

City of Bainbridge Island

Traffic Report

Focused Traffic Study

December 11, 2013



TABLE OF CONTENTS

1.0	EXECUTIVE SUMMARY.....	1
2.0	BLAKELY AVENUE NE.....	3
3.0	NE BUCKLIN HILL ROAD.....	9
4.0	FLETCHER BAY ROAD NE.....	13
5.0	LYNWOOD CENTER ROAD NE.....	19
6.0	PHELPS ROAD NE.....	25
7.0	PLEASANT BEACH DRIVE NE.....	31
8.0	SPORTSMAN CLUB ROAD NE.....	35
9.0	NE NEW BROOKLYN ROAD.....	39
10.0	LYNWOOD CENTER ROAD NE AND NE BAKER HILL ROAD.....	43
11.0	MILLER ROAD NE AND NE KOURA ROAD.....	49
12.0	NE VALLEY ROAD AND SUNRISE DRIVE NE.....	55
13.0	REFERENCES.....	61

LIST OF TABLES

TABLE 1-1: SUMMARY OF RECOMMENDATIONS.....	1
TABLE 2-1: CHARACTERISTICS SUMMARY BY ZONE FOR BLAKELY AVE NE.....	4
TABLE 2-2: CRASH REPORT SUMMARY FOR BLAKELY AVE NE.....	5
TABLE 2-3: CRASH RATES FOR BLAKELY AVE NE.....	5
TABLE 2-4: RADAR SPEED STUDY SUMMARY FOR BLAKELY AVE NE.....	6
TABLE 3-1: CHARACTERISTICS SUMMARY FOR NE BUCKLIN HILL RD.....	10
TABLE 3-2: CRASH REPORT SUMMARY FOR NE BUCKLIN HILL RD.....	11
TABLE 3-3: CRASH RATE FOR NE BUCKLIN HILL RD.....	11
TABLE 3-4: RADAR SPEED SURVEY FOR NE BUCKLIN HILL RD.....	11
TABLE 4-1: CHARACTERISTICS SUMMARY BY ZONE FOR FLETCHER BAY RD NE.....	14
TABLE 4-2: CRASH REPORT SUMMARY FOR FLETCHER BAY RD NE.....	15
TABLE 4-3: CRASH RATES FOR FLETCHER BAY RD NE.....	15
TABLE 4-4: RADAR SPEED STUDY SUMMARY FOR FLETCHER BAY RD NE.....	15
TABLE 5-1: CHARACTERISTICS SUMMARY BY ZONE FOR LYNWOOD CENTER RD NE.....	20
TABLE 5-2: CRASH REPORT SUMMARY FOR LYNWOOD CENTER RD NE.....	21
TABLE 5-3: CRASH RATES FOR LYNWOOD CENTER RD NE.....	21
TABLE 5-4: RADAR SPEED STUDY SUMMARY FOR LYNWOOD CENTER RD NE.....	22
TABLE 6-1: CHARACTERISTICS SUMMARY BY ZONE FOR PHELPS RD NE.....	26
TABLE 6-2: CRASH REPORT SUMMARY FOR PHELPS RD NE.....	27
TABLE 6-3: CRASH RATES FOR PHELPS RD NE.....	27
TABLE 6-4: RADAR SPEED STUDY SUMMARY FOR PHELPS RD NE.....	28
TABLE 7-1: CHARACTERISTICS SUMMARY FOR PLEASANT BEACH DR NE.....	32
TABLE 7-2: CRASH REPORT SUMMARY FOR PLEASANT BEACH DR NE.....	33
TABLE 7-3: CRASH RATE FOR PLEASANT BEACH DR NE.....	33
TABLE 7-4: RADAR SPEED STUDY SUMMARY FOR PLEASANT BEACH DR NE.....	33
TABLE 8-1: CHARACTERISTICS SUMMARY FOR SPORTSMAN CLUB RD NE.....	36
TABLE 8-2: CRASH REPORT SUMMARY FOR SPORTSMAN CLUB RD NE.....	37
TABLE 8-3: CRASH RATE FOR SPORTSMAN CLUB RD NE.....	37
TABLE 8-4: RADAR SPEED SURVEY FOR SPORTSMAN CLUB ROAD NE.....	37
TABLE 9-1: CHARACTERISTICS SUMMARY FOR NE NEW BROOKLYN RD AT NORTH TOWN DR NE.....	40
TABLE 9-2: RADAR SPEED SURVEY FOR NE NEW BROOKLYN RD.....	41
TABLE 10-1: CHARACTERISTICS SUMMARY FOR LYNWOOD CENTER RD NE & NE BAKER HILL RD.....	44
TABLE 10-2: CRASH REPORT SUMMARY FOR LYNWOOD CENTER RD NE & NE BAKER HILL RD.....	45
TABLE 10-3: INTERSECTION TURNING MOVEMENTS FOR LYNWOOD CENTER RD NE & NE BAKER HILL RD.....	45
TABLE 10-4: SYNCHRO ANALYSIS FOR LYNWOOD CENTER RD NE & NE BAKER HILL RD.....	45
TABLE 11-1: CHARACTERISTICS SUMMARY FOR THE INTERSECTION OF MILLER RD NE & NE KOURA RD.....	50
TABLE 11-2: CRASH REPORT SUMMARY FOR MILLER RD NE & NE KOURA RD.....	51
TABLE 11-3: INTERSECTION TURNING MOVEMENTS FOR MILLER RD NE & NE KOURA RD.....	51
TABLE 11-4: SYNCHRO ANALYSIS FOR MILLER RD NE & NE KOURA RD.....	52
TABLE 12-1: CHARACTERISTICS SUMMARY FOR THE INTERSECTION OF NE VALLEY RD & SUNRISE DR NE.....	56
TABLE 12-2: CRASH REPORT SUMMARY FOR NE VALLEY RD & SUNRISE DR NE.....	57
TABLE 12-3: INTERSECTION TURNING MOVEMENTS FOR NE VALLEY RD & SUNRISE DR NE.....	57
TABLE 12-4: RADAR SPEED STUDY SUMMARY FOR NE VALLEY RD.....	57
TABLE 12-5: SYNCHRO ANALYSIS FOR NE VALLEY RD & SUNRISE DR NE.....	58

LIST OF FIGURES

FIGURE 2-1: BLAKELY AVE NE CORRIDOR MAP WITH SIGNING.....	3
FIGURE 2-2: MIDDLE ZONE FACING NORTH.....	4
FIGURE 2-3: SOUTH ZONE FACING SOUTH.....	4
FIGURE 3-1: NE BUCKLIN HILL RD CORRIDOR MAP WITH SIGNING.....	9
FIGURE 3-2: FACING WEST NEAR BLAKELY AVE NE.....	10
FIGURE 3-3: FACING EAST NEAR FIRE STATION.....	10
FIGURE 3-4: PROPOSED NE BUCKLIN HILL RD SIGNING.....	12
FIGURE 4-1: FLETCHER BAY RD NE CORRIDOR MAP WITH SIGNING.....	13
FIGURE 4-2: FACING NORTH NEAR NE HIGH SCH. RD.....	14
FIGURE 4-3: S. ZONE NEAR LYNWOOD CTR. RD NE.....	14
FIGURE 5-1: LYNWOOD CENTER RD NE CORRIDOR MAP WITH SIGNING.....	19
FIGURE 5-2: N. ZONE NEAR FLETCHER BAY RD NE.....	20
FIGURE 5-3: S. ZONE AT POINT WHITE DR NE.....	20
FIGURE 6-1: PHELPS RD NE CORRIDOR MAP WITH SIGNING.....	25
FIGURE 6-2: N. ZONE NEAR MADISON AVE NE.....	26
FIGURE 6-3: GUARDRAIL ALONG WEST SIDE.....	26
FIGURE 7-1: PLEASANT BEACH DR NE CORRIDOR MAP WITH SIGNING.....	31
FIGURE 7-2: PLEASANT BEACH DR NE FACING NORTH.....	32
FIGURE 7-3: PLEASANT BEACH DR NE FACING SOUTH.....	32
FIGURE 8-1: SPORTSMAN CLUB RD NE CORRIDOR MAP WITH SIGNING.....	35
FIGURE 8-2: FACING SOUTH.....	36
FIGURE 8-3: FACING NORTH.....	36
FIGURE 9-1: NE NEW BROOKLYN RD CORRIDOR MAP WITH SIGNING.....	39
FIGURE 9-2: NE NEW BROOKLYN RD AT CROSSWALK.....	40
FIGURE 9-3: NE NEW BROOKLYN RD SCHOOL ZONE.....	40
FIGURE 9-4: EXAMPLE SIGNING PLAN FOR NE NEW BROOKLYN RD.....	42
FIGURE 10-1: SIGNING AT LYNWOOD CENTER RD NE & NE BAKER HILL RD.....	43
FIGURE 10-2: FACING NORTH.....	44
FIGURE 10-3: FACING WEST.....	44
FIGURE 10-4: MUTCD TRAFFIC SIGNAL PEAK HOUR WARRANT.....	46
FIGURE 11-1: SIGNING AT MILLER RD NE & NE KOURA RD.....	49
FIGURE 11-2: NW CORNER FACING NORTH.....	50
FIGURE 11-3: SW CORNER FACING SOUTH.....	50
FIGURE 11-4: MUTCD TRAFFIC SIGNAL PEAK HOUR WARRANT.....	53
FIGURE 12-1: SIGNING AT NE VALLEY RD & SUNRISE DR NE.....	55
FIGURE 12-2: WEST APPROACH.....	56
FIGURE 12-3: INTERSECTION FREIGHT DELIVERY.....	56
FIGURE 12-4: MUTCD TRAFFIC SIGNAL PEAK HOUR WARRANT.....	58

I.0 EXECUTIVE SUMMARY

A series of engineering studies was conducted for eight segments and three intersections for the City of Bainbridge Island to determine whether the existing traffic control is adequate given the geometric, environmental and traffic conditions. In addition to referencing data provided by the City, measurements were taken and analyzed to determine the appropriate traffic control for each location. Each section of the report includes a discussion of existing conditions, crash history, and issues that were identified during the study. The combination of these factors provides the basis for each recommendation. Table I-1 is a summary of the recommendations made based on location. Additional details are documented in the report.

Table I-1: Summary of Recommendations

Location	Study Type	Recommendation
Blakely Ave NE	Speed	Maintain speed limits. Install speed zone ahead signing.
NE Bucklin Hill Rd	Speed	Reduce speed limit to 30 mph.
Fletcher Bay Rd NE	Speed	Maintain speed limits.
Lynwood Center Rd NE	Speed	Shift speed zone locations. Install additional speed limit sign. Install reduced speed limit ahead sign.
Phelps Rd NE	Speed	Maintain speed limits. Install reduced speed limit ahead sign. Examine recommended speeds for curves.
Pleasant Beach Dr NE	Speed	Reduce speed limit to 20 mph. Install recommended speed and curve warning signs.
Sportsman Club Rd NE	Speed	Replace existing 30-mph speed sign with a school zone ahead sign. Maintain all other speed limit signs.
NE New Brooklyn Rd	School Zone	Incorporate crosswalk in school zone.
Lynwood Center Rd NE & NE Baker Hill Rd	Intersection	Maintain existing intersection traffic control. Relocate stop bars on NE Baker Hill Rd. Install crosswalk signing. Review crosswalk illumination.
Miller Rd NE & NE Koura Rd	Intersection	Maintain existing intersection traffic control. Remove vegetation to increase intersection sight distance on west leg. Install stop ahead sign.
NE Valley Rd & Sunrise Dr NE	Intersection	Maintain existing intersection traffic control. Install marked crosswalks and signing. Install stop bars. Install reduced speed limit ahead sign. Relocate speed limit signs.

2.0 ENGINEERING AND SPEED SURVEY – BLAKELY AVENUE NE: NE COUNTRY CLUB ROAD TO NE BUCKLIN HILL ROAD

Blakely Avenue NE is a minor arterial that connects Blakely Harbor to Bucklin Hill Road NE, which leads to the island’s central downtown area. Blakely Avenue NE runs north-south between NE Bucklin Road and W Blakely Ave NE. A horizontal curve in the vicinity of Birkland Rd NE changes the alignment to east-west. Blakely Ave NE has an average daily traffic volume of 3,500 vehicles per day (vpd). The primary objective for this study was to determine the appropriate speed limits for the corridor between NE Country Club Rd and NE Bucklin Hill Rd. Figure 2-1 shows the project limits with the posted regulatory and warning signing along the roadway.

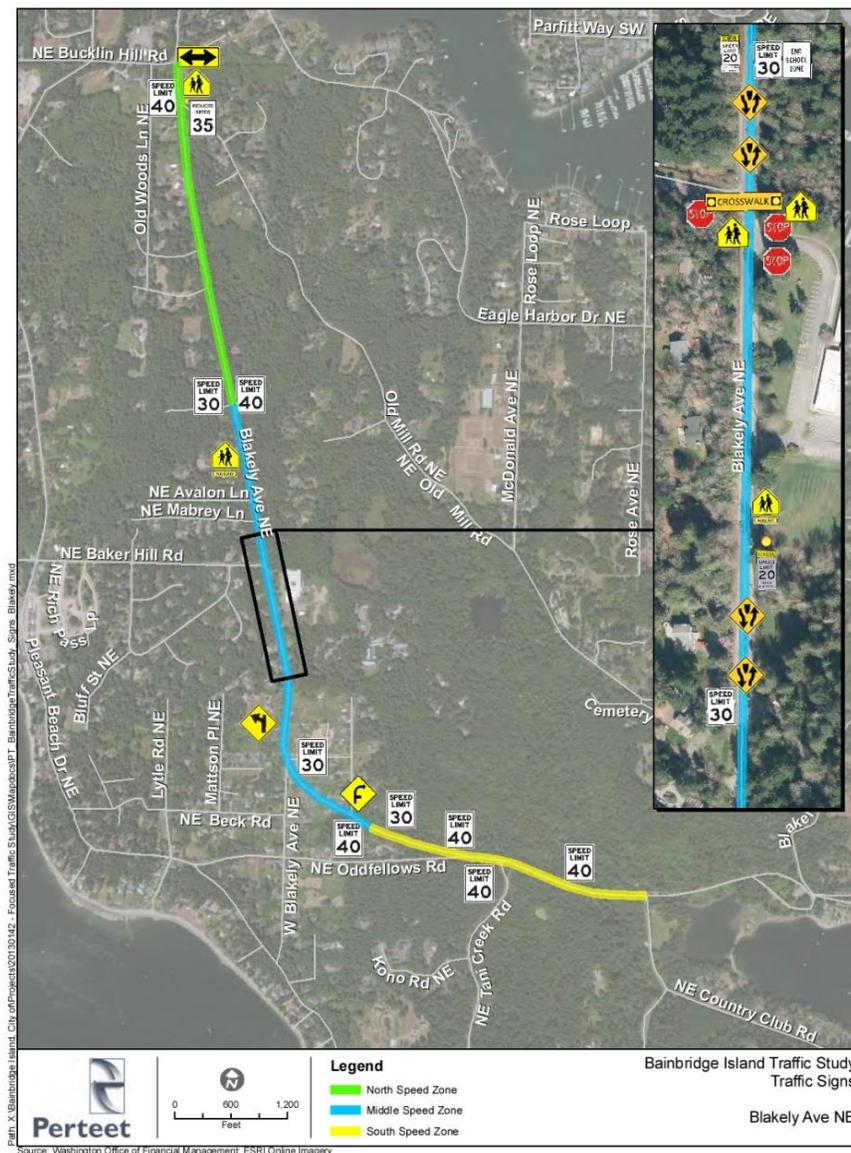


Figure 2-1: Blakely Ave NE corridor map with signing

2.1 Project Area Description



Figure 2-2: Middle zone facing north



Figure 2-3: South zone facing south

Blakely Ave NE has three marked speed zones with slightly varying characteristics. The attributes for the entire corridor are summarized in Table 2-1.

Table 2-1: Characteristics Summary by Zone for Blakely Ave NE

Item	North Speed Zone	Middle Speed Zone	South Speed Zone
Geometry			
Alignment	North-south	North-south	East-west
Lanes (per direction)	1	1	1
Lane Width	11'	11'	11'
Shoulder Width	1' to 2'	0.5'	0.5' to 3'
Horizontal Curves	Minor	Major near W Blakely Ave NE	Minor
Vertical Curves	Minor	Minor	Moderate near Birkland Rd NE
Surrounding Environment			
Setting	Forested	Forested, occasional open areas	Forested
Roadside Ditches	Infrequent	Infrequent	Infrequent
Driveways	Infrequent	Multiple for Cpt. Blakely Elem. School	Infrequent
Pull-Out Areas	Not present	Not present	Multiple (gravel)
Clear Zones	Infrequent trees	Overgrown vegetation, infrequent obstacles	Infrequent trees
Curb, Gutter and Sidewalk	Not present	Present only at SW and SE corners of intersection with NE Baker Hill Rd	Not present
Lighting	Not present	One streetlight at marked crosswalk	Not present

Traffic Control			
Lane Markings	Marked centerline and edge lines	Marked centerline and edge lines, marked bike lanes near Cpt. Blakely Elem. School	Marked centerline and edge lines
Speed Limit	40 mph	30 mph	40 mph
Major Intersections	Thru at NE Bucklin Hill Rd	Thru at NE Baker Hill Rd	Stop at Lynwood Center Rd NE
Additional Measures	None	Two traffic islands	None

2.2 Crash History

Twelve reported crashes have occurred along this segment from January 1, 2008 to June 30, 2013: six in the north segment, three in the middle, and three in the south. Each crash is summarized in Table 2-2.

Table 2-2: Crash Report Summary for Blakely Ave NE

Date	Time	Description
North Speed Zone		
05/12/2010	15:54	Intersection collision after driver failed to see other driver before turning
05/23/2010	23:23	Driver travelling greater than 50 mph left roadway, hit ditch and re-entered
06/03/2010	19:01	Driver lost control of vehicle due to seeing coyote
07/24/2010	11:25	Driver struck deer which jumped in front of vehicle
05/24/2011	13:10	Collision after one driver fell asleep at the wheel
06/08/2011	13:50	Driver left road, hit tree and landed on side due to deer running into road
Middle Speed Zone		
08/23/2008	13:27	Driver turning left was rear ended by a driver talking on a cell phone
12/19/2009	00:00	Driver struck a suddenly-appearing deer
01/04/2012	14:30	Vehicle turned into school parking lot and scraped a parked car
South Speed Zone		
01/29/2010	23:39	Inattentive driver struck fire hydrant
11/24/2012	21:42	Driver drifted off road into utility pole
06/22/2013	00:00	Driver drifted off road into ditch, overcorrected, crossed road, stuck tree

The crash rate for each speed zone was calculated based on the number of reported crashes, daily traffic volumes, segment length, and crash history duration. Table 2-3 summarizes the crash rates for Blakely Ave NE, with a comparison to county and statewide averages.

Table 2-3: Crash Rates for Blakely Ave NE

Location	Crashes	Average Daily Traffic (vpd)	Study Length (miles)	Crash History (months)	Crashes per Million Veh-Miles
Blakely Ave NE	12	3,500	2.23	66	0.77
North Speed Zone	6	3,500	0.87	66	0.98
Middle Speed Zone	3	3,500	0.71	66	0.61
South Speed Zone	3	3,500	0.65	66	0.66
Kitsap County¹	-	-	-	-	1.72
Washington State²	-	-	-	-	2.57

All three segments individually, as well as the corridor as a whole, have crash rates lower than the average for Kitsap County. The Federal Highway Administration (FHWA) recommends reducing speed limits if crash rates exceed the statewide average. The average crash rate for urban minor arterial state routes in Washington State is 2.57 crashes per million vehicle miles. No portion of Blakely Ave NE exceeds this crash rate. Therefore, the speed limits should not be reduced because of crash history.

2.3 Speed Survey

A radar speed survey was conducted on August 22, 2013 for all three segments. The weather was sunny, dry, and clear. Table 2-4 is a summary of these studies. Traffic was light, with virtually no platoons and a random flow rate.

Table 2-4: Radar Speed Study Summary for Blakely Ave NE

Location	Sample Size	Speed Limit (mph)	Mean Speed (mph)	10-mph Pace	Percent Within Pace	85 th Percentile Speed (mph)
North Speed Zone (1500' N of NE Baker Hill Rd)	99	40	40.7	36 to 46	90%	44.0
Middle Speed Zone (1000' S of NE Baker Hill Rd)	81	30	33.0	28 to 38	89%	37.0
South Speed Zone (800' W of NE Oddfellows Rd)	66	40	40.4	35 to 45	86%	44.0

North Speed Zone

The speed survey for the north speed zone reveals a high (90%) number of vehicles within the 10-mph pace speed, indicating a consistent flow speed.

The 85th percentile of 44.0 mph means that the posted speed limit of 40 mph may be too low for this segment. Established protocol suggests setting a speed limit so that at least 85% of drivers are within compliance. In this case, that would mean setting the speed limit at 45 mph. However, the difference between the current statutory speed limit and the 85th percentile speed is not extreme. Considering the low crash history and consistent driver speeds, it would be reasonable to maintain the current speed limit in this zone. Assuming no change in driver behavior, increasing the speed limit would decrease the percentage of drivers exceeding the speed limit from 59% (at 40 mph) to 6% (at 45 mph).

Middle Speed Zone

The speed survey for the middle speed zone reveals a high (89%) number of vehicles within the 10-mph pace speed, indicating a consistent flow speed.

The 85th percentile of 37.0 mph means that the currently posted speed limit of 30 mph is being deviated from by a majority of the vehicles on the roadway segment. With this sample, a lower posted speed limit would increase the percentage of drivers exceeding the posted limit from 75% (at 30 mph) to 99% (at 25 mph).

South Speed Zone

The speed survey for the south speed zone reveals a high (86%) number of vehicles within the 10-mph pace speed, indicating a consistent flow speed.

The 85th percentile of 44.0 mph means that the posted speed limit of 40 mph may be too low for this segment. Established protocol suggests setting a speed limit so that at least 85% of drivers are within compliance. In this case, that would mean setting the speed limit at 45 mph. However, the difference between the current statutory speed limit and the 85th percentile speed is not extreme. Considering the low crash history and consistent driver speeds, it would be reasonable to maintain the current speed limit in this zone. Assuming no change in driver behavior, increasing the speed limit would decrease the percentage of drivers exceeding the speed limit from 52% (at 40 mph) to 11% (at 45 mph).

2.4 Issues and Candidate Mitigation

Wild Animals – Four of twelve crash reports for this corridor cite wild animals as the primary cause. Animal-based crashes can be severe as drivers may swerve quickly to avoid the animal and lose control of the vehicle, exit the roadway, or strike a road user. Currently, there are no warning signs highlighting the presence of animals in the area. The WSDOT Traffic Manual recommends that one of the following criteria be met prior to installation of a deer crossing sign:

- (1) Minimum of 5 documented deer/vehicle collisions per mile per year for at least two of the past 10 years
- (2) Minimum of 10 carcass counts per mile per year for at least three of the past 10 years
- (3) Concurrence from region maintenance personnel

This analysis was only able to evaluate criterion (1) based on available information. There have been four collisions involving wildlife, and three related to deer, since 2008. This criterion is not met and, therefore, wildlife warning signs are not recommended.

Illumination – This corridor has no continuous illumination, which is consistent with rural areas throughout Bainbridge Island. There is illumination at the crosswalk at NE Baker Hill Rd. A lack of illumination can lead to drivers being unable to see their surroundings, including traffic control devices such as signs or obstacles such as animals that must be avoided. Because the City of Bainbridge Island does not have any warrants for illumination, this analysis used WSDOT warrants. Illumination is warranted along roadways of this type if the segment is classified as commercial and either the nighttime level of service is D or the nighttime crash warrant is satisfied. This roadway segment is not classified as commercial and, therefore, does not meet illumination warrants.

Bicycle Facilities – Multiple cyclists were observed during the radar speed study. The City of Bainbridge Island's Non-Motorized Transportation Plan (2008 revision) recommends bike lanes on both sides of Blakely Ave NE. The addition of bike lanes in this corridor would provide an increase in bicyclist safety.

Speed – Throughout the corridor, the 85th percentile speeds exceed the posted speed limit. The crash rate, which is below the average county and state rates, and a review of the collision descriptions do not indicate that current speed limits need to be modified. The difference between measured 85th

percentile speed and the posted speed limit in the north and south speed zones is less than 5 mph. The difference in the middle zone is 7 mph. This could be indicative of drivers that are unaware of the speed limit change.

Signing – Some signing in the corridor is not consistent with current Manual on Uniform Traffic Control Devices (MUTCD) standards. When the current W6-1 signs at each end of the median islands near Captain Blakely Elementary School reach the end of their functional life, they should be replaced by standard R4-7 signs³. Type 1 or Type 3 object markers should also be installed for increased visibility⁴. W3-5 or W3-5a signs should be installed in the southbound direction just north of the middle speed zone and in the northbound direction just south of the middle speed zone to inform drivers that they need to reduce their speed by at least 10 mph⁵.



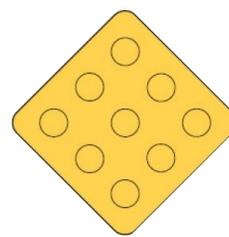
W6-1



R4-7



W3-5



Type 1



Type 3

2.5 Recommendation

The following is recommended for the Blakely Avenue NE corridor:

1. Maintain current speed limits and zones.
2. Replace existing W6-1 signs located in the median islands near Captain Blakely Elementary School at the end of their functional life with standard R4-7 signs and Type 1 object markers per the MUTCD.
3. Install reduced speed limit ahead warning signs (W3-5 and W3-5a) for both north and southbound traffic prior to entering the middle speed zone.

3.0 ENGINEERING AND SPEED SURVEY – NE BUCKLIN HILL ROAD: LYNWOOD CENTER ROAD NE TO BLAKELY AVENUE NE

NE Bucklin Hill Road is a minor arterial that connects Fletcher Bay Road NE, Lynwood Center Road NE, and Blakely Avenue NE to Eagle Harbor Drive NE. NE Bucklin Hill Rd has an average daily traffic of 2,800 vpd. The primary objective for this study was to determine the appropriate speed limits for the corridor between Lynwood Center Rd NE and Blakely Ave NE. Figure 3-1 shows the project limits with the posted regulatory and warning signing along the roadway.



Figure 3-1: NE Bucklin Hill Rd corridor map with signing

3.1 Project Area Description



Figure 3-2: Facing west near Blakely Ave NE



Figure 3-3: Facing east near fire station

NE Bucklin Hill Rd has the characteristic listed in Table 3-1.

Table 3-1: Characteristics Summary for NE Bucklin Hill Rd

Item		NE Bucklin Hill Rd
Geometry		
Alignment		East-west
Lanes (per direction)		1
Lane Width		11'
Shoulder Width		0 to 1'
Horizontal Curves		None
Vertical Curves		None
Surrounding Environment		
Setting		Mix of forested and clear
Roadside Ditches		Frequent
Private Driveways		Frequent
Pull-Out Areas		Not present
Clear Zones		Clear
Curb, Gutter and Sidewalk		Not present
Lighting		Street lights present near school and fire station
Traffic Control		
Lane Markings		Marked centerline and edge lines
Speed Limit		35 mph (see below)
Major Intersections		Stop at Blakely Ave NE, thru transition at Lynwood Center Rd NE

3.2 Crash Analysis

Three reported crashes have occurred along this segment from January 1, 2008 to June 30, 2013. Each crash is summarized in Table 3-2.

Table 3-2: Crash Report Summary for NE Bucklin Hill Rd

Date	Time	Description
04/24/2009	18:46	Driver drifted into opposing lane after taking curve at high speed; sideswipe
11/24/2009	21:47	Driver spun out and fishtailed into ditch after turning
01/20/2011	17:15	Driver hit oncoming driver after crossing center line

The crash rate for the corridor was calculated based on the number of reported crashes, daily traffic volumes, segment length, and crash history duration. Table 3-3 summarizes the crash rate for NE Bucklin Hill Rd, with a comparison to county and statewide averages.

Table 3-3: Crash Rate for NE Bucklin Hill Rd

Location	Crashes	Average Daily Traffic (vpd)	Study Length (miles)	Crash History (months)	Crashes per Million Veh-Miles
NE Bucklin Hill Rd	3	2,800	0.17	66	3.13
Kitsap County¹	-	-	-	-	1.72
Washington State²	-	-	-	-	2.57

The corridor has a higher crash rate than the Kitsap County average. FHWA recommends reducing speed limits if crash rates exceed the statewide average. The average crash rate for urban minor arterial state routes in Washington State is 2.57 crashes per million vehicle miles. NE Bucklin Hill Rd does exceed this crash rate. Therefore, it may be warranted to reduce the speed limit due to crash history.

3.3 Speed Survey

A radar speed survey was taken on November 4, 2013. The weather was partly sunny and dry. Table 3-4 is a summary of this study. Traffic was light, with virtually no platoons and a random flow rate.

Table 3-4: Radar Speed Survey for NE Bucklin Hill Rd

Location	Sample Size	Speed Limit (mph)	Mean Speed (mph)	10-mph Pace	Percent Within Pace	85 th Percentile Speed (mph)
NE Bucklin Hill Rd	94	35	31.4	27 to 37	90%	35.8

The speed survey reveals a high (90%) numbers of vehicles within the 10-mph pace speed, indicating a consistent flow speed.

The 85th percentile of 35.8 mph means that the currently posted speed limit of 35 mph is being followed by a majority of the vehicles on the roadway segment. Speed zoning theory best practices recommend that the 85th percentile speed be captured below the posted speed limit in most cases, suggesting that the speed limit should be increased to 40 mph. However, the difference between the posted speed limit and the 85th percentile speed is minimal. With this sample, a lower posted speed limit would increase the percentage of drivers exceeding the posted limit from 15% (at 35 mph) to 53% (at 30 mph).

3.4 Issues and Candidate Mitigation

Speed – In the current 35-mph speed zone, the 85th percentile speed closely matches the posted speed limit. The crash rate in the corridor exceeds both the Kitsap County and WA State averages. However, an analysis of the crash rate reveals that only two of the reported crashes involved multiple vehicles, the other was a driver who fishtailed. Both of the remaining crashes were sideswipes in which one driver crossed the double-yellow centerline. This type of collision suggests that speed alone may not be the reason behind the issue of optimal safety in this segment. There are other factors to consider; limited roadway width, a school / pedestrian environment, significant bicycle presence and a lack of segregated non-motorized facilities should be taken into consideration. The City’s Non-Motorized Transportation Plan calls for bike lanes on either side of NE Bucklin Hill Rd. Once installed, these lanes will allow for emergency maneuver room which should reduce the likelihood of future crashes due to vehicles crossing the centerline. In the interim, a reduction in posted speed limit may alter driver behavior in the segment to reduce the potential for traffic accident.

3.5 Recommendation

The following is recommended for the NE Bucklin Hill Rd corridor:

1. Reduce the posted speed limit in this segment of the corridor from the existing 35 mph to 30 mph until planned roadway improvements to provide segregated non-motorized facilities are in place. Figure 3-4 provides a possible signing configuration for the segment.



Figure 3-4: Proposed NE Bucklin Hill Rd signing

4.0 ENGINEERING AND SPEED SURVEY – FLETCHER BAY ROAD NE: LYNWOOD CENTER ROAD NE TO NE HIGH SCHOOL ROAD

Fletcher Bay Road NE is a minor arterial that connects Lynwood Center Road NE to NE High School Road and Miller Road NE. Fletcher Bay Rd NE has an average daily traffic of 5,000 vpd. The primary objective for this study was to determine the appropriate speed limits for the corridor between Lynwood Center Rd NE and NE High School Rd. Figure 4-1 shows the project limits with the posted regulatory and warning signing along the roadway.

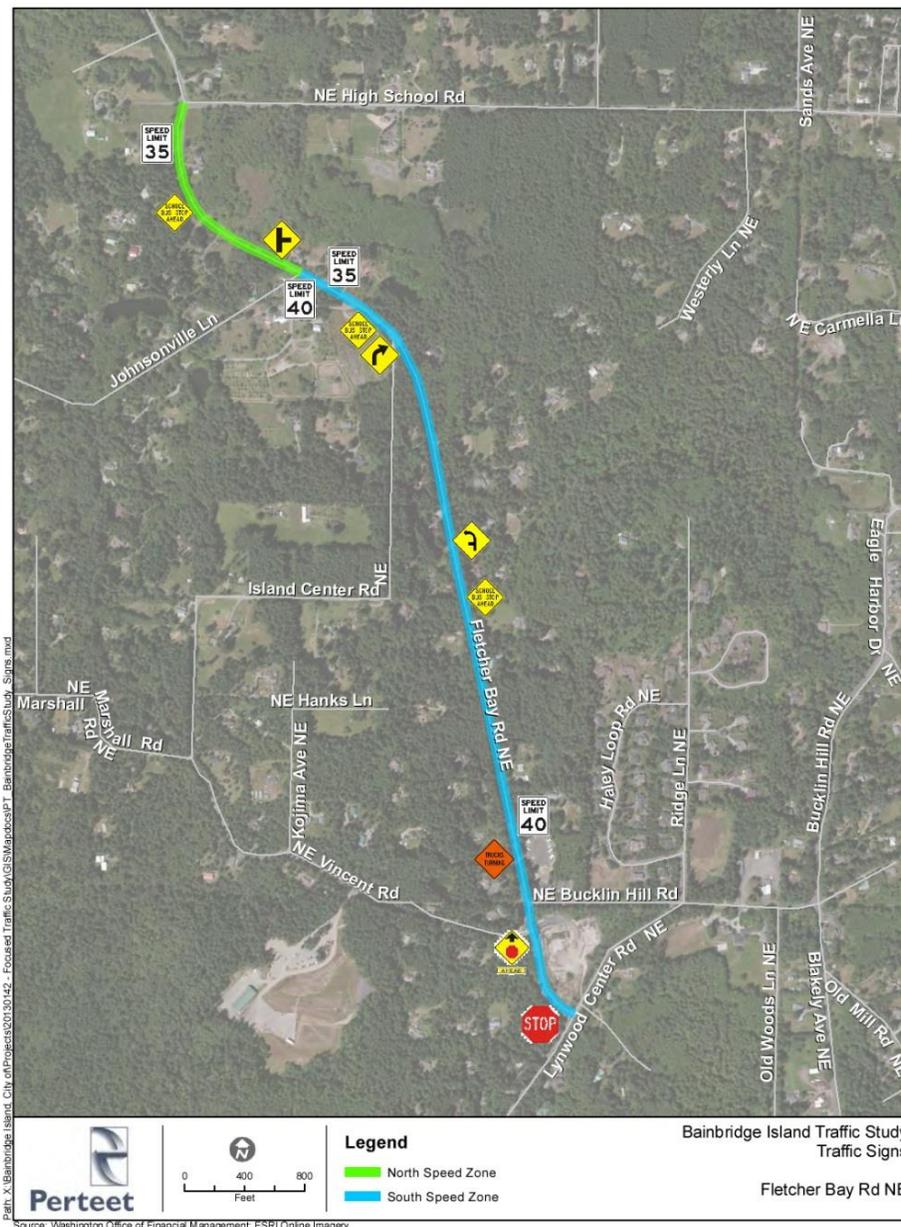


Figure 4-1: Fletcher Bay Rd NE corridor map with signing

4.1 Project Area Description



Figure 4-2: Facing north near NE High Sch. Rd



Figure 4-3: S. zone near Lynwood Ctr. Rd NE

Fletcher Bay Rd NE has two marked speed zones with slightly varying characteristics. The attributes for the entire corridor are summarized in Table 4-1.

Table 4-1: Characteristics Summary by Zone for Fletcher Bay Rd NE

Item	North Speed Zone	South Speed Zone
Geometry		
Alignment	North-south	North-south
No. of Lanes (per direction)	1	1
Lane Width	12'	12'
Shoulder Width	0.5' to 3'	0.5' to 3'
Horizontal Curves	Multiple, large	Major near Lynwood Ctr Rd NE
Vertical Curves	Minor	Minor
Surrounding Environment		
Setting	Forested	Forested
Roadside Ditches	Infrequent	Infrequent
Private Driveways	Infrequent	Infrequent
Pull-Out Areas	Not present	Multiple, gravel
Clear Zones	Infrequent trees	Infrequent trees
Curb, Gutter and Sidewalk	Not present	Not present
Lighting	Not present	Not present
Traffic Control		
Lane Markings	Marked centerline and edge lines	Marked centerline and edge lines
Speed Limit	35 mph	40 mph
Major Intersections	Thru at NE High School Rd	Stop at Lynwood Center Rd NE

4.2 Crash History

Two reported crashes have occurred along this segment from January 1, 2008 to June 30, 2013. Both of these crashes occurred in the north speed zone. Each crash is summarized in Table 4-2.

Table 4-2: Crash Report Summary for Fletcher Bay Rd NE

Date	Time	Description
North Speed Zone		
03/14/2008	20:48	Driver crossed road centerline and struck oncoming vehicle
12/30/2008	06:00	Vehicle left roadway and rolled, due to icy conditions

The crash rate for each speed zone was calculated based on the number of reported crashes, daily traffic volumes, segment length, and crash history duration. Table 4-3 summarizes the crash rates for Fletcher Bay Rd NE, with a comparison to county and statewide averages.

Table 4-3: Crash Rates for Fletcher Bay Rd NE

Location	Crashes	Average Daily Traffic (vpd)	Study Length (miles)	Crash History (months)	Crashes per Million Veh-Miles
Fletcher Bay Rd NE	2	5,000	1.35	66	0.15
North Speed Zone	2	5,000	0.55	66	0.36
South Speed Zone	0	5,000	0.80	66	0.00
Kitsap County¹	-	-	-	-	1.72
Washington State²	-	-	-	-	2.57

Both segments individually, as well as the corridor as a whole, have crash rates lower than the average for Kitsap County. FHWA recommends reducing speed limits if crash rates exceed the statewide average. The average crash rate for urban minor arterial state routes in Washington State is 2.57 crashes per million vehicle miles. No portion of Fletcher Bay Rd NE exceeds this crash rate. Therefore, the speed limits should not be reduced because of crash history.

4.3 Speed Survey

A radar speed survey was conducted on August 22, 2013 for both segments. The weather was sunny, dry, and clear. Table 4-4 is a summary of these studies. Traffic was light, with virtually no platoons and a random flow rate.

Table 4-4: Radar Speed Study Summary for Fletcher Bay Rd NE

Location	Sample Size	Speed Limit (mph)	Mean Speed (mph)	10-mph Pace	Percent Within Pace	85 th Percentile Speed (mph)
North Speed Zone (550' S of NE High School Rd)	84	35	34.8	29 to 39	95%	38.0
South Speed Zone (800' N of NE Bucklin Hill Rd)	96	40	39.0	36 to 46	88%	42.5

North Speed Zone

The speed survey for the north speed zone reveals a high (95%) number of vehicles within the 10-mph pace speed, indicating a consistent flow speed.

The 85th percentile of 38.0 mph means that the currently posted speed limit of 35 mph is being followed by a majority of the vehicles on the roadway segment. Established protocol suggests setting a speed limit so that at least 85% of drivers are within compliance. In this case, that would mean setting the speed limit at 45 mph. However, the difference between the current statutory speed limit and the 85th percentile speed is not extreme. Considering the low crash history and consistent driver speeds, it would be reasonable to maintain the current speed limit in this zone. Assuming no change in driver behavior, lowering the posted speed limit would increase the percentage of drivers exceeding the posted limit from 45% (at 35 mph) to 90% (at 30 mph).

South Speed Zone

The speed survey for the south speed zone also reveals a high (88%) number of vehicles within the 10-mph pace speed, indicating a consistent flow speed.

The 85th percentile of 42.5 mph means that the currently posted speed limit of 40 mph is being followed by a majority of the vehicles on the roadway segment. Established protocol suggests setting a speed limit so that at least 85% of drivers are within compliance. In this case, that would mean setting the speed limit at 45 mph. However, the difference between the current statutory speed limit and the 85th percentile speed is not extreme. Considering the low crash history and consistent driver speeds, it would be reasonable to maintain the current speed limit in this zone. Assuming no change in driver behavior, lowering the posted speed limit would increase the percentage of drivers exceeding the posted limit from 33% (at 40 mph) to 87% (at 35 mph).

4.4 Issues and Candidate Mitigation

Speed – Throughout the corridor, the 85th percentile speeds exceed the posted speed limit. The crash rate, however, does not suggest that current speed limits need to be reduced. Because the speed differences are not extreme and the crash rate is low, the speed limits for Fletcher Bay Rd NE are appropriate.

Illumination – This corridor has no continuous illumination, which is consistent with rural areas throughout Bainbridge Island. A lack of illumination can lead to drivers being unable to see their surroundings, including traffic control devices such as signs or obstacles such as animals that must be avoided. Because the City of Bainbridge Island does not have any warrants for illumination, this analysis used WSDOT warrants. Illumination is warranted along roadways of this type if the segment is classified as commercial and either the nighttime level of service is D or the nighttime crash warrant is satisfied. This roadway segment is not classified as commercial and, therefore, does not meet illumination warrants.

Bicycle Facilities – Multiple cyclists were observed during the speed study. The City of Bainbridge Island's Non-Motorized Transportation Plan (2008 revision) recommends shoulder bike lanes on both sides of Fletcher Bay Rd NE. The addition of bike lanes in this corridor would provide an increase in bicyclist safety.

4.5 Recommendation

The following is recommended for the Fletcher Bay Rd NE corridor:

- I. Maintain current speed limits and zones.

5.0 ENGINEERING AND SPEED SURVEY – LYNWOOD CENTER ROAD NE: POINT WHITE DRIVE NE TO NE BUCKLIN HILL ROAD

Lynwood Center Road NE is a minor arterial that connects the middle of Bainbridge Island to the Lynwood Center commercial district. Lynwood Center Rd NE has an average daily traffic volume of 3,850 vpd. The primary objective for this study was to determine the appropriate speed limits for the corridor between Point White Drive NE and NE Bucklin Hill Road. Figure 5-1 shows the project limits with the posted regulatory and warning signing along the roadway.

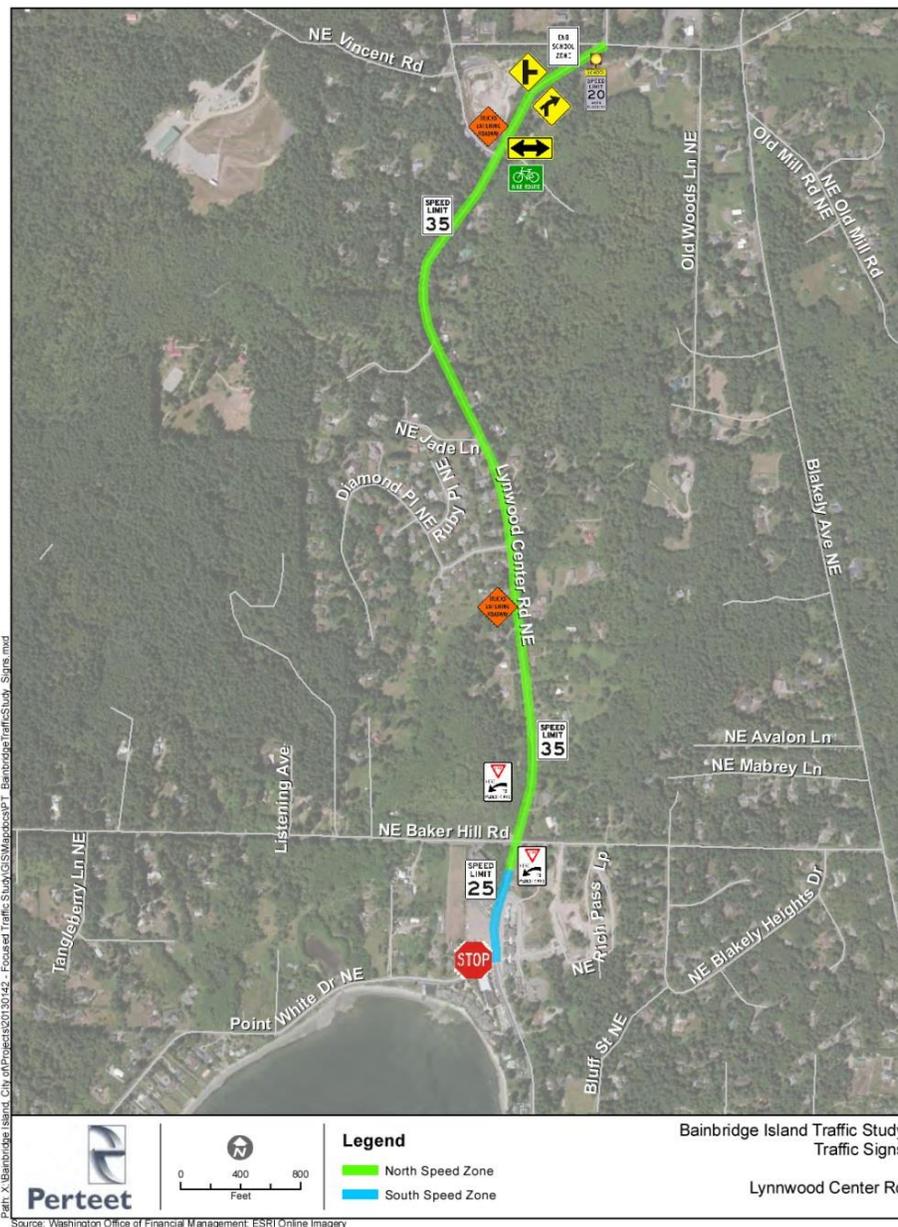


Figure 5-1: Lynwood Center Rd NE corridor map with signing

5.1 Project Area Description



Figure 5-2: N. zone near Fletcher Bay Rd NE



Figure 5-3: S. zone at Point White Dr NE

Lynwood Center Rd NE has two marked speed zones with varying characteristics. The attributes for the entire corridor are summarized in Table 5-1. The intersection with Baker Hill Rd is discussed in depth in Chapter 10 of this report.

Table 5-1: Characteristics Summary by Zone for Lynwood Center Rd NE

Item	North Speed Zone	South Speed Zone
Geometry		
Alignment	North-south	North-south
No. of Lanes (per direction)	1	1
Lane Width	11'	11'
Shoulder Width	1' (SB) and 3' (NB)	0.5' to 3'
Horizontal Curves	Major near NE Bucklin Hill Rd	Minor
Vertical Curves	Minor	Minor
Surrounding Environment		
Setting	Forested	Commercial
Roadside Ditches	Infrequent	Infrequent
Private Driveways	Infrequent	Infrequent
Pull-Out Areas	Multiple, gravel	Multiple, gravel
Clear Zones	Frequent obstacles, occasionally encroaching vegetation	Infrequent trees
Curb, Gutter and Sidewalk	Not present	Present, both sides
Lighting	Not present	Present
Parking	Not present	Present, angled and straight
Traffic Control		
Lane Markings	Marked centerline and edge lines	Marked centerline and edge lines, 4' bike lanes on either side
Speed Limit	35 mph	25 mph
Major Intersections	Thru at NE Baker Hill Rd and NE Bucklin Hill Rd	Stop at Lynwood Center Rd NE
Additional Measures	Marked crosswalk at south leg of NE Baker Hill Rd intersection	Multiple marked crosswalks

5.2 Crash History

Eleven reported crashes have occurred along this segment from January 1, 2008 to June 30, 2013. Of these, nine have occurred in the north segment and two in the south segment. Each crash is summarized in Table 5-2.

Table 5-2: Crash Report Summary for Lynwood Center Rd NE

Date	Time	Description
North Speed Zone		
01/23/2008	08:50	Driver turned on to Lynwood Center Rd NE and lost control due to ice
08/08/2008	21:14	Driver struck deer
01/27/2009		Driver slid on wet/snowy pavement, vehicle flipped and landed on its top
12/12/2008	16:09	Tree limb fell on vehicle
05/07/2009	15:25	Driver crossed centerline, struck two vehicles, sending one over a steep embankment
06/30/2010	00:38	Cyclist lost control and slid off shoulder into ravine
07/31/2010	11:00	Single car rollover, found abandoned
03/28/2012	23:05	Driver took corner too fast, overcorrected and went into ditch
03/20/2013	02:30	Driver unable to negotiate curve on wet roadway
South Speed Zone		
10/23/2008	22:26	Bicyclist struck pedestrian
05/24/2010	12:00	Driver backed out of parking space into another parked vehicle

The crash rate for each speed zone was calculated based on the number of reported crashes, daily traffic volumes, segment length, and crash history duration. Table 5-3 summarizes the crash rates for Lynwood Center Rd NE, with a comparison to county and statewide averages.

Table 5-3: Crash Rates for Lynwood Center Rd NE

Location	Crashes	Average Daily Traffic (vpd)	Study Length (miles)	Crash History (months)	Crashes per Million Veh-Miles
Lynwood Center Rd NE	11	3,850	1.30	66	1.12
North Speed Zone	9	3,850	1.15	66	1.00
South Speed Zone	2	3,850	0.15	66	2.24
Kitsap County¹	-	-	-	-	1.72
Washington State²	-	-	-	-	2.57

The north speed zone and corridor as a whole have crash rates below the Kitsap County average. The south section has a higher crash rate though it has seen much fewer crashes since 2008 due primarily to segment length. A review of the two crashes in this segment indicates that speed may only be a factor in the bicycle-pedestrian crash. Removal of the parking vehicle collision results in a crash rate of 1.12, which is lower than the county rate. FHWA recommends reducing speed limits if crash rates exceed the statewide average. The average crash rate for urban minor arterial state routes in Washington State is 2.57 crashes per million vehicle miles. No portion of Lynwood Center Rd NE exceeds this crash rate. Based on this and a review of the crash descriptions, the speed limits should not be reduced because of crash history.

5.3 Speed Survey

A radar speed survey was conducted on August 22, 2013 for the north segment and September 19, 2013 for the south segment. On each day, the weather was sunny, dry, and clear. Table 5-4 is a summary of this study. Traffic was light, with virtually no platoons and a random flow rate.

Table 5-4: Radar Speed Study Summary for Lynwood Center Rd NE

Location	Sample Size	Speed Limit (mph)	Mean Speed (mph)	10-mph Pace	Percent Within Pace	85 th Percentile Speed (mph)
North Speed Zone (½ mi N of NE Baker Hill Rd)	93	35	38.2	34 to 44	88%	41.9
South Speed Zone (Near Woodson Lane NE)	107	25	26.4	22 to 32	84%	31.0

North Speed Zone

The speed survey for the north speed zone reveals a high (88%) number of vehicles within the 10-mph pace speed, indicating a consistent flow speed.

The 85th percentile of 41.9 mph means that the currently posted speed limit of 35 mph is being deviated from by a high number of drivers. Established protocol suggests setting a speed limit so that at least 85% of drivers are within compliance. In this case, that would mean setting the speed limit at 45 mph. However, based on the crash history, which includes several incidents involving drivers losing control on large curves, raising the speed limit is not recommended. Lowering the speed limit does not tend to increase compliance with the posted speed limit, though it would likely lower average travel speeds. Assuming no change in driver behavior, lowering the posted speed limit would increase the percentage of drivers exceeding the posted limit from 80% (at 35 mph) to 98% (at 30 mph).

South Speed Zone

The speed survey for the north speed zone reveals a high (84%) number of vehicles within the 10-mph pace speed, indicating a consistent flow speed.

The 85th percentile of 31.0 mph means that the currently posted speed limit of 25 mph is being deviated from by a high number of drivers. Established protocol suggests setting a speed limit so that at least 85% of drivers are within compliance. In this case, that would mean setting the speed limit at 35 mph. However, based on the commercial nature of the area and high pedestrian volumes, it is not recommended to raise the speed limit. Doing so would reduce the percentage of drivers exceeding the posted limit from 55% (at 25 mph) to 16% (at 30 mph). Lowering the speed limit does not tend to increase compliance with the posted speed limit, though it would likely lower average travel speeds. Assuming no change in driver behavior, lowering the posted speed limit would increase the percentage of drivers exceeding the posted limit from 55% (at 25 mph) to 94% (at 20 mph).

5.4 Issues and Candidate Mitigation

Speed – Throughout the corridor, the 85th percentile speeds exceed the posted speed limit. In the north speed zone, excessive speeds may be contributing to an increased crash rate because of drivers losing control on the large curve between Fletcher Bay Rd NE and NE Baker Hill Rd, so an increased speed limit is not recommended. Conversely, the north speed zone crash rate is still below county and statewide averages, so a reduced speed is not recommended. To improve compliance in the north speed zone, additional speed limit signs should be installed to inform drivers of the appropriate speed. This treatment should be monitored to gauge if compliance increases. In the commercial area, the current speed limit of 25 mph is consistent with similar areas on the island. The crash history and high pedestrian volumes suggest that the speed is appropriate. To improve compliance as drivers enter the speed zone from the north, a W3-5 (reduced speed limit ahead) sign should be installed before drivers enter the 25-mph speed zone. Northbound traffic through the south zone is adequately controlled by stop signs and crosswalks and slightly higher speeds beyond the commercial area do not pose a safety threat.



Speed Zone Limits – The speed limits at the intersection with NE Baker Hill Rd are not consistent: southbound traffic is operating under a 35-mph speed limit while northbound traffic is in a 25-mph zone. Speed zones should be consistent whenever possible to improve driver expectations. Because the intersection of Lynwood Center Rd NE and NE Baker Hill Rd has a marked pedestrian crosswalk across the south leg with a bus stop at the southeast corner, and the surrounding environment changes abruptly between commercial and rural at the intersection, the posted speed limit should match the lower of the two values. In the northbound direction, the current 35-mph speed limit sign should remain in place. In the southbound direction, the 25-mph speed limit sign should be moved to match the opposing speed limit sign.

Illumination – This north speed zone has no illumination, which is consistent with rural areas throughout Bainbridge Island. A lack of illumination can lead to drivers being unable to see their surroundings, including traffic control devices such as signs or obstacles such as animals that must be avoided. Because the City of Bainbridge Island does not have any warrants for illumination, this analysis used WSDOT warrants. Illumination is warranted along roadways of this type if the segment is classified as commercial and either the nighttime level of service is D or the nighttime crash warrant is satisfied. This north speed zone segment is not classified as commercial and, therefore, does not meet illumination warrants.

Bicycle Facilities – Multiple cyclists were observed during the radar speed study. The City of Bainbridge Island's Non-Motorized Transportation Plan (2008 revision) recommends bike lanes on both sides of Lynwood Center Rd NE. The addition of bike lanes in this corridor would provide an increase in bicyclist safety.

5.5 Recommendation

The following is recommended for the Lynwood Center Rd NE corridor:

1. Make the speed limits near NE Baker Hill Rd consistent by moving the existing 25-mph speed limit sign to be in-line with the existing 35-mph speed limit sign in the northbound direction north of the intersection.
2. Add one additional 35-mph speed limit sign in the north speed zone in the southbound direction, prior to entering the large horizontal curve.
3. Install a reduced speed limit ahead (W3-5) sign prior to the relocated 25-mph speed sign for southbound traffic. Monitor effectiveness of treatment.

6.0 ENGINEERING AND SPEED SURVEY – PHELPS ROAD NE: NE DAY ROAD TO MADISON AVENUE NE

Phelps Road NE is a minor arterial that connects the Port Madison area to SR-305. Phelps Rd NE has an average daily traffic volume of 1,350 vpd. The primary objective for this study was to determine the appropriate speed limits for the corridor between NE Day Road and Madison Avenue NE. Figure 6-1 shows the project limits with the posted regulatory and warning signing along the roadway.

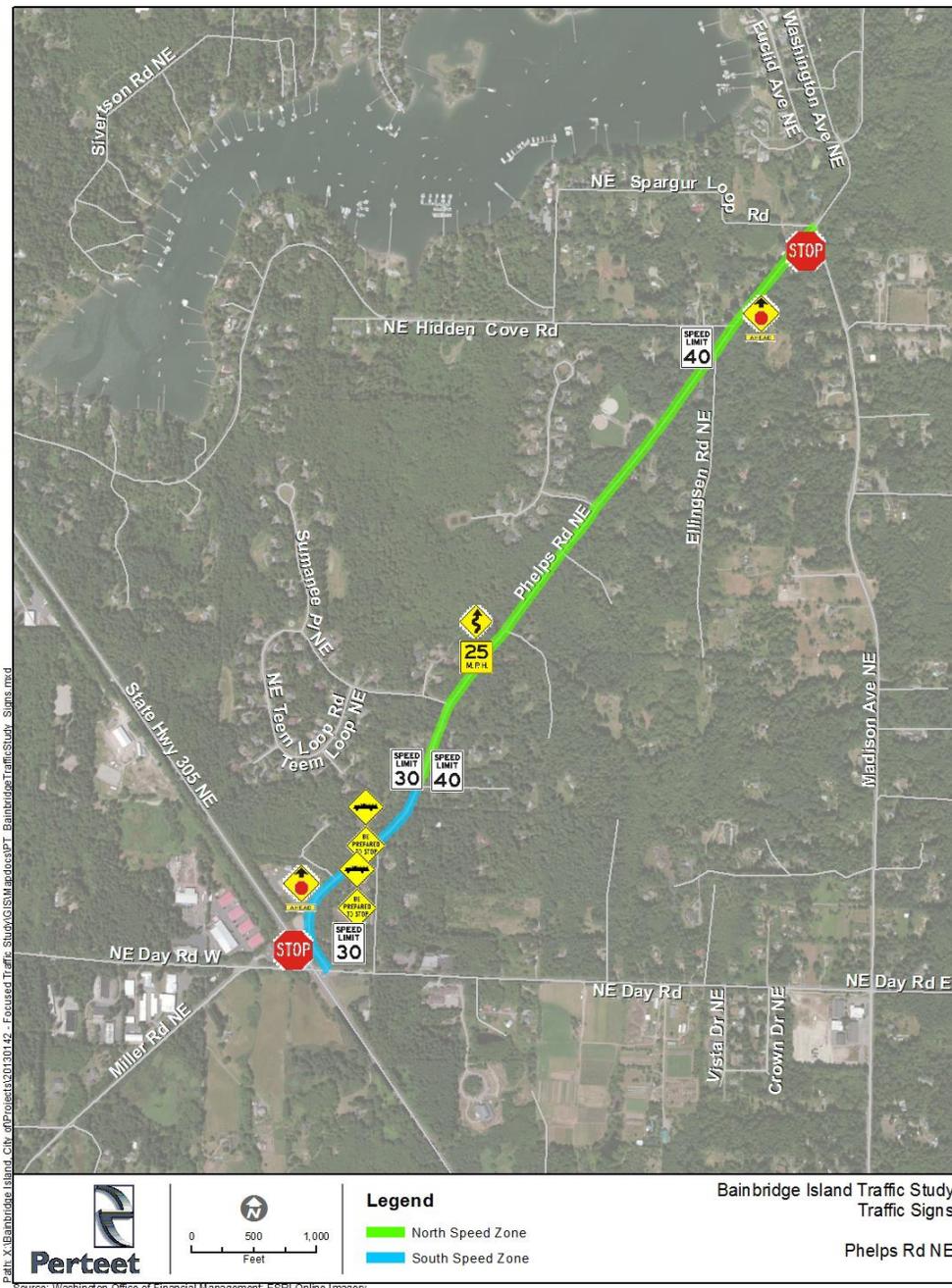


Figure 6-1: Phelps Rd NE corridor map with signing

6.1 Project Area Description



Figure 6-2: N. zone near Madison Ave NE



Figure 6-3: Guardrail along west side

Phelps Road NE has two marked speed zones with varying characteristics. The attributes for the entire corridor are summarized in Table 6-1.

Table 6-1: Characteristics Summary by Zone for Phelps Rd NE

Item	North Speed Zone	South Speed Zone
Geometry		
Alignment	North-south	North-south
No. of Lanes (per direction)	1	1
Lane Width	11'	11'
Shoulder Width	0.5' north of NE Hidden Cove Rd, 4' to 6' (SB only) south of NE Hidden Cove Rd	0.5' (NB), 4' to 6' (SB)
Horizontal Curves	Minor	Major near fire station
Vertical Curves	Minor	Minor
Surrounding Environment		
Setting	Forested	Forested
Roadside Ditches	Continuous along east side	Infrequent
Private Driveways	Frequent	Infrequent
Pull-Out Areas	Multiple (gravel)	Multiple (gravel)
Clear Zones	Infrequent obstacles, occasionally encroaching vegetation	Infrequent obstacles, occasionally encroaching vegetation
Curb, Gutter and Sidewalk	Not present	Not present
Lighting	Not present	Not present
Guardrails	Two (150' each) along west side	Not present
Traffic Control		
Lane Markings	Marked centerline and edge lines	Marked centerline and edge lines
Speed Limit	40 mph	30 mph
Major Intersections	Stop at Madison Ave NE	Stop at NE Day Rd

6.2 Crash History

Six reported crashes have occurred along this segment from January 1, 2008 to June 30, 2013. Of these, five have occurred in the north segment and one in the south segment. Each crash is summarized in Table 6-2.

Table 6-2: Crash Report Summary for Phelps Rd NE

Date	Time	Description
North Speed Zone		
03/17/2008	18:07	Driver swerved to miss cat, left roadway and hit two mailboxes
01/10/2009	16:44	Driver took eyes off road and ran off shoulder
04/29/2010	21:27	Driver struck deer that jumped into roadway
09/05/2010	01:30	Driver crashed into fence and abandoned vehicle
05/05/2011	08:27	Driver fell asleep at wheel, struck bus shelter, tree and utility pole
South Speed Zone		
02/27/2009	16:00	Driver lost control and left roadway, vehicle flipped

The crash rate for each speed zone was calculated based on the number of reported crashes, daily traffic volumes, segment length, and crash history duration. Table 6-3 summarizes the crash rates for Phelps Rd NE, with a comparison to county and statewide averages.

Table 6-3: Crash Rates for Phelps Rd NE

Location	Crashes	Average Daily Traffic (vpd)	Study Length (miles)	Crash History (months)	Crashes per Million Veh-Miles
Phelps Rd NE	6	1,350	1.40	66	1.61
North Speed Zone	5	1,350	1.00	66	1.84
South Speed Zone	1	1,350	0.40	66	0.97
Kitsap County¹	-	-	-	-	1.72
Washington State²	-	-	-	-	2.57

The south speed zone and corridor as a whole have crash rates below the Kitsap County average, while the crash rate for the north speed zone exceeds the county average. A review of the five crashes in the north segment indicates that speed may be a factor in four of the crashes. FHWA recommends reducing speed limits if crash rates exceed the statewide average. The average crash rate for urban minor arterial state routes in Washington State is 2.57 crashes per million vehicle miles. No portion of Phelps Rd NE exceeds this crash rate. Based on this and a review of the crash descriptions, the speed limits should not be reduced because of crash history.

6.3 Speed Survey

A radar speed survey was conducted on August 12, 2013 for both segments. The weather was sunny, dry, and clear. Table 6-4 is a summary of these studies. Traffic was light, with virtually no platoons and a random flow rate.

Table 6-4: Radar Speed Study Summary for Phelps Rd NE

Location	Sample Size	Speed Limit (mph)	Mean Speed (mph)	10-mph Pace	Percent Within Pace	85 th Percentile Speed (mph)
North Speed Zone (Near Ellingsen Rd NE)	82	40	38.5	34 to 44	93%	41.0
South Speed Zone (1000' N of fire station)	75	30	35.7	31 to 41	79%	40.0

North Speed Zone

The speed survey for the north speed zone reveals a high (93%) number of vehicles within the 10-mph pace speed, indicating a consistent flow speed.

The 85th percentile of 41.0 mph means that the currently posted speed limit of 40 mph is being followed by a majority of the vehicles on the roadway segment.

Established protocol suggests setting a speed limit so that at least 85% of drivers are within compliance. In this case, that would mean setting the speed limit at 45 mph. However, the difference between the posted speed limit and the 85th percentile speed is minimal. Assuming no change in driver behavior, lowering the posted speed limit would increase the percentage of drivers exceeding the posted limit from 18% (at 40 mph) to 79% (at 35mph).

South Speed Zone

The data sample for the south speed zone was taken near the transition zone for the two speed limits because of several factors. First, the south speed zone is primarily comprised of a large horizontal curve. This curve will slow driver speeds and is more appropriately governed by an advisory speed sign than a posted statutory limit. Second, the fire station and additional signing that drivers “be prepared to stop” will tend to decrease travel speeds and negatively impact the study by preventing the true segment travel speed from being captured. To avoid these factors, the speed survey was conducted in a tangent segment away from the effects of the fire station signing. The only location that met these criteria was north of the fire station near the transition zone. Tube speed measurements by Traffic Count Consultants, Inc. were referenced to verify travel speeds within the south speed zone.

The speed survey for the south speed zone reveals a medium (78%) number of vehicles within the 10-mph pace speed, indicating a moderately consistent flow speed.

The 85th percentile of 40.0 mph means that the currently posted speed limit of 30 mph is being deviated from by a majority of the vehicles on the roadway segment. Established protocol suggests setting a speed limit so that at least 85% of drivers are within compliance. In this case, that would mean setting the speed limit at 40 mph. Several other factors need to be considered, however. First, the data near the transition zone may have been clouded by drivers who were in the process of adjusting to a new speed zone by either accelerating or decelerating. Second, a low crash rate indicates that this segment does not have any issues with speed as it is currently posted, though the crash rate could change if the speed limit is adjusted. Third, the geometry in the area, particularly the multiple horizontal curves near

the fire station, may prohibit the speed limit from rising due to limiting factors such as sight distance. Assuming no change in driver behavior, raising the posted speed limit would decrease the percentage of drivers exceeding the posted limit from 85% (at 30 mph) to 13% (at 40 mph).

6.4 Issues and Candidate Mitigation

Speed – In the north speed zone, the 85th percentile speed (41.0 mph) only slightly exceeds the posted speed limit (40 mph). Because of that, as well as similar characteristics of other 40-mph corridors on the Island, the speed limit should not change. In the south zone, however, the situation is more complicated. In the south zone, north of the fire station, the 85th percentile speeds for northbound traffic (40 mph) were very similar to southbound (41 mph). Northbound traffic at this location is accelerating out of the curve and into a higher speed zone. Southbound traffic, however, should already be slowing due to entering the 30 mph speed zone. The data suggests that southbound vehicles entering the south speed zone are not yet slowing significantly to match the 10-mph speed reduction. An analysis of the tube speed measurements by Traffic Count Consultants, Inc. reveals that just before the fire station, 20% of drivers are travelling between 41 and 45 mph, 35% between 36 and 40 mph, 26% between 31 and 35 mph, and only 10% between 26-30 mph. To reduce speeds for southbound traffic, a reduced speed limit ahead (W3-5) warning sign should be installed prior to entering the 30-mph zone.



Curve Signing – The recommended signing for curves on Phelps Rd NE is inconsistent. Within the north speed zone, W1-5 and W13-IP signs inform southbound drivers that they are approaching an S-curve with a recommended speed of 25 mph. While traversing the S-curve, drivers encounter a 30-mph statutory speed limit sign. These signs are not installed for northbound traffic. The large horizontal curve south of the fire station is not marked by any signing and does not have a posted recommended speed. Based on area maps, the curve radius for the horizontal curve appears to be tighter than the radii for the reverse S-curves in the transition speed area, suggesting that a lower advisory speed is appropriate. While this study did not investigate the radii or appropriate recommended travel speeds for each curve, each curve should be evaluated either by using record drawings or a ballbank test to establish the maximum safe travel speed and to determine the appropriate signing that should be installed.

Wild Animals – One of six crash reports for this corridor cite wild animals as the primary cause. Animal-based crashes can be severe as drivers may swerve quickly to avoid the animal and lose control of the vehicle, exit the roadway, or strike a road user. Currently, there are no warning signs highlighting the presence of animals in the area. The WSDOT Traffic Manual recommends that one of the following criteria be met prior to installation of a deer crossing sign:

- (1) Minimum of 5 documented deer/vehicle collisions per mile per year for at least two of the past 10 years
- (2) Minimum of 10 carcass counts per mile per year for at least three of the past 10 years
- (3) Concurrence from region maintenance personnel

This analysis was only able to evaluate criterion (1) based on available information. There has been only one crash involving deer since 2008. This criterion is not met and, therefore, wildlife warning signs are not recommended.

Illumination – This corridor has no continuous illumination, which is consistent with rural areas throughout Bainbridge Island. A lack of illumination can lead to drivers being unable to see their surroundings, including traffic control devices such as signs or obstacles such as animals that must be avoided. Because the City of Bainbridge Island does not have any warrants for illumination, this analysis used WSDOT warrants. Illumination is warranted along roadways of this type if the segment is classified as commercial and either the nighttime level of service is D or the nighttime crash warrant is satisfied. This roadway segment is not classified as commercial and, therefore, does not meet illumination warrants.

6.5 Recommendation

The following is recommended for the Phelps Rd NE corridor:

1. Maintain current speed limits and zones.
2. Install a reduced speed limit ahead (W3-5) warning sign for southbound traffic north of the 30-mph speed zone. Monitor effectiveness of treatment.
3. Analyze whether advisory speeds are necessary for the reverse S-curves north of the fire station and the horizontal curve between the station and NE Day Rd. Analysis may be done either by referencing record drawings or by conducting ballbank tests.

7.0 ENGINEERING AND SPEED SURVEY – PLEASANT BEACH DRIVE NE: NE ODDFELLOWS RD TO FORT WARD PARK

Pleasant Beach Drive NE is a local road that connects the Lynwood Center commercial area to Fort Ward Park. Pleasant Beach Dr NE has an average daily traffic volume of less than 500 vpd. The primary objective for this study was to determine the appropriate speed limit for the corridor between NE Oddfellows Rd and Fort Ward Park. Figure 7-1 shows the project limits with the posted regulatory and warning signing along the roadway.



Figure 7-1: Pleasant Beach Dr NE corridor map with signing

7.1 Project Area Description



Figure 7-2: Pleasant Beach Dr NE facing north



Figure 7-3: Pleasant Beach Dr NE facing south

Pleasant Beach Dr NE has one marked speed zone with the characteristics listed in Table 7-1.

Table 7-1: Characteristics Summary for Pleasant Beach Dr NE

Pleasant Beach Dr NE	
Geometry	
Alignment	North-south
Pavement Width	18'
Horizontal Curves	Moderate near Campbell St NE
Vertical Curves	Minor
Surrounding Environment	
Setting	Forested, Residential
Roadside Ditches	Infrequent
Private Driveways	Frequent
Pull-Out Areas	Occasional private pull-outs near driveways (gravel), multiple Fort Ward Park parking lots (gravel)
Clear Zones	Infrequent obstacles, occasionally encroaching vegetation
Curb, Gutter and Sidewalk	Not present
Lighting	Not present
Traffic Control	
Lane Markings	Not present
Speed Limit	25 mph
Major Intersections	Stop at NE Oddfellows Rd
Additional Measures	Speed bump near Fort Ward Park

7.2 Crash History

One reported crash has occurred along this segment from January 1, 2008 to June 30, 2013. The crash is summarized in Table 7-2.

Table 7-2: Crash Report Summary for Pleasant Beach Dr NE

Date	Time	Description
09/03/2012	13:04	Cyclist lost control after crossing speed bump at Fort Ward Park

The crash rate for the corridor was calculated based on the number of reported crashes, daily traffic volumes, segment length, and crash history duration. Table 7-3 summarizes the crash rate for Pleasant Beach Dr NE, with a comparison to the county average.

Table 7-3: Crash Rate for Pleasant Beach Dr NE

Location	Crashes	Average Daily Traffic (vpd)	Study Length (miles)	Crash History (months)	Crashes per Million Veh-Miles
Pleasant Beach Dr NE	1	500	0.82	66	1.22
Kitsap County¹	-	-	-	-	1.72

The corridor has a lower crash rate than the Kitsap County average. FHWA recommends reducing speed limits if crash rates exceed the statewide average. However, statewide crash rates are not available for local roads such as Pleasant Beach Dr NE. As such, this criterion cannot be evaluated.

7.3 Speed Survey

A radar speed survey was conducted on September 19, 2013. The weather was sunny, dry, and clear. Table 7-4 is a summary of this study. Traffic was light, with virtually no platoons and a random flow rate.

Table 7-4: Radar Speed Study Summary for Pleasant Beach Dr NE

Location	Sample Size	Speed Limit (mph)	Mean Speed (mph)	10-mph Pace	Percent Within Pace	85 th Percentile Speed (mph)
Pleasant Beach Dr NE	39	25	22.1	18 to 28	95%	25.0

The speed survey reveals a very high (95%) numbers of vehicles within the 10-mph pace speed, indicating a consistent flow speed.

The 85th percentile of 25.0 mph means that the currently posted speed limit of 25 mph is being followed by a majority of the vehicles on the roadway segment. Speed zoning theory best practices recommend that the 85th percentile speed be captured below the posted speed limit, a condition satisfied by existing conditions on this roadway segment. Assuming no change in driver behavior, lowering the posted speed limit would increase the percentage of drivers exceeding the posted limit from 10% (at 25 mph) to 69% (at 20 mph).

7.4 Issues and Candidate Mitigation

Narrow Travel Lanes – Pleasant Beach Drive NE has an 18'-wide paved surface for bi-directional travel. Furthermore, there are no pavement markings to help guide drivers. On tangent segments, this is rarely an issue as approaching vehicles are visible to drivers, however curved areas with limited sight distance

may present a larger challenge for drivers. During the speed survey, multiple vehicles passed each other near curves and slowed down in order to do so. To improve safety, W1-5 curve warning signs with a 20-mph recommended speed (W13-IP) should be installed.

Roadside environment – Exacerbating the issue of narrow travel lanes is the unforgiving roadside condition throughout this roadway segment. Vegetation encroaches to the pavement edge, compounding all sight-distance considerations as well as allowing no escape room beyond the narrow pavement. With no segregated facilities for non-motorized users, local residents and those accessing the Fort Ward Park, the combination of physical features creates a challenging environment for all users. When considered as a whole, these factors justify a variance from the 85th percentile convention in speed zone theory.

Illumination – This corridor has no continuous illumination, which is consistent with rural areas throughout Bainbridge Island. A lack of illumination can lead to drivers being unable to see their surroundings, including traffic control devices such as signs or obstacles such as animals that must be avoided. Because the City of Bainbridge Island does not have any warrants for illumination, this analysis used WSDOT warrants. Illumination is warranted along roadways of this type if the segment is classified as commercial and either the nighttime level of service is D or the nighttime crash warrant is satisfied. This roadway segment is not classified as commercial and, therefore, does not meet illumination warrants.



W1-5



W13-IP

7.5 Recommendation

The following is recommended for the Pleasant Beach Dr NE corridor:

1. Reduce the current speed limit from 25 to 20 mph.
2. Install a W1-5 turn warning sign with a 20-mph W13-IP advisory speed sign for each direction at the roadway curves immediately south of Campbell St NE.

8.0 ENGINEERING AND SPEED SURVEY – SPORTSMAN CLUB ROAD NE: NE HIGH SCHOOL ROAD TO NE NEW BROOKLYN ROAD

Sportsman Club Road NE is a minor arterial that connects SR-305 to multiple residential areas near the center of Bainbridge Island. Sportsman Club Rd NE has an average daily traffic volume of 3,300 vpd. The primary objective for this study was to determine the appropriate speed limit for the corridor between NE High School Rd and NE New Brooklyn Rd. Figure 8-1 shows the project limits with the posted regulatory and warning signing along the roadway.

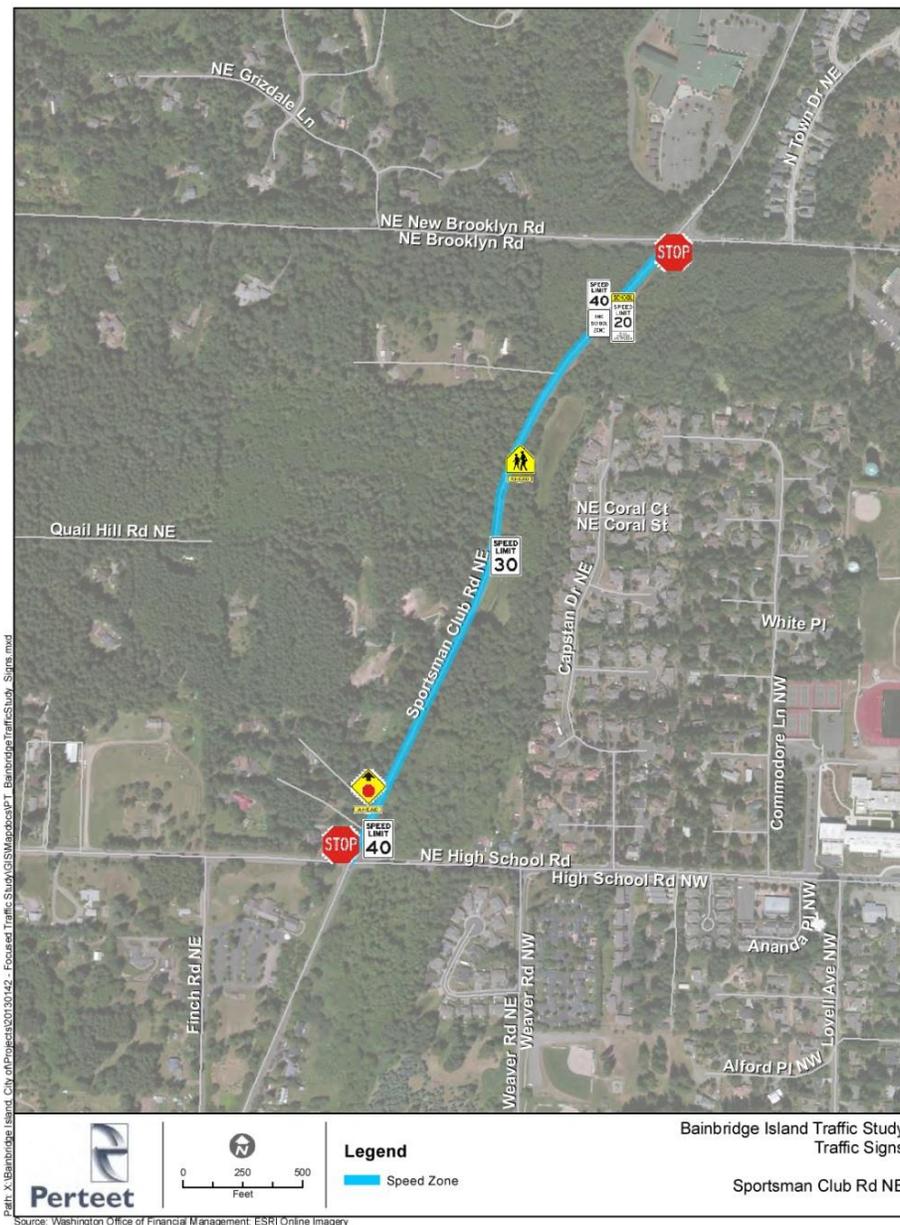


Figure 8-1: Sportsman Club Rd NE corridor map with signing

8.1 Project Area Description



Figure 8-2: Facing south



Figure 8-3: Facing north

Sportsman Club Rd NE has the characteristic listed in Table 8-1.

Table 8-1: Characteristics Summary for Sportsman Club Rd NE

Item		Sportsman Club Rd NE
Geometry		
Alignment		North-south
Lanes (per direction)		1
Lane Width		12'
Shoulder Width		4.5'
Horizontal Curves		Minor
Vertical Curves		Moderate
Surrounding Environment		
Setting		Forested
Roadside Ditches		Infrequent
Private Driveways		Infrequent
Pull-Out Areas		Not present
Clear Zones		Infrequent obstacles, occasionally encroaching vegetation
Curb, Gutter and Sidewalk		Not present
Lighting		Not present
Traffic Control		
Lane Markings		Marked centerline and edge lines
Speed Limit		40 mph (see below)
Major Intersections		Stop at NE High School Rd, stop at NE New Brooklyn Rd

The speed limits for northbound and southbound traffic are not consistent. Northbound traffic enters the study area at 40 mph and is then stepped-down to 30-mph and 20-mph during school zone hours (5 am to 7 pm, Monday through Friday). Southbound traffic is consistently in a 40-mph speed zone. This analysis treated the study corridor as 40-mph speed zone throughout.

8.2 Crash Analysis

Two reported crashes have occurred along this segment from January 1, 2008 to June 30, 2013. Each crash is summarized in Table 8-2.

Table 8-2: Crash Report Summary for Sportsman Club Rd NE

Date	Time	Description
08/02/2008	22:35	Driver travelled too fast for curve and left roadway
05/31/2013	08:35	Driver blacked out, ran off road, struck tree

The crash rate for the corridor was calculated based on the number of reported crashes, daily traffic volumes, segment length, and crash history duration. Table 8-3 summarizes the crash rate for Sportsman Club Rd NE, with a comparison to county and statewide averages.

Table 8-3: Crash Rate for Sportsman Club Rd NE

Location	Crashes	Average Daily Traffic (vpd)	Study Length (miles)	Crash History (months)	Crashes per Million Veh-Miles
Sportsman Club Rd NE	2	3,300	0.56	66	0.54
Kitsap County¹	-	-	-	-	1.72
Washington State²	-	-	-	-	2.57

The corridor has a lower crash rate than the Kitsap County average. FHWA recommends reducing speed limits if crash rates exceed the statewide average. The average crash rate for urban minor arterial state routes in Washington State is 2.57 crashes per million vehicle miles. Sportsman Club Rd NE does not exceed this crash rate. Therefore, the speed limits should not be reduced because of crash history.

8.3 Speed Survey

A radar speed survey was taken on August 12, 2013. The weather was sunny, dry, and clear. Table 8-4 is a summary of this study. Traffic was light, with virtually no platoons and a random flow rate.

Table 8-4: Radar Speed Survey for Sportsman Club Road NE

Location	Sample Size	Speed Limit (mph)	Mean Speed (mph)	10-mph Pace	Percent Within Pace	85 th Percentile Speed (mph)
Sportsman Club Rd NE	188	40	37.5	32 to 42	91%	41.0

The speed survey reveals a high (91%) numbers of vehicles within the 10-mph pace speed, indicating a consistent flow speed.

The 85th percentile of 41.0 mph means that the currently posted speed limit of 40 mph is being followed by a majority of the vehicles on the roadway segment. Speed zoning theory best practices recommend that the 85th percentile speed be captured below the posted speed limit in most cases, suggesting that the speed limit should be increased to 45 mph. However, the difference between the posted speed limit

and the 85th percentile speed is minimal. With this sample, a lower posted speed limit would increase the percentage of drivers exceeding the posted limit from 17% (at 40 mph) to 76% (at 35 mph).

8.4 Issues and Candidate Mitigation

Speed – In the current 40-mph speed zone, the 85th percentile speed slightly exceeds the posted speed limit. The crash rate, however, does not suggest that current speed limits need to be reduced. Because the speed difference is minimal and the crash rate is low, the speed limits for Sportsman Club Rd NE should not change.

Speed Zones – The current speed limits for this corridor are not consistent: southbound is posted at 40 mph, while northbound is posted at 40 mph, 30 mph, and 20 mph (during school zone hours only). Speed zones should be balanced whenever possible to improve operations and meet driver expectations. Because of a minimal crash history and no apparent geometric restrictions, the northbound speed limit should be raised to 40 mph in all portions of the corridor that are not currently within a school zone. The existing 30-mph statutory speed limit sign should be removed and replaced with a reduced school speed limit ahead (S4-5) sign to notify drivers that they are approaching a school zone.



S4-5

Illumination – This corridor has no continuous illumination, which is consistent with rural areas throughout Bainbridge Island. A lack of illumination can lead to drivers being unable to see their surroundings, including traffic control devices such as signs or obstacles such as animals that must be avoided. Because the City of Bainbridge Island does not have any warrants for illumination, this analysis used WSDOT warrants. Illumination is warranted along roadways of this type if the segment is classified as commercial and either the nighttime level of service is D or the nighttime crash warrant is satisfied. This roadway segment is not classified as commercial and, therefore, does not meet illumination warrants.

8.5 Recommendation

The following is recommended for the Sportsman Club Rd NE corridor:

2. Maintain the current speed limit for the southbound direction.
3. Replace the existing 30-mph speed limit sign with a S4-5 sign to notify drivers that they are approaching a designated school zone.

9.0 ENGINEERING AND SCHOOL ZONE ANALYSIS – NE NEW BROOKLYN ROAD AT NORTH TOWN DRIVE NE

NE New Brooklyn Road is a minor arterial that connects residential areas in the middle of the Island to other arterials near various schools and commercial areas. NE New Brooklyn Rd has an average daily traffic volume of 3,100 vpd. The primary objective for this location is to assess if the current school zone to the west of North Town Dr NE should be extended east to include the entrance to the North Town Woods neighborhood. Figure 9-1 shows the project limits with the posted signing along the roadway.



Figure 9-1: NE New Brooklyn Rd corridor map with signing

9.1 Project Area Description



Figure 9-2: NE New Brooklyn Rd at crosswalk



Figure 9-3: NE New Brooklyn Rd school zone

NE New Brooklyn Rd, at the intersection with North Town Dr NE, has the characteristics listed in Table 9-1.

Table 9-1: Characteristics Summary for NE New Brooklyn Rd at North Town Dr NE

Item	NE New Brooklyn Rd
Geometry	
Alignment	East-west
Lanes (per direction)	1
Lane Width	12'
Shoulder Width	4'
Horizontal Curves	None
Vertical Curves	Moderate on either side of North Town Dr NE
Intersection Configuration	T-intersection
Surrounding Environment	
Setting	Forested
Clear Zones	Well-maintained
Curb, Gutter and Sidewalk	Curb and sidewalk present at all NW, NE and SE corners, sidewalk and planter strip line the south edge
Lighting	Not present
Traffic Control	
Lane Markings	Marked centerline and edge lines
Speed Limit	30 mph
Pedestrian Facilities	Marked crosswalk at east leg, curb ramps at east and north legs
Vehicle Pavement Markings	Stop bars on either side of marked crosswalk
Additional Measures	Small median traffic island at the beginning of North Town Dr NE

9.2 Crash History

There have been no reported crashes for this location between January 1, 2008 and June 30, 2013.

9.3 Speed Survey

Two radar speed surveys were taken on September 19, 2013. The weather was sunny, dry, and clear. Table 9-2 is a summary of these studies. Traffic was light, with virtually no platoons and a random flow rate.

Table 9-2: Radar Speed Survey for NE New Brooklyn Rd

Location	Sample Size	Speed Limit (mph)	Mean Speed (mph)	10-mph Pace	Percent Within Pace	85 th Percentile Speed (mph)
At Crosswalk	63	30	27.1	22 to 32	81%	32.0
Within School Zone	91	20	21.5	17 to 27	84%	26.0

9.4 Assessment

At the crosswalk, speeds generally conform to the posted speed limit of 30 mph. The percent within pace is good, though not as high as at other locations surveyed in this report. Within the school zone, however, the overall 85th percentile speed is significantly higher than the school zone speed of 20 mph. Furthermore, within the school zone, there is a strong directional difference between 85th percentile speeds. Vehicles travelling westbound moved slower than eastbound traffic (21.0 versus 28.1 mph). In addition to entering a school zone, westbound traffic is headed toward a visible stop sign at the intersection of NE New Brooklyn Rd and Sportsman Club Rd NE.

Eastbound traffic is not adhering to the current school zone speed requirement. The eastbound 85th percentile speed is more than 40% higher than the posted speed limit of 20 mph. This non-compliance is likely due to the fact that drivers entering this area from the east are unaware that the school zone is still in effect as no school zone sign has been displayed to them. The only sign indicating that they are within a school zone is an “end school zone” (S5-2) sign.

9.5 Recommendation

The following is recommended for the school zone near North Town Drive NE:

- I. The existing school zone should be extended to include the marked crosswalk at the intersection of NE Brooklyn Rd and North Town Dr NE. Because the marked crosswalk is being used by children to travel to and from school, it warrants being part of a designated school zone. As such, the current school zone should be extended east to incorporate the crosswalk. A school zone sign should be posted in the westbound direction such that vehicles travelling over the crest hill have ample time to react to the reduced speed limit and stop for any children that may be present. Eastbound traffic, which is accelerating from the intersection at Sportsman Club Rd NE, should be informed that a school zone is still in effect. A school zone sign should be placed where the current “end school zone” sign is located for eastbound traffic. Enacting these measures should substantially slow traffic at the crosswalk and increase safety for crossing pedestrians. An example signing plan is shown in Figure 9-4.



Figure 9-4: Example signing plan for NE New Brooklyn Rd

10.0 INTERSECTION TRAFFIC OPERATIONS – LYNWOOD CENTER ROAD NE AND NE BAKER HILL ROAD

Lynwood Center Road NE intersects NE Baker Hill Road less than 500 feet north of the Lynwood Center urban area. Currently, Lynwood Center Rd NE near this intersection has an average daily traffic volume of 3,850 vpd. NE Baker Hill Rd has an average daily traffic volume of 1,700 vpd. The primary objective for this intersection was to determine if Lynwood Center Rd NE should be stop-controlled, creating all-way stop control at the intersection. Figure 10-1 shows the intersection with the posted regulatory and warning signing.

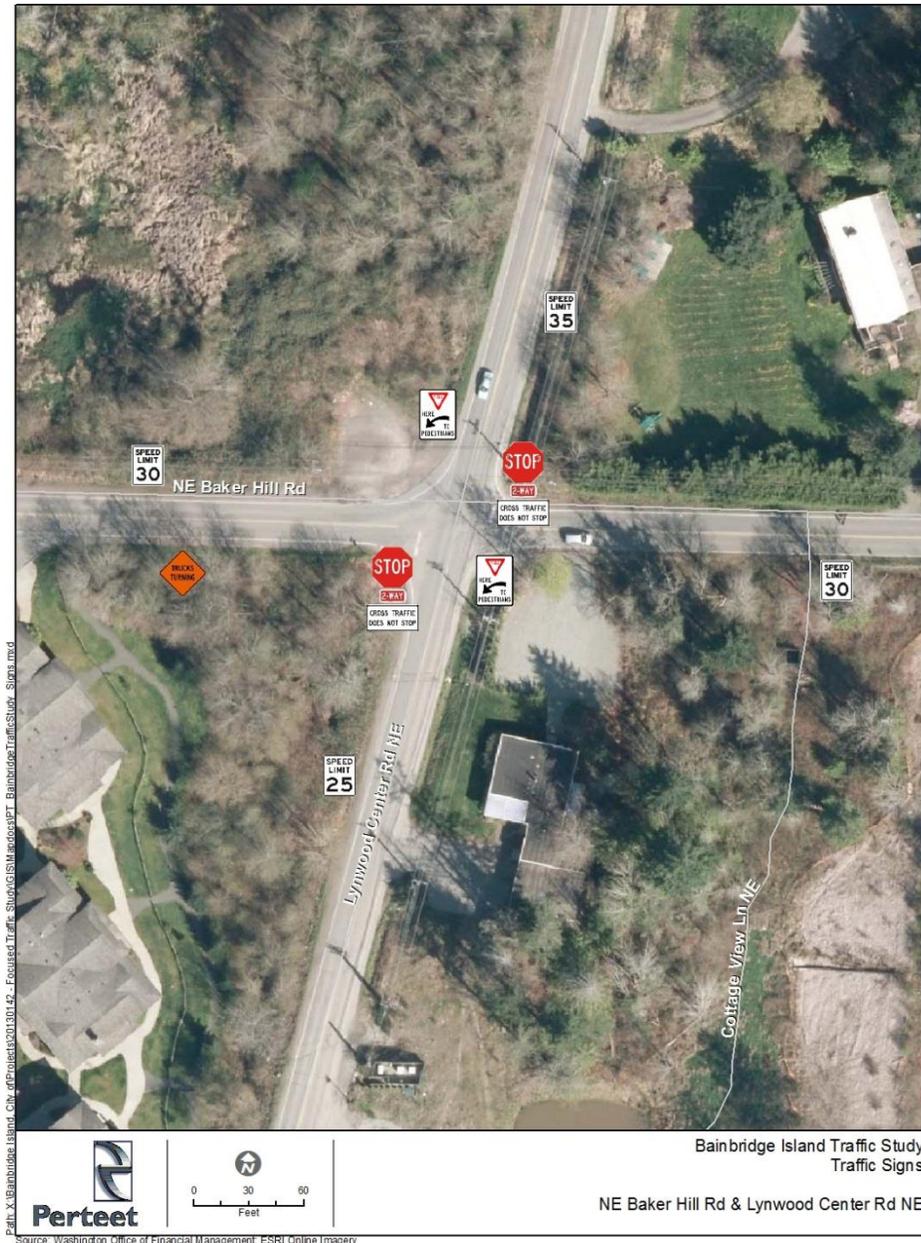


Figure 10-1: Signing at Lynwood Center Rd NE & NE Baker Hill Rd

10.1 Project Area Description



Figure 10-2: Facing north



Figure 10-3: Facing west

The intersection and influence area of Lynwood Center Rd and NE Baker Hill Rd have the characteristics listed in Table 10-1.

Table 10-1: Characteristics Summary for Lynwood Center Rd NE & NE Baker Hill Rd

Item	Intersection
Geometry	
Alignment	Lynwood Center Rd NE: north-south NE Baker Hill Rd: east-west
Lanes (per direction)	1
Lane Width	12'
Shoulder Width	3'
Intersection Skew	15 degrees
Approach Grades	Lynwood Center Rd NE: minor NE Baker Hill Rd NE: minor for west approach, steep for east approach (sloping toward intersection)
Surrounding Environment	
Setting	Mixed, open and forested
Utility Furniture	Power poles at NE and SE corners, cabinets at NE corner
Parking	Angled parking on Lynwood Center Rd NE south approach, gravel parking at NW corner
Transit	Kitsap Transit bus stop at SE corner
Vegetation	Overgrown at SW and NE corners
Curb, Gutter and Sidewalk	Present only at SE corner
Lighting	Not present
Traffic Control	
Lane Markings	Marked centerline and edge lines
Stop Control	Lynwood Center Rd NE: no stop control NE Baker Hill Rd: both approaches stop controlled
Legal Maneuvers	Left, through, and right at all approaches
Pedestrian Facilities	Marked crosswalk at south leg with curb ramp at SE corner
Vehicle Pavement Markings	Stop bars: NE Baker Hill Rd; yield lines: Lynwood Center Rd NE

10.2 Crash History

Two reported crashes have occurred within this intersection influence area from January 1, 2008 to June 30, 2013. Each crash is summarized in Table 10-2.

Table 10-2: Crash Report Summary for Lynwood Center Rd NE & NE Baker Hill Rd

Date	Time	Description
01/23/2008	08:50	Driver turned northbound onto Lynwood Ctr Rd and lost control due to ice
09/22/2012	11:57	Driver stopped at stop sign but failed to yield to and struck an oncoming car

10.3 Traffic Count

A traffic count was performed from 4:00 PM to 5:00 PM on August 22, 2013. The weather was sunny, dry and clear. The volume for all movements is summarized in Table 10-3.

Table 10-3: Intersection Turning Movements for Lynwood Center Rd NE & NE Baker Hill Rd

From NORTH			From SOUTH			From EAST			From WEST			Ped	Bike
L	T	R	L	T	R	L	T	R	L	T	R	Total	Total
6	154	57	7	133	1	5	11	1	45	3	3	1	11

L = left T = through R = right

10.4 Intersection Operations

Left-turning traffic from NE Baker Hill Rd frequently stopped between the stop bar and travel lanes before turning. Sight distance for left-turn maneuvers is limited by vegetation and, occasionally, site furniture. No crashes or significant delays were observed during the study.

Most approaching vehicles from NE Baker Hill Rd were able to clear the intersection within one minute of stopping. The worst observed case was a roughly two-minute wait for one driver. A Synchro analysis was performed to quantify the average delay per vehicle at the intersection. The analysis is summarized in Table 10-4.

Table 10-4: Synchro Analysis for Lynwood Center Rd NE & NE Baker Hill Rd

Approach	Traffic Control	Average Delay (s)	Level of Service
Eastbound	Stop	11.9	B
Westbound	Stop	11.7	B
Northbound	Free	0.4	-
Southbound	Free	0.2	-

The Highway Capacity Manual (HCM) defines level of service (LOS) for two-way stop controlled intersections based on average delay for a particular approach. The level of service is not calculated for free movements. LOS B for vehicle movements is an average delay between 10 and 15 seconds.

10.5 Traffic Control Warrants

The MUTCD establishes the criteria for whether or not an intersection warrants having a traffic signal based on volumes for the major and minor streets. A full signal warrant analysis requires an 8-hour

minimum vehicle count. A peak hour warrant is also available, and was applied in this case because of the limited collected data. If the peak hour warrant is not met, then it is reasonable to assume that no warrants will be met despite not having a complete count to justify it.

Based on the above traffic count data, a peak hour warrant was evaluated for the intersection of Lynwood Center Rd NE and NE Baker Hill Rd. Figure 10-4 shows the warrant analysis in graphical form.

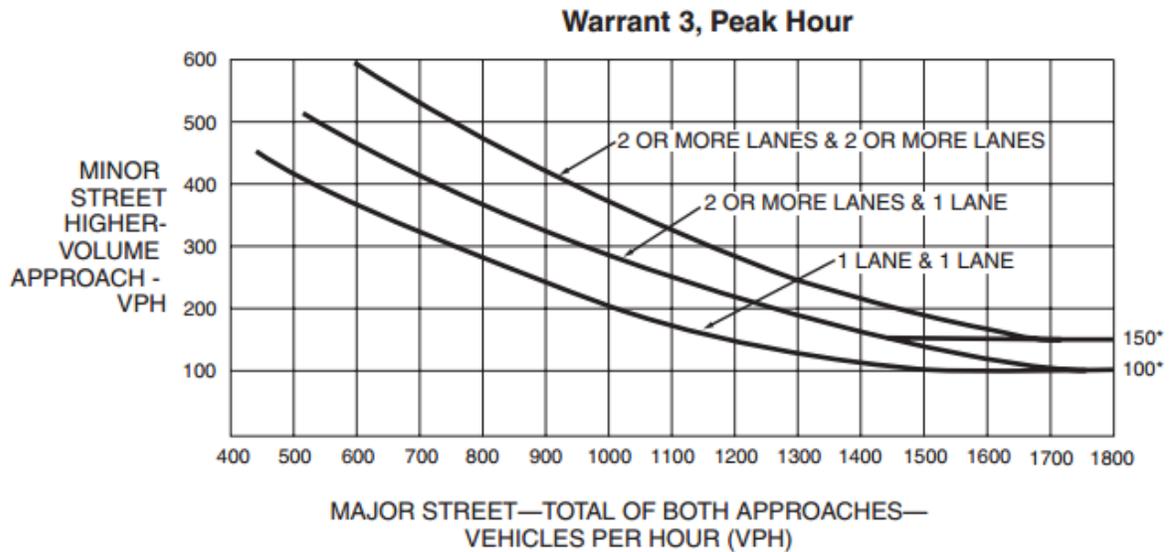


Figure 10-4: MUTCD traffic signal peak hour warrant

The major street (Lynwood Center Rd NE) volume for this intersection during the peak hour is 358, while the minor street higher volume approach (NE Baker Hill Rd, eastbound) is 51. The minimum required peak hour volume for the minor street higher volume approach is 100 vehicles. The volumes do not meet this warrant and are not expected to meet either the four- or eight-hour warrants.

While all-way stop-controlled intersections do not have a warrant process in the MUTCD, several justifications are provided for their installation. These justifications include: relatively equal major and minor street volumes, temporary traffic control measure prior to signal installation, correctable 12-month crash history, and 300 vehicles per hour (vph) for the major street over eight hours in a single day with 200 vph for the minor street over the same eight hours. Based on the major to minor street volume ratio (5.26), crash history, and vehicle count, these justifications are not met.

10.6 Issues and Candidate Mitigation

Intersection Traffic Control – All-way stop control is not warranted at this intersection. The approach delays for the east and west approaches are under 12 seconds, meaning that the existing traffic control does not cause undue delay to any driver, even at the peak hour. While installing stop signs for the Lynwood Center Rd NE approaches might decrease delay for east and westbound traffic, it would substantially increase delay for north and southbound traffic. Additionally, the peak hour MUTCD warrant for signals (or all-way stops) is not met in this case because the minor street volumes are too low. Two-way stop control is appropriate for this intersection.

Sight Distance – Traffic on NE Baker Hill Rd has limited sight distance at the marked stop bars. Most drivers continue beyond these before stopping at the edge of the closest travel lane on Lynwood Center Rd NE. The reduced sight distance is a combination of overgrown vegetation, the intersection skew, and various site furniture including a wooden bus stop. To improve sight distance, the stop bars should be moved closer to the north-south travel lanes and overgrown vegetation should be trimmed.

Signing and Markings – Both northbound and southbound Lynwood Center Rd NE approaches have a Yield Here for Pedestrians regulatory sign (MUTCD Sign R1-5) and an associated yield line. Based on comments and discussions with the City of Bainbridge Island, these markings have resulted in driver confusion. Because of this confusion, additional signing to Baker Hill Road has been added, including a 2-way supplemental sign and a Cross Traffic Does Not Stop warning sign. The 2009 MUTCD states that the 2-way supplemental plaque is prohibited. Removal of the sign will help reduce driver confusion between all-way stop locations. Additionally, drivers on NE Baker Hill Rd may misinterpret the yield line as a stop line and assume that northbound and southbound traffic will stop. Removal of the yield line will reduce driver confusion.

Crosswalk – Fluorescent yellow-green crosswalk signs (W11-2) and supplemental warning plates (W16-7P) should be installed at the crosswalk to warn drivers of pedestrians. Additionally, adequate illumination should be provided at both corners to improve pedestrian safety and further increase visibility.



R1-5



W11-2



W16-7P

10.7 Recommendation

The following is recommended for the intersection of Lynwood Center Rd NE and NE Baker Hill Rd:

1. Maintain existing east and westbound stop control for NE Baker Hill Rd.
2. Remove and replace existing stop lines for east and westbound traffic on NE Baker Hill Rd. Place stop bar approximately 4-feet from the shoulder edge on Lynwood Center Rd NE.
3. Remove existing “2-way” supplemental plaque on NE Baker Hill Rd approaches.
4. Remove existing yield line markings.
5. Install fluorescent yellow-green pedestrian crosswalk warning signs (W11-2) and supplemental warning plaques (W16-7P) at the crosswalk. Maintain existing “yield here to pedestrians” (R1-5) signs.
6. Review illumination to determine if adequate visibility is available at the crosswalk.

11.0 INTERSECTION TRAFFIC OPERATIONS – MILLER ROAD NE AND NE KOURA ROAD

Miller Road NE intersects NE Koura Road 1.4 miles west of SR-305. Currently, Miller Rd NE near this intersection has an average daily traffic volume of 4,800 vpd. NE Koura Rd has an average daily traffic volume of 1,625 vpd. The primary objective for this intersection was to determine if Miller Rd NE should be stop-controlled, creating all-way stop control at the intersection. Figure 11-1 shows the intersection with the posted regulatory and warning signing.

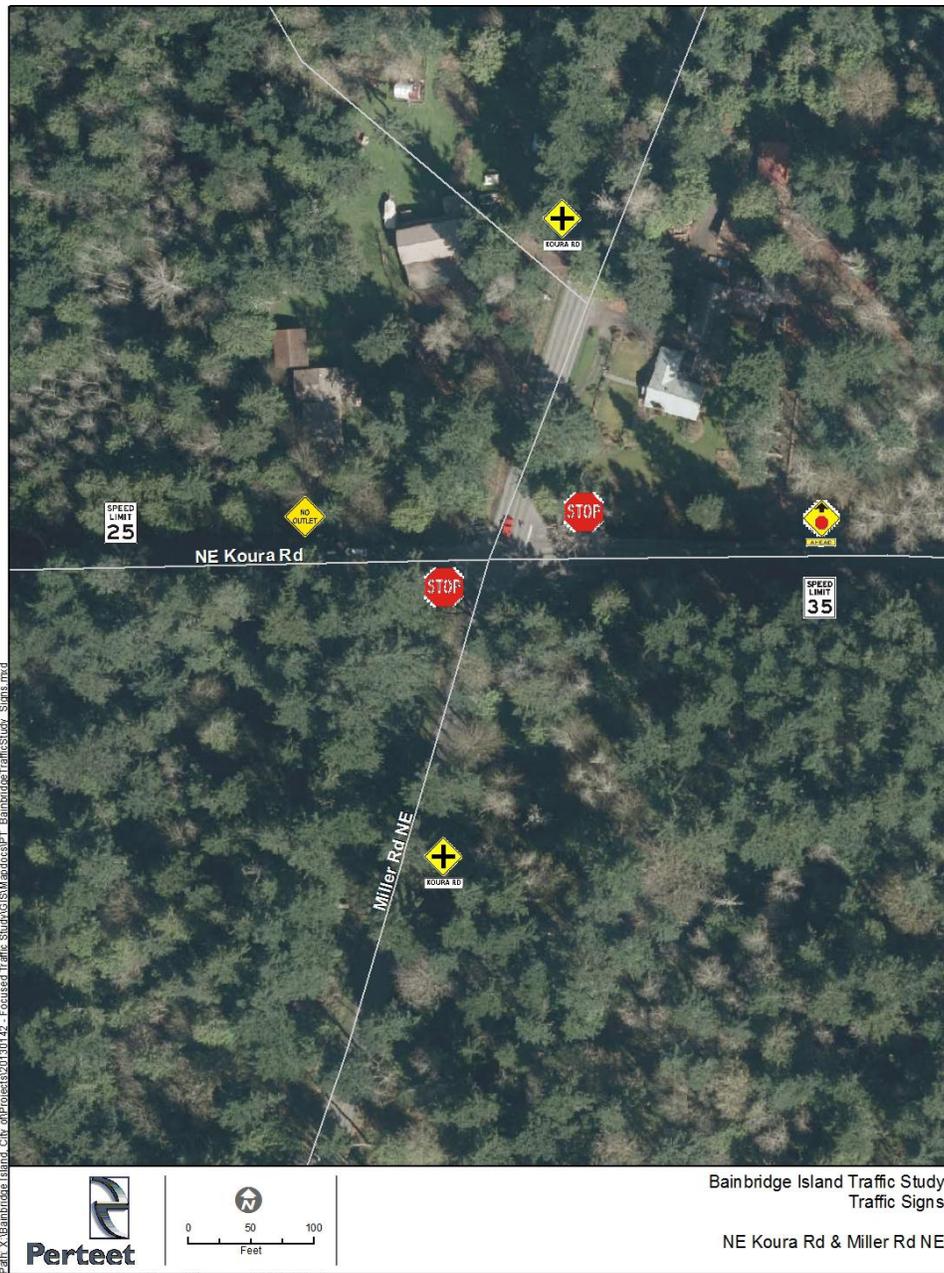


Figure 11-1: Signing at Miller Rd NE & NE Koura Rd

11.1 Project Area Description



Figure 11-2: NW corner facing north



Figure 11-3: SW corner facing south

The intersection and influence area of Miller Rd NE and NE Koura Rd have the characteristics listed in Table 11-1.

Table 11-1: Characteristics Summary for the Intersection of Miller Rd NE & NE Koura Rd

Item	Intersection
Geometry	
Alignment	Miller Rd NE: north-south NE Koura Rd: east-west
Lanes (per direction)	1
Lane Width	11'
Intersection Skew	15 degrees
Approach Grades	Lynwood Center Rd NE: minor NE Baker Hill Rd NE: minor for east approach, steep for west approach (sloping away from intersection)
Surrounding Environment	
Setting	Forested
Utility Furniture	Multiple utility poles and junction boxes
Parking	Not present, wide unpaved pull-out area on east leg
Transit	Not present
Vegetation	Some trees in clear zone
Shoulders	Present on all sides of all approaches
Curb, Gutter and Sidewalk	Not present
Lighting	Not present
Traffic Control	
Lane Markings	Miller Rd NE: Marked centerline and edge lines NE Koura Rd: Single dashed yellow centerline
Stop Control	Miller Rd NE: no stop control NE Koura Rd: both approaches stop controlled
Legal Maneuvers	Left, through, and right at all approaches
Pedestrian Facilities	Not present
Vehicle Pavement Markings	Stop bars on NE Koura Rd

11.2 Crash History

Eight reported crashes have occurred within this intersection influence area from January 1, 2008 to June 30, 2013. Each crash is summarized in Table 11-2.

Table 11-2: Crash Report Summary for Miller Rd NE & NE Koura Rd

Date	Time	Description
08/01/2008	15:06	Vehicle stopped at stop sign on Koura was rear-ended
08/01/2008	15:17	Driver attempted to make U-turn at intersection and was T-boned
12/31/2008	17:50	Driver sideswiped other vehicle while turning at intersection
10/13/2009	18:55	Westbound driver was struck by a southbound driver
10/24/2009	00:10	Eastbound driver failed to stop at stop sign, hit southbound vehicle
11/05/2009	10:00	Driver who was waiting for a turn was rear-ended
06/26/2011	11:21	Driver failed to yield right-of-way and hit another vehicle
01/22/2013	15:27	Driver turning east onto Koura failed to yield to northbound vehicle

11.3 Traffic Count

A traffic count was performed from 3:15 – 4:15 PM on August 12, 2013. Conditions were sunny, dry and clear. The volume for all movements is summarized in Table 11-3.

Table 11-3: Intersection Turning Movements for Miller Rd NE & NE Koura Rd

From NORTH			From SOUTH			From EAST			From WEST		
L	T	R	L	T	R	L	T	R	L	T	R
18	134	6	10	160	32	42	10	20	4	12	10

L = left T = through R = right

11.4 Intersection Operations

Drivers are presented with rural roadway characteristics typical to the general condition of many roadways in the area as they approach this intersection from all directions. The intersection is not easily identified in approaching it along Miller Rd NE due to trees and other roadside foliage, particularly in the southbound approach due to the crest vertical curve and horizontal curve. Of particular concern is the sight distance from the stop-bar decision point on the western leg. Eastbound traffic entering the intersection is challenged by a combination of factors:

- A utility pole and telephone splice box at the northwest corner
- Vegetation on the northwest corner
- The +8% eastbound approach grade
- The horizontal and crest vertical curves partially obstructing southbound traffic sight line
- No shoulder / narrow lanes
- Intersection skew
- Shadowing created by the overhead tree canopy
- Lack of area lighting

Vehicles passing through the intersection on Miller Rd NE travel roughly 35 mph. The south and east approaches are relatively tangent and level. The north leg approach has both a horizontal curve and a crest vertical curve reducing sight distance.

A Synchro analysis was performed to quantify the average delay per vehicle at the intersection. The analysis is summarized in Table 11-4.

Table 11-4: Synchro Analysis for Miller Rd NE & NE Koura Rd

Approach	Traffic Control	Average Delay (s)	Level of Service
Eastbound	Stop	12.2	B
Westbound	Stop	12.0	B
Northbound	Free	0.4	-
Southbound	Free	0.9	-

The HCM defines LOS for two-way stop controlled intersections based on average delay for a particular approach. The level of service is not calculated for free movements. LOS B for vehicle movements is an average delay between 10 and 15 seconds.

11.5 Traffic Control Warrants

The MUTCD establishes the criteria for whether or not an intersection warrants having a traffic signal based on volumes for the major and minor streets. A full signal warrant analysis requires an 8-hour minimum vehicle count. A peak hour warrant is also available, and was applied in this case because of the limited collected data. If the peak hour warrant is not met, then it is reasonable to assume that no warrants will be met despite not having a complete count to justify it.

Based on the above traffic count data, a peak hour warrant was evaluated for the intersection of Miller Rd NE and NE Koura Rd. Figure 11-4 shows the warrant analysis in graphical form.

The major street (Miller Rd NE) volume for this intersection during the peak hour is 360, while the minor street higher volume approach (NE Koura Rd, WB) is 72. The minimum required peak hour volume for the minor street higher volume approach is 100 vehicles. The volumes do not meet this warrant and are not expected to meet either the eight- or four-hour warrant.

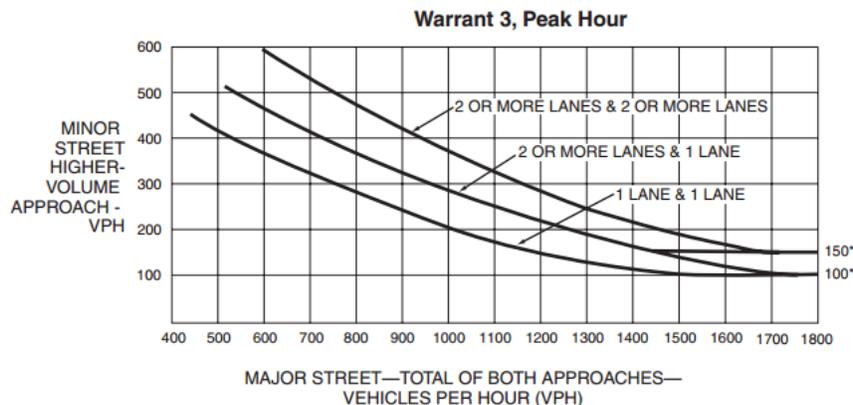


Figure 11-4: MUTCD traffic signal peak hour warrant

While all-way stop-controlled intersections do not have a warrant process in the MUTCD, several justifications are provided for their installation. These justifications include: relatively equal major and minor street volumes, temporary traffic control measure prior to signal installation, correctable 12-month crash history, and 300 vph for the major street over eight hours in a single day with 200 vph for the minor street over the same eight hours. Based on the major to minor street volume ration (3.67), crash history, and vehicle count, these justifications are not met.

11.6 Issues and Candidate Mitigation

Intersection Traffic Control – All-way stop control is not warranted at this intersection. The approach delays for the east and west approaches are under 13 seconds, meaning that the existing traffic control does not cause undue delay to any driver, even at the peak hour. While installing stop signs for the Miller Rd NE approaches might decrease delay for east and westbound traffic, it would substantially increase delay for north and southbound traffic. Additionally, the peak hour MUTCD warrant for signals (or all-way stops) is not met in this case because the minor street volumes are too low. The intersection should retain its current stop sign arrangement.

Sight Distance – Sight distance is limited due to vegetation and site furniture such as utility poles and junction boxes. The western leg is particularly troublesome as the approach grade is roughly 8%. According to *A Policy on Geometric Design of Highways and Streets*, additional sight distance is required for traffic that approaches an intersection at a grade exceeding 3%. To reduce this risk of increased crashes, obstacles should be removed from the critical sight locations near the intersection. Where obstacles cannot be removed, maintenance efforts should be taken to improve sight distance as much as possible.

11.7 Recommendation

The following is recommended for the intersection of Miller Rd NE and NE Koura Rd:

1. Maintain existing east and westbound stop control for NE Koura Rd.
2. Provide proper sight distance by trimming or removing overgrown vegetation as necessary.
3. Install a stop sign ahead (W3-1) warning sign for the west NE Koura Rd approach.



W3-1

12.0 INTERSECTION TRAFFIC OPERATIONS – NE VALLEY ROAD AND SUNRISE DRIVE NE

NE Valley Rd intersects Sunrise Dr NE at the Rolling Bay commercial area. Currently, NE Valley Rd near this intersection has an average daily traffic volume of 2,800 vpd. Sunrise Dr NE has an average daily traffic volume of 1,500 vpd. The primary objective for this intersection was to determine if NE Valley Rd should be stop-controlled, creating all-way stop control. Figure 12-1 shows the intersection with the posted regulatory and warning signing.



Figure 12-1: Signing at NE Valley Rd & Sunrise Dr NE

12.1 Project Area Description



Figure 12-2: West approach



Figure 12-3: Intersection freight delivery

The intersection and influence area of NE Valley Road and Sunrise Drive NE have the characteristics listed in Table 12-1.

Table 12-1: Characteristics Summary for the Intersection of NE Valley Rd & Sunrise Dr NE

Item	Intersection
Geometry	
Alignment	NE Valley Rd: east-west Sunrise Dr NE: north-south
Lanes (per direction)	1
Lane Width	11'
Intersection Skew	None
Approach Grades	None
Surrounding Environment	
Setting	Commercial
Utility Furniture	Not present
Parking	Various configurations throughout influence area
Transit	Not present
Vegetation	Not present
Shoulders	Present on all sides of all approaches
Curb, Gutter and Sidewalk	Curb present only at NW corner
Lighting	Not present
Traffic Control	
Lane Markings	Marked centerline and edge lines
Stop Control	NE Valley Rd: no stop control Sunrise Dr NE: both approaches stop controlled
Legal Maneuvers	Left, through, and right at all approaches
Pedestrian Facilities	Not present
Vehicle Pavement Markings	Not present

12.2 Crash History

One reported crash has occurred within this intersection influence area from January 1, 2008 to June 30, 2013. The crash is summarized in Table 12-2.

Table 12-2: Crash Report Summary for NE Valley Rd & Sunrise Dr NE

Date	Time	Description
04/14/2008	13:31	Driver failed to yield and t-boned another vehicle

12.3 Traffic Count

A traffic count was performed from 4:15 – 5:25 PM on August 12, 2013. The weather was sunny, dry and clear. The volume for all movements is summarized in Table 12-3.

Table 12-3: Intersection Turning Movements for NE Valley Rd & Sunrise Dr NE

From NORTH			From SOUTH			From EAST			From WEST				Ped	Bike
L	T	R	L	T	R	L	T	R	U	L	T	R	Total	Total
3	9	59	12	8	4	3	36	21	2	83	27	20	35	21

L = left T = through R = right U = U-turn

12.4 Speed Survey

A radar speed study was conducted for NE Valley Rd on November 4, 2013. Data was captured for eastbound traffic before entering the 25-mph speed zone as well as before entering the intersection influence area. The weather was overcast and dry. Table 12-4 is a summary of these studies. Traffic was light, and vehicles that were slowed or obstructed by parking activities were not considered.

Table 12-4: Radar Speed Study Summary for NE Valley Rd

Location	Sample Size	Speed Limit (mph)	Mean Speed (mph)	10-mph Pace	Percent Within Pace	85 th Percentile Speed (mph)
35-mph Speed Zone	29	35	34.1	28 to 38	83%	39.5
25-mph Speed Zone (outside influence area)	38	25	23.2	18 to 28	97%	27

12.5 Intersection Operations

There is considerable local access demand for the commercial establishments, which include a post office adjacent to the intersection. The local activities generate a noticeable presence of pedestrian and bicycle traffic in and around the intersection area. Combined with the local destinations at the intersection there is a significant sub-regional travel demand through the intersection. The most significant traffic demands for the intersection are the eastbound-left and southbound-right movements. Additionally, east-west through traffic is also substantial.

There is a mixture of on-street and adjacent off-street parking in the area, and a fairly consistent lack of access management. Fairly high parking demand persists throughout the business day, with a high turnover rate due principally to the post office generation. In the immediate intersection area there is a

mixture of on-street parallel parking and 90-degree parking accessible directly from the street. Combined with the high intersection turning volumes, lack of segregated facilities for pedestrian and bicycle movement, and a low level of access control and traffic control devices (including advance warning signing, marked crosswalks or stop bars), the intersection area presents a localized and isolated area of high friction and unpredictability incongruous with the surrounding rural roadway system.

A Synchro analysis was performed to quantify the average delay per vehicle at the intersection. The analysis is summarized in Table 12-5.

Table 12-5: Synchro Analysis for NE Valley Rd & Sunrise Dr NE

Approach	Traffic Control	Average Delay (s)	Level of Service
Eastbound	Free	4.8	-
Westbound	Free	0.4	-
Northbound	Stop	11.1	B
Southbound	Stop	9.3	A

The HCM defines LOS for two-way stop controlled intersections based on average delay for a particular approach. The level of service is not calculated for free movements. LOS A for vehicle movements is an average delay of 10 seconds or less. LOS B for vehicle movements is an average delay between 10 and 15 seconds.

12.6 Traffic Control Warrants

The MUTCD establishes the criteria for whether or not an intersection warrants having a traffic signal based on volumes for the major and minor streets. A full signal warrant analysis requires an 8-hour minimum vehicle count. A peak hour warrant is also available, and was applied in this case because of the limited collected data. If the peak hour warrant is not met, then it is reasonable to assume that no warrants will be met despite not having a complete count to justify it.

Based on the above traffic count data, a peak hour warrant was evaluated for the intersection of NE Valley Rd and Sunrise Dr NE. Figure 12-4 shows the warrant analysis in graphical form.

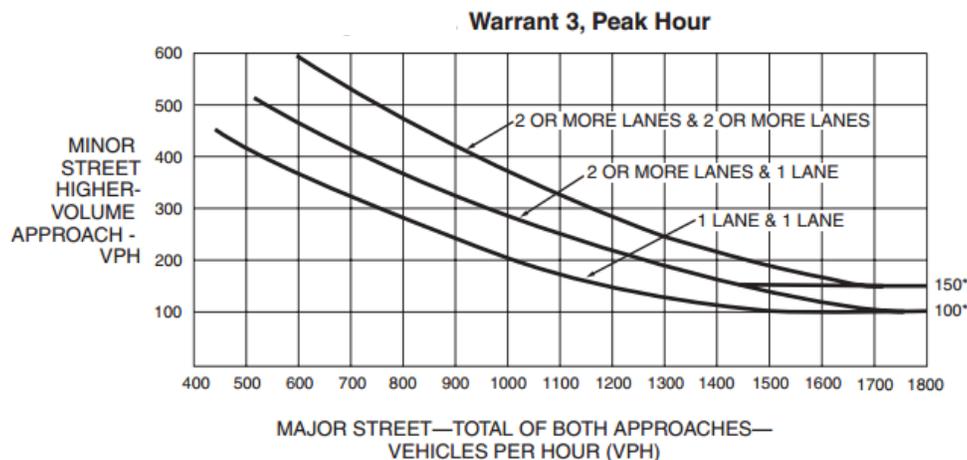


Figure 12-4: MUTCD traffic signal peak hour warrant

The major street (NE Valley Rd) volume for this intersection during the peak hour is 192, while the minor street higher volume approach (Sunrise Dr NE, SB) is 71. The minimum required peak hour volume for the minor street higher volume approach is 100 vehicles. The volumes do not meet this warrant and are not expected to meet either the eight- or four-hour warrant.

While all-way stop-controlled intersections do not have a warrant process in the MUTCD, several justifications are provided for their installation. These justifications include: relatively equal major and minor street volumes, temporary traffic control measure prior to signal installation, correctable 12-month crash history, and 300 vph for the major street over eight hours in a single day with 200 vph for the minor street over the same eight hours. Based on the major to minor street volume ration (2.02), crash history, and vehicle count, these justifications are not met.

12.7 Issues and Candidate Mitigation

Stop Control – All-way stop control is not warranted at this intersection. The approach delays for the north and south approaches are under 12 seconds, meaning that the existing traffic control does not cause undue delay to any driver, even at the peak hour. While installing stop signs for the Miller Rd NE approaches might decrease delay for east and westbound traffic, it would substantially increase delay for north and southbound traffic. Additionally, the peak hour MUTCD warrant for signals (or all-way stops) is not met in this case because the minor street volumes are too low. The intersection should retain its current stop sign arrangement.

Speed on NE Valley Rd – Travel speeds prior to entering the 25-mph speed zone are higher than ideal. The 85th percentile speed in the 35-mph zone is 39.5 mph. This study only measured eastbound traffic, which at this location is on a very steep downgrade, which is likely contributing to higher operating speeds. Within the 25-mph speed zone, however, travel speeds are substantially lower. The 10-mph pace drops by 10 mph between the two zones, and the 85th percentile speed is reduced from 39.5 mph to 27 mph. The difference between the posted speed limit and 85th percentile speed in the intersection area does not present an issue as the difference is minor. To calm speeds in the 35-mph zone, a reduced speed ahead (W3-5) sign should be installed prior to eastbound traffic entering the 25-mph zone. It is also noted that the commercial area and its influence zone have grown westward and northward in recent years and now extend beyond the existing location of the speed limit change on NE Valley Rd and Sunrise Dr NE, respectively. To incorporate the influence zone within the 25-mph zone, and noting that speeds at the western end of this area are higher than desired, it is recommended that the 25-mph zone be extended somewhat further to the west and north.

Channelization – Stop bars should be installed at each stop-controlled approach. Due to the pedestrian nature of the area, marked crosswalks should be installed across all legs to improve safety.

Signing – Warning signs (W11-2) should be installed at the crosswalk to inform drivers of possible pedestrian activity.



W3-5



W11-2



W16-7P

12.8 Recommendation

1. Maintain existing north and southbound stop control for Sunrise Dr NE.
2. Install stop bars for both Sunrise Dr NE approaches.
3. Install marked crosswalks at all legs.
4. Install a crosswalk (W11-2) sign and a supplemental warning plaque (W16-7P) at each crosswalk.
5. Relocate the existing speed limit signs (eastbound 25 mph and westbound 35 mph) approximately 200' westward on NE Valley Rd.
6. Relocate the existing speed limit sign (northbound 35 mph) approximately 200' northward on Sunset Dr NE.
7. Install a reduced speed limit ahead (W3-5) sign for eastbound traffic prior to entering the 25-mph intersection speed zone.

13.0 REFERENCES

American Association of State Highway and Transportation Officials. *A Policy on Geometric Design of Highways and Streets, 2011*.

American Association of State Highway and Transportation Officials. *Guide for the Development of Bicycle Facilities, 2012*.

Federal Highway Administration. *Manual on Uniform Traffic Control Devices, 2009 edition with 2012 revisions*.

Washington State Department of Transportation. *WSDOT 2011 Collision Report*.

Washington State Department of Transportation. *WSDOT 2011 Traffic Manual*.

¹ Kitsap County crash rate covers all types of roadways and crashes.

² Washington State crash rate covers only state routes. 2.57 is the crash rate for urban minor arterials. No crash rate is published for local state routes.

³ See MUTCD Section 2C.22

⁴ See MUTCD Section 2C.64

⁵ See MUTCD Section 2C.38