



145th Street Corridor Improvement Project (SR 523)

Intersection Control Evaluation Report

Final

May 2020

City of Shoreline, Washington



**INTERSECTION CONTROL EVALUATION REPORT
APPROVAL DOCUMENTATION**

Project Name: SR-523 (N/NE 145th Street), SR-99 (Aurora Avenue N) to I-5 Intersection

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Acronyms and Abbreviations

ADT	average daily traffic
Ave	Avenue
CATF	Citizen Advisory Task Force
City	City of Shoreline
EB	eastbound
I-5	Interstate 5
LOS	level of service
NB	northbound
project	145th Street Corridor Improvement Project
RRFB	Rapid Rectangular Flashing Beacon
SB	southbound
SR	State Route
St	Street
TSP	transit signal priority
WB	westbound
WSDOT	Washington State Department of Transportation

1. Objectives

The purpose of this report is to evaluate the compatibility of different intersection control types with respect to context, modal priority, intersection design vehicle, and the identified balance of performance needs.

2. Overview

The 145th Street Corridor Improvement Project (project) is located on NE 145th Street (State Route [SR] 523) from SR 99 to the Interstate 5 (I-5) southbound on/off ramps. The SR 523 corridor experiences significant traffic congestion, particularly in the peak hours. For transit users, there is limited bus service through the corridor and many bus stops on the corridor are not Americans with Disabilities Act accessible. Much of the sidewalks along the corridor lack adequate width for pedestrian access. There are currently no bicycle facilities on 145th Street. There is a high rate of angle and rear-end collisions along the corridor. The addition of the Sound Transit light rail station near the I-5/145th Street interchange, likely opening in 2024, will increase the pedestrian and bicycle demand on the 145th Street corridor, supporting the need for additional non-motorized connectivity and improved intersections for all users. In addition, frequent transit service is planned through the project corridor to and from the light rail station with service beginning in 2023. The focus of the project is to improve mobility and safety for pedestrians, bikes, buses, and vehicles and improve intersection operations to reduce delay and provide better access for pedestrians moving along the corridor and accessing the future light rail station at 145th Street and I-5.

In 2016, the City of Shoreline (City) adopted a revised land use plan with higher-density, mixed-use residential zoning for parcels in the vicinity of the light rail station. Parcels from Meridian Avenue (Ave) to I-5 in this project area are included in the rezone area. Some parcels adjacent to the project are already subject to high density redevelopment applications.

The City conducted the 145th Street Multimodal Corridor Study in 2015-2016 to evaluate current conditions for all users while considering transportation demands that will be the result of a future light rail station at approximately 145th Street and I-5 and planned land use changes around the light rail station area along 145th Street. The corridor study area extended from SR 99 to SR 522. Through an extensive public process, the City tailored the proposed improvements to maximize multimodal mobility and safety benefit while aiming to minimize property impacts. After the public process, a preferred design concept was adopted by the Shoreline Council.

This project extends from SR 99 to the I-5 interchange. The City is conducting a separate project evaluating improvements at the I-5 interchange. The preferred design concept for this corridor project includes sidewalk and accessibility improvements along the corridor, enhanced transit features, a corridor bicycle facility that is mainly off-corridor with some widened sidewalks on the corridor, and intersection capacity improvements.

Finally, this project is intended to support the Washington State Department of Transportation (WSDOT) Strategic Plan by improving mode integration on SR 523 and supporting City economic and community needs established in the [145th Street Multimodal Corridor Study](#).

Two signalized intersections in the project corridor will be modified and improved with this project. Both require an Intersection Control Evaluation: Meridian Ave N and 1st Ave NE (shown highlighted in Figure 1). These two intersections are discussed in this report. The evaluation considers the project context and

therefore the roundabout options are evaluated as a system, rather than separately for each intersection. The appendix to this report contains the modeling data for both intersections.



Figure 1. Project Vicinity Map Showing SR 523 from SR 99 to I-5

3. Existing Conditions/Collision History

SR 523 is a four-lane urban highway located in King County, on the boundary of the City of Seattle and the City of Shoreline. The highway is classified as an Urban Principle Arterial with a posted speed limit of 35 miles per hour. Average daily traffic (ADT) volumes range from 24,000 to 30,000 vehicles per day increasing from west to east with approximately 3.5 percent trucks. Lane widths on SR 523 are 11 feet.

The intersection of SR 523 and Meridian Ave N is signalized. There are two lanes in each direction on SR 523 and one lane in each direction on Meridian Ave N. The current intersection configuration does not have turn lanes on any leg and does not have any protected left-turn phasing.

In the last 5 years (2013-2017), the intersection at Meridian Ave N has experienced 47 total crashes (2 pedestrian/bike crashes), of which 53 percent were property damage-only crashes and 47 percent were injury crashes. There were no fatal or serious injury crashes at this intersection. The majority of crashes (49 percent) were angle collisions (78 percent were due to vehicles making left turns). The next most prominent crash type was rear-end collisions (30 percent), which were largely due to following too closely, inattention, and speeding.

The intersection of SR 523 and 1st Ave NE is signalized. There are two lanes in each direction on SR 523 and one lane in each direction on 1st Ave NE. The current intersection configuration does not have turn lanes on any leg. Left turns are prohibited from eastbound SR 523 to northbound 1st Ave NE. Left turns from westbound SR 523 to southbound 1st Ave NE have a protected left-turn phase.

In the last 5 years (2013-2017), the intersection at 1st Ave NE has experienced 46 total crashes (1 pedestrian/bike crashes), of which 61 percent were property damage-only crashes. There were no fatal or serious injury crashes at this intersection. The majority of crashes (57 percent) were angle collisions (73 percent were due to vehicles making left turns). The next most prominent crash type was rear-end collisions (35 percent), which were largely due to following too closely, inattention, and speeding.

UNDER 23 UNITED STATES CODE – SECTION 409, Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential accident sites, hazardous roadway conditions, or railway-highway crossings, pursuant to sections 130, 144, and 148 of this title or for the purpose of developing any highway safety construction improvement project which may be implemented utilizing Federal-aid highway funds shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

4. Right-of-Way

Right-of-way is narrow along the corridor with only 60 feet of width to accommodate all modes. Any improvements at the intersections that require expanding the footprint of the roadway will require the project to purchase additional right-of-way.

The 145th Street right-of-way is a unique, multijurisdictional setting – the south side of the roadway is within the City of Seattle and the north side of 145th Street is the City of Shoreline. Right-of-way acquisition, permitting, design, and construction for the project will require multiagency approvals. The City of Shoreline has been working and continues to work closely with the City of Seattle to develop the project. The City of Seattle is supportive of the project; however, the City of Seattle is not supportive of significant property acquisitions/full-parcel acquisitions within Seattle for project improvements. Since the south half of the roadway is within the City of Seattle and permitting and design approvals will be required from Seattle, it would be a fatal flaw of the project to plan significant property acquisition within the City of Seattle limits.

The 145th Street Townhomes development (Shoreline Project #PRE18-0137) at the northwest corner of 145th Street (St) and 1st Ave NE has provided 22 feet of right-of-way dedication on 145th St and 2 feet of right-of-way dedication on 1st Ave NE for future improvements. The project has been permitted by the City of Shoreline and is currently in construction. This project restricts any property acquisition in the northwest corner of the intersection.

The Lakeside School is located at the southeast corner of the 145th St and 1st Ave NE intersection. The school's parking lot is in this corner of the parcel. Any impacts to the school property would likely have major schedule impacts during the environmental process.

5. Environmental Impacts

There are no major environmental concerns within the project limits. One minor concern is that there is potential for steep slopes on the western edge of the project. A historic property assessment will be conducted to evaluate if there are any historic properties that could be affected by the project.

6. Signal Warrants

The intersections of SR 523 with Meridian Ave N and 1st Ave NE are signalized and meet the current FHWA *Manual on Uniform Traffic Control Devices* peak hour signal warrants.

7. Identify Modal Treatments

SR 523 is a T-3 Freight Route with trucks constituting 3.5 percent of all traffic on the highway. The ADT volume is 24,000 to 30,000. King County Metro Route 304 is a commuter route that runs along SR 523 during peak hours. There are bus routes that cross SR 523. The RapidRide E-Line runs along SR 99 and the King County Metro Routes 316 and 346 run along Meridian Ave N crossing SR 523 where the roads intersect. Current pedestrian activity is generated by bus stops and is centered around intersections with SR 99 and Meridian Ave N where bus routes intersect. Future pedestrian activity is expected to increase with the zoning changes and installation of the light rail station on SR 523 near I-5. Bicycle volumes are low on SR 523 due to narrow sidewalks and high volume and speed of traffic, which encourage many users to look off-corridor for a bike route. It is expected that bicycle activity will increase with the installation of the light rail station on SR 523 near I-5.

This corridor is multimodal and any alternative should address the following modes of travel:

- Passenger Vehicles
- Buses (Articulated)
- Trucks (WB-67)
- Pedestrians
- Bicycles

Future frequent bus service is planned along the corridor by King County Metro with service beginning by 2023. The frequent bus service will run along Meridian Ave N, south of SR 523, and turn eastbound onto SR 523 to the light rail station at I-5. The selected alternative will need to accommodate this future bus service.

8. Alternatives

According to the WSDOT *Design Manual* section 1300.05(1), a roundabout is the preferred intersection control type and is required to be evaluated. The alternatives considered are described as follows:

- Alternative 1
 - Meridian Ave N – Add left-turn pockets for all legs of the intersections, improve signal timing, and add transit signal priority (TSP)
 - 1st Ave N – Add left-turn pockets for all legs of the intersection except for the south leg, which would add a right-turn pocket, improve signal timing, and add TSP
- Alternative 2
 - Meridian Ave N – convert to a two-lane roundabout
 - 1st Ave N – convert to a two-lane roundabout

Alternative 2 was developed to evaluate preferred locations and configurations of the roundabouts. Alternative 2 places the roundabouts near the existing intersections in a location that minimizes impacts and still allows 145th St to function as a principal arterial.

An evaluation of the alternatives and justification for selecting the preferred alternative is located in Section 19, Alternative Selection.

9. SR 523 and Meridian Ave N Intersection

Alternative 1 for this intersection is to widen the roadway to the north and provide left-turn pockets on all legs of the intersection. Alternative 2 reconstructs the intersection to provide a two-lane roundabout with a 136-foot inscribed circle diameter for a design vehicle of WB-67 on the east-west through movement and the city bus for turning movements. See Figures 2 and 3 for the layout of these alternatives.

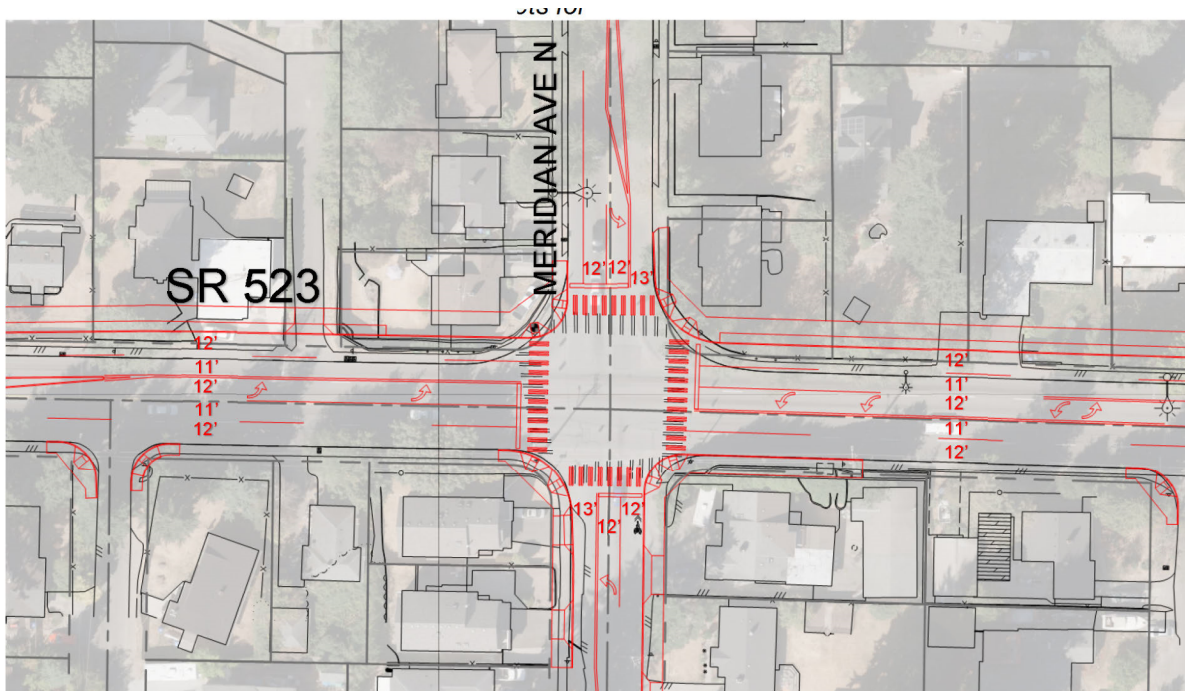


Figure 2. Alternative 1 – Add Left-Turn Pockets for All Legs

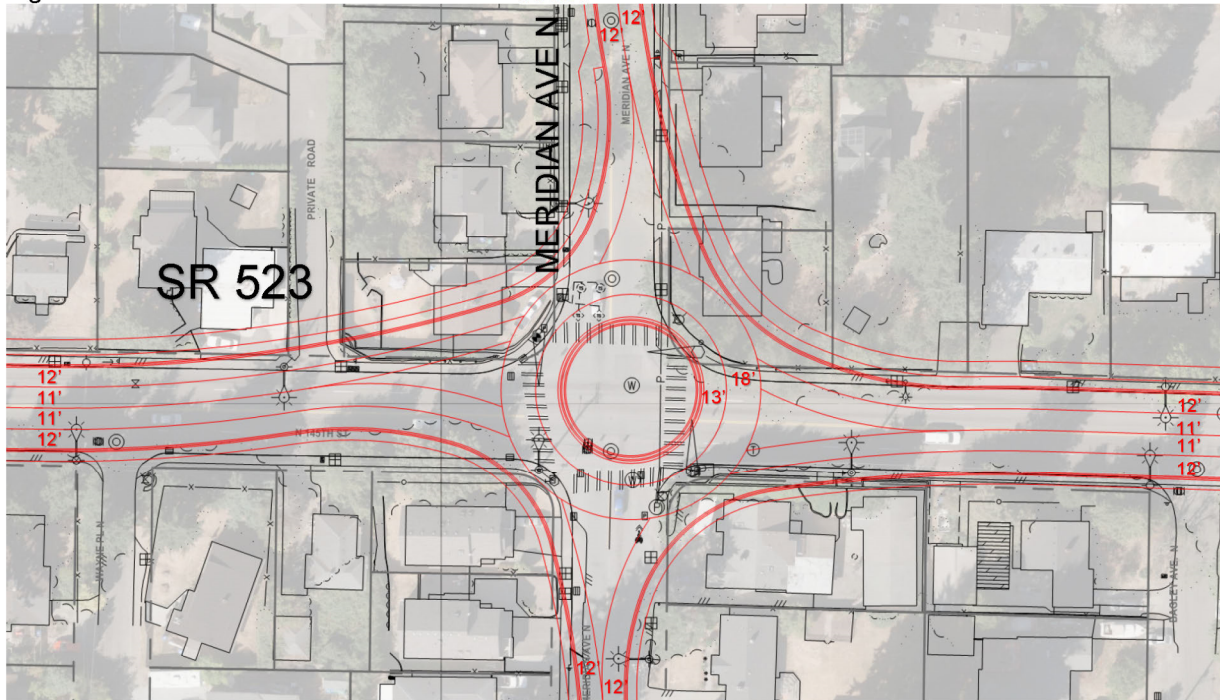


Figure 3. Alternative 2 – Add Roundabout with 136-foot Inscribed Circle Diameter

10. SR 523 and 1st Ave NE Intersection

Alternative 1 for this intersection is to widen the roadway to the north and provide left-turn pockets on all legs of the intersection except for the south leg, which would add a right-turn pocket. Westbound vehicles already have a protective left-turn phase and eastbound left turns are prohibited. Alternative 2 reconstructs the intersection to provide a two-lane roundabout with a 136-foot inscribed circle diameter for a design vehicle of WB-67 on the east-west through movement and the city bus for movements. See Figures 4 and 5 for the layout of these alternatives.

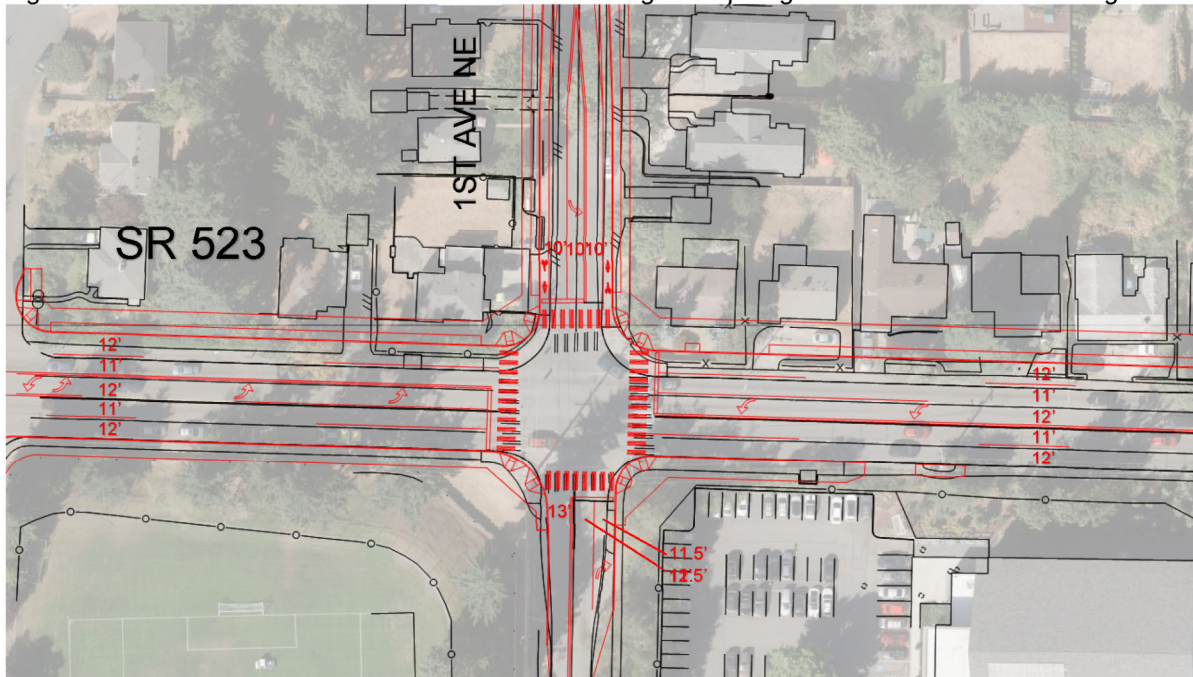


Figure 4. Alternative 1 – Add Left-Turn Pockets for All Legs except Right-Turn Pocket for South Leg

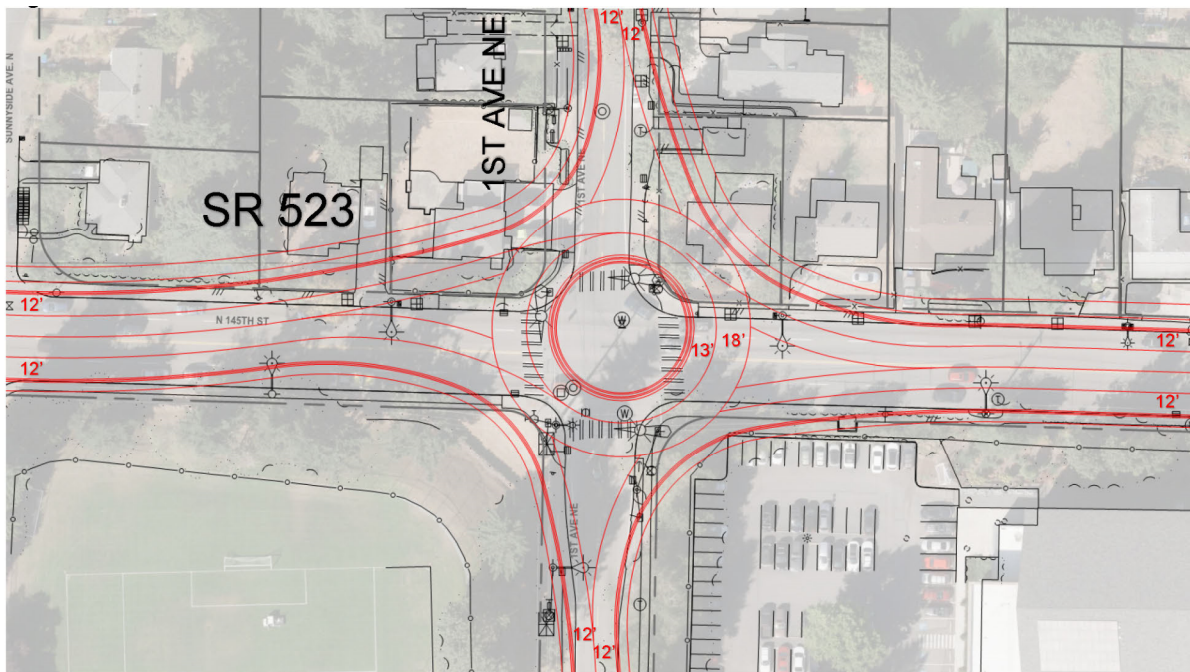


Figure 5. Alternative 1 – Add Left-Turn Pockets for All Legs except Right-Turn Pocket for South Leg

11. Footprint and Property Impacts Considerations

Each alternative would impact properties and require full acquisitions. An estimated nine full property acquisitions along the corridor would be required for the signal improvements (Alternative 1) at Meridian

Ave N and 1st Ave NE. These acquisitions are wholly on the north side of the road within the City of Shoreline.

An estimated 12 full property acquisitions would be required for Alternative 2. Most of these acquisitions are on the north side of the road within the City of Shoreline, with three property acquisitions on the south side of the road within the City of Seattle. The property acquisitions within the City of Seattle are located on the southwest and southeast corners of the intersection with Meridian Ave N. In addition, Alternative 2 results in large property acquisitions needed from the Lakeside School property on the southeast and southwest quadrants of 1st Ave N.

The property acquisition analysis assumes roadway improvements outside of the intersections are similar (for example, sidewalk and landscaping) for each of the alternatives with the exception of the median width, which is 12 feet for Alternative 1 and 6 feet (4-foot raised median and 1-foot shy on either side) for Alternative 2. The limits of the property impacts analysis are from the southbound I-5 on/off ramps to Wallingford Ave N for both alternatives. Wallingford Ave N is the western limits of the analysis since it is the location where Alternative 1, widening for a left-turn lane, matches existing curb lines.

12. Traffic Operations Considerations

Traffic operations for the existing conditions at the intersections are shown in Table 1.

Table 1. Existing Delay for PM Peak

Existing Conditions						
Approach	Analysis Year	Peak Hour	N 145th St/SR 523 & Meridian Ave N		N 145th St/SR 523 & 1st Ave NE	
			LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
EB	2018	PM	A	8.3	B	11.1
WB	2018	PM	A	5.3	C	23.4
NB	2018	PM	D	45.4	D	43.9
SB	2018	PM	E	67.3	C	34.6
Overall	2018	PM	B	15.2	C	23.0

Note: LOS = level of service

13. SR 523 and Meridian Avenue N Intersection

Projected operations and delay based on existing PM peak volumes are shown in Table 2 for the SR 523 and Meridian Ave intersection.

Table 2. Meridian Avenue Intersection – Projected Operations/Delay based on Existing PM Peak Volumes

SR 523 and Meridian Ave N Intersection								
Approach	Analysis Year	Peak Hour	No Build		Alternative 1 (Signal)		Alternative 2 (Roundabout)	
			LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
EB	2035	PM	C	31.5	C	23.3	A	3.6
WB	2035	PM	A	8.4	C	28.6	A	9.2
NB	2035	PM	E	56.4	E	57.6	B	10.9
SB	2035	PM	E	66.9	D	35.4	A	8.7
Overall	2035	PM	C	28.2	C	32.4	A	7.7

Note: Overall intersection LOS should be considered to be the LOS of the worst approach.

For Alternative 1, the addition of eastbound and westbound left-turn pockets removes the potential blocking problems that occurs today when left-turning vehicles wait in-lane for acceptable gaps in the opposing traffic. For this study, the eastbound and westbound left-turn movements were modeled with a protected green phase followed by a permissive phase with the through movements. The additional phases take time from other phases which resulted in longer delays for most approaches. The southbound approach improved with the addition of a southbound left-turn pocket. The pocket allows through vehicles to bypass left-turning vehicles waiting for acceptable gaps in the opposing traffic.

For multilane roundabouts, pedestrian crossing protection will be provided for each crosswalk, either Rapid Rectangular Flashing Beacon (RRFB) or some type of pedestrian signal.

14. SR 523 and 1st Avenue N Intersection

Projected operations and delays based on existing PM peak volumes are shown in Table 3 for the SR 523 and 1st Ave N intersection.

Table 3. 1st Avenue Intersection – Projected Operations/Delay based on Existing PM Peak Volumes

SR 523 and 1st Ave N Intersection								
Approach	Analysis Year	Peak Hour	No Build		Alternative 1 (Signal)		Alternative 2 (Roundabout)	
			LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
EB	2035	PM	B	18.3	B	18.2	A	3.0
WB	2035	PM	E	59.1	B	19.5	A	6.1
NB	2035	PM	F	87.4	D	44.8	B	10.9

Table 3. 1st Avenue Intersection – Projected Operations/Delay based on Existing PM Peak Volumes

SR 523 and 1st Ave N Intersection								
Approach	Analysis Year	Peak Hour	No Build		Alternative 1 (Signal)		Alternative 2 (Roundabout)	
			LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)
SB	2035	PM	F	129.7	C	31.1	A	8.4
Overall	2035	PM	D	52.7	C	23.4	A	6.0

Note: Overall intersection LOS should be considered to be the LOS of the worst approach.

The addition of a westbound left-turn pocket removes the potential blocking problems that occurs today when left-turning vehicles wait in-lane for acceptable gaps in the opposing traffic. Eastbound left-turns are prohibited today. The restriction can be removed with the addition of an eastbound left-turn pocket. For this study, the eastbound and westbound left-turn movements were modeled with a protected green phase followed by a permissive phase with the through movements. No significant changes in the levels-of-service and delays from existing conditions with the addition of left-turn pockets. The northbound approach operates better with a right-turn pocket instead of a left-turn pocket due to the heavy right-turn volumes in the peak hour. For this study, the northbound approach was modeled with one through/left lane and a right-turn pocket, which matches existing conditions.

For multilane roundabouts, pedestrian crossing protection will be provided for each crosswalk, either RRFB or some type of pedestrian signal.

Impacts of Queue Spill Back from I-5 Ramps. Traffic operations was modeled for the PM peak period. However, the AM peak for eastbound traffic has been observed to regularly queue from the I-5 ramps as far back as Meridian Ave N. This queueing could have negative impacts to traffic operations during the AM peak period for the project corridor. The City of Shoreline is planning to construct two roundabouts at the 145th St I-5 ramp terminals and will likely improve this morning condition. Funding is not secured for this work yet.

Overall, traffic operations likely flow better through most of the day with the roundabout option.

15. Safety

Over a 5-year period, a total of 93 collisions were reported for both intersections. More than 70 percent included collisions involving left-turning vehicles.

Alternative 1 includes adding left-turn lanes and protected green phases and is anticipated to improve the safety performance at the study intersections by up to 20 percent. Other safety performance improvements for Alternative 1 include:

- **Reflective signal backplates.** The Federal Highway Administration (FHWA) identified signal backplates with reflective borders as a [Proven Safety Countermeasure](#) because of their ability to substantially reduce the types of crashes that result in injury or loss of life.

- **Leading pedestrian intervals.** FHWA identified leading pedestrian intervals as a [Proven Safety Countermeasure](#) because of their ability to substantially reduce the types of crashes that result in injury or loss of life.

The roundabout alternative is expected to improve the safety performance at the intersection. FHWA identified roundabouts as a [Proven Safety Countermeasure](#) because of their ability to substantially reduce the types of crashes that result in injury or loss of life. Replacing the existing traffic signal with a signal lane roundabout should reduce collisions by 78 percent, according to FHWA.

Roundabouts are designed to improve safety for all users, including pedestrians and bicycles. Some non-motorized benefits of roundabouts include but are not limited to:

- Roundabouts have fewer conflict points. A single lane roundabout has 50 percent fewer pedestrian-vehicle conflict points than a comparable stop- or signal-controlled intersection. Conflicts between bicycles and vehicles are reduced as well.
- Pedestrians cross a shorter distance of only one direction of traffic at a time since the entering and exiting flows are separated. Drivers focus on pedestrians apart from entering, circulating, and exiting maneuvers.
- Traffic speed at any road or intersection is vitally important to the safety of everyone, and especially non-motorized users. Lower speed is associated with better yielding rates, reduced vehicle stopping distance, and lower risk of collision injury or fatality. Also, the speed of traffic through a roundabout is more consistent with comfortable bicycle-riding speeds.

16. Transit Considerations

Future frequent bus service is planned along the corridor by King County Metro with service beginning by 2023. The frequent bus service will run along Meridian Ave N, south of SR 523, and turn eastbound onto SR 523 to the light rail station at I-5. King County Metro's Long-Range Plan also identifies bus rapid transit service through the entire project corridor on 145th St by 2040. The selected alternative will need to accommodate this future bus service.

Alternative 1 provides for right-turning buses from Meridian Ave N northbound to 145th St eastbound without the need to acquire a parcel on the south side of 145th St. Bus stations can be placed in proximity to the intersection to speed the transfer experience for transit riders but requires pedestrians to cross more travel lanes with no center pedestrian refuge island.

Alternative 2 provides for right-turning buses from Meridian Ave northbound to 145th St eastbound, however full acquisition of a parcel on the south side of 145th St may be necessary to make this accommodation. Bus stations may need to be placed farther away from the intersection than Alternative 1, making longer distances for transfers to other bus stations. This option provides for fewer travel lanes to cross and would include a center pedestrian refuge island. The size and layout of the roundabouts were developed to accommodate buses so that buses can traverse the roundabout without shifting into another lane. If this option is selected, the geometry is expected to be refined to consider accommodating bus travel by straddling approach and circulating lanes on 145th St.

17. Community Outreach

The City of Shoreline has made it a priority to engage the public since 2015 as part of the larger corridor study used to define the project and throughout the design. The City has engaged the public through a

number of methods, including Citizen Advisory Task Force (CATF) meetings, neighborhood briefing meetings, public open houses, and attending and participating in community events.

Throughout the 145th Street corridor study process, the City worked to ensure that community members had approachable, useful, and accurate information about the project goals, schedules, and outcomes. The City also worked to support strong connections between members of the public, the CATF, and Shoreline City Council. The project team used creative input-gathering methods to maximize participation at the public open houses.

At the first open house in May 2015, project staff introduced the study process and gathered public input on existing conditions along the corridor. At the second open house in September 2015, project staff presented a range of potential route concepts and gathered public input on what aspects from each concept were appropriate for different segments of the corridor. Feedback at the second open house focused on how the public wanted to balance the benefits and costs of corridor improvements for safety, mobility, accessibility, and more. At the third open house in February 2016, project staff presented the preferred design concept for the corridor and gathered public input on how appropriately the concept balanced improvements. Feedback from the third open house confirmed that the preferred concept incorporated a level of improvement that was appropriate for the corridor. The fourth open house in April 2019 presented design information including proposed layout, project timeline, and design elements with an opportunity to meet the project team, provide input, and ask questions.

18. Context-Sensitive/Land Use Considerations

The City of Shoreline has invested considerable resources in comprehensive planning and land use planning in the project corridor. The City has adopted a land use plan to respond to the changing community context around the light rail station. It is important to account for the context considerations when selecting an alternative for the SR 523 project. The City vision and code includes high density (70-foot mixed-use development) radiating from the light rail station and I-5. The City's Comprehensive Plan calls for higher priority on pedestrian and bike safety over traffic operations.

Alternative 1 minimizes impact on current redevelopment plans over Alternative 2, consistent with the City's recently adopted land use plan. Both alternatives improve safety for pedestrian crossings. Alternative 1 provides stop control to protect crossings at intersections. Alternative 2 provides RRFB or other treatments to protect pedestrian crossings. Both options are consistent with the City's land use vision for the corridor of a dense urban transit-oriented development.

19. Alternative Selection

Both Alternatives 1 and 2 serve the community vision and improve safety performance. Alternative 2 provides the best overall traffic operations performance but both options meet current City minimum level of service requirements in the design year (2035). Alternative 1 fits better within the built environment constraints and with the extensive community visioning completed a few years ago by the City. WSDOT, Sound Transit, King County, and many other agencies served as stakeholders to this effort. The WSDOT and City of Shoreline recommended traffic control for 145th St (SR 523) at 1st Ave NE and Meridian Ave N is traffic signals. The teams' considerations are summarized as follows:

- 1) **Operations:** Alternative 2 provides for the lowest delays and best overall traffic operations performance. Both options meet current minimum City intersection performance requirements (Concurrency and Level of Service, [City of Shoreline Transportation Master Plan, 2011](#)).

- 2) **Right-of-Way/Property Impacts:** Though each alternative has a similar number of parcel impacts, Alternative 1 can be implemented without property acquisitions from the City of Seattle. Property acquisitions in Seattle are considered a fatal flaw to the project and may impede project delivery. At 1st Ave NE, a current redevelopment project restricts available property on the north side of the intersection that impacts Alternative 2.
- 3) **Land Use/City Vision:** The City has adopted a land use plan to respond to the changing community context around the light rail station. The City vision and code includes high density (70-foot mixed-use development) radiating from the light rail station and I-5. Both alternatives improve safety for pedestrian crossings supporting this vision.
- 4) **Transit Use:** Both alternatives support transit operations.
- 5) **Safety:** Both alternatives improve safety performance although the roundabout alternative is expected to provide the best safety performance results.
- 6) **Community Outreach:** Alternative 1 is consistent with the corridor vision developed cooperatively with the community and adopted by the City of Shoreline.

Appendix Modeling Data

**145TH AND MERIDIAN
EXISTING CONDITIONS**

**HCM Signalized Intersection Capacity Analysis
6: Meridian Ave N & N 145th St**

01/31/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕↕			↕↕			↕	↕		↕	↕
Traffic Volume (vph)	27	882	17	40	1177	18	18	214	35	51	102	51
Future Volume (vph)	27	882	17	40	1177	18	18	214	35	51	102	51
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	12	12	12	10	10	12	10	10
Total Lost time (s)		6.0			6.0			6.0	6.0		6.0	6.0
Lane Util. Factor		0.95			0.95			1.00	1.00		1.00	1.00
Frbp, ped/bikes		1.00			1.00			1.00	0.98		1.00	0.98
Flpb, ped/bikes		1.00			1.00			1.00	1.00		1.00	1.00
Frt		1.00			1.00			1.00	0.85		1.00	0.85
Flt Protected		1.00			1.00			1.00	1.00		0.98	1.00
Satd. Flow (prot)		3522			3523			1732	1441		1710	1441
Flt Permitted		0.87			0.88			0.96	1.00		0.53	1.00
Satd. Flow (perm)		3077			3096			1676	1441		927	1441
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	29	959	18	43	1279	20	20	233	38	55	111	55
RTOR Reduction (vph)	0	1	0	0	1	0	0	0	26	0	0	44
Lane Group Flow (vph)	0	1005	0	0	1341	0	0	253	12	0	166	11
Confl. Peds. (#/hr)			10			10			10			10
Turn Type	Perm	NA		Perm	NA		Perm	NA	Perm	Perm	NA	Perm
Protected Phases		4			4			2			2	
Permitted Phases	4			4			2		2	2		2
Actuated Green, G (s)		68.1			68.1			19.9	19.9		19.9	19.9
Effective Green, g (s)		68.1			68.1			19.9	19.9		19.9	19.9
Actuated g/C Ratio		0.68			0.68			0.20	0.20		0.20	0.20
Clearance Time (s)		6.0			6.0			6.0	6.0		6.0	6.0
Vehicle Extension (s)		2.0			2.0			3.0	3.0		3.0	3.0
Lane Grp Cap (vph)		2095			2108			333	286		184	286
v/s Ratio Prot												
v/s Ratio Perm		0.33			0.43			0.15	0.01		0.18	0.01
v/c Ratio		0.48			0.64			0.76	0.04		0.90	0.04
Uniform Delay, d1		7.6			9.0			37.8	32.3		39.1	32.3
Progression Factor		1.00			0.52			1.00	1.00		1.00	1.00
Incremental Delay, d2		0.8			0.6			9.6	0.1		39.8	0.1
Delay (s)		8.3			5.3			47.4	32.4		78.9	32.4
Level of Service		A			A			D	C		E	C
Approach Delay (s)		8.3			5.3			45.4			67.3	
Approach LOS		A			A			D			E	

Intersection Summary

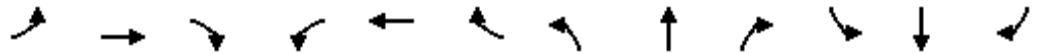
HCM 2000 Control Delay	15.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	102.7%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

**145TH AND MERIDIAN
ALTERNATIVE 1: LEFT TURN LANES**

**HCM Signalized Intersection Capacity Analysis
6: Meridian Ave N & N 145th St**

02/01/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	68	871	33	36	1144	241	70	344	126	63	156	33
Future Volume (vph)	68	871	33	36	1144	241	70	344	126	63	156	33
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	12	12	12	10	10	12	10	10
Total Lost time (s)	4.5	6.0		4.5	6.0		6.0	6.0		6.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	1.00		1.00	1.00	
Frbp, ped/bikes	1.00	1.00		1.00	0.99		1.00	0.99		1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.97		1.00	0.96		1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3514		1770	3418		1770	1658		1770	1686	
Flt Permitted	0.08	1.00		0.21	1.00		0.57	1.00		0.15	1.00	
Satd. Flow (perm)	156	3514		386	3418		1064	1658		288	1686	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	74	947	36	39	1243	262	76	374	137	68	170	36
RTOR Reduction (vph)	0	3	0	0	17	0	0	13	0	0	8	0
Lane Group Flow (vph)	74	980	0	39	1488	0	76	498	0	68	198	0
Confl. Peds. (#/hr)			10			10			10			10
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases	7	4		3	8			2			2	
Permitted Phases	4			8			2			2		
Actuated Green, G (s)	53.7	47.9		50.5	46.3		31.4	31.4		31.4	31.4	
Effective Green, g (s)	53.7	47.9		50.5	46.3		31.4	31.4		31.4	31.4	
Actuated g/C Ratio	0.54	0.48		0.50	0.46		0.31	0.31		0.31	0.31	
Clearance Time (s)	4.5	6.0		4.5	6.0		6.0	6.0		6.0	6.0	
Vehicle Extension (s)	3.0	2.0		3.0	2.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	177	1683		253	1582		334	520		90	529	
v/s Ratio Prot	c0.02	0.28		0.01	c0.44			c0.30			0.12	
v/s Ratio Perm	0.20			0.07			0.07			0.24		
v/c Ratio	0.42	0.58		0.15	0.94		0.23	0.96		0.76	0.38	
Uniform Delay, d1	19.1	18.8		13.5	25.5		25.3	33.6		30.8	26.7	
Progression Factor	1.64	1.13		1.32	0.80		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.4	1.3		0.2	8.4		0.3	28.7		29.7	0.4	
Delay (s)	32.7	22.5		18.0	28.9		25.7	62.4		60.5	27.1	
Level of Service	C	C		B	C		C	E		E	C	
Approach Delay (s)		23.3			28.6			57.6			35.4	
Approach LOS		C			C			E			D	

Intersection Summary			
HCM 2000 Control Delay	32.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	16.5
Intersection Capacity Utilization	94.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

**145TH AND MERIDIAN
ALTERNATIVE 2: ROUNDABOUT**

MOVEMENT SUMMARY

 **Site: 103 [Meridian Ave N]**

Meridian Ave N/N 145th St
Roundabout

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Total veh/h	Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	of Queue Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
South: Meridian Ave N											
3	L2	76	2.0	0.811	16.5	LOS B	7.4	188.7	0.90	1.16	28.4
8	T1	374	2.0	0.811	9.8	LOS A	7.4	188.7	0.90	1.16	27.6
18	R2	137	2.0	0.811	10.9	LOS B	7.4	188.7	0.90	1.16	26.8
Approach		587	2.0	0.811	10.9	LOS B	7.4	188.7	0.90	1.16	27.5
East: N 145th St											
1	L2	39	2.0	0.739	17.3	LOS B	10.0	252.8	0.98	1.06	32.2
6	T1	1243	2.0	0.739	9.0	LOS A	10.8	275.2	0.97	1.01	32.0
16	R2	262	2.0	0.739	8.8	LOS A	10.8	275.2	0.97	0.96	31.2
Approach		1545	2.0	0.739	9.2	LOS A	10.8	275.2	0.97	1.00	31.9
North: Meridian Ave N											
7	L2	68	2.0	0.536	13.6	LOS B	3.4	85.5	0.88	0.98	29.2
4	T1	170	2.0	0.536	6.9	LOS A	3.4	85.5	0.88	0.98	28.4
14	R2	36	2.0	0.536	8.0	LOS A	3.4	85.5	0.88	0.98	27.5
Approach		274	2.0	0.536	8.7	LOS A	3.4	85.5	0.88	0.98	28.5
West: N 145th St											
5	L2	74	2.0	0.406	10.4	LOS B	3.1	77.9	0.60	0.44	34.1
2	T1	947	2.0	0.406	3.0	LOS A	3.3	83.3	0.59	0.38	33.7
12	R2	36	2.0	0.406	3.8	LOS A	3.3	83.3	0.58	0.34	32.5
Approach		1057	2.0	0.406	3.6	LOS A	3.3	83.3	0.59	0.38	33.7
All Vehicles		3462	2.0	0.811	7.7	LOS A	10.8	275.2	0.84	0.84	31.3

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.

LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6).

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

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Project: \\SEAFPP01\Proj\ShorelineWaCityOf\696236_145thStCorridor\05_ConceptRefinement\01_Refinement_of_Roadway_Footprint\ICAs
\Roundabout Analysis\145th Roundabouts_2035.sip7

**145TH AND 1ST
EXISTING CONDITIONS**

HCM Signalized Intersection Capacity Analysis

3: 1st Ave NE & N 145th St

01/31/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑			↑↑			↑	↑		↑	
Traffic Volume (vph)	0	867	16	133	1188	41	52	201	167	34	57	11
Future Volume (vph)	0	867	16	133	1188	41	52	201	167	34	57	11
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	12	12	12	10	10	12	12	12
Total Lost time (s)		5.0			5.0			5.0	5.0		5.0	
Lane Util. Factor		0.95			0.95			1.00	1.00		1.00	
Frbp, ped/bikes		1.00			1.00			1.00	0.97		1.00	
Flpb, ped/bikes		1.00			1.00			1.00	1.00		1.00	
Frt		1.00			1.00			1.00	0.85		0.99	
Flt Protected		1.00			1.00			0.99	1.00		0.98	
Satd. Flow (prot)		3527			3501			1721	1437		1800	
Flt Permitted		1.00			0.63			0.91	1.00		0.63	
Satd. Flow (perm)		3527			2210			1591	1437		1147	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	942	17	145	1291	45	57	218	182	37	62	12
RTOR Reduction (vph)	0	1	0	0	2	0	0	0	77	0	5	0
Lane Group Flow (vph)	0	958	0	0	1479	0	0	275	105	0	106	0
Confl. Peds. (#/hr)			10			10			10			10
Turn Type		NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	
Protected Phases		4		3	8			2			2	
Permitted Phases				8			2		2	2		
Actuated Green, G (s)		56.7			68.7			21.3	21.3		21.3	
Effective Green, g (s)		56.7			68.7			21.3	21.3		21.3	
Actuated g/C Ratio		0.57			0.69			0.21	0.21		0.21	
Clearance Time (s)		5.0			5.0			5.0	5.0		5.0	
Vehicle Extension (s)		2.0			2.0			2.0	2.0		2.0	
Lane Grp Cap (vph)		1999			1608			338	306		244	
v/s Ratio Prot		0.27			c0.06							
v/s Ratio Perm					c0.57			c0.17	0.07		0.09	
v/c Ratio		0.48			0.92			0.81	0.34		0.44	
Uniform Delay, d1		12.9			13.3			37.5	33.4		34.1	
Progression Factor		0.80			1.00			1.00	1.00		1.00	
Incremental Delay, d2		0.7			10.0			13.2	0.2		0.5	
Delay (s)		11.1			23.4			50.7	33.7		34.6	
Level of Service		B			C			D	C		C	
Approach Delay (s)		11.1			23.4			43.9			34.6	
Approach LOS		B			C			D			C	

Intersection Summary

HCM 2000 Control Delay	23.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.94		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	102.0%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

**145TH AND 1ST
ALTERNATIVE 1: LEFT TURN LANES**

**HCM Signalized Intersection Capacity Analysis
3: 1st Ave NE & N 145th St**

02/01/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↕		↖	↕			↕	↗	↖	↕	↗
Traffic Volume (vph)	30	1018	36	127	1429	65	47	262	212	39	65	10
Future Volume (vph)	30	1018	36	127	1429	65	47	262	212	39	65	10
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	12	12	12	12	10	10	12	12	12
Total Lost time (s)	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	0.95			1.00	1.00	1.00	1.00	
Frbp, ped/bikes	1.00	1.00		1.00	1.00			1.00	0.97	1.00	1.00	
Flpb, ped/bikes	1.00	1.00		1.00	1.00			1.00	1.00	1.00	1.00	
Frt	1.00	0.99		1.00	0.99			1.00	0.85	1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00			0.99	1.00	0.95	1.00	
Satd. Flow (prot)	1770	3515		1770	3509			1725	1437	1770	1819	
Flt Permitted	0.08	1.00		0.14	1.00			0.94	1.00	0.27	1.00	
Satd. Flow (perm)	146	3515		260	3509			1632	1437	494	1819	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	33	1107	39	138	1553	71	51	285	230	42	71	11
RTOR Reduction (vph)	0	2	0	0	3	0	0	0	129	0	6	0
Lane Group Flow (vph)	33	1144	0	138	1621	0	0	336	101	42	76	0
Confl. Peds. (#/hr)			10			10			10			10
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	
Protected Phases	7	4		3	8			2			2	
Permitted Phases	4			8			2		2	2		
Actuated Green, G (s)	55.1	51.2		66.2	57.8			23.8	23.8	23.8	23.8	
Effective Green, g (s)	55.1	51.2		66.2	57.8			23.8	23.8	23.8	23.8	
Actuated g/C Ratio	0.55	0.51		0.66	0.58			0.24	0.24	0.24	0.24	
Clearance Time (s)	4.5	5.0		5.0	5.0			5.0	5.0	5.0	5.0	
Vehicle Extension (s)	3.0	2.0		2.0	2.0			2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	143	1799		323	2028			388	342	117	432	
v/s Ratio Prot	0.01	0.33		c0.04	c0.46							0.04
v/s Ratio Perm	0.12			0.24				c0.21	0.07	0.08		
v/c Ratio	0.23	0.64		0.43	0.80			0.87	0.30	0.36	0.18	
Uniform Delay, d1	14.2	17.7		10.5	16.6			36.6	31.2	31.7	30.3	
Progression Factor	1.71	0.94		1.00	1.00			1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.7	1.4		4.1	3.4			17.4	0.2	0.7	0.1	
Delay (s)	24.9	18.0		14.6	20.0			54.0	31.4	32.4	30.4	
Level of Service	C	B		B	B			D	C	C	C	
Approach Delay (s)		18.2			19.5			44.8			31.1	
Approach LOS		B			B			D			C	

Intersection Summary

HCM 2000 Control Delay	23.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	87.1%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

**145TH AND 1ST
ALTERNATIVE 2: ROUNDABOUT**

MOVEMENT SUMMARY

 **Site: 104 [1st Ave NE]**

1st Ave NE/N 145th St
Roundabout

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Total veh/h	Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
South: 1st Ave NE											
3	L2	51	2.0	0.797	16.6	LOS B	7.1	179.6	0.90	1.15	28.4
8	T1	285	2.0	0.797	9.8	LOS A	7.1	179.6	0.90	1.15	27.6
18	R2	230	2.0	0.797	10.9	LOS B	7.1	179.6	0.90	1.15	26.8
Approach		566	2.0	0.797	10.9	LOS B	7.1	179.6	0.90	1.15	27.3
East: N 145th St											
1	L2	138	2.0	0.719	13.6	LOS B	9.3	237.4	0.89	0.83	33.0
6	T1	1553	2.0	0.719	5.5	LOS A	9.5	241.2	0.87	0.71	32.7
16	R2	71	2.0	0.719	5.8	LOS A	9.5	241.2	0.85	0.63	31.7
Approach		1762	2.0	0.719	6.1	LOS A	9.5	241.2	0.87	0.71	32.7
North: 1st Ave NE											
7	L2	42	2.0	0.291	12.8	LOS B	1.5	38.8	0.86	0.88	29.3
4	T1	71	2.0	0.291	6.0	LOS A	1.5	38.8	0.86	0.88	28.4
14	R2	11	2.0	0.291	7.1	LOS A	1.5	38.8	0.86	0.88	27.5
Approach		124	2.0	0.291	8.4	LOS A	1.5	38.8	0.86	0.88	28.6
West: N 145th St											
2	T1	1107	2.0	0.423	2.9	LOS A	3.3	83.0	0.54	0.35	34.0
12	R2	39	2.0	0.423	3.7	LOS A	3.3	83.0	0.53	0.33	32.7
Approach		1146	2.0	0.423	3.0	LOS A	3.3	83.0	0.54	0.35	34.0
All Vehicles		3598	2.0	0.797	6.0	LOS A	9.5	241.2	0.77	0.67	31.9

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Signalised Intersections.

Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.

LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).

Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6).

Roundabout Capacity Model: SIDRA Standard.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

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Project: \\SEAFPP01\Proj\ShorelineWaCityOf\696236_145thStCorridor\05_ConceptRefinement\01_Refinement_of_Roadway_Footprint\ICAs
\Roundabout Analysis\145th Roundabouts_2035.sip7