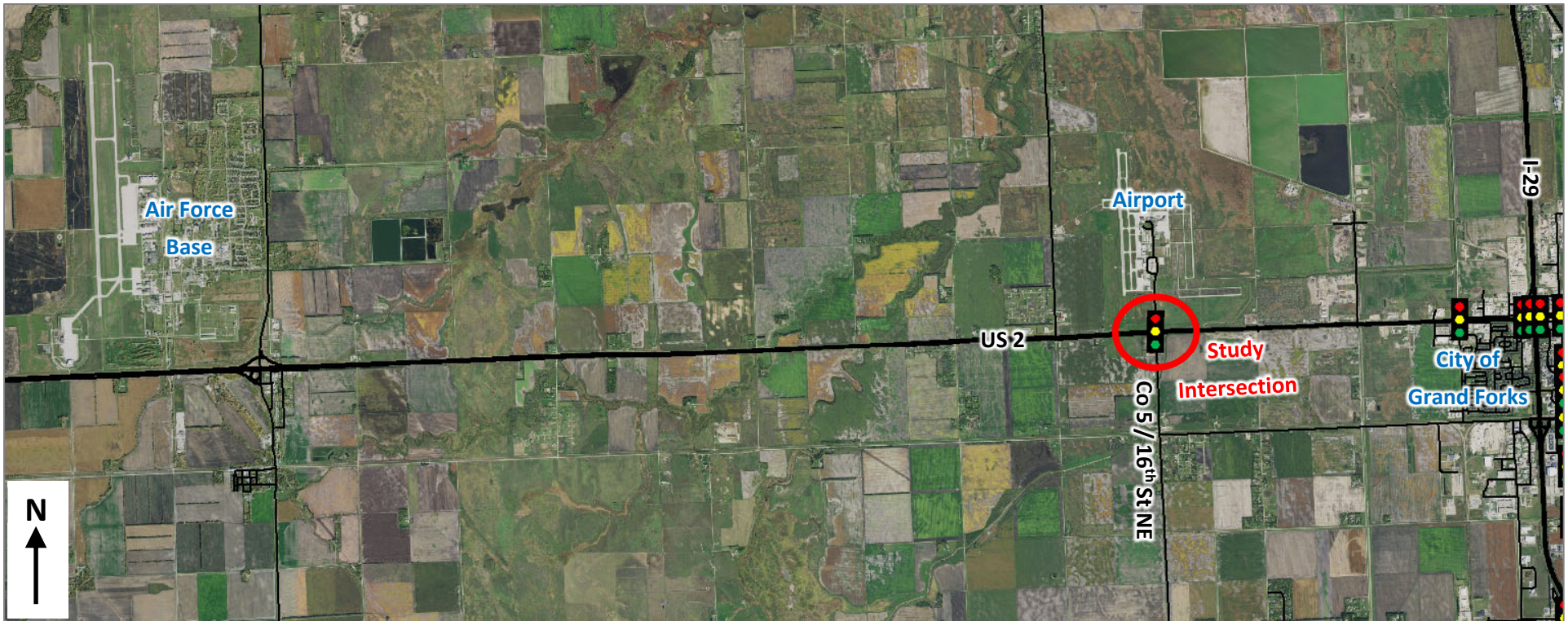


TRAFFIC OPERATIONS STUDY

US 2 & Grand Forks Airport / Co 5 / 16th St NE



Prepared By:
NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
PROGRAMMING DIVISION
TRAFFIC OPERATIONS SECTION

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INTRODUCTION

Roundabouts are gaining popularity in ND for providing safe and efficient traffic flow at a variety of intersections. The Grand Forks District asked the Traffic Operations Section how a roundabout would compare with other intersection types at the US 2 & Grand Forks Airport intersection. The purpose of this study is to compare traffic operations and safety for a variety of intersection configurations.

Documents referenced in this study include:

- AASHTO Green Book, 2018 Edition
- FHWA's Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition
- ND's Vision Zero Plan, 2018
- NDDOT's Traffic Operations Manual, January 2023
- TRB's Highway Capacity Manual (HCM), 7th Edition, 2022

Previous Studies:

In 2014 NDDOT published a Local Road Safety Plan for Grand Forks County, which recommended a Reduced Conflict Intersection (a.k.a. J-Turn, Reduced Crossing U-Turn, Directional Median). The concept is explained later in this study. [NDDOT Local Road Safety Program \(LRSP\)](#)

In 2015 the MPO commissioned KLJ to perform a corridor study for US 2, which recommended to install a Staggered-T Intersection. The concept is explained later in this study. [MPO US 2 Corridor Study](#)

In 2017 a Road Safety Review meeting was held and included attendees from NDDOT, MPO, Grand Forks County, City of Grand Forks, and the Grand Forks International Airport. Consensus could not be reached regarding a major change to the intersection, but minor improvements were recommended and completed in 2018 with PCN 22029.

EXISTING CONDITIONS

US 2: Functional Classification = Principal Arterial

Highway Performance Classification System = Interregional Corridor

Speed Limit = 55mph, changes to 70mph just west of the intersection

*The 2015 MPO Study reported that the 85th percentile speeds were measured to be 72mph for WB traffic and 69mph for EB traffic.

Co 5 / 16th St NE (south leg of intersection): Functional Classification = Major Collector

Speed Limit = 55mph

Airport Rd (north leg of intersection): Functional Classification = Local

Speed Limit = 40mph

The intersection is controlled with a traffic signal, and equipment ages are shown in **Table 1**.

Table 1 - Traffic Signal Equipment Ages		
Equipment	Year Installed (age)	Typical Life
Controller	2019 (4yrs old)	10-15yrs
Video Detection System	2019 (4yrs old)	10-15yrs
Oldest Poles	1994 (29yrs old)	20-30yrs

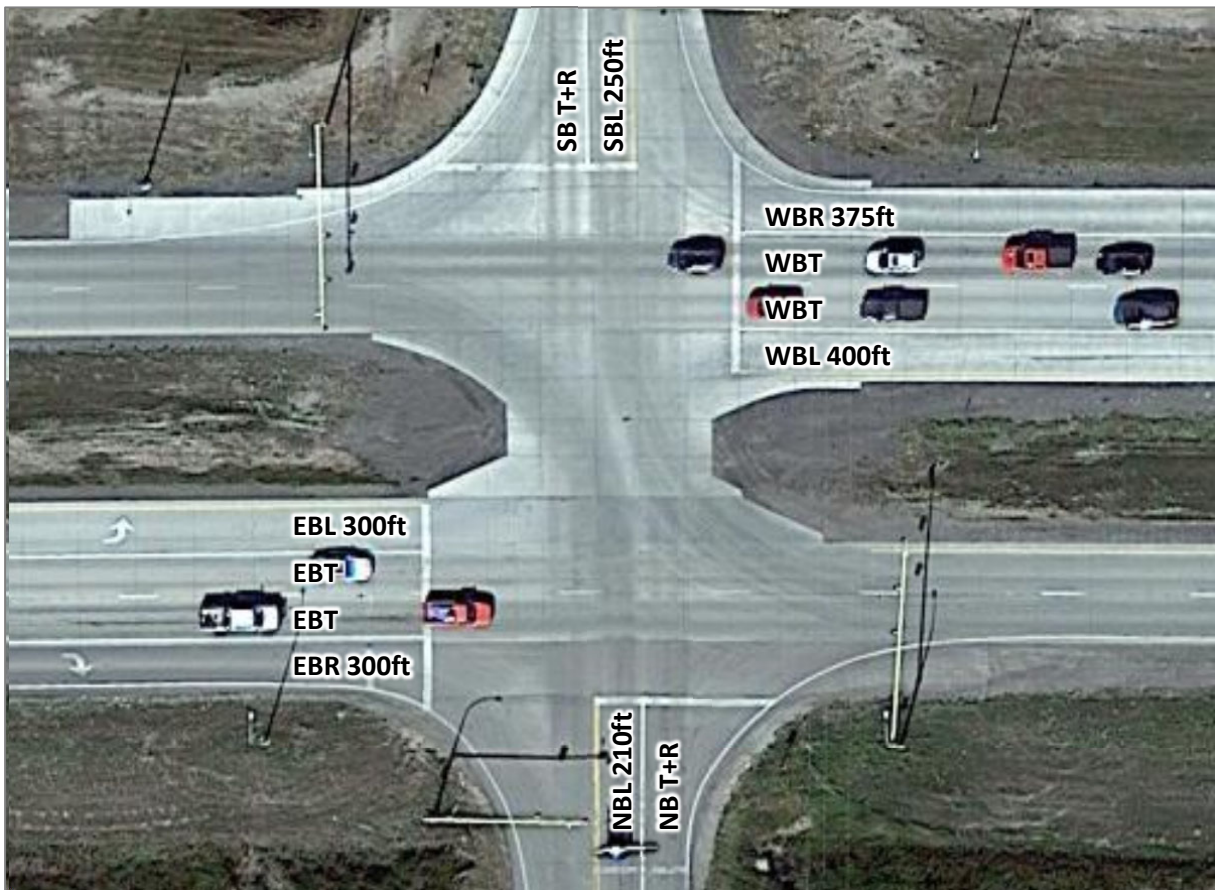


Figure 1 – Existing Lane Configurations and Full Width Lengths, Image from Google Maps

TRAFFIC VOLUME INFORMATION

NDDOT's Traffic Data Section counted traffic on 9/19/2023. **Appendix B** contains detailed volume info and **Table 3** summarizes the volumes.

Table 3 - Peak Hour Volumes, US 2 & Grand Forks Airport														
	SB R	SB T	SB L	WB R	WB T	WB L	NB R	NB T	NB L	EB R	EB T	EB L	Totals	PHF
2023 AM Peak	0	3	16	67	442	10	42	29	193	120	309	3	1,237	0.86
2023 PM Peak	8	49	103	72	339	50	25	17	141	269	439	6	1,519	0.94
2023 All-Day	66	370	935	1,013	4,338	370	443	358	1,630	1,741	4,179	57	15,509	
	0%	2%	6%	7%	28%	2%	3%	2%	11%	11%	27%	0%		
All-Day Trucks	6%	1%	1%	2%	20%	59%	60%	1%	5%	6%	23%	2%	17%	
2043 AM Peak	0	4	22	90	595	13	57	39	260	162	416	4	1,666	0.86
2043 PM Peak	11	66	139	97	457	67	34	23	190	362	591	8	2,046	0.94

Future traffic based on growth of 1.5% per year.

Highest Volume Movements

EB+WB through movements dominate at this intersection.

Next are NB to WB left turners and EB to SB right turners. These vehicles go to/from the air force base, located ~9 miles west of this intersection.

Next are SB to EB left turners and WB to NB right turners. These vehicles go to/from the airport. In 2021 the Grand Forks International Airport was ranked the 12th busiest airport in the nation. <https://www.grandforksherald.com/news/local/grand-forks-airport-ranked-12th-busiest-in-the-country-in-2021>





TRAFFIC SIGNAL ANALYSIS

Traffic Signal Warrants

The traffic signal warrant form is in **Appendix C** and warrants #1B and #2 are satisfied. Therefore, traffic signal configurations are included in the alternatives section below. Satisfying a traffic signal warrant does not mean that a traffic signal **MUST** be installed. MUTCD section 4B.04.01 states "...consideration should be given to providing alternatives to traffic control signals even if one or more of the signal warrants has been satisfied."

Left Turn Phasing

NDDOT's Traffic Operations Manual has a flowchart to help determine the appropriate left turn phasing for each approach. The flowcharts are in **Appendix C** and results are shown in **Table 4**.

Table 4 - Recommended Left Turn Heads*		
Directions	Existing Geometry	Revised Geometry
EB+WB		 Flash
NB+SB	 Flash	 Flash
*If the intersection is signalized.		

ALTERNATIVES

The next page shows NDDOT's Traffic Operations Manual graph to help determine which alternatives may be appropriate. According to the graph, traffic volumes are not high enough to justify an interchange. Therefore, an interchange was not analyzed in this study.

Six alternatives were analyzed:

Existing Geometry (signalized) – no changes

Revised Geometry (signalized) – **Figure 2**

Staggered-T Intersection (unsignalized) – **Figure 3**

Reduced Conflict Intersection (unsignalized*) – **Figure 4**

*This configuration is also known as a J-Turn, RCUT (Reduced Crossing U-Turn), or Superstreet

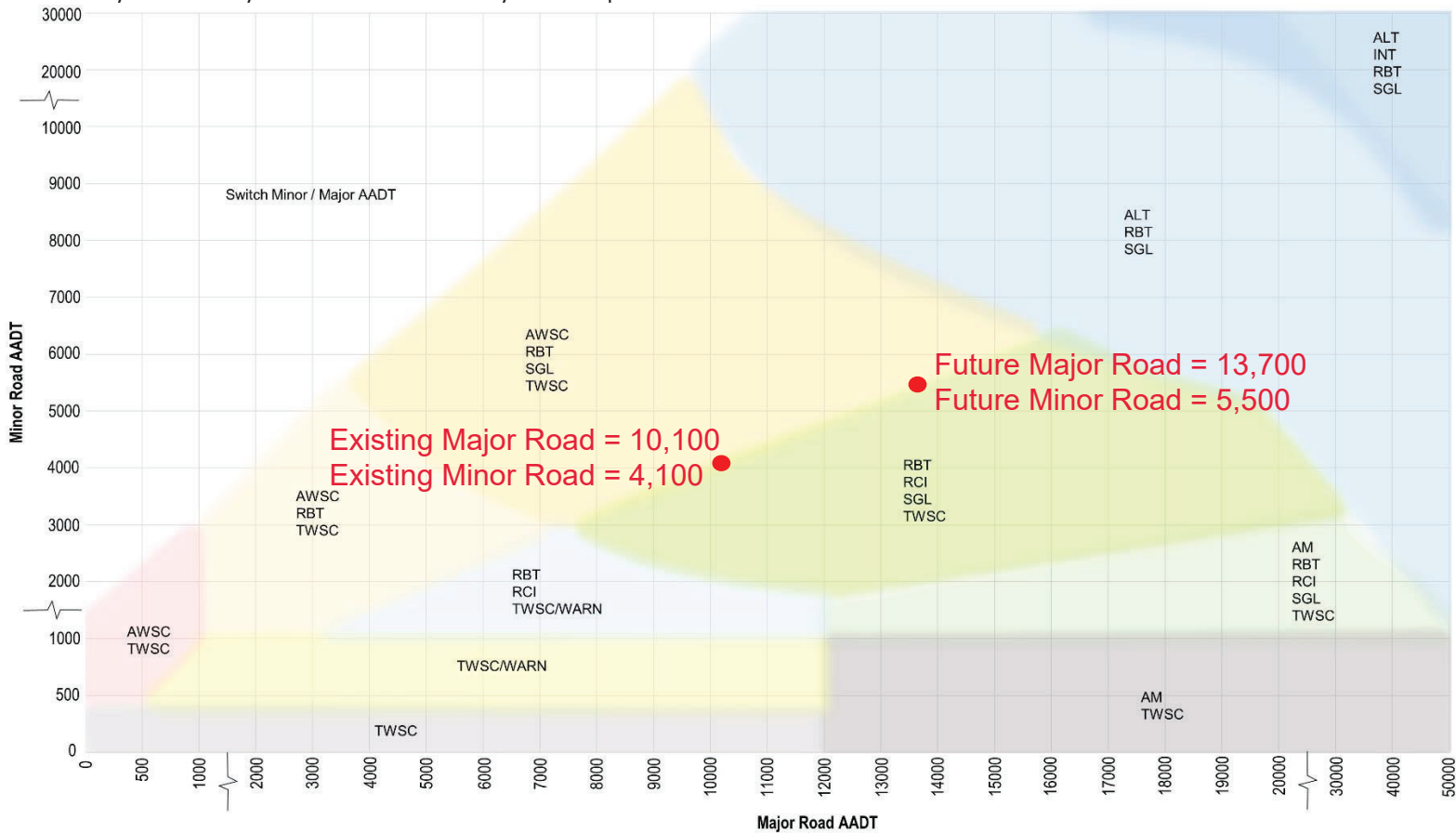
*This configuration could be signalized in the future if traffic increases.

Roundabout 2x1 – **Figure 5**

Roundabout 1x1 with Right Turn Lane Drops – **Figure 6**

INTERSECTION TYPE - HIGH LEVEL

Given the AADT's on the major and minor roads, use the chart below as a *starting point* to determine the appropriate type of analysis of a study intersection. The acronyms are explained in further detail below.



- ALT:** Alternative Intersections – As traffic volumes increase, conventional intersections may no longer be appropriate. A displaced left turn is an example of an alternative intersection. For more information see FHWA: https://safety.fhwa.dot.gov/intersection/alter_design/
- AM:** Access Management - Removing a minor road connection can be considered in cases where the minor road has a very low volume and the major road has heavy traffic. Opportunities to reroute the minor road traffic to a different location should be explored. Other options for access management may be ¾ intersection or right-in/right-out. See [Access Management](#) section.
- AWSC:** All-way Stop Control - Stop control is in place on all intersection approaches. This type of intersection works best without the presence of turn lanes where a 2-lane road meets with another 2-lane road. Use [SFN form 59012](#) to evaluate MUTCD warrants for all-way stop control.
- INT:** Interchange – A grade-separated intersection
- RBT:** Roundabout – This type of intersection is becoming more common throughout the country due to their proven safety benefits. They may be considered at any intersection. A rule of thumb for a traffic study is to consider a roundabout when both the major road and minor road AADT is over 1000.
- RCI:** Reduced Conflict Intersection - this type of intersection reduces the number of conflict points by re-routing left turn movements from the minor road.
- SGL:** [Traffic Signal](#) - an analysis of MUTCD warrants should be done prior to a traffic signal capacity analysis.
- TWSC:** Two-way Stop Control - The most common type of intersection where the major road is free-flow and the minor road traffic is controlled by a stop sign.
- WARN:** [Warning Enhancements for rural intersections](#) – adding additional emphasis to an existing TWSC intersection using signing and markings may be appropriate.

Figure 2 – Revised Geometry Concept Drawing

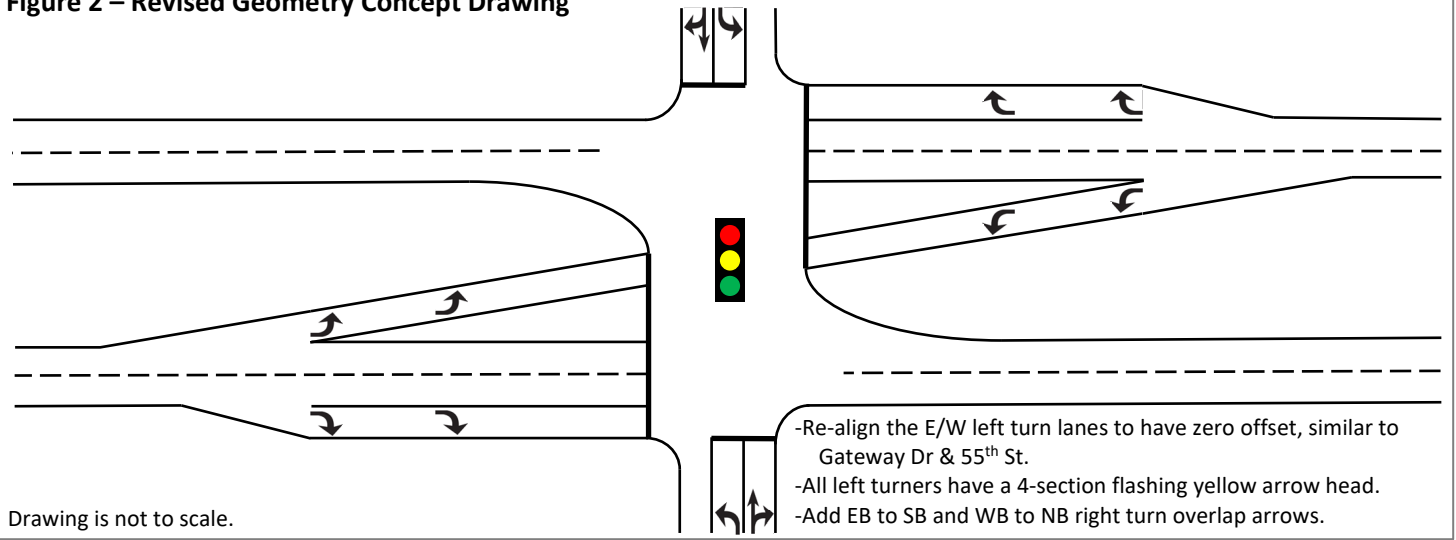


Figure 3 – Staggered-T Concept Drawing (unsignalized)

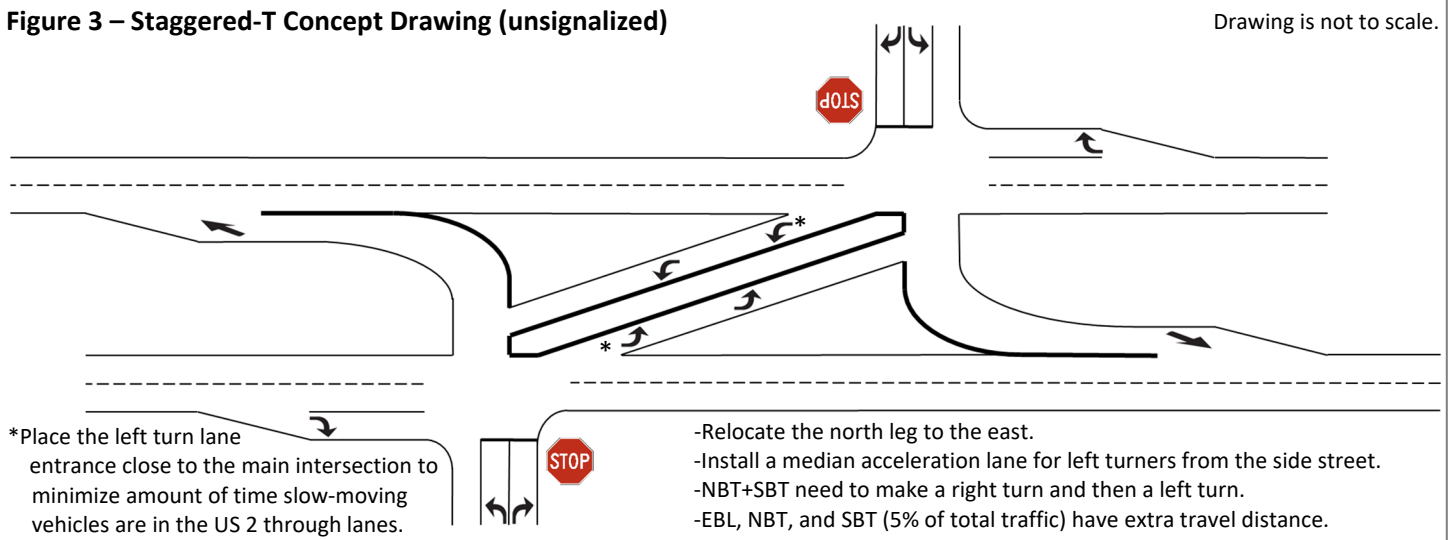


Figure 4 – Reduced Conflict Intersection Concept Drawing (unsignalized)

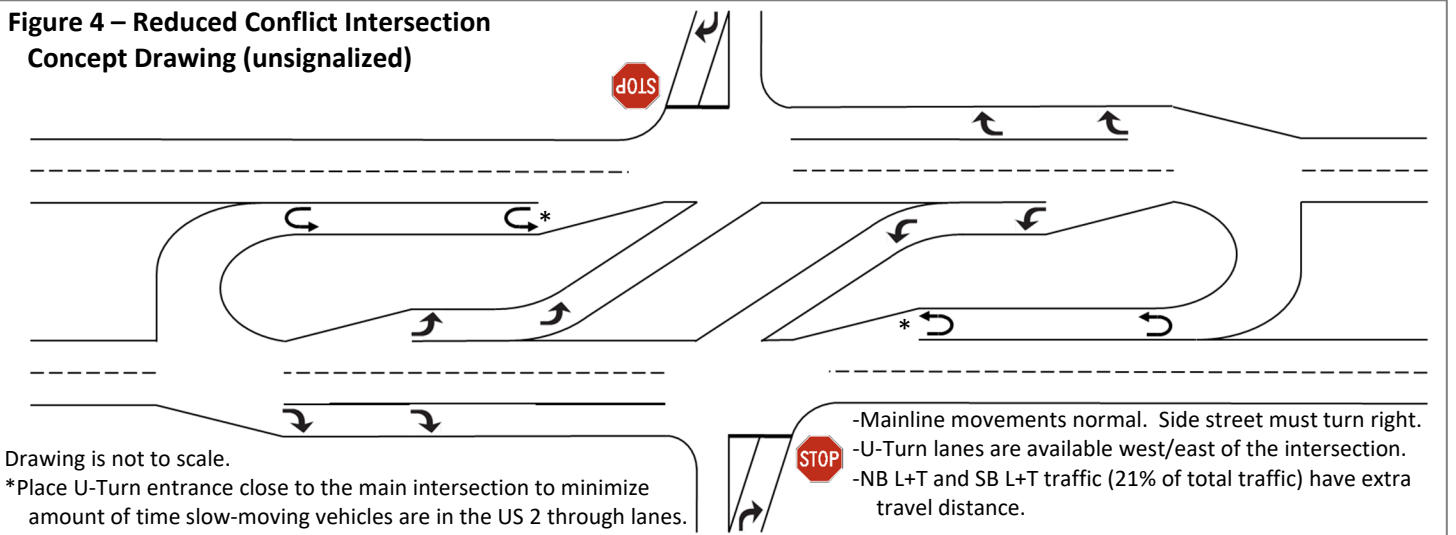


Figure 5 – Roundabout 2x1 Concept Drawing

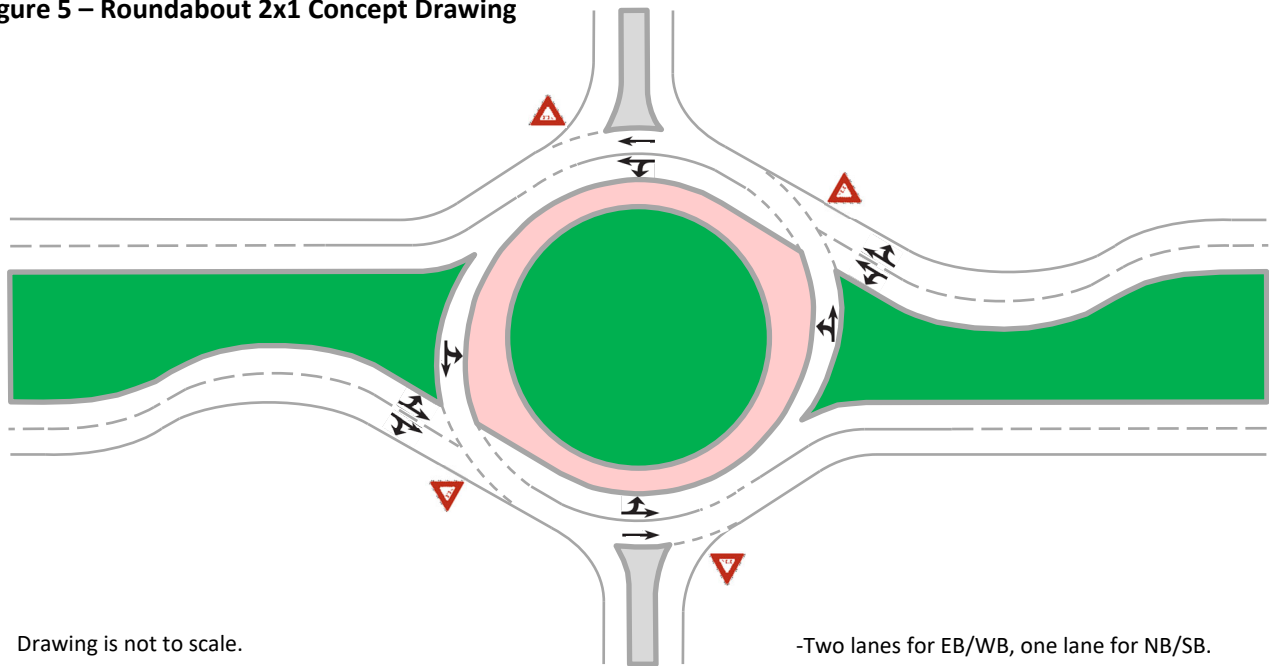
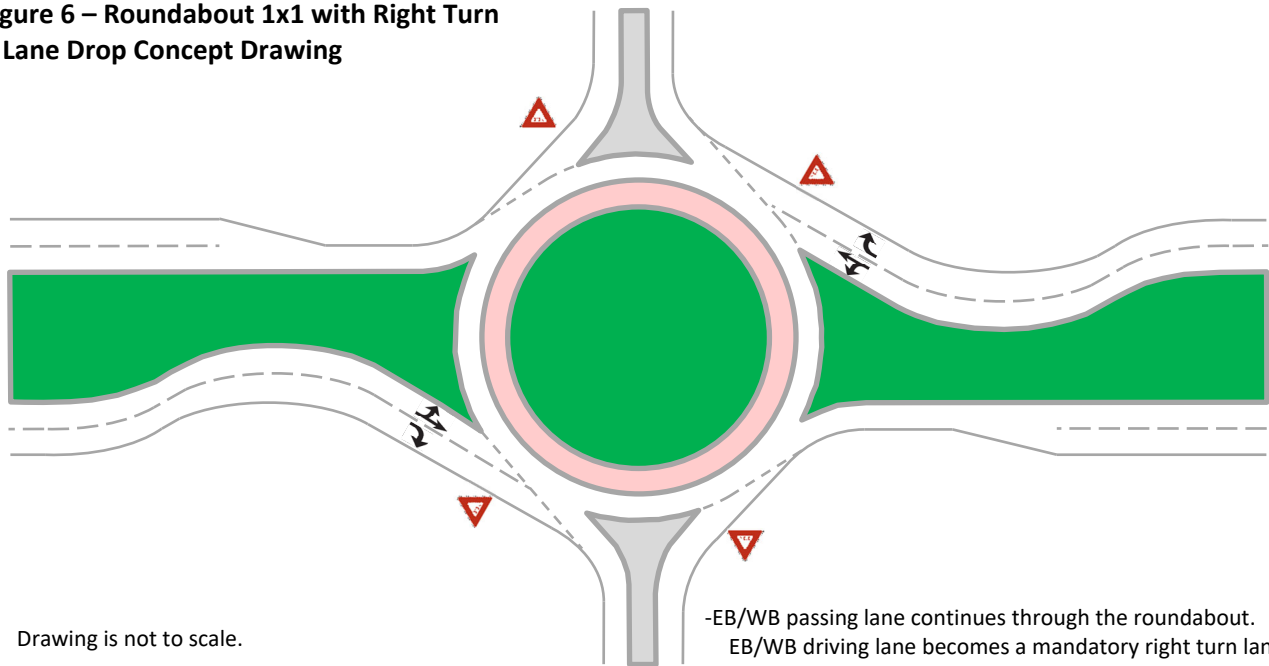


Figure 6 – Roundabout 1x1 with Right Turn Lane Drop Concept Drawing



Conflict Points

Conflict points are locations where vehicle paths overlap each other. Crossing conflicts are generally more severe than merging/diverging conflicts. Conflict points are often used as a safety surrogate, especially for newer/innovative intersection configurations.

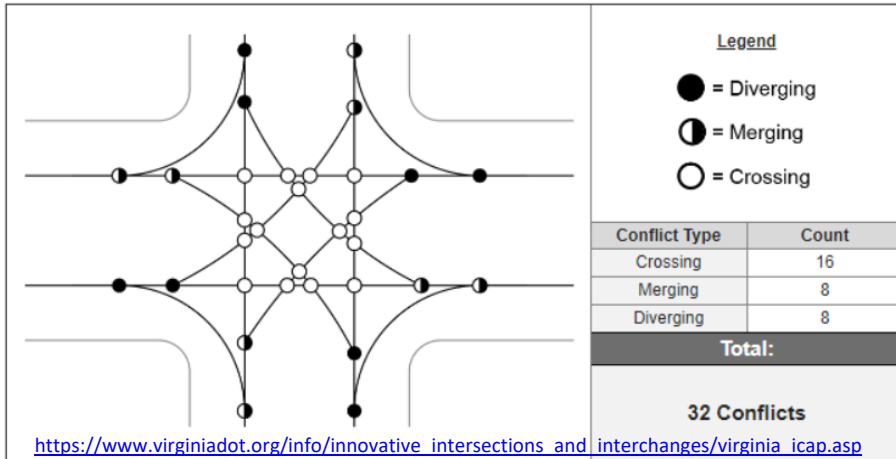


Figure 7a – Existing/Revised Geometry Conflict Points

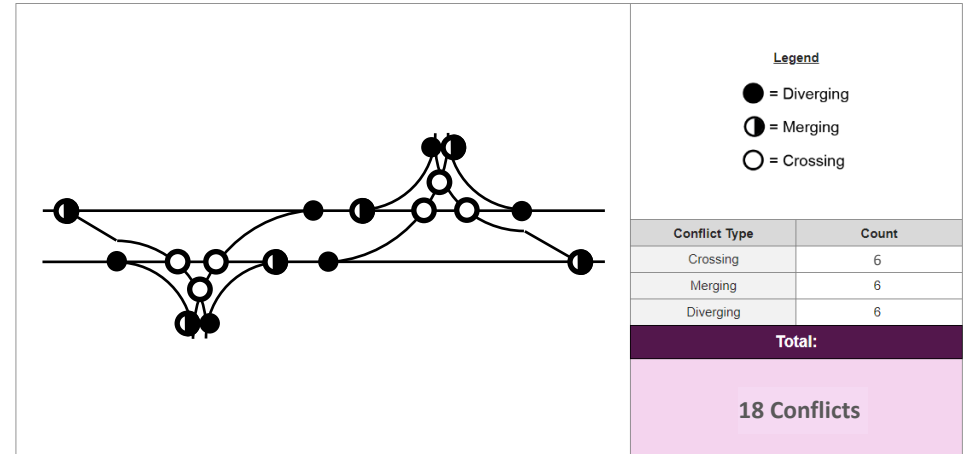


Figure 7b – Staggered-T Conflict Points

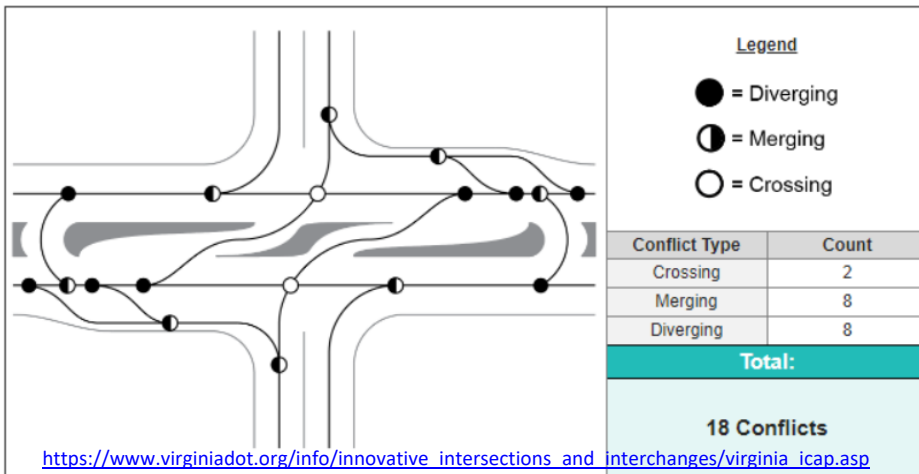


Figure 7c – Reduced Conflict Intersection Conflict Points

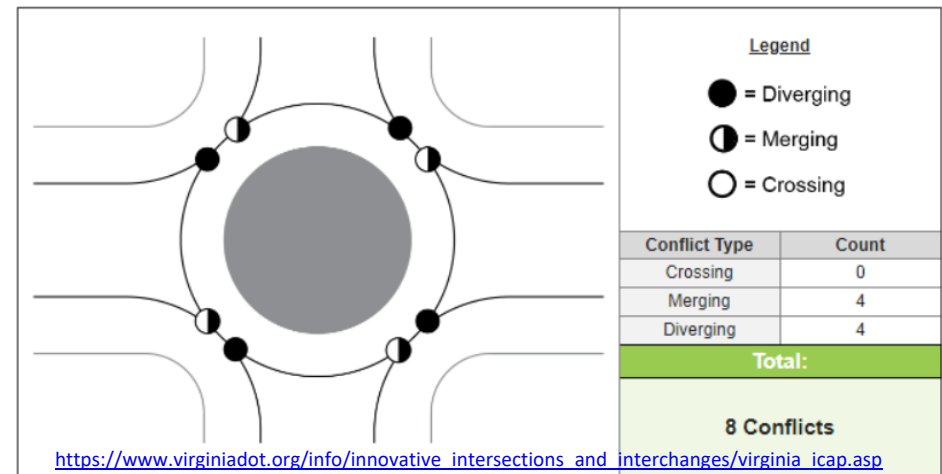


Figure 7d – Roundabout Conflict Points

CAPACITY ANALYSIS

The software program HCS2022 (version 8.1) was used to perform capacity analyses. The software print-out sheets are in **Appendix D** and **Table 5** lists the LOS (Level of Service) ranges. The Staggered-T and Reduced Conflict Intersection alternatives are considered "Distributed Intersections" (some vehicles are re-routed) and have the same LOS thresholds as signalized intersections. Roundabouts, however, have a lower threshold for LOS letters.

The signalized alternatives have BE PREPARED TO STOP WHEN FLASHING assemblies which hold mainline for an extra 7sec after gapping out. In the capacity analysis, this extra 7sec delay was added to the yellow time.

Table 6 on the next page shows the capacity results.

Table 5 - Capacity LOS Ranges		
LOS	Roundabout Delay (sec/veh)	Signalized and Distributed Intersection Delay (sec/veh)
A	≤ 10	≤ 10
B	>10 - 15	>10 - 20
C	>15 - 25	>20 - 35
D	>25 - 35	>35 - 55
E	>35 - 50	>55 - 80
F	>50	>80
-LOS = Level of Service -Values from 2022 HCM Exhibits 19-8, 22-8, and 23-13. -The Staggered-T and Reduced Conflict Intersection configurations are "Distributed Intersections".		

Existing Geometry (signalized)

The overall intersection LOS is C or better with existing or future traffic volumes. However, due to protected-only left turn phasing, EB and WB left turners have long wait times (LOS E and F). It is recommended to discard this alternative in favor of Revised Geometry Signalized, which has similar delay for the overall intersection but 2x to 5x less delay for EB+WB left turners.

Revised Geometry (signalized)

The future overall intersection LOS is C for both the AM and PM peaks. The longest queue lengths are WB T (275ft) in the AM Peak and EB T (300ft) in the PM Peak.

Staggered-T (unsignalized)

The future overall intersection LOS is A in the AM Peak and C in the PM Peak. The main benefit of this alternative is that the highest volumes (EB T + WB T) do not have to stop. In the PM Peak the highest-volume side street movement (NB L) operates with LOS F (170 sec/veh delay, 275ft queue length). SB T and WB L volumes are both higher in the PM Peak than in the AM Peak, which results in limited gaps for NB L vehicles. Because the highest-volume side street movement has LOS F, it is recommended to discard this alternative.

Reduced Conflict Intersection (unsignalized)

The future overall intersection LOS is B in both the AM and PM peaks, with the overall intersection delay being roughly 3x less than Revised Geometry Signalized. The main benefit of this alternative is that the highest volumes (EB T + WB T) do not have to stop. 21% of traffic must re-route and experience extra travel time, but there are only short queue lengths for all movements. If traffic volumes increase more than expected, this alternative could be signalized in the future.

Roundabout 2x1

The future overall intersection LOS is A for the AM Peak and B for the PM Peak. All movements have short queue lengths.

Roundabout 1x1 with Right Turn Lane Drops

The future overall intersection LOS is C for the AM Peak and B for the PM Peak. The worst movement is WB L+T (delay 26.1 sec/veh, 250ft queue length) in the AM Peak. Because the lane drops could potentially surprise drivers and result in abrupt lane-changes and because the 2x1 roundabout has better operations, it is recommended to discard this alternative in favor of the 2x1 roundabout.

Table 6 - Capacity Analysis Results																					
Time Period	Alternative	EB				WB				NB				SB				Inter Section	WB to EB U-Turn	EB to WB U-Turn	
		L	T	R	Appr	L	T	R	Appr	L	T	R	Appr	L	T	R	Appr				
Existing 2023	AM Peak	Ex Geom Signalized	E 62.0 0	B 16.7 75	B 15.0 25	B 16.8	F 107.4 25	B 17.6 100	B 14.2 25	B 19.1	C 22.1 100	B 17.8 25	C 21.2	B 18.5 0	A 0.0 0	B 18.3	B 18.8	---	---		
	PM Peak	Ex Geom Signalized	D 49.8 0	B 18.6 100	B 18.8 100	B 18.9	F 137.9 100	B 15.3 75	B 13.5 25	C 29.3	C 23.9 75	B 18.7 0	C 23.2	C 21.1 50	B 19.3 25	C 20.5	C 22.8	---	---		
Future 2043	AM Peak	Ex Geom Signalized	E 72.9 0	C 26.0 175	B 12.1 50	C 23.6	F 135.4 25	C 28.2 250	B 19.7 50	C 29.5	C 27.6 225	C 24.9 50	C 27.0	C 22.1 25	C 25.0 0	C 24.1	C 26.9	---	---		
		Rev Geom Signalized	C 24.8 0	C 29.1 200	B 14.2 50	C 26.2	C 23.9 25	C 32.0 275	C 22.2 50	C 30.9	C 26.2 225	C 24.2 50	C 25.8	C 26.9 25	A 0.0 0	C 28.0	C 28.2	---	---		
		Staggered-T* Unsignalized	C 30.8 0	A 0.0 0	A 0.0 0	A 0.2	B 11.1 0	A 0.0 0	A 0.0 0	A 0.2	A 0.2	C 27.2 125	D 43.1 25	B 26.6 25	B 18.1 25	D 42.9 10.7 0	B 22.0	A 6.2	---	---	
		RCI* Unsignalized	B 11.0 0	A 0.0 0	A 0.0 0	A 0.1	B 11.2 0	A 0.0 0	A 0.0 0	A 0.2	A 0.2	D 49.8 100	D 49.8 16.0	B 44.4	D 40.0	D 40.0 0.0 0	A 40.0	D 10.2	A 9.9 0	B 16.1 75	
		Roundabout 2x1	A 5.7 25	A 6.2 25	A 6.0	A 6.0	A 9.7 50	B 10.8 75	B 10.3	B 13.8	B 13.8	B 13.8	B 13.8	B 13.8	A 7.7 0	A 7.7	A 9.5	---	---		
		Roundabout 1x1 with RT Lane Drops	A 7.9 50	A 4.4 25	A 7.0	D 26.1 250	A 5.2	C 23.8	C 18.4	C 18.4	C 18.4	C 18.4	C 18.4	C 18.4	A 9.8 25	A 9.8	C 16.5	---	---		
	PM Peak	Ex Geom Signalized	E 64.2 25	C 29.4 250	B 18.9 200	C 26.2	E 73.7 100	C 21.1 150	B 12.9 25	C 26.1	C 30.7 150	C 34.4 25	C 31.3	C 29.0 125	D 39.7 75	C 32.8	C 27.5	---	---		
		Rev Geom Signalized	C 24.6 25	D 39.8 300	C 26.8 250	D 35.3	C 29.9 50	C 29.6 225	B 19.1 50	C 28.5	C 27.5 175	C 31.4 25	C 28.1	D 38.1 200	C 34.7 75	D 36.9	C 32.5	---	---		
		Staggered-T* Unsignalized	C 30.1 0	A 0.0 0	A 0.0 0	A 0.3	B 18.0 50	A 0.0 0	A 0.0 0	A 2.0	A 2.0	F 170.3 275	D 42.7 25	B 12.6 25	F 136.9 50	B 18.9 50	D 49.9 10.8 25	B 28.0	C 20.2	---	---
		RCI* Unsignalized	A 9.5 0	A 0.0 0	A 0.0 0	A 0.1	B 19.0 25	A 0.0 0	A 0.0 0	A 2.0	A 2.0	D 44.9 50	D 44.9 15.5 50	B 40.9	D 46.7	D 46.7 13.4 50	B 45.0	D 10.3	B 15.6 50	B 11.7 25	
Roundabout 2x1		B 11.1 75	B 12.8 100	B 12.0	A 7.4 50	A 8.0 50	A 7.7	B 13.8	B 13.8	B 13.8	B 13.8	B 13.8	B 13.8	B 10.3 50	B 10.3	B 10.8	---	---			
Roundabout 1x1 with RT Lane Drops		C 18.4 175	A 8.5 50	B 15.0	B 12.8 100	A 4.7	B 11.8	C 19.3	C 19.3	C 19.3	C 19.3	C 19.3	C 19.3	B 13.6 50	B 13.6	B 14.4	---	---			

-Values shown are LOS, Delay (sec), and Queue Length (ft).
 -Queue lengths ≥ 200ft are highlighted blue.
 *For the Staggered-T scenario; the EB L, NB T, and SB T results account for extra distance travel time.
 *For the Staggered-T scenario, the distance between the north leg and the south leg was assumed to be 715ft (50ft cushion for turning, 180ft taper, 335ft decel, 100ft storage, 50ft cushion for turning). If the actual design is farther apart, then extra distance travel time will be longer than shown here (more delay than shown here).
 *For the RCI (Reduced Conflict Intersection) scenario; the NB L, NB T, SB L, and SB T results account for extra distance travel time.
 *For the RCI scenario, the distance between the main intersection and the U-Turn was assumed to be 715ft (50ft cushion for turning, 180ft taper, 335ft decel, 100ft storage, 50ft cushion for turning). If the actual design is farther apart, then extra distance travel time will be longer than shown here (more delay than shown here).

RECOMMENDATIONS

If it is decided to make changes to the intersection, then it is recommended to carry forward the below three alternatives to the environmental document. Concept drawings are on pages 10 and 11. **Table 7** compares some attributes of the three alternatives.

Table 7 - Comparison of Recommended Alternatives				
		Revised Geometry (signalized)	Reduced Conflict Intersection (unsignalized)	Roundabout 2x1
Number of Conflict Points		32 total (16 crossing)	18 total (2 crossing)	8 total (0 crossing)
Amount of traffic required to travel extra distance		None	21%	None
2043 AM Peak	Overall LOS/Delay	C 28.2 sec/veh	B 10.2 sec/veh	A 9.5 sec/veh
	Worst Movement Delay/Queue	WB T 32.0 sec/veh 275ft queue	NB 49.8* sec/veh 100ft queue	NB 13.8 sec/veh 100ft queue
2043 PM Peak	Overall LOS/Delay	C 32.5 sec/veh	B 10.3 sec/veh	B 10.8 sec/veh
	Worst Movement Delay/Queue	EB T 39.8 sec/veh 300ft queue	NB 44.9* sec/veh 50ft queue	EB T 12.8 sec/veh 100ft queue
Is EB+WB through traffic required to stop?		Yes, on red lights	No	Yes, if conflicting traffic is present
Are there extra features that may cause snow drifts?		No	Yes, raised curbs	Yes, raised curbs and center mound
Intersection still operates normally during a power outage?		No	Yes	Yes
*Accounts for control delay and extra distance travel time.				

Appendix A – Crash Information

Intersection and/or Urban Crash Summary Sheets

Total Crashes: 24 (Sorted by Date)
 City: Grand Forks
 Location: US 2 & Grand Forks Airport
 Start - End Date: 10/1/2018 - 9/30/2023 (5 Years)

23 USC § 407 Documents
 NDDOT Reserves All Objections

LEGEND
 ▶ Fatal
 ▶ Incapacitating Injury
 ▶ Non-Incapacitating Injury
 ▷ Possible Injury
 ◆ Wet surface
 ❄ Snow, Ice, Slush, Frost
 ▲ Crash related to work zone
 ① Unit number

1. Contributing Factor
 * = alcohol or drugs involved
2. Most Harmful Event
 For single vehicle crashes, the most harmful event is shown in parentheses in the "Type of Collision" column



Crash No.	Crash Severity Date, Day Surface Conditions, Weather Lighting, Time	Type of Collision	① AGE SEX CITY STATE Unit Configuration Movement (traffic control) Contributing Factor ¹ Most Harmful Event ²	②	③	Shortened Narrative	Diagram
1 1077407	PDO 04/28/19 Sunday Wet Rain Dark(L) 9:15 PM	Rear End	① 25M GRAND FORKS ND Pickup - Van - Utility EB Stopped (Signal) Weather	② 56M ADAMS ND Pickup - Van - Utility EB Stopped (Signal) Weather			→→
2 1089847	PDO 01/14/20 Tuesday Ice / Snow Blowing Snow Dawn 7:10 AM	Rear End	① 30M GRAND FORKS ND Passenger Car SB Slowing/Stopping (Signal) To Fast for Conditions	② 59M GRAND FORKS ND Pickup - Van - Utility SB Going Straight (Signal)			↓ ↓
3 1096208	PDO 07/08/20 Wednesday Dry Clear Daylight 10:40 AM	Rear End	① 42F DEVILS LAKE ND Pickup - Van - Utility EB Going Straight (Signal) Ran Red Light	② 24M GRAND FORKS ND Pickup - Van - Utility EB Stopped (Signal)			→→
4 1096330	▷ Possible Injury 07/13/20 Monday Dry Cloudy Daylight 9:46 AM	Sideswipe (Same Dir.)	① 65M NORTHWOOD ND Truck Tractor NB Turning Right (Signal)	② 44M BUXTON ND Passenger Car NB Passing (Signal) Improper Overtaking			↑↑
5 1096635	PDO 07/13/20 Monday Dry Clear Daylight 6:34 PM	Rear End	① 21M GRAND FORKS ND Passenger Car EB Going Straight (Signal) Following too Close	② 15M GRAND FORKS ND Passenger Car EB Going Straight (Signal)	③ 17M GRAND FORKS ND Passenger Car EB Stopped (Signal)		→→
6 1096399	PDO 07/15/20 Wednesday Dry Clear Daylight 7:53 AM	Rear End	① 58M CRARY ND Truck Tractor EB Going Straight (Signal) Careless/Reckless Driving	② 64M ESTERO FL Pickup - Van - Utility EB Stopped (Signal)	③ 49M GRAND FORKS ND Pickup - Van - Utility EB Stopped (Signal)		→→
7 1097802	PDO 08/17/20 Monday Dry Clear Daylight 8:42 AM	Rear End	① 19M WEST FARGO ND Pickup - Van - Utility WB Going Straight (Signal) Following too Close	② 64M LEEDS ND Pickup - Van - Utility WB Stopped (Signal) Following			←←
8 1099713	PDO 10/05/20 Monday Dry Clear Daylight 2:21 PM	Rear End	① 67M LAKOTA ND Passenger Car EB Going Straight (Beacon) Care Required	② 76M THOMPSON ND Pickup - Van - Utility EB Going Straight			→→
9 1102036	PDO 12/13/20 Sunday Snow Clear Daylight 8:16 AM	Head on	① 60M DEVILS LAKE ND Pickup - Van - Utility SB Turning Right (Signal) Weather	② 53F EMERADO ND Passenger Car NB Going Straight (Signal)			↓ ↑
10 1108361	PDO 05/28/21 Friday Dry Clear Daylight 3:18 PM	Rear End	① 23F GRAND FORKS AFB ND Passenger Car EB Going Straight (Signal) Following too Close	② 17M GRAND FORKS AFB ND Pickup - Van - Utility EB Stopped (Signal)			→→

Intersection and/or Urban Crash Summary Sheets

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LEGEND
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 ▶ Incapacitating Injury
 ▶ Non-Incapacitating Injury
 ▷ Possible Injury
 ◆ Wet surface
 ❄ Snow, Ice, Slush, Frost
 ▲ Crash related to work zone
 ① Unit number

1. Contributing Factor
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 For single vehicle crashes, the most harmful event is shown in parentheses in the "Type of Collision" column



Crash No.	Crash Severity Date, Day Surface Conditions, Weather Lighting, Time	Type of Collision	① AGE SEX CITY STATE Unit Configuration Movement (traffic control) Contributing Factor ¹ Most Harmful Event ²	②	③	Shortened Narrative	Diagram
11 1108945	▶ Non-incapacitating injury 06/15/21 Tuesday Dry Cloudy Daylight 5:21 PM	▲ Rear End	① 19M FORDVILLE ND Truck Tractor EB Going Straight (Signal) Following too Close	② 70M GRAND FORKS ND Truck Tractor EB Stopped (Signal)	③ 25F GRAND FORKS ND Passenger Car EB Stopped (Signal)		→→→
12 1109077	PDO 06/22/21 Tuesday Dry Clear Daylight 7:20 AM	▲ Rear End	① 33M GRAND FORKS ND Pickup - Van - Utility WB Going Straight (Signal) Careless/Reckless Driving	② 35M WALES MI Pickup - Van - Utility WB Stopped (Signal)	③ 34M GRAND FORKS ND Passenger Car WB Stopped (Signal)		←←←
13 1109723	PDO 07/01/21 Thursday Dry Clear Daylight 4:25 PM	▲ Rear End	① 20M GRAND FORKS ND Pickup - Van - Utility EB Going Straight Speed	② 26M GRAND FORKS ND Pickup - Van - Utility EB Going Straight Speed	③ 86M NIAGARA ND Passenger Car EB Going Straight Speed		→→→
14 1109637	▶ Fatal 07/02/21 Friday Dry Clear Daylight 7:33 AM	▲ Rear End	① 54M FELTON MN Unknown Heavy Truck EB Going Straight (Signal)	② 61M DES MOINES IA Passenger Car EB Stopped (Signal)	③ 57M WATERVILLE MN Pickup - Van - Utility EB Stopped (Signal)	V1 (semi truck) rear-ended V2, which was stopped behind other traffic at a red light. There were a total of 8 vehicles involved. D2 died.	→→→
15 1109614	PDO 07/06/21 Tuesday Dry Cloudy Daylight 4:11 PM	▲ Rear End	① 66M REEDER ND Unknown Heavy Truck EB Going Straight (Signal) Careless/Reckless Driving	② 68M PLYMOUTH NH Pickup - Van - Utility EB Stopped (Signal)			→→→
16 1109854	▷ Possible Injury 07/08/21 Thursday Dry Cloudy Daylight 8:27 PM	▲ Rear End	① 39F GRAND FORKS ND Pickup - Van - Utility EB Going Straight (Signal) D.U.I. (Drugs)*	② 41M SPRING GROVE MN Pickup - Van - Utility EB Stopped (Signal)			→→→
17 1112577	PDO 09/20/21 Monday Wet Rain Daylight 11:20 AM	◆ ▲ Angle	① 21M GRAND FORKS ND Passenger Car SB Going Straight (Signal)	② 77M ROTHSA Y MN Pickup - Van - Utility WB Going Straight (Signal) Ran Red Light			↓ ←
18 1114942	PDO 11/12/21 Friday Wet Clear Daylight 3:04 PM	◆ Sideswipe (Same Dir.)	① 48M GRAND FORKS ND Passenger Car EB Changing Lanes (Signal) Fail Keep in Proper Lane	② 65M NORTHWOOD ND Pickup - Van - Utility EB Going Straight (Signal)			→ →
19 1116848	PDO 12/26/21 Sunday Ice / Snow Cloudy Daylight 11:05 AM	❄ Single Veh. (Overturn / Rollover)	① 59F FARGO ND Pickup - Van - Utility EB Turning Right (Signal) Too Fast for Conditions Overturn / Rollover				→X
20 1124426	PDO 06/20/22 Monday Wet Cloudy Daylight 5:10 PM	◆ Rear End	① 68M WEST FARGO ND 2-Axle EB Going Straight Careless/Reckless Driving	② 28M FARGO ND Pickup - Van - Utility EB Going Straight			→→→

Intersection and/or Urban Crash Summary Sheets

Total Crashes: 24 (Sorted by Date)
 City: Grand Forks
 Location: US 2 & Grand Forks Airport
 Start - End Date: 10/1/2018 - 9/30/2023 (5 Years)

23 USC § 407 Documents
 NDDOT Reserves All Objections

- LEGEND**
 ▶ Fatal
 ▶ Incapacitating Injury
 ▶ Non-Incapacitating Injury
 ▷ Possible Injury
 ◆ Wet surface
 ❄ Snow, Ice, Slush, Frost
 ▲ Crash related to work zone
 ① Unit number

1. Contributing Factor
 * = alcohol or drugs involved

2. Most Harmful Event
 For single vehicle crashes, the most harmful event is shown in parentheses in the "Type of Collision" column



Crash No.	Crash Severity Date, Day Surface Conditions, Weather Lighting, Time	Type of Collision	① AGE SEX CITY STATE Unit Configuration Movement (traffic control) Contributing Factor ¹ Most Harmful Event ²	Shortened Narrative	Diagram
21 1125049	PDO 07/02/22 Saturday Dry Clear Daylight 8:25 AM	Single Veh. (Traffic Signal Support)	① 48M HUNTSVILLE TX Truck Tractor EB Going Straight (Signal) Traffic Signal Support		→X
22 1130168	PDO 11/16/22 Wednesday Ice / Snow Blowing Snow Dark(L) 5:22 PM	❄ Rear End	① 45F GRAND FORKS AFB ND Pickup - Van - Utility EB Slowing/Stopping (Signal) To Fast for Conditions	② 24M GRAND FORKS ND Passenger Car EB Stopped (Signal)	→→
23 1135875	PDO 03/05/23 Sunday Dry Clear Daylight 11:54 AM	Rear End	① 24M DEVILS LAKE ND Pickup - Van - Utility NB Turning Left (Signal) Following too Close	② 39F GRAND FORKS AFB ND Pickup - Van - Utility NB Turning Left (Signal)	↑ ↑
24 1143157	PDO 09/06/23 Wednesday Dry Clear Daylight 12:00 PM	Sideswipe (Same Dir.)	① 20M GRAND FORKS ND Pickup - Van - Utility SB Changing Lanes (Signal) Improper Turn	② 48F EAST GRAND FORKS MN Pickup - Van - Utility SB Turning Left (Signal)	↓ ↓
25					
26					
27					
28					
29					
30					

Appendix B – Traffic Volume Information



Intersection Traffic Volumes
 North Dakota Department of Transportation
 SFN 7921 (Rev. 4-85)

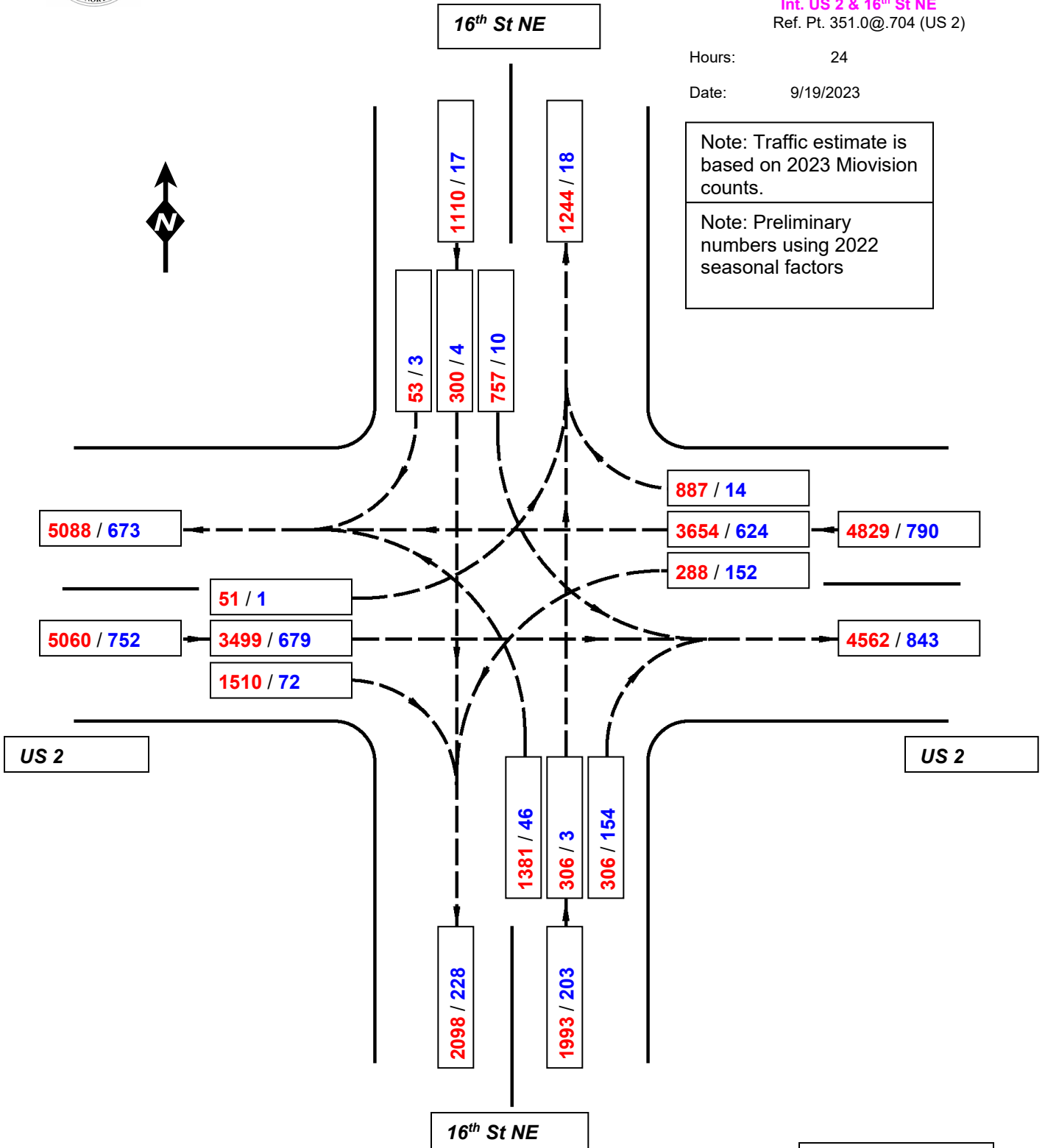
Intersection No. 1

Description: Grand Forks
 Int. US 2 & 16th St NE
 Ref. Pt. 351.0@.704 (US 2)

Hours: 24

Date: 9/19/2023

Note: Traffic estimate is based on 2023 Miovision counts.
 Note: Preliminary numbers using 2022 seasonal factors



LEGEND: AADT / TRUCKS - 2023

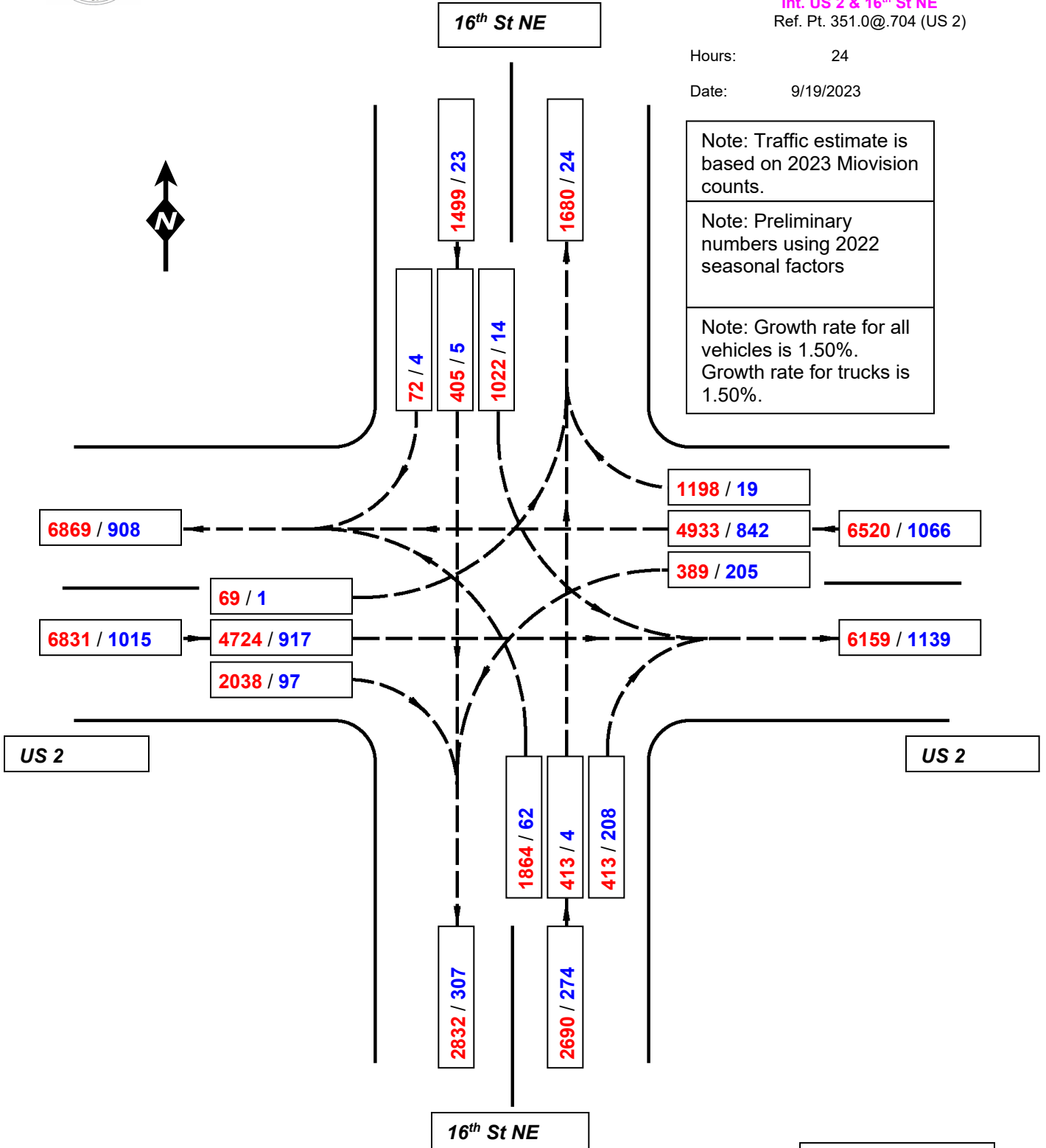
Completed by NR



Intersection Traffic Volumes
 North Dakota Department of Transportation
 SFN 7921 (Rev. 4-85)

Intersection No. 1
 Description: Grand Forks
 Int. US 2 & 16th St NE
 Ref. Pt. 351.0@.704 (US 2)
 Hours: 24
 Date: 9/19/2023

Note: Traffic estimate is based on 2023 Miovision counts.
 Note: Preliminary numbers using 2022 seasonal factors
 Note: Growth rate for all vehicles is 1.50%.
 Growth rate for trucks is 1.50%.



LEGEND: AADT / TRUCKS - 2043

Completed by NR

Study Name US 2 & Grand Forks Airport
Start Date 09/19/2023

23 USC § 407 Documents
NDDOT Reserves All Objections

Start Time	SB R	SB T	SB L	SB U	WB R	WB T	WB L	WB U	NB R	NB T	NB L	NB U	EB R	EB T	EB L	EB U	Totals	PHF
0.00	2	0	9	0	0	8	0	0	1	2	4	0	3	6	0	0	35	
0.25	0	3	3	0	0	3	0	0	0	1	1	0	2	6	0	0	19	
0.50	0	1	1	0	0	5	0	0	0	0	2	0	1	4	0	0	14	
0.75	0	0	0	0	1	1	0	0	0	0	0	0	1	6	0	0	9	
1.00	0	0	0	0	0	2	0	0	0	0	0	0	0	5	0	0	7	
1.25	0	0	0	0	2	4	0	0	0	0	2	0	0	3	0	0	11	
1.50	0	1	0	0	0	2	0	0	0	0	0	0	0	4	0	0	7	
1.75	0	0	0	0	0	3	0	0	0	0	0	0	0	4	0	0	7	
2.00	0	0	0	0	0	1	1	0	0	0	1	0	2	3	0	0	8	
2.25	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	
2.50	0	0	0	0	4	3	0	0	0	1	5	0	1	0	0	0	14	
2.75	0	0	0	0	4	4	0	0	0	1	0	0	0	3	0	0	12	
3.00	0	1	1	0	5	4	0	0	0	0	0	0	0	5	0	0	16	
3.25	0	1	0	0	3	1	0	0	0	4	0	0	0	5	0	0	14	
3.50	0	1	3	0	13	4	0	0	0	4	0	0	1	5	1	0	32	
3.75	0	3	4	0	6	3	0	0	0	4	0	0	1	8	1	0	30	
4.00	1	1	1	0	5	6	0	0	0	1	0	0	3	5	1	0	24	
4.25	0	0	1	0	6	10	0	0	0	1	1	0	2	5	0	0	26	
4.50	0	1	2	0	2	7	0	0	1	0	10	0	6	15	1	0	45	
4.75	0	0	0	0	3	18	0	0	1	1	2	0	3	8	0	0	36	
5.00	0	4	3	0	1	16	1	0	2	0	4	0	8	15	0	0	54	
5.25	0	0	0	0	3	33	0	0	0	0	6	0	5	13	0	0	60	
5.50	0	2	2	0	7	29	0	0	4	3	11	0	6	17	0	0	81	
5.75	1	1	0	0	6	48	0	0	2	2	8	0	9	32	2	0	111	
6.00	0	1	1	0	8	53	0	0	2	3	19	0	7	25	2	0	121	
6.25	0	0	2	0	16	66	1	0	4	7	32	0	20	44	0	0	192	
6.50	0	0	1	0	21	104	1	0	4	9	56	0	14	53	1	0	264	
6.75	0	0	1	0	20	81	3	0	6	9	44	0	17	52	2	0	235	
7.00	0	1	0	0	8	132	2	0	15	5	51	0	28	64	0	0	306	0.86
7.25	0	1	5	0	20	119	1	0	10	8	46	0	31	87	0	0	328	
7.50	0	0	2	0	19	107	3	0	14	6	61	3	43	101	2	0	361	
7.75	0	1	9	0	20	84	4	0	3	10	35	0	18	57	1	0	242	
8.00	0	1	7	0	19	67	10	0	4	8	31	0	25	58	0	0	230	
8.25	1	0	5	0	13	92	6	0	6	5	42	0	26	63	0	0	259	
8.50	1	1	7	0	13	82	15	0	9	8	31	0	30	64	1	0	262	
8.75	0	2	8	0	14	60	3	0	17	5	21	0	18	51	0	0	199	
9.00	1	2	13	0	8	70	5	0	9	4	18	0	37	58	2	0	227	
9.25	1	1	5	0	14	60	7	0	14	3	15	0	20	52	2	1	195	
9.50	0	1	8	0	25	68	8	0	9	5	9	0	24	67	1	0	225	
9.75	1	1	6	0	19	55	7	0	4	6	25	0	28	45	1	0	198	

Hourly Volume	Hourly Rank	Major Rd EB+WB	Minor Rd NB L+T+R	Minor Rd SB L+T+R
77	22	77	11	19
32	24	32	2	1
37	23	37	8	0
92	21	92	12	14
131	20	131	18	7
306	16	306	42	13
812	12	812	195	6
1,237	2	1,237	264	19
950	7	950	187	33
845	11	845	121	40

Study Name US 2 & Grand Forks Airport
Start Date 09/19/2023

23 USC § 407 Documents
NDDOT Reserves All Objections

Start Time	SB R	SB T	SB L	SB U	WB R	WB T	WB L	WB U	NB R	NB T	NB L	NB U	EB R	EB T	EB L	EB U	Totals	PHF
10.00	2	0	7	0	17	59	5	0	8	4	15	0	15	56	0	0	188	
10.25	1	9	24	0	22	53	13	0	15	13	19	0	34	65	2	0	270	
10.50	1	4	10	0	27	68	4	0	10	7	14	0	20	60	0	0	225	
10.75	0	6	6	0	31	70	8	0	4	16	18	0	23	56	0	0	238	
11.00	2	14	29	0	20	66	11	0	14	10	15	0	14	54	1	0	250	
11.25	3	10	38	0	19	74	10	0	8	4	19	0	16	75	1	0	277	
11.50	1	4	21	0	16	64	8	0	4	7	19	0	23	54	1	0	222	
11.75	1	12	17	0	13	55	9	0	9	6	14	0	18	62	2	0	218	
12.00	1	2	15	0	19	60	12	0	12	3	14	0	16	68	0	0	222	
12.25	0	4	16	0	17	63	2	2	10	3	18	0	19	61	1	0	216	
12.50	2	6	16	0	25	62	6	0	9	7	21	0	19	61	2	0	236	
12.75	2	2	17	0	16	70	8	0	10	7	20	0	29	57	1	0	239	
13.00	1	5	10	0	19	61	5	0	7	3	20	0	22	70	0	0	223	
13.25	1	7	17	0	19	71	5	0	8	4	21	0	21	72	3	0	249	
13.50	1	6	10	0	16	64	14	0	13	4	20	0	26	87	0	0	261	
13.75	1	3	9	0	18	53	9	0	6	5	22	0	22	55	0	0	203	
14.00	2	2	10	0	17	72	5	0	13	6	21	0	31	59	1	0	239	
14.25	2	6	22	0	16	67	7	0	19	3	29	0	32	71	0	0	274	
14.50	2	5	22	0	27	72	7	0	5	6	19	2	32	85	1	0	285	
14.75	3	12	16	0	14	48	5	0	5	6	34	0	38	61	3	0	245	
15.00	2	5	10	0	12	73	14	0	7	3	14	0	43	69	2	0	254	
15.25	3	6	18	0	18	78	10	0	9	1	33	0	38	84	4	0	302	
15.50	0	11	18	0	17	70	9	0	9	9	31	0	45	93	0	0	312	
15.75	1	6	21	0	17	81	4	0	12	3	36	0	45	96	0	0	322	
16.00	2	4	21	0	19	85	7	0	7	6	32	0	55	124	0	0	362	
16.25	0	8	11	0	26	95	9	0	4	4	42	0	65	96	0	0	360	
16.50	4	11	19	0	23	84	7	0	2	7	35	0	66	120	2	0	380	
16.75	3	11	42	0	17	73	18	1	6	3	17	0	75	132	4	0	402	
17.00	1	19	31	0	6	87	16	0	13	3	47	0	63	91	0	0	377	
17.25	1	6	12	0	12	69	9	0	3	2	37	0	35	87	0	0	273	
17.50	0	5	17	0	7	61	4	0	10	4	24	0	38	79	0	0	249	
17.75	0	4	19	0	12	49	4	0	7	1	33	0	26	62	2	0	219	
18.00	0	9	18	0	13	57	3	0	3	1	22	0	28	56	0	0	210	
18.25	0	7	15	0	3	64	2	0	2	2	24	0	15	65	1	0	200	
18.50	2	6	13	0	7	48	3	0	2	1	31	0	28	47	0	0	188	
18.75	0	5	19	0	14	50	3	0	0	4	18	0	20	55	0	0	188	
19.00	0	7	7	0	8	36	1	0	1	10	20	0	14	39	0	0	143	
19.25	0	7	11	0	6	38	2	0	2	3	17	0	15	43	1	0	145	
19.50	0	3	10	0	7	48	1	0	0	2	23	0	19	51	0	0	164	
19.75	0	6	14	0	8	39	2	0	4	2	19	0	9	36	0	0	139	

0.94

Hourly Volume	Hourly Rank	Major Rd EB+WB	Minor Rd NB L+T+R	Minor Rd SB L+T+R
921	9	921	143	70
967	6	967	129	152
913	10	913	134	83
936	8	936	133	71
1,043	5	1,043	166	104
1,190	3	1,190	167	101
1,504	1	1,504	165	136
1,118	4	1,118	184	115
786	13	786	110	94
591	14	591	103	65

Study Name US 2 & Grand Forks Airport
Start Date 09/19/2023

23 USC § 407 Documents
NDDOT Reserves All Objections

Start Time	SB R	SB T	SB L	SB U	WB R	WB T	WB L	WB U	NB R	NB T	NB L	NB U	EB R	EB T	EB L	EB U	Totals	PHF
20.00	0	2	11	0	3	29	2	0	0	0	13	0	18	21	0	0	99	
20.25	1	4	12	0	4	30	1	0	3	0	17	0	13	37	0	0	122	
20.50	0	4	11	0	2	24	1	0	4	3	14	0	10	37	0	0	110	
20.75	1	2	8	0	2	21	3	0	0	5	6	0	6	29	0	0	83	
21.00	0	2	4	0	2	28	0	0	0	11	10	0	4	18	0	0	79	
21.25	0	6	1	0	4	26	0	0	1	7	8	0	7	15	0	0	75	
21.50	0	1	9	0	0	24	3	0	0	3	4	0	8	12	0	0	64	
21.75	0	5	2	0	2	12	0	0	1	0	1	0	5	15	0	0	43	
22.00	0	5	7	0	0	15	0	0	0	0	10	0	6	16	0	0	59	
22.25	0	0	2	0	7	17	0	0	0	1	3	0	3	9	0	0	42	
22.50	1	2	15	0	5	7	0	0	1	0	2	0	3	7	0	0	43	
22.75	0	4	7	0	3	6	0	0	0	0	0	0	2	6	0	0	28	
23.00	0	5	15	0	3	9	0	0	0	0	0	0	2	4	0	0	38	
23.25	0	5	13	0	2	7	1	0	0	3	0	0	1	5	0	0	37	
23.50	3	11	19	0	4	6	0	0	0	3	0	0	1	7	0	0	54	
23.75	3	14	11	0	2	5	0	0	0	1	2	0	0	6	1	0	45	
Totals	66	370	935	0	1,013	4,338	370	3	443	358	1,630	5	1,741	4,179	57	1	15,509	
	0%	2%	6%	0%	7%	28%	2%	0%	3%	2%	11%	0%	11%	27%	0%	0%		

Hourly Volume	Hourly Rank	Major Rd EB+WB	Minor Rd NB L+T+R	Minor Rd SB L+T+R
414	15	414	65	56
261	17	261	46	30
172	19	172	17	43
174	18	174	9	99

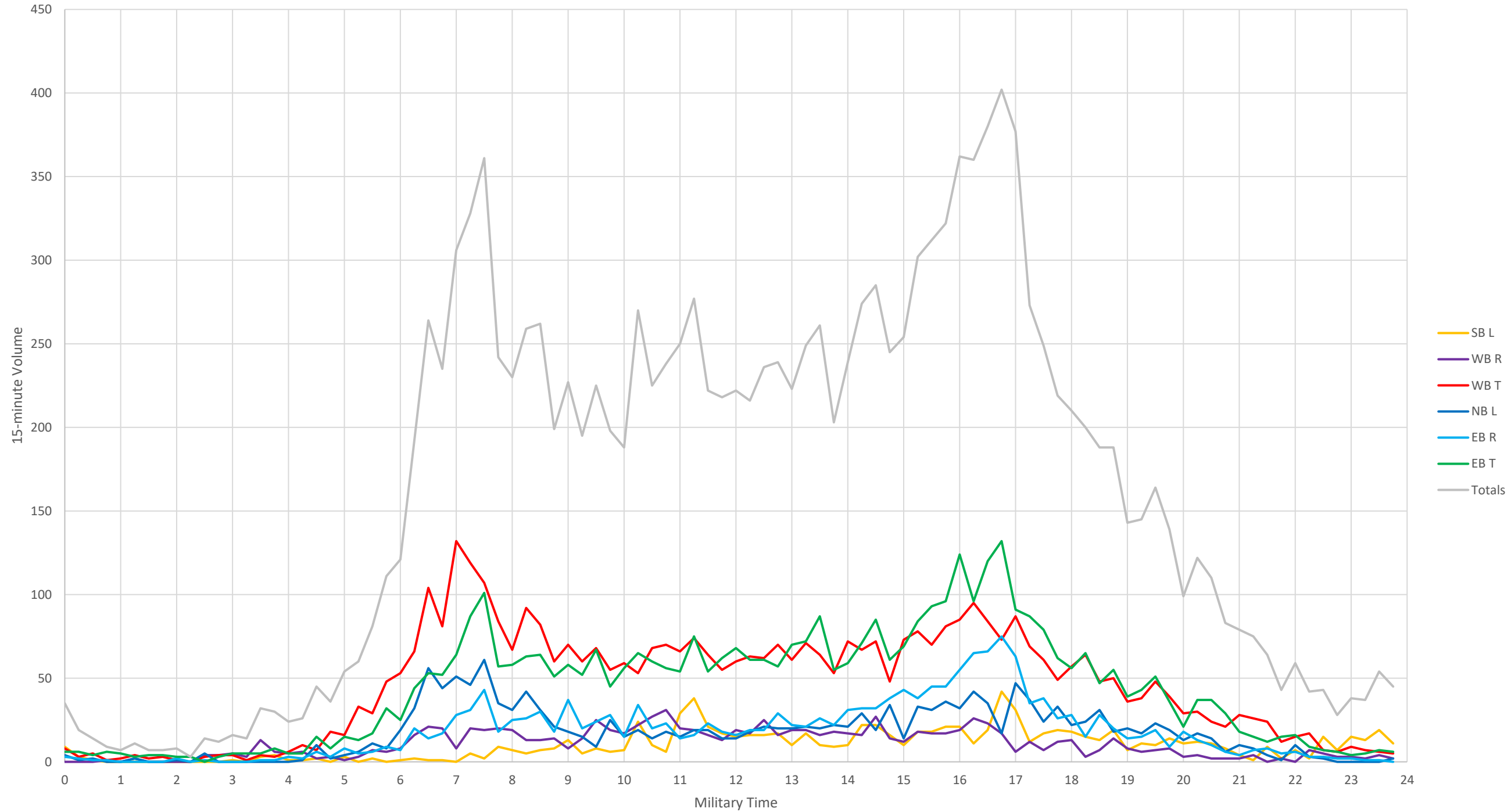
Table 3 - Peak Hour Volumes, US 2 & Grand Forks Airport																		
	SB R	SB T	SB L	SB U	WB R	WB T	WB L	WB U	NB R	NB T	NB L	NB U	EB R	EB T	EB L	EB U	Totals	PHF
2023 AM Peak	0	3	16	0	67	442	10	0	42	29	193	3	120	309	3	0	1,237	0.86
2023 PM Peak	8	49	103	0	72	339	50	1	25	17	141	0	269	439	6	0	1,519	0.94
2023 All-Day	66	370	935	0	1,013	4,338	370	3	443	358	1,630	5	1,741	4,179	57	1	15,509	
	0%	2%	6%	0%	7%	28%	2%	0%	3%	2%	11%	0%	11%	27%	0%	0%		
All-Day Trucks	6%	1%	1%	0%	2%	20%	59%	0%	60%	1%	5%	0%	6%	23%	2%	0%	17%	
2043 AM Peak	0	4	22	0	90	595	13	0	57	39	260	4	162	416	4	0	1,666	0.86
2043 PM Peak	11	66	139	0	97	457	67	1	34	23	190	0	362	591	8	0	2,046	0.94

Future traffic based on growth of 1.5% per year.

Start Time	SB R	SB T	SB L	SB U	WB R	WB T	WB L	WB U	NBR	NBT	NBL	NBU	EBR	EBT	EBL	EBU	Totals	PHF
------------	------	------	------	------	------	------	------	------	-----	-----	-----	-----	-----	-----	-----	-----	--------	-----

Hourly Volume	Hourly Rank	Major Rd EB+WB	Minor Rd NB L+T+R	Minor Rd SB L+T+R
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US 2 & Grand Forks Airport, Traffic Volumes on 9/19/23



Appendix C – Traffic Signal Forms and Flowcharts

Traffic Signal Warrant Form..... 29

Left Turn Phasing Flowcharts..... 36

TRAFFIC CONTROL STUDY - WARRANTS FOR TRAFFIC SIGNALS

North Dakota Department of Transportation, Programming
SFN 7924 (3-2023)

**23 USC § 407 Documents
NDDOT Reserves All Objections**

Date 10/13/2023	Prepared by CLH	City Grand Forks	Analysis Year 2023
Major Road US 2 (EB+WB)		Speed Limit (mph) 55	Number of Lanes 2
Minor Road Grand Forks Airport (highest of NB or SB)		Speed Limit (mph) 55	Number of Lanes 2

Minor road right-turn traffic excluded from the analysis because there is an exclusive right-turn lane and right-turn traffic enters the Major Road with minimal conflict:

1. Posted or 85th-percentile speed of major road traffic is > 40 mph:

Yes No

Yes No

2. In built-up area of isolated community < 10,000 population:

Yes No

If question 1 or 2 is answered yes, then use 70% volume criteria:

70% 100%

WARRANT 1, EIGHT-HOUR VEHICULAR VOLUME

Requirements: Either Condition A (Minimum Vehicular Volume) or Condition B (Interruption of Continuous Traffic) is satisfied to 100% of the stated volumes for each of any 8 hours of an average day.

Or: Both Condition A and Condition B are satisfied to 80% of the stated volumes for each of any 8 hours of an average day.

Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume

Condition A - Minimum Vehicular Volume

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100% ^a	80% ^b	70% ^c	56% ^d	100% ^a	80% ^b	70% ^c	56% ^d
1	1	500	400	350	280	150	120	105	84
2 or more	1	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1	2 or more	500	400	350	280	200	160	140	112

Condition B - Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100% ^a	80% ^b	70% ^c	56% ^d	100% ^a	80% ^b	70% ^c	56% ^d
1	1	750	600	525	420	75	60	53	42
2 or more	1	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1	2 or more	750	600	525	420	100	80	70	56

^a Basic minimum hourly volume

^b Used for combination of Conditions A and B after adequate trial of other remedial measures

^c May be used when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

^d May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

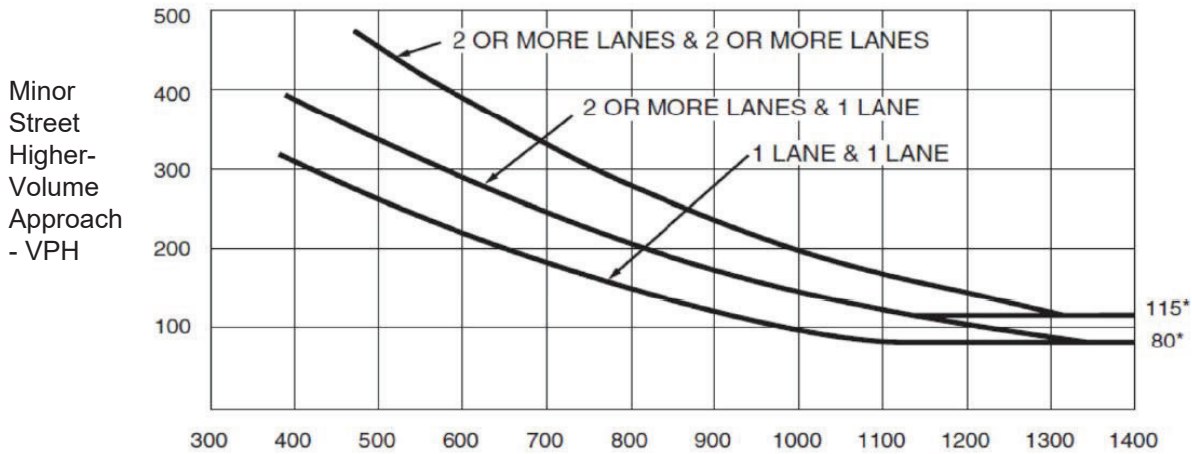
8 Highest Hour Volumes									
	1	2	3	4	5	6	7	8	
Both Approaches Major Road	1,504	1,237	1,190	1,118	1,043	967	950	936	
Highest Approach Minor Road	165	264	167	184	166	152	187	133	

Warrant 1 Met? Yes No Does not apply

WARRANT 2, FOUR-HOUR VEHICULAR VOLUME

Requirements: Plot four highest hour volumes on the applicable figure below. If four points lie above the applicable curve then the warrant is satisfied.

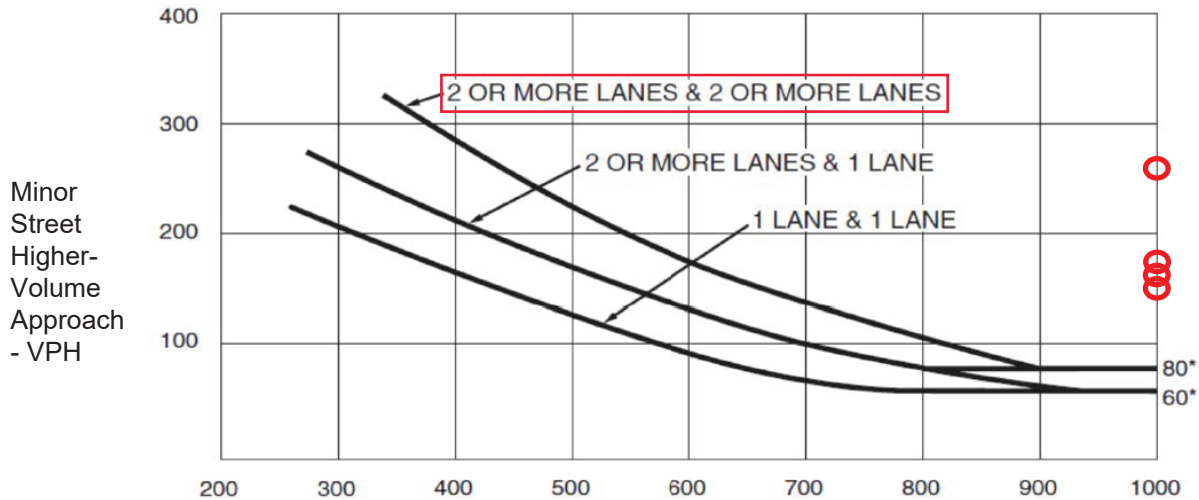
Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume



MAJOR STREET - TOTAL OF BOTH APPROACHES
VEHICLES PER HOUR (VPH)

*Note: 115 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-2. Warrant 2, Four-Hour Vehicular Volume (70% Factor)
(Community Less than 10,000 Population or Above 40 MPH on Major Street)



MAJOR STREET -- TOTAL OF BOTH APPROACHES
VEHICLES PER HOUR (VPH)

*Note: 80 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 60 vph applies as the lower threshold volume for a minor-street approach with one lane.

WARRANT 3, PEAK HOUR

Requirements: This signal warrant shall only be applied in unusual cases. Such cases include, but are not limited to, office complexes, manufacturing plants, industrial complexes, or high occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.

Unusual Condition

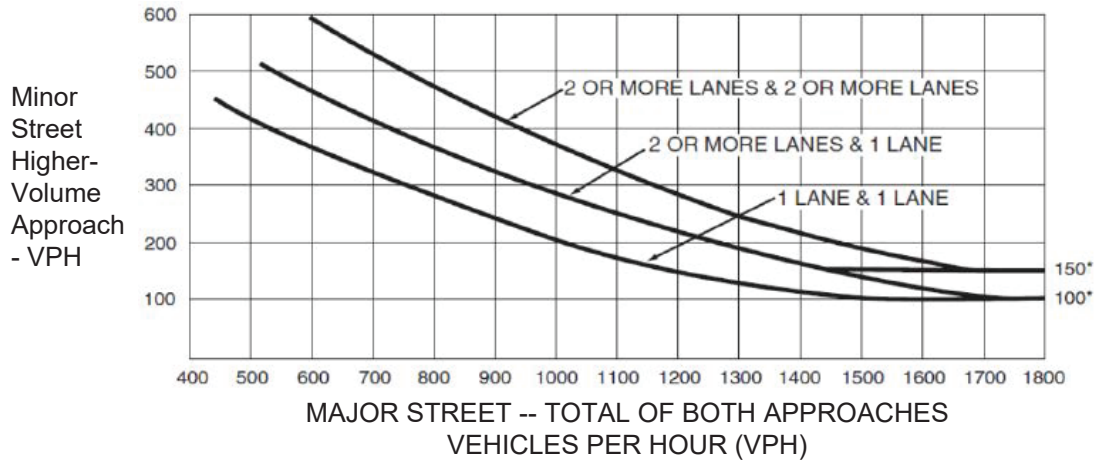
Either Condition A or Condition B is satisfied.

Condition A: The condition is satisfied if all three of the criteria are satisfied.

Criteria	Criteria Met if	Peak-Hour Value	Satisfied?	
			Yes	No
Delay on Minor Approach (veh-hr)	4 veh-hr for 1 lane approach or 5 veh-hr for two-lane approach		<input type="checkbox"/>	<input type="checkbox"/>
Volume on Minor Approach (veh/hr)	100 veh/hr for one moving lane of traffic, or 150 veh/hr for two lanes		<input type="checkbox"/>	<input type="checkbox"/>
Total Entering Volume (veh/hr)	650 veh/hr for 3 approaches or 800 veh/hr for 4 or more		<input type="checkbox"/>	<input type="checkbox"/>

Condition B: Plot peak hour volumes on the applicable figure below. These conditions exist for the same 1 hour (and four consecutive, 15-minute periods) of an average day. If the point is above the appropriate line, then the warrant is satisfied.

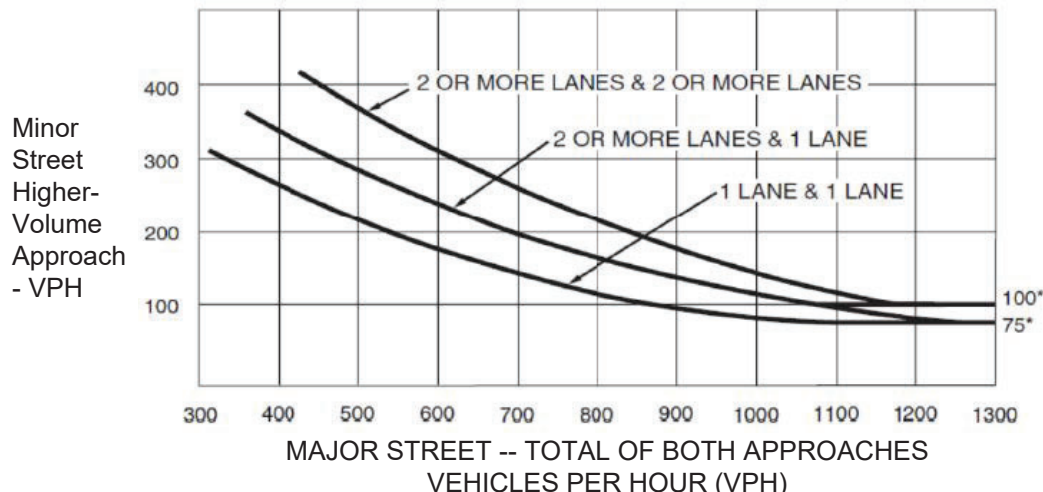
Figure 4C-3. Warrant 3, Peak Hour



*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-4. Warrant 3, Peak Hour (70% Factor)

(Community Less than 10,000 Population or Above 40 MPH on Major Street)



*Note: 100 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 75 vph applies as the lower threshold volume for a minor-street approach with one lane.

Warrant 3 Met? Yes No Does not apply

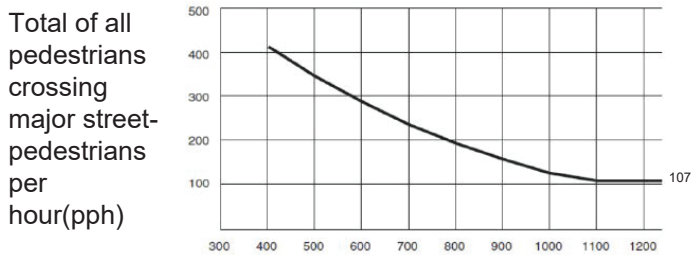
WARRANT 4, PEDESTRIAN VOLUME

Requirements: This warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street. It shall not be applied at locations where the distance to the nearest traffic signal or stop sign controlling the street that pedestrians desire to cross is less than 300 feet.

Either criterion A or criterion B is satisfied.

A: For each of any 4 hours of an average day, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) all fall above the curve in Figure 4C-5.

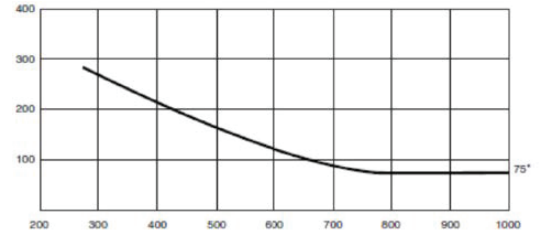
Figure 4C-5. Warrant 4, Pedestrian Four-Hour Volume



MAJOR STREET -- TOTAL OF BOTH APPROACHES VEHICLES PER HOUR (VPH)

*Note: 107 pph applies as the lower threshold volume.

Figure 4C-6. Warrant 4, Pedestrian Four-Hour Volume (70% Factor)

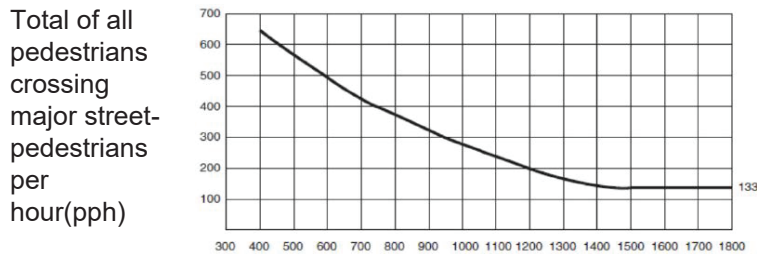


MAJOR STREET -- TOTAL OF BOTH APPROACHES VEHICLES PER HOUR (VPH)

*Note: 75 pph applies as the lower threshold volume.

B: For 1 hour (any four consecutive 15-minute periods) of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) all fall above the curve in Figure 4C-7.

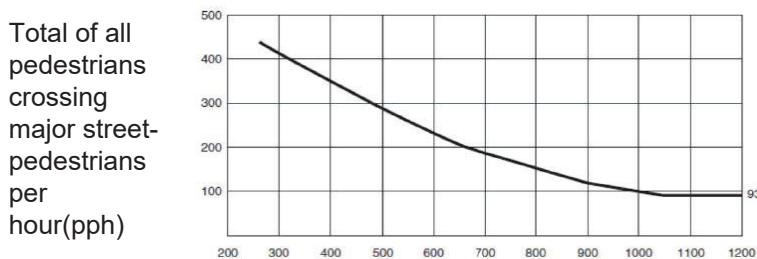
Figure 4C-7. Warrant 4, Pedestrian Peak Hour



MAJOR STREET -- TOTAL OF BOTH APPROACHES VEHICLES PER HOUR (VPH)

*Note: 133 pph applies as the lower threshold volume.

Figure 4C-8. Warrant 4, Pedestrian Peak Hour (70% Factor)



MAJOR STREET -- TOTAL OF BOTH APPROACHES VEHICLES PER HOUR (VPH)

*Note: 93 pph applies as the lower threshold volume.

If the speed on major street exceeds 40 mph, or if population is less than 10,000, Figure 4C-6 or 4C-8 may be used.

WARRANT 5, SCHOOL CROSSING

Requirements: This warrant is intended for application where the fact that schoolchildren cross the major street is the principal reason to consider installing a traffic control signal. For the purposes of this warrant, the word "schoolchildren" includes elementary through high school students.

The warrant is satisfied if all three of the criteria are satisfied.

Criteria	Satisfied?	
	Yes	No
During the time period when schoolchildren are using the crossing: Gaps < Number of minutes	<input type="checkbox"/>	<input type="checkbox"/>
There are a minimum of 20 schoolchildren during the highest crossing hour	<input type="checkbox"/>	<input type="checkbox"/>
The nearest traffic signal along the major road is located more than 300 ft away. Or, the nearest traffic signal is within 300 ft but the proposed traffic signal will not restrict the progressive movement of traffic.	<input type="checkbox"/>	<input type="checkbox"/>

Warrant 5 Met? Yes No Does not apply

WARRANT 6, COORDINATED SIGNAL SYSTEM

Requirements: This warrant is satisfied if either criteria is satisfied. This warrant should not be applied when the resulting signal spacing would be less than 1000 ft.

Criteria	Satisfied?	
	Yes	No
On a one-way street or a street that has traffic predominantly in one direction, the adjacent signals are so far apart that they do not provide the necessary degree of vehicular platooning.	<input type="checkbox"/>	<input type="checkbox"/>
On a two-way street, adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.	<input type="checkbox"/>	<input type="checkbox"/>

Warrant 6 Met? Yes No Does not apply

WARRANT 7, CRASH EXPERIENCE

Requirements: The warrant is satisfied if all three of the criteria are satisfied.

Criteria	Hour	Satisfied?	
		Yes	No
One of the warrants to the right is met:	Warrant 4.1 at 80% of volume requirements: 80 ped/hr for 4 hrs or 152 ped/hr for 1 hr	<input type="checkbox"/>	<input type="checkbox"/>
	Warrant 1, Condition A (80% satisfied)	<input type="checkbox"/>	<input type="checkbox"/>
	Warrant 1, Condition B (80% satisfied)	<input type="checkbox"/>	<input type="checkbox"/>
Adequate trial of other remedial measures has failed to reduce crash frequency.	Measures Tried	<input type="checkbox"/>	<input type="checkbox"/>
Five or more reported crashes, of types susceptible to correction by signal control, have occurred within a 12 month period.	Number of Crashes 1 angle in 5yrs	<input type="checkbox"/>	<input checked="" type="checkbox"/>

Warrant 7 Met? Yes No Does not apply

WARRANT 8, ROADWAY NETWORK

Requirements: A "major route" as used in this signal warrant shall have at least one of the following characteristics:

Characteristics of a Major Route	Satisfied?	
	Yes	No
Part of the street or highway system that serves as a principal roadway network for through traffic flow.	<input type="checkbox"/>	<input type="checkbox"/>
Rural or suburban highway outside of, entering, or traversing a city.	<input type="checkbox"/>	<input type="checkbox"/>
Appears as a major route on an official plan.	<input type="checkbox"/>	<input type="checkbox"/>

The need for a traffic control signal shall be considered if an engineering study finds that the common intersection of two or more major routes meets one or both of the following criteria:

Criteria			Satisfied?	
			Yes	No
1. Both of the criteria to the right are met.	a. Total entering volume of at least 1,000 veh/hr during typical weekday peak hour.	Entering Volume: <input style="width: 90%;" type="text"/>	<input type="checkbox"/>	<input type="checkbox"/>
	b. Five-year projected volumes that satisfy one or more of Warrants 1,2, or 3.	Warrant(s) satisfied: <input style="width: 90%;" type="text"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Total entering volume of at least 1,000 veh/hr for each of any 5 hours of a non-normal business day (Sat. or Sun.)	Hour	Volume	<input type="checkbox"/>	<input type="checkbox"/>
	<input style="width: 90%;" type="text"/>	<input style="width: 90%;" type="text"/>		
	<input style="width: 90%;" type="text"/>	<input style="width: 90%;" type="text"/>		
	<input style="width: 90%;" type="text"/>	<input style="width: 90%;" type="text"/>		
	<input style="width: 90%;" type="text"/>	<input style="width: 90%;" type="text"/>		
	<input style="width: 90%;" type="text"/>	<input style="width: 90%;" type="text"/>		

Warrant 8 Met? Yes No Does not apply

WARRANT 9, INTERSECTION NEAR A GRADE CROSSING

Requirements: This warrant is intended for use at a location where none of the conditions described in the other eight traffic signal warrants are met, but the proximity to the intersection of grade crossing on an intersection approach controlled by a STOP or YIELD sign is the principal reason to consider installing a traffic signal.

Both condition A and condition B are satisfied.

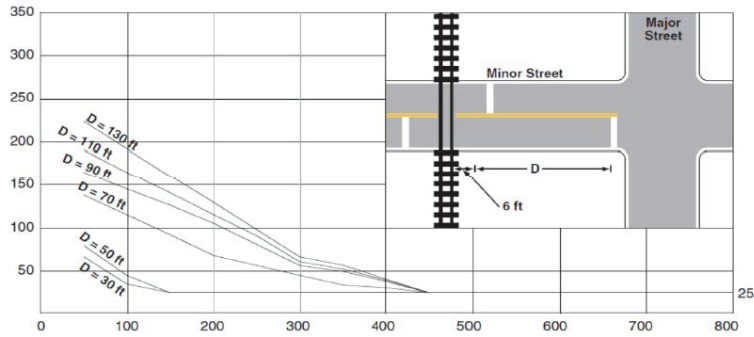
Criteria	Satisfied?	
	Yes	No
A. A grade crossing exists on an approach controlled by a STOP or YIELD sign and the center of the track nearest to the intersection is within 140 feet of the stop line or yield line on the approach.	<input type="checkbox"/>	<input type="checkbox"/>
B. During the highest traffic volume hour during which rail traffic use the crossing, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the minor-street approach that crosses the track (one direction only, approaching the intersection) falls above the applicable curve in Figure 4C-9 or 4C-10 for the existing combination of approach lanes over the track and the distance D, which is the clear storage distance as defined in Section 1A.13.	<input type="checkbox"/>	<input type="checkbox"/>

Warrant 9 Continued on next page

WARRANT 9, CONTINUED

**Figure 4C-9. Warrant 9, Intersection near a Grade Crossing
(one Approach Lane at the Track Crossing)**

Minor Street,
Crossing
Approach-
Equivalent
VPH**



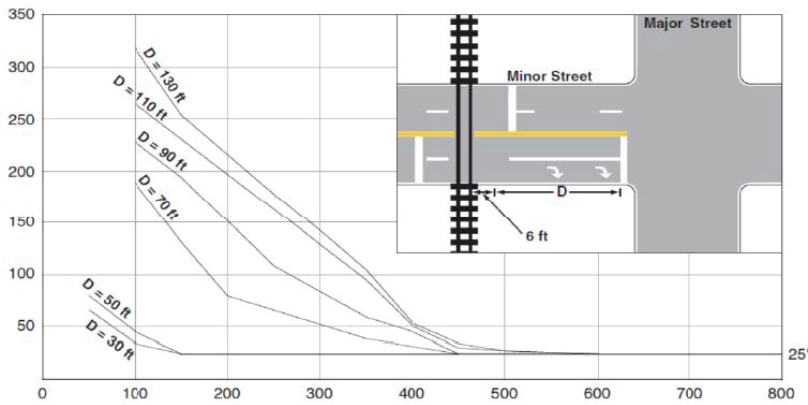
MAJOR STREET -- TOTAL OF BOTH APPROACHES - VEHICLES PER HOUR (VPH)

*Note: 25 vph applies as the lower threshold volume.

**Note: VPH after applying the adjustment factors in Tables 4C-2, 4C-3, and/or 4C-4, if appropriate.

**Figure 4C-10. Warrant 9, Intersection near a Grade Crossing
(Two or More Approach Lanes at the Track Crossing)**

Minor Street,
Crossing
Approach-
Equivalent
VPH**



MAJOR STREET -- TOTAL OF BOTH APPROACHES - VEHICLES PER HOUR (VPH)

*Note: 25 vph applies as the lower threshold volume.

**Note: VPH after applying the adjustment factors in Tables 4C-2, 4C-3, and/or 4C-4, if appropriate.

Warrant 9 Met? Yes No Does not apply

CONCLUSION

Warrants Satisfied
1B and 2

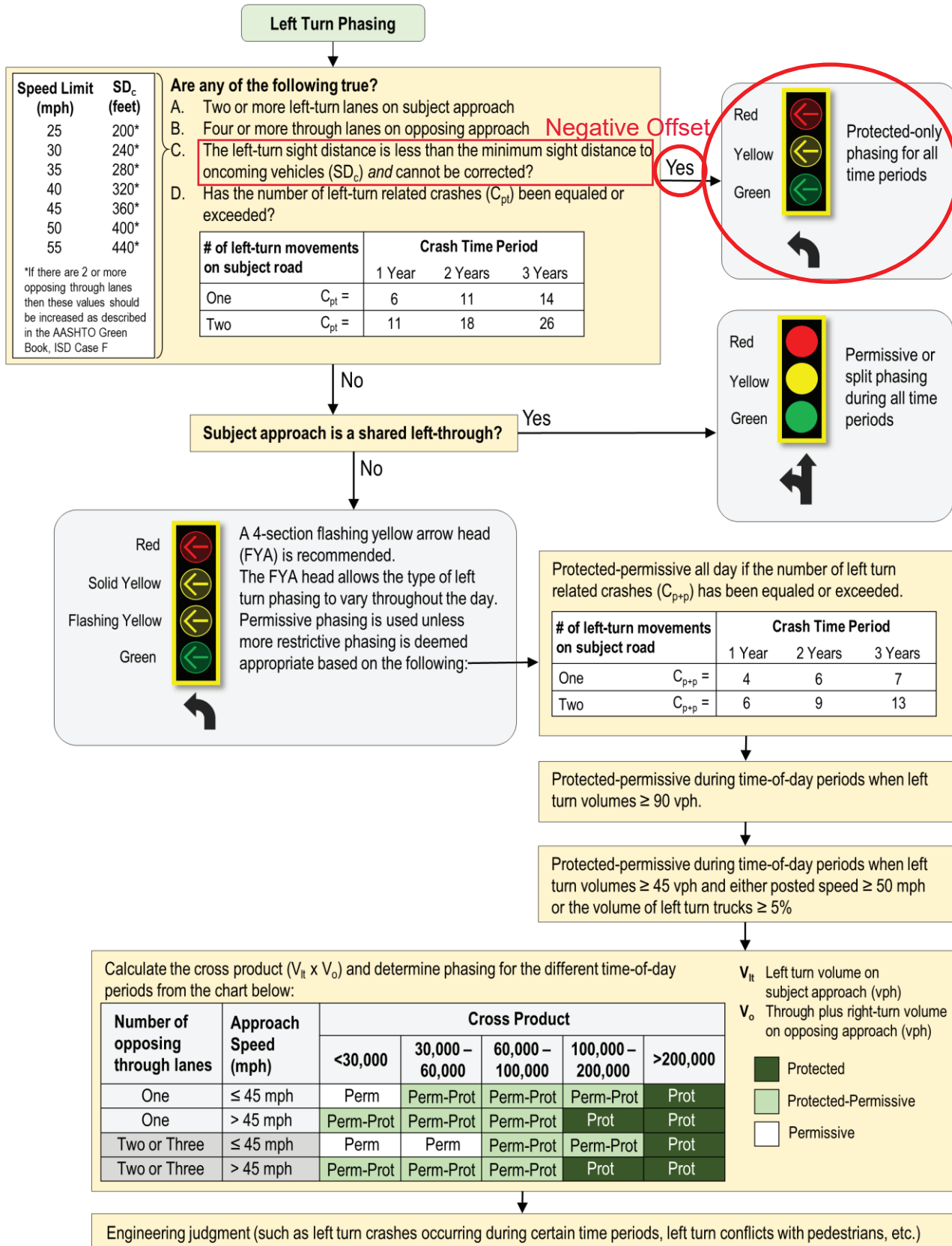
Signal Warranted Yes No

Remarks

N/S analyzed as two lanes due to the left turn lane having higher volumes than the shared T+R lane.

LEFT TURN PHASING

This flowchart was adapted from the Signal Timing Manual¹ along with engineering judgment.

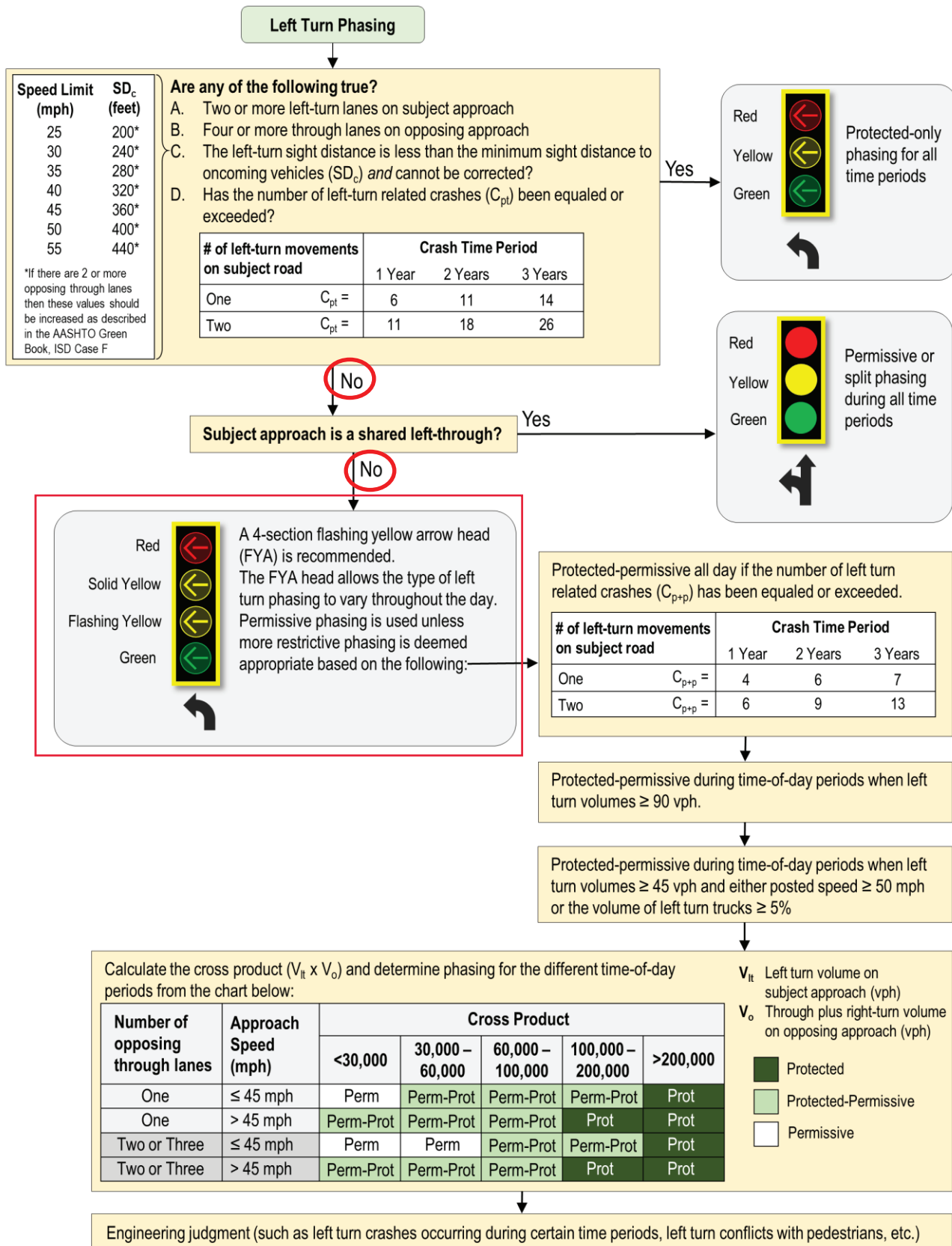


References:

1. TRB, "NCHRP Report 812: Signal Timing Manual, 2nd Edition", 2015

LEFT TURN PHASING

This flowchart was adapted from the Signal Timing Manual¹ along with engineering judgment.

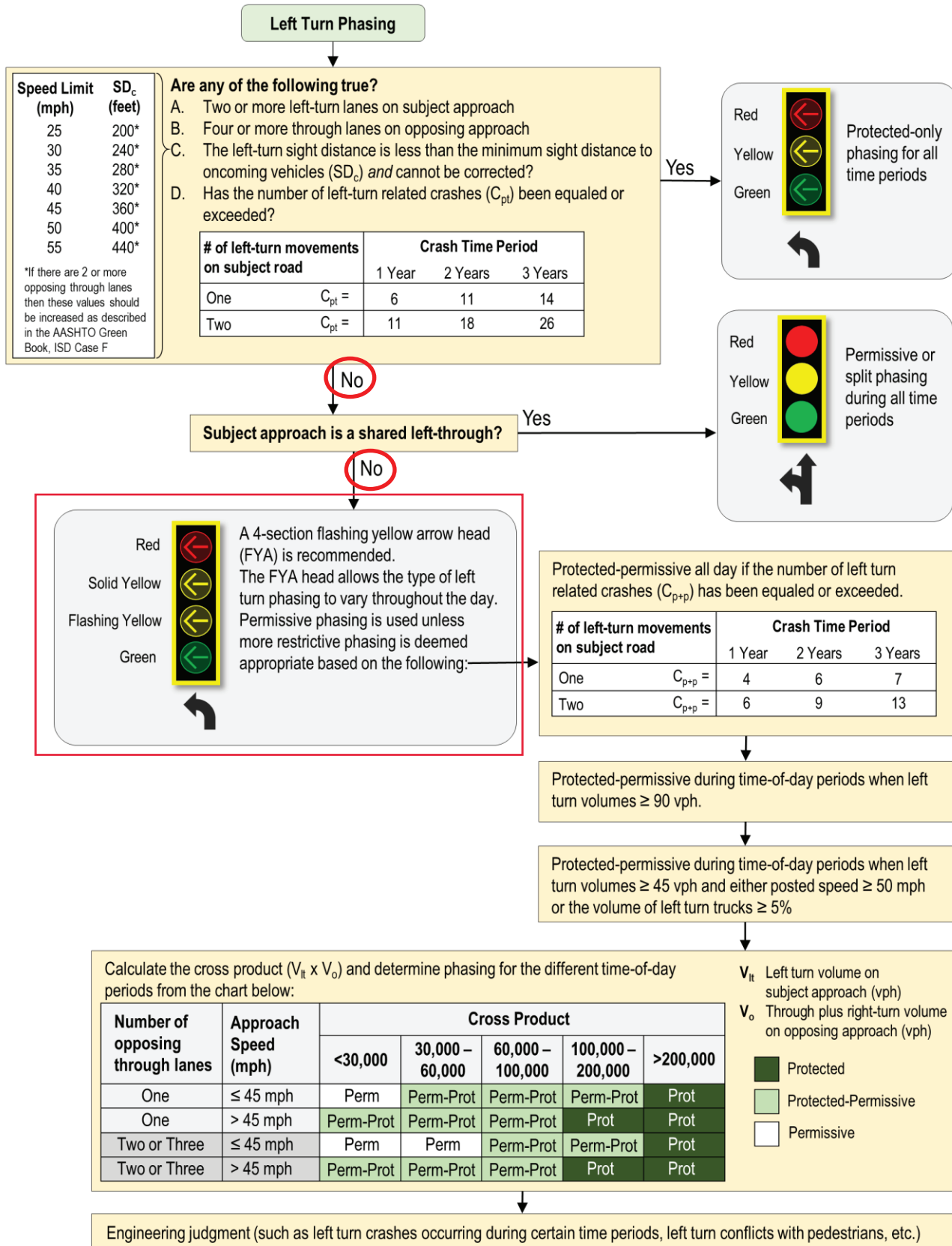


References:

- TRB, "NCHRP Report 812: Signal Timing Manual, 2nd Edition", 2015

LEFT TURN PHASING

This flowchart was adapted from the Signal Timing Manual¹ along with engineering judgment.



References:

1. TRB, "NCHRP Report 812: Signal Timing Manual, 2nd Edition", 2015

Appendix D – Capacity Analysis Sheets

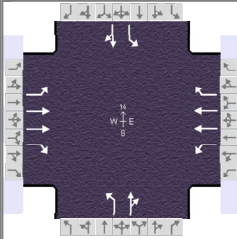
Existing 2023

AM Existing Geometry.....	40
PM Existing Geometry.....	41

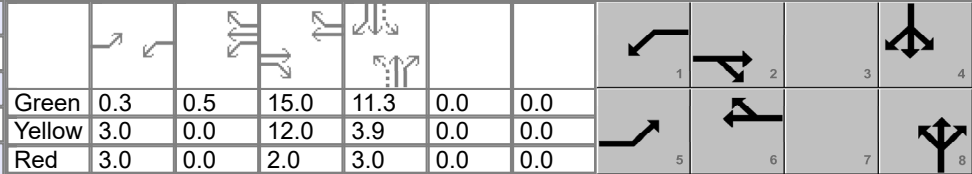
Future 2043

AM Existing Geometry.....	42
AM Revised Geometry (signalized).....	43
AM Staggered-T.....	44
AM Reduced Conflict Intersection.....	46
AM Roundabout 2x1.....	50
AM Roundabout 1x1 with Right Turn Lane Drops.....	51
PM Existing Geometry.....	52
PM Revised Geometry (signalized).....	53
PM Staggered-T.....	54
PM Reduced Conflict Intersection.....	56
PM Roundabout 2x1.....	60
PM Roundabout 1x1 with Right Turn Lane Drops.....	61

HCS Signalized Intersection Results Summary

General Information				Intersection Information		
Agency	NDDOT			Duration, h	0.250	
Analyst	CLH	Analysis Date	Oct 13, 2023	Area Type	Other	
Jurisdiction		Time Period	AM Peak	PHF	0.86	
Urban Street	US 2	Analysis Year	2023	Analysis Period	1 > 7:00	
Intersection	Grand Forks Airport & U...	File Name	2023 AM Peak Ex Geom Signalized.xus			
Project Description	2023 AM Ex Geom Signalized					

Demand Information	EB			WB			NB			SB		
	L	T	R	L	T	R	L	T	R	L	T	R
Approach Movement												
Demand (v), veh/h	3	309	120	10	442	67	193	29	42	16	3	0

Signal Information														
Cycle, s	54.0	Reference Phase	2	Green	0.3	0.5	15.0	11.3	0.0	0.0				
Offset, s	0	Reference Point	Begin	Yellow	3.0	0.0	12.0	3.9	0.0	0.0				
Uncoordinated	Yes	Simult. Gap E/W	On	Red	3.0	0.0	2.0	3.0	0.0	0.0				
Force Mode	Fixed	Simult. Gap N/S	On											

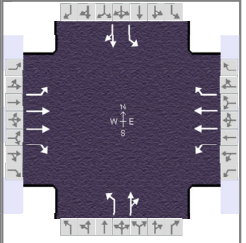
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6		8		4
Case Number	2.0	3.0	2.0	3.0		6.0		6.0
Phase Duration, s	6.3	29.0	6.8	29.5		18.2		18.2
Change Period, ($Y+R_c$), s	6.0	14.0	6.0	14.0		6.9		6.9
Max Allow Headway (MAH), s	4.2	4.2	4.2	4.2		4.3		4.3
Queue Clearance Time (g_s), s	2.1	7.9	2.7	10.6		10.3		4.2
Green Extension Time (g_e), s	0.0	4.8	0.0	4.7		1.1		1.1
Phase Call Probability	0.05	1.00	0.16	1.00		0.99		0.99
Max Out Probability	0.00	0.00	0.00	0.00		0.00		0.00

Movement Group Results	EB			WB			NB			SB		
	L	T	R	L	T	R	L	T	R	L	T	R
Approach Movement												
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	3	359	70	12	514	43	224	59		19	0	
Adjusted Saturation Flow Rate (s), veh/h/ln	1641	1367	1414	900	1406	1460	1379	1611		1354	0	
Queue Service Time (g_s), s	0.1	5.9	2.0	0.7	8.6	1.2	8.3	1.6		0.6	0.0	
Cycle Queue Clearance Time (g_c), s	0.1	5.9	2.0	0.7	8.6	1.2	8.3	1.6		2.2	0.0	
Green Ratio (g/C)	0.00	0.28	0.28	0.01	0.29	0.29	0.21	0.21		0.21		
Capacity (c), veh/h	8	760	393	13	810	421	354	336		310		
Volume-to-Capacity Ratio (X)	0.447	0.473	0.178	0.868	0.634	0.102	0.634	0.176		0.060	0.000	
Back of Queue (Q), ft/ln (95 th percentile)												
Back of Queue (Q), veh/ln (95 th percentile)	0.2	2.6	0.9	0.8	3.9	0.6	4.1	0.9		0.3	0.0	
Queue Storage Ratio (RQ) (95 th percentile)	0.02	0.00	0.08	0.08	0.00	0.04	0.54	0.00		0.03	0.00	
Uniform Delay (d_1), s/veh	26.8	16.2	14.8	26.5	16.7	14.1	20.2	17.5		18.4		
Incremental Delay (d_2), s/veh	35.2	0.5	0.2	80.8	0.8	0.1	1.9	0.2		0.1	0.0	
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	62.0	16.7	15.0	107.4	17.6	14.2	22.1	17.8		18.5		
Level of Service (LOS)	E	B	B	F	B	B	C	B		B		
Approach Delay, s/veh / LOS	16.8		B	19.1		B	21.2		C	18.3		B
Intersection Delay, s/veh / LOS	18.8						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.93	B	1.90	B	2.47	B	2.51	C
Bicycle LOS Score / LOS	0.84	A	0.96	A	0.96	A	0.52	A

HCS Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	NDDOT			Duration, h	0.250
Analyst	CLH	Analysis Date	Oct 13, 2023	Area Type	Other
Jurisdiction		Time Period	PM Peak	PHF	0.94
Urban Street	US 2	Analysis Year	2023	Analysis Period	1 > 7:00
Intersection	Grand Forks Airport & U...	File Name	2023 PM Peak Ex Geom Signalized.xus		
Project Description	2023 PM Ex Geom Signalized				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	6	439	269	50	339	72	141	17	25	103	49	8

Signal Information														
Cycle, s	56.6	Reference Phase	2											
Offset, s	0	Reference Point	Begin											
Uncoordinated	Yes	Simult. Gap E/W	On	Green	0.5	2.4	15.8	11.0	0.0	0.0				
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	3.0	0.0	12.0	3.9	0.0	0.0				
				Red	3.0	0.0	2.0	3.0	0.0	0.0				

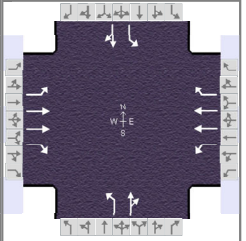
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6		8		4
Case Number	2.0	3.0	2.0	3.0		6.0		6.0
Phase Duration, s	6.5	29.8	8.9	32.2		17.9		17.9
Change Period, ($Y+R_c$), s	6.0	14.0	6.0	14.0		6.9		6.9
Max Allow Headway (MAH), s	4.2	4.2	4.2	4.2		4.3		4.3
Queue Clearance Time (g_s), s	2.2	10.4	4.9	7.7		9.9		6.6
Green Extension Time (g_e), s	0.0	5.4	0.1	5.4		1.2		1.3
Phase Call Probability	0.10	1.00	0.57	1.00		1.00		1.00
Max Out Probability	0.00	0.00	0.00	0.00		0.00		0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	6	467	222	53	361	45	150	23		110	61	
Adjusted Saturation Flow Rate (s), veh/h/ln	1641	1367	1414	900	1406	1460	1310	1668		1399	1694	
Queue Service Time (g_s), s	0.2	8.4	7.6	2.9	5.7	1.2	6.1	0.6		3.9	1.7	
Cycle Queue Clearance Time (g_c), s	0.2	8.4	7.6	2.9	5.7	1.2	7.9	0.6		4.6	1.7	
Green Ratio (g/C)	0.01	0.28	0.28	0.05	0.32	0.32	0.20	0.20		0.20	0.20	
Capacity (c), veh/h	14	762	394	46	904	469	279	326		320	331	
Volume-to-Capacity Ratio (X)	0.459	0.613	0.564	1.158	0.399	0.095	0.537	0.072		0.342	0.183	
Back of Queue (Q), ft/ln (95 th percentile)												
Back of Queue (Q), veh/ln (95 th percentile)	0.3	3.9	3.7	3.5	2.5	0.6	3.0	0.4		2.0	1.0	
Queue Storage Ratio (RQ) (95 th percentile)	0.02	0.00	0.33	0.35	0.00	0.04	0.39	0.00		0.20	0.00	
Uniform Delay (d_1), s/veh	28.0	17.8	17.5	26.9	15.0	13.5	22.3	18.6		20.5	19.0	
Incremental Delay (d_2), s/veh	21.8	0.8	1.3	111.0	0.3	0.1	1.6	0.1		0.6	0.3	
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	49.8	18.6	18.8	137.9	15.3	13.5	23.9	18.7		21.1	19.3	
Level of Service (LOS)	D	B	B	F	B	B	C	B		C	B	
Approach Delay, s/veh / LOS	18.9	B		29.3	C		23.2	C		20.5	C	
Intersection Delay, s/veh / LOS	22.8						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.93	B	1.90	B	2.47	B	2.51	C
Bicycle LOS Score / LOS	1.06	A	0.87	A	0.77	A	0.77	A

HCS Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	NDDOT			Duration, h	0.250
Analyst	CLH	Analysis Date	Oct 13, 2023	Area Type	Other
Jurisdiction		Time Period	AM Peak	PHF	0.86
Urban Street	US 2	Analysis Year	2023	Analysis Period	1 > 7:00
Intersection	Grand Forks Airport & U...	File Name	2043 AM Peak Ex Geom Signalized (NS Prot-Per...		
Project Description	2043 AM Ex Geom Signalized (NS prot-perm)				



Demand Information	EB			WB			NB			SB		
	L	T	R	L	T	R	L	T	R	L	T	R
Approach Movement												
Demand (v), veh/h	4	416	162	13	595	90	260	39	57	22	4	0

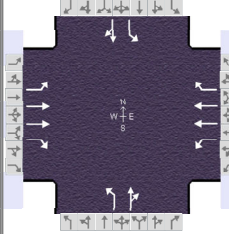
Signal Information													
Cycle, s	87.5	Reference Phase	2										
Offset, s	0	Reference Point	Begin										
Uncoordinated	Yes	Simult. Gap E/W	On	Green	0.5	1.0	27.1	2.3	8.3	9.4			
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	3.0	0.0	12.0	3.0	3.0	3.9			
				Red	3.0	0.0	2.0	3.0	3.0	3.0			

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	2.0	3.0	2.0	3.0	1.1	4.0	1.1	4.0
Phase Duration, s	6.5	41.1	7.5	42.1	22.6	30.6	8.3	16.3
Change Period, (Y+R _c), s	6.0	14.0	6.0	14.0	6.0	6.9	6.0	6.9
Max Allow Headway (MAH), s	4.2	4.2	4.2	4.2	3.2	4.3	3.2	4.3
Queue Clearance Time (g _s), s	2.2	15.0	3.5	21.4	16.3	5.7	3.0	2.2
Green Extension Time (g _e), s	0.0	7.0	0.0	6.6	0.2	0.3	0.0	0.3
Phase Call Probability	0.11	1.00	0.31	1.00	1.00	1.00	0.46	0.94
Max Out Probability	0.00	0.03	0.00	0.07	0.71	0.00	0.00	0.00

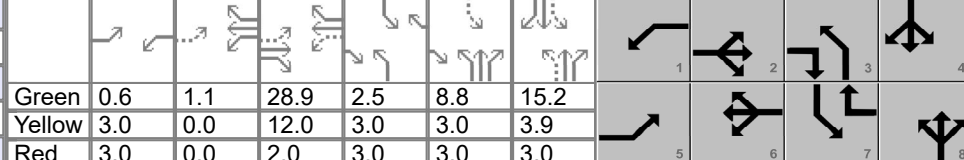
Movement Group Results	EB			WB			NB			SB		
	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	5	484	119	15	692	70	302	88		26	0	
Adjusted Saturation Flow Rate (s), veh/h/ln	1641	1367	1414	900	1406	1460	1602	1596		1654	0	
Queue Service Time (g _s), s	0.2	13.0	4.0	1.5	19.4	2.9	14.3	3.7		1.0	0.0	
Cycle Queue Clearance Time (g _c), s	0.2	13.0	4.0	1.5	19.4	2.9	14.3	3.7		1.0	0.0	
Green Ratio (g/C)	0.01	0.31	0.50	0.02	0.32	0.35	0.30	0.27		0.30		
Capacity (c), veh/h	10	846	705	16	902	507	490	432		386		
Volume-to-Capacity Ratio (X)	0.461	0.572	0.168	0.953	0.767	0.138	0.617	0.204		0.066	0.000	
Back of Queue (Q), ft/ln (95 th percentile)												
Back of Queue (Q), veh/ln (95 th percentile)	0.3	6.9	1.9	1.3	9.9	1.6	8.7	2.4		0.6	0.0	
Queue Storage Ratio (RQ) (95 th percentile)	0.03	0.00	0.17	0.13	0.00	0.11	0.45	0.00		0.06	0.00	
Uniform Delay (d ₁), s/veh	43.4	25.4	12.0	43.0	26.8	19.6	26.7	24.7		22.0		
Incremental Delay (d ₂), s/veh	29.5	0.6	0.1	92.5	1.4	0.1	1.0	0.2		0.0	0.0	
Initial Queue Delay (d ₃), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	72.9	26.0	12.1	135.4	28.2	19.7	27.6	24.9		22.1		
Level of Service (LOS)	E	C	B	F	C	B	C	C		C		
Approach Delay, s/veh / LOS	23.6		C	29.5		C	27.0		C	24.1		C
Intersection Delay, s/veh / LOS	26.9						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.95	B	1.92	B	2.48	B	2.54	C
Bicycle LOS Score / LOS	0.99	A	1.13	A	1.13	A	0.54	A

HCS Signalized Intersection Results Summary

General Information				Intersection Information		
Agency	NDDOT			Duration, h	0.250	
Analyst	CLH	Analysis Date	Oct 13, 2023	Area Type	Other	
Jurisdiction		Time Period	AM Peak	PHF	0.86	
Urban Street	US 2	Analysis Year	2023	Analysis Period	1 > 7:00	
Intersection	Grand Forks Airport & U...	File Name	2043 AM Peak Rev Geom Signalized.xus			
Project Description	2043 AM Rev Geom Signalized					

Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	4	416	162	13	595	90	260	39	57	22	4	0

Signal Information																							
Cycle, s	96.0	Reference Phase	2	Green	0.6	1.1	28.9	2.5	8.8	15.2	Yellow	3.0	0.0	12.0	3.0	3.0	3.9	Red	3.0	0.0	2.0	3.0	3.0
Offset, s	0	Reference Point	Begin																				
Uncoordinated	Yes	Simult. Gap E/W	On																				
Force Mode	Fixed	Simult. Gap N/S	On																				

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	1.1	3.0	1.1	3.0	1.1	4.0	1.1	4.0
Phase Duration, s	6.6	42.9	7.7	44.0	23.3	36.9	8.5	22.1
Change Period, ($Y+R_c$), s	6.0	14.0	6.0	14.0	6.0	6.9	6.0	6.9
Max Allow Headway (MAH), s	3.2	4.2	3.2	4.2	3.2	4.3	3.2	4.3
Queue Clearance Time (g_s), s	2.2	16.4	3.1	23.5	16.8	32.0	3.0	2.2
Green Extension Time (g_e), s	0.0	7.0	0.0	6.5	0.5	0.0	0.0	0.3
Phase Call Probability	0.12	1.00	0.33	1.00	1.00	1.00	0.49	0.96
Max Out Probability	0.00	0.04	0.00	0.10	0.00	1.00	0.00	0.00

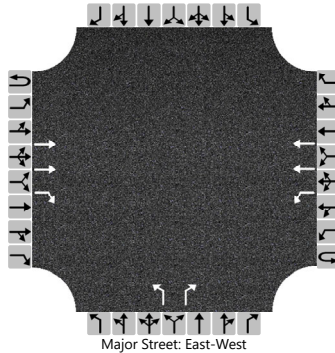
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	5	484	119	15	692	70	302	88		26	0	
Adjusted Saturation Flow Rate (s), veh/h/ln	1641	1367	1414	900	1406	1460	1602	1596		1654	0	
Queue Service Time (g_s), s	0.2	14.4	4.6	1.1	21.5	3.2	14.8	3.9		1.0	0.0	
Cycle Queue Clearance Time (g_c), s	0.2	14.4	4.6	1.1	21.5	3.2	14.8	3.9		1.0	0.0	
Green Ratio (g/C)	0.32	0.30	0.48	0.32	0.31	0.34	0.34	0.31		0.34		
Capacity (c), veh/h	114	824	681	129	879	494	541	499		80		
Volume-to-Capacity Ratio (X)	0.041	0.587	0.174	0.117	0.787	0.141	0.559	0.177		0.319	0.000	
Back of Queue (Q), ft/ln (95 th percentile)												
Back of Queue (Q), veh/ln (95 th percentile)	0.1	7.8	2.3	0.4	11.1	1.8	8.8	2.4		0.7	0.0	
Queue Storage Ratio (RQ) (95 th percentile)	0.01	0.00	0.20	0.04	0.00	0.12	0.46	0.00		0.07	0.00	
Uniform Delay (d_1), s/veh	24.8	28.4	14.1	23.8	30.1	22.1	25.9	24.0		26.0		
Incremental Delay (d_2), s/veh	0.1	0.7	0.1	0.1	1.9	0.1	0.3	0.2		0.8	0.0	
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	24.8	29.1	14.2	23.9	32.0	22.2	26.2	24.2		26.9		
Level of Service (LOS)	C	C	B	C	C	C	C	C		C		
Approach Delay, s/veh / LOS	26.2		C	30.9		C	25.8		C	28.0		C
Intersection Delay, s/veh / LOS	28.2						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.95	B	1.92	B	2.48	B	2.54	C
Bicycle LOS Score / LOS	0.99	A	1.13	A	1.13	A	0.54	A

HCS Two-Way Stop-Control Report

General Information				Site Information			
Analyst	CLH			Intersection	US 2 & Grand Forks Airport		
Agency/Co.	NDDOT			Jurisdiction			
Date Performed	10/26/2023			East/West Street	US 2		
Analysis Year	2043			North/South Street	Grand Forks Airport		
Time Analyzed	AM Peak			Peak Hour Factor	0.86		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2043 AM Offset Tee, West Intersection						

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	0	2	1	0	1	2	0		1	0	1		0	0	0
Configuration			T	R		L	T			L		R				
Volume (veh/h)			420	162	0	18	0			260		96				
Percent Heavy Vehicles (%)					0	59				5		60				
Proportion Time Blocked																
Percent Grade (%)									0							
Right Turn Channelized	No								No							
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1					7.5		6.9			
Critical Headway (sec)						5.28					6.90		8.10			
Base Follow-Up Headway (sec)						2.2					3.5		3.3			
Follow-Up Headway (sec)						2.79					3.55		3.90			

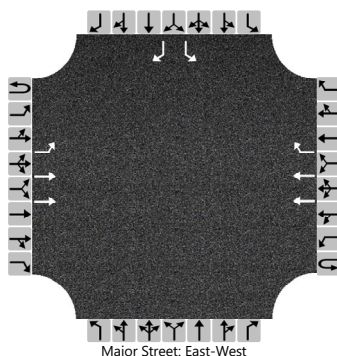
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)					21					302		112				
Capacity, c (veh/h)					615					455		606				
v/c Ratio					0.03					0.66		0.18				
95% Queue Length, Q ₉₅ (veh)					0.1					4.8		0.7				
Control Delay (s/veh)					11.1					27.2		12.3				
Level of Service (LOS)					B					D		B				
Approach Delay (s/veh)					11.1				23.2							
Approach LOS					B				C							

HCS Two-Way Stop-Control Report

General Information				Site Information			
Analyst	CLH			Intersection	US 2 & Grand Forks Airport		
Agency/Co.	NDDOT			Jurisdiction			
Date Performed	10/26/2023			East/West Street	US 2		
Analysis Year	2043			North/South Street	Grand Forks Airport		
Time Analyzed	AM Peak			Peak Hour Factor	0.86		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2043 AM Offset Tee, East Intersection						

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	1	2	0	0	0	2	1		0	0	0		1	0	1
Configuration		L	T				T	R						L		R
Volume (veh/h)	0	43	0				609	90						22		4
Percent Heavy Vehicles (%)	0	2												1		6
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized					No								No			
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.5		6.9
Critical Headway (sec)		4.14												6.82		7.02
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.51		3.36

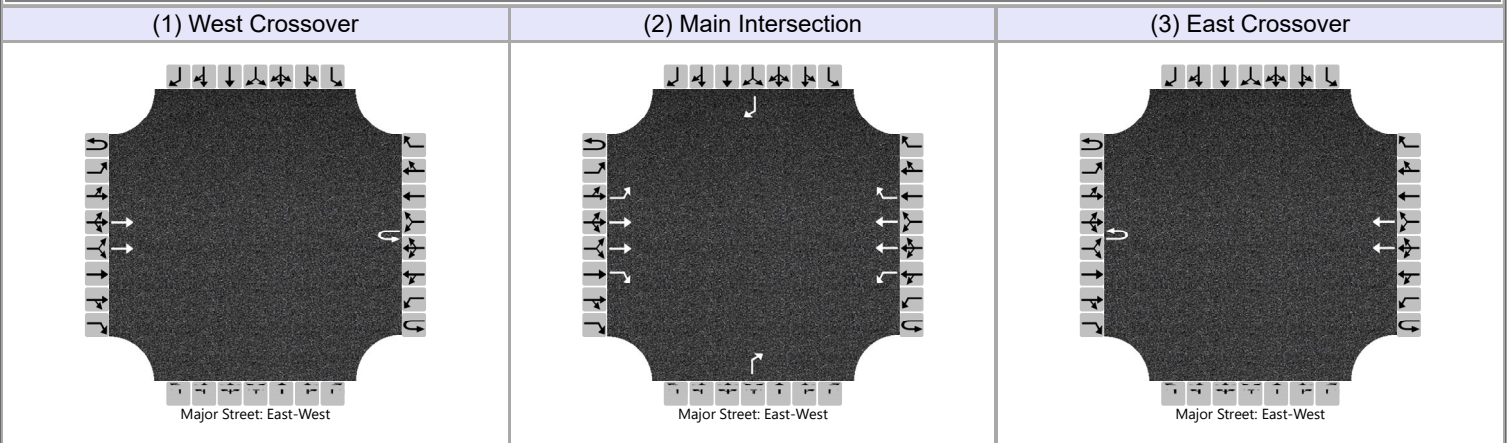
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		50												26		5	
Capacity, c (veh/h)		810												301		631	
v/c Ratio		0.06												0.09		0.01	
95% Queue Length, Q ₉₅ (veh)		0.2												0.3		0.0	
Control Delay (s/veh)		9.7												18.1		10.7	
Level of Service (LOS)		A												C		B	
Approach Delay (s/veh)		9.7												16.9			
Approach LOS		A												C			

HCS Alternative Intersections Results Summary

General Information				Alternative Intersection Information			
Agency	NDDOT			Intersection Type	RCUT with TWSC		
Analyst	CLH	Analysis Date	10/27/2023	Segment One Distance, ft	715		
Jurisdiction		Duration, h	0.25	Segment Two Distance, ft	715		
Intersection	US 2 & Grand Forks Airport	PHF	0.86	Arterial Direction	East-West		
Main Intersection File	2043 AM RCI, Main Intersection.xtw						
West Crossover File	2043 AM RCI, West U-Turn.xtw						
East Crossover File	2043 AM RCI, East U-Turn.xtw						
Project Description	2043 AM RCI, Main Intersection						

Demand	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL	SBT	SBR
Intersection One Demand (v), veh/h			582		26											
Intersection Two Demand (v), veh/h	0	4	438	166	0	13	855	129				356				26
Intersection Three Demand (v), veh/h	299						699									



Queue-to-Storage Ratio	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL	SBT	SBR
Intersection One (R _Q)					0.01											
Intersection Two (R _Q)		0.00				0.01										
Intersection Three (R _Q)	0.16															

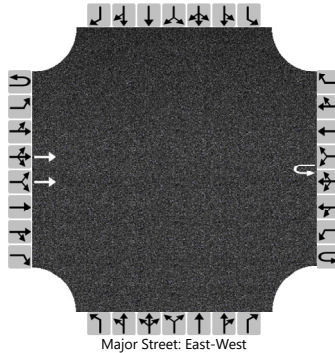
Alternative Intesection Results									
O-D	O-D Movements	Flow Rate (veh/h)	Control Delay (s/veh)	EDTT (s/veh)	ETT (s/veh)	v/c>1?	R _Q >1?	LOS	
EBL	EBL(2)	3	11.0	--	11.0	No	No	B	
EBT	EBT(2)	359	0.0	--	0.0	--	--	A	
EBR	EBR(2)	140	0.0	--	0.0	--	--	A	
WBL	WBL(2)	12	11.2	--	11.2	No	No	B	
WBT	WBT(2)	514	0.0	--	0.0	--	--	A	
WBR	WBR(2)	78	0.0	--	0.0	--	--	A	
NBL	NBR(2) + EBU(3) + WBT(2)	224	32.1	17.7	49.8	No	No	D	
NBT	NBR(2) + EBU(3) + WBR(2)	34	32.1	17.7	49.8	No	No	D	
NBR	NBR(2)	49	16.0	--	16.0	No	No	B	
SBL	SBR(2) + WBU(1) + EBT(2)	19	22.3	17.7	40.0	No	No	D	
SBT	SBR(2) + WBU(1) + EBR(2)	3	22.3	17.7	40.0	No	No	D	
SBR	SBR(2)	0				No	No		

Overall Results	EB		WB		NB		SB	
Approach ETT, s/veh LOS	0.1	A	0.2	A	44.4	D	40.0	D
Intersection ETT, s/veh LOS	10.2				B			

HCS Two-Way Stop-Control Report

General Information				Site Information			
Analyst	CLH			Intersection	US 2 & Grand Forks Airport		
Agency/Co.	NDDOT			Jurisdiction			
Date Performed	10/27/2023			East/West Street	US 2		
Analysis Year	2043			North/South Street	Grand Forks Airport		
Time Analyzed	AM Peak			Peak Hour Factor	0.86		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2043 AM RCI, West U-Turn						

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	0	2	0	1	0	0	0		0	0	0		0	0	0
Configuration			T		U											
Volume (veh/h)			582		26											
Percent Heavy Vehicles (%)					4											
Proportion Time Blocked																
Percent Grade (%)																
Right Turn Channelized																
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)					4.3											
Critical Headway (sec)					4.42											
Base Follow-Up Headway (sec)					2.6											
Follow-Up Headway (sec)					2.61											

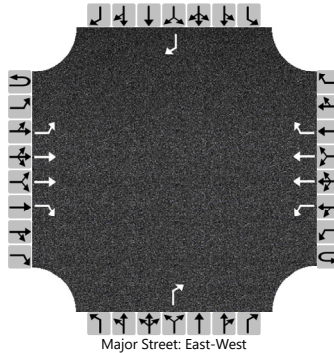
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)					30											
Capacity, c (veh/h)					760											
v/c Ratio					0.04											
95% Queue Length, Q ₉₅ (veh)					0.1											
Control Delay (s/veh)					9.9											
Level of Service (LOS)					A											
Approach Delay (s/veh)					9.9											
Approach LOS					A											

HCS Two-Way Stop-Control Report

General Information				Site Information			
Analyst	CLH			Intersection	US 2 & Grand Forks Airport		
Agency/Co.	NDDOT			Jurisdiction			
Date Performed	10/27/2023			East/West Street	US 2		
Analysis Year	2043			North/South Street	Grand Forks Airport		
Time Analyzed	AM Peak			Peak Hour Factor	0.86		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2043 AM RCI, Main Intersection						

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	1	2	1	0	1	2	1		0	0	1		0	0	1
Configuration		L	T	R		L	T	R				R				R
Volume (veh/h)	0	4	438	166	0	13	855	129				356				26
Percent Heavy Vehicles (%)	0	2			0	59						5				1
Proportion Time Blocked																
Percent Grade (%)									0				0			
Right Turn Channelized	No				No				No				No			
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1						6.9				6.9
Critical Headway (sec)		4.14				5.28						7.00				6.92
Base Follow-Up Headway (sec)		2.2				2.2						3.3				3.3
Follow-Up Headway (sec)		2.22				2.79						3.35				3.31

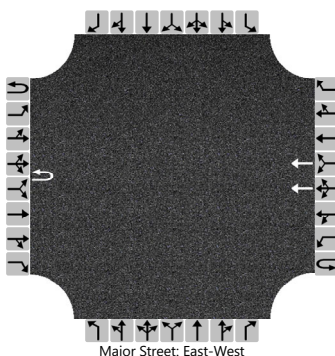
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		5				15						414				30	
Capacity, c (veh/h)		606				597						736				521	
v/c Ratio		0.01				0.03						0.56				0.06	
95% Queue Length, Q ₉₅ (veh)		0.0				0.1						3.5				0.2	
Control Delay (s/veh)		11.0				11.2						16.0				12.3	
Level of Service (LOS)		B				B						C				B	
Approach Delay (s/veh)		0.1				0.1				16.0				12.3			
Approach LOS		A				A				C				B			

HCS Two-Way Stop-Control Report

General Information				Site Information			
Analyst	CLH			Intersection	US 2 & Grand Forks Airport		
Agency/Co.	NDDOT			Jurisdiction			
Date Performed	10/27/2023			East/West Street	US 2		
Analysis Year	2043			North/South Street	Grand Forks Airport		
Time Analyzed	AM Peak			Peak Hour Factor	0.86		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2043 AM RCI, East U-Turn						

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	1	0	0	0	0	0	2	0		0	0	0		0	0	0
Configuration	U						T									
Volume (veh/h)	299						699									
Percent Heavy Vehicles (%)	5															
Proportion Time Blocked																
Percent Grade (%)																
Right Turn Channelized																
Median Type Storage	Undivided															

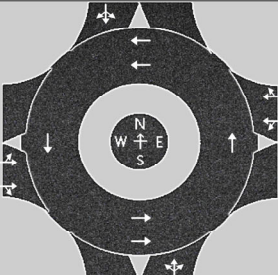
Critical and Follow-up Headways

Base Critical Headway (sec)	4.3															
Critical Headway (sec)	4.44															
Base Follow-Up Headway (sec)	2.6															
Follow-Up Headway (sec)	2.62															

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)	348															
Capacity, c (veh/h)	668															
v/c Ratio	0.52															
95% Queue Length, Q ₉₅ (veh)	3.0															
Control Delay (s/veh)	16.1															
Level of Service (LOS)	C															
Approach Delay (s/veh)	16.1															
Approach LOS	C															

HCS Roundabouts Report

General Information				Site Information				
Analyst	CLH				Intersection	US 2 & Grand Forks Airport		
Agency or Co.	NDDOT				E/W Street Name	US 2		
Date Performed	10/27/2023				N/S Street Name	Grand Forks Airport		
Analysis Year	2043				Analysis Time Period, hrs	0.25		
Time Analyzed	AM Peak				Peak Hour Factor	0.86		
Project Description	2043 AM RAB 2x1				Jurisdiction			

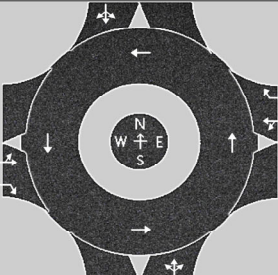
Volume Adjustments and Site Characteristics																
Approach	EB				WB				NB				SB			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	2	0	0	0	2	0	0	0	1	0	0	0	1	0
Lane Assignment	LT		TR		LT		TR		LTR				LTR			
Volume (V), veh/h	0	4	416	162	0	13	595	90	0	260	39	57	0	22	4	0
Percent Heavy Vehicles, %	0	2	23	6	0	59	20	2	0	5	1	60	0	1	1	6
Flow Rate (V _{PCE}), pc/h	0	5	595	200	0	24	830	107	0	317	46	106	0	26	5	0
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				2				2			
Pedestrians Crossing, p/h	0				0				0				0			
Proportion of CAVs	0															

Critical and Follow-Up Headway Adjustment													
Approach	EB			WB			NB			SB			
	Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway, s		4.5436	4.5436		4.5436	4.5436			4.3276			4.3276	
Follow-Up Headway, s		2.5352	2.5352		2.5352	2.5352			2.5352			2.5352	

Flow Computations, Capacity and v/c Ratios													
Approach	EB			WB			NB			SB			
	Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v _e), pc/h		376	424		452	509			469			31	
Entry Volume, veh/h		318	359		381	430			414			31	
Circulating Flow (v _c), pc/h	55			368			626			1171			
Exiting Flow (v _{ex}), pc/h	727			1147			158			229			
Capacity (C _{PCE}), pc/h	1351	1351		1016	1016			834			525		
Capacity (c), veh/h	1144	1144		858	858			736			520		
v/c Ratio (x)	0.28	0.31		0.44	0.50			0.56			0.06		

Delay and Level of Service													
Approach	EB			WB			NB			SB			
	Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		5.7	6.2		9.7	10.8			13.8			7.7	
Lane LOS		A	A		A	B			B			A	
95% Queue, veh		1.1	1.4		2.3	2.9			3.5			0.2	
Approach Delay, s/veh	6.0			10.3			13.8			7.7			
Approach LOS	A			B			B			A			

HCS Roundabouts Report

General Information				Site Information				
Analyst	CLH				Intersection	US 2 & Grand Forks Airport		
Agency or Co.	NDDOT				E/W Street Name	US 2		
Date Performed	10/27/2023				N/S Street Name	Grand Forks Airport		
Analysis Year	2043				Analysis Time Period, hrs	0.25		
Time Analyzed	AM Peak				Peak Hour Factor	0.86		
Project Description	2043 AM RAB 1x1 with RT La...				Jurisdiction			

Volume Adjustments and Site Characteristics																
Approach	EB				WB				NB				SB			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	1	0	0	1	1	0	0	1	0	0	0	1	0
Lane Assignment	LT		R		LT		R		LTR				LTR			
Volume (V), veh/h	0	4	416	162	0	13	595	90	0	260	39	57	0	22	4	0
Percent Heavy Vehicles, %	0	2	23	6	0	59	20	2	0	5	1	60	0	1	1	6
Flow Rate (V _{PCE}), pc/h	0	5	595	200	0	24	830	107	0	317	46	106	0	26	5	0
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			
Proportion of CAVs	0															

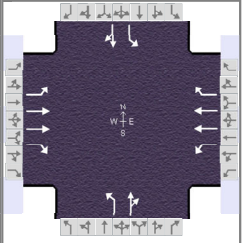
Critical and Follow-Up Headway Adjustment													
Approach	EB			WB			NB			SB			
	Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway, s		4.5436	4.5436		4.5436	4.5436			4.9763			4.9763	
Follow-Up Headway, s		2.5352	2.5352		2.5352	2.5352			2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios														
Approach	EB			WB			NB			SB				
	Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	
Entry Flow (v _e), pc/h		600	200		854	107			469			31		
Entry Volume, veh/h		508	169		721	90			414			31		
Circulating Flow (v _c), pc/h		55			368				626			1171		
Exiting Flow (v _{ex}), pc/h		727			1147				158			229		
Capacity (C _{PCE}), pc/h		1351	1351		1016	1016			729			418		
Capacity (c), veh/h		1144	1144		858	858			643			414		
v/c Ratio (x)		0.44	0.15		0.84	0.11			0.64			0.07		

Delay and Level of Service														
Approach	EB			WB			NB			SB				
	Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	
Lane Control Delay (d), s/veh		7.9	4.4		26.1	5.2			18.4			9.8		
Lane LOS		A	A		D	A			C			A		
95% Queue, veh		2.3	0.5		10.0	0.4			4.7			0.2		
Approach Delay, s/veh		7.0			23.8				18.4			9.8		
Approach LOS		A			C				C			A		

HCS Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	NDDOT			Duration, h	0.250
Analyst	CLH	Analysis Date	Oct 13, 2023	Area Type	Other
Jurisdiction		Time Period	PM Peak	PHF	0.94
Urban Street	US 2	Analysis Year	2023	Analysis Period	1 > 7:00
Intersection	Grand Forks Airport & U...	File Name	2043 PM Peak Ex Geom Signalized.xus		
Project Description	2043 PM Ex Geom Signalized				



Demand Information	EB			WB			NB			SB		
	L	T	R	L	T	R	L	T	R	L	T	R
Approach Movement												
Demand (v), veh/h	8	591	362	67	457	97	190	23	34	139	66	11

Signal Information													
Cycle, s	91.2	Reference Phase	2										
Offset, s	0	Reference Point	Begin										
Uncoordinated	Yes	Simult. Gap E/W	On	Green	1.0	0.8	28.4	8.8	3.4	10.0			
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	3.0	3.0	12.0	3.0	0.0	3.9			
				Red	3.0	3.0	2.0	3.0	0.0	3.0			

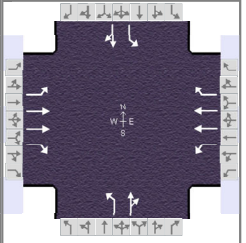
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	2.0	3.0	2.0	3.0	1.1	4.0	1.1	4.0
Phase Duration, s	7.0	42.4	13.8	49.2	18.2	20.3	14.8	16.9
Change Period, ($Y+R_c$), s	6.0	14.0	6.0	14.0	6.0	6.9	6.0	6.9
Max Allow Headway (MAH), s	4.2	4.2	4.2	4.2	3.2	4.2	3.2	4.2
Queue Clearance Time (g_s), s	2.5	20.8	9.2	13.7	12.0	3.9	8.8	6.1
Green Extension Time (g_e), s	0.0	7.6	0.1	8.1	0.2	0.4	0.2	0.4
Phase Call Probability	0.19	1.00	0.84	1.00	0.99	1.00	0.98	1.00
Max Out Probability	0.00	0.11	0.00	0.05	0.01	0.00	0.00	0.00

Movement Group Results	EB			WB			NB			SB		
	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	9	629	321	71	486	71	202	39		148	82	
Adjusted Saturation Flow Rate (s), veh/h/ln	1641	1367	1414	900	1406	1460	1602	1626		1654	1693	
Queue Service Time (g_s), s	0.5	18.8	14.9	7.2	11.7	2.4	10.0	1.9		6.8	4.1	
Cycle Queue Clearance Time (g_c), s	0.5	18.8	14.9	7.2	11.7	2.4	10.0	1.9		6.8	4.1	
Green Ratio (g/C)	0.01	0.31	0.44	0.09	0.39	0.48	0.24	0.15		0.24	0.11	
Capacity (c), veh/h	18	851	629	77	1085	704	336	238		372	185	
Volume-to-Capacity Ratio (X)	0.486	0.739	0.511	0.927	0.448	0.101	0.602	0.165		0.398	0.442	
Back of Queue (Q), ft/ln (95 th percentile)												
Back of Queue (Q), veh/ln (95 th percentile)	0.5	9.5	7.7	3.9	6.2	1.2	6.4	1.3		4.5	3.0	
Queue Storage Ratio (RQ) (95 th percentile)	0.04	0.00	0.68	0.39	0.00	0.08	0.34	0.00		0.45	0.00	
Uniform Delay (d_1), s/veh	44.9	28.1	18.2	41.5	20.8	12.9	30.0	34.1		28.8	38.0	
Incremental Delay (d_2), s/veh	19.3	1.3	0.6	32.3	0.3	0.1	0.6	0.3		0.3	1.7	
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	64.2	29.4	18.9	73.7	21.1	12.9	30.7	34.4		29.0	39.7	
Level of Service (LOS)	E	C	B	E	C	B	C	C		C	D	
Approach Delay, s/veh / LOS	26.2		C	26.1		C	31.3		C	32.8		C
Intersection Delay, s/veh / LOS	27.5						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.95	B	1.91	B	2.49	B	2.54	C
Bicycle LOS Score / LOS	1.28	A	1.01	A	0.89	A	0.87	A

HCS Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	NDDOT			Duration, h	0.250
Analyst	CLH	Analysis Date	Oct 13, 2023	Area Type	Other
Jurisdiction		Time Period	PM Peak	PHF	0.94
Urban Street	US 2	Analysis Year	2023	Analysis Period	1 > 7:00
Intersection	Grand Forks Airport & U...	File Name	2043 PM Peak Rev Geom Signalized.xus		
Project Description	2043 PM Rev Geom Signalized				



Demand Information	EB			WB			NB			SB		
	L	T	R	L	T	R	L	T	R	L	T	R
Approach Movement												
Demand (v), veh/h	8	591	362	67	457	97	190	23	34	139	66	11

Signal Information													
Cycle, s	113.2	Reference Phase	2										
Offset, s	0	Reference Point	Begin										
Uncoordinated	Yes	Simult. Gap E/W	On	Green	1.2	0.3	32.9	9.9	3.0	27.0			
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	3.0	3.0	12.0	3.0	0.0	3.9			
				Red	3.0	3.0	2.0	3.0	0.0	3.0			

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	1.1	3.0	1.1	3.0	1.1	4.0	1.1	4.0
Phase Duration, s	7.2	46.9	13.4	53.2	18.9	36.9	15.9	33.9
Change Period, (Y+R _c), s	6.0	14.0	6.0	14.0	6.0	6.9	6.0	6.9
Max Allow Headway (MAH), s	3.2	4.2	3.2	4.2	3.2	4.2	3.2	4.2
Queue Clearance Time (g _s), s	2.4	26.0	8.3	17.5	12.6	32.0	9.7	6.4
Green Extension Time (g _e), s	0.0	7.0	0.1	7.8	0.4	0.0	0.3	0.4
Phase Call Probability	0.23	1.00	0.89	1.00	1.00	1.00	0.99	1.00
Max Out Probability	0.00	0.19	0.00	0.07	0.00	1.00	0.00	0.00

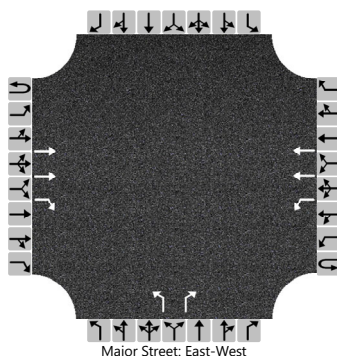
Movement Group Results	EB			WB			NB			SB		
	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (v), veh/h	9	629	321	71	486	71	202	39		148	82	
Adjusted Saturation Flow Rate (s), veh/h/ln	1641	1367	1414	900	1406	1460	1602	1626		1654	1693	
Queue Service Time (g _s), s	0.4	24.0	19.8	6.3	15.5	3.3	10.6	2.1		7.7	4.4	
Cycle Queue Clearance Time (g _c), s	0.4	24.0	19.8	6.3	15.5	3.3	10.6	2.1		7.7	4.4	
Green Ratio (g/C)	0.36	0.29	0.41	0.36	0.35	0.43	0.35	0.27		0.35	0.24	
Capacity (c), veh/h	240	795	573	126	974	633	471	431		177	404	
Volume-to-Capacity Ratio (X)	0.035	0.790	0.561	0.567	0.499	0.113	0.429	0.091		0.838	0.203	
Back of Queue (Q), ft/ln (95 th percentile)												
Back of Queue (Q), veh/ln (95 th percentile)	0.3	12.3	10.3	2.3	8.5	1.9	6.8	1.4		7.6	3.1	
Queue Storage Ratio (RQ) (95 th percentile)	0.02	0.00	0.91	0.23	0.00	0.13	0.36	0.00		0.76	0.00	
Uniform Delay (d ₁), s/veh	24.6	36.9	25.9	28.5	29.2	19.1	27.2	31.3		34.0	34.5	
Incremental Delay (d ₂), s/veh	0.0	2.8	0.9	1.5	0.4	0.1	0.2	0.1		4.0	0.2	
Initial Queue Delay (d ₃), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay (d), s/veh	24.6	39.8	26.8	29.9	29.6	19.1	27.5	31.4		38.1	34.7	
Level of Service (LOS)	C	D	C	C	C	B	C	C		D	C	
Approach Delay, s/veh / LOS	35.3		D	28.5		C	28.1		C	36.9		D
Intersection Delay, s/veh / LOS	32.5						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.96	B	1.93	B	2.49	B	2.54	C
Bicycle LOS Score / LOS	1.28	A	1.01	A	0.89	A	0.87	A

HCS Two-Way Stop-Control Report

General Information				Site Information			
Analyst	CLH			Intersection	US 2 & Grand Forks Airport		
Agency/Co.	NDDOT			Jurisdiction			
Date Performed	10/26/2023			East/West Street	US 2		
Analysis Year	2043			North/South Street	Grand Forks Airport		
Time Analyzed	PM Peak			Peak Hour Factor	0.94		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2043 PM Offset Tee, West Intersection						

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	0	2	1	0	1	2	0		1	0	1		0	0	0
Configuration			T	R		L	T			L		R				
Volume (veh/h)			599	362	0	133	0			190		57				
Percent Heavy Vehicles (%)					0	59				5		60				
Proportion Time Blocked																
Percent Grade (%)									0							
Right Turn Channelized	No								No							
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1					7.5		6.9			
Critical Headway (sec)						5.28					6.90		8.10			
Base Follow-Up Headway (sec)						2.2					3.5		3.3			
Follow-Up Headway (sec)						2.79					3.55		3.90			

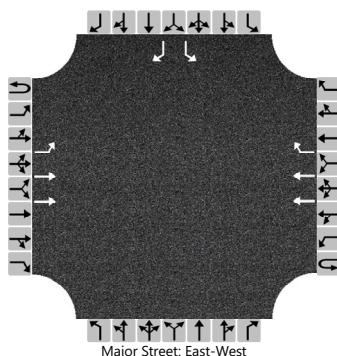
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						141					202		61			
Capacity, c (veh/h)						417					175		533			
v/c Ratio						0.34					1.16		0.11			
95% Queue Length, Q ₉₅ (veh)						1.5					10.6		0.4			
Control Delay (s/veh)						18.0					170.3		12.6			
Level of Service (LOS)						C					F		B			
Approach Delay (s/veh)					18.0				133.9							
Approach LOS					C				F							

HCS Two-Way Stop-Control Report

General Information				Site Information			
Analyst	CLH			Intersection	US 2 & Grand Forks Airport		
Agency/Co.	NDDOT			Jurisdiction			
Date Performed	10/26/2023			East/West Street	US 2		
Analysis Year	2043			North/South Street	Grand Forks Airport		
Time Analyzed	PM Peak			Peak Hour Factor	0.94		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2043 PM Offset Tee, East Intersection						

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	1	2	0	0	0	2	1		0	0	0		1	0	1
Configuration		L	T				T	R						L		R
Volume (veh/h)	0	31	0				524	97						139		77
Percent Heavy Vehicles (%)	0	2												1		6
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized					No								No			
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.5		6.9
Critical Headway (sec)		4.14												6.82		7.02
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.51		3.36

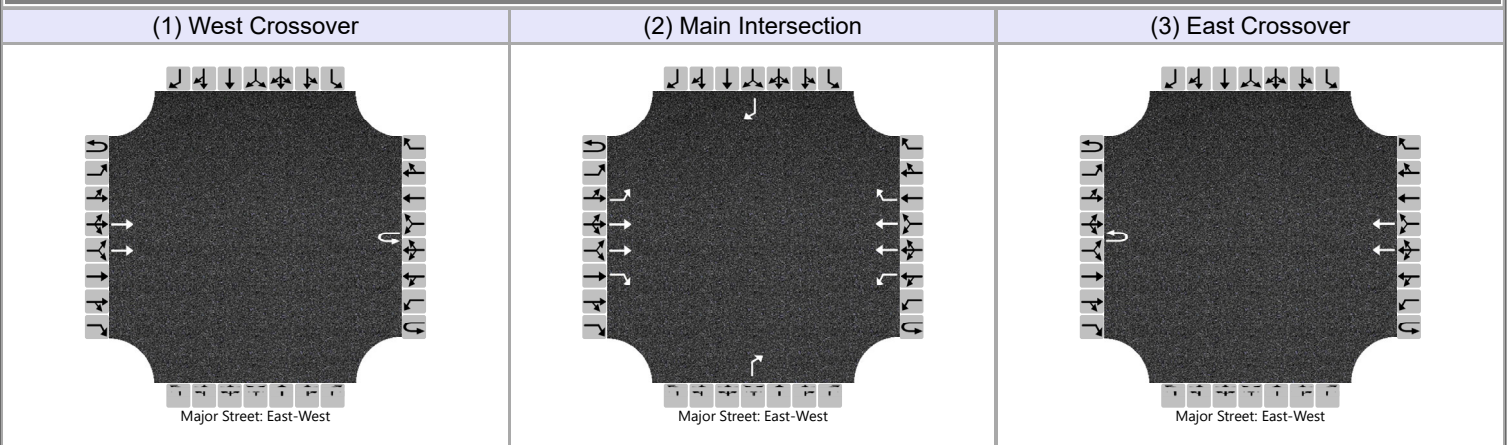
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		33												148		82
Capacity, c (veh/h)		924												405		707
v/c Ratio		0.04												0.36		0.12
95% Queue Length, Q ₉₅ (veh)		0.1												1.6		0.4
Control Delay (s/veh)		9.0												18.9		10.8
Level of Service (LOS)		A												C		B
Approach Delay (s/veh)	9.0												16.0			
Approach LOS	A												C			

HCS Alternative Intersections Results Summary

General Information				Alternative Intersection Information			
Agency	NDDOT			Intersection Type	RCUT with TWSC		
Analyst	CLH	Analysis Date	10/27/2023	Segment One Distance, ft	715		
Jurisdiction		Duration, h	0.25	Segment Two Distance, ft	715		
Intersection	US 2 & Grand Forks Airport	PHF	0.94	Arterial Direction	East-West		
Main Intersection File	2043 PM RCI, Main Intersection.xtw						
West Crossover File	2043 PM RCI, West U-Turn.xtw						
East Crossover File	2043 PM RCI, East U-Turn.xtw						
Project Description	2043 PM RCI, Main Intersection						

Demand	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL	SBT	SBR
Intersection One Demand (v), veh/h			962		205											
Intersection Two Demand (v), veh/h	0	8	730	428	0	67	646	120				246				215
Intersection Three Demand (v), veh/h	213						621									



Queue-to-Storage Ratio	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR	SBU	SBL	SBT	SBR
Intersection One (R _Q)					0.10											
Intersection Two (R _Q)		0.00				0.06										
Intersection Three (R _Q)	0.06															

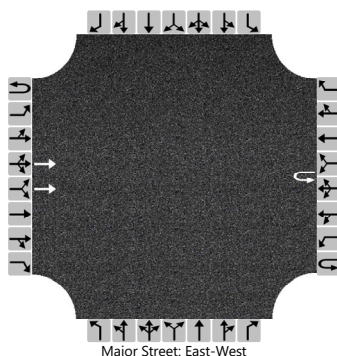
Alternative Intersection Results									
O-D	O-D Movements	Flow Rate (veh/h)	Control Delay (s/veh)	EDTT (s/veh)	ETT (s/veh)	v/c>1?	R _Q >1?	LOS	
EBL	EBL(2)	9	9.5	--	9.5	No	No	A	
EBT	EBT(2)	629	0.0	--	0.0	--	--	A	
EBR	EBR(2)	385	0.0	--	0.0	--	--	A	
WBL	WBL(2)	71	19.0	--	19.0	No	No	B	
WBT	WBT(2)	486	0.0	--	0.0	--	--	A	
WBR	WBR(2)	103	0.0	--	0.0	--	--	A	
NBL	NBR(2) + EBU(3) + WBT(2)	202	27.2	17.7	44.9	No	No	D	
NBT	NBR(2) + EBU(3) + WBR(2)	24	27.2	17.7	44.9	No	No	D	
NBR	NBR(2)	36	15.5	--	15.5	No	No	B	
SBL	SBR(2) + WBU(1) + EBT(2)	148	29.0	17.7	46.7	No	No	D	
SBT	SBR(2) + WBU(1) + EBR(2)	70	29.0	17.7	46.7	No	No	D	
SBR	SBR(2)	12	13.4	--	13.4	No	No	B	

Overall Results	EB		WB		NB		SB	
Approach ETT, s/veh LOS	0.1	A	2.0	A	40.9	D	45.0	D
Intersection ETT, s/veh LOS	10.3				B			

HCS Two-Way Stop-Control Report

General Information				Site Information			
Analyst	CLH			Intersection	US 2 & Grand Forks Airport		
Agency/Co.	NDDOT			Jurisdiction			
Date Performed	10/27/2023			East/West Street	US 2		
Analysis Year	2043			North/South Street	Grand Forks Airport		
Time Analyzed	PM Peak			Peak Hour Factor	0.94		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2043 PM RCI, West U-Turn						

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	0	2	0	1	0	0	0		0	0	0		0	0	0
Configuration			T		U											
Volume (veh/h)			962		205											
Percent Heavy Vehicles (%)					4											
Proportion Time Blocked																
Percent Grade (%)																
Right Turn Channelized																
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)					4.3											
Critical Headway (sec)					4.42											
Base Follow-Up Headway (sec)					2.6											
Follow-Up Headway (sec)					2.61											

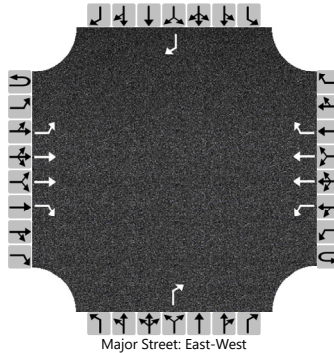
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)					218											
Capacity, c (veh/h)					556											
v/c Ratio					0.39											
95% Queue Length, Q ₉₅ (veh)					1.9											
Control Delay (s/veh)					15.6											
Level of Service (LOS)					C											
Approach Delay (s/veh)					15.6											
Approach LOS					C											

HCS Two-Way Stop-Control Report

General Information				Site Information			
Analyst	CLH			Intersection	US 2 & Grand Forks Airport		
Agency/Co.	NDDOT			Jurisdiction			
Date Performed	10/27/2023			East/West Street	US 2		
Analysis Year	2043			North/South Street	Grand Forks Airport		
Time Analyzed	PM Peak			Peak Hour Factor	0.94		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2043 PM RCI, Main Intersection						

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	0	1	2	1	0	1	2	1		0	0	1		0	0	1
Configuration		L	T	R		L	T	R				R				R
Volume (veh/h)	0	8	730	428	0	67	646	120				246				215
Percent Heavy Vehicles (%)	0	2			0	59						5				1
Proportion Time Blocked																
Percent Grade (%)									0				0			
Right Turn Channelized	No				No				No				No			
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1						6.9				6.9
Critical Headway (sec)		4.14				5.28						7.00				6.92
Base Follow-Up Headway (sec)		2.2				2.2						3.3				3.3
Follow-Up Headway (sec)		2.22				2.79						3.35				3.31

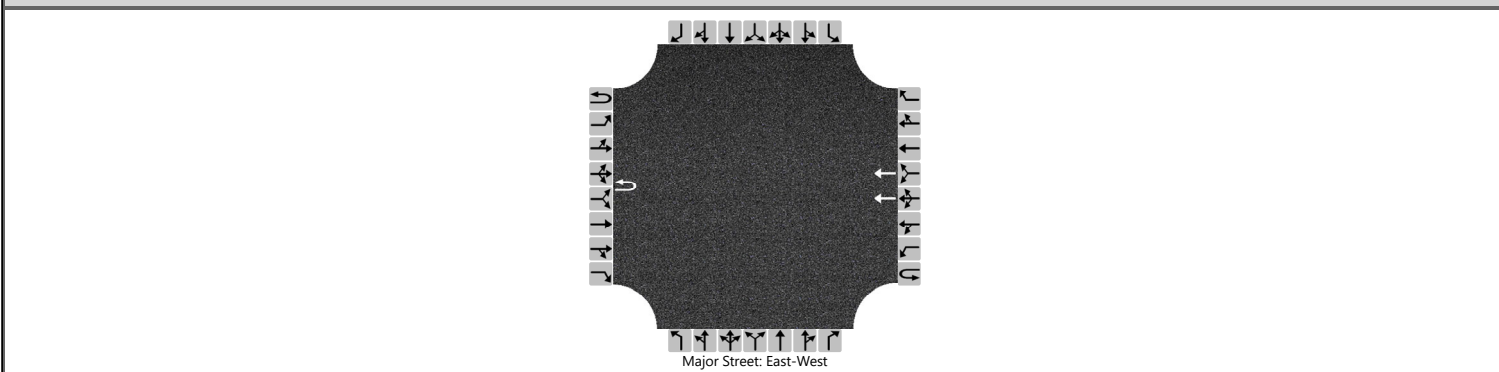
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		9				71						262				229	
Capacity, c (veh/h)		808				329						602				655	
v/c Ratio		0.01				0.22						0.43				0.35	
95% Queue Length, Q ₉₅ (veh)		0.0				0.8						2.2				1.6	
Control Delay (s/veh)		9.5				19.0						15.5				13.4	
Level of Service (LOS)		A				C						C				B	
Approach Delay (s/veh)		0.1				1.5				15.5				13.4			
Approach LOS		A				A				C				B			

HCS Two-Way Stop-Control Report

General Information				Site Information			
Analyst	CLH			Intersection	US 2 & Grand Forks Airport		
Agency/Co.	NDDOT			Jurisdiction			
Date Performed	10/27/2023			East/West Street	US 2		
Analysis Year	2043			North/South Street	Grand Forks Airport		
Time Analyzed	PM Peak			Peak Hour Factor	0.94		
Intersection Orientation	East-West			Analysis Time Period (hrs)	0.25		
Project Description	2043 PM RCI, East U-Turn						

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Movement	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Priority																
Number of Lanes	1	0	0	0	0	0	2	0		0	0	0		0	0	0
Configuration	U						T									
Volume (veh/h)	213						621									
Percent Heavy Vehicles (%)	5															
Proportion Time Blocked																
Percent Grade (%)																
Right Turn Channelized																
Median Type Storage	Undivided															

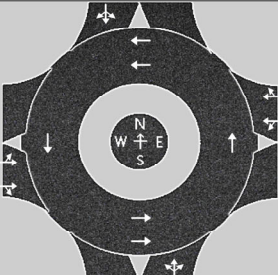
Critical and Follow-up Headways

Base Critical Headway (sec)	4.3															
Critical Headway (sec)	4.44															
Base Follow-Up Headway (sec)	2.6															
Follow-Up Headway (sec)	2.62															

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)	227															
Capacity, c (veh/h)	766															
v/c Ratio	0.30															
95% Queue Length, Q ₉₅ (veh)	1.2															
Control Delay (s/veh)	11.7															
Level of Service (LOS)	B															
Approach Delay (s/veh)	11.7															
Approach LOS	B															

HCS Roundabouts Report

General Information				Site Information			
Analyst	CLH		Intersection	US 2 & Grand Forks Airport			
Agency or Co.	NDDOT		E/W Street Name	US 2			
Date Performed	10/27/2023		N/S Street Name	Grand Forks Airport			
Analysis Year	2043		Analysis Time Period, hrs	0.25			
Time Analyzed	PM Peak		Peak Hour Factor	0.94			
Project Description	2043 PM RAB 2x1		Jurisdiction				

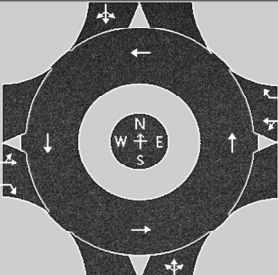
Volume Adjustments and Site Characteristics																
Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	2	0	0	0	2	0	0	0	1	0	0	0	1	0
Lane Assignment	LT		TR		LT		TR		LTR				LTR			
Volume (V), veh/h	0	8	591	362	0	67	457	97	0	190	23	34	0	139	66	11
Percent Heavy Vehicles, %	0	2	23	6	0	59	20	2	0	5	1	60	0	1	1	6
Flow Rate (V _{PCE}), pc/h	0	9	773	408	0	113	583	105	0	212	25	58	0	149	71	12
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				2				2			
Pedestrians Crossing, p/h	0				0				0				0			
Proportion of CAVs	0															

Critical and Follow-Up Headway Adjustment													
Approach	EB			WB			NB			SB			
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	
Critical Headway, s	4.5436	4.5436		4.5436	4.5436			4.3276			4.3276		
Follow-Up Headway, s	2.5352	2.5352		2.5352	2.5352			2.5352			2.5352		

Flow Computations, Capacity and v/c Ratios													
Approach	EB			WB			NB			SB			
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	
Entry Flow (v _e), pc/h	559	631		376	425			295			232		
Entry Volume, veh/h	480	542		310	350			263			229		
Circulating Flow (v _c), pc/h	333			246			931			908			
Exiting Flow (v _e), pc/h	980			807			139			592			
Capacity (C _{PCE}), pc/h	1049	1049		1135	1135			644			656		
Capacity (c), veh/h	901	901		935	935			574			648		
v/c Ratio (x)	0.53	0.60		0.33	0.37			0.46			0.35		

Delay and Level of Service													
Approach	EB			WB			NB			SB			
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	
Lane Control Delay (d), s/veh	11.1	12.8		7.4	8.0			13.8			10.3		
Lane LOS	B	B		A	A			B			B		
95% Queue, veh	3.2	4.1		1.5	1.8			2.4			1.6		
Approach Delay, s/veh	12.0			7.7			13.8			10.3			
Approach LOS	B			A			B			B			

HCS Roundabouts Report

General Information				Site Information			
Analyst	CLH		Intersection	US 2 & Grand Forks Airport			
Agency or Co.	NDDOT		E/W Street Name	US 2			
Date Performed	10/27/2023		N/S Street Name	Grand Forks Airport			
Analysis Year	2043		Analysis Time Period, hrs	0.25			
Time Analyzed	PM Peak		Peak Hour Factor	0.94			
Project Description	2043 PM RAB 1x1 with RT La...		Jurisdiction				

Volume Adjustments and Site Characteristics																
Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	1	0	0	1	1	0	0	1	0	0	0	1	0
Lane Assignment	LT		R		LT		R		LTR				LTR			
Volume (V), veh/h	0	8	591	362	0	67	457	97	0	190	23	34	0	139	66	11
Percent Heavy Vehicles, %	0	2	23	6	0	59	20	2	0	5	1	60	0	1	1	6
Flow Rate (V _{PCE}), pc/h	0	9	773	408	0	113	583	105	0	212	25	58	0	149	71	12
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			
Proportion of CAVs	0															

Critical and Follow-Up Headway Adjustment													
Approach	EB			WB			NB			SB			
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	
Critical Headway, s	4.5436	4.5436		4.5436	4.5436			4.9763			4.9763		
Follow-Up Headway, s	2.5352	2.5352		2.5352	2.5352			2.6087			2.6087		

Flow Computations, Capacity and v/c Ratios													
Approach	EB			WB			NB			SB			
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	
Entry Flow (v _e), pc/h	782	408		696	105			295			232		
Entry Volume, veh/h	672	350		573	86			263			229		
Circulating Flow (v _c), pc/h	333			246			931			908			
Exiting Flow (v _e), pc/h	980			807			139			592			
Capacity (C _{PCE}), pc/h	1049	1049		1135	1135			534			547		
Capacity (c), veh/h	901	901		935	935			476			540		
v/c Ratio (x)	0.75	0.39		0.61	0.09			0.55			0.42		

Delay and Level of Service													
Approach	EB			WB			NB			SB			
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	
Lane Control Delay (d), s/veh	18.4	8.5		12.8	4.7			19.3			13.6		
Lane LOS	C	A		B	A			C			B		
95% Queue, veh	7.1	1.9		4.3	0.3			3.3			2.1		
Approach Delay, s/veh	15.0			11.8			19.3			13.6			
Approach LOS	C			B			C			B			