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TECHNICAL MEMORANDUM

Date:	May 5, 2017	Project #: 19890.3
To:	Jim Whynot and Jacque Betz, City of Gladstone Gail Curtis, Oregon Department of Transportation, Region 1	
From:	Matt Bell and Molly McCormick, Kittelson and Associates, Inc.	
Project:	Gladstone Transportation System Plan (TSP) Update	
Subject:	Final Tech Memo 6: Needs Analysis (Subtask 3.2)	

This memorandum documents the existing and future transportation system needs within the city of Gladstone. The information presented in this memorandum builds upon the gaps and deficiencies identified in *Tech Memo 5: Existing Gaps and Deficiencies* and provides the technical analysis needed to support the development of potential solutions that will be identified in *Tech Memo 8: TSP Solutions* This information is intended to inform the development of the city's 2017 Transportation System Plan (TSP) update which will address existing transportation system needs and additional facilities that are required to serve future growth. *Attachment "A" contains a menu of potential solutions that can be used to address many of these needs identified in this memo.*

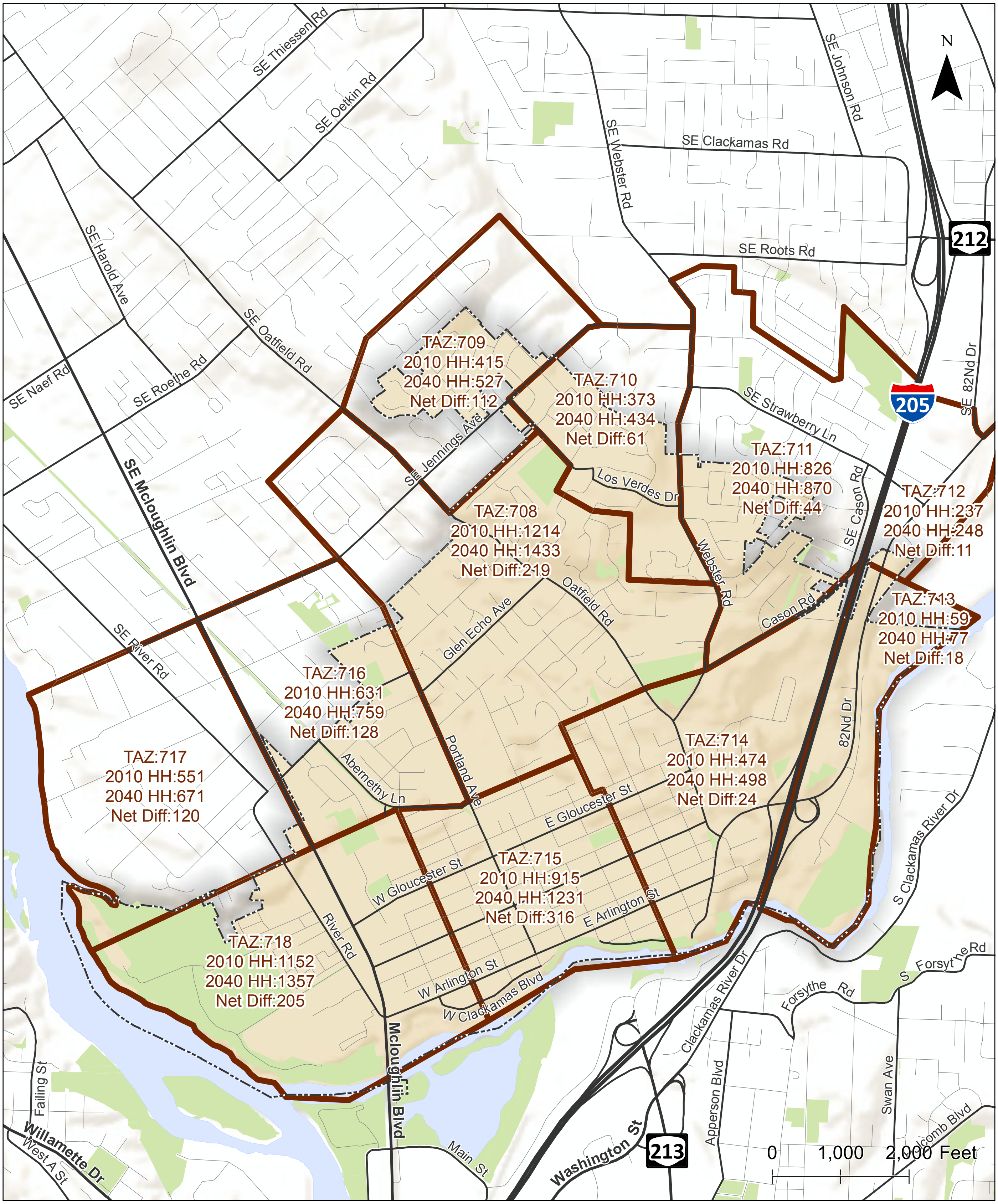
PROJECTED LAND USES

Land use plays an important role in developing a comprehensive transportation system. The amount of land that is planned to be developed, the type of land uses, and how the land uses are mixed together have a direct impact on how the transportation system will be used in the future. Understanding land use is critical to taking actions to maintain or enhance the transportation system.

Land use data for Gladstone was provided by Metro. The data includes base year 2010 and forecast year 2040 population, household, and employment estimates for the city by Transportation Analysis Zone (TAZ). There are 11 TAZs that cover the city limits of Gladstone. Figures 1 and 2 illustrate the TAZs and the household and employment changes expected between base year 2010 and forecast year 2040. Table 1 summarizes the TAZ data for base year 2010 and forecast year 2040 conditions. As shown in Table 1, the growth in population and households over the 30 year period is expected to be less than 1% per year while the growth in employment is expected to be more than 2% per year.

Table 1: Gladstone Land Use Summary

Land Use	2010	2040	Change	Percent Change
Population	16,006	18,691	+2,685	+16.8%
Households	6,847	8,105	+1,258	+18.4%
Employment	3,062	4,912	+1,850	+60.4%



Net Difference in Households by TAZ (2010 to 2040) Gladstone, Oregon

Figure 1

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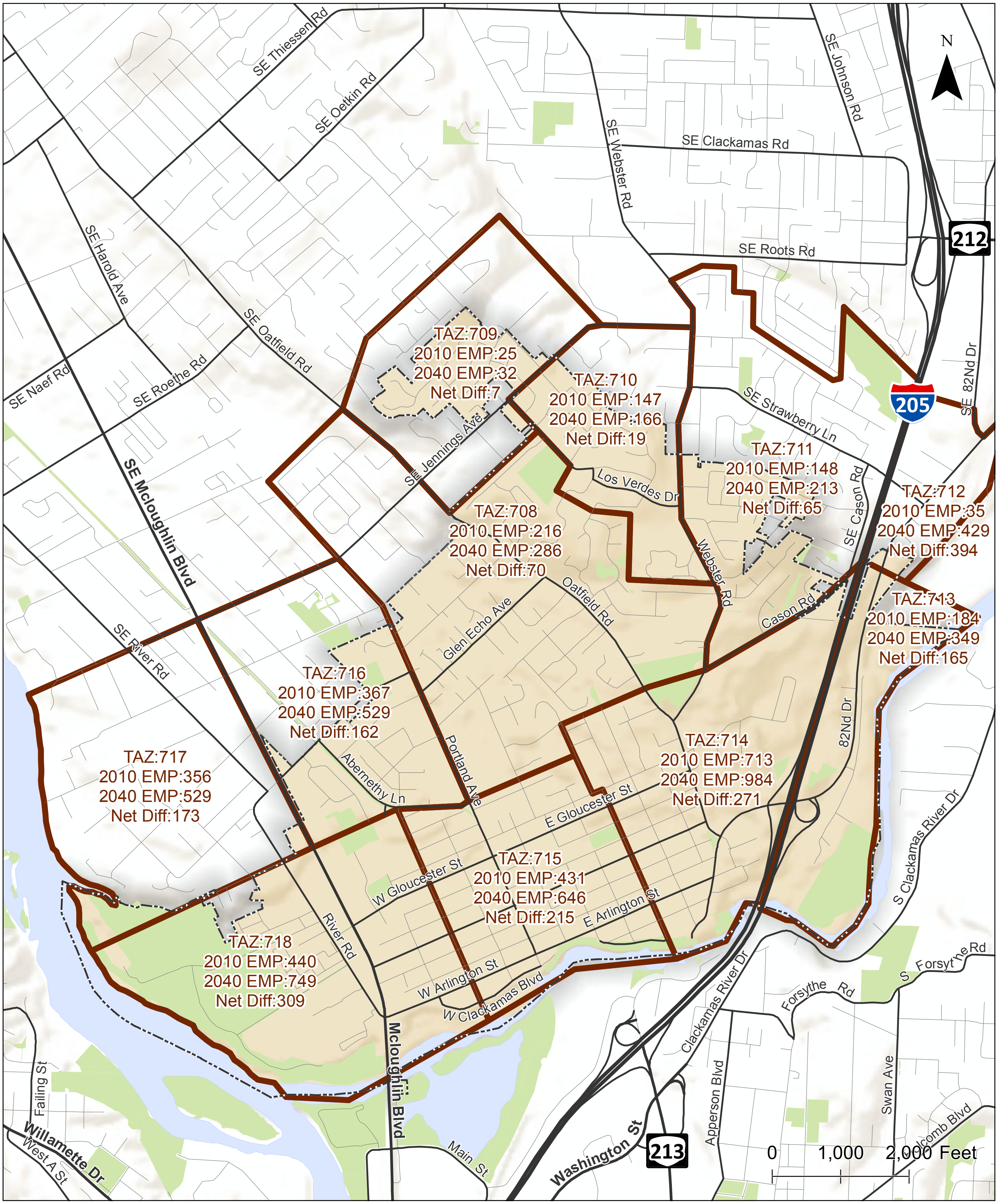

Net Difference in Employment by TAZ (2010 to 2040)
Gladstone, Oregon

Figure
2

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As land uses change in proportion to each other (i.e. there is a significant increase in employment relative to household growth), there will be a shift in the overall operation of the transportation system. Retail land uses generate a higher number of trips per acre of land than residential and other land uses. The location and design of retail land uses in a community can greatly affect transportation system operation. Additionally, if a community is homogeneous in land use character (i.e. all employment or all residential), the transportation system must support significant trips coming to or from the community rather than within the community. Typically, there should be a mix of residential, commercial, and employment type land uses so that some residents may work and shop locally, reducing the need for residents to travel long distances. The data shown in Table 1 indicates that significant growth is expected in Gladstone in the coming years, particularly employment opportunities. The transportation system should be monitored to make sure that land uses in the plan are balanced with transportation system capacity.

PUBLIC TRANSIT SYSTEM NEEDS

Transit Level-of-Service Analysis

A transit level-of-service analysis was conducted in accordance with the methodology described in *TCRP Report 100: Transit Capacity and Quality of Service Manual* (TCQSM). Chapter 3 of the TCQSM provides an extended discussion on quality of service, which is the evaluation of transit service from the passenger's point-of-view. The TCQSM uses six measures to quantify service quality. Each of these measures is assigned a letter value, where LOS A represents the best service from the passenger perspective and LOS F represents the worst service. *(Note that high LOS values, such as LOS A or B, may not reflect optimal service from the transit agency's perspective, because the market may not support those service levels. The development of agency service standards helps to bridge the gap between the kind of service passengers would ideally want and the kind of service that is reasonable to provide, given available resources.)* The transit LOS approach mirrors the system commonly used for streets and highways, and allows a speedy comparison of service performance to transit passenger desires.

Of the six available measures, three were selected for this analysis as being most relevant to a long-range planning effort. Table 2 summarizes the TCQSM measures used and the ranges of values used to determine the LOS result for each measure.

Table 2: Transit Capacity and Quality of Service Manual - Level of Service (LOS) Measures

Level of Service	Transit Capacity and Quality of Service Measures		
	Service Frequency (minutes)	Hours of Service	Service Coverage
LOS A	<10	19-24	90.0-100.0%
LOS B	10-14	17-18	80.0-89.9%
LOS C	15-20	14-16	70.0-79.9%
LOS D	21-30	12-13	60.0-69.9%
LOS E	31-60	4-11	50.0-59.9%
LOS F	>60	0-3	<50.0%

Service Frequency

From the user's perspective, *service frequency* determines how many times an hour a user has access to transit service, assuming that service is provided within acceptable walking distance (measured by *service coverage*) and at the times the user wishes to travel (measured by *hours of service*). Service frequency also measures the convenience of transit service to riders and is one component of overall transit trip time (helping to determine the wait time at a stop). Table 3 summarizes the transit level-of-service analysis results for service frequency.

Table 3: Service Frequency Level-of-Service Analysis

Provider	Routes	Service Frequency	LOS
TriMet	Line 32	30-60 minutes[1]	D-E
	Line 33	15-30 minutes[1]	C-D
	Line 34	40 minutes[2]	E
	Line 79	30-40 minutes[1]	D-E
	Line 99	15-30 minutes[2]	C-D

1. Service is less frequent on Saturday and Sunday.
2. No service is provided on Saturday or Sunday.

As shown in Table 3, Lines 33 and 99 operate at LOS C during the morning and evening peak periods and at LOS D during off-peak periods while Lines 32 and 79 operate at LOS D during the morning and evening peak periods and at LOS E during off peak periods. At LOS C, service frequencies provide a reasonable choice of travel times, but the wait involved if a bus is missed becomes long. At LOS D, service is only available about twice per hour and requires passengers to adjust their routines to fit the transit service provided. At LOS E, service is provided approximately once per hour and puts passengers in the position of potentially spending long periods of time waiting for service and/or rearranging schedules to be able to take transit.

This type of service (frequent peak hour service with less frequent off-peak service) is typical of smaller communities, particularly those with relatively low household densities. Per the TCQSM, areas with densities of 3-6 households per acre (hh/acre) typically have 1-hour service while areas with 6-8 hh/acre have 30-minute service, areas with 8-12 hh/acre have 15-minute service, and areas with 12+ hh/acre have 10-minute service. As indicated below, most areas within Gladstone have less than 6 hh/acre with the exception of the area in the southern part of the city. Household density in this area is currently 8-10 hh/acre and is projected to be more than 10 hh/acre in the future.

Hours of Service

Hours of service, also known as "service span," is the number of hours during the day when transit service is provided along a route, a segment of a route, or between two locations. It plays as important a role as *frequency* and *service coverage* in determining the availability of transit service to potential users: if transit service is not provided at the time of day a potential passenger needs to take a trip, it does not matter where or how often transit service is provided the rest of the day. Table 4 summarizes the transit level-of-service analysis results for hours of service.

Table 4: Hours of Service Level-of-Service Analysis

Provider	Routes	Hours of Service	LOS
TriMet	Line 32	17 hours[1]	B
	Line 33	21 hours[1]	A
	Line 34	14 hours[2]	C
	Line 79	17 hours[1]	B
	Line 99	7 hours[2]	E

1. Service is less frequent on Saturday or Sunday.
2. No service is provided on Saturday or Sunday.

As shown in Table 4, Line 32 operates at LOS A and Lines 31 and 79 operate at LOS B, while Line 34 operates at LOS C. At LOS A, service is available for most or all of the day. Workers who do not work traditional 8-to-5 jobs receive service and all riders are assured that they will not be stranded until the next morning if a late-evening bus is missed. At LOS B, service is available late into the evening, which allows a range of trip purposes other than commute trips to be served. At LOS C, service runs only into the early evening, but still provides some flexibility in one's choice of time for the trip home. Also shown in Table 4, Line 99 operates at LOS E. At LOS E, midday service is limited or non-existent and/or commuters have a limited choice of travel times.

Service Coverage

Service Coverage is a measure of the area within walking distance of transit service. Areas must be within 1/4-mile of a bus stop (or service route if there are no designated stops) or 1/2 mile of a transit station to be considered an area served by transit. As with the other availability measures, service coverage does not provide a complete picture of transit availability by itself, but when combined with frequency and hours of service, it helps identify the number of opportunities people have to access transit from different locations. Service coverage LOS evaluates the percentage of transit-supportive areas—areas that would typically produce the majority of a system's ridership—that are served by transit.

To qualify as a transit-supportive area (TSA) one of the following thresholds must be met:

- Minimum population density of 3 households/gross acre; or
- Minimum job density of 4 employees/gross acre.

Service coverage is an all-or-nothing issue for transit riders—either service is available for a particular trip or it is not. As a result, there is no direct correlation between service coverage LOS and what a passenger would experience for a given trip. Rather, service coverage LOS reflects the number of potential trip origins and destinations available to potential passengers. As noted in Table 2, at LOS A, 90 percent or more of the TSA's have transit service; at LOS F, less than half of the TSA's have service.

Figure 3 displays the existing transit level-of-service analysis results for service coverage in Gladstone. Areas defined as transit supportive that have service are shown in green. Areas defined as transit supportive but lacking service are shown in red. Areas that have transit service, but do not qualify as a TSA, are shown in orange. A majority of the areas shown in red would require additional transit routes or the development of new pathway connections (increasing the area that is within ¼ mile walking distance) to existing transit routes to be served.

The percentage of TSAs served and the corresponding level of service has been identified using the Transit Level of Service (TLOS) methodology. As shown in Table 5, the percent of transit supportive population areas served is 82 percent and the percent of transit supportive employment areas served is also 82 percent. The corresponding LOS is B.

Table 5: Existing Transit Service Coverage Analysis

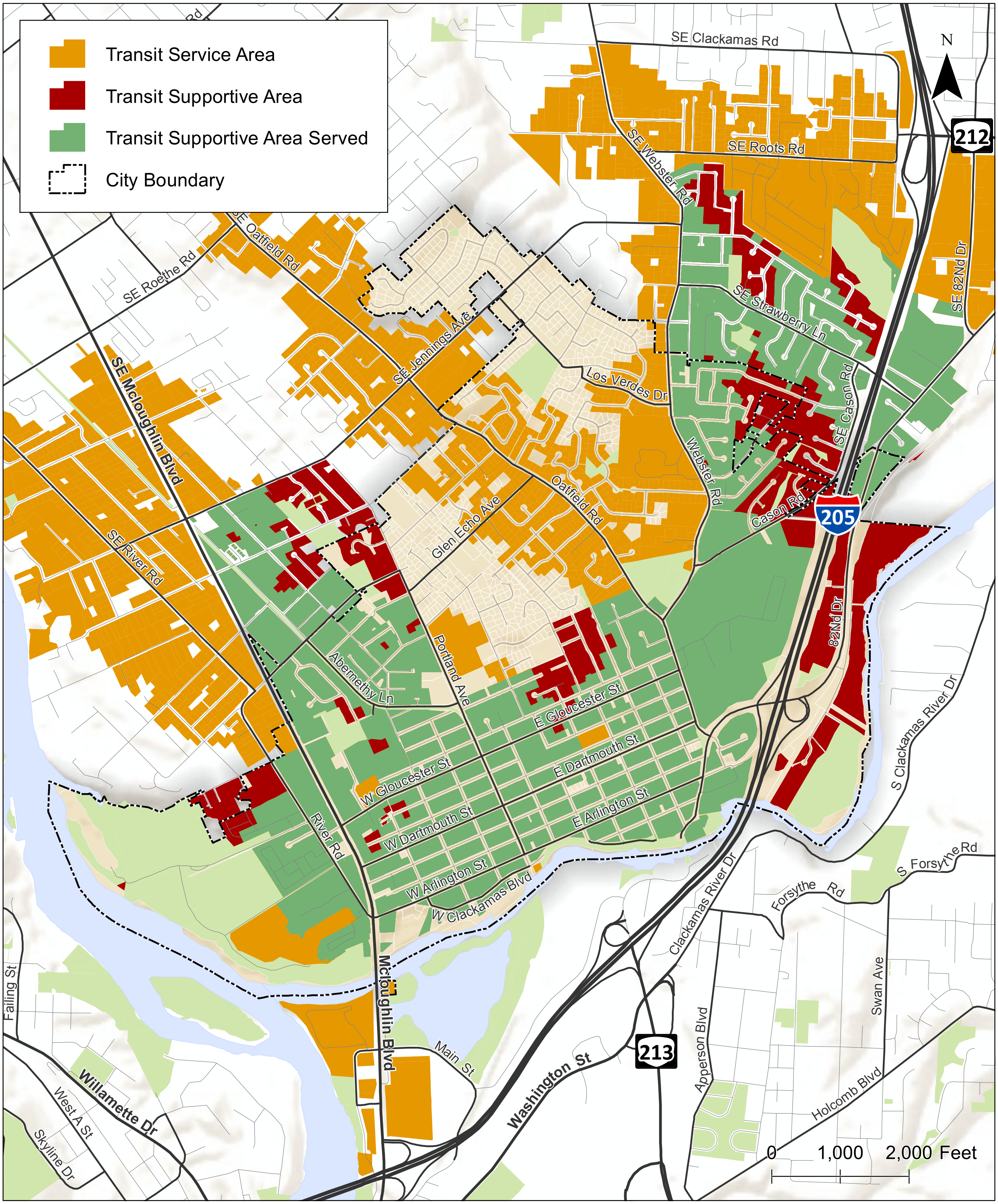
Area Type	Households	Employment
Transit Supportive Areas (TSA)[1]	2,533	1,372
Transit Supportive Areas Served[2]	2,072	1,123
Percent TSA Served by Transit	82%	82%
Level of Service	LOS B	LOS B
Transit Supportive Areas without service	461	249
Total Transit Area Served[3]	3,083	1,441
Additional Areas Served by Transit	1,011	318

1. Area shown in Green and red in Figure 3.
2. Area shown in Green in Figure 3.
3. Area shown in Green and orange in Figure 3.

As shown above, 461 households and 249 jobs are located within TSAs that do not have transit service. These areas currently have a population and/or employment density that can support transit service and therefore should be included in future efforts to improve service routes and stop locations. Also shown above, 3,083 households and 1,441 jobs are currently served by transit. Of the total area served, 1,011 households and 318 jobs are located within areas that have transit service, but currently do not have the population and/or job density necessary to economically support transit service. A few of these areas, however, are shown in Figure 3 as containing a large portion of the transportation disadvantaged population in Gladstone and therefore the service provided in these areas is an important consideration.

Future Transit Service Coverage

The future transit level-of-service analysis assumes that existing service frequencies, service hours, and service coverage is the same in the future. The only difference is the population and employment growth assumptions included in the regional traffic model and the resulting transit supportive areas. Figure 4 displays the TLOS analysis results for future transit service coverage. As shown, the number of transit supportive areas is expected to increase. While many of these areas are expected to be served by existing transit services, the remaining areas will require additional service routes or connections to existing routes in order to be served.



Existing Transit Supportive Areas
Gladstone, Oregon

Figure 3

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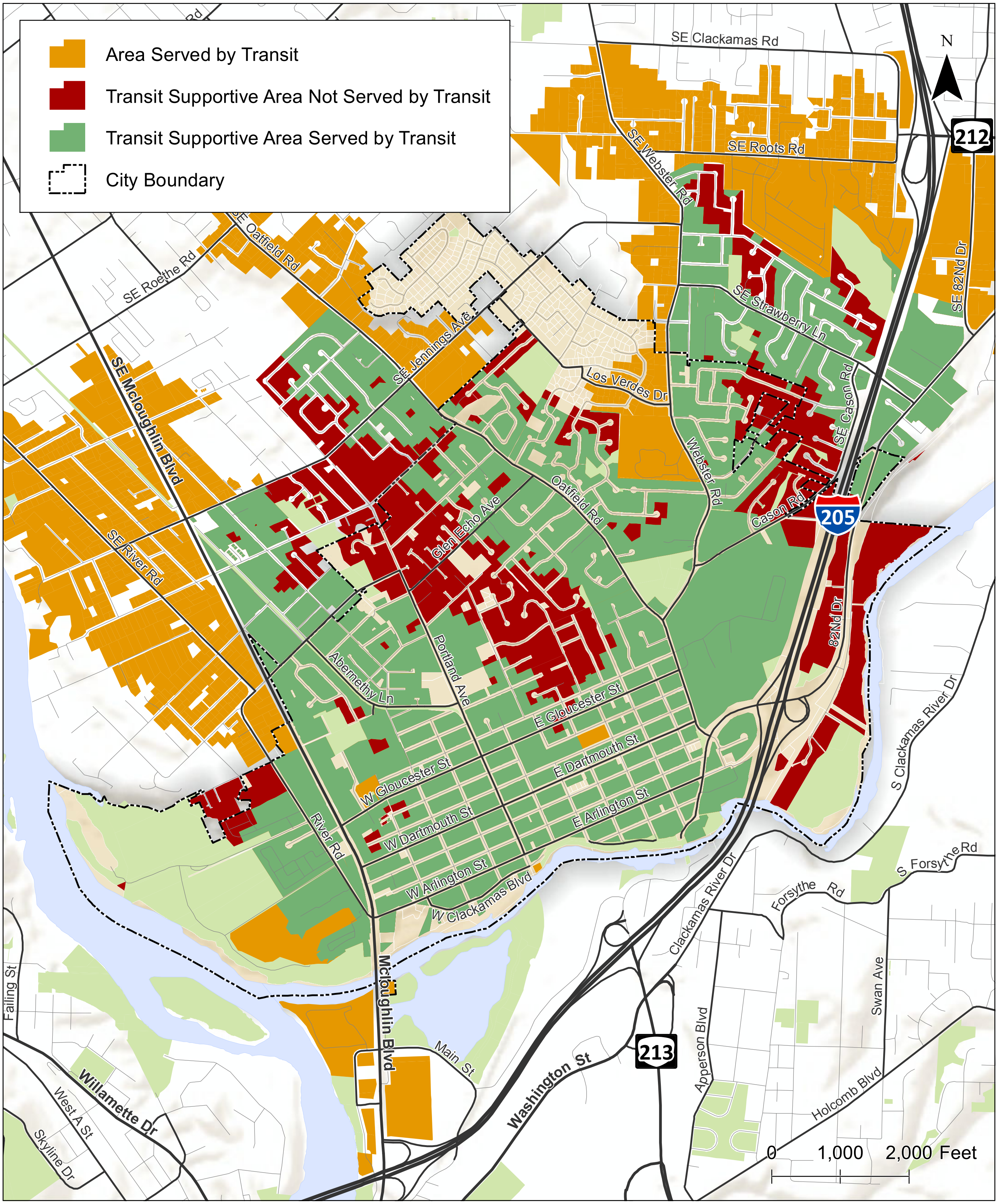
Portland Metro Data Resource Center



Transit Supportive Areas have population and employment densities sufficient to support a basic level of public transit service

Future Transit Supportive Areas Gladstone, Oregon

Figure 4

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System Connectivity

The TLOS analysis described above indicates that transit service coverage is relatively high within the city, meaning that most people have access to public transit. However, there are a few areas where additional fixed-route service could be provided to improve access to transit as well as areas where existing service frequencies and hours of service could be increased to make public transit a more viable option for commuting.

Fixed-Routes

The areas shown in red in Figures 3 and 4 represent areas that support transit service under existing and/or future conditions but lack existing service. These areas could be served by providing new service or re-routing existing service along streets that currently do not provide transit service. The following provides a summary of the streets where transit service could be provided to address the need in these areas:

- Portland Avenue from Abernathy Lane to Jennings Avenue – Portland Avenue currently does not connect to Jennings Avenue
- Jennings Avenue from OR 99E to Oatfield Road
- Carson Road from Webster Road to Strawberry Lane
- 82nd Drive from Oatfield Road to the north city limits

Service along these streets would increase service coverage within the areas that currently support transit service, as well as the areas that are projected to support transit service in the future. Other fixed-route service needs identified by committee members and the general public include:

- Express service north on 82nd Drive
- Extended hours of service for Line 79
- Convert Line 79 to an express service “Freeway Flyer” to the Clackamas Town Center Transit Center and the MAX Green Line
- Direct service to the Portland City Center (no transfers)
- Fixed-route service along Portland Avenue (formerly served by Line 33)

Transit Stops

Amenities at transit stops, such as bus benches and bus shelters enhance a transit system and make it more user-friendly. Steps that can make this mode as comfortable and accommodating as possible may help encourage ridership. TriMet generally limits placement of bus shelters to locations with 35 or more weekday boardings. Ridership data was obtained from TriMet that reflects the average number of boardings and alightings (ons and offs) that occurred at each stop in Spring 2016. Based on a review of the data, Gladstone has six stops that meet this threshold, of which four currently do not have shelters. These stops include:

- Bus stop ID: 10323, SE McLoughlin Boulevard/Glen Echo Avenue,
- Bus stop ID: 10324, SE McLoughlin Boulevard/Gloucester Street,
- Bus stop ID: 10325, SE McLoughlin Boulevard/River Road, and
- Bus stop ID: 10327, SE McLoughlin Boulevard/Gloucester Street.

Due to low ridership levels at other stops, the City may need to directly fund the installation of bus benches, bus shelters and other amenities. Other potential amenities identified by committee members and the general public include:

- Improved signage and other amenities at transit stops

Park-and-Rides

Park-and-ride facilities provide parking for people who wish to transfer from their personal vehicle to public transportation or carpools/vanpools. Park-and-rides are frequently located near major intersections, at commercial centers, or on express and commuter bus routes. It is Oregon state policy to encourage the development and use of park-and-ride facilities at appropriate urban and rural locations adjacent to or within the highway right-of-way. Park-and-ride facilities can provide an efficient method to enhance access to transit service to and from low density areas, connecting people to jobs, and provide an alternate mode to complete long-distance commutes.

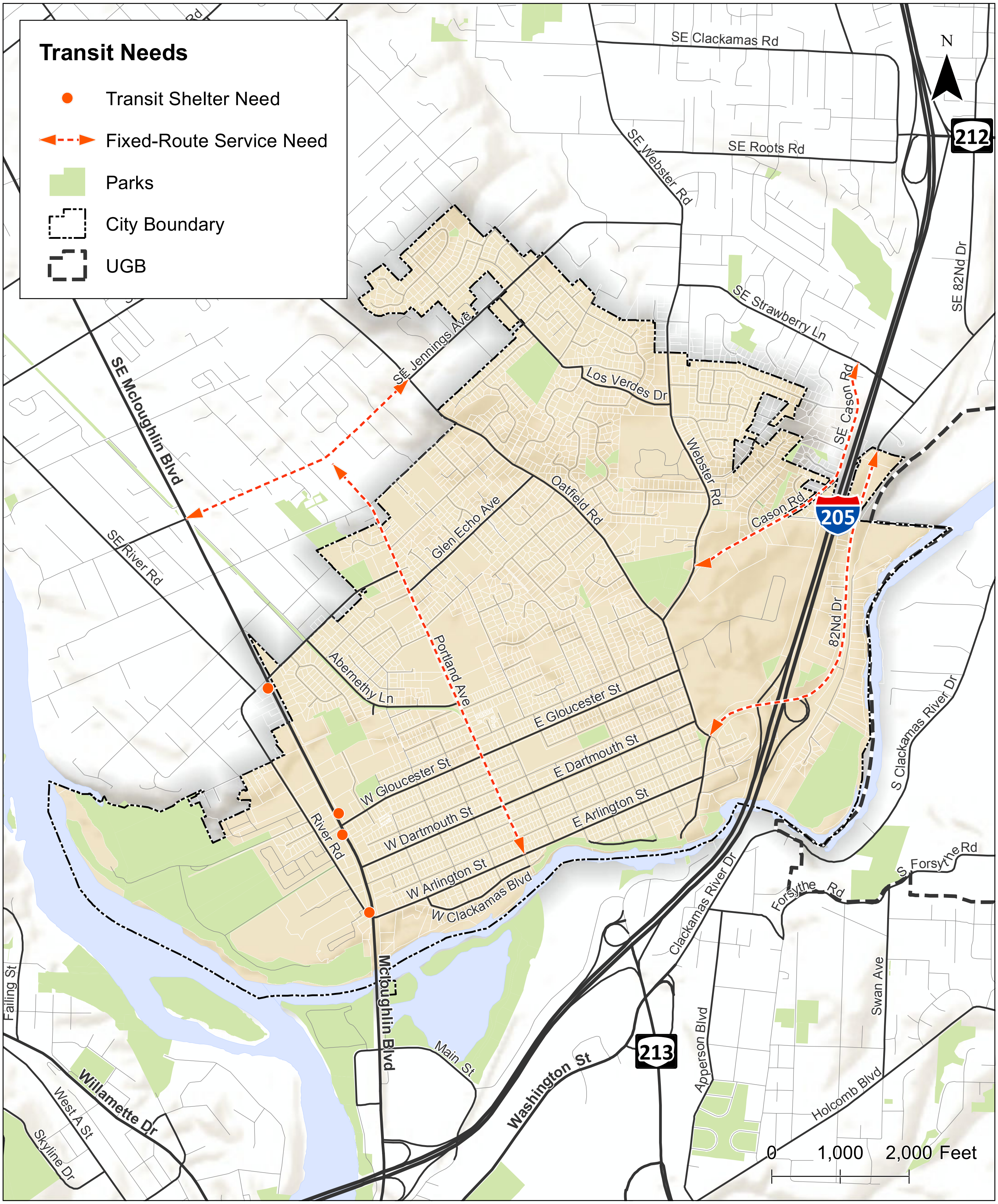
As indicated in *Tech Memo #5: Existing Gaps and Deficiencies*, there are currently no park and ride facilities located within Gladstone. While the TLOS analysis indicates that most people can access transit from their homes, a park and ride could encourage more people routinely choose transit for their daily commute. Potential park-and-ride lot locations identified by committee members and the general public include:

- OR 99E and Arlington Street (park-and-ride and bus shelter)
- First Christian Church on Dartmouth
- Baptist Church at intersection of Cason and Webster
- Mormon Church at intersection of Cason and Webster

Figure 5 illustrates the public transit system needs for Gladstone

Regional High Capacity Transit

High capacity transit is characterized by exclusive right-of-way and routes with fewer transit stops. In July 2009, Metro adopted the Regional High Capacity Transit (HCT) System Plan. The HCT Plan identifies corridors where new HCT is desired over the next 30 years and prioritizes corridors for implementation, based on a set of evaluation criteria consistent with the goals of the RTP and 2040 Concept. The location of any final HCT corridor is decided through a corridor refinement plan and/or alternatives analysis, and through a series of local and regional actions described in the plan.



Transit System Needs
Gladstone, Oregon

Figure
5

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The HCT plan identifies one Next Phase Regional Priority Corridor along the segment of I-205 that travels through Gladstone. HCT Corridor 28 will provide service between the Clackamas Town Center, the Oregon City Transit Center, and Washington Square via I-205 and Highway 217. Other HCT Corridors within the area include two Next Phase Regional Priority Corridors in Oregon City. HCT Corridor 8 will provide service between the Clackamas Town Center and the Oregon City Transit Center via I-205 and HCT Corridor 9 will provide service between Park Avenue and the Oregon City Transit Center via McLoughlin Boulevard (OR 99E). Next Phase Regional Priority Corridors are corridors where future HCT investment may be viable if recommended planning and policy actions are implemented. The City of Gladstone should work with TriMet to ensure that local transit service continues to provide access to the Oregon City Transit Center and other transit centers where HCT routes are planned.

Transportation Disadvantaged

The primary transportation disadvantaged populations in Gladstone include minorities, elderly people, people with low income, and people with disabilities (See *Tech Memo 5: Existing Gaps and Deficiencies* for additional information). Therefore, access to schools, parks, and other essential destinations should be prioritized to serve these populations. The City of Gladstone should continue to support the Clackamas County Transportation Consortium services to the elderly and ADA-eligible residents, and other services currently being provided. Also, because needs are expected to increase, Gladstone should work with existing providers to assess the needs and develop ways to best meet them.

PEDESTRIAN SYSTEM NEEDS

Pedestrian facilities, such as sidewalks, shared-use paths and trails, marked and unmarked, signalized and unsignalized pedestrian crossings are essential elements of the city's pedestrian system. While these facilities are currently provided along many city streets, there are many more streets where these facilities are needed to improve pedestrian access and connectivity. The following provides a summary of the pedestrian system needs within Gladstone, which are based on the gaps and deficiencies identified in *Tech Memo 5: Existing Gaps and Deficiencies* and a system-level analysis of the pedestrian facilities located along arterial and collector streets. As described below, the most common overall need is to provide a safe and interconnected pedestrian system that encourages people to walk, especially for trips less than one-half mile in length.

Pedestrian Level of Traffic Stress Analysis

The pedestrian facilities located along the city's arterial and collector streets were evaluated in an effort to identify potential issues that could be addressed as part of the TSP update. The Oregon Department of Transportation (ODOT) Analysis Procedures Manual (APM) provides a methodology for evaluating pedestrian facilities within urban and rural environments called Pedestrian Level of Traffic Stress (PLTS). As applied by ODOT, this methodology classifies four levels of traffic stress that a pedestrian can experience on the roadway, ranging from PLTS 1 (little traffic stress) to PLTS 4 (high traffic stress). A road segment that is rated PLTS 1 generally has low traffic volumes and travel speeds and has a sidewalk that is separated from vehicular traffic. These segments are generally suitable for all users, including children. A road segment that is rated PLTS 4 generally has high traffic volumes and travel speeds and is perceived as unsafe by most adults. Road segments rated PLTS 4 also include those with no sidewalks or other pedestrian facilities. Per the APM, PLTS 2 is considered a reasonable target for most pedestrian facilities due to its acceptability with the majority of people.

The PLTS score is based on four criteria, including sidewalk condition, physical buffer type, total buffering width, and general land use. All four criteria are scored from 1 to 4 and the highest score determines the overall score for the road segment. Figure 6 illustrates the results of the PLTS analysis for Gladstone's arterial and collector streets. It is important to note that while some segments are shown as PLTS 3 or 4, they may have shorter segments with lower PLTS scores. Table 6 summarizes the detailed results of the PLTS analysis, which includes the scores for each criteria. As shown, there are 27 road segments rated PLTS 3 and 21 road segments rated PLTS 4.

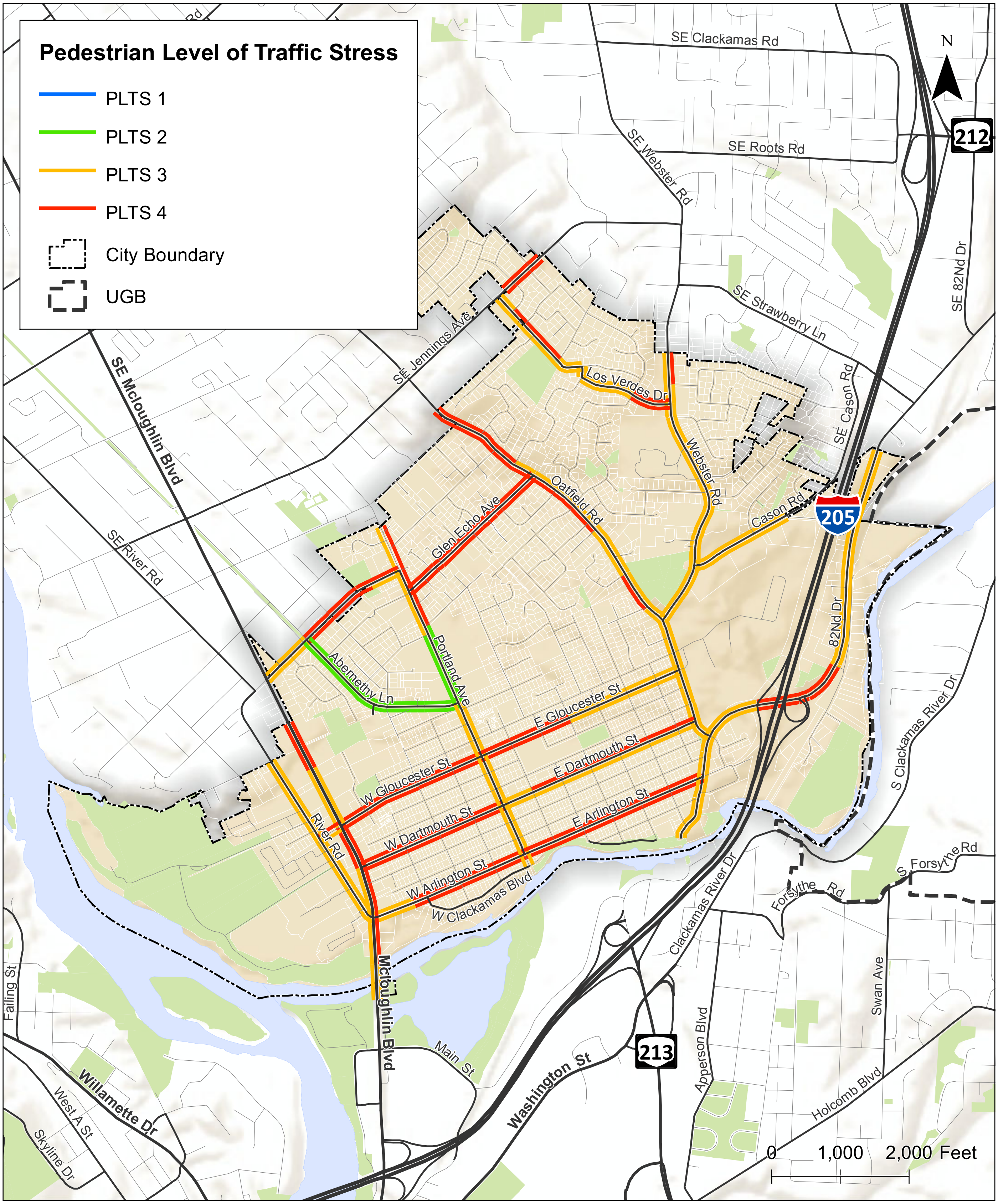
A majority of the road segments rated PLTS 3 have sidewalks in fair condition; however, they are too narrow and/or do not have illumination present. In order for these segments to be rated LTS 2, the sidewalks would need to be widened to five feet or more and illumination would need to be installed along the full length of the roadway. Several road segments are also rated LTS 3 due to having curb-tight sidewalks on roadways with speeds of 30 mph or higher. In order for these segments to be rated LTS 2, the speeds would need to be reduced to 25 mph or a buffer would need to be installed between the sidewalk and vehicle travel lane. For several other segments rated LTS 3, adjusting the LTS score will be difficult because it is controlled by the general land use next to the segment. A majority of the segments rated PLTS 4 have no sidewalks or other pedestrian facilities to accommodate pedestrians. In order for these segments to be rated PLTS 2, sidewalks with appropriate sidewalk and buffer widths would need to be installed along the full length of the roadway. *Attachment "B" contains detailed information on the PLTS analysis results.*

System Connectivity

A well-connected pedestrian system provides continuous sidewalks and other pedestrian facilities between essential destinations, such as residential neighborhoods, schools, parks, and retail/commercial centers. Strategies to improve pedestrian connectivity include identifying, prioritizing, and ultimately constructing new sidewalks, shared-use paths and trails, pedestrian crossings, and connections between neighborhoods. The following provides a summary of connectivity needs for the pedestrian system.

Sidewalks

As indicated in *Tech Memo 5: Existing Gaps and Deficiencies* and in the PLTS analysis described above, there are several arterial and collector streets that need new sidewalks or updates to existing sidewalks and other pedestrian facilities to improve connectivity. Figure 7 illustrates the pedestrian system needs within Gladstone. The following summarizes the arterial and collector streets where there is a need to fill in the gaps in the existing sidewalk network or install new sidewalks along one or two sides of the roadway:



Pedestrian Level of Traffic Stress
Gladstone, Oregon

Figure
6

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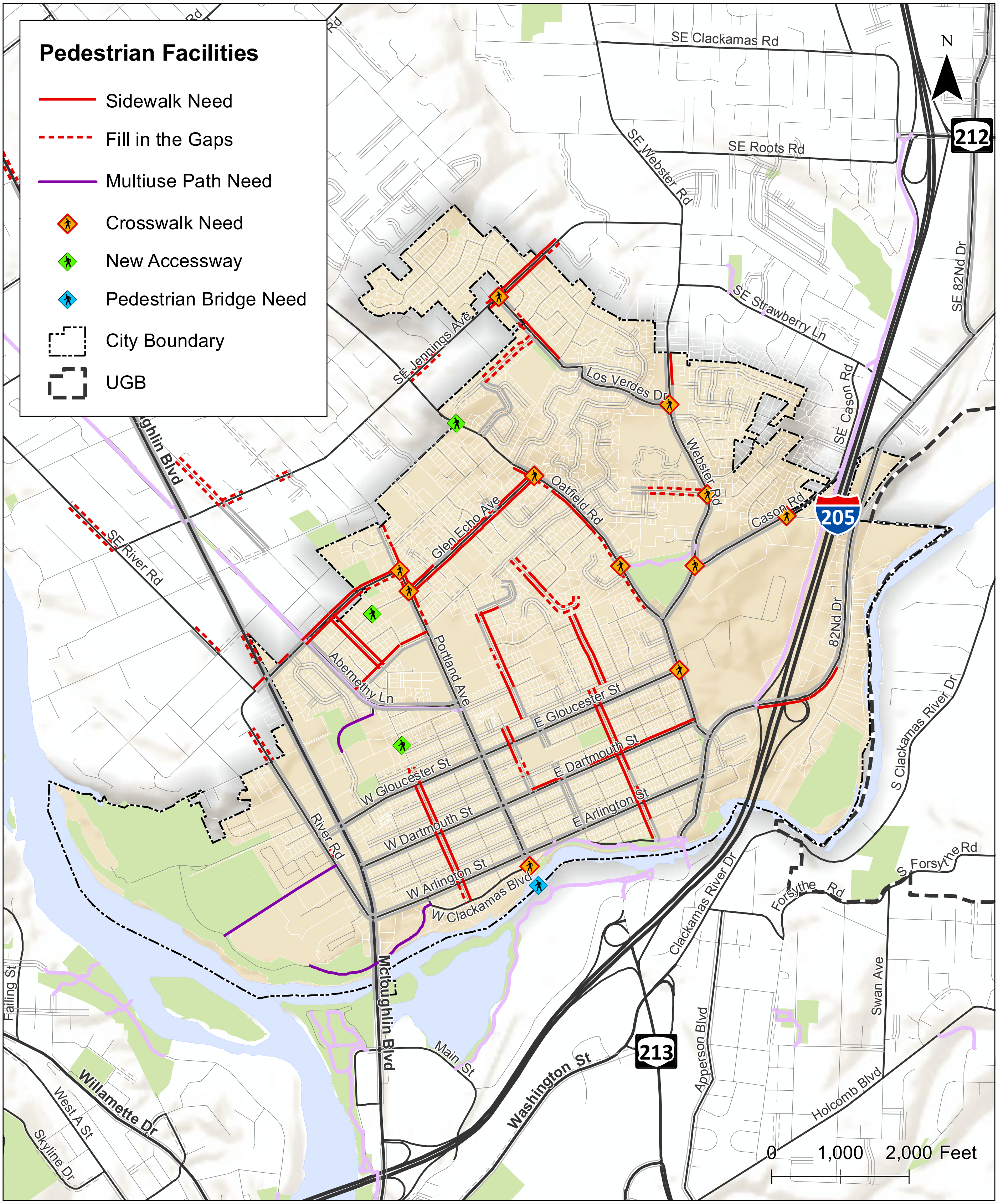

Pedestrian System Needs Gladstone, Oregon

Figure 7

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Table 6: PLTS Analysis Results

Street	From	To	Side	Pedestrian LTS Criteria Scores				Pedestrian LTS
				Sidewalk Condition	Physical Buffer Type	Total Buffering Width	General Land Use Criteria	
Major Arterial								
OR 99E	City Limits	North of OR 99E Bridge	Both	2*[1]	2	3[2]	3	**3**
	North of OR 99E Bridge	Gloucester Street	East	2*[1]	4	2	3	**4**
	North of OR 99E Bridge	Dartmouth Street	West	2*[1]	2	1	3	**3**
	Dartmouth Street	Gloucester Street	West	2*[1]	4	2	3	**4**
	Gloucester Street	19340 OR 99E	Both	2*[1]	2	1	3	**3**
	19340 OR 99E	City Limits	East	2*[1]	4	2	3	**4**
	19340 OR 99E	19250 OR 99E	West	2*[1]	4	3	3	**4**
	19250 OR 99E	19210 OR 99E	West	4	4	3	3	**4**
	19210 OR 99E	City Limits	West	2*[1]	4	3	3	**4**
Minor Arterial								
River Road	Arlington Street	Jensen Road	East	2	3	2	3	**3**
	Jensen Road	City Limits	East	2	3	1	3	**3**
	Arlington Street	City Limits	West	2	3	2	2	**3**
Arlington Street	OR 99E	430 W Arlington Street	Both	2[1]	2	2[3]	3	**3**
	430 W Arlington Street	82nd Drive	Both	4[1]	1	2[3]	1	**4**
Portland Avenue	Clackamas Boulevard	High School Driveway	East	3	1	1	1	**3**
	Clackamas Boulevard	Abernethy Lane	West	3	1	1	1	**3**
	High School Driveway	Nelson Lane	East	1*	2	2[3]	1	**2**
	Nelson Lane	City Limits	East	4	4	2	1	**4**
	Abernathy Lane	Barclay Street	West	2	2	2[3]	1	**2**
	Barclay Street	Duniway Avenue	West	3	2	2[3]	1	**3**
	Duniway Avenue	18390 Portland Avenue	West	4	4	2[3]	1	**4**

	18390 Portland Avenue	City Limits	West	3	2	2[3]	1	**3**
82nd Drive	End of road	Columbia Avenue	West	3[1]	2	2	3	**3**
	Columbia Avenue	1st Street	West	3[1]	2	1	3	**3**
	End of road	1st Street	East	3[1]	2	1	3	**3**
	1st Street	I-205 Southbound Terminal	Both	3[1]	2	2	3	**3**
	I-205 Southbound Terminal	Edgewater Road	South	4	4	2	4	**4**
	I-205 Southbound Terminal	Edgewater Road	North	3	3	2	4	**4**
	Edgewater Road	City Limits	Both	3	3	2	3	**3**
Oatfield Road	82nd Drive	Webster Road	East	2	3	2	1	**3**
	Webster Road	17925 SE Oatfield Road	East	2	3	2	1	**3**
	17925 SE Oatfield Road	Park Way	East	3	2	2	1	**3**
	82nd Drive	Kenmore Street	West	2	3	2	1	**3**
	Kenmore Street	18490 SE Oatfield Road	West	4	4	2	1	**4**
	18490 SE Oatfield Road	18215 SE Oatfield Road	West	3	3	2	1	**3**
	18215 SE Oatfield Road	Park Way	West	4	4	2	1	**4**
	Park Way	City Limits	Both	4	4	2	1	**4**
Webster Road	Oatfield Road	Los Verdes Drive	Both	2	3	2	2	**3**
	Los Verdes Drive	Charolais Drive	East	3	3	1	2	**3**
	Charolais Drive	City Limits	East	4	4	2	2	**4**
	Los Verdes Drive	City Limits	West	3	3	1	2	**3**
Jennings Avenue	Valley View Road	City Limits	Both	4	4	2	1	**4**
Collector								
Dartmouth Street	OR 99E	Portland Avenue	Both	4[1]	1	2[3]	1	**4**
	Portland Avenue	Chicago Avenue	North	3	2	2[3]	1	**3**
	Chicago Avenue	Harvard Avenue	North	4[1]	4	2[3]	1	**4**
	Harvard Avenue	Yale Avenue	North	4[1]	1	2[3]	1	**4**
	Yale Avenue	Oatfield Road	North	4[1]	4	2[3]	1	**4**
	Portland Avenue	Oatfield Road	South	3	1	2[3]	1	**3**

Gloucester Street	River Road	OR 99E	North	4[1]	2	2[3]	3	**4**
	River Road	OR 99E	South	3[1]	2	2[3]	3	**3**
	OR 99E	Yale Avenue	Both	4[1]	2	2[3]	1	**4**
	Yale Avenue	Oatfield Road	Both	3[1]	2	2[3]	1	**3**
Abernethy Lane	Glen Echo Avenue	Portland Avenue	North	1	2	2	1	**2**
	Glen Echo Avenue	Portland Avenue	South	1	1	2	1	**2**
Glen Echo Avenue	OR 99E	Abernethy Lane	Both	3[1]	3	2[3]	1	**3**
	Abernethy Lane	Portland Avenue	North	4[1]	4	2	1	**4**
	Abernethy Lane	5800 Glen Echo Avenue	South	4[1]	4	2	1	**4**
	5800 Glen Echo Avenue	Portland Avenue	South	3[1]	3	2	1	**3**
	Portland Avenue	6740 Glen Echo Avenue	North	4[1]	4	2	1	**4**
	6740 Glen Echo Avenue	6890 Glen Echo Avenue	North	3[1]	2	2	1	**3**
	6890 Glen Echo Avenue	Oatfield Road	North	4[1]	4	2	1	**4**
	Portland Avenue	Oatfield Road	South	4[1]	4	2	1	**4**
Cason Road	Webster Road	City Limits	Both	2	3	2	1	**3**
Via Del Verde/Los Verdes Drive	Valley View Road	Crownview Drive	Both	3	1	2[3]	1	**3**
	Crownview Drive	Webster Road	North	4[1]	1	2[3]	1	**4**
	Crownview Drive	Webster Road	South	4[1]	2	2[3]	1	**4**
Valley View Road/Valley View Drive	Los Verdes Drive	Valley View Road	Both	3	1	2[3]	1	**3**
	Valley View Road	Churchill Drive	North	4	4	2[3]	1	**4**
	Churchill Drive	Jennings Avenue	North	3	2	2[3]	1	**3**
	Valley View Road	Jennings Avenue	South	3	2	2[3]	1	**3**

Shaded cells segments that do not meet the LTS 2 target.
* The effective width of the pedestrian facility is greater than 6 feet. The LTS value is from the last line of the sidewalk condition criteria table in the APM.
[1] No illumination present. LTS degraded by one unless already at LTS 4.
[2] Segment located on a bridge. LTS improved to LTS 3.
[3] Existing non-striped parking. Assume parking area is six to eight feet wide.

- Portland Avenue, from Nelson Lane to city limits.
- 82nd Drive, from the I-205 southbound ramp terminal to Edgewater Road.
- Oatfield Road, from Webster Road to Park Way.
- Webster Road, from Charolais Drive to city limits.
- Jennings Avenue, from city limits to city limits.
- Dartmouth Street, from Chicago Avenue to Oatfield Road.
- Glen Echo Avenue, from River Road to Oatfield Road.
- Valley View Road, from Valley View Road to Churchill Drive.

In addition to the arterial and collector streets, there are several local streets that have been identified in previous planning documents as serving a critical need for local residents. The following summarizes the local streets where there is a need to "fill in the gaps" in the existing sidewalk network or "install new sidewalks" along one or two sides of the streets:

- Beatrice Avenue, from Clackamas Boulevard to Hereford Street
- Harvard Avenue, from Hereford Street to Beverly Lane
- Cornell Avenue, from Clackamas Boulevard to Collins Crest
- Beverly Lane east of Harvard Avenue
- Oakridge Drive, from Oatfield Road to Valley View Road
- Clayton Way, from Stonewood Drive to Webster Road
- Chicago Avenue, from Hereford Street to Dartmouth Street
- Fairfield Street, south side from Portland Avenue to Chicago Avenue
- Addie Street from Glen Echo Avenue to Barclay Street
- Barclay Street from Abernathy Lane to Portland Avenue

As indicated by the PLTS analysis described above, there are several additional needs associated with sidewalks in Gladstone. With the exception of Abernethy Lane, all of the city's arterial and collector streets have sidewalk deficiencies. The following provides a summary of the general needs associated with sidewalks:

- Lighting is needed along roadways where lighting levels were found to be insufficient.
- Wider sidewalks are needed where sidewalks are less than five feet wide.
- New sidewalks or repairs to existing sidewalks are needed where sidewalk conditions were found to be poor or very poor.
- Physical buffers are needed adjacent to roadways with vehicle speeds are equal to or greater than 30 mph.

- Wider buffers are needed adjacent to roadways with three or more travel lanes.
- Travel speeds need to be reduced to 25 mph or lower adjacent to pedestrian facilities that lack physical buffers.
- Land use changes need to be considered in areas with auto-oriented commercial and light industrial uses.

The needs associated with other pedestrian facilities, such as new pedestrian crossings, shared-use paths and trails, and neighborhood connections are described below.

Pedestrian Crossings

Pedestrian crossings along the city's arterial and collector streets are limited to major intersections and a few key mid-block crossing locations near pedestrian destinations. There are marked pedestrian crossings at each of the signalized intersections located along OR 99E, 82nd Drive, and Oatfield Road that include pedestrian push buttons and pedestrian signal heads. There are also marked pedestrian crossings at several unsignalized intersections along Portland Avenue and other streets in select areas throughout the city. However, there are several additional locations where marked pedestrian crossings are needed to provide connectivity as well as access to schools, parks, and other essential destinations within the city. The following provides a summary of the additional pedestrian crossing needs:

- Enhanced pedestrian crossing at Arlington Street and Portland Avenue
- Enhanced pedestrian crossing at Portland Avenue and Glen Echo Avenue (north and south)
- Enhanced pedestrian crossing at Oatfield Road and Gloucester Street
- Enhanced pedestrian crossing at Oatfield Road and Glen Echo Avenue
- Enhanced pedestrian crossing at Webster Road and Cason Road
- Enhanced pedestrian crossing at Jennings Avenue and Valley View Road
- Enhanced pedestrian crossing at Cason Road and Ohlson Road

Other potential pedestrian crossing needs identified by committee members and the general public during include:

- Enhanced pedestrian crossing at Oatfield Road and Stoneoaks Court
- Enhanced pedestrian crossing at Webster Road and Clayton Way-Ridgewood Drive
- Enhanced pedestrian crossing at Webster Road and Los Verdes Drive
- Evaluate the existing pedestrian crossing at Oatfield Road and Ridegate Drive and install Rectangular Rapid Flash Beacons (RRFBs) or other enhanced pedestrian crossing treatments as necessary.

Figure 7 also illustrates the locations of the crossing needs. Marked pedestrian crossing at each of these locations would improve connectivity along the roadways as well as access to essential destinations. *Note: the Downtown Revitalization Plan will recommend design treatments for crossings on Portland Avenue, including special paving, curb extensions, and raised crossings at key intersections, such as Abernathy Lane, Dartmouth Street, and Arlington Street as well as near the high school.*

Shared-Use Paths and Trails

Shared-use paths and trails are designated pathways for both cyclists and pedestrians. The Trolley Trail, the Cross Park Trail, the Charles Ames Park Way, and the I-205 Trail all serve different portions of Gladstone. Continuous shared-use paths are most comfortable for both pedestrians and cyclists and increasing the lengths of the Cross Park Trail and the Charles Ames Park Walk along with providing and improving connections between shared-use paths and trails with on-street connections would create a more robust network to augment and support the sidewalks and bike lanes on roadways. The following summarizes the multi-use and trail needs within Gladstone:

- New shared-use path/trail, from Clackamas Boulevard at Portland Avenue across the Clackamas River to Oregon City (Trolley Trail Bridge)
- New shared-use path/trail, from Dahl Park Road under OR 99E to Arlington Road
- New shared-use path/trail, from Abernathy Court to Risley Avenue
- New shared-use paths/trail in Meldrum Bar Park
- Install pedestrian scale lighting along the shared-use path adjacent to Arlington Street.

Pedestrian Accessways

Connections between cul-de-sacs and adjacent roadways can significantly reduce travel distances for pedestrians, thereby encouraging more people to walk. Appropriate improvements should provide for more direct, convenient, and safe bicycle or pedestrian travel within and between residential areas and neighborhood activity centers. Gladstone has several existing accessways that create connections between neighborhoods and pedestrian and bicycle routes. Additional accessways are not always possible due to topography and existing development patterns. However, there is a need for at least one additional accessway:

- Duniway Avenue accessway, from Duniway Avenue terminus to Duniway Avenue terminus
- Beatrice Avenue accessway, from Jersey Street terminus to Ipswich Street terminus
- Hull Avenue accessway from Hull Avenue terminus to Oatfield Road

The Gladstone School District should also consider connecting the accessways on Ridgegate Drive and Monte Verde Drive with a paved multi-use path on the Kraxberger School grounds to provide safe and convenient access to and around this major activity center.

BICYCLE SYSTEM NEEDS

Bicycle facilities, such as on-street bicycle lanes, shoulder bikeways, shared roadway pavement markings, bicycle crossings, bicycle parking, and wayfinding signage, are essential elements of a the city's bicycle system. While these facilities are currently provided along many city streets, there are many more streets where these facilities are needed to improve bicycle access and connectivity. The following provides a summary of the bicycle system needs within Gladstone, which are based on the gaps and deficiencies identified in *Tech Memo 5: Existing Gaps and Deficiencies* and a system-level analysis of the bicycle facilities located along arterial and collector streets. As described below, the most common overall need is to provide a safe and interconnected bicycle system that encourages people to ride their bikes, especially for trips less than three miles in length.

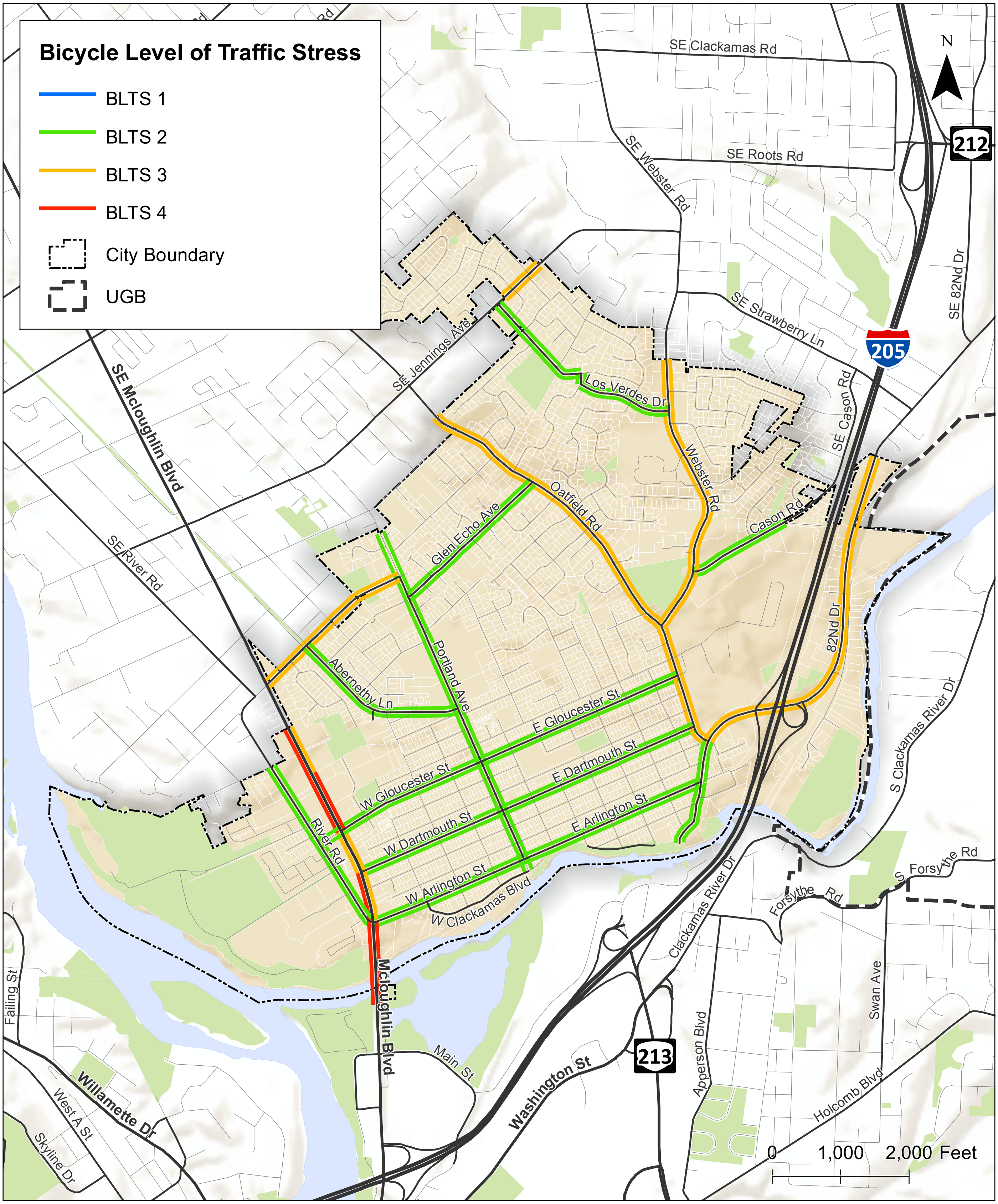
Bicycle Level of Traffic Stress Analysis

The bicycle facilities located along the city's arterial and collector streets were evaluated in an effort to identify potential issues that could be addressed as part of the TSP update. The APM provides a methodology for evaluating bicycle facilities within urban and rural environments called Bicycle Level of Traffic Stress (BLTS). As applied by ODOT, this methodology classifies four levels of traffic stress that a bicyclist can experience on the roadway, ranging from BLTS 1 (little traffic stress) to BLTS 4 (high traffic stress). A road segment that is rated B LTS 1 generally has low traffic volumes and travel speeds and is suitable for all cyclists, including children. A road segment that is rated BLTS 4 generally has high traffic volumes and travel speeds and is perceived as unsafe by most adults. Per the APM, BLTS 2 is considered a reasonable target for bicycle facilities due to its acceptability with the majority of people.

The BLTS score is determined based on the speed of the roadway, the number of travel lanes per direction, the presence and width of an on-street bicycle lane and/or adjacent parking lane, and several other factors. Figure 8 illustrates the results of the BLTS analysis for Gladstone's arterial and collector streets. It is important to note that while some segments are shown as BLTS 3 or 4, they may have shorter segments with lower BLTS scores. Table 7 summarizes the detailed results of the BLTS analysis. As shown, there eight segments rated BLTS 3 and four segments rated BLTS 4.

A majority of the segments rated BLTS 3 have striped bicycle lanes; however, they are too narrow for roadways conditions. In order for these segments to be rated BLTS 2, the striped bicycle lanes would need to be widened to 7 feet and/or the posted speed limits would need to be reduced to as low as 30 mph. Other segments rated BLTS 3 were evaluated as shared roadways. In order for these segments to be rated BLTS 2, the speed would need to be reduced to as low as 25 mph or the centerline stripe would need to be removed.

All segments rated BLTS 4 are located along OR 99E and have striped bicycle lanes that are too narrow for roadway conditions. In order for these segments to be rated BLTS 2, the striped bicycle lanes would need to be widened to 7 feet and/or the posted speed limits would need to be reduced to as low as 30 mph. Enhanced facilities, such as separated bike facilities or multi-use paths, may also be needed in some areas where traffic volumes and/or travel speeds are high.



Bicycle Level of Traffic Stress
Gladstone, Oregon

Figure
8

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Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Portland Metro Data Resource Center

Table 7: BLTS Analysis Results

Street	From	To	Side	Facility Type	LTS Criteria					Bicycle LTS
					Speed (MPH)	Lanes per Direction	Bike Lane Width (feet)	Parking	Frequent Blockage	
Major Arterial										
OR 99E	City Limits	Arlington Street	Both	Bike Lane	40	2	< 7	No	No	4
	Arlington Street	Dartmouth Street	East	Bike Lane	40	2	> 7	No	No	3
	Arlington Street	Dartmouth Street	West	Bike Lane	40	2	< 7	No	No	4
	Dartmouth Street	Gloucester Street	Both	Bike Lane	40	2	> 7	No	No	3
	Gloucester Street	19370 OR 99E	East	Bike Lane	40	2	< 7	No	No	4
	19370 OR 99E	City Limits	East	Bike Lane	40	2	> 7	No	No	3
	Gloucester Street	City Limits	West	Bike Lane	40	2	< 7	No	No	4
Minor Arterial										
River Road	Arlington Street	Jensen Road	Both	Bike Lane	30	1	< 5.5	No	No	2
	Jensen Road	City Limits	East	Bike Lane	30	1	< 5.5	Yes	No	2
	Jensen Road	City Limits	West	Bike Lane	30	1	< 5.5	No	No	2
Arlington Street	OR 99E	82nd Drive	Both	Mixed Traffic	25	1	N/A	Yes	No	2
Portland Avenue	Clackamas Boulevard	Nelson Lane	Both	Mixed Traffic	20	1	N/A	Yes	No	2
	Nelson Lane	Caldwell Road	East	Bike Lane	20	1	< 5.5	No	No	2
	Nelson Lane	Caldwell Road	West	Mixed Traffic	20	1	N/A	No	No	2
	Caldwell Road	City Limits	Both	Mixed Traffic	25	1	N/A	Yes	No	2
82nd Drive	City Limits	Oatfield Road	Both	Bike Lane	35	1	5.5 - 7	No	No	3
	Oatfield Road	1st Street	Both	Bike Lane	25	1	5.5 - 7	No	No	2
	1st Street	End of road	East	Bike Lane	25	1	5.5 - 7	Yes	No	2
	1st Street	Columbia Avenue	West	Bike Lane	25	1	5.5 - 7	Yes	No	2
	Columbia Avenue	End of road	West	Bike Lane	25	1	5.5 - 7	No	No	2
Oatfield Road	82nd Drive	City Limits	Both	Bike Lane	35	1	5.5 - 7	No	No	3
Webster Road	Oatfield Road	Los Verdes Drive	Both	Bike Lane	35	1	5.5 - 7	No	No	3
	Los Verdes Drive	City Limits	Both	Bike Lane	35	1	5.5 - 7	Yes	No	3
Jennings Avenue	Valley View Road	City Limits	Both	Mixed Traffic	30	1	N/A	Partial	No	3
Collector										

Dartmouth Street	OR 99E	Oatfield Road	Both	Mixed Traffic	25	1	N/A	Yes	No	2
Gloucester Street	River Road	Oatfield Road	Both	Mixed Traffic	25	1	N/A	Yes	No	2
Abernethy Lane	Glen Echo Avenue	Portland Avenue	North	Mixed Traffic	25	1	N/A	Yes	No	2
	Glen Echo Avenue	Portland Avenue	South	Multi-Use Path	25	1	N/A	No	No	2
Glen Echo Avenue	OR 99E	Portland Avenue	Both	Mixed Traffic	30	1	N/A	Partial	No	3
	Portland Avenue	Oatfield Road	Both	Mixed Traffic	25	1	N/A	No	No	2
Cason Road	Webster Road	City Limits	Both	Bike Lane	30	1	5.5-7	No	No	2
Via Del Verde/Los Verdes Drive	Valley View Road	Webster Road	Both	Mixed Traffic	25	1	N/A	Yes	No	2
Valley View Road/Valley View Drive	Los Verdes Drive	Jennings Avenue	Both	Mixed Traffic	25	1	N/A	No	No	2

Shaded cells segments that do not meet the LTS 2 target.

It should also be noted that a majority of the shared roadway segments that were rated LTS 2 could include signage and potentially striping to remind motorists to share the road. The signing and striping can also provide important wayfinding for cyclists to inform them of the preferred bicycle routes.

System Connectivity

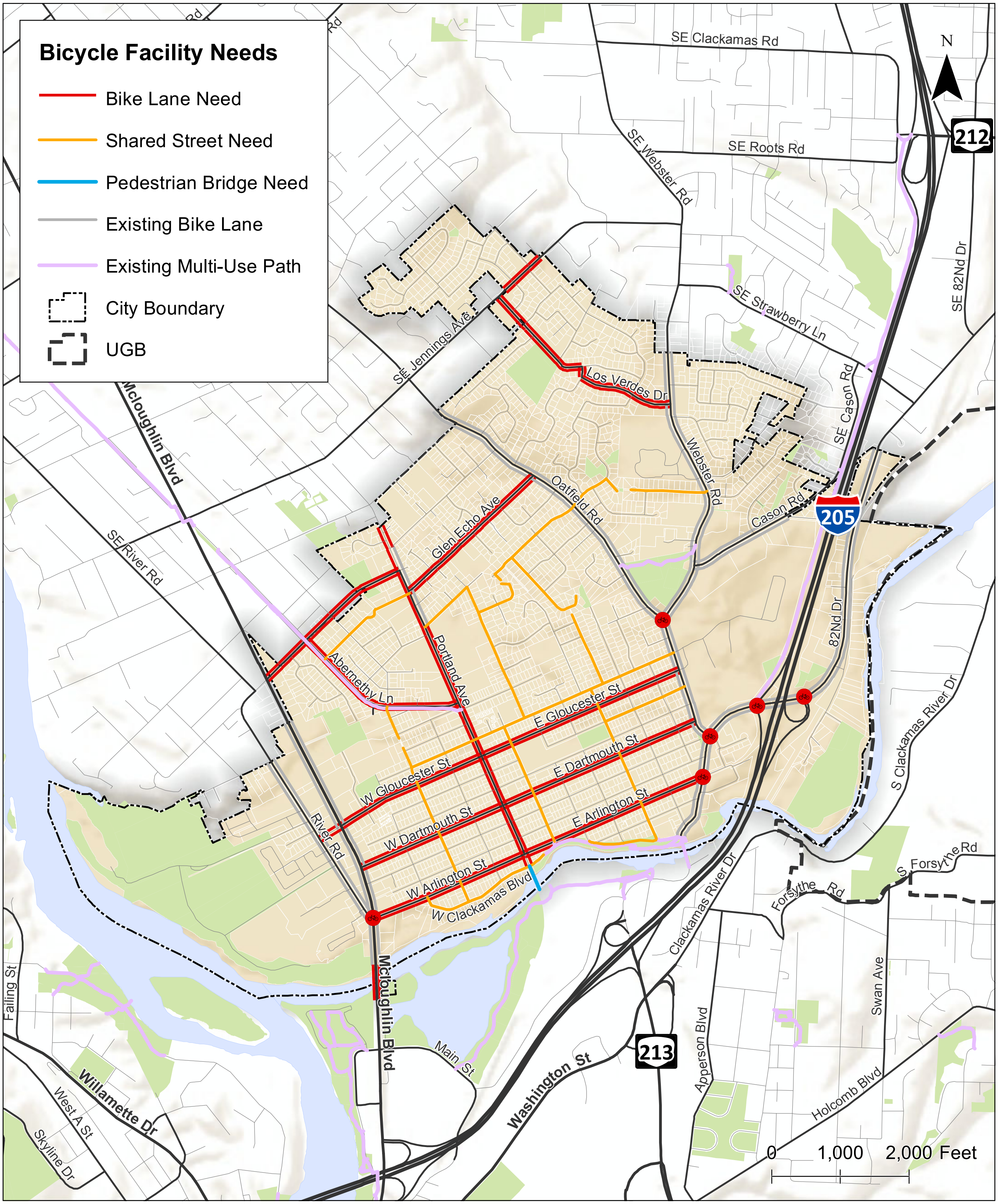
A well-connected bicycle system provides continuous bicycle lanes and other bicycle facilities between essential destinations, such as residential neighborhoods, schools, parks, and retail/commercial centers. Strategies to improve bicycle connectivity include identifying, prioritizing, and ultimately constructing new on-street bicycle lanes, shared-use pavement markings, bicycle crossings, shared-use paths, and bicycle parking.

On-street Bicycle Lanes

As indicated in *Tech Memo 5: Existing Gaps and Deficiencies* and in the BLTS analysis described above, there are several arterial and collector streets that need new on-street bicycle lanes and other bicycle facilities to improve connectivity. Figure 9 illustrates the bicycle system needs within Gladstone. The following summarizes the arterials and collector streets where there is a need for new on-street bicycle lanes on one or two sides of the roadway:

- Glen Echo Avenue, from River Road to Oatfield Road
- Abernathy Lane, from Glen Echo Road to Portland Avenue
  - There is a shared-use path along the south/west side of Abernathy Lane
- Gloucester Street, from River Road to Oatfield Road
- Dartmouth Street, from OR 99E to Oatfield Road
- Arlington Street, from OR 99E to 82nd Drive
- Portland Avenue, from Arlington Street to the north city limits
- Los Verdes Drive, from Webster Road to Valley View Road
- Valley View Road, from Los Verdes Drive to north city limits

It should be noted that while on-street bicycle lanes are typically provided along both sides of arterial and collector streets, it may not be feasible or cost effective to construct them along both sides of all streets. Along some streets it may be suitable for bicyclists to share the roadway with motorists while along others it may be suitable to have a parallel shared-use path that accommodates bicyclists in two directions. As indicated in the BLTS analysis described in the previous section, several of the arterial and collector streets listed above as needing on-street bicycle lane are rated BLTS 2, which suggests that on-street bicycle lanes may not be needed. *Note: the Downtown Revitalization Plan will recommend design treatments for bicycle facilities on Portland Avenue.*



Bicycle System Needs
Gladstone, Oregon

Figure
9

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Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Portland Metro Data Resource Center

It should also be noted that several of the arterial and collector streets that currently have on-street bicycle lanes were rated BLTS 3 or higher. This suggests that on-street bicycle lanes alone may not be sufficient to accommodate a majority of bicyclists on these streets. The following summarizes the needs associated with these streets:

- Wider bicycle lanes (up to 7 feet) are needed along streets with bicycle lanes of 5-feet or less.
- Buffers between the bicycle lane and adjacent travel lane are needed along street where the posted speed limits are 30 mph or above.
- Separated bicycle paths are needed along streets where appropriate and feasible.
- Designated alternative bicycle routes are need where treatments are not feasible.

Further review of potential solutions along these streets will be completed in subsequent tech memos.

Shared-Use Streets

Arterials and collectors cannot fully address bicycle travel needs in and around the city. Bicycle trips can and should be accommodated on lower classified streets with lower traffic volumes and travel speeds that offer parallel or alternative routes to essential destinations, such as schools, parks, and retail/commercial centers. These facilities could be designated as shared-use streets or could have a specific designation such as a "bike boulevard" where treatments are applied to the roadway to enhance the bicycle environment and/or make additional connections to bicycle destinations. There are several streets where shared roadway pavement markings could be used to improve access and circulation for cyclists. The streets include:

- Valley View Road/Los Verdes Drive;
- Clackamas Boulevard, Arlington Road to 82nd Drive
- Beatrice Avenue, from Abernathy Lane to Clackamas Boulevard
- Hereford Street, from Beatrice Avenue to Oatfield Road
- Nelson Lane/Harvard Avenue, from Portland Avenue to Hereford Street
- Beverly Lane/Collins Crest, from Harvard Avenue to Oatfield Road
- Ridgegate Drive/Penny Court/Clayton Way, from Oatfield Road to Webster Road
- Duniway Avenue, from Abernathy Lane Abernathy Lane to Portland Avenue
- Fairfield Street, from Cornell Avenue to Oatfield Road
- Cornell Avenue, from Clackamas Boulevard to Collins Crest
- Chicago Avenue, from Hereford Street to Arlington Street

As discussed in the current TSP, Gladstone's existing roadways are generally wide enough and carry sufficiently moderate traffic volumes at low to moderate speeds that most of the adjacent streets are suitable for shared roadway bicycle facilities and are so utilized by residents. However, the lack of specific, designated bicycle routes (designated by "Bike Route" signage, not necessarily parking-prohibited bicycle lanes) may discourage an environment of safe bicycle usage as a convenient alternative transportation mode.

Bicycle Crossings

Intersections can be potentially unsafe locations in the bicycle network, as there are more conflict points with right- and left-turning vehicles and cross street traffic. There are various configurations for addressing bicycle needs alongside right-turn lanes, although the desired configuration is to have the right-turn lane to the right of the bicycle lane, with right-turning vehicles yielding to through cyclists as they cross the bicycle lane. The following summarizes the bicycle crossing needs within Gladstone, which include both intersections with existing bicycle crossings that could be enhanced and intersections without bicycle crossings.

- Enhanced bicycle crossing at OR 99E and Arlington Street
- Enhanced bicycle crossing at Arlington Street and 82nd Drive
- Enhanced bicycle crossing at Oatfield Road and 82nd Drive
- Enhanced bicycle crossing at **Oatfield Road and Webster Road**
- Enhanced bicycle crossing at I-205 Southbound Terminal and 82nd Drive
- Enhanced bicycle crossing at I-205 Northbound Terminal and 82nd Drive

Bicycle Parking

The availability of bicycle parking is an important component of a well-designed bicycle system. Lack of proper storage facilities discourages potential riders from traveling by bicycle. Bicycle racks should be located at significant activity generators including schools, parks, and retail/commercial areas. Bicycle racks should be placed in highly-visible locations and within convenient proximity to main building entrances. Bicycle racks should be designed to provide two points of contact to the bicycle (e.g., so the user can lock both the wheel and the frame to the rack). Bicycle lockers or other storage facilities would be helpful at locations where long-term parking is expected, such as major employment centers. The attractiveness of bicycle parking may also be improved by providing covered parking and/or secured facilities where bicycles may be locked away.

The City's bicycle parking standards are found in Gladstone Municipal Code Section 17.48.050. Bicycle parking standards apply to new multi-family dwellings of four units or more and new commercial/industrial developments. See Table 5 in Tech Memo 1 for preliminary recommendations regarding potential changes to bicycle parking standards.

MOTOR VEHICLE SYSTEM NEEDS

System Connectivity

A well-connected transportation network minimizes the need for out-of-direction travel while supporting an efficient distribution of travel demand among multiple parallel roadways. The most common example of an efficient transportation network is the traditional grid system, with north-south and east-west streets spaced at generally equal distances. River Road, OR 99E, Oatfield Road, Webster Road, and 82nd Drive are all part of a larger grid system that provides connectivity on a regional level as well as connectivity within Gladstone. The southern part of Gladstone is based on a grid system while the northern part is made up of a less connected network of cul-de-sacs and stub streets that conform to the steeper topography and natural features. The following sections highlight the needs associated with street system connectively within Gladstone.

Arterial Street Connectivity

The RTP provides designations for four types of arterials, including principal arterials, major arterials, minor arterials, and rural arterials; a majority of which are located within Gladstone. According to the RTP, arterials are intended to provide general mobility for travel within the region as well as connect major commercial, residential, industrial, and institutional centers. Arterials are usually spaced about 1-mile apart and are designed to accommodate motor vehicle and truck traffic as well as pedestrians, bicyclists, and buses. Based on a review of the existing arterial street system, many of the city's arterials currently meet the RTP's arterial spacing guidelines. However, there is the potential need for a new arterial between Jennings Avenue and Arlington Street. Additional information on this potential need is provided below:

- New east-west arterial – Jennings Avenue and Arlington Street are located approximately 1.25 to 1.50 miles apart; therefore, a new arterial could be identified between the two streets to improve arterial connectivity within the city. Given that most of the area between the two streets is largely built out, the most likely approach would be to redesignate an existing street as an arterial. Based on a review of the existing street network, the most likely street is Glen Echo Avenue. However, Glen Echo Avenue has a 350-foot "jog" at Portland Avenue, which would limit connectivity. It also has several single family residential homes that have direct access to the street. Given these challenges, Glen Echo is more appropriately designated as a collector.

Further review of the arterial street system indicates that there is also the potential need for a new arterial street that connects Webster Road to 82nd Drive further north-east of Oatfield Road; however, this potential connection would be located outside the city limits and therefore is not discussed. There is also the potential need to redesignate Portland Avenue as a collector street. Additional information on this potential need is described under Collector Streets.

Collector Streets

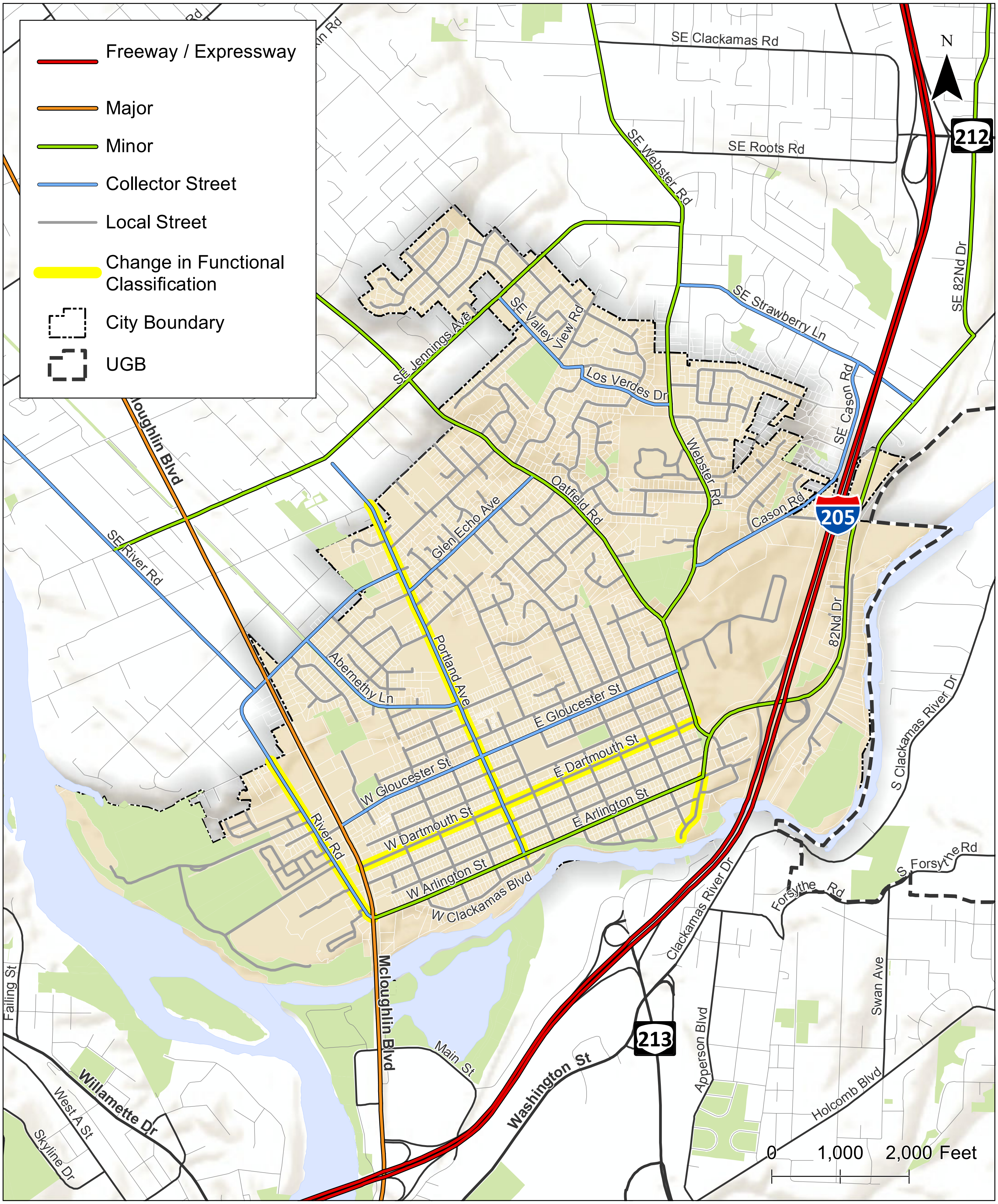
The RTP identifies collector streets as general access streets for neighborhood circulation and as support streets for the regional transportation network. Connectivity at this level is especially important for pedestrian and bicycle trips. The RTP recommends a maximum spacing of 1/2 mile for collectors in order to encourage local traffic to use them instead of higher order facilities. Based on a review of the existing collector street system, there is the potential need for a new collector between OR 99E and Oatfield Road and a new collector between Jennings Avenue and Webster Road. Additional information on these potential needs is provided below.

- New north-south collector – OR 99E and Oatfield Road are located approximately 1.0 mile apart; therefore, a new collector could be identified between the two streets to improve collector connectivity within the city. Given that most of the area between the two streets is largely built out, the most likely approach is to redesignate an existing street as a collector. Based on a review of the existing street network, the most likely street is Portland Avenue. The change in designation could be applied to the segment from Arlington Street to the north city limits; however, the City could also coordinate with Clackamas County to continue the designation (and roadway) to Jennings Avenue.
- New east-west collector – Jennings Avenue and Webster Road are located approximately 1.0 mile apart; therefore, a new collector could be identified between the two streets to improve collector connectivity within the city. Given that most of the area between the two streets is largely built out, the most likely approach would be to redesignate an existing street as a collector. Based on a review of the existing street network, the most likely street is Park Way. However, Park Way is relatively narrow and steep. It also has several single family residential homes that have direct access to the street. Given these challenges, Park Way is more appropriately designated as a local Street.

Further review of the collector street system indicates that there is also the potential need to redesignate Abernathy Lane and Dartmouth Street as local Streets, or to develop a new functional classification for the streets. Additional information on these potential needs is provided below.

- New Functional Classification – Abernathy Lane and Dartmouth Street are located less than ½ mile from other collector streets, and therefore may be more appropriately designated as local streets. As an alternative, the City could create a new functional classification that better reflects the role the two streets play in the street network. Other jurisdictions, such as West Linn and Milwaukie classify streets like these as Neighborhood Routes.

Each of these potential changes could enhance the north-south and east-west connectivity within the city and reduce reliance on the state system for making local trips. Given that significant constraints prevent further expansion or continuation of the arterial or collector network, the TSP update will focus on opportunities to improve local street connectivity as well as maximize and improve the pedestrian, bicycle, and public transportation systems along existing arterials as described below. Figure 10 illustrates the potential changes to the functional classification plan.



Functional Classification Plan Updates
Gladstone, Oregon

Figure
10

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Local Street

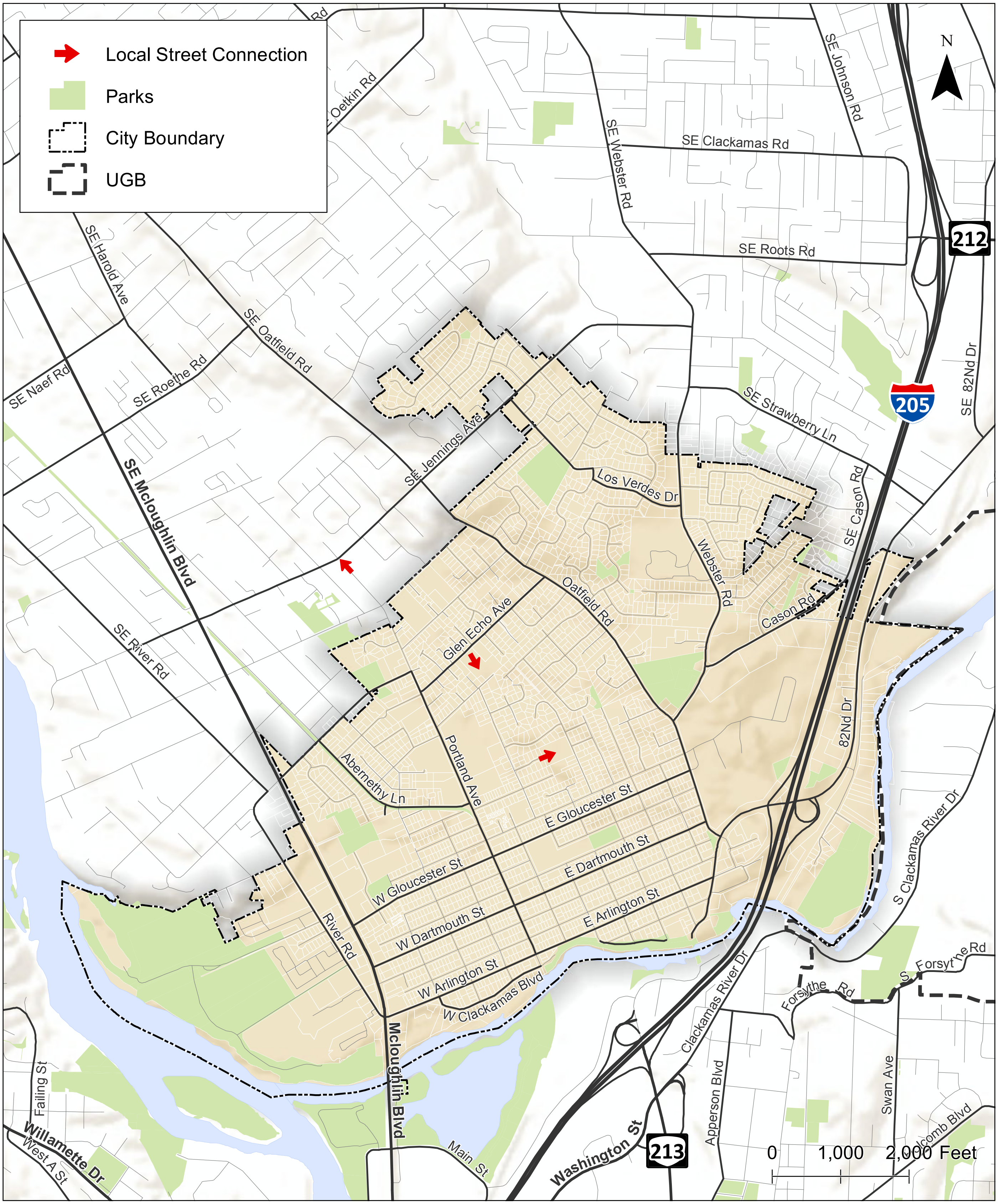
Based on the RTP, local streets primarily provide direct access to adjacent land uses and therefore serve an important role for supporting pedestrian and bicycle travel. The RTP recommends a maximum spacing of 1/10 mile for local streets and suggests limiting cul-de-sacs to 200 feet in length. Much of the local street system within southern part of Gladstone is on a grid system, which provides the highest level of connectivity However, much of the northern part of Gladstone is characterized by short, indirect streets with numerous cul-de-sacs. Although this type of system can have the effect of limiting traffic speeds and volumes on local streets, it can also result in indirect travel paths and a reliance on arterials for local trips. Based on a review of the local street system, opportunities to improve and expand local street connectivity exist in few areas throughout the city. Figure 11 illustrates the local street connectivity opportunities within Gladstone. The arrows shown in Figure 11 represent the placement and general direction of potential connections. The following summarizes the opportunities identified in Figure 11 to show the potential impact of the connections on local street connectivity.

- Portland Avenue Extension – Portland Avenue currently terminates approximately 200-feet south of Jennings Avenue. The Portland Avenue extension could improve access and circulation within the city and reduce reliance on OR 99E, Abernathy Lane, and other streets for providing access to commercial activity along Portland Avenue.
    - The Portland Avenue extension along with the segment of Portland Avenue between the current roadway terminus and Glen Echo Avenue should be designated consistent with the segment further to the south.
- Tryon Court Extension – As development occurs along the south side of Glen Echo Avenue, a new street connection the extends southeast from Tryon Court to Nelson Lane could provide access to the development area as well as improve local street connectivity within the northern part of Gladstone.
- Kenmore Street Extension – As development occurs on the west side of High Street, a new local street connection that extends northeast from Kenmore Street to High Street could provide access to the development areas as well as improve local street connectivity to the central part of Gladstone and within the vicinity of the Gladstone High School.

As new development occurs, the opportunities identified in Figure 11 should be considered to create a more efficient network consistent with the RTP guidelines. It should be noted that the primary constraint associated with each of the opportunities shown in Figure 11 is that they are located on private property and will likely only occur as part of future development or redevelopment.

Future Traffic Operations

Future traffic operations were evaluated at the eight study intersections in accordance with the assumptions and methodologies identified in *Tech Memo 4: TSP Methodology and Assumptions*.



Local Street Connectivity Needs Gladstone, Oregon

Figure 11

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Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Oregon Department of Transportation, Portland Metro Data Resource Center

Forecast Traffic Volume and Peak Hour Operations

Forecast traffic volumes were developed for the study intersections based on the existing traffic counts and information provided in Metro's travel demand model for the Gladstone area. The travel demand model provides base year 2010 and forecast year 2040 traffic volume projections that reflect anticipated land use changes and planned transportation improvements within the study area. The forecast traffic volumes were developed by applying the post-processing methodology presented in the National Cooperative Highway Research Program (NCHRP) Report 255 *Highway Traffic Data for Urbanized Area Project Planning and Design*, in conjunction with engineering judgment and knowledge of the study area. *Attachment "C" contains the travel demand model data provided by Metro.*

Figure 12 illustrates the location of the study intersections. Figure 13 illustrates the year 2040 forecast traffic volumes at the study intersection during the weekday p.m. peak hour. Figure 13 and Table 8 summarize the results of the future traffic operations analysis at the study intersections under year 2040 traffic conditions. *Attachment "D" contains the year 2040 existing traffic conditions worksheets.*

Table 8: Future Year 2040 Weekday PM Peak Hour Intersection Operations

Map ID	Intersection	Level of Service (LOS)	Delay (Sec)	Volume/ Capacity (V/C)	Measure of Effectiveness (MOE)		MOE Met?
					Agency	Maximum	
	Signalized Intersections						
1	OR 99E/S Arlington Street	F	>80.0	>1.0	ODOT	v/c 1.1	***No***
2	OR 99E/W Gloucester Street	C	24.6	0.93	ODOT	v/c 1.1	Yes
3	OR 99E/Glen Echo Avenue	F	>80.0	>1.0	ODOT	v/c 1.1	***No***
4	Oatfield Road/SE 82nd Drive	C	27.8	0.61	ODOT	v/c 0.99	Yes
7	I-205 Southbound Ramp Terminal/SE 82nd Drive	E	67.7	1.00	ODOT	v/c 0.85[1]	***No***
8	I-205 Northbound Ramp Terminal/SE 82nd Drive	D	40.7	>1.0	ODOT	v/c 0.85[1]	***No***
	Unsignalized Intersections						
5	Oatfield Road/Ridgegate Drive-Collins Crest Street	E	35.1	0.26	City	LOS E	Yes
6	Oatfield Road/Glen Echo Avenue	E	36.2	0.49	City	LOS E	Yes

Notes:
LOS = Intersection Level of Service (Signal), Critical Movement Level of Service (TWSC).
Delay = Intersection Average vehicle delay (Signal), critical movement vehicle delay (TWSC).
V/C = Intersection V/C (Signal) critical movement V/C (TWSC).
MOE = Measure of Effectiveness

1. The maximum v/c ratio at ramp terminals within an urban area may be increased to 0.90 if it can be determined that the 95th percentile queue does not extend onto the mainline or into the portion of the ramp needed to safely accommodate deceleration or where an adopted Interchange Area Management Plan (IAMP) is present.

As shown in Table 8, four study intersections are forecast to exceed their acceptable mobility standards and targets under year 2040 forecast traffic conditions. Additional information about the operations issues identified at these study intersections is provided below.

Study Intersections
Gladstone, Oregon

Figure
12

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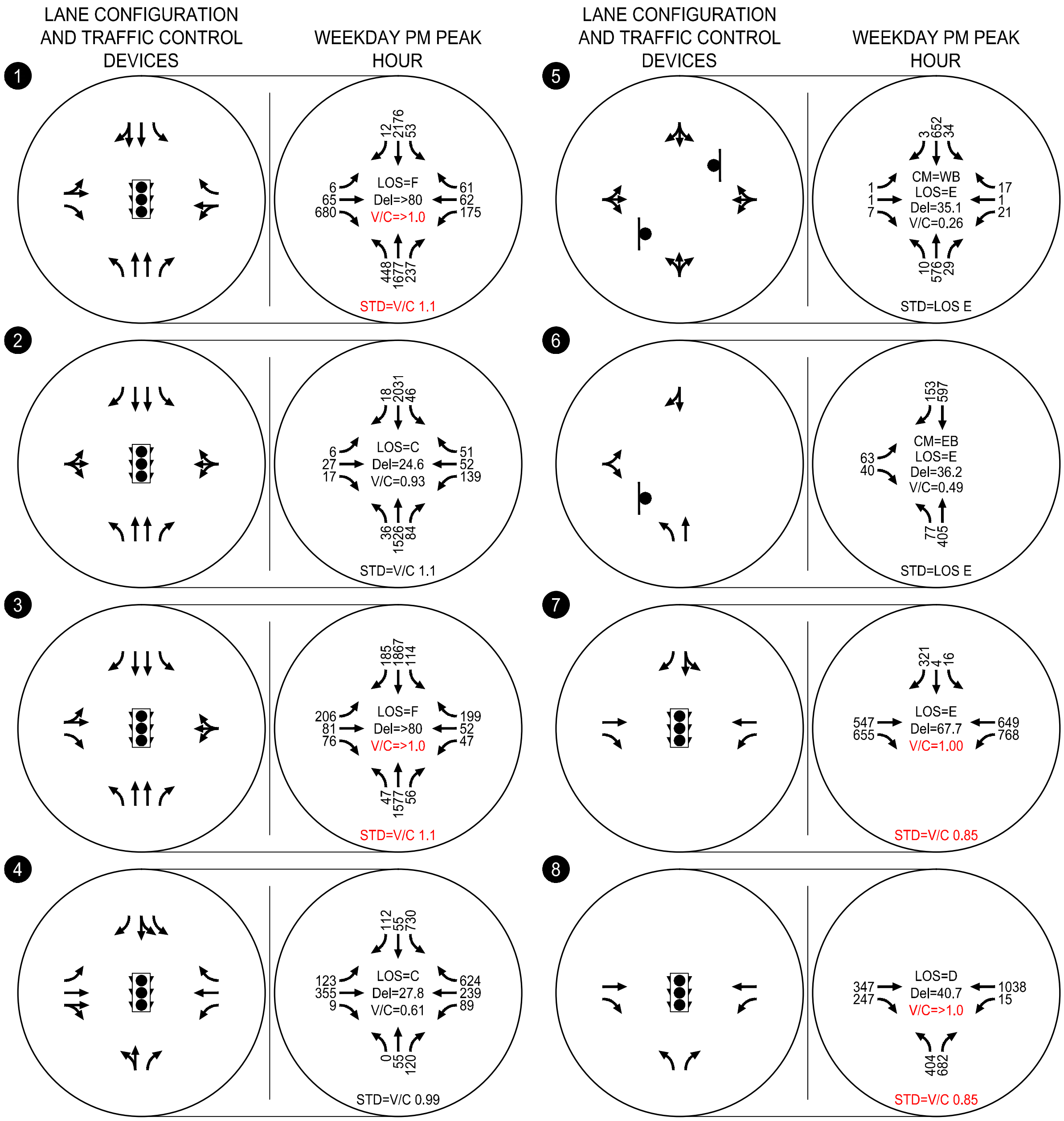
Oregon Department of Transportation, Portland Metro Data Resource Center



Year 2040 Future Traffic Operations
Weekday PM Peak Hour
Gladstone, Oregon

Figure 13

OR 99E/S Arlington Street

The OR 99E/S Arlington Street intersection is projected to operate at level of service F and above capacity (v/c =1.65) during the weekday p.m. peak hour. This is primarily due to the projected increase in traffic volumes along River Road and OR 99E. The eastbound right and northbound left-turn movements are projected to increase by more than 100% over the 25-year period resulting in significant delay at each approach.

OR 99E/Glen Echo Avenue

The OR 99E/Glen Echo Avenue intersection is projected to operate at level of service F and above capacity (v/c =1.37) during the weekday p.m. peak hour. This is primarily due to the projected increase in traffic volumes along Glen Echo Road and OR 99E. The eastbound left, westbound right, southbound left, and southbound right-turn movements are all projected to increase by more than 100% over the 25-year period resulting in significant delay at each approach.

I-205 Southbound Ramp Terminal/SE 82nd Avenue

The I-205 Southbound Ramp Terminal/82nd Drive intersection is projected to operate at LOS E and at capacity (V/C = 1.0) during the weekday p.m. peak hour. This is primarily due to the moderate increase in eastbound right and westbound left-turn movements expected over the 25 year period.

I-205 Northbound Ramp Terminal/82nd Drive

The I-205 Northbound Ramp Terminal/82nd Drive intersection currently operates at LOS D and above capacity (v/c = 1.05 during the weekday p.m. peak hour. This is primarily due to the moderate increase in westbound through movements expected over the 25 year period.

Oatfield Road/Gloucester Street

The current TSP identifies the need for a traffic signal at the Oatfield Road/Gloucester Street intersection "to provide a safe and convenient point of access onto Oatfield Road, and reinforce Gloucester Street's function as a collector and connection route to Portland Avenue and McLoughlin Boulevard." The new traffic signal was also proposed to be coordinated with the existing Oatfield Road traffic signals at Webster Street and 82nd Drive.

Queueing

A queuing analysis was conducted at the signalized study intersections. Table 9 summarizes the 95th percentile queues during the weekday a.m. and p.m. peak hours under year 2021 background and total traffic conditions. The vehicle queue and storage lengths were rounded to the nearest 25-feet. The storage lengths reflect the striped storage for each movement at the intersections.

Table 9: Weekday PM Peak Hour Queuing

Intersection	Movement	95th Percentile Queue	Storage Length (feet)	Adequate?
OR 99E/Arlington Street	WBR	16	175	Yes
	NBL	#710	200	***No***
	NBR	40	280	Yes
	SBL	m13	250	Yes
OR 99E/Gloucester Street	NBL	m12	220	Yes
	NBR	m20	175	Yes
	SBL	m20	250	Yes
	SBR	m0	160	Yes
OR 99E/Glen Echo Avenue	EBR	64	100	Yes
	NBL	m26	185	Yes
	NBR	m12	160	Yes
	SBL	71	185	Yes
	SBR	51	160	Yes
Oatfield Road/82nd Drive	EBL	171	80	***No***
	WBL	134	170	Yes
	WBR	160	170	Yes
	NBR	62	100	Yes
	SBL	436	110	***No***
	SBR	43	101	Yes
I-205 SB Ramp Terminal/82nd Drive	WBL	m#527	310	***No***
	SBR	#80	360	Yes
I-205 NB Ramp Terminal/82nd Drive	EBR	m32	50	Yes
	WBL	25	200	Yes
	NBR	#338	575	Yes

Where WB = Westbound, SB = Southbound, EB = Eastbound, NB = Northbound, L = Left, R = Right
#: 95th percentile volume exceeds capacity, queue may be longer.
m: Volume for 95th percentile queue is metered by upstream signal.

As shown in Table 9, three study intersections are expected to have 95th percentile queues that exceed the striped storage for the movements:

- The northbound left-turn movement at the OR 99E/Arlington Road intersection is expected to exceed the striped storage for the movement by approximately 510 feet.
- The eastbound left-turn movement at the Oatfield Road/82nd Drive intersection is expected to exceed the striped storage for the movement by approximately 91 feet.
- The southbound left-turn movement at the Oatfield Road/82nd Drive intersection is expected to exceed the striped storage for the movement by approximately 326 feet.
- The westbound left-turn movement at the I-205 SB Ramp Terminal/82nd Drive intersection is expected to exceed the striped storage for the movement by approximately 217 feet.

Traffic Safety

As indicated in *Tech Memo 5: Existing Gaps and Deficiencies*, one study intersection was found to exceed the critical crash rate by intersection type and volume and one study intersection was identified as within the top five percent of statewide crash sites over the last five-year period. Several other intersections and corridors were also identified as having existing safety issues. The following provides a summary of the traffic safety needs for the city:

- I-205 Southbound Ramp Terminal/SE 82nd Drive
- OR 99E/Arlington Road
- OR 99E Corridor
- Oatfield Road Corridor
- 82nd Drive Corridor

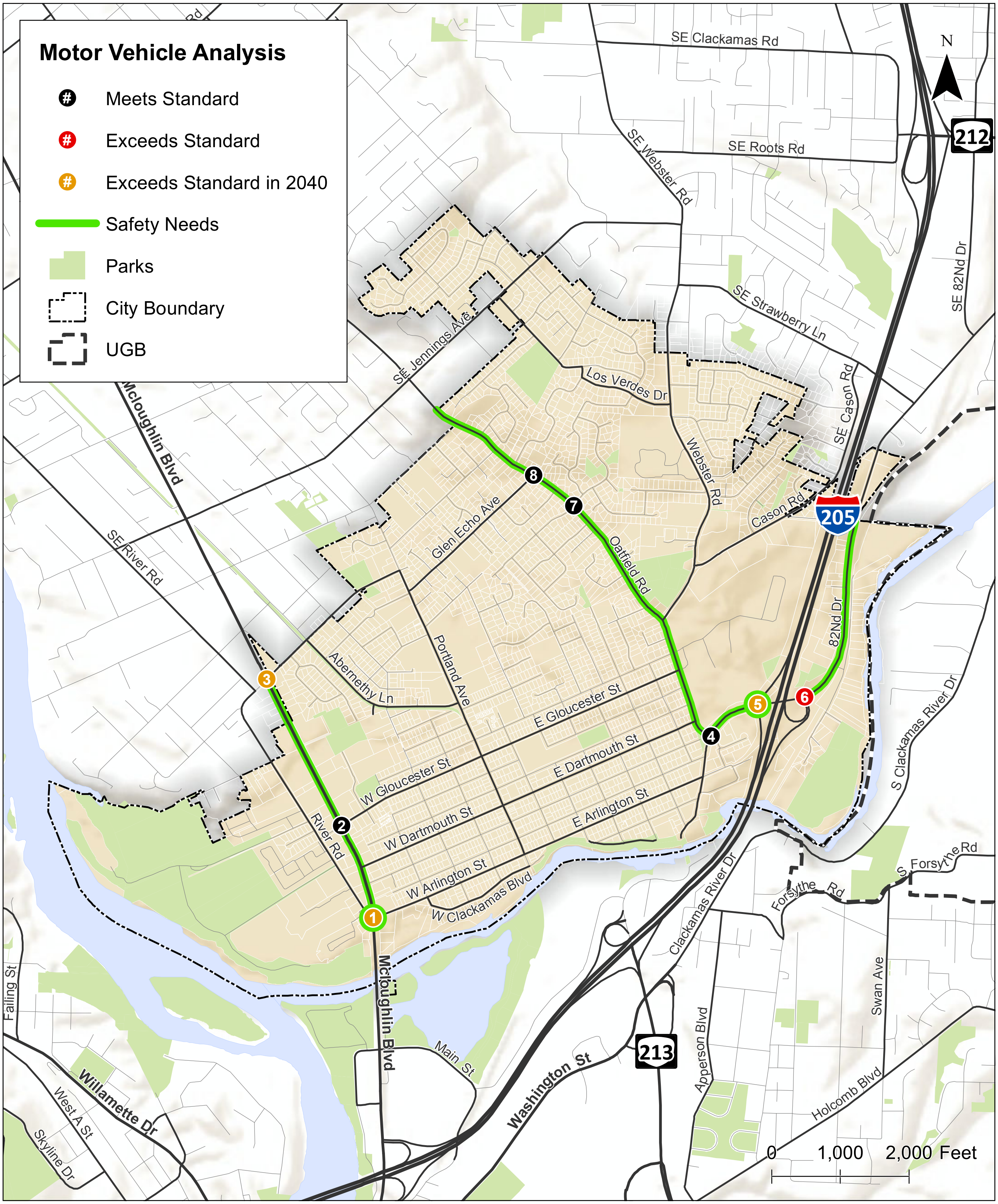
Figure 14 illustrates the motor vehicle system needs at the study intersections.

Freight Needs

As indicated in *Tech Memo 5: Existing Gaps and Deficiencies*, the only designated freight routes in Gladstone are OR 99E and I-205. The RTP identifies the segment of I-205 that travels through Gladstone as a Main Roadway Route, which is intended to connect major activity centers in the region to other areas in Oregon or the United States, Mexico, and Canada. Within Oregon, these routes include I-5, I-84, I-205, US 26, Hwy 217, 99E, and 99W. The RTP identifies the segment of OR 99E that travels through Gladstone as a road connector, which connects freight facilities or freight generation areas to the main roadway routes, such as I-205.

The RTP identifies five policies to serve as the foundation for the regional freight network, including 1) Use a system approach to plan for and manage the freight network, 2) Reduce delay and increase reliability, 3) Protect industrial lands and freight transportation investments, 4) Look beyond the roadway network to address critical marine and rail needs, and 5) Pursue clean, green and smart technologies and practices.

Freight movement within the city consists of commercial freight traffic traveling through the city on OR 99E, I-205, and 82nd Drive and the delivery of goods to the retail/commercial areas along OR 99E, Portland Avenue, and 82nd Drive. Therefore the primary freight needs are minimizing conflicts between freight vehicles and other travel modes along designated freight routes; reducing congestion on OR 99E and at the I-205/82nd Drive interchange to ensure the continuous movement of goods, and; ensuring adequate access to/from retail/commercial areas along OR 99E, Portland Avenue, and 82nd Drive as well as other parts of the city for the delivery of goods. These needs will most likely be addressed by improvements to the public transit, pedestrian, bicycle, motor vehicles systems within the city.



Motor Vehicle System Needs
Gladstone, Oregon

Figure
14

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Oregon Department of Transportation, Portland Metro Data Resource Center

OTHER TRAVEL MODES NEEDS

Rail

As indicated in *Tech Memo 5: Existing Gaps and Deficiencies*, there are currently no freight rail or passenger rail terminals located within Gladstone. The closest terminals are located to the south in Oregon City. Access to the terminals is provided via the local street network and either OR 99E or I-205. A typical trip from Gladstone could take up to 10 minutes by car or 20 minutes by transit, which also involves up to 15 minutes of walking. Alternatively, a trip from Gladstone could take up to 40 minutes by foot or 20 minutes by bike and involve travel along OR 99E and/or a series of local streets that may or may not have sidewalks. Therefore, the needs associated with the rail travel include ensuring adequate access to/from the freight and passenger rail terminals in Oregon City by all travel modes. This need will be addressed through the identification of improvements to the public transit, pedestrian, bicycle, motor vehicles systems within the city.

Air

As indicate in *Tech Memo 5: Existing Gaps and Deficiencies*, there are currently no airports located within Gladstone. The closest airports include Portland International Airport, the Aurora State Airport, and the Mulino Airport. Access to the Portland Airport can be a challenge for Gladstone residents due to congestion on I-205, the most direct and commonly used route to the airport. Transit service, which involves transferring in Portland, is a time-consuming and indirect way to access the Portland Airport. A typical trip from Gladstone to the Portland International Airport would take 20-30 minutes by vehicle (depending on traffic) or 100 minutes by public transit. Public transit routes to the Portland International Airport would include two transfers, either two buses and the MAX red line or one bus, the MAX Green line, and the MAX red line. Therefore, the needs associated with air travel include ensuring adequate access to/from the airports in Portland, Aurora, and Mulino by all (feasible) travel modes. This need will be addressed through the identification of improvements to the public transit, pedestrian, bicycle, motor vehicles systems within the city.

Water

As indicated in *Tech Memo 5: Existing Gaps and Deficiencies*, waterways in Gladstone are rarely used to support transportation. However, they are used for recreational purposes. Access to the rivers is provided by Meldrum Bar Park, Dahl Beach Park, and High Rock Park. The parks are used year round to access the river for recreation. Therefore, the needs associated with water travel include ensuring adequate access to/from the parks within Gladstone. This need will be addressed through the identification of improvements to the public transit, pedestrian, bicycle, motor vehicles systems within the city.

Pipeline

There are currently no needs associated with pipelines.

TRANSPORTATION SYSTEM MANAGEMENT OPERATIONS

Transportation System Management and Operations (TSMO) measures are designed to increase the efficiency and safety of the transportation system without physically increasing roadway capacity. Typical TSMO measures include Intelligent Transportation System (ITS) solutions, real-time traveler information, and services that respond quickly to traffic incidents. Several TSMO strategies are identified in Attachment A and will be further evaluated in *Tech Memo 8: TSP Solutions.*

TRANSPORTATION DEMAND MANAGEMENT

Transportation Demand Management (TDM) strategies measures typically include any method intended to shift travel demand from single occupant vehicles to non-auto modes or carpooling, travel at less congested times of the day, etc. Several TDM strategies are identified in Attachment A and will be further evaluated in *Tech Memo 8: TSP Solutions.*

Attachment A Menu of Potential Solutions

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TECHNICAL MEMORANDUM

Date:	May 5, 2017	Project #: 19890.3
To:	Jim Whynot and Jacque Betz, City of Gladstone Gail Curtis, Oregon Department of Transportation	
From:	Matt Bell and Molly McCormick, Kittelson and Associates, Inc.	
Project:	Gladstone Transportation System Plan (TSP) Update	
Subject:	Menu of Potential Solutions	

This memorandum summarizes a range of potential transportation-related solutions that can be used guide the city as it grows and redevelops in the future. These "toolbox" measures fall into the following categories:

- Active transportation
- Connectivity
- Intersection control
- Neighborhood traffic management
- Transportation system management and operations
- Land use

The potential solutions included in this toolbox are intended to help the city maximize its investment in the existing infrastructure and enhance the quality and availability of pedestrian, bicycle, transit, and motor vehicle facilities, as well as plan for the long-term transportation needs of the community.

ACTIVE TRANSPORTATION

One of the city's priorities is to reduce the reliance of single occupancy vehicles for local trips by providing residents with the option to walk, bike, or take transit to their destination. The provision of pedestrian and bicycle facilities between key destinations as well as the implementation of other active transportation strategies can enable the community to establish a well-connected system that promotes walking, bicycling, and taking transit.

Pedestrian Facilities

Pedestrian facilities are the elements of the transportation system that enable people to walk safely and efficiently between neighborhoods, retail/commercial centers, employment areas, and transit stops. These include facilities for pedestrian movement along key roadways (e.g., sidewalks, shared use paths and trails) as well as for safe roadway crossing locations (e.g., crosswalks, crossing beacons, pedestrian refuge islands). Each plays a role in developing a comprehensive pedestrian network.

A few of the city’s arterial and collector streets currently lack pedestrian facilities. Others have facilities that are deficient or do not provide a comfortable environment for most pedestrians. In the future, as arterial and collector streets are improved, most of these streets will include sidewalks and/or shared-use paths alongside the roadway. Pedestrian improvements should be prioritized based on their ability to complete connections between places that generate walking trips such as residential neighborhoods and schools, parks, retail/commercial center, and transit stops. Shared-use path projects are discussed in a subsequent section because of their utility for both pedestrians and bicyclists.

Sidewalks

Sidewalks are the fundamental building blocks of the pedestrian system. They enable people to walk comfortably, conveniently and safely from place to place. They also provide an important means of mobility for people with disabilities and families with strollers, and others who may not be able to travel on an unimproved roadside surface. Sidewalks are usually constructed from concrete and they provide an area separated from the roadway by a curb, landscaping, and/or on-street parking. Sidewalks are widely used in urban and suburban settings. The images below show sidewalks in a variety of urban and suburban settings.

Types of Pedestrian Crossings

Crossing facilities enable pedestrians to safely cross streets, railroad tracks, and other transportation facilities. Planning for appropriate pedestrian crossings requires the community to balance vehicular mobility needs with providing crossing locations that are located along the desired routes of walkers.

The state of Oregon considers all roadway intersections to be legal crossing locations for pedestrians regardless of whether a painted crosswalk is provided. At these locations, drivers are required to yield the right of way to pedestrians to allow them to cross. Driver compliance to yielding is often inconsistent and pedestrians often have difficulty crossing higher volume and higher speed roadways. There are several different types of pedestrian crossing treatments; each of which is applicable under a different range of considerations.

A brief description of the various pedestrian crossing types and where they can be applied is provided below.

High Visibility Crosswalk

Clear, reflective roadway markings and accompanying devices are placed at intersections and priority pedestrian crossings where there is sufficient sight distance and reaction time for motorists to yield. Crosswalks can be used at intersections and at mid-block crossings.

Raised Crosswalk

A raised crosswalk is raised higher than the surface of the street to give motorists and pedestrians a better view of the crossing area. A raised crosswalk is similar to a speed table and are often marked and signed for pedestrian crossing. Raised crosswalks are often used in areas with low speeds where people and difficulty crossing the street.

Raised Pedestrian Refuge

A raised median island provides a protected area in the middle of a crosswalk for pedestrians to stop while crossing the street. These refuges allow pedestrians to cross one direction of traffic at a time. Pedestrian refuges are often used in areas with high traffic volumes and/or at locations with a crash history involving pedestrians.

In-Street Yield

"Yield to Pedestrian" signs can be placed in the middle of crosswalks to increase driver awareness of crossing locations and the legal responsibility to yield right-of-way to pedestrians crossing the street. These signs can be effective in areas that experience high volumes of pedestrian crossings and low levels of motorist yielding rates.

Grade-Separated Crossing

Grade-separated crossings are either underpasses or overpasses that allow pedestrians to entirely avoid conflicts with automobiles when crossing a busy roadway. When used as part of a shared-use path, grade-separated crossings also accommodate bicycles. Grade-separated crossings are necessary wherever pedestrian crossings of freeways are constructed and in other limited circumstances, such as railroad crossings. However, they are often perceived as unsafe (especially under-crossings), and may result in significant out-of-direction travel for pedestrians. Grade-separated crossings can also be very expensive to build and are typically used sparingly.

Rapid Rectangular Flashing Beacon (RRFB)

These crossing treatments include signs that have a pedestrian-activated "strobe-light" flashing pattern to attract motorists' attention and provide awareness of pedestrians that are intending to cross the roadway. RRFBs are often used in areas with high volumes of pedestrians desiring to cross a street at a mid-block location.

Pedestrian Hybrid Beacon (HAWK)

A HAWK is a pedestrian-activated signal that is unlit when not in use. When activated the signal begins with a yellow light alerting drivers to slow and then a solid red light appears requiring drivers to stop while pedestrians have the right-of-way to cross the street. HAWKs are often used on wide roadways where mid-block crossings are difficult.

Bicycle System

Bicycle facilities enable cyclists to travel safely and efficiently on the transportation system. Both public infrastructure (bicycle lanes, shared roadways, shared-use paths and trails, signing and striping) and "on-site" facilities (secure parking, changing rooms, and showers at worksites) are important to providing a comprehensive bicycle system.

Many different bicycle facility types are needed to create a complete bicycle system that connects people to their destinations and allows cyclists to feel comfortable and safe while riding. While there are some bicycle lanes along select arterial and collector streets within the city, these lanes are not provided along the entire lengths of the corridors. The existing network could be supplemented by additional bicycle lanes or other types of bicycle facilities.

Types of Bicycle Facilities

Several types of bicycle facilities are discussed below.

Bike Lanes

Bike lanes are on-street bicycle facilities that provide a designated space for cyclists that is separated from vehicle traffic by pavement markings. Bike lanes are generally used on collector and arterial streets with adequate space to accommodate the bike lane width and with vehicular travel volumes and speeds that make it difficult for drivers and cyclists to "share the road." Bike lanes typically include white striping with a bicycle symbol or they can be buffered as shown below.

Buffered Bike Lanes

Buffered bike lanes are on-street bike lanes that include a physical separation ("buffer") between the bike lane and the vehicle traffic lane and/or the vehicle parking lane. Buffered bike lanes can be particularly helpful on streets with high vehicle speeds, high vehicle volumes, or relatively frequent parking turnover.

Cycletracks

Cycletracks are exclusive bikeways separated from vehicle travel lanes, parking lanes and sidewalks. They can be one- or two-way in direction and can be even with the street, the sidewalk, or somewhere between. On existing streets, cycletracks can be constructed where there is sufficient roadway width and/or in contexts where the number of vehicular travel lanes can be reduced.

Sharrows

A shared-lane pavement marking, or sharrow, is a pavement marking that can be used where space does not allow for a bike lane and/or where vehicular volumes and travel speeds allow cyclists to comfortably and conveniently "share the road" with motorists. Sharrows remind motorists of the presence of bicycles and indicate to cyclists where to safely ride within the roadway.

Low-Traffic Bikeway

Also known as "bicycle boulevards," streets with low vehicular volumes and speeds can be optimized for bicycle travel by including treatments for traffic calming and traffic reduction, signage and pavement markings, and intersection crossing treatments. Bike boulevards are ideal on local streets that parallel larger, high traffic routes and provide connections to similar destinations.

Mixed-Use Shoulder

A mixed-use shoulder is a roadway shoulder that is wide enough to be used by pedestrians and bicyclists as a mixed-use path. Mixed-use shoulders are ideal on low-volume streets where topography or the surrounding environment does not allow for the addition of a sidewalk or separate bicycle facility.

Wayfinding Signage

Wayfinding signs can direct bicyclists and pedestrians towards key destinations both within the city as well as to neighboring communities. These signs often include the distance to the destination and/or average travel times. Wayfinding signs are generally used on primary bicycle routes and multi-use trails.

"Share the Road" Signs

"Share the Road" signs can be used to remind drivers to watch for bicyclists on roadways without on-street bicycle lanes. However, the signs are not meant as a replacement for using the other facility types listed in this table. An alternative to the "Share the Road" sign is a "Bikes in Road" sign that suggests bicyclists take the lane rather than share the road.

Bicycle Crossings

Bicycle crossing treatments connect bike facilities at high traffic intersections, trailheads, or other bike routes. Frequently used crossing treatments are shown below.

Marked Bicycle Detectors at Traffic Signals

Many traffic signals are "actuated", meaning that a green light is provided to a particular intersection approach only when a vehicle is detected on that approach. However, actuating a signal as a cyclist is difficult if no indication is given of the location of detection equipment. Pavement markings can show cyclists where to stand to actuate a signal. Additionally, the sensitivity of all traffic signal loop detectors can be set to allow for bicycle activation. At intersections where bicyclists wait in areas separate from traffic, specific bicycle detectors can be installed.

Bicycle-only Signal

Bicycle-only signals can be used at intersections to provide a separate signal phase that is dedicated to bicyclists. They are especially useful at roadway intersections with multi-use trails, where there are high volumes of bicyclists crossing, or at intersections where large numbers of right-turning vehicles have the potential to conflict with through bicycles.

Preferential Movement for Bicycles

Some intersections may be designed such that cars cannot make particular movements, but bicyclists can. This type of treatment allows greater connectivity for bicyclists.

Striping Through Intersections

At high-vehicle and/or high-bicycle volume intersections, extending bicycle lane striping through the intersection can alert drivers to look out for bicyclists traveling through the intersection and help bicyclists know where to proceed with crossing.

On-Site Facilities

Bicyclists also benefit from facilities that are located on-site within key employment, commercial and institutional locations. These facilities can include indoor and/or outdoor secure bicycle parking, open or covered U-shaped racks, showers/changing rooms, and storage lockers for clothing and gear. The City can use incentives to encourage developers to include these types of facilities in new buildings.

Shared-use Pathways

Paved, bi-directional shared-use pathways can be designed as part of a Park and Recreational System and/or can be constructed adjacent to roadways where the topography, right-of-way, or other issues don't allow for the construction of sidewalks and bike facilities.

Intersections of shared-use paths and roadways require crossing treatments that are well-marked and highly visible to vehicles and trail users. Shared-use paths can be used to create longer-distance links within and between communities, provide regional connections and play an integral role in recreation, commuting, and accessibility for residents due to their broad appeal to users of all ages and skill levels.

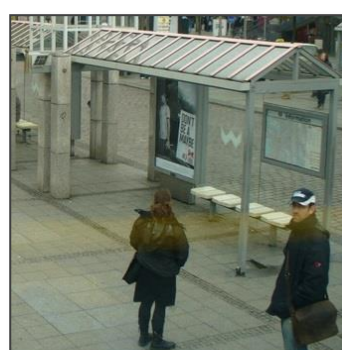
Shared-use paths provide a comfortable space for pedestrians and bicyclists of all ages.

The City may use shared-use paths in lieu of sidewalks and bike facilities, where appropriate. The Parks Master Plan, which is currently underway, will likely include shared use paths.

Public Transit

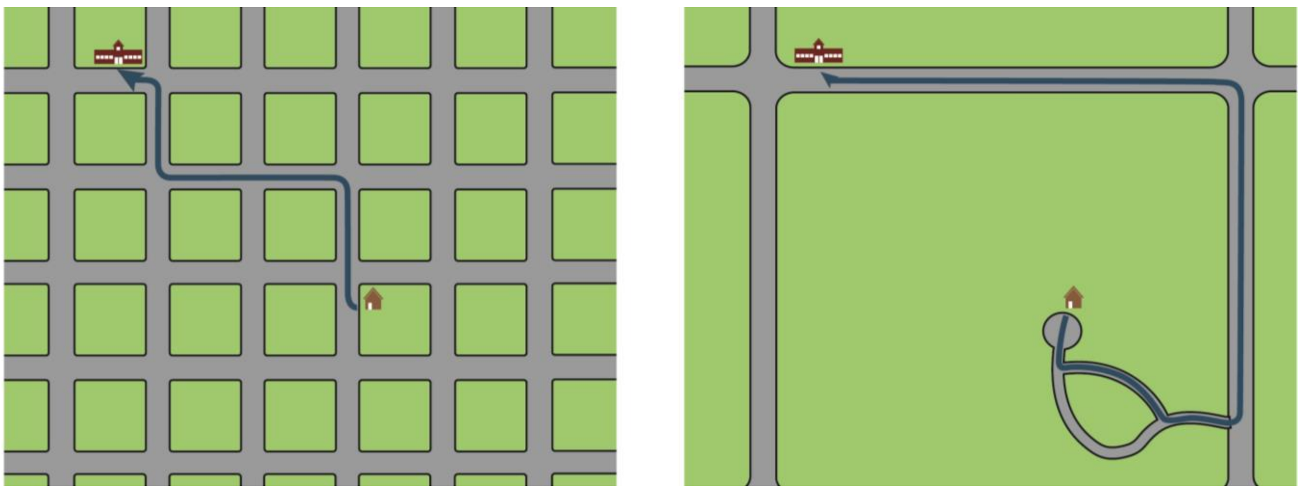
Public transit can provide important connections to destinations for people that do not drive or bike and can provide an additional option for all transportation system users for certain trips. Public transit can also provide links to walking, bicycling, or driving trips: users can walk to and from transit stops and their homes, shopping or work places, people can drive to park-and-ride locations to access a bus, or people can bring their bikes on transit vehicles and bicycle from a transit stop to their final destination.

Providing transit service in smaller cities is generally led by a local or regional transit agency, and is dependent on having the land use and densities that can support service. The city can plan for transit-supportive land use patterns and support future transit viability by designing and building streets that will comfortably accommodate transit stops and include the right-of-way that could allow for transit stops to be located as close as possible to important destinations in the city. At a minimum, a transit stop should be well-signed and have a comfortable space to wait. Benches that prove people with a place to sit and shelters that protect people from the weather can improve user comfort. Including bike parking near bus stops allows people the option to leave their bike at one trip-end instead of bringing it on the bus.



CONNECTIVITY

A well connected grid network of streets provides for convenient travel for vehicles, pedestrians and cyclists. Given an equivalent number of roadway lane-miles, a connected system generally has more capacity than a disconnected road network and provides the shortest, most direct routes for all users. A grid network can also lessen the effects of congestion along a single route, due to the number of alternate routes available. A connected system also can create easier and more expedient emergency response and can encourage pedestrians and bicyclists, who benefit greatly from having a direct route due to generally slower travel speeds. The images below show how someone might travel between their home and school on a well-connected grid network versus one that is a system of cul-de-sacs.



The left illustration is a connected street grid, on the right is a less connected system. Travel distance from home to school is shorter in a connected system.

The southern part of Gladstone is largely built on a grid system, while the northern part is largely built on a system of cul-de-sacs and dead ends. These streets can be desirable to residents because they can limit traffic speeds and volumes on local streets, but cul-de-sacs and dead ends result in longer trip distances, increased reliance on arterials for local trips, and limited options for people to walk and bike to the places they want to go.

The future street system needs to balance the benefits of providing a well-connected grid system with physical and topographical challenges, particularly in the northern part of the city. Incremental improvements to the street system can be planned carefully to provide route choices for motorists, cyclists and pedestrians while accounting for potential neighborhood impacts. In addition, the quality of the transportation system can be improved by making connectivity improvements to the pedestrian and bicycle system separate from street connectivity.

INTERSECTION CONTROL

The Oregon Department of Transportation (ODOT) maintains the traffic signals located along OR 99E and 82nd Drive. The City maintains the signals located along Oatfield Road. The rest of the intersections in the city are stop-controlled. The majority of these are two-way stop controlled (TWSC), with the stop sign provided on the lower volume of the two intersecting roadways. In the future, increasing traffic volumes may warrant different intersection options, such as roundabouts, traffic signals, and all-way stop control. The type of intersection control and final design for each intersection will need to consider the desired function of the roadways, travel speeds, safety, pedestrian and bicycle needs, topography, anticipated traffic volumes, sight distance, available space and other potential constraints and opportunities.

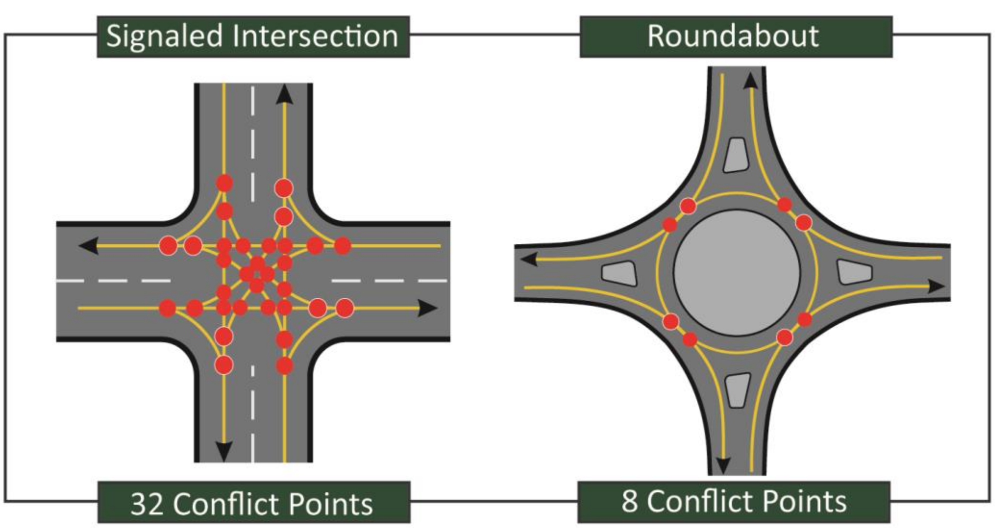
All-way Stop-control

All-way stop control is often used when the two intersecting roadways have similar vehicular volumes and where a traffic signal or roundabout is not needed. All-way stop control intersections are relatively inexpensive and can be implemented more easily than traffic signals and roundabouts.

Roundabout

Roundabouts are circular intersections where entering vehicles yield to vehicles already in the circle. They are designed to slow vehicle speeds to 20 to 30 mph or less before they enter the intersection. As shown below, roundabouts have fewer conflict-points and have been shown to reduce the severity of crashes, as compared to signalized intersections. Roundabouts can be more costly to design and install when compared to other intersection control types, but they have a lower operating and maintenance cost than traffic signals. Topography must be carefully evaluated in considering a roundabout, given that slope characteristics at an intersection may render a roundabout infeasible.

Roundabouts have fewer conflict points than signalized intersections.



Depending on the design, roundabouts can be more land-intensive than other intersection controls. To maintain the flexibility to construct roundabouts at key intersections, the City may want to ensure adequate right-of-way is provided at intersection locations whenever right-of-way dedication or acquisition activities are undertaken. Information contained in the City's development code and engineering standards can account for this need.

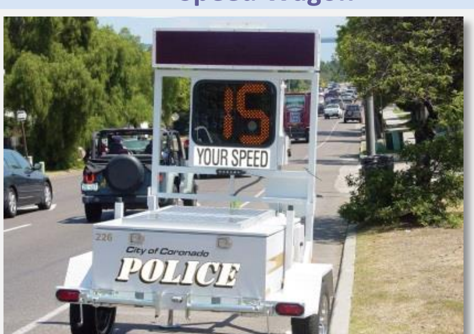
Key intersections of arterial/arterial, arterial/collector, and collector/collector streets may be candidates for roundabout installation in the future. Within Gladstone, a majority of these locations could likely be well served by a single lane roundabout. Based on national guidance, the right-of-way dedication at these locations could include a circle with a radius of 85 feet measured from the center of the intersection, to preserve space for a single-lane roundabout, sidewalk, and landscaping in a 170-foot diameter circle. On intersections along key freight routes within the city, a 95-foot radius (190 feet in diameter) circle could be preserved.

Traffic Signals

Traffic signals allow opposing streams of traffic to proceed in an alternating pattern. Both national and state guidance indicates when it is appropriate to install traffic signals at intersections. When used, traffic signals can effectively manage high traffic volumes, and provide for dedicated times in which pedestrians and cyclists can cross roadways. Because they continuously draw from a power source and must be periodically re-timed, signals typically have higher maintenance costs than other types of intersection control. Signals can improve safety at intersections where signal warrants are met, however, signals may result in a shift to higher levels of rear-end crashes compared to alternatives.

NEIGHBORHOOD TRAFFIC MANAGEMENT

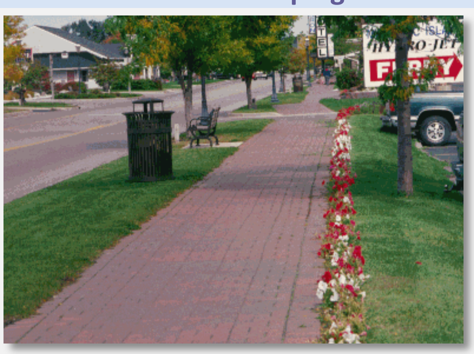
Neighborhood Traffic Management (NTM), also known as "traffic calming," describes traffic control devices typically used in residential neighborhoods to slow traffic or possibly reduce the volume of traffic. Below are illustrations and descriptions of neighborhood traffic management strategies that could be applied in Gladstone to address traffic issues that arise over time.

Speed Wagon	Pros	Cons
	▪ Inexpensive ▪ Low operating costs ▪ Mobile	▪ Penalties for speeding not enforced ▪ Not permanent ▪ Placement may obstruct bicycle lane or shoulder

Speed Humps	Pros	Cons
	▪ Permanent ▪ Can be used to provide raised pedestrian crossings ▪ Can be modified to accommodate emergency vehicles	▪ Placement of speed humps can be contentious ▪ Requires maintenance

Traffic Circles	Pros	Cons
	▪ Can have aesthetic value ▪ Physical barrier encourages lower speeds	▪ Can impede emergency vehicles or freight/delivery truck movement ▪ Increased maintenance costs

Medians	Pros	Cons
	▪ Eliminates potential conflict points ▪ Provides pedestrian refuge ▪ Can benefit access management	▪ Can be more expensive to construct than other NTM measures ▪ Can impede roadway connectivity ▪ Can impact business access

Landscaping	Pros	Cons
	▪ Aesthetic value ▪ Provides buffer for pedestrians ▪ Can have traffic calming effect	▪ Requires additional maintenance, including weed management ▪ Requires additional right-of-way allocation ▪ Can impede sight distance

Curb Extensions	Pros	Cons
	▪ Reduces pedestrian crossing distance ▪ Can have a traffic calming effect	▪ Can be expensive to construct ▪ Can impede freight movements

Choker	Pros	Cons
	▪ Can be used in conjunction with a midblock pedestrian crossing ▪ Can have traffic calming affect	▪ Expensive to construct

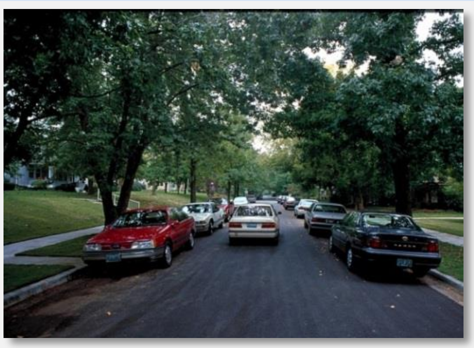
Narrow Streets	Pros	Cons
	▪ Reduces pedestrian crossing distance ▪ Can have a traffic calming effect ▪ Less asphalt to maintain	▪ Can impede emergency vehicles ▪ Can limit availability of on-street parking

Photo Radar	Pros	Cons
	▪ Permanent speed enforcement ▪ Strong deterrent for excessive speeds	▪ Expensive initial investment required ▪ Not portable

On-Street Parking	Pros	Cons
	▪ Increases available parking for commercial and/or residential uses ▪ Narrows feel of the street ▪ Potential revenue source when metered	▪ Adequate right-of-way must exist or be created ▪ Can conflict with bicycle lanes ▪ Can create additional conflict points for vehicles ▪ Can reduce sight distance

Selective Enforcement	Pros	Cons
	▪ Mobile ▪ Can target identified problem areas	▪ Requires allocation of enforcement resources ▪ May only result in temporary improvement in motorist compliance with posted speeds

Partial Street Closures	Pros	Cons
	▪ Lack of direct through routes for vehicles can reduce speeds ▪ Maintain connectivity for bicycles and pedestrians	▪ Can create connectivity issues, counter to TSP goals ▪ May increase speeds on alternative routes ▪ May increase volumes on alternative routes

Traffic calming should be considered in an area-wide manner to avoid shifting impacts between neighborhoods and adjacent streets. Typically, traffic calming receives a favorable reception by residents adjacent to streets where vehicles travel at speeds above 30 miles per hour. However, traffic calming can also be contentious because it may be perceived as just moving the problem from one neighborhood to another rather than solving it. Traffic calming may also be perceived as impacting emergency vehicle travel.

TRANSPORTATION SYSTEM MANAGEMENT AND OPERATIONS (TSMO)

Transportation Demand Management (TDM) and Transportation System Management (TSM) strategies are two complementary approaches to managing transportation and maximizing the existing system. Together, these strategies are referred to as Transportation System Management and Operations (TSMO). TDM addresses the *demand* on the system: the number of vehicles traveling on the roadways each day. TDM measures include any method intended to shift travel demand from single occupant vehicles to non-auto modes or carpooling, travel at less congested times of the day, etc. TSM addresses the *supply* of the system: using strategies to improve the system efficiency without increasing roadway widths or building new roads. TSM measures are focused on improving operations by enhancing capacity during peak times, typically with advanced technologies to improve traffic operations.

Metro's Regional TSMO Plan identifies four main areas of investment to improve system performance:

- Multi-modal traffic management (TSM)
- Traffic incident management
- Traveler information
- Transportation demand management (TDM)

The TSMO Plan also identifies specific strategies for 24 mobility corridors in the region. The following strategies are identified for the mobility corridors in Gladstone:

- Freeway Management for I-205
- Arterials Corridor Management for OR 99E

In the TSMO Plan, Freeway Management refers to the expansion of freeway vehicle detection to provide comprehensive freeway traveler information including travel speed, travel times, volumes, forecasted information, incident conditions, and weather conditions. Arterial Corridor Management (ACM) refers to installing upgraded traffic signal controllers, establishing communications to the central traffic signal system, providing arterial detection (including bicycle detection where appropriate), routinely updating signal timings, upgrading traffic signage, and performing on-going maintenance and parts replacement. In addition, it may include providing real-time and forecast traveler information on arterial roadways including current roadway conditions, congestion information, travel times, incident information, construction work zones, current weather conditions and other events that may affect traffic conditions.

The following section provides an overview of a broad range of TSMO measures that are being implemented and considered in the region and identifies and explains those that are most applicable to Gladstone.

TSMO Strategies

Successful implementation of TSMO strategies relies on the participation of a variety of public and private entities. Strategies can be implemented by a region, a city, a neighborhood, or particular employer. In addition, they can be categorized as policies, programs, or physical infrastructure investments. Table 1 provides a summary of potential measures that can be implemented within the Metro region and which entities are generally in the position to implement each one. As the city continues to grow and redevelop over the next 20 to 40 years, the applicability of these strategies can be further reviewed. Additional information on potential strategy implementation within Gladstone is discussed below.

Table 1: Transportation System Management (TSM) and Transportation Demand Management (TDM) strategies

TSMO Strategy	TDM or TSM?	Type of Investment	City/ County/ Region	Transportation Management Association[1]	Developers	Transit Provider	Employers	State
Parking management	TSM / TDM	Policy	P		S	S	S	
Limited/flexible parking requirements	TDM	Policy	P		S		S	
Access management	TSM / TDM	Policy / Infrastructure	P					P
Connectivity standards	TSM / TDM	Policy / Infrastructure	P		S			P
Congestion pricing	TSM / TDM	Policy / Infrastructure	P					P
Flexible Work Shifts	TDM	Program / Policy	S				P	
Frequent transit service	TDM	Program	S			P		
Free or subsidized transit passes	TDM	Program	S				P	
Preferential carpool parking	TDM	Program	S				P	
Carpool match services	TDM	Program	S	P			S	
Parking cash out	TDM	Program		S		S	P	
Carsharing program support	TDM	Program	P	S	P	P	P	
Bicycle facilities	TDM	Infrastructure	P		S		S	S
Pedestrian Facilities	TDM	Infrastructure	P		S			
Regional ITS	TSM	Infrastructure	P					
Regional traffic management	TSM	Infrastructure	P					
Advanced signal systems	TSM	Infrastructure	P			S		
Real time traveler data	TSM	Infrastructure	P					P
Arterial corridor management	TSM	Infrastructure	P					

[1]A Transportation Management Association does not currently exist in Gladstone
P: Primary role
S: Secondary/Support role
* Primary implementation depends on roadway jurisdiction

Strategies for Gladstone

The following section provides more detail on policy, programming and infrastructure strategies that may be effective for managing transportation demand and increasing system efficiency in Gladstone, especially within the next 10 to 20 years.

Programming

Programming solutions can provide effective and low cost options for reducing transportation demand. Some of the most effective programming strategies can be implemented by employers and are aimed at encouraging non-single occupancy vehicle (SOV) commuting. These strategies are discussed below.

Carpool Match Services

Metro coordinates a rideshare/carpool program (see the DriveLessConnect.com website) that regional commuters can use to find other commuters with similar routes to work. The program allows commuters to connect and coordinate with others on locations, departure times, and driving responsibilities. Employers can also play a role in encouraging carpooling by sharing information about the system, providing preferential carpool parking, and allowing employee flexibility in workday schedules.

Collaborative Marketing

Cities, employers, future transit service providers, and developers can collaborate on marketing to get the word out to residents about transportation options that provide alternatives to single-occupancy vehicles.

Policy

Policy solutions can be implemented by cities, counties, regions, or at the statewide level. Regional and state-level policies will affect transportation demand in Gladstone, but local policies can also have an impact.

Limited and/or Flexible Parking Requirements

Cities set policies related to parking requirements for new developments. In order to allow developments that encourage multi-modal transportation, cities can set parking maximums and low minimums and/or allow for shared parking between uses. Cities can also provide developers the option to pay in-lieu fees instead of constructing additional parking. This option provides additional flexibility to developers that can increase the likelihood of development, especially on smaller lots where surface parking would cover a high portion of the total property.

Finally, cities can set policies that require provision of parking to the rear of buildings, allowing buildings in commercial areas to directly front the street. This urban form creates a more appealing environment for walking and window-shopping. In-lieu parking fees support this type of development for parcels that do not have rear- or side-access points.

Parking Management

Parking plays a large role in transportation demand management, and effective management of parking resources can encourage use of non-single occupancy vehicle modes. Cities can tailor policies to charge for public parking in certain areas and impose time limits on street parking in retail centers. Cities can also monitor public parking supply and utilization in order to inform future parking strategy.

Access Management

Access management describes a practice of managing the number, placement, and movements of intersections and driveways that provide access to adjacent land uses. Access management policies can be an important tool to improve transportation system efficiency by limiting the number of opportunities for turning movements on to or off of certain streets.

In addition, well deployed access management strategies can help manage travel demand by improving travel conditions for pedestrian and bicycles. Eliminating the number of access points on roadways allows for continuous sidewalk and bicycle facilities and reduces the number of potential interruptions and conflict points between pedestrians, bicyclists, and cars.

Access management is typically adopted as a policy in development guidelines. It can be extremely difficult to implement an access management program once properties have been developed along a corridor. Cooperation among and involvement of relevant government agencies, business owners, land developers and the public is necessary to establish an access management plan that benefits all roadway users and businesses.

Signal Systems Improvements

Signal retiming and optimization offer a relatively low cost option to increase system efficiency. Retiming and optimization refers to updating timing plans to better match prevailing traffic conditions and coordinating signals. Timing optimization can be applied to existing systems or may include upgrading signal technology, such as signal communication infrastructure, signal controllers, or cabinets. Signal retiming can reduce travel times and be especially beneficial to improving travel time reliability. In high pedestrian or desired pedestrian areas, signal retiming can facilitate pedestrian movements through intersections by increasing minimum green times to give pedestrians time to cross during each cycle, eliminating the need to push pedestrian crossing buttons. Signals can also facilitate bicycle movements with the inclusion of bicycle detectors.

Signal upgrades often come at a higher cost and usually require further coordination between jurisdictions. However, upgrading signals provides the opportunity to incorporate advanced signal systems to further improve the efficiency of a transportation network. Strategies include coordinated signal operations across jurisdictions, centralized control of traffic signals, adaptive or active signal control, and transit or freight signal priority. These advanced signal systems can reduce delay, travel time and the number of stops for transit, freight, and other vehicles. In addition, these systems may help reduce vehicle emissions and improve travel time reliability.

Transit signal priority systems use sensors to detect approaching transit vehicles and alter signal timings to improve transit performance. This improves travel times for transit, reliability of transit travel time, and overall attractiveness of transit. The City of Portland has one of the only systems of transit signal priority in the region, which is applied on most of the major arterial corridors throughout the city.

Adaptive or active signal control systems improve the efficiency of signal operations by actively changing the allotment of green time for vehicle movements and reducing the average delay for vehicles. Adaptive or active signal control systems require several vehicle detectors at intersections in order to detect traffic flows adequately, in addition to hardware and software upgrades.

Traffic responsive control uses data collected from traffic detectors to change signal timing plans for intersections. The data collected from the detectors is used by the system to automatically select a timing plan best suited to current traffic conditions. This system is able to determine times when peak-hour timing plans begin or end; potentially reducing vehicle delays.

Truck signal priority systems use sensors to detect approaching heavy vehicles and alter signal timings to improve truck freight travel. While truck signal priority may improve travel times for trucks, its primary purpose is to improve the overall performance of intersection operations by clearing any trucks that would otherwise be stopped at the intersection and subsequently have to spend a longer time getting back up to speed. Implementing truck signal priority requires additional advanced detector loops, usually placed in pairs back from the approach to the intersection.

Real-Time Traveler Information

Traveler information consists of collecting and disseminating real-time transportation system information to the traveling public. This includes information on traffic and road conditions, general public transportation and parking information, interruptions due to roadway incidents, roadway maintenance and construction, and weather conditions. Traveler information is collected from roadway sensors, traffic cameras, vehicle probes, and more recently, media access control (MAC) devices such as cell phones or laptops. Data from these sources are sent to a central system and subsequently disseminated to the public so that drivers track conditions specific to their cars and can provide historical and real-time traffic conditions for travelers.

When roadway travelers are supplied with information on their trips, they may be able to avoid heavy congestion by altering a travel path, delaying the start of a trip, or changing which mode they can choose. This can reduce overall delay and fuel emissions. Traveler information projects can be prioritized over increasing capacity on roadway, often with high project visibility among the public.

Real-Time Transit Information

Transit agencies or third-party sources can disseminate both schedule and system performance information to travelers through a variety of applications, such as in-vehicle, wayside, or in-terminal dynamic message signs, as well as the Internet or wireless devices. Coordination with regional or multimodal traveler information efforts can increase the availability of this transit schedule and system performance information. TriMet has implemented this through its Transit Tracker system. These systems enhance passenger convenience and may increase the attractiveness of transit to the public by encouraging travelers to consider transit as opposed to driving alone. They do require cooperation and integration between agencies for disseminating the information.

LAND USE

The types and intensities of land uses are closely correlated with travel demand. Land use patterns in many areas of the city are suburban in nature and low density, with more moderate densities near OR 99E in the southern part of the city. In the future the city is envisioned to be a mixture of housing densities and areas of mixed use development (i.e., a mix of residential, retail, commercial and/or office uses).

Commercial Nodes in Residential Areas

Commercial nodes in residential areas provide residents with the opportunity to walk or ride their bike for non-work related trips. Neighborhood commercial nodes can include small restaurants, coffee shops, hair salons or other neighborhood retail or personal service uses. The city's zoning map currently shows a limited number of commercial notes within the city outside from those located along OR 99E, Portland Avenue, and 82nd Drive.

As future nodes develop, the City can encourage individual business to share parking to provide for the more efficient use of land and reduce land, development and maintenance concepts. Nodal development and shared parking allows people to drive, bike, or take transit to one location and then comfortably walk between businesses.

Mixed Use Development

Mixed use developments can reduce automobile trips by supporting higher frequency transit service and promoting pedestrian and bicycle travel. Urban areas with mixed uses and higher densities can be promoted in targeted areas, such as the four main general commercial areas and/or future town centers. Creating new employment areas near existing and future residential areas in Gladstone also can create opportunities for people to live closer to where they work.

Attachment B PLTS Analysis Results

Table B-1: Detailed PLTS Analysis Results

Street	From	To	Side	Pedestrian LTS Criteria: Speed (MPH)	Total Number of Lanes	Bike Lane Width (feet)	Parking	Sidewalk Condition	Sidewalk Width (feet) [1]	Buffer	Illumination	Land Use	PLTS
Major Arterial													
OR 99E	City Limits	North of OR 99E Bridge	Both	40	4	< 7	No	Fair	=> 5	Vertical	No	Auto-oriented Commercial	3
	North of OR 99E Bridge	Dartmouth Street	West	40	5	< 7	No	Fair	=> 5	Landscaped	No	Auto-oriented Commercial	4
	Dartmouth Street	Gloucester Street	West	40	5	< 7	No	Fair	=> 5	Curb-tight	No	Auto-oriented Commercial	3
	North of OR 99E Bridge	Gloucester Street	East	40	5	=> 7	No	Fair	=> 5	Curb-tight	No	Auto-oriented Commercial	4
	Gloucester Street	19340 OR 99E	Both	40	5	< 7	No	Fair	=> 5	Landscaped	No	Auto-oriented Commercial	3
	19340 OR 99E	City Limits	East	40	5	=> 7	No	Fair	=> 5	Curb-tight	No	Auto-oriented Commercial	4
	19340 OR 99E	19250 OR 99E	West	40	5	< 7	No	Good	=> 5	Curb-tight	No	Auto-oriented Commercial	4
	19250 OR 99E	19210 OR 99E	West	40	5	< 7	No	None	N/A	N/A	No	Auto-oriented Commercial	4
	19210 OR 99E	City Limits	West	40	5	< 7	No	Fair	=> 5	Curb-tight	No	Auto-oriented Commercial	4
Minor Arterial													
River Road	Arlington Street	Jensen Road	East	30	2	< 5.5	No	Fair	=> 5	Curb-tight	Yes	Auto-oriented Commercial	3
	Jensen Road	City Limits	East	30	2	< 5.5	Yes	Fair	=> 5	Curb-tight	Yes	Auto-oriented Commercial	3
	Arlington Street	City Limits	West	30	2	< 5.5	No	Fair	=> 5	Curb-tight	Yes	Low density development	3
Arlington Street	OR 99E	Barton Road	Both	25	2	N/A	Yes	Fair	=> 5	Curb-tight	No	Auto-oriented Commercial	3
	Barton Road	82nd Drive	Both	25	2	N/A	Yes	Fair	4 - 5	Landscaped	No	Residential	4
Portland Avenue	Clackamas Boulevard	High School Driveway	East	20	3	N/A	Yes	Fair	4 - 5	Landscaped	Yes	Residential; CBD	3

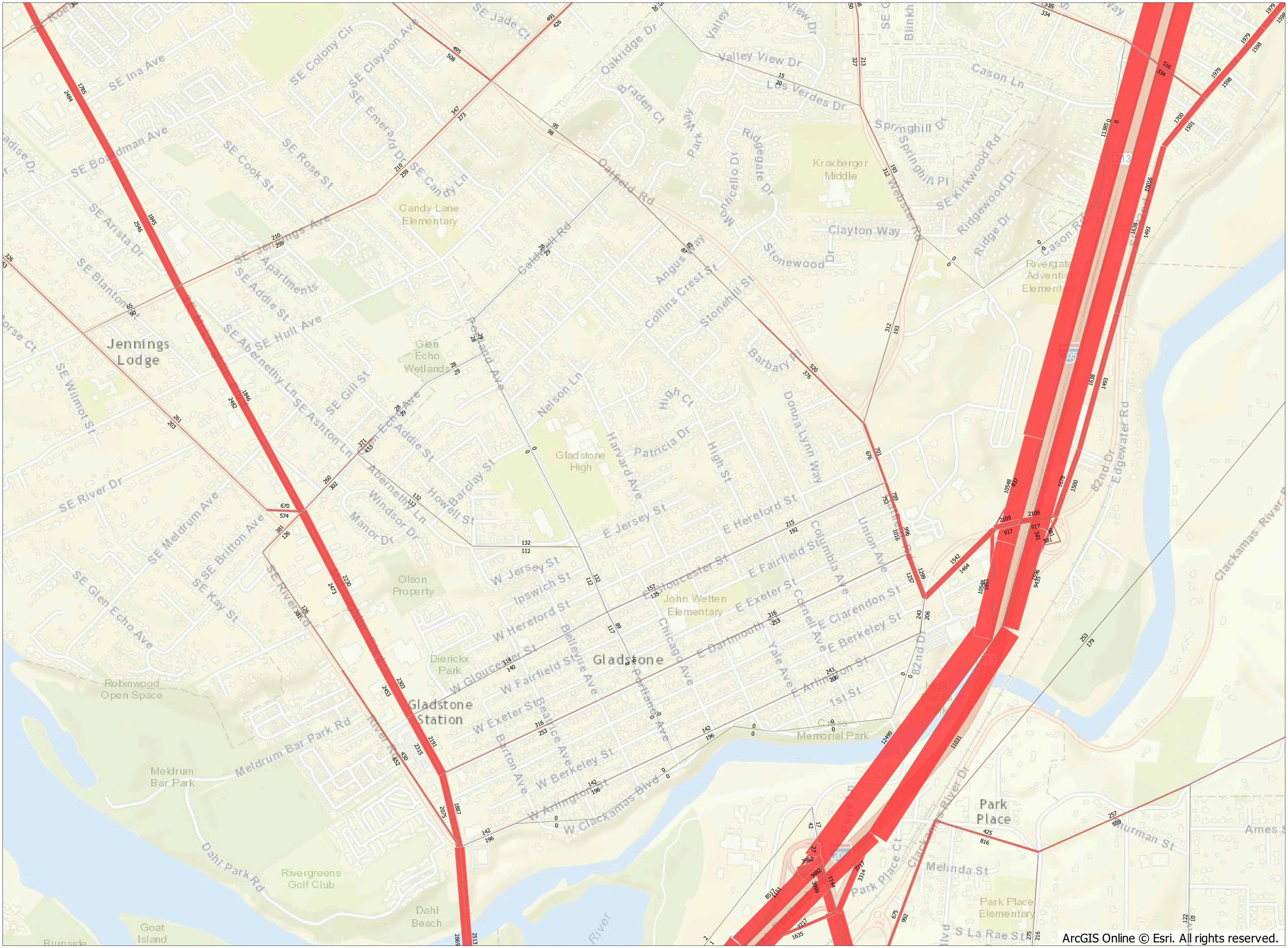
	Clackamas Boulevard	Abernethy Lane	West	20	3	N/A	Yes	Fair	4 - 5	Landscaped	Yes	Residential; CBD	3
	High School Driveway	Nelson Lane	East	20	2	N/A	Yes	Good	=> 5	Curb-tight	Yes	Public Facility	2
	Nelson Lane	City Limits	East	20-25	2	< 5.5	No	None	N/A	N/A	Yes	Residential	4
	Abernathy Lane	Barclay Street	West	20	3	N/A	Yes	Fair	=> 5	Curb-tight	Yes	Residential; Public Facility	2
	Barclay Street	Duniway Avenue	West	20	2	N/A	Yes	Fair	4 - 5	Curb-tight	Yes	Residential	3
	Duniway Avenue	18390 Portland Avenue	West	25	2	N/A	Yes	None	N/A	N/A	Yes	Residential	4
	18390 Portland Avenue	City Limits	West	25	2	N/A	Yes	Fair	4 - 5	Curb-tight	Yes	Residential	3
82nd Drive	End of road	Columbia Avenue	West	25	2	5.5 - 7	No	Fair/Poor	=> 5	Curb-tight	Yes	Light Industrial	3
	Columbia Avenue	1st Street	West	25	2	5.5 - 7	Yes	Fair	=> 5	Curb-tight	Yes	Freeway Interchange	3
	End of road	1st Street	East	25	2	5.5 - 7	Yes	Fair	=> 5	Curb-tight	Yes	Freeway Interchange	3
	1st Street	I-205 Southbound Terminal	Both	25	2	5.5 - 7	No	Fair	=> 5	Curb-tight	No	Auto-oriented commercial	3
	I-205 Southbound Terminal	Edgewater Road	South	35	3	5.5 - 7	Yes	None	N/A	N/A	No	Auto-oriented commercial	4
	I-205 Southbound Terminal	Edgewater Road	North	35	3	5.5 - 7	Yes	Fair	4 - 5	Curb-tight	No	Auto-oriented commercial	4
	Edgewater Road	City Limits	Both	35	3	5.5 - 7	No	Fair/Poor	4 - 5	Curb-tight	No	Auto-oriented commercial	3
Oatfield Road	82nd Drive	Webster Road	East	35	3	5.5 - 7	No	Fair	=> 5	Curb-tight	Yes	Residential	3
	Webster Road	17925 SE Oatfield Road	East	35	2	5.5 - 7	No	Fair	=> 5	Curb-tight	Yes	Residential	3
	17925 SE Oatfield Road	Park Way	East	35	2	5.5 - 7	No	Poor	4 - 5	Landscaped	Yes	Residential	3

	82nd Drive	Kenmore Street	West	35	3	5.5 - 7	No	Fair	=> 5	Curb-tight	Yes	Residential	3
	Kenmore Street	18490 SE Oatfield Road	West	35	2	5.5 - 7	No	None	N/A	N/A	Yes	Residential	4
	18490 SE Oatfield Road	18215 SE Oatfield Road	West	35	2	5.5 - 7	Yes	Fair	4 - 5	Curb-tight	Yes	Residential	3
	18215 SE Oatfield Road	Park Way	West	35	2	5.5 - 7	No	None	N/A	N/A	Yes	Residential	4
	Park Way	City Limits	Both	35	2	5.5 - 7	No	None	N/A	N/A	Yes	Residential	4
Webster Road	Oatfield Road	Los Verdes Drive	Both	35	2	5.5 - 7	No	Fair	=> 5	Curb-tight	Yes	Low density development	3
	Los Verdes Drive	Charolais Drive	East	35	2	5.5 - 7	Yes	Fair	4 - 5	Curb-tight	Yes	Low density development	3
	Charolais Drive	City Limits	East	35	2	5.5 - 7	Yes	None	N/A	N/A	Yes	Low density development	4
	Los Verdes Drive	City Limits	West	35	2	5.5 - 7	Yes	Fair	4 - 5	Curb-tight	Yes	Low density development	3
Jennings Avenue	Valley View Road	City Limits	Both	30	2	N/A	Partial	None	N/A	N/A	No	Residential	4
Collector													
Dartmouth Street	OR 99E	Portland Avenue	Both	25	2	N/A	Yes	Fair	4 - 5	Landscaped	No	Residential	4
	Portland Avenue	Chicago Avenue	North	25	2	N/A	Yes	Poor	4 - 5	Curb-tight	Yes	Residential	3
	Chicago Avenue	Harvard Avenue	North	25	2	N/A	Yes	None	N/A	N/A	No	Residential	4
	Harvard Avenue	Yale Avenue	North	25	2	N/A	Yes	Poor	=> 5	Landscaped	No	Residential	4
	Yale Avenue	Oatfield Road	North	25	2	N/A	Yes	None	N/A	N/A	No	Residential	4
	Portland Avenue	Oatfield Road	South	25	2	N/A	Yes	Fair	4-5	Landscaped	Partial	Residential	3
Gloucester Street	River Road	OR 99E	North	25	2	N/A	Yes	Good	4 - 5	Curb-tight	No	Auto-oriented Commercial	4
	River Road	OR 99E	South	25	2	N/A	Yes	Good	=> 5	Curb-tight	No	Auto-oriented Commercial	3
	OR 99E	Yale Avenue	Both	25	2	N/A	Yes	Fair	4 - 5	Landscaped	No	Residential	4

	Yale Avenue	Oatfield Road	Both	25	2	N/A	Yes	Fair	=> 5	Curb-tight	No	Residential	3
Abernethy Lane	Glen Echo Avenue	Portland Avenue	North	25	2	N/A	Yes	Fair	=> 5	Curb-tight	Yes	Residential	2
	Glen Echo Avenue	Portland Avenue	South	25	2	N/A	No	Fair[2]	=> 5	Landscaped	Yes	Residential	2
Glen Echo Avenue	OR 99E	Abernethy Lane	Both	30	2	N/A	Partial	Fair	=> 5	Curb-tight	No	Residential	3
	Abernethy Lane	Portland Avenue	North	30	2	N/A	No	None	N/A	N/A	No	Residential	4
	Abernethy Lane	5800 Glen Echo Avenue	South	30	2	N/A	No	None	N/A	N/A	No	Residential	4
	5800 Glen Echo Avenue	Portland Avenue	South	30	2	N/A	No	Fair	=> 5	Curb-tight	No	Residential	3
	Portland Avenue	6740 Glen Echo Avenue	North	25	2	N/A	No	None	N/A	N/A	No	Residential	4
	6740 Glen Echo Avenue	6890 Glen Echo Avenue	North	25	2	N/A	No	Fair	=> 5	Curb-tight	No	Residential	3
	6890 Glen Echo Avenue	Oatfield Road	North	25	2	N/A	No	None	N/A	N/A	No	Residential	4
	Portland Avenue	Oatfield Road	South	25	2	N/A	No	None	N/A	N/A	No	Residential	4
Cason Road	Webster Road	City Limits	Both	30	2	5.5-7	No	Fair	=> 5	Curb-tight	Yes	Residential	3
Via Del Verde/Los Verdes Drive	Valley View Road	Crownview Drive	Both	25	2	N/A	Yes	Fair	4 - 5	Landscaped	Yes	Residential	3
	Crownview Drive	Webster Road	North	25	2	N/A	Yes	Fair	4 - 5	Landscaped	No	Residential	4
	Crownview Drive	Webster Road	South	25	2	N/A	Yes	Fair	=> 5	Curb-tight	No	Residential	4
Valley View Road/Valley View Drive	Los Verdes Drive	Valley View Road	Both	25	2	N/A	No	Fair	4 - 5	Landscaped	Yes	Residential	3
	Valley View Road	Churchill Drive	North	25	2	N/A	No	None	N/A	N/A	Yes	Residential	4
	Churchill Drive	Jennings Avenue	North	25	2	N/A	No	Fair	4 - 5	Curb-tight	Yes	Residential	3
	Valley View Road	Jennings Avenue	South	25	2	N/A	No	Fair	4 - 5	Curb-tight	Yes	Residential	3

[1] Sidewalk refers to sidewalks, shared-use paths, and pedestrian paths.
[2] Shared-use path.

Attachment C Travel Demand Model Data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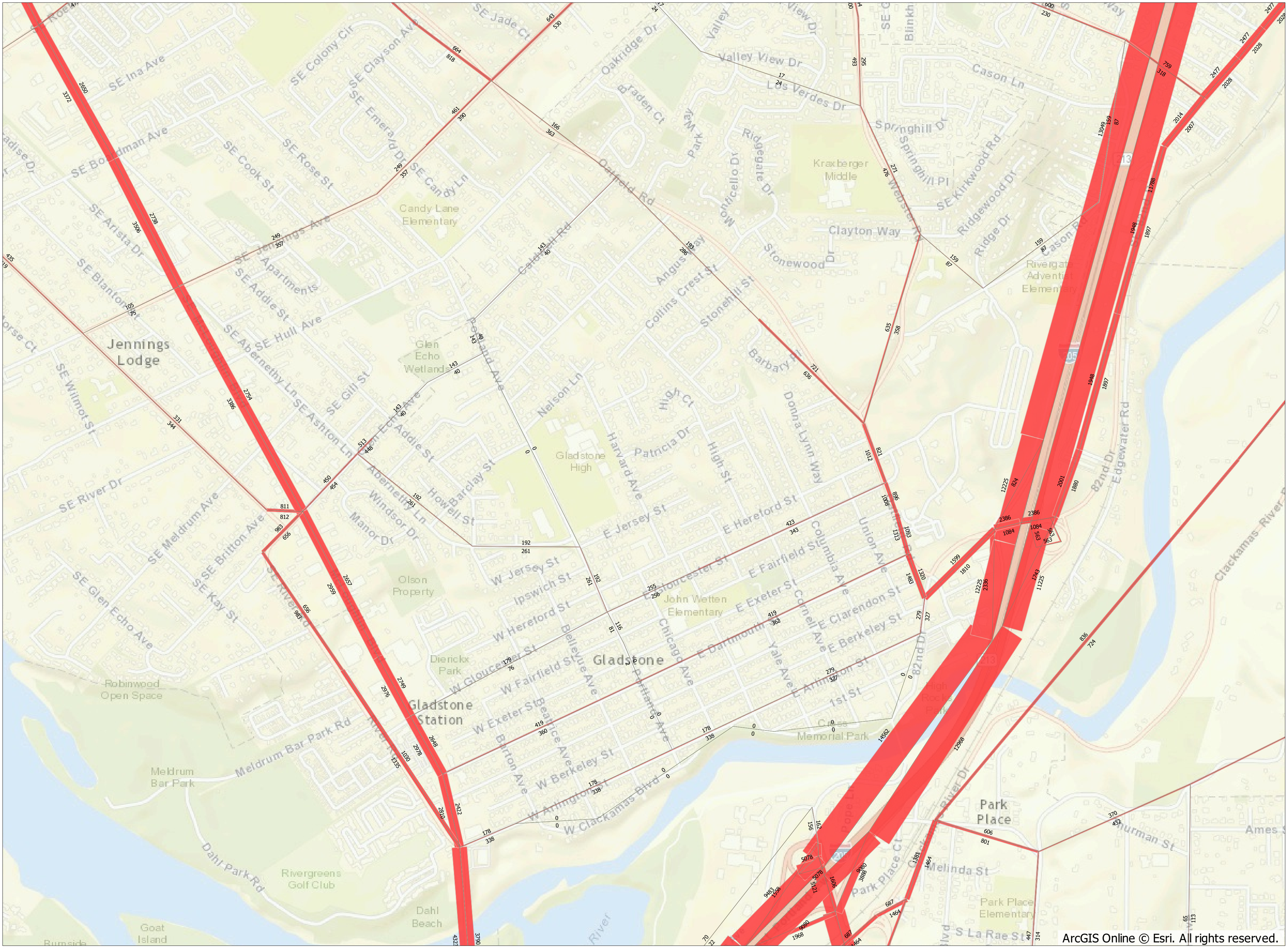
Gladstone
Gladstone Station
Park Place
Candy Lane Elementary
Glen Echo Wetlands
Gladstone High
Kraxberger Middle
Rivergate Adventist Elementary
Olson Property
John Wetten Elementary
Dierickx Park
Robinwood Open Space
Meldrum Bar Park
Rivergreens Golf Club
Dahl Beach
Goat Island
Cross Memorial Park
High Rocks Park
Park Place Elementary
SE Boardman Ave
SE Jennings Ave
SE Hull Ave
SE River Dr
SE Meldrum Ave
Oatfield Rd
Webster Rd
Portland Ave
Clackamas River
Meldrum Bar Park Rd
Dahl Park Rd
W Clackamas Blvd
82nd Dr
Edgewater Rd
Valley View Dr
Los Verdes Dr
Clayton Way
Cason Ln
Thurman St
Melinda St


Jennings Lodge
Gladstone
Gladstone Station
Park Place
Candy Lane Elementary
Glen Echo Wetland
Gladstone High
Olson Property
Dierickx Park
John Wetten Elementary
Kraxberger Middle
Rivergate Adventist Elementary
Cross Memorial Park
High Rocks Park
Robinwood Open Space
Meldrum Bar Park
Rivergreens Golf Club
Dahl Beach
Goat Island
Park Place Elementary
SE Ina Ave
SE Colony Cir
SE Clayson Ave
SE Jade Ct
SE Boardman Ave
SE Cook St
SE Rose St
SE Emerald Dr
SE Candy Ln
SE Jennings Ave
SE Arista Dr
SE Blanton St
SE Addie St
SE Hull Ave
SE Abernethy Ln
SE Ashton Ln
SE Gill St
SE River Dr
SE Meldrum Ave
SE Britton Ave
SE Kay St
SE Glen Echo Ave
SE Wilmot St
Oakridge Dr
Braden Ct
Valley View Dr
Los Verdes Dr
Springhill Dr
Springhill Pl
Webster Rd
SE Kirkwood Rd
Ridgewood Dr
Ridge Dr
Clayton Way
Cason Ln
Cason Rd
Oatfield Rd
Ridgegate Dr
Stonewood
Angus Way
Collins Crest St
Stonehill St
Barbary Pl
Caldwell Rd
Nelson Ln
High Ct
Patricia Dr
High St
Harvard Ave
Donna Lynn Way
Barclay St
Howell St
Windsor Dr
Manor Dr
Abernethy Ln
E Jersey St
E Hereford St
E Fairfield St
E Gloucester St
E Exeter St
E Dartmouth St
E Clarendon St
E Berkeley St
E Arlington St
1st St
Columbia Ave
Union Ave
Cornell Ave
Yale Ave
Chicago Ave
Portland Ave
Bellevue Ave
Beatrice Ave
Barton Ave
W Jersey St
Ipswich St
W Hereford St
W Gloucester St
W Fairfield St
W Exeter St
W Berkeley St
W Arlington St
W Clackamas Blvd
Meldrum Bar Park Rd
Dahl Park Rd
82nd Dr
Edgewater Rd
Clackamas River Dr
Thurman St
Melinda St
Park Place Ct
S La Rae St
Clackamas River
Ames St

Attachment D Year 2040 Traffic Conditions Analysis Worksheets

Lane Group	EBT	EBR	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Group Flow (vph)	74	716	249	64	472	1765	249	56	2304
v/c Ratio	0.18	1.49	0.87	0.15	1.74	0.79	0.24	0.35	1.17
Control Delay	39.9	258.1	74.7	3.6	373.9	20.0	2.4	10.7	103.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	39.9	258.1	74.7	3.6	373.9	20.0	2.4	10.7	103.5
Queue Length 50th (ft)	47	~648	187	0	~496	510	7	13	~1148
Queue Length 95th (ft)	90	#886	#336	16	#710	644	40	m13	m#1277
Internal Link Dist (ft)	442		371			477			1350
Turn Bay Length (ft)				175	200		280	250	
Base Capacity (vph)	401	480	286	414	272	2234	1043	261	1961
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.18	1.49	0.87	0.15	1.74	0.79	0.24	0.21	1.17

Intersection Summary

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

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

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

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	6	65	680	175	62	61	448	1677	237	53	2176	12
Future Volume (vph)	6	65	680	175	62	61	448	1677	237	53	2176	12
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.8	4.8	4.0	4.8	
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	
Frpb, ped/bikes		1.00	0.97		1.00	0.98	1.00	1.00	0.97	1.00	1.00	
Flpb, ped/bikes		1.00	1.00		0.99	1.00	1.00	1.00	1.00	1.00	1.00	
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	
Flt Protected		1.00	1.00		0.96	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)		1892	1529		1739	1565	1787	3505	1511	1770	3502	
Flt Permitted		0.97	1.00		0.73	1.00	0.06	1.00	1.00	0.07	1.00	
Satd. Flow (perm)		1851	1529		1323	1565	122	3505	1511	122	3502	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	6	68	716	184	65	64	472	1765	249	56	2291	13
RTOR Reduction (vph)	0	0	150	0	0	50	0	0	82	0	0	0
Lane Group Flow (vph)	0	74	566	0	249	14	472	1765	167	56	2304	0
Confl. Peds. (#/hr)	7		13	13		7	4		3	3		4
Confl. Bikes (#/hr)						1			2			
Heavy Vehicles (%)	0%	0%	3%	6%	0%	1%	1%	3%	4%	2%	3%	0%
Turn Type	Perm	NA	Perm	Perm	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		
Actuated Green, G (s)		26.0	26.0		26.0	26.0	76.5	75.7	75.7	66.4	66.4	
Effective Green, g (s)		26.0	26.0		26.0	26.0	76.5	75.7	75.7	66.4	66.4	
Actuated g/C Ratio		0.22	0.22		0.22	0.22	0.64	0.63	0.63	0.55	0.55	
Clearance Time (s)		4.0	4.0		4.0	4.0	4.0	4.8	4.8	4.0	4.8	
Vehicle Extension (s)		2.5	2.5		2.5	2.5	2.3	4.7	4.7	2.3	4.7	
Lane Grp Cap (vph)		401	331		286	339	283	2211	953	143	1937	
v/s Ratio Prot							c0.21	0.50		0.02	c0.66	
v/s Ratio Perm		0.04	c0.37		0.19	0.01	c0.86		0.11	0.20		
v/c Ratio		0.18	1.71		0.87	0.04	1.67	0.80	0.17	0.39	1.19	
Uniform Delay, d1		38.4	47.0		45.4	37.1	48.9	16.5	9.2	22.4	26.8	
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	0.67	0.76	
Incremental Delay, d2		0.2	332.6		23.7	0.0	315.7	3.1	0.4	0.5	87.6	
Delay (s)		38.5	379.6		69.0	37.2	364.5	19.6	9.6	15.6	108.1	
Level of Service		D	F		E	D	F	B	A	B	F	
Approach Delay (s)		347.6			62.5			84.1			105.9	
Approach LOS		F			E			F			F	

Intersection Summary			
HCM 2000 Control Delay	126.6	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.65		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	12.8
Intersection Capacity Utilization	129.9%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBT	WBT	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	53	260	39	1641	90	49	2184	19
v/c Ratio	0.17	1.00	0.26	0.74	0.09	0.17	0.89	0.02
Control Delay	31.8	103.9	9.6	23.1	4.0	12.5	16.6	1.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	31.8	103.9	9.6	23.1	4.0	12.5	16.6	1.7
Queue Length 50th (ft)	23	197	12	714	18	12	347	0
Queue Length 95th (ft)	61	#374	m12	787	m20	m20	m#458	m0
Internal Link Dist (ft)	261	413		1350			2302	
Turn Bay Length (ft)			220		175	250		160
Base Capacity (vph)	309	260	266	2213	962	309	2452	1061
Starvation Cap Reductn	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.17	1.00	0.15	0.74	0.09	0.16	0.89	0.02

Intersection Summary

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

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

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	6	27	17	139	52	51	36	1526	84	46	2031	18
Future Volume (vph)	6	27	17	139	52	51	36	1526	84	46	2031	18
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.8	4.8	4.0	4.8	4.8
Lane Util. Factor		1.00			1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes		0.99			1.00		1.00	1.00	0.95	1.00	1.00	0.96
Flpb, ped/bikes		1.00			0.99		1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.95			0.97		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.99			0.97		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1731			1734		1805	3505	1487	1805	3505	1497
Flt Permitted		0.97			0.81		0.06	1.00	1.00	0.09	1.00	1.00
Satd. Flow (perm)		1684			1443		108	3505	1487	167	3505	1497
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	6	29	18	149	56	55	39	1641	90	49	2184	19
RTOR Reduction (vph)	0	15	0	0	8	0	0	0	24	0	0	6
Lane Group Flow (vph)	0	38	0	0	252	0	39	1641	66	49	2184	13
Confl. Peds. (#/hr)	6		11	11		6	5		10	10		5
Confl. Bikes (#/hr)									1			1
Heavy Vehicles (%)	0%	6%	0%	2%	2%	4%	0%	3%	3%	0%	3%	4%
Turn Type	Perm	NA		Perm	NA		pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8			2		2	6		6
Actuated Green, G (s)		21.0			21.0		74.2	74.2	74.2	83.2	82.4	82.4
Effective Green, g (s)		21.0			21.0		74.2	74.2	74.2	83.2	82.4	82.4
Actuated g/C Ratio		0.18			0.18		0.62	0.62	0.62	0.69	0.69	0.69
Clearance Time (s)		4.0			4.0		4.0	4.8	4.8	4.0	4.8	4.8
Vehicle Extension (s)		2.5			2.5		2.3	4.7	4.7	2.3	4.7	4.7
Lane Grp Cap (vph)		294			252		120	2167	919	279	2406	1027
v/s Ratio Prot							0.01	c0.47		0.02	c0.62	
v/s Ratio Perm		0.02			c0.17		0.19		0.04	0.10		0.01
v/c Ratio		0.13			1.00		0.33	0.76	0.07	0.18	0.91	0.01
Uniform Delay, d1		41.8			49.5		27.3	16.4	9.1	22.2	15.6	5.9
Progression Factor		1.00			1.00		0.74	1.29	0.98	0.99	0.81	5.10
Incremental Delay, d2		0.1			56.0		0.6	1.6	0.1	0.1	4.0	0.0
Delay (s)		41.9			105.5		20.8	22.8	9.1	22.1	16.7	30.3
Level of Service		D			F		C	C	A	C	B	C
Approach Delay (s)		41.9			105.5			22.1			16.9	
Approach LOS		D			F			C			B	

Intersection Summary			
HCM 2000 Control Delay	24.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	12.8
Intersection Capacity Utilization	85.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBT	EBR	WBT	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	305	81	317	50	1678	60	121	1986	197
v/c Ratio	3.59	0.26	2.07	0.35	0.74	0.06	0.54	0.83	0.18
Control Delay	1209.3	20.5	525.1	19.4	11.7	5.5	18.5	18.2	3.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	1209.3	20.5	525.1	19.4	11.7	5.5	18.5	18.2	3.9
Queue Length 50th (ft)	~423	18	~342	11	178	4	21	560	23
Queue Length 95th (ft)	#602	64	#525	m26	m297	m12	71	697	51
Internal Link Dist (ft)	271		213		2302			539	
Turn Bay Length (ft)		100		185		160	185		160
Base Capacity (vph)	85	311	153	277	2263	1001	313	2404	1094
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	3.59	0.26	2.07	0.18	0.74	0.06	0.39	0.83	0.18

Intersection Summary

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

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

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

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	206	81	76	47	52	199	47	1577	56	114	1867	185
Future Volume (vph)	206	81	76	47	52	199	47	1577	56	114	1867	185
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0		4.0	4.8	4.8	4.0	4.8	4.8
Lane Util. Factor		1.00	1.00		1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes		1.00	0.98		0.99		1.00	1.00	0.95	1.00	1.00	0.97
Flpb, ped/bikes		1.00	1.00		1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt		1.00	0.85		0.91		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97	1.00		0.99		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1812	1528		1671		1736	3505	1525	1805	3505	1548
Flt Permitted		0.26	1.00		0.32		0.05	1.00	1.00	0.07	1.00	1.00
Satd. Flow (perm)		487	1528		531		94	3505	1525	139	3505	1548
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)	219	86	81	50	55	212	50	1678	60	121	1986	197
RTOR Reduction (vph)	0	0	44	0	60	0	0	0	16	0	0	33
Lane Group Flow (vph)	0	305	37	0	257	0	50	1678	44	121	1986	164
Confl. Peds. (#/hr)	3		4	4		3	4		8	8		4
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	0%	4%	4%	3%	2%	1%	4%	3%	1%	0%	3%	1%
Turn Type	Perm	NA	Perm	Perm	NA		pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8			2		2	6		6
Actuated Green, G (s)		21.0	21.0		21.0		82.2	77.5	77.5	90.2	81.5	81.5
Effective Green, g (s)		21.0	21.0		21.0		82.2	77.5	77.5	90.2	81.5	81.5
Actuated g/C Ratio		0.18	0.18		0.18		0.69	0.65	0.65	0.75	0.68	0.68
Clearance Time (s)		4.0	4.0		4.0		4.0	4.8	4.8	4.0	4.8	4.8
Vehicle Extension (s)		2.5	2.5		2.5		2.3	4.7	4.7	2.3	4.7	4.7
Lane Grp Cap (vph)		85	267		92		128	2263	984	225	2380	1051
v/s Ratio Prot							0.02	0.48		c0.04	c0.57	
v/s Ratio Perm		c0.63	0.02		0.48		0.25		0.03	0.36		0.11
v/c Ratio		3.59	0.14		2.79		0.39	0.74	0.04	0.54	0.83	0.16
Uniform Delay, d1		49.5	41.9		49.5		16.8	14.4	7.8	16.0	14.3	6.9
Progression Factor		1.00	1.00		1.00		1.68	0.67	1.49	1.00	1.00	1.00
Incremental Delay, d2		1193.4	0.2		835.4		0.8	1.6	0.1	1.6	3.6	0.3
Delay (s)		1242.9	42.0		884.9		28.9	11.2	11.6	17.6	17.9	7.2
Level of Service		F	D		F		C	B	B	B	B	A
Approach Delay (s)		990.9			884.9			11.7			17.0	
Approach LOS		F			F			B			B	

Intersection Summary			
HCM 2000 Control Delay	150.8	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.37		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	12.8
Intersection Capacity Utilization	105.5%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBL	EBT	WBL	WBT	WBR	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	129	383	94	252	657	58	126	415	411	118
v/c Ratio	0.56	0.45	0.48	0.62	0.61	0.35	0.50	0.71	0.70	0.19
Control Delay	54.3	35.3	55.8	45.0	5.9	55.1	16.9	36.3	35.7	6.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	54.3	35.3	55.8	45.0	5.9	55.1	16.9	36.3	35.7	6.2
Queue Length 50th (ft)	75	104	55	140	52	34	0	225	222	2
Queue Length 95th (ft)	171	193	134	285	160	94	62	436	431	43
Internal Link Dist (ft)		452		736		230			650	
Turn Bay Length (ft)	80		170		170		100	110		110
Base Capacity (vph)	480	1915	388	910	1290	309	358	904	911	882
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.27	0.20	0.24	0.28	0.51	0.19	0.35	0.46	0.45	0.13

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	123	355	9	89	239	624	0	55	120	730	55	112
Future Volume (vph)	123	355	9	89	239	624	0	55	120	730	55	112
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	5.0		4.5	5.0	5.0		5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	0.95		1.00	1.00	1.00		1.00	1.00	0.95	0.95	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00	0.99		1.00	1.00	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00		1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		1.00	1.00	0.95	0.96	1.00
Satd. Flow (prot)	1770	3526		1787	1863	1568		1900	1553	1665	1678	1538
Flt Permitted	0.95	1.00		0.95	1.00	1.00		1.00	1.00	0.95	0.96	1.00
Satd. Flow (perm)	1770	3526		1787	1863	1568		1900	1553	1665	1678	1538
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	129	374	9	94	252	657	0	58	126	768	58	118
RTOR Reduction (vph)	0	2	0	0	0	186	0	0	115	0	0	73
Lane Group Flow (vph)	129	381	0	94	252	471	0	58	11	415	411	45
Confl. Peds. (#/hr)	2		3	3		2	5					5
Confl. Bikes (#/hr)						2						
Heavy Vehicles (%)	2%	2%	0%	1%	2%	2%	0%	0%	4%	3%	4%	2%
Turn Type	Prot	NA		Prot	NA	pm+ov		NA	Perm	Split	NA	Perm
Protected Phases	5	2		1	6	4		8		4	4	
Permitted Phases						6	8		8			4
Actuated Green, G (s)	12.8	23.4		10.7	21.3	55.7		8.7	8.7	34.4	34.4	34.4
Effective Green, g (s)	12.8	23.4		10.7	21.3	55.7		8.7	8.7	34.4	34.4	34.4
Actuated g/C Ratio	0.13	0.24		0.11	0.22	0.58		0.09	0.09	0.36	0.36	0.36
Clearance Time (s)	4.5	5.0		4.5	5.0	5.0		5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	2.3	4.2		2.3	4.2	2.5		2.5	2.5	2.5	2.5	2.5
Lane Grp Cap (vph)	234	853		197	410	984		170	139	592	596	547
v/s Ratio Prot	c0.07	0.11		0.05	c0.14	0.17		c0.03		c0.25	0.24	
v/s Ratio Perm						0.13			0.01			0.03
v/c Ratio	0.55	0.45		0.48	0.61	0.48		0.34	0.08	0.70	0.69	0.08
Uniform Delay, d1	39.3	31.2		40.4	34.0	12.0		41.3	40.3	26.7	26.6	20.7
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.0	0.6		1.1	3.3	0.3		0.9	0.2	3.5	3.0	0.0
Delay (s)	41.2	31.7		41.4	37.3	12.3		42.2	40.5	30.2	29.6	20.7
Level of Service	D	C		D	D	B		D	D	C	C	C
Approach Delay (s)		34.1			21.3			41.0			28.8	
Approach LOS		C			C			D			C	

Intersection Summary			
HCM 2000 Control Delay	27.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.61		
Actuated Cycle Length (s)	96.7	Sum of lost time (s)	19.5
Intersection Capacity Utilization	62.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	1.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Vol, veh/h	1	1	7	21	1	17	10	576	29	34	652	3
Future Vol, veh/h	1	1	7	21	1	17	10	576	29	34	652	3
Conflicting Peds, #/hr	2	0	2	2	0	2	2	0	0	0	0	2
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	95	95	95	95	95	95	95	95	95	95	95	95
Heavy Vehicles, %	0	0	0	10	0	6	0	2	3	0	3	0
Mvmt Flow	1	1	7	22	1	18	11	606	31	36	686	3

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1415	1421	692	1411	1408	626	691	0	0	639	0	0
Stage 1	761	761	-	645	645	-	-	-	-	-	-	-
Stage 2	654	660	-	766	763	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.2	6.5	6.26	4.1	-	-	4.1	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.2	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.2	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.59	4	3.354	2.2	-	-	2.2	-	-
Pot Cap-1 Maneuver	116	138	447	111	140	477	913	-	-	955	-	-
Stage 1	401	417	-	448	471	-	-	-	-	-	-	-
Stage 2	459	463	-	383	416	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	104	127	445	102	128	475	911	-	-	953	-	-
Mov Cap-2 Maneuver	104	127	-	102	128	-	-	-	-	-	-	-
Stage 1	393	391	-	439	461	-	-	-	-	-	-	-
Stage 2	432	453	-	352	390	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	18.8	36.1	0.1	0.4
HCM LOS	C	E		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	911	-	-	271	156	953	-	-
HCM Lane V/C Ratio	0.012	-	-	0.035	0.263	0.038	-	-
HCM Control Delay (s)	9	0	-	18.8	36.1	8.9	0	-
HCM Lane LOS	A	A	-	C	E	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0.1	1	0.1	-	-

Intersection						
Int Delay, s/veh	3.3					
Movement	**EBL**	**EBR**	**NBL**	**NBT**	**SBT**	**SBR**
Traffic Vol, veh/h	63	40	77	405	597	153
Future Vol, veh/h	63	40	77	405	597	153
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	-	120	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	6	1	0	3	3	0
Mvmt Flow	65	41	79	418	615	158
Major/Minor	**Minor2**		**Major1**		**Major2**	
Conflicting Flow All	1270	694	773	0	-	0
Stage 1	694	-	-	-	-	-
Stage 2	576	-	-	-	-	-
Critical Hdwy	6.46	6.21	4.1	-	-	-
Critical Hdwy Stg 1	5.46	-	-	-	-	-
Critical Hdwy Stg 2	5.46	-	-	-	-	-
Follow-up Hdwy	3.554	3.309	2.2	-	-	-
Pot Cap-1 Maneuver	182	444	851	-	-	-
Stage 1	488	-	-	-	-	-
Stage 2	554	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	165	444	851	-	-	-
Mov Cap-2 Maneuver	165	-	-	-	-	-
Stage 1	488	-	-	-	-	-
Stage 2	503	-	-	-	-	-
Approach	**EB**		**NB**		**SB**	
HCM Control Delay, s	36.3		1.5		0	
HCM LOS	E					
Minor Lane/Major Mvmt	**NBL**	**NBT**	**EBLn1**	**SBT**	**SBR**	
Capacity (veh/h)	851	-	218	-	-	
HCM Lane V/C Ratio	0.093	-	0.487	-	-	
HCM Control Delay (s)	9.7	-	36.3	-	-	
HCM Lane LOS	A	-	E	-	-	
HCM 95th %tile Q(veh)	0.3	-	2.4	-	-	

Lane Group	EBT	EBR	WBL	WBT	SBT	SBR
Lane Group Flow (vph)	564	675	792	669	20	331
v/c Ratio	0.91	0.94	1.33	0.48	0.10	0.70
Control Delay	45.3	37.6	175.9	2.7	31.3	13.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	45.3	37.6	175.9	2.7	31.3	13.1
Queue Length 50th (ft)	247	188	~490	52	8	0
Queue Length 95th (ft)	#436	#414	m#527	m69	28	#80
Internal Link Dist (ft)	736			638	725	
Turn Bay Length (ft)			310			
Base Capacity (vph)	621	719	596	1403	196	474
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.91	0.94	1.33	0.48	0.10	0.70

Intersection Summary

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

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

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

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	547	655	768	649	0	0	0	0	16	4	321
Future Volume (vph)	0	547	655	768	649	0	0	0	0	16	4	321
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.5	4.5	4.5	4.5						5.5	5.5
Lane Util. Factor		1.00	1.00	1.00	1.00						1.00	1.00
Frpb, ped/bikes		1.00	1.00	1.00	1.00						1.00	1.00
Flpb, ped/bikes		1.00	1.00	1.00	1.00						1.00	1.00
Frt		1.00	0.85	1.00	1.00						1.00	0.85
Flt Protected		1.00	1.00	0.95	1.00						0.96	1.00
Satd. Flow (prot)		1827	1568	1687	1863						1730	1599
Flt Permitted		1.00	1.00	0.95	1.00						0.96	1.00
Satd. Flow (perm)		1827	1568	1687	1863						1730	1599
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	0	564	675	792	669	0	0	0	0	16	4	331
RTOR Reduction (vph)	0	0	187	0	0	0	0	0	0	0	0	293
Lane Group Flow (vph)	0	564	488	792	669	0	0	0	0	0	20	38
Confl. Peds. (#/hr)							2					2
Confl. Bikes (#/hr)						1						
Heavy Vehicles (%)	0%	4%	3%	7%	2%	0%	0%	0%	0%	7%	0%	1%
Turn Type		NA	Perm	Prot	NA					Split	NA	Prot
Protected Phases		2		1	6					4	4	4
Permitted Phases			2									
Actuated Green, G (s)		25.5	25.5	26.5	56.5						8.5	8.5
Effective Green, g (s)		25.5	25.5	26.5	56.5						8.5	8.5
Actuated g/C Ratio		0.34	0.34	0.35	0.75						0.11	0.11
Clearance Time (s)		4.5	4.5	4.5	4.5						5.5	5.5
Vehicle Extension (s)		4.2	4.2	2.3	0.2						6.0	6.0
Lane Grp Cap (vph)		621	533	596	1403						196	181
v/s Ratio Prot		0.31		c0.47	0.36						0.01	c0.02
v/s Ratio Perm			c0.31									
v/c Ratio		0.91	0.92	1.33	0.48						0.10	0.21
Uniform Delay, d1		23.6	23.7	24.2	3.6						29.8	30.2
Progression Factor		1.00	1.00	0.93	0.62						1.00	1.00
Incremental Delay, d2		19.5	22.9	151.7	0.4						0.6	1.6
Delay (s)		43.1	46.6	174.2	2.6						30.5	31.8
Level of Service		D	D	F	A						C	C
Approach Delay (s)		45.0			95.6			0.0			31.7	
Approach LOS		D			F			A			C	

Intersection Summary			
HCM 2000 Control Delay	67.7	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	14.5
Intersection Capacity Utilization	101.0%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	369	263	16	1104	430	726
v/c Ratio	0.38	0.29	0.12	1.06	0.82	0.92
Control Delay	12.4	6.9	34.0	65.2	37.0	26.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	12.4	6.9	34.0	65.2	37.0	26.1
Queue Length 50th (ft)	64	29	7	~599	176	100
Queue Length 95th (ft)	m93	m32	25	#850	269	#338
Internal Link Dist (ft)	638			440	402	
Turn Bay Length (ft)		50	200			575
Base Capacity (vph)	972	912	240	1044	619	843
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.38	0.29	0.07	1.06	0.69	0.86

Intersection Summary

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

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

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

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↱	↰	↑	↰	↱
Traffic Volume (vph)	347	247	15	1038	404	682
Future Volume (vph)	347	247	15	1038	404	682
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.0	4.5	5.5	5.5
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
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)	1810	1568	1805	1845	1752	1482
Flt Permitted	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (perm)	1810	1568	1805	1845	1752	1482
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	369	263	16	1104	430	726
RTOR Reduction (vph)	0	77	0	0	0	345
Lane Group Flow (vph)	369	186	16	1104	430	381
Heavy Vehicles (%)	5%	3%	0%	3%	3%	9%
Turn Type	NA	Perm	Prot	NA	Prot	Prot
Protected Phases	2		1	6	8	8
Permitted Phases		2				
Actuated Green, G (s)	37.0	37.0	1.4	42.4	22.6	22.6
Effective Green, g (s)	37.0	37.0	1.4	42.4	22.6	22.6
Actuated g/C Ratio	0.49	0.49	0.02	0.57	0.30	0.30
Clearance Time (s)	4.5	4.5	4.0	4.5	5.5	5.5
Vehicle Extension (s)	0.2	0.2	2.3	4.2	2.3	2.3
Lane Grp Cap (vph)	892	773	33	1043	527	446
v/s Ratio Prot	0.20		0.01	c0.60	0.25	c0.26
v/s Ratio Perm		0.12				
v/c Ratio	0.41	0.24	0.48	1.06	0.82	0.85
Uniform Delay, d1	12.1	10.9	36.4	16.3	24.3	24.6
Progression Factor	0.93	1.11	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.8	0.4	6.4	44.7	9.1	14.4
Delay (s)	12.0	12.6	42.8	61.0	33.4	39.0
Level of Service	B	B	D	E	C	D
Approach Delay (s)	12.2			60.7	36.9	
Approach LOS	B			E	D	

Intersection Summary			
HCM 2000 Control Delay	40.7	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.05		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	14.0
Intersection Capacity Utilization	85.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			