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2023-12-14
Project: 200068

Nick Gougoulas
Snyders Road (Baden) Development Inc.
91 Caldari Road, Unit 1
Concord ON L4K 3Z9

RE: 1012 SNYDER'S ROAD WEST, BADEN, ON TRANSPORTATION IMPACT STUDY - ADDENDUM LETTER

Snyders Road (Baden) Development Inc. retained Paradigm Transportation Solutions Limited (Paradigm) to undertake a Transportation Impact Study¹ (April 2021 TIS) for their proposed residential developments located in the community of Baden, Township of Wilmot, Ontario.

Since the submission, the Snyders Road (Baden) Development property (West Property) was revised to address comments² from Salvini Consulting. The comments were concerned with proposed site traffic from Activa Holdings Inc (North Property) using the existing residential local roads of Jacob Cressman Drive and Isaac Shantz Drive. Salvini Consulting comments suggested incorporating a collector road connection through both subdivisions to direct traffic to towards Snyder's Road West.

Development Description

The West Property was revised to include a collector road that connects the North Property to Street One. **Figure 1** illustrates the revised concept plan for the West Property. The revised concept plan includes a maximum 407 single detached units, 169 medium density (townhomes and low rise apartments), and an elementary school.

A revised concept for the North Property was not provided and is assumed that the units from the April 2021 TIS remained the same. The only difference is that access to/from the North Property is now via the West Property through Street One, Wagler Avenue, and Street Two. The connections to Jacob Cressman Drive and Isaac Shantz Drive are still proposed, however the primary traffic flow will be directed through the west property.

¹ Paradigm Transportation Solutions Limited, *1012 Snyder's Road West, Baden ON Transportation Impact Study*, (PTSL April 2021).

² Salvini Consulting, *Review of April 2021 TIS for 1012 Snyder's Road West*, (Salvini Consulting: Township of Wilmot, September 16 2021).

Trip Generation

The Institute of Transportation Engineers (ITE) Trip Generation³ methods were used to calculate the site trip generation. The following Land Use Codes (LUC) were used:

- ▶ LUC 210 (Single-Family Detached Housing);
- ▶ LUC 220 (Multifamily Housing, Low-Rise); and
- ▶ LUC 520 (Elementary School).

Regression equation rates were used to calculate the trips generated by the residential uses. Observed rates were used to calculate the trips generated by the Elementary School. The Waterloo Catholic School Board provided observed rates from co-located rural or dispersed urban neighbourhoods. The observed rates show 0.40 trips per student in the AM peak hour and 0.10 trips per student in the PM peak hour.

The Township of Wilmot has recently introduced secondary suites in existing homes. These secondary suites are typically in basements of single detached or semi-detached homes as additional parking is usually provided in the larger driveways. As this is fairly new to the Township, there are no details on the exact number of secondary suites have been permitted and built. Therefore, it was assumed an additional 10 per cent of the single-family lots would be included as secondary suites.

Table 1 summarizes the estimated trip generation. The two development parcels are forecast to generate approximately 647 AM peak hour trips and 708 PM peak hour trips. No reductions for alternative modes of transportation were assumed.

TABLE 1: TRIP GENERATION

ITE Land Use	Units	AM Peak Hour			PM Peak Hour		
		In	Out	Total	In	Out	Total
North Property (Activa)							
210 - Single Family Detached Housing	192	31	89	120	88	52	140
Secondary Suites	19	4	11	15	10	6	16
220 - Multifamily Housing, Low Rise	238	23	74	97	77	46	123
North Property Trip Generation		58	174	232	175	104	279
West Property (Snyders Road (Baden) GP Inc)							
210 - Single Family Detached Housing	407	62	175	237	179	105	284
Secondary Suites	41	8	21	29	21	12	33
220 - Multifamily Housing, Low Rise	169	18	57	75	59	34	93
520 - Elementary School (Students)	250	54	46	100	12	13	25
Internal School Trips	25%	-14	-12	-26	-3	-3	-6
West Property Trip Generation		128	287	415	268	161	429
Net Total Trip Generation		186	461	647	443	265	708

³ Institute of Transportation Engineers, *Trip Generation Manual*, 11th ed., (Washington, DC: ITE, 2021).



The trip assignment is based on the distribution from the April 2021 TIS. The North Property site trip assignment is now via Street One and Wagler Avenue through the West Property.

Figure 2 contains the revised trip assignment for the weekday AM and PM peak hours.

2028 Total Traffic Horizon

Figure 3 contains the 2028 total traffic volumes. The background traffic volumes are the same volumes noted in the April 2021 TIS.

The study area intersection operations analysis for the future total traffic scenario followed the same methodology used for the existing and background traffic conditions. **Table 2** details the level of service conditions.

All study area intersections, including the site accesses are forecast to operate within acceptable levels of service during the AM and PM peak hour with the following critical movements:

- ▶ Snyder's Road at Livingston Boulevard/Foundry Street:
 - Eastbound through/right-turn movement with LOS E and v/c ratio of 1.00 during the AM peak hour
 - Northbound left-turn with queue length exceeding available storage during the AM and PM peak hours
 - Southbound left-turn with queue length exceeding available storage during the AM peak hour.
- ▶ Snyder's Road at Livingston Boulevard:
 - Southbound shared left/right-turn movement with at LOS E with v/c ratio of 0.72 during the AM peak hour. The v/c ratio indicates that while there is delay, there remains excess capacity for this movement.
- ▶ Snyder's Road at Christian Street/Street One:
 - Northbound shared left/through/right-turn movement with LOS E with v/c ratio of 0.06 during the AM peak hour. The v/c ratio indicates that while there is delay, there remains excess capacity for this movement; and
 - Southbound shared left/through/right-turn movement with LOS F and v/c ratio greater than 1.00 during the AM peak hour.

Appendix A contains the supporting detailed Synchro reports.

Response to Comment #4

Snyder's Road West at Street One/Christian Street is forecast to operate with acceptable levels of service with no turning lanes, however, the minor approaches are forecast to operate with poor levels of service and v/c ratios greater than 1.00 during the AM peak hour.



TABLE 2A: 2028 TOTAL TRAFFIC OPERATIONS – AM PEAK HOUR

Analysis Period	Intersection	Control Type	MOE	Direction / Movement / Approach																
				Eastbound				Westbound				Northbound				Southbound				Overall
				Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	
AM Peak Hour	Snyder's Road & Livingston Boulevard / Foundry Street	TCS	LOS Delay V/C Q Ex Avail.	C 24 0.02 5 35 30	E 72 1.00 169	> > > > > >	E 71	< < < < < <	B 18 0.39 53	> > > > > >	B 18	D 36 0.69 73 50 -23	B 17 0.17 25	> > > > > >	C 30	C 22 0.33 40 35 -5	C 23 0.46 69	> > > > > >	C 22	D 40 0.76
	Snyder's Road & Livingston Boulevard	TWSC	LOS Delay V/C Q Ex Avail.	A 9 0.05 1 50 49	A 0 0.29 0	> > > > > >	A 1	> > > > > >	A 0 0.30 0	> > > > > >	A 0	> > > > > >	> > > > > >	> > > > > >	E 42 0.72 41	> > > > > >	> > > > > >	E 42	A 8	
	Snyder's Road & Christian Street / Street One	TWSC	LOS Delay V/C Q Ex Avail.	< < < < < <	A 2 0.08 2	> > > > > >	A 2	< < < < < <	A 0 0.00 0	> > > > > >	A 0	< < < < < <	E 44 0.06 2	> > > > > >	E 44	< < < < < <	F 129 1.12 108	> > > > > >	F 129	D 31
	Wagler Avenue & Livingston Boulevard (East)	TWSC	LOS Delay V/C Q Ex Avail.	B 11 0.25 8	> > > > > >	> > > > > >	B 11	> > > > > >	> > > > > >	> > > > > >	> > > > > >	> > > > > >	A 2 0.02 1	> > > > > >	A 2	> > > > > >	A 0 0.15 0	> > > > > >	A 0	A 4
	Wagler Avenue & Livingston Boulevard (West)	TWSC	LOS Delay V/C Q Ex Avail.	< < < < < <	B 13 0.33 11	> > > > > >	B 13	< < < < < <	B 12 0.05 1	> > > > > >	B 12	< < < < < <	A 3 0.02 1	> > > > > >	A 3	< < < < < <	A 0 0.00 0	> > > > > >	A 0	A 8
	Wagler Avenue & Hunsberger Drive / McFadyen Street	TWSC	LOS Delay V/C Q Ex Avail.	< < < < < <	B 11 0.19 6	> > > > > >	B 11	< < < < < <	B 11 0.07 2	> > > > > >	B 11	< < < < < <	A 0 0.00 0	> > > > > >	A 0	< < < < < <	A 5 0.03 1	> > > > > >	A 5	A 9

MOE - Measure of Effectiveness

LOS - Level of Service

Delay - Average Delay per Vehicle in Seconds

Q - 95th Percentile Queue Length (m)

Ex. - Existing Available Storage (m)

Avail. - Available Storage (m)

TCS - Traffic Control Signal

TWSC - Two-Way Stop Control

< - Shared Left-turn

> - Shared Right-turn



TABLE 2B: 2028 TOTAL TRAFFIC OPERATIONS – PM PEAK HOUR

Analysis Period	Intersection	Control Type	MOE	Direction / Movement / Approach																
				Eastbound				Westbound				Northbound				Southbound				Overall
				Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	
PM Peak Hour	Snyder's Road & Livingston Boulevard / Foundry Street	TCS	LOS Delay V/C Q Ex Avail.	B 19 0.04 6 35 29	C 23 0.52 67 > >	> > > > > >	C 23	< < < < < <	B 18 0.67 105 > >	> > > > > >	B 18	D 38 0.70 79 50 -29	C 25 0.42 55 > >	> > > > > >	C 32	C 25 0.24 23 35 12	C 21 0.24 31 > >	> > > > > >	C 22	C 25 0.75
	Snyder's Road & Livingston Boulevard	TWSC	LOS Delay V/C Q Ex Avail.	A 10 0.09 2 50 48	A 0 0.19 0 > >	> > > > > >	A 2	> > > > > >	A 0	> > > > > >	A 0	> > > > > >	> > > > > >	> > > > > >	> > > > > >	D 27 0.40 15 > >	> > > > > >	D 27	A 3	
	Snyder's Road & Christian Street / Street One	TWSC	LOS Delay V/C Q Ex Avail.	< < < < < <	A 4 0.13 4 > >	> > > > > >	A 4	< < < < < <	A 0 0.00 0 > >	> > > > > >	A 0	< < < < < <	D 27 0.05 1 > >	> > > > > >	D 27	< < < < < <	D 34 0.63 32 > >	> > > > > >	D 34	A 7
	Wagler Avenue & Livingston Boulevard (East)	TWSC	LOS Delay V/C Q Ex Avail.	A 10 0.08 2 > >	> > > > > >	> > > > > >	A 10	> > > > > >	> > > > > >	> > > > > >	> > > > > >	> > > > > >	A 2 0.05 1 > >	> > > > > >	A 2	> > > > > >	A 0 0.07 0 > >	> > > > > >	A 0	A 3
	Wagler Avenue & Livingston Boulevard (West)	TWSC	LOS Delay V/C Q Ex Avail.	< < < < < <	B 11 0.15 4 > >	> > > > > >	B 11	< < < < < <	B 12 0.12 3 > >	> > > > > >	B 12	< < < < < <	A 5 0.08 2 > >	> > > > > >	A 5	< < < < < <	A 0 0.00 0 > >	> > > > > >	A 0	A 7
	Wagler Avenue & Hunsberger Drive / McFadyen Street	TWSC	LOS Delay V/C Q Ex Avail.	< < < < < <	A 10 0.08 2 > >	> > > > > >	A 10	< < < < < <	A 10 0.17 4 > >	> > > > > >	A 10	< < < < < <	A 0 0.00 0 > >	> > > > > >	A 0	< < < < < <	A 4 0.01 0 > >	> > > > > >	A 4	A 8

MOE - Measure of Effectiveness
LOS - Level of Service
Delay - Average Delay per Vehicle in Seconds
Q - 95th Percentile Queue Length (m)
Ex. - Existing Available Storage (m)
Avail. - Available Storage (m)
TCS - Traffic Control Signal
TWSC - Two-Way Stop Control
< - Shared Left-turn
> - Shared Right-turn



Future Daily Traffic Volumes

Table 3 shows the forecast future daily traffic volumes on the local roads in the study area. The daily volumes were derived from the PM peak hour traffic volumes shown in **Figure 3**. PM peak hour volumes were assumed to be 10 per cent of total daily traffic.

With the forecast background traffic growth and the introduction of the site generated traffic, several sections of the local road network exceed the Transportation Association of Canada (TAC) local road threshold of 1,000 vehicles per day including:

- ▶ Livingston Boulevard between Snyder's Road West and Wagler Avenue with daily vehicles ranging from 430 to 3,920 over the TAC threshold. Site generated traffic accounts for approximately 32% to 79% of the excess volume
- ▶ Wagler Avenue between Livingston Boulevard and Hunsberger Drive with daily vehicles ranging from 1,390 to 1,930 over the TAC threshold. Site generated traffic accounts for approximately 83% to 120% of the excess volumes; and
- ▶ Street One from Snyder's Road West is forecast to have daily traffic volumes of approximately 4,500 vehicles per day which meets TAC residential collector road volume thresholds.

In an ideal road system, public lanes connect with local roads, local roads with collectors, collectors with arterials, and arterials with expressways and freeways. The TAC definition for a residential collector road⁴ is a road on which traffic movement and access have similar importance, less than 8,000 vehicles per day, and provides for traffic from local roads to access arterial roads and vice versa. Based on this criteria, Livingston Boulevard can be considered to operate as a collector road as it provides connection to Snyder's Road from the various Townships roads and will have up to 6,150 forecast daily traffic volumes.

⁴ Transportation Association of Canada, Geometric Design Guide for Canadian Roads, June 2017, Table 2.6.5: Characteristics of Urban Roads



TABLE 3: FUTURE DAILY TRAFFIC VOLUMES

Road Section		Two-Way Daily Traffic			
From	To	2020 Existing	2028 Background	Site Generated	2028 Total
Livingston Boulevard (East)					
Snyder's Road	Wagler Avenue	3,250	3,650	1,270	4,920
Livingston Boulevard (West)					
Snyder's Road	Wagler Avenue	960	1,090	340	1,430
Wagler Avenue					
Livingston Boulevard (East)	Livingston Boulevard (West)	640	720	1,670	2,390
Livingston Boulevard	Hunsberger Drive	1,170	1,320	1,610	2,930
Street One					
Snyder's Road	Wagler Avenue	-	-	4,500	4,500

Left-Turn Lane Warrants

The Ministry of Transportation's Design Supplement for the Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads⁵ provides guidance on the assessment and/or need for auxiliary left-turn lanes.

The warrants have been completed for:

- ▶ Snyder's Road West and Christian Street/Street One (eastbound);
- ▶ Livingston Boulevard at Wagler Avenue (West), and
- ▶ Livingston Boulevard at Wagler Avenue (East).

Response to Comment #1

A design speed of 50 km/h (equal to the posted speed limit as requested by the Region of Waterloo) has been used for the analysis purposes. **Table 4** summarizes the left-turn lane warrants.

The warrant analysis suggests that an eastbound left-turn lane with 25 metres of storage is warranted on Snyder's Road West at Christian Street/Street One. Left-turn lanes are not warranted on the Livingston Boulevard intersections with Wagler Avenue.

Appendix B contains the left-turn lane warrant nomographs.

⁵ Ontario Ministry of Transportation, *MTO Design Supplement for TAC Geometric Design Guide for Canadian Roads*, (Toronto: Queen's Printer for Ontario, 2020).



TABLE 4: LEFT-TURN LANE WARRANT SUMMARY

Roadway	Snyder's Road West		Livingston Boulevard (West)				Livingston Boulevard (East)			
Intersection	Street One		Wagler Avenue				Wagler Avenue			
Approach Direction	Eastbound		Northbound				Northbound			
Design Speed	50 km/h		50 km/h				50 km/h			
Horizon	Total 2028		Background 2028		Total 2028		Background 2028		Total 2028	
Peak Hour	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Advancing Volume	514	429	89	130	108	194	112	246	124	272
Opposing Volumes	564	616	106	34	106	34	254	114	254	114
Left Turning Traffic	82	128	16	60	35	124	14	48	26	74
% of Left Turning Traffic	16%	30%	18%	46%	32%	64%	13%	20%	21%	27%
Figure Used*	9A-3	9A-4	9A-3	9A-5	9A-4	9A-5	9A-3	9A-3	9A-3	9A-4
Warranted	Yes	Yes	No	No	No	No	No	No	No	No
Storage Length Required	25m	25m	-	-	-	-	-	-	-	-

Based on MTO Design Supplement for TAC Geometric Design Guide for Canadian Roads - June 2017

The *Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads, June 2017* was referenced, specifically Chapter 9 – Intersections, Section 9.17 Left-Turn Lanes.

The approach and departure taper ratio for a design speed of 60 km/h is 15:1 – 36:1 and a horizontal curve to smooth taper radius of 750 metres.

Assuming a lane width of 3.5 metres, the approach and departure taper requires a taper length of 55 metres (using the 15:1 ratio).

Traffic Control Improvements

The traffic analysis indicates that traffic control improvements may be required to accommodate forecast traffic volumes at Snyder's Road West and Christian Street/Street One.

Traffic signal warrants was assessed using the Ontario Traffic Manual (OTM Book 12 – Justification 7) procedures⁶. **Appendix C** contains the detailed analysis. **Table 5** summarizes the results. It indicates that traffic control signals are not justified at the intersection of Snyder's Road West and Snyder's Road West and Christian Street/Street One.

⁶ Ontario Ministry of Transportation, *Ontario Traffic Manual Book 12: Traffic Signals*, (Toronto: Queen's Printer for Ontario, 2012).



TABLE 5: TRAFFIC SIGNAL WARRANT SUMMARY

Intersection	Horizon Year	OTM Warrants					
		1A	1B	2A	2B	120%	150%
Snyder's Road West & Livingston Boulevard	2028 Total	128%	45%	111%	90%	No	No
Snyder's Road West & Christian Street/Street One	2028 Total	139%	112%	111%	120%	No	No

As traffic volumes increase over time, actual traffic volumes may satisfy the minimum warrant criteria post 2028 horizon year. It is recommended that the Region of Waterloo and Township of Wilmot monitor the future traffic volumes to ensure appropriate forms of traffic control are in place.

Street One Analysis

Analysis of Street One was conducted for the Total Traffic 2028 horizon year for the following intersections and traffic control:

- ▶ Snyder's Road West and Christian Street/Street One (unwarranted traffic signal)
- ▶ Street One and Wagler Avenue (stop-control on Wagler Avenue)
- ▶ Street One and Street Seven (all-way stop control); and
- ▶ Street One and Street Two (traffic circle).

Figure 5 shows the forecast 2028 total traffic volumes along Street One for the weekday AM and PM peak hours.

The study area intersection operations analysis for the Street One future total traffic scenario followed the same methodology used for the 2028 total traffic conditions. **Table 6** details the level of service conditions.

All study area intersections are forecast to operate within acceptable levels of service during the AM and PM peak hour with no specific problem movements. The southbound 95th percentile queue reach on Street One at Snyder's Road West is forecast at 45 metres during the AM peak hour and 21 metres during the PM peak hour.

Appendix D contains the supporting detailed Synchro reports.



TABLE 6: 2028 TOTAL TRAFFIC STREET ONE OPERATIONS

Analysis Period	Intersection	Control Type	MOE	Direction / Movement / Approach																
				Eastbound				Westbound				Northbound				Southbound				Overall
				Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	
AM Peak Hour	Snyder's Road & Christian Street / Street One	TCS	LOS Delay V/C Q Ex Avail.	< 21 < 0.79 < 96 < >	C 21	< 17 < 0.75 < 81 < >	B 17	< 0 < 0.01 < 0 < >	A 0	< 18 < 0.32 < 45 < >	B 18	B 15 0.71								
	Street One & Wagler Avenue	TWSC	LOS Delay V/C Q Ex Avail.	< 10 < 0.04 < 1 < >	A 10	< 14 < 0.07 < 2 < >	B 14	< 1 < 0.02 < 0 < >	A 1	< 2 < 0.06 < 2 < >	A 2	A 3								
	Street One & Street Seven	AWSC	LOS Delay V/C Q Ex Avail.	< 7 < 0.03 < >	A 7	< 8 < 0.04 < >	A 8	< 8 < 0.12 < >	A 8	< 9 < 0.35 < >	A 9	A 9								
	Street One & Street Two	RDBT	LOS Delay V/C Q Ex Avail.	< >	A 4 0.04 0	< >	A 4 0.12 0	< >	A 3 0.06 0	< >	A 4 0.09 0	A 4								
PM Peak Hour	Snyder's Road & Christian Street / Street One	TCS	LOS Delay V/C Q Ex Avail.	< 13 < 0.65 < 62 < >	B 13	< 12 < 0.70 < 79 < >	B 12	< 0 < 0.02 < 0 < >	A 0	< 12 < 0.49 < 21 < >	B 12	B 10 0.58								
	Street One & Wagler Avenue	TWSC	LOS Delay V/C Q Ex Avail.	< 9 < 0.02 < 1 < >	A 9	< 14 < 0.18 < 5 < >	B 14	< 1 < 0.02 < 1 < >	A 1	< 2 < 0.03 < 1 < >	A 2	A 3								
	Street One & Street Seven	AWSC	LOS Delay V/C Q Ex Avail.	< 7 < 0.01 < >	A 7	< 8 < 0.02 < >	A 8	< 9 < 0.28 < >	A 9	< 8 < 0.17 < >	A 8	A 9								
	Street One & Street Two	RDBT	LOS Delay V/C Q Ex Avail.	< >	A 3 0.01 0	< >	A 4 0.11 0	< >	A 4 0.12 0	< >	A 4 0.06 0	A 4								

MOE - Measure of Effectiveness
LOS - Level of Service
Delay - Average Delay per Vehicle in Seconds

Q - 95th Percentile Queue Length (m)
Ex. - Existing Available Storage (m)
Avail. - Available Storage (m)

TCS - Traffic Control Signal
TWSC - Two-Way Stop Control
RDBT - Roundabout

AWSC - All-Way Stop Control
< - Shared Left-turn
> - Shared Right-turn



Future Development

As noted in the April 2021 TIS, analysis was conducted based on the future lands within the Countryside Line. No changes to expected unit count and trip generation from the April 2021 TIS were made. Only the traffic assignment to the future development site traffic to Street One was included.

Figure 4 illustrates the 2033 future traffic volumes. With PM peak hour volumes assumed to be 10 per cent of total daily traffic, the future development would include an additional 3,710 daily trips to Street One.

The traffic operations along the Snyder's Road West intersections are forecast to be worse. However, the traffic signals at Snyder's Road West and Christian Street/Street One are likely to be warranted with this increase.

Transportation studies will be required to be updated as part of the application process for these future lands.

Roundabout Screening Tool

Response to Comment #2

A Region of Waterloo Roundabout Feasibility Initial Screening was completed for the intersection of Snyder's Road West and Christian Street/Street One. The screening tool indicates that the 20-year life cycle cost comparison is greater for the addition of auxiliary turn lanes than a roundabout. Therefore, it is recommended to proceed to an Intersection Control Study at Snyder's Road West and Christian Street/Street One. **Table 7** shows the 20-year life cycle cost. **Appendix E** contains the roundabout screening tool.

TABLE 7: 20-YEAR LIFE-CYCLE COST COMPARISON

20-Year Life-Cycle Cost Comparison		
Cost Item	Turn Lanes	Roundabout
Implementation Cost	\$400,000 (EB & WB LT Lanes)	\$900,000
Injury Collision Cost (Present Value)	\$1,038,624	\$273,820
Total Life Cycle Cost	\$1,438,624	\$1,173,820

Traffic Calming

Careful consideration was given through the design process for appropriate pedestrian links within the subdivision and connecting to the adjacent, existing development. The design was



further reviewed with the project team to determine how best to direct traffic away from the existing community while promoting safe active links.

Various road users, including pedestrians, cyclists, automobiles, transit, trucks, and service vehicles, are intended to co-exist in relative safety and harmony on urban residential roads. When problems related to high traffic speeds, high traffic volumes, poor roadway geometry, poor traffic operations, or any combination of these characteristics are experienced, residential streets are no longer perceived as being pleasant or safe for all road uses (e.g. pedestrians, cyclists, and even drivers). A solution to mitigate these poor characteristics is traffic calming.

Traffic calming is a contentious subject and should be dealt with in a clear, concise, and transparent process that should meet the needs and expectations of the community. This section outlines several measures that could be implemented along the study area roadways, however if measures are implemented, they should be initiated and implemented based on consultation with the community.

The implementation of traffic calming should be well designed to minimize the inconvenience to local services such as garbage collection, snow ploughing, emergency services, and residents. There is also value in adding traffic calming measures incrementally to respond to local traffic issues while mitigating the creation of excess “nuisance” to community travel. The following outlines measures that could be considered:

- ▶ **Narrowing**, decreases the overall width of the road and serves as a visual cue to drivers that they are entering a neighbourhood street or area. When used in this way the narrowing is called a ‘gateway’ to minor streets
- ▶ **Corner Extension/Bulb-Out**, the horizontal extension of the sidewalk into the street results in a narrower roadway section. An effective method for narrowing pedestrian crossing distances and increase pedestrian visibility. Can also facilitate midblock crossing (known as a ‘choker’) to add public space and facilitate midblock pedestrian crossings on low-volume streets.
- ▶ **Radar Speed Signs**, to slow vehicles down by making drivers aware they are driving at speeds above the posted speed limits.
- ▶ **Pavement Treatments**, special pavement textures (cobblestones, bricks, etc.) and markings to designate special areas.
- ▶ **Pedestrian Crossover**, where a crossing that is not signalized exists, such as to get to parks or schools, a pedestrian crossover can be used to satisfy a desired line. Pedestrian crossovers can be raised to meet sidewalk height to slow vehicles down and increase safety and accessibility for pedestrians. Variation of signage, signals and line painting can increase visibility of pedestrians to drivers.
- ▶ **On-Street Parking**, the allocation of paved roadway space to parking of vehicles. It narrows the road travel lanes and increases side friction to traffic flow. On-street parking can either be parallel or angled, but parallel is generally preferred for maximized speed reduction.



- ▶ **Tighter Corner Radii** affects traffic turning speeds. A tighter radius forces a driver to reduce speed. It is particularly helpful for intersections with high pedestrian traffic.
- ▶ **Rumble Strips**, low bumps or grooves cut into the pavement that make a noise when driven over. Useful in approaching stop signs and marking edge of pavement. Not typically used in residential neighbourhoods due to noise they create.
- ▶ **Perceptual Design Features**, patterns painted onto road surfaces and other perceptual design features that encourage drivers to reduce their speeds.
- ▶ **Street Trees**, planting trees along a street to create a sense of enclosure and improve the pedestrian environment.
- ▶ **Neotraditional Street Design**, narrower lanes, shorter blocks, T-intersections, and other design features to control traffic speed and volumes.
- ▶ **Roadway Striping**, painting roadway markings that narrow traffic lanes and encourage lower traffic speeds.

The concept plans have been designed to facilitate safe pedestrian connectivity throughout as well as directing new traffic away from the established residential community. **Figure 6** illustrates the pedestrian sidewalks as well as the areas with raised pedestrian crossings and refuges.

Response to Comment #3

Currently, the only controlled pedestrian crossing of Synder's Road West is at the signalized intersection of Foundry Street/Livingston Boulevard. With an existing public school and proposed public school on the north side of Synder's Road West, there is potential for increased pedestrian crossings. With unwarranted traffic control signals being recommended at Synder's Road West and Christian Street/Street One, this would provide a second controlled pedestrian crossing, which will provide direct access to the proposed school via Street One.

Any existing speeding concerns can be address by Township staff through traffic calming measures with public engagement to determine the most appropriate measures to implement.

Any traffic calming measures internal to the new subdivisions should be addressed through detailed engineering design and consider safer pedestrian crossings in the vicinity of the proposed school.

Conclusions

With the site generated traffic from the Activa Holdings Inc. (North Property) being assigned through the Snyders Road (Baden) Development Inc. (West Property) via Street One, the intersection of Snyder's Road West and Christian Street/Street One will experience increased delays and capacity constraints during the AM peak hour than what was previously reported. In the TIS, the traffic from the North Property was distributed through the existing development.



An eastbound left-turn lane with 25 metres of storage is warranted on Snyder's Road West and Christian Street/Street One.

Traffic signals at Snyder's Road West and Christian Street/Street One are close to being warranted under 2028 total traffic conditions. With the inclusion of additional site traffic from the future developable lands, traffic signals are likely to be warranted.

It is recommended that The Region of Waterloo and Township of Wilmot monitor the future traffic volumes on Snyder's Road West to ensure appropriate forms of traffic control (traffic signals or roundabout) are in place.

Any traffic calming measures internal to the new subdivisions should be addressed through detailed engineering design and consider safer pedestrian crossings in the vicinity of the proposed school.

It is further recommended that transportation studies be updated as comprehensive development plans become available for the surrounding area.

We trust that this response is sufficient at this time. Please feel free to contact me should you have any questions.

Yours very truly,

PARADIGM TRANSPORTATION SOLUTIONS LIMITED



Erica Bayley

P.Eng.

Senior Project Manager, Associate



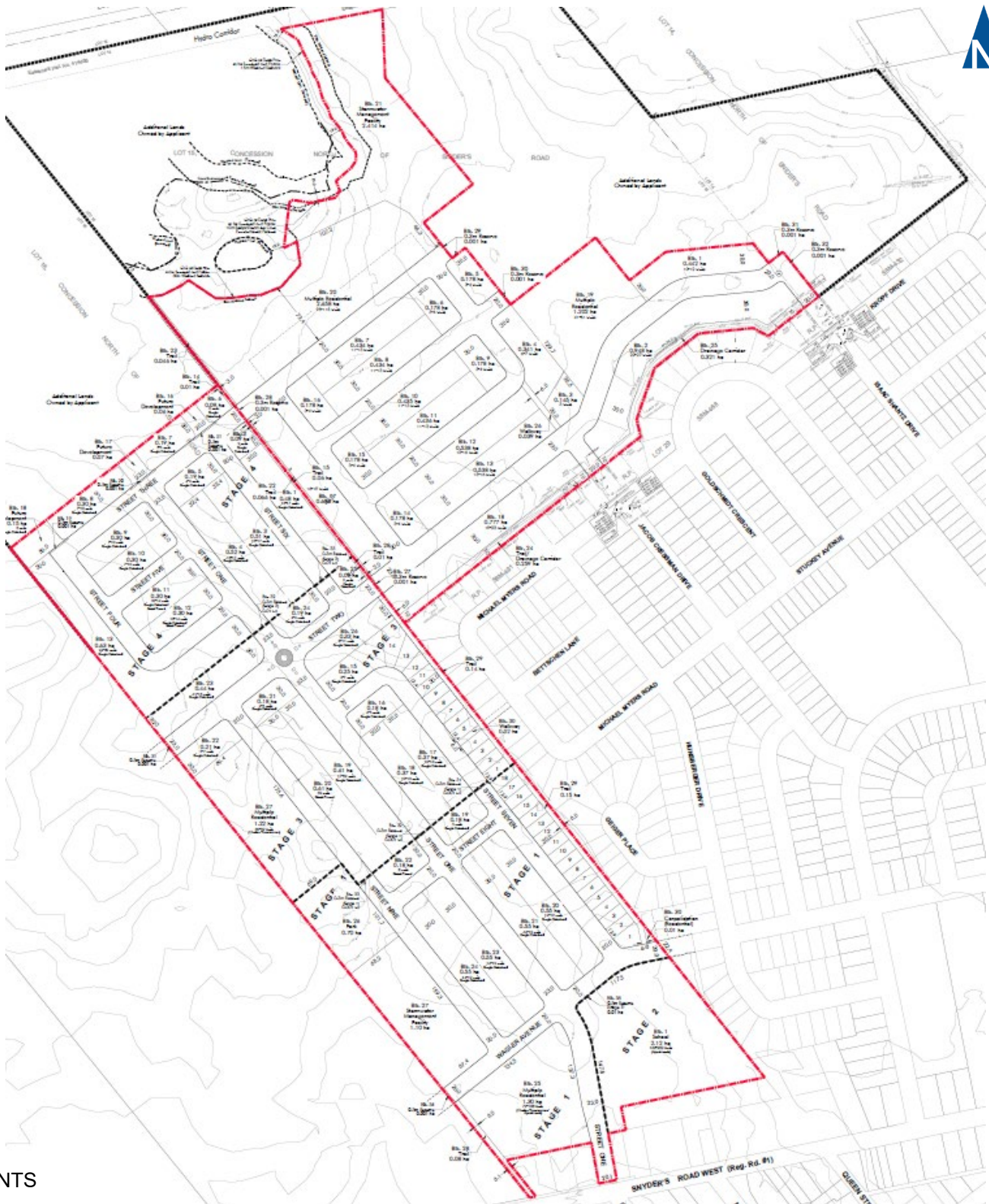
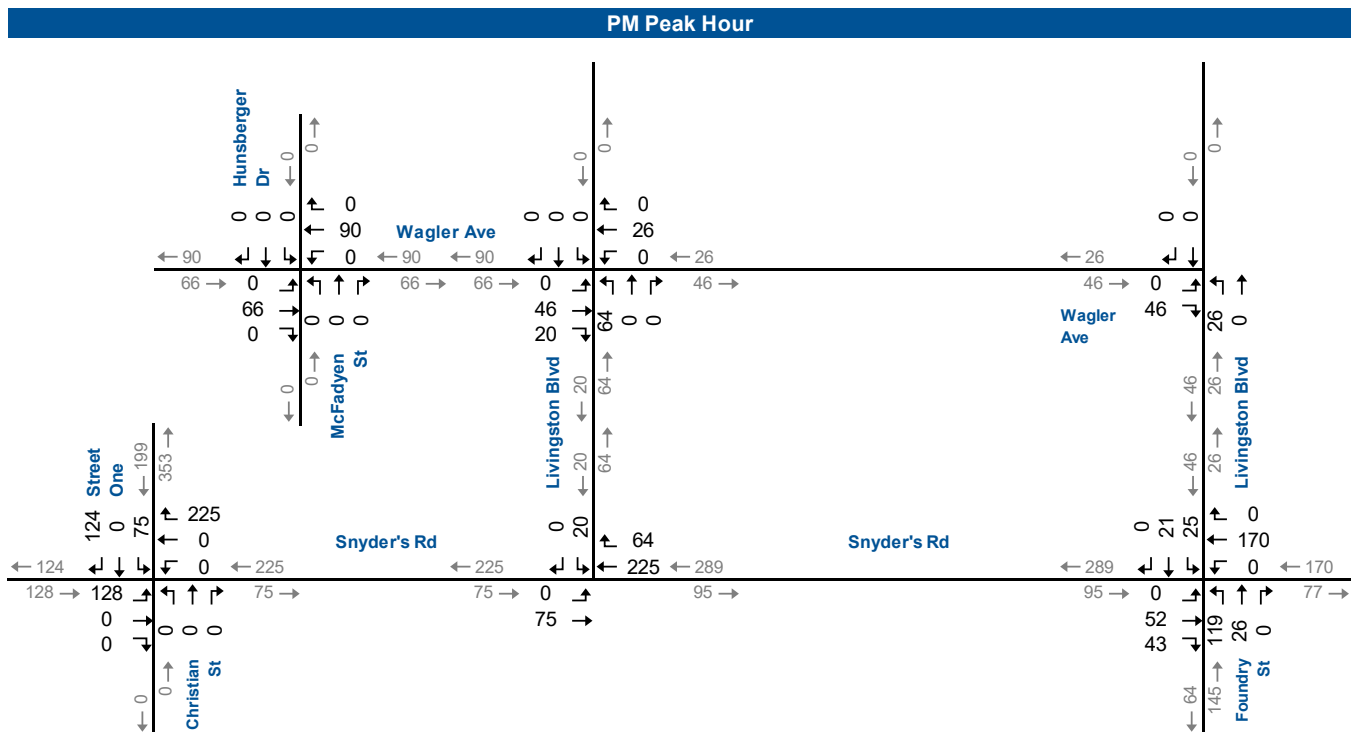
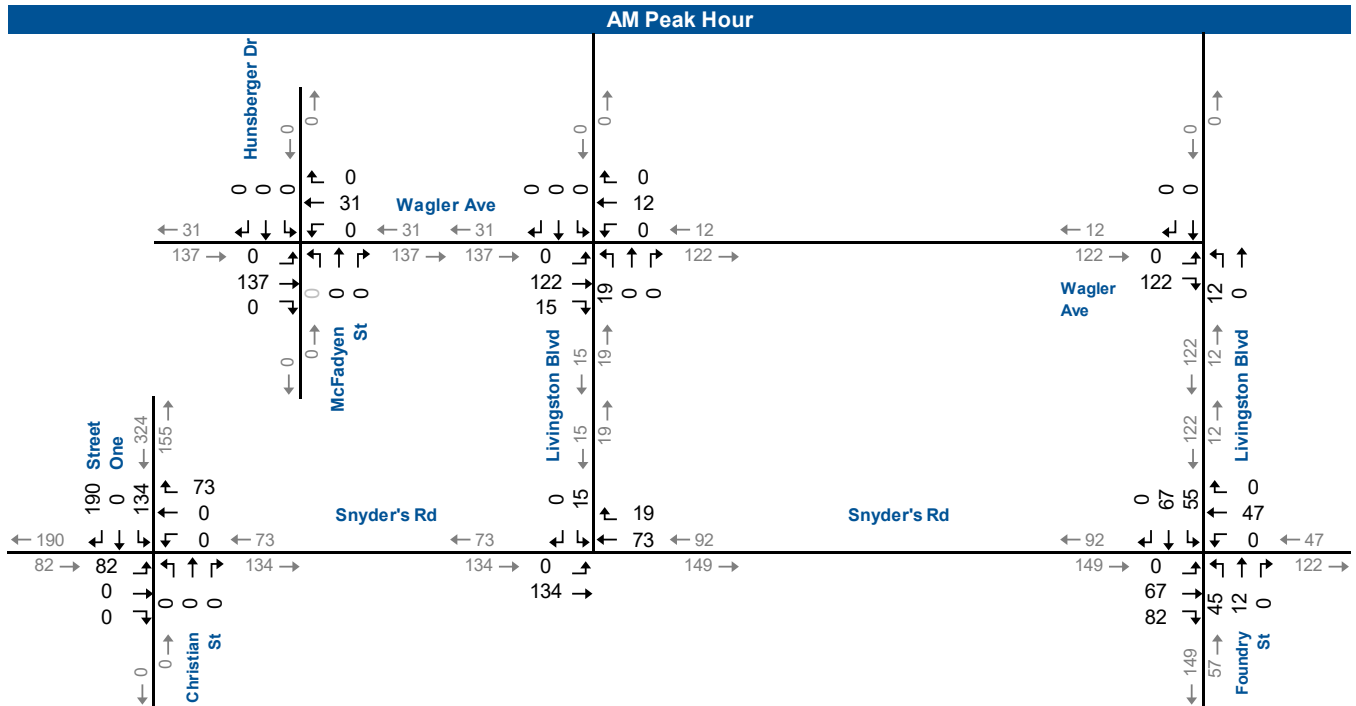
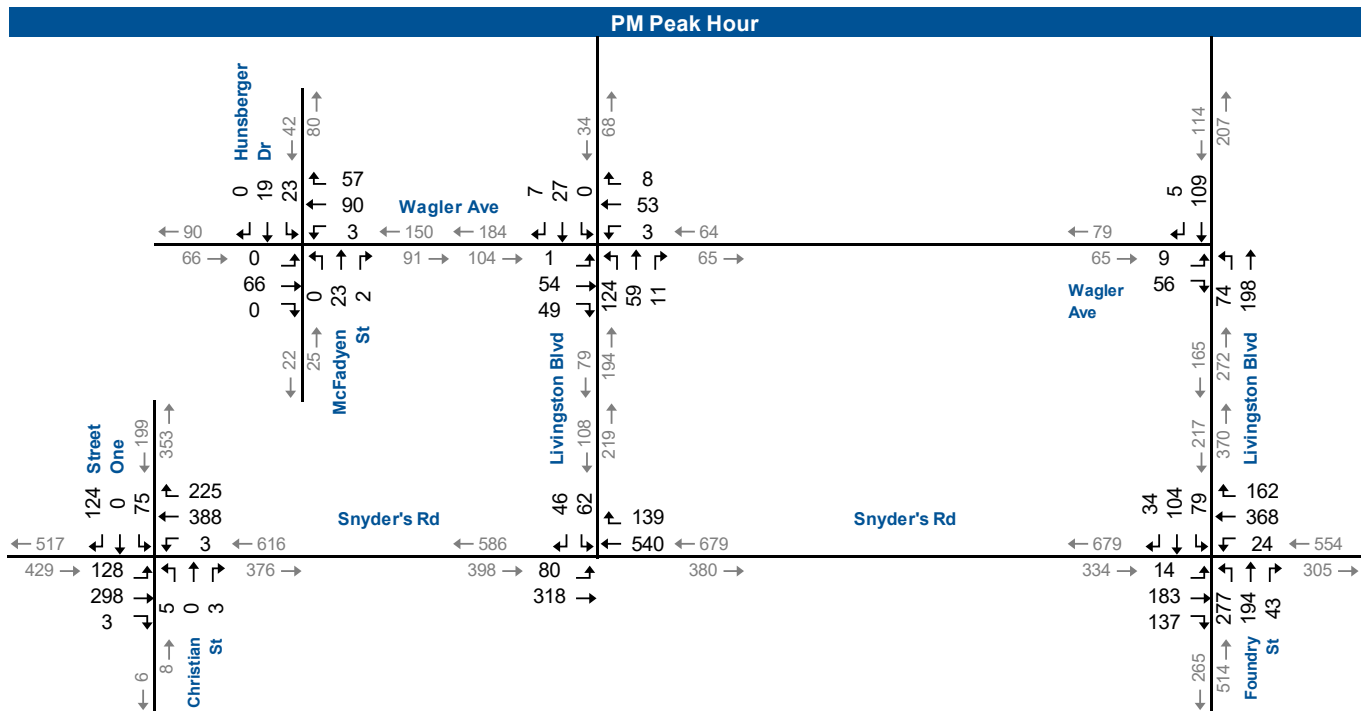
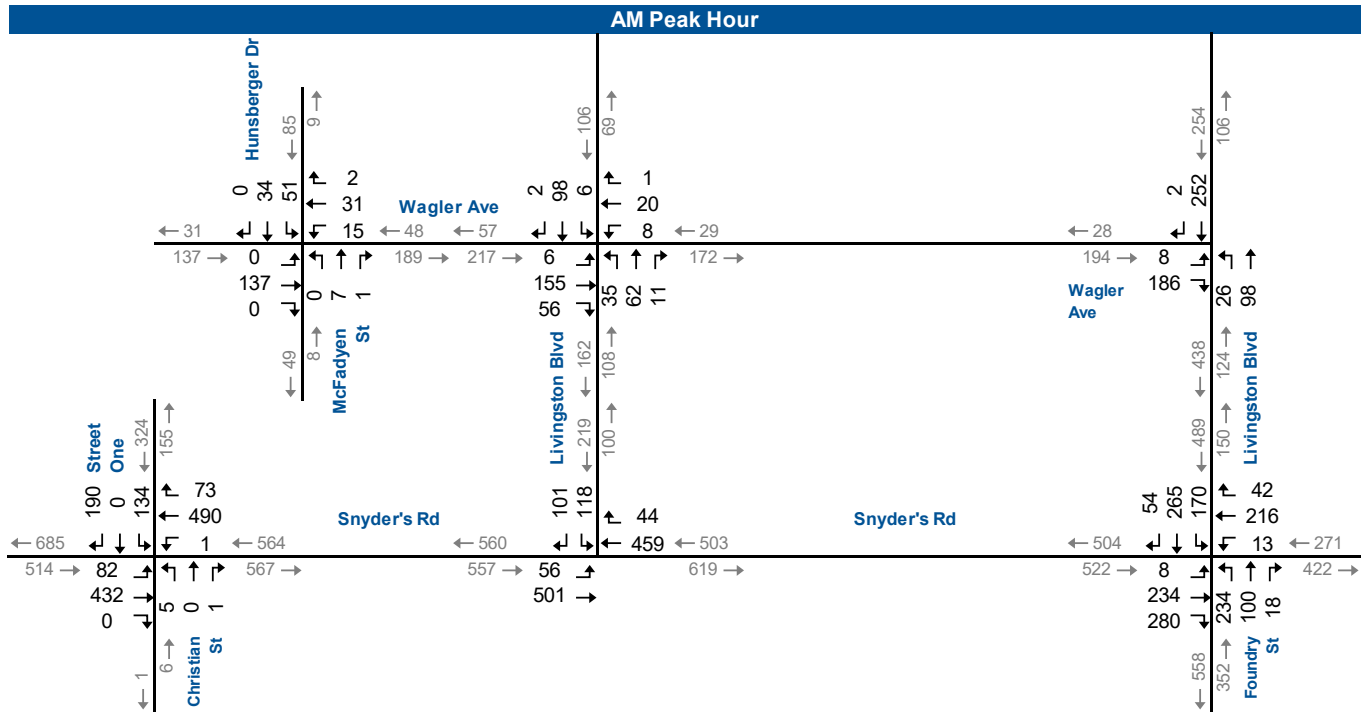


Figure 1



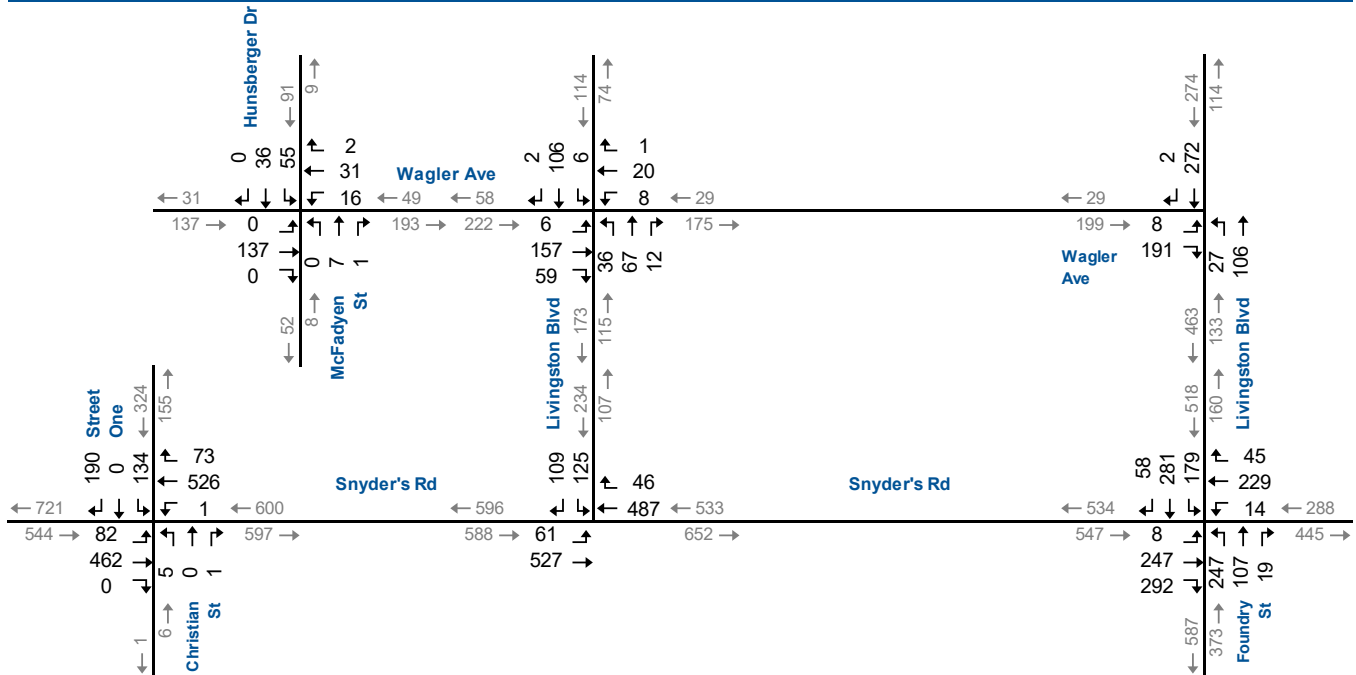
Site Generated Traffic Volumes



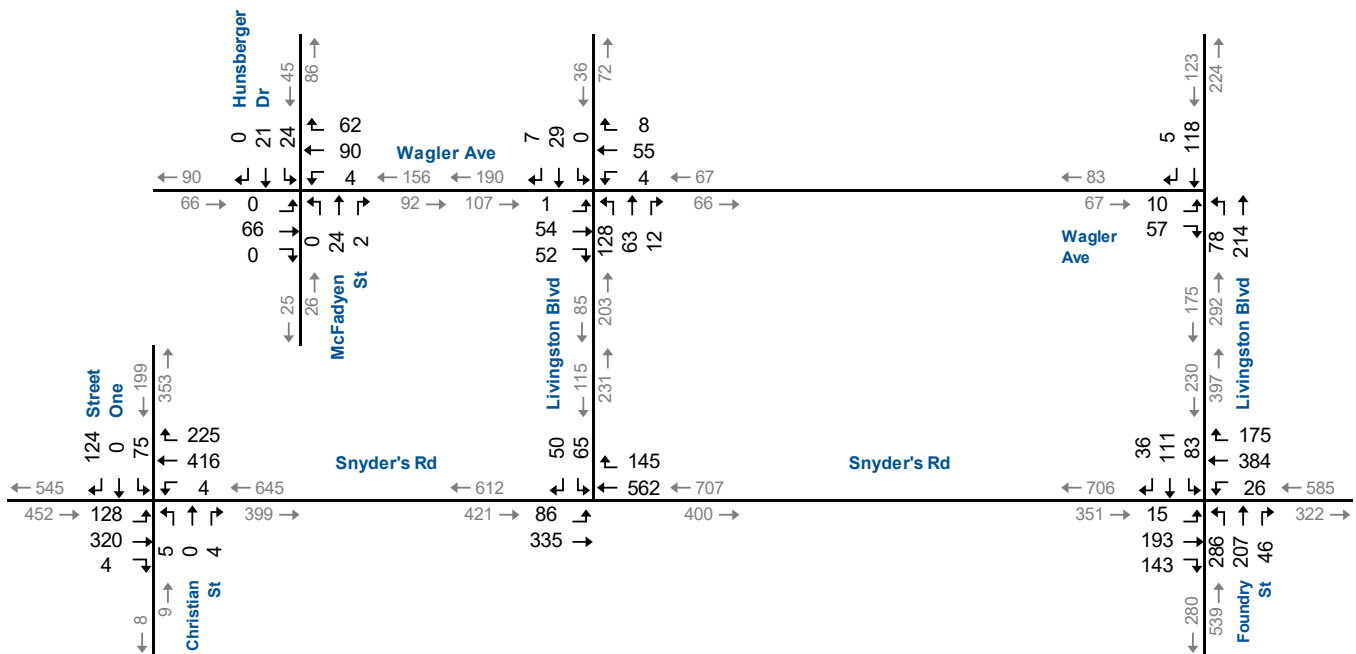
2028 Total Traffic Volumes



AM Peak Hour



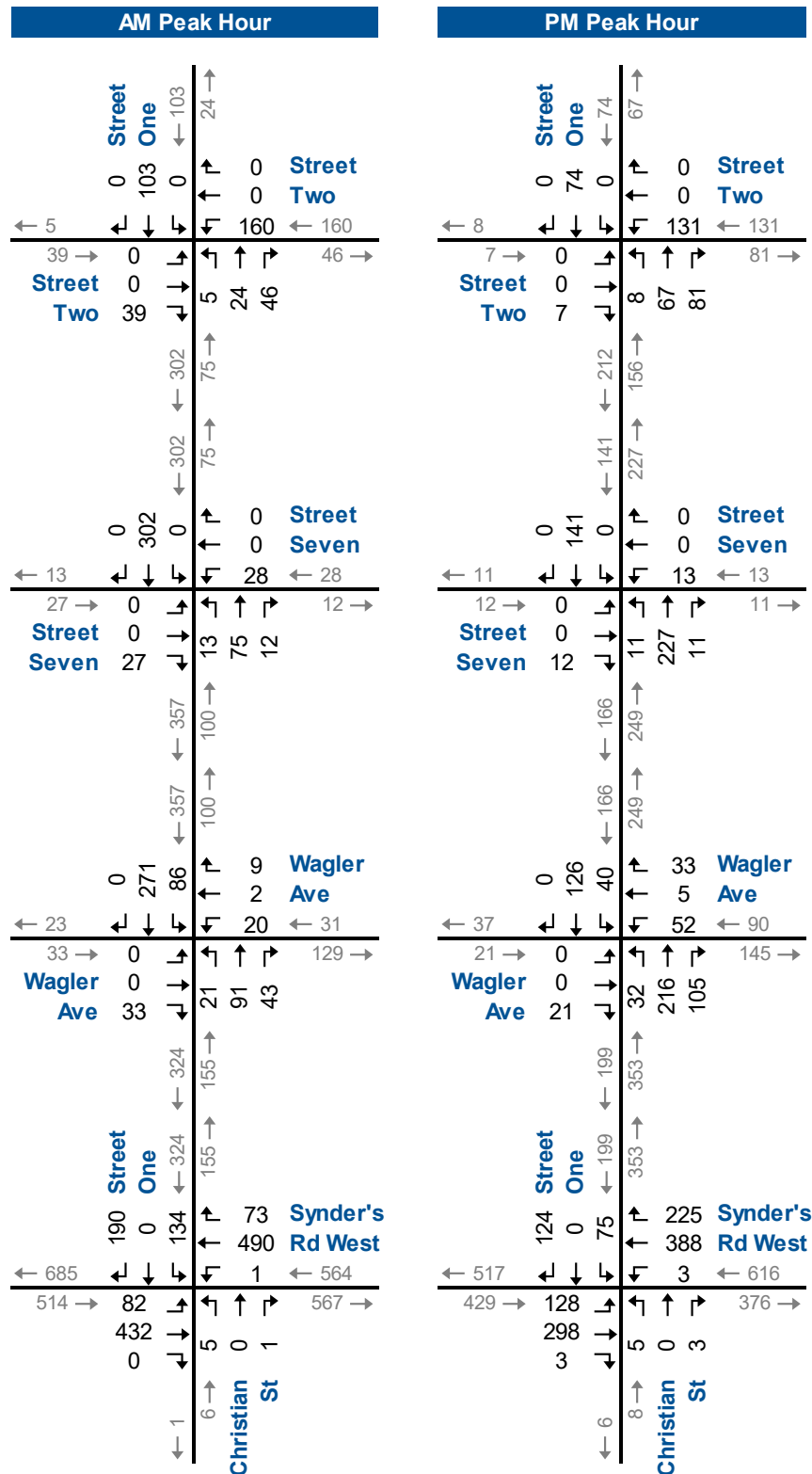
PM Peak Hour

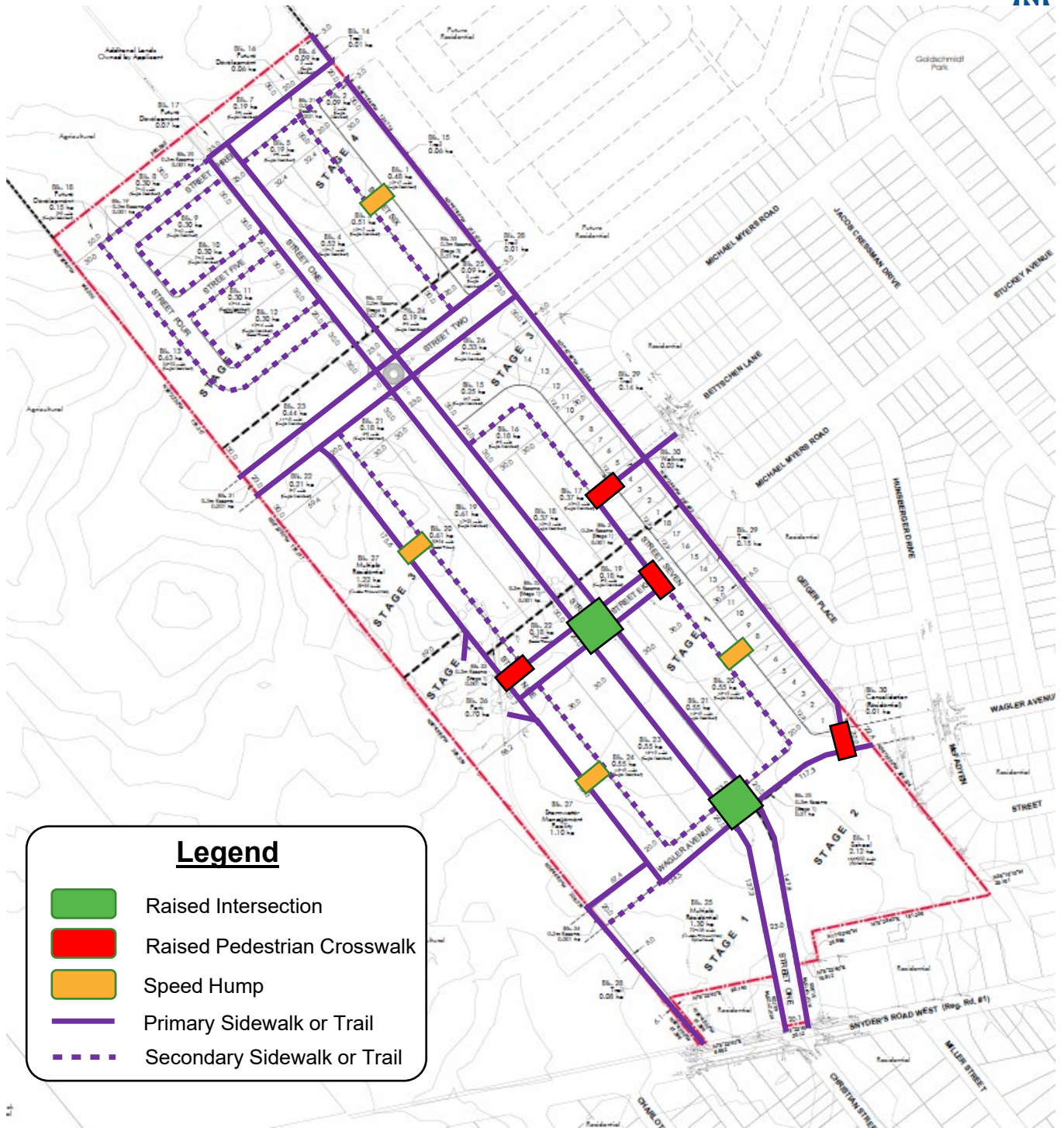


2033 Future Traffic Volumes

1012 Snyder's Road West, Baden TIS
200068

Figure 4





NTS



Possible Traffic Calming Plan

1012 Snyder's Road West, Baden TIS
200068

Figure 6

APPENDIX A



Lanes, Volumes, Timings

1: Foundry St/Livingston Blvd & Snyder's Rd

Total (2028)

AM Peak Hour

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↱		↰	↱	
Traffic Volume (vph)	8	234	280	13	216	42	234	98	18	170	265	54
Future Volume (vph)	8	234	280	13	216	42	234	98	18	170	265	54
Ideal Flow (vphpl)	1775	1650	1650	1550	1550	1550	1775	1650	1650	1775	1650	1650
Storage Length (m)	35.0		0.0	0.0		0.0	50.0		0.0	35.0		0.0
Storage Lanes	1		0	0		0	1		0	1		0
Taper Length (m)	40.0			7.5			25.0			35.0		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor	0.99				1.00			1.00		1.00		
Frt		0.918			0.979			0.977			0.975	
Flt Protected	0.950				0.998		0.950			0.950		
Satd. Flow (prot)	1686	1460	0	0	1426	0	1637	1538	0	1670	1577	0
Flt Permitted	0.593				0.985		0.457			0.682		
Satd. Flow (perm)	1045	1460	0	0	1407	0	788	1538	0	1196	1577	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		62			13			11			13	
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		299.0			280.1			388.3			251.4	
Travel Time (s)		21.5			20.2			28.0			18.1	
Confl. Peds. (#/hr)	6					6			2	2		
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	0%	7%	1%	10%	6%	3%	3%	4%	7%	1%	2%	2%
Adj. Flow (vph)	8	234	280	13	216	42	234	98	18	170	265	54
Shared Lane Traffic (%)												
Lane Group Flow (vph)	8	514	0	0	271	0	234	116	0	170	319	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Left	Right	Right
Median Width(m)		3.6			3.6			3.6			3.6	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.09	1.20	1.20	1.29	1.29	1.29	1.09	1.20	1.20	1.09	1.20	1.20
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Turn Type	Perm	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		4		3	8			2			6	
Permitted Phases	4			8			2			6		
Minimum Split (s)	37.1	37.1		14.1	39.1		48.1	48.1		48.1	48.1	
Total Split (s)	37.1	37.1		17.1	54.2		48.1	48.1		48.1	48.1	
Total Split (%)	36.3%	36.3%		16.7%	53.0%		47.0%	47.0%		47.0%	47.0%	
Maximum Green (s)	30.0	30.0		13.0	47.1		40.0	40.0		40.0	40.0	
Yellow Time (s)	4.1	4.1		4.1	4.1		4.1	4.1		4.1	4.1	
All-Red Time (s)	3.0	3.0		0.0	3.0		4.0	4.0		4.0	4.0	
Lost Time Adjust (s)	-3.1	-3.1			-3.1		-4.1	-4.1		-4.1	-4.1	
Total Lost Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Walk Time (s)	10.0	10.0			10.0		30.0	30.0		30.0	30.0	
Flash Dont Walk (s)	20.0	20.0			20.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0			0		0	0		0	0	

1012 Snyder's Road, Baden TIS
PTSL (200068)Synchro 9 Report
Page 1

Lanes, Volumes, Timings

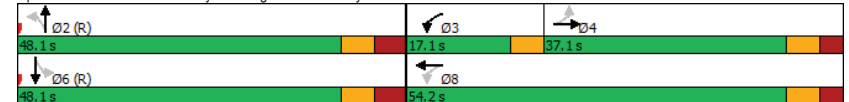
1: Foundry St/Livingston Blvd & Snyder's Rd

Total (2028)

AM Peak Hour

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Act Effct Green (s)	33.1	33.1			50.2		44.1	44.1		44.1	44.1	
Actuated g/C Ratio	0.32	0.32			0.49		0.43	0.43		0.43	0.43	
v/c Ratio	0.02	1.00			0.39		0.69	0.17		0.33	0.46	
Control Delay	24.0	71.6			17.5		36.3	17.0		21.6	22.5	
Queue Delay	0.0	0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay	24.0	71.6			17.5		36.3	17.0		21.6	22.5	
LOS	C	E			B		D	B		C	C	
Approach Delay		70.8			17.5			29.9			22.2	
Approach LOS		E			B			C			C	
Intersection Summary												
Area Type:	Other											
Cycle Length:	102.3											
Actuated Cycle Length:	102.3											
Offset:	0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green											
Natural Cycle:	100											
Control Type:	Pretimed											
Maximum v/c Ratio:	1.00											
Intersection Signal Delay:	38.6											
Intersection Capacity Utilization	87.3%											
ICU Level of Service	E											
Analysis Period (min)	15											

Splits and Phases: 1: Foundry St/Livingston Blvd & Snyder's Rd

1012 Snyder's Road, Baden TIS
PTSL (200068)Synchro 9 Report
Page 2

Queues

1: Foundry St/Livingston Blvd & Snyder's Rd

Total (2028)

AM Peak Hour

	←	→	←	←	↑	↘	↓
Lane Group	EBL	EBT	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	8	514	271	234	116	170	319
v/c Ratio	0.02	1.00	0.39	0.69	0.17	0.33	0.46
Control Delay	24.0	71.6	17.5	36.3	17.0	21.6	22.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	24.0	71.6	17.5	36.3	17.0	21.6	22.5
Queue Length 50th (m)	1.1	96.8	32.4	38.6	13.1	23.0	44.3
Queue Length 95th (m)	4.6	#168.7	52.8	#73.2	24.9	39.9	69.4
Internal Link Dist (m)		275.0	256.1		364.3		227.4
Turn Bay Length (m)	35.0			50.0		35.0	
Base Capacity (vph)	338	514	699	339	669	515	687
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.02	1.00	0.39	0.69	0.17	0.33	0.46

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis

1: Foundry St/Livingston Blvd & Snyder's Rd

Total (2028)

AM Peak Hour

	←	→	↘	↙	←	↘	↙	↑	↘	↙	↓	↘
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↘	↘			↘	↘	↘	↘		↘	↘	
Traffic Volume (vph)	8	234	280	13	216	42	234	98	18	170	265	54
Future Volume (vph)	8	234	280	13	216	42	234	98	18	170	265	54
Ideal Flow (vphpl)	1775	1650	1650	1550	1550	1550	1775	1650	1650	1775	1650	1650
Total Lost time (s)	4.0	4.0			4.0	4.0	4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Flpb, ped/bikes	0.99	1.00			1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	0.92			0.98	1.00	0.98	1.00		1.00	0.97	
Flt Protected	0.95	1.00			1.00	0.95	1.00	0.95		1.00	1.00	
Satd. Flow (prot)	1674	1461			1425	1637	1537	1666		1577	1577	
Flt Permitted	0.59	1.00			0.99	0.46	1.00	0.68		1.00	1.00	
Satd. Flow (perm)	1044	1461			1408	788	1537	1196		1577	1577	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	8	234	280	13	216	42	234	98	18	170	265	54
RTOR Reduction (vph)	0	42	0	0	7	0	0	6	0	0	7	0
Lane Group Flow (vph)	8	472	0	0	264	0	234	110	0	170	312	0
Confl. Peds. (#/hr)	6					6		2		2		
Heavy Vehicles (%)	0%	7%	1%	10%	6%	3%	3%	4%	7%	1%	2%	2%
Turn Type	Perm	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		4		3	8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	30.0	30.0			47.1		40.0	40.0		40.0	40.0	
Effective Green, g (s)	33.1	33.1			50.2		44.1	44.1		44.1	44.1	
Actuated g/C Ratio	0.32	0.32			0.49		0.43	0.43		0.43	0.43	
Clearance Time (s)	7.1	7.1			7.1		8.1	8.1		8.1	8.1	
Lane Grp Cap (vph)	337	472			693		339	662		515	679	
v/s Ratio Prot		c0.32			c0.06			0.07			0.20	
v/s Ratio Perm	0.01				0.13		c0.30			0.14		
v/c Ratio	0.02	1.00			0.38		0.69	0.17		0.33	0.46	
Uniform Delay, d1	23.6	34.6			16.3		23.6	17.8		19.3	20.6	
Progression Factor	1.00	1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.1	41.5			1.6		11.0	0.5		1.7	2.2	
Delay (s)	23.7	76.1			17.9		34.5	18.4		21.0	22.9	
Level of Service	C	E			B		C	B		C	C	
Approach Delay (s)		75.3			17.9			29.2			22.2	
Approach LOS		E			B			C			C	

Intersection Summary

HCM 2000 Control Delay	40.0	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	102.3	Sum of lost time (s)	12.1
Intersection Capacity Utilization	87.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Lanes, Volumes, Timings
2: Snyder's Rd & Livingston Blvd

Total (2028)
AM Peak Hour

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	56	501	459	44	118	101
Future Volume (vph)	56	501	459	44	118	101
Ideal Flow (vphpl)	1650	1650	1650	1650	1765	1765
Storage Length (m)	50.0			0.0	0.0	0.0
Storage Lanes	1			0	1	0
Taper Length (m)	35.0				7.5	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor						
Frt			0.988		0.938	
Flt Protected	0.950				0.974	
Satd. Flow (prot)	1522	1557	1532	0	1613	0
Flt Permitted	0.950				0.974	
Satd. Flow (perm)	1522	1557	1532	0	1613	0
Link Speed (k/h)		50	50		50	
Link Distance (m)		342.5	299.0		251.5	
Travel Time (s)		24.7	21.5		18.1	
Confl. Peds. (#/hr)	10			10		
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	3%	6%	7%	0%	0%	0%
Adj. Flow (vph)	56	501	459	44	118	101
Shared Lane Traffic (%)						
Lane Group Flow (vph)	56	501	503	0	219	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		3.6	3.6		3.6	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		4.8	4.8		4.8	
Two way Left Turn Lane						
Headway Factor	1.20	1.20	1.20	1.20	1.10	1.10
Turning Speed (k/h)	25			15	25	15
Sign Control		Free	Free		Stop	
Intersection Summary						
Area Type:	Other					
Control Type:	Unsignalized					
Intersection Capacity Utilization	58.3%			ICU Level of Service B		
Analysis Period (min)	15					

HCM Unsignalized Intersection Capacity Analysis
2: Snyder's Rd & Livingston Blvd

Total (2028)
AM Peak Hour

	EBL	EBT	WBT	WBR	SBL	SBR
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↔	↑	↔		↔	
Traffic Volume (veh/h)	56	501	459	44	118	101
Future Volume (Veh/h)	56	501	459	44	118	101
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	56	501	459	44	118	101
Pedestrians					10	
Lane Width (m)					3.6	
Walking Speed (m/s)					1.2	
Percent Blockage					1	
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (m)			299			
pX, platoon unblocked	0.95				0.95	0.95
vC, conflicting volume	513				1104	491
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	459				1082	435
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	95				45	83
cM capacity (veh/h)	1031				216	587
Direction, Lane #	EB 1	EB 2	WB 1	SB 1		
Volume Total	56	501	503	219		
Volume Left	56	0	0	118		
Volume Right	0	0	44	101		
cSH	1031	1700	1700	305		
Volume to Capacity	0.05	0.29	0.30	0.72		
Queue Length 95th (m)	1.4	0.0	0.0	41.4		
Control Delay (s)	8.7	0.0	0.0	42.0		
Lane LOS	A			E		
Approach Delay (s)	0.9		0.0	42.0		
Approach LOS				E		
Intersection Summary						
Average Delay			7.6			
Intersection Capacity Utilization			58.3%		ICU Level of Service	B
Analysis Period (min)			15			

Lanes, Volumes, Timings

3: Christian St/Street One & Snyder's Rd

Total (2028)

AM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (vph)	82	432	0	1	490	73	5	0	1	134	0	190
Future Volume (vph)	82	432	0	1	490	73	5	0	1	134	0	190
Ideal Flow (vphpl)	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt				0.983				0.977			0.921	
Flt Protected		0.992						0.960			0.980	
Satd. Flow (prot)	0	1459	0	0	1445	0	0	1454	0	0	1399	0
Flt Permitted		0.992						0.960			0.980	
Satd. Flow (perm)	0	1459	0	0	1445	0	0	1454	0	0	1399	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		587.8			342.5			168.2			137.2	
Travel Time (s)		42.3			24.7			12.1			9.9	
Confl. Peds. (#/hr)			2	2								
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	6%	0%	0%	6%	2%	0%	0%	0%	0%	0%	0%
Adj. Flow (vph)	82	432	0	1	490	73	5	0	1	134	0	190
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	514	0	0	564	0	0	6	0	0	324	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.6			3.6			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Free			Free			Stop			Stop	

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 102.8%

ICU Level of Service G

Analysis Period (min) 15

HCM Unsignalized Intersection Capacity Analysis

3: Christian St/Street One & Snyder's Rd

Total (2028)

AM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (veh/h)	82	432	0	1	490	73	5	0	1	134	0	190
Future Volume (Veh/h)	82	432	0	1	490	73	5	0	1	134	0	190
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	82	432	0	1	490	73	5	0	1	134	0	190
Pedestrians								2				
Lane Width (m)								3.6				
Walking Speed (m/s)								1.2				
Percent Blockage								0				
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	563			434			1316	1163	434	1126	1126	526
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	563			434			1316	1163	434	1126	1126	526
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	92			100			94	100	100	22	100	66
cM capacity (veh/h)	1008			1135			84	180	625	172	189	555
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total	514	564	6	324								
Volume Left	82	1	5	134								
Volume Right	0	73	1	190								
cSH	1008	1135	98	289								
Volume to Capacity	0.08	0.00	0.06	1.12								
Queue Length 95th (m)	2.1	0.0	1.5	107.6								
Control Delay (s)	2.2	0.0	44.3	128.9								
Lane LOS	A	A	E	F								
Approach Delay (s)	2.2	0.0	44.3	128.9								
Approach LOS		E		F								

Intersection Summary

Average Delay 30.7

Intersection Capacity Utilization 102.8% ICU Level of Service G

Analysis Period (min) 15

Lanes, Volumes, Timings
4: Livingston Blvd & Wagler Ave

Total (2028)
AM Peak Hour

						
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	 			 	 	
Traffic Volume (vph)	8	186	26	98	252	2
Future Volume (vph)	8	186	26	98	252	2
Ideal Flow (vphpl)	1765	1765	1650	1650	1650	1650
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor						
Frt	0.871				0.999	
Flt Protected	0.998			0.990		
Satd. Flow (prot)	1497	0	0	1608	1626	0
Flt Permitted	0.998			0.990		
Satd. Flow (perm)	1497	0	0	1608	1626	0
Link Speed (k/h)	50			50	50	
Link Distance (m)	297.7			251.4	141.5	
Travel Time (s)	21.4			18.1	10.2	
Confl. Peds. (#/hr)	1		2			2
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	14%	2%	0%	2%	1%	50%
Adj. Flow (vph)	8	186	26	98	252	2
Shared Lane Traffic (%)						
Lane Group Flow (vph)	194	0	0	124	254	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.6			3.6	3.6	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	4.8			4.8	4.8	
Two way Left Turn Lane						
Headway Factor	1.10	1.10	1.20	1.20	1.20	1.20
Turning Speed (k/h)	25	15	25			15
Sign Control	Stop			Free	Free	
Intersection Summary						
Area Type:	Other					
Control Type:	Unsignalized					
Intersection Capacity Utilization	45.9%			ICU Level of Service A		
Analysis Period (min)	15					

HCM Unsignalized Intersection Capacity Analysis
4: Livingston Blvd & Wagler Ave

Total (2028)
AM Peak Hour

	EBL	EBR	NBL	NBT	SBT	SBR
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	W			W	W	
Traffic Volume (veh/h)	8	186	26	98	252	2
Future Volume (Veh/h)	8	186	26	98	252	2
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	8	186	26	98	252	2
Pedestrians	2				1	
Lane Width (m)	3.6				3.6	
Walking Speed (m/s)	1.2				1.2	
Percent Blockage	0				0	
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (m)				251		
pX, platoon unblocked						
vC, conflicting volume	406	255	256			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	406	255	256			
tC, single (s)	6.5	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.6	3.3	2.2			
p0 queue free %	99	76	98			
cM capacity (veh/h)	566	782	1318			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	194	124	254			
Volume Left	8	26	0			
Volume Right	186	0	2			
cSH	770	1318	1700			
Volume to Capacity	0.25	0.02	0.15			
Queue Length 95th (m)	8.0	0.5	0.0			
Control Delay (s)	11.2	1.8	0.0			
Lane LOS	B	A				
Approach Delay (s)	11.2	1.8	0.0			
Approach LOS	B					
Intersection Summary						
Average Delay		4.2				
Intersection Capacity Utilization		45.9%		ICU Level of Service	A	
Analysis Period (min)		15				

Lanes, Volumes, Timings
5: Livingston Blvd & Wagler Ave

Total (2028)
AM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (vph)	6	155	56	8	20	1	35	62	11	6	98	2
Future Volume (vph)	6	155	56	8	20	1	35	62	11	6	98	2
Ideal Flow (vphpl)	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt		0.965			0.995			0.986			0.997	
Flt Protected		0.999			0.986			0.984			0.997	
Satd. Flow (prot)	0	1494	0	0	1521	0	0	1474	0	0	1527	0
Flt Permitted		0.999			0.986			0.984			0.997	
Satd. Flow (perm)	0	1494	0	0	1521	0	0	1474	0	0	1527	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		158.5			297.7			251.5			116.3	
Travel Time (s)		11.4			21.4			18.1			8.4	
Confl. Peds. (#/hr)	3		1	1		3	17		6	6		17
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	20%	0%	1%	0%
Adj. Flow (vph)	6	155	56	8	20	1	35	62	11	6	98	2
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	217	0	0	29	0	0	108	0	0	106	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Free			Free	

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 35.5% ICU Level of Service A

Analysis Period (min) 15

HCM Unsignalized Intersection Capacity Analysis
5: Livingston Blvd & Wagler Ave

Total (2028)
AM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (veh/h)	6	155	56	8	20	1	35	62	11	6	98	2
Future Volume (Veh/h)	6	155	56	8	20	1	35	62	11	6	98	2
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	6	155	56	8	20	1	35	62	11	6	98	2
Pedestrians		17			6			1			3	
Lane Width (m)		3.6			3.6			3.6			3.6	
Walking Speed (m/s)		1.2			1.2			1.2			1.2	
Percent Blockage		1			1			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	280	277	117	389	272	76	117			79		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	280	277	117	389	272	76	117			79		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	99	74	94	98	97	100	98			100		
cM capacity (veh/h)	625	605	926	415	608	983	1463			1524		
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total	217	29	108	106								
Volume Left	6	8	35	6								
Volume Right	56	1	11	2								
cSH	665	545	1463	1524								
Volume to Capacity	0.33	0.05	0.02	0.00								
Queue Length 95th (m)	11.3	1.3	0.6	0.1								
Control Delay (s)	13.0	12.0	2.6	0.4								
Lane LOS	B	B	A	A								
Approach Delay (s)	13.0	12.0	2.6	0.4								
Approach LOS	B	B										

Intersection Summary

Average Delay 7.6

Intersection Capacity Utilization 35.5% ICU Level of Service A

Analysis Period (min) 15

Lanes, Volumes, Timings

6: McFadyen St/Hunsberger Dr & Wagler Ave

Total (2028)

AM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (vph)	0	137	0	15	31	2	0	7	1	51	34	0
Future Volume (vph)	0	137	0	15	31	2	0	7	1	51	34	0
Ideal Flow (vphpl)	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt					0.994			0.983				
Flt Protected					0.985						0.971	
Satd. Flow (prot)	0	1550	0	0	1518	0	0	1524	0	0	1505	0
Flt Permitted					0.985						0.971	
Satd. Flow (perm)	0	1550	0	0	1518	0	0	1524	0	0	1505	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		119.3			158.5			76.5			91.6	
Travel Time (s)		8.6			11.4			5.5			6.6	
Confl. Peds. (#/hr)						1			5	5		
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Adj. Flow (vph)	0	137	0	15	31	2	0	7	1	51	34	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	137	0	0	48	0	0	8	0	0	85	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Free			Free	

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 34.8%

ICU Level of Service A

Analysis Period (min) 15

HCM Unsignalized Intersection Capacity Analysis

6: McFadyen St/Hunsberger Dr & Wagler Ave

Total (2028)

AM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (veh/h)	0	137	0	15	31	2	0	7	1	51	34	0
Future Volume (Veh/h)	0	137	0	15	31	2	0	7	1	51	34	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	0	137	0	15	31	2	0	7	1	51	34	0
Pedestrians					5						1	
Lane Width (m)					3.6						3.6	
Walking Speed (m/s)					1.2						1.2	
Percent Blockage					0						0	
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	162	149	34	217	148	14	34			13		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	162	149	34	217	148	14	34			13		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	81	100	98	96	100	100			97		
cM capacity (veh/h)	758	720	1045	616	720	1067	1591			1612		
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total	137	48	8	85								
Volume Left	0	15	0	51								
Volume Right	0	2	1	0								
cSH	720	693	1591	1612								
Volume to Capacity	0.19	0.07	0.00	0.03								
Queue Length 95th (m)	5.6	1.8	0.0	0.8								
Control Delay (s)	11.2	10.6	0.0	4.5								
Lane LOS	B	B		A								
Approach Delay (s)	11.2	10.6	0.0	4.5								
Approach LOS	B	B										

Intersection Summary

Average Delay 8.7

Intersection Capacity Utilization 34.8%

ICU Level of Service

A

Analysis Period (min) 15

Lanes, Volumes, Timings

1: Foundry St/Livingston Blvd & Snyder's Rd

Total (2028)

PM Peak Hour

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↱		↰	↱	
Traffic Volume (vph)	14	183	137	24	368	162	277	194	43	79	104	34
Future Volume (vph)	14	183	137	24	368	162	277	194	43	79	104	34
Ideal Flow (vphpl)	1775	1650	1650	1550	1550	1550	1775	1650	1650	1775	1650	1650
Storage Length (m)	35.0		0.0	0.0		0.0	50.0		0.0	35.0		0.0
Storage Lanes	1		0	0		0	1		0	1		0
Taper Length (m)	40.0			7.5			25.0			35.0		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor	0.99	0.99			0.99		0.99	0.99		0.99	0.99	
Frt		0.936			0.961			0.973			0.963	
Flt Protected	0.950				0.998		0.950			0.950		
Satd. Flow (prot)	1686	1494	0	0	1459	0	1686	1594	0	1686	1579	0
Flt Permitted	0.457				0.982		0.644			0.511		
Satd. Flow (perm)	806	1494	0	0	1435	0	1137	1594	0	896	1579	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		46			35			13			19	
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		299.0			280.1			388.3			251.4	
Travel Time (s)		21.5			20.2			28.0			18.1	
Confl. Peds. (#/hr)	10		10	10		10	4		12	12		4
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	0%	1%	3%	5%	1%	0%	0%	0%	0%	0%	0%	0%
Adj. Flow (vph)	14	183	137	24	368	162	277	194	43	79	104	34
Shared Lane Traffic (%)												
Lane Group Flow (vph)	14	320	0	0	554	0	277	237	0	79	138	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Right	Left	Left	Right	
Median Width(m)		3.6			3.6			3.6			3.6	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.09	1.20	1.20	1.29	1.29	1.29	1.09	1.20	1.20	1.09	1.20	1.20
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Turn Type	Perm	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		4		3	8			2			6	
Permitted Phases	4			8			2			6		
Minimum Split (s)	42.1	42.1		14.1	42.1		48.1	48.1		48.1	48.1	
Total Split (s)	42.1	42.1		17.1	59.2		38.1	38.1		38.1	38.1	
Total Split (%)	43.3%	43.3%		17.6%	60.8%		39.2%	39.2%		39.2%	39.2%	
Maximum Green (s)	35.0	35.0		8.0	52.1		30.0	30.0		30.0	30.0	
Yellow Time (s)	4.1	4.1		4.1	4.1		4.1	4.1		4.1	4.1	
All-Red Time (s)	3.0	3.0		5.0	3.0		4.0	4.0		4.0	4.0	
Lost Time Adjust (s)	-3.1	-3.1			-3.1		-4.1	-4.1		-4.1	-4.1	
Total Lost Time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Walk Time (s)	15.0	15.0			15.0		20.0	20.0		20.0	20.0	
Flash Dont Walk (s)	20.0	20.0			20.0		10.0	10.0		10.0	10.0	
Pedestrian Calls (#/hr)	0	0			0		0	0		0	0	

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Lanes, Volumes, Timings

1: Foundry St/Livingston Blvd & Snyder's Rd

Total (2028)

PM Peak Hour

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Act Effct Green (s)	38.1	38.1			55.2		34.1	34.1		34.1	34.1	
Actuated g/C Ratio	0.39	0.39			0.57		0.35	0.35		0.35	0.35	
v/c Ratio	0.04	0.52			0.67		0.70	0.42		0.25	0.24	
Control Delay	19.0	22.9			18.4		38.1	25.4		25.3	20.7	
Queue Delay	0.0	0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay	19.0	22.9			18.4		38.1	25.4		25.3	20.7	
LOS	B	C			B		D	C		C	C	
Approach Delay		22.7			18.4			32.2			22.3	
Approach LOS		C			B			C			C	

Intersection Summary

Area Type: Other

Cycle Length: 97.3

Actuated Cycle Length: 97.3

Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green

Natural Cycle: 105

Control Type: Pretimed

Maximum v/c Ratio: 0.70

Intersection Signal Delay: 24.2

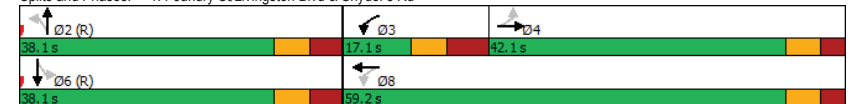
Intersection Capacity Utilization 112.5%

Analysis Period (min) 15

Intersection LOS: C

ICU Level of Service H

Splits and Phases: 1: Foundry St/Livingston Blvd & Snyder's Rd

1012 Snyder's Road, Baden TIS
PTSL (200068)Synchro 9 Report
Page 2

Queues

1: Foundry St/Livingston Blvd & Snyder's Rd

Total (2028)

PM Peak Hour

	←	→	←	←	↑	↘	↓
Lane Group	EBL	EBT	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	14	320	554	277	237	79	138
v/c Ratio	0.04	0.52	0.67	0.70	0.42	0.25	0.24
Control Delay	19.0	22.9	18.4	38.1	25.4	25.3	20.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	19.0	22.9	18.4	38.1	25.4	25.3	20.7
Queue Length 50th (m)	1.7	40.5	66.5	46.6	33.3	11.0	16.4
Queue Length 95th (m)	5.8	67.3	105.0	#78.9	55.1	23.1	31.1
Internal Link Dist (m)		275.0	256.1		364.3		227.4
Turn Bay Length (m)	35.0			50.0		35.0	
Base Capacity (vph)	315	612	832	398	567	314	565
Starvation Cap Reductn	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0
Reduced v/c Ratio	0.04	0.52	0.67	0.70	0.42	0.25	0.24

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis

1: Foundry St/Livingston Blvd & Snyder's Rd

Total (2028)

PM Peak Hour

	←	→	↘	↙	←	←	←	↑	↘	↙	↓	↘
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↙	↘			↘	↙	↙	↘		↙	↘	
Traffic Volume (vph)	14	183		137	24	368	162	277	194	43	79	104
Future Volume (vph)	14	183		137	24	368	162	277	194	43	79	104
Ideal Flow (vphpl)	1775	1650		1650	1550	1550	1775	1650	1650	1775	1650	1650
Total Lost time (s)	4.0	4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00			1.00		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	0.99			0.99		1.00	0.99		1.00	0.99	
Flpb, ped/bikes	0.99	1.00			1.00		0.99	1.00		0.99	1.00	
Frt	1.00	0.94			0.96		1.00	0.97		1.00	0.96	
Flt Protected	0.95	1.00			1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1675	1494			1458		1677	1594		1665	1579	
Flt Permitted	0.46	1.00			0.98		0.64	1.00		0.51	1.00	
Satd. Flow (perm)	806	1494			1434		1138	1594		896	1579	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	14	183		137	24	368	162	277	194	43	79	104
RTOR Reduction (vph)	0	28		0	15	0	0	8	0	0	12	0
Lane Group Flow (vph)	14	292		0	539	0	277	229	0	79	126	0
Confl. Peds. (#/hr)	10		10	10		10	4		12	12		4
Heavy Vehicles (%)	0%	1%	3%	5%	1%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm	NA		pm+pt	NA		Perm	NA		Perm	NA	
Protected Phases		4		3	8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	35.0	35.0			52.1		30.0	30.0		30.0	30.0	
Effective Green, g (s)	38.1	38.1			55.2		34.1	34.1		34.1	34.1	
Actuated g/C Ratio	0.39	0.39			0.57		0.35	0.35		0.35	0.35	
Clearance Time (s)	7.1	7.1			7.1		8.1	8.1		8.1	8.1	
Lane Grp Cap (vph)	315	585			816		398	558		314	553	
v/s Ratio Prot		0.20			c0.08			0.14			0.08	
v/s Ratio Perm	0.02				c0.30		c0.24			0.09		
v/c Ratio	0.04	0.50			0.66		0.70	0.41		0.25	0.23	
Uniform Delay, d1	18.3	22.4			14.6		27.1	24.0		22.5	22.3	
Progression Factor	1.00	1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.3	3.0			4.2		9.7	2.2		1.9	1.0	
Delay (s)	18.6	25.4			18.7		36.8	26.2		24.4	23.3	
Level of Service	B	C			B		D	C		C	C	
Approach Delay (s)		25.1			18.7			31.9			23.7	
Approach LOS		C			B			C			C	

Intersection Summary

HCM 2000 Control Delay	24.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	97.3	Sum of lost time (s)	17.1
Intersection Capacity Utilization	112.5%	ICU Level of Service	H
Analysis Period (min)	15		
c Critical Lane Group			

Lanes, Volumes, Timings
2: Snyder's Rd & Livingston Blvd

Total (2028)
PM Peak Hour

	EBL	EBT	WBT	WBR	SBL	SBR
Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↔	↔	↔	↔	↔	↔
Traffic Volume (vph)	80	318	540	139	62	46
Future Volume (vph)	80	318	540	139	62	46
Ideal Flow (vphpl)	1650	1650	1650	1650	1765	1765
Storage Length (m)	50.0			0.0	0.0	0.0
Storage Lanes	1			0	1	0
Taper Length (m)	35.0				7.5	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor						
Frt			0.972		0.942	
Flt Protected	0.950				0.972	
Satd. Flow (prot)	1568	1634	1604	0	1616	0
Flt Permitted	0.950				0.972	
Satd. Flow (perm)	1568	1634	1604	0	1616	0
Link Speed (k/h)		50	50		50	
Link Distance (m)		342.5	299.0		251.5	
Travel Time (s)		24.7	21.5		18.1	
Confl. Peds. (#/hr)	12			12	1	2
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	0%	1%	0%	0%	0%	0%
Adj. Flow (vph)	80	318	540	139	62	46
Shared Lane Traffic (%)						
Lane Group Flow (vph)	80	318	679	0	108	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(m)		3.6	3.6		3.6	
Link Offset(m)		0.0	0.0		0.0	
Crosswalk Width(m)		4.8	4.8		4.8	
Two way Left Turn Lane						
Headway Factor	1.20	1.20	1.20	1.20	1.10	1.10
Turning Speed (k/h)	25			15	25	15
Sign Control		Free	Free		Stop	
Intersection Summary						
Area Type:	Other					
Control Type:	Unsignalized					
Intersection Capacity Utilization 65.1%	ICU Level of Service C					
Analysis Period (min) 15						

HCM Unsignalized Intersection Capacity Analysis
2: Snyder's Rd & Livingston Blvd

Total (2028)
PM Peak Hour

	EBL	EBT	WBT	WBR	SBL	SBR
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations	↔	↔	↔	↔	↔	↔
Traffic Volume (veh/h)	80	318	540	139	62	46
Future Volume (Veh/h)	80	318	540	139	62	46
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	80	318	540	139	62	46
Pedestrians		2	1		12	
Lane Width (m)		3.6	3.6		3.6	
Walking Speed (m/s)		1.2	1.2		1.2	
Percent Blockage		0	0		1	
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (m)			299			
pX, platoon unblocked	0.90				0.90	0.90
vC, conflicting volume	691				1100	624
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	603				1057	528
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	91				70	91
cM capacity (veh/h)	879				204	494
Direction, Lane #	EB 1	EB 2	WB 1	SB 1		
Volume Total	80	318	679	108		
Volume Left	80	0	0	62		
Volume Right	0	0	139	46		
cSH	879	1700	1700	272		
Volume to Capacity	0.09	0.19	0.40	0.40		
Queue Length 95th (m)	2.4	0.0	0.0	14.5		
Control Delay (s)	9.5	0.0	0.0	26.7		
Lane LOS	A			D		
Approach Delay (s)	1.9		0.0	26.7		
Approach LOS				D		
Intersection Summary						
Average Delay			3.1			
Intersection Capacity Utilization			65.1%		ICU Level of Service	C
Analysis Period (min)			15			

Lanes, Volumes, Timings

3: Christian St/Street One & Snyder's Rd

Total (2028)

PM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (vph)	128	298	3	3	388	225	5	0	3	75	0	124
Future Volume (vph)	128	298	3	3	388	225	5	0	3	75	0	124
Ideal Flow (vphpl)	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt		0.999			0.951			0.949			0.916	
Flt Protected		0.985						0.970			0.982	
Satd. Flow (prot)	0	1504	0	0	1465	0	0	1427	0	0	1394	0
Flt Permitted		0.985						0.970				
Satd. Flow (perm)	0	1504	0	0	1465	0	0	1427	0	0	1394	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		587.8			342.5			168.2			124.8	
Travel Time (s)		42.3			24.7			12.1			9.0	
Confl. Peds. (#/hr)			5	5								
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	0%	2%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Adj. Flow (vph)	128	298	3	3	388	225	5	0	3	75	0	124
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	429	0	0	616	0	0	8	0	0	199	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		3.6			3.6			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Free			Free			Stop			Stop	

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 95.3%

ICU Level of Service F

Analysis Period (min) 15

HCM Unsignalized Intersection Capacity Analysis

3: Christian St/Street One & Snyder's Rd

Total (2028)

PM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (veh/h)	128	298	3	3	388	225	5	0	3	75	0	124
Future Volume (Veh/h)	128	298	3	3	388	225	5	0	3	75	0	124
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	128	298	3	3	388	225	5	0	3	75	0	124
Pedestrians								5				
Lane Width (m)								3.6				
Walking Speed (m/s)								1.2				
Percent Blockage								0				
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	613			306			1191	1180	304	1065	1068	500
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	613			306			1191	1180	304	1065	1068	500
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	87			100			96	100	100	58	100	78
cM capacity (veh/h)	976			1261			116	166	737	180	193	574
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total	429	616	8	199								
Volume Left	128	3	5	75								
Volume Right	3	225	3	124								
cSH	976	1261	169	315								
Volume to Capacity	0.13	0.00	0.05	0.63								
Queue Length 95th (m)	3.6	0.1	1.2	32.3								
Control Delay (s)	3.8	0.1	27.3	34.2								
Lane LOS	A	A	D	D								
Approach Delay (s)	3.8	0.1	27.3	34.2								
Approach LOS		D		D								

Intersection Summary

Average Delay 6.9

Intersection Capacity Utilization 95.3% ICU Level of Service F

Analysis Period (min) 15

Lanes, Volumes, Timings
4: Livingston Blvd & Wagler Ave

Total (2028)
PM Peak Hour

						
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	9	56	74	198	109	5
Future Volume (vph)	9	56	74	198	109	5
Ideal Flow (vphpl)	1765	1765	1650	1650	1650	1650
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor						
Frt	0.884				0.994	
Flt Protected	0.993			0.987		
Satd. Flow (prot)	1549	0	0	1629	1625	0
Flt Permitted	0.993			0.987		
Satd. Flow (perm)	1549	0	0	1629	1625	0
Link Speed (k/h)	50			50	50	
Link Distance (m)	297.7			251.4	141.5	
Travel Time (s)	21.4			18.1	10.2	
Confl. Peds. (#/hr)		1	27			27
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	0%	0%	0%	0%	1%	0%
Adj. Flow (vph)	9	56	74	198	109	5
Shared Lane Traffic (%)						
Lane Group Flow (vph)	65	0	0	272	114	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Right	Left	Left	Left	Right
Median Width(m)	3.6			3.6	3.6	
Link Offset(m)	0.0			0.0	0.0	
Crosswalk Width(m)	4.8			4.8	4.8	
Two way Left Turn Lane						
Headway Factor	1.10	1.10	1.20	1.20	1.20	1.20
Turning Speed (k/h)	25	15	25			15
Sign Control	Stop			Free	Free	
Intersection Summary						
Area Type:	Other					
Control Type:	Unsignalized					
Intersection Capacity Utilization	34.7%			ICU Level of Service A		
Analysis Period (min)	15					

HCM Unsignalized Intersection Capacity Analysis
4: Livingston Blvd & Wagler Ave

Total (2028)
PM Peak Hour

	EBL	EBR	NBL	NBT	SBT	SBR
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	W			W	W	
Traffic Volume (veh/h)	9	56	74	198	109	5
Future Volume (Veh/h)	9	56	74	198	109	5
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	9	56	74	198	109	5
Pedestrians	27			1		
Lane Width (m)	3.6			3.6		
Walking Speed (m/s)	1.2			1.2		
Percent Blockage	2			0		
Right turn flare (veh)						
Median type				None	None	
Median storage (veh)						
Upstream signal (m)				251		
pX, platoon unblocked						
vC, conflicting volume	484	140	141			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	484	140	141			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	98	94	95			
cM capacity (veh/h)	505	893	1422			
Direction, Lane #	EB 1	NB 1	SB 1			
Volume Total	65	272	114			
Volume Left	9	74	0			
Volume Right	56	0	5			
cSH	807	1422	1700			
Volume to Capacity	0.08	0.05	0.07			
Queue Length 95th (m)	2.1	1.3	0.0			
Control Delay (s)	9.9	2.4	0.0			
Lane LOS	A	A				
Approach Delay (s)	9.9	2.4	0.0			
Approach LOS	A					
Intersection Summary						
Average Delay		2.9				
Intersection Capacity Utilization		34.7%		ICU Level of Service	A	
Analysis Period (min)		15				

Lanes, Volumes, Timings
5: Livingston Blvd & Wagler Ave

Total (2028)
PM Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	1	54	49	3	53	8	124	59	11	0	27	7
Future Volume (vph)	1	54	49	3	53	8	124	59	11	0	27	7
Ideal Flow (vphpl)	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt		0.936			0.983			0.992			0.972	
Flt Protected					0.998			0.969				
Satd. Flow (prot)	0	1451	0	0	1521	0	0	1481	0	0	1507	0
Flt Permitted					0.998			0.969				
Satd. Flow (perm)	0	1451	0	0	1521	0	0	1481	0	0	1507	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		158.5			297.7			251.5			116.3	
Travel Time (s)		11.4			21.4			18.1			8.4	
Confl. Peds. (#/hr)	3		2	2		3	2		4	4		2
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%
Adj. Flow (vph)	1	54	49	3	53	8	124	59	11	0	27	7
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	104	0	0	64	0	0	194	0	0	34	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Free			Free	
Intersection Summary												
Area Type:	Other											
Control Type:	Unsignalized											
Intersection Capacity Utilization	34.5%											
Analysis Period (min)	15											
ICU Level of Service A												

HCM Unsignalized Intersection Capacity Analysis
5: Livingston Blvd & Wagler Ave

Total (2028)
PM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (veh/h)	1	54	49	3	53	8	124	59	11	0	27	7
Future Volume (Veh/h)	1	54	49	3	53	8	124	59	11	0	27	7
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	1	54	49	3	53	8	124	59	11	0	27	7
Pedestrians		2			4			2			3	
Lane Width (m)		3.6			3.6			3.6			3.6	
Walking Speed (m/s)		1.2			1.2			1.2			1.2	
Percent Blockage		0			0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	382	354	34	425	352	72	36			74		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	382	354	34	425	352	72	36			74		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	90	95	99	90	99	92			100		
cM capacity (veh/h)	495	527	1041	445	528	991	1585			1533		
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total	104	64	194	34								
Volume Left	1	3	124	0								
Volume Right	49	8	11	7								
cSH	686	555	1585	1533								
Volume to Capacity	0.15	0.12	0.08	0.00								
Queue Length 95th (m)	4.3	3.1	2.0	0.0								
Control Delay (s)	11.2	12.3	5.0	0.0								
Lane LOS	B	B	A									
Approach Delay (s)	11.2	12.3	5.0	0.0								
Approach LOS	B	B										
Intersection Summary												
Average Delay		7.4										
Intersection Capacity Utilization		34.5%										
Analysis Period (min)		15										
ICU Level of Service A												

Lanes, Volumes, Timings

6: McFadyen St/Hunsberger Dr & Wagler Ave

Total (2028)

PM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔		↔	↔			↔		↔	↔	
Traffic Volume (vph)	0	66	0	3	90	57	0	23	2	23	19	0
Future Volume (vph)	0	66	0	3	90	57	0	23	2	23	19	0
Ideal Flow (vphpl)	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor												
Frt					0.949			0.989				
Flt Protected					0.999						0.973	
Satd. Flow (prot)	0	1550	0	0	1469	0	0	1533	0	0	1508	0
Flt Permitted					0.999						0.973	
Satd. Flow (perm)	0	1550	0	0	1469	0	0	1533	0	0	1508	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		140.6			158.5			76.5			91.6	
Travel Time (s)		10.1			11.4			5.5			6.6	
Confl. Peds. (#/hr)						2			2	2		
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Adj. Flow (vph)	0	66	0	3	90	57	0	23	2	23	19	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	66	0	0	150	0	0	25	0	0	42	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Free			Free	

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 29.4%

ICU Level of Service A

Analysis Period (min) 15

HCM Unsignalized Intersection Capacity Analysis

6: McFadyen St/Hunsberger Dr & Wagler Ave

Total (2028)

PM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔		↔	↔			↔		↔	↔	
Traffic Volume (veh/h)	0	66	0	3	90	57	0	23	2	23	19	0
Future Volume (Veh/h)	0	66	0	3	90	57	0	23	2	23	19	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	0	66	0	3	90	57	0	23	2	23	19	0
Pedestrians					2						2	
Lane Width (m)					3.6						3.6	
Walking Speed (m/s)					1.2						1.2	
Percent Blockage					0						0	
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	193	92	19	124	91	28	19			27		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	193	92	19	124	91	28	19			27		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	92	100	100	89	95	100			99		
cM capacity (veh/h)	656	789	1065	789	790	1049	1611			1597		
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total	66	150	25	42								
Volume Left	0	3	0	23								
Volume Right	0	57	2	0								
cSH	789	872	1611	1597								
Volume to Capacity	0.08	0.17	0.00	0.01								
Queue Length 95th (m)	2.2	5.0	0.0	0.4								
Control Delay (s)	10.0	10.0	0.0	4.0								
Lane LOS	A	A		A								
Approach Delay (s)	10.0	10.0	0.0	4.0								
Approach LOS	A	A										

Intersection Summary

Average Delay 8.2

Intersection Capacity Utilization 29.4%

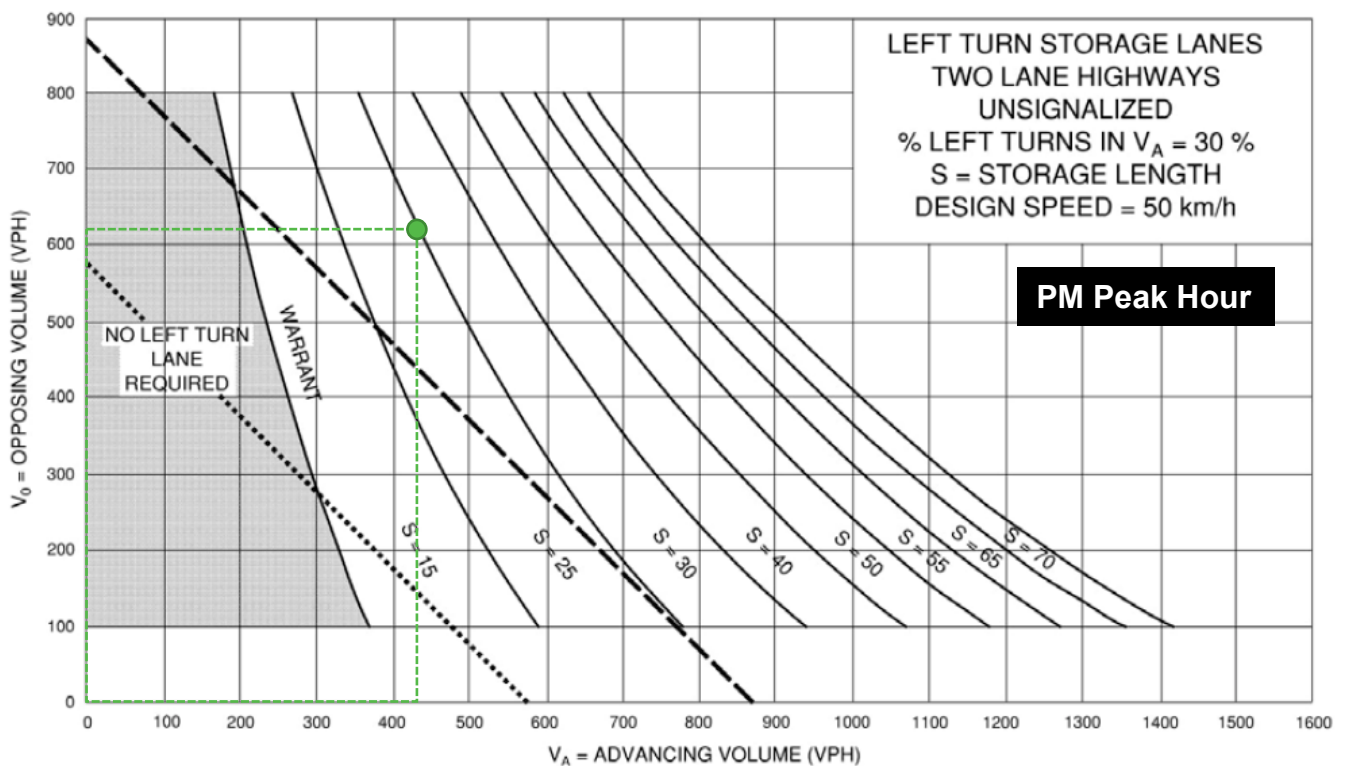
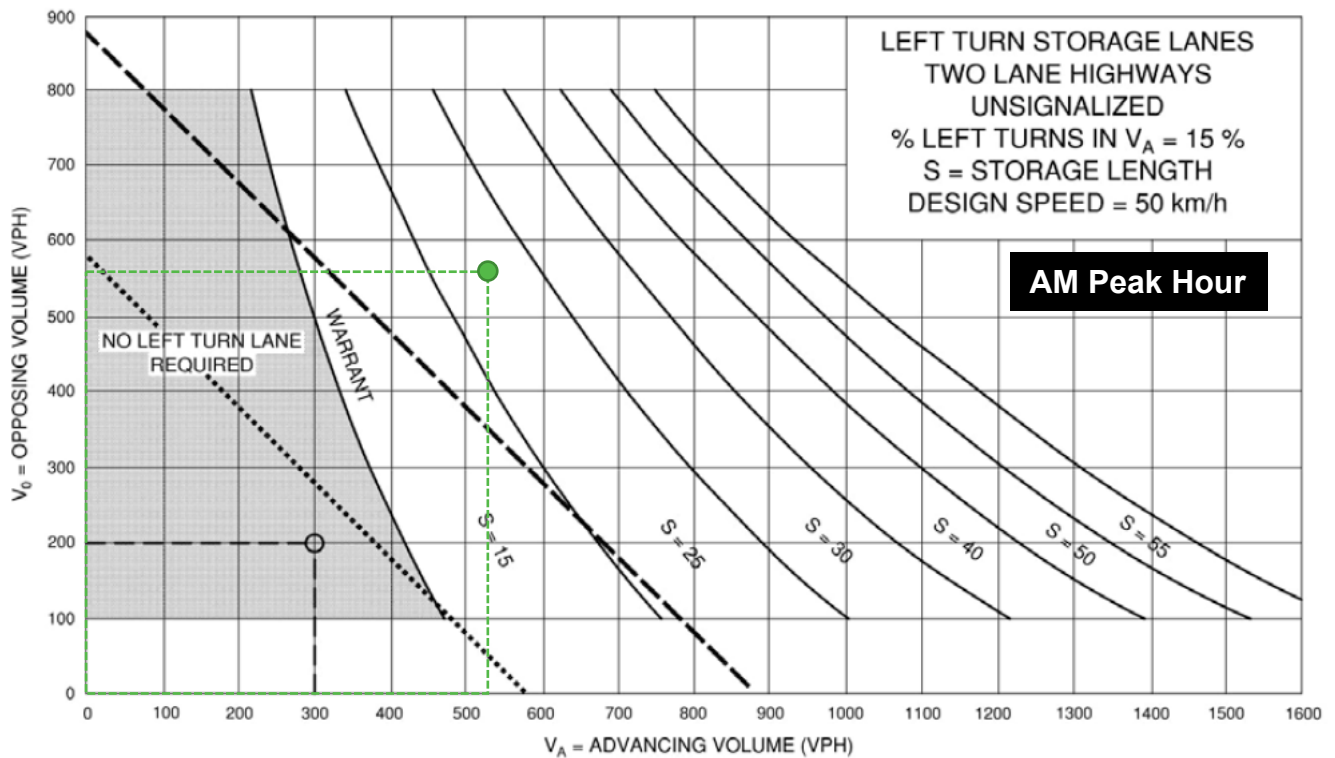
ICU Level of Service

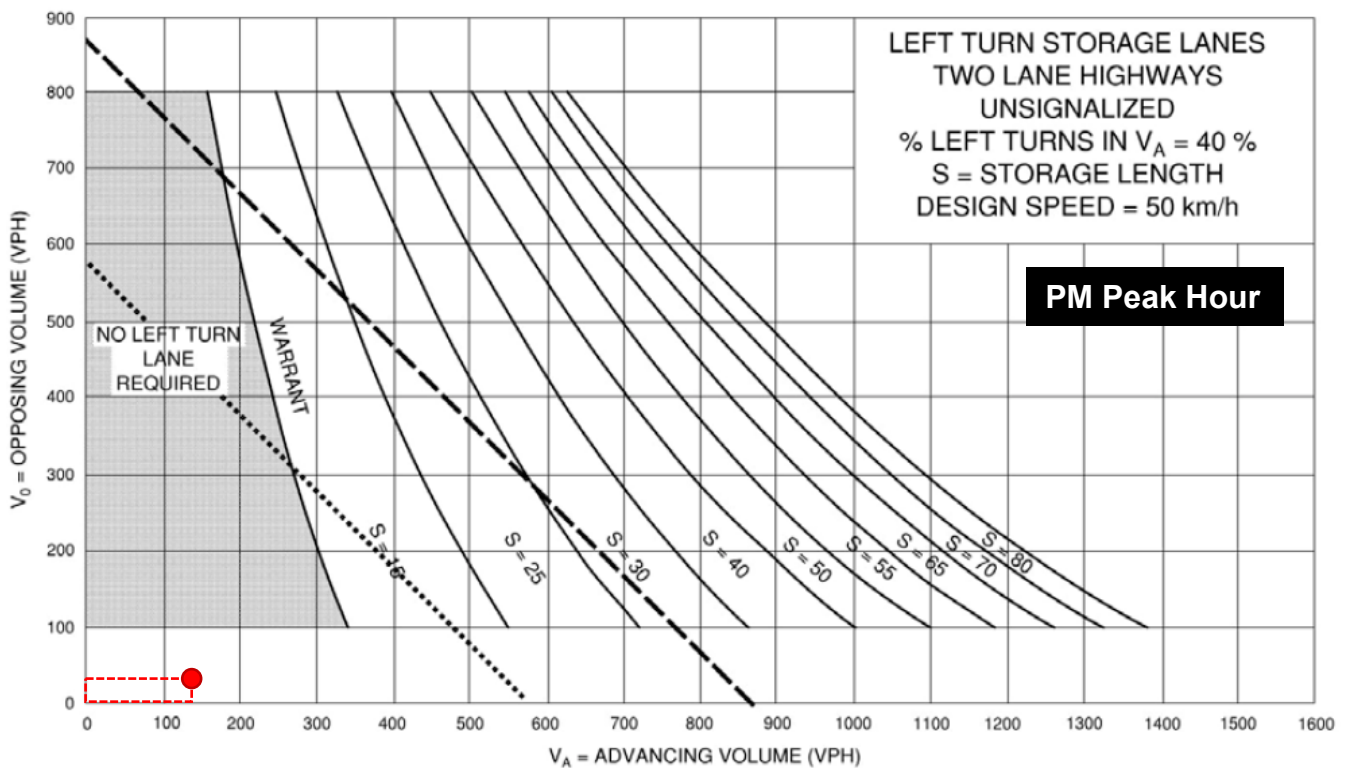
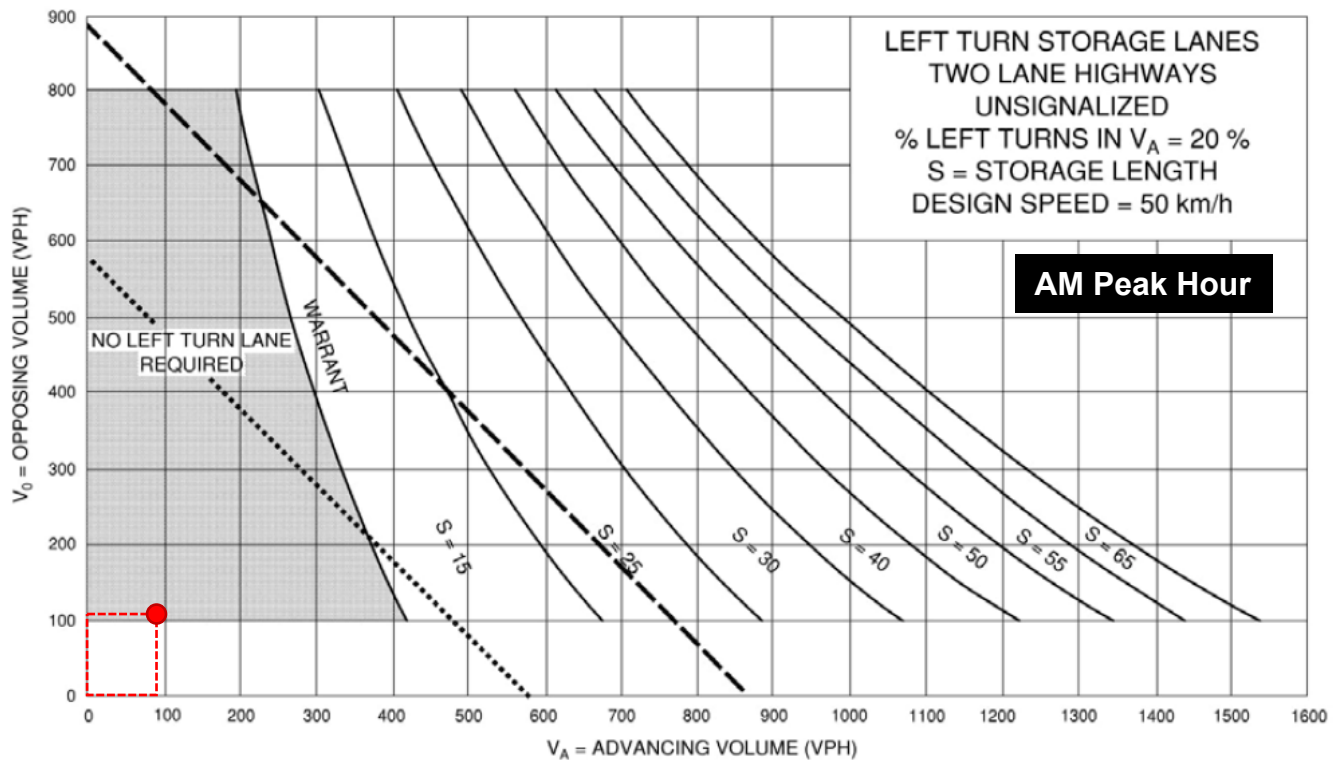
A

Analysis Period (min) 15

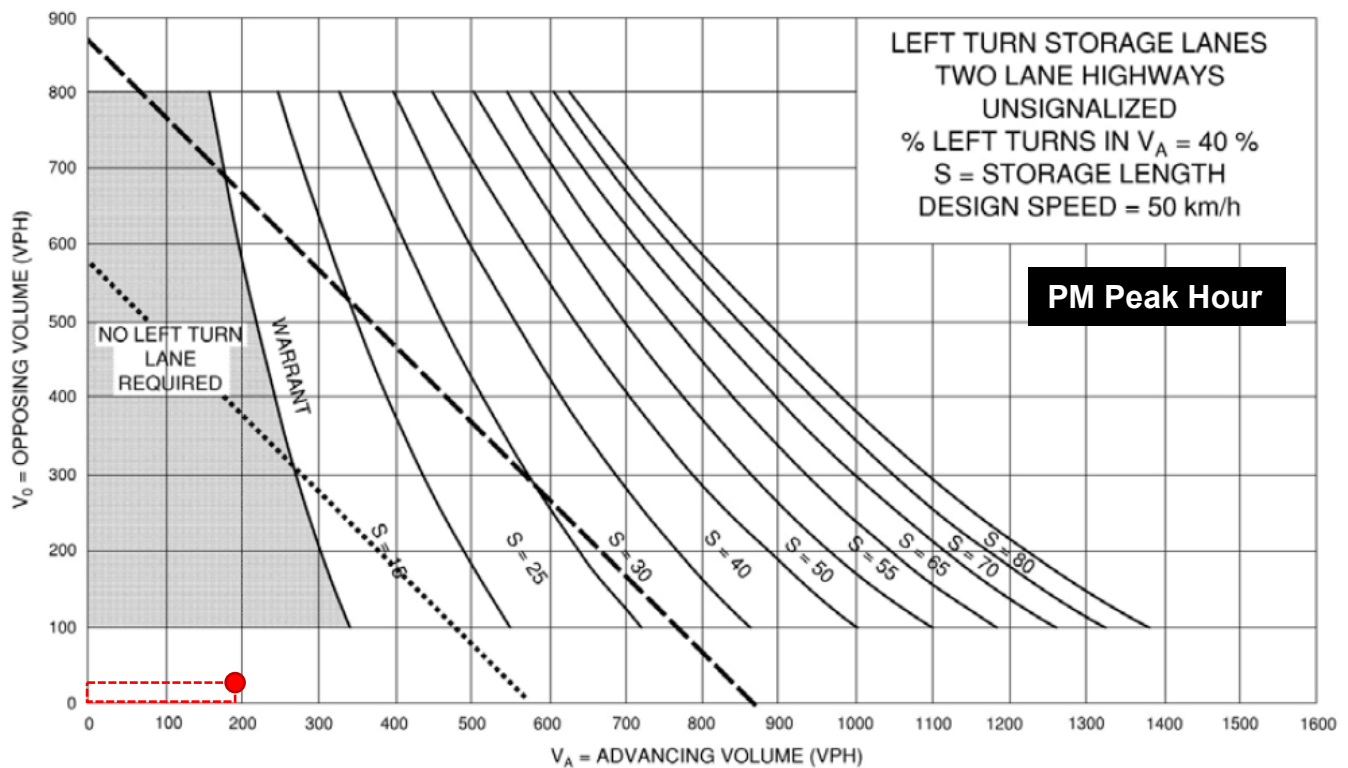
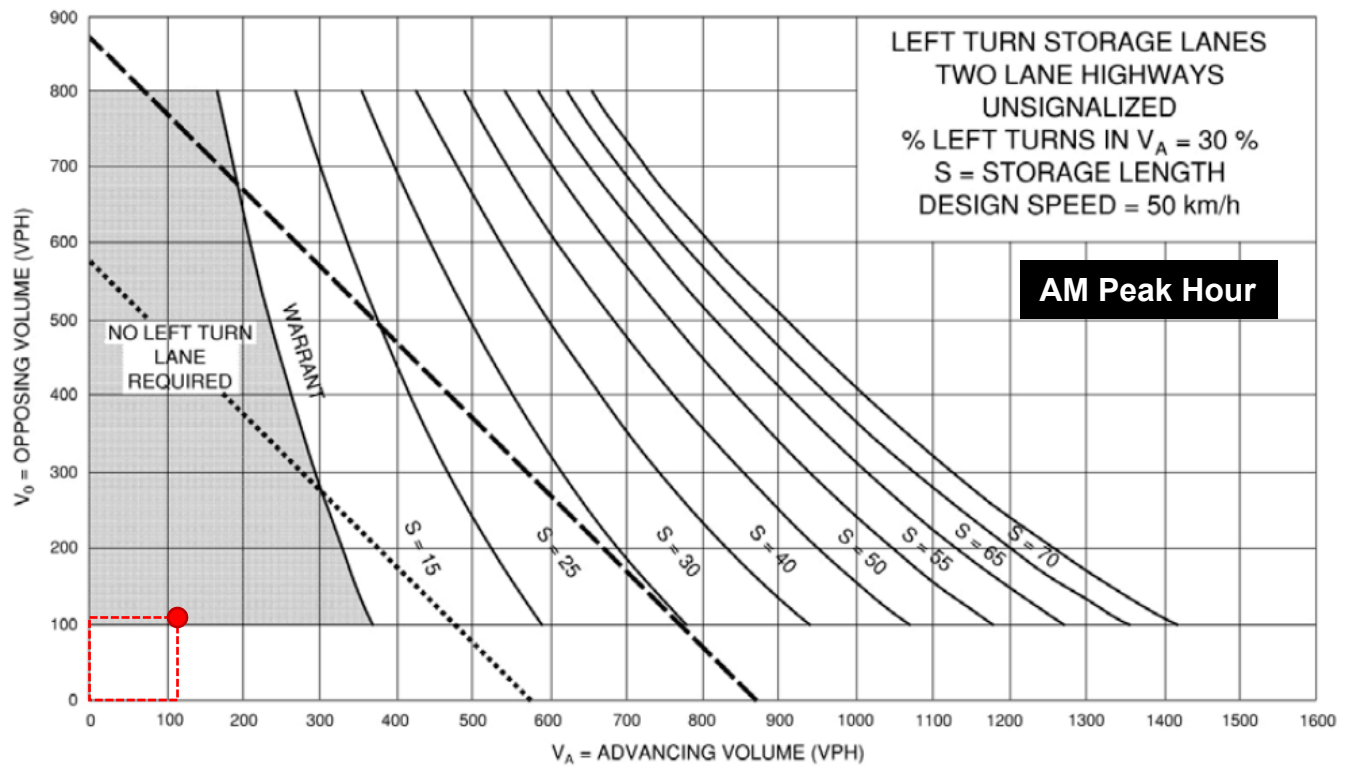
APPENDIX B

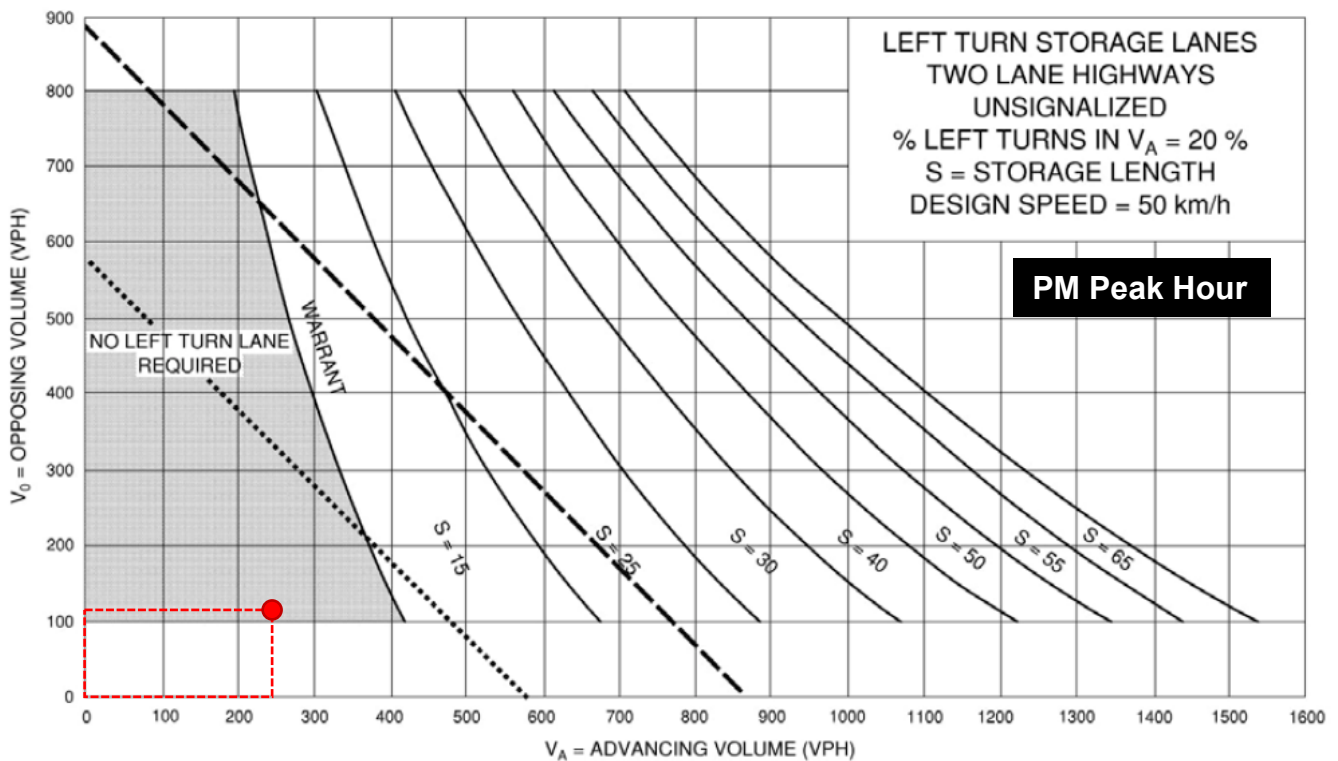
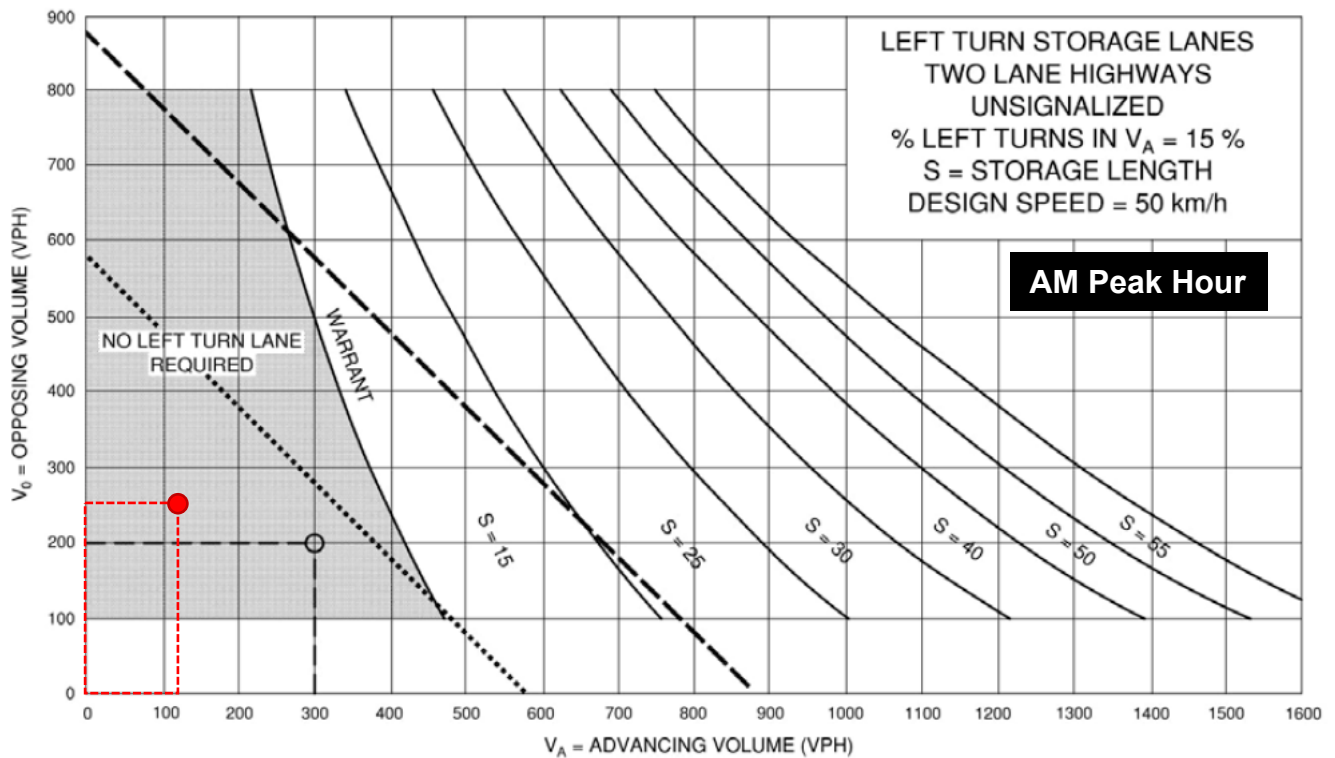


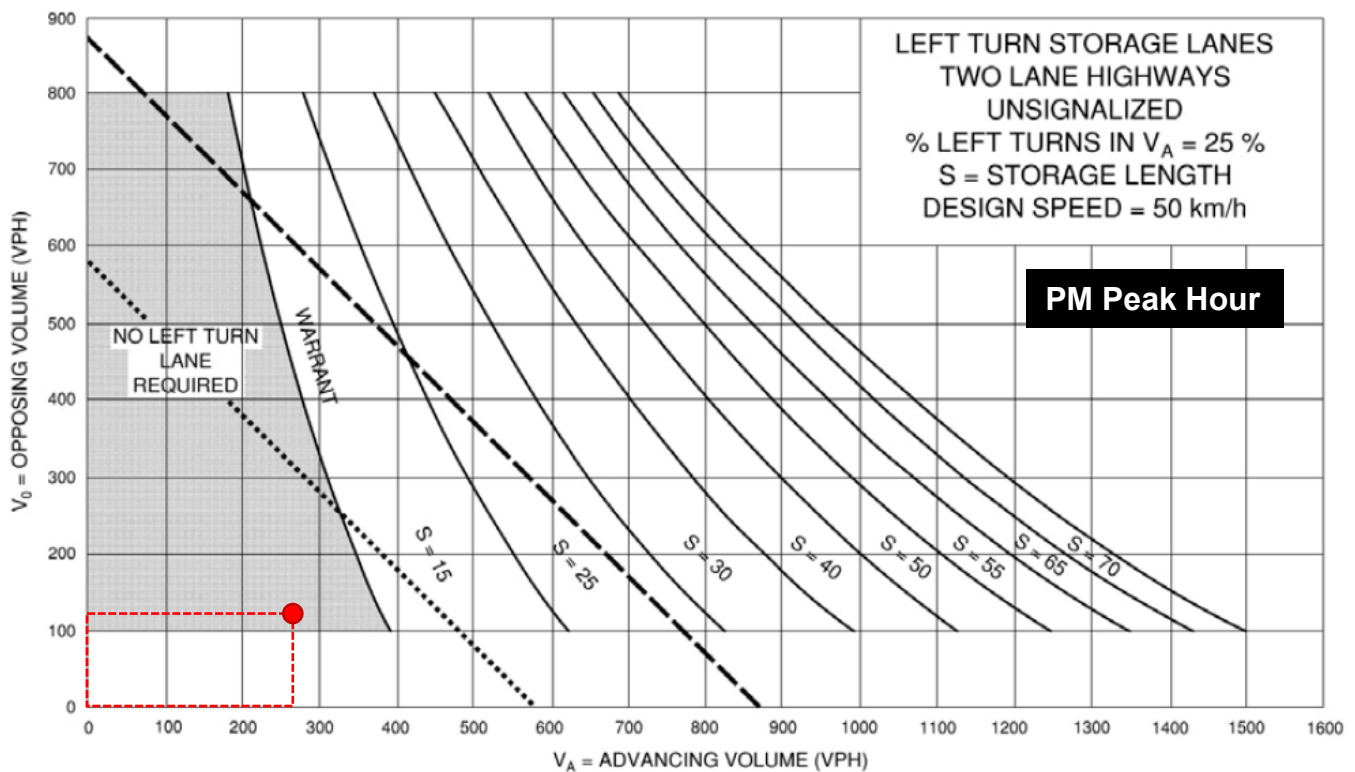
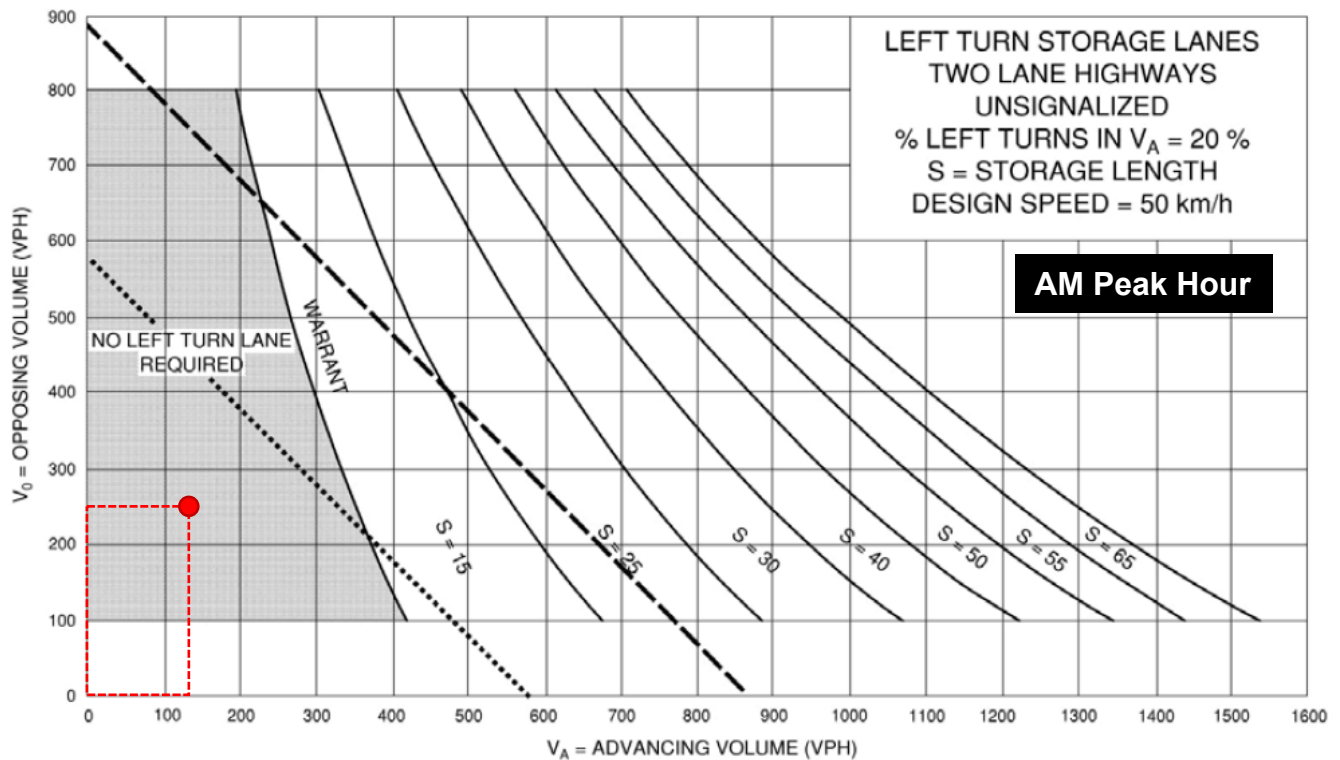




Left-Turn Lane Warrant Nomograph
Northbound
Livingston Boulevard (West) at Wagler Avenue
2028 Background Traffic







APPENDIX C



Signal Justification Calculation for Forecasted Volumes (OTM Book 12 - Justification 7)



Horizon Year: Total (2028)
Region/City/Township: Baden, Region of Waterloo

Major Street: Snyder's Road West
Minor Street: Christain Street

North/South?: N

Number of Approach Lanes: 1
Tee Intersection?: N
Flow Conditions: Free

PM Forecast Only? N

Warrant Results		
150% Satisfied	No	Justification for new intersections with forecast traffic
120% Satisfied	No	Justification for existing intersections with forecast traffic

Time Period	Major Street Snyder's Road West						Minor Street Christain Street						Peds Crossing Main Road
	Eastbound			Westbound			Northbound			Southbound			
	Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
AM Peak Hour	82	432	0	1	490	73	5	0	1	134	0	190	10
PM Peak Hour	128	298	3	3	388	225	5	0	3	75	0	124	10
Average Hourly Volume	53	183	1	1	220	75	3	0	1	52	0	79	5

Warrant	AHV
1A - All	665
1B - Minor	134
2A - Major	531
2B - Cross	60

Warrant 1 - Minimum Vehicular Volume

1A	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
		X				
	All Approaches	480	720	600	900	
% Fulfilled						138.5%

1B	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
		X				
	Minor Street Approaches	120	170	120	170	
% Fulfilled						111.9%

Warrant 2 - Delay To Cross Traffic

2A	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
		X				
	Major Street Approaches	480	720	600	900	
% Fulfilled						110.6%

2B	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
		X				
	Traffic Crossing Major Street	50	75	50	75	
% Fulfilled						119.5%

Signal Justification Calculation for Forecasted Volumes (OTM Book 12 - Justification 7)



Horizon Year: Total (2028)
Region/City/Township: Baden, Region of Waterloo

Major Street: Snyder's Road West
Minor Street: Livingston Blvd (West)

North/South?: N

Number of Approach Lanes: 1
Tee Intersection?: Y
Flow Conditions: Free

PM Forecast Only? N

Warrant Results		
150% Satisfied	No	Justification for new intersections with forecast traffic
120% Satisfied	No	Justification for existing intersections with forecast traffic

Time Period	Major Street						Minor Street						Peds Crossing Main Road
	Snyder's Road West						Livingston Blvd (West)						
	Eastbound			Westbound			Northbound			Southbound			
	Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
AM Peak Hour	56	501			459	44				118		101	0
PM Peak Hour	80	318			540	139				62		46	0
Average Hourly Volume	34	205	0	0	250	46	0	0	0	45	0	37	0

Warrant	AHV
1A - All	616
1B - Minor	82
2A - Major	534
2B - Cross	45

Warrant 1 - Minimum Vehicular Volume

1A	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
		X				
	All Approaches	480	720	600	900	
% Fulfilled						128.3%

1B	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
		X				
	Minor Street Approaches	180	255	180	255	
% Fulfilled						45.4%

Warrant 2 - Delay To Cross Traffic

2A	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
		X				
	Major Street Approaches	480	720	600	900	
% Fulfilled						111.3%

2B	Approach Lanes	1		2 or more		Average Hourly Volume
	Flow Conditions	Free	Restricted	Free	Restricted	
		X				
	Traffic Crossing Major Street	50	75	50	75	
% Fulfilled						90.0%

APPENDIX D



Lanes, Volumes, Timings

1: Christian St/Street One & Snyder's Rd

Total (2028) - Street One

AM Peak Hour

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	82	432	0	1	490	73	5	0	1	134	0	190
Future Volume (vph)	82	432	0	1	490	73	5	0	1	134	0	190
Ideal Flow (vphpl)	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor					1.00							
Frt					0.983			0.977			0.921	
Flt Protected		0.992						0.960			0.980	
Satd. Flow (prot)	0	1459	0	0	1445	0	0	1454	0	0	1399	0
Flt Permitted		0.865			0.999			0.776			0.863	
Satd. Flow (perm)	0	1273	0	0	1443	0	0	1175	0	0	1232	0
Right Turn on Red		Yes			Yes			Yes			Yes	
Satd. Flow (RTOR)					19			55			128	
Link Speed (k/h)	50				50			50			50	
Link Distance (m)	587.8				1099.6			168.2			137.2	
Travel Time (s)	42.3				79.2			12.1			9.9	
Confl. Peds. (#/hr)		2		2								
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	2%	6%	0%	0%	6%	2%	0%	0%	0%	0%	0%	0%
Adj. Flow (vph)	82	432	0	1	490	73	5	0	1	134	0	190
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	514	0	0	564	0	0	6	0	0	324	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Number of Detectors	1	2		1	2		1	2		1	2	
Detector Template	Left	Thru		Left	Thru		Left	Thru		Left	Thru	
Leading Detector (m)	2.0	10.0		2.0	10.0		2.0	10.0		2.0	10.0	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Position(m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Size(m)	2.0	0.6		2.0	0.6		2.0	0.6		2.0	0.6	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 2 Position(m)		9.4			9.4			9.4			9.4	
Detector 2 Size(m)		0.6			0.6			0.6			0.6	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			4			8	
Permitted Phases	2			6			4			8		

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PTSL (200068)Synchro 9 Report
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Lanes, Volumes, Timings

1: Christian St/Street One & Snyder's Rd

Total (2028) - Street One

AM Peak Hour

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	2	2		6	6		4	4		8	8	
Switch Phase												
Minimum Initial (s)	8.0	8.0		8.0	8.0		8.0	8.0		8.0	8.0	
Minimum Split (s)	24.0	24.0		24.0	24.0		24.0	24.0		24.0	24.0	
Total Split (s)	36.0	36.0		36.0	36.0		24.0	24.0		24.0	24.0	
Total Split (%)	60.0%	60.0%		60.0%	60.0%		40.0%	40.0%		40.0%	40.0%	
Maximum Green (s)	30.0	30.0		30.0	30.0		18.0	18.0		18.0	18.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lost Time Adjust (s)		-2.0			-2.0			-2.0			-2.0	
Total Lost Time (s)		4.0			4.0			4.0			4.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	None	None		None	None		None	None		None	None	
Walk Time (s)	7.0	7.0		7.0	7.0		7.0	7.0		7.0	7.0	
Flash Dont Walk (s)	11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)		25.6			25.6			15.7			15.7	
Actuated g/C Ratio		0.52			0.52			0.32			0.32	
v/c Ratio		0.79			0.75			0.01			0.68	
Control Delay		21.2			17.4			0.0			18.4	
Queue Delay		0.0			0.0			0.0			0.0	
Total Delay		21.2			17.4			0.0			18.4	
LOS		C			B			A			B	
Approach Delay		21.2			17.4						18.4	
Approach LOS		C			B						B	

Intersection Summary

Area Type: Other

Cycle Length: 60

Actuated Cycle Length: 49.7

Natural Cycle: 60

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 0.79

Intersection Signal Delay: 18.9

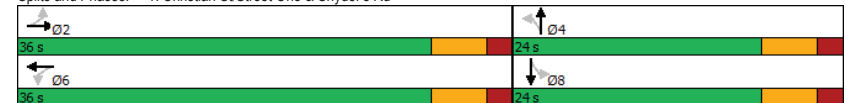
Intersection LOS: B

Intersection Capacity Utilization 102.8%

ICU Level of Service G

Analysis Period (min) 15

Splits and Phases: 1: Christian St/Street One & Snyder's Rd

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Queues

1: Christian St/Street One & Snyder's Rd

Total (2028) - Street One

AM Peak Hour

	→	←	↑	↓
Lane Group	EBT	WBT	NBT	SBT
Lane Group Flow (vph)	514	564	6	324
v/c Ratio	0.79	0.75	0.01	0.68
Control Delay	21.2	17.4	0.0	18.4
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	21.2	17.4	0.0	18.4
Queue Length 50th (m)	36.3	37.3	0.0	16.0
Queue Length 95th (m)	#95.6	#81.1	0.0	#44.6
Internal Link Dist (m)	563.8	1075.6	144.2	113.2
Turn Bay Length (m)				
Base Capacity (vph)	865	987	530	597
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.59	0.57	0.01	0.54

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis

1: Christian St/Street One & Snyder's Rd

Total (2028) - Street One

AM Peak Hour

	↖	→	↗	↙	←	↖	↗	↑	↙	↗	↓	↖
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (vph)	82	432	0	1	490	73	5	0	1	134	0	190
Future Volume (vph)	82	432	0	1	490	73	5	0	1	134	0	190
Ideal Flow (vphpl)	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Flpb, ped/bikes		1.00			1.00			1.00			1.00	
Flpb, ped/bikes		1.00			1.00			1.00			1.00	
Frt		1.00			0.98			0.98			0.92	
Flt Protected		0.99			1.00			0.96			0.98	
Satd. Flow (prot)		1459			1444			1455			1398	
Flt Permitted		0.86			1.00			0.78			0.86	
Satd. Flow (perm)		1272			1443			1176			1232	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	82	432	0	1	490	73	5	0	1	134	0	190
RTOR Reduction (vph)	0	0	0	0	9	0	0	4	0	0	87	0
Lane Group Flow (vph)	0	514	0	0	555	0	0	2	0	0	237	0
Confl. Peds. (#/hr)		2		2								
Heavy Vehicles (%)	2%	6%	0%	0%	6%	2%	0%	0%	0%	0%	0%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			4			8	
Permitted Phases	2			6			4			8		
Actuated Green, G (s)		23.5			23.5			13.6			13.6	
Effective Green, g (s)		25.5			25.5			15.6			15.6	
Actuated g/C Ratio		0.52			0.52			0.32			0.32	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		660			749			373			391	
v/s Ratio Prot												
v/s Ratio Perm		c0.40			0.38			0.00			c0.19	
v/c Ratio		0.78			0.74			0.01			0.61	
Uniform Delay, d1		9.5			9.2			11.4			14.1	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		5.8			4.0			0.0			2.6	
Delay (s)		15.3			13.2			11.5			16.8	
Level of Service		B			B			B			B	
Approach Delay (s)		15.3			13.2			11.5			16.8	
Approach LOS		B			B			B			B	

Intersection Summary

HCM 2000 Control Delay	14.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	49.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	102.8%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Lanes, Volumes, Timings
2: Street One & Wagler Ave

Total (2028) - Street One
AM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	33	20	2	9	21	91	43	86	271	0
Future Volume (vph)	0	0	33	20	2	9	21	91	43	86	271	0
Ideal Flow (vphpl)	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.865			0.961			0.963				
Flt Protected					0.969			0.993			0.988	
Satd. Flow (prot)	0	1497	0	0	1611	0	0	1655	0	0	1710	0
Flt Permitted					0.969			0.993			0.988	
Satd. Flow (perm)	0	1497	0	0	1611	0	0	1655	0	0	1710	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		119.0			107.2			68.0			314.0	
Travel Time (s)		8.6			7.7			4.9			22.6	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	33	20	2	9	21	91	43	86	271	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	33	0	0	31	0	0	155	0	0	357	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Free			Free	

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 48.3% ICU Level of Service A

Analysis Period (min) 15

HCM Unsignalized Intersection Capacity Analysis
2: Street One & Wagler Ave

Total (2028) - Street One
AM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	33	20	2	9	21	91	43	86	271	0
Future Volume (Veh/h)	0	0	33	20	2	9	21	91	43	86	271	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	0	0	33	20	2	9	21	91	43	86	271	0
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (m)								205				
pX, platoon unblocked												
vC, conflicting volume	608	619	271	630	598	112	271			134		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	608	619	271	630	598	112	271			134		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	96	94	99	99	98			94		
cM capacity (veh/h)	380	374	768	355	385	940	1292			1451		
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total	33	31	155	357								
Volume Left	0	20	21	86								
Volume Right	33	9	43	0								
cSH	768	436	1292	1451								
Volume to Capacity	0.04	0.07	0.02	0.06								
Queue Length 95th (m)	1.1	1.8	0.4	1.5								
Control Delay (s)	9.9	13.9	1.2	2.2								
Lane LOS	A	B	A	A								
Approach Delay (s)	9.9	13.9	1.2	2.2								
Approach LOS	A	B										

Intersection Summary

Average Delay 3.0

Intersection Capacity Utilization 48.3% ICU Level of Service A

Analysis Period (min) 15

Lanes, Volumes, Timings
3: Street One & Street Seven

Total (2028) - Street One
AM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (vph)	0	0	27	28	0	0	13	75	12	0	302	0
Future Volume (vph)	0	0	27	28	0	0	13	75	12	0	302	0
Ideal Flow (vphpl)	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.865						0.984				
Flt Protected					0.950			0.994				
Satd. Flow (prot)	0	1497	0	0	1644	0	0	1692	0	0	1730	0
Flt Permitted					0.950			0.994				
Satd. Flow (perm)	0	1497	0	0	1644	0	0	1692	0	0	1730	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		95.8			90.4			314.0			278.7	
Travel Time (s)		6.9			6.5			22.6			20.1	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	27	28	0	0	13	75	12	0	302	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	27	0	0	28	0	0	100	0	0	302	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Stop			Stop	

Intersection Summary

Area Type: Other

Control Type: Unsignalized

Intersection Capacity Utilization 32.1% ICU Level of Service A

Analysis Period (min) 15

HCM Unsignalized Intersection Capacity Analysis
3: Street One & Street Seven

Total (2028) - Street One
AM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Sign Control		Stop			Stop			Stop			Stop	
Traffic Volume (vph)	0	0	27	28	0	0	13	75	12	0	302	0
Future Volume (vph)	0	0	27	28	0	0	13	75	12	0	302	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	0	0	27	28	0	0	13	75	12	0	302	0
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total (vph)	27	28	100	302								
Volume Left (vph)	0	28	13	0								
Volume Right (vph)	27	0	12	0								
Hadj (s)	-0.57	0.23	-0.01	0.03								
Departure Headway (s)	4.3	5.1	4.3	4.2								
Degree Utilization, x	0.03	0.04	0.12	0.35								
Capacity (veh/h)	763	650	803	839								
Control Delay (s)	7.4	8.3	7.9	9.4								
Approach Delay (s)	7.4	8.3	7.9	9.4								
Approach LOS	A	A	A	A								
Intersection Summary												
Delay			8.9									
Level of Service			A									
Intersection Capacity Utilization			32.1%									
Analysis Period (min)			15									

Lanes, Volumes, Timings
4: Street One & Street Two

Total (2028) - Street One
AM Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	39	160	0	0	5	24	46	0	103	0
Future Volume (vph)	0	0	39	160	0	0	5	24	46	0	103	0
Ideal Flow (vphpl)	1900	1650	1650	1650	1650	1900	1765	1900	1765	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.865							0.917				
Flt Protected					0.950				0.997			
Satd. Flow (prot)	0	1399	0	0	1537	0	0	1703	0	0	1863	0
Flt Permitted					0.950				0.997			
Satd. Flow (perm)	0	1399	0	0	1537	0	0	1703	0	0	1863	0
Link Speed (k/h)	50			50			50			50		
Link Distance (m)	155.5			136.9			278.7			168.8		
Travel Time (s)	11.2			9.9			20.1			12.2		
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	39	160	0	0	5	24	46	0	103	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	39	0	0	160	0	0	75	0	0	103	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)	0.0			0.0			0.0			0.0		
Link Offset(m)	0.0			0.0			0.0			0.0		
Crosswalk Width(m)	4.8			4.8			4.8			4.8		
Two way Left Turn Lane												
Headway Factor	1.00	1.20	1.20	1.20	1.20	1.00	1.10	1.00	1.10	1.00	1.00	1.00
Turning Speed (k/h)	25		15		25		15		25		15	
Sign Control	Yield			Yield			Yield			Stop		
Intersection Summary												
Area Type:	Other											
Control Type: Roundabout												
Intersection Capacity Utilization 32.1%												
ICU Level of Service A												
Analysis Period (min) 15												

HCM Unsignalized Intersection Capacity Analysis
4: Street One & Street Two

Total (2028) - Street One
AM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Right Turn Channelized												
Traffic Volume (veh/h)	0	0	39	160	0	0	5	24	46	0	103	0
Future Volume (veh/h)	0	0	39	160	0	0	5	24	46	0	103	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	0	0	39	160	0	0	5	24	46	0	103	0
Approach Volume (veh/h)	39			160			75			103		
Crossing Volume (veh/h)	263			29			0			165		
High Capacity (veh/h)	1127			1354			1385			1217		
High v/c (veh/h)	0.03			0.12			0.05			0.08		
Low Capacity (veh/h)	927			1133			1161			1009		
Low v/c (veh/h)	0.04			0.14			0.06			0.10		
Intersection Summary												
Maximum v/c High	0.12											
Maximum v/c Low	0.14											
Intersection Capacity Utilization	32.1%			ICU Level of Service					A			

HCM 6th Roundabout
4: Street One & Street Two

Total (2028) - Street One
AM Peak Hour

Intersection				
Intersection Delay, s/veh	3.7			
Intersection LOS	A			
Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	39	160	75	103
Demand Flow Rate, veh/h	40	163	76	105
Vehicles Circulating, veh/h	268	29	0	168
Vehicles Exiting, veh/h	5	47	308	24
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	3.8	3.7	3.1	3.9
Approach LOS	A	A	A	A
Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	40	163	76	105
Cap Entry Lane, veh/h	1050	1340	1380	1163
Entry HV Adj Factor	0.975	0.982	0.981	0.980
Flow Entry, veh/h	39	160	75	103
Cap Entry, veh/h	1024	1315	1353	1140
V/C Ratio	0.038	0.122	0.055	0.090
Control Delay, s/veh	3.8	3.7	3.1	3.9
LOS	A	A	A	A
95th %tile Queue, veh	0	0	0	0

Lanes, Volumes, Timings
1: Christian St/Street One & Snyder's Rd

Total (2028) - Street One
PM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		+			+			+			+	
Traffic Volume (vph)	128	298	3	3	388	225	5	0	3	75	0	124
Future Volume (vph)	128	298	3	3	388	225	5	0	3	75	0	124
Ideal Flow (vphpl)	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor	1.00											
Frt	0.999											
Fit Protected	0.985											
Satd. Flow (prot)	0	1504	0	0	1465	0	0	1427	0	0	1394	0
Fit Permitted	0.746											
Satd. Flow (perm)	0	1139	0	0	1462	0	0	1197	0	0	1244	0
Right Turn on Red	Yes											
Satd. Flow (RTOR)	1											
Link Speed (k/h)	50											
Link Distance (m)	587.8											
Travel Time (s)	42.3											
Confl. Peds. (#/hr)	5											
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	0%	2%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Adj. Flow (vph)	128	298	3	3	388	225	5	0	3	75	0	124
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	429	0	0	616	0	0	8	0	0	199	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)	0.0											
Link Offset(m)	0.0											
Crosswalk Width(m)	4.8											
Two way Left Turn Lane												
Headway Factor	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.29
Turning Speed (k/h)	25	25	15	25	25	15	25	25	15	25	25	15
Number of Detectors	1	2		1	2		1	2		1	2	
Detector Template	Left	Thru		Left	Thru		Left	Thru		Left	Thru	
Leading Detector (m)	2.0	10.0		2.0	10.0		2.0	10.0		2.0	10.0	
Trailing Detector (m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Position(m)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Size(m)	2.0	0.6		2.0	0.6		2.0	0.6		2.0	0.6	
Detector 1 Type	Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex		Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Queue (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 1 Delay (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	
Detector 2 Position(m)	9.4											
Detector 2 Size(m)	0.6											
Detector 2 Type	Cl+Ex											
Detector 2 Channel												
Detector 2 Extend (s)	0.0											
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases	2											
Permitted Phases	2											

Lanes, Volumes, Timings

1: Christian St/Street One & Snyder's Rd

Total (2028) - Street One

PM Peak Hour

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Detector Phase	2	2		6	6		4	4		8	8	
Switch Phase												
Minimum Initial (s)	5.0	5.0		5.0	5.0		8.0	8.0		8.0	8.0	
Minimum Split (s)	24.0	24.0		24.0	24.0		24.0	24.0		24.0	24.0	
Total Split (s)	36.0	36.0		36.0	36.0		24.0	24.0		24.0	24.0	
Total Split (%)	60.0%	60.0%		60.0%	60.0%		40.0%	40.0%		40.0%	40.0%	
Maximum Green (s)	30.0	30.0		30.0	30.0		18.0	18.0		18.0	18.0	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lost Time Adjust (s)		-2.0			-2.0			-2.0			-2.0	
Total Lost Time (s)		4.0			4.0			4.0			4.0	
Lead/Lag												
Lead-Lag Optimize?												
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Recall Mode	Min	Min		Min	Min		None	None		None	None	
Walk Time (s)	7.0	7.0		7.0	7.0		7.0	7.0		7.0	7.0	
Flash Dont Walk (s)	11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0	
Pedestrian Calls (#/hr)	0	0		0	0		0	0		0	0	
Act Effct Green (s)		28.4			28.4			12.2			12.2	
Actuated g/C Ratio		0.58			0.58			0.25			0.25	
v/c Ratio		0.65			0.70			0.02			0.49	
Control Delay		13.3			12.3			0.1			11.6	
Queue Delay		0.0			0.0			0.0			0.0	
Total Delay		13.3			12.3			0.1			11.6	
LOS		B			B			A			B	
Approach Delay		13.3			12.3			0.1			11.6	
Approach LOS		B			B			A			B	

Intersection Summary

Area Type: Other

Cycle Length: 60

Actuated Cycle Length: 48.7

Natural Cycle: 60

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 0.70

Intersection Signal Delay: 12.5

Intersection LOS: B

Intersection Capacity Utilization 95.3%

ICU Level of Service F

Analysis Period (min) 15

Splits and Phases: 1: Christian St/Street One & Snyder's Rd

→ Ø2	36 s	→ Ø4	24 s
← Ø6	36 s	↓ Ø8	24 s

Queues

1: Christian St/Street One & Snyder's Rd

Total (2028) - Street One

PM Peak Hour

Lane Group	EBT	WBT	NBT	SBT
Lane Group Flow (vph)	429	616	8	199
v/c Ratio	0.65	0.70	0.02	0.49
Control Delay	13.3	12.3	0.1	11.6
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	13.3	12.3	0.1	11.6
Queue Length 50th (m)	19.1	24.4	0.0	4.6
Queue Length 95th (m)	61.6	#78.6	0.0	20.7
Internal Link Dist (m)	563.8	1117.5	144.2	100.8
Turn Bay Length (m)				
Base Capacity (vph)	760	1000	531	591
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.56	0.62	0.02	0.34

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
1: Christian St/Street One & Snyder's Rd

Total (2028) - Street One
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (vph)	128	298	3	3	388	225	5	0	3	75	0	124
Future Volume (vph)	128	298	3	3	388	225	5	0	3	75	0	124
Ideal Flow (vphpl)	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frpb, ped/bikes		1.00			1.00			1.00			1.00	
Flpb, ped/bikes		1.00			1.00			1.00			1.00	
Frt		1.00			0.95			0.95			0.92	
Flt Protected		0.99			1.00			0.97			0.98	
Satd. Flow (prot)		1505			1464			1427			1393	
Flt Permitted		0.75			1.00			0.81			0.88	
Satd. Flow (perm)		1139			1462			1198			1243	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	128	298	3	3	388	225	5	0	3	75	0	124
RTOR Reduction (vph)	0	0	0	0	31	0	0	6	0	0	93	0
Lane Group Flow (vph)	0	429	0	0	585	0	0	2	0	0	106	0
Confl. Peds. (#/hr)		5		5								
Heavy Vehicles (%)	0%	2%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		2			6			4			8	
Permitted Phases	2			6			4			8		
Actuated Green, G (s)		26.4			26.4			10.2			10.2	
Effective Green, g (s)		28.4			28.4			12.2			12.2	
Actuated g/C Ratio		0.58			0.58			0.25			0.25	
Clearance Time (s)		6.0			6.0			6.0			6.0	
Vehicle Extension (s)		3.0			3.0			3.0			3.0	
Lane Grp Cap (vph)		665			854			300			312	
v/s Ratio Prot												
v/s Ratio Perm		0.38			c0.40			0.00			c0.09	
v/c Ratio		0.64			0.69			0.01			0.34	
Uniform Delay, d1		6.7			7.0			13.7			14.9	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		2.1			2.3			0.0			0.7	
Delay (s)		8.9			9.3			13.7			15.6	
Level of Service		A			A			B			B	
Approach Delay (s)		8.9			9.3			13.7			15.6	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM 2000 Control Delay	10.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	48.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	95.3%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Lanes, Volumes, Timings
2: Wagler Avenue & Street One

Total (2028) - Street One
PM Peak Hour

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (vph)	0	0	21	52	5	33	32	216	105	40	126	0
Future Volume (vph)	0	0	21	52	5	33	32	216	105	40	126	0
Ideal Flow (vphpl)	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.865			0.950			0.960				
Flt Protected					0.972			0.995			0.988	
Satd. Flow (prot)	0	1497	0	0	1598	0	0	1653	0	0	1710	0
Flt Permitted					0.972			0.995			0.988	
Satd. Flow (perm)	0	1497	0	0	1598	0	0	1653	0	0	1710	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		124.6			90.7			91.1			294.0	
Travel Time (s)		9.0			6.5			6.6			21.2	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	21	52	5	33	32	216	105	40	126	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	21	0	0	90	0	0	353	0	0	166	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Stop			Stop			Free			Free	

Intersection Summary	
Area Type:	Other
Control Type:	Unsignalized
Intersection Capacity Utilization 41.9%	ICU Level of Service A
Analysis Period (min) 15	

HCM Unsignalized Intersection Capacity Analysis 2: Wagler Avenue & Street One

Total (2028) - Street One
PM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	21	52	5	33	32	216	105	40	126	0
Future Volume (Veh/h)	0	0	21	52	5	33	32	216	105	40	126	0
Sign Control	Stop			Stop			Free			Free		
Grade	0%			0%			0%			0%		
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	0	0	21	52	5	33	32	216	105	40	126	0
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type	None								None			
Median storage (veh)												
Upstream signal (m)	216											
pX, platoon unblocked												
vC, conflicting volume	574	591	126	560	538	268	126				321	
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	574	591	126	560	538	268	126				321	
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1				4.1	
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2				2.2	
p0 queue free %	100	100	98	87	99	96	98				97	
cM capacity (veh/h)	391	397	924	412	425	770	1460				1239	
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total	21	90	353	166								
Volume Left	0	52	32	40								
Volume Right	21	33	105	0								
cSH	924	498	1460	1239								
Volume to Capacity	0.02	0.18	0.02	0.03								
Queue Length 95th (m)	0.6	5.2	0.5	0.8								
Control Delay (s)	9.0	13.8	0.9	2.1								
Lane LOS	A	B	A	A								
Approach Delay (s)	9.0	13.8	0.9	2.1								
Approach LOS	A	B										
Intersection Summary												
Average Delay				3.3								
Intersection Capacity Utilization				41.9%	ICU Level of Service			A				
Analysis Period (min)				15								

Lanes, Volumes, Timings 3: Street One & Street Seven

Total (2028) - Street One
PM Peak Hour

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	12	13	0	0	11	227	11	0	141	0
Future Volume (vph)	0	0	12	13	0	0	11	227	11	0	141	0
Ideal Flow (vphpl)	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765	1765
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	0.865						0.994					
Flt Protected					0.950		0.998					
Satd. Flow (prot)	0	1497	0	0	1644	0	0	1717	0	0	1730	0
Flt Permitted					0.950		0.998					
Satd. Flow (perm)	0	1497	0	0	1644	0	0	1717	0	0	1730	0
Link Speed (k/h)	50				50		50				50	
Link Distance (m)	90.4				114.7		294.0				215.4	
Travel Time (s)	6.5				8.3		21.2				15.5	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	12	13	0	0	11	227	11	0	141	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	12	0	0	13	0	0	249	0	0	141	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)	0.0				0.0		0.0				0.0	
Link Offset(m)	0.0				0.0		0.0				0.0	
Crosswalk Width(m)	4.8				4.8		4.8				4.8	
Two way Left Turn Lane												
Headway Factor	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control	Stop				Stop				Stop			
Intersection Summary												
Area Type:	Other											
Control Type: Unsignalized												
Intersection Capacity Utilization 37.4%					ICU Level of Service A							
Analysis Period (min) 15												

HCM Unsignalized Intersection Capacity Analysis 3: Street One & Street Seven

Total (2028) - Street One
PM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Movement												
Lane Configurations		↔			↔			↔			↔	
Sign Control		Stop			Stop			Stop			Stop	
Traffic Volume (vph)	0	0	12	13	0	0	11	227	11	0	141	0
Future Volume (vph)	0	0	12	13	0	0	11	227	11	0	141	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	0	0	12	13	0	0	11	227	11	0	141	0
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total (vph)	12	13	249	141								
Volume Left (vph)	0	13	11	0								
Volume Right (vph)	12	0	11	0								
Hadj (s)	-0.57	0.23	0.02	0.03								
Departure Headway (s)	4.2	5.0	4.1	4.2								
Degree Utilization, x	0.01	0.02	0.28	0.17								
Capacity (veh/h)	774	658	858	835								
Control Delay (s)	7.2	8.1	8.7	8.1								
Approach Delay (s)	7.2	8.1	8.7	8.1								
Approach LOS	A	A	A	A								
Intersection Summary												
Delay			8.5									
Level of Service			A									
Intersection Capacity Utilization			37.4%									
Analysis Period (min)			15									

Lanes, Volumes, Timings 4: Street One & Street Two

Total (2028) - Street One
PM Peak Hour

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group												
Lane Configurations		↔			↔			↔			↔	
Traffic Volume (vph)	0	0	7	131	0	0	8	67	81	0	74	0
Future Volume (vph)	0	0	7	131	0	0	8	67	81	0	74	0
Ideal Flow (vphpl)	1900	1650	1650	1650	1650	1900	1765	1900	1765	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.865						0.930				
Flt Protected					0.950			0.997				
Satd. Flow (prot)	0	1399	0	0	1537	0	0	1727	0	0	1863	0
Flt Permitted					0.950			0.997				
Satd. Flow (perm)	0	1399	0	0	1537	0	0	1727	0	0	1863	0
Link Speed (k/h)		50			50			50			50	
Link Distance (m)		148.4			145.0			215.4			201.8	
Travel Time (s)		10.7			10.4			15.5			14.5	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	0	7	131	0	0	8	67	81	0	74	0
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	7	0	0	131	0	0	156	0	0	74	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(m)		0.0			0.0			0.0			0.0	
Link Offset(m)		0.0			0.0			0.0			0.0	
Crosswalk Width(m)		4.8			4.8			4.8			4.8	
Two way Left Turn Lane												
Headway Factor	1.00	1.20	1.20	1.20	1.20	1.00	1.10	1.00	1.10	1.00	1.00	1.00
Turning Speed (k/h)	25		15	25		15	25		15	25		15
Sign Control		Yield			Yield			Yield			Stop	
Intersection Summary												
Area Type:	Other											
Control Type:	Roundabout											
Intersection Capacity Utilization	37.2%											
Analysis Period (min)	15											

HCM Unsignalized Intersection Capacity Analysis
4: Street One & Street Two

Total (2028) - Street One
PM Peak Hour

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Right Turn Channelized												
Traffic Volume (veh/h)	0	0	7	131	0	0	8	67	81	0	74	0
Future Volume (veh/h)	0	0	7	131	0	0	8	67	81	0	74	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hourly flow rate (vph)	0	0	7	131	0	0	8	67	81	0	74	0
Approach Volume (veh/h)	7			131			156			74		
Crossing Volume (veh/h)	205			75			0			139		
High Capacity (veh/h)	1179			1306			1385			1242		
High v/c (veh/h)	0.01			0.10			0.11			0.06		
Low Capacity (veh/h)	975			1090			1161			1032		
Low v/c (veh/h)	0.01			0.12			0.13			0.07		
Intersection Summary												
Maximum v/c High	0.11											
Maximum v/c Low	0.13											
Intersection Capacity Utilization	37.2%			ICU Level of Service			A					

HCM 6th Roundabout
4: Street One & Street Two

Total (2028) - Street One
PM Peak Hour

Intersection				
Intersection Delay, s/veh	3.6			
Intersection LOS	A			
Approach	EB	WB	NB	SB
Entry Lanes	1	1	1	1
Conflicting Circle Lanes	1	1	1	1
Adj Approach Flow, veh/h	7	131	156	74
Demand Flow Rate, veh/h	7	134	159	75
Vehicles Circulating, veh/h	209	76	0	142
Vehicles Exiting, veh/h	8	83	216	68
Ped Vol Crossing Leg, #/h	0	0	0	0
Ped Cap Adj	1.000	1.000	1.000	1.000
Approach Delay, s/veh	3.3	3.7	3.6	3.6
Approach LOS	A	A	A	A
Lane	Left	Left	Left	Left
Designated Moves	LTR	LTR	LTR	LTR
Assumed Moves	LTR	LTR	LTR	LTR
RT Channelized				
Lane Util	1.000	1.000	1.000	1.000
Follow-Up Headway, s	2.609	2.609	2.609	2.609
Critical Headway, s	4.976	4.976	4.976	4.976
Entry Flow, veh/h	7	134	159	75
Cap Entry Lane, veh/h	1115	1277	1380	1194
Entry HV Adj Factor	1.000	0.978	0.979	0.980
Flow Entry, veh/h	7	131	156	74
Cap Entry, veh/h	1115	1248	1351	1170
V/C Ratio	0.006	0.105	0.115	0.063
Control Delay, s/veh	3.3	3.7	3.6	3.6
LOS	A	A	A	A
95th %tile Queue, veh	0	0	0	0

APPENDIX E



2023-12-11
Project: 200068

Project

1012 Snyder's Road West, Baden TIS

Based On

Region of Waterloo Roundabout Feasibility
Initial Screening Tool 1.0 23 May 2012

RE: SNYDER'S ROAD WEST (RR1) AT CHRISTIAN STREET/STREET ONE, BADEN

The intent of this screening tool is to provide a relatively quick assessment of the feasibility of a modern roundabout at a particular intersection in comparison to other appropriate forms of traffic control or road improvements including auxiliary lanes, traffic control signals, four-way stops, etc. The intended outcome of this tool is to provide enough information to assist staff in deciding whether or not to proceed to an Intersection Control Study to further investigate in more detail the feasibility of a roundabout.

1) Project Name / File Number

- ▶ 200068 1012 Snyder's Road West, Baden TIS

2) Intersection Location

(Street/Road Names, distance from major intersection, etc.)

- ▶ Snyder's Road West (RR1) at Christian Street / Street One
- ▶ Nearest major intersection: Foundry Street at Snyder's Road (signalized) is approximately 0.64 km to the east.

3) Brief Description of Intersection

Number of legs, lanes on each leg, total AADT, AADT on each road, etc. Attach or sketch diagram showing existing and horizon-year turning movements)

- ▶ Three-legged intersection with northbound approach (minor leg) stop controlled.
- ▶ Fourth leg (southbound approach) would be new municipal roadway upon completion of subdivision.
- ▶ Existing AADT approximately 5,700 on major road (Snyder's Road West) and 130 on minor road (Christian Street).

- ▶ 10-Year forecast AADT approximately 10,440 on major road (Synder's Road) and 5,520 (North Leg) and 170 (south left) approaches.

4) What Operation Problems are being experienced at this location?

- ▶ Under existing conditions, none.
- ▶ Under 2028 future total traffic conditions, the northbound and southbound approaches are forecast to operate at LOS E and v/c ratio of 0.06 (northbound) and LOS F and v/c ratio of 1.00 or greater (southbound) during AM peak hour. There are no operational concerns in the forecast PM peak hour.

5) Is it a new intersection or is it a retrofit of an existing intersections?

If existing, what is the existing traffic control?

- ▶ Existing, two-way stop-control for the minor approaches.

6) Is the intersection in the vicinity of a railroad crossing or another intersection?

If so, how close and what type of traffic control exists at the adjacent intersection? Will queues be a problem?

- ▶ Nearest railroad crossing is approximately 0.64 km to the east at the Foundry Street and Snyder's Road intersection.
- ▶ Nearest intersection is Snyder's Road West and Miller Street (unsignalized) approximately 110 metres to the east.
- ▶ Queueing not expected to be a problem.

7) Would the intersection be located within a coordinated signal system?

- ▶ Potentially yes, Foundry Street at Snyder's Road is controlled by traffic signals.

8) Would the intersection be located on a Preferred Roundabout Corridor?

- ▶ No, there are currently no roundabouts nearby, but a roundabout is proposed at Snyder's Road West and Nafziger Road approximately 1.64 kilometres to the west.



9) Is the intersection located within a corridor that is scheduled for improvements in the 10 Year Transportation Capital Program?

What is the ultimate cross-section of the approach roads?

- ▶ Snyder's Road West from Nafziger Road to Baden Water Tower Entrance (approximately 100m west of Christian Street) identified in the 10-Year Transportation Capital Program under Base Program during 2025 to 2029 timeframe. No expansion program identified for Snyder's Road West.
- ▶ No improvements/widening of Snyder's Road West identified in the Region of Waterloo Transportation Master Plan.
- ▶ Ultimate cross-section of major and minor approaches are single lane.

10) What is the collision history of the intersection for the past five years?

Is there a collision problem that needs to be addressed?

- ▶ There has been one (1) reported collision (non-fatal injury) at the intersection of Snyder's Road West and Christian Street in the last five years.

11) Are person with disabilities or horse and buggies frequent users of this intersection?

- ▶ Not expected to be, but there is the possibility of persons with disabilities and/or horse and buggies to use this intersection.

12) What traditional road improvements are proposed for this intersection?

(eg. Traffic signals, all-way stop, auxiliary lanes etc.) Please attach a sketch of the traditional road improvements.

- ▶ A 25-metre eastbound left-turn lane on Snyder's Road West is warranted under future total traffic conditions. A westbound let-turn lane to address lane balancing.

13) If traffic control signals are being considered, are the traffic signal warrants met for the horizon year?

- ▶ Traffic signals are not warranted under for future 2028 horizon year.

14) What size of roundabout is being considered for this intersection?

- ▶ 40m ICD single-lane with single lane approaches.



15) 20-Year Life Cycle Cost Estimate

- ▶ 10 Year AADT: 10,040 (major) and 4,810 (minor)
- ▶ Non-injury Social Collision Cost (Signal): \$5,000
- ▶ Non-injury Social Collision Cost (Roundabout): \$4,500
- ▶ Injury Social Collision Cost: \$60,500
- ▶ Fatal Injury Collision Cost: \$1,656,500
- ▶ Discount Rate (i): 6%

20-Year Life-Cycle Cost Comparison		
Cost Item	Turn Lanes	Roundabout
Implementation Cost	\$400,000 (EB & WB LT Lanes)	\$900,000
Injury Collision Cost (Present Value)	\$1,038,624	\$273,820
Total Life Cycle Cost	\$1,438,624	\$1,173,820

Conclusions and Recommendations

- ▶ Roundabout cost is less than auxiliary turn lanes.
- ▶ Proceed to Intersection Control Study.





INTERSECTION CONTROL STUDIES SAFETY ASSESSMENT METHODOLOGY

Last Rev JAN 2021

Scenario: **1012 Synder's Road West, Baden TIS**

Major Road: **Synder's Road West (RR1)**

Minor Road: **Christian Street / Street One**

Major Road Direction: **East / West**

Urban or Rural: **Rural**

Proposed Control: **Signalized**

Proposed Config: **4-Leg Intersection**

LT Lanes Proposed (non roundabout):		RT Lanes Proposed (non roundabout):	
Major	2 Approaches	Major	No RT Lanes
Minor	No LT Lanes	Minor	No RT Lanes

Is there going to be any fully protected left-turn phasing? **NO**

Number of approaches with FPLTP: **N/A**

Is the proposed intersection "new" or is it existing: **EXISTING**

Does control and number of approaches remain the same: **NO**

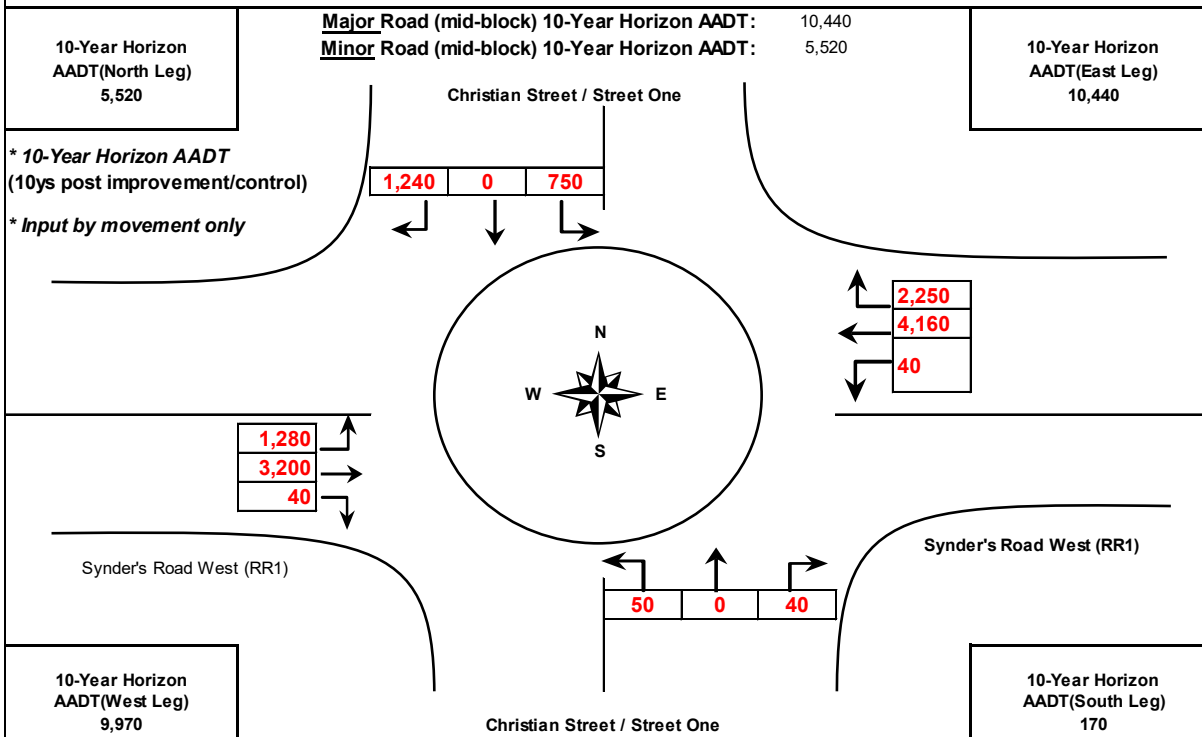
Will the proposed intersection have illumination: **YES**

5-Year Total Collisions: **1**

5-Year PDO Collisions: **0**

Proposed RA Configuration? **SINGLE - 4 x 1**

* Proposed RA config. - 1st number represents approaches while 2nd represents lanes



Direct Capital Costs

Fatal = \$1,656,500

Injury = \$60,500

PDO_{SIG} = \$5,000

PDO_{RA} = \$4,500

Discount Rate = 0.06

20-Year Present Value Collision Costs (DIRECT CAPITAL COSTS)

Collisions by Severity	Total	PDO	Injury	Fatal
Signalized	\$1,038,624.31	\$123,301.65	\$763,323.26	\$151,999.40
Roundabout	\$273,819.65	\$109,798.97	\$164,020.68	\$0.00

* Roundabout calibration Factor - 0.5





INTERSECTION CONTROL STUDIES SAFETY ASSESSMENT METHODOLOGY (HSM)

Last Rev JAN 2021

Scenario: 1012 Synder's Road West, Baden TIS

Major Road: Synder's Road West (RR1)

Minor Road: Christian Street / Street One

Major Road Direction: East / West

Urban or Rural: Rural

Proposed Control: Signalized

Proposed Config. 4-Leg Intersection

Roundabout Conflicts: 7880

5-Year Total Collisions: 1

5-Year PDO Collisions: 0

Estimated ANNUAL (1-YEAR ONLY) Collisions				
Future Expected Collisions by Severity	Total	PDO	Injury	Fatal
Signalized	3.26	2.15	1.10	0.01
Roundabout	2.36	2.13	0.24	0.00

TOTAL CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	4-Leg Intersection	-5.13	0.6	0.2	N/A	0.007	n/a

PDO CRASH COEFFICIENTS USED IN CALCULATION						Fatal/Inj. Ratio	Collision Factor
Control	Intersection Config	Intercept	AADTmaj	AADTmin	Overdispersion		
Signalized	4-Leg Intersection	-5.13	0.6	0.2	N/A	0.007	0.66

Collision Modification Factors (cmf's)	Left Turn Lane	Right Turn Lane	Calibration Factor	Empirical Bays Weighting	
	0.67		0.64	Total	PDO
				N/A	N/A
	Illumination	Protected LT Phasing			
	0.89	1.00			

Comments:

