Wyatt Way NW
Transportation Analysis

CITY OF BAINBRIDGE ISLAND

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BAINBRIDGE ISLAND

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1. Introduction

Background

The Wyatt Way NW complete street project begins at the intersection of Madison Ave N and terminates 1,350 feet west at Lovell Way NW. Capital improvements to manage future vehicular traffic growth and improve connectivity for pedestrians and bicycles are the main purpose for this project. Proposed changes will increase operational efficiency and improve the Level of Service (LOS).

Wyatt Way NW will be widened to provide a cross-section between Madison Ave N and Grow Ave NW that accommodates, at a minimum, one lane of travel in each directions, bike lanes, curb and gutter, and sidewalk. This fills the gap that currently exists in the pedestrian and bicycle facilities and make connections to transit facilities along this section of roadway.

This traffic analysis looks at four options for intersection improvements at Wyatt Way NW and Madison Ave N, including No Build, Traffic Signal, Mini-Roundabout, and an Urban Compact Roundabout. Conceptual layouts of the mini-roundabout and urban compact roundabout designs are located in Appendix A.

This analysis also looks at options for the intersection of Wyatt Way NW and Grow Ave NW, including No Build and replacing the existing All Way Stop Control (AWSC) with a proposed Two-Way Stop Control (TWSC) and pedestrian improvements with active traffic control devices, including Rectangular Rapid Flashing Beacons (RRFB) and a High-Intensity Activated crossWalK (HAWK) beacon.

Traffic operations for both the study year (2014) and the design year (2035) are analyzed for both intersections.

Intersection Treatments and Traffic Control Device Descriptions

A HAWK beacon is a traffic control device used to stop traffic to allow pedestrians to cross the roadway. It is officially known as Pedestrian Hybrid Beacon (PHB). The 2009 edition of the Manual on Uniform Traffic Control Devices (MUTCD) provides guidance that when used the PHB should be placed at least 100 feet from a side street that is controlled by STOP or YIELD signs.

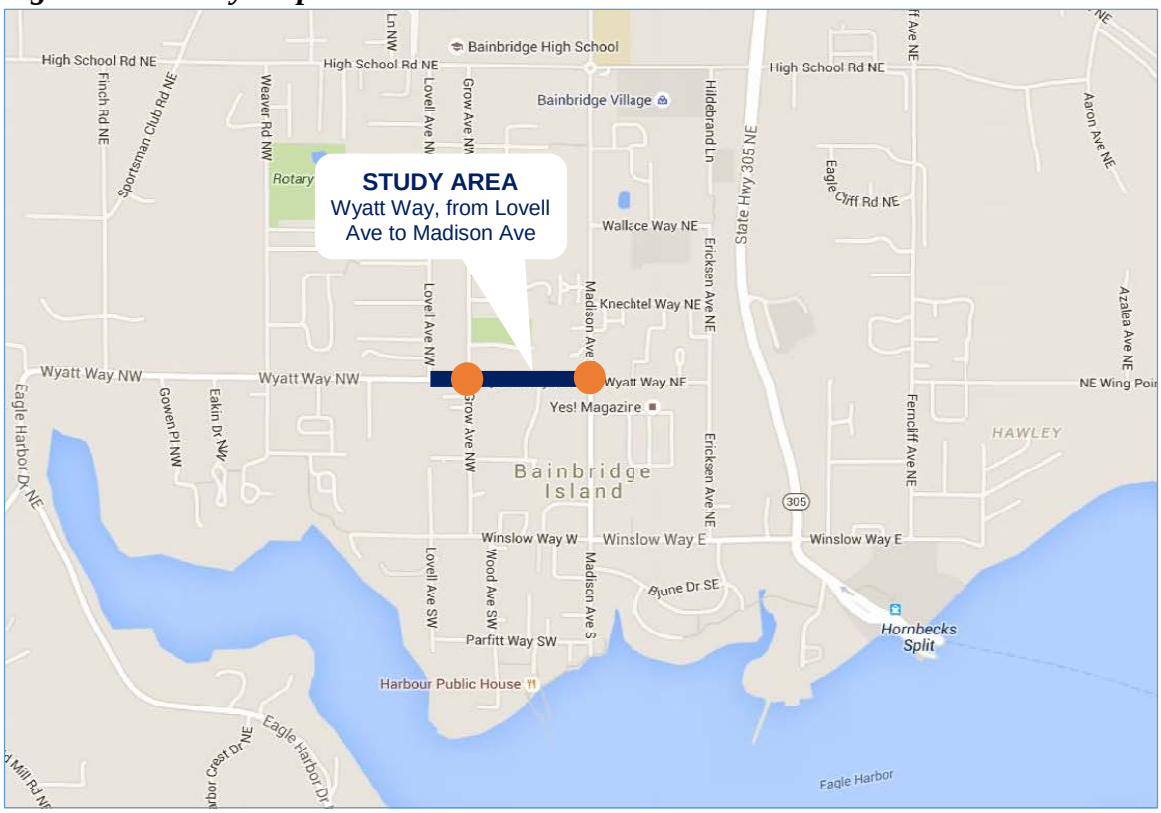
A RRFB is an active traffic control device used to alert drivers to stop and allow pedestrians and bicyclists to cross the roadway. The MUTCD provides direction that when used the RRFB should not be placed near traffic signals, STOP or YIELD signs.

Mini-roundabouts are small single-lane roundabouts generally used in 25 mph or less urban/suburban environments. Because of this, mini-roundabouts are typically not suitable for use on higher-volume (greater than 6,000 AADT) state routes. In retrofit applications, mini-roundabouts are relatively inexpensive because they normally require minimal additional pavement at the intersecting roads. A 2-inch mountable curb for the splitter islands and the central island is desirable because larger vehicles might be required to cross over it[1].

Like mini-roundabouts, urban compact roundabouts are intended to be pedestrian and bicyclist-friendly because their perpendicular approach legs require very low vehicle speeds to make a distinct right turn into and out of the circulatory roadway. All legs have single-lane entries. However, the urban compact treatment meets all the design requirements of effective roundabouts. The principal objective of this design is to enable pedestrians to have safe and effective use of the intersection. The geometric design includes raised splitter islands that incorporate at-grade pedestrian storage areas, and a non-mountable central island. There is usually an apron surrounding the non-mountable part of the compact central island to accommodate large vehicles[2].

Figure 1 shows a vicinity map for the study area.

Figure 1 - Vicinity Map



[1] *WSDOT Design Manual, Chapter 1320*

[2] *Roundabouts: An Informational Guide, FHWA*

2. Existing Conditions

Wyatt Way NW is a two-lane secondary urban arterial in the City of Bainbridge Island. The City designates that intersections should operate at a LOS standard of D or better for secondary arterials in urban zones[3]. This section of Wyatt Way NW between Madison and Lovell Avenue carries approximately 6,400 vehicles east/westbound daily, and Madison Ave N carries 7,900 vehicles north/southbound daily. Grow Ave NW carries about 2,500 vehicles north/southbound on average each day (See Appendix B).

The following is a brief description of the existing roadway characteristics of Wyatt Way NW, Madison Ave N, and Grow Ave NW:

- Wyatt Way NW between Madison Ave N and Lowell consists of two11-foot wide travel lanes. Along the south side of Wyatt Way for approximately 650' east of Grow Ave there is a newly install curb, sidewalk and parking setback areas. There is no curb or sidewalk in the approximate remaining 250' to Madison Ave N. Along the north side of Wyatt Way for about 275 feet west of Madison Ave N. there is an existing curb and sidewalk, with no on-street parking. From the end of this sidewalk to Lovell Avenue NW, there is an open ditch along the shoulder of the pavement.
- Madison Ave N north of Wyatt Way NW is a 36-foot wide road between curbs with one lane in each direction and bicycle lanes. Madison Ave N south of Wyatt Way NW widens to about 46 feet wide with one lane in each direction, bicycle lanes, and a two-way left-turn lane in the center. Curbs and sidewalks exist on both sides of Madison Ave N north and south of Wyatt Way
- Grow Ave NW south of Wyatt Way is mostly 26-foot wide with a10-foot wide travel lane in each direction and 2 to 3 foot wide shoulders. The roadway widens a couple feet on the east side for about 300 feet south of Wyatt Way, which allows for a designated 5 foot wide bike lane in the northbound direction. There is also approximately 275 feet of sidewalk on the east side of Grow Ave NW south of the intersection with Wyatt Way fronting the recent Grow Development. There are no sidewalk facilities on the west side.
- Both the intersections of Wyatt Way NW with Madison Ave N and Grow Ave NW operate with All Way Stop Controls.
- The speed limit on Wyatt Way NW is posted at 25 MPH.
- There are currently only five existing street lights along Wyatt Way NW between Madison Ave N and Lowell Ave NW. They are located, at Madison Ave N, at approximately 500' west of Madison Ave N, at approximately 250' east of Grow Ave NW, at Grow Ave NW and at Lowell Ave NW.

Signal Operations and Maintenance Agreements

[3] *City of Bainbridge Island Island-Wide Transportation Plan, Chapter 4*

The City of Bainbridge Island does not currently have in-house resources to operate and maintain traffic signals at this time. The City has an interlocal agreement with the City of Bremerton to operate and maintain flashing beacons for the City of Bainbridge Island. Revisions to this interlocal agreement to have City of Bremerton staff handle traffic signal maintenance and operations responsibilities maybe required if any additional electrical traffic control devices, such as a traffic signal, HAWK or RRFB, were installed.

3. Data Collection

Existing Traffic Volumes

Traffic counts used for the traffic analysis were collected in 2014 and 2016.The AM and PM peak hour turning movements at the intersections of Wyatt Way NW at Madison Ave N and at Grow Ave NW are summarized in Table.1. The 2014 data was collected in the June, while the 2016 data was collected in February. It should be noted that the analysis used the 2014 data, if available, instead of the 2016 data because the summer volumes were found to actually be higher, and better represented the peak volumes for the area. The original data sheets are located in Appendix B.

Table 1: 2014 AM and PM Peak Hour Intersection Turning Movement Summary

Intersection	Peak Hour	Peak Hour	% Heavy Vehicles	Approach											
				Eastbound			Northbound			Westbound			Southbound		
				Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Wyatt Way NW @ Madison Ave N	AM	0.91	1.3	86	83	144	42	126	7	8	25	4	11	267	42
Wyatt Way NW @ Grow NW (2016)	AM	0.85	2.1	42	271	112	51	130	20	10	97	5	19	71	23
Wyatt Way NW @ Madison Ave N	PM	0.96	0.8	71	44	112	130	361	18	12	137	21	16	251	69
Wyatt Way NW @ Grow NW	PM	0.93	1.3	6	494	49	30	14	48	43	478	64	48	23	20

Forecast Traffic Volumes

The City of Bainbridge Island developed a traffic model in 2014 as an element of the comprehensive plan update. After incorporating new vehicle trips from planned growth, this model estimated future PM peak hour traffic volumes in 2035. The model includes the intersections of Wyatt Way NW at Madison Ave N and at Grow Ave NW, but not Lovell Ave NW. Based on this model, the annual growth rate in the PM peak hour on the Wyatt Way NW corridor is about 0.9%.These forecasted volumes are shown in Table 2.

Average Daily Traffic (ADT) from 2012[4] (Appendix B) shows Wyatt Way NW with 6,289 trips and Madison Ave N with 7,734. Applying the annual growth rate to the 2012 daily traffic data, the forecasted daily volumes on Wyatt Way NW are 6,400 in 2014, and 6,520 vehicles in 2035. The volumes on Madison Ave N are about 7,900 in 2014, and 8,050 in 2035.

To calculate the ADT on Grow Ave NW, the east and westbound volumes entering the intersection (330+309=639) were divided by the ADT on Wyatt Way (6,400) to arrive at a peak hour factor of 0.086. The north and southbound volumes entering the intersection (82+168=250) were divided by the peak hour factor to determine the Grow Ave NW ADT of 2,500.

Table 2: Adjusted 2035 AM and PM Peak Hour Turning Movement Summary

Intersection	Peak Hour	PHF	% HV	Approach											
				Eastbound			Northbound			Westbound			Southbound		
				Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Wyatt Way NW @ Madison Ave N	AM	0.91	1.3	87	84	146	43	128	7	8	25	4	11	272	43
Wyatt Way NW @ Grow NW	AM	0.85	2.1	43	276	114	52	31	20	10	99	5	19	72	23
Wyatt Way NW @ Madison Ave N	PM	0.96	0.8	85	78	146	152	459	28	22	171	15	16	341	80
Wyatt Way NW @ Grow NW	PM	0.93	1.3	19	274	97	116	63	8	12	346	21	17	56	23

4. Intersection Analysis

Design and Analysis Assumptions

The following criteria and assumptions were used for the analysis and design in this report:

- Existing Analysis Year = 2014
- Future Design Year = 2035
- Future peak hour factor: Used same as 2014
- Future Heavy Vehicle Percentage: Used same percentages as 2014
- Environment Factor = 1.1
- Annual Growth Rate = 0.9% (calculated from City of Bainbridge Transportation Model)
- HCM 2000 edition

[4] *City of Bainbridge Island 2012 Traffic Data*

Methodology

The following software and analyses were used to perform the intersection analysis:

- Stop control intersection analysis: Synchro 9.1 with Sim Traffic used to determine the 95 percentile queuing for All Way Stop Control situations (see Appendix C)
- Roundabout analysis: SIDRA, Version 3.2 (see Appendix D)
- Signal analysis: Synchro 9.1 for the traffic signal option (see Appendix E).

Design Vehicles

Madison Ave N provides freight access to a number of mixed use commercial businesses. As a result, the roundabout and signal concepts were designed to accommodate WB-40 vehicles in the north and south directions, and a 40 foot long bus making left turns to westbound Wyatt Way NW. The intersection with Grow Ave NW is not anticipated to larger trucks, so an SU-30 design vehicle was used. The SU-30 vehicle category includes those typically found on local streets, such as garbage trucks and delivery trucks (UPS, U-Haul, etc.).

Wyatt Way NW and Madison Ave N Intersection Analysis

A LOS and queuing analysis was performed for the no build, roundabout and traffic signal options at the intersection of Madison Ave N and Wyatt Way NW for the AM and PM peak hours. These software programs provide analysis based on the methodologies presented in the *Highway Capacity Manual* (HCM) (Transportation Research Board, 2000 Edition).The Synchro software can also can determine performance using methodologies from the 2010 HCM. However, this report used the 2000 HCM methodology to be consistent with the transportation element of the City Comprehensive Plan.

Intersection LOS and Delay

LOS	Signalized Delay per Vehicle (sec/veh)	Unsignalized Delay per Vehicle (sec/veh)
A	0-10	0-10
B	>10-20	>10-15
C	>20-35	>15-25
D	>35-55	>25-35
E	>55-80	>35-50
F	>80	>50

Source: 2000 Highway Capacity Manual

A summary of the 2014 and 2035 Wyatt Way NW and Madison Ave N intersection analysis for the roundabouts and traffic signal options is provided in Tables 3 and 4.

Table 3 shows a comparison of the LOS and average delay for the two intersection options. The results show that in 2035 the overall expected intersection delay is 10.7 seconds for both the traffic signal and urban compact roundabout options. The mini-roundabout shows slightly more delay at 13.4 seconds. All options are predicted to operate at LOS B in the future design year.

Table 3: PM Peak Hour LOS Summary –Wyatt Way NW and Madison Ave N

Traffic Control	2014 LOS[1] and Delay[2]				2035 LOS[1] and Delay[2]			
	No Build	Mini-Roundabout	Urban Roundabout	Traffic Signal	No Build	Mini-Roundabout	Urban Roundabout	Traffic Signal
SB Approach	D-32.2	A-8.9	A-7.9	A-5.5	**F-76.3**	A-5.5	B-10.6	A-9.0
NB Approach	**E-47.8**	B-11.6	A-9.2	A-5.7	**F-62.6**	A-5.7	B-11.7	B-10.3
WB Approach	C-22.8	A-9.2	A-7.7	B-12.0	**E-47.4**	B-12.0	B-10.7	B-10.9
EB Approach	C-23.1	A-7.3	A-6.7	B-11.4	**F-66.2**	B-11.4	A-9.0	B-13.2
Overall	**E-35.0**	**A-9.8**	**A-8.2**	**A-7.8**	**F-64.1**	**B-13.4**	**B-10.7**	**B-10.7**

1. Level of service, based on 2000 Highway Capacity Manual methodology.
2. Average delay in seconds per vehicle.

Table 4 shows a comparison of the 95th percentile approach queue lengths. Overall, this table indicates the roundabout options have shorter vehicle queues than the traffic signal options in the PM peak hour.

Table 4: PM Peak Hour Queue Summary Wyatt Way NW and Madison Ave N*

Traffic Control	2014 Queue Length (feet)				2035 Queue Length (feet)			
	No Build	Mini-Roundabout	Urban Roundabout	Traffic Signal	No Build	Mini-Roundabout	Urban Roundabout	Traffic Signal
SB Approach	139’	61’	55’	105’	146’	107’	89’	158’
NB Approach	111’	124’	102’	130’	265’	183’	134’	190’
WB Approach	63’	40’	35’	56’	94’	68’	56’	78’
EB Approach	77’	40’	36’	55’	109’	67’	61’	110’

*95th percentile queue length is based on the SIDRA analysis for roundabout and the Synchro analysis for traffic signals. Queue shown is the maximum after 2 cycles.

Roundabout Analysis

The following is a summary of the 2014 and 2035 intersection analysis for the roundabout option at Wyatt Way NW and Madison Ave N intersection using Sidra software:

- 2014 Intersection Analysis for Roundabout Options: A one lane urban compact roundabout in 2014 will operate at LOS A for PM peak hour. During the PM peak hour, the northbound 95th percentile queue length will be approximately 102 feet. The southbound 95th percentile queue length will be 55 feet. The average intersection delay will be 8.2 seconds per vehicle in the PM peak hour.

  A one lane mini-roundabout in 2014 will also operate at LOS A with an average intersection delay of 9.8 seconds per vehicle in the PM peak hour. The northbound 95th percentile queue length will be approximately 124 feet, and the southbound 95th percentile queue length will be 61 feet. While the mini-roundabout option is

expected to operate with slightly more delay and longer vehicle queues than the urban compact design, it still functions at LOS A.

- 2035 Intersection Analysis for Roundabout Options: The 2035 traffic analysis for a one lane urban compact roundabout shows that the overall operation will be LOS B during the PM peak hour. The 95th percentile northbound queue length will be 134 feet and the southbound 95th percentile queue length will be 89 feet. The average intersection delay will be 10.7 seconds per vehicle in the PM peak hour.

  The mini-roundabout in 2035 will also operate at LOS B with an average intersection delay of13.4 seconds per vehicle in the PM peak hour. The northbound 95th percentile queue length is approximately 183 feet, and the southbound will be 107 feet. Similar to 2014, the mini-roundabout option is expected to operate with slightly more delay and longer vehicle queues than the urban compact design and functions at LOS B.

Roundabout Options: Based on the traffic analysis for 2035, a roundabout at Wyatt Way NW and Madison Ave N will operate at LOS of B with an average intersection delay of 10.7 seconds per vehicle. The 2035 estimated approach volumes on Wyatt Way NW are 508 vehicles during the PM peak hour, and the approach volumes along Madison Ave N are forecast to be 1,076 vehicles. The proposed single lane roundabout will have more than enough capacity to handle traffic volumes in 2035.

Traffic Signal Analysis

The following is a summary of the 2014and 2035 intersection analysis for the traffic signal option at Wyatt Way NW and Madison Ave N intersection using Synchro software:

- 2014 Intersection Analysis for a Traffic Signal Option: For the signalized intersection option, one lane each direction, but no dedicated turn lanes, were assumed for the eastbound and westbound approaches along Wyatt Way NW, and single lane each direction with a left turn pocket for the northbound approach, and a single lane each direction only for the southbound approach along Madison Ave N. Based on the analysis, a traffic signal at the intersection will operate at LOS A during the PM peak period in 2014. The northbound 95th percentile queue length will be about 130 feet. The southbound queue length will be about 105 feet. The average intersection delay will be 7.8 seconds per vehicle in the PM peak.

- 2035 Intersection Analysis for a Traffic Signal Option: In 2035, a traffic signal at Wyatt Way NW and Madison Ave N will also operate at LOS B. The 95th percentile northbound queue length will be 190 feet and the southbound 95th percentile queue length will be 158 feet. The average intersection delay will be 10.7 seconds per vehicle in the PM peak.

Traffic Signal Option: Based on the traffic analysis for 2035, the Wyatt Way NW and Madison Ave N traffic signal will operate at LOS of B with an average intersection delay

of 10.7 seconds per vehicle in the PM peak hour. The 2035 estimated intersection approach volumes during the PM peak hour are 508 vehicles on Wyatt Way NW, and 1,076 on Madison Ave N. This intersection configuration also has the capacity to handle traffic volumes in 2035.

Wyatt Way NW and Grow Ave NW Intersection Analysis

A level of service (LOS) and queuing analysis was performed for the AWSC and TWSC options at Grow Ave NW and Wyatt Way NW for the AM and PM peak hours. This analysis was performed using Synchro 9.1 to analyze STOP controlled intersections, and Sim Traffic was used to determine the 95 percentile queuing for AWSC and TWSC situations (Appendices C and E).

2014 and 2035 Intersection Analysis for AWSC and TWSC

A summary of the 2014 and 2035 Wyatt Way NW and Grow Ave NW intersection analysis for the AWSC and TWSC is provided in Tables 5 and 6.

Table 5 shows a comparison of the LOS and average delay for the two intersection options. The results show that in 2035 the overall expected intersection delay is 28.2 seconds (LOS D) for the AWSC option. LOS measurements are not applicable to two-way stops, so the standard practice is to use the approach with the largest delay.

Table 5: PM Peak Hour LOS Summary –Wyatt Way NW and Grow Ave NW

	2014 LOS[1] and Delay[2]		2035 LOS[1] and Delay[2]	
Traffic Control	**AWSC**	**TWSC**	**AWSC**	**TWSC**
Southbound Approach	B-11.3	C-22.0	B-13.4	D-33.8
Northbound Approach	B-13.1	**F-57.5**	C-16.3	**F-195.2**
Westbound Approach	C-18.7	A-0.4	D-34.1	A-0.4
Eastbound Approach	C-16.2	A-0.6	D-31.7	A-0.6
Overall	**C-16.1**	**F-57.5**[3]	**D-28.2**	**F-195.2**[3]

1. Level of service, based on 2000 Highway Capacity Manual methodology.
2. Average delay in seconds per vehicle.
3. Worst approach values

Table 6 shows a comparison of the 95thpercentile approach queue lengths. Overall, this table indicates the northbound traffic experiences the longest queuing if the stop signs are removed from the east and westbound approaches in the PM peak hour.

Table 6: PM Peak Hour Queue Summary Wyatt Way NW and Grow Ave NW*

	2014 Queue Length		2035 Queue Length	
Traffic Control	AWSC	TWSC	AWSC	TWSC
Southbound Approach	48	38	57	69
Northbound Approach	92	146	135	298
Westbound Approach	77	1	116	1
Eastbound Approach	81	1	178	2

5. Safety Analysis

Wyatt Way NW Collision Analysis

Collisions occurring along Wyatt Way NW from Madison Ave N intersection to Lovell Ave NW intersection were examined in order to determine the safety operation and potential needs. Historical collision data for this section of Wyatt Way NW was provided by WSDOT for the 3 year period from 2013 to 2015. The purpose of this collision analysis is to identify potential safety "hot spots" and correctable collision types.

Along this section of Wyatt Way NW, there were a total of 9 collisions reported during the three year analysis period. These crash details are shown in the Appendix F. Of these collisions, two collisions were reported to have evident or possible injury collisions. There were no collisions with fatalities, serious injuries, bicycles or pedestrians reported.

The collision rate for Kitsap County in 2013 was 1.54 crashes per million vehicle miles travelled[5]. Typically, any intersection with a collision rate over one collision per one million vehicles per year should be monitored, and safety devices may be considered. Five collisions were at or related to the Wyatt Way NW and Madison Ave N intersection. Given the 2014 AADT the annual collision rate at the intersection is 0.319 per million vehicles (see table 5).

Table 7: Collision Rate Calculation at Wyatt Way and Madison Ave N

Number of intersection related crashes	5
Wyatt Way NW volume (ADT)	6,400
Madison Ave N volume (ADT)	7,900
Time period (years)	3
Collision Rate (per million entering vehicles) =(5*10^6)/(365*3*(6,400 +7,900))	0.319

[5] *Source: 2013 Washington State Annual Collision Summary*

There were three collisions reported at the Wyatt Way and Grow Ave NW intersection. Using the 2014 AADT the annual collision rate at the intersection is 0.308 per million vehicles (see table 6), which is also below the one per one million entering vehicles mark.

Table 8: Collision Rate Calculation at Wyatt Way and Grow Ave NW

Number of intersection related crashes	3
Wyatt Way NW volume (ADT)	6,400
Grow Ave NW volume (ADT)	2,500
Time period (years)	3
Collision Rate (per million entering vehicles) =(3*10^6)/(365*3*(6,400+2,500))	0.308

6. Discussion of Intersection Improvement Options

Wyatt Way and Madison Avenue

For the purposes of this section, a discussion of the no build scenario is not included because the intersection does not achieve the required LOS in accordance with the City's Island Wide Transportation Plan. Additionally, it is anticipated the intersection will function similar to the exiting condition but with additional delay due to traffic growth.

A traffic signal at the proposed intersection will not greatly reduce the speed of traffic approaching the intersection of Wyatt Way NW and Madison Ave N when drivers have a green light. Higher speed and stopping conditions associated with traffic signals typically result in higher number of rear-end collisions and angle-related collisions with greater severity of injuries than would be expected with a roundabout. A roundabout, whether it be an urban compact or mini, at the Wyatt Way NW and Madison Ave N intersection will help reduce traffic speeds along Wyatt Way NW approaching the intersection. Due to the angled approaches and the maneuvering necessary, vehicles must slow to navigate the intersection. Roundabouts will provide a safer travel speed, more in keeping with the emerging urban character of the area, and improve safety as vehicles approach the intersection.

A roundabout option will provide better overall traffic operations than a traffic signal. The Urban Compact design is projected to operate at LOS B throughout the design year of the project, as will the traffic signal. The mini-roundabout has a slightly more intersection delay, but still operates at LOS B. The roundabout options result in shorter queues than those anticipated with a traffic signal, and are expected to have a fewer and less severe collisions than what would be experienced if a traffic signal were installed due to reduced operating speeds, fewer conflict points, and yield control on all approach legs.

Operationally, roundabouts are expected to have a lower overall intersection delay than traffic signals or all-way stops by reducing the number and duration of stops. This provides environmental benefits in the form of noise and air quality impacts. Fuel consumption will

be reduced by reducing the number of acceleration/deceleration cycles and the time spent idling.

A comparison of vehicle-to-vehicle conflict points for a signalized intersection to a roundabout shows that there is a reduction in the number of conflict points with a roundabout. The most severe conflict points in an intersection are those associated with left turns and right angles. Roundabouts reduce vehicle crossing conflicts by converting all movements to right turns. Roundabouts have been proven to reduce collision severity due to lower operating speeds and the elimination of vehicle crossing conflicts. An Insurance Institute for Highway Safety (IIHS) study shows approximately a 76 percent reduction factor for injury collisions at roundabouts compared to signalized intersections.

A roundabout at Wyatt Way NW and Madison Ave N would be operationally compatible with the existing roundabout at High School Road and Madison Ave N.

As an option to the traditional roundabout, a smaller (mini) roundabout at Wyatt Way NW and Madison Ave N would minimize right-of-way acquisition while meeting pedestrian and traffic needs. A mini roundabout is a low-profile roundabout that provides a center island that is slightly elevated, visually dissimilar from the asphalt road, and drivable. Trucks crossing the intersection will have the option to go around the center island or drive over it. The low profile roundabout will function efficiently since the low profile center island will be clearly marked, routing vehicles around the center island in the through lanes. In addition, the splitter islands are typically narrower of constructed with mountable curbs. Narrow, mountable splitter islands do not offer much benefit as a refuge for pedestrians or bicycles as they cross a roadway.

Right of Way:

The right of way needs for a roundabout are greater than that needed for the roadway widening for the traffic signal improvements. The existing right of way width of Wyatt Way NW at Madison Ave N is 50 feet to the west, and only 30 feet to the east. Some right of way will need to be acquired in the NE corner for all alternatives in order to have room for sidewalks, curb ramps, and bicycle facilities. Planning level estimates for the amount of right of way needed for the Urban Compact roundabout option are 3,500 sf, while the mini-roundabout option is closer to 1,200 sf.

Preliminary layouts for the proposed two roundabout options at the Wyatt Way NW and Madison Ave N intersection are illustrated in Appendix A.

Estimated costs:

A high end planning level construction cost estimate for an urban compact roundabout can be as much as $575k. These estimates are for construction only, and does not include right of way costs, design, and construction management. There are a number of assumptions used in this estimate, such as the full replacement or removal of roadway elements that are included in the final scope. This estimate could be reduced through the design process as

the design details are decided upon and a closer look at quantities and construction needs are completed.

The planning level construction subtotal cost estimate for the traffic signal option is about $500K. Similar to the roundabout, this estimate is for construction only, and does not include right of way costs, environmental costs, design, and construction management.

For all of the intersection options, sidewalks and curb ramps may need to be reconstructed at Madison Ave N, Grow Ave NW and Lowell Ave NW to accommodate the proposed bike lanes and new sidewalks and comply with ADA requirements. Street lighting should also need to be improved with intersection modifications.

Pedestrian and Bicycle Access:

This project scope will construct missing stretches of curb, gutter, and sidewalk along both sides of Wyatt Way NW between Madison Ave N and Lovell Ave NW, connecting to existing facilities to the west, south, and east.

Roundabouts can reduce delay, improve safety, and provide for good connections for pedestrians and bicyclists. To improve bicycle connectivity, ramps are installed in the bike lanes at the roundabout approaches to provide cyclists the option of riding on the sidewalk or in the street. Drivers approaching a roundabout are slowing and prepared to stop if necessary. This reduces the number and severity of accidents. By eliminating left turns, there are fewer conflicting maneuvers for pedestrians and bicyclists to keep track of when crossing a roadway. In addition, depending on the design of the splitter island and location of the crosswalk, pedestrians may be able to cross one lane at a time, and use the splitter island as a refuge to wait until there is a safe opportunity to cross.

With traffic signals, drivers approaching the intersection with a green signal indication tend to travel at the posted or operating speed. One study that reviewed 1,297 signalized intersections found that 22% of pedestrian accidents involved left-turning vehicles[6]. Protected left turn phases can help reduce conflicts with pedestrians.

Wyatt Way and Grow Avenue

For the purposes of this section, a discussion of the no build scenario is included because the intersection achieves the required LOS in accordance with the City's Island Wide Transportation Plan. Additionally, it is anticipated the intersection will function similar to or better than the TWSC alternatives.

The existing AWSC (the No Build option) operates fairly safely and provides for good north/south connectivity for pedestrians and bicycles. The STOP controls for Wyatt Way NW help reduce vehicle speeds approaching the intersection and mitigate for the reduction of sight lines on Wyatt Way NW due to the vertical grade in the roadway. However, the

[6]Khasnabis, S., C.V. Zegeer, and M.J. Cynecki. Effects of Pedestrian Signals on Safety, Operations, and Pedestrian Behavior - Literature Review. In Transportation *Research Record 847, TRB, National Research Council, Washington, D.C., 1982*

reduced delay and vehicle queuing can also attract more drivers who are looking for the routes with the shortest travel time.

The TWSC option is intended to intentionally increase congestion on Grow Ave NW to help keep speeds slow and to hopefully minimize traffic growth related to its attractiveness as a cut-through route. By removing STOP signs on Wyatt Way NW, the north/south connectivity for pedestrians and bicycles is perceived reduced. Therefore, the options for using RRFB or HAWK beacons was looked at to help mitigate the removal of the STOP signs by raising driver awareness of pedestrians and cyclists. Removal of the STOP signs may increase the overall vehicle speeds, and would also raise the issue of limited sightlines due to the vertical grade of the roadway.

7. Comparison of Alternatives

There are a number of different factors that need to be considered when deciding on the best alternative for the situation. While performance and safety are certainly important, there are other key evaluation criteria as well. Capital costs are a critical factor, both for initial construction and ongoing maintenance. Right of way impacts is an important part related to cost in that the more right of way needed, the less of the project budget is available for construction. City values and goals are another consideration, where multimodal options, sidewalks, and preserving trees are priorities of the community that fit together to help improve livability. Given the differences in the operation of the intersections of Wyatt Way and Madison Ave and at Grow Ave, the decision on the best alternative at each is best considered independently while taking into consideration goals for the broader area.

Wyatt Way NW and Madison Ave N

Figure 2 summarizes key evaluation criteria for each of the intersection options considered.

Figure 2 - Wyatt Way and Madison Ave N Evaluation Matrix

Summary of Key Evaluation Criteria

Intersection Option	Future LOS Performance	Connectivity	Safety	Capital Costs	Operations (Cost & Maintenance)	Right-of-Way Impacts	Tree Impacts
All-Way Stop	🔴	🟢	🟡	🟢	🟢	🟢	🟢
Mini-Roundabout	🟢	🟢	🟢	🟡	🟢	🟡	🟡
Urban Compact Roundabout	🟢	🟢	🟢	🔴	🟢	🔴	🔴
Traffic Signal	🟢	🟢	🟡	🟡	🔴	🟢	🟢

Legend

🟢 Desireable 🟡 Neutral 🔴 Less desireable

Future LOS performance

The predicted LOS for the existing All-Way Stop is F, while the roundabouts and traffic signal alternatives operate at LOS B.

Connectivity

All the options will provide for the desired pedestrian and bicycle connectivity.

Safety

Roundabouts are considered to operate more safely than traffic signal and stop controlled intersections. The design of a roundabout reduces speeds and eliminates the right angle collision types that can result in serious injuries.

Capital Costs

The existing all way stop essentially has no cost. Traffic signals including paving of the intersection typically costs are in the $400K range. Mini and Urban Compact roundabouts can be $600k or more depending on right of way needs.

Operations and Maintenance Costs

Once built, roundabouts do not need additional maintenance other than landscaping, if included. Maintenance costs for stop signs is minimal. Traffic signal equipment needs to be inspected and maintained two to three times annually, and typically have a 20 year service life before needing replacement or upgrades. Also, traffic signal timings should be reviewed and optimized every three to five years.

Right of way impacts

The traffic signal concepts should not need additional right of way, unless more is desired for cabinet or pole placement. The mini roundabout alternative will require some additional right of way. The Urban compact roundabout alternative will need more right of way due it larger footprint.

Tree impacts

No tree impacts are anticipated for the existing or traffic signal alternatives. There will be some trees impacted by the mini roundabout, and some additional trees by the Urban Compact design.

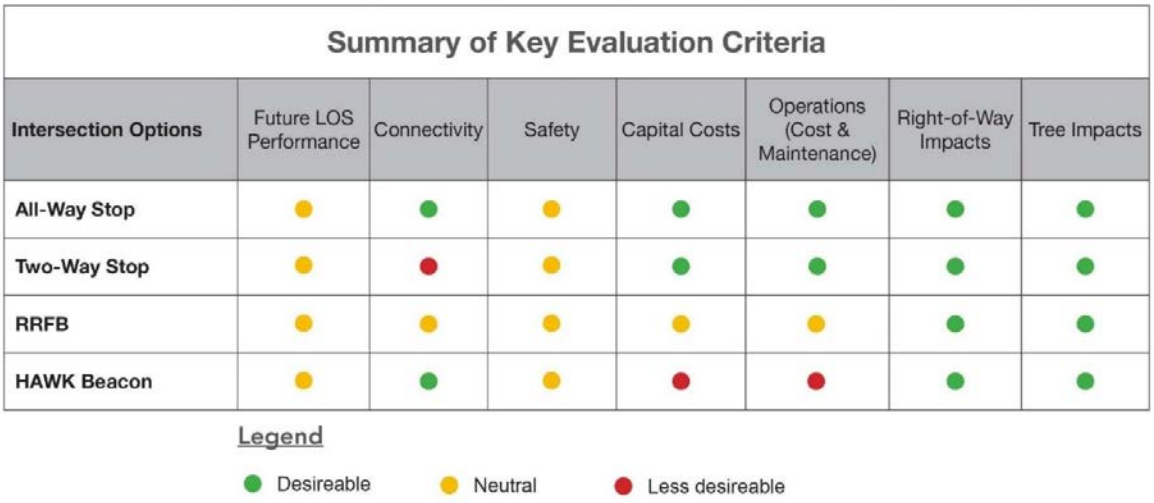
Community Feedback

As a part of the design process the City conducted a public outreach plan to solicit feedback on the potential intersection improvements and design alternatives. The outreach plan included two public meetings and additional feedback opportunities through the project website for community input. Based on comments received the public does not support a proposed traffic signal, with major concerns including: does not fit the character of the neighborhood, concerns with increased traffic speeds and there no other traffic signals on the island.

Wyatt Way NW and Grow Ave NW

Figure 3 summarizes key evaluation criteria for each of the intersection options considered.

Figure 3 - Wyatt Way and Grow Ave NW Evaluation Matrix



Future LOS performance

The predicted LOS for the existing AWSC is D, which still meets City standards. There is no methodology in the HCM for computing overall LOS for intersections with TWSC in that two approaches of an intersection are uncontrolled. Instead, the performance is measured by the stop controlled approach with the highest delay. For Grow Ave, if the traffic volumes increase as predicted, the LOS will be F on the northbound approach. Since there is no delay for Wyatt Way vehicles balanced with high delay for vehicles on Grow Ave, the performance in the chart was rated neutral.

Connectivity

With AWSC, the pedestrian and bicycle connectivity is good. Removing Stop signs on Wyatt Way increases delay for pedestrians and bicyclists as it may take longer to find safer crossing opportunities while waiting for drivers to stop. The TWSC with an RRFB device improves driver awareness and compliance for stopping for pedestrians. The HAWK has even better driver compliance.

Safety

The existing AWSC has three right angle crashes reported in the past three years. There were no pedestrian related crashed reported in the past five years. There is a 9% grade in the profile of Wyatt Way east of Grow Ave NW. This vertical alignment contributes to sight distance limitations for vehicles entering the intersection.

Changing this to TWSC will not reduce the likelihood of these right angle types of accidents. Adding RRFB devices will help driver compliance for stopping for pedestrians,

but does not address reducing collisions. The HAWK beacons also help pedestrians and bicycles cross, but does not affect vehicle safety.

Capital Costs

The HAWK beacon installation requires poles with mast arms and signal heads, foundations, and pedestrian push buttons – similar to a traffic signal. An RRFB installation does not require large poles and mast arms, so it does not need engineered foundations. The RRFB can be solar powered and use wireless communications to further keep costs down.

Operations and Maintenance Costs

Both the HAWK and RRFB systems could be added to the existing interlocal agreement with City of Bremerton. Inspections can be done annually.

Right of way impacts

None of the alternatives are expected to need additional right of way.

Tree impacts

None of the intersection alternatives are expected to impact trees beyond what is required to install new bike lanes, curbs and sidewalks, and curb ramps along Wyatt Way NW.

Community Feedback

Based on comments received the public does not support a two-way stopped controlled intersection. The intersection was previously a TWSC and community members recalled high traffic speeds and more frequent traffic accidents. Major concerns with a TWSC are:

- Increased traffic speeds along Wyatt Way
- Long wait times or less safe north/south crossings for people walking and biking along Grow Avenue NW
- Poor sight distances due to existing topography.

8. Summaries

Madison Ave N and Wyatt Way NW Intersection Analysis

The 2014 overall delay during the PM peak hour for the intersection of Madison Ave and Wyatt Way is 35 seconds, which is LOS D. By 2035, the delay is expected to increase to 64 seconds for the No Build scenario, which is LOS F. Building a traffic signal reduces the intersection delay in the PM peak to 10.7 seconds (LOS B). The proposed single-lane urban compact roundabout accommodates future traffic volumes (2035) in the PM peak hours at a LOS B with shorter queues than a traffic signal. The proposed mini-roundabout has slightly more overall delay, but still operates at LOS B and has shorter queues.

Compared to traffic signals, roundabouts are:

- more environmentally friendly,
- operate at lower speeds,
- typically have fewer and less severe collisions
- have lower annual operational costs than a signalized intersection
- have higher construction costs

Our planning level construction cost estimate for a mini-roundabout at this location is roughly $500k, and $575k for an urban compact roundabout (see Appendix G).

While initial construction costs for the traffic signal option are lower than a roundabout, maintenance and operational costs are higher. Traffic signal equipment needs to be inspected and maintained two to three times annually, and typically have a 20 year service life before needing replacement or upgrades. Also, traffic signal timings should be reviewed and optimized every three to five years.

Grow Ave NW and Wyatt Way NW Intersection Analysis

The 2014 overall delay during the PM peak hour for the intersection of Grow Ave NW and Wyatt Way NW is 16 seconds, which is LOS C. By 2035, the delay is expected to increase to 28 seconds for the No Build scenario, which is LOS D. Both the existing and the future condition Meet the City of Bainbridge Island standard of LOS D or better.

9. Recommendations

Madison Ave N and Wyatt Way NW

- All-way stop – Existing condition does not meet future LOS standards
- Traffic Signal – Option does not meet Community goals
- Mini roundabout – Option meets LOS, safety and community goals – Recommended in that this option has smaller footprint requiring less right of way and fewer impacts to adjacent trees and properties than the Urban Compact roundabout.
- Urban Compact roundabout – Option meets LOS, safety and community goals

Grow Ave NW and Wyatt Way NW

- All-way stop – Existing condition meets future LOS standards, safety and community non-motorized goals related to traffic speed and connectivity – Recommended in that this option satisfies the most goals for the least cost, including better connectivity without increasing speeds or other safety concerns. Traffic calming measures can also be used along Grow Ave NW, similar to Seattle's Neighborhood Greenways program, to help achieve higher use by pedestrians and bicycles.
- 2-way stop with RRFB – Option meets overall future LOS and safety goals, however, less consistent with community goals than an all-way stop
- 2-way stop with HAWK – Option meets overall future LOS and safety goals, however, less consistent with community goals than an all-way stop.

APPENDICIES

Appendix A: Concepts

Appendix B: Traffic Count Data

Appendix C: Sim Traffic

Appendix D: Sidra Outputs

Appendix E: Synchro Outputs

Appendix F: Collision Summary Report

Appendix G: Roundabout Construction Cost Estimates