Chapter 4. Level of Service

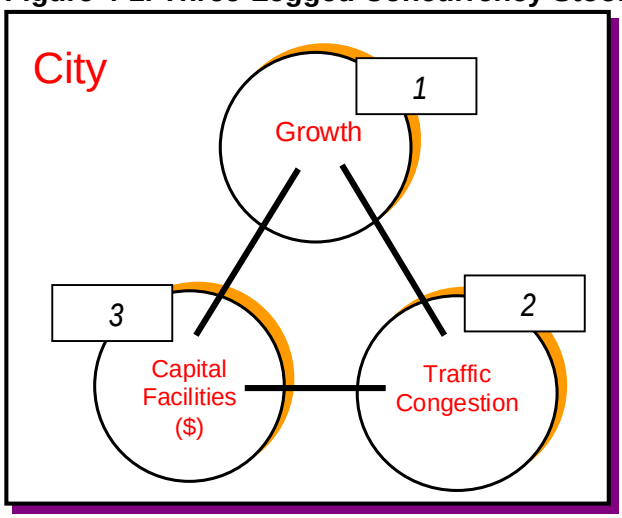
Transportation and Growth Management

The State Growth Management Act (GMA) requires each local jurisdiction to identify facility and service needs based on level of service standards for all arterials and transit routes. Level of service standards are used to judge the performance of the transportation system. The GMA further requires that a City's comprehensive plan transportation element include specific actions and requirements for bringing into compliance any facilities or services that are below an established level of service standard. It also requires that system expansion needs be identified for at least ten years, based on the traffic forecasts for the adopted land use plan and level of service standards.

If probable funding falls short of meeting identified needs, the jurisdiction is given two options: 1) to raise additional funding, and/or 2) to reassess the land use assumptions. Under the GMA it is also possible to lower the LOS standards. The relationship between LOS standards, funding needs to accommodate increased travel, and land use assumptions is referred to as "concurrency". The concept of concurrency is illustrated Figure 4-1. The three "legs" of the concurrency stool represent the following planning components:

1: Growth
2: Traffic congestion (measured with the level of service standards)
3: Resources needed to fund new capital facilities

Figure 4-1. Three-Legged Concurrency Stool



Concurrency is balanced when growth is matched with needed facilities. If any of the features is unbalanced, one of the following three actions must be taken:

1. Reduce growth by denying or delaying land use permit applications, or
2. Increase funding for new facilities, or
3. Change the level of service standard.

Level of Service Standards for Roads

The GMA allows each local jurisdiction to choose a Level of Service (LOS) method and standards. Level of Service is a qualitative measure used to denote intersection operating conditions. It generally describes levels of traffic congestion at signalized and unsignalized intersections in an urban area. The level of service standard is one of the cornerstones of Shoreline's Transportation Element. Two of the most important criteria to be applied for selecting a LOS methodology are 1) whether it is easy to administer and 2) whether it is technically/legally proven. The City of Shoreline in the past used a relatively simple but technically unreliable method to calculate level of service. This method is referred to as a critical movement volume-to-capacity ratio method. The Transportation Research Board explained the method in Transportation Research Circular Number 212 in 1980 but it was not adopted as a tool to calculate level of service. The most recent Highway Capacity Manual 2000 (HCM 2000) defines level of service with seconds of delays at an intersection in urban areas. For addressing transportation concurrency and level of service for the City of Shoreline, the consultant used the Transportation Research Board's HCM 2000 method. Using this delay method, LOS was calculated for the PM peak hour with the 2022 volumes from the Shoreline traffic model and LOS was calculated using Synchro software.

Level of service is represented on a scale ranging from A at the highest level to F at the lowest level. As shown in **Table 4-1**, level of service is based on the average delay time per vehicle entering the intersection as defined in the Highway Capacity Manual 2000. It also provides qualitative descriptions of each level of service (LOS) rating. Intersection delay is the travel time in seconds experienced by a driver traveling through the intersection, compared with a free flow condition.

LOS A and B represent minimal delays, and LOS C represents generally acceptable delays. LOS D represents an increasing amount of delay and an increasing number of vehicles stopped at the intersection. An intersection with LOS E is approaching capacity and is processing the maximum number of vehicles possible through the intersection. LOS F means that the intersection is operating with excessive delays, meaning that it has a high level of traffic congestion. Vehicles approaching an intersection with LOS F may have to wait for more than one signal cycle to get through the intersection.

Level of Service for Highways of Statewide Significance

The GMA requires WSDOT to identify transportation facilities and services of statewide significance. Local jurisdictions are required to include these in their inventories of essential facilities, along with level-of-service standards, needs and impacts, but cities and counties may not deny development based upon their performance (i.e., they are excluded from local concurrency requirements). The City of Shoreline currently has three state highways of statewide significance passing through or adjacent to the City: SR 99 (Aurora Avenue), I-5, and NE 205th Street between SR 99 and I-5. (NE 205th is outside Shoreline's city limits.)

Table 4-1. Level of Service Definition (Delay Method)

LOS	Average Signalized Intersection Delay Per Vehicle (seconds)	Average Unsignalized Intersection Delay Per Vehicle (seconds)	Descriptions of Level of Service Operations
A	>10	>10	Highest driver comfort. Little delay. Free flow.
B	>10 and>20	>10 and >15	High degree of driver comfort. Little delay.
C	>20 and >35	>15 and>25	Some delays. Acceptable level of driver comfort. Efficient traffic operation.
D	>35 and>55	>25 and >35	Long cycle length. Some driver frustration. Efficient traffic operation.
E	>55 and >80	>35 and >50	Approaching capacity. Notable delays. High level of driver frustration.
F	>80	>50	Flow breaks down. Excessive delays.

Source: 2000 Highway Capacity Manual

Level of Service for Regionally Significant State Highways

The Puget Sound Regional Council (PSRC) has designated two state highways in or adjacent to Shoreline that are not of "statewide significance" as "regionally significant": NE 145th Street and Ballinger Way. (Note: NE 145th Street is mostly under King County and City of Seattle jurisdiction, and outside the City of Shoreline.) The PSRC, its member cities and counties, and WSDOT worked together to adopt level of service standards for regionally significant highways. The proposed standard that applies to the City of Shoreline (Tier 1) is LOS "E/mitigated," meaning that congestion should be mitigated (through alternative means of travel such as transit) when PM peak hour LOS falls below LOS E.

Level of Service Methodology for Roadways and Intersections

The City of Shoreline's 1997 Comprehensive Plan used a volume-to capacity ratio (V/C) methodology for calculating levels of service. This technique is based on the "Critical Movement Summation" concept developed by traffic engineers in the 1970s to calculate intersection capacity. In essence, LOS with this method is based on a calculated critical intersection volume and compares that volume against a benchmark intersection capacity that is stratified by level of service. Since that time, transportation researchers have found that the critical volume-to-capacity ratio is only one of several factors that affect the level of service. The quality of signal progression, the cycle length, the green ratio, the roadway grade, pedestrian crossings, availability of on-street parking and the lane width will influence the level of service.

At this time, transportation experts find that the Highway Capacity Manual (HCM) 2000 method produces the most useful information by which to effectively understand levels of traffic congestion in an urban street network. The HCM 2000 methodology can calculate level of service for each approach leg of an intersection, whereas the V/C method cannot.

For these reasons, this study used the HCM 2000 delay method to calculate intersection levels of service for signalized and unsignalized intersections throughout Shoreline. The LOS table in **Appendix 4-1** provides the existing (2002) averaged delay and level of service for each intersection legs at each signalized intersection as well as the volume-to-capacity ratio at the same intersection. The table also shows the 1996 volume-to-capacity rations, which can be compared against the 2001/2002 volume-to-capacity ratios. **Appendix 4-1** also shows the existing (2002) levels of service for selected unsignalized intersections. **Appendix 4-2** provides more detail on this methodology.

Adopted and Recommended Level of Service Standards

The City of Shoreline's existing Transportation Element defines level of service standards as follows in Policy T3:

> *Maintain Level of Service "D" by area-wide averaging in Zone 1,2, and 3, and LOS "E" in Zones 4 and 5, and develop a funding plan to improve Level of Service. Improvements to transit service or other modes should be considered in developing a concurrency management system as a potential mitigation to increasing intersection capacity.*
>
> *Zone 1 is the area west of the Aurora Avenue Corridor*
> *Zone 2 is the Aurora Avenue Corridor*
> *Zone 3 is the area between the Aurora Avenue Corridor and I-5*
> *Zone 4 is the area between I-5 and the east City limits*
> *Zone 5 is the Annexation Area A*

This approach can be characterized as an "area-wide intersection averaging" method. The advantages of this method can be listed as follows:

- One or two congested intersections are unlikely to cause a concurrency problem.
- It helps the City approach traffic congestion from a broad perspective.
- There will be tendency to find solutions that will benefit the transportation system.

At the same time, some disadvantages can be identified:

- This method does not provide precise information about where traffic congestion problems are occurring within the City.
- Related to development applications, it will be harder to identify specific traffic mitigation and to require actions to mitigate traffic impacts from the developments.
- It is difficult to explain congestion problems to the public.

Consultant Recommended LOS Standard

Mirai Associates believes that the disadvantages of the City's current LOS method and standards outweigh the advantages. The problem with the current LOS approach of the area-wide intersection averaging method is that the public as well as the policy makers may not gain a clear understanding of the implications of averaged LOS findings. As the result, it would be difficult to establish effective policies to address the issue of transportation

concurrency in the City. Mirai Associates therefore recommends that the City adopt LOS E to best balance levels of congestion, the cost of added capacity and the need to minimize diversion of traffic onto neighborhood streets.

Transportation Policy T3 state's the recommended LOS method and standard:

> *Adopt LOS E at the signalized intersections on the arterials within the City as the level of service standards for evaluating planning level concurrency and reviewing traffic impacts of developments, excluding the Highways of Statewide Significance (Aurora Avenue N and Ballinger Way NE). The level of service shall be calculated with the delay method described in the Transportation Research Board's Highway Capacity Manual 2000 or its updated versions.*

Future Study

The City will, in the future, develop a multi-modal LOS measure to emphasize person trips, rather than simply vehicle trips, as directed in Transportation Policy Tw:

> *The City of Shoreline shall pursue the development of a multi-modal measure for Level of Service that takes into account not only vehicular travel and delay, but transit service and other modes of travel.*

Existing Level of Service (2002)

Mirai calculated existing PM peak hour levels of service for all arterial intersections, including state facilities and selected unsignalized intersections. The results are shown in **Appendix 4-1**. One intersection within the City is currently operating at LOS F: N 175th Street and Meridian Avenue.

One intersection on an arterial adjacent to the City is operating at LOS F: N 145th Street and I-5 Northbound Ramp/5th Avenue NE location. (145th Street belongs to King County.)

Four intersections within the City are operating at LOS E:

- N 185th Street and Meridian Avenue
- N 185th Street and Aurora Avenue
- N 175th Street and Aurora Avenue
- N 155th Street and Aurora Avenue

As pointed out above, Aurora Avenue N is designated as a Highway of Statewide Significance by the state and is therefore excluded from this concurrency analysis.

The following intersections, adjacent to and located outside the City, operate at LOS E:

- N 145th Street and Greenwood Avenue
- N 145th Street and 15th Avenue NE
- N 145th Street and Bothell Way NE
- N 205th Street and Meridian Avenue North

Several other intersections that operate at LOS D or better also have at least one approach (i.e. one "leg") at LOS E or F:

- N 155th Street and Meridian Avenue – Eastbound approach at LOS F
- Perkins Way and 15th Avenue NE: Eastbound approach at LOS F
- 24th Avenue NE and 155th Avenue NE: Westbound approach at LOS E
- N 155th Street and 15th Avenue NE: Eastbound approach at LOS E
- N 205th Street and Aurora Avenue: Northbound & Eastbound approaches at LOS E
- N 200th Street and Aurora Avenue: Northbound & Eastbound approaches at LOS E
- Ballinger Road NE and 19th Avenue NE: Northbound and Southbound at LOS F
- N 205th Street and 15th Avenue NE: Northbound at LOS E
- N 205th Street and 19th Avenue NE: Eastbound at LOS F

Two unsignalized intersections operate at LOS E or F at one approach:

- 15th Avenue NE and NE 150th Street: Westbound at LOS F
- 5th Avenue NE and NE 185th Street: Northbound at LOS F

Future No Action Level of Service (2022)

Tables in **Appendix 4-1** show the future (2022) levels of service for the signalized intersections on all arterials, and selected unsignalized intersections, if no transportation improvements are made beyond what is currently funded in the City's capital improvement plan. Most of the LOS E intersections listed above degrade to LOS F.

In addition to one intersection (N 175th Street and Meridian Avenue North), which is operating at LOS F, five other intersections will operate at LOS F within the City. They are

- N 205th Street and Aurora Avenue N
- N 175th Street and Aurora Avenue N
- N 155th Street and Aurora Avenue N
- N 185th Street and Meridian Avenue N
- Perkins Way and 15th Avenue NE

As noted above, Aurora Avenue N within the City of Shoreline is designated as the Highway of Statewide Significance, and it is excluded for a concurrency evaluation under the GMA.

For the adjacent arterials, in addition to the intersection of N 145th Street and I-5 Northbound ramps/5th Avenue, which is operating LOS F, two additional intersections will operate at LOS F:

- N 145th Street and Bothell Way
- N 205th Street and Meridian Avenue N

Five additional intersections will operate at LOS E within the City:

- N 155th Street and Meridian Avenue
- N 175th Street and 15th Avenue NE
- N 185th Street and Aurora Avenue N
- N 200th Street and Aurora Avenue N
- Ballinger Road NE and 19th Avenue NE

In addition to the two unsignalized intersections at LOS F in 2002, the following two additional unsignalized intersections will operate at LOS F at one approach in 2022:

- 10th Avenue NE and NE 185th Street
- 5th Avenue NE and NE 165th Street

Future Level of Service with Improvements (2022)

If the City retains the LOS standard in Transportation Policy T3, the following improvement projects will meet and/or reduce risks of not meeting that standard. A revised standard may result in a different set of project recommendations. (Note: the No Action analysis assumes that the Aurora Avenue corridor improvement project adopted in the 2002 Shoreline Capital Improvement Program will be completed by 2022. While several intersections in the corridor will operate at LOS F with the project, no additional improvements in the corridor are recommended.)

- N 175th Street and Meridian Avenue N: provide a westbound right turn lane and add a northbound through lane
- N 185th Street and Meridian Avenue N: provide an additional northbound through lane
- Perkins Way NE and 15th Avenue NE: provide westbound and eastbound left turn lanes
- N 155th Street and Meridian Avenue N: provide an additional northbound through lane
- NE 175th Street and 15th Avenue NE: provide a eastbound right turn lane, an additional northbound through lane and separate a westbound left turn lane from the existing through lane
- Ballinger Way NE and 19th Avenue NE: provide northbound and southbound left turn lanes on 19th Avenue

To reduce delays at unsignalized intersections, two new signals should be installed at the following locations:

- NE 150th Street and 15th Avenue NE (This project is listed in the 2004 - 2009 CIP.)
- NE 185th Street and 5th Avenue NE

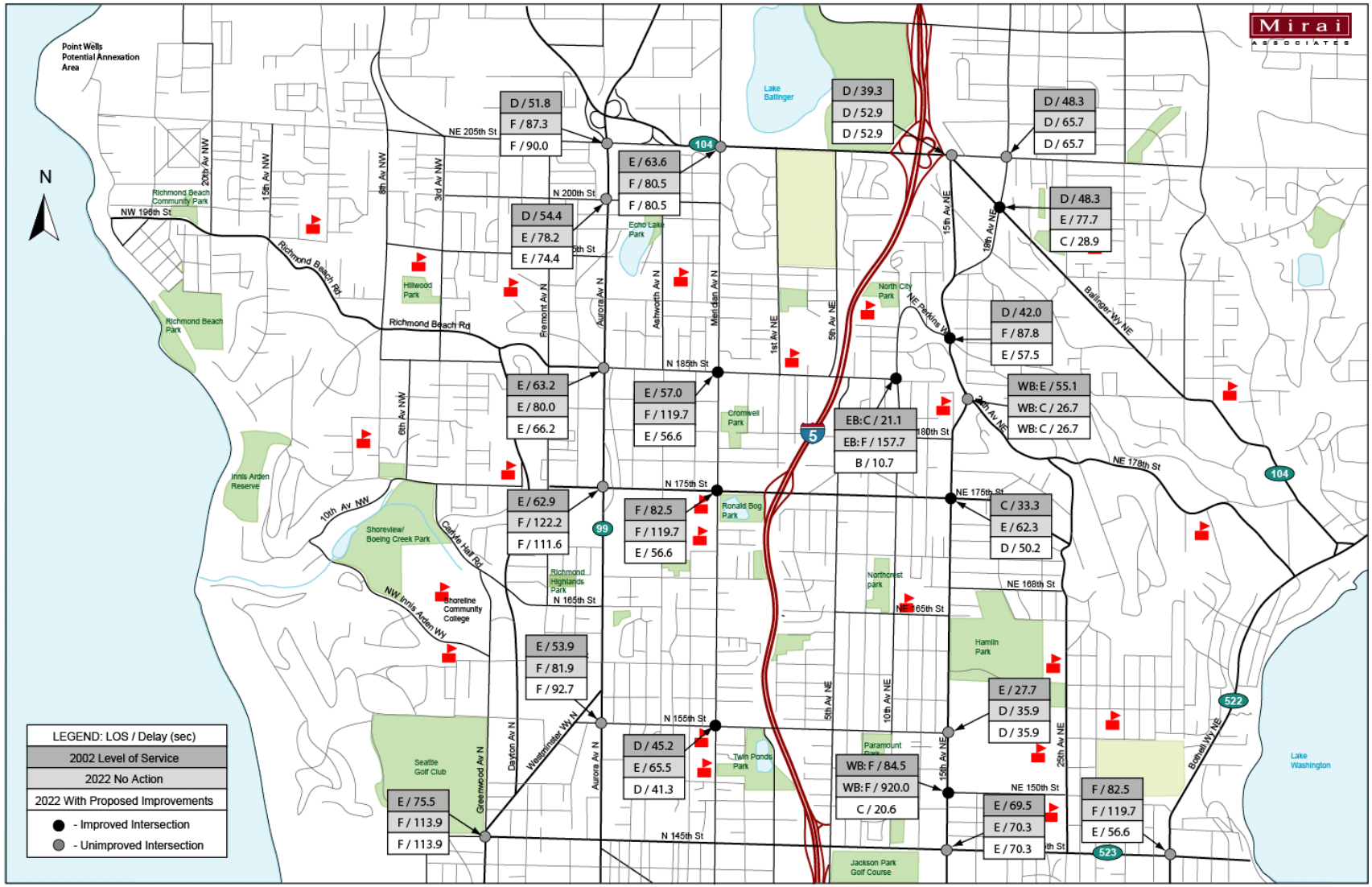
To improve access to the neighborhoods and improve safety, the following improvements are recommended on N 175th Street between Aurora Avenue N and Meridian Avenue N:

- Install a signal at N 175th Street and Ashworth Avenue N with left turn lanes on N 175th Street and provide sidewalks

- Install a signal at N 175th Street and Stone Avenue N, extend Stone Avenue N from the north to N 175th Street, and convert the existing signal at N 175th Street and Midvale Avenue N to a pedestrian actuated signal as a part of the Interurban Trail crossing.

The 2022 levels of service with the recommended improvements are shown in **Appendix 4-1**. The recommended improvements will bring the congested intersections to operate at LOS E or better in 2022 except several of the intersections on Aurora Avenue N within the City of Shoreline. **Figure 4-2** shows LOS and delay for signalized intersections for 2002, 2022 no action and 2022 with improvements.

Figure 4-2. Level of Service and Delay for Signalized Intersections:
2002, 2022 No Action and 2022 with Proposed Improvements



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Level of Service for Transit

Recommended LOS Standard

The level of service (LOS) for transit is based upon a number of factors. LOS needs to account for both the availability and the quality of transit service. Measures of availability look at the frequency of the service, hours of service, accessibility, and service coverage. When looking at the quality of service, issues of reliability, safety and travel times are of concern. However, due to the availability of certain measures, the recommended LOS standard for the City of Shoreline focuses upon measures of availability. In addition, grading will be dependent upon the type of service: community, inter-community and regional. Tables 4-2, 4-3 and 4-4 summarize the recommended LOS standards for each service.

Table 4-2. Recommended Level of Service Definition: Community Service

LOS	Guideline					
	Peak Headways	Vehicle/Hr	Off Peak Headways	Vehicle/Hr	Daily Hours of Service	Description of LOS
A	< 10 min	> 6	< 20 min	> 3	19 - 24	Passengers do not need schedules.
B	10 – 14 min	5 - 6	20 - 40 min	1 – 3	17 - 18	Frequent service, passengers consult schedules.
C	15 – 20 min	3 - 4	20 - 40 min	1 - 3	14 - 16	Maximum desirable time to wait if bus missed.
D	21 – 30 min	2	40 - 60 min	1	12 - 13	Service unattractive to choice riders.
E	31 – 60 min	1	> 60 min	< 1	4 - 11	Service available during hour.
F	> 60 min	< 1	> 60 min	< 1	0 - 3	Service unattractive to all riders.

Table 4-3. Recommended Level of Service Definition: Inter-Community Service

LOS	Guideline					
	Peak Headways	Vehicle/Hr	Off Peak Headways	Vehicle/Hr	Daily Hours of Service	Description of LOS
A	< 20 min	> 3	< 30 min	> 2	19 - 24	Passengers do not need schedules.
B	20 – 30 min	2 - 3	30 - 45 min	1 - 2	17 - 18	Frequent service, passengers consult schedules.
C	31 – 45 min	1 – 2	45 - 60 min	1	14 - 16	Maximum desirable time to wait if bus missed.
D	46 – 60 min	1	> 60 min	< 1	12 - 13	Service unattractive to choice riders.
E	> 60 min	<1	> 60 min	< 1	4 - 11	Service available during hour.
F	> 60 min	< 1	None	0	0 - 3	Service unattractive to

						all riders.

Table 4-4. Recommended Level of Service Definition: Regional Service

LOS	Guideline					
	Peak Headways	Vehicle/Hr	Off Peak Headways	Vehicle/Hr	Daily Hours of Service	Description of LOS
A	< 20 min	> 3	< 30 min	> 2	19 - 24	Passengers do not need schedules.
B	20 – 30 min	2 - 3	30 - 45 min	1 - 2	17 - 18	Frequent service, passengers consult schedules.
C	31 – 45 min	1 – 2	45 - 60 min	1	14 - 16	Maximum desirable time to wait if bus missed.
D	46 – 60 min	1	> 60 min	< 1	12 - 13	Service unattractive to choice riders.
E	> 60 min	<1	> 60 min	< 1	4 - 11	Service available during hour.
F	> 60 min	< 1	None	0	0 - 3	Service unattractive to all riders.

Table 4-5. Level of Service for Existing Transit Service

Route	Provider	Peak		Midday	Early Evening	Late Evening	Saturday	Sunday	LOS
		Peak dir	Both dir						
*77**	*Metro Transit*	15	-	-	-	-	-	-	A
*100**	*Community Transit*	20	-	-	-	-	-	-	A
*242**	*Metro Transit*	30	-	-	-	-	-	-	B
*243**	*Metro Transit*	30	-	-	-	-	-	-	B
*303**	*Metro Transit*	25	-	-	-	-	-	-	B
*304**	*Metro Transit*	25	-	-	-	-	-	-	B
*308**	*Metro Transit*	30	-	-	-	-	-	-	B
*316**	*Metro Transit*	25	-	-	-	-	-	-	B
*342**	*Metro Transit*	30	-	-	-	-	-	-	B
*355**	*Metro Transit*	15	-	-	-	-	-	-	A
*373**	*Metro Transit*	30	-	-	-	-	-	-	B
*416**	*Community Transit*	20	-	-	-	-	-	-	B
*301**	*Metro Transit*	-	15/30	-	-	-	-	-	B
330*	Metro Transit	-	30	-	-	-	-	-	B
510	*Sound Transit*	30	-	60	30	60	60	60	B
511	*Sound Transit*	30	-	30	30	60	60	60	B
118	*Community Transit*	-	30	30	60	-	60/30/60	60	B
630	*Community Transit*	-	30	30	60	-	60	60	B
5	*Metro Transit*	-	30	30	30	30	30	30	B
101	*Community Transit*	-	20/15	15	15	30	30	30	A
331	Metro Transit	-	30	30	30	60	30/60	60	B
345	Metro Transit	-	30	30	30	60	60/30/60	60	B
346	Metro Transit	-	30	30	60	60	60/30/60	60	B
347	Metro Transit	-	30	30	60	60	60/30/60	60	B
348	Metro Transit	-	30	30	60	60	60/30/60	60	B
358	*Metro Transit*	-	8/15	15	30	30	30/15/30	30	A

NOTE: *Italicized* routes provide regional transit service. * Peak hour service only.

Table 4-5 summarizes the transit LOS for each transit route servicing Shoreline. For the size and population density of Shoreline, a community oriented transit service is not feasible due to costs and probable low ridership. However, most inter-community transit service for the City of Shoreline operates at LOS B, which is acceptable given Shoreline 's demographics. Regional service currently operates at LOS B for the routes serviced by Sound Transit and Community Transit. However, Metro Transit route 358 along Aurora Avenue N is a LOS A. On less traveled corridors, most peak hour service was operating at a LOS B.

The average interval between transit stops in urban areas should be within ¼ mile of each other. As a general rule, ¼ mile is accepted as a comfortable walking distance for pedestrians. This spacing is greatly dependent upon the availability of public right of way, pedestrian crossings, safety and topography. **Figure 4-2** maps out the coverage area around each bus stop in Shoreline regardless of the type of transit service. The orange ring represents a radius of 1/8 mile and the tan ring represents a radius of ¼ mile away from the transit stop. Most of Shoreline's residents are within a quarter mile from a transit stop. Connections to transit stops through the sidewalk infrastructure is limited.

Bicyclists can catch a bus at any transit stop. All buses are equipped with bicycle racks and can carry up to two bikes at any time. For those who are not within close proximity of a bus stop, one of the eight Park-and-ride lots are within a five-mile distance from any point in Shoreline. The blue "P" on the map represents a Park-and-ride.

The majority of the bus stops in the City are handicapped accessible. However, there are several that are not due to limited right-of-way and/or topography. Shelters are provided at most locations where there are a high number of boardings. King County Metro provides and maintains all bus stops in the City of Shoreline.

Figure 4-3 represents the transit coverage for weekday and weekend service. Areas with a deficiency in transit service are similar to areas that are not within easy access to a transit stop. Areas that are noticeably outside of all day transit service are Briarcrest, the eastern edge of North City, Innis Arden, the Highlands, and parts of Richmond Beach.

Figure 4-3. Existing Transit Stop Coverage Areas

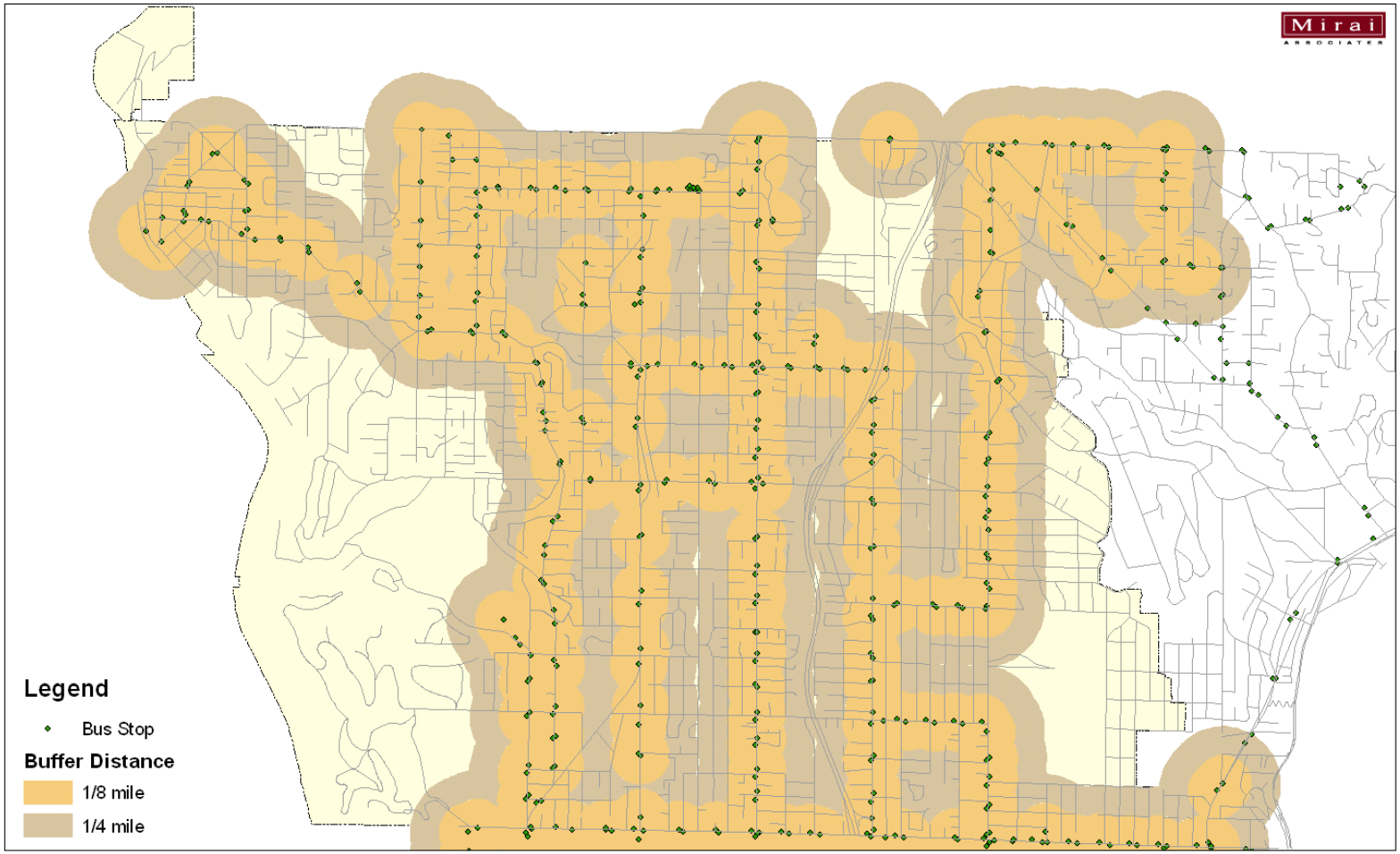

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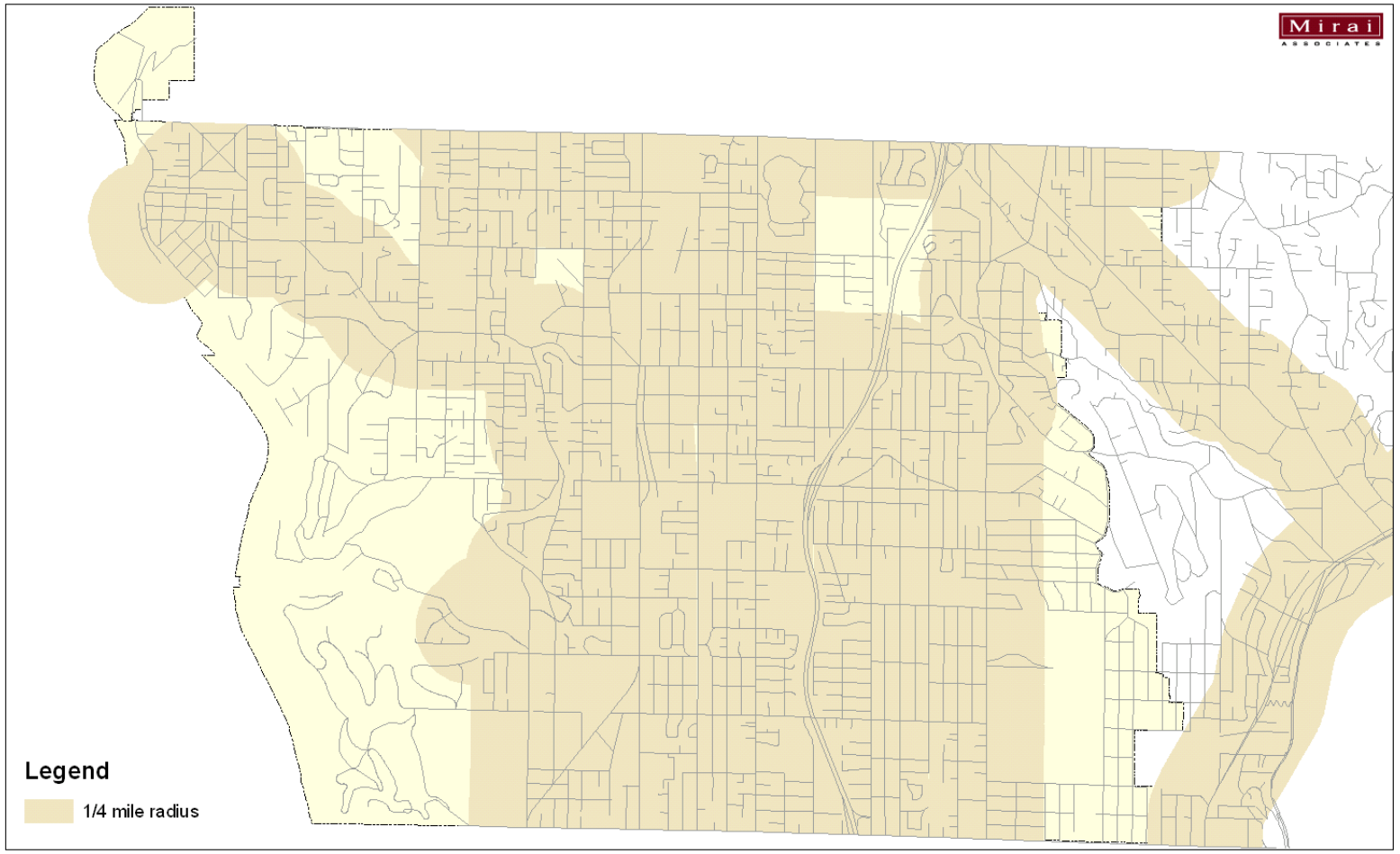
Figure 4-4. Existing All Day Transit Service Coverage Area



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