	PM	9	A
10	198th Ave (East) & Sargent Rd	TWSC	PM	9	A
11	Sargent Rd & Old Hwy 99	TWSC	PM	14	B
12	201st Ave & Old Hwy 99	TWSC	PM	16	C
13	Old Hwy 9 & Old Hwy 99	TWSC	PM	14	B

Notes:
[1] Intersection analyzed using SIDRA Software.
Intersection analysis completed using Highway Capacity Manual 6th Edition Methodology & Synchro 10 Software.

Appendix B: Grand Mound Transportation Study Future Conditions Documentation

FEHR PEERS

Memorandum

Date: January 29, 2020

To: Allison Osterberg, Thurston Regional Planning Council

From: Michael Adamson & Kara Hall, Fehr & Peers

Subject: Grand Mound Transportation Study Future Conditions Documentation

SE19-0676

As part of the Grand Mound Transportation Study, travel demand modeling and operational analysis has been completed to evaluate future conditions in the Grand Mound Urban Growth Area (UGA) under two scenarios: 1) 2040 assuming only funded improvement projects, 2) 2040 assuming funded improvement projects and projects recommend by this study.

The following sections outline the projects considered, the growth in traffic volume expected, and the operational results for roadway segments and intersections for both scenarios. An overview of project development and selection for this study is also documented below.

Scenario 1: 2040 with Planned and Funded Improvements

Scenario 1 establishes the baseline conditions for the year 2040 in the Grand Mound UGA. This scenario represents how the transportation network would operate with the growth in traffic expected to occur by 2040 if only improvements currently funded are implemented. Findings from the operational analysis completed for this scenario were used to identify where additional transportation improvements would be needed by 2040 in order to maintain the County's mobility standards.

2040 Traffic Volume

To develop traffic volume forecasts for 2040, Fehr & Peers applied the Dynamic Traffic Assignment (DTA) Model developed by Thurston Regional Planning Council (TRPC). The model used for this study was validated and calibrated as described in the *Grand Mound Transportation Study Travel Demand Forecasting & Results Memorandum*, prepared in October 2019.

The only funded improvement within the study area included in this scenario was the Sargent Road/US 12 Roundabout, expected to be complete by 2023. As DTA models assign trips to the

roadway network with consideration for delay and queueing experienced by drivers, signal timing updates were also made at the US 12/Elderberry Road/Old Highway 99 and both Interstate 5 (I-5) ramp terminal intersections, to ensure that the signals were operating efficiently under future demand.[1]

As documented in the *Forecasting Methodology & Results Memorandum*, 2040 forecasts were developed using the difference method. In general, this method adds the growth in volume between the Base Year and Future Year models to existing traffic counts to develop future traffic volume.

Under Scenario 1, traffic volume in the Grand Mound area is expected to increase at a rate of 1.9 percent per year. While volume in the study area is increasing overall, several locations will see a decrease in volume as a result of the new US 12/Sargent Road connection. Those locations are:

- Northbound left-turn at Elderberry Street/193rd Avenue SW
- Northbound and southbound thru and eastbound right-turn at Elderberry Street/196th Avenue SW
- Southbound left-turn at Sargent Road/196th Avenue SW
- Northbound and southbound thru at Old Highway 99/US 12

Future traffic volume at the study intersections is presented in **Attachment A**.

2040 Operations

Operational analysis completed for this scenario evaluated both intersections and roadway segments in the study area, using criteria identified in the Thurston County Comprehensive Plan (2018), which identifies Level of Service (LOS) D as the minimum threshold for acceptable operations.

Study Intersections

All signalized and stop-controlled intersections were evaluated using Synchro Software to determine the delay and LOS consistent with thresholds defined in the Highway Capacity Manual (HCM) 6th Edition. SIDRA software was used to analyze the planned roundabout at US 12/Sargent Road, consistent with guidelines published by the Washington State Department of Transportation (WSDOT).

[1] These signal timing adjustments reflect what would happen in real world conditions, as all of these signals are actuated, meaning they adjust their timing plans with fluctuations in traffic volumes over the course of the day.

Analysis completed for study intersections under Scenario 1 found that two intersections would operate unacceptably by 2040. The two intersections with inadequate capacity in 2040 are:

- US 12/Elderberry Street/Old Highway 99, operating at LOS F
- Old Highway 9/Old Highway 99, operating at LOS F

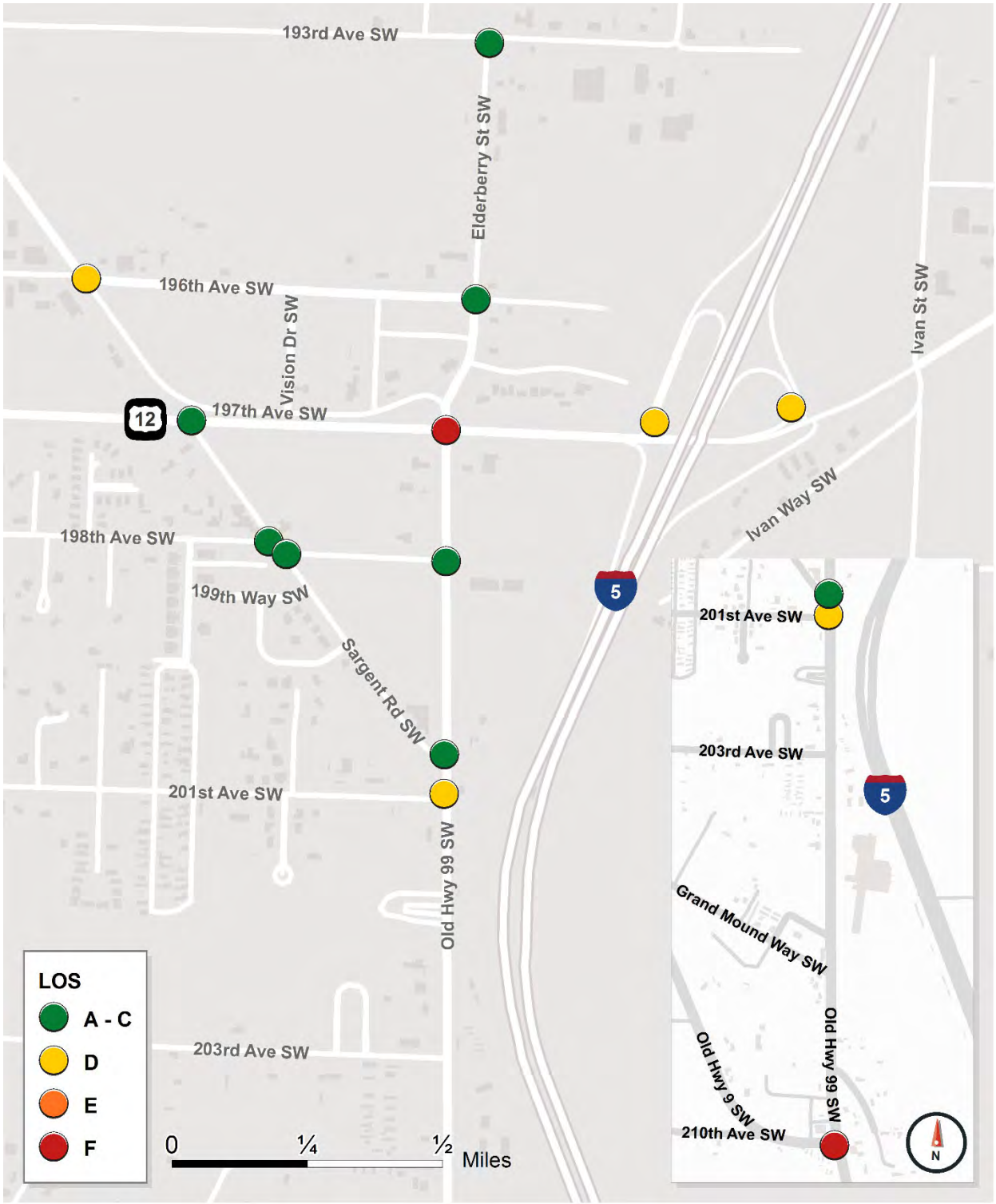
Figure 1 presents the LOS expected at all study intersections in 2040. Detailed results can also be found in **Attachment B**.

Signal warrant analysis was also completed using 2040 volumes under this scenario at three intersections that are currently side-street-stop-controlled. The intersections analyzed include:

- 196th Avenue SW/Sargent Road – Peak Hour Warrant Met
- 196th Avenue SW/Elderberry Street – Peak Hour Warrant Not Met
- Old Highway 9/Old Highway 99 - Peak Hour Warrant Met

Two of the three study intersections would meet the peak hour signal warrant by 2040 indicating that strategies for intersection signal control should be considered.

Figure 1: Scenario 1 2040 LOS



Roadway Segments

The two-hour PM peak period volume was used to evaluate study roadway segments using standards consistent with the Thurston County Comprehensive Plan. As shown in **Table 1**, all study segments were found to meet the LOS standard, indicating that there is adequate capacity to serve demand in 2040.

Table 1: Scenario 1 Roadway Segment Operations

Project Location	Direction	PM Volume (2-hr)	LOS Standard	V/C Ratio	PM Pass/Fail
Elderberry Street SW between 196th and 193rd Avenue SW	NB	499	D	0.28	Pass
	SB	266	D	0.15	Pass
196th Avenue SW between Sargent Rd SW and Elderberry Street SW	EB	260	D	0.15	Pass
	WB	720	D	0.41	Pass
Sargent Road SW between US-12 and 196th Avenue SW	NB	560	D	0.32	Pass
	SB	870	D	0.49	Pass
Elderberry Street SW between US-12 and 196th Street SW	NB	998	D	0.57	Pass
	SB	532	D	0.30	Pass
Sargent Road SW between 198th Way SW and US-12	NB	700	D	0.40	Pass
	SB	940	D	0.53	Pass
198th Avenue SW between Sargent Road SW and Old Hwy 99	EB	380	D	0.22	Pass
	WB	440	D	0.25	Pass
Sargent Road SW between Old Highway 99 and 198th Way SW	NB	700	D	0.40	Pass
	SB	700	D	0.40	Pass
Old Highway 99 between 198th Ave SW and Sargent Road	NB	1,502	D	0.42	Pass
	SB	1,286	D	0.36	Pass
	EB	240	D	0.14	Pass

Table 1: Scenario 1 Roadway Segment Operations

Project Location	Direction	PM Volume (2-hr)	LOS Standard	V/C Ratio	PM Pass/Fail
201st Avenue SW between Tea Street Old Highway 99	WB	60	D	0.03	Pass
Old Highway 99 between 201st Avenue SW and Old Highway 9	NB	1,942	D	0.55	Pass
	SB	1,466	D	0.41	Pass

Fehr & Peers, 2020

Project Development & Selection

Community engagement, completed in 2018, resulted in a list of Draft Actions for the Grand Mound UGA. This list of actions served as a starting point in the development of projects for this study, with a total of 14 transportation improvements identified, some of which are moving

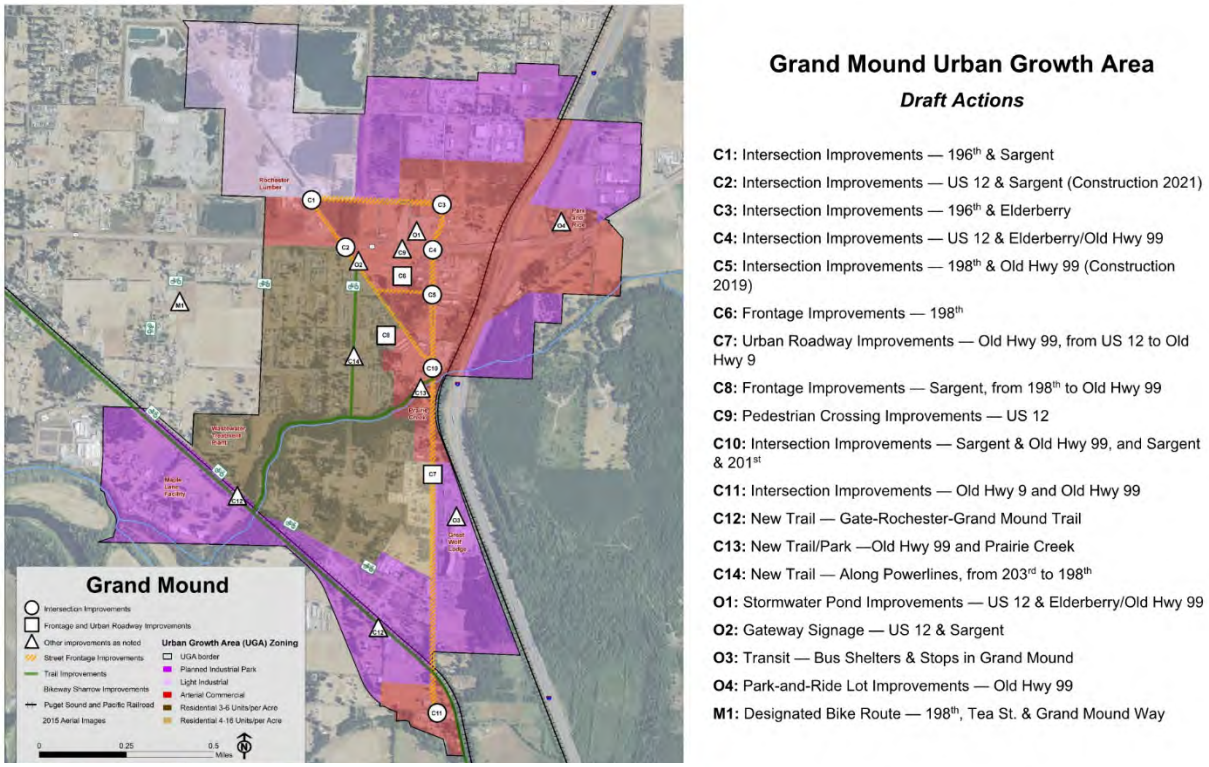


Figure 2: Draft Actions for the Grand Mound UGA

forward outside of this study, such as the 198th & Old Highway 99 intersection improvements, which were constructed in 2019 . The Draft Actions identified are shown on **Figure 2**.

The first step in project selection was the application of a project evaluation matrix, which used the project goals to evaluate improvements identified as Draft Actions. The criteria used to evaluate projects' consistency with the ultimate vision for Grand Mound include:

- **Safety:** Transportation infrastructure in Grand Mound provides safe options for all users.
- **Efficient:** Roadways and intersections have adequate capacity and function with acceptable levels of congestion for autos and freight, even as the region grows.
- **Character:** Transportation infrastructure contributes to Grand Mound's identity as a distinctive place with rural character.
- **Multi-Modal Connections:** Grand Mound's transportation system accommodates walking and biking, including connections to regional trails, transit, and commercial land uses.
- **Economic Diversity & Tourism:** Transportation facilities support economic growth in Grand Mound, including residential, commercial, jobs, and tourism.
- **Supported:** Transportation infrastructure in Grand Mound reflects community input

The current Grand Mound Project Evaluation Matrix, along with performance measures evaluated is located in **Attachment C**. It should be noted that final matrix will be completed following the planned community engagement for this study.

This tool, along with input from the Project Team, which included members of TRPC and Thurston County Public Works, resulted in the eight projects described below being selected for further evaluation as part of this study. Other projects on the list, but not evaluated in more detail, could be considered outside the scope of this study, or by future studies completed in the area. Draft project layouts can be found in **Attachment D**.

Project C1 – 196th Avenue SW/Sargent Road Intersection Improvements: This project would construct a single-lane roundabout at the intersection and would include widening of sidewalks to 10 feet on all four legs of the roundabout to provide a safe and comfortable option for bicyclists to navigate the roundabout.

Project C3 -196th Avenue SW/Elderberry Street Intersection Improvements: This project would construct a single-lane roundabout at the intersection, including converting the existing driveway that aligns with the intersection on the east side of Elderberry Street to a full leg. This leg of the intersection would provide access to potential development to the east of Elderberry Street. This project would also widen sidewalks to 10 feet on all sides of the intersection to provide additional space on the sidewalk for bicyclists.

Project C4 & C9 – US 12/Elderberry Street/Old Highway 99 Intersection Improvements: At this time two alternatives are being considered for this location. The first alternative would construct pedestrian refuge-islands for pedestrians crossing the east, west, and south legs of the intersection. Addition of the pedestrian islands would decrease crossing times for pedestrians, resulting in decreased pedestrian exposure, and also allowing the signal to operate more efficiently. The other alternative being considered is a pedestrian overcrossing over US 12 to the west of the intersection. This would separate pedestrians from vehicles as they cross US 12, eliminating potential conflicts with vehicles traveling at high speeds.

Project C7 – Old Highway 99 Improvements: A major concern on Old Highway 99 today is the mix of users with little separation of modes. Improvements on Old Highway 99 would focus on providing accommodations for all modes in dedicated spaces. First, consolidation of access points from businesses along Old Highway 99 is recommend. At a maximum, parcels should have one driveway with full access (allowing both left-and right-turns into and out of the driveway). If additional access points cannot be consolidated they should be limited to right-in/right-out access only. Opportunities to consolidate access between parcels should also be investigated. Consolidation of driveway access along Old Highway would decrease potential conflicts for bicyclists and pedestrians in the area, while also limiting locations where vehicles are making uncontrolled left-turns across oncoming traffic. Bicyclists would be accommodated on a shared-use path on the west side of Old Highway 99. On the east side of Old Highway 99 existing sidewalks, which are intermittent along the corridor today, would be connected between Old Highway 9 and 198th Avenue SW. The existing three-lane cross-section would be maintained, with the center lane transitioning between a two-way-left-turn-lane, left-turn pockets, and a median based on access requirements along the corridor. At least two mid-block crossings would also be recommended as part of these improvements. Specific locations should be identified as land use along the corridor develops, creating desire lines for pedestrian travel across Old Highway 99.

Project C8 – Sargent Road Improvements: This project would widen the existing Sargent Road cross-section to accommodate bicyclists and pedestrians, while providing adequate capacity for vehicles. The proposed Sargent Road cross-section includes a two-lane roadway, widening at intersections to provide storage for left-turning vehicles. To ensure bicyclists of all ages and all abilities have a facility separated from vehicles a shared-use path on the south/west side of Sargent Road for bicyclists and pedestrians is proposed. The north/east side of Sargent Road would also provide a sidewalk for pedestrians.

Project C10– Sargent Road/201st Avenue SW/Old Highway 99 Intersection Improvements: Today the 201st Avenue SW and Sargent Road intersections with Old Highway 99 are approximately 200 feet apart. With the connection of Sargent Road to US 12, the number of vehicles turning onto Sargent Road from Old Highway 99 will increase significantly. To limit queuing between intersections causing congestion on Old Highway 99, significant reconfiguration of these two intersections is proposed. One alternative at this intersection would create one

intersection controlled with a five-leg roundabout. The second alternative would reconfigure Sargent Road to right-in/right-out access only and roundabout control at the 201st Avenue SW/Old Highway 99 intersection.

Project C11 – Old Highway 99/Old Highway 9 Intersection: This project would construct a traffic signal or a single-lane roundabout at the intersection. Traffic control at this intersection would significantly reduce delay experienced by vehicles on Old Highway 9 caused by fewer gaps in traffic as traffic volume on Old Highway 99 increases. This intersection has a high percentage of large trucks that use the intersection to travel west of Old Highway 99, creating safety concerns for passenger vehicles, bicyclists, and pedestrian. The number of conflict points between other vehicles, bicyclists, and pedestrians, would be reduced with either a traffic signal or roundabout at this intersection.

Project C13 & C14– Multi-Use Power Lines Trail: This project would construct a multi-use trail following the current power lines alignment. This trail would create a parallel route to Old Highway 99 for bicyclists and pedestrians from 198th Avenue SW to 203rd Avenue SW. This trail would also serve as a connection to other trails and parks planned in the area, including along Prairie Creek and the proposed Grand Mound-Rochester Trail to the south.

For projects where more than one alternative is being considered, a recommended alternative will be identified based on on-going technical analysis paired with feedback from the community and local business owners. Community input will also be used in the prioritization of investments within the Grand Mound UGA.

The following section describes how these projects were considered in the technical evaluation and how the transportation system in Grand Mound is expected to operate with the improvements in place.

Scenario 2: 2040 with Project Improvements

Scenario 2 considers future growth in the study area with the improvements described above in place. The DTA model was used to understand how proposed improvements might shift travel patterns in the area, while operational analysis was used to confirm that improvements will result in all study locations operating acceptably in 2040.

2040 Traffic Volume

Consistent with traffic volume forecasts developed for Scenario 1, TRPC's DTA model was applied to forecast growth in the study area. The ability to understand how planned improvements will change traffic patterns and growth is the primary advantage of applying DTA model over traditional four-step models. Forecasts presented for Scenario 2 include the following roadway network updates in the DTA model:

- C1 – Roundabout control at 196th Avenue SW/Sargent Road
- C3 – Roundabout control at 196th Avenue SW/Elderberry Street
- C4 & C9 – Signal timing improvements at US 12/Elderberry Street/Old Highway 99
- C10 – Restriction of left-turn movements at Sargent Road/Old Highway 99 and roundabout control at 201st Avenue SW/Old Highway 99
- C11 – Roundabout control at Old Highway 99/Old Highway 9

When compared to traffic volume forecasts developed for Scenario 1, these improvements would result in a minimal increase in traffic volume in the study area. While overall increase in traffic volume is minimal, the reconfiguration of access at Sargent Road/Old Highway 99 results in changes to how trips travel from US 12 to Old Highway 99 and vice versa within the study area. With the improvements in place, volume would be shifted from Sargent Road to 198th Avenue SW. This shift is a result of vehicles being prohibited from turning left from Old Highway 99 to connect to US 12 at Sargent Road. A smaller number of trips would also remain on Old Highway 99 northbound, making a left-turn movement at the US 12 intersection instead of Sargent Road.

Future traffic volumes at study intersections can be found in **Attachment A**.

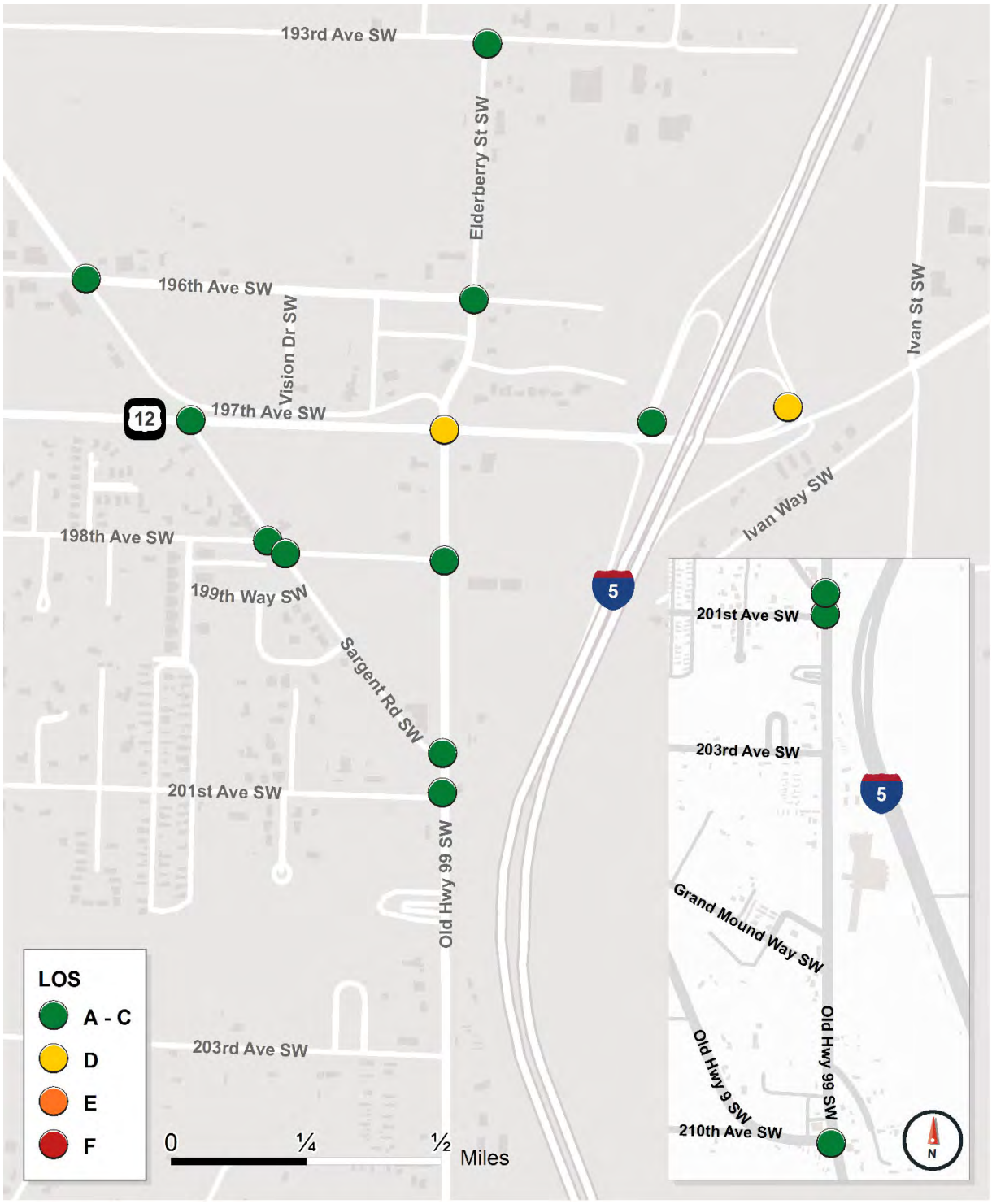
2040 Operations

Consistent with Scenario 1, both study intersections and roadway segments were evaluated for consistency with the Thurston County Comprehensive Plan's thresholds for acceptable operations.

Study Intersections

Evaluation of the study intersections using Synchro Software and SIDRA to evaluate delay and LOS found that with the proposed improvements in place all intersections would operate at LOS D or better. **Figure 3** presents the LOS expected at all study intersections in 2040. Detailed results can also be found in **Attachment B**.

Figure 3: Scenario 2 2040 LOS



The two-hour PM peak period volume was used to evaluate study roadway segments using standards consistent with the Thurston County Comprehensive Plan. As shown in **Table 2**, all study segments were found to meet the LOS standard, indicating that there is adequate capacity to serve demand in 2040.

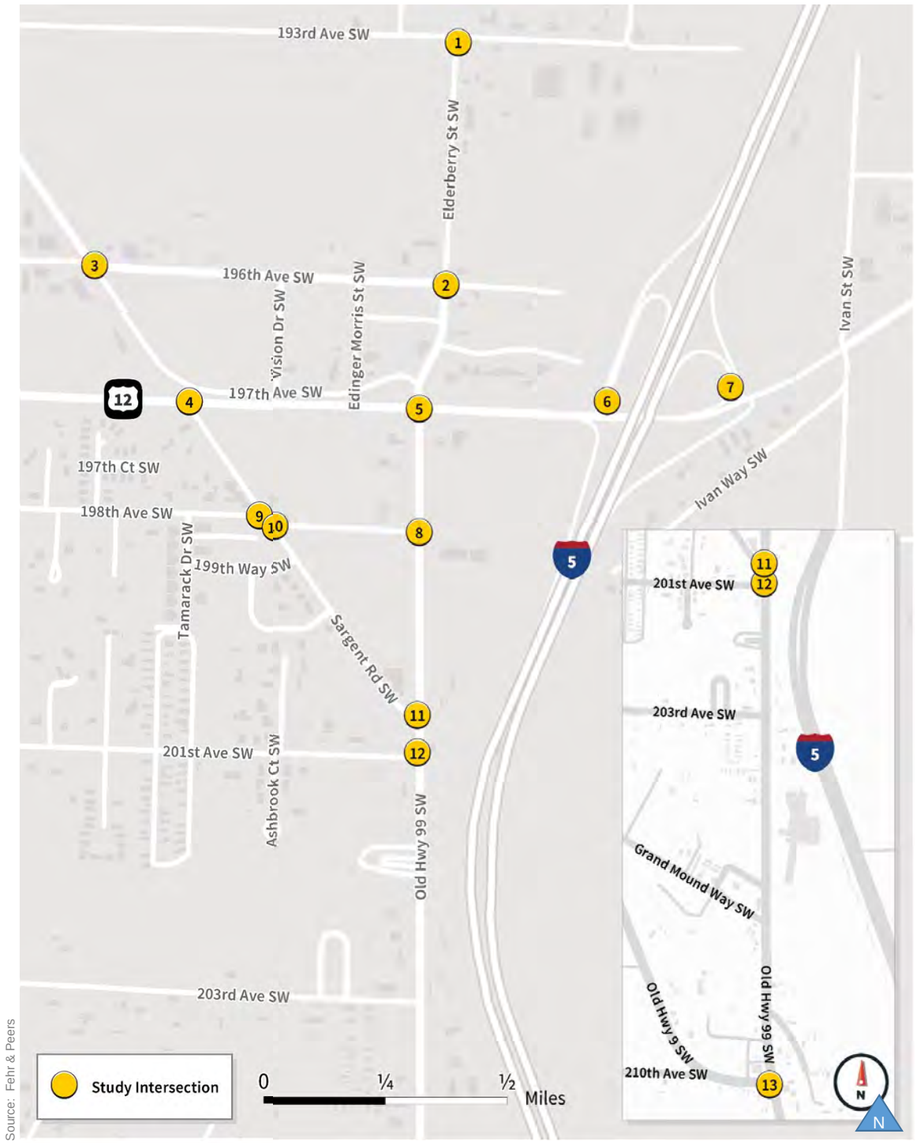
Table 2: Scenario 2 Roadway Segment Operations

Project Location	Direction	PM Volume (2-hr)	LOS Standard	V/C Ratio	PM Pass/Fail
Elderberry Street SW between 196th and 193rd Avenue SW	NB	656	D	0.37	Pass
	SB	529	D	0.30	Pass
196th Avenue SW between Sargent Rd SW and Elderberry Street SW	EB	322	D	0.18	Pass
	WB	728	D	0.41	Pass
Sargent Road SW between US-12 and 196th Avenue SW	NB	520	D	0.30	Pass
	SB	740	D	0.42	Pass
Elderberry Street SW between US-12 and 196th Street SW	NB	1,312	D	0.75	Pass
	SB	1,058	D	0.60	Pass
Sargent Road SW between 198th Way SW and US-12	NB	1,170	D	0.66	Pass
	SB	700	D	0.40	Pass
198th Avenue SW between Sargent Road SW and Old Hwy 99	EB	500	D	0.28	Pass
	WB	870	D	0.49	Pass
Sargent Road SW between Old Highway 99 and 198th Way SW	NB	690	D	0.39	Pass
	SB	260	D	0.15	Pass
Old Highway 99 between 198th Ave SW and Sargent Road	NB	2,134	D	0.60	Pass
	SB	1,536	D	0.43	Pass
201st Avenue SW between Tea Street Old Highway 99	EB	222	D	0.13	Pass
	WB	60	D	0.03	Pass

Table 2: Scenario 2 Roadway Segment Operations

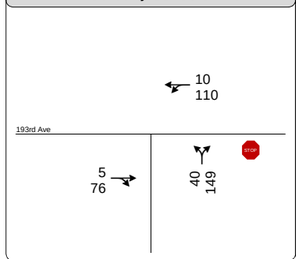
Project Location	Direction	PM Volume (2-hr)	LOS Standard	V/C Ratio	PM Pass/Fail
Old Highway 99 between 201st Avenue SW and Old Highway 9	NB	2,134	D	0.60	Pass
	SB	1,556	D	0.44	Pass

Attachment A: 2040 Volume

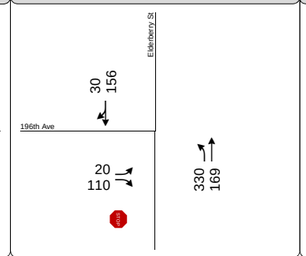


Source: Fehr & Peers

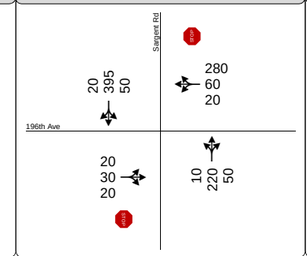
1. Elderberry St/193rd Ave



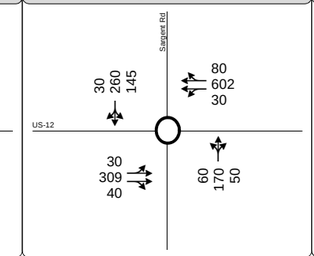
2. Elderberry St/196th Ave



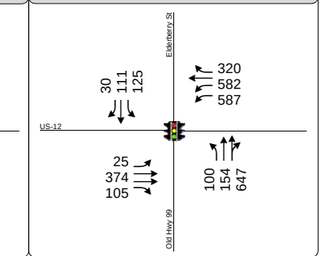
3. Sargent Rd/196th Ave



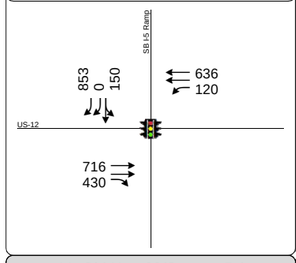
4. Sargent Rd/US-12



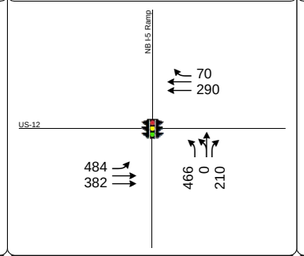
5. Elderberry St/Old Hwy 99/US-12



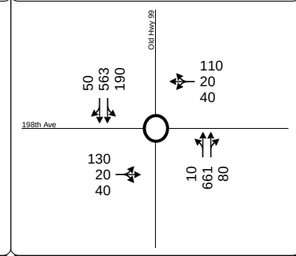
6. SB I-5 Ramp/US-12



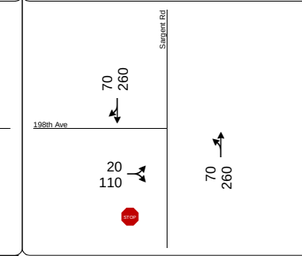
7. NB I-5 Ramp/US-12



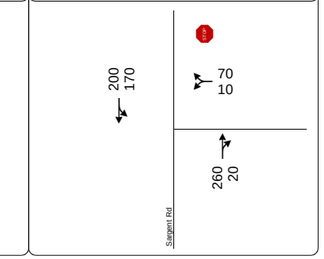
8. Old Hwy 99/198th Ave



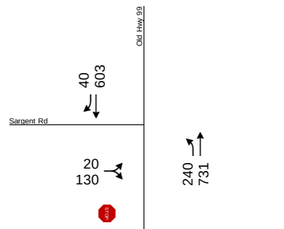
9. Sargent Rd/198th Ave



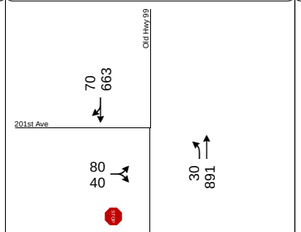
10. Sargent Rd/198th Ave



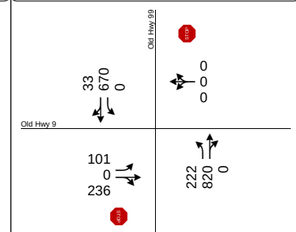
11. Old Hwy 99/Sargent Rd



12. Old Hwy 99/201st Ave



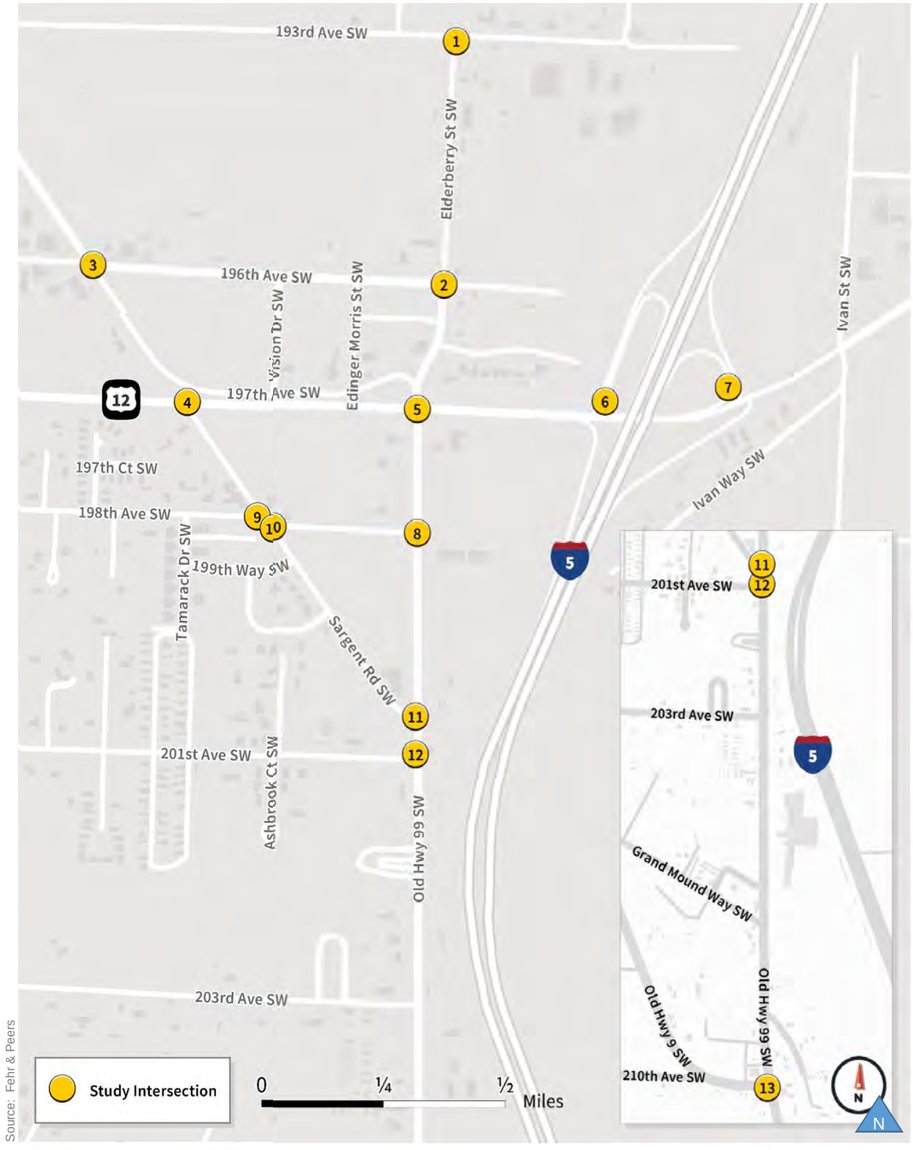
13. Old Hwy 99/Old Hwy 9



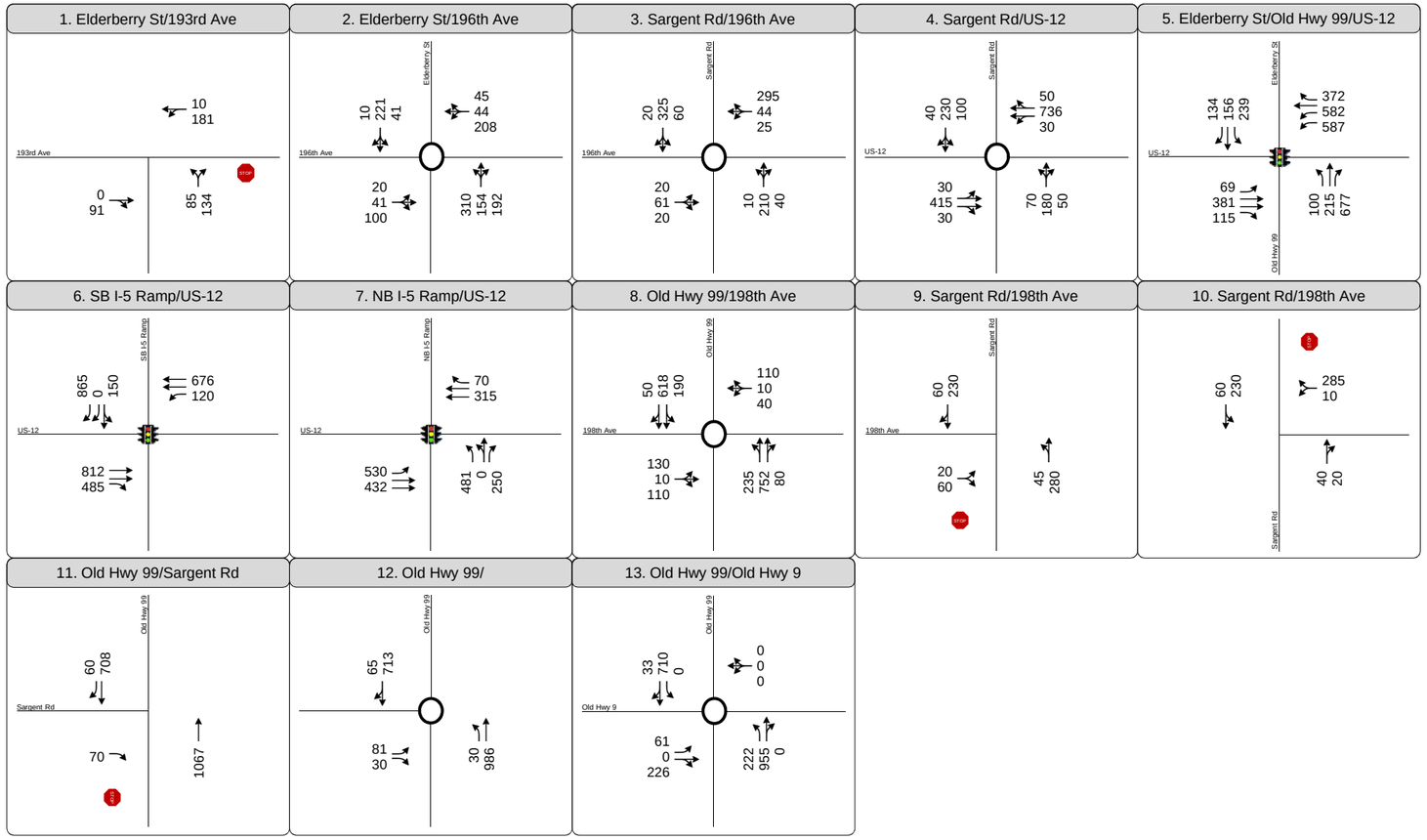
LEGEND

- # — PM Peak Hour Traffic Volume
- Lane Configuration
- Stop Sign
- Signalized

Attachment A
PM Peak Hour Intersection Volumes
2040 Baseline Conditions



Source: Fehr & Peers



LEGEND

- # — PM Peak Hour Traffic Volume
- Lane Configuration
- Stop Sign
- Signalized

Attachment A
PM Peak Hour Intersection Volumes
2040 Scenario 2

Attachment B – LOS Summary

FEHR PEERS

Grand Mound Transportation Study – Level of Service Summary

INT #	Intersection	Peak Hour	Existing		2040 - Scenario 1		2040 - Scenario 2	
			Delay	LOS	Delay	LOS	Delay	LOS
1	193rd Ave & Elderberry St	PM	10	A	10	B	12	B
2	196th Ave & Elderberry St	PM	10	A	13	B	8	A
3	196th Ave & Sargent Rd	PM	14	B	33	D	2	A
4	Sargent Rd & US-12	PM	-	-	7	A	6	A
5	Old Hwy 99/Elderberry St & US-12	PM	48	D	97	F	46	D
6	SB I-5 Ramp & US-12	PM	25	C	38	D	33	C
7	NB I-5 Ramp & US-12	PM	28	C	40	D	39	D
8	198th Ave & Old Hwy 99	PM	5	A	7	A	7	A
9	198th Ave (West) & Sargent Rd	PM	9	A	13	B	12	B
10	198th Ave (East) & Sargent Rd	PM	9	A	13	B	11	B
11	Sargent Rd & Old Hwy 99	PM	14	B	20	C	15	C
12	201st Ave & Old Hwy 99	PM	16	C	31	D	6	A
13	Old Hwy 9 & Old Hwy 99	PM	14	B	430	F	27	C

Intersection	
Int Delay, s/veh	7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	5	76	110	10	40	149
Future Vol, veh/h	5	76	110	10	40	149
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	98	98	98	98	98	98
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	5	78	112	10	41	152

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	83	0	278	44
Stage 1	-	-	-	-	44	-
Stage 2	-	-	-	-	234	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1514	-	712	1026
Stage 1	-	-	-	-	978	-
Stage 2	-	-	-	-	805	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1514	-	659	1026
Mov Cap-2 Maneuver	-	-	-	-	659	-
Stage 1	-	-	-	-	978	-
Stage 2	-	-	-	-	745	-

Approach	EB	WB	NB
HCM Control Delay, s	0	6.9	10
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	918	-	-	1514	-
HCM Lane V/C Ratio	0.21	-	-	0.074	-
HCM Control Delay (s)	10	-	-	7.6	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	0.8	-	-	0.2	-

Intersection	
Int Delay, s/veh	5.4

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	20	110	330	169	156	30
Future Vol, veh/h	20	110	330	169	156	30
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	75	0	100	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	21	117	351	180	166	32

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1064	182	198	0	-	0
Stage 1	182	-	-	-	-	-
Stage 2	882	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.218	-	-	-
Pot Cap-1 Maneuver	247	861	1375	-	-	-
Stage 1	849	-	-	-	-	-
Stage 2	405	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	184	861	1375	-	-	-
Mov Cap-2 Maneuver	184	-	-	-	-	-
Stage 1	633	-	-	-	-	-
Stage 2	405	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	12.5	5.6	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	1375	-	184	861	-	-
HCM Lane V/C Ratio	0.255	-	0.116	0.136	-	-
HCM Control Delay (s)	8.5	-	27.1	9.8	-	-
HCM Lane LOS	A	-	D	A	-	-
HCM 95th %tile Q(veh)	1	-	0.4	0.5	-	-

Intersection	
Int Delay, s/veh	10.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	20	30	20	20	60	280	10	220	50	50	395	20
Future Vol, veh/h	20	30	20	20	60	280	10	220	50	50	395	20
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	22	33	22	22	65	304	11	239	54	54	429	22

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1021	863	440	864	847	266	451	0	0	293	0	0
Stage 1	548	548	-	288	288	-	-	-	-	-	-	-
Stage 2	473	315	-	576	559	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	215	292	617	274	299	773	1109	-	-	1269	-	-
Stage 1	521	517	-	720	674	-	-	-	-	-	-	-
Stage 2	572	656	-	503	511	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	101	272	617	228	279	773	1109	-	-	1269	-	-
Mov Cap-2 Maneuver	101	272	-	228	279	-	-	-	-	-	-	-
Stage 1	515	488	-	711	666	-	-	-	-	-	-	-
Stage 2	309	648	-	427	482	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	32.6	27.1	0.3	0.9
HCM LOS	D	D		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1109	-	-	205	541	1269	-	-
HCM Lane V/C Ratio	0.01	-	-	0.371	0.723	0.043	-	-
HCM Control Delay (s)	8.3	0	-	32.6	27.1	8	0	-
HCM Lane LOS	A	A	-	D	D	A	A	-
HCM 95th %tile Q(veh)	0	-	-	1.6	6	0.1	-	-

Intersection	
Intersection Delay, s/veh	9.6
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	2	2	1	1
Conflicting Circle Lanes	2	2	2	2
Adj Approach Flow, veh/h	412	774	304	474
Demand Flow Rate, veh/h	421	790	310	484
Vehicles Circulating, veh/h	484	289	538	767
Vehicles Exiting, veh/h	767	559	367	312
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	6.5	7.2	7.9	17.1
Approach LOS	A	A	A	C

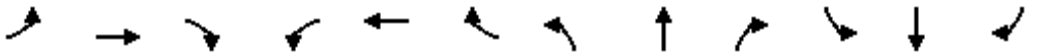
Lane	Left	Right	Left	Right	Left	Left
Designated Moves	LT	TR	LT	TR	LTR	LTR
Assumed Moves	LT	TR	LT	TR	LTR	LTR
RT Channelized						
Lane Util	0.470	0.530	0.470	0.530	1.000	1.000
Follow-Up Headway, s	2.667	2.535	2.667	2.535	2.535	2.535
Critical Headway, s	4.645	4.328	4.645	4.328	4.328	4.328
Entry Flow, veh/h	198	223	371	419	310	484
Cap Entry Lane, veh/h	865	941	1035	1111	899	740
Entry HV Adj Factor	0.979	0.980	0.980	0.979	0.982	0.980
Flow Entry, veh/h	194	219	364	410	304	474
Cap Entry, veh/h	846	922	1014	1087	882	725
V/C Ratio	0.229	0.237	0.359	0.377	0.345	0.654
Control Delay, s/veh	6.7	6.3	7.3	7.2	7.9	17.1
LOS	A	A	A	A	A	C
95th %tile Queue, veh	1	1	2	2	2	5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	25	374	105	587	582	320	100	154	647	125	111	30
Future Volume (vph)	25	374	105	587	582	320	100	154	647	125	111	30
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.9	5.9	5.5	5.9	5.9	5.5	5.9		5.5	5.9	5.9
Lane Util. Factor	1.00	0.95	1.00	0.97	1.00	1.00	1.00	0.95		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.88		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)	1770	3539	1583	3400	1863	1583	1770	3015		1770	1863	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (perm)	1770	3539	1583	3400	1863	1583	1770	3015		1770	1863	1583
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	27	398	112	624	619	340	106	164	688	133	118	32
RTOR Reduction (vph)	0	0	67	0	0	140	0	256	0	0	0	29
Lane Group Flow (vph)	27	398	45	624	619	200	106	596	0	133	118	3
Heavy Vehicles (%)	2%	2%	2%	3%	2%	2%	2%	2%	6%	2%	2%	2%
Turn Type	Prot	NA	Perm	Prot	NA	Perm	Prot	NA		Prot	NA	Perm
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases			2			6						4
Actuated Green, G (s)	3.0	52.1	52.1	15.5	64.6	64.6	25.7	32.1		7.5	13.9	13.9
Effective Green, g (s)	3.0	52.1	52.1	15.5	64.6	64.6	25.7	32.1		7.5	13.9	13.9
Actuated g/C Ratio	0.02	0.40	0.40	0.12	0.50	0.50	0.20	0.25		0.06	0.11	0.11
Clearance Time (s)	5.5	5.9	5.9	5.5	5.9	5.9	5.5	5.9		5.5	5.9	5.9
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	40	1418	634	405	925	786	349	744		102	199	169
v/s Ratio Prot	0.02	0.11		c0.18	c0.33		0.06	c0.20		c0.08	0.06	
v/s Ratio Perm			0.03			0.13						0.00
v/c Ratio	0.68	0.28	0.07	1.54	0.67	0.25	0.30	1.09dr		1.30	0.59	0.02
Uniform Delay, d1	63.0	26.3	24.0	57.2	24.6	18.8	44.5	46.0		61.2	55.4	52.0
Progression Factor	1.00	1.00	1.00	0.98	1.01	1.50	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	36.7	0.5	0.2	252.8	3.0	0.6	0.5	6.2		191.0	4.7	0.0
Delay (s)	99.8	26.8	24.2	308.8	27.9	28.9	45.0	52.1		252.2	60.0	52.0
Level of Service	F	C	C	F	C	C	D	D		F	E	D
Approach Delay (s)		29.9			138.8			51.4			149.5	
Approach LOS		C			F			D			F	

Intersection Summary			
HCM 2000 Control Delay	97.4	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	22.8
Intersection Capacity Utilization	85.9%	ICU Level of Service	E
Analysis Period (min)	15		

dr Defacto Right Lane. Recode with 1 though lane as a right lane.

c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	25	374	105	587	582	320	100	154	647	125	111	30
Future Volume (veh/h)	25	374	105	587	582	320	100	154	647	125	111	30
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1856	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	27	398	35	624	619	177	106	164	481	133	118	3
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	2	3	2	2	2	2	2	2	2	2
Cap, veh/h	43	1166	520	409	792	671	528	568	506	103	151	128
Arrive On Green	0.02	0.33	0.33	0.12	0.42	0.42	0.30	0.32	0.32	0.06	0.08	0.08
Sat Flow, veh/h	1781	3554	1585	3428	1870	1585	1781	1777	1585	1781	1870	1585
Grp Volume(v), veh/h	27	398	35	624	619	177	106	164	481	133	118	3
Grp Sat Flow(s),veh/h/ln	1781	1777	1585	1714	1870	1585	1781	1777	1585	1781	1870	1585
Q Serve(g_s), s	2.0	11.0	0.8	15.5	37.1	7.0	5.8	9.0	38.5	7.5	8.0	0.2
Cycle Q Clear(g_c), s	2.0	11.0	0.8	15.5	37.1	7.0	5.8	9.0	38.5	7.5	8.0	0.2
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	43	1166	520	409	792	671	528	568	506	103	151	128
V/C Ratio(X)	0.63	0.34	0.07	1.53	0.78	0.26	0.20	0.29	0.95	1.29	0.78	0.02
Avail Cap(c_a), veh/h	69	1166	520	409	792	671	528	588	524	103	577	489
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	0.71	0.71	0.71	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	62.9	33.0	5.5	57.2	32.3	13.6	34.2	33.2	43.2	61.2	58.6	42.5
Incr Delay (d2), s/veh	14.4	0.8	0.2	245.7	5.5	0.7	0.2	0.3	26.8	186.9	8.5	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	4.8	0.8	20.5	17.4	3.5	2.5	3.9	18.4	8.7	4.1	0.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	77.3	33.8	5.7	302.9	37.8	14.3	34.4	33.4	70.0	248.2	67.1	42.6
LnGrp LOS	E	C	A	F	D	B	C	C	E	F	E	D
Approach Vol, veh/h		460			1420			751			254	
Approach Delay, s/veh		34.2			151.4			57.0			161.7	
Approach LOS		C			F			E			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	21.0	48.6	44.0	16.4	8.6	61.0	13.0	47.4
Change Period (Y+Rc), s	5.5	5.9	5.5	5.9	5.5	5.9	5.5	5.9
Max Green Setting (Gmax), s	15.5	41.2	10.4	40.1	5.0	51.7	7.5	43.0
Max Q Clear Time (g_c+I1), s	17.5	13.0	7.8	10.0	4.0	39.1	9.5	40.5
Green Ext Time (p_c), s	0.0	2.6	0.1	0.6	0.0	3.7	0.0	1.0

Intersection Summary	
HCM 6th Ctrl Delay	109.0
HCM 6th LOS	F

Notes

User approved pedestrian interval to be less than phase max green.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	25	374	105	587	582	320	100	154	647	125	111	30
Future Volume (veh/h)	25	374	105	587	582	320	100	154	647	125	111	30
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q, veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj (A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Lanes Open During Work Zone												
Adj Sat Flow, veh/h/ln	1870	1870	1870	1856	1870	1870	1870	1870	1870	1870	1870	1870
Adj Flow Rate, veh/h	27	398	35	624	619	177	106	164	481	133	118	3
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	2	3	2	2	2	2	2	2	2	2
Opposing Right Turn Influence	Yes			Yes			Yes			Yes		
Cap, veh/h	43	1166	520	409	792	671	528	568	506	103	151	128
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Prop Arrive On Green	0.02	0.33	0.33	0.12	0.42	0.42	0.30	0.32	0.32	0.06	0.08	0.08
Unsig. Movement Delay												
Ln Grp Delay, s/veh	77.3	33.8	5.7	302.9	37.8	14.3	34.4	33.4	70.0	248.2	67.1	42.6
Ln Grp LOS	E	C	A	F	D	B	C	C	E	F	E	D
Approach Vol, veh/h		460			1420			751			254	
Approach Delay, s/veh		34.2			151.4			57.0			161.7	
Approach LOS		C			F			E			F	

Timer:	1	2	3	4	5	6	7	8
Assigned Phs	1	2	4	3	5	6	8	7
Case No	2.0	3.0	3.0	2.0	2.0	3.0	4.0	2.0
Phs Duration (G+Y+Rc), s	21.0	48.6	16.4	44.0	8.6	61.0	47.4	13.0
Change Period (Y+Rc), s	5.5	5.9	5.9	5.5	5.5	5.9	5.9	5.5
Max Green (Gmax), s	15.5	41.2	40.1	10.4	5.0	51.7	43.0	7.5
Max Allow Headway (MAH), s	3.7	4.9	5.0	3.7	3.7	4.8	5.3	3.7
Max Q Clear (g_c+I1), s	17.5	13.0	10.0	7.8	4.0	39.1	40.5	9.5
Green Ext Time (g_e), s	0.0	2.6	0.6	0.1	0.0	3.7	1.0	0.0
Prob of Phs Call (p_c)	1.00	1.00	0.99	0.98	0.62	1.00	1.00	0.99
Prob of Max Out (p_x)	1.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00

Left-Turn Movement Data								
Assigned Mvmt	1			3	5			7
Mvmt Sat Flow, veh/h	3428			1781	1781			1781

Through Movement Data								
Assigned Mvmt		2	4			6	8	
Mvmt Sat Flow, veh/h		3554	1870			1870	1777	

Right-Turn Movement Data								
Assigned Mvmt		12	14			16	18	
Mvmt Sat Flow, veh/h		1585	1585			1585	1585	

Left Lane Group Data								
Assigned Mvmt	1	0	0	3	5	0	0	7
Lane Assignment	L (Prot)			L (Prot)	L (Prot)			L (Prot)

Lanes in Grp	2	0	0	1	1	0	0	1
Grp Vol (v), veh/h	624	0	0	106	27	0	0	133
Grp Sat Flow (s), veh/h/ln	1714	0	0	1781	1781	0	0	1781
Q Serve Time (g_s), s	15.5	0.0	0.0	5.8	2.0	0.0	0.0	7.5
Cycle Q Clear Time (g_c), s	15.5	0.0	0.0	5.8	2.0	0.0	0.0	7.5
Perm LT Sat Flow (s_l), veh/h/ln	0	0	0	0	0	0	0	0
Shared LT Sat Flow (s_sh), veh/h/ln	0	0	0	0	0	0	0	0
Perm LT Eff Green (g_p), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perm LT Serve Time (g_u), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perm LT Q Serve Time (g_ps), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Time to First Blk (g_f), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Serve Time pre Blk (g_fs), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prop LT Inside Lane (P_L)	1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00
Lane Grp Cap (c), veh/h	409	0	0	528	43	0	0	103
V/C Ratio (X)	1.53	0.00	0.00	0.20	0.63	0.00	0.00	1.29
Avail Cap (c_a), veh/h	409	0	0	528	69	0	0	103
Upstream Filter (I)	0.71	0.00	0.00	1.00	1.00	0.00	0.00	1.00
Uniform Delay (d1), s/veh	57.2	0.0	0.0	34.2	62.9	0.0	0.0	61.2
Incr Delay (d2), s/veh	245.7	0.0	0.0	0.2	14.4	0.0	0.0	186.9
Initial Q Delay (d3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	302.9	0.0	0.0	34.4	77.3	0.0	0.0	248.2
1st-Term Q (Q1), veh/ln	6.6	0.0	0.0	2.5	0.9	0.0	0.0	3.3
2nd-Term Q (Q2), veh/ln	13.9	0.0	0.0	0.0	0.2	0.0	0.0	5.3
3rd-Term Q (Q3), veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile Back of Q Factor (f_B%)	1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00
%ile Back of Q (50%), veh/ln	20.5	0.0	0.0	2.5	1.0	0.0	0.0	8.7
%ile Storage Ratio (RQ%)	0.81	0.00	0.00	0.21	0.04	0.00	0.00	0.81
Initial Q (Qb), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final (Residual) Q (Qe), veh	53.8	0.0	0.0	0.0	0.0	0.0	0.0	7.6
Sat Delay (ds), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Q (Qs), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Cap (cs), veh/h	0	0	0	0	0	0	0	0
Initial Q Clear Time (tc), h	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.3

Middle Lane Group Data								
Assigned Mvmt	0	2	4	0	0	6	8	0
Lane Assignment		T	T			T	T	
Lanes in Grp	0	2	1	0	0	1	1	0
Grp Vol (v), veh/h	0	398	118	0	0	619	164	0
Grp Sat Flow (s), veh/h/ln	0	1777	1870	0	0	1870	1777	0
Q Serve Time (g_s), s	0.0	11.0	8.0	0.0	0.0	37.1	9.0	0.0
Cycle Q Clear Time (g_c), s	0.0	11.0	8.0	0.0	0.0	37.1	9.0	0.0
Lane Grp Cap (c), veh/h	0	1166	151	0	0	792	568	0
V/C Ratio (X)	0.00	0.34	0.78	0.00	0.00	0.78	0.29	0.00
Avail Cap (c_a), veh/h	0	1166	577	0	0	792	588	0
Upstream Filter (I)	0.00	1.00	1.00	0.00	0.00	0.71	1.00	0.00
Uniform Delay (d1), s/veh	0.0	33.0	58.6	0.0	0.0	32.3	33.2	0.0
Incr Delay (d2), s/veh	0.0	0.8	8.5	0.0	0.0	5.5	0.3	0.0
Initial Q Delay (d3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	0.0	33.8	67.1	0.0	0.0	37.8	33.4	0.0
1st-Term Q (Q1), veh/ln	0.0	4.7	3.8	0.0	0.0	16.2	3.8	0.0
2nd-Term Q (Q2), veh/ln	0.0	0.1	0.4	0.0	0.0	1.2	0.0	0.0

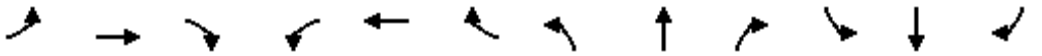
3rd-Term Q (Q3), veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile Back of Q Factor (f_B%)	0.00	1.00	1.00	0.00	0.00	1.00	1.00	0.00
%ile Back of Q (50%), veh/ln	0.0	4.8	4.1	0.0	0.0	17.4	3.9	0.0
%ile Storage Ratio (RQ%)	0.00	0.10	0.38	0.00	0.00	0.45	0.18	0.00
Initial Q (Qb), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final (Residual) Q (Qe), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Delay (ds), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Q (Qs), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Cap (cs), veh/h	0	0	0	0	0	0	0	0
Initial Q Clear Time (tc), h	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Right Lane Group Data								
Assigned Mvmt	0	12	14	0	0	16	18	0
Lane Assignment		R	R			R	T+R	
Lanes in Grp	0	1	1	0	0	1	1	0
Grp Vol (v), veh/h	0	35	3	0	0	177	481	0
Grp Sat Flow (s), veh/h/ln	0	1585	1585	0	0	1585	1585	0
Q Serve Time (g_s), s	0.0	0.8	0.2	0.0	0.0	7.0	38.5	0.0
Cycle Q Clear Time (g_c), s	0.0	0.8	0.2	0.0	0.0	7.0	38.5	0.0
Prot RT Sat Flow (s_R), veh/h/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prot RT Eff Green (g_R), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prop RT Outside Lane (P_R)	0.00	1.00	1.00	0.00	0.00	1.00	1.00	0.00
Lane Grp Cap (c), veh/h	0	520	128	0	0	671	506	0
V/C Ratio (X)	0.00	0.07	0.02	0.00	0.00	0.26	0.95	0.00
Avail Cap (c_a), veh/h	0	520	489	0	0	671	524	0
Upstream Filter (I)	0.00	1.00	1.00	0.00	0.00	0.71	1.00	0.00
Uniform Delay (d1), s/veh	0.0	5.5	42.5	0.0	0.0	13.6	43.2	0.0
Incr Delay (d2), s/veh	0.0	0.2	0.1	0.0	0.0	0.7	26.8	0.0
Initial Q Delay (d3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	0.0	5.7	42.6	0.0	0.0	14.3	70.0	0.0
1st-Term Q (Q1), veh/ln	0.0	0.7	0.1	0.0	0.0	3.4	14.7	0.0
2nd-Term Q (Q2), veh/ln	0.0	0.0	0.0	0.0	0.0	0.1	3.8	0.0
3rd-Term Q (Q3), veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile Back of Q Factor (f_B%)	0.00	1.00	1.00	0.00	0.00	1.00	1.00	0.00
%ile Back of Q (50%), veh/ln	0.0	0.8	0.1	0.0	0.0	3.5	18.4	0.0
%ile Storage Ratio (RQ%)	0.00	0.20	0.05	0.00	0.00	0.09	0.86	0.00
Initial Q (Qb), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final (Residual) Q (Qe), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Delay (ds), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Q (Qs), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Cap (cs), veh/h	0	0	0	0	0	0	0	0
Initial Q Clear Time (tc), h	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	109.0
HCM 6th LOS	F

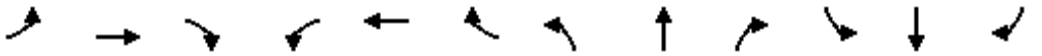
Notes

User approved pedestrian interval to be less than phase max green.



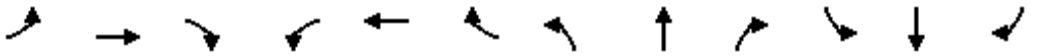
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	716	430	120	636	0	0	0	0	150	0	853
Future Volume (vph)	0	716	430	120	636	0	0	0	0	150	0	853
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9	5.9	5.5	5.9						5.9	5.9
Lane Util. Factor		0.95	1.00	1.00	0.95						1.00	0.88
Frt		1.00	0.85	1.00	1.00						1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00						0.95	1.00
Satd. Flow (prot)		3406	1583	1770	3539						1770	2760
Flt Permitted		1.00	1.00	0.95	1.00						0.95	1.00
Satd. Flow (perm)		3406	1583	1770	3539						1770	2760
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	0	823	494	138	731	0	0	0	0	172	0	980
RTOR Reduction (vph)	0	0	245	0	0	0	0	0	0	0	0	546
Lane Group Flow (vph)	0	823	249	138	731	0	0	0	0	0	172	434
Heavy Vehicles (%)	2%	6%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%
Turn Type		NA	Perm	Prot	NA					Perm	NA	Perm
Protected Phases		2		1	6						4	
Permitted Phases			2							4		4
Actuated Green, G (s)		65.4	65.4	12.3	83.2						25.5	25.5
Effective Green, g (s)		65.4	65.4	12.3	83.2						25.5	25.5
Actuated g/C Ratio		0.50	0.50	0.09	0.64						0.20	0.20
Clearance Time (s)		5.9	5.9	5.5	5.9						5.9	5.9
Vehicle Extension (s)		3.0	3.0	3.5	5.0						4.0	4.0
Lane Grp Cap (vph)		1713	796	167	2264						347	541
v/s Ratio Prot		c0.24		c0.08	0.21							
v/s Ratio Perm			0.16								0.10	c0.16
v/c Ratio		0.48	0.31	0.83	0.32						0.50	0.80
Uniform Delay, d1		21.2	19.0	57.8	10.6						46.5	49.8
Progression Factor		0.95	2.62	1.00	1.00						1.00	1.00
Incremental Delay, d2		0.8	0.8	27.7	0.4						1.5	8.9
Delay (s)		20.8	50.8	85.5	11.0						48.0	58.7
Level of Service		C	D	F	B						D	E
Approach Delay (s)		32.1			22.8			0.0			57.1	
Approach LOS		C			C			A			E	

Intersection Summary			
HCM 2000 Control Delay	38.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	21.3
Intersection Capacity Utilization	62.5%	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)	484	382	0	0	290	70	466	0	210	0	0	0
Future Volume (vph)	484	382	0	0	290	70	466	0	210	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.5	5.9			5.9	5.9	5.9	5.9	5.9			
Lane Util. Factor	1.00	0.95			0.95	1.00	0.95	0.95	1.00			
Frt	1.00	1.00			1.00	0.85	1.00	1.00	0.85			
Flt Protected	0.95	1.00			1.00	1.00	0.95	0.95	1.00			
Satd. Flow (prot)	1703	3539			3539	1583	1681	1681	1583			
Flt Permitted	0.95	1.00			1.00	1.00	0.95	0.95	1.00			
Satd. Flow (perm)	1703	3539			3539	1583	1681	1681	1583			
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	532	420	0	0	319	77	512	0	231	0	0	0
RTOR Reduction (vph)	0	0	0	0	0	54	0	0	189	0	0	0
Lane Group Flow (vph)	532	420	0	0	319	23	256	256	42	0	0	0
Heavy Vehicles (%)	6%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA			NA	Perm	Perm	NA	Perm			
Protected Phases	5	2			6			8				
Permitted Phases						6	8		8			
Actuated Green, G (s)	47.0	89.2			36.7	36.7	22.6	22.6	22.6			
Effective Green, g (s)	47.0	89.2			36.7	36.7	22.6	22.6	22.6			
Actuated g/C Ratio	0.38	0.72			0.30	0.30	0.18	0.18	0.18			
Clearance Time (s)	5.5	5.9			5.9	5.9	5.9	5.9	5.9			
Vehicle Extension (s)	4.0	3.0			3.5	3.5	4.0	4.0	4.0			
Lane Grp Cap (vph)	647	2554			1050	470	307	307	289			
v/s Ratio Prot	c0.31	0.12			c0.09							
v/s Ratio Perm						0.01	c0.15	0.15	0.03			
v/c Ratio	0.82	0.16			0.30	0.05	0.83	0.83	0.15			
Uniform Delay, d1	34.5	5.4			33.6	31.0	48.7	48.7	42.4			
Progression Factor	1.00	1.00			1.00	1.00	1.00	1.00	1.00			
Incremental Delay, d2	8.7	0.1			0.7	0.2	18.1	18.1	0.3			
Delay (s)	43.2	5.6			34.3	31.2	66.8	66.8	42.7			
Level of Service	D	A			C	C	E	E	D			
Approach Delay (s)		26.6			33.7			59.3			0.0	
Approach LOS		C			C			E			A	

Intersection Summary			
HCM 2000 Control Delay	39.6	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	123.6	Sum of lost time (s)	17.3
Intersection Capacity Utilization	62.5%	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 (veh/h)	484	382	0	0	290	70	466	0	210	0	0	0
Future Volume (veh/h)	484	382	0	0	290	70	466	0	210	0	0	0
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Adj Sat Flow, veh/h/ln	1811	1870	0	0	1870	1870	1870	1870	1870			
Adj Flow Rate, veh/h	532	420	0	0	319	15	512	0	42			
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91			
Percent Heavy Veh, %	6	2	0	0	2	2	2	2	2			
Cap, veh/h	580	2611	0	0	1255	560	598	0	266			
Arrive On Green	0.34	0.73	0.00	0.00	0.35	0.35	0.17	0.00	0.17			
Sat Flow, veh/h	1725	3647	0	0	3647	1585	3563	0	1585			
Grp Volume(v), veh/h	532	420	0	0	319	15	512	0	42			
Grp Sat Flow(s),veh/h/ln	1725	1777	0	0	1777	1585	1781	0	1585			
Q Serve(g_s), s	35.9	4.3	0.0	0.0	7.7	0.7	16.9	0.0	2.7			
Cycle Q Clear(g_c), s	35.9	4.3	0.0	0.0	7.7	0.7	16.9	0.0	2.7			
Prop In Lane	1.00		0.00	0.00		1.00	1.00		1.00			
Lane Grp Cap(c), veh/h	580	2611	0	0	1255	560	598	0	266			
V/C Ratio(X)	0.92	0.16	0.00	0.00	0.25	0.03	0.86	0.00	0.16			
Avail Cap(c_a), veh/h	875	2611	0	0	1255	560	708	0	315			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	1.00			
Uniform Delay (d), s/veh	38.6	4.8	0.0	0.0	27.9	25.6	49.0	0.0	43.1			
Incr Delay (d2), s/veh	11.9	0.1	0.0	0.0	0.5	0.1	9.6	0.0	0.4			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	16.5	1.4	0.0	0.0	3.3	0.3	8.1	0.0	1.1			
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	50.5	5.0	0.0	0.0	28.4	25.7	58.7	0.0	43.5			
LnGrp LOS	D	A	A	A	C	C	E	A	D			
Approach Vol, veh/h		952			334			554				
Approach Delay, s/veh		30.4			28.2			57.5				
Approach LOS		C			C			E				
Timer - Assigned Phs		2			5	6		8				
Phs Duration (G+Y+Rc), s		95.0			46.3	48.7		26.2				
Change Period (Y+Rc), s		5.9			5.5	5.9		5.9				
Max Green Setting (Gmax), s		89.1			61.5	22.1		24.1				
Max Q Clear Time (g_c+I1), s		6.3			37.9	9.7		18.9				
Green Ext Time (p_c), s		2.9			2.9	1.8		1.4				

Intersection Summary	
HCM 6th Ctrl Delay	38.2
HCM 6th LOS	D

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	484	382	0	0	290	70	466	0	210	0	0	0
Future Volume (veh/h)	484	382	0	0	290	70	466	0	210	0	0	0
Number	5	2	12	1	6	16	3	8	18			
Initial Q, veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj (A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Lanes Open During Work Zone												
Adj Sat Flow, veh/h/ln	1811	1870	0	0	1870	1870	1870	1870	1870			
Adj Flow Rate, veh/h	532	420	0	0	319	15	512	0	42			
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91			
Percent Heavy Veh, %	6	2	0	0	2	2	2	2	2			
Opposing Right Turn Influence	Yes			No			Yes					
Cap, veh/h	580	2611	0	0	1255	560	598	0	266			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Prop Arrive On Green	0.34	0.73	0.00	0.00	0.35	0.35	0.17	0.00	0.17			
Unsig. Movement Delay												
Ln Grp Delay, s/veh	50.5	5.0	0.0	0.0	28.4	25.7	58.7	0.0	43.5			
Ln Grp LOS	D	A	A	A	C	C	E	A	D			
Approach Vol, veh/h		952			334			554				
Approach Delay, s/veh		30.4			28.2			57.5				
Approach LOS		C			C			E				

Timer:	1	2	3	4	5	6	7	8
Assigned Phs		2	8		5	6		
Case No		4.0	9.0		2.0	7.0		
Phs Duration (G+Y+Rc), s		95.0	26.2		46.3	48.7		
Change Period (Y+Rc), s		5.9	5.9		5.5	5.9		
Max Green (Gmax), s		89.1	24.1		61.5	22.1		
Max Allow Headway (MAH), s		5.0	4.7		4.7	5.5		
Max Q Clear (g_c+I1), s		6.3	18.9		37.9	9.7		
Green Ext Time (g_e), s		2.9	1.4		2.9	1.8		
Prob of Phs Call (p_c)		1.00	1.00		1.00	1.00		
Prob of Max Out (p_x)		0.00	0.87		0.01	0.00		

Left-Turn Movement Data								
Assigned Mvmt			3		5	1		
Mvmt Sat Flow, veh/h			3563		1725	0		

Through Movement Data								
Assigned Mvmt		2	8			6		
Mvmt Sat Flow, veh/h		3647	0			3647		

Right-Turn Movement Data								
Assigned Mvmt		12	18			16		
Mvmt Sat Flow, veh/h		0	1585			1585		

Left Lane Group Data								
Assigned Mvmt	0	0	3	0	5	1	0	0
Lane Assignment			L		L (Prot)			

Lanes in Grp	0	0	2	0	1	0	0	0
Grp Vol (v), veh/h	0	0	512	0	532	0	0	0
Grp Sat Flow (s), veh/h/ln	0	0	1781	0	1725	0	0	0
Q Serve Time (g_s), s	0.0	0.0	16.9	0.0	35.9	0.0	0.0	0.0
Cycle Q Clear Time (g_c), s	0.0	0.0	16.9	0.0	35.9	0.0	0.0	0.0
Perm LT Sat Flow (s_l), veh/h/ln	0	0	1781	0	0	0	0	0
Shared LT Sat Flow (s_sh), veh/h/ln	0	0	0	0	0	0	0	0
Perm LT Eff Green (g_p), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perm LT Serve Time (g_u), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perm LT Q Serve Time (g_ps), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Time to First Blk (g_f), s	0.0	0.0	0.0	0.0	0.0	42.8	0.0	0.0
Serve Time pre Blk (g_fs), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prop LT Inside Lane (P_L)	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00
Lane Grp Cap (c), veh/h	0	0	598	0	580	0	0	0
V/C Ratio (X)	0.00	0.00	0.86	0.00	0.92	0.00	0.00	0.00
Avail Cap (c_a), veh/h	0	0	708	0	875	0	0	0
Upstream Filter (I)	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00
Uniform Delay (d1), s/veh	0.0	0.0	49.0	0.0	38.6	0.0	0.0	0.0
Incr Delay (d2), s/veh	0.0	0.0	9.6	0.0	11.9	0.0	0.0	0.0
Initial Q Delay (d3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	0.0	0.0	58.7	0.0	50.5	0.0	0.0	0.0
1st-Term Q (Q1), veh/ln	0.0	0.0	7.3	0.0	14.6	0.0	0.0	0.0
2nd-Term Q (Q2), veh/ln	0.0	0.0	0.8	0.0	1.9	0.0	0.0	0.0
3rd-Term Q (Q3), veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile Back of Q Factor (f_B%)	0.00	0.00	1.00	0.00	1.00	1.00	0.00	0.00
%ile Back of Q (50%), veh/ln	0.0	0.0	8.1	0.0	16.5	0.0	0.0	0.0
%ile Storage Ratio (RQ%)	0.00	0.00	0.91	0.00	1.92	0.00	0.00	0.00
Initial Q (Qb), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final (Residual) Q (Qe), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Delay (ds), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Q (Qs), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Cap (cs), veh/h	0	0	0	0	0	0	0	0
Initial Q Clear Time (tc), h	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Middle Lane Group Data								
Assigned Mvmt	0	2	8	0	0	6	0	0
Lane Assignment		T				T		
Lanes in Grp	0	2	0	0	0	2	0	0
Grp Vol (v), veh/h	0	420	0	0	0	319	0	0
Grp Sat Flow (s), veh/h/ln	0	1777	0	0	0	1777	0	0
Q Serve Time (g_s), s	0.0	4.3	0.0	0.0	0.0	7.7	0.0	0.0
Cycle Q Clear Time (g_c), s	0.0	4.3	0.0	0.0	0.0	7.7	0.0	0.0
Lane Grp Cap (c), veh/h	0	2611	0	0	0	1255	0	0
V/C Ratio (X)	0.00	0.16	0.00	0.00	0.00	0.25	0.00	0.00
Avail Cap (c_a), veh/h	0	2611	0	0	0	1255	0	0
Upstream Filter (I)	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00
Uniform Delay (d1), s/veh	0.0	4.8	0.0	0.0	0.0	27.9	0.0	0.0
Incr Delay (d2), s/veh	0.0	0.1	0.0	0.0	0.0	0.5	0.0	0.0
Initial Q Delay (d3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	0.0	5.0	0.0	0.0	0.0	28.4	0.0	0.0
1st-Term Q (Q1), veh/ln	0.0	1.3	0.0	0.0	0.0	3.2	0.0	0.0
2nd-Term Q (Q2), veh/ln	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0

3rd-Term Q (Q3), veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile Back of Q Factor (f_B%)	0.00	1.00	1.00	0.00	0.00	1.00	0.00	0.00
%ile Back of Q (50%), veh/ln	0.0	1.4	0.0	0.0	0.0	3.3	0.0	0.0
%ile Storage Ratio (RQ%)	0.00	0.05	0.00	0.00	0.00	0.14	0.00	0.00
Initial Q (Qb), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final (Residual) Q (Qe), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Delay (ds), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Q (Qs), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Cap (cs), veh/h	0	0	0	0	0	0	0	0
Initial Q Clear Time (tc), h	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Right Lane Group Data								
Assigned Mvmt	0	12	18	0	0	16	0	0
Lane Assignment			R			R		
Lanes in Grp	0	0	1	0	0	1	0	0
Grp Vol (v), veh/h	0	0	42	0	0	15	0	0
Grp Sat Flow (s), veh/h/ln	0	0	1585	0	0	1585	0	0
Q Serve Time (g_s), s	0.0	0.0	2.7	0.0	0.0	0.7	0.0	0.0
Cycle Q Clear Time (g_c), s	0.0	0.0	2.7	0.0	0.0	0.7	0.0	0.0
Prot RT Sat Flow (s_R), veh/h/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prot RT Eff Green (g_R), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prop RT Outside Lane (P_R)	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00
Lane Grp Cap (c), veh/h	0	0	266	0	0	560	0	0
V/C Ratio (X)	0.00	0.00	0.16	0.00	0.00	0.03	0.00	0.00
Avail Cap (c_a), veh/h	0	0	315	0	0	560	0	0
Upstream Filter (I)	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00
Uniform Delay (d1), s/veh	0.0	0.0	43.1	0.0	0.0	25.6	0.0	0.0
Incr Delay (d2), s/veh	0.0	0.0	0.4	0.0	0.0	0.1	0.0	0.0
Initial Q Delay (d3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	0.0	0.0	43.5	0.0	0.0	25.7	0.0	0.0
1st-Term Q (Q1), veh/ln	0.0	0.0	1.1	0.0	0.0	0.3	0.0	0.0
2nd-Term Q (Q2), veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3rd-Term Q (Q3), veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile Back of Q Factor (f_B%)	0.00	1.00	1.00	0.00	0.00	1.00	0.00	0.00
%ile Back of Q (50%), veh/ln	0.0	0.0	1.1	0.0	0.0	0.3	0.0	0.0
%ile Storage Ratio (RQ%)	0.00	0.00	0.12	0.00	0.00	0.07	0.00	0.00
Initial Q (Qb), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final (Residual) Q (Qe), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Delay (ds), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Q (Qs), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Cap (cs), veh/h	0	0	0	0	0	0	0	0
Initial Q Clear Time (tc), h	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	38.2
HCM 6th LOS	D

Notes

User approved volume balancing among the lanes for turning movement.

Intersection	
Intersection Delay, s/veh	7.5
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	2	2
Conflicting Circle Lanes	2	2	2	2
Adj Approach Flow, veh/h	198	178	782	836
Demand Flow Rate, veh/h	202	181	825	859
Vehicles Circulating, veh/h	849	878	361	74
Vehicles Exiting, veh/h	84	308	690	985
Ped Vol Crossing Leg, #/h	0	0	0	4
Ped Cap Adj	1.000	1.000	1.000	0.996
Approach Delay, s/veh	9.0	8.8	8.4	5.9
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Right	Left	Right
Designated Moves	LTR	LTR	LT	TR	LT	TR
Assumed Moves	LTR	LTR	LT	TR	LT	TR
RT Channelized						
Lane Util	1.000	1.000	0.470	0.530	0.470	0.530
Follow-Up Headway, s	2.535	2.535	2.667	2.535	2.667	2.535
Critical Headway, s	4.328	4.328	4.645	4.328	4.645	4.328
Entry Flow, veh/h	202	181	388	437	404	455
Cap Entry Lane, veh/h	690	673	968	1045	1261	1334
Entry HV Adj Factor	0.978	0.981	0.947	0.948	0.973	0.974
Flow Entry, veh/h	198	178	367	414	393	443
Cap Entry, veh/h	675	661	917	991	1222	1294
V/C Ratio	0.293	0.269	0.401	0.418	0.322	0.343
Control Delay, s/veh	9.0	8.8	8.5	8.3	5.9	5.9
LOS	A	A	A	A	A	A
95th %tile Queue, veh	1	1	2	2	1	2

Intersection	
Int Delay, s/veh	2.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	20	110	70	260	260	70
Future Vol, veh/h	20	110	70	260	260	70
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	22	120	76	283	283	76

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	756	321	359	0	-	0
Stage 1	321	-	-	-	-	-
Stage 2	435	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.218	-	-	-
Pot Cap-1 Maneuver	376	720	1200	-	-	-
Stage 1	735	-	-	-	-	-
Stage 2	653	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	348	720	1200	-	-	-
Mov Cap-2 Maneuver	348	-	-	-	-	-
Stage 1	680	-	-	-	-	-
Stage 2	653	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	12.5	1.7	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1200	-	618	-	-
HCM Lane V/C Ratio	0.063	-	0.229	-	-
HCM Control Delay (s)	8.2	0	12.5	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0.2	-	0.9	-	-

Intersection	
Int Delay, s/veh	3.4

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	10	70	260	20	170	200
Future Vol, veh/h	10	70	260	20	170	200
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	84	84	84	84	84	84
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	12	83	310	24	202	238

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	964	322	0	0	334	0
Stage 1	322	-	-	-	-	-
Stage 2	642	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	283	719	-	-	1225	-
Stage 1	735	-	-	-	-	-
Stage 2	524	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	229	719	-	-	1225	-
Mov Cap-2 Maneuver	229	-	-	-	-	-
Stage 1	735	-	-	-	-	-
Stage 2	424	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	12.6	0	3.9
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	567	1225	-
HCM Lane V/C Ratio	-	-	0.168	0.165	-
HCM Control Delay (s)	-	-	12.6	8.5	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.6	0.6	-

Intersection	
Int Delay, s/veh	3.1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	20	130	240	731	603	40
Future Vol, veh/h	20	130	240	731	603	40
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	75	-	-	75
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	98	98	98	98	98	98
Heavy Vehicles, %	2	2	2	6	3	2
Mvmt Flow	20	133	245	746	615	41

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1851	615	656	0	-	0
Stage 1	615	-	-	-	-	-
Stage 2	1236	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.218	-	-	-
Pot Cap-1 Maneuver	82	491	931	-	-	-
Stage 1	539	-	-	-	-	-
Stage 2	274	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	60	491	931	-	-	-
Mov Cap-2 Maneuver	174	-	-	-	-	-
Stage 1	397	-	-	-	-	-
Stage 2	274	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	19.8	2.5	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	931	-	395	-	-
HCM Lane V/C Ratio	0.263	-	0.387	-	-
HCM Control Delay (s)	10.2	-	19.8	-	-
HCM Lane LOS	B	-	C	-	-
HCM 95th %tile Q(veh)	1.1	-	1.8	-	-

Intersection	
Int Delay, s/veh	2.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	80	40	30	891	663	70
Future Vol, veh/h	80	40	30	891	663	70
Conflicting Peds, #/hr	0	1	1	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	100	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	2	2	2	6	3	2
Mvmt Flow	84	42	32	938	698	74

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1738	737	773	0	-	0
Stage 1	736	-	-	-	-	-
Stage 2	1002	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.218	-	-	-
Pot Cap-1 Maneuver	96	418	842	-	-	-
Stage 1	474	-	-	-	-	-
Stage 2	355	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	92	417	841	-	-	-
Mov Cap-2 Maneuver	223	-	-	-	-	-
Stage 1	456	-	-	-	-	-
Stage 2	355	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	30.5	0.3	0
HCM LOS	D		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	841	-	264	-	-
HCM Lane V/C Ratio	0.038	-	0.478	-	-
HCM Control Delay (s)	9.4	-	30.5	-	-
HCM Lane LOS	A	-	D	-	-
HCM 95th %tile Q(veh)	0.1	-	2.4	-	-

Intersection	
Int Delay, s/veh	70.8

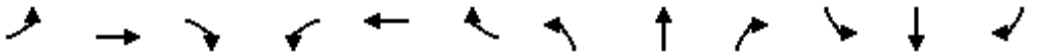
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	101	0	236	0	0	0	222	820	0	0	670	33
Future Vol, veh/h	101	0	236	0	0	0	222	820	0	0	670	33
Conflicting Peds, #/hr	0	0	1	1	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	125	-	-	-	-	-	120	-	-	75	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	94	94	94	94	94	94	94	94	94	94	94	94
Heavy Vehicles, %	2	2	5	2	2	2	6	6	2	2	3	2
Mvmt Flow	107	0	251	0	0	0	236	872	0	0	713	35

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	2075	2075	732	2201	2092	872	748	0	0	872	0	0
Stage 1	731	731	-	1344	1344	-	-	-	-	-	-	-
Stage 2	1344	1344	-	857	748	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.25	7.12	6.52	6.22	4.16	-	-	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.345	3.518	4.018	3.318	2.254	-	-	2.218	-	-
Pot Cap-1 Maneuver	~ 39	54	416	32	52	350	843	-	-	773	-	-
Stage 1	413	427	-	187	220	-	-	-	-	-	-	-
Stage 2	187	220	-	352	420	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	~ 31	39	416	10	37	350	843	-	-	773	-	-
Mov Cap-2 Maneuver	~ 31	39	-	10	37	-	-	-	-	-	-	-
Stage 1	297	427	-	135	158	-	-	-	-	-	-	-
Stage 2	135	158	-	139	420	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	$ 430.4	0	2.3	0
HCM LOS	F	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	843	-	-	31	416	-	773	-	-
HCM Lane V/C Ratio	0.28	-	-	3.466	0.604	-	-	-	-
HCM Control Delay (s)	10.9	-	-	$ 1375.3	26	0	0	-	-
HCM Lane LOS	B	-	-	F	D	A	A	-	-
HCM 95th %tile Q(veh)	1.1	-	-	12.7	3.8	-	0	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	716	430	120	636	0	0	0	0	150	0	853
Future Volume (vph)	0	716	430	120	636	0	0	0	0	150	0	853
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9	5.9	5.5	5.9						5.9	5.9
Lane Util. Factor		0.95	1.00	1.00	0.95						1.00	0.88
Frt		1.00	0.85	1.00	1.00						1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00						0.95	1.00
Satd. Flow (prot)		3406	1583	1770	3539						1770	2760
Flt Permitted		1.00	1.00	0.95	1.00						0.95	1.00
Satd. Flow (perm)		3406	1583	1770	3539						1770	2760
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	0	823	494	138	731	0	0	0	0	172	0	980
RTOR Reduction (vph)	0	0	245	0	0	0	0	0	0	0	0	546
Lane Group Flow (vph)	0	823	249	138	731	0	0	0	0	0	172	434
Heavy Vehicles (%)	2%	6%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%
Turn Type		NA	Perm	Prot	NA					Perm	NA	Perm
Protected Phases		2		1	6						4	
Permitted Phases			2							4		4
Actuated Green, G (s)		65.4	65.4	12.3	83.2						25.5	25.5
Effective Green, g (s)		65.4	65.4	12.3	83.2						25.5	25.5
Actuated g/C Ratio		0.50	0.50	0.09	0.64						0.20	0.20
Clearance Time (s)		5.9	5.9	5.5	5.9						5.9	5.9
Vehicle Extension (s)		3.0	3.0	3.5	5.0						4.0	4.0
Lane Grp Cap (vph)		1713	796	167	2264						347	541
v/s Ratio Prot		c0.24		c0.08	0.21							
v/s Ratio Perm			0.16								0.10	c0.16
v/c Ratio		0.48	0.31	0.83	0.32						0.50	0.80
Uniform Delay, d1		21.2	19.0	57.8	10.6						46.5	49.8
Progression Factor		0.95	2.62	1.00	1.00						1.00	1.00
Incremental Delay, d2		0.8	0.8	27.7	0.4						1.5	8.9
Delay (s)		20.8	50.8	85.5	11.0						48.0	58.7
Level of Service		C	D	F	B						D	E
Approach Delay (s)		32.1			22.8			0.0			57.1	
Approach LOS		C			C			A			E	

Intersection Summary			
HCM 2000 Control Delay	38.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	21.3
Intersection Capacity Utilization	62.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

MOVEMENT SUMMARY

Site: 101 [Sargent Rd & US 12]

New Site
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
South: Old Hwy 99												
3	L2	65	3.0	0.335	11.9	LOS B	1.5	39.3	0.55	0.66	0.55	30.0
8	T1	185	3.0	0.335	6.1	LOS A	1.5	39.3	0.55	0.66	0.55	35.5
18	R2	54	3.0	0.335	7.6	LOS A	1.5	39.3	0.55	0.66	0.55	20.6
Approach		304	3.0	0.335	7.6	LOS A	1.5	39.3	0.55	0.66	0.55	30.4
East: 198th Ave												
1	L2	87	3.0	0.328	1.1	LOS A	1.7	43.0	0.44	0.25	0.44	21.2
6	T1	654	3.0	0.328	1.1	LOS A	1.7	44.1	0.43	0.23	0.43	18.7
16	R2	33	3.0	0.328	1.0	LOS A	1.7	44.1	0.43	0.22	0.43	20.7
Approach		774	3.0	0.328	1.1	LOS A	1.7	44.1	0.43	0.23	0.43	19.1
North: Old Hwy 99												
7	L2	158	3.0	0.587	15.2	LOS B	3.6	92.7	0.72	0.92	0.91	20.2
4	T1	283	3.0	0.587	8.6	LOS A	3.6	92.7	0.72	0.92	0.91	34.3
14	R2	33	3.0	0.587	8.4	LOS A	3.6	92.7	0.72	0.92	0.91	27.6
Approach		473	3.0	0.587	10.8	LOS B	3.6	92.7	0.72	0.92	0.91	27.5
West: 198th Ave												
5	L2	33	3.0	0.212	7.4	LOS A	1.1	28.4	0.58	0.69	0.58	28.3
2	T1	336	3.0	0.212	6.4	LOS A	1.2	29.9	0.58	0.67	0.58	17.9
12	R2	43	3.0	0.212	3.1	LOS A	1.2	29.9	0.58	0.65	0.58	27.8
Approach		412	3.0	0.212	6.2	LOS A	1.2	29.9	0.58	0.67	0.58	19.2
All Vehicles		1963	3.0	0.587	5.5	LOS A	3.6	92.7	0.55	0.55	0.60	22.0

Site Level of Service (LOS) Method: Delay & Degree of Saturation (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
Intersection and Approach LOS values are based on average delay for all movements (v/c not used).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [198th Ave & Old Hwy 99]

New Site
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
South: Old Hwy 99												
3	L2	11	3.0	0.406	12.0	LOS B	2.3	58.7	0.56	0.58	0.56	30.3
8	T1	718	3.0	0.406	6.1	LOS A	2.3	59.3	0.55	0.59	0.55	36.0
18	R2	87	3.0	0.406	7.5	LOS A	2.3	59.3	0.55	0.59	0.55	20.7
Approach		816	3.0	0.406	6.4	LOS A	2.3	59.3	0.55	0.59	0.55	33.3
East: 198th Ave												
1	L2	120	3.0	0.255	3.0	LOS A	1.0	26.1	0.60	0.60	0.60	21.0
6	T1	11	3.0	0.255	3.0	LOS A	1.0	26.1	0.60	0.60	0.60	18.5
16	R2	43	3.0	0.255	3.0	LOS A	1.0	26.1	0.60	0.60	0.60	20.4
Approach		174	3.0	0.255	3.0	LOS A	1.0	26.1	0.60	0.60	0.60	20.7
North: Old Hwy 99												
7	L2	207	3.0	0.371	11.4	LOS B	2.2	56.5	0.37	0.58	0.37	20.6
4	T1	612	3.0	0.371	4.8	LOS A	2.2	56.6	0.37	0.50	0.37	36.2
14	R2	54	3.0	0.371	4.8	LOS A	2.2	56.6	0.37	0.46	0.37	29.1
Approach		873	3.0	0.371	6.4	LOS A	2.2	56.6	0.37	0.52	0.37	30.3
West: 198th Ave												
5	L2	141	3.0	0.299	8.5	LOS A	1.2	29.9	0.61	0.79	0.61	28.2
2	T1	22	3.0	0.299	7.6	LOS A	1.2	29.9	0.61	0.79	0.61	17.9
12	R2	43	3.0	0.299	4.2	LOS A	1.2	29.9	0.61	0.79	0.61	27.4
Approach		207	3.0	0.299	7.5	LOS A	1.2	29.9	0.61	0.79	0.61	26.4
All Vehicles		2070	3.0	0.406	6.2	LOS A	2.3	59.3	0.49	0.58	0.49	29.7

Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Intersection	
Int Delay, s/veh	8

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	0	91	181	10	85	134
Future Vol, veh/h	0	91	181	10	85	134
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	98	98	98	98	98	98
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	93	185	10	87	137

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	93	0	427	47
Stage 1	-	-	-	-	47	-
Stage 2	-	-	-	-	380	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1501	-	584	1022
Stage 1	-	-	-	-	975	-
Stage 2	-	-	-	-	691	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1501	-	512	1022
Mov Cap-2 Maneuver	-	-	-	-	512	-
Stage 1	-	-	-	-	975	-
Stage 2	-	-	-	-	605	-

Approach	EB	WB	NB
HCM Control Delay, s	0	7.3	12
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	737	-	-	1501	-
HCM Lane V/C Ratio	0.303	-	-	0.123	-
HCM Control Delay (s)	12	-	-	7.7	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	1.3	-	-	0.4	-

Intersection	
Intersection Delay, s/veh	9.6
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	172	323	703	291
Demand Flow Rate, veh/h	175	330	717	297
Vehicles Circulating, veh/h	517	525	113	617
Vehicles Exiting, veh/h	397	305	579	238
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	6.8	9.7	10.0	10.3
Approach LOS	A	A	A	B

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	175	330	717	297
Cap Entry Lane, veh/h	814	808	1230	735
Entry HV Adj Factor	0.983	0.979	0.980	0.981
Flow Entry, veh/h	172	323	703	291
Cap Entry, veh/h	801	791	1205	721
V/C Ratio	0.215	0.409	0.583	0.404
Control Delay, s/veh	6.8	9.7	10.0	10.3
LOS	A	A	A	B
95th %tile Queue, veh	1	2	4	2

Intersection	
Intersection Delay, s/veh	6.4
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	110	396	282	440
Demand Flow Rate, veh/h	111	404	288	448
Vehicles Circulating, veh/h	454	266	155	88
Vehicles Exiting, veh/h	82	177	410	582
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	5.4	7.6	5.3	6.3
Approach LOS	A	A	A	A

Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	111	404	288	448
Cap Entry Lane, veh/h	868	1052	1178	1261
Entry HV Adj Factor	0.988	0.980	0.981	0.982
Flow Entry, veh/h	110	396	282	440
Cap Entry, veh/h	858	1031	1155	1239
V/C Ratio	0.128	0.384	0.244	0.355
Control Delay, s/veh	5.4	7.6	5.3	6.3
LOS	A	A	A	A
95th %tile Queue, veh	0	2	1	2

Intersection	
Intersection Delay, s/veh	9.8
Intersection LOS	A

Approach	EB	WB	NB	SB
Entry Lanes	2	2	1	1
Conflicting Circle Lanes	2	2	2	2
Adj Approach Flow, veh/h	517	887	326	402
Demand Flow Rate, veh/h	528	905	333	410
Vehicles Circulating, veh/h	400	312	605	928
Vehicles Exiting, veh/h	938	626	323	289
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	6.5	8.3	9.1	18.3
Approach LOS	A	A	A	C

Lane	Left	Right	Left	Right	Left	Left
Designated Moves	LT	TR	LT	TR	LTR	LTR
Assumed Moves	LT	TR	LT	TR	LTR	LTR
RT Channelized						
Lane Util	0.470	0.530	0.470	0.530	1.000	1.000
Follow-Up Headway, s	2.667	2.535	2.667	2.535	2.535	2.535
Critical Headway, s	4.645	4.328	4.645	4.328	4.328	4.328
Entry Flow, veh/h	248	280	425	480	333	410
Cap Entry Lane, veh/h	934	1011	1013	1089	849	645
Entry HV Adj Factor	0.980	0.979	0.981	0.979	0.979	0.980
Flow Entry, veh/h	243	274	417	470	326	402
Cap Entry, veh/h	915	989	994	1067	831	633
V/C Ratio	0.265	0.277	0.420	0.441	0.392	0.635
Control Delay, s/veh	6.7	6.4	8.3	8.2	9.1	18.3
LOS	A	A	A	A	A	C
95th %tile Queue, veh	1	1	2	2	2	5

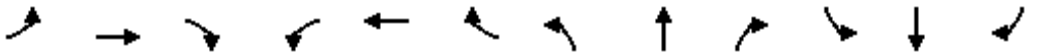
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	69	381	115	587	582	372	100	215	677	239	156	134
Future Volume (veh/h)	69	381	115	587	582	372	100	215	677	239	156	134
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		0.98	1.00		0.98	1.00		0.98
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870	1856	1870	1870	1870	1870	1811	1870	1870	1870
Adj Flow Rate, veh/h	73	405	45	624	619	233	106	229	513	254	166	114
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	2	3	2	2	2	2	6	2	2	2
Cap, veh/h	89	799	349	700	709	591	133	408	641	259	541	450
Arrive On Green	0.05	0.22	0.22	0.20	0.38	0.38	0.07	0.22	0.22	0.15	0.29	0.29
Sat Flow, veh/h	1781	3554	1553	3428	1870	1558	1781	1870	1503	1781	1870	1556
Grp Volume(v), veh/h	73	405	45	624	619	233	106	229	513	254	166	114
Grp Sat Flow(s),veh/h/ln	1781	1777	1553	1714	1870	1558	1781	1870	1503	1781	1870	1556
Q Serve(g_s), s	4.5	11.0	2.5	19.5	33.8	12.0	6.4	12.0	24.0	15.6	7.6	6.2
Cycle Q Clear(g_c), s	4.5	11.0	2.5	19.5	33.8	12.0	6.4	12.0	24.0	15.6	7.6	6.2
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	89	799	349	700	709	591	133	408	641	259	541	450
V/C Ratio(X)	0.82	0.51	0.13	0.89	0.87	0.39	0.80	0.56	0.80	0.98	0.31	0.25
Avail Cap(c_a), veh/h	89	799	349	795	709	591	212	408	641	259	541	450
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	0.69	0.69	0.69	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	51.8	37.3	34.0	42.6	31.7	24.9	50.1	38.3	27.8	46.8	30.5	30.0
Incr Delay (d2), s/veh	43.0	2.3	0.8	8.3	10.2	1.4	10.5	1.7	7.1	50.3	0.3	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.0	4.9	1.0	8.8	16.5	4.5	3.2	5.6	12.4	10.4	3.4	2.3
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	94.8	39.6	34.8	50.9	41.9	26.3	60.5	40.1	35.0	97.1	30.8	30.3
LnGrp LOS	F	D	C	D	D	C	E	D	C	F	C	C
Approach Vol, veh/h		523			1476			848			534	
Approach Delay, s/veh		46.9			43.2			39.5			62.2	
Approach LOS		D			D			D			E	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	28.0	30.6	13.7	37.7	11.0	47.6	21.5	29.9
Change Period (Y+Rc), s	5.5	5.9	5.5	5.9	5.5	5.9	5.5	5.9
Max Green Setting (Gmax), s	25.5	21.7	13.1	26.9	5.5	41.7	16.0	24.0
Max Q Clear Time (g_c+I1), s	21.5	13.0	8.4	9.6	6.5	35.8	17.6	26.0
Green Ext Time (p_c), s	1.0	1.7	0.1	1.1	0.0	2.4	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	45.9
HCM 6th LOS	D

Notes

User approved pedestrian interval to be less than phase max green.



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	69	381	115	587	582	372	100	215	677	239	156	134
Future Volume (veh/h)	69	381	115	587	582	372	100	215	677	239	156	134
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q, veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj (A_pbT)	1.00		0.98	1.00		0.98	1.00		0.98	1.00		0.98
Parking Bus Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Lanes Open During Work Zone												
Adj Sat Flow, veh/h/ln	1870	1870	1870	1856	1870	1870	1870	1870	1811	1870	1870	1870
Adj Flow Rate, veh/h	73	405	45	624	619	233	106	229	513	254	166	114
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	2	3	2	2	2	2	6	2	2	2
Opposing Right Turn Influence	Yes			Yes			Yes			Yes		
Cap, veh/h	89	799	349	700	709	591	133	408	641	259	541	450
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Prop Arrive On Green	0.05	0.22	0.22	0.20	0.38	0.38	0.07	0.22	0.22	0.15	0.29	0.29
Unsig. Movement Delay												
Ln Grp Delay, s/veh	94.8	39.6	34.8	50.9	41.9	26.3	60.5	40.1	35.0	97.1	30.8	30.3
Ln Grp LOS	F	D	C	D	D	C	E	D	C	F	C	C
Approach Vol, veh/h		523			1476			848			534	
Approach Delay, s/veh		46.9			43.2			39.5			62.2	
Approach LOS		D			D			D			E	

Timer:	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Case No	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0
Phs Duration (G+Y+Rc), s	28.0	30.6	13.7	37.7	11.0	47.6	21.5	29.9
Change Period (Y+Rc), s	5.5	5.9	5.5	5.9	5.5	5.9	5.5	5.9
Max Green (Gmax), s	25.5	21.7	13.1	26.9	5.5	41.7	16.0	24.0
Max Allow Headway (MAH), s	3.7	4.9	3.7	4.6	3.7	4.8	3.7	4.3
Max Q Clear (g_c+I1), s	21.5	13.0	8.4	9.6	6.5	35.8	17.6	26.0
Green Ext Time (g_e), s	1.0	1.7	0.1	1.1	0.0	2.4	0.0	0.0
Prob of Phs Call (p_c)	1.00	1.00	0.96	1.00	0.89	1.00	1.00	1.00
Prob of Max Out (p_x)	0.89	0.00	0.38	0.00	1.00	0.00	1.00	1.00

Left-Turn Movement Data								
Assigned Mvmt	1		3		5		7	
Mvmt Sat Flow, veh/h	3428		1781		1781		1781	

Through Movement Data								
Assigned Mvmt		2		4		6		8
Mvmt Sat Flow, veh/h		3554		1870		1870		1870

Right-Turn Movement Data								
Assigned Mvmt		12		14		16		18
Mvmt Sat Flow, veh/h		1553		1556		1558		1503

Left Lane Group Data								
Assigned Mvmt	1	0	3	0	5	0	7	0
Lane Assignment	L (Prot)		L (Prot)		L (Prot)		L (Prot)	

Lanes in Grp	2	0	1	0	1	0	1	0
Grp Vol (v), veh/h	624	0	106	0	73	0	254	0
Grp Sat Flow (s), veh/h/ln	1714	0	1781	0	1781	0	1781	0
Q Serve Time (g_s), s	19.5	0.0	6.4	0.0	4.5	0.0	15.6	0.0
Cycle Q Clear Time (g_c), s	19.5	0.0	6.4	0.0	4.5	0.0	15.6	0.0
Perm LT Sat Flow (s_l), veh/h/ln	0	0	0	0	0	0	0	0
Shared LT Sat Flow (s_sh), veh/h/ln	0	0	0	0	0	0	0	0
Perm LT Eff Green (g_p), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perm LT Serve Time (g_u), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perm LT Q Serve Time (g_ps), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Time to First Blk (g_f), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Serve Time pre Blk (g_fs), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prop LT Inside Lane (P_L)	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Lane Grp Cap (c), veh/h	700	0	133	0	89	0	259	0
V/C Ratio (X)	0.89	0.00	0.80	0.00	0.82	0.00	0.98	0.00
Avail Cap (c_a), veh/h	795	0	212	0	89	0	259	0
Upstream Filter (I)	0.69	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Uniform Delay (d1), s/veh	42.6	0.0	50.1	0.0	51.8	0.0	46.8	0.0
Incr Delay (d2), s/veh	8.3	0.0	10.5	0.0	43.0	0.0	50.3	0.0
Initial Q Delay (d3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	50.9	0.0	60.5	0.0	94.8	0.0	97.1	0.0
1st-Term Q (Q1), veh/ln	8.0	0.0	2.8	0.0	2.0	0.0	6.7	0.0
2nd-Term Q (Q2), veh/ln	0.8	0.0	0.4	0.0	1.1	0.0	3.6	0.0
3rd-Term Q (Q3), veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile Back of Q Factor (f_B%)	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
%ile Back of Q (50%), veh/ln	8.8	0.0	3.2	0.0	3.0	0.0	10.4	0.0
%ile Storage Ratio (RQ%)	0.35	0.00	0.27	0.00	0.13	0.00	0.93	0.00
Initial Q (Qb), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final (Residual) Q (Qe), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Delay (ds), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Q (Qs), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Cap (cs), veh/h	0	0	0	0	0	0	0	0
Initial Q Clear Time (tc), h	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Middle Lane Group Data								
Assigned Mvmt	0	2	0	4	0	6	0	8
Lane Assignment		T		T		T		T
Lanes in Grp	0	2	0	1	0	1	0	1
Grp Vol (v), veh/h	0	405	0	166	0	619	0	229
Grp Sat Flow (s), veh/h/ln	0	1777	0	1870	0	1870	0	1870
Q Serve Time (g_s), s	0.0	11.0	0.0	7.6	0.0	33.8	0.0	12.0
Cycle Q Clear Time (g_c), s	0.0	11.0	0.0	7.6	0.0	33.8	0.0	12.0
Lane Grp Cap (c), veh/h	0	799	0	541	0	709	0	408
V/C Ratio (X)	0.00	0.51	0.00	0.31	0.00	0.87	0.00	0.56
Avail Cap (c_a), veh/h	0	799	0	541	0	709	0	408
Upstream Filter (I)	0.00	1.00	0.00	1.00	0.00	0.69	0.00	1.00
Uniform Delay (d1), s/veh	0.0	37.3	0.0	30.5	0.0	31.7	0.0	38.3
Incr Delay (d2), s/veh	0.0	2.3	0.0	0.3	0.0	10.2	0.0	1.7
Initial Q Delay (d3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	0.0	39.6	0.0	30.8	0.0	41.9	0.0	40.1
1st-Term Q (Q1), veh/ln	0.0	4.6	0.0	3.3	0.0	14.5	0.0	5.4
2nd-Term Q (Q2), veh/ln	0.0	0.3	0.0	0.0	0.0	2.0	0.0	0.2

3rd-Term Q (Q3), veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile Back of Q Factor (f_B%)	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
%ile Back of Q (50%), veh/ln	0.0	4.9	0.0	3.4	0.0	16.5	0.0	5.6
%ile Storage Ratio (RQ%)	0.00	0.10	0.00	0.31	0.00	0.42	0.00	0.26
Initial Q (Qb), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final (Residual) Q (Qe), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Delay (ds), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Q (Qs), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Cap (cs), veh/h	0	0	0	0	0	0	0	0
Initial Q Clear Time (tc), h	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Right Lane Group Data								
Assigned Mvmt	0	12	0	14	0	16	0	18
Lane Assignment		R		R		R		R
Lanes in Grp	0	1	0	1	0	1	0	1
Grp Vol (v), veh/h	0	45	0	114	0	233	0	513
Grp Sat Flow (s), veh/h/ln	0	1553	0	1556	0	1558	0	1503
Q Serve Time (g_s), s	0.0	2.5	0.0	6.2	0.0	12.0	0.0	24.0
Cycle Q Clear Time (g_c), s	0.0	2.5	0.0	6.2	0.0	12.0	0.0	24.0
Prot RT Sat Flow (s_R), veh/h/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1534.8
Prot RT Eff Green (g_R), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.5
Prop RT Outside Lane (P_R)	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
Lane Grp Cap (c), veh/h	0	349	0	450	0	591	0	641
V/C Ratio (X)	0.00	0.13	0.00	0.25	0.00	0.39	0.00	0.80
Avail Cap (c_a), veh/h	0	349	0	450	0	591	0	641
Upstream Filter (I)	0.00	1.00	0.00	1.00	0.00	0.69	0.00	1.00
Uniform Delay (d1), s/veh	0.0	34.0	0.0	30.0	0.0	24.9	0.0	27.8
Incr Delay (d2), s/veh	0.0	0.8	0.0	0.3	0.0	1.4	0.0	7.1
Initial Q Delay (d3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	0.0	34.8	0.0	30.3	0.0	26.3	0.0	35.0
1st-Term Q (Q1), veh/ln	0.0	0.9	0.0	2.3	0.0	4.3	0.0	11.1
2nd-Term Q (Q2), veh/ln	0.0	0.1	0.0	0.0	0.0	0.2	0.0	1.3
3rd-Term Q (Q3), veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile Back of Q Factor (f_B%)	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
%ile Back of Q (50%), veh/ln	0.0	1.0	0.0	2.3	0.0	4.5	0.0	12.4
%ile Storage Ratio (RQ%)	0.00	0.26	0.00	1.17	0.00	0.11	0.00	0.59
Initial Q (Qb), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final (Residual) Q (Qe), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Delay (ds), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Q (Qs), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Cap (cs), veh/h	0	0	0	0	0	0	0	0
Initial Q Clear Time (tc), h	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	45.9
HCM 6th LOS	D

Notes

User approved pedestrian interval to be less than phase max green.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	530	432	0	0	315	70	481	0	250	0	0	0
Future Volume (veh/h)	530	432	0	0	315	70	481	0	250	0	0	0
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Adj Sat Flow, veh/h/ln	1811	1870	0	0	1870	1870	1870	1870	1870			
Adj Flow Rate, veh/h	582	475	0	0	346	15	529	0	86			
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91			
Percent Heavy Veh, %	6	2	0	0	2	2	2	2	2			
Cap, veh/h	630	2597	0	0	1138	508	614	0	273			
Arrive On Green	0.37	0.73	0.00	0.00	0.32	0.32	0.17	0.00	0.17			
Sat Flow, veh/h	1725	3647	0	0	3647	1585	3563	0	1585			
Grp Volume(v), veh/h	582	475	0	0	346	15	529	0	86			
Grp Sat Flow(s),veh/h/ln	1725	1777	0	0	1777	1585	1781	0	1585			
Q Serve(g_s), s	39.4	5.1	0.0	0.0	8.9	0.8	17.6	0.0	5.8			
Cycle Q Clear(g_c), s	39.4	5.1	0.0	0.0	8.9	0.8	17.6	0.0	5.8			
Prop In Lane	1.00		0.00	0.00		1.00	1.00		1.00			
Lane Grp Cap(c), veh/h	630	2597	0	0	1138	508	614	0	273			
V/C Ratio(X)	0.92	0.18	0.00	0.00	0.30	0.03	0.86	0.00	0.31			
Avail Cap(c_a), veh/h	870	2597	0	0	1138	508	704	0	313			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Upstream Filter(I)	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	1.00			
Uniform Delay (d), s/veh	37.0	5.1	0.0	0.0	31.2	28.4	49.0	0.0	44.1			
Incr Delay (d2), s/veh	13.4	0.2	0.0	0.0	0.7	0.1	10.3	0.0	0.9			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	18.3	1.6	0.0	0.0	3.9	0.3	8.5	0.0	2.3			
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	50.5	5.3	0.0	0.0	31.9	28.5	59.3	0.0	45.1			
LnGrp LOS	D	A	A	A	C	C	E	A	D			
Approach Vol, veh/h		1057			361			615				
Approach Delay, s/veh		30.2			31.7			57.3				
Approach LOS		C			C			E				
Timer - Assigned Phs		2			5	6		8				
Phs Duration (G+Y+Rc), s		95.0			50.0	45.0		26.9				
Change Period (Y+Rc), s		5.9			5.5	5.9		5.9				
Max Green Setting (Gmax), s		89.1			61.5	22.1		24.1				
Max Q Clear Time (g_c+I1), s		7.1			41.4	10.9		19.6				
Green Ext Time (p_c), s		3.3			3.1	1.8		1.4				

Intersection Summary	
HCM 6th Ctrl Delay	38.7
HCM 6th LOS	D

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	530	432	0	0	315	70	481	0	250	0	0	0
Future Volume (veh/h)	530	432	0	0	315	70	481	0	250	0	0	0
Number	5	2	12	1	6	16	3	8	18			
Initial Q, veh	0	0	0	0	0	0	0	0	0			
Ped-Bike Adj (A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00			
Parking Bus Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Work Zone On Approach		No			No			No				
Lanes Open During Work Zone												
Adj Sat Flow, veh/h/ln	1811	1870	0	0	1870	1870	1870	1870	1870			
Adj Flow Rate, veh/h	582	475	0	0	346	15	529	0	86			
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91			
Percent Heavy Veh, %	6	2	0	0	2	2	2	2	2			
Opposing Right Turn Influence	Yes			No			Yes					
Cap, veh/h	630	2597	0	0	1138	508	614	0	273			
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
Prop Arrive On Green	0.37	0.73	0.00	0.00	0.32	0.32	0.17	0.00	0.17			
Unsig. Movement Delay												
Ln Grp Delay, s/veh	50.5	5.3	0.0	0.0	31.9	28.5	59.3	0.0	45.1			
Ln Grp LOS	D	A	A	A	C	C	E	A	D			
Approach Vol, veh/h		1057			361			615				
Approach Delay, s/veh		30.2			31.7			57.3				
Approach LOS		C			C			E				

Timer:	1	2	3	4	5	6	7	8
Assigned Phs		2	8		5	6		
Case No		4.0	9.0		2.0	7.0		
Phs Duration (G+Y+Rc), s		95.0	26.9		50.0	45.0		
Change Period (Y+Rc), s		5.9	5.9		5.5	5.9		
Max Green (Gmax), s		89.1	24.1		61.5	22.1		
Max Allow Headway (MAH), s		5.0	4.7		4.7	5.5		
Max Q Clear (g_c+I1), s		7.1	19.6		41.4	10.9		
Green Ext Time (g_e), s		3.3	1.4		3.1	1.8		
Prob of Phs Call (p_c)		1.00	1.00		1.00	1.00		
Prob of Max Out (p_x)		0.00	1.00		0.02	0.00		

Left-Turn Movement Data								
Assigned Mvmt			3		5	1		
Mvmt Sat Flow, veh/h			3563		1725	0		

Through Movement Data								
Assigned Mvmt		2	8			6		
Mvmt Sat Flow, veh/h		3647	0			3647		

Right-Turn Movement Data								
Assigned Mvmt		12	18			16		
Mvmt Sat Flow, veh/h		0	1585			1585		

Left Lane Group Data								
Assigned Mvmt	0	0	3	0	5	1	0	0
Lane Assignment			L		L (Prot)			

Lanes in Grp	0	0	2	0	1	0	0	0
Grp Vol (v), veh/h	0	0	529	0	582	0	0	0
Grp Sat Flow (s), veh/h/ln	0	0	1781	0	1725	0	0	0
Q Serve Time (g_s), s	0.0	0.0	17.6	0.0	39.4	0.0	0.0	0.0
Cycle Q Clear Time (g_c), s	0.0	0.0	17.6	0.0	39.4	0.0	0.0	0.0
Perm LT Sat Flow (s_l), veh/h/ln	0	0	1781	0	0	0	0	0
Shared LT Sat Flow (s_sh), veh/h/ln	0	0	0	0	0	0	0	0
Perm LT Eff Green (g_p), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perm LT Serve Time (g_u), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perm LT Q Serve Time (g_ps), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Time to First Blk (g_f), s	0.0	0.0	0.0	0.0	0.0	39.1	0.0	0.0
Serve Time pre Blk (g_fs), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prop LT Inside Lane (P_L)	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00
Lane Grp Cap (c), veh/h	0	0	614	0	630	0	0	0
V/C Ratio (X)	0.00	0.00	0.86	0.00	0.92	0.00	0.00	0.00
Avail Cap (c_a), veh/h	0	0	704	0	870	0	0	0
Upstream Filter (I)	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00
Uniform Delay (d1), s/veh	0.0	0.0	49.0	0.0	37.0	0.0	0.0	0.0
Incr Delay (d2), s/veh	0.0	0.0	10.3	0.0	13.4	0.0	0.0	0.0
Initial Q Delay (d3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	0.0	0.0	59.3	0.0	50.5	0.0	0.0	0.0
1st-Term Q (Q1), veh/ln	0.0	0.0	7.6	0.0	15.9	0.0	0.0	0.0
2nd-Term Q (Q2), veh/ln	0.0	0.0	0.9	0.0	2.4	0.0	0.0	0.0
3rd-Term Q (Q3), veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile Back of Q Factor (f_B%)	0.00	0.00	1.00	0.00	1.00	1.00	0.00	0.00
%ile Back of Q (50%), veh/ln	0.0	0.0	8.5	0.0	18.3	0.0	0.0	0.0
%ile Storage Ratio (RQ%)	0.00	0.00	0.96	0.00	2.13	0.00	0.00	0.00
Initial Q (Qb), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final (Residual) Q (Qe), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Delay (ds), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Q (Qs), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Cap (cs), veh/h	0	0	0	0	0	0	0	0
Initial Q Clear Time (tc), h	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Middle Lane Group Data								
Assigned Mvmt	0	2	8	0	0	6	0	0
Lane Assignment		T				T		
Lanes in Grp	0	2	0	0	0	2	0	0
Grp Vol (v), veh/h	0	475	0	0	0	346	0	0
Grp Sat Flow (s), veh/h/ln	0	1777	0	0	0	1777	0	0
Q Serve Time (g_s), s	0.0	5.1	0.0	0.0	0.0	8.9	0.0	0.0
Cycle Q Clear Time (g_c), s	0.0	5.1	0.0	0.0	0.0	8.9	0.0	0.0
Lane Grp Cap (c), veh/h	0	2597	0	0	0	1138	0	0
V/C Ratio (X)	0.00	0.18	0.00	0.00	0.00	0.30	0.00	0.00
Avail Cap (c_a), veh/h	0	2597	0	0	0	1138	0	0
Upstream Filter (I)	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00
Uniform Delay (d1), s/veh	0.0	5.1	0.0	0.0	0.0	31.2	0.0	0.0
Incr Delay (d2), s/veh	0.0	0.2	0.0	0.0	0.0	0.7	0.0	0.0
Initial Q Delay (d3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	0.0	5.3	0.0	0.0	0.0	31.9	0.0	0.0
1st-Term Q (Q1), veh/ln	0.0	1.6	0.0	0.0	0.0	3.8	0.0	0.0
2nd-Term Q (Q2), veh/ln	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0

3rd-Term Q (Q3), veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile Back of Q Factor (f_B%)	0.00	1.00	1.00	0.00	0.00	1.00	0.00	0.00
%ile Back of Q (50%), veh/ln	0.0	1.6	0.0	0.0	0.0	3.9	0.0	0.0
%ile Storage Ratio (RQ%)	0.00	0.07	0.00	0.00	0.00	0.16	0.00	0.00
Initial Q (Qb), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final (Residual) Q (Qe), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Delay (ds), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Q (Qs), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Cap (cs), veh/h	0	0	0	0	0	0	0	0
Initial Q Clear Time (tc), h	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Right Lane Group Data								
Assigned Mvmt	0	12	18	0	0	16	0	0
Lane Assignment			R			R		
Lanes in Grp	0	0	1	0	0	1	0	0
Grp Vol (v), veh/h	0	0	86	0	0	15	0	0
Grp Sat Flow (s), veh/h/ln	0	0	1585	0	0	1585	0	0
Q Serve Time (g_s), s	0.0	0.0	5.8	0.0	0.0	0.8	0.0	0.0
Cycle Q Clear Time (g_c), s	0.0	0.0	5.8	0.0	0.0	0.8	0.0	0.0
Prot RT Sat Flow (s_R), veh/h/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prot RT Eff Green (g_R), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prop RT Outside Lane (P_R)	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00
Lane Grp Cap (c), veh/h	0	0	273	0	0	508	0	0
V/C Ratio (X)	0.00	0.00	0.31	0.00	0.00	0.03	0.00	0.00
Avail Cap (c_a), veh/h	0	0	313	0	0	508	0	0
Upstream Filter (I)	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00
Uniform Delay (d1), s/veh	0.0	0.0	44.1	0.0	0.0	28.4	0.0	0.0
Incr Delay (d2), s/veh	0.0	0.0	0.9	0.0	0.0	0.1	0.0	0.0
Initial Q Delay (d3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (d), s/veh	0.0	0.0	45.1	0.0	0.0	28.5	0.0	0.0
1st-Term Q (Q1), veh/ln	0.0	0.0	2.2	0.0	0.0	0.3	0.0	0.0
2nd-Term Q (Q2), veh/ln	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
3rd-Term Q (Q3), veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile Back of Q Factor (f_B%)	0.00	1.00	1.00	0.00	0.00	1.00	0.00	0.00
%ile Back of Q (50%), veh/ln	0.0	0.0	2.3	0.0	0.0	0.3	0.0	0.0
%ile Storage Ratio (RQ%)	0.00	0.00	0.26	0.00	0.00	0.08	0.00	0.00
Initial Q (Qb), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final (Residual) Q (Qe), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Delay (ds), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Q (Qs), veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sat Cap (cs), veh/h	0	0	0	0	0	0	0	0
Initial Q Clear Time (tc), h	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Intersection Summary	
HCM 6th Ctrl Delay	38.7
HCM 6th LOS	D

Notes

User approved volume balancing among the lanes for turning movement.

Intersection	
Intersection Delay, s/veh	10.4
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	1	1	2	2
Conflicting Circle Lanes	2	2	2	2
Adj Approach Flow, veh/h	260	167	1111	894
Demand Flow Rate, veh/h	265	170	1165	918
Vehicles Circulating, veh/h	908	1218	350	303
Vehicles Exiting, veh/h	313	297	823	1085
Ped Vol Crossing Leg, #/h	0	0	0	4
Ped Cap Adj	1.000	1.000	1.000	0.997
Approach Delay, s/veh	11.4	12.6	11.4	8.3
Approach LOS	B	B	B	A

Lane	Left	Left	Left	Right	Left	Right
Designated Moves	LTR	LTR	LT	TR	LT	TR
Assumed Moves	LTR	LTR	LT	TR	LT	TR
RT Channelized						
Lane Util	1.000	1.000	0.470	0.530	0.469	0.531
Follow-Up Headway, s	2.535	2.535	2.667	2.535	2.667	2.535
Critical Headway, s	4.328	4.328	4.645	4.328	4.645	4.328
Entry Flow, veh/h	265	170	548	617	431	487
Cap Entry Lane, veh/h	656	504	978	1055	1021	1098
Entry HV Adj Factor	0.980	0.981	0.953	0.954	0.975	0.973
Flow Entry, veh/h	260	167	522	589	420	474
Cap Entry, veh/h	643	495	932	1006	992	1064
V/C Ratio	0.404	0.337	0.560	0.585	0.423	0.445
Control Delay, s/veh	11.4	12.6	11.5	11.4	8.4	8.3
LOS	B	B	B	B	A	A
95th %tile Queue, veh	2	1	4	4	2	2

Intersection	
Int Delay, s/veh	1.9

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	20	60	45	280	230	60
Future Vol, veh/h	20	60	45	280	230	60
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	22	65	49	304	250	65

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	685	283	315	0	-	0
Stage 1	283	-	-	-	-	-
Stage 2	402	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.218	-	-	-
Pot Cap-1 Maneuver	414	756	1245	-	-	-
Stage 1	765	-	-	-	-	-
Stage 2	676	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	395	756	1245	-	-	-
Mov Cap-2 Maneuver	395	-	-	-	-	-
Stage 1	729	-	-	-	-	-
Stage 2	676	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	11.8	1.1	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1245	-	615	-	-
HCM Lane V/C Ratio	0.039	-	0.141	-	-
HCM Control Delay (s)	8	0	11.8	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0.1	-	0.5	-	-

Intersection	
Int Delay, s/veh	7.9

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	10	285	40	20	230	60
Future Vol, veh/h	10	285	40	20	230	60
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	84	84	84	84	84	84
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	12	339	48	24	274	71

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	679	60	0	0	72	0
Stage 1	60	-	-	-	-	-
Stage 2	619	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	417	1005	-	-	1528	-
Stage 1	963	-	-	-	-	-
Stage 2	537	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	339	1005	-	-	1528	-
Mov Cap-2 Maneuver	339	-	-	-	-	-
Stage 1	963	-	-	-	-	-
Stage 2	437	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	11.1	0	6.2
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	942	1528	-
HCM Lane V/C Ratio	-	-	0.373	0.179	-
HCM Control Delay (s)	-	-	11.1	7.9	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	1.7	0.7	-

Intersection	
Int Delay, s/veh	0.6

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	0	70	0	1067	708	60
Future Vol, veh/h	0	70	0	1067	708	60
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	-	75
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	98	98	98	98	98	98
Heavy Vehicles, %	2	2	2	6	3	2
Mvmt Flow	0	71	0	1089	722	61

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	-	722	-	0	-	0
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-
Critical Hdwy	-	6.22	-	-	-	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	-	-	-
Follow-up Hdwy	-	3.318	-	-	-	-
Pot Cap-1 Maneuver	0	427	0	-	-	-
Stage 1	0	-	0	-	-	-
Stage 2	0	-	0	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	-	427	-	-	-	-
Mov Cap-2 Maneuver	-	-	-	-	-	-
Stage 1	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	15.1	0	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	-	427	-	-
HCM Lane V/C Ratio	-	0.167	-	-
HCM Control Delay (s)	-	15.1	-	-
HCM Lane LOS	-	C	-	-
HCM 95th %tile Q(veh)	-	0.6	-	-

Intersection	
Intersection Delay, s/veh	14.8
Intersection LOS	B

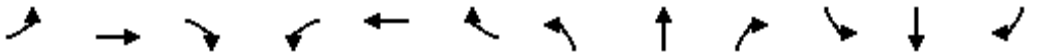
Approach	EB	NB	SB
Entry Lanes	2	2	1
Conflicting Circle Lanes	1	1	1
Adj Approach Flow, veh/h	121	1105	846
Demand Flow Rate, veh/h	124	1127	862
Vehicles Circulating, veh/h	790	90	34
Vehicles Exiting, veh/h	106	824	1183
Ped Vol Crossing Leg, #/h	0	0	0
Ped Cap Adj	1.000	1.000	1.000
Approach Delay, s/veh	6.5	18.7	10.9
Approach LOS	A	C	B

Lane	Left	Right	Left	Right	Left
Designated Moves	L	TR	L	TR	TR
Assumed Moves	L	TR	L	TR	TR
RT Channelized					
Lane Util	0.726	0.274	0.030	0.970	1.000
Follow-Up Headway, s	2.535	2.535	2.535	2.535	2.609
Critical Headway, s	4.544	4.544	4.544	4.544	4.976
Entry Flow, veh/h	90	34	34	1093	862
Cap Entry Lane, veh/h	692	692	1308	1308	1333
Entry HV Adj Factor	0.978	0.971	0.971	0.980	0.981
Flow Entry, veh/h	88	33	33	1072	846
Cap Entry, veh/h	677	672	1270	1283	1307
V/C Ratio	0.130	0.049	0.026	0.835	0.647
Control Delay, s/veh	6.8	5.9	3.0	19.2	10.9
LOS	A	A	A	C	B
95th %tile Queue, veh	0	0	0	11	5

Intersection	
Intersection Delay, s/veh	13.9
Intersection LOS	B

Approach	EB	WB	NB	SB
Entry Lanes	2	1	2	2
Conflicting Circle Lanes	2	2	2	2
Adj Approach Flow, veh/h	305	0	1252	790
Demand Flow Rate, veh/h	318	0	1327	814
Vehicles Circulating, veh/h	778	1393	66	250
Vehicles Exiting, veh/h	286	0	1030	1143
Ped Vol Crossing Leg, #/h	0	0	1	0
Ped Cap Adj	1.000	1.000	0.999	1.000
Approach Delay, s/veh	8.9	0.0	14.9	14.2
Approach LOS	A	-	B	B

Lane	Left	Right	Left	Left	Right	Left	Right
Designated Moves	L	TR	LTR	L	TR	L	TR
Assumed Moves	L	TR	LTR	L	TR	L	TR
RT Channelized							
Lane Util	0.208	0.792	1.000	0.188	0.812	0.000	1.000
Follow-Up Headway, s	2.667	2.535	2.535	2.667	2.535	2.667	2.535
Critical Headway, s	4.645	4.328	4.328	4.645	4.328	4.645	4.328
Entry Flow, veh/h	66	252	0	250	1077	0	814
Cap Entry Lane, veh/h	660	733	435	1270	1343	1073	1148
Entry HV Adj Factor	0.985	0.952	1.000	0.944	0.943	1.000	0.971
Flow Entry, veh/h	65	240	0	236	1016	0	790
Cap Entry, veh/h	650	698	435	1198	1265	1073	1115
V/C Ratio	0.100	0.344	0.000	0.197	0.803	0.000	0.709
Control Delay, s/veh	6.7	9.6	8.3	4.7	17.2	3.4	14.2
LOS	A	A	A	A	C	A	B
95th %tile Queue, veh	0	2	0	1	9	0	6



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	812	485	120	676	0	0	0	0	150	0	865
Future Volume (vph)	0	812	485	120	676	0	0	0	0	150	0	865
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		5.9	5.9	5.5	5.9						5.9	5.9
Lane Util. Factor		0.95	1.00	1.00	0.95						1.00	0.88
Frt		1.00	0.85	1.00	1.00						1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00						0.95	1.00
Satd. Flow (prot)		3406	1583	1770	3539						1770	2760
Flt Permitted		1.00	1.00	0.95	1.00						0.95	1.00
Satd. Flow (perm)		3406	1583	1770	3539						1770	2760
Peak-hour factor, PHF	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Adj. Flow (vph)	0	933	557	138	777	0	0	0	0	172	0	994
RTOR Reduction (vph)	0	0	281	0	0	0	0	0	0	0	0	549
Lane Group Flow (vph)	0	933	276	138	777	0	0	0	0	0	172	445
Heavy Vehicles (%)	2%	6%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%
Turn Type		NA	Perm	Prot	NA					Perm	NA	Perm
Protected Phases		2		1	6						4	
Permitted Phases			2							4		4
Actuated Green, G (s)		59.5	59.5	10.5	75.5						23.2	23.2
Effective Green, g (s)		59.5	59.5	10.5	75.5						23.2	23.2
Actuated g/C Ratio		0.50	0.50	0.09	0.63						0.19	0.19
Clearance Time (s)		5.9	5.9	5.5	5.9						5.9	5.9
Vehicle Extension (s)		3.0	3.0	3.5	5.0						4.0	4.0
Lane Grp Cap (vph)		1688	784	154	2226						342	533
v/s Ratio Prot		c0.27		c0.08	0.22							
v/s Ratio Perm			0.17								0.10	c0.16
v/c Ratio		0.55	0.35	0.90	0.35						0.50	0.84
Uniform Delay, d1		21.0	18.5	54.2	10.6						43.2	46.6
Progression Factor		1.00	1.00	1.00	1.00						1.00	1.00
Incremental Delay, d2		1.3	1.2	43.9	0.4						1.6	11.4
Delay (s)		22.3	19.7	98.1	11.0						44.8	57.9
Level of Service		C	B	F	B						D	E
Approach Delay (s)		21.3			24.1			0.0			56.0	
Approach LOS		C			C			A			E	

Intersection Summary			
HCM 2000 Control Delay	33.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	21.3
Intersection Capacity Utilization	65.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

MOVEMENT SUMMARY

Site: 101 [Elderberry St & 196th Ave SW]

New Site
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
South: Elderberry St												
3	L2	337	3.0	0.584	10.7	LOS B	5.5	140.7	0.42	0.54	0.42	30.1
8	T1	167	3.0	0.584	4.6	LOS A	5.5	140.7	0.42	0.54	0.42	35.5
18	R2	209	3.0	0.584	4.7	LOS A	5.5	140.7	0.42	0.54	0.42	34.5
Approach		713	3.0	0.584	7.5	LOS A	5.5	140.7	0.42	0.54	0.42	32.5
East: Development Access												
1	L2	226	3.0	0.377	13.5	LOS B	2.5	65.1	0.73	0.81	0.73	33.9
6	T1	48	3.0	0.377	7.6	LOS A	2.5	65.1	0.73	0.81	0.73	33.9
16	R2	49	3.0	0.377	7.4	LOS A	2.5	65.1	0.73	0.81	0.73	32.9
Approach		323	3.0	0.377	11.7	LOS B	2.5	65.1	0.73	0.81	0.73	33.8
North: Elderberry St												
7	L2	11	3.0	0.374	14.1	LOS B	2.4	61.2	0.74	0.79	0.74	35.3
4	T1	240	3.0	0.374	8.5	LOS A	2.4	61.2	0.74	0.79	0.74	35.2
14	R2	45	3.0	0.374	8.2	LOS A	2.4	61.2	0.74	0.79	0.74	28.2
Approach		296	3.0	0.374	8.6	LOS A	2.4	61.2	0.74	0.79	0.74	33.9
West: 196th Ave												
5	L2	22	3.0	0.198	7.8	LOS A	1.1	27.4	0.58	0.60	0.58	30.8
2	T1	45	3.0	0.198	6.7	LOS A	1.1	27.4	0.58	0.60	0.58	30.7
12	R2	109	3.0	0.198	3.7	LOS A	1.1	27.4	0.58	0.60	0.58	29.9
Approach		175	3.0	0.198	5.0	LOS A	1.1	27.4	0.58	0.60	0.58	30.2
All Vehicles		1507	3.0	0.584	8.3	LOS A	5.5	140.7	0.57	0.65	0.57	32.7

Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [196th Ave SW & Sargent Rd]

New Site
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
South: Sargent Rd												
3	L2	11	2.0	0.243	6.1	LOS A	1.4	34.5	0.36	0.18	0.36	26.0
8	T1	228	2.0	0.243	0.9	LOS A	1.4	34.5	0.36	0.18	0.36	24.3
18	R2	43	2.0	0.243	1.8	LOS A	1.4	34.5	0.36	0.18	0.36	24.7
Approach		283	2.0	0.243	1.2	LOS A	1.4	34.5	0.36	0.18	0.36	24.4
East: 196th Ave SW												
1	L2	27	2.0	0.364	7.0	LOS A	2.4	60.8	0.54	0.45	0.54	25.7
6	T1	48	2.0	0.364	1.8	LOS A	2.4	60.8	0.54	0.45	0.54	24.0
16	R2	321	2.0	0.364	2.6	LOS A	2.4	60.8	0.54	0.45	0.54	24.4
Approach		396	2.0	0.364	2.8	LOS A	2.4	60.8	0.54	0.45	0.54	24.5
North: Sargent Rd												
7	L2	65	2.0	0.359	5.9	LOS A	2.4	61.4	0.32	0.21	0.32	25.8
4	T1	353	2.0	0.359	0.9	LOS A	2.4	61.4	0.32	0.21	0.32	25.3
14	R2	22	2.0	0.359	1.5	LOS A	2.4	61.4	0.32	0.21	0.32	24.6
Approach		440	2.0	0.359	1.7	LOS A	2.4	61.4	0.32	0.21	0.32	25.3
West: 196th Ave SW												
5	L2	22	2.0	0.118	7.4	LOS A	0.6	15.0	0.52	0.45	0.52	25.4
2	T1	66	2.0	0.118	2.5	LOS A	0.6	15.0	0.52	0.45	0.52	24.9
12	R2	22	2.0	0.118	3.3	LOS A	0.6	15.0	0.52	0.45	0.52	24.2
Approach		110	2.0	0.118	3.6	LOS A	0.6	15.0	0.52	0.45	0.52	24.8
All Vehicles		1228	2.0	0.364	2.1	LOS A	2.4	61.4	0.42	0.30	0.42	24.8

Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Sargent Rd & US 12]

New Site
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
South: Old Hwy 99												
3	L2	76	3.0	0.427	13.1	LOS B	2.1	54.4	0.62	0.78	0.67	29.7
8	T1	196	3.0	0.427	7.3	LOS A	2.1	54.4	0.62	0.78	0.67	35.1
18	R2	54	3.0	0.427	8.7	LOS A	2.1	54.4	0.62	0.78	0.67	20.4
Approach		326	3.0	0.427	8.9	LOS A	2.1	54.4	0.62	0.78	0.67	30.2
East: 198th Ave												
1	L2	33	3.0	0.417	1.5	LOS A	2.3	59.9	0.51	0.31	0.51	21.2
6	T1	800	3.0	0.417	1.4	LOS A	2.4	60.4	0.51	0.31	0.51	18.7
16	R2	54	3.0	0.417	1.4	LOS A	2.4	60.4	0.50	0.30	0.50	20.6
Approach		887	3.0	0.417	1.4	LOS A	2.4	60.4	0.51	0.31	0.51	18.9
North: Old Hwy 99												
7	L2	109	3.0	0.625	17.1	LOS B	3.9	100.3	0.77	0.97	1.04	19.9
4	T1	250	3.0	0.625	10.5	LOS B	3.9	100.3	0.77	0.97	1.04	33.6
14	R2	43	3.0	0.625	10.3	LOS B	3.9	100.3	0.77	0.97	1.04	27.2
Approach		402	3.0	0.625	12.3	LOS B	3.9	100.3	0.77	0.97	1.04	27.8
West: 198th Ave												
5	L2	33	3.0	0.263	6.9	LOS A	1.4	34.9	0.52	0.65	0.52	28.4
2	T1	451	3.0	0.263	6.0	LOS A	1.4	35.4	0.52	0.64	0.52	18.0
12	R2	33	3.0	0.263	2.8	LOS A	1.4	35.4	0.52	0.63	0.52	27.8
Approach		516	3.0	0.263	5.9	LOS A	1.4	35.4	0.52	0.64	0.52	18.8
All Vehicles		2132	3.0	0.625	5.7	LOS A	3.9	100.3	0.58	0.59	0.63	21.4

Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [198th Ave & Old Hwy 99]

New Site
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
South: Old Hwy 99												
3	L2	255	3.0	0.519	11.2	LOS B	3.5	90.6	0.51	0.61	0.51	29.9
8	T1	817	3.0	0.519	5.4	LOS A	3.6	91.0	0.51	0.55	0.51	35.8
18	R2	87	3.0	0.519	6.8	LOS A	3.6	91.0	0.51	0.52	0.51	20.7
Approach		1160	3.0	0.519	6.8	LOS A	3.6	91.0	0.51	0.56	0.51	32.6
East: 198th Ave												
1	L2	120	3.0	0.301	4.2	LOS A	1.3	32.4	0.68	0.70	0.70	20.7
6	T1	11	3.0	0.301	4.2	LOS A	1.3	32.4	0.68	0.70	0.70	18.4
16	R2	43	3.0	0.301	4.2	LOS A	1.3	32.4	0.68	0.70	0.70	20.2
Approach		174	3.0	0.301	4.2	LOS A	1.3	32.4	0.68	0.70	0.70	20.4
North: Old Hwy 99												
7	L2	54	3.0	0.473	13.1	LOS B	2.9	74.8	0.61	0.64	0.62	20.6
4	T1	672	3.0	0.473	6.5	LOS A	2.9	74.9	0.61	0.64	0.61	35.7
14	R2	207	3.0	0.473	6.4	LOS A	2.9	74.9	0.61	0.64	0.61	28.6
Approach		933	3.0	0.473	6.8	LOS A	2.9	74.9	0.61	0.64	0.61	32.5
West: 198th Ave												
5	L2	141	3.0	0.404	9.1	LOS A	1.9	49.5	0.67	0.83	0.74	28.4
2	T1	11	3.0	0.404	8.2	LOS A	1.9	49.5	0.67	0.83	0.74	17.9
12	R2	120	3.0	0.404	4.8	LOS A	1.9	49.5	0.67	0.83	0.74	27.6
Approach		272	3.0	0.404	7.1	LOS A	1.9	49.5	0.67	0.83	0.74	27.4
All Vehicles		2538	3.0	0.519	6.7	LOS A	3.6	91.0	0.58	0.63	0.59	30.7

Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Sargent Rd/201st Ave & Old Hwy 99]

New Site
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
South: Old Hwy 99												
3	L2	33	3.0	0.571	8.0	LOS A	0.0	0.0	0.00	0.54	0.00	35.0
8	T1	1072	2.0	0.571	5.4	LOS A	0.0	0.0	0.00	0.54	0.00	35.3
Approach		1104	2.0	0.571	5.4	LOS A	0.0	0.0	0.00	0.54	0.00	35.3
North: Old Hwy 99												
4	T1	775	2.0	0.778	5.6	LOS A	11.3	286.8	0.44	0.44	0.44	35.4
14	R2	71	3.0	0.778	6.5	LOS A	11.3	286.8	0.44	0.44	0.44	33.9
Approach		846	2.1	0.778	5.6	LOS A	11.3	286.8	0.44	0.44	0.44	35.3
West: RoadName												
5	L2	88	3.0	0.220	15.7	LOS B	1.3	34.1	0.79	0.88	0.79	31.8
12	R2	33	3.0	0.220	10.4	LOS B	1.3	34.1	0.79	0.88	0.79	31.7
Approach		121	3.0	0.220	14.3	LOS B	1.3	34.1	0.79	0.88	0.79	31.8
All Vehicles		2071	2.1	0.778	6.0	LOS A	11.3	286.8	0.23	0.52	0.23	35.1

Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

MOVEMENT SUMMARY

Site: 101 [Old Hwy 9 & Old Hwy 99]

New Site
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
South: Old Hwy 99												
3	L2	241	6.0	1.081	48.0	LOS F	90.6	2372.4	1.00	1.07	1.59	17.7
8	T1	1038	6.0	1.081	42.9	LOS F	90.6	2372.4	1.00	1.07	1.59	17.4
Approach		1279	6.0	1.081	43.9	LOS D	90.6	2372.4	1.00	1.07	1.59	17.5
North: Old Hwy 99												
4	T1	772	3.0	0.785	5.1	LOS A	11.7	299.4	0.92	0.80	1.05	24.4
14	R2	36	2.0	0.785	5.9	LOS A	11.7	299.4	0.92	0.80	1.05	23.8
Approach		808	3.0	0.785	5.2	LOS A	11.7	299.4	0.92	0.80	1.05	24.4
West: Old Hwy 9												
5	L2	66	2.0	0.553	13.5	LOS B	4.9	126.0	0.95	1.08	1.15	23.8
12	R2	246	5.0	0.553	9.5	LOS A	4.9	126.0	0.95	1.08	1.15	22.8
Approach		312	4.4	0.553	10.4	LOS B	4.9	126.0	0.95	1.08	1.15	23.0
All Vehicles		2399	4.8	1.081	26.5	LOS C	90.6	2372.4	0.97	0.98	1.35	20.0

Site Level of Service (LOS) Method: Delay & v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

FEHR PEERS

Attachment C – Project Evaluation Matrix

PRELIMINARY - PROJECT EVALUATION MATRIX

ID	Project Name	Project Description	Total Project Cost	Eligible for Impact Fees?	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5	Goal 6	Composite Score	Rank
C1	Intersection Improvements — 196th & Sargent	Construction of a single-lane roundabout at the 196th Ave SW and Sargent Road intersection.	$4.34M	Yes	3	6	3	3	6		21	4
C3	Intersection Improvements — 196th & Elderberry	Construction of a 4-leg single-lane roundabout with sidewalks connecting to existing facilities at the Elderberry Road and 196th Ave SW.	$3.35M	Yes	3	3	3	3	6		18	7
C4, C9	Intersection Improvements — US 12 & Elderberry/Old Hwy 99	Improve pedestrian right-of-way to decrease crossing times; implement a right-turn overlap phase for the Northbound approach	Splitter Islands - $80-$100K Overcrossing - $15-$20M	Yes	3	6	6	3	3		21	4
C7	Urban Roadway Improvements — Old Hwy 99, from US 12 to Old Hwy 9	Develop a cross-section for Old Highway 99 that provides adequate vehicle capacity will providing separated space for bicyclists and pedestrians.	$6M	Yes	6	3	6	6	3		24	1
C8	Frontage Improvements — Sargent, from 198th to Old Hwy 99	Develop a cross-section for Sargent Road that provides adequate vehicle capacity will providing separated space for bicyclists and pedestrians.	$2.04M	Yes	0	3	6	6	6		21	4
C10	Intersection Improvements — Sargent & Old Hwy 99, and Old Hwy 99 & 201st	Combine the Sargent Road and 201st intersections with Old Highway 99 with a roundabout.	TBD	Yes	6	6	3	4	3		22	3
C11	Intersection Improvements — Old Hwy 9 and Old Hwy 99	Construct a traffic signal or roundabout at the Old Highway 99 and Old Highway 9 intersection.	Signal - $800-900K Roundabout - $3.5-$4.5M	Yes	6	6	3	3	6		24	1
C13-C14	New Trail — Along Power lines, from 203rd to 198th	Build new multi-use path along the power lines west of Old Hwy 99 from 203rd Ave SW to 198th Ave SW. This includes creating a park near Prairie Creek and providing connections to the planned Rochester-Grand Mound Trail.	$3.0M	No	0	0	6	6	6		18	7
O3-O4	Park-and-Ride Lot Improvements — Old Hwy 99	Construct and improve bus shelters and stops throughout Grand Mound, including improving the Grand Mound Park & Ride and providing north-south service through Grand Mound.	-	No	0	0	3	6	3		12	9
M1	Designated Bike Route — 198th, Tea St. & Grand Mound Way	Identify and provide sharrow striping for a safe designated bike route in a C-shape along 198th Ave SW, Tea St, and Grand Mound Way	-	No	0	0	0	3	3		6	10

Note: Evaluation of Goal #5 to be updated based on on-going stakeholder input. Evaluation of Goal #6 to be updated after community engagement is complete.

Attachment D – DRAFT Project Layouts

EXHIBIT DRAWING
FOR INFORMATIONAL PURPOSES ONLY

PERTEET
2707 COLBY AVENUE, SUITE 900
EVERETT, WA 98201
425.252.7700 | 800.615.9900

TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

196TH AVE SW & SARGENT RD SW ROUNDABOUT LAYOUT

Jan 21, 2020 - 7:57am erin.routledge X:\Grand Mound, City of\Projects\20180263 - Grand Mound Transportation Study\CADD\01 - Ref\20180263 PROP.dwg Layout Name: 196th-Sargent

196TH AVE SW

ELDERBERRY ST SW

SCALE
50 0 50 100
FEET

EXHIBIT DRAWING
FOR INFORMATIONAL PURPOSES ONLY

PERTEET
2707 COLBY AVENUE, SUITE 900
EVERETT, WA 98201
425.252.7700 | 800.615.9900

TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

196TH AVE SW & ELDERBERRY ST SW ROUNDABOUT LAYOUT

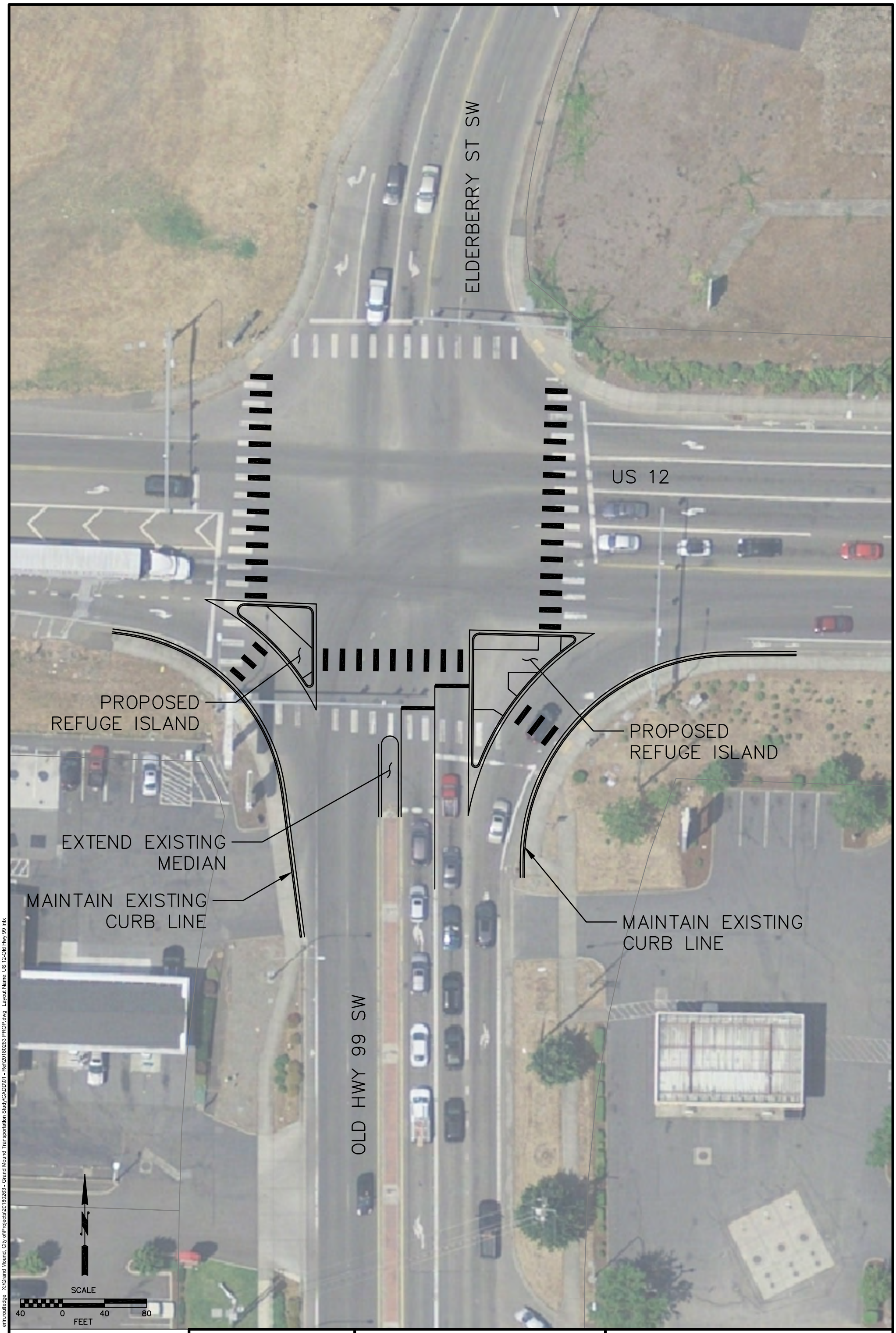


EXHIBIT DRAWING
FOR INFORMATIONAL PURPOSES ONLY

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2707 COLBY AVENUE, SUITE 900
EVERETT, WA 98201
425.252.7700 | 800.615.9900

TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

OLD HWY 99/US 12
PEDESTRIAN REFUGE ISLANDS

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

N

Pedestrian Overcrossing

Ramps to Overcrossing

Proposed Pedestrian Overcrossing

EXHIBIT DRAWING
FOR INFORMATIONAL PURPOSES ONLY

PERTEET
2707 COLBY AVENUE, SUITE 900
EVERETT, WA 98201
425.252.7700 | 800.615.9900

TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

SARGENT RD SW CROSS SECTION
SHEET 1 OF 2

Jan 21, 2020 - 8:06am ethn.routledge X:\Grand Mound, City of\Projects\20180263 - Grand Mound Transportation Study\CADD\01 - Ref\20180263 PROP.dwg Layout Name: Sargent Cross Section 1

EXHIBIT DRAWING
FOR INFORMATIONAL PURPOSES ONLY

PERTEET
2707 COLBY AVENUE, SUITE 900
EVERETT, WA 98201
425.252.7700 | 800.615.9900

TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

SARGENT RD SW CROSS SECTION
SHEET 2 OF 2

EXHIBIT DRAWING
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2707 COLBY AVENUE, SUITE 900
EVERETT, WA 98201
425.252.7700 | 800.615.9900

TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

OLD HWY 99 SW CROSS SECTION
SHEET 1 OF 3

Jan 21, 2020 - 3:40pm erin.routledge X:\Grand Mound, City of\Projects\20180263 - Grand Mound Transportation Study\CADD\01 - Ref\20180263 PROP.dwg Layout Name: Old Hwy 99 X-Section 1

EXHIBIT DRAWING
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PERTEET
2707 COLBY AVENUE, SUITE 900
EVERETT, WA 98201
425.252.7700 | 800.615.9900

TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

OLD HWY 99 SW CROSS SECTION
SHEET 2 OF 3

Jan 21, 2020 - 3:41pm erin.routledge X:\Grand Mound, City of\Projects\20180263 - Grand Mound Transportation Study\CADD\01 - Ref\20180263 PROP.dwg Layout Name: Old Hwy 99 X-Section 2

198TH WAY SW

OLD HWY 99 SW

201ST AVE SW

SCALE
150 0 150 300
FEET

EXHIBIT DRAWING
FOR INFORMATIONAL PURPOSES ONLY

PERTEET
2707 COLBY AVENUE, SUITE 900
EVERETT, WA 98201
425.252.7700 | 800.615.9900

TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

OLD HWY 99 SW CROSS SECTION
SHEET 3 OF 3

SARGENT RD SW

OLD HWY 99 SW

RIGHT IN–RIGHT OUT ACCESS
AT SARGENT RD SW

201ST AVE SW

MAINTAIN EXISTING
CURB LINE

SCALE
40 0 40 80
FEET

EXHIBIT DRAWING
FOR INFORMATIONAL
PURPOSES ONLY

PERTEET
2707 COLBY AVENUE, SUITE 900
EVERETT, WA 98201
425.252.7700 | 800.615.9900

TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

OLD HWY 99 SW/201ST AVE SW ROUNDABOUT LAYOUT

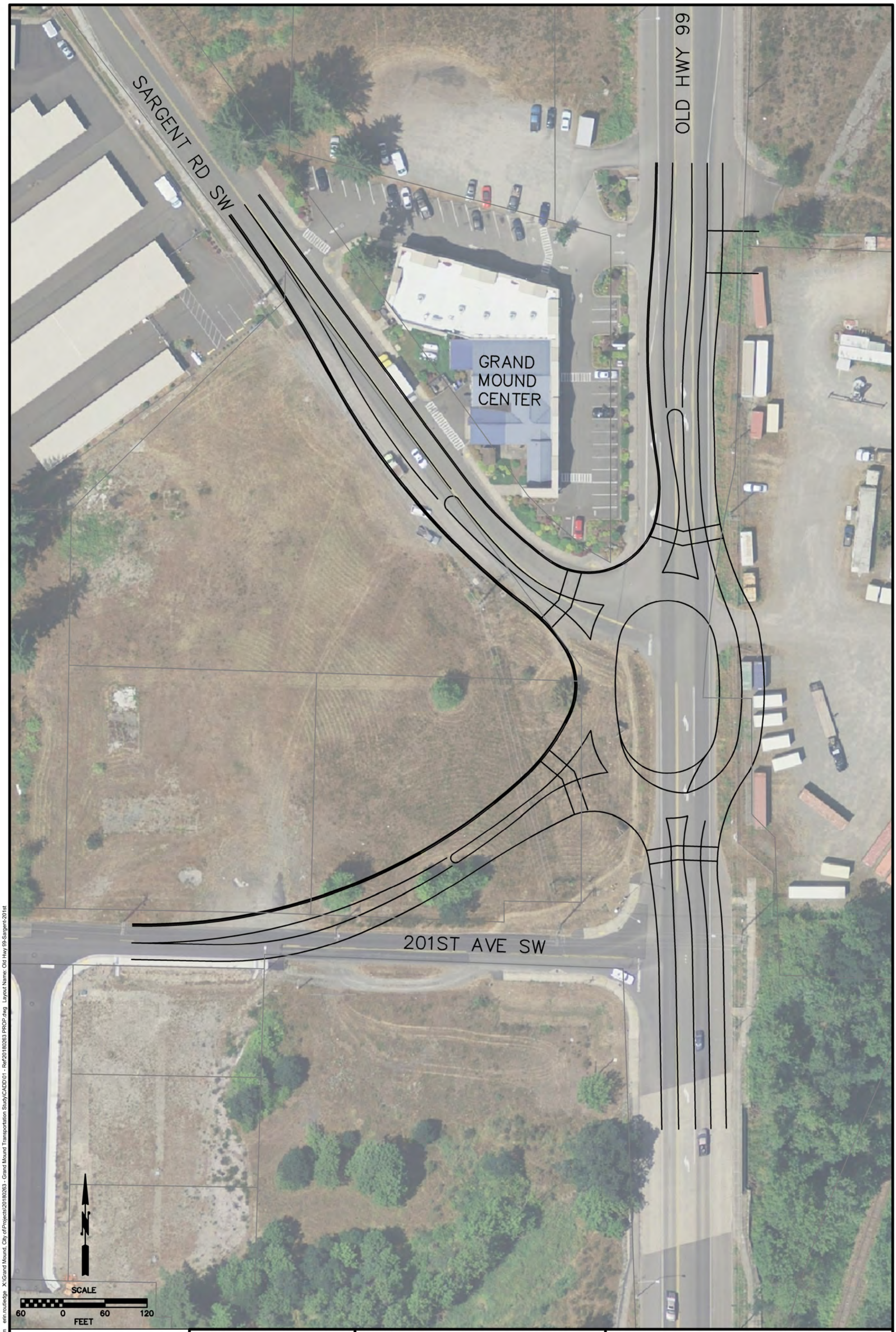

EXHIBIT DRAWING
FOR INFORMATIONAL PURPOSES ONLY

PERTEET
2707 COLBY AVENUE, SUITE 900
EVERETT, WA 98201
425.252.7700 | 800.615.9900

TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
DECEMBER 12, 2019

SARGENT RD/201ST SW/OLD HWY 99 ROUNDABOUT LAYOUT

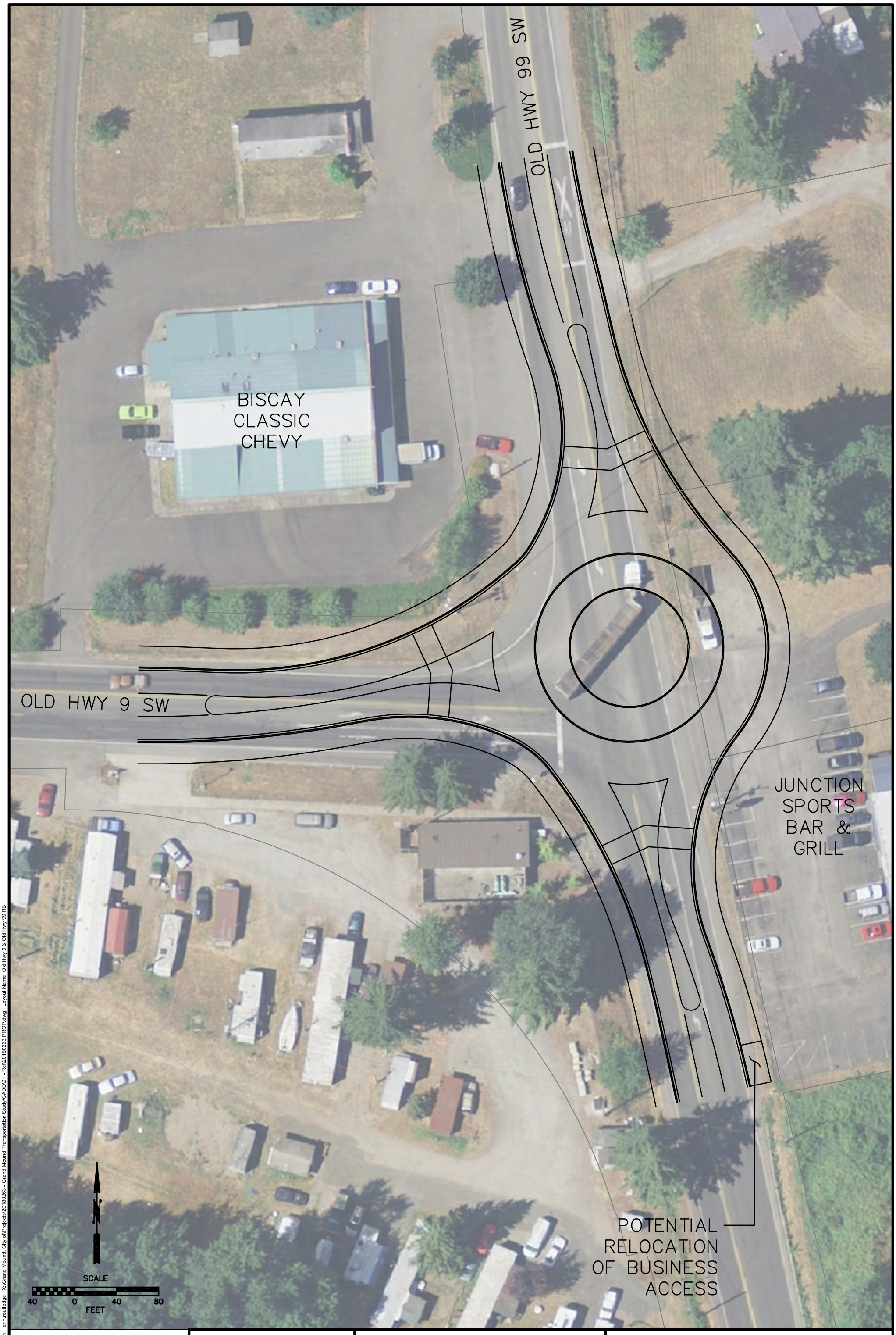

EXHIBIT DRAWING
FOR INFORMATIONAL PURPOSES ONLY

PERTEET
2707 COLBY AVENUE, SUITE 900
EVERETT, WA 98201
425.252.7700 | 800.615.9900

TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

OLD HWY 99 SW & OLD HWY 9 SW ROUNDABOUT LAYOUT

EXHIBIT DRAWING
FOR INFORMATIONAL PURPOSES ONLY

PERTEET
2707 COLBY AVENUE, SUITE 900
EVERETT, WA 98201
425.252.7700 | 800.615.9900

TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

OLD HWY 99 SW & OLD HWY 9 SW SIGNAL LAYOUT

Jan 21, 2020 - 8:22am eth.roudledge X:\Grand Mound, City of\Projects\20180263 - Grand Mound Transportation Study\CADD\01 - Ref\20180263 PROP.dwg Layout Name: Old Hwy 9 & Old Hwy 99 Signal

Appendix C: Project Evaluation Matrix

#	Goal	Metric		
		Match	Description	Score
1	**Safety:** Transportation infrastructure in Grand Mound provides safe options for all users. (Project addresses safety issue)	High	Is a known countermeasure/rebuilds a high/severe collision location	6
		Medium	Rebuilds a known low/non-severe collision location	3
		Low	None of the above	0
2	**Efficient:** Roadways and intersections have adequate capacity and function with acceptable levels of delayfor autos and freight, even as the region grows. (Project improves vehicle LOS)	High	Fix bottleneck/LOS failure in 2040	6
		Medium	Improves facilities/provides more capacity in 2040	3
		Low	Not vehicle capacity project	0
3	**Character:** Transportation infrastructure contributes to Grand Mound's identity as a distinctive place with rural character. (Project adds to Grand Mound's character)	High	Gateway elements/landscaping/art	6
		Medium	Building to standards/making facilities more consistent	3
		Low	None of the above	0
4	**Multi-Modal Connections:** Grand Mound's transportation system accommodates walking and biking, including connections to regional trails, transit, and commercial land uses. (Project accommodates modes other than car)	High	Meaningful bike/ped/transit project; intermodal connection	6
		Medium	Small bike/ped/transit project or reduces modal conflicts	3
		Low	None of the above	0
5	**Economic Diversity & Tourism:** Transportation facilities support economic growth in Grand Mound, including residential, commercial, jobs, and tourism. (Supports economic growth)	High	Improvement identified as needed to promote development and highly supported by project stakeholders with an economic interest	6
		Medium	Improvement identified as needed to promote development in the Grand Mound Development Plan or previously completed study	3
		Low	Not identified as needed to support development	0

Grand Mound Project Evaluation Matrix

ID	Project Name	Project Description	Roadway/Location	Extents (From)	Extents (To)	Mode	Total Project Cost	Eligible for Impact Fees?	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5	Composite Score	Rank
C1	Intersection Improvements — 196th & Sargent	Construction of a single-lane roundabout at the 196th Ave SW and Sargent Road intersection.	196th Ave SW/Sargent Rd	-	-	Vehicle	$5.15M	Yes	3	6	3	3	6	21	4
C3	Intersection Improvements — 196th & Elderberry	Construction of a 4-leg single-lane roundabout with sidewalks connecting to existing facilities at the Elderberry Road and 196th Ave SW.	196th Ave SW/Elderberry St	-	-	Vehicle	$4.51M	Yes	3	3	3	3	6	18	7
C4, C9	Intersection Improvements — US 12 & Elderberry/Old Hwy 99	Improve pedestrian right-of-way to decrease crossing times; implement a right-turn overlap phase for the Northbound approach	US 12/Elderberry St	-	-	Vehicle/Ped/Bike	$230,000	Yes	3	6	6	3	3	21	4
C7	Urban Roadway Improvements — Old Hwy 99, from US 12 to Old Hwy 9	Develop a cross-section for Old Highway 99 that provides adequate vehicle capacity will providing separated space for bicyclists and pedestrians.	Old Hwy 99	US 12	Old Hwy 9	Vehicle/Ped/Bike	$8.24M	Yes	6	3	6	6	3	24	1
C8	Frontage Improvements — Sargent, from 198th to Old Hwy 99	Develop a cross-section for Sargent Road that provides adequate vehicle capacity will providing separated space for bicyclists and pedestrians.	Sargent Rd	198th Ave SW	Old Hwy 99	Vehicle/Ped/Bike	$2.93M	Yes	0	3	6	6	6	21	4
C10	Intersection Improvements — Sargent & Old Hwy 99, and Old Hwy 99 & 201st	Combine the Sargent Road and 201st intersections with Old Highway 99 with a roundabout.	Sargent Rd/Old Hwy 99 and 201st Ave SW/Old Hwy 99	-	-	Vehicle	$3.5M	Yes	6	6	3	4	3	22	3
C11	Intersection Improvements — Old Hwy 9 and Old Hwy 99	Construct a traffic signal or roundabout at the Old Highway 99 and Old Highway 9 intersection.	Old Hwy 9/Old Hwy 99	-	-	Vehicle	$879,000	Yes	6	6	3	3	6	24	1
C13-C14	New Trail — Along Power lines, from 203rd to 198th	Build new multi-use path along the power lines west of Old Hwy 99 from 203rd Ave SW to 198th Ave SW. This includes creating a park near Prairie Creek and providing connections to the planned Rochester-Grand Mound Trail.	New Trail	203rd Ave SW	198th Ave SW	Ped/Bike	$3M	No	0	0	6	6	6	18	7
O3-O4	Park-and-Ride Lot Improvements — Old Hwy 99	Construct and improve bus shelters and stops throughout Grand Mound, including improving the Grand Mound Park & Ride and providing north-south service through Grand Mound.	-	-	-	Transit		No	0	0	3	6	3	12	9
M1	Designated Bike Route — 198th, Tea St. & Grand Mound Way	Identify and provide sharrow striping for a safe designated bike route in a C-shape along 198th Ave SW, Tea St, and Grand Mound Way	-	-	-	Bike		No	0	0	0	3	3	6	10

Note: Evaluation of Goal #5 to be updated based on on-going stakeholder input. Evaluation of Goal #6 to be updated after community engagement is complete.

Appendix D: Project Layouts & Cost Estimates

EXHIBIT DRAWING
FOR INFORMATIONAL PURPOSES ONLY

PERTEET
2707 COLBY AVENUE, SUITE 900
EVERETT, WA 98201
425.252.7700 | 800.615.9900

TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

196TH AVE SW & SARGENT RD SW ROUNDABOUT LAYOUT

Jan 21, 2020 - 7:57am erin.routledge X:\Grand Mound, City of\Projects\20180263 - Grand Mound Transportation Study\CADD\01 - Ref\20180263 PROP.dwg Layout Name: 196th-Sargent

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PLANNING LEVEL OPINION OF COST SUMMARY

Project Description:	Grand Mound Transportation Study	Client:	TRPC
Corridor Section:	196th & Elderberry Roundabout	Date:	2/24/2020
Location:	City of Grand Mound	Date of Cost Index:	2019

		ITEM	UNIT	ESTIMATED UNIT COST	QTY	COST
I.		**RIGHT OF WAY**				
		RIGHT OF WAY (urban developed)	SF	$60	14,000	$840,000
		ADMINISTRATION (TITLES, APPRAISALS, ETC.)	EA	$15,000	9	$135,000
		RIGHT OF WAY TOTAL				**$975,000**
II.		**CONSTRUCTION**				
1		**PREPARATION/GRADING/DRAINAGE**				
	1.1	**PREPARATION**				
		CLEAR & GRUB,DEMO	ACRE	$7,000	1.3	$9,100
		REMOVE TREE (12"+)	EA	$500	18	$9,000
		PAVEMENT GRINDING	SY	$7	1,900	$13,300
		REMOVAL STRUCTURES & OBSTRUCTIONS	LS	$10,000	1	$10,000
	1.2	**EARTHWORK**				
		ROADWAY EXCAVATION, INCL HAUL	CY	$25	1,400	$35,000
	1.3	**STORMWATER MITIGATION**				
		DETENTION AND TREATMENT	SF	$10	19,600	$196,000
	1.4	**STORM SEWER**				
		CATCH BASIN TYPE 1	EA	$1,500	16	$24,000
		CATCH BASIN TYPE 2	EA	$2,200	6	$13,200
		PLAIN CONC. STORM SEWER PIPE 12 IN. DIAM.	LF	$70	2,430	$170,100
		STRUCTURE EXCAVATION CL. B	CY	$40	400	$16,000
2		**SURFACING**				
		HOT MIX ASPHALT	TON	$120	700	$84,000
		CRUSHED SURFACING	TON	$50	1,500	$75,000
3		**ROADSIDE DEVELOPMENT**				
		SEEDING, MULCHING & FERTILIZING	ACRE	$5,000	0.6	$3,000
		TEMP. WATER POLLUTION & EROSION CONTROL (6%)	LS	$89,600	1	$89,600
		LANDSCAPING	LS	$8,000	1	$8,000
		PROPERTY RESTORATION	LS	$15,000	1	$15,000
4		**TRAFFIC**				
		ILLUMINATION	LS	$150,000	1	$150,000
		SIGNING	LS	$15,000	1	$15,000
		CHANNELIZATION	LS	$5,000	1	$5,000
		CURBS	LF	$25	3,900	$97,500
		CURB RAMP	EA	$4,000	8	$32,000
		SIDEWALKS	SY	$65	2,500	$162,500
		TRUCK APRON	SY	$150	1,000	$150,000
		TRAFFIC CONTROL (15%)	LS	$224,000	1	$224,000
5		**OTHER ITEMS**				
		SURVEYING (6%)	LS	$89,600	1	$89,600
		FLASHING BEACONS	EA	$25,000	8	$200,000

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PLANNING LEVEL OPINION OF COST SUMMARY

Project Description:	Grand Mound Transportation Study	Client:	TRPC
Corridor Section:	196th & Elderberry Roundabout	Date:	2/24/2020
Location:	City of Grand Mound	Date of Cost Index:	2019

6	**CONSTRUCTION SUBTOTAL (ITEMS 1 THRU 5)**				**$1,895,900**
7	**MOBILIZATION (10%)**				
	10% OF ITEM 6	EST	$189,600	1	$189,600
8	**SUBTOTAL (ITEMS 6 & 7)**				**$2,085,500**
9	**CONSTRUCTION ADMINISTRATION**				
	ENGINEERING (12% OF ITEM 8)	EST	$228,000	1	$228,000
	PERMITTING (2% OF ITEM 8)	EST	$41,800	1	$41,800
10	**CONTINGENCY (30%)**				
	30% OF ITEM 8	EST	$625,700	1	$625,700
11	**CONSTRUCTION TOTAL (ITEMS 8, 9 & 10)**				**$2,981,000**
III.	**PRELIMINARY WORK**				
	PRELIMINARY ENGINEERING (15% OF ITEM 11)	EST	$447,200	1	$447,200
	ENVIRONMENTAL PERMITS	EST	$100,000	1	$100,000
IV.	**TOTAL ESTIMATED COST**				
	(ITEMS I, 11 & III)				**$4,510,000**

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Assumptions:
30% contingency - appropriate for this level of design
Environmental Permitting includes Pocket Gopher Mitigation
2" grind and overlay for existing hot mix asphalt (HMA) within proposed widening
4" HMA over 2" CSTC over 9" CBSC for new HMA within proposed widening per Thurston County Roadway Standards
Circulating lane assumed to be HMA
8 flashing beacons (2 per approach for non-motorized crossing)

196TH AVE SW

ELDERBERRY ST SW

22'-5"

21'-6"

10'-5"

19'-1"

18'-8"

SCALE
50 0 50 100
FEET

EXHIBIT DRAWING
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TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

196TH AVE SW & ELDERBERRY ST SW ROUNDABOUT LAYOUT

Jan 21, 2020 - 7:53am erfin.routledge X:\Grand Mound, City of\Projects\20180263 - Grand Mound Transportation Study\CADD\01 - Ref\20180263 PROP.dwg Layout Name: 196th-Elderberry

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PLANNING LEVEL OPINION OF COST SUMMARY

Project Description:	Grand Mound Transportation Study	Client:	TRPC
Corridor Section:	196th & Sargent Roundabout	Date:	2/24/2020
Location:	City of Grand Mound	Date of Cost Index:	2019

		ITEM	UNIT	ESTIMATED UNIT COST	QTY	COST
I.		**RIGHT OF WAY**				
		RIGHT OF WAY (urban developed)	SF	$60	16,300	$978,000
		ADMINISTRATION (TITLES, APPRAISALS, ETC.)	EA	$15,000	5	$75,000
		RIGHT OF WAY TOTAL				**$1,053,000**
II.		**CONSTRUCTION**				
1		**PREPARATION/GRADING/DRAINAGE**				
	1.1	**PREPARATION**				
		CLEAR & GRUB,DEMO	ACRE	$7,000	2.1	$14,700
		REMOVE TREE (12"+)	EA	$500	22	$11,000
		PAVEMENT GRINDING	SY	$7	3,100	$21,700
		REMOVAL STRUCTURES & OBSTRUCTIONS	LS	$10,000	1	$10,000
	1.2	**EARTHWORK**				
		ROADWAY EXCAVATION, INCL HAUL	CY	$25	2,100	$52,500
	1.3	**STORMWATER MITIGATION**				
		DETENTION AND TREATMENT	SF	$10	35,600	$356,000
	1.4	**STORM SEWER**				
		CATCH BASIN TYPE 1	EA	$1,500	19	$28,500
		CATCH BASIN TYPE 2	EA	$2,200	6	$13,200
		PLAIN CONC. STORM SEWER PIPE 12 IN. DIAM.	LF	$70	3,370	$235,900
		STRUCTURE EXCAVATION CL. B	CY	$45	600	$27,000
2		**SURFACING**				
		HOT MIX ASPHALT	TON	$120	900	$108,000
		CRUSHED SURFACING	TON	$50	1,900	$95,000
3		**ROADSIDE DEVELOPMENT**				
		SEEDING, MULCHING & FERTILIZING	ACRE	$5,000	0.9	$4,500
		TEMP. WATER POLLUTION & EROSION CONTROL (6%)	LS	$115,100	1	$115,100
		LANDSCAPING	LS	$10,000	1	$10,000
		PROPERTY RESTORATION	LS	$15,000	1	$15,000
4		**TRAFFIC**				
		ILLUMINATION	LS	$150,000	1	$150,000
		SIGNING	LS	$15,000	1	$15,000
		CHANNELIZATION	LS	$5,000	1	$5,000
		CURBS	LF	$25	4,900	$122,500
		CURB RAMP	EA	$4,000	8	$32,000
		SIDEWALKS	SY	$65	3,700	$240,500
		TRUCK APRON	SY	$150	1,000	$150,000
		TRAFFIC CONTROL (15%)	LS	$287,800	1	$287,800
5		**OTHER ITEMS**				
		SURVEYING (6%)	LS	$115,100	1	$115,100
		FLASHING BEACONS	EA	$25,000	8	$200,000

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PLANNING LEVEL OPINION OF COST SUMMARY

Project Description:	Grand Mound Transportation Study		Client: TRPC		
Corridor Section:	196th & Sargent Roundabout		Date: 2/24/2020		
Location:	City of Grand Mound		Date of Cost Index: 2019		
6	**CONSTRUCTION SUBTOTAL (ITEMS 1 THRU 5)**				**$2,436,000**
7	**MOBILIZATION (10%)**				
	10% OF ITEM 6	EST	$243,600	1	$243,600
8	**SUBTOTAL (ITEMS 6 & 7)**				**$2,679,600**
9	**CONSTRUCTION ADMINISTRATION**				
	ENGINEERING (12% OF ITEM 8)	EST	$322,000	1	$322,000
	PERMITTING (2% OF ITEM 8)	EST	$54,000	1	$54,000
10	**CONTINGENCY**				
	30% OF ITEM 8	EST	$730,800	1	$730,800
11	**CONSTRUCTION TOTAL (ITEMS 8, 9 & 10)**				**$3,786,400**
III.	**PRELIMINARY WORK**				
	PRELIMINARY ENGINEERING (15% OF ITEM 11)	EST	$568,000	1	$568,000
	ENVIRONMENTAL COMPLIANCE	EST	$100,000	1	$100,000
IV.	**TOTAL ESTIMATED COST**				
	(ITEMS I, II & III)				**$5,510,000**

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Assumptions:
30% contingency - appropriate for this level of design
Environmental Permitting includes Pocket Gopher Mitigation
2" grind and overlay for existing hot mix asphalt (HMA) within proposed widening
4" HMA over 2" CSTC over 9" CBSC for new HMA within proposed widening per Thurston County Roadway Standards
Circulating lane assumed to be HMA
8 flashing beacons (2 per approach for non-motorized crossing)

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PLANNING LEVEL OPINION OF COST SUMMARY

Project Description:	Grand Mound Transportation Study	Client: TRPC	
Corridor Section:	US 12 & Old Hwy 99 Pedestrian Refuge Islands	Date: 4/9/2020	
Location:	City of Grand Mound	Date of Cost Index: 2019	

		ITEM	UNIT	ESTIMATED UNIT COST	QTY	COST
I.		**RIGHT OF WAY**				
		RIGHT OF WAY (urban developed)	SF	$60	-	$0
		ADMINISTRATION (TITLES, APPRAISALS, ETC.)	EA	$15,000	-	$0
		RIGHT OF WAY TOTAL				**$0**
II.		**CONSTRUCTION**				
1		**PREPARATION/GRADING/DRAINAGE**				
	1.1	**EARTHWORK**				
		ROADWAY EXCAVATION, INCL HAUL	CY	$50	150	$7,500
		SAWCUTTING	LF	$5	430	$2,150
2		**SURFACING**				
		HOT MIX ASPHALT	TON	$120	40	$4,800
		CRUSHED SURFACING	TON	$50	150	$7,500
3		**TRAFFIC**				
		CHANNELIZATION	LS	$8,000	1	$8,000
		SIGNING	LS	$1,000	1	$1,000
		CURBS	LF	$20	400	$8,000
		CEMENT CONC. REFUGE ISLAND	SY	$65	200	$13,000
		TRAFFIC CONTROL (20%)	LS	$10,400	1	$10,400
4		**OTHER ITEMS**				
		TRAFFIC SIGNAL MODIFCATIONS	LS	$54,000	1	$54,000
		SURVEYING (10%)	LS	$5,200	1	$5,200
5		**CONSTRUCTION SUBTOTAL (ITEMS 1 THRU 4)**				**$121,550**
6		**MOBILIZATION (10%)**				
		10% OF ITEM 5	EST	$12,200	1	$12,200
7		**SUBTOTAL (ITEMS 5 & 6)**				**$133,750**
8		**CONSTRUCTION ADMINISTRATION**				
		ENGINEERING (12% OF ITEM 7)	EST	$15,000	1	$15,000
		PERMITTING (2% OF ITEM 7)	EST	$2,700	1	$2,700
9		**CONTINGENCY (30%)**				
		30% OF ITEM 7	EST	$40,200	1	$40,200
10		**CONSTRUCTION TOTAL (ITEMS 7, 8 & 9)**				**$191,650**
III.		**PRELIMINARY WORK**				
		PRELIMINARY ENGINEERING (15% OF ITEM 10)	EST	$28,800	1	$28,800
IV.		**TOTAL ESTIMATED COST**				
		(ITEMS I, 10 & III)				**$230,000**

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Assumptions:
30% contingency - appropriate for this level of design
Curb returns at SW and SE corners will remain as-is
Refuge islands will be installed by sawcutting, removing pavement, and then placing crushed surfacing and cement concrete
No environmental permitting required
Pedestrian signal heads and push buttons installed in refuge islands to facilitate pedestrian crossing

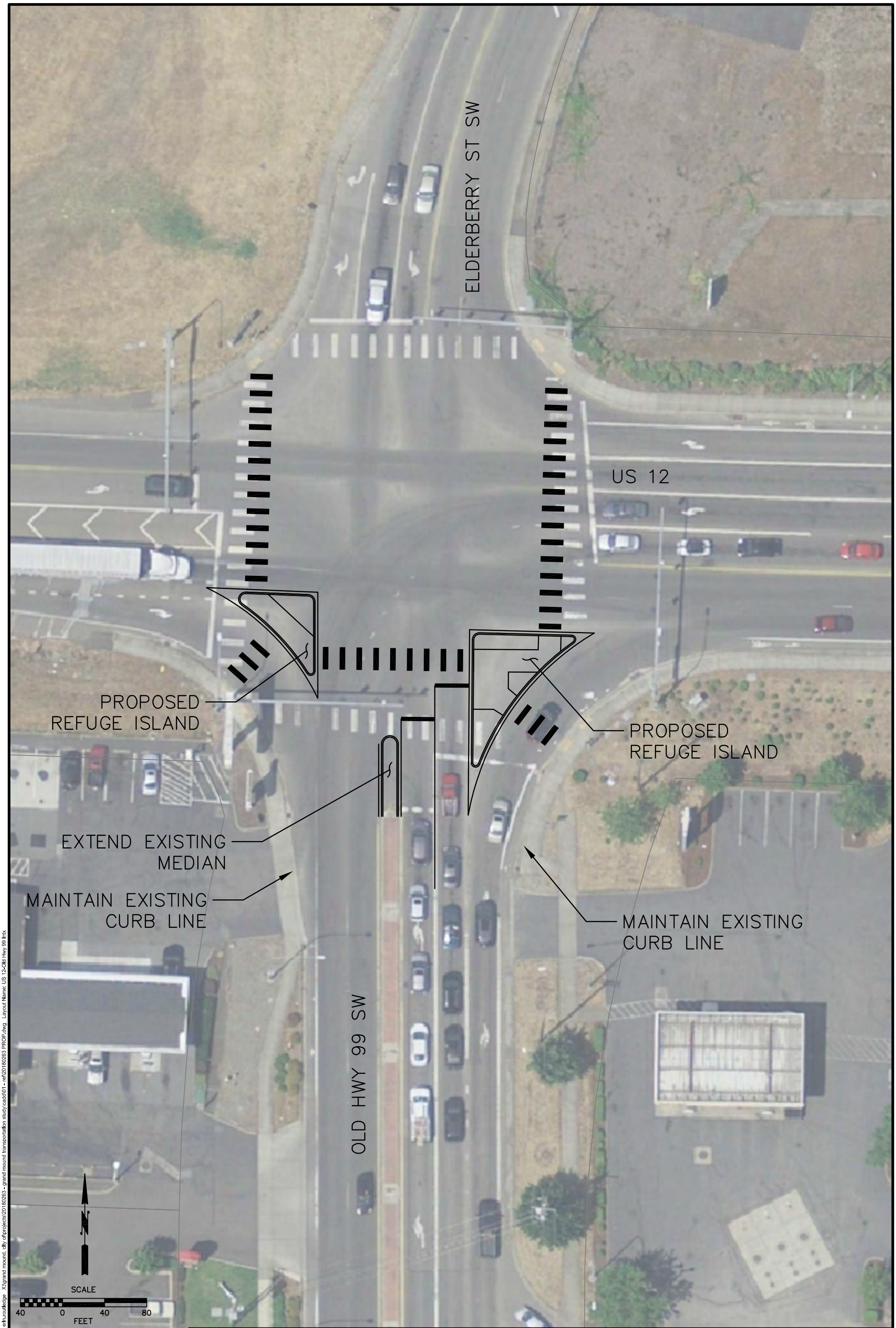

EXHIBIT DRAWING
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TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
APRIL 8, 2020

C4, C9 – OLD HWY 99 SW/US 12 PEDESTRIAN REFUGE ISLANDS

2707 Colby Avenue, Suite 900, Everett, WA 98201 | P 425.252.7700

PLANNING LEVEL OPINION OF COST SUMMARY

Project Description:	Grand Mound Transportation Study	Client:	TRPC
Corridor Section:	Old Hwy 99 Cross Section	Date:	2/24/2020
Location:	City of Grand Mound	Date of Cost Index:	2019

		ITEM	UNIT	ESTIMATED UNIT COST	QTY	COST
I.		**RIGHT OF WAY**				
		RIGHT OF WAY (urban undeveloped)	SF	$30	79,900	$2,397,000
		ADMINISTRATION (TITLES, APPRAISALS, ETC.)	EA	$15,000	18	$270,000
		RIGHT OF WAY TOTAL				**$2,667,000**
II.		**CONSTRUCTION**				
1		**PREPARATION/GRADING/DRAINAGE**				
	1.1	**PREPARATION**				
		CLEAR & GRUB,DEMO	ACRE	$7,000	3.2	$22,400
		REMOVE TREE (12"+)	EA	$500	63	$31,500
		REMOVAL STRUCTURES & OBSTRUCTIONS	LS	$10,000	1	$10,000
	1.2	**EARTHWORK**				
		ROADWAY EXCAVATION, INCL HAUL	CY	$25	3,600	$90,000
	1.3	**STORMWATER**				
		PLANTER STRIP BIOSWALE	LF	$30	10,500	$315,000
2		**SURFACING**				
		CRUSHED SURFACING	TON	$50	2,000	$100,000
3		**ROADSIDE DEVELOPMENT**				
		SEEDING, MULCHING & FERTILIZING	ACRE	$5,000	2.3	$11,500
		TEMP. WATER POLLUTION & EROSION CONTROL (6%)	LS	$146,000	1	$146,000
		PROPERTY RESTORATION	LS	$12,000	1	$12,000
4		**TRAFFIC**				
		ILLUMINATION	LS	$300,000	1	$300,000
		MID-BLOCK CROSSING	LS	$25,000	3	$75,000
		SIGNING	LS	$15,000	1	$15,000
		CHANNELIZATION	LS	$2,000	1	$2,000
		CURBS	LF	$25	10,500	$262,500
		CURB RAMP	EA	$4,000	6	$24,000
		SIDEWALKS	SY	$65	9,800	$637,000
		HARDSCAPE MEDIANS	SY	$150	1,500	$225,000
		TRAFFIC CONTROL (10%)	LS	$250,000	1	$250,000
		RAILROAD CROSSING PEDESTRIAN SIGNAL	LS	$300,000	1	$300,000
5		**OTHER ITEMS**				
		SURVEYING (6%)	LS	$146,000	1	$146,000
6		**CONSTRUCTION SUBTOTAL (ITEMS 1 THRU 5)**				**$2,974,900**
7		**MOBILIZATION (10%)**				
		10% OF ITEM 6	EST	$297,500	1	$297,500
8		**SUBTOTAL (ITEMS 6 & 7)**				**$3,272,400**

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PLANNING LEVEL OPINION OF COST SUMMARY

Project Description:	Grand Mound Transportation Study		Client: TRPC		
Corridor Section:	Old Hwy 99 Cross Section		Date: 2/24/2020		
Location:	City of Grand Mound		Date of Cost Index: 2019		
9	**CONSTRUCTION ADMINISTRATION**				
	ENGINEERING (12% OF ITEM 9)	EST	$393,000	1	$393,000
	PERMITTING (2% OF ITEM 9)	EST	$66,000	1	$66,000
10	**CONTINGENCY (30%)**				
	30% OF ITEM 8	EST	$981,800	1	$981,800
11	**CONSTRUCTION TOTAL (ITEMS 9 & 10)**				**$4,713,200**
III.	**PRELIMINARY WORK**				
	PRELIMINARY ENGINEERING (15% OF ITEM 11)	EST	$707,000	1	$707,000
	ENVIRONMENTAL PERMITS	EST	$150,000	1	$150,000
IV.	**TOTAL ESTIMATED COST**				
	(ITEMS I, II & III)				**$8,240,000**

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Assumptions:
30% contingency - appropriate for this level of design
Environmental Permitting includes Pocket Gopher Mitigation
Adding improvements (hardscaped median in existing two-way left-turn lane, 12' shared used path on west side of roadway, and 6' sidewalk on east side of roadway) **only** where there are gaps in the existing roadway prism
Shared use path and sidewalk assumed to be concrete
Assume no overlay of traveled lanes

EXHIBIT DRAWING
FOR INFORMATIONAL PURPOSES ONLY

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TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

OLD HWY 99 SW CROSS SECTION
SHEET 1 OF 3

Jan 21, 2020 - 3:40pm erin.routledge X:\Grand Mound, City of\Projects\20180263 - Grand Mound Transportation Study\CADD\01 - Ref\20180263 PROP.dwg Layout Name: Old Hwy 99 X-Section 1

EXHIBIT DRAWING
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TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

OLD HWY 99 SW CROSS SECTION
SHEET 2 OF 3

Jan 21, 2020 - 3:41pm erin.routledge X:\Grand Mound, City of\Projects\20180263 - Grand Mound Transportation Study\CADD\01 - Ref\20180263 PROP.dwg Layout Name: Old Hwy 99 X-Section 2

198TH WAY SW

OLD HWY 99 SW

201ST AVE SW

SCALE
150 0 150 300
FEET

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TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

OLD HWY 99 SW CROSS SECTION
SHEET 3 OF 3

2707 Colby Avenue, Suite 900, Everett, WA 98201 | P 425.252.7700

PLANNING LEVEL OPINION OF COST SUMMARY

Project Description:	Grand Mound Transportation Study	Client:	TRPC
Corridor Section:	Sargent Rd Cross Section	Date:	2/24/2020
Location:	City of Grand Mound	Date of Cost Index:	2019
		Calculated By/Entered By:	SAT
		Checked By:	ENR

		ITEM	UNIT	ESTIMATED UNIT COST	QTY	COST
I.		**RIGHT OF WAY**				
		TEMPORARY CONSTRUCTION EASEMENT AND POSSIBLE FUTURE R/W NEEDS	EST	$100,000	1	$100,000
II.		**CONSTRUCTION**				
1		**PREPARATION/GRADING/DRAINAGE**				
	1.1	**PREPARATION**				
		CLEAR & GRUB,DEMO	ACRE	$7,000	1.5	$10,500
		REMOVE TREE (12"+)	EA	$500	34	$17,000
		PAVEMENT GRINDING	SY	$7	2,400	$16,800
		REMOVAL STRUCTURES & OBSTRUCTIONS	LS	$24,600	1	$24,600
	1.2	**EARTHWORK**				
		ROADWAY EXCAVATION, INCL HAUL	CY	$25	1,300	$32,500
	1.3	**STORMWATER MITIGATION**				
		DETENTION AND TREATMENT	SF	$10	24,400	$244,000
	1.4	**STORM SEWER**				
		CATCH BASIN TYPE 1	EA	$1,500	14	$21,000
		CATCH BASIN TYPE 2	EA	$2,200	6	$13,200
		PLAIN CONC. STORM SEWER PIPE 12 IN. DIAM.	LF	$70	2,270	$158,900
		STRUCTURE EXCAVATION CL. B	CY	$45	900	$40,500
2		**SURFACING**				
		HOT MIX ASPHALT	TON	$120	600	$72,000
		CRUSHED SURFACING	TON	$50	1,100	$55,000
3		**ROADSIDE DEVELOPMENT**				
		SEEDING, MULCHING & FERTILIZING	ACRE	$5,000	0.7	$3,500
		TEMP. WATER POLLUTION & EROSION CONTROL (6%)	LS	$69,400	1	$69,400
		LANDSCAPING	LS	$23,000	1	$23,000
		PROPERTY RESTORATION	LS	$13,000	1	$13,000
4		**TRAFFIC**				
		ILLUMINATION	LS	$150,000	1	$150,000
		SIGNING	LS	$15,000	1	$15,000
		CHANNELIZATION	LS	$2,000	1	$2,000
		CURBS	LF	$25	2,300	$57,500
		CURB RAMP	EA	$3,000	8	$24,000
		SIDEWALKS	SY	$65	2,500	$162,500
		TRAFFIC CONTROL (10%)	LS	$200,000	1	$200,000
5		**OTHER ITEMS**				
		SURVEYING (6%)	LS	$69,400	1	$69,400
6		**CONSTRUCTION SUBTOTAL (ITEMS 1 THRU 5)**				**$1,495,300**

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PLANNING LEVEL OPINION OF COST SUMMARY

Project Description:	Grand Mound Transportation Study	Client:	TRPC
Corridor Section:	Sargent Rd Cross Section	Date:	2/24/2020
Location:	City of Grand Mound	Date of Cost Index:	2019

7	**MOBILIZATION (10%)**				
	10% OF ITEM 6	EST	$149,600	1	$149,600
8	**SUBTOTAL (ITEMS 6 & 7)**				**$1,644,900**
9	**CONSTRUCTION ADMINISTRATION**				
	ENGINEERING (12% OF ITEM 8)	EST	$198,000	1	$198,000
	PERMITTING (2% OF ITEM 8)	EST	$33,000	1	$33,000
10	**CONTINGENCY (30%)**				
	30% OF ITEM 8	EST	$493,500	1	$493,500
11	**CONSTRUCTION TOTAL (ITEMS 8, 9 & 10)**				**$2,369,400**
III.	**PRELIMINARY WORK**				
	PRELIMINARY ENGINEERING (15% OF ITEM 11)	EST	$355,500	1	$355,500
	ENVIRONMENTAL PERMITS	EST	$100,000	1	$100,000
IV.	**TOTAL ESTIMATED COST**				
	(ITEMS I, II & III)				**$2,930,000**

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Assumptions:
30% contingency - appropriate for this level of design
Environmental Permitting includes Pocket Gopher Mitigation
2" grind and overlay for existing hot mix asphalt (HMA) within proposed widening
4" HMA over 2" CSTC over 9" CBSC for new HMA within proposed widening per Thurston County Roadway Standards

EXHIBIT DRAWING
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TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

SARGENT RD SW CROSS SECTION
SHEET 1 OF 2

Jan 21, 2020 - 8:06am ethn.routledge X:\Grand Mound, City of\Projects\20180263 - Grand Mound Transportation Study\CADD\01 - Ref\20180263 PROP.dwg Layout Name: Sargent Cross Section 1

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TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

SARGENT RD SW CROSS SECTION
SHEET 2 OF 2

2707 Colby Avenue, Suite 900, Everett, WA 98201 | P 425.252.7700

PLANNING LEVEL OPINION OF COST SUMMARY

Project Description:	Grand Mound Transportation Study	Client:	TRPC
Corridor Section:	Old Hwy 99-201st Ave SW-Sargent Rd Roundabout	Date:	3/13/2020
Location:	City of Grand Mound	Date of Cost Index:	2019

		ITEM	UNIT	ESTIMATED UNIT COST	QTY	COST
I.		**RIGHT OF WAY**				
		RIGHT OF WAY (urban developed)	SF	$60	8,200	$492,000
		ADMINISTRATION (TITLES, APPRAISALS, ETC.)	EA	$15,000	2	$30,000
		RIGHT OF WAY TOTAL				**$522,000**
II.		**CONSTRUCTION**				
1		**PREPARATION/GRADING/DRAINAGE**				
	1.1	**PREPARATION**				
		CLEAR & GRUB,DEMO	ACRE	$7,000	0.7	$4,900
		REMOVE TREE (12"+)	EA	$500	2	$1,000
		PAVEMENT GRINDING	SY	$7	2,500	$17,500
		REMOVAL STRUCTURES & OBSTRUCTIONS	LS	$10,000	1	$10,000
	1.2	**EARTHWORK**				
		ROADWAY EXCAVATION, INCL HAUL	CY	$25	900	$22,500
	1.3	**STORMWATER MITIGATION**				
		DETENTION AND TREATMENT	SF	$10	26,300	$263,000
	1.4	**STORM SEWER**				
		CATCH BASIN TYPE 1	EA	$1,500	7	$10,500
		CATCH BASIN TYPE 2	EA	$2,200	4	$8,800
		PLAIN CONC. STORM SEWER PIPE 12 IN. DIAM.	LF	$70	1,160	$81,200
		STRUCTURE EXCAVATION CL. B	CY	$40	900	$36,000
2		**SURFACING**				
		HOT MIX ASPHALT	TON	$120	600	$72,000
		CRUSHED SURFACING	TON	$50	800	$40,000
3		**ROADSIDE DEVELOPMENT**				
		SEEDING, MULCHING & FERTILIZING	ACRE	$5,000	0.3	$1,500
		TEMP. WATER POLLUTION & EROSION CONTROL (6%)	LS	$74,700	1	$74,700
		LANDSCAPING	LS	$12,000	1	$12,000
		PROPERTY RESTORATION	LS	$15,000	1	$15,000
4		**TRAFFIC**				
		ILLUMINATION	LS	$150,000	1	$150,000
		SIGNING	LS	$15,000	1	$15,000
		CHANNELIZATION	LS	$5,000	1	$5,000
		CURBS	LF	$25	2,500	$62,500
		CURB RAMP	EA	$4,000	6	$24,000
		SIDEWALKS	SY	$65	1,400	$91,000
		TRUCK APRON	SY	$150	1,000	$150,000
		TRAFFIC CONTROL (15%)	LS	$186,600	1	$186,600
5		**OTHER ITEMS**				
		SURVEYING (6%)	LS	$74,700	1	$74,700
		FLASHING BEACONS	EA	$25,000	6	$150,000

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PLANNING LEVEL OPINION OF COST SUMMARY

Project Description:	Grand Mound Transportation Study	Client:	TRPC
Corridor Section:	Old Hwy 99-201st Ave SW-Sargent Rd Roundabout	Date:	3/13/2020
Location:	City of Grand Mound	Date of Cost Index:	2019

6	**CONSTRUCTION SUBTOTAL (ITEMS 1 THRU 5)**				**$1,579,400**
7	**MOBILIZATION (10%)**				
	10% OF ITEM 6	EST	$158,000	1	$158,000
8	**SUBTOTAL (ITEMS 6 & 7)**				**$1,737,400**
9	**CONSTRUCTION ADMINISTRATION**				
	ENGINEERING (12% OF ITEM 8)	EST	$190,000	1	$190,000
	PERMITTING (2% OF ITEM 8)	EST	$34,800	1	$34,800
10	**CONTINGENCY (30%)**				
	30% OF ITEM 8	EST	$521,300	1	$521,300
11	**CONSTRUCTION TOTAL (ITEMS 8, 9 & 10)**				**$2,483,500**
III.	**PRELIMINARY WORK**				
	PRELIMINARY ENGINEERING (15% OF ITEM 11)	EST	$372,600	1	$372,600
	ENVIRONMENTAL PERMITS	EST	$100,000	1	$100,000
IV.	**TOTAL ESTIMATED COST**				
	(ITEMS I, 11 & III)				**$3,480,000**

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Assumptions:
30% contingency - appropriate for this level of design
Environmental Permitting includes Pocket Gopher Mitigation
2" grind and overlay for existing hot mix asphalt (HMA) within proposed widening
4" HMA over 2" CSTC over 9" CBSC for new HMA within proposed widening per Thurston County Roadway Standards
Circulating lane assumed to be HMA
8 flashing beacons (2 per approach for non-motorized crossing)
Assume well-infiltrating soils

SARGENT RD SW

OLD HWY 99 SW

RIGHT IN–RIGHT OUT ACCESS
AT SARGENT RD SW

201ST AVE SW

MAINTAIN EXISTING
CURB LINE

SCALE
40 0 40 80
FEET

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TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

OLD HWY 99 SW/201ST AVE SW ROUNDABOUT LAYOUT

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PLANNING LEVEL OPINION OF COST SUMMARY

Project Description:	Grand Mound Transportation Study	Client:	TRPC
Corridor Section:	Old Hwy 9 SW & Old Hwy 99 Signal	Date:	4/9/2020
Location:	City of Grand Mound	Date of Cost Index:	2019

		ITEM	UNIT	ESTIMATED UNIT COST	QTY	COST
I.		**RIGHT OF WAY**				
		RIGHT OF WAY (urban developed)	SF	$60	-	$0
		ADMINISTRATION (TITLES, APPRAISALS, ETC.)	EA	$15,000	-	$0
		RIGHT OF WAY TOTAL				**$0**
II.		**CONSTRUCTION**				
1		**PREPARATION/GRADING/DRAINAGE**				
	1.1	**PREPARATION**				
		CLEAR & GRUB,DEMO	ACRE	$7,000	0.5	$3,500
		REMOVE TREE (12"+)	EA	$500	2	$1,000
		REMOVAL STRUCTURES & OBSTRUCTIONS	LS	$10,000	1	$10,000
	1.2	**EARTHWORK**				
		ROADWAY EXCAVATION, INCL HAUL	CY	$35	500	$17,500
	1.3	**STORMWATER MITIGATION**				
		DETENTION AND TREATMENT	SF	$10	13,300	$133,000
	1.4	**STORM SEWER**				
		CATCH BASIN TYPE 1	EA	$1,500	7	$10,500
		CATCH BASIN TYPE 2	EA	$2,200	4	$8,800
		PLAIN CONC. STORM SEWER PIPE 12 IN. DIAM.	LF	$70	1,000	$70,000
		STRUCTURE EXCAVATION CL. B	CY	$45	800	$36,000
2		**SURFACING**				
		HOT MIX ASPHALT	TON	$120	120	$14,400
		CRUSHED SURFACING	TON	$50	530	$26,500
3		**ROADSIDE DEVELOPMENT**				
		SEEDING, MULCHING & FERTILIZING	ACRE	$5,000	0.3	$1,500
		TEMP. WATER POLLUTION & EROSION CONTROL (6%)	LS	$41,600	1	$41,600
		PROPERTY RESTORATION	LS	$15,000	1	$15,000
4		**TRAFFIC**				
		ILLUMINATION	LS	$0	1	$0
		SIGNING	LS	$5,000	1	$5,000
		CHANNELIZATION	LS	$6,000	1	$6,000
		CURBS	LF	$25	1,000	$25,000
		CURB RAMP	EA	$4,000	4	$16,000
		SIDEWALKS	SY	$65	600	$39,000
		TRAFFIC CONTROL (15%)	LS	$104,000	1	$104,000
5		**OTHER ITEMS**				
		SURVEYING (6%)	LS	$41,600	1	$41,600
		TRAFFIC SIGNAL	EA	$254,000	1	$254,000
6		**CONSTRUCTION SUBTOTAL (ITEMS 1 THRU 5)**				**$879,900**

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PLANNING LEVEL OPINION OF COST SUMMARY

Project Description:	Grand Mound Transportation Study		Client: TRPC		
Corridor Section:	Old Hwy 9 SW & Old Hwy 99 Signal		Date: 4/9/2020		
Location:	City of Grand Mound		Date of Cost Index: 2019		
7	**MOBILIZATION (10%)**				
	10% OF ITEM 6	EST	$88,000	1	$88,000
8	**SUBTOTAL (ITEMS 6 & 7)**				**$967,900**
9	**CONSTRUCTION ADMINISTRATION**				
	ENGINEERING (12% OF ITEM 8)	EST	$117,000	1	$117,000
	PERMITTING (2% OF ITEM 8)	EST	$20,000	1	$20,000
10	**CONTINGENCY**				
	30% OF ITEM 8	EST	$264,000	1	$264,000
11	**CONSTRUCTION TOTAL (ITEMS 8, 9 & 10)**				**$1,368,900**
III.	**PRELIMINARY WORK**				
	PRELIMINARY ENGINEERING (15% OF ITEM 11)	EST	$205,400	1	$205,400
	ENVIRONMENTAL COMPLIANCE	EST	$100,000	1	$100,000
IV.	**TOTAL ESTIMATED COST**				
	(ITEMS I, II & III)				**$1,680,000**

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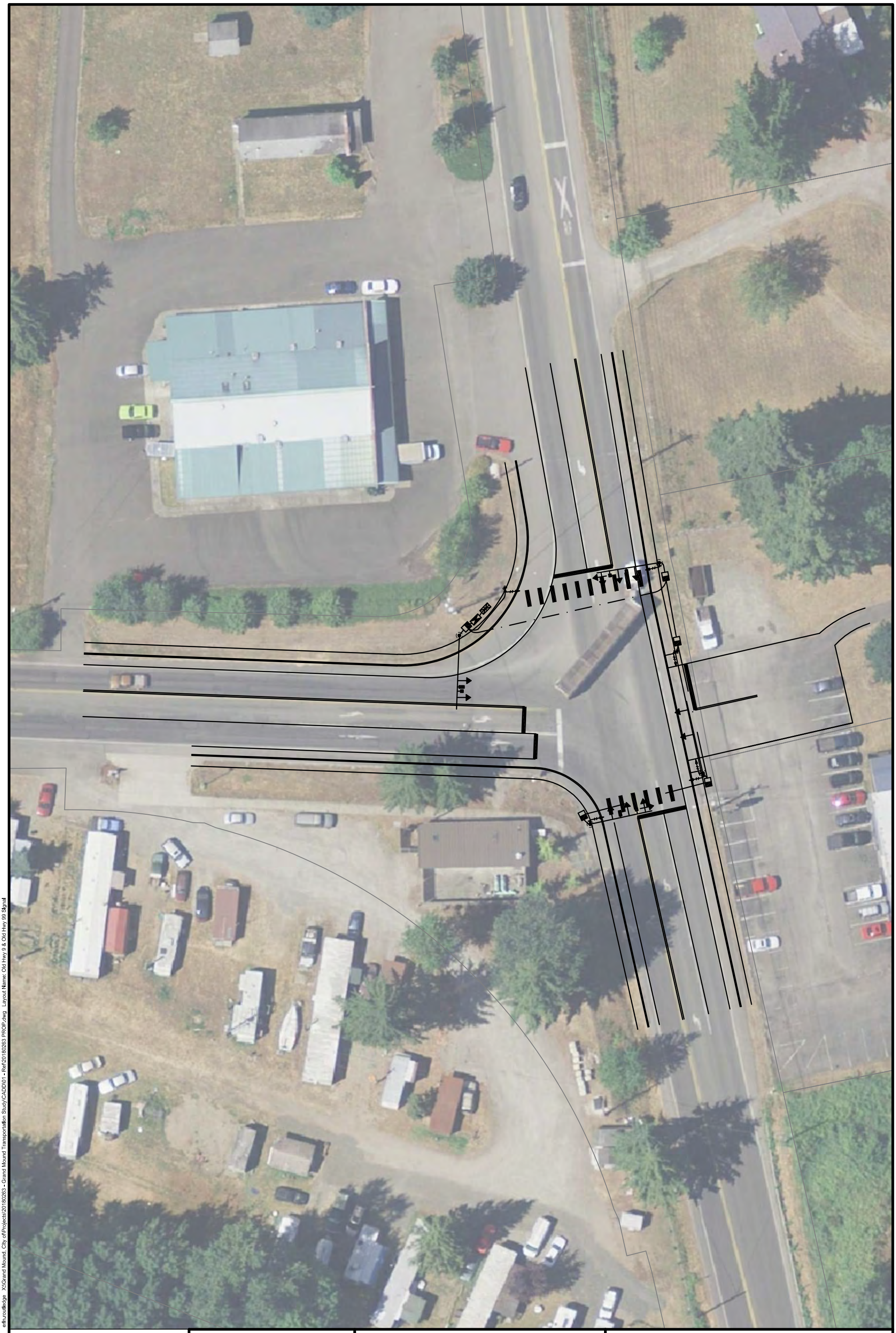
Assumptions:
30% contingency - appropriate for this level of design
Mast arm signal poles
Pedestrian push buttons installed at each pedestrian crossing
Curb, gutter, and sidewalk improvements 150 feet +/- to north, south, and west of intersection
No right-of-way acquisition needed
Soils suitable for infiltration



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TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
APRIL 8, 2020

C11 – OLD HWY 99 SW & OLD HWY 9 SW SIGNAL LAYOUT

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PLANNING LEVEL OPINION OF COST SUMMARY

Project Description:	Grand Mound Transportation Study	Client:	TRPC
Corridor Section:	Power Line Trail	Date:	2/24/2020
Location:	City of Grand Mound	Date of Cost Index:	2019

		ITEM	UNIT	ESTIMATED UNIT COST	QTY	COST
I.		**RIGHT OF WAY**				
		RIGHT OF WAY (urban developed)	SF	$60	40,900	$2,454,000
		ADMINISTRATION (TITLES, APPRAISALS, ETC.)	EA	$15,000	11	$165,000
		RIGHT OF WAY TOTAL				**$2,619,000**
II.		**CONSTRUCTION**				
1		**PREPARATION/GRADING/DRAINAGE**				
	1.1	**PREPARATION**				
		CLEAR & GRUB,DEMO	ACRE	$5,000	2.3	$11,500
		REMOVAL STRUCTURES & OBSTRUCTIONS	LS	$10,000	1	$10,000
2		**SURFACING**				
		HOT MIX ASPHALT	TON	$120	500	$60,000
		CRUSHED SURFACING	TON	$50	1,700	$85,000
3		**ROADSIDE DEVELOPMENT**				
		TEMP. WATER POLLUTION & EROSION CONTROL (6%)	LS	$12,200	1	$12,200
4		**TRAFFIC**				
		SIGNING	LS	$5,000	1	$5,000
		CURB RAMP	EA	$3,000	6	$18,000
5		**OTHER ITEMS**				
		SURVEYING (6%)	LS	$12,200	1	$12,200
		PROPERTY RESTORATION	EST	$13,000	1	$13,000
6		**CONSTRUCTION SUBTOTAL (ITEMS 1 THRU 5)**				**$226,900**
7		**MOBILIZATION (10%)**				
		10% OF ITEM 7	EST	$22,700	1	$22,700
8		**SUBTOTAL (ITEMS 6 & 7)**				**$249,600**
9		**CONSTRUCTION ADMINISTRATION**				
		ENGINEERING (12% OF ITEM 8)	EST	$30,000	1	$30,000
		PERMITTING (2% OF ITEM 8)	EST	$5,000	1	$5,000
10		**CONTINGENCY (20%)**				
		20% OF ITEM 8	EST	$50,000	1	$50,000
11		**CONSTRUCTION TOTAL (ITEMS 8, 9, & 10)**				**$334,600**
III.		**PRELIMINARY WORK**				
		PRELIMINARY ENGINEERING (15% OF ITEM 11)	EST	$50,200	1	$50,200
		ENVIRONMENTAL PERMITS	EST	$20,000	1	$20,000
IV.		**TOTAL ESTIMATED COST**				
		(ITEMS I, II & III)				**$3,030,000**

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PLANNING LEVEL OPINION OF COST SUMMARY

Project Description:	Grand Mound Transportation Study	Client:	TRPC
Corridor Section:	Power Line Trail	Date:	2/24/2020
Location:	City of Grand Mound	Date of Cost Index:	2019

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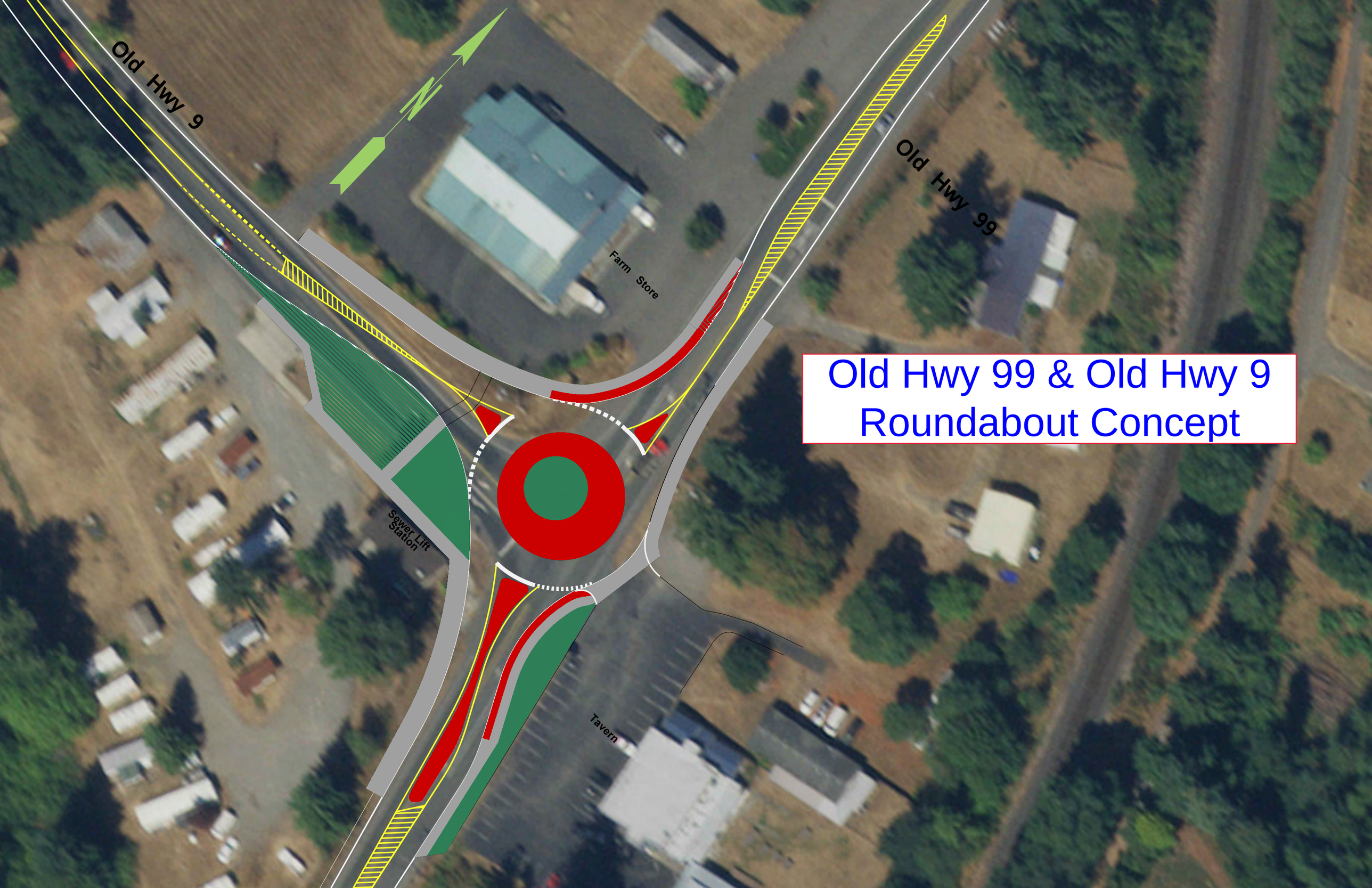
Assumptions:
20% contingency - appropriate for this level of trail design
Trail section assumed to be 2" HMA over 6" CSBC
Shoulder section assumed to be 8" CSBC



Old Hwy 99 & Old Hwy 9 Roundabout Concept

15’

27’

70’

62’

60’

PROPOSED
TRAIL
ALIGNMENT

15’

N

SCALE

200 0 200 400

FEET

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TRPC
GRAND MOUND TRANSPORTATION STUDY

PROJECT NO. 20180263
JANUARY 24, 2019

POWER LINE TRAIL
198TH WAY SW TO 203RD AVE SW

Jan 21, 2020 - 8:09am erin.routledge X:\Grand Mound, City of\Projects\20180263 - Grand Mound Transportation Study\CADD\01 - Ref\20180263 PROP.dwg Layout Name: Power Line Trail

Appendix E: Forecasting Memorandum

FEHR PEERS

Memorandum

Date: June 3, 2019

To: Allison Osterberg, Thurston Regional Planning Council

From: Michael Adamson & Kara Hall, Fehr & Peers

Subject: Grand Mound Transportation Study Travel Demand Forecasting Methodology & Results

SE19-0676

As part of the Grand Mound Transportation Study, travel demand modeling has been completed to forecast anticipated traffic conditions within the study area by 2040. This memorandum documents the tools, assumptions, and methodology used in the forecasting process for this study.

Travel Demand Modelling Tools

The year 2040 forecasts for turning movements at study intersections and roadway segment volumes were developed through consultation of two versions of the Thurston Regional Planning Council (TRPC) model: a static regional model, which forecasts macroscale travel patterns based on land use and transportation network characteristics and a Dynamic Traffic Assignment (DTA) model, a mesoscale model that reflects how travelers alter their routes based on congestion levels and queueing.

The TRPC Regional Travel Demand Model was used to complete the trip generation, trip distribution, and mode choice steps. The TRPC Regional Demand Model runs using the EMME modeling platform and is built to forecast demand during two time periods: a 2015 base year, which includes land use and transportation network intended to reflect current year conditions, and a future year model, which includes land use growth and transportation network improvements assumed to be in place by 2040.

The origin-destinations by Traffic Analysis Zones (TAZ) were extracted from the EMME model and used as inputs in the DTA models for both base year and future year models developed for the Grand Mound area. The DTA models run on the Dynameq modeling platform and are used only for the assignment step of the modeling process. The network area in the Grand Mound model

includes roadways along US 12 from Old Highway 9 to the northbound I-5 Ramp and roadways along Old Highway 99/Elderberry Street SW from 193rd Street SW to Old Highway 9. The model assesses traffic movement along these roadways from 2:00 PM to 7:00 PM (five 1-hr intervals). Per existing traffic counts, it was decided that the 5:00-6:00 PM interval would be treated as the peak hour.

For this process, a base year model, representing 2015 conditions in the Grand Mound Urban Growth Area (UGA) was validated as described in the following section, to ensure that the model reflects existing travel patterns. Next, a future year model with expected land use and roadway network improvements planned to be completed prior to 2040 was used to represent future conditions.

Travel Demand Model Validation and Calibration

Before using the DTA models to develop future year forecasts, the base year model was validated using data collected and analysis completed for the existing conditions documentation. The goal of model validation for DTA models is to ensure that for base year conditions, changes to the traffic routing are in the correct direction and magnitude when network changes are made (such as changes in speed, capacities or connections) and that metrics from the model match observed conditions in the field.

For this study, Level of Service (LOS) at study intersection and link-level volume were identified as the two most important metrics for validation. For LOS, results from Dynameq, described below, were compared to the results calculated using Synchro as part of the existing conditions analysis. For the volume validation, data collected in the study area between 2016 and 2019 was compared to the link-level volume extracted from Dynameq.

The only initial change made to the base year model received from TRPC, were updates to the Group Delay coding. This dataset allows the upstream delay to be appropriately attributed to intersections where queueing may extend past the links representing the intersection in the model, causing the model to under-report delay. To ensure accurate reporting for "Group Delay", the link grouping was updated so that links along an approach to a given intersection were all in the same group.

The results for LOS and volume for the initial model run are summarized in **Table 1** and **Table 2**, respectively.

The Dynameq model was considered valid based on the following criteria for intersection LOS:

- If Synchro LOS was between LOS A-C, Dynameq LOS must also be between LOS A-C
- If Synchro LOS was LOS D, E, or F, Dynameq LOS must match

Table 1. Synchro LOS vs Dynameq LOS Prior to Model Adjustments

Intersection		Control	Synchro					Dynameq				
			NB	SB	EB	WB	Total	NB	SB	EB	WB	Total
1	193rd Ave & Elderberry St	Stop	A	-	A	A	A	A	-	A	A	A
2	196th Ave & Elderberry St	Stop	A	A	A	-	A	A	A	A	-	A
3	196th Ave & Sargent Rd	Stop	A	A	B	B	B	A	A	A	A	A
4	Sargent Rd & US-12	Stop	-	-	-	-	-	-	-	-	-	-
5	Old Hwy 99/Elderberry St & US-12	Signal	E	E	C	D	D	**A**	**D**	**D**	**C**	**C**
6	SB I-5 Ramp & US-12	Signal	-	D	B	B	C	-	**E**	C	**C**	C
7	NB I-5 Ramp & US-12	Signal	D	-	C	B	C	**C**	-	B	C	C
8	198th Ave & Old Hwy 99	Stop	A	A	A	A	A	A	A	A	A	A
9	198th Ave (West) & Sargent Rd	Stop	A	A	A	-	A	A	A	A	-	A
10	198th Ave (East) & Sargent Rd	Stop	A	A	-	A	C	A	A	-	A	A
11	Sargent Rd & Old Hwy 99	Stop	A	A	B	-	B	A	A	A	-	A
12	201st Ave & Old Hwy 99	Stop	A	A	C	-	C	A	A	A	-	A
13	Old Hwy 9 & Old Hwy 99	Stop	A	A	B	-	B	A	A	A	-	A

Bold text indicates location did not meet validation requirements.

Table 2. Volume Comparison After Model Adjustments

Intersection		Observed					Model (%)				
		NB	SB	EB	WB	Total	NB	SB	EB	WB	Total
1	193rd Ave & Elderberry St	143	-	30	76	249	-59%	-	-60%	-63%	-60%
2	196th Ave & Elderberry St	428	112	164	-	704	-46%	-64%	-2%	-	-39%
3	196th Ave & Sargent Rd	7	153	28	257	445	-100%	-1%	-89%	-40%	-31%
4	Sargent Rd & US-12	-	-	-	-	-	-	-	-	-	-
5	Old Hwy 99/Elderberry St & US-12	684	280	371	1,069	2,404	-25%	-29%	13%	-24%	-19%
6	SB I-5 Ramp & US-12	-	639	774	660	2,073	-	-46%	5%	14%	-8%
7	NB I-5 Ramp & US-12	581	-	536	312	1,429	-12%	-	-39%	36%	-11%
8	198th Ave & Old Hwy 99	613	649	34	75	1,371	-35%	-26%	135%	-95%	-30%
9	198th Ave (West) & Sargent Rd	63	2	43	-	108	92%	-100%	-53%	-	31%
10	198th Ave (East) & Sargent Rd	24	43	-	53	120	-50%	-33%	-	123%	33%
11	Sargent Rd & Old Hwy 99	563	490	40	-	1,093	-31%	-23%	-98%	-	-30%
12	201st Ave & Old Hwy 99	539	507	66	-	1,112	-39%	-25%	17%	-	-29%
13	Old Hwy 9 & Old Hwy 99	566	364	180	-	1,110	-30%	-30%	38%	-	-19%

As shown in **Table 1**, most study intersections were validated based on the initial run; however at the Old Highway 99/Elderberry Street/US 12 intersection and the Northbound I-5 Ramps, the Dynameq model showed less delay than existing conditions, while for the Southbound I-5 Ramps intersection, the Dynameq model reflected higher delays than observed conditions. Generally, the model estimated lower volumes than those observed.

For locations not meeting the criteria, the calibration process began with a detailed review of the roadway network, including the number of lanes and lane configuration at intersections in the study area. As part of that review, the following changes were made to the base year model at the Old Highway 99/Elderberry Street and US 12 intersection:

- Northbound shared through-right added
- Southbound through added

Signal timing at the three study intersections was also updated to match timing information received from the Washington State Transportation Department (WSDOT) as part of the existing conditions data collection effort. Signal timing inputs for Dynameq are in the form of actuated green-times, which must be estimated using Synchro, rather than obtained from a timing sheet. This requires that the signal timing information provided be input into Synchro, along with traffic volume at the intersection. The timing reports from Synchro can then be used to determine the actuated green-time which is then input into Dynameq. As part of this process, signal timing and phasing was updated at the following study intersections:

- Old Highway 99/Elderberry Street & US 12
- I-5 Southbound Ramp & US 12
- I-5 Northbound Ramp & US 12

The model was then reran, resulting in the LOS and link-level volume presented in **Table 3** and **Table 4**, respectively.

Updates to the model resulted in the expected changes, an increase in delay at signalized intersections along the US 12 corridor, however; the signalized locations continue to operate just outside the thresholds for validation. Upon further investigation this was determined to be due to a difference in the base year model conditions (2015) and the slight growth that likely occurred in the area between 2015 and the data collection years (2016-2019). As the model responded to changes as expected, an important part of dynamic model validation, the model was considered valid.

Table 3. Synchro LOS vs Dynameq LOS Prior to Model Adjustments

Intersection		Control	Observed					Model				
			NB	SB	EB	WB	Total	NB	SB	EB	WB	Total
1	193rd Ave & Elderberry St	Stop	A	-	A	A	A	A	-	A	A	A
2	196th Ave & Elderberry St	Stop	A	A	A	-	A	A	A	A	-	A
3	196th Ave & Sargent Rd	Stop	A	A	B	B	B	A	A	A	A	A
4	Sargent Rd & US-12	Stop	-	-	-	-	-	-	-	-	-	-
5	Old Hwy 99/Elderberry St & US-12	Signal	E	E	C	D	D	**B**	**D**	C	**C**	**C**
6	SB I-5 Ramp & US-12	Signal		D	B	B	C	-	**C**	A	**D**	C
7	NB I-5 Ramp & US-12	Signal	D	-	C	B	C	**E**	-	B	B	C
8	198th Ave & Old Hwy 99	Stop	A	A	A	A	A	A	A	A	A	A
9	198th Ave (West) & Sargent Rd	Stop	A	A	A	-	A	A	A	A	-	A
10	198th Ave (East) & Sargent Rd	Stop	A	A	-	A	C	A	A	-	A	A
11	Sargent Rd & Old Hwy 99	Stop	A	A	B	-	B	A	A	A	-	A
12	201st Ave & Old Hwy 99	Stop	A	A	C	-	C	A	A	A	-	A
13	Old Hwy 9 & Old Hwy 99	Stop	A	A	B	-	B	A	A	A	-	A

Bold text indicates location did not meet validation requirements.

Table 4. Volume Comparison Prior to Model Adjustments

Intersection		Observed					Model (%)				
		NB	SB	EB	WB	Total	NB	SB	EB	WB	Total
1	193rd Ave & Elderberry St	143	-	30	76	249	-	-	-73%	-54%	-83%
2	196th Ave & Elderberry St	428	112	164	-	704	-54%	-60%	-8%	-	-44%
3	196th Ave & Sargent Rd	7	153	28	257	445	-100%	-5%	-89%	-49%	-37%
4	Sargent Rd & US-12	-	-	-	-	-	-	-	-	-	-
5	Old Hwy 99/Elderberry St & US-12	684	280	371	1,069	2,404	-21%	-30%	35%	-23%	-14%
6	SB I-5 Ramp & US-12	-	639	774	660	2,073	-	-36%	23%	7%	0%
7	NB I-5 Ramp & US-12	581	-	536	312	1,429	-19%	-	-31%	36%	-12%
8	198th Ave & Old Hwy 99	613	649	34	75	1,371	-31%	-39%	141%	-95%	-34%
9	198th Ave (West) & Sargent Rd	63	2	43	-	108	54%	-100%	-56%	-	7%
10	198th Ave (East) & Sargent Rd	24	43	-	53	120	-58%	-33%	-	85%	14%
11	Sargent Rd & Old Hwy 99	563	490	40	-	1,093	-27%	-37%	-98%	-	-34%
12	201st Ave & Old Hwy 99	539	507	66	-	1,112	-32%	-39%	-2%	-	-33%
13	Old Hwy 9 & Old Hwy 99	566	364	180	-	1,110	-19%	-40%	15%	-	-20%

Forecasting Methodology & Assumptions

The 2040 model, developed and refined by TRPC, along with the base year model were utilized to develop future forecasts for the study area.

The origin-destination information used in the 2040 Dynameq model was based on the TRPC Regional Travel Demand Model outputs. The land use updates for the Grand Mound UGA in the regional model include an increase in commercial, industrial and business park uses. Planned roadway improvements in the study area were also included in both the EMME and Dynameq models. At present, the only planned improvement within the study area between existing and 2040 is the construction of a roundabout connecting Sargent Road across US 12.

Traffic volume forecasts for study intersections and roadway segments were then prepared using the difference method. When utilizing the difference method, the change between the base year and future year models is added to existing counts to develop future forecasts. As part of the model post-processing, intersection volumes were balanced along US 12 to account for the closely spaced intersections with no access to US 12 between intersections.

The initial post-processed volumes were then input into the Synchro model developed for the study to ensure that the correct signal timing was being utilized in future conditions. Signal timing was optimized to reflect altered route choice for travelers given land growth and transportation network changes between now and 2040. The signal timing changes required through this process were minimal, but were incorporated into the future Dynameq model.

The final step in the forecasting process was the manual addition of trips associated with the planned Maple Lane Correctional Center. While no final plan for this project has been determined at this time, the trip generation estimates prepared as part of the Draft Environmental Impact Statement[1] were manually added after all of the model post-processing was complete.

Grand Mound 2040 Forecasts

The final intersection volumes for the Grand Mound UGA are shown on **Attachment A**, while **Table 5** summarizes the roadway segment volume developed as part of the forecasting effort.

While overall volumes at study locations are expected to increase at an average of 1.9 percent per year, several locations are expected to see negative growth due to the new connection of Sargent Road and US 12. Locations where decreases in volumes are expected:

- Northbound left-turn at Elderberry Street/193rd Avenue SW

[1] DOC Maple Lane Correctional Center Traffic Generation Estimates (Heffron Transportation Inc, April 2019)

- Northbound and southbound thru and eastbound right-turn at Elderberry Street/196th Avenue SW
- Southbound left-turn at Sargent Road/196th Avenue SW
- Northbound and southbound thru at Old Highway 99/US 12

Table 5. Roadway Segment Operations

Project Location	Direction	Existing Volume (2-hr)	2040 Volume (2-hr)
Elderberry St SW between 196th and 193rd	NB	230	252
	SB	191	133
196th Ave SW between Sargent Rd SW and Elderberry St SW	EB	321	120
	WB	523	350
Sargent Rd SW between US-12 and 196th Ave SW	NB	14	350
	SB	64	455
Elderberry St SW between US-12 and 196th St SW	NB	634	519
	SB	448	281
Sargent Rd SW between 198th Way SW and US-12	NB	-	430
	SB	4	520
198th Ave SW between Sargent Rd SW and Old Hwy 99	EB	44	190
	WB	93	220
Sargent Rd SW between Old Hwy 99 and 198th Way SW	NB	95	430
	SB	55	400
Old Hwy 99 between 198th Ave SW and Sargent Rd	NB	1,050	991
	SB	1,054	673
201st Ave SW west of Old Hwy 99	EB	143	90
	WB	194	30
Old Hwy 99 south of 201st Ave SW	NB	912	1,271
	SB	842	823
Tea St SW between Grand Mound Way SW / Old Hwy 9	NB	164	335
	SB	-	250