March 9, 2020

Mr. Greg Zwicker, MCIP, LPP, Principal
Urban Planner
ZZap Consulting Inc. [via email: greg@zzap.ca]

RE: Traffic Impact Analysis – Lovett Lake Phase 3
Halifax, Nova Scotia

Dear Mr. Zwicker:

Armco Capital Inc. is planning a development on currently undeveloped lands adjacent to Lovett Lake on St. Margarets Bay Road (Trunk 3) in Halifax, NS (See Figure 1). This is the Traffic Impact Analysis for Phase 3 of the proposed development.

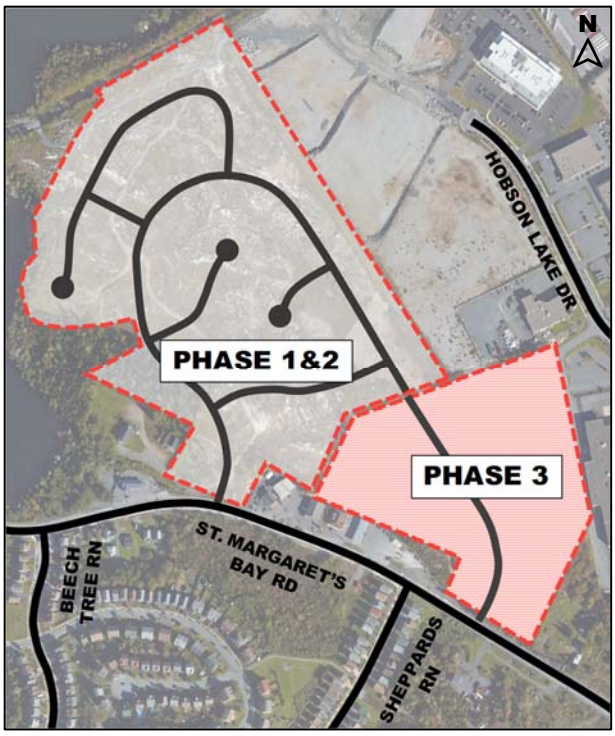


Figure 1 – Study Area

BACKGROUND INFORMATION

In 2012, WSP completed a Traffic Impact Study for the Lovett Lake Lands Mixed-Use Development (Phase 1 and 2). Phase 1 and 2 were expected to consist of 156 single family detached homes, 34 semi-detached homes, 120 townhouses and approximately 2,000 ft^2 of leasable commercial space. Access to this portion of the development was expected to be from a new public road (Higgins Avenue) adjacent to the Beechville Baptist Church (approximately 210 m east of Beech Tree Run and 230 m west of Sheppards Run). From the Traffic Impact Study, it was recommended that a westbound channelized right turn lane and an eastbound left turn lane should in included on the St. Margarets Bay Road approaches. It was also recommended that crosswalk be installed near the intersection of Beech Tree Run at St. Margarets Bay Road.

PHASE 3 SITE DESCRIPTION

Phase 3 of the proposed development is located adjacent to the Phase 1 and 2 development boundaries. Phase 3 is expected to consist of 83 single family detached homes and 10 townhouse units. Access for the development is expected to be located on St. Margarets Bay Road, east of Sheppards Run as well as a street connection to Phase 1/2 (See Figure 2). Access to the townhouse units is expected to be through shared driveways to Higgins Avenue. If driveway access is planned to be from St. Margarets Bay Road then sight distances must be confirmed. The road through Phase 3 will also serve to provide a second connection to Phase 1/2 of the development. Full build-out of the development was assumed to be 2030, based on a 10-year horizon period, which was assumed in the approved Traffic Impact Study (2012) for Phase 1/2.

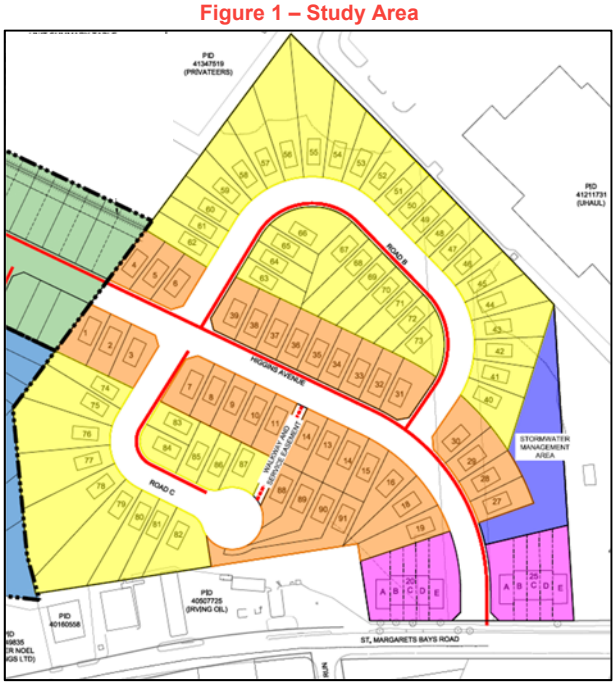


Figure 2 – Phase 3 Study Area

1 Spectacle Lake Drive
Dartmouth, NS, Canada B3B 1X7
Tel.: +1 902-835-9955
Fax: +1 902-835-1645
www.wsp.com

STREET AND INTERSECTION DESCRIPTIONS

St. Margarets Bay Road (Trunk 3) is a 2-lane collector with auxiliary left turn lanes at Beech Tree Run and Sheppards Run. The posted speed limit is 50km/h through the study area, increasing to 70km/h approximately 200 m east of Sheppards Run. Along the site frontage, there is a multi-use pathway on the north side of St. Margarets Bay Road. In addition, HRM Transit currently operates Route 21 (Timberlea) and Route 123 (Timberlea Express) with several eastbound and westbound bus stops on St. Margarets Bay Road near the proposed development site.

Sheppards Run is a 2-lane local street that provides access to the Beechville Estates residential subdivision. The posted speed limit is 50 km/h.

St. Margarets Bay Road at Sheppards Run is a 3-leg, stop controlled intersection with an approximately 115 m westbound left-turn lane on St. Margarets Bay Road and a one lane approach on Sheppards Run. There is an RA-5 crosswalk with flashing beacons on the west side of the intersection, which will provide pedestrian access from Phase 3 to the inbound bus stop.

ACCESS REVIEW

Access to Phases 1/2 of the development is expected to be along St. Margarets Bay Road, east of Beech Tree Run. The 3-leg intersection is expected to provide full access to the development. Throughout development, a secondary access is expected along St. Margarets Bay Road through Phase 3.

Access to the Phase 3 portion of the development is expected to be located along the site frontage with St. Margarets Bay Road, east of Sheppards Run. The exact location of the street depends on the available westbound stopping sight distance. While there is sufficient eastbound sight distance available along the site frontage sight distance for the westbound approach is restricted by the vertical alignment of St. Margarets Bay Road. Based on the vehicle speed in the transition from the 70 km/h zone and the negative grade present in the westbound direction (approximately 4%), it was determined that the minimum distance required for a vehicle travelling at 70 km/h to make a controlled stop is 118 m. In order to determine the approximate location of the site access, available sight distances were measured at the locations marked in Figure 3. It was determined that there is adequate stopping sight distance available for westbound vehicles to make a controlled stop between location markers 1-4 and 9-10 (See Table 1). If the site access were located between marker locations 4-9, there would not be enough sight distance available for vehicles to make a controlled stop. Based on the available stopping sight distances and the available site frontage, to maximize the distance from Sheppards Run it was determined that the access should be located approximately 80 m east of Sheppards Run (See Photo 1 and Photo 2). Due to the proximity of Sheppards Run, which includes a westbound left turn lane on St. Margarets Bay Road, high traffic volume on St. Margarets Bay Road, and limited sight distance, it is recommended that this access accommodate right-in and right-out (RIRO) maneuvers only (See Figure 4).

Table 1 - Available Westbound Stopping Sight Distance

Location Marker Number	Available Stopping Sight Distance (m)	Stopping Sight Distance Threshold Met?
1	200	✓
2	190	✓
3	157	✓
4	130	✓
5	108	✗
6	88	✗
7	72	✗
8	68	✗
9	148	✓
10	139	✓

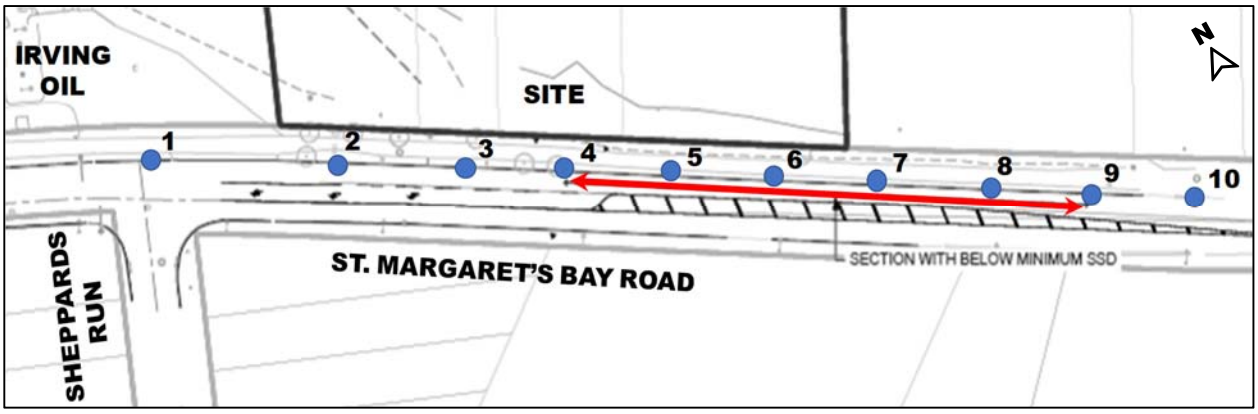


Figure 3 – Stopping Sight Distance Measurement Locations for Westbound Approaching Vehicles

Photo 1 – Looking east (to the left) on St. Margarets Bay Road from the Proposed Site Access

Photo 2 – Looking west (to the right) on St. Margarets Bay Road from the Proposed Site Access

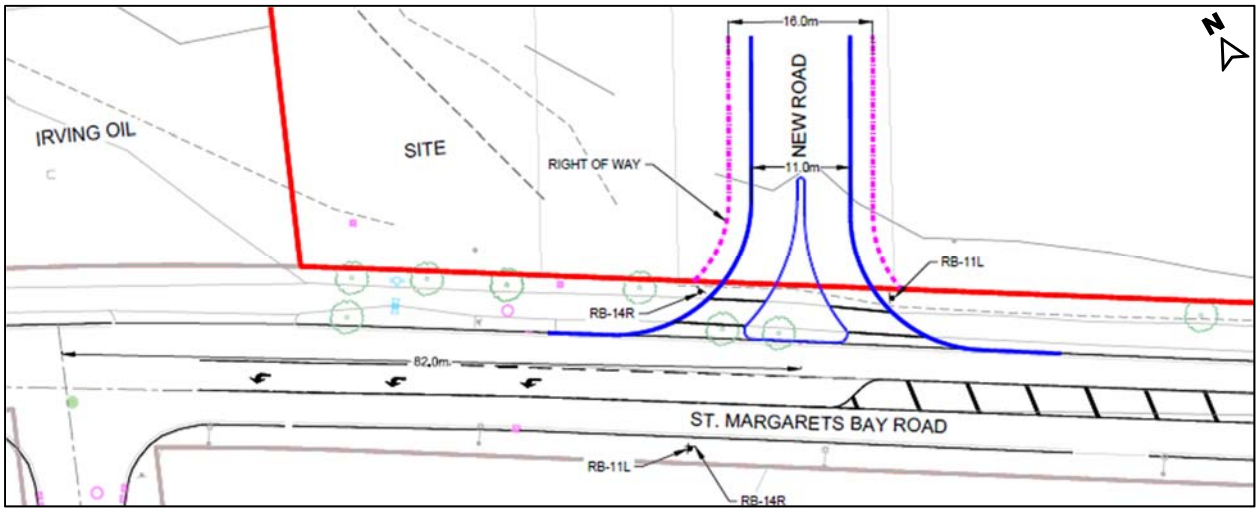


Figure 4 – Location of Right-In/Right-Out Site Access

ESTIMATION OF DESIGN HOURLY BACKGROUND TRAFFIC VOLUMES

Turning movement counts at the St. Margarets Bay Road at Sheppards Run intersection were collected by WSP on Wednesday, January 15, 2020 during morning, midday and evening peak periods. Intersection counts have been tabulated in 15-minute intervals with peak hours indicated by shaded areas (See Table A-1, Appendix A).

To estimate the 2020 design hourly volumes (DHVs) at the intersection, a factor of 1.1 (10% increase in volumes) has been applied to the January 2020 observed traffic volumes. To project background traffic volumes without site development, the 2020 DHVs have been increased by an annual growth rate of 1.5%, which was used in the Phase 1/2 Traffic Impact Study (2012) and is considered typical for this growing area. The annual growth rate was not applied to turning movements to/from Sheppards Run because no additional growth is expected in the Beechville Estates subdivision (i.e. fully occupied). Projected 2030 AM and PM peak hour design hourly background volumes are shown diagrammatically in Figure A-1, Appendix A.

TRIP GENERATION

When using the published trip generation rates in *Trip Generation Manual, 10th Edition* (Institute of Transportation Engineers, Washington, 2017) the transportation engineer's objective should be to provide a realistic estimate of the number of trips that will be generated.

WSP completed a Traffic Impact Study for Phase 1 and Phase 2 of the proposed mixed-use development in July 2012. Trips projected for Phase 1/2 in that study include:

- 238 two-way trips (62 entering and 176 exiting) during the AM peak hour; and,
- 324 two-way trips (203 entering and 121 exiting) during the PM peak hour.

Phase 3 of the proposed development is expected to include 93 single family homes. Trip generation estimates were prepared using *Trip Generation Manual, 10th Edition* (Institute of Transportation Engineers, Washington, 2017) for Phase 3 of the mixed-use development (See Table 2). It was estimated that Phase 3 of the site will generate:

- **71 new** two-way vehicle trips (18 entering and 53 exiting) during the AM peak hour; and,
- **95 new** two-way trips (60 entering and 35 exiting) during the PM peak hour.

It was estimated that full build-out of the site will generate:

- 309 two-way vehicle trips (80 entering and 229 exiting) during the AM peak hour; and,
- 419 two-way trips (263 entering and 156 exiting) during the PM peak hour.

Table 2 - Trip Generation Estimates

Land Use [1]	Units [2]	Trip Generation Rates [3]				Trips Generated [3]			
		AM Peak		PM Peak		AM Peak		PM Peak	
		In	Out	In	Out	In	Out	In	Out
Phase 3									
Single Family (Land Use 210)	93 units	Equations from Pages 3 and 4 (Residential - Land Uses 200 - 299)				18	53	60	35
Total New Trips Generated by Phase 3						**18**	**53**	**60**	**35**
Full Build-Out (Phase 1-3)									
Total Estimated Trips by Phase 1 and 2 [5]						**62**	**176**	**203**	**121**
Total Estimated Trips by Full Build-Out (Phase 1-3)						**80**	**229**	**263**	**156**

Notes:
1. Land Use Code 210 is from *Trip Generation*, *10th Edition,* (Institute of Transportation Engineers, Washington, 2017).
2. Number of detached single family dwellings.
3. Trip generation rates are 'vehicles per hour unit'.
4. Trips generated are 'vehicles per hour' for AM and PM peak hours.
5. Trip generation estimates from the 2012 Traffic Impact Study.

TRIP DISTRIBUTION AND ASSIGNMENT

Trips generated by the proposed development were assigned to the roadway network based on trip origins and destinations within the study area. It was assumed that 70% of all trips generated will be arriving from and exiting to the east (Halifax, Bedford, Dartmouth, etc.) and 30% will be travelling to and from the west (Lakeside, Timberlea, Stillwater Lake, etc.). Estimated trips generated by the proposed development have been assigned to the two (2) proposed access locations, Higgins Avenue (West) and Higgins Avenue (East), see Figure 5. Distributed site trips are shown in Figure A-2, Appendix A. Background traffic volumes with estimated site generated trips are shown in Figure A-3, Appendix A.

Trips Entering the Site

It was estimated that traffic from the east will be assigned as follows:

- 50% will use Higgins Avenue (West) – Full Access
- 50% will use Higgins Avenue (East) – RIRO Access

It was estimated that traffic from the west will be assigned as follows:

- 100% will use Higgins Avenue (West) – Full Access
- 0% will use Higgins Avenue (East) – RIRO Access

Trips Exiting the Site

It was estimated that traffic to the east will be assigned as follows:

- 100% will use Higgins Avenue (West) – Full Access
- 0% will use Higgins Avenue (East) – RIRO Access

It was estimated that traffic to the west will be assigned as follows:

- 70% will use Higgins Avenue (West) – Full Access
- 30% will use Higgins Avenue (East) – RIRO Access

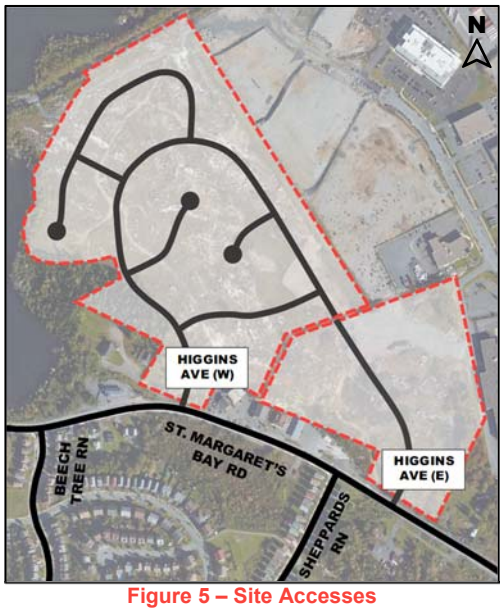


Figure 5 – Site Accesses

HIGGINS AVENUE TRAFFIC VOLUMES

The daily traffic volume on Higgins Avenue was estimated based on the trips that are expected to be generated by the full build-out of the proposed development. It should be noted that all trips entering Higgins Avenue are expected to have a destination within the Lovett Lake development (i.e. no through volumes on Higgins Avenue). The traffic volumes during the evening peak periods traditionally represent approximately 10-12% of the daily traffic volume. Using this information, it was estimated that the average daily traffic volume on the western end of Higgins Avenue near St. Margarets Bay Road would be in the range of approximately 2,500-3,000 vehicles per day (vpd). Similarly, it was estimated that the average daily traffic volume on the eastern end of Higgins Avenue would be in the range of approximately 900-1,100 vpd.

TRAFFIC SIGNAL WARRANT

A traffic signal warrant analysis was conducted for the intersection of St. Margarets Bay Road and Higgins Avenue (West) to consider whether traffic signals are the optimal form of traffic control. The Canadian Traffic Signal Warrant Matrix Analysis (Transportation Association of Canada (TAC), 2005) considers 100 warrant points, and higher than 75 vph average approach volume on the side street, as an indication that traffic signals will provide a positive impact. The signal warrant analysis uses vehicular and pedestrian volumes, and intersection, roadway and study area characteristics to calculate a warrant point value.

A signal warrant was conducted to determine if traffic signals are warranted based on the 2030 design hourly volumes, including estimated site generated trips. The intersection is expected to be supplemented with a westbound right turn lane and an eastbound left turn lane on St. Margarets Bay Road. The Higgins Avenue approach is expected to include two lanes. The resulting traffic signal warrant indicates that traffic signals would be warranted (112 warrant points, See Table B-1, Appendix B).

Traffic signals are expected to be warranted at the St. Margarets Bay Road and Higgins Avenue (West) intersection with respect to the 2030 design hourly volumes (112 warrant points, See Table B-1, Appendix B).

LEFT TURN LANE WARRANT

Left-turn movements on a two-lane street may cause both operational and safety problems. Operational problems result as a vehicle stopped waiting for an opportunity to turn across 'heavy' opposing traffic causes a queue of stopped vehicles to form. Safety problems result from rear end collisions when a stopped left-turning vehicle is struck by an

advancing vehicle, or from head-on or right-angle collisions when a left-turning vehicle is struck by an opposing vehicle.

The *Geometric Design Standards for Ontario Highways Manual* contains nomographs for left turn lane analysis for two lane streets. The analysis method, which is normally used by WSP to evaluate need for left turn lanes, uses a series of nomographs that consider speed, advancing volumes, left turns as a percentage of advancing volumes, and opposing volumes. A point, based on 'opposing' and 'advancing' volumes, plotted to the right of the 'warrant line' of the appropriate '% left turns' and 'approach speed' nomograph, indicates that a left turn lane is warranted for the conditions used in the analysis. Similarly, a point that is plotted to the left of the warrant line indicates that a left turn lane is not warranted.

Review of the left turn warrant for Sheppards Run with the existing and projected traffic volumes along St. Margarets Bay Road indicate the need for a left turn storage length in the range of the approximate 75 m left turn lane on St. Margarets Bay Road. The left turn lane warrant can be found in Figure B-2, Appendix B.

OPERATIONAL ANALYSIS

Synchro 10.0 software was used to model the intersection operations with respect to the 2030 morning and evening peak period design hourly volumes. The Level of Service (LOS) criteria are stated in terms of control delay (average delay in seconds per vehicle) for signalized intersection. The LOS criteria range from very low delays to unacceptable delays (See Table 3 for LOS criteria).

Table 3 - LOS Criteria for Stop Controlled and Signalized Intersections

LOS	Signalized Intersections Control Delay (Seconds per Vehicle)	LOS Description	Two Way Stop Controlled (TWSC) Intersections Control Delay (Seconds per Vehicle)
A	Less than 10.0	Very low delay; most vehicles do not stop **(Excellent)**	Less than 10.0
B	Between 10.0 and 20.0	Higher delay; most vehicles stop **(Very Good)**	Between 10.0 and 15.0
C	Between 20.0 and 35.0	Higher level of congestion; number of vehicles stopping is significant, although many still pass through intersection without stopping **(Good)**	Between 15.0 and 25.0
D	Between 35.0 and 55.0	Congestion becomes noticeable; vehicles must sometimes wait through more than one red light; many vehicles stop **(Satisfactory)**	Between 25.0 and 35.0
E	Between 55.0 and 80.0	Vehicles must often wait through more than one red light; considered by many agencies to be the limit of **acceptable** delay	Between 35.0 and 50.0
F	Greater than 80.0	This level is considered to be unacceptable to most drivers; occurs when arrival flow rates exceed the capacity of the intersection **(Unacceptable)**	Greater than 50.0

Operations at the Higgins Avenue (West) site access were reviewed with site development with respect to a 100 second cycle length during the AM and PM peak periods (See Table 4). The St. Margarets Bay Road approaches are expected to operate with delays of 16.0 seconds per vehicle (LOS B) or better during the morning and evening peak periods. It's expected that the southbound left and right turning vehicles will operate at a LOS D and B respectively during the peak periods. All approaches are expected to have a volume-to-capacity ratio (v/c) of 0.82 or better. The intersection is expected to operate at a LOS B with the addition of site generated trips during both peak periods.

Table 4 – St. Margarets Bay Road at Higgins Avenue (West) – Operational Analysis Summary (Signalized)

LOS Criteria	Control Delay (sec/veh), Level of Service (LOS), v/c Ratio, and 95th %ile Queue (m) by Intersection Movement						Overall Intersection	
	St. Margarets Bay Road				Higgins Avenue (West)			
	EB-L	EB-T	WB-T	WB-R	SB-L	SB-R	Delay	LOS
AM Design Hour **with** Site Development (Page C-3)								
Delay	4.7	16.0	7.3	1.7	41.7	11.8	15.2	B
LOS	A	B	A	A	D	B		
v/c	0.05	0.82	0.46	0.03	0.60	0.17		
Queue	3.8	171.6	58.5	2.3	52.8	9.8		
PM Design Hour **with** Site Development (Page C-6)								
Delay	9.0	7.2	10.8	2.1	37.2	12.9	10.5	B
LOS	A	A	B	A	D	B		
v/c	0.32	0.52	0.71	0.08	0.44	0.13		
Queue	13.5	82.7	149.1	6.0	37.0	8.4		

Operations at the Sheppards Run intersection were determined without and with site development (See Table 5). The St. Margarets Bay Road approaches are expected to experience minimal impacts with site development. Without site development, the Sheppards Run approach is expected to operate at a LOS C during peak periods. With site development, the Sheppards Run approach is expected to operate at a LOS F during the morning peak (v/c = 0.81) and while delays have increased due to higher volumes on St. Margarets Bay Road, the Sheppards Run approach continues to operate within available capacity. During the PM peak, the approach is expected to operate at LOS E (v/c = 0.11). The intersection is expected to operate at a LOS A during the morning and evening peak periods, respectively, without and with site development.

Table 5 – St. Margarets Bay Road at Sheppards Run – Operational Analysis Summary (Stop Controlled)

LOS Criteria	Control Delay (sec/veh), Level of Service (LOS), v/c Ratio, and 95th %ile Queue (m) by Intersection Movement				Overall Intersection	
	St. Margarets Bay Road			Sheppards Run		
	EB-TR	WB-L	WB-T	NB-LR	Delay	LOS
AM Design Hour **without** Site Development (Page C-1)						
Delay	0.0	10.4	0.0	23.6	1.0	A
LOS	A	B	A	C		
v/c	0.61	0.01	0.32	0.22		
Queue	0.0	0.1	0.0	6.2		
AM Design Hour **with** Site Development (Page C-4)						
Delay	0.0	16.2	0.0	133.0	5.0	A
LOS	A	C	A	F		
v/c	0.71	0.01	0.35	0.81		
Queue	0.0	0.3	0.0	32.1		
PM Design Hour **without** Site Development (Page C-2)						
Delay	0.0	9.4	0.0	21.6	0.5	A
LOS	A	A	A	C		
v/c	0.44	0.06	0.58	0.05		
Queue	0.0	1.4	0.0	1.2		
PM Design Hour **with** Site Development (Page C-7)						
Delay	0.0	10.4	0.0	36.5	0.6	A
LOS	A	B	A	E		
v/c	0.50	0.07	0.64	0.11		
Queue	0.0	1.7	0.0	2.9		

Operations at the Higgins Avenue (East) site access were reviewed with site development (See Table 6). The St. Margarets Bay Road approaches are expected to operate with negligible delays. It's expected that the southbound right turning vehicles will operate at a LOS B and C respectively during the peak periods. All approaches are expected to have a volume-to-capacity ratio (v/c) of 0.74 or better. The intersection is expected to operate at a LOS A with the addition of site generated trips during both peak periods.

Table 6 – St. Margarets Bay Road at Higgins Avenue (East) – Operational Analysis Summary (Stop Controlled)

LOS Criteria	Control Delay (sec/veh), Level of Service (LOS), v/c Ratio, and 95th %ile Queue (m) by Intersection Movement			Overall Intersection	
	St. Margarets Bay Road		Higgins Avenue (West)		
	EB-T	WB-TR	SB-R	Delay	LOS
AM Design Hour **with** Site Development (Page C-5)					
Delay	0.0	0.0	12.5	0.1	A
LOS	A	A	B		
v/c	0.74	0.36	0.04		
Queue	0.0	0.0	1.0		
PM Design Hour **with** Site Development (Page C-8)					
Delay	0.0	0.0	21.6	0.2	A
LOS	A	A	C		
v/c	0.51	0.72	0.07		
Queue	0.0	0.0	1.7		

SUMMARY

1. Plans are being prepared to complete Phase 3 of the Lovett Lake development in Halifax, Nova Scotia.

2. Phase 3 is expected to consist of 93 single family homes.

3. Two (2) access locations will be provided for Phase 3 development including Higgins Avenue (West) through Phases 1/2 and Higgins Avenue (East) intersection at St. Margarets Bay Road.

4. Trip generation estimates for Phase 3 were prepared using rates published in *Trip Generation, 10th Edition* (Institute of Transportation Engineers, Washington 2017). It was estimated that Phase 3 of the proposed redevelopment will generate:
   - **71 new** two-way vehicle trips (18 entering and 53 exiting) during the AM peak hour; and,
   - **95 new** two-way trips (60 entering and 35 exiting) during the PM peak hour.

5. Traffic volume data used in the analyses reflects projected 2030 design hourly volumes.

6. Considering the development with a full access at Higgins Avenue (West) and a right-in/right-out at Higgins Avenue (East), traffic signals are warranted at the St. Margarets Bay Road and Higgins Avenue (West) intersection with respect to full build-out of the proposed mixed-use development ***(112 warrant points)***.

7. A westbound left turn lane continues to be warranted on St. Margarets Bay Road at Sheppards Run consistent with the existing configuration.

8. The average daily traffic volume on the western end of Higgins Avenue is expected to be within the range of 2,500-3,000 vpd and the average daily traffic volume on the eastern end of Higgins Avenue is expected to be within the range of 900-1,100 vpd.

RECOMMENDATIONS

9. Consideration should be given to locating the Higgins Avenue (East) access approximately 80 m east of Sheppards Run to ensure appropriate stopping sight distance for westbound traffic.

10. The secondary access to the entire Lovett Lake development, Higgins Avenue (East), should include right-in and right-out movements only due to the available stopping sight distances proximity to Sheppards Run and the traffic volumes on St. Margarets Bay Road.

11. The townhouse units shown facing St. Margarets Bay Road should be designed with shared driveway access from Higgins Avenue.

12. Consideration should be given to the installation of traffic signals on St. Margarets Bay Road at Higgins Avenue (West).

CONCLUSION

13. Site generated trips are not expected to have any significant impact to levels of performance on St. Margarets Bay Road.

If you have any questions or comments, please contact me by email at greg.obrien@wsp.com or by telephone at 902-444-8347.

Sincerely,

Original Signed

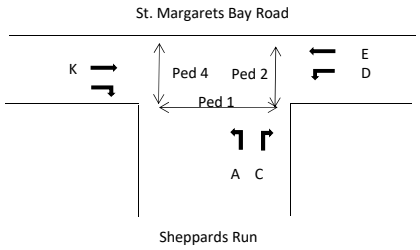
Greg O'Brien, P.Eng.
Atlantic Practice Manager, Traffic Engineering and Transportation Planning
WSP Canada Inc

APPENDIX A – TRAFFIC VOLUME DATA

Table A-1

St. Margarets Bay Road
@
Sheppards Run

Beechville, NS
Wednesday, January 15, 2020



AM Peak Period Volume Data

Time		Sheppards Run Northbound Approach		St. Margarets Bay Road Westbound Approach		St. Margarets Bay Road Eastbound Approach		Total Vehicles
		A	C	D	E	K	L	
07:00	07:15	0	6	0	24	82	0	112
07:15	07:30	2	2	0	34	110	1	149
07:30	07:45	0	10	1	43	158	0	212
07:45	08:00	2	9	1	61	175	0	248
08:00	08:15	2	14	0	77	187	1	281
08:15	08:30	2	11	0	92	198	2	305
08:30	08:45	2	18	4	113	189	3	329
08:45	09:00	2	8	0	129	202	1	342
AM Peak Hour		**8**	**51**	**4**	**411**	**776**	**7**	**1257**
07:00	**08:00**	**4**	**27**	**2**	**162**	**525**	**1**	**721**
08:00	**09:00**	**8**	**51**	**4**	**411**	**776**	**7**	**1257**
		Ped 1		**Ped 2**		**Ped 4**		**Total Peds**
07:00	**08:00**	**0**		**0**		**1**		**1**
08:00	**09:00**	**0**		**0**		**0**		**0**

Midday Peak Period Volume Data

Time		Sheppards Run Northbound Approach		St. Margarets Bay Road Westbound Approach		St. Margarets Bay Road Eastbound Approach		Total Vehicles
		A	C	D	E	K	L	
11:30	11:45	0	2	5	82	111	0	200
11:45	12:00	2	3	1	89	108	1	204
12:00	12:15	0	4	3	98	90	0	195
12:15	12:30	1	5	3	73	108	3	193
12:30	12:45	1	4	3	103	112	0	223
12:45	13:00	1	3	3	101	94	0	202
13:00	13:15	0	5	6	107	124	1	243
13:15	13:30	0	1	1	107	112	1	222
Midday Peak Hour		**2**	**13**	**13**	**418**	**442**	**2**	**890**
11:30	**12:30**	**3**	**14**	**12**	**342**	**417**	**4**	**792**
12:30	**13:30**	**2**	**13**	**13**	**418**	**442**	**2**	**890**
		Ped 1		**Ped 2**		**Ped 4**		**Total Peds**
11:30	**12:30**	**0**		**0**		**3**		**3**
12:30	**13:30**	**0**		**0**		**0**		**0**

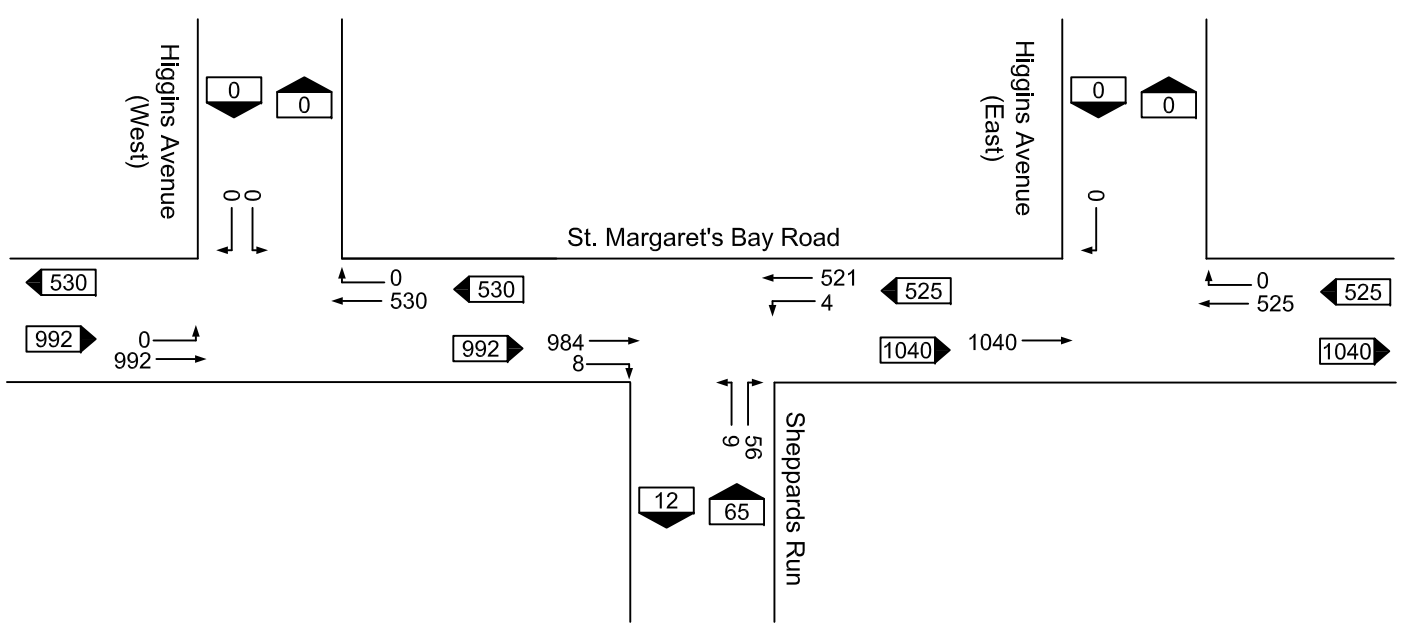
PM Peak Period Volume Data

Time		Sheppards Run Northbound Approach		St. Margarets Bay Road Westbound Approach		St. Margarets Bay Road Eastbound Approach		Total Vehicles
		A	C	D	E	K	L	
15:30	15:45	0	9	5	125	118	0	257
15:45	16:00	0	2	7	102	108	3	222
16:00	16:15	1	6	8	141	116	0	272
16:15	16:30	1	6	6	149	96	1	259
16:30	16:45	1	4	15	186	120	0	326
16:45	17:00	3	2	7	178	123	3	316
17:00	17:15	0	2	7	187	180	2	378
17:15	17:30	0	6	13	185	125	2	331
PM Peak Hour		**4**	**14**	**42**	**736**	**548**	**7**	**1351**
15:30	**16:30**	**2**	**23**	**26**	**517**	**438**	**4**	**1010**
16:30	**17:30**	**4**	**14**	**42**	**736**	**548**	**7**	**1351**
		Ped 1		**Ped 2**		**Ped 4**		**Total Peds**
15:30	**16:30**	**0**		**0**		**3**		**3**
16:30	**17:30**	**0**		**0**		**5**		**5**

* Count completed by WSP

2030 AM Peak Hour
Background Volumes Without Site Development

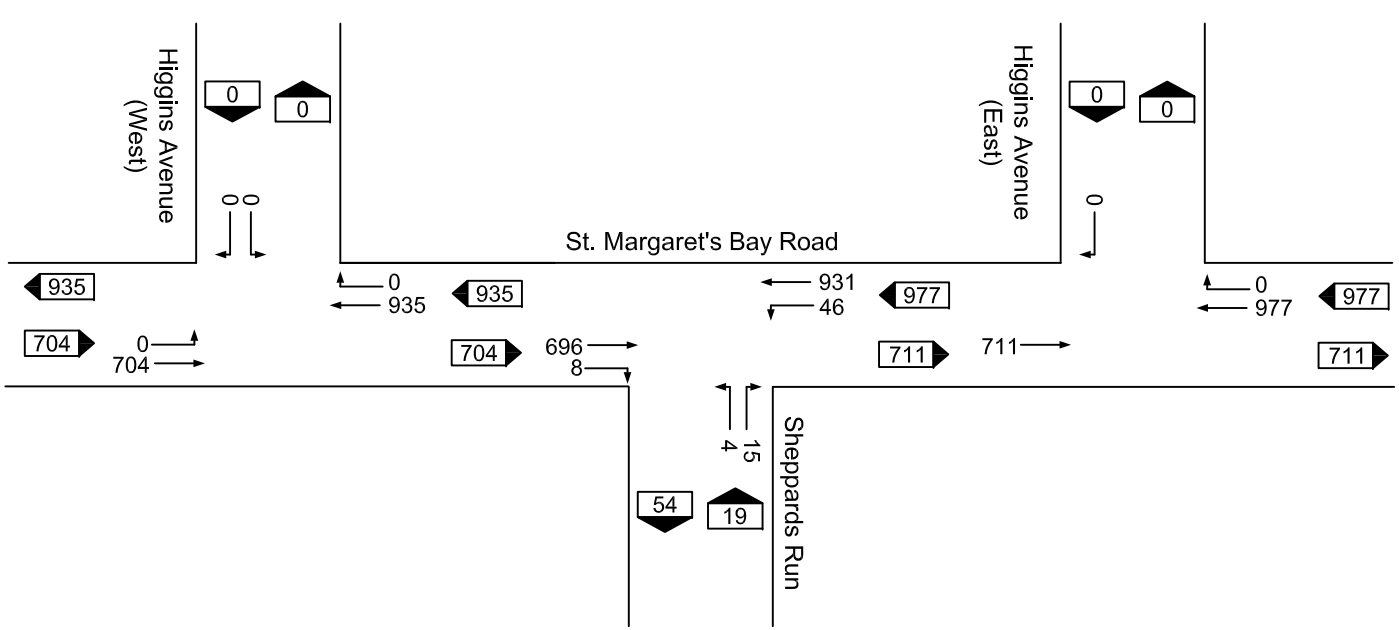
A
AM Peak Hour



NOT TO SCALE

2030 PM Peak Hour
Background Volumes Without Site Development

B
PM Peak Hour

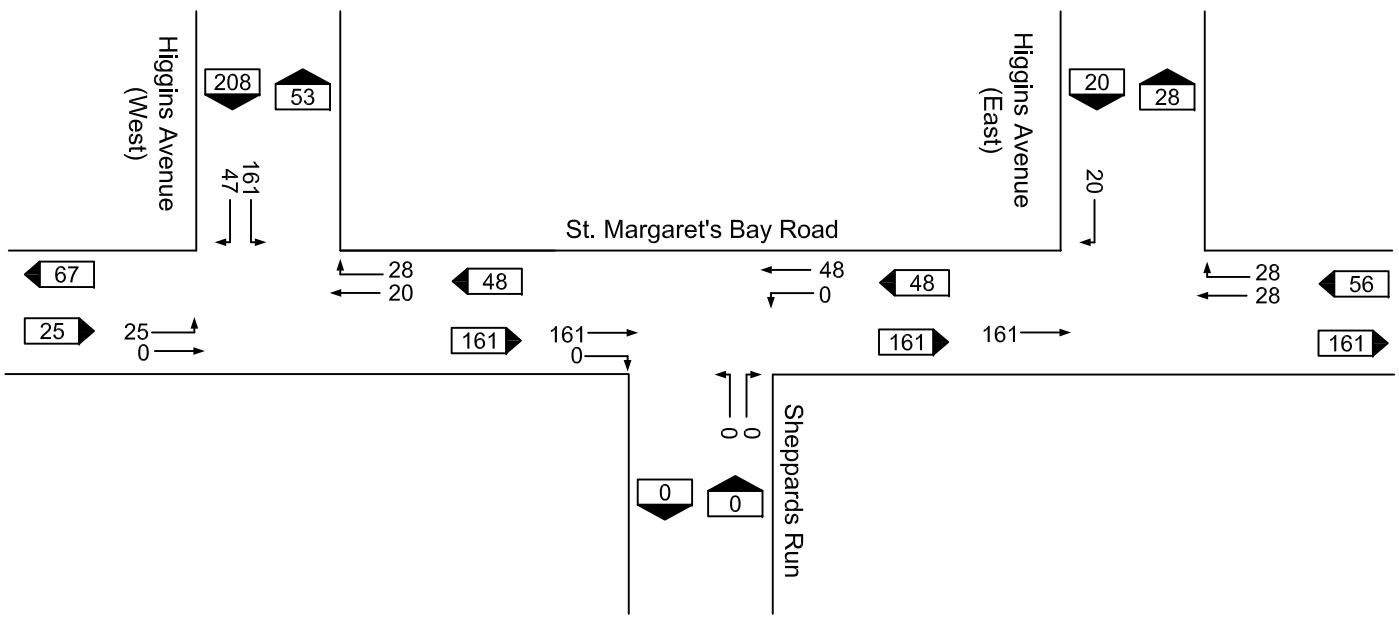


NOT TO SCALE

WSP	Traffic Impact Analysis - Lovett Lake Phase 3 Lovett Lake, Halifax, NS	Figure A-1
	Projected 2030 Weekday AM and PM Peak Hour Background Traffic Without Site Development	March 2020

2030 AM Peak Hour
Estimated Site Generated Trips

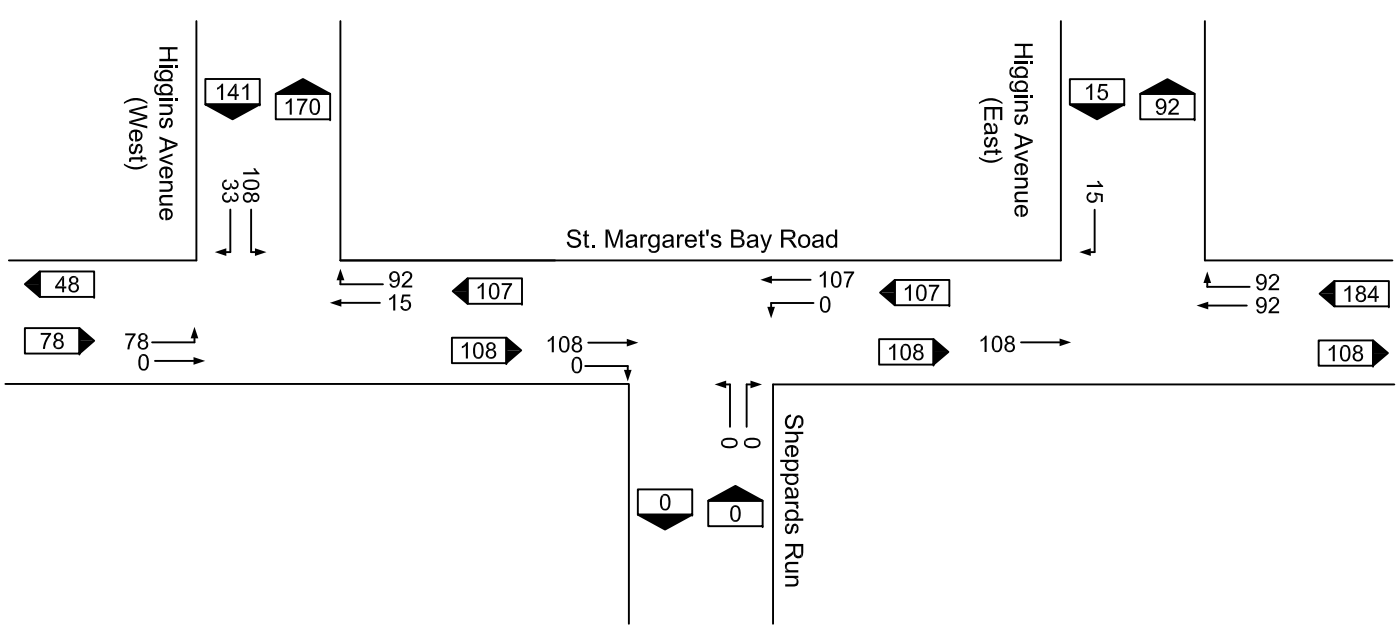
A
AM Peak Hour



NOT TO SCALE

2030 PM Peak Hour
Estimated Site Generated Trips

B
PM Peak Hour

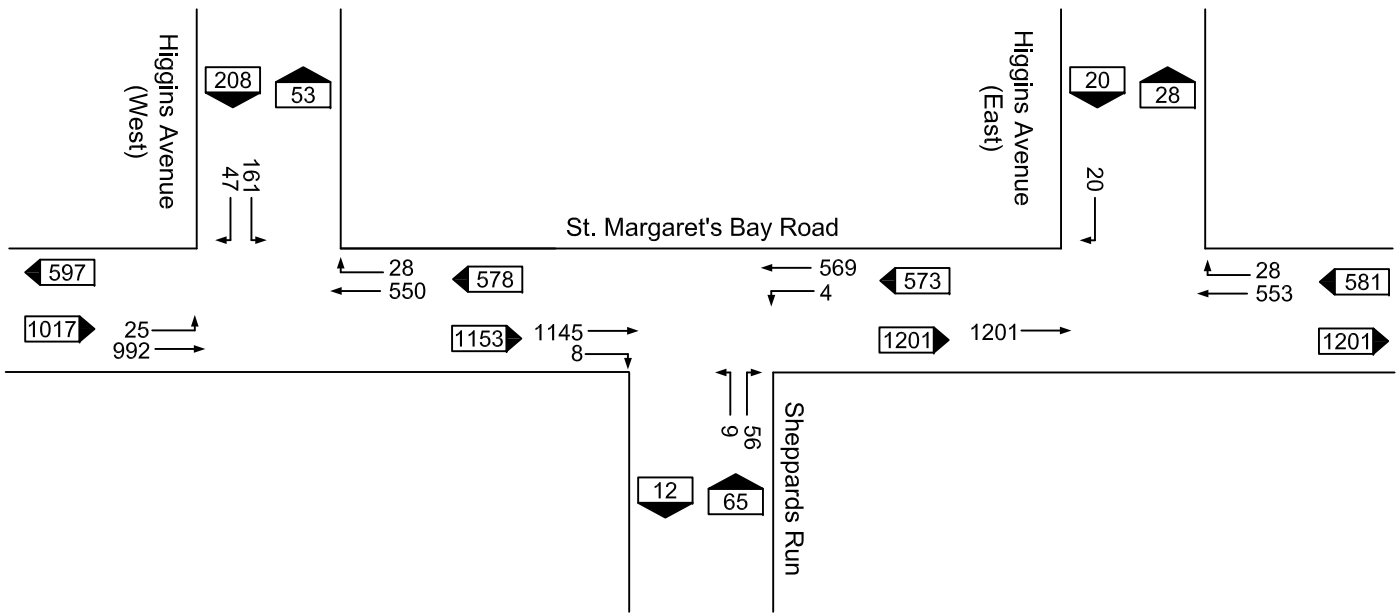


NOT TO SCALE

WSP	Traffic Impact Analysis - Lovett Lake Phase 3 Lovett Lake, Halifax, NS	Figure A-2
	Projected 2030 Weekday AM and PM Peak Hour Estimated Site Generated Trips	March 2020

2030 AM Peak Hour
Background Volumes With Site Development

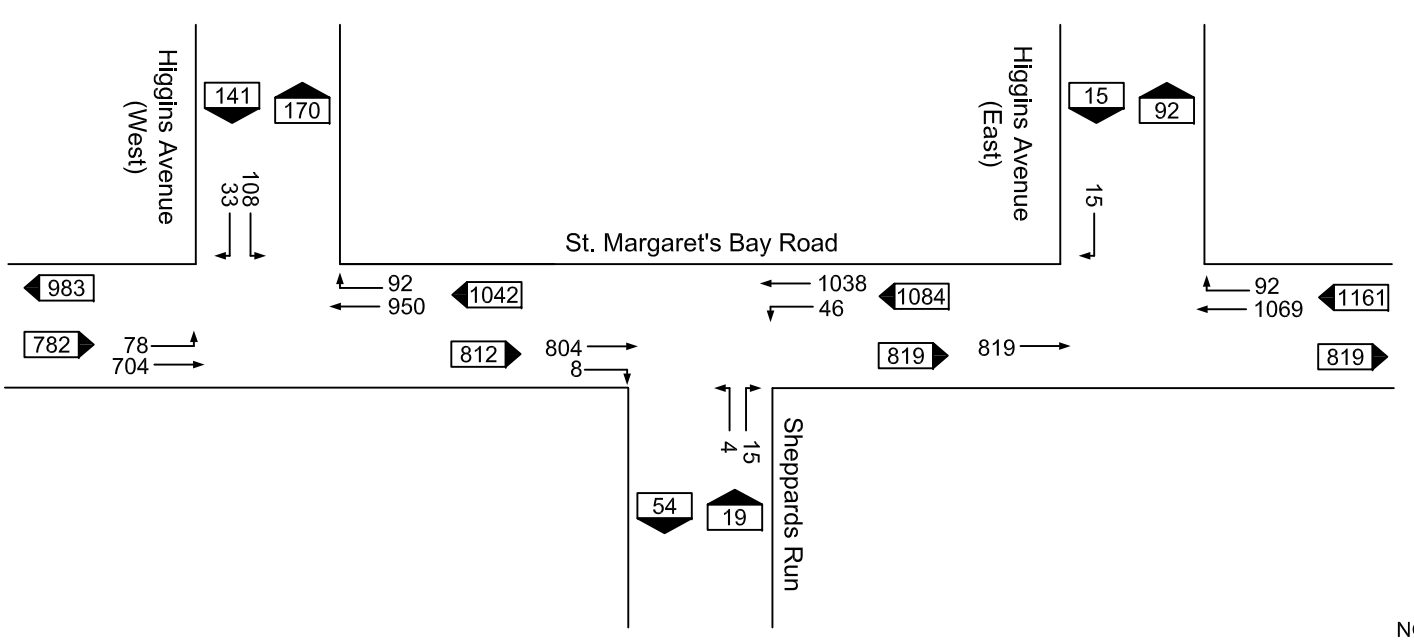
A
AM Peak Hour



NOT TO SCALE

2030 PM Peak Hour
Background Volumes With Site Development

B
PM Peak Hour



NOT TO SCALE

WSP	Traffic Impact Analysis - Lovett Lake Phase 3 Lovett Lake, Halifax, NS	Figure A-3
	Projected 2030 Weekday AM and PM Peak Hour Background Traffic With Site Development	March 2020

APPENDIX B – WARRANTS

2005 Canadian Traffic Signal Warrant Matrix Analysis

Table B-1 St. Margaret's Bay Rd @ Higgens Ave (Full Access) - Projected 2030 DHVs With Full Development (Phases 1-3)

Main Street (name)	St. Margaret's Bay Rd	Direction (EW or NS)	EW	Date:	March 2020
Side Street (name)	Higgins Ave (West)	Direction (EW or NS)	NS	City:	HRM

Lane Configuration		Excl LT	Th & LT	Through or Th+RT+LT	Th & RT	Excl RT	UpStream Signal (m)	# of Thru Lanes	
St. Margaret's Bay Rd	WB			1				1	
St. Margaret's Bay Rd	EB	1		1				1	
N/A	NB								
Higgins Ave (West)	SB	1				1			

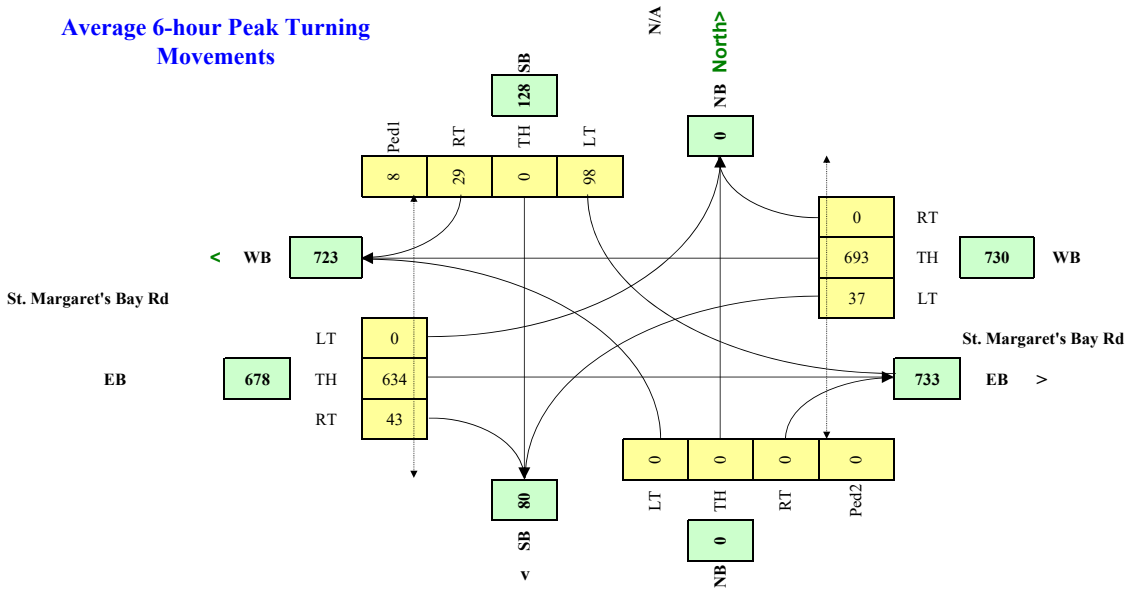
Other input		Speed (Km/h)	Trucks %	Bus Rt (y/n)	Median (m)
St. Margaret's Bay Rd	EW	60	2.0%	y	0.0
Higgins Ave (West)	NS		2.0%	y	

	Ped1	Ped2	Ped3	Ped4
	NS	NS	EW	EW
	W Side	E Side	N Side	S side
7:00 - 8:00	10	0	0	0
8:00 - 9:00	10	0	0	0
11:00 - 12:00	5	0	0	0
12:00 - 13:00	5	0	0	0
16:00 - 17:00	10	0	0	0
17:00 - 18:00	10	0	0	0
Total (6-hour peak)	**50**	**0**	**0**	**0**
Average (6-hour peak)	**8**	**0**	**0**	**0**

Demographics		
Elementary School	(y/n)	n
Senior's Complex	(y/n)	n
Pathway to School	(y/n)	n
Metro Area Population	(#)	380,000
Central Business District	(y/n)	n

Traffic Input	NB			SB			WB			EB		
	LT	Th	RT	LT	Th	RT	LT	Th	RT	LT	Th	RT
7:00 - 8:00	0	0	0	160	0	45	25	990	0	0	550	30
8:00 - 9:00	0	0	0	120	0	35	20	745	0	0	415	20
11:00 - 12:00	0	0	0	55	0	15	15	560	0	0	540	20
12:00 - 13:00	0	0	0	55	0	15	15	560	0	0	540	20
16:00 - 17:00	0	0	0	90	0	30	65	600	0	0	810	80
17:00 - 18:00	0	0	0	110	0	35	80	705	0	0	950	90
Total (6-hour peak)	**0**	**0**	**0**	**590**	**0**	**175**	**220**	**4,160**	**0**	**0**	**3,805**	**260**
Average (6-hour peak)	**0**	**0**	**0**	**98**	**0**	**29**	**37**	**693**	**0**	**0**	**634**	**43**

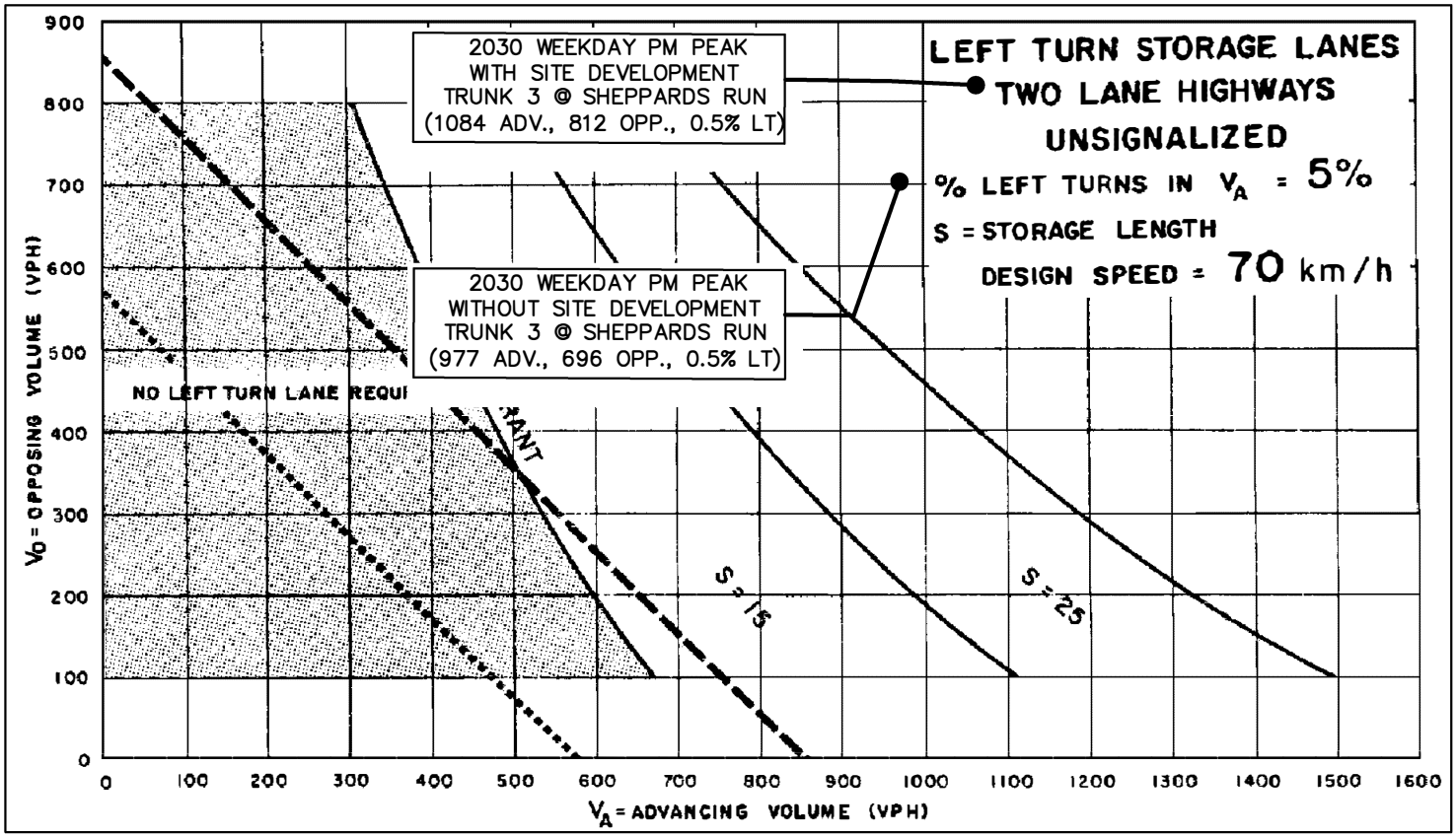
Average 6-hour Peak Turning Movements



$$W = [C_{bt}(X_{v\text{-}v}) / K_1 + (F (X_{v\text{-}p}) L) / K_2] \times C_i$$

W =	112	99	13
		Veh	*Ped*

Warranted



WSP	Traffic Impact Analysis - Lovett Lake Phase 3 Lovett Lake, Halifax, NS	Figure B-2
	Left Turn Lane Warrants St. Margarets Bay Road at Sheppards Run	March 2020

APPENDIX C – OPERATIONAL ANALYSIS

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	984	8	4	521	8	56
Future Volume (Veh/h)	984	8	4	521	8	56
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.92	0.92	0.95	0.92	0.92
Hourly flow rate (vph)	1036	9	4	548	9	61
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type	None			None		
Median storage veh)						
Upstream signal (m)	240					
pX, platoon unblocked						
vC, conflicting volume			1045		1596	1040
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			1045		1596	1040
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		92	78
cM capacity (veh/h)			666		117	280

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	1045	4	548	70
Volume Left	0	4	0	9
Volume Right	9	0	0	61
cSH	1700	666	1700	321
Volume to Capacity	0.61	0.01	0.32	0.22
Queue Length 95th (m)	0.0	0.1	0.0	6.2
Control Delay (s)	0.0	10.4	0.0	23.6
Lane LOS		B		C
Approach Delay (s)	0.0	0.1		23.6
Approach LOS				C

Intersection Summary			
Average Delay	1.0		
Intersection Capacity Utilization	62.4%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	696	8	46	931	4	15
Future Volume (Veh/h)	696	8	46	931	4	15
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.92	0.92	0.95	0.92	0.92
Hourly flow rate (vph)	733	9	50	980	4	16
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type	None			None		
Median storage veh)						
Upstream signal (m)	240					
pX, platoon unblocked						
vC, conflicting volume			742		1818	738
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			742		1818	738
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			94		95	96
cM capacity (veh/h)			865		81	418

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	742	50	980	20
Volume Left	0	50	0	4
Volume Right	9	0	0	16
cSH	1700	865	1700	403
Volume to Capacity	0.44	0.06	0.58	0.05
Queue Length 95th (m)	0.0	1.4	0.0	1.2
Control Delay (s)	0.0	9.4	0.0	21.6
Lane LOS		A		C
Approach Delay (s)	0.0	0.5		21.6
Approach LOS				C

Intersection Summary			
Average Delay	0.5		
Intersection Capacity Utilization	59.0%	ICU Level of Service	B
Analysis Period (min)	15		

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	25	992	550	28	161	47
Future Volume (vph)	25	992	550	28	161	47
Satd. Flow (prot)	1789	1883	1883	1601	1789	1601
Flt Permitted	0.398				0.950	
Satd. Flow (perm)	750	1883	1883	1601	1789	1601
Satd. Flow (RTOR)				30		51
Lane Group Flow (vph)	27	1044	579	30	175	51
Turn Type	Perm	NA	NA	Perm	Prot	Perm
Protected Phases		4	8		6	
Permitted Phases	4			8		6
Total Split (s)	77.0	77.0	77.0	77.0	23.0	23.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Act Effct Green (s)	52.0	52.0	52.0	52.0	12.6	12.6
Actuated g/C Ratio	0.68	0.68	0.68	0.68	0.16	0.16
v/c Ratio	0.05	0.82	0.46	0.03	0.60	0.17
Control Delay	4.7	16.0	7.3	1.7	41.7	11.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	4.7	16.0	7.3	1.7	41.7	11.8
LOS	A	B	A	A	D	B
Approach Delay		15.7	7.0		35.0	
Approach LOS		B	A		C	
Queue Length 50th (m)	1.1	91.4	32.6	0.0	21.8	0.0
Queue Length 95th (m)	3.8	171.6	58.5	2.3	52.8	9.8
Internal Link Dist (m)		180.3	216.0		114.8	
Turn Bay Length (m)	80.0			30.0	40.0	
Base Capacity (vph)	674	1693	1693	1443	410	406
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.04	0.62	0.34	0.02	0.43	0.13

Intersection Summary

Cycle Length: 100
Actuated Cycle Length: 77
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.82
Intersection Signal Delay: 15.2 Intersection LOS: B
Intersection Capacity Utilization 71.1% ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 1: Trunk 3 & Higgins Ave (W)

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	1145	8	4	569	9	56
Future Volume (Veh/h)	1145	8	4	569	9	56
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.92	0.92	0.95	0.92	0.92
Hourly flow rate (vph)	1205	9	4	599	10	61
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type	None			None		
Median storage veh)						
Upstream signal (m)	240					
pX, platoon unblocked			0.38		0.38	0.38
vC, conflicting volume			1214		1816	1210
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			745		2336	733
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		34	62
cM capacity (veh/h)			327		15	159

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	1214	4	599	71
Volume Left	0	4	0	10
Volume Right	9	0	0	61
cSH	1700	327	1700	88
Volume to Capacity	0.71	0.01	0.35	0.81
Queue Length 95th (m)	0.0	0.3	0.0	32.1
Control Delay (s)	0.0	16.2	0.0	133.0
Lane LOS		C		F
Approach Delay (s)	0.0	0.1		133.0
Approach LOS				F

Intersection Summary			
Average Delay	5.0		
Intersection Capacity Utilization	70.9%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	1201	553	28	0	20
Future Volume (Veh/h)	0	1201	553	28	0	20
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.95	0.95	0.92	0.92	0.92
Hourly flow rate (vph)	0	1264	582	30	0	22
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		326				
pX, platoon unblocked					0.39	
vC, conflicting volume	612				1861	597
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	612				2415	597
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	96
cM capacity (veh/h)	967				14	503

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	1264	612	22
Volume Left	0	0	0
Volume Right	0	30	22
cSH	1700	1700	503
Volume to Capacity	0.74	0.36	0.04
Queue Length 95th (m)	0.0	0.0	1.0
Control Delay (s)	0.0	0.0	12.5
Lane LOS			B
Approach Delay (s)	0.0	0.0	12.5
Approach LOS			B

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	66.5%	ICU Level of Service	C
Analysis Period (min)	15		

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	78	704	950	92	108	33
Future Volume (vph)	78	704	950	92	108	33
Satd. Flow (prot)	1789	1883	1883	1601	1789	1601
Flt Permitted	0.187				0.950	
Satd. Flow (perm)	352	1883	1883	1601	1789	1601
Satd. Flow (RTOR)				61		36
Lane Group Flow (vph)	85	741	1000	100	117	36
Turn Type	Perm	NA	NA	Perm	Prot	Perm
Protected Phases		4	8		6	
Permitted Phases	4			8		6
Total Split (s)	77.0	77.0	77.0	77.0	23.0	23.0
Total Lost Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Act Effct Green (s)	53.6	53.6	53.6	53.6	10.7	10.7
Actuated g/C Ratio	0.75	0.75	0.75	0.75	0.15	0.15
v/c Ratio	0.32	0.52	0.71	0.08	0.44	0.13
Control Delay	9.0	7.2	10.8	2.1	37.2	12.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	9.0	7.2	10.8	2.1	37.2	12.9
LOS	A	A	B	A	D	B
Approach Delay		7.4	10.0		31.5	
Approach LOS		A	A		C	
Queue Length 50th (m)	3.8	42.0	73.2	1.4	13.9	0.0
Queue Length 95th (m)	13.5	82.7	149.1	6.0	37.0	8.4
Internal Link Dist (m)		180.3	216.0		114.8	
Turn Bay Length (m)	80.0			30.0	40.0	
Base Capacity (vph)	326	1745	1745	1489	458	437
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.26	0.42	0.57	0.07	0.26	0.08

Intersection Summary

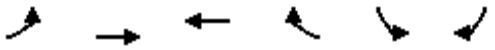
Cycle Length: 100
Actuated Cycle Length: 71.1
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.71
Intersection Signal Delay: 10.5 Intersection LOS: B
Intersection Capacity Utilization 75.3% ICU Level of Service D
Analysis Period (min) 15

Splits and Phases: 1: Trunk 3 & Higgins Ave (W)

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	804	8	46	1038	4	15
Future Volume (Veh/h)	804	8	46	1038	4	15
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.95	0.92	0.92	0.95	0.92	0.92
Hourly flow rate (vph)	846	9	50	1093	4	16
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						1
Median type	None			None		
Median storage veh)						
Upstream signal (m)	240					
pX, platoon unblocked			0.77		0.77	0.77
vC, conflicting volume			855		2044	850
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			664		2205	658
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			93		89	96
cM capacity (veh/h)			714		35	358

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	855	50	1093	20
Volume Left	0	50	0	4
Volume Right	9	0	0	16
cSH	1700	714	1700	175
Volume to Capacity	0.50	0.07	0.64	0.11
Queue Length 95th (m)	0.0	1.7	0.0	2.9
Control Delay (s)	0.0	10.4	0.0	36.5
Lane LOS		B		E
Approach Delay (s)	0.0	0.5		36.5
Approach LOS				E

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	64.6%	ICU Level of Service	C
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	819	1069	92	0	15
Future Volume (Veh/h)	0	819	1069	92	0	15
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.95	0.95	0.92	0.92	0.92
Hourly flow rate (vph)	0	862	1125	100	0	16
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		326				
pX, platoon unblocked					0.78	
vC, conflicting volume	1225				2037	1175
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1225				2189	1175
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				100	93
cM capacity (veh/h)	569				39	233

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	862	1225	16
Volume Left	0	0	0
Volume Right	0	100	16
cSH	1700	1700	233
Volume to Capacity	0.51	0.72	0.07
Queue Length 95th (m)	0.0	0.0	1.7
Control Delay (s)	0.0	0.0	21.6
Lane LOS			C
Approach Delay (s)	0.0	0.0	21.6
Approach LOS			C

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	71.8%	ICU Level of Service	C
Analysis Period (min)	15		