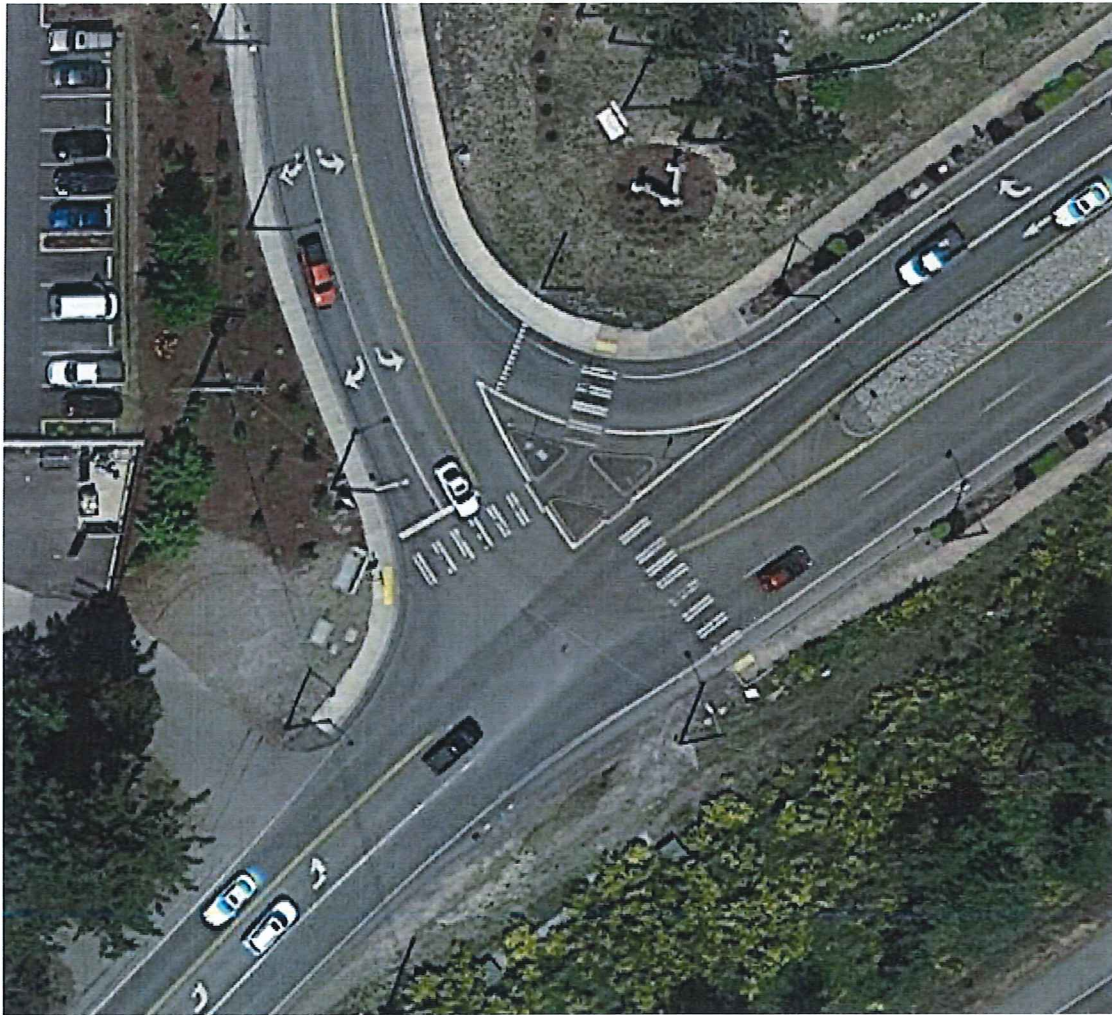


# NW Greaves Way at Old Frontier Road NW Traffic Study

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Traffic Division  
Kitsap County Public Works

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Published August 2019

**CERTIFICATION**

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal, as a professional engineer licensed to practice as such, is affixed below.



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### List of Abbreviations

AASHTO	American Association of State Highway Transportation Officials
CMF	Crash Modification Factor
FHWA	Federal Highway Administration
HSM	Highway Safety Manual
LOS	Level of Service
MUTCD	Manual on Uniform Traffic Control Devices
NCHRP	National Cooperative Highway Research Program
WSDOT	Washington State Department of Transportation

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## Executive Summary

NW Greaves Way was constructed in 2010. At the time of the NW Greaves Way construction the intersection did not warrant signalization and was designed for future signalization with interim stop control on the north leg. The intersection of NW Greaves Way at Old Frontier Road NW was converted to all-way stop control in 2018 based on an engineering study. The MUTCD signal warrant analysis performed as part of the engineering study for the intersection control conversion showed the intersection met Warrant 1 – 8 Hour, Warrant 2 – 4 Hour, Warrant 3 – Peak Hour, and Warrant 7 – Crash Experience. The intersection is listed as number 1 on the Kitsap County's 2014-2018 Intersection Safety List (up from #4 on the 2013-2017 list).

The 2019-2024 Six Year Transportation Improvement Program included the Greaves Way NW / Old Frontier Road NW Project as priority number 40. The project has a budget of \$800,000 with a construction date of April 2023. The project is described as a traffic signal installation. The County has a policy to evaluate other traffic control devices including a roundabout prior to a traffic signal installation. This traffic study evaluates the intersection operations under both signal and roundabout design.

The intersection was evaluated under existing and design year 2043 traffic conditions. The evaluation included analysis of signalized and single lane roundabout control options. The analysis concluded that the operational performance of the NW Greaves Way at Old Frontier Road intersection would be improved by signalization or roundabout conversion. Both traffic control measures would reduce per-vehicle delay and reduce frequency and severity of angle-entry and left versus opposing through collisions.

Whether the preferred alternative is a signal or a roundabout, this report recommends:

- Exterior lanes should be 12 feet wide,
- Sidewalks should be 6 feet wide and installed on all sides of the intersection,
- Bicycle lanes should be 5 feet wide and installed on all legs,
- Intersection lighting should follow ANSI/IES recommendations,
- If the intersection is converted to a roundabout, then the report recommends a single lane compact design.

The decision to convert the intersections from "T" intersections with stop control to roundabouts should consider:

- Safety- reductions in fatal and injury collisions
  - Pedestrians – roundabouts offer shorter crossing distances and pedestrians only cross one direction of traffic at a time
- Maintenance costs – no signal hardware or equipment maintenance with roundabouts
- Traffic calming – reduced vehicular speeds with roundabouts



# 1 Introduction

NW Greaves Way was constructed in 2010 and the intersection of NW Greaves Way and Old Frontier Road NW as designed for future signalization with interim stop control on the north leg. The intersection of NW Greaves Way at Old Frontier Road NW was converted to all-way stop control in 2018 based on an engineering study. The MUTCD signal warrant analysis performed as part of the engineering study for the intersection control conversion showed the intersection met Warrant 1 – 8 Hour, Warrant 2 – 4 Hour, Warrant 3 – Peak Hour, and Warrant 7 – Crash Experience. The intersection is listed as number 1 on the Kitsap County’s 2014-2018 Intersection Safety List (up from #4 on the 2013-2017 list).

# 2 Project Description

The 2019-2024 Six Year Transportation Improvement Program (TIP) included the Greaves Way NW / Old Frontier Road NW Project as priority number 40. The project is described as a traffic signal installation. The County has a policy to evaluate other traffic control devices including a roundabout prior to a traffic signal installation. This traffic study evaluates the intersection operations under both signal and roundabout design.

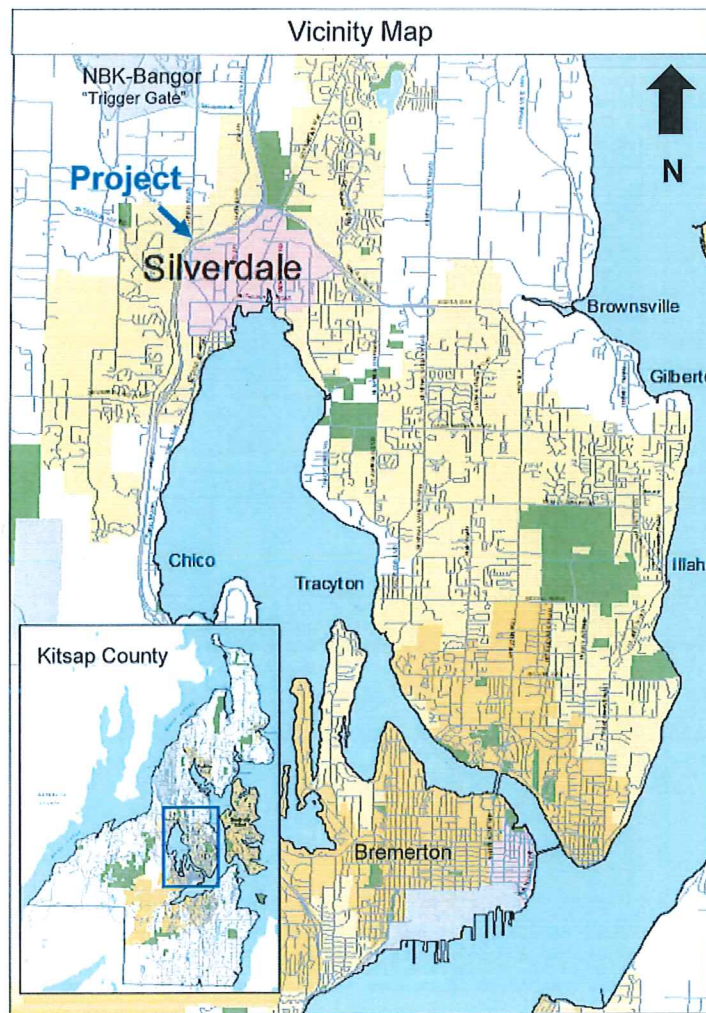


Figure 1 – Vicinity Map

## 2.1 Land Use

The project area is in the Silverdale Urban Growth Area (UGA) in Section 17, Township 25 North, and Range 1 East of the Willamette Meridian. The intersection is within the Waaga Way Town Center District in the adopted Silverdale Design Standards. The area surrounding the intersection is zoned commercial and industrial and has seen significant development within the last few years. Figure 2 is a zoning map of the location and the surrounding area.

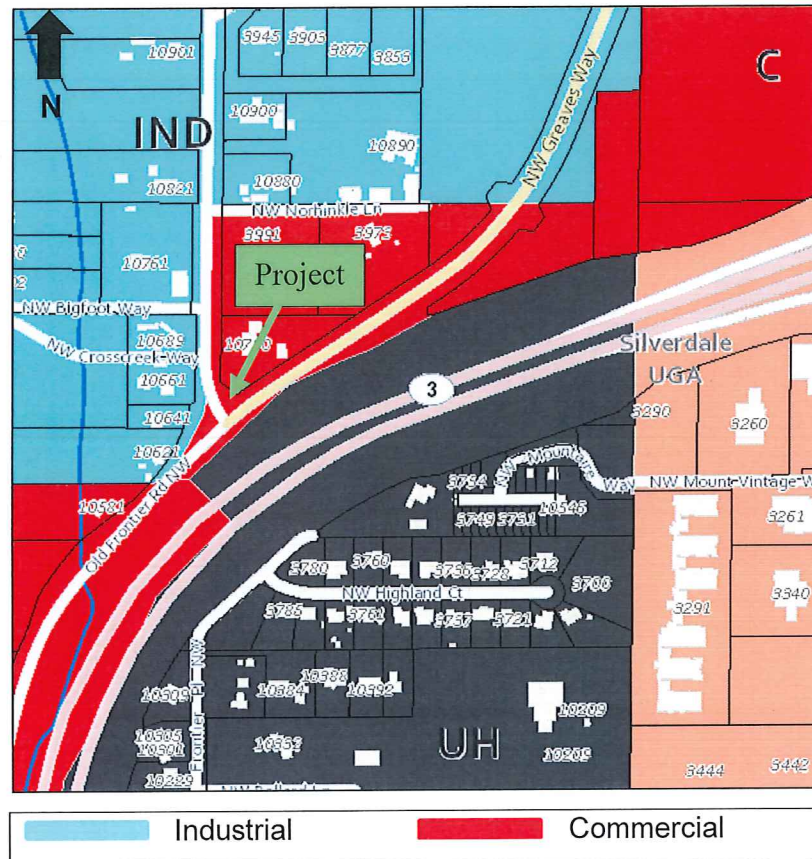


Figure 2 – Zoning Map

## 2.2 Bicycle/Pedestrian/Transit

The Kitsap County Non-Motorized Facilities Plan identifies opportunities for bikers, walkers, and all persons with "connections within communities" and "connections between communities". The Plan goals are:

- Recognize mobility needs of everyone
- Identify differences between rural and urban areas
- Make connections within communities, i.e. schools, parks, and services
- Make connections between communities within Kitsap County
- Promote recreational uses

The Kitsap County Non-Motorized Facility Plan identifies NW Greaves Way and Old Frontier Road NW as non-motorized routes. These routes combine to be the primary north-south connecting route west of SR 3 for the County. A map of the routes, extracted from the plan, is shown as Figure 3.

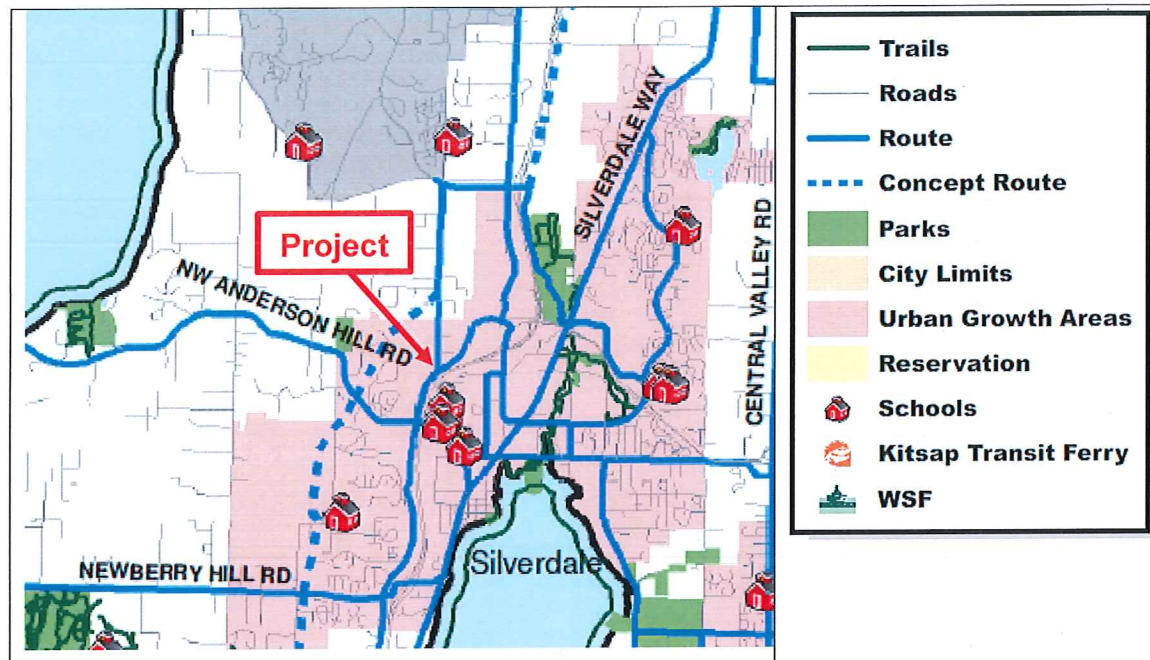


Figure 3 – Regional Bicycle Route Map

Kitsap Transit’s routed buses do not serve the study intersection. Approximately ½ mile east of the intersection is a commercial shopping center and the Kitsap Transit’s Silverdale Transit Center. A 2017 traffic count showed no pedestrians crossing at the intersection during the PM peak hour and a 2016 traffic count showed 3 pedestrian crossings during the PM peak hour. No studies were conducted to count average daily pedestrian volumes.

### 3 Roadway Characteristics

#### 3.1 Roadway Descriptions

NW Greaves Way was constructed in 2010. Prior to the NW Greaves Way construction, Old Frontier Road curved to the north at the location of the current intersection. Greaves Way provides a direct connection to State Route (SR) 3 from the west side of Silverdale. The construction of NW Greaves Way allowed commercial development of the adjacent land.

NW Greaves Way (Road Log ID 57768) is a paved urban minor arterial which generally runs in an east-west orientation. NW Greaves Way forms the study intersection’s east leg. It begins at Old Frontier Road NW and terminates State Route 303. It consists of two 11-foot travel lanes in each direction separated by a planted median. There are 5-foot bike lanes on both sides of NW Greaves Way and 6-foot sidewalks separated from the travel lanes by planted buffer strips. The posted speed on NW Greaves Way is 35 mph.

Old Frontier Road NW (Road Log ID 57810) is a paved urban major collector. It forms the intersection's west and north legs. Old Frontier Road NW begins at NW Anderson Hill Road and runs in a southwest to northeast direction then makes sharp turn to the north at the intersection with NW Greaves Way and terminates at NW Half Mile Road. It consists of one 12-foot travel lane in each direction. West of the study intersection Old Frontier Road NW has 3-foot paved shoulders on each side of the roadway delineated by white edge lines and a posted speed of 35 mph. North of the study intersection there are 6-foot sidewalks adjacent to the travel lanes on both sides of the road and it has a posted speed of 40 mph. One full movement commercial driveway exists within the intersection functional area. It is located on Old Frontier Road NW approximately 60 feet west of the intersection.

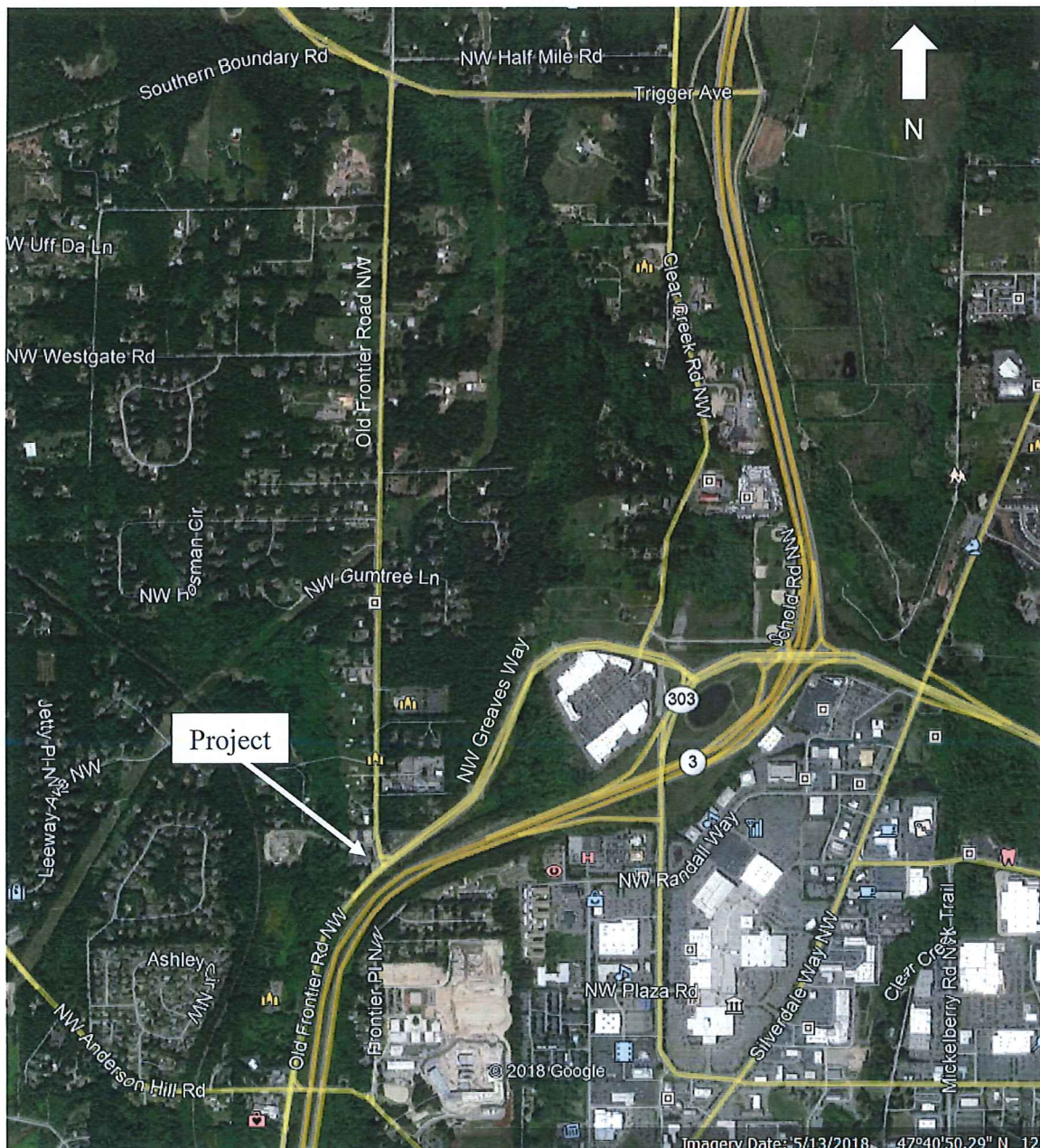


Figure 4 – Roadway Orientation

### 3.2 Intersection Description

The junction of NW Greaves Way and Old Frontier Road form a three-leg intersection with stop control on all approaches. The intersection corresponds to milepost 0.00 on NW Greaves Way and milepost 0.424 on Old Frontier Road NW. The north leg consists of a separate left turn lane and separate right turn lane. The west leg consists of a separate left turn lane and a separate through lane. The east leg consists of a separate through lane and a right-turn slip lane controlled by a yield sign. Pedestrian facilities at the study intersection include marked crosswalks on the east and north legs. Within the intersection limits, sidewalk is present on both sides of Greaves Way and on both sides of Old Frontier Road north of the intersection. There is no sidewalk, only 3-foot paved shoulders on Old Frontier Road west of the intersection. Bike lanes exist only on NW Greaves Way. Figure 5 is an aerial view of the study intersection.



Figure 5 – Greaves Way at Old Frontier Intersection

## 4 Traffic Count Data

The daily traffic count data were determined by road tube counts. Traffic count data for the Old Frontier Road NW legs were collected on March 29, 2017. Traffic count data for the NW Greaves Way leg was collected on March 29, 2018. Counts were conducted on a mid-week day, which better represents an average daily traffic condition. Copies of the

Daily Vehicle Volume and Daily Vehicle Classification are found in Appendix A of this report.

### 4.1 Current and Future ADT Volumes

Average daily traffic (ADT) volumes for the study intersection are shown in Table 1 for both current and design year conditions. The future ADT volumes were calculated by applying a historical 2% annual growth rate to the 2017 volumes.

**Table 1 – Existing and future ADT volumes**

Leg	Existing Year ADT	Design Year 2043 ADT
North	4,652	7,769
West	8,748	14,609
East	8,590	14,345

### 4.2 Design Vehicle

AASHTO's *A Policy on Geometric Design of Highways and Streets* defines standard characteristics of 19 design vehicles within the general vehicle classes. From the AASHTO list, the following vehicles have been selected as the minimum design vehicle for each functional classification of Kitsap County roadways:

- Principal Arterial .....WB-40 (Intermediate Semi-trailer)
- Minor Arterial .....WB-40 (Intermediate Semi-trailer)
- Collector .....SU (Single Unit Truck)
- Local Access .....SU (Single Unit Truck)

Based on the roadway functional classification a WB-40 (Intermediate Semi-trailer) is an appropriate design vehicle for the intersection. Old Frontier Road NW is classified as an urban major collector. NW Greaves Way is classified as an urban minor arterial. However, a design of a roadway should consider the dimensions and operating characteristics of the vehicles traveling on the roadway. Kitsap County Road Standards state that the road's geometry must accommodate the physical dimensions and turning radius for the largest design vehicle likely to use the road with considerable frequency. Of the 992 total daily trucks entering the intersection, 980 (98.8%) were single-unit trucks of which 925 (93.2%) were two axel single unit trucks. In addition, 9 (0.9%) of the total trucks were double-unit trucks, and 3 (0.3%) of the total trucks were multi-unit trucks.

### 4.3 Current and Future Turning Movement Counts

Turning movement counts were collected on October 26, 2017. These counts were used to represent existing conditions. Figure 6 shows the existing PM peak turning movement counts for the study intersection. The PM peak hour is between 4:30 PM and 5:30 PM. Appendix B includes a copy of the turning movement counts report.



Figure 6 – Existing PM Peak Hour Volumes

Base on a 20-year design life and a construction date of 2023, the design year 2043 background turning movement counts were derived by applying a historical 2.0% annual growth rate to existing volumes. Figure 7 shows the 2043 PM peak hour traffic volumes used in this report's analysis.



Figure 7 – 2043 PM Peak Hour Volumes

## 5 Traffic Safety

The current 2014-2018 Traffic Safety Intersection List ranks the intersection of NW Greaves Way and Old Frontier Road NW as 1 out of 81. In the previous 2013-2017 Traffic Safety Intersection List, the study intersection was ranked 4 of 78. All reported motor vehicle collisions within the project limits from January 1, 2014 through December 31, 2018 were analyzed. Collision data was retrieved using Mobility, a database utility maintained by WSDOT's County Road Administration Board. The collisions were analyzed for their type and frequency. A collision diagram is included with this report as Appendix C.

### 5.1 Collision Types and Frequencies

A total of 29 collisions occurred at the project intersection 2014-2018. Of the 29 collisions:

- 1 was fatal,
- 12 were injury collisions,
- 16 were property damage only (PDO) collisions.

The most frequently cited contributing circumstance to crashes was "failure to grant right of way" (total of 17), followed by inattention (total of 5), and speed (total of 2). Of the 29 collisions analyzed:

- 18 were left-turn vs. opposing through,
- 5 were angle-entry,
- 4 were fixed object,
- 1 were rear-end;
- 1 was vehicle hits pedestrian.

## 6 Traffic Analysis

### 6.1 Intersection Control Warrants

An existing intersection signal control warrant analysis was performed. The 2009 Manual on Uniform Traffic Control Devices (MUTCD) prescribes nine warrants for traffic signal control installation. The intersection currently meets Warrant 1 – 8 Hour, Warrant 2 – 4 Hour, Warrant 3 – Peak Hour, and Warrant 7 – Crash Experience. Appendix D includes the traffic signal warrant analysis worksheet.

### 6.2 Intersection LOS

Signalized intersection Level of Service (LOS) were evaluated using Synchro Studio 10 by Trafficware. The method used for evaluating intersection LOS is described in the Highway Capacity Manual (HCM). Table 2 shows the control delay and corresponding HCM LOS for signalized intersections.

LOS can be characterized for the entire intersection, each intersection approach, and each lane group. Control delay alone is used to characterize LOS for the entire



intersection or an approach. Control delay and volume to capacity ratios are used to characterize LOS for a lane group.

**Table 2 – HCM Intersection LOS Standards**

Signalized Delay (s/veh)	LOS by Volume-to-Capacity Ratio	
	v/c ≤ 1.0	v/c ≥ 1.0
≤ 10	A	F
> 10 - 20	B	F
> 20 - 35	C	F
> 35 - 55	D	F
> 55 - 80	E	F
> 80	F	F

Roundabout operations for the intersection were analyzed using SIDRA Intersection 8.0 by Akcelik and Associates Pty Ltd. The analysis method followed WSDOT guidelines. Table 3 shows the SIDRA method level of service definitions base on delay and degree of saturation.

**Table 3 - SIDRA LOS Standards**

LOS	Control Delay per vehicle in seconds (d)*	Degree of saturation (v/c ratio) (x)
A	d ≤ 10	0 < x ≤ 0.85
B	10 < d ≤ 20	0 < x ≤ 0.85
C	20 < d ≤ 35	0 < x ≤ 0.85
D	30 < d ≤ 50	0 < x ≤ 0.85
D	0 < d ≤ 50	0.85 < x ≤ 0.95
E	50 < d ≤ 70	0 < x ≤ 0.95
E	0 < d ≤ 70	0.95 < x ≤ 1.00
F	70 < d	1.00 < x

\*Only the average delay value is considered in determining LOS for approaches and the intersection

### 6.2.1 No-Build LOS

Intersection delay and LOS is not defined by the HCM for unsignalized all-way stop controlled (AWSC) intersections. The HCM methodology calculates delay and LOS for individual movements. Analysis of existing conditions indicates that intersection individual movements are operating acceptably. A detailed LOS analysis for the study intersection under the AWSC is included with this report as Appendix E. Table 4 summarizes the existing and future LOS for the intersection’s critical movements.

**Table 4 – No-build AWSC Intersection LOS Summary**

Movement	Existing			2043		
	LOS	V/C	Delay (s/veh)	LOS	V/C	Delay (s/veh)
Greaves Way (East Leg)						
Thru	D	.78	27.5	F	1.59	300
Right	B	.28	10.5	C	0.60	19.7
Old Frontier Rd (North Leg)						
Left	B	.26	13.1	C	.52	20.4
Right	B	.37	12.9	D	.76	27.8
Old Frontier Rd (West Leg)						
Left	B	.27	12.3	C	.56	20.6
Thru	C	.53	16.2	F	1.11	81.2

### 6.2.2 Signalized LOS

The project intersection was analyzed under signal control for existing and 2043 PM peak hour traffic volumes. All the lane groups and approaches operated at acceptable LOS D or better under future traffic volumes and existing geometry. Table 5 gives a summary of intersection operations. Detailed intersection LOS analysis worksheets are included in Appendix F.

**Table 5 – Signalized Intersection LOS Summary**

Lane Group	Existing			2043		
	LOS	Delay (s/veh)	95 <sup>th</sup> Percentile Queue (ft)	LOS	Delay (s/veh)	95 <sup>th</sup> Percentile Queue (ft)
Greaves Way (East) Through	B	13.1	161	C	34.4	399
Old Frontier Rd (North) Left	B	13.5	71	C	25.5	135
Old Frontier Rd (North) Right	B	16.3	73	D	51.6	205
Old Frontier Rd (West) Left	B	18.5	85	D	49.9	135
Old Frontier Rd (West) Through	A	4.3	99	A	6.7	248
Intersection	B	12.2	---	C	31.5	----

### 6.2.3 Roundabout LOS

Per Kitsap County Policy (PW-33.31.01), roundabouts should be considered as an alternative when an intersection meets all-way stop and/or signal warrants under existing traffic conditions or under projected traffic volumes one year after project construction, or if an accident pattern suggests that a roundabout would be an appropriate countermeasure.

Roundabouts typically operate better when the traffic volume demands for the approach legs are about equal. Roundabout operations for the intersection of NW Greaves Way and Old Frontier Road NW were analyzed using SIDRA Intersection 8 by Akcelik and Associates Pty Ltd. The analysis method followed WSDOT guidelines. A single-lane roundabout analysis for 2043 showed the intersection operating at an acceptable LOS A.

Table 6 is a summary of the roundabout approaches and intersection LOS under existing and future conditions. The analysis details are included with this report as Appendix G.

**Table 6 – Roundabout LOS Summary**

Approach	Existing			2043		
	LOS	Delay (s/veh)	95 <sup>th</sup> Percentile Queue (ft)	LOS	Delay (s/veh)	95 <sup>th</sup> Percentile Queue (ft)
Greaves Way (East)	A	4.1	78	A	5.5	207
Old Frontier Rd (North)	A	8.5	44	B	13.1	147
Old Frontier Rd (West)	A	5.4	50	A	5.9	109
Intersection	A	5.5	---	A	7.4	---

## 7 Design Elements

### 7.1 Potential Design Issues

Turning movements projected for 2043 show that the roundabout would operate at LOS A if a single lane circulating road is in use. The Kitsap County Comprehensive Plan shows no plans to expand Old Frontier Road NW. One potential challenge to converting the study intersection to a roundabout is acquiring the needed right-of-way. Appendix H includes a figure depicting a single lane roundabout design. It appears that additional right-of-way on the south side of the intersection may be required. This right-of-way belongs to WSDOT.

A second potential design issue involves a commercial driveway access on Old Frontier Road NW west of the intersection. The driveway is within the functional area of the intersection and provides access to commercial building on a small parcel adjacent to the intersection (see Appendix H). It appears from an aerial view that the small parcel also has access to an easement across the back side of an adjoining property to a private road north of the intersection. Both parcels are owned by Old Frontier LLC.

## 8 Conclusion

The operational performance of the NW Greaves Way at Old Frontier Road intersection would be improved by signalization or roundabout conversion. Both traffic control measures would reduce per-vehicle delay and reduce frequency and severity of angle-entry and left versus opposing through collisions. Whether the preferred alternative is a signal or a roundabout, this report recommends:

- Exterior lanes should be 12 feet wide,
- Sidewalks should be 6 feet wide and installed on all sides of the intersection,
- Bicycle lanes should be 5 feet wide and installed on all legs,
- Intersection lighting should follow ANSI/IES recommendations,
- If the intersection is converted to a roundabout, then the report recommends a single lane compact design.

The decision to convert the intersections from “T” intersections with stop control to roundabouts should consider:












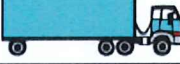






















- Safety- reductions in fatal and injury collisions
  - Pedestrians – roundabouts offer shorter crossing distances and pedestrians only cross one direction of traffic at a time
- Maintenance costs – no signal hardware or equipment maintenance with roundabouts
- Traffic calming – reduced vehicular speeds with roundabouts

## 9 References

1. *Design Manual*. Washington State Department of Transportation, February 2019.
2. "FHWA Vehicle Classification." Federal Highway Administration, November 2014 (accessed June 13, 2016).  
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8. *Roadside Design Guide*. American Association of State Highway Transportation Officials, 2011.

**Appendix A. Vehicle Volume/Classification/Speed Data**

FHWA Vehicle Classification System

<p><b>Class 1</b> Motorcycles</p>		<p><b>Class 7</b> Four or more axle, single unit</p>	
<p><b>Class 2</b> Passenger cars</p>		<p><b>Class 8</b> Four or less axle, single trailer</p>	
			
			
			
<p><b>Class 3</b> Four tire, single unit</p>		<p><b>Class 9</b> 5-Axle tractor semitrailer</p>	
			
			
<p><b>Class 4</b> Buses</p>		<p><b>Class 10</b> Six or more axle, single trailer</p>	
			
		<p><b>Class 11</b> Five or less axle, multi trailer</p>	
<p><b>Class 5</b> Two axle, six tire, single unit</p>		<p><b>Class 12</b> Six axle, multi-trailer</p>	
			
		<p><b>Class 13</b> Seven or more axle, multi-trailer</p>	
<p><b>Class 6</b> Three axle, single unit</p>			
			
			

## Daily Vehicle Volume Report

Study Date: Wednesday, 03/29/2017 / Thursday, 03/30/2017

Unit ID: 5

Location: Old Frontier Rd. N. of Greaves Way 110.7

	Southbound Volume	Northbound Volume	Total Volume
11:00 - 11:59	175	137	312
12:00 - 12:59	150	172	322
13:00 - 13:59	147	128	275
14:00 - 14:59	180	137	317
15:00 - 16:59	285	179	464
16:00 - 16:59	257	177	434
17:00 - 17:59	186	183	369
18:00 - 18:59	147	144	291
19:00 - 19:59	98	93	191
20:00 - 20:59	47	65	112
21:00 - 21:59	17	30	47
22:00 - 22:59	10	18	28
23:00 - 23:59	6	10	16
00:00 - 00:59	4	3	7
01:00 - 01:59	4	2	6
02:00 - 02:59	0	4	4
03:00 - 03:59	4	4	8
04:00 - 04:59	13	16	29
05:00 - 05:59	23	122	145
06:00 - 06:59	97	202	299
07:00 - 07:59	97	169	266
08:00 - 08:59	121	123	244
09:00 - 09:59	148	101	249
10:00 - 10:59	111	106	217
<b>Totals</b>	<b>2327</b>	<b>2325</b>	<b>4652</b>
<b>AM Peak Time</b>	<b>11:00 - 11:59</b>	<b>05:49 - 06:48</b>	<b>06:44 - 07:43</b>
<b>AM Peak Volume</b>	<b>175</b>	<b>204</b>	<b>314</b>
<b>PM Peak Time</b>	<b>15:34 - 16:33</b>	<b>16:54 - 17:53</b>	<b>15:30 - 16:29</b>
<b>PM Peak Volume</b>	<b>305</b>	<b>190</b>	<b>492</b>



## Daily Southbound Classes Report

Study Date: Wednesday, 03/29/2017 / Thursday, 03/30/2017

Unit ID: 5

Location: Old Frontier Rd. N. of Greaves Way 110.7

	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	Total
11:00 - 11:59	0	141	25	0	9	0	0	0	0	0	0	0	0	175
12:00 - 12:59	0	110	29	0	10	1	0	0	0	0	0	0	0	150
13:00 - 13:59	0	113	24	1	9	0	0	0	0	0	0	0	0	147
14:00 - 14:59	1	132	35	3	9	0	0	0	0	0	0	0	0	180
15:00 - 15:59	3	199	58	1	24	0	0	0	0	0	0	0	0	285
16:00 - 16:59	1	184	38	5	28	1	0	0	0	0	0	0	0	257
17:00 - 17:59	0	145	18	0	22	0	0	1	0	0	0	0	0	186
18:00 - 18:59	1	122	19	0	5	0	0	0	0	0	0	0	0	147
19:00 - 19:59	0	83	8	0	7	0	0	0	0	0	0	0	0	98
20:00 - 20:59	0	42	4	0	1	0	0	0	0	0	0	0	0	47
21:00 - 21:59	0	16	0	0	1	0	0	0	0	0	0	0	0	17
22:00 - 22:59	0	7	2	0	1	0	0	0	0	0	0	0	0	10
23:00 - 23:59	0	6	0	0	0	0	0	0	0	0	0	0	0	6
00:00 - 00:59	0	2	0	0	2	0	0	0	0	0	0	0	0	4
01:00 - 01:59	0	4	0	0	0	0	0	0	0	0	0	0	0	4
02:00 - 02:59	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:00 - 03:59	0	3	1	0	0	0	0	0	0	0	0	0	0	4
04:00 - 04:59	0	11	2	0	0	0	0	0	0	0	0	0	0	13
05:00 - 05:59	0	20	3	0	0	0	0	0	0	0	0	0	0	23
06:00 - 06:59	0	78	14	1	4	0	0	0	0	0	0	0	0	97
07:00 - 07:59	1	72	15	2	7	0	0	0	0	0	0	0	0	97
08:00 - 08:59	0	100	16	1	3	0	1	0	0	0	0	0	0	121
09:00 - 09:59	0	115	18	3	11	1	0	0	0	0	0	0	0	148
10:00 - 10:59	0	85	20	1	5	0	0	0	0	0	0	0	0	111
<b>Totals</b>	<b>7</b>	<b>1790</b>	<b>349</b>	<b>18</b>	<b>158</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2327</b>
Percent of Total	0.3	76.9	15.0	0.8	6.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Percent of AM	0.1	79.2	14.3	1.0	5.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	100
Percent of PM	0.4	75.8	15.4	0.7	7.6	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	100

**Truck Summary:**

Total Trucks: 181

% Trucks: 7.8

AM % Trucks: 6.4

PM % Trucks: 8.5

Classification Scheme: FHWA (ID: 1)

- #1 Motorcycles - 2 Axles
- #2 Passenger Cars - 2 Axles
- #3 Pickup Trucks, Vans - 2 Axles
- #4 Buses
- #5 Single Unit - 2 Axles, 6 Tires

- #6 Single Unit Truck - 3 Axles
- #7 Single Unit - 4 Axles
- #8 Single Unit - 4 Axles or Less
- #9 Double Unit - 5 Axles
- #10 Double Unit - 6 Axles or More

- #11 Multi-Unit - 5 Axles or Less
- #12 Multi-Unit - 6 Axles
- #13 Multi-Unit - 7 Axles or More

## Daily Vehicle Volume Report

Study Date: Wednesday, 03/29/2017 / Thursday, 03/30/2017

Unit ID: 3

Location: Old Frontier Rd. S. of Greaves Way 94.2

	Southbound Volume	Northbound Volume	Total Volume
11:00 - 11:59	235	230	465
12:00 - 12:59	270	236	506
13:00 - 13:59	290	215	505
14:00 - 14:59	321	322	643
15:00 - 15:59	519	331	850
16:00 - 16:59	485	381	866
17:00 - 17:59	402	312	714
18:00 - 18:59	297	245	542
19:00 - 19:59	241	128	369
20:00 - 20:59	178	123	301
21:00 - 21:59	89	46	135
22:00 - 22:59	46	28	74
23:00 - 23:59	38	25	63
00:00 - 00:59	21	10	31
01:00 - 01:59	7	8	15
02:00 - 02:59	4	7	11
03:00 - 03:59	7	11	18
04:00 - 04:59	13	32	45
05:00 - 05:59	45	151	196
06:00 - 06:59	151	294	445
07:00 - 07:59	261	366	627
08:00 - 08:59	226	284	510
09:00 - 09:59	236	223	459
10:00 - 10:59	170	188	358
Totals	4552	4196	8748
AM Peak Time	06:44 - 07:43	06:51 - 07:50	06:52 - 07:51
AM Peak Volume	285	380	662
PM Peak Time	15:32 - 16:31	14:41 - 15:40	15:31 - 16:30
PM Peak Volume	557	394	911

## Daily Northbound Classes Report

Study Date: Wednesday, 03/29/2017 / Thursday, 03/30/2017

Unit ID: 3

Location: Old Frontier Rd. S. of Greaves Way 94.2

	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	Total
11:00 - 11:59	1	183	25	1	19	1	0	0	0	0	0	0	0	230
12:00 - 12:59	0	187	29	2	17	1	0	0	0	0	0	0	0	236
13:00 - 13:59	0	147	30	5	31	1	0	1	0	0	0	0	0	215
14:00 - 14:59	1	265	32	3	21	0	0	0	0	0	0	0	0	322
15:00 - 15:59	1	271	37	0	20	2	0	0	0	0	0	0	0	331
16:00 - 16:59	2	305	53	0	19	1	1	0	0	0	0	0	0	381
17:00 - 17:59	1	257	36	0	18	0	0	0	0	0	0	0	0	312
18:00 - 18:59	1	212	23	0	9	0	0	0	0	0	0	0	0	245
19:00 - 19:59	0	109	15	0	4	0	0	0	0	0	0	0	0	128
20:00 - 20:59	1	103	18	0	1	0	0	0	0	0	0	0	0	123
21:00 - 21:59	0	41	2	0	3	0	0	0	0	0	0	0	0	46
22:00 - 22:59	0	23	4	0	1	0	0	0	0	0	0	0	0	28
23:00 - 23:59	0	20	5	0	0	0	0	0	0	0	0	0	0	25
00:00 - 00:59	0	10	0	0	0	0	0	0	0	0	0	0	0	10
01:00 - 01:59	0	6	2	0	0	0	0	0	0	0	0	0	0	8
02:00 - 02:59	0	7	0	0	0	0	0	0	0	0	0	0	0	7
03:00 - 03:59	0	10	1	0	0	0	0	0	0	0	0	0	0	11
04:00 - 04:59	1	25	3	0	3	0	0	0	0	0	0	0	0	32
05:00 - 05:59	3	115	19	1	13	0	0	0	0	0	0	0	0	151
06:00 - 06:59	1	197	53	6	36	1	0	0	0	0	0	0	0	294
07:00 - 07:59	1	267	53	1	44	0	0	0	0	0	0	0	0	366
08:00 - 08:59	1	209	40	3	28	1	0	1	1	0	0	0	0	284
09:00 - 09:59	3	188	19	0	10	1	0	0	1	1	0	0	0	223
10:00 - 10:59	0	139	32	0	14	2	1	0	0	0	0	0	0	188
<b>Totals</b>	<b>18</b>	<b>3296</b>	<b>531</b>	<b>22</b>	<b>311</b>	<b>11</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>4196</b>
Percent of Total	0.4	78.6	12.7	0.5	7.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Percent of AM	0.6	75.2	13.7	0.7	9.3	0.3	0.1	0.1	0.1	0.1	0.0	0.0	0.0	100
Percent of PM	0.3	81.1	11.9	0.4	6.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100

**Truck Summary:**

Total Trucks: 351

% Trucks: 8.4

AM % Trucks: 10.5

PM % Trucks: 6.7

Classification Scheme: FHWA (ID: 1)

- #1 Motorcycles - 2 Axles
- #2 Passenger Cars - 2 Axles
- #3 Pickup Trucks, Vans - 2 Axles
- #4 Buses
- #5 Single Unit - 2 Axles, 6 Tires

- #6 Single Unit Truck - 3 Axles
- #7 Single Unit - 4 Axles
- #8 Single Unit - 4 Axles or Less
- #9 Double Unit - 5 Axles
- #10 Double Unit - 6 Axles or More

- #11 Multi-Unit - 5 Axles or Less
- #12 Multi-Unit - 6 Axles
- #13 Multi-Unit - 7 Axles or More

## Kitsap County Traffic Engineering Daily Vehicle Volume Report

Study Date: Thursday, 03/29/2018 / Friday, 03/30/2018

Unit ID: 28

Location: Greaves Way E. of Old Frontier Rd. 110.6

	Northbound Volume	Southbound Volume	Total Volume
11:00 - 11:59	285	293	578
12:00 - 12:59	362	347	709
13:00 - 13:59	353	346	699
14:00 - 14:59	315	307	622
15:00 - 15:59	380	320	700
16:00 - 16:59	409	350	759
17:00 - 17:59	387	308	695
18:00 - 18:59	292	212	504
19:00 - 19:59	202	165	367
20:00 - 20:59	209	107	316
21:00 - 21:59	89	46	135
22:00 - 22:59	53	26	79
23:00 - 23:59	37	13	50
00:00 - 00:59	12	4	16
01:00 - 01:59	12	7	19
02:00 - 02:59	6	4	10
03:00 - 03:59	4	13	17
04:00 - 04:59	12	14	26
05:00 - 05:59	44	43	87
06:00 - 06:59	161	177	338
07:00 - 07:59	191	317	508
08:00 - 08:59	213	190	403
09:00 - 09:59	221	257	478
10:00 - 10:59	224	251	475
<b>Totals</b>	<b>4473</b>	<b>4117</b>	<b>8590</b>
AM Peak Time	11:00 - 11:59	07:00 - 07:59	11:00 - 11:59
AM Peak Volume	285	317	578
PM Peak Time	16:11 - 17:10	16:03 - 17:02	16:10 - 17:09
PM Peak Volume	428	361	785

## Daily Southbound Classes Report

Study Date: Thursday, 03/29/2018 / Friday, 03/30/2018

Unit ID: 28

Location: Greaves Way E. of Old Frontier Rd. 110.6

	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	Total
11:00 - 11:59	0	217	46	0	30	0	0	0	0	0	0	0	0	293
12:00 - 12:59	2	244	48	14	38	0	0	1	0	0	0	0	0	347
13:00 - 13:59	3	260	47	2	30	2	0	1	0	0	1	0	0	346
14:00 - 14:59	1	235	47	1	17	4	1	1	0	0	0	0	0	307
15:00 - 15:59	0	232	64	0	22	1	0	1	0	0	0	0	0	320
16:00 - 16:59	0	282	40	0	25	1	0	1	0	1	0	0	0	350
17:00 - 17:59	4	240	37	0	25	1	0	1	0	0	0	0	0	308
18:00 - 18:59	0	161	33	0	16	2	0	0	0	0	0	0	0	212
19:00 - 19:59	0	137	16	0	12	0	0	0	0	0	0	0	0	165
20:00 - 20:59	0	92	8	0	7	0	0	0	0	0	0	0	0	107
21:00 - 21:59	0	37	6	0	3	0	0	0	0	0	0	0	0	46
22:00 - 22:59	0	21	3	0	2	0	0	0	0	0	0	0	0	26
23:00 - 23:59	0	12	1	0	0	0	0	0	0	0	0	0	0	13
00:00 - 00:59	0	3	1	0	0	0	0	0	0	0	0	0	0	4
01:00 - 01:59	0	7	0	0	0	0	0	0	0	0	0	0	0	7
02:00 - 02:59	0	4	0	0	0	0	0	0	0	0	0	0	0	4
03:00 - 03:59	0	12	1	0	0	0	0	0	0	0	0	0	0	13
04:00 - 04:59	1	10	1	0	2	0	0	0	0	0	0	0	0	14
05:00 - 05:59	0	27	8	0	8	0	0	0	0	0	0	0	0	43
06:00 - 06:59	0	110	23	10	33	1	0	0	0	0	0	0	0	177
07:00 - 07:59	3	226	37	1	43	3	1	2	1	0	0	0	0	317
08:00 - 08:59	2	140	17	1	28	1	0	0	1	0	0	0	0	190
09:00 - 09:59	1	180	48	0	21	4	1	2	0	0	0	0	0	257
10:00 - 10:59	0	178	41	1	24	0	0	2	2	1	2	0	0	251
<b>Totals</b>	<b>17</b>	<b>3067</b>	<b>573</b>	<b>30</b>	<b>386</b>	<b>20</b>	<b>3</b>	<b>12</b>	<b>4</b>	<b>2</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>4117</b>
Percent of Total	0.4	74.5	13.9	0.7	9.4	0.5	0.1	0.3	0.1	0.0	0.1	0.0	0.0	100
Percent of AM	0.4	71.0	14.2	0.8	12.0	0.6	0.1	0.4	0.3	0.1	0.1	0.0	0.0	100
Percent of PM	0.4	76.7	13.7	0.7	7.7	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0	100

**Truck Summary:**

Total Trucks: 460

% Trucks: 11.2

AM % Trucks: 14.4

PM % Trucks: 9.2

Classification Scheme: FHWA (ID: 1)

- #1 Motorcycles - 2 Axles
- #2 Passenger Cars - 2 Axles
- #3 Pickup Trucks, Vans - 2 Axles
- #4 Buses
- #5 Single Unit - 2 Axles, 6 Tires

- #6 Single Unit Truck - 3 Axles
- #7 Single Unit - 4 Axles
- #8 Single Unit - 4 Axles or Less
- #9 Double Unit - 5 Axles
- #10 Double Unit - 6 Axles or More

- #11 Multi-Unit - 5 Axles or Less
- #12 Multi-Unit - 6 Axles
- #13 Multi-Unit - 7 Axles or More

**Appendix B. Peak Hour Turning Movement Count Data**

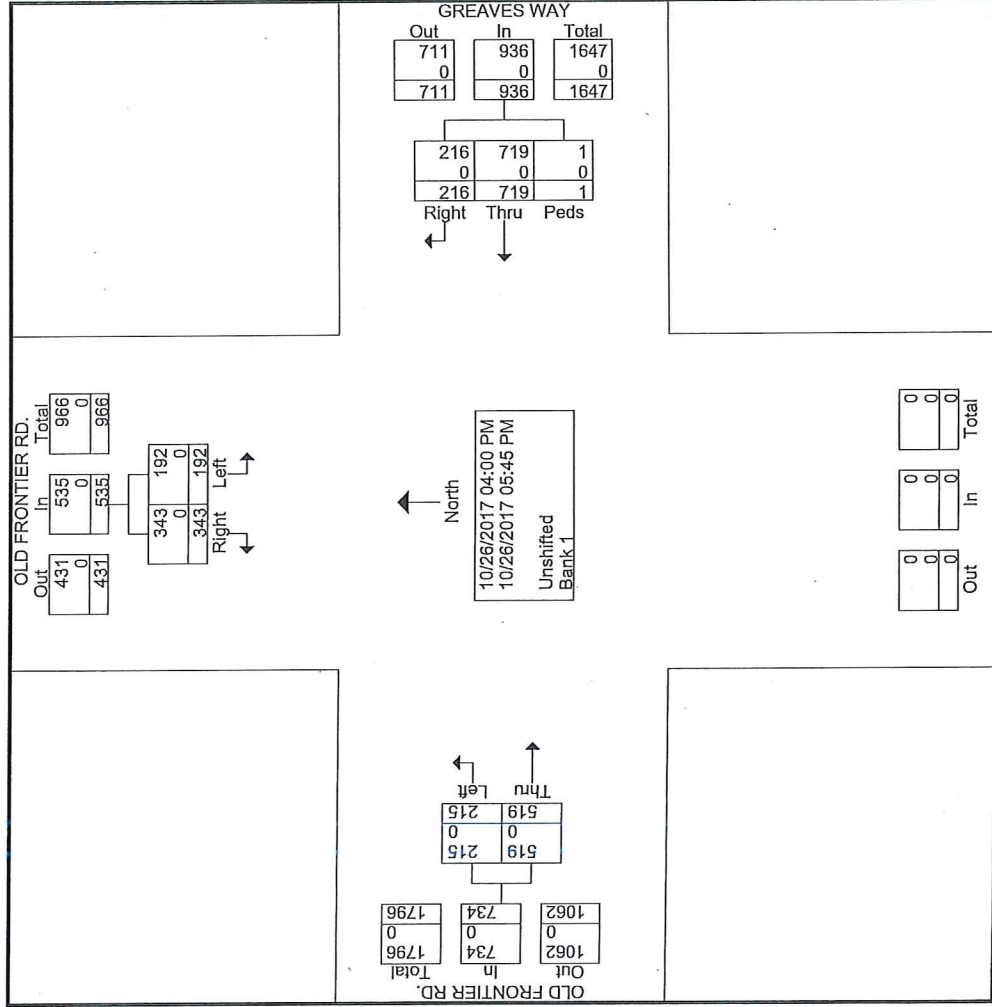


# Your Company Name Here

This is your address  
Your City, State, Zip Code  
*Your Tagline Here*

Old Frontier Rd. & Greaves Way  
Turning Movement Count  
October  
4:00 to 6:00 PM

File Name : OLD FRONTIER-OF GREAVES\_11-15-17\_TM\_0  
Site Code : 00000000  
Start Date : 10/26/2017  
Page No : 2





# Your Company Name Here

This is your address  
Your City, State, Zip Code  
*Your Tagline Here*

Old Frontier Rd. & Greaves Way  
Turning Movement Count  
October  
4:00 to 6:00 PM

File Name : OLD FRONTIER-OF GREAVES\_11-15-17\_TM\_0  
Site Code : 00000000  
Start Date : 10/26/2017  
Page No : 3

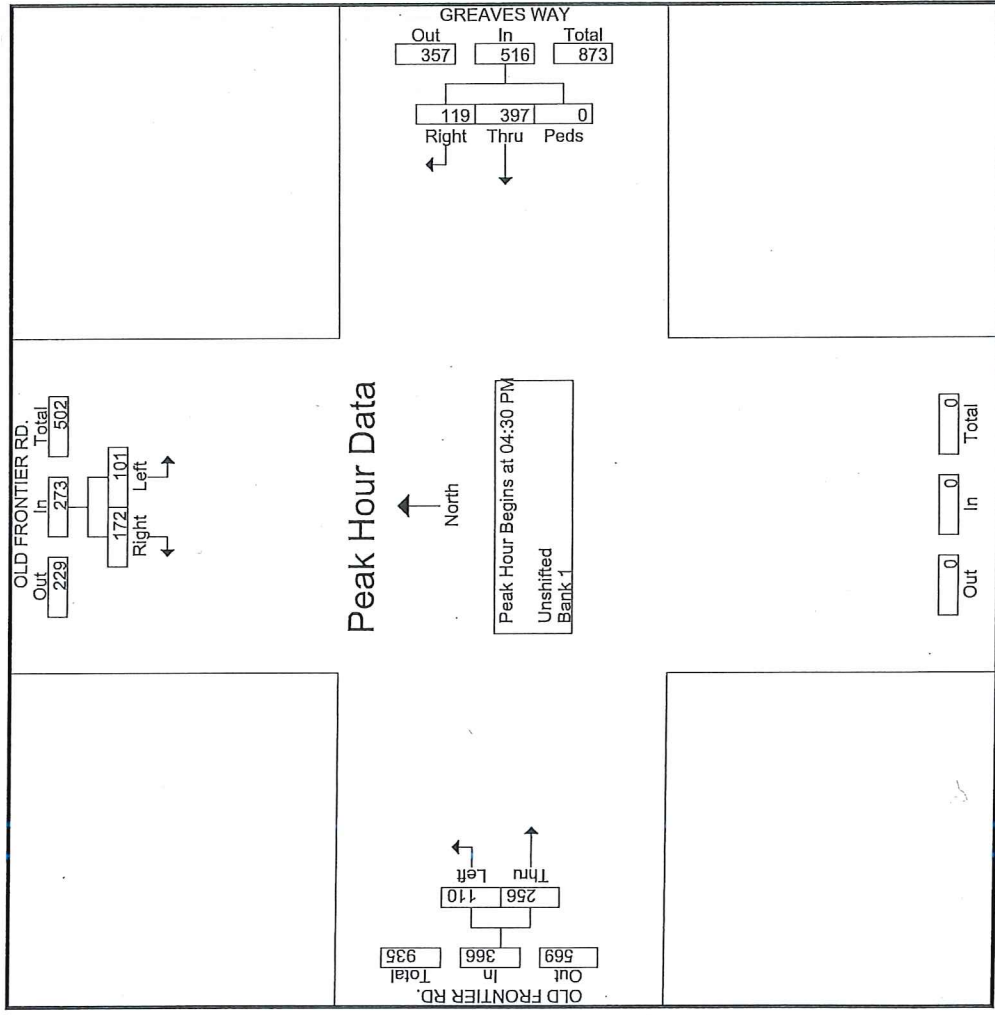
Start Time	OLD FRONTIER RD. From North			Peds	GREAVES WAY From East			OLD FRONTIER RD. From West			Int. Total
	Left	Right	App. Total		Thru	Right	App. Total	Left	Thru	App. Total	
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1											
Peak Hour for Entire Intersection Begins at 04:30 PM											
04:30 PM	21	51	72	0	96	20	116	31	70	101	289
04:45 PM	22	38	60	0	87	46	133	25	52	77	270
05:00 PM	30	39	69	0	102	30	132	34	73	107	308
05:15 PM	28	44	72	0	112	23	135	20	61	81	288
Total Volume	101	172	273	0	397	119	516	110	256	366	1155
% App. Total	37	63	94.8	0	76.9	23.1	95.6	30.1	69.9	87.7	93.8
PHF	.842	.843	.843	.000	.886	.647	.956	.809	.877	.855	.938

# Your Company Name Here

This is your address  
Your City, State, Zip Code  
*Your Tagline Here*

Old Frontier Rd. & Greaves Way  
Turning Movement Count  
October  
4:00 to 6:00 PM

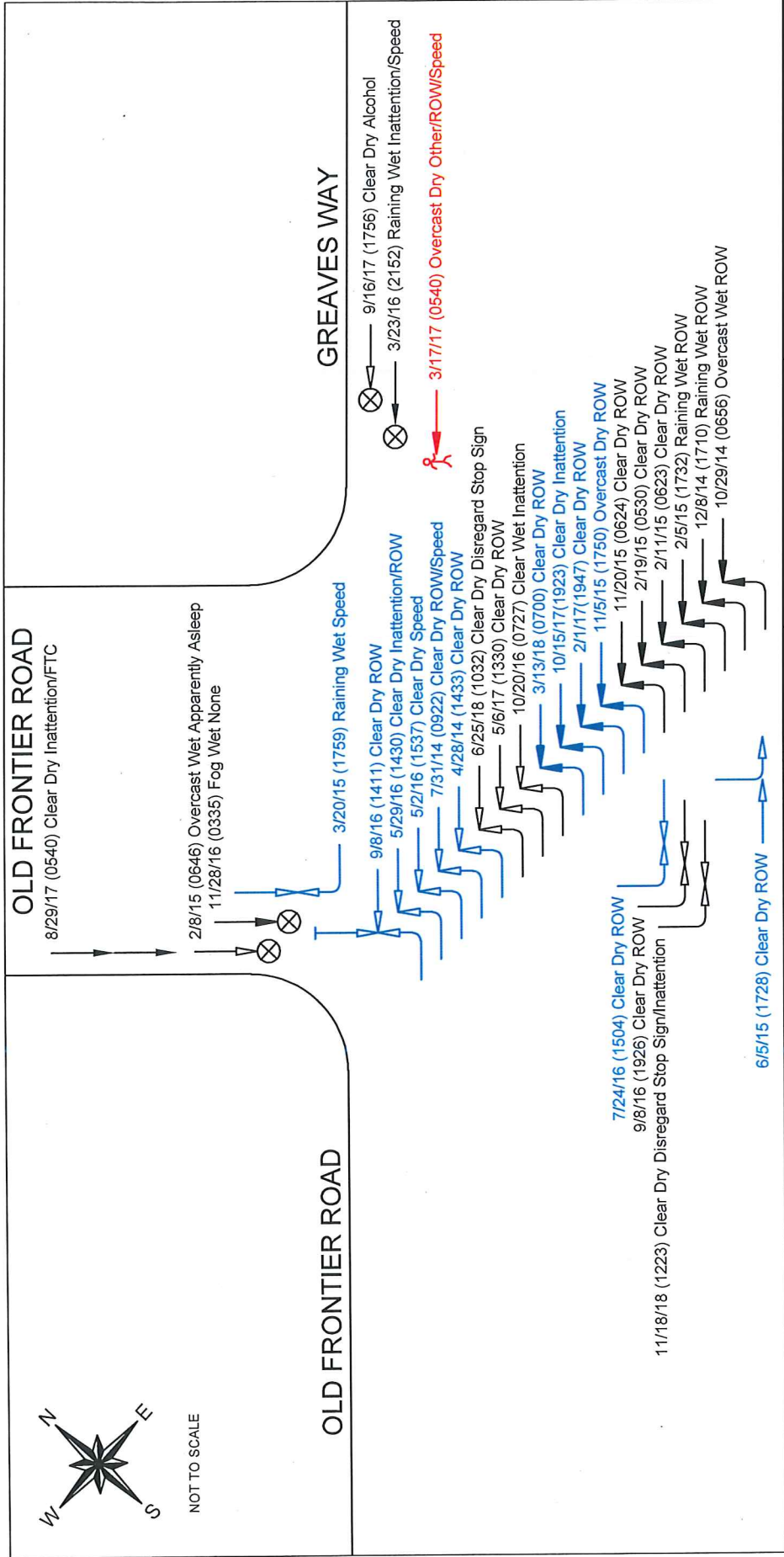
File Name : OLD FRONTIER-OF GREAVES\_11-15-17\_TM\_0  
Site Code : 00000000  
Start Date : 10/26/2017  
Page No : 4



**Appendix C. Collision Diagram**



NOT TO SCALE



COLOR CODE	TOP CONTRIBUTING CIRCUMSTANCES	ROAD CONDITION	LABEL KEY
Black indicates Property Damage Only (PDO)	FAILED TO GRANT RIGHT OF WAY	DRY	21
Blue indicates INJURY	INATTENTION	WET	8
Red indicates FATAL	SPEED	SNOW / ICE	0
<ul style="list-style-type: none"> <li>Daytime</li> <li>Nighttime</li> </ul>			<ul style="list-style-type: none"> <li>Date</li> <li>Time</li> <li>Weather</li> <li>Road Condition</li> <li>Contributing Factor</li> </ul>
			01/01/01 (2308) Clear Dry Speed

LEGEND	NUMBER OF COLLISIONS	COLLISION DIAGRAM
RIGHT TURN	PDO 16	<b>ENGINEERING STUDY</b>  <b>OLD FRONTIER ROAD &amp; GREAVES WAY</b>
LEFT TURN	INJURY 12	
MOVING STRAIGHT	FATAL 1	
STOPPED	TOTAL 29	
BACKING	NIGHTTIME COLLISIONS 14	
OUT-OF-CONTROL		

**Appendix D. Signal Warrant Worksheet**



**Kitsap County Department of Public Works - Traffic Operations**  
 614 Division Street, MS-26, Port Orchard, WA 98366

**TRAFFIC SIGNAL VOLUME WARRANT ANALYSIS**

Intersection name: **Greave Way & Old Frontier**

Date: 4/5/2018

Major street name: Greave Way  
 Number of approach lanes: 2  
 Posted speed (mph): 35  
 Minor street name: Old Frontier  
 Number of approach lanes: 2  
 Posted speed (mph): 35  
 Count year: 2018  
 Analysis year: 2018  
 Annual growth rate (%): 1.5  
 Growth factor: 1.00

Volume Criteria		
Warrant	Major	Minor
1A-Met	420	140
1B	630	70
1A & 1B	Major	Minor
1A	336	112
1B	504	56
2	890	80
3B	1183	100

Peak hour: 4:00 PM

Isolated community with population < 10,000 ?  
 85th percentile speed > 40 mph on major street?

No
Yes

Hours	Major Total	Minor Road Highest Approach	Met	Not Met	Met		Met	Met
			Warrant 1A	Warrant 1B	Combination 1A & 1B		Warrant 2	Warrant 3B
			Met	Met	Met	Met	Met	Met
12:00 AM	14	4	No	No	No	No	No	No
12:15 AM	15	4	No	No	No	No	No	No
12:30 AM	13	5	No	No	No	No	No	No
12:45 AM	13	4	No	No	No	No	No	No
1:00 AM	15	4	No	No	No	No	No	No
1:15 AM	13	4	No	No	No	No	No	No
1:30 AM	14	2	No	No	No	No	No	No
1:45 AM	12	1	No	No	No	No	No	No
2:00 AM	11	0	No	No	No	No	No	No
2:15 AM	11	1	No	No	No	No	No	No
2:30 AM	10	2	No	No	No	No	No	No
2:45 AM	16	3	No	No	No	No	No	No
3:00 AM	24	4	No	No	No	No	No	No
3:15 AM	28	5	No	No	No	No	No	No
3:30 AM	33	7	No	No	No	No	No	No
3:45 AM	36	10	No	No	No	No	No	No
4:00 AM	46	13	No	No	No	No	No	No
4:15 AM	72	13	No	No	No	No	No	No
4:30 AM	111	14	No	No	No	No	No	No
4:45 AM	145	18	No	No	No	No	No	No
5:00 AM	194	23	No	No	No	No	No	No
5:15 AM	256	35	No	No	No	No	No	No
5:30 AM	320	47	No	No	No	No	No	No
5:45 AM	400	56	No	No	No	No	No	No
6:00 AM	471	97	No	No	No	No	No	No
6:15 AM	535	101	No	No	No	Yes	No	No
6:30 AM	610	109	No	No	No		No	No
6:45 AM	662	122	No	Yes	Yes		No	No
7:00 AM	683	97	No				No	No
7:15 AM	625	104	No			Yes	No	No
7:30 AM	548	113	No				No	No
7:45 AM	502	111	No	No	No		No	No
8:00 AM	474	121	No	No	Yes		No	No
8:15 AM	504	150	Yes	No		Yes	No	No
8:30 AM	505	146		No			No	No
8:45 AM	480	143		No			No	No
9:00 AM	480	148		No	Yes		No	No
9:15 AM	467	113	No	No		No	No	No
9:30 AM	441	119	No	No		No	No	No
9:45 AM	447	120	No	No		No	No	No

10:00 AM	439	111	No	No	No	No	No	No
10:15 AM	447	139	No	No	Yes	No	No	No
10:30 AM	496	148	Yes	No		No	No	No
10:45 AM	519	155		No		Yes	No	No
11:00 AM	523	175		No			No	No
11:15 AM	538	162		No	Yes		No	No
11:30 AM	557	161	Yes	No			No	No
11:45 AM	576	172		No		Yes	No	No
12:00 PM	583	150		No			No	No
12:15 PM	587	154		No	Yes		No	No
12:30 PM	571	142	Yes	No			No	No
12:45 PM	562	135		No		Yes	No	No
1:00 PM	561	147		No			No	No
1:15 PM	567	143		No	Yes		No	No
1:30 PM	566	154	Yes	No			No	No
1:45 PM	583	162		No		Yes	No	No
2:00 PM	629	180		No			Yes	No
2:15 PM	666	198		Yes	Yes			No
2:30 PM	697	223	Yes					No
2:45 PM	688	264				Yes		Yes
3:00 PM	651	285					Yes	
3:15 PM	652	294		Yes	Yes			
3:30 PM	672	303	Yes					
3:45 PM	692	284				Yes		Yes
4:00 PM	731	257					Yes	
4:15 PM	725	250		Yes	Yes			
4:30 PM	700	221	Yes					
4:45 PM	675	201				Yes		No
5:00 PM	620	186					Yes	No
5:15 PM	557	168		No	Yes			No
5:30 PM	520	160	Yes	No				No
5:45 PM	494	149		No		No		No
6:00 PM	457	147		No		No	No	No
6:15 PM	426	135		No	Yes	No	No	No
6:30 PM	391	137	No	No		No	No	No
6:45 PM	321	120	No	No		No	No	No
7:00 PM	293	98	No	No		No	No	No
7:15 PM	274	82	No	No	No	No	No	No
7:30 PM	237	54	No	No	No	No	No	No
7:45 PM	243	50	No	No	No	No	No	No
8:00 PM	230	47	No	No	No	No	No	No
8:15 PM	187	44	No	No	No	No	No	No
8:30 PM	153	34	No	No	No	No	No	No
8:45 PM	124	20	No	No	No	No	No	No
9:00 PM	92	17	No	No	No	No	No	No
9:15 PM	77	12	No	No	No	No	No	No
9:30 PM	76	15	No	No	No	No	No	No
9:45 PM	67	16	No	No	No	No	No	No
10:00 PM	54	10	No	No	No	No	No	No
10:15 PM	56	12	No	No	No	No	No	No
10:30 PM	53	9	No	No	No	No	No	No
10:45 PM	39	7	No	No	No	No	No	No
11:00 PM	38	6	No	No	No	No	No	No
11:15 PM	28	4	No	No	No	No	No	No
11:30 PM	19	2	No	No	No	No	No	No
11:45 PM	17	4	No	No	No	No	No	No
Total			9	4	12	10	4	2
Criteria			8 hours	8 hours	8 hours for 1A and 1B		4 Hours	1 Hour
Warrant Summary			Warrant 1A	Warrant 1B	Warrant 1A	Warrant 1B	Warrant 2	Warrant 3B
			Met	Not Met	Met		Met	Met

Warrant 1 - Eight Hour Volume

- Condition A - Minimum Vehicular Volume,
- Condition B - Interruption of Continuous Traffic,
- Combination - Warrant 1A and 1B

Warrant 2 - Four Hour Volume - MUTCD, Figure 4C-1 and 4C-2

Warrant 3B - Peak Hour Volume - MUTCD, Figure 4C-3 and 4C-4

**Appendix E. AWSC Analysis Worksheets**



Intersection

Intersection Delay, s/veh	18
Intersection LOS	C

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations	↘	↗	↘	↗	↗	↗
Traffic Vol, veh/h	101	172	110	256	397	119
Future Vol, veh/h	101	172	110	256	397	119
Peak Hour Factor	0.84	0.84	0.81	0.88	0.89	0.65
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	120	205	136	291	446	183
Number of Lanes	1	1	1	1	1	1

Approach	SB	NE	SW
Opposing Approach		SW	NE
Opposing Lanes	0	2	2
Conflicting Approach Left	SW	SB	
Conflicting Lanes Left	2	2	0
Conflicting Approach Right	NE		SB
Conflicting Lanes Right	2	0	2
HCM Control Delay	13	15	22.6
HCM LOS	B	B	C

Lane	NELn1	NELn2	SBLn1	SBLn2	SWLn1	SWLn2
Vol Left, %	100%	0%	100%	0%	0%	0%
Vol Thru, %	0%	100%	0%	0%	100%	0%
Vol Right, %	0%	0%	0%	100%	0%	100%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	110	256	101	172	397	119
LT Vol	110	0	101	0	0	0
Through Vol	0	256	0	0	397	0
RT Vol	0	0	0	172	0	119
Lane Flow Rate	136	291	120	205	446	183
Geometry Grp	7	7	7	7	7	7
Degree of Util (X)	0.264	0.524	0.256	0.366	0.776	0.282
Departure Headway (Hd)	6.993	6.484	7.66	6.437	6.263	5.551
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes
Cap	512	553	468	557	575	644
Service Time	4.762	4.252	5.428	4.204	4.025	3.312
HCM Lane V/C Ratio	0.266	0.526	0.256	0.368	0.776	0.284
HCM Control Delay	12.3	16.2	13.1	12.9	27.5	10.5
HCM Lane LOS	B	C	B	B	D	B
HCM 95th-tile Q	1.1	3	1	1.7	7.2	1.2

Queuing and Blocking Report  
 PM-peak level of service

08/13/2019

Intersection: 4076: Old Frontier Rd & Greaves Way

Movement	SB	SB	NE	NE	SW
Directions Served	L	R	L	T	T
Maximum Queue (ft)	64	70	75	100	213
Average Queue (ft)	29	32	37	55	91
95th Queue (ft)	49	57	62	84	166
Link Distance (ft)		633		423	917
Upstream Blk Time (%)					
Queuing Penalty (veh)					
Storage Bay Dist (ft)	100		100		
Storage Blk Time (%)	0	0	0	0	
Queuing Penalty (veh)	0	0	0	0	

Network Summary

Network wide Queuing Penalty: 0

<b>Intersection</b>	
Intersection Delay, s/veh	124.5
Intersection LOS	F

Movement	SBL	SBR	NEL	NET	SWT	SWR
Lane Configurations	↘	↗	↘	↗	↗	↗
Traffic Vol, veh/h	169	287	184	428	663	199
Future Vol, veh/h	169	287	184	428	663	199
Peak Hour Factor	0.84	0.84	0.81	0.88	0.89	0.65
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	201	342	227	486	745	306
Number of Lanes	1	1	1	1	1	1

Approach	SB	NE	SW
Opposing Approach		SW	NE
Opposing Lanes	0	2	2
Conflicting Approach Left	SW	SB	
Conflicting Lanes Left	2	2	0
Conflicting Approach Right	NE		SB
Conflicting Lanes Right	2	0	2
HCM Control Delay	25.1	61.9	218.4
HCM LOS	D	F	F

Lane	NELn1	NELn2	SBLn1	SBLn2	SWLn1	SWLn2
Vol Left, %	100%	0%	100%	0%	0%	0%
Vol Thru, %	0%	100%	0%	0%	100%	0%
Vol Right, %	0%	0%	0%	100%	0%	100%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	184	428	169	287	663	199
LT Vol	184	0	169	0	0	0
Through Vol	0	428	0	0	663	0
RT Vol	0	0	0	287	0	199
Lane Flow Rate	227	486	201	342	745	306
Geometry Grp	7	7	7	7	7	7
Degree of Util (X)	0.514	1.033	0.481	0.703	1.6	0.596
Departure Headway (Hd)	8.861	8.343	9.347	8.103	7.733	7.011
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes
Cap	409	438	388	451	469	511
Service Time	6.561	6.043	7.047	5.803	5.53	4.807
HCM Lane V/C Ratio	0.555	1.11	0.518	0.758	1.588	0.599
HCM Control Delay	20.6	81.2	20.4	27.8	300	19.7
HCM Lane LOS	C	F	C	D	F	C
HCM 95th-tile Q	2.8	13.8	2.5	5.4	41.2	3.8

Queuing and Blocking Report  
 PM-peak level of service

08/13/2019

Intersection: 4076: Old Frontier Rd & Greaves Way

Movement	SB	SB	NE	NE	SW	SW
Directions Served	L	R	L	T	T	R
Maximum Queue (ft)	124	209	125	302	964	956
Average Queue (ft)	70	87	73	118	936	933
95th Queue (ft)	124	169	125	222	952	946
Link Distance (ft)		633		423	917	917
Upstream Blk Time (%)				0	99	80
Queuing Penalty (veh)				0	0	0
Storage Bay Dist (ft)	100		100			
Storage Blk Time (%)	2	9	2	11		
Queuing Penalty (veh)	6	15	10	20		

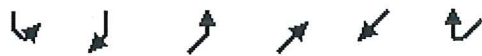
Network Summary

Network wide Queuing Penalty: 51

**Appendix F. Signalized Analysis Worksheets**

HCM 6th Signalized Intersection Summary  
 4076: Old Frontier Rd & Greaves Way

08/13/2019



Movement	SBL	SBR	NEL	NET	SWT	SWR	
Lane Configurations	↙	↗	↖	↗	↗	↗	
Traffic Volume (veh/h)	101	172	110	256	397	119	
Future Volume (veh/h)	101	172	110	256	397	119	
Initial Q (Qb), veh	0	0	0	0	0	0	
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	
Work Zone On Approach	No			No	No		
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	
Adj Flow Rate, veh/h	120	205	136	291	446	0	
Peak Hour Factor	0.84	0.84	0.81	0.88	0.89	0.65	
Percent Heavy Veh, %	2	2	2	2	2	2	
Cap, veh/h	346	308	217	1054	600		
Arrive On Green	0.19	0.19	0.12	0.56	0.32	0.00	
Sat Flow, veh/h	1781	1585	1781	1870	1870	1585	
Grp Volume(v), veh/h	120	205	136	291	446	0	
Grp Sat Flow(s),veh/h/ln	1781	1585	1781	1870	1870	1585	
Q Serve(g_s), s	2.2	4.4	2.7	3.0	7.9	0.0	
Cycle Q Clear(g_c), s	2.2	4.4	2.7	3.0	7.9	0.0	
Prop In Lane	1.00	1.00	1.00			1.00	
Lane Grp Cap(c), veh/h	346	308	217	1054	600		
V/C Ratio(X)	0.35	0.67	0.63	0.28	0.74		
Avail Cap(c_a), veh/h	839	747	408	1687	1032		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	0.00	
Uniform Delay (d), s/veh	12.9	13.9	15.5	4.2	11.3	0.0	
Incr Delay (d2), s/veh	0.6	2.5	3.0	0.1	1.9	0.0	
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	
%ile BackOfQ(50%),veh/ln	0.7	0.2	1.1	0.5	2.6	0.0	
Unsig. Movement Delay, s/veh							
LnGrp Delay(d),s/veh	13.5	16.3	18.5	4.3	13.1	0.0	
LnGrp LOS	B	B	B	A	B		
Approach Vol, veh/h	325			427	446	A	
Approach Delay, s/veh	15.3			8.8	13.1		
Approach LOS	B			A	B		
Timer - Assigned Phs				4	6	7	8
Phs Duration (G+Y+Rc), s				25.4	11.7	9.0	16.4
Change Period (Y+Rc), s				4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s				33.5	17.5	8.5	20.5
Max Q Clear Time (g_c+I1), s				5.0	6.4	4.7	9.9
Green Ext Time (p_c), s				1.7	0.8	0.1	2.0
<b>Intersection Summary</b>							
HCM 6th Ctrl Delay			12.2				
HCM 6th LOS			B				
<b>Notes</b>							
Unsignalized Delay for [SWR] is excluded from calculations of the approach delay and intersection delay.							

Queuing and Blocking Report  
PM-peak level of service

08/13/2019

Intersection: 4076: Old Frontier Rd & Greaves Way

Movement	SB	SB	NE	NE	SW
Directions Served	L	R	L	T	T
Maximum Queue (ft)	86	94	108	133	200
Average Queue (ft)	36	38	49	48	101
95th Queue (ft)	71	73	85	99	161
Link Distance (ft)		633		423	917
Upstream Blk Time (%)					
Queuing Penalty (veh)					
Storage Bay Dist (ft)	100		100		
Storage Blk Time (%)	0	0	1	0	
Queuing Penalty (veh)	0	0	2	0	

Network Summary

Network wide Queuing Penalty: 3

HCM 6th Signalized Intersection Summary  
4076: Old Frontier Rd & Greaves Way

08/13/2019



Movement	SBL	SBR	NEL	NET	SWT	SWR	
Lane Configurations							
Traffic Volume (veh/h)	169	287	184	428	663	199	
Future Volume (veh/h)	169	287	184	428	663	199	
Initial Q (Qb), veh	0	0	0	0	0	0	
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	
Work Zone On Approach	No			No	No		
Adj Sat Flow, veh/h/ln	1870	1870	1870	1870	1870	1870	
Adj Flow Rate, veh/h	201	342	227	486	745	0	
Peak Hour Factor	0.84	0.84	0.81	0.88	0.89	0.65	
Percent Heavy Veh, %	2	2	2	2	2	2	
Cap, veh/h	425	378	268	1201	808		
Arrive On Green	0.24	0.24	0.15	0.64	0.43	0.00	
Sat Flow, veh/h	1781	1585	1781	1870	1870	1585	
Grp Volume(v), veh/h	201	342	227	486	745	0	
Grp Sat Flow(s),veh/h/ln	1781	1585	1781	1870	1870	1585	
Q Serve(g_s), s	7.3	15.8	9.4	9.5	28.3	0.0	
Cycle Q Clear(g_c), s	7.3	15.8	9.4	9.5	28.3	0.0	
Prop In Lane	1.00	1.00	1.00			1.00	
Lane Grp Cap(c), veh/h	425	378	268	1201	808		
V/C Ratio(X)	0.47	0.91	0.85	0.40	0.92		
Avail Cap(c_a), veh/h	437	389	295	1303	881		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	0.00	
Uniform Delay (d), s/veh	24.6	27.9	31.2	6.5	20.2	0.0	
Incr Delay (d2), s/veh	0.8	23.7	18.7	0.2	14.2	0.0	
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	
%ile BackOfQ(50%),veh/ln	2.9	15.1	5.2	2.9	14.0	0.0	
Unsig. Movement Delay, s/veh							
LnGrp Delay(d),s/veh	25.5	51.6	49.9	6.7	34.4	0.0	
LnGrp LOS	C	D	D	A	C		
Approach Vol, veh/h	543			713	745	A	
Approach Delay, s/veh	41.9			20.5	34.4		
Approach LOS	D			C	C		
Timer - Assigned Phs				4	6	7	8
Phs Duration (G+Y+Rc), s				52.9	22.5	15.8	37.1
Change Period (Y+Rc), s				4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s				52.5	18.5	12.5	35.5
Max Q Clear Time (g_c+I1), s				11.5	17.8	11.4	30.3
Green Ext Time (p_c), s				3.3	0.2	0.1	2.2
<b>Intersection Summary</b>							
HCM 6th Ctrl Delay			31.5				
HCM 6th LOS			C				
<b>Notes</b>							
Unsignalized Delay for [SWR] is excluded from calculations of the approach delay and intersection delay.							



Queuing and Blocking Report  
PM-peak level of service

08/13/2019

Intersection: 4076: Old Frontier Rd & Greaves Way

Movement	SB	SB	NE	NE	SW
Directions Served	L	R	L	T	T
Maximum Queue (ft)	124	276	124	343	449
Average Queue (ft)	79	108	94	110	235
95th Queue (ft)	135	205	135	248	399
Link Distance (ft)		633		423	917
Upstream Blk Time (%)				0	
Queuing Penalty (veh)				0	
Storage Bay Dist (ft)	100		100		
Storage Blk Time (%)	4	7	13	3	
Queuing Penalty (veh)	11	11	54	6	

Network Summary

Network wide Queuing Penalty: 83

**Appendix G. Roundabout Analysis Worksheets**

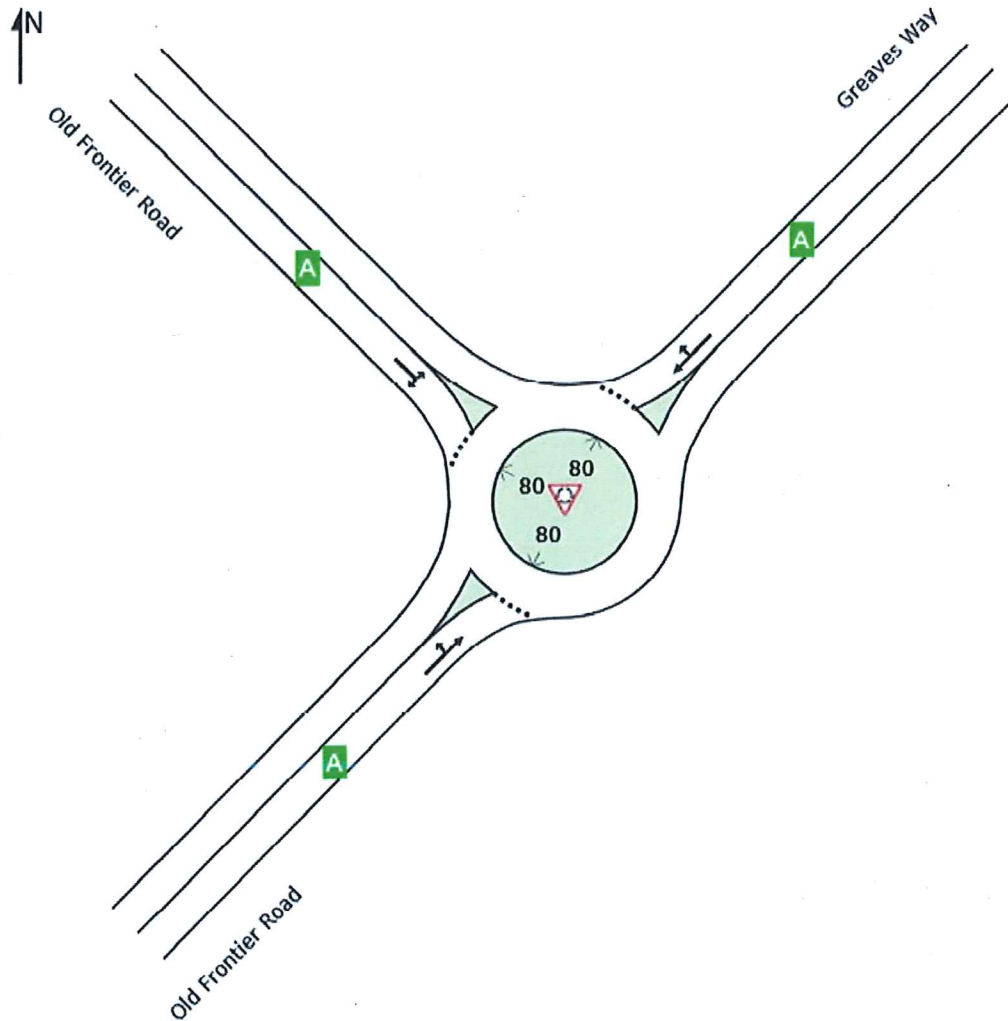
# LANE LEVEL OF SERVICE

## Lane Level of Service

 **Site: 101 [2017\_Old Frontier Rd & Greaves Way-all single approach]**

Old Frontier Rd & Greaves Way  
 Site Category: (None)  
 Roundabout

	Approaches			Intersection
	Northeast	Northwest	Southwest	
LOS	A	A	A	A



Site Level of Service (LOS) Method: Delay & Degree of Saturation (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Signalised Intersections.

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

Intersection and Approach LOS values are based on average delay for all lanes (v/c not used).

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

# MOVEMENT SUMMARY

 Site: 101 [2017\_Old Frontier Rd & Greaves Way-all single approach]

Old Frontier Rd & Greaves Way  
 Site Category: (None)  
 Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Total veh/h	Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Queue Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
NorthEast: Greaves Way												
6x	T1	397	3.0	0.453	4.0	LOS A	3.0	77.9	0.38	0.45	0.38	33.0
16x	R2	119	3.0	0.453	4.2	LOS A	3.0	77.9	0.38	0.45	0.38	33.6
Approach		516	3.0	0.453	4.1	LOS A	3.0	77.9	0.38	0.45	0.38	33.1
NorthWest: Old Frontier Road												
7x	L2	101	3.0	0.302	11.9	LOS B	1.7	43.5	0.58	0.72	0.58	33.5
14x	R2	172	3.0	0.302	6.5	LOS A	1.7	43.5	0.58	0.72	0.58	32.6
Approach		273	3.0	0.302	8.5	LOS A	1.7	43.5	0.58	0.72	0.58	32.9
SouthWest: Old Frontier Road												
5x	L2	110	3.0	0.321	9.0	LOS A	2.0	50.2	0.33	0.49	0.33	33.9
2x	T1	256	3.0	0.321	3.8	LOS A	2.0	50.2	0.33	0.49	0.33	32.5
Approach		366	3.0	0.321	5.4	LOS A	2.0	50.2	0.33	0.49	0.33	32.9
All Vehicles		1155	3.0	0.453	5.5	LOS A	3.0	77.9	0.41	0.53	0.41	33.0

Site Level of Service (LOS) Method: Delay & Degree of Saturation (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Signalised Intersections.

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

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

Roundabout Capacity Model: SIDRA Standard.

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

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

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

# LANE LEVEL OF SERVICE

Lane Level of Service

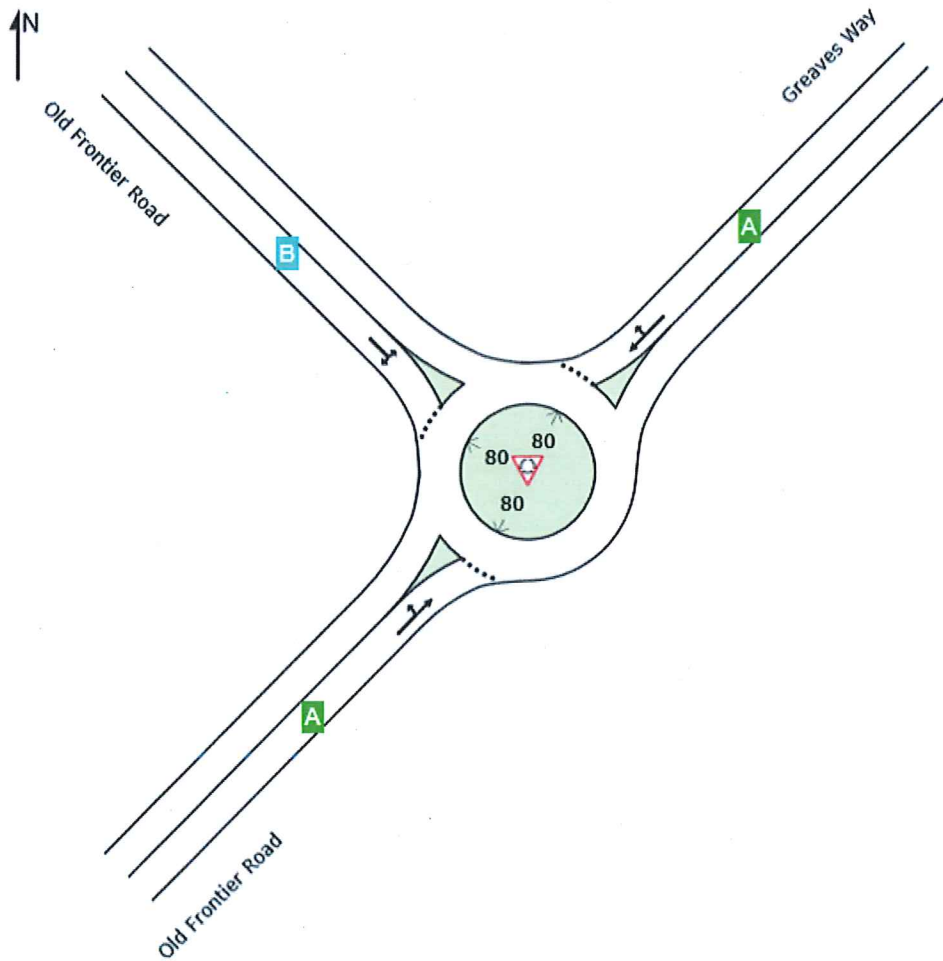
 Site: 101 [2043\_Old Frontier Rd & Greaves Way-all single approach]

Old Frontier Rd & Greaves Way

Site Category: (None)

Roundabout

	Approaches			Intersection
	Northeast	Northwest	Southwest	
LOS	A	B	A	A



Site Level of Service (LOS) Method: Delay & Degree of Saturation (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Signalised Intersections.

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

Intersection and Approach LOS values are based on average delay for all lanes (v/c not used).

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

# MOVEMENT SUMMARY

 Site: 101 [2043\_Old Frontier Rd & Greaves Way-all single approach]

Old Frontier Rd & Greaves Way

Site Category: (None)

Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Total veh/h	Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance ft	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed mph
NorthEast: Greaves Way												
6x	T1	663	3.0	0.727	5.4	LOS A	8.1	207.4	0.70	0.61	0.73	32.1
16x	R2	199	3.0	0.727	5.6	LOS A	8.1	207.4	0.70	0.61	0.73	32.7
Approach		862	3.0	0.727	5.5	LOS A	8.1	207.4	0.70	0.61	0.73	32.2
NorthWest: Old Frontier Road												
7x	L2	169	3.0	0.598	16.4	LOS B	5.7	146.6	0.91	1.01	1.12	31.4
14x	R2	287	3.0	0.598	11.1	LOS B	5.7	146.6	0.91	1.01	1.12	30.5
Approach		456	3.0	0.598	13.1	LOS B	5.7	146.6	0.91	1.01	1.12	30.9
SouthWest: Old Frontier Road												
5x	L2	184	3.0	0.519	9.5	LOS A	4.3	109.2	0.54	0.54	0.54	33.4
2x	T1	428	3.0	0.519	4.4	LOS A	4.3	109.2	0.54	0.54	0.54	32.0
Approach		612	3.0	0.519	5.9	LOS A	4.3	109.2	0.54	0.54	0.54	32.4
All Vehicles		1930	3.0	0.727	7.4	LOS A	8.1	207.4	0.70	0.68	0.76	32.0

Site Level of Service (LOS) Method: Delay & Degree of Saturation (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

Roundabout LOS Method: Same as Signalised Intersections.

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

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

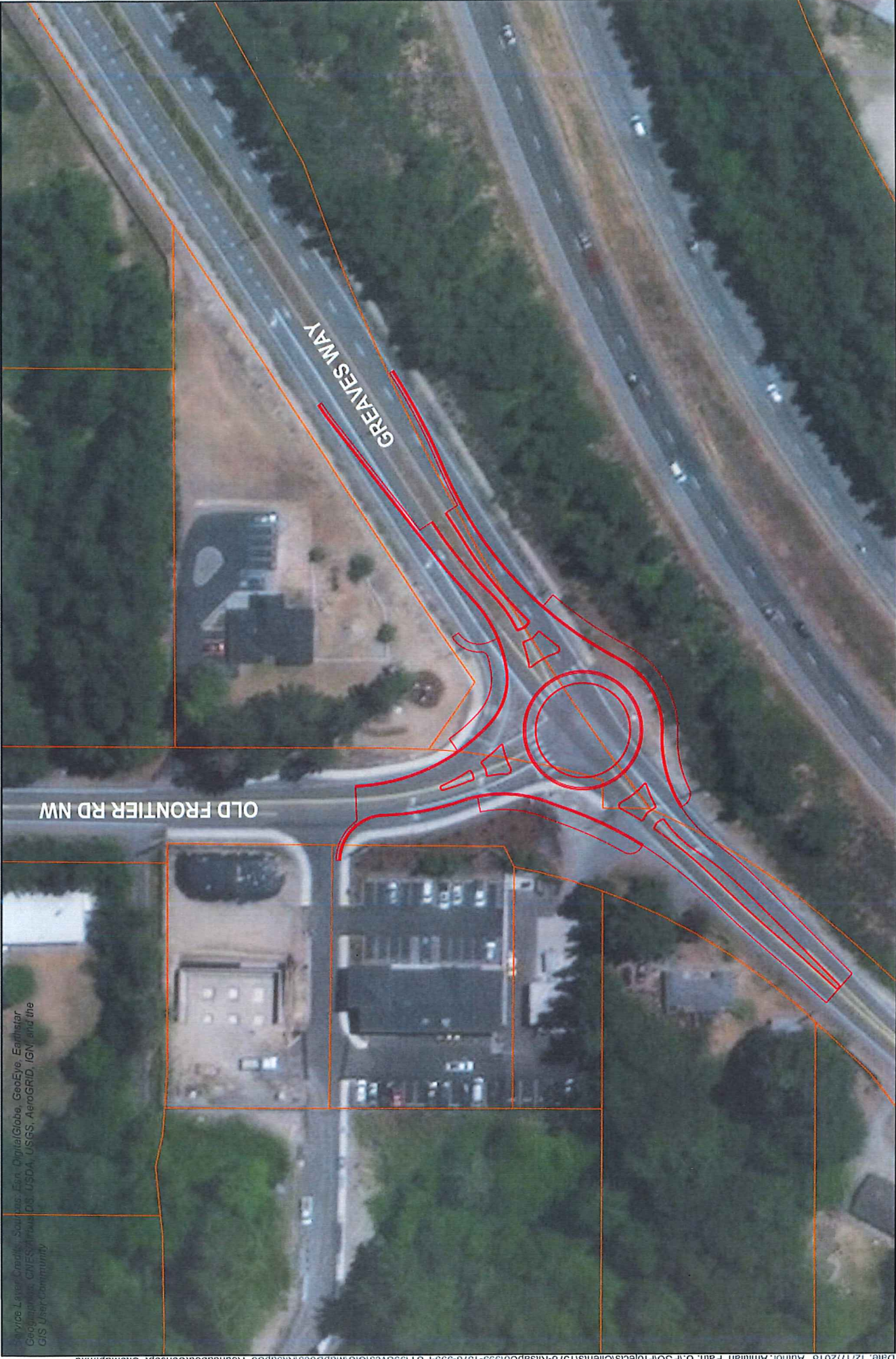
Roundabout Capacity Model: SIDRA Standard.

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

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

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

**Appendix H. Roundabout Conceptual Design**



**Figure 1.**  
Site Location

Silverdale, Washington

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar  
Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the  
GIS User Community

Date: 12/17/2018 Author: Amilhan Path: U:\PSO\Projects\Clients\1578-KitapCo\199-1578-999-FU\199SVC\GIS\MapDocs\KitsapCo Roundabout\Concept\_SiteMap.mxd

**Parametrix**



0 50 100 200



Parcels