Item 7.1.3 v

TRAFFIC IMPACT STUDY

PAPER MILL LAKE AREA

PREPARED FOR:
UNITED GULF CONSTRUCTION INC.

Project No. 181-14531

DECEMBER 2019

wsp

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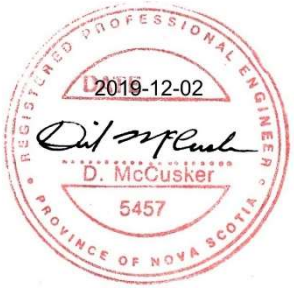
APPENDICES



1 INTRODUCTION

Background

In 1994 Bedford Town Council approved a development agreement (D.A.) for 221 acres of Residential Comprehensive Development District (RCDD) zoned land in the vicinity of Paper Mill Lake in Bedford. A portion of these lands were developed in the 1990s and the Development Agreement still applies to the remaining lands. A condition of the agreement is that not more than 100 single family dwelling units should be developed on the south side of Kearney Run without the proposed collector street (Nine Mile Drive) extending from what is now Oceanview Drive in the Crestview subdivision to Hammonds Plains Road. This was because the only access/egress to the area was via Moirs Mill Road and Nelsons Landing Boulevard to the Bedford Highway.

Since that time, the road network has changed significantly with the construction of the Larry Uteck interchange, Oceanview Drive, Nine Mile Drive, Southgate Drive, and Larry Uteck Boulevard. This has clearly relieved pressure on the two roadway connections to the Bedford Highway, which was the basis for the original 100 dwelling unit limit.

WSP Canada Inc. has been retained to prepare a Traffic Impact Study to determine whether these changes to the roadway network will allow for additional growth in the RCDD lands without compromising traffic functionality and the intent of the 100 dwelling unit limit.

A Traffic Impact Study Usually Considers Four Questions

A TIS usually consists of determining answers for the following questions:

1. **What is the existing transportation situation** adjacent to the study site? How have volumes changed historically?
2. **What transportation changes are expected** at key Study Area locations? How many vehicle and active mode trips are expected to be generated by the proposed development during weekday peak hours? What routes are the trips expected to use to travel within and through the Study Area?
3. **What transportation impacts will occur** on Study Area roads, sidewalks, and intersections?
4. **What transportation improvements are required** to mitigate project impacts on Study Area travel? Are there transportation modifications that should be made to improve the travel experience for all users?

Study Objectives

The objectives of the study are to:

1. Develop projected future background weekday AM and PM peak hourly volumes and daily two-way traffic volumes for Study Area roads that do not include trips generated by proposed site development.
2. Estimate the number of weekday AM and PM peak hour trips and daily two-way trips that will be generated by the proposed development.
3. Distribute and assign site generated trips to Study Area intersections to project future volumes that include site generated trips.
4. Evaluate impacts of site generated traffic on the performance and level of service of study intersections and the volume threshold expectations of collector and local streets in the study area.
5. Estimate daily two-way volumes on key study area streets.

2 STUDY AREA DESCRIPTIONS

Description of Proposed Development and Site Access

The development site is shown in Figure 1. It is bound between the Bedford Highway and the Bicentennial Highway to the north and south of Paper Mill Lake. The study area, along with key connection points to the adjacent roadway network is shown in Figure 2. For the purpose of this study, the lands are divided into three areas:

Area A: This is an area of approximately 42 acres within the RCDD lands south of Paper Mill Lake. Development of these lands would result in the 100 unit limit specified in the original agreement being exceeded. Determining the impact of developing these lands is the objective of this study

Area B1: This consists of an area within the RCDD zone that is adjacent to, but not part of the current development proposal.

Area B2: This is an area of approximately 60 additional acres within the RCDD lands north and west of Paper Mill Lake. While these lands are currently not proposed for development, their eventual presence, along with the extension of Nine Mile Drive through them to Hammonds Plains Road, are being considered in this study to help determine longer term traffic patterns and the functional requirement of Nine Mile Drive as a completed connection between Larry Uteck Boulevard and Hammonds Plains Road.

Current access to the site is primarily via Moirs Mill Road and Oceanview Dr/Amin St/Nelsons Landing Blvd to the Bedford Highway and via Nine Mile Drive to Larry Uteck Boulevard. Future access to the site from Hammonds Plains Road via an extension of Nine Mile Drive is expected to be built as Area B2 is developed.

The internal roadway network is as shown in Figure 1. The Development Agreement and previous concept plan showed a direct road connection (Richardson Drive) between Moirs Mill Road and Oceanview Drive. Concern, however, has arisen about the potential for this direct connection adding new traffic to Oceanview Drive. The road network shown in Figure 1 adjusts the configuration of this connection so that it connects to a collector street (Nine Mile Drive) rather than to a local street (Oceanview Drive).

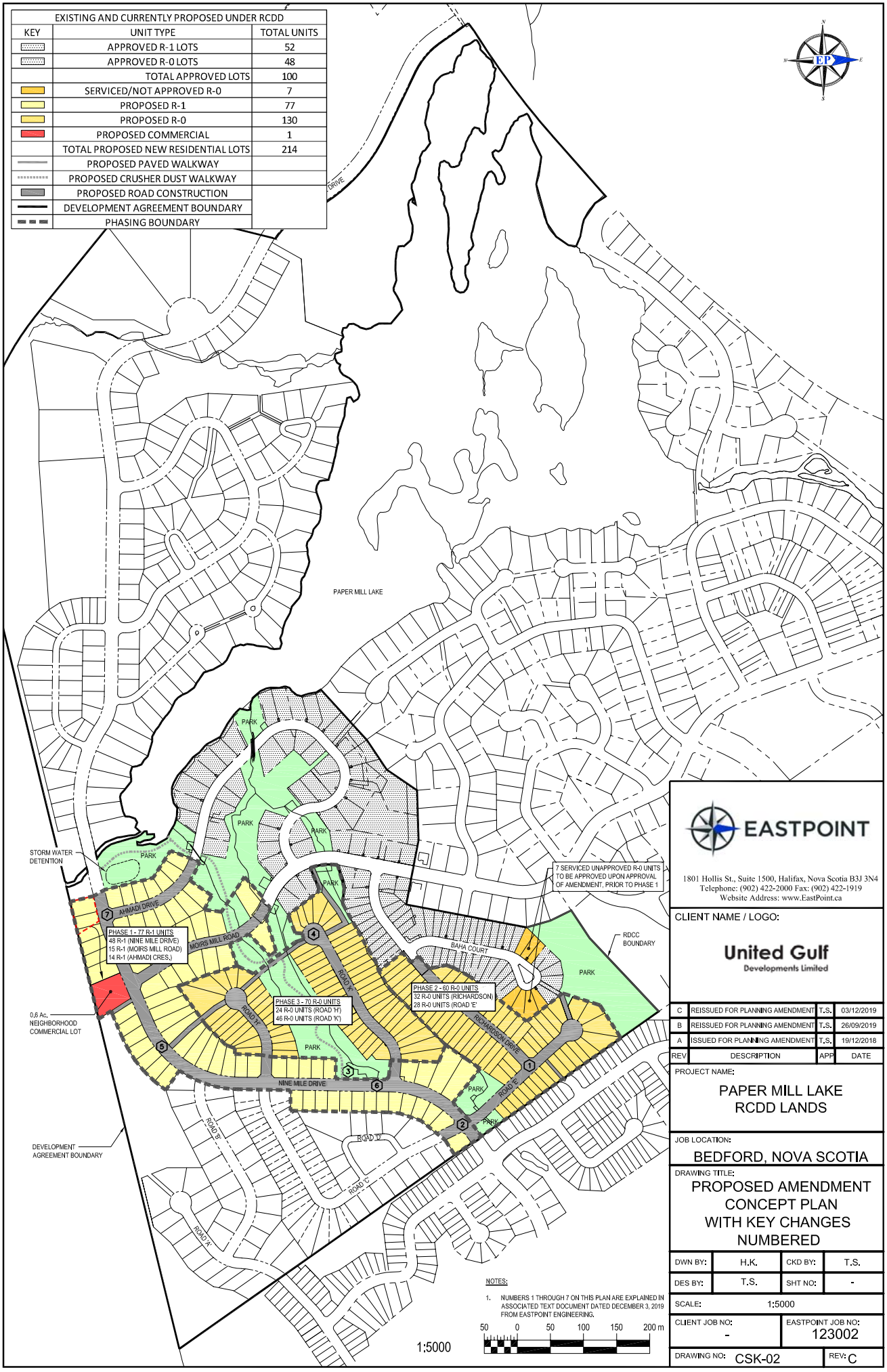
Existing Road Designations

HRM Engineering has indicated that both Moirs Mill Road and Nine Mile Drive are considered collector streets. All other streets within the study area, in particular Oceanview Drive, Amin Street and Nelsons Landing Boulevard, are considered local streets.

Intersection Descriptions

Bedford Highway/Moirs Mill Road is a signalized T-intersection. The northbound Bedford Highway approach has a single through lane, a left turn storage lane and a signalized pedestrian crossing. The southbound Bedford Highway approach has two through lanes, although these taper to a single lane shortly after the intersection. The Moirs Mill Road approach has separate lanes for left and right turns and a signalized pedestrian crossing.

EXISTING AND CURRENTLY PROPOSED UNDER RCDD		
KEY	UNIT TYPE	TOTAL UNITS
	APPROVED R-1 LOTS	52
	APPROVED R-0 LOTS	48
	TOTAL APPROVED LOTS	100
	SERVICED/NOT APPROVED R-0	7
	PROPOSED R-1	77
	PROPOSED R-0	130
	PROPOSED COMMERCIAL	1
	TOTAL PROPOSED NEW RESIDENTIAL LOTS	214
	PROPOSED PAVED WALKWAY	
	PROPOSED CRUSHER DUST WALKWAY	
	PROPOSED ROAD CONSTRUCTION	
	DEVELOPMENT AGREEMENT BOUNDARY	
	PHASING BOUNDARY	



NOTES:

1. NUMBERS 1 THROUGH 7 ON THIS PLAN ARE EXPLAINED IN ASSOCIATED TEXT DOCUMENT DATED DECEMBER 3, 2019 FROM EASTPOINT ENGINEERING.

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EASTPOINT

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CLIENT NAME / LOGO:

United Gulf Developments Limited

REV	DESCRIPTION	APP	DATE
C	REISSUED FOR PLANNING AMENDMENT	T.S.	03/12/2019
B	REISSUED FOR PLANNING AMENDMENT	T.S.	26/09/2019
A	ISSUED FOR PLANNING AMENDMENT	T.S.	19/12/2018

PROJECT NAME:

PAPER MILL LAKE
RCDD LANDS

JOB LOCATION:

BEDFORD, NOVA SCOTIA

DRAWING TITLE:

PROPOSED AMENDMENT CONCEPT PLAN WITH KEY CHANGES NUMBERED

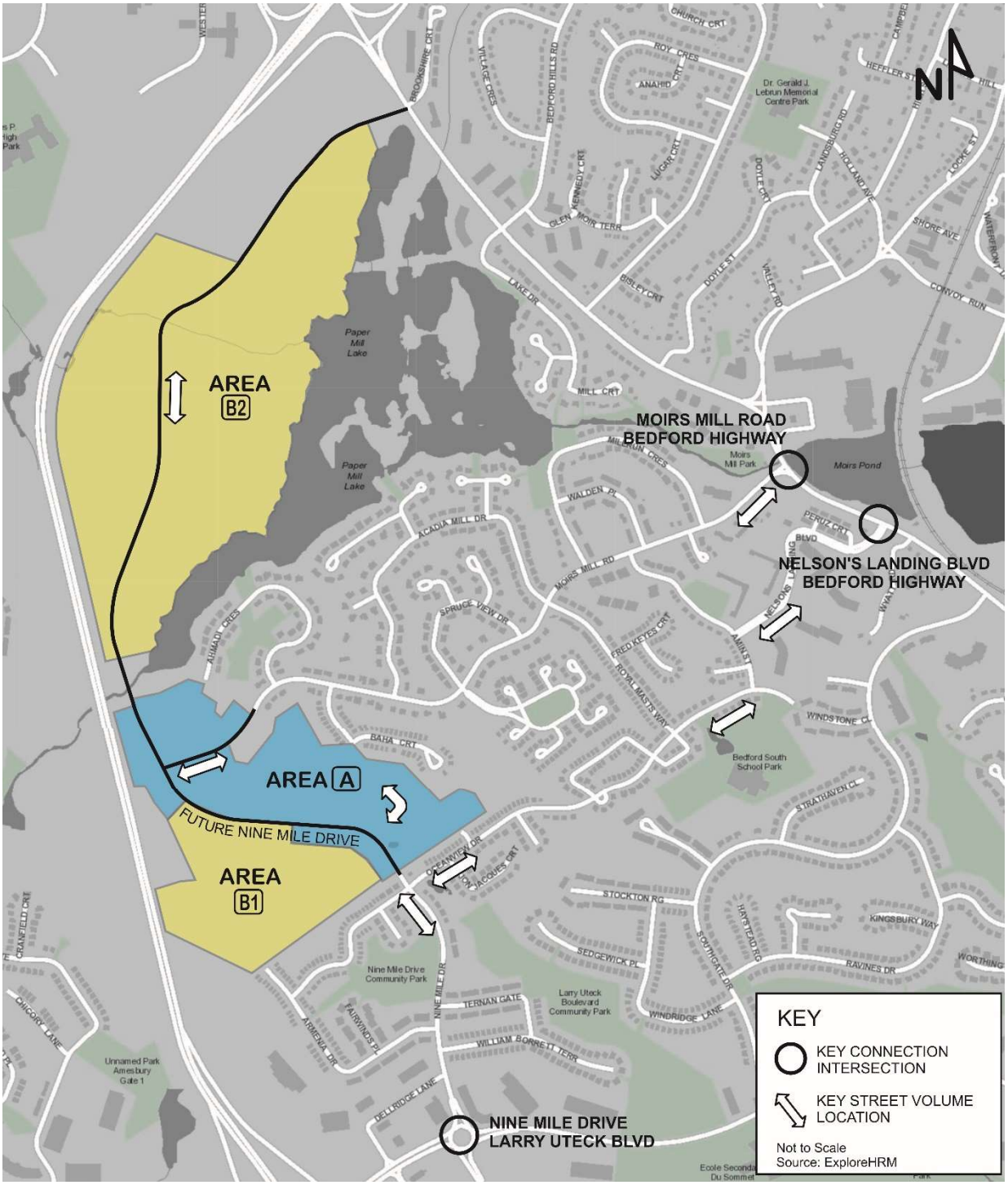
DWN BY:	H.K.	CKD BY:	T.S.
DES BY:	T.S.	SHT NO:	-

SCALE: 1:5000

CLIENT JOB NO:	EASTPOINT JOB NO:
-	123002

DRAWING NO: CSK-02 REV: C

Figure 2: Study Area and Roadway Connections



Intersection Descriptions (Continued)

Bedford Highway /Nelsons Landing Boulevard is an unsignalized T-intersection with stop control on the Nelsons Landing Boulevard approach. The northbound Bedford Highway approach has a single through lane and a left turn storage lane. The southbound Bedford Highway approach has a single lane for through and right movements plus a curbside bike lane. There is a pedestrian crossing on this leg controlled by overhead pedestrian-activated lights. The Nelson's Landing Boulevard approach has sufficient space for both left and right turning traffic. This approach has a pedestrian crossing that is uncontrolled.

Nine Mile Drive / Larry Uteck Boulevard is a roundabout with a two-lane circulating roadway. All four approaches to this intersection have a marked pedestrian crossing and two approach lanes.

Photo 1: Looking north to Moirs Mill Road/Bedford Highway Intersection

Photo 2: Looking south on Nine Mile Drive toward Larry Uteck Blvd.

Traffic Volume Data

Intersection turning movement counts were conducted by WSP at all three study intersections during November 2018 using MioVision technology. Daily two-way traffic volume counts were conducted in November 2018 using radar counters.

Traffic Growth Rate

Traffic growth on the roadway network, over and above the addition of traffic from the development, needs to be considered. For this study, all counted peak hour traffic volumes on the adjacent roadway network have been increased by five percent. With regional growth rates normally in the range of half a percent per year, this provides for an assessment horizon of approximately ten years. Counted traffic volumes within the study area street network have been increased by one percent. Since this area (outside of the development

lands being assessed) is now substantially fully built, this one percent increase accounts for some very minor future in-filling.

Photo 3: Looking west on Larry Uteck Blvd at Nine Mile Drive

Projected 2021 Background Volumes

Projected AM and PM peak hour and two-way daily background volumes are shown diagrammatically in Figure A-1, Appendix. They consist of the counted traffic volumes plus the projected growth.

Active Transportation / Transit

The site has good accessibility for pedestrians, with concrete sidewalks on one side of all study area streets and both sides of Nine Mile Drive. The area has been well-designed for active transportation connections within the community and on-going plans to improve the Bedford Highway as an active transportation corridor create a high opportunity for making functional active transportation trips.

The development area is served by transit route 91 with potential to increase penetration of that route into the lands once they are developed. The Bedford Highway is a planned high-frequency bus corridor, and its proximity to the development site (900m to 1,400m) for accessing by walking, biking or an efficient bus transfer will make transit an attractive travel choice. There is opportunity for this corridor to become even more attractive for transit trips with commuter rail or high-speed ferry being future possibilities.

3 TRIP GENERATION, DISTRIBUTION, AND ASSIGNMENT

Anticipated Land Use for Proposed Multi-Use Development

Each of the three sub-areas within the study area has different land use components and trip distribution characteristics. The proposed and anticipated land use is described below.

Area A: This is the area currently being proposed for development. The development consists of single family homes and a small neighbourhood office/retail centre. This area is connected to the roadway network via Moirs Mill Road and Nelsons Landing Boulevard to the Bedford Highway and via Nine Mile Drive to Larry Uteck Boulevard.

Area B2: This area is adjacent to Area A, but not part of the current development application. It is expected to contain single family homes and semi-detached residential units.

Area B2: This area may be developed in the future and is not part of the current development application. The purpose of including this area in the analysis is to project the ultimate traffic loading on collector roadways within the study area. In addition to the existing connections described above for Area A, development of this area would establish an additional connection to Hammonds Plains Road via an extension of Nine Mile Drive. This area consists of single family homes, small-size multi-unit residential buildings (6 to 8 units on two or three floors), medium-size multi-unit residential buildings (3-10 story buildings) and a school.

Assessment Scenarios

Two assessment scenarios are examined in this study:

Scenario One: Area A is developed and vehicles access the regional roadway network using the three existing connection points shown on Figure 1.

Scenario Two: Areas A, B1 and B2 are developed and Nine Mile Drive is extended to a new connection point on Hammonds Plains Road.

Estimation of Total Site Generated Trips

Generation of trips for each of the proposed land uses is determined by applying the *Trip Generation Handbook, 10th Edition* (Institute of Transportation Engineers, Washington, 2017). This reference provides a calculation for the anticipated number of trips produced by each type of land use based on data collected from studies across North America. Trip generation is summarized for Area A in Table 1, for Area B1 in Table 2 and for B2 in Table 3.

It should be noted that the *ITE Trip Generation Handbook* provides "driveway counts" for each of the land uses, meaning that the counts consider only the trip directly entering or exiting the site. For an assessment of a larger, comprehensive study area such as this one, engineering judgement needs to be employed to determine how many of these trips stay within the study area and how many originate from or are destined to areas outside of the study area. In cases where a trip stays within the study area, it will have been identified as a trip that originates from one of the study area land uses and is destined to another land use within the study area. Even though this is one single trip, it will have been calculated as a trip from both the origin and the destination, so a reduction calculation is required to prevent double-counting. For example, a resident of the study area making a trip to the local school site to pick up a student and return home will create one trip out

of their driveway and one trip in, as well as one trip into the school site and one trip out. But rather than four trips being created there are one two: home-to-school and school-to-home. Accordingly, some adjustments to the rates have been made based on the following assumptions.

Table 1 – Trip Generation Estimates Area A

Land Use[1]	Units[2]	Trip Generation Rates[3]					Trip Generation Estimates[3]				
		AM Peak		PM Peak		Daily	AM Peak		PM Peak		Daily
		In	Out	In	Out	2-way	In	Out	In	Out	2-way
Single Family (Land Use 210)	214	Equations from Pages 2 to 4					39	118	133	78	2094
Small Office Bldg. (Land Use 712)	6 KGFA	1.59	0.33	0.78	1.67	16.19	10	2	5	10	97
Speciality Retail (Land Use 826)	6 KGLA	0.76	0.6	1.19	1.52	44.32	5	4	7	9	266
Total Trip Generation Estimate							54	124	145	97	2457
15% Reduction for Non-Auto Trips							8	18	21	14	369
40% Reduction for Internal Commercial Trips							2	2	3	4	106
Corresponding Reduction for Residential Trips to / from Commercial Area							2	2	4	3	106
Adjusted Trip Estimates							42	101	116	75	1876

NOTES:

1. *Rates and equations are from Trip Generation, 10th Edition, Institute of Transportation Engineers, 2017.*
2. *Number of Dwelling Units for Residential; KGFA is 'Gross Floor Area x 1000 SF''.*
3. *Rates are 'vehicles per hour per unit'; trips generated are 'vehicles per hour for peak hours'.*

Table 2 – Trip Generation Estimates Area B1

Land Use[1]	Units[2]	Trip Generation Rates[3]					Trip Generation Estimates[3]				
		AM Peak		PM Peak		Daily	AM Peak		PM Peak		Daily
		In	Out	In	Out	2-way	In	Out	In	Out	2-way
Single Family (Land Use 210)	53	Equations from Pages 2 to 4					11	32	35	20	580
Semi-Detached (Land Use 210)	44	Equations from Pages 2 to 4					9	27	29	17	489
Total Trip Generation Estimate							20	59	64	37	1069
15% Reduction for Non-Auto Trips							3	9	10	6	160
Adjusted Trip Estimates							17	50	54	31	909

NOTES:

1. *Rates and equations are from Trip Generation, 10th Edition, Institute of Transportation Engineers, 2017.*
2. *Number of Dwelling Units for Residential; KGFA is 'Gross Floor Area x 1000 SF''.*
3. *Rates are 'vehicles per hour per unit'; trips generated are 'vehicles per hour for peak hours'.*

Table 3 – Trip Generation Estimates Area B2

Land Use[1]	Units[2]	Trip Generation Rates[3]					Trip Generation Estimates[3]				
		AM Peak		PM Peak		Daily	AM Peak		PM Peak		Daily
		In	Out	In	Out	2-way	In	Out	In	Out	2-way
Single Family (Land Use 210)	152	Equations from Pages 2 to 4					28	85	96	56	1528
Low-Rise Multi (Land Use 220)	48	Equations from Pages 31 to 33					5	18	19	11	322
Medium-Rise Multi (Land Use 230)	248	Equations from Pages 73 to 75					22	62	65	41	1350
School[4] (Land Use 520)	400 students	0.36	0.31	0.08	0.09	1.89	144	124	32	36	756
Total Trip Generation Estimate							199	289	212	144	3956
15% Reduction for Non-Auto Trips							30	43	32	22	594
53% Reduction for Internal Primary and Pass-by School Trips							76	66	17	19	401
Adjusted Trip Estimates							93	180	163	103	2961

NOTES:

1. *Rates and equations are from Trip Generation, 10th Edition, Institute of Transportation Engineers, 2017.*
2. *Number of Dwelling Units for Residential; KGFA is 'Gross Floor Area x 1000 SF'.*
3. *Rates are 'vehicles per hour per unit'; trips generated are 'vehicles per hour for peak hours'.*
4. *Refer to Appendix B for more detail on school trip calculations.*

Increased Transit and Active Transportation

The normal trip generation rates are measured in suburban areas, typically with lower transit and active transportation use. This study area is well-positioned to take advantage of improving transit service and active transportation connections proposed in the *Integrated Mobility Plan*. This will reduce the number of vehicle trips generated by each type of land use. Although the *Integrated Mobility Plan* strives for twenty-five percent of generated trips to use non-vehicle modes of travel, a more conservative reduction of fifteen percent has been applied for this study.

Trips to Neighbourhood Office/Commercial Site

The proposed office/commercial site is small enough that it can be expected many of the trips into and out of the site, for the commercial use(s) in particular, will originate from within the study area. To prevent a single trip from being counted twice (generated once by the residential unit and again by the commercial site) the total number of trips generated by the commercial site is reduced. For this analysis, an assumption of 40% of all trips to the commercial site originating from within the study area was made based on knowledge of other similar sites in the region. No reduction was made for the office use.

Trips to School Site

Similar to the office/commercial site, a school site will generate trips that originate from both inside and outside of the study area. A site survey of a nearby proxy school (Bedford South Elementary School was used to gauge the characteristics of trips entering and leaving the site. It was determined that during the morning peak, 30% of all trips would

be school staff entering the site from outside of the study area, 50% of trips would be student "drop-off" trips originating from a home within the study area and destined to a location outside of the study area, and 20% of trips would be student "drop-off" trips that leave from a home in the study area and return to that home. More details on the site survey and the school trip analysis is provided in Appendix A.

Size of the School

Although a site will be set aside in the future for a local school, the exact size and type of school will not be determined until a later date. To develop a reasonable assumption of trip generation, an elementary school with a student population of 400 has been assumed. For comparative purposes, the sizes of other schools in the area are shown in Table 4. In addition to some new collector area, this school would likely result in redistribution of some of the Bedford South collection area, resulting in a single school with a student population of about 600 becoming two schools each with a student population of 400. To be conservative, no trip reduction for the Bedford South Elementary School has been assumed.

Table 4 – Typical School Sizes in the Vicinity of the Site

School	Students (2018)
Basinview Drive	620
Kingswood	616
Bedford South	612
Rockingham	491
Sunnyside	287
Bedford & Forsythe	256
Michael Wallace	180

Source: hrce.ca/about-our-schools

Trip Distribution and Assignment

Primary site trips generated by the proposed development were assigned to the roadway network based on counted volumes and local knowledge of the area considering major trip origins and destinations in the region. Some guidance was also taken from previous studies that considered trip distribution in this area (Table 5). Separate trip distribution assumptions were made for Scenario One (Figure 3) and Scenario Two (Figure 4). Trip distribution characteristics for Area B1 were assumed to be the same as for Area A.

Table 5 – Trip Distribution Estimates from Previous Studies

	To/From Hammonds Plains Road	To/From Bedford Hwy then north	To/From Bedford Hwy then south	To/From Larry Uteck Blvd
Beasy Nicoll 1990	40%	34%	26%	N/A
Streetwise 1994	50%	30%	20%	N/A
ARTM 2005	N/A	65%	35%	N/A
DesignPoint 2016	N/A	50%		50%

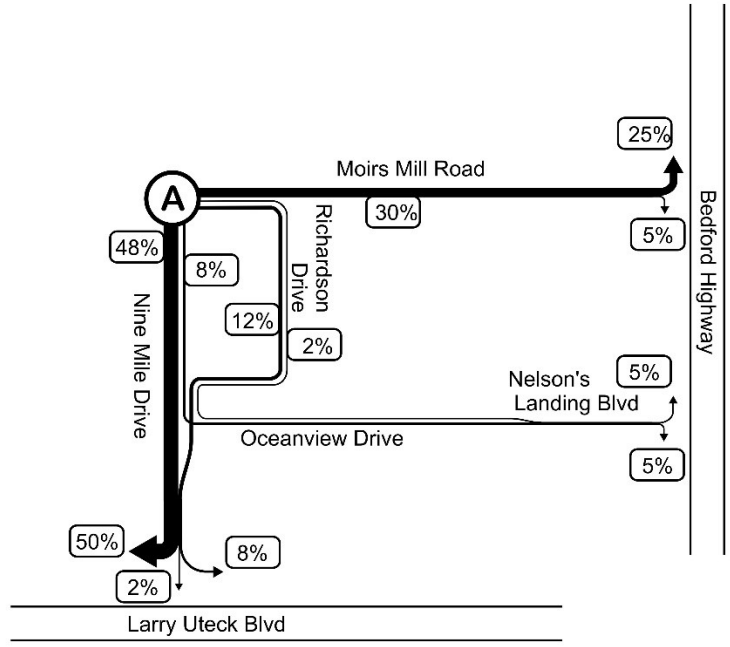


Figure 3 – Trip Distribution Assumptions – Scenario One

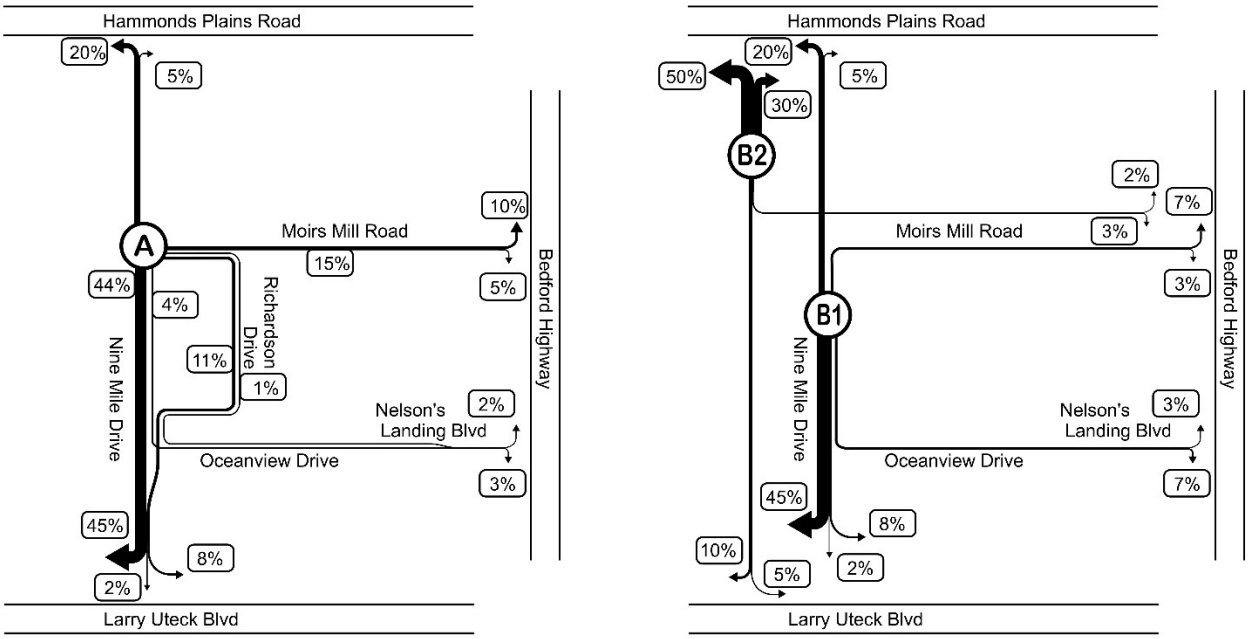


Figure 4 – Trip Distribution Assumptions – Scenario Two

Redistributing Background Traffic

The creation of a new connections to the regional roadway network will result in shifting of existing traffic to new routes. Two redistribution scenarios have been included in the analysis, described below and illustrated in Figure 5.

Redistribution #1

Some traffic currently generated on Moirs Mill Road and streets that connect to it access Larry Uteck Boulevard via Amin Street and Oceanview Drive. In Scenarios One and Two, Moirs Mill Road is connected to Nine Mile Drive and a new connection is made to Oceanview Drive via Richardson Drive. Both of these new connections provide a more direct route to Larry Uteck Boulevard and can both be expected to attract traffic away from Amin Street and Oceanview Drive. The volume of traffic assumed to be redistributed is 600 vehicles per day or approximately 34% of the traffic currently on Amin Street. An analysis of travel times (see Appendix C) was used to show that Moirs Mill Road is a more desirable connection than Richardson Drive assuming traffic control measures are implemented. For this reason, one-quarter of the redistributed traffic was added to Richardson Drive and three-quarters was added to Moirs Mill Road.

Redistribution #2

A new connection to Hammonds Plains Road via Nine Mile Drive in Scenario Two can be expected to shift current traffic patterns. For this assessment, it was assumed that 20% of traffic currently using Moirs Mill Road to access the Bedford Highway and 10% of traffic using Nelson's Landing Boulevard will be shifted to this new connector.

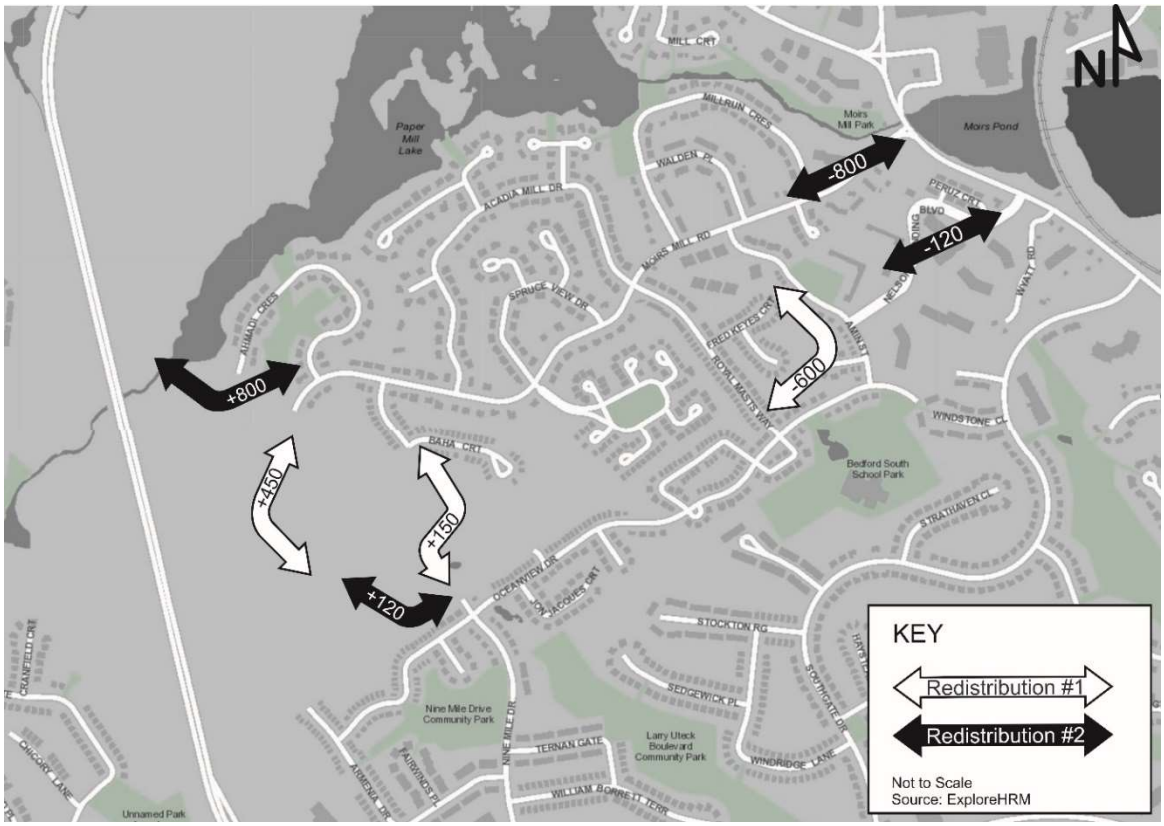


Figure 5 – Redistribution of Existing Traffic to New Connections

Projected Volumes that Include Site Generated Trips

Trips generated by the proposed development (Figure A-2, Appendix) have been added to the projected background volumes (Figure A-1, Appendix) to provide projected AM and PM peak hourly and daily traffic volumes, illustrated diagrammatically in Figure A-3, Appendix A.

4 OPERATIONAL ANALYSIS

Daily Volumes by Street Classification

HRM's Municipal Guidelines specify that 3,000 vehicles per day is characteristic of a Local Street. It further suggests that Collector Streets normally accommodate up to 12,000 vehicles per day while Major Collector Streets may exceed a daily volume of 12,000. Projected daily volumes for the key study area streets are summarized in Table 6.

Table 6 – Two-way Daily Volumes on Key Collector and Local Streets

Street	Classification	Existing	Scenario One	Scenario Two
Moirs Mill Rd (W of Bedford Hwy)	Collector	4,000	4,600	3,800
Moirs Mill Rd (E of Nine Mile Dr)	Collector	0	1,000	1,800
Nelsons Landing Blvd	Local	1,150	1,350	1,250
Oceanview Dr (W of Amin Street)	Local	1,750	1,350	1,200
Oceanview Dr (E of Nine Mile Dr)	Local	3,250	2,850	2,950
Nine Mile Dr (S of Oceanview Dr)	Collector	4,700	4,800	5,650
Nine Mile Dr (S of Hammonds Pl Rd)	Collector	0	0	4,000
Richardson Drive	Local	250	650	650

Moirs Mill Road

Volumes on Moirs Mill Road remain within the normal range of a collector street. In the original *Paper Mill Lake Area Traffic Impact Study* (Streetwise Traffic Engineering, 1994) that led to the establishment of the 100-lot limit for this area, a maximum volume of 5,000 vehicles per day was set for Moirs Mill Road. While this limit may no longer have status for the municipality, it is comforting to see that volumes nonetheless remain below this threshold due to the additional connection to Larry Uteck Boulevard that was not anticipated in the original study.

Nelsons Landing Boulevard

Little increase to volume on Nelsons Landing Boulevard is expected and volumes remain well below the normal local street volumes.

Oceanview Drive

Portions of Oceanview Drive currently exceed the characteristic 3,000 vehicle daily volume for a local street but that volume is expected to drop below 3,000 due to connection of Moirs Mill Road to Nine Mile Drive under Scenario One. In Scenario Two, that volume will increase slightly at the Nine Mile Drive end and decrease slightly at the Amin Street end due to the creation of an additional connection to the study area (Nine Mile Drive extension to Hammonds Plains Road). An increased stop delay at the Nelsons Landing Boulevard intersection at the Bedford Highway along with traffic calming measures on Oceanview Drive being considered by HRM may reduce this volume even further.

Nine Mile Drive

Daily volumes on Nine Mile Drive for full build-out (Scenario Two) are projected to range between 4000 and 6000. The street can be expected to operate successfully as a two-lane Collector Street with these volumes.

Richardson Drive

Richardson Drive (including Road 'E') is a local street, the majority of which will be constructed as part of the development project. As a dead-end street it currently handles only traffic generated along it. Once further development occurs along the street and it is connected between Moirs Mill Road and Nine Mile Drive, traffic will increase. As suggested in the travel time analysis (Appendix C), volumes are expected to remain well below 1000 vehicles per day if traffic calming measures are employed.

Intersection Capacity Analysis Results

Synchro 10.0 (signalized and stop control intersections) and *SIDRA* (roundabout intersection) have been used for performance evaluation of Study Area intersections for projected design hourly volumes without and with the addition of Scenario One site generated trips. Analysis results are included in Appendix A and summarized in Tables 7 to 9 below and indicate that all movements at all three intersections are expected to operate within HRM Guidelines without and with the addition of traffic generated by Scenario One.

Moirs Mill Rd/Bedford Hwy (Table 7) – Overall performance at the intersection is expected to be satisfactory both without and with the addition of site generated trips. All movements are expected to operate within HRM acceptable limits.

Table 7 – Intersection Capacity Moirs Mill Rd/Bedford Hwy (Scenario One)

LOS Criteria	Control Delay (sec/veh), v/c Ratio, and 95th %ile Queue (m) by Intersection Movement				Overall Intersection
	Moirs Mill Road		Bedford Highway		
	EB-L	EB-R	NB-LT	SB-TR	Delay
AM Design Hourly Volumes **without** Site Generated Trips					
Delay	50.3	10.9	6.7	6.3	12.8
v/c	0.69	0.14	0.35	0.35	
Queue	58.2	8.3	48.5	47.8	
AM Design Hourly Volumes **with** Site Generated Trips					
Delay	49.9	11.5	7.4	6.9	13.9
v/c	0.72	0.15	0.36	0.36	
Queue	63.4	9.3	52.4	51.8	
PM Design Hourly Volumes **without** Site Generated Trips					
Delay	56.7	15.8	6.7	7.2	10.6
v/c	0.64	0.09	0.49	0.57	
Queue	49.3	6.7	71.0	96.9	
PM Design Hourly Volumes **with** Site Generated Trips					
Delay	56.6	14.8	7.6	8.1	11.7
v/c	0.67	0.10	0.53	0.60	
Queue	54.1	7.1	78.9	108.5	

Nelsons Landing Boulevard (Table 8) – Delay at the stop-controlled leg of this intersection is currently high, particularly in the PM peak. As expected, that delay will increase with additional site-generated traffic. This intersection could be evaluated for possible signalization, it does not meet the volume threshold in the signalization warrant (75 vehicles per hour approaching) and signalization would work contrary to the aim of minimizing volumes on the local streets that feed the intersection. Maintaining status quo as a deterrent to high use of this connection is recommended and is similar to several other stop-controlled intersections on major roadways (including along the Bedford Highway).

Nine Mile Drive/Larry Uteck (Table 9) – Overall performance at this roundabout intersection is expected to be satisfactory both without and with the addition of site generated trips, all movements are expected to operate within HRM acceptable limits.

Intersection Capacity Analysis Results (Continued)

Table 8 – Intersection Capacity: Nelsons Landing Blvd/Bedford Hwy (Scenario One)

LOS Criteria	Control Delay (sec/veh), v/c Ratio, and 95th %ile Queue (m) by Intersection Movement					Overall Intersection
	Nelsons Landing Boulevard		Bedford Highway			
	EB-L	EB-R	NB-L	NB-T	SB-TR	Delay
AM Design Hourly Volumes **without** Site Generated Trips						
Delay	28.2	12.0	8.7	0.0	0.0	1.6
v/c	0.20	0.09	0.04	0.33	0.32	
Queue	5.4	2.2	0.9	0.0	0.0	
AM Design Hourly Volumes **with** Site Generated Trips						
Delay	29.8	12.1	8.8	0.0	0.0	1.8
v/c	0.23	0.10	0.04	0.33	0.33	
Queue	6.5	2.4	1.0	0.0	0.0	
PM Design Hourly Volumes **without** Site Generated Trips						
Delay	102.3	15.4	10.3	0.0	0.0	1.7
v/c	0.38	0.09	0.05	0.52	0.50	
Queue	10.7	2.2	1.3	0.0	0.0	
PM Design Hourly Volumes **with** Site Generated Trips						
Delay	124.4	15.6	10.4	0.0	0.0	2.2
v/c	0.48	0.10	0.06	0.53	0.50	
Queue	13.6	2.4	1.5	0.0	0.0	

Table 9 – Intersection Capacity: Nine Mile Drive/Larry Uteck Blvd (Scenario One)

LOS Criteria	Control Delay (sec/veh), v/c Ratio, and 95th %ile Queue (m) by Intersection Movement												Overall Intersection
	Larry Uteck Boulevard						Starboard Drive			Nine Mile Drive			
	EB-L	EB-T	EB-R	WB-L	WB-T	WB-R	NB-L	NB-T	NB-R	SB-L	SB-T	SB-R	Delay
AM Design Hourly Volumes **without** Site Generated Trips													
Delay	11.2	3.8	3.8	14.2	6.5	6.4	12.3	5.9	6.0	14.2	6.9	6.2	8.1
v/c	0.33	0.33	0.33	0.47	0.47	0.47	0.44	0.20	0.20	0.25	0.25	0.30	
Queue	13.0	13.0	13.0	21.0	22.0	22.0	17.0	6.0	6.0	8.0	8.0	11.0	
AM Design Hourly Volumes **with** Site Generated Trips													
Delay	11.2	3.8	3.9	14.5	6.8	6.6	12.4	6.0	6.1	14.4	7.1	6.6	8.3
v/c	0.34	0.34	0.34	0.48	0.48	0.48	0.45	0.21	0.21	0.28	0.28	0.37	
Queue	13.0	14.0	14.0	22.0	23.0	23.0	18.0	6.0	6.0	9.0	9.0	14.0	
PM Design Hourly Volumes **without** Site Generated Trips													
Delay	12.7	5.1	5.2	19.1	11.0	10.7	16.6	8.3	8.4	14.3	6.8	6.3	10.6
v/c	0.60	0.60	0.60	0.57	0.57	0.57	0.68	0.44	0.44	0.29	0.29	0.29	
Queue	33.0	33.0	33.0	31.0	33.0	33.0	38.0	17.0	17.0	10.0	11.0	11.0	
PM Design Hourly Volumes **with** Site Generated Trips													
Delay	13.2	5.6	5.6	21.1	12.8	12.4	17.6	8.9	9.0	14.6	7.1	6.4	11.4
v/c	0.63	0.63	0.63	0.61	0.61	0.61	0.71	0.46	0.46	0.33	0.33	0.33	
Queue	37.0	37.0	37.0	35.0	38.0	38.0	41.0	18.0	18.0	12.0	13.0	13.0	

Analysis uses an Environmental factor of 1.2 for all approaches.

5 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 SUMMARY

Description of the Proposed Development	1. Consideration is being given to allowing additional development within an existing RCDD zone in the Paper Mill Lake area. The expansion is proposed to include: • 214 single family residential units; • 6,000 square feet of leasable neighbourhood retail floor space; and, • 6,000 square feet of office floor space. The conditions of the Development Agreement currently limit the number of lots that can be developed based on the volume of traffic that would be placed on collector and local streets in the area.
Access to the Development Area	2. Vehicular access to the area currently consists of connections to the Bedford Highway via Moirs Mill Road and Nelsons Landing Boulevard and to Larry Uteck Boulevard via Nine Mile Drive. When the original Development Agreement was put in place, this latter connection was not available. An additional scenario was considered in this assessment whereby a fourth connection is established northward to Hammonds Plains Road via an extension of Nine Mile Drive.
Study Area Roads	3. Traffic on several streets in the area was considered. Volumes were evaluated for Moirs Mill Road (collector), Nine Mile Drive (collector), Nelsons Landing Boulevard (local), Richardson Drive (local) and Oceanview Drive (local).
Background Traffic Volumes	4. Projected future weekday AM and PM peak hour background volumes were estimated using growth rate of 5%. With an annual traffic growth on 0.5% being typical in this area, 5% represents a development horizon of approximately ten years. An overall growth rate of 1% was used for streets internal to the study area.
Estimation of Site Generated Trips	5. Trip generation estimates, were prepared using rates published in *Trip Generation, 10th Edition* (Institute of Transportation Engineers, Washington, 2017). Modifications were made to consider the effects of transit and active transportation as well as synergies within the development area.
Trip Distribution and Assignment	6. Primary vehicle trips generated by the development have been assigned to study area streets and intersections based on observation, local knowledge and previous traffic assessments in the area.
Development Scenarios	7. Two development scenarios were created for this assessment. Scenario One represents the currently proposed development and its impact on the street network with its existing configuration. Scenario Two was considered to help determine longer term traffic patterns and the functional requirement of Nine Mile Drive as a completed connection between Larry Uteck Boulevard and Hammonds Plains Road.

Volumes on Local and Collector Streets	8. Traffic volumes on all streets are consistent with the suggested characteristics of their street classification.
Summary – Intersection Capacity Analysis	9. The existing Bedford Highway intersections at Moirs Mill Road and at Nelsons Landing Boulevard, along with the Nine Mile Drive/Larry Uteck Boulevard roundabout will continue to operate within their capacity with the addition of traffic from the proposed development. The unsignalized approach at Nelsons Landing Boulevard and the Bedford Highway currently experiences high delays on the stop-controlled approach and this will increase with added traffic from the development. All intersections are expected to continue to operate within HRM Guidelines.

5.2 RECOMMENDATIONS

Nelsons Landing Boulevard Intersection	10. Although signalization may reduce delays on Nelsons Landing Boulevard, the volume is lower than the warrant threshold (75 per hour) and signalization is neither desirable nor recommended as it would increase the attractiveness of the local street connections to it. As Moirs Mill Road provides an alternative signalized connection to the Bedford Highway with adequate capacity, higher delays at Nelson's Landing Boulevard should not be considered problematic.
Oceanview Drive	11. Connecting Richardson Drive to Nine Mile Drive will be successful in maintaining traffic volumes on Oceanview Drive below 3000 vehicles per day. Traffic calming measures and increasing delay on Nelsons Landing Boulevard may result in this volume being reduced even further.
Nine Mile Drive	12. Nine Mile Drive can be expected to carry traffic volumes at full build-out of the Paper Mill Lake area not in excess of 5,500 vehicles per day. This is suited to a two-lane collector roadway standard.
Richardson Drive	13. Traffic volumes are expected to remain well below 1000 vehicles per day on Richardson Drive. The analysis shown in Appendix C relies on the local street context and a ninety-degree turn as a deterrent to vehicles choosing this as an attractive path between Moirs Mill Road and Nine Mile Drive. HRM may wish to consider adding traffic calming measures if short-cutting is demonstrated to be an issue.
Public Transit and Active Transportation	14. Continue to develop the Bedford Highway as a corridor for both transit and active transportation. The study area has good connectivity to this corridor and the development area can be expected to produce high percentages of transit and active transportation trips.

5.3 CONCLUSIONS

Impacts to Vehicular Traffic	15. With implementation of recommendations above, trips generated by Scenario One site development are not expected to have a significant impact to levels of performance on adjacent intersections or to the regional road network.

APPENDIX

A

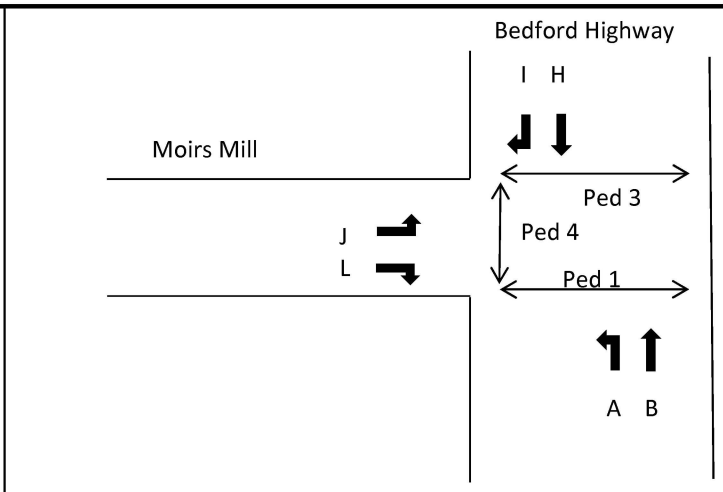
TRAFFIC VOLUME DATA AND INTERSECTION PERFORMANCE ANALYSIS

Table A-1

Bedford Highway @ Moirs Mill

Bedford, NS

Wednesday, November 7, 2018



AM Peak Period Volume Data

Time		Bedford Highway Northbound Approach		Bedford Highway Southbound Approach		Moirs Mill Eastbound Approach		Total Vehicles
		A	B	H	I	J	L	
07:00	07:15	2	83	92	5	30	8	220
07:15	07:30	3	92	76	11	41	13	236
07:30	07:45	0	117	98	15	42	9	281
07:45	08:00	3	119	101	26	41	11	301
08:00	08:15	4	117	107	27	38	11	304
08:15	08:30	4	122	120	31	58	8	343
08:30	08:45	2	125	115	18	58	9	327
08:45	09:00	5	157	114	29	40	14	359
AM Peak Hour		**15**	**521**	**456**	**105**	**194**	**42**	**1333**
07:00	**08:00**	**8**	**411**	**367**	**57**	**154**	**41**	**1038**
08:00	**09:00**	**15**	**521**	**456**	**105**	**194**	**42**	**1333**
		Ped 1		**Ped 3**		**Ped 4**		**Total Peds**
07:00	**08:00**	**12**		**0**		**7**		**19**
08:00	**09:00**	**13**		**0**		**19**		**32**

PM Peak Period Volume Data

Time		Bedford Highway Northbound Approach		Bedford Highway Southbound Approach		Moirs Mill Eastbound Approach		Total Vehicles
		A	B	H	I	J	L	
16:00	16:15	11	174	155	44	30	7	421
16:15	16:30	11	193	165	57	32	5	463
16:30	16:45	6	200	204	34	38	9	491
16:45	17:00	7	181	173	35	25	7	428
17:00	17:15	3	171	203	82	38	2	499
17:15	17:30	11	167	199	52	39	4	472
17:30	17:45	13	161	177	54	47	7	459
17:45	18:00	13	142	137	43	35	4	374
PM Peak Hour		**27**	**719**	**779**	**203**	**140**	**22**	**1890**
16:00	**17:00**	**35**	**748**	**697**	**170**	**125**	**28**	**1803**
17:00	**18:00**	**40**	**641**	**716**	**231**	**159**	**17**	**1804**
		Ped 1		**Ped 3**		**Ped 4**		**Total Peds**
16:00	**17:00**	**27**		**0**		**22**		**49**
17:00	**18:00**	**31**		**0**		**6**		**37**

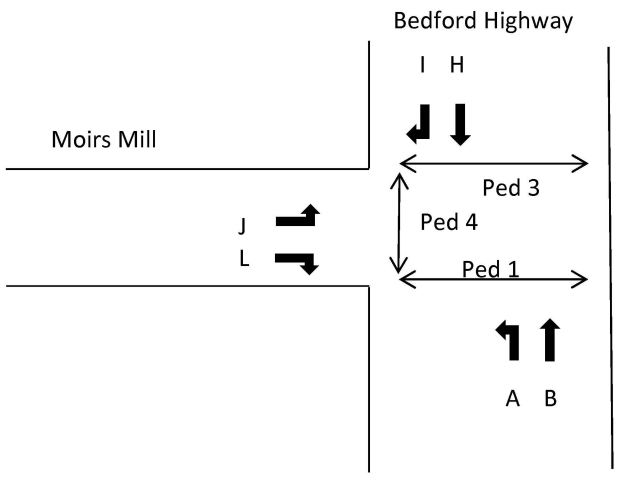
* Count completed by WSP

Table A-2

Bedford Highway @ Nelsons Landing Boulevard

Bedford, NS

Wednesday, November 7, 2018



AM Peak Period Volume Data

Time		Bedford Highway Northbound Approach		Bedford Highway Southbound Approach		Nelsons Landing Boulevard Eastbound Approach		Total Vehicles
		A	B	H	I	J	L	
07:00	07:15	2	82	108	1	7	12	212
07:15	07:30	5	89	90	4	8	5	201
07:30	07:45	1	98	98	3	12	7	219
07:45	08:00	6	115	116	6	8	7	258
08:00	08:15	9	111	108	5	9	10	252
08:15	08:30	14	123	117	5	3	12	274
08:30	08:45	11	111	127	5	11	17	282
08:45	09:00	2	146	112	4	12	6	282
AM Peak Hour		**36**	**491**	**464**	**19**	**35**	**45**	**1090**
07:00	**08:00**	**14**	**384**	**412**	**14**	**35**	**31**	**890**
08:00	**09:00**	**36**	**491**	**464**	**19**	**35**	**45**	**1090**
		Ped 1		**Ped 3**		**Ped 4**		**Total Peds**
07:00	**08:00**	**0**		**5**		**4**		**9**
08:00	**09:00**	**0**		**5**		**4**		**9**

PM Peak Period Volume Data

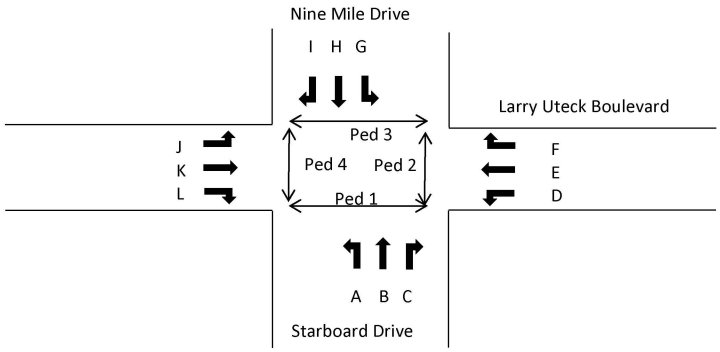
Time		Bedford Highway Northbound Approach		Bedford Highway Southbound Approach		Nelsons Landing Boulevard Eastbound Approach		Total Vehicles
		A	B	H	I	J	L	
16:00	16:15	9	202	151	7	8	7	384
16:15	16:30	11	211	166	11	4	6	409
16:30	16:45	11	183	179	5	7	14	399
16:45	17:00	7	204	178	8	4	8	409
17:00	17:15	7	182	171	22	4	4	390
17:15	17:30	12	179	172	10	6	10	389
17:30	17:45	6	182	161	16	1	12	378
17:45	18:00	15	152	145	8	7	5	332
PM Peak Hour		**36**	**780**	**694**	**46**	**19**	**32**	**1607**
16:00	**17:00**	**38**	**800**	**674**	**31**	**23**	**35**	**1601**
17:00	**18:00**	**40**	**695**	**649**	**56**	**18**	**31**	**1489**
		Ped 1		**Ped 3**		**Ped 4**		**Total Peds**
16:00	**17:00**	**0**		**19**		**10**		**29**
17:00	**18:00**	**0**		**18**		**6**		**24**

* Count completed by WSP

Table A-3

Larry Uteck Boulevard
@
Nine Mile Drive / Starboard Drive

Bedford, NS
Thursday, November 15, 2018



AM Peak Period Volume Data

Time		Starboard Drive Northbound Approach			Larry Uteck Boulevard Westbound Approach			Nine Mile Drive Southbound Approach			Larry Uteck Boulevard Eastbound Approach			Total Vehicles
		A	B	C	D	E	F	G	H	I	J	K	L	
07:00	07:15	58	5	11	24	81	7	5	13	43	21	45	22	335
07:15	07:30	87	10	12	31	110	8	6	8	61	35	50	12	430
07:30	07:45	96	11	10	30	103	11	7	11	56	40	66	20	461
07:45	08:00	86	14	12	25	111	11	12	23	52	42	98	20	506
08:00	08:15	97	9	18	47	134	18	8	12	50	56	70	25	544
08:15	08:30	105	10	13	26	122	21	17	20	47	55	73	33	542
08:30	08:45	99	16	11	37	123	14	11	25	69	63	78	25	571
08:45	09:00	85	13	21	38	95	13	17	24	34	61	87	25	513
AM Peak Hour		**386**	**48**	**63**	**148**	**474**	**66**	**53**	**81**	**200**	**235**	**308**	**108**	**2170**
07:00	**08:00**	**327**	**40**	**45**	**110**	**405**	**37**	**30**	**55**	**212**	**138**	**259**	**74**	**1732**
08:00	**09:00**	**386**	**48**	**63**	**148**	**474**	**66**	**53**	**81**	**200**	**235**	**308**	**108**	**2170**
		Ped 1			**Ped 2**			**Ped 3**			**Ped 4**			**Total Peds**
07:00	**08:00**	**1**			**1**			**0**			**5**			**7**
08:00	**09:00**	**2**			**2**			**1**			**4**			**9**

PM Peak Period Volume Data

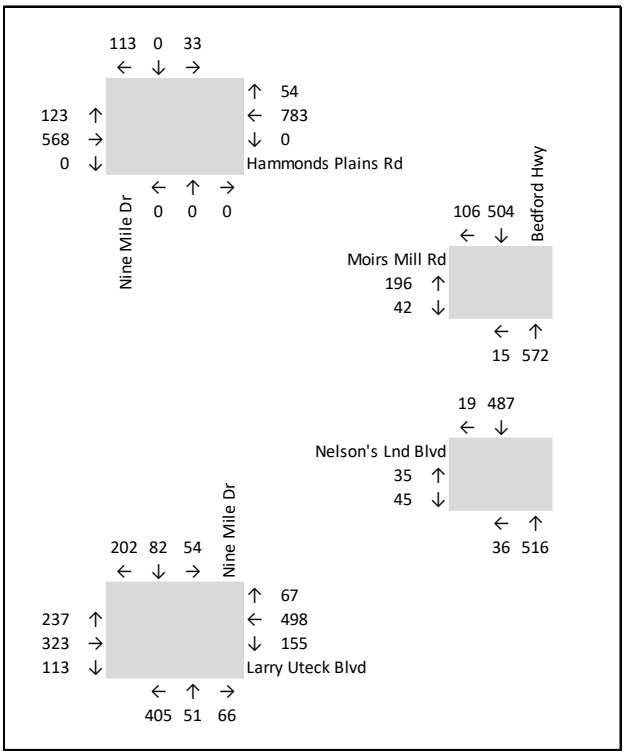
Time		Starboard Drive Northbound Approach			Larry Uteck Boulevard Westbound Approach			Nine Mile Drive Southbound Approach			Larry Uteck Boulevard Eastbound Approach			Total Vehicles
		A	B	C	D	E	F	G	H	I	J	K	L	
16:00	16:15	109	25	40	50	92	18	11	21	28	83	121	42	640
16:15	16:30	126	17	20	42	87	24	20	29	39	107	121	54	686
16:30	16:45	119	16	44	46	91	18	14	25	41	118	124	50	706
16:45	17:00	113	11	43	40	103	21	21	26	47	99	141	54	719
17:00	17:15	92	16	44	49	102	25	25	25	31	102	124	46	681
17:15	17:30	93	15	36	46	62	18	18	12	31	108	144	55	638
17:30	17:45	96	9	35	36	93	22	18	19	32	94	133	48	635
17:45	18:00	84	8	36	40	88	19	13	19	32	70	127	44	580
PM Peak Hour		**450**	**60**	**151**	**177**	**383**	**88**	**80**	**105**	**158**	**426**	**510**	**204**	**2792**
16:00	**17:00**	**467**	**69**	**147**	**178**	**373**	**81**	**66**	**101**	**155**	**407**	**507**	**200**	**2751**
17:00	**18:00**	**365**	**48**	**151**	**171**	**345**	**84**	**74**	**75**	**126**	**374**	**528**	**193**	**2534**
		Ped 1			**Ped 2**			**Ped 3**			**Ped 4**			**Total Peds**
16:00	**17:00**	**12**			**14**			**5**			**5**			**36**
17:00	**18:00**	**3**			**2**			**1**			**6**			**12**

* Count completed by WSP

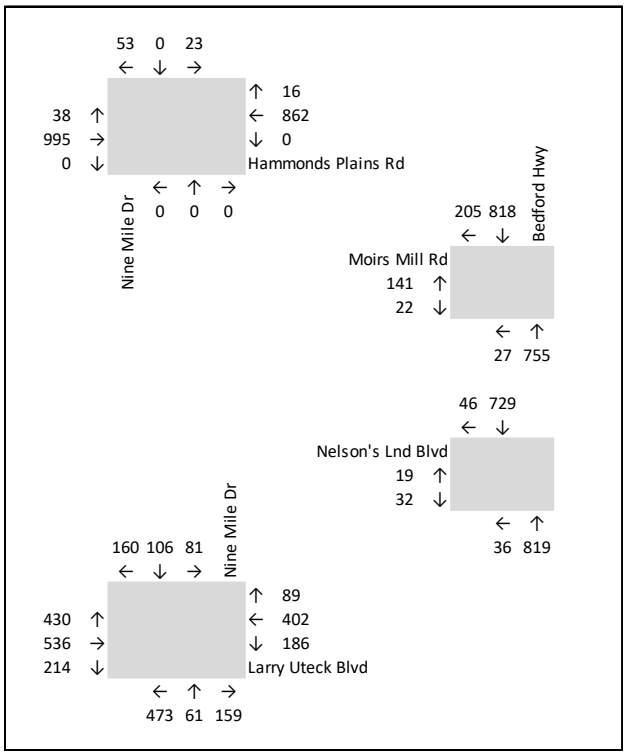
TRAFFIC VOLUMES

Projected Design Hourly AM and PM Peak Hour Background Traffic without Site Development

AM PEAK



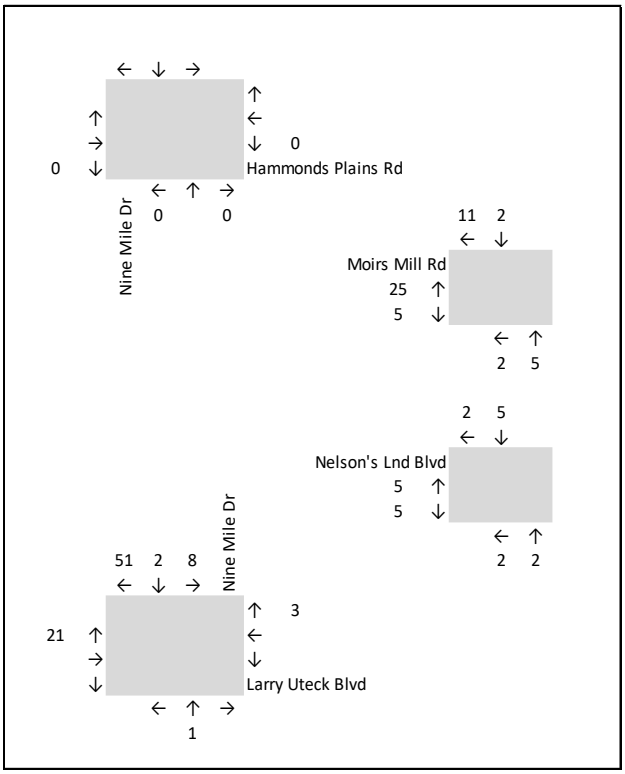
PM PEAK



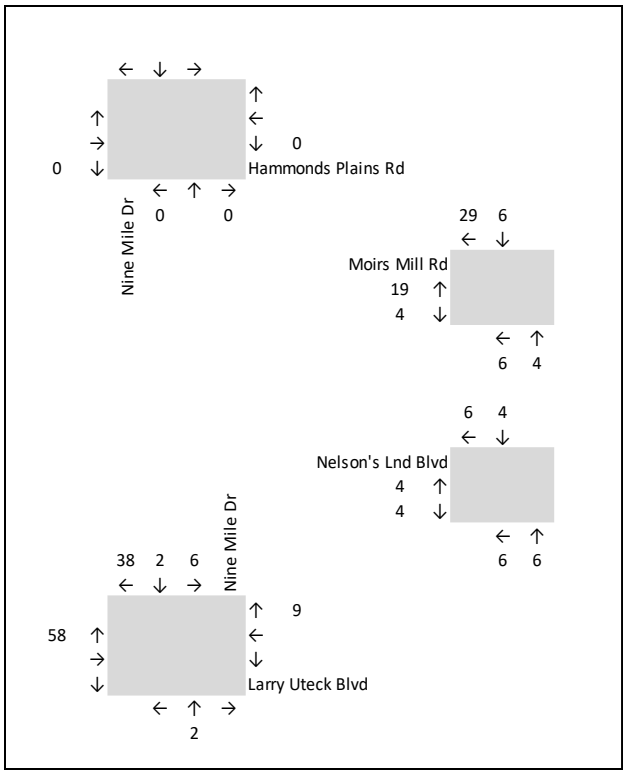
TRAFFIC VOLUMES

Estimated AM and PM Peak Hour Trip Assignment – Scenario A

AM PEAK



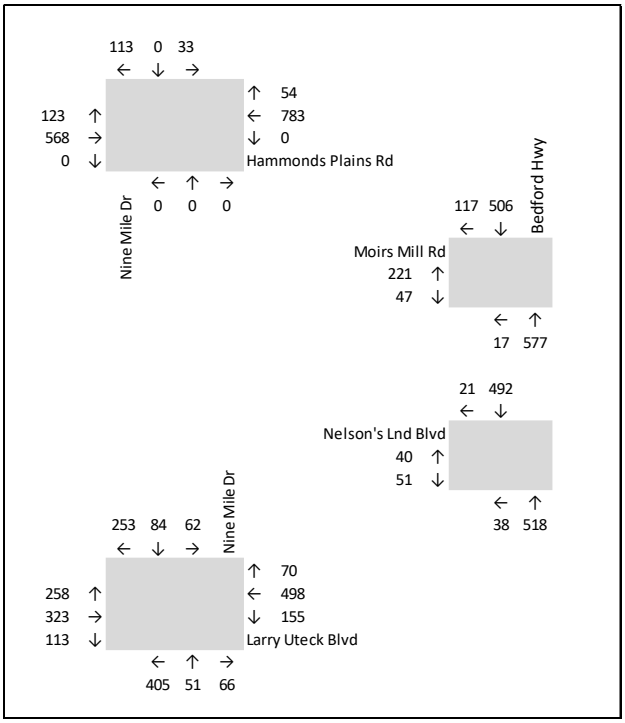
PM PEAK



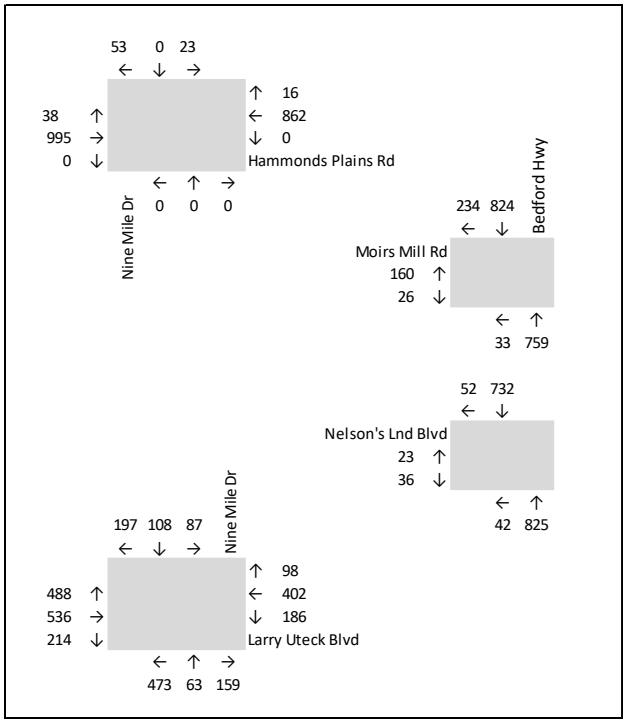
TRAFFIC VOLUMES

Projected Design Hourly AM and PM Peak Hour Traffic with Scenario A Site Development

AM PEAK



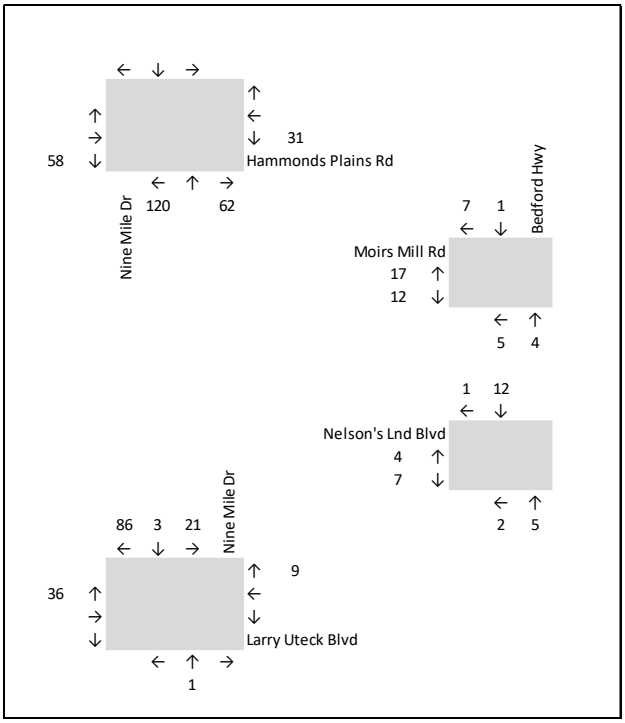
PM PEAK



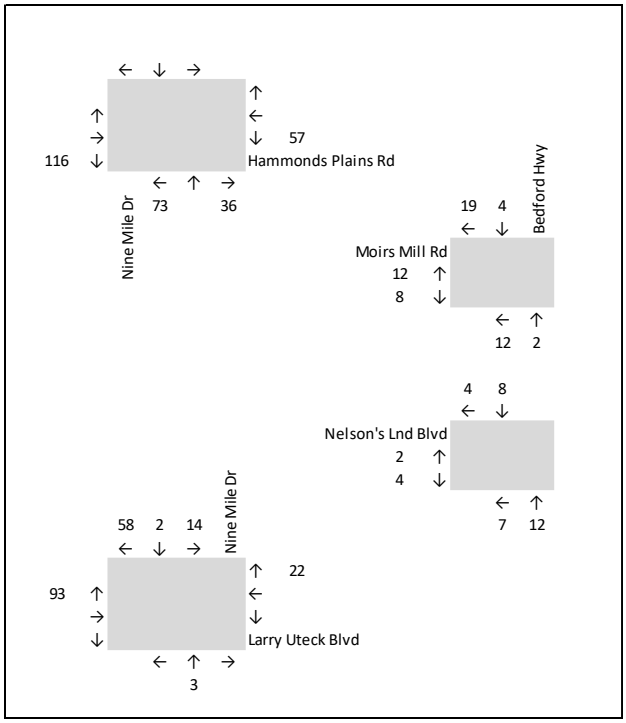
TRAFFIC VOLUMES

Estimated AM and PM Peak Hour Trip Assignment – Scenario B

AM PEAK



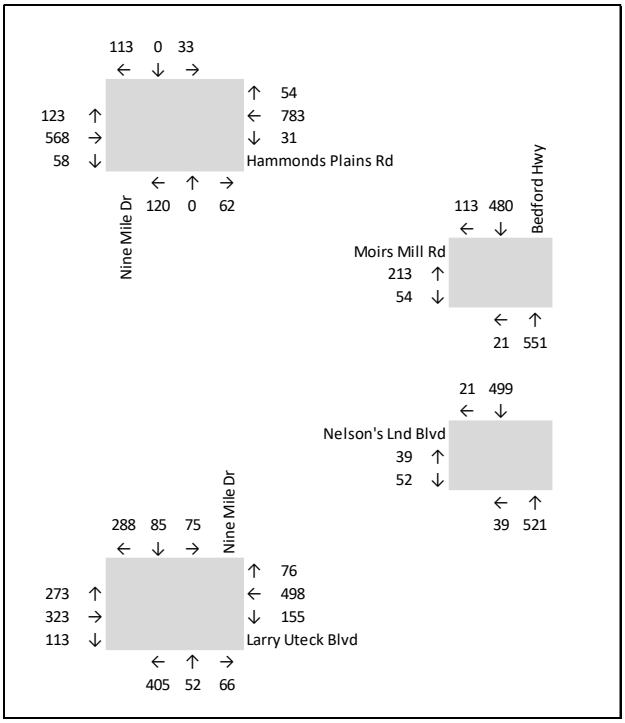
PM PEAK



TRAFFIC VOLUMES

Projected Design Hourly AM and PM Peak Hour Traffic with Scenario B Site Development

AM PEAK



PM PEAK

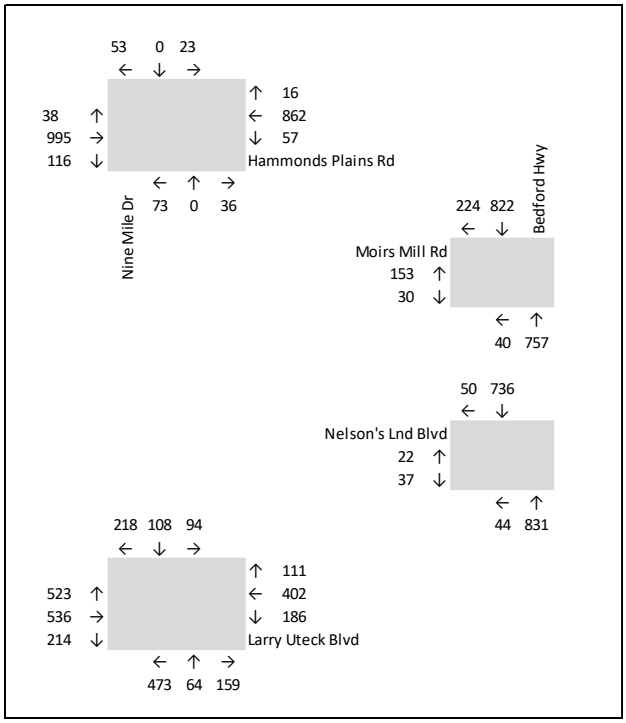


Table A1 - Two-Way Traffic Volumes – Scenario One

Street Location	Background Traffic	Background Traffic Growth	Redistribution #1	Site Generated Traffic	Total
Moirs Mill Road (west of Bedford Hwy)	4019	40		562	4621
Moirs Mill Road (at Nine Mile Dr)	0	0	+450	562	1012
Nelson's Landing Boulevard	1174	12		188	1374
Oceanview Drive (west of Amin Street)	1740	17	-600	188	1345
Oceanview Drive (east of Nine Mile Dr.)	3226	32	-600	188	2846
Nine Mile Drive (south of Oceanview Dr)	3624	36		1126	4786
Richardson Drive	250*	3	+150	263	666

*Note: The existing two-way volume on Richardson Drive as a cul-de-sac is 500 vehicles per day. It is assumed that once the street has two exits, traffic will split evenly between the two exits.

Table A2 - Two-Way Traffic Volumes – Scenario Two

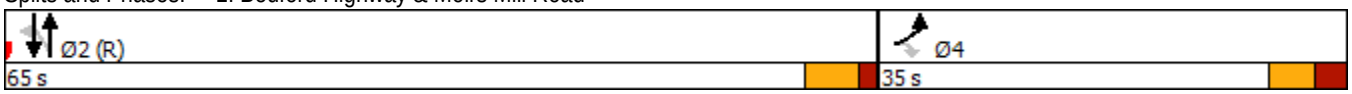
Street Location	Backgrnd Traffic	Backgrnd Traffic Growth	Redist #1	Redist #2	Internal School Trips	Site Generated Traffic	Total
Moirs Mill Road (west of Bedford Hwy)	4019	40		-800		520	3779
Moirs Mill Road (at Nine Mile Dr)	0	0	+450	+800	+50	520	1820
Nelson's Landing Boulevard	1174	12		-120		185	1251
Oceanview Drive (west of Amin Street)	1740	17	-600	-120		185	1222
Oceanview Drive (east of Nine Mile Dr.)	3226	32	-600	+120		184	2963
Nine Mile Drive (south of HamPlns Rd)	0	0		+920		3065	3985
Nine Mile Drive (south of Oceanview Dr)	3624	36				1976	5636
Richardson Drive	250	3	+150			225	628

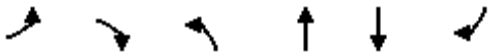
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	196	42	15	572	504	106
Future Volume (vph)	196	42	15	572	504	106
Satd. Flow (prot)	1789	1601	0	2634	2568	0
Flt Permitted	0.950			0.924		
Satd. Flow (perm)	1789	1601	0	2436	2568	0
Satd. Flow (RTOR)		46			28	
Lane Group Flow (vph)	213	46	0	638	663	0
Turn Type	Prot	Perm	Perm	NA	NA	
Protected Phases	4			2	2	
Permitted Phases		4	2			
Total Split (s)	35.0	35.0	65.0	65.0	65.0	
Total Lost Time (s)	6.0	6.0		5.5	5.5	
Act Effct Green (s)	17.2	17.2		71.3	71.3	
Actuated g/C Ratio	0.17	0.17		0.71	0.71	
v/c Ratio	0.69	0.15		0.37	0.36	
Control Delay	50.3	10.6		6.9	6.5	
Queue Delay	0.0	0.0		0.0	0.0	
Total Delay	50.3	10.6		6.9	6.5	
LOS	D	B		A	A	
Approach Delay	43.2			6.9	6.5	
Approach LOS	D			A	A	
Queue Length 50th (m)	39.2	0.0		29.5	28.9	
Queue Length 95th (m)	58.3	8.7		51.7	50.8	
Internal Link Dist (m)	241.6			32.5	268.6	
Turn Bay Length (m)		25.0				
Base Capacity (vph)	518	496		1736	1838	
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	0.41	0.09		0.37	0.36	

Intersection Summary

Cycle Length: 100
Actuated Cycle Length: 100
Offset: 0 (0%), Referenced to phase 2:NBSB and 6:, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.69
Intersection Signal Delay: 12.8 Intersection LOS: B
Intersection Capacity Utilization 64.6% ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 1: Bedford Highway & Moirs Mill Road





Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	35	45	36	516	487	19
Future Volume (Veh/h)	35	45	36	516	487	19
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	38	49	39	561	529	21
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)					252	
pX, platoon unblocked	0.89	0.89	0.89			
vC, conflicting volume	1178	540	550			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1140	425	437			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	80	91	96			
cM capacity (veh/h)	191	562	1003			

Direction, Lane #	EB 1	EB 2	NB 1	NB 2	SB 1
Volume Total	38	49	39	561	550
Volume Left	38	0	39	0	0
Volume Right	0	49	0	0	21
cSH	191	562	1003	1700	1700
Volume to Capacity	0.20	0.09	0.04	0.33	0.32
Queue Length 95th (m)	5.5	2.2	0.9	0.0	0.0
Control Delay (s)	28.5	12.0	8.7	0.0	0.0
Lane LOS	D	B	A		
Approach Delay (s)	19.2		0.6		0.0
Approach LOS	C				

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	39.9%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	141	22	27	755	818	206
Future Volume (vph)	141	22	27	755	818	206
Satd. Flow (prot)	1789	1601	0	2632	2558	0
Flt Permitted	0.950			0.845		
Satd. Flow (perm)	1789	1601	0	2228	2558	0
Satd. Flow (RTOR)		24			34	
Lane Group Flow (vph)	153	24	0	850	1113	0
Turn Type	Prot	Perm	Perm	NA	NA	
Protected Phases	4			2	2	
Permitted Phases		4	2			
Total Split (s)	36.0	36.0	74.0	74.0	74.0	
Total Lost Time (s)	6.0	6.0		5.5	5.5	
Act Effct Green (s)	14.7	14.7		83.8	83.8	
Actuated g/C Ratio	0.13	0.13		0.76	0.76	
v/c Ratio	0.64	0.10		0.50	0.57	
Control Delay	56.7	15.6		6.8	7.2	
Queue Delay	0.0	0.0		0.0	0.0	
Total Delay	56.7	15.6		6.8	7.2	
LOS	E	B		A	A	
Approach Delay	51.1			6.8	7.2	
Approach LOS	D			A	A	
Queue Length 50th (m)	31.5	0.0		41.8	57.7	
Queue Length 95th (m)	49.5	7.1		72.2	97.2	
Internal Link Dist (m)	241.6			32.5	268.6	
Turn Bay Length (m)		25.0				
Base Capacity (vph)	487	454		1696	1956	
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	0.31	0.05		0.50	0.57	

Intersection Summary

Cycle Length: 110
Actuated Cycle Length: 110
Offset: 0 (0%), Referenced to phase 2:NBSB and 6:, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.64
Intersection Signal Delay: 10.7 Intersection LOS: B
Intersection Capacity Utilization 74.1% ICU Level of Service D
Analysis Period (min) 15

Splits and Phases: 1: Bedford Highway & Moirs Mill Road

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	19	32	36	819	729	46
Future Volume (Veh/h)	19	32	36	819	729	46
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	21	35	39	890	792	50
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)					252	
pX, platoon unblocked	0.77	0.77	0.77			
vC, conflicting volume	1785	817	842			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1872	609	642			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	63	91	95			
cM capacity (veh/h)	57	379	723			

Direction, Lane #	EB 1	EB 2	NB 1	NB 2	SB 1
Volume Total	21	35	39	890	842
Volume Left	21	0	39	0	0
Volume Right	0	35	0	0	50
cSH	57	379	723	1700	1700
Volume to Capacity	0.37	0.09	0.05	0.52	0.50
Queue Length 95th (m)	10.2	2.3	1.3	0.0	0.0
Control Delay (s)	100.1	15.4	10.3	0.0	0.0
Lane LOS	F	C	B		
Approach Delay (s)	47.2		0.4		0.0
Approach LOS	E				

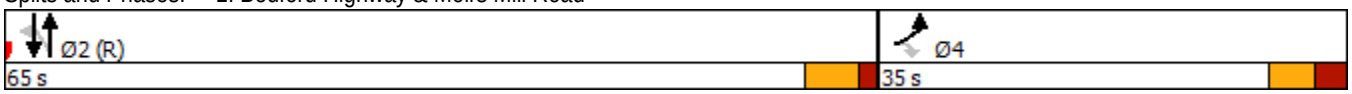
Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	53.1%	ICU Level of Service	A
Analysis Period (min)	15		

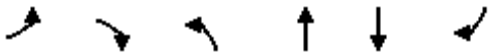
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	221	47	17	577	506	117
Future Volume (vph)	221	47	17	577	506	117
Satd. Flow (prot)	1789	1601	0	2634	2563	0
Flt Permitted	0.950			0.918		
Satd. Flow (perm)	1789	1601	0	2421	2563	0
Satd. Flow (RTOR)		46			32	
Lane Group Flow (vph)	240	51	0	645	677	0
Turn Type	Prot	Perm	Perm	NA	NA	
Protected Phases	4			2	2	
Permitted Phases		4	2			
Total Split (s)	35.0	35.0	65.0	65.0	65.0	
Total Lost Time (s)	6.0	6.0		5.5	5.5	
Act Effct Green (s)	18.7	18.7		69.8	69.8	
Actuated g/C Ratio	0.19	0.19		0.70	0.70	
v/c Ratio	0.72	0.15		0.38	0.38	
Control Delay	50.0	11.6		7.7	7.2	
Queue Delay	0.0	0.0		0.0	0.0	
Total Delay	50.0	11.6		7.7	7.2	
LOS	D	B		A	A	
Approach Delay	43.3			7.7	7.2	
Approach LOS	D			A	A	
Queue Length 50th (m)	44.1	0.8		32.1	31.7	
Queue Length 95th (m)	64.1	9.5		56.0	55.3	
Internal Link Dist (m)	241.6			32.5	268.6	
Turn Bay Length (m)		25.0				
Base Capacity (vph)	518	496		1690	1799	
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	0.46	0.10		0.38	0.38	

Intersection Summary

Cycle Length: 100
Actuated Cycle Length: 100
Offset: 0 (0%), Referenced to phase 2:NBSB and 6:, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.72
Intersection Signal Delay: 13.9 Intersection LOS: B
Intersection Capacity Utilization 66.0% ICU Level of Service C
Analysis Period (min) 15

Splits and Phases: 1: Bedford Highway & Moirs Mill Road





Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	40	51	38	518	492	21
Future Volume (Veh/h)	40	51	38	518	492	21
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	43	55	41	563	535	23
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)					252	
pX, platoon unblocked	0.89	0.89	0.89			
vC, conflicting volume	1192	546	558			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1151	423	436			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	77	90	96			
cM capacity (veh/h)	186	559	995			

Direction, Lane #	EB 1	EB 2	NB 1	NB 2	SB 1
Volume Total	43	55	41	563	558
Volume Left	43	0	41	0	0
Volume Right	0	55	0	0	23
cSH	186	559	995	1700	1700
Volume to Capacity	0.23	0.10	0.04	0.33	0.33
Queue Length 95th (m)	6.6	2.5	1.0	0.0	0.0
Control Delay (s)	30.1	12.1	8.8	0.0	0.0
Lane LOS	D	B	A		
Approach Delay (s)	20.0		0.6		0.0
Approach LOS	C				

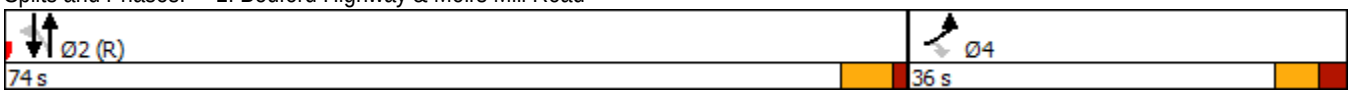
Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	41.6%	ICU Level of Service	A
Analysis Period (min)	15		

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	160	26	33	759	824	234
Future Volume (vph)	160	26	33	759	824	234
Satd. Flow (prot)	1789	1601	0	2632	2550	0
Flt Permitted	0.950			0.808		
Satd. Flow (perm)	1789	1601	0	2131	2550	0
Satd. Flow (RTOR)		28			39	
Lane Group Flow (vph)	174	28	0	861	1150	0
Turn Type	Prot	Perm	Perm	NA	NA	
Protected Phases	4			2	2	
Permitted Phases		4	2			
Total Split (s)	36.0	36.0	74.0	74.0	74.0	
Total Lost Time (s)	6.0	6.0		5.5	5.5	
Act Effct Green (s)	16.0	16.0		82.5	82.5	
Actuated g/C Ratio	0.15	0.15		0.75	0.75	
v/c Ratio	0.67	0.11		0.54	0.60	
Control Delay	56.5	14.3		7.9	8.2	
Queue Delay	0.0	0.0		0.0	0.0	
Total Delay	56.5	14.3		7.9	8.2	
LOS	E	B		A	A	
Approach Delay	50.7			7.9	8.2	
Approach LOS	D			A	A	
Queue Length 50th (m)	35.9	0.0		46.9	65.0	
Queue Length 95th (m)	54.7	7.5		81.3	109.5	
Internal Link Dist (m)	241.6			32.5	268.6	
Turn Bay Length (m)		25.0				
Base Capacity (vph)	487	457		1597	1921	
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	0.36	0.06		0.54	0.60	

Intersection Summary

Cycle Length: 110
Actuated Cycle Length: 110
Offset: 0 (0%), Referenced to phase 2:NBSB and 6:, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.67
Intersection Signal Delay: 12.0 Intersection LOS: B
Intersection Capacity Utilization 75.1% ICU Level of Service D
Analysis Period (min) 15

Splits and Phases: 1: Bedford Highway & Moirs Mill Road



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	23	36	42	825	732	52
Future Volume (Veh/h)	23	36	42	825	732	52
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	25	39	46	897	796	57
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)					252	
pX, platoon unblocked	0.75	0.75	0.75			
vC, conflicting volume	1814	824	853			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1920	595	633			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	51	90	94			
cM capacity (veh/h)	52	376	709			

Direction, Lane #	EB 1	EB 2	NB 1	NB 2	SB 1
Volume Total	25	39	46	897	853
Volume Left	25	0	46	0	0
Volume Right	0	39	0	0	57
cSH	52	376	709	1700	1700
Volume to Capacity	0.49	0.10	0.06	0.53	0.50
Queue Length 95th (m)	13.9	2.6	1.6	0.0	0.0
Control Delay (s)	128.4	15.7	10.4	0.0	0.0
Lane LOS	F	C	B		
Approach Delay (s)	59.7		0.5		0.0
Approach LOS	F				

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		

APPENDIX

B

SCHOOL TRIP PROJECTION DETAILS

APPENDIX B SCHOOL TRIP PROJECTION DETAILS

Background

As noted in Section 3 of this report, the ITE trip generation numbers provide only a driveway count and judgement needs to be made to determine how many of those driveway trips have an origin or destination outside of the study area and how many remain inside.

Site Count at Bedford South Elementary School

An onsite trip generation count was undertaken at Bedford South Elementary School to substantiate assumptions made for trip generation at the proposed school in Area B2. This school was judged to be a good proxy for the proposed school as due to its proximity to the study area. Bedford South Elementary School has a passenger pickup area that is separated from the staff parking lot. This makes allows for counting of three types of trips:

- Primary trips – staff arriving at the site in the morning and departing in the afternoon
- Pass-by trips - parents driving from home in the morning, dropping child(ren) off, then continuing on to work or vice versa in the afternoon.
- Internal primary trips – parents driving to the site, dropping child(ren) off, then returning home

The data from the site count (below) shows that approximately half of the trips are Primary (enter or exit the staff parking lot) and the other half are either Pass-by or Internal Primary (enter or exit the student drop-off area). Without actually surveying parents, it is not possible to determine how many of the drop-off trips are Pass-by and how many are Internal Primary. We believe an assumption that 80% of these trips are Pass-by is reasonable.

TIME	Passenger Pickup Area		Parking Lot	
	IN	OUT	IN	OUT
8:00 – 8:15	18	19	36	0
8:15 – 8:30	32	32	11	2
8:30 – 8:45	7	6	2	0
8:45 – 9:00	1	1	3	0
AM Total	**58**	**58**	**52**	**2**
16:15 – 16:30	5	8	0	6
16:30 – 16:45	4	1	1	4
16:45 – 17:00	2	3	0	5
17:00 – 17:15	3	2	0	3
PM Total	**14**	**14**	**1**	**18**

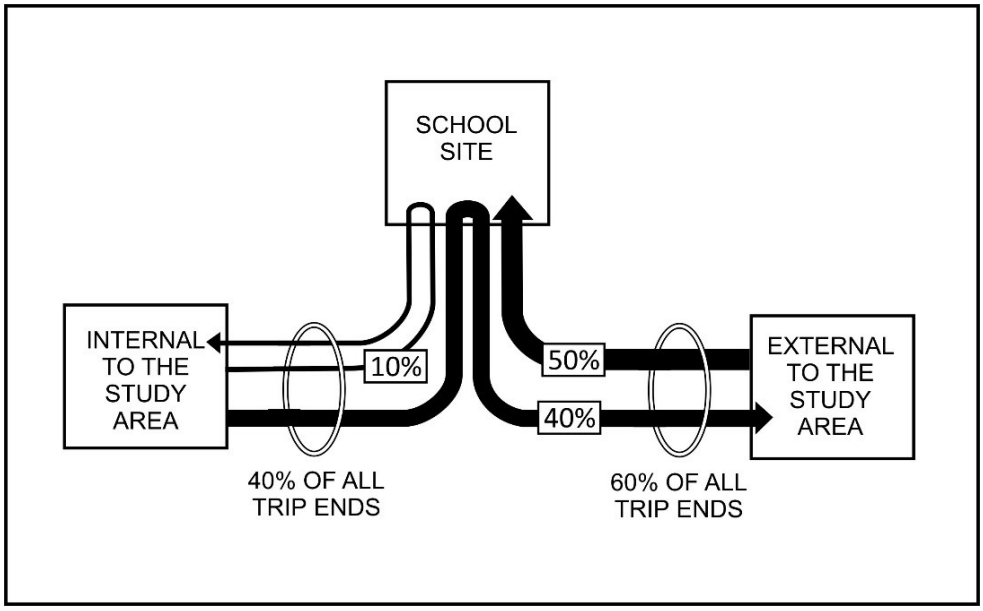
Note: Counts were taken on June 25, 2019 at Bedford South Elementary School
Time periods counted correspond to the peak traffic on adjacent streets

School Catchment

The figure on the next page shows the catchment area for Bedford Elementary School and demonstrates that a school of this type can be expected to serve students in an area no larger than the study area used in this study. This provides us confidence that virtually all of the student drop-off trips will originate within the study area in the morning and be destined to it in the afternoon.

Trip Distribution Summary

The figure below shows the relative volume of each of the three trip types identified. The result is that it is to be expected 60% of trip ends will be outside of the study area and 40% will be internal to the study area. This explains why a 40% trip reduction is used in Table 3 when determining trips entering and exiting the study area. Some of the internal trips are added to the internal streets as shown in Appendix A.



Note: This diagram illustrates morning peak trips. Afternoon peak trips would be the reverse of this diagram.

A Conservative Analysis

Overall, we believe this analysis of school-generated traffic is very conservative. Since the nature of the school that will be located here (if any) is unknown, this provides good assurance that any variety of school can be accommodated.

Firstly, the trip generation numbers used from the ITE Handbook are about 50% higher than what was counted at the proxy site. The assumption that all primary trips to the site (staff) have an origin and destination outside of the study area is also conservative.

APPENDIX

C

TRIP DISTRIBUTION COMPARATIVE TIME ANALYSIS

APPENDIX C TRIP DISTRIBUTION COMPARATIVE TIME ANALYSIS

Background

There are two alternative routes to travelling between Moirs Mill Road and the Nine Mile Drive connection to Larry Uteck Boulevard. One route uses collector streets (Moir Mill Road and Nine Mile Drive) and the other uses local streets (Richardson Drive and Road E). To determine which path will have the greatest attractiveness for traffic, assumptions were made regarding travel time for each segment of each route in both the outbound and inbound directions. A variety of street design and control components were considered and travel times were assigned based on knowledge of traffic control modeling and published data. The components that were assessed are listed in the sections below.

Stop-Controlled Intersection

Right turns at stop sign	10 second delay
Left turns at stop sign	15 second delay
Right turns from through street	3 second delay
Left turns from through street	8 second delay
Through along through street	0 second delay

The TRB (Highway Capacity Manual) has a methodology to determine expected average stopped delay at stop-controlled intersections. This methodology is based on the number of gaps available for vehicles to enter an intersection which, in turn, depends of the volume of traffic that right of way needs to be yielded to. All traffic on the minor street (facing the stop sign) and left turns on the main street all need to yield to at least one direction of traffic before being able to traverse the intersection. In addition to normal stopped delay, a few seconds have been added for turning movements to account for the deceleration and acceleration experienced in turning. Although we do not have detailed hourly intersection volumes to precisely model stopped delay, the numbers we have used above are typical for main streets with the volumes we expect.

All-Way Stop-Controlled Intersection

Right turns	8 second delay
Left turns	10 second delay
Through	8 second delay

TRB also provides a methodology for assessing delay at all-way stop controlled intersections. At these intersections, gap availability is no longer a consideration as right-of-way occurs on a rotational basis. All vehicles still need to stop and wait their turn, sometimes behind other vehicles. Left turns have slightly greater delay due to yielding to oncoming traffic.

Travel on Collector Streets

Arterial streets in residential neighbourhoods are designed for travel speeds of 50 km/h and field measurements normally confirm travel speeds to be in this range. For this exercise, a travel speed of 50 km/h for collector streets was assumed.

Travel on Local Streets

Local streets do not have the same degree of intersection and driveway control, on-street parking control, and are normally narrower in width than collector streets. For this reason, travel speeds are expected to be lower than would be the case on a collector street. For this exercise, we have used an average speed of 45 km/h.

Travel on Local Streets with Speed Humps

Speed humps can be an effective method of traffic calming on local residential streets. We propose that Richardson Drive and Road E would be designed with speed humps to reduce travel speed. The FHWA (Traffic Calming) suggests that travel speeds over speed humps will be 16-24 km/h increasing to 40-50 km/h between speed humps. TAC (Traffic Calming Manual) suggests that overall speed on a street with speed humps will be reduced by 6-13 km/h on average. We have assumed the average travel speed on a local street with speed humps will be 35 km/h.

Mini-roundabouts

Right turns	3 second delay
Left turns	6 second delay
Through	3 second delay

A mini-roundabout is small circular island that is placed in the middle of a local-local street intersection. It has a traffic calming effect by causing vehicles to decelerate, negotiate the intersection, and accelerate. TAC suggests that the average speed will be reduced by 14 km/h and that delay at a mini-roundabout will range from 1.3 seconds to 10.7 seconds. The speed reduction is suggested for emergency vehicles, but should be a reasonable guide for delay to car traffic.

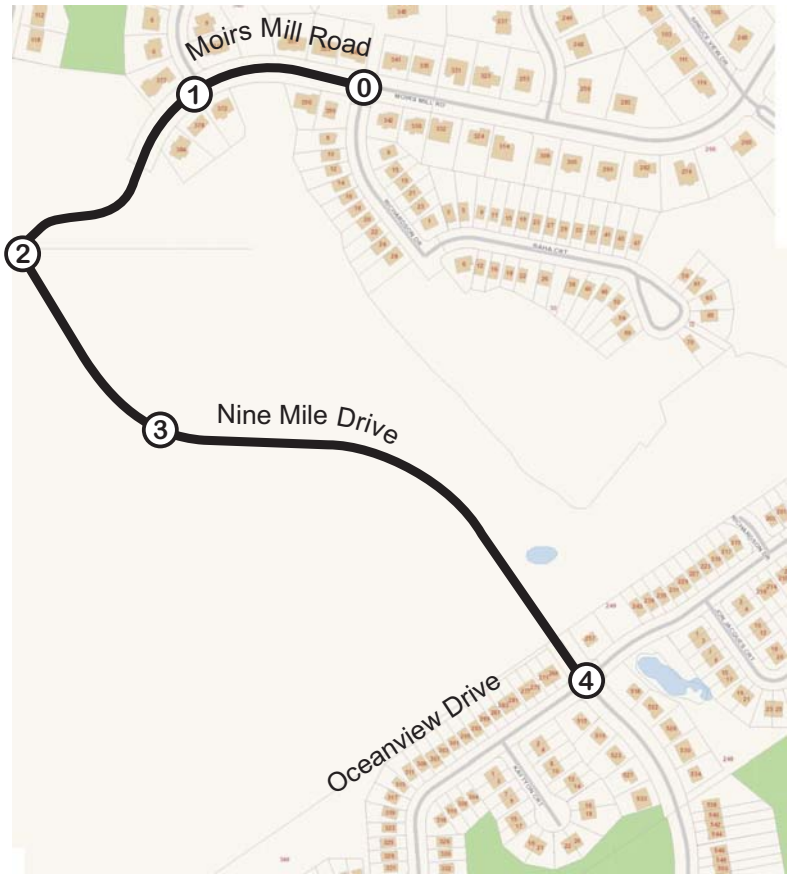
Travel on Local Streets

The figures on pages C-3 and C-4 outline our analysis and provides total travel time projections for each of the two routes in both directions. Caution should be exercised in assessing these values as they are projections based on our experience with delay modeling at intersections and with published data on traffic calming devices in other cities. We believe, however, that this exercise provides a helpful comparison of travel paths. The table below summarizes the results:

	OUTBOUND DIRECTION	INBOUND DIRECTION
Collector Street Route	90 s	88 s
Local Street Route	99 s	97 s

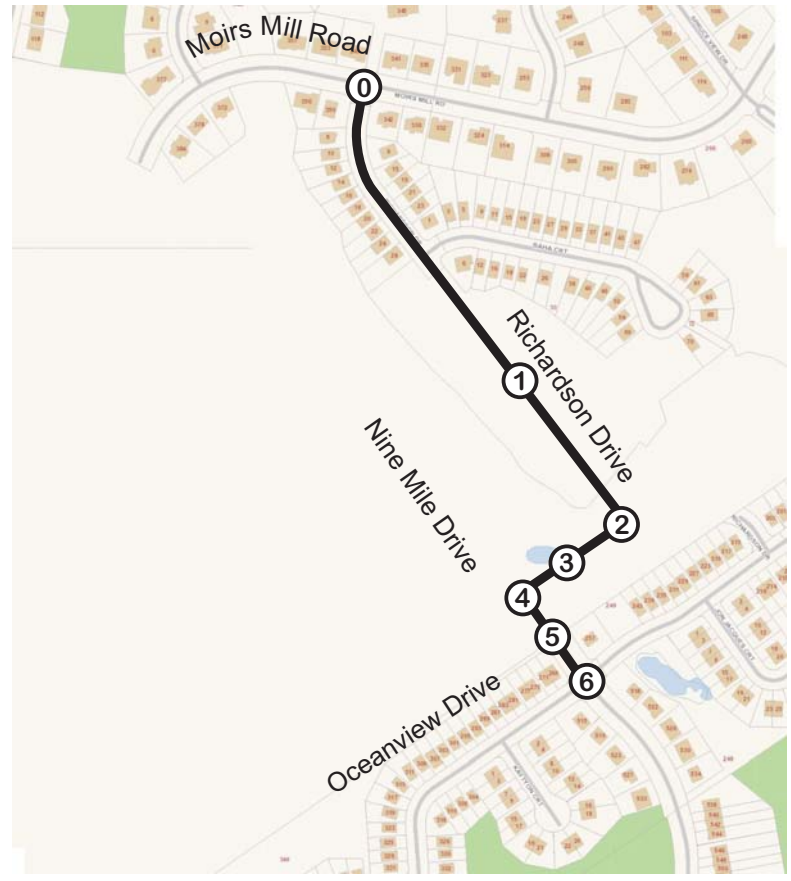
We believe this analysis supports our assumption that the majority of traffic connecting between Moirs Mill Road and Nine Mile Drive/Larry Uteck will use Moirs Mill Road and Nine Mile Drive as it provides the shortest travel time. This assumes that a mini-roundabouts will be used at the Richardson/Road E intersection and that speed humps will also be employed.

OUTBOUND ROUTE TRIP TIME ANALYSIS



Collector Street Route

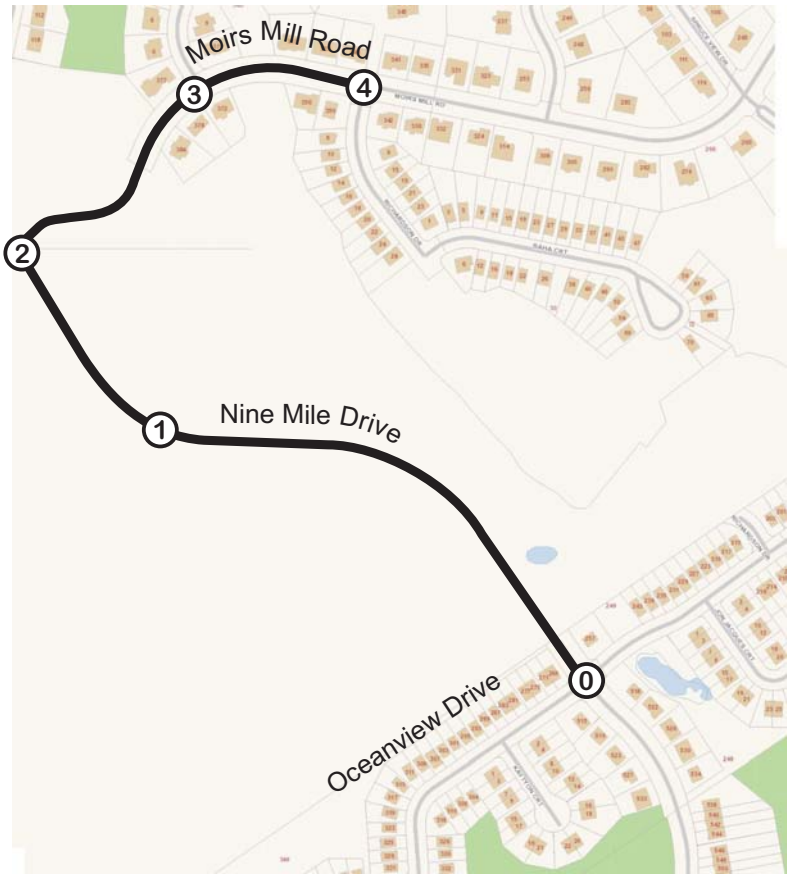
0	0s	Thru at intersection
1	31s	430m @ 50 km/h (collector)
2	10s	Left at all-way stop
3	41s	570m @ 50 km/h (collector)
4	8s	Thru at all-way stop
	90s	



Local Street Route

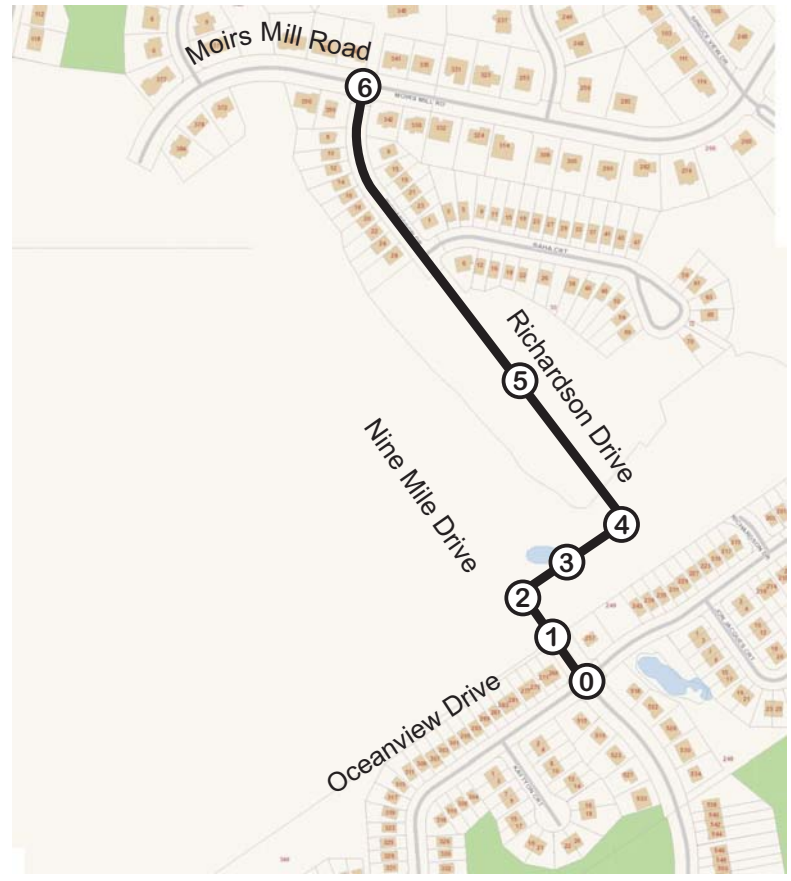
0	8s	Left at intersection
1	44s	440m @ 35 km/h (local with speed humps)
2	3s	Right at mini-roundabout
3	17s	160m @ 35 km/h (local with speed humps)
4	15s	Left at stop sign
5	4s	60m @ 50 km/h (collector)
6	8s	Thru at all-way stop
	99s	

INBOUND ROUTE TRIP TIME ANALYSIS



Collector Street Route

0	8s	Thru at all-way stop
1	41s	570m @ 50 km/h (collector)
2	8s	Right at all-way stop
3	31s	430m @ 50 km/h (collector)
4	0s	Thru at intersection
	88s	



Local Street Route

0	8s	Thru at all-way stop
1	4s	60m @ 50 km/h (collector)
2	3s	Right at intersection
3	17s	160m @ 35 km/h (local with speed humps)
4	6s	Left at mini-roundabout
5	44s	430m @ 35 km/h (local with speed humps)
6	10s	Right at stop sign
	92s	