Fifth Wheel Redevelopment
398 North Service Road
Town of Grimsby
Transportation Impact Study Update

Paradigm Transportation Solutions Limited

October 2019

ptsl.com

Project Summary

Project Number
190563

October 2019

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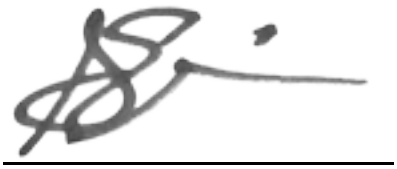
Signatures and Seals



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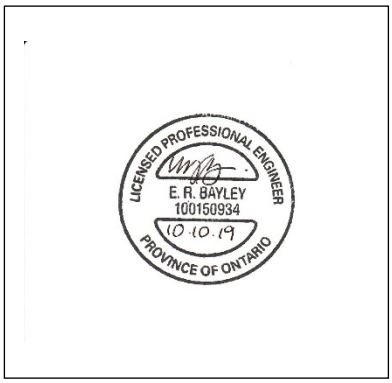

Engineer's Seal

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Executive Summary

Content

Losani Homes retained Paradigm Transportation Solutions Limited (Paradigm) to conduct this Transportation Impact Study for a proposed mixed-use development located at 398 North Service Road in the Town of Grimsby.

This Transportation Impact Study (TIS) includes an analysis of existing traffic conditions, a description of the proposed development, traffic forecasts for a five-year horizon from full build-out (Year 2034), Transportation Demand Management (TDM) measures and any recommendations required to improve future traffic conditions.

Development Concept

The subject site is located on the former Fifth Wheel lands located in the northeast quadrant of the Casablanca Boulevard and Queen Elizabeth Way interchange in the Town of Grimsby. The subject site is proposed to consist of the following land uses:

- 36 townhouse units;
- 1,240 condominium apartment units (high-rise);
- 50,510 square feet of employment land uses; and
- 30,636 square feet of commercial land uses.

Vehicular access is proposed by four driveway connections to the North Service Road. The build-out of the subject site is anticipated to occur by Year 2029. However, timing may change to reflect market conditions.

Conclusions

Based on the investigations carried out, it is concluded that:

- **Existing Traffic Conditions:** All study area intersections are operating at acceptable levels of service;
- **Background Traffic Conditions:** All study area intersections are forecast to operate with acceptable levels of service;
- **Development Generated Traffic:** The subject site is forecast to generate approximately 600 new vehicle trips during the AM peak hour and approximately 644 new vehicle trips during the PM peak hour;

- **Total Traffic Conditions:** All study area intersections are forecast to operate with acceptable levels of service.

  From a capacity perspective, four full move driveways to the North Service Road are not viewed as necessary to support the site generated traffic. Two of the driveway connections should be designed to function as right-in/right-out driveways.

- **Remedial Measures**: Auxiliary left-turn lanes with 25-metres of storage are warranted at the North Service Road intersection with the Winston Road driveway and at the proposed Driveway B intersection.

- **Transportation Demand Management:** to encourage sustainable travel choices TDM measures be reviewed at the Site Plan Approval stage.

Recommendations

Based on the findings of this study, it is recommended that:

- Auxiliary left-turn lanes with 25-metres of storage be developed at the North Service Road intersection with the Winston Road driveway and at the proposed Driveway B intersection.
- Site Driveway A and Driveway C be restricted to right-in/right-out connections. Left-turn restrictions should be enforced by raised centre medians on the North Service Road.
- All site driveways operate under stop control for the driveway approach to the North Service Road.
- To encourage sustainable travel choices TDM measures should be incorporated into the overall development design and program.
- The final site design and layout be addressed at the Site Plan Approval stage.
- The Town of Grimsby should consider developing on-street bicycle lanes across the site's North Service Road frontage to connect to the existing cycling infrastructure west of Casablanca Boulevard and to the cycling infrastructure proposed as part of the Casablanca Boulevard and GO Station EA.
- Due to the increasing urbanization of the North Service Road corridor, the Town of Grimsby consider lowering the posted speed limit on the North Service Road across the site's frontage to 50 km/h.

Contents

Appendices

Figures

Tables

1 Introduction

1.1 Overview

Losani Homes retained Paradigm Transportation Solutions Limited (Paradigm) to conduct this Transportation Impact Study for a proposed mixed-use development located at 398 North Service Road in the Town of Grimsby. **Figure 1.1** illustrates the location of the subject site.

The original study was submitted to the Town of Grimsby in May 2018[1]. Town of Grimsby Staff provided comment on the study in April 2019. **Appendix A** contains the Town Comments. In September 2019, the site plan was updated to reflect design changes to the development program. This updated report is intended to address the Town's comments.

1.2 Purpose and Scope

This study determines the traffic impacts of the proposed development on the surrounding road network and identifies the recommended improvements to accommodate the site-generated traffic. The scope of the study includes:

- Assessment of the current traffic and site conditions within the study area;
- Estimates of background traffic growth for a five-year horizon following the anticipated build-out of the site (Year 2034);
- Estimates of additional traffic generated by the subject site;
- Analysis of the impact of the future traffic on the surrounding road network;
- Recommendations necessary to mitigate the site generated traffic in a satisfactory manner; and
- Transportation Demand Management (TDM) strategies to promote the use of alternative modes of transportation.

The study area intersections assessed in this study include:

- North Service Road and Casablanca Boulevard (signalized); and

[1] *Winston Road And North Service Road, Town Of Grimsby – Fifth Wheel Site – Transportation Impact Study Brief. Paradigm Transportation Solutions Limited. May 2018. Project 170205*

- Four proposed site driveways to North Service Road (unsignalized).

This study has been prepared in accordance with the Niagara Region Guidelines for Transportation Impact Studies[2].

[2] *Guidelines for Transportation Impact Studies, Niagara Region, May 2012.*

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Location of Subject Site

398 North Service Road Fifth Wheel Site, Grimsby TIS
190563

Figure 1.1

2 Existing Conditions

2.1 Existing Roadways

The main roadways near the subject site considered in assessing the traffic impacts of the development include:

- **Casablanca Boulevard** is a north-south minor arterial[3] roadway with a two-lane cross-section and a posted speed limit of 60 km/h. The roadway has an interchange with the Queen Elizabeth Way (QEW) to the south of the study area. Within the study area there are no sidewalks present or any visible cycling infrastructure along this roadway. The intersection with the North Service Road is signalized and operates with an eastbound right-turn lane and westbound left-turn lane.
- **North Service Road** is an east-west minor arterial roadway with a two-lane cross section. The speed limit west of Casablanca Boulevard is 60 km/h. East of Casablanca Boulevard the speed limit is 50 km/h. Sidewalks are provided on both sides of this roadway west of Casablanca Boulevard. East of Casablanca Boulevard, discontinuous sidewalks are provided along the north side of this roadway to Winston Road. Sidewalks connect to the Waterfront Trail. Dedicated on-street bicycle lanes are provided on both sides of this roadway west of Casablanca Boulevard. No visible cycling infrastructure is present east of Casablanca Boulevard.

Figure 2.1 illustrates the existing lane configuration and traffic control at the study area intersection. The surrounding land uses include mid-rise residential to the west, low rise residential to the east and Lake Ontario to the north.

2.2 Existing Transit Service

There is currently no local transit service available within the Town of Grimsby. However, GO Transit operates one route within proximity to the subject site.

GO Bus Route 12 travels from Niagara Falls to Burlington with a stop in Grimsby within the park and ride at the northwest corner of Casablanca Boulevard and South Service Road. The route operates from Monday to Friday with headways of approximately 30-45 minutes.

[3] *Town of Grimsby Official Plan, Schedule C – Transportation and Trails, August 2018.*

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Existing Lane Configuration and Traffic Control

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Image Source: Go Transit

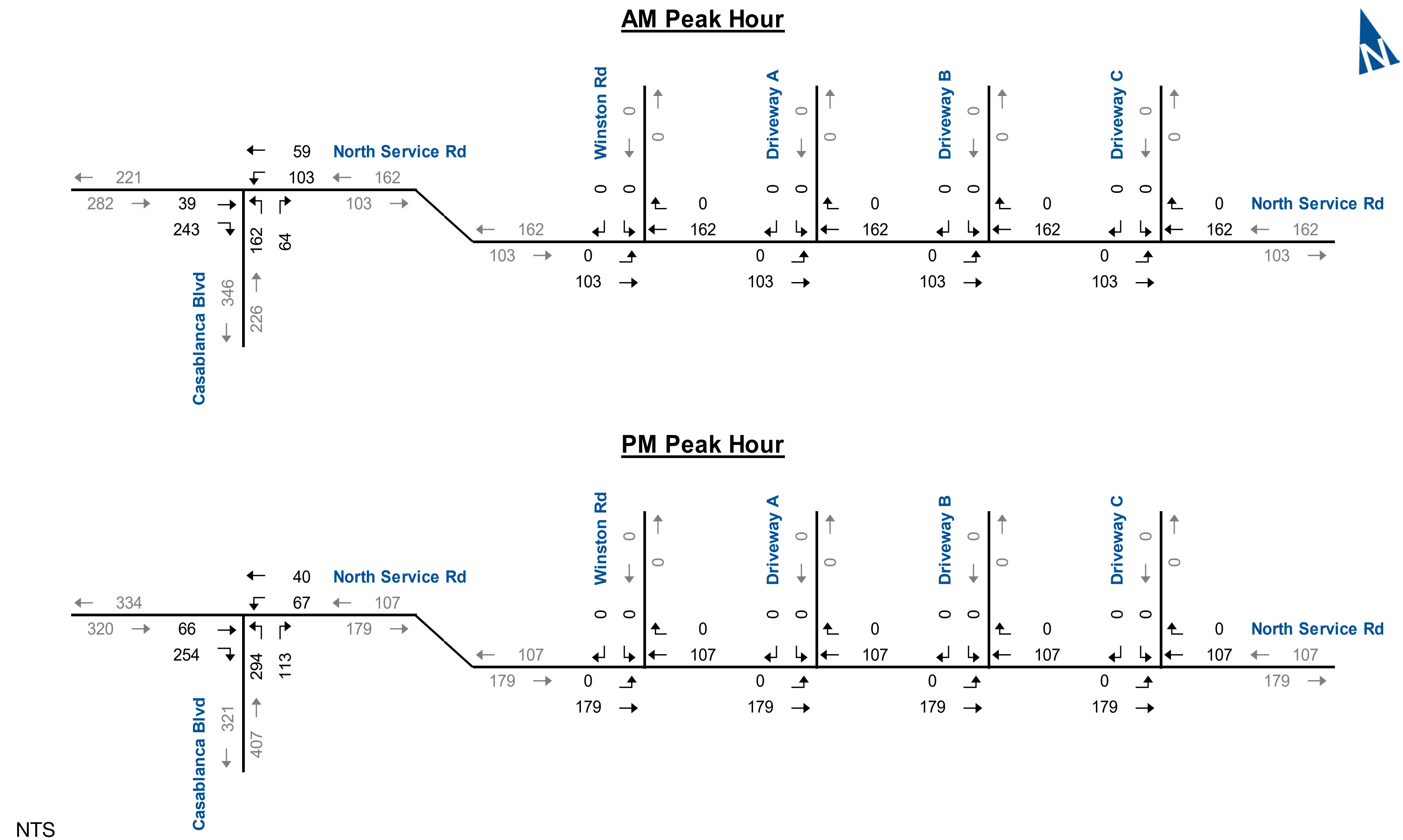
Existing Go Transit Network – Route 12

2.3 Existing Traffic Data

Turning Movement Count (TMC) data contained in the Environmental Assessment (Class EA) for Casablanca Boulevard[4] is used in this updated report. TMC data was provided by the Niagara Region with 8-hour TMC collected during May 2018. **Figure 2.3** illustrates the existing AM and PM weekday peak hour traffic volumes.

A data request for existing signal timings was made to the Niagara Region (September 2019). However, the data was not provided in time for this study update. Existing signal timings used in the analysis have been optimized.

[4] *Niagara Region Detailed Transportation Assessment – Draft Report Detailed Transportation Assessment and Municipal Class Environmental Assessment for Casablanca Boulevard, in the Town of Grimsby. October 2018.*



Existing Traffic Volumes

Figure 2.3

2.4 Traffic Operations

Intersection level of service (LOS) is a recognized method of quantifying the average delay experienced by drivers at intersections. It is based on the delay experienced by individual vehicles executing the various movements. The delay is related to the number of vehicles intending to make a particular movement, compared to the estimated capacity for that movement. The capacity is based on a number of criteria related to the opposing traffic flows and intersection geometry.

The highest possible rating is LOS A, under which the average total delay is equal or less than 10.0 seconds per vehicle. When the average delay exceeds 80 seconds for signalized intersections, 50 seconds for unsignalized intersections or when the volume to capacity ratio is greater than 1.0, the movement is classed as LOS F and remedial measures are usually implemented, if they are feasible. LOS E is usually used as a guideline for the determination of road improvement needs on through lanes, while LOS F may be acceptable for left-turn movements at peak times, depending on delays.

The operations of the study area intersections were evaluated using the existing lane configurations, traffic controls and the existing traffic peak volumes.

The level of service conditions on the existing road network have been assessed using Synchro 9. Movements are considered critical under the following conditions at signalized intersections:

- Overall intersection, through and/or through-right an/or right-turn movements with a v/c ratio greater than 0.85; and
- V/C ratios for dedicated left-turn movements greater than 0.90;

Movements are considered critical under the following conditions at unsignalized intersections:

- Movements expected to operate at LOS D or worse; and
- Estimated 95th percentile queue length for an individual movement exceeds the available queueing space.

Table 2.1 summarizes the existing intersection operations. The entries in the table indicate the AM and PM peak hour level of service (LOS), volume to capacity ratios (v/c), and 95th percentile queue lengths.

All intersections are forecast to operate within acceptable levels, with no specific movements considered critical under existing traffic conditions. **Appendix B** contains the detailed Synchro 9 reports.

TABLE 2.1: EXISTING TRAFFIC OPERATIONS

Analysis Period	Intersection	Control Type	MOE	Direction / Movement / Approach																
				Eastbound				Westbound				Northbound				Southbound				OVERALL
				Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	
AM Peak Hour	Casablanca Boulevard & North Service Road	TCS	LOS		B	B	**B**	B	B		**B**	A		>	**A**					**B**
			Delay		15	15	**15**	17	15		**16**	5		>	**5**					**12**
			V/C		0.12	0.18		0.38	0.17			0.24		>						**0.28**
			95th		9	13		19	12			19		>						
			Storage		-	60		160	-			-		>						
			Avail.		-	47		141	-			-		>						
PM Peak Hour	Casablanca Boulevard & North Service Road	TCS	LOS		B	B	**B**	B	B		**B**	A		>	**A**					**B**
			Delay		16	16	**16**	16	15		**16**	6		>	**6**					**11**
			V/C		0.20	0.19		0.27	0.11			0.42		>						**0.39**
			95th		13	14		13	9			37		>						
			Storage		-	60		160	-			-		>						
			Avail.		-	46		147	-			-		>						

MOE - Measure of Effectiveness
TWSC - Two-Way Stop Control
LOS - Level of Service
TCS - Traffic Control Signal
V/C - Volume to Capacity Ratio
95th - 95th Percentile Queue Length
Storage - Existing Storage (m)
Avail. - Available Storage (m)
> - Shared Right-Turn Lane
< - Shared Left-Turn Lane

3 Development Concept

3.1 Development Description

The subject site is located on the former Fifth Wheel lands located in the northeast quadrant of the Casablanca Boulevard and Queen Elizabeth Way interchange in the Town of Grimsby. The subject site is proposed to consist of the following land uses:

- 36 townhouse units;
- 1,240 condominium apartment units (high-rise);
- 50,510 square feet of employment land uses; and
- 30,636 square feet of commercial land uses.

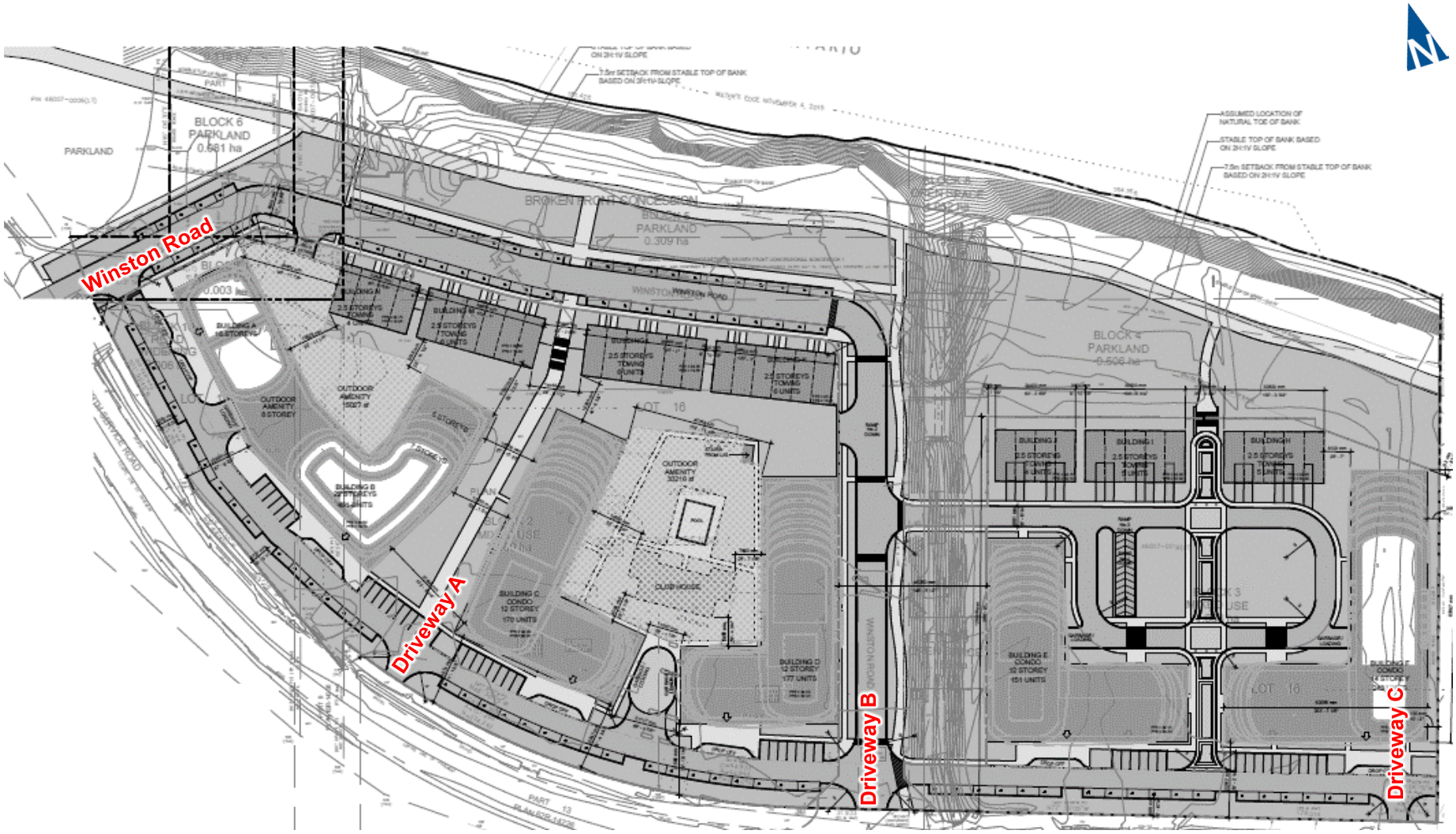
Vehicular access is proposed by four driveway connections to North Service Road. The driveways are positioned as follows:

- Winston Road – 225 metres (centre line (CL) to CL) east of Casablanca Boulevard;
- Driveway A – 380 metres (CL to CL) east of Casablanca Boulevard;
- Driveway B – 535 metres (CL to CL) east of Casablanca Boulevard; and
- Driveway C – 695 metres (CL to CL) east of Casablanca Boulevard.

All driveways are proposed to operate as a single lane stop controlled approach to the North Service Road.

Build-out of the subject site is anticipated to occur by Year 2029. However, timing may change to reflect market conditions.

Figure 3.1 illustrates the site concept plan.



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Proposed Site Plan

398 North Service Road Fifth Wheel Site, Grimsby TIS
190563

Figure 3.1

3.2 Development Trip Generation

The Institute of Transportation Engineers (ITE) Trip Generation[5] methods predict the site trip generation. The following Land Use Codes (LUC) were used to estimate the site trip generation:

- Townhouse units – LUC 220 (Multifamily Housing, Low-Rise);
- Condominium apartment units – LUC 222 (Multifamily Housing, High-Rise);
- Employment land uses – LUC 710 (General Office Building); and
- Commercial land uses – LUC 820 (Shopping Centre).

Regression equation rates were used to calculate the trips generated by the subject site for all land uses. **Table 3.1** summarizes the estimated trip generation. The site's total trip generation is estimated to be approximately 619 AM peak hour trips and 740 PM peak hour trips.

The Transportation Tomorrow Survey[6] (TTS) data was used to estimate the modal split for the site. A 3% modal split reduction for active transportation modes such as cycling and walking is identified for the Town of Grimsby.

The commercial land uses are estimated to generate pass-by trips during the PM peak hour. An average pass-by trip rate of 34% is noted for LUC 820[7]. Pass-by trips were distributed based on the existing traffic volumes on North Service Road east of Casablanca Boulevard and the general location of the commercial land uses within the site.

After modal split and pass-by trip reductions, the site's net trip generation is estimated to be approximately 600 AM peak hour trips and 644 PM peak hour trips.

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[5] *Trip Generation Manual 10th Edition Institute of Transportation Engineers Washington DC*
[6] *TTS 2016. Frequency Distribution Query Form - Trip - 2016 v1.1 Field: Primary travel mode of trip - mode_prime Planning district of household - pd_hhld In 51 (Grimsby)*
[7] *ITE Trip Generation Handbook 3rd Edition Table E.9 Average Pass-by trip percentage*

TABLE 3.1: ESTIMATED TRIP GENERATION

Land Use/ Number of Units/GFA		AM Peak Hour			PM Peak Hour		
		In	Out	Sum	In	Out	Sum
LUC 220 [1]	36	4	14	**18**	15	9	**24**
LUC 222 [2]	1,240	86	274	**360**	262	168	**430**
LUC 710 [3]	50.51	64	10	**74**	10	50	**60**
LUC 820 [4]	30.64	104	63	**167**	108	118	**226**
Total Generation		**258**	**361**	**619**	**395**	**345**	**740**
Modal Split (3%) [5]		8	11	**19**	12	10	**22**
Pass-by Trips (PM -34%)[6]		0	0	**0**	37	37	**74**
Net Generation		**250**	**350**	**600**	**346**	**298**	**644**

1 - LUC 220. AM Ln(T) = 0.95 Ln(X) - 0.51 | PM Ln(T) = 0.89 Ln(X) - 0.02
2 - LUC 222. AM T = 0.28(X) + 12.86 | PM T = 0.34(X) + 8.56
3 - LUC 710. AM T = 0.94(X) + 26.49 | PM Ln(T) = 0.95 Ln(X) + 0.36
4 - LUC 820. AM T = 0.50(X) + 151.78 | PM Ln(T) = 0.74 Ln(X) + 2.89
5 – TTS Modal Split – Town of Grimsby
6 - ITE Trip Generation Handbook 3rd Edition Table E.9 Average Pass-by trip percentage

Table 3.2 summarizes the estimated trip distribution. The distribution was developed using TTS 2016 data for the zone containing the subject site[8]. Site traffic is assigned to the site driveways using the proposed distribution of land uses. **Figure 3.2** illustrates the net trip generation. **Figure 3.3** illustrates the pass-by trip generation. **Figure 3.4** illustrates the total vehicle trip generation (sum of net generation and pass-by trips).

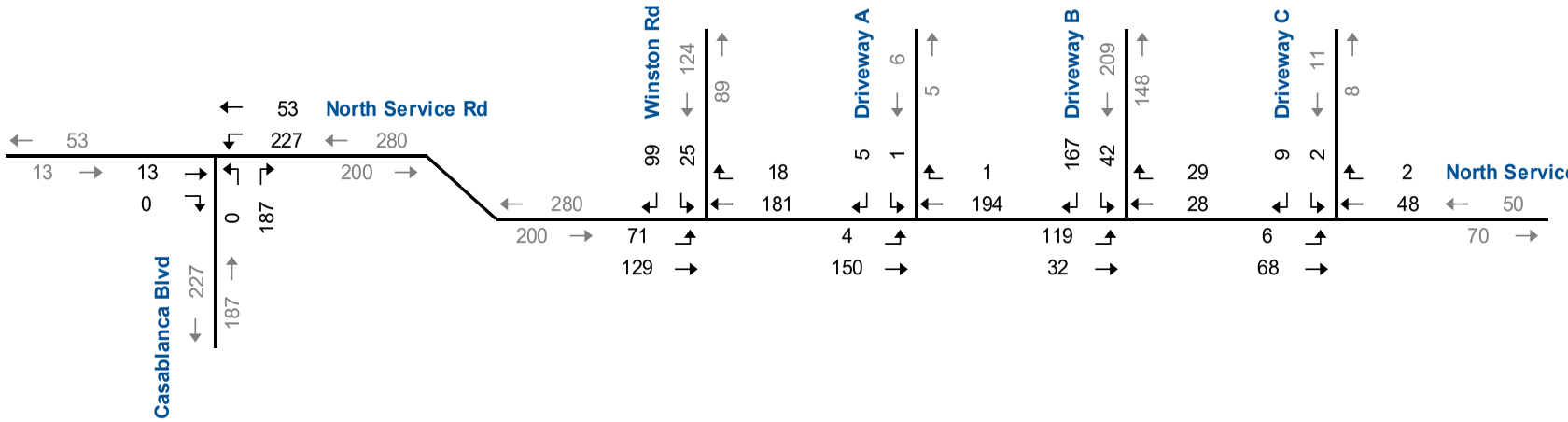
TABLE 3.2: ESTIMATED TRIP DISTRIBUTION

Origin/Destination	In	Out
South via Casablanca Boulevard	75%	65%
East via North Service Road	20%	20%
West via North Service Road	5%	15%
Total	**100%**	**100%**

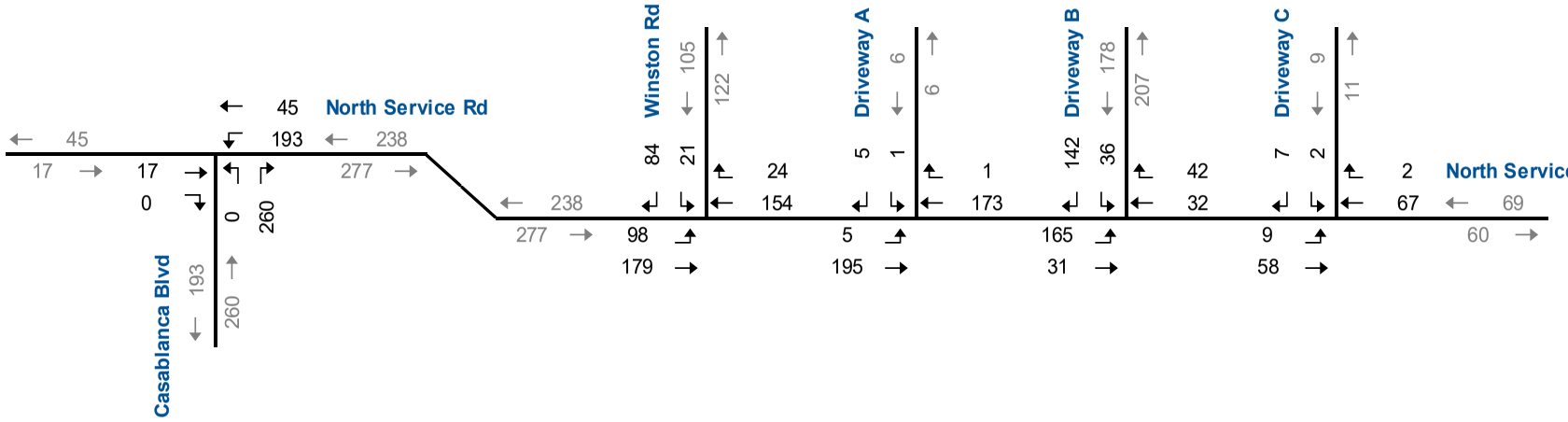
Site generated traffic originating or destined to areas east of the subject site via the North Service Road is expected to use Olive Street to filter through the existing network towards the QEW or downtown Grimsby.

[8] TTS 2016 – Zone 6001

AM Peak Hour



PM Peak Hour



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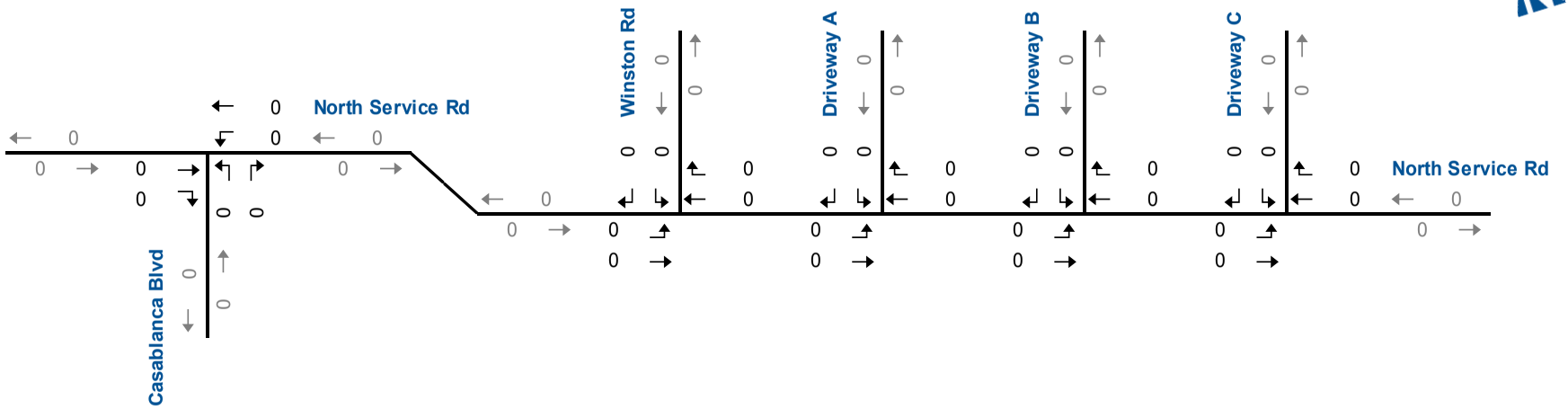
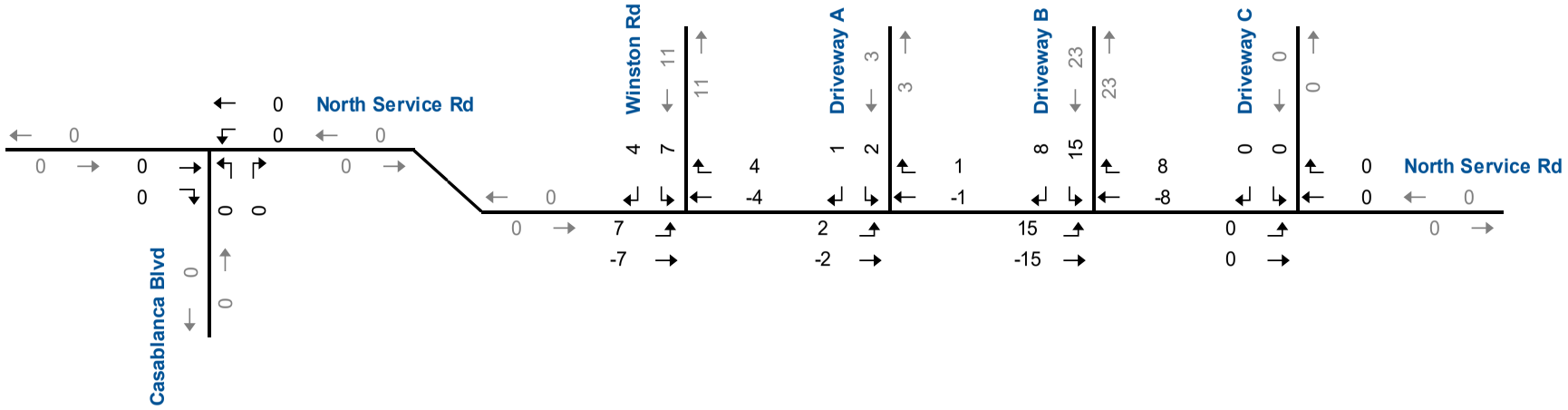
Site Generated Traffic Volumes – Net Generation

AM Peak Hour



PM Peak Hour



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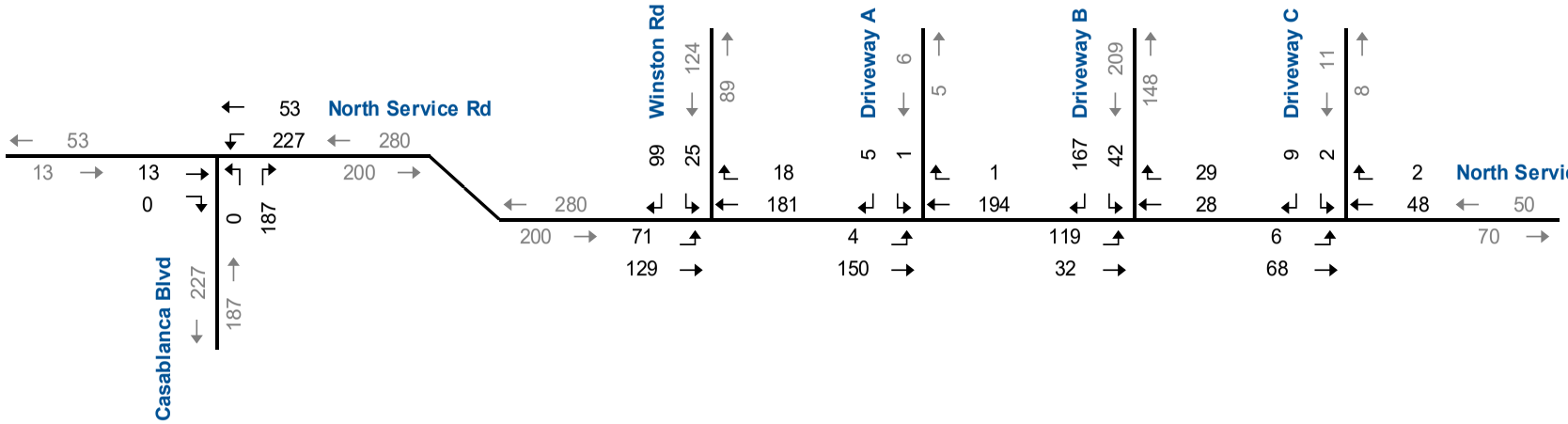
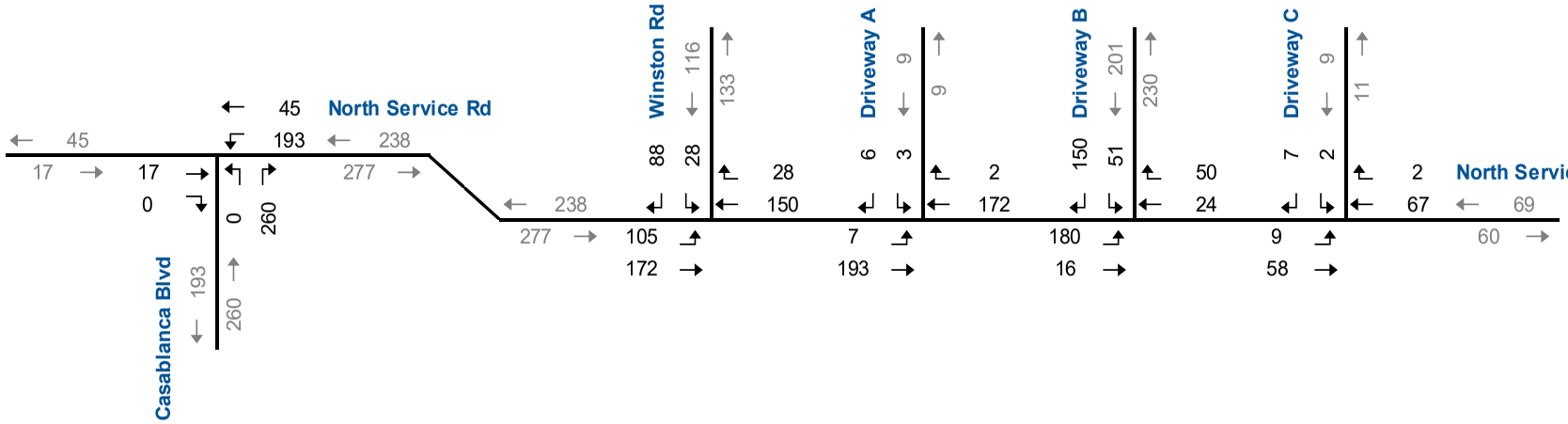
Site Generated Traffic Volumes – Pass-by Trips

AM Peak Hour



PM Peak Hour



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Site Generated Traffic Volumes – Total Vehicle Trips

4 Future Conditions

The assessment of the future traffic conditions contained in this section includes the traffic forecasts as well as the level of service analysis.

4.1 Network Improvements

The preferred design resulting from Class EA includes a four-lane cross-section for Casablanca Boulevard between the North Service Road and the South Service Road. At the North Service Road intersection, a northbound right-turn lane is planned.

The preferred design includes an Parclo A4 concept for the QEW interchange with both the north and south ramps operating as signalized intersections.

To support cycling and pedestrian traffic crossing the interchange, a multi-use path is proposed along the west side of Casablanca Boulevard between the North Service Road and the South Service Road. This path is proposed to be separated from vehicle traffic and will help provide cycling and pedestrian connectivity across the interchange with connectively to the Waterfront Trail.

4.2 Traffic Forecasts

A five-year horizon (Year 2034) following the anticipated build-out of the subject site has been assessed. The likely future traffic volumes near the subject site are estimated to consist of:

- Increased non-site traffic (generalized background traffic growth);
- Traffic generated by adjacent development applications in the West End development area; and
- Traffic generated by the subject site.

The generalized background traffic growth assumes an annual growth rate of 2% per annum. This growth rate is consistent with the Region's TIS guidelines.

A total of eight developments are identified within the West End development area[9], including the subject site (Site 6).

[9] *CIMA+ Town of Grimsby Traffic Operations Study for the Future Development on Casablanca Boulevard between Winston Road and South Service Road, November 2016.*

The majority of the West End lands appear to be built-out and occupied and would be captured in the existing turning movement data. Construction is underway for the Aqua Zul (Site 7B) mixed-use development. Site 8 appears to be vacant and is planned as a mixed-use development. **Figure 4.1** illustrates the location for the background developments. These developments are described generally as follows:

- The Aqua Zul (Site 7B) mixed-use development located on the southwest corner of Casablanca Boulevard and North Service Road is proposed to consist of 342 high-rise condominium units and 59,200 square feet of office land uses. The site is estimated to generate approximately 244 AM peak hour trips and 262 PM peak hour trips.
- A mixed-use development (Site 8) on the south side of North Service Road between Casablanca Boulevard and Hunter Road is proposed to consist of 179 apartment units and 7,200 square feet of office land uses. The site is estimated to generate approximately 67 AM peak hour trips and 93 PM peak hour trips.

Appendix C contains the forecast traffic volumes.

Figure 4.2 illustrates the forecast Five-Year Background Traffic volumes which is the combination of the generalized growth and the background developments. **Figure 4.3** illustrates the forecast Five-Year Total Traffic volumes which includes the subject site generated traffic.

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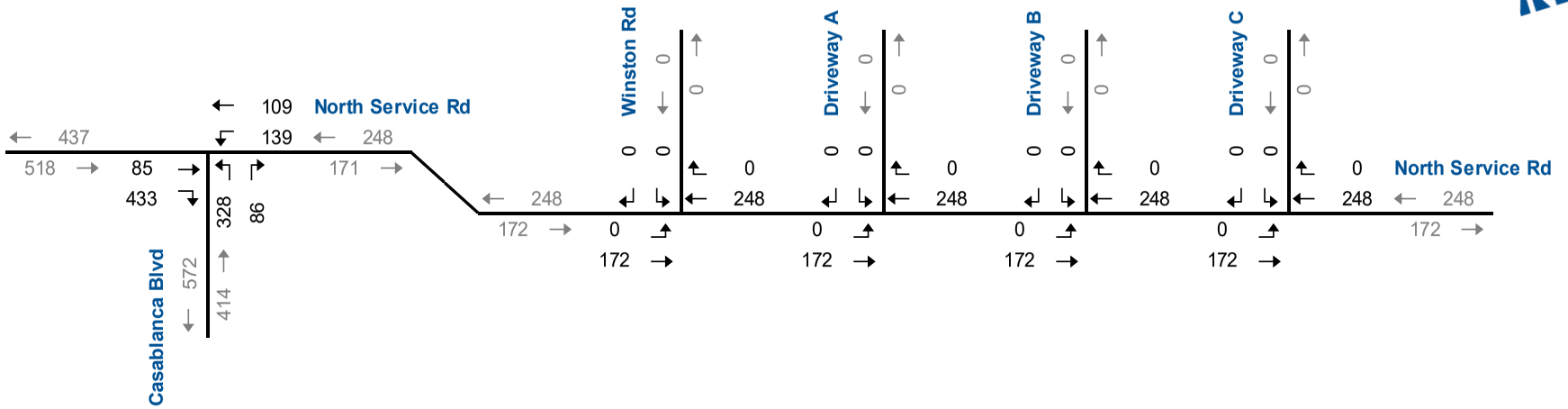
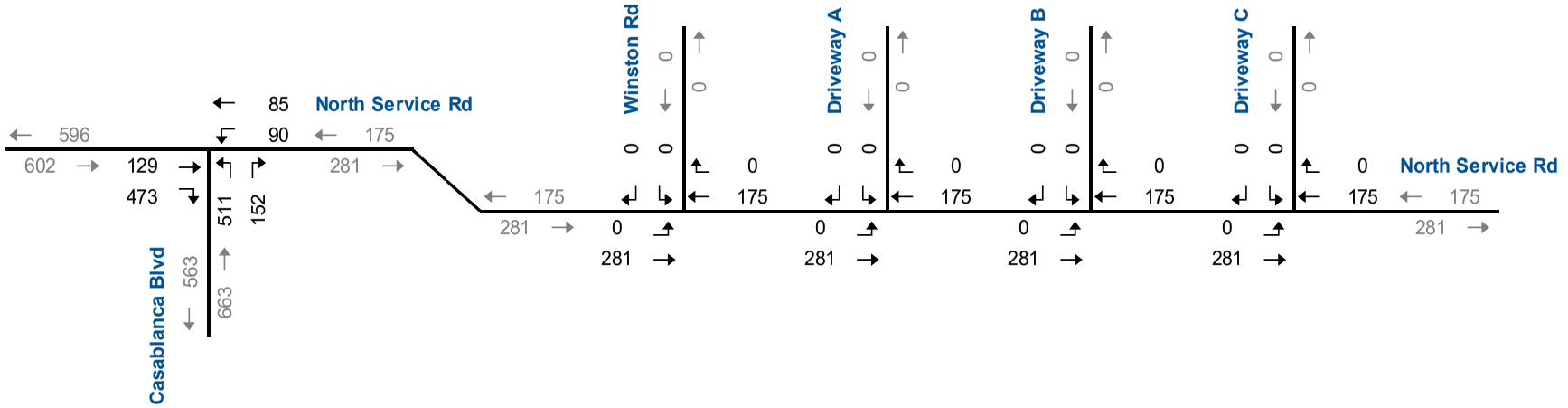
Location of Background Developments

AM Peak Hour



PM Peak Hour



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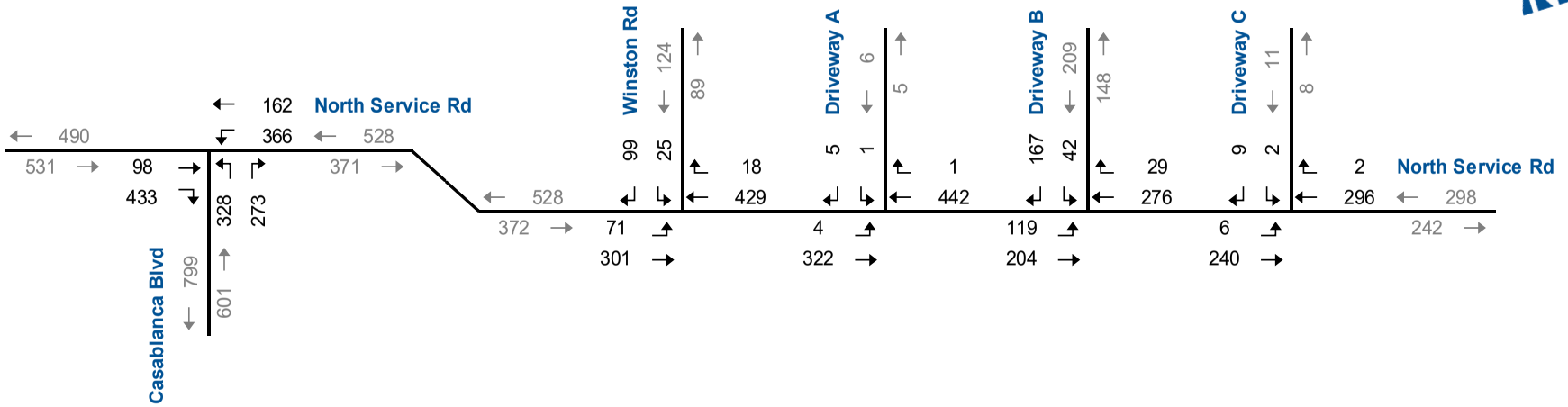
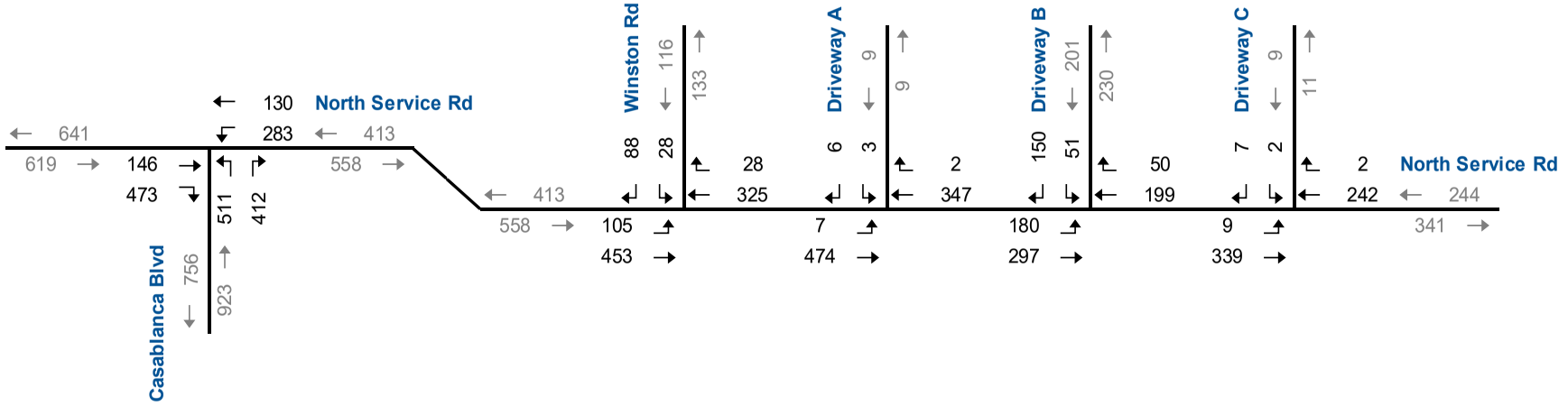
Background Traffic Forecast

Figure 4.2

AM Peak Hour



PM Peak Hour



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Total Traffic Forecast

4.2 Traffic Operations

The background and total traffic volumes at the 2034 horizon year were analyzed using the same methodology and parameters used for the existing traffic conditions. Signal optimization was applied to assist in maintaining a reasonable level of service.

4.2.1 Background Traffic Operations

Table 4.1 summarizes the results of the background traffic operations. The study area intersections are forecast to operate with acceptable levels of service during the AM and PM peak hours. No movements are considered critical.

Overall, the Casablanca Boulevard intersection with the North Service Road is estimated to operate with delays in the LOS B range with a v/c ratio of less than 0.55.

The 95th percentile queue lengths are not expected to exceed the available storage lengths.

Appendix D contains the supporting detailed Synchro 9 reports.

4.2.2 Total Traffic Operations

Table 4.2 summarizes the results of the total traffic operations. The study area intersections are forecast to operate with acceptable levels of service during the AM and PM peak hours. No movements are considered critical.

Overall, the Casablanca Boulevard intersection with the North Service Road is estimated to operate with delays in the LOS B range with a v/c ratio of less than 0.75.

The site driveway connections to the North Service Road are forecast to operate with delays in the LOS B to C range with low v/c ratios.

The 95th percentile queue lengths are not expected to exceed the available storage lengths. Queue lengths on the site driveway approaches range from 10-20 metres.

Appendix E contains the supporting detailed Synchro 9 reports.

TABLE 4.1: BACKGROUND TRAFFIC OPERATIONS

Analysis Period	Intersection	Control Type	MOE	Direction / Movement / Approach																
				Eastbound				Westbound				Northbound				Southbound				OVERALL
				Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	
AM Peak Hour	Casablanca Boulevard & North Service Road	TCS	LOS		B	B	**B**	B	B		**B**	A		A	**A**					**B**
			Delay		14	15	**14**	16	14		**15**	7		6	**7**					**12**
			V/C		0.22	0.32		0.45	0.27			0.40		0.06						**0.42**
			95th		15	16		24	18			40		6						
			Storage		-	60		160	-			-		-						
			Avail.		-	44		136	-			-		-						
PM Peak Hour	Casablanca Boulevard & North Service Road	TCS	LOS		B	B	**B**	B	B		**B**	A		A	**A**					**B**
			Delay		15	15	**15**	15	14		**15**	9		6	**8**					**12**
			V/C		0.32	0.36		0.33	0.20			0.58		0.11						**0.51**
			95th		21	17		16	15			78		9						
			Storage		-	60		160	-			-		-						
			Avail.		-	43		144	-			-		-						

MOE - Measure of Effectiveness
TWSC - Two-Way Stop Control
LOS - Level of Service
TCS - Traffic Control Signal
V/C - Volume to Capacity Ratio
95th - 95th Percentile Queue Length
Storage - Existing Storage (m)
Avail. - Available Storage (m)
> - Shared Right-Turn Lane
< - Shared Left-Turn Lane

TABLE 4.2: TOTAL TRAFFIC OPERATIONS

Analysis Period	Intersection	Control Type	MOE	Direction / Movement / Approach																OVERALL
				Eastbound				Westbound				Northbound				Southbound				
				Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	
AM Peak Hour	Casablanca Boulevard & North Service Road	TCS	LOS		B	B	**B**	C	B		**B**	B		B	**B**					**B**
			Delay		10	11	**11**	22	11		**18**	14		12	**13**					**14**
			V/C		0.17	0.32		0.79	0.26			0.52		0.21						**0.65**
			95th		15	14		76	22			54		14						
			Storage		-	60		160	-			-		-						
			Avail.		-	46		84	-			-		-						
	North Service Road & Winston Road	TWSC	LOS	<	A		**A**		A	>	**A**					C		>	**C**	
			Delay	<	2		**2**		0	>	**0**					16		>	**16**	
			V/C	<	0.07				0.29	>						0.28		>		
			95th	<	2				0	>						9		>		
	North Service Road & Driveway A	TWSC	LOS	<	A		**A**		A	>	**A**					B		>	**B**	
			Delay	<	0		**0**		0	>	**0**					12		>	**12**	
			V/C	<	0.00				0.28	>						0.01		>		
			95th	<	0				0	>						0		>		
	North Service Road & Driveway B	TWSC	LOS	<	A		**A**		A	>	**A**					C		>	**C**	
			Delay	<	4		**4**		0	>	**0**					15		>	**15**	
			V/C	<	0.10				0.20	>						0.39		>		
			95th	<	3				0	>						15		>		
	North Service Road & Driveway C	TWSC	LOS	<	A		**A**		A	>	**A**					B		>	**B**	
			Delay	<	0		**0**		0	>	**0**					11		>	**11**	
			V/C	<	0.01				0.19	>						0.02		>		
			95th	<	0				0	>						0		>		
PM Peak Hour	Casablanca Boulevard & North Service Road	TCS	LOS		B	B	**B**	C	B		**B**	B		B	**B**					**B**
			Delay		13	14	**14**	23	13		**20**	15		11	**13**					**15**
			V/C		0.26	0.36		0.75	0.23			0.67		0.30						**0.70**
			95th		23	16		62	21			83		14						
			Storage		-	60		160	-			-		-						
			Avail.		-	44		98	-			-		-						
	North Service Road & Winston Road	TWSC	LOS	<	A		**A**		A	>	**A**					C		>	**C**	
			Delay	<	3		**3**		0	>	**0**					16		>	**16**	
			V/C	<	0.10				0.23	>						0.28		>		
			95th	<	3				0	>						9		>		
	North Service Road & Driveway A	TWSC	LOS	<	A		**A**		A	>	**A**					B		>	**B**	
			Delay	<	0		**0**		0	>	**0**					12		>	**12**	
			V/C	<	0.01				0.22	>						0.02		>		
			95th	<	0				0	>						1		>		
	North Service Road & Driveway B	TWSC	LOS	<	A		**A**		A	>	**A**					C		>	**C**	
			Delay	<	4		**4**		0	>	**0**					17		>	**17**	
			V/C	<	0.15				0.16	>						0.43		>		
			95th	<	4				0	>						17		>		
	North Service Road & Driveway C	TWSC	LOS	<	A		**A**		A	>	**A**					B		>	**B**	
			Delay	<	0		**0**		0	>	**0**					10		>	**10**	
			V/C	<	0.01				0.16	>						0.01		>		
			95th	<	0				0	>						0		>		

MOE - Measure of Effectiveness
TWSC - Two-Way Stop Control
LOS - Level of Service
TCS - Traffic Control Signal
V/C - Volume to Capacity Ratio
95th - 95th Percentile Queue Length
Storage - Existing Storage (m)
Avail. - Available Storage (m)
> - Shared Right-Turn Lane
< - Shared Left-Turn Lane

5 Sensitivity Analysis

5.1 Driveway Turning Restrictions

The site concept plan includes four all move driveway connections to the North Service Road.

Table 4.2 indicates that the site driveway connections are forecast to operate with delays in the LOS B to C range during the AM and PM peak hours. From a capacity perspective, the four connections are not viewed as necessary to support the site generated traffic.

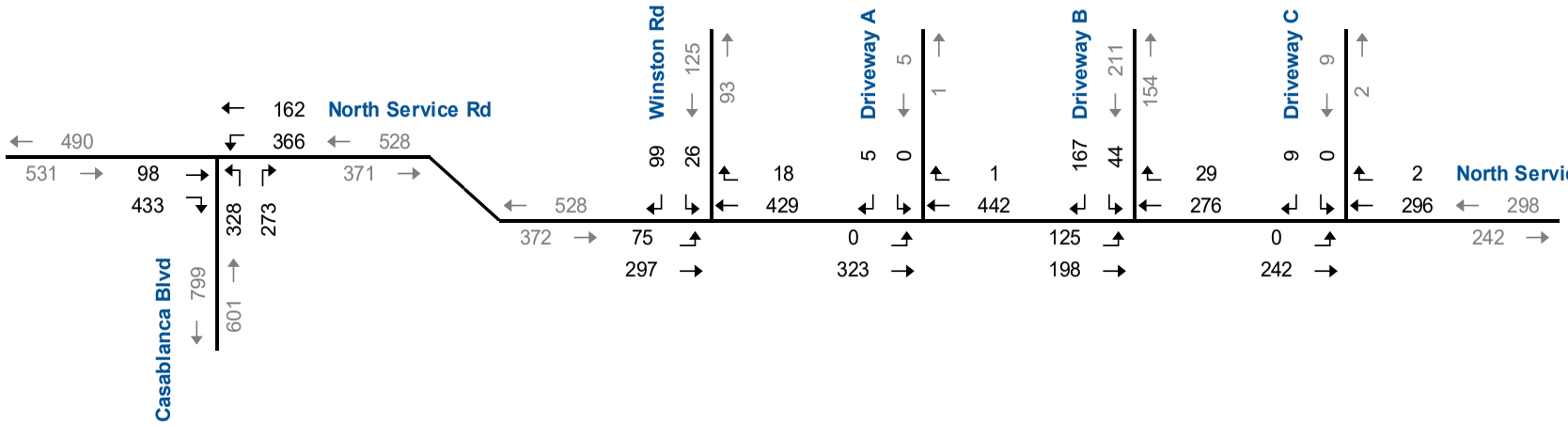
To limit conflict points and to establish a cross-section similar to what the Town has developed west of Casablanca Boulevard (raised centre medians with on-street bicycle lanes), it is recommended that the Driveway A and Driveway C connections be restricted to right-in/right-out operation. Left-turn restrictions should ideally be enforced through use of raised centre medians along the North Service Road.

Figure 5.1 illustrates the forecast total traffic volumes with left-turn movements restricted at the Driveway A and C intersections. **Table 5.1** summarizes the results of the total traffic operations with turning restrictions applied to the Driveway A and Driveway C intersections.

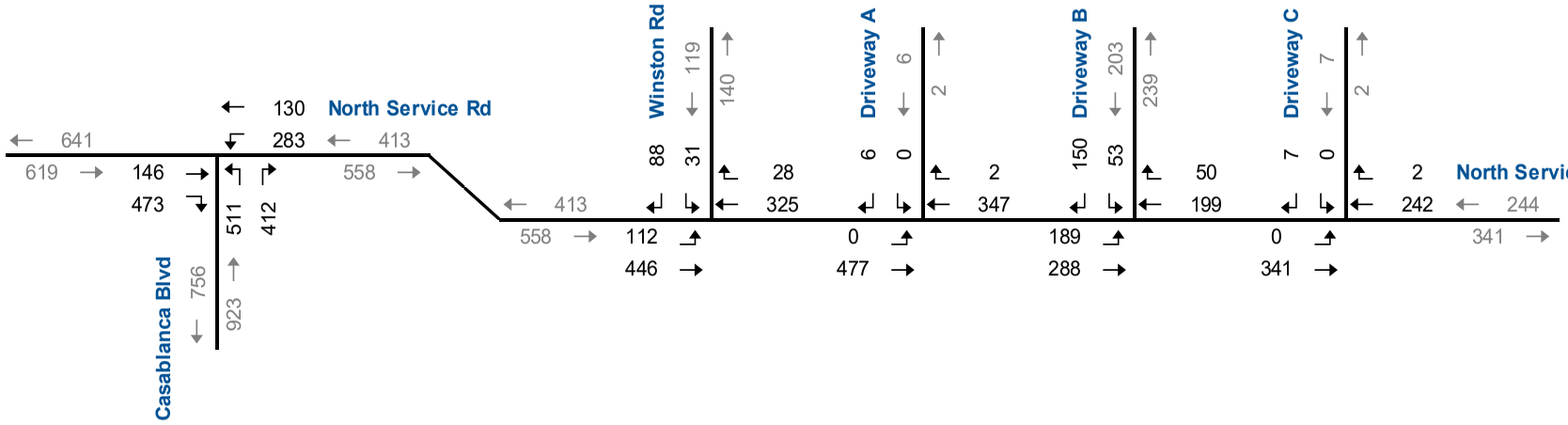
The analysis indicates that with only two full movement driveways, the driveway approaches are forecast to operate with delays in the A to C range.

Appendix F contains the detailed Synchro 9 reports.

AM Peak Hour



PM Peak Hour



NTS

Total Traffic Forecast – Sensitivity Analysis

TABLE 5.1: TOTAL TRAFFIC OPERATIONS - SENSITIVITY ANALYSIS

Analysis Period	Intersection	Control Type	MOE	Direction / Movement / Approach																
				Eastbound				Westbound				Northbound				Southbound				
				Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	Left	Through	Right	Approach	OVERALL
AM Peak Hour	Casablanca Boulevard & North Service Road	TCS	LOS		B	B	**B**	C	B		**B**	B		B	**B**					**B**
			Delay		10	11	**11**	22	11		**18**	14		12	**13**					**14**
			V/C		0.17	0.32		0.79	0.26			0.52		0.21						**0.65**
			95th		15	14		76	22			54		14						
			Storage		-	60		160	-			-		-						
			Avail.		-	46		84	-			-		-						
	North Service Road & Winston Road	TWSC	LOS	<	A		**A**		A	>	**A**					C		>	**C**	
			Delay	<	2		**2**		0	>	**0**					16		>	**16**	
			V/C	<	0.08				0.29	>						0.29		>		
			95th	<	2				0	>						9		>		
	North Service Road & Driveway A	TWSC	LOS		A		**A**		A	>	**A**							B	**B**	
			Delay		0		**0**		0	>	**0**							11	**11**	
			V/C		0.21				0.28	>								0.01		
			95th		0				0	>								0		
	North Service Road & Driveway B	TWSC	LOS	<	A		**A**		A	>	**A**					C		>	**C**	
			Delay	<	4		**4**		0	>	**0**					15		>	**15**	
			V/C	<	0.11				0.20	>						0.40		>		
			95th	<	3				0	>						15		>		
	North Service Road & Driveway C	TWSC	LOS		A		**A**		A	>	**A**							B	**B**	
			Delay		0		**0**		0	>	**0**							10	**10**	
			V/C		0.15				0.19	>								0.01		
			95th		0				0	>								0		
PM Peak Hour	Casablanca Boulevard & North Service Road	TCS	LOS		B	B	**B**	C	B		**B**	B		B	**B**					**B**
			Delay		13	14	**14**	23	13		**20**	15		11	**13**					**15**
			V/C		0.26	0.36		0.75	0.23			0.67		0.30						**0.70**
			95th		23	16		62	21			83		14						
			Storage		-	60		160	-			-		-						
			Avail.		-	44		98	-			-		-						
	North Service Road & Winston Road	TWSC	LOS	<	A		**A**		A	>	**A**					C		>	**C**	
			Delay	<	3		**3**		0	>	**0**					17		>	**17**	
			V/C	<	0.10				0.23	>						0.30		>		
			95th	<	3				0	>						10		>		
	North Service Road & Driveway A	TWSC	LOS		A		**A**		A	>	**A**							B	**B**	
			Delay		0		**0**		0	>	**0**							10	**10**	
			V/C		0.30				0.22	>								0.01		
			95th		0				0	>								0		
	North Service Road & Driveway B	TWSC	LOS	<	A		**A**		A	>	**A**					C		>	**C**	
			Delay	<	4		**4**		0	>	**0**					18		>	**18**	
			V/C	<	0.16				0.16	>						0.45		>		
			95th	<	5				0	>						18		>		
	North Service Road & Driveway C	TWSC	LOS		A		**A**		A	>	**A**							A	**A**	
			Delay		0		**0**		0	>	**0**							10	**10**	
			V/C		0.22				0.16	>								0.01		
			95th		0				0	>								0		

MOE - Measure of Effectiveness
TWSC - Two-Way Stop Control
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TCS - Traffic Control Signal

V/C - Volume to Capacity Ratio
95th - 95th Percentile Queue Length
Storage - Existing Storage (m)

Avail. - Available Storage (m)
> - Shared Right-Turn Lane
< - Shared Left-Turn Lane

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6 Remedial Measures

6.1 Left-Turn Lanes

The Ministry of Transportation's Design Supplement for the Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads[10] provides guidance on the assessment and/or need for auxiliary left-turn lanes at intersections.

Warrants have been calculated for the four proposed site driveways to the North Service Road. The warrants have been completed using the nomographs for left-turn lanes on a two-lane undivided highway at an unsignalized intersection. A design speed of 70 km/h (10 km/h over the posted speed limit) has been used for analysis purposes.

The following auxiliary left-turn lanes are warranted:

- Winston Road – eastbound left-turn lane with 25 metres of storage;
- Driveway B – eastbound left-turn lane with 25 metres of storage;

The forecast traffic volumes at the Driveway A and Driveway C intersections do not meet the minimum vehicular warrants. However it is recommended that left-turn movements at these driveways be restricted.

With Driveway A and Driveway C restricted to right-in-right-out operations, the amount of storage warranted for the eastbound left-turn lanes on North Service Road at Winston Road and at Driveway B are the same as under the unrestricted conditions. Two eastbound left-turn lanes with 25 metres of storage remains warranted.

Appendix G contains the left-turn warrant lane nomographs.

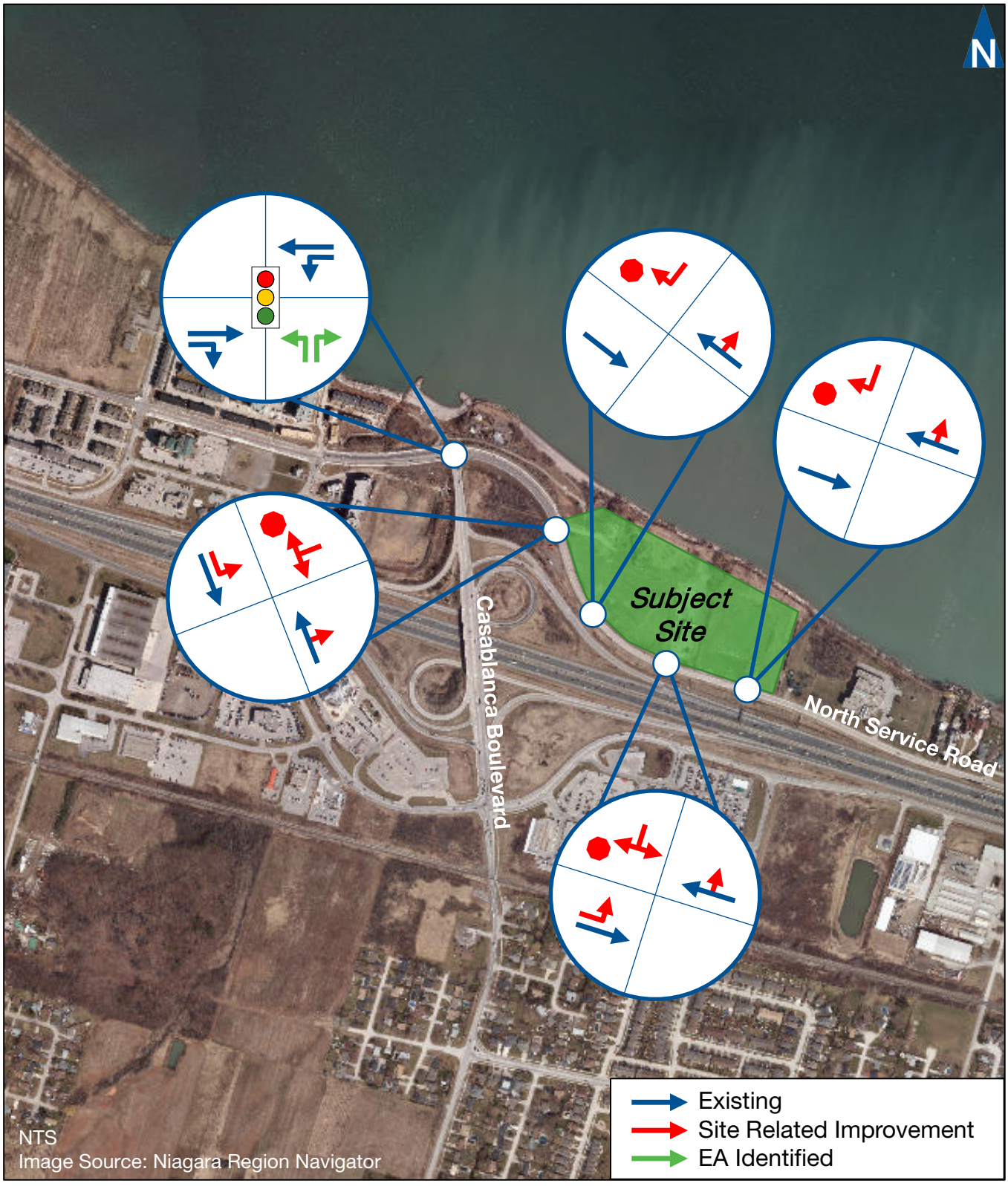
6.2 Traffic Control Improvements

No improvements to the existing form of traffic control at the Casablanca Boulevard intersection with the North Service Road are recommended. The Niagara Region should continue to monitor signal timings in the future as the West End Developments build-out and following the implementation of the Casablanca Boulevard EA improvements.

[10] *MTO Design Supplement for TAC Geometric Design Guide for Canadian Roads, June 2017 Appendix 9 for Chapter 9 Intersections*

The capacity analysis for the site driveways suggests that stop control is the appropriate form of traffic control for the site driveway approaches to the North Service Road.

Figure 6.1 illustrates the future lane configuration and traffic control for the study area intersections.



paradigm TRANSPORTATION SOLUTIONS LIMITED

Future Lane Configuration and Traffic Control

6.3 North Service Road Sight Lines

The existing design of the North Service Road should allow for minimum stopping sight distance (105 metres) in both travel directions[11]. However, sight distance requirements on the North Service Road will need to be reviewed considering the recommended modifications, including the addition of eastbound left-turn lanes at the Winston Road and Driveway B connections, and the provision of raised centre medians at the Driveway A and Driveway C connections to restrict left-turns.

It may also be appropriate for the Town of Grimsby to lower the posted speed limit on the North Service Road across the site's frontage to 50 km/h. This would be supportive to the increasing urbanization of the corridor and will lower the design requirements for designing auxiliary turn lanes and sight distances.

6.4 Site Plan Design

In order for major driveways to operate efficiently, both from the roadside and internally, it is desirable to provide a no conflict and storage zone within the driveway. This zone is commonly referred to as the clear throat length or set-back distance and is measured from the ends of the driveway curb return radii at the roadway and the point of first conflict on-site. Failure to provide sufficient throat distance results in frequent blocking of on-site circulation roads which can in turn create queues of entering vehicles.

The recommended clear throat length for each site driveway is 25 metres[12]. The site plan indicates a clear throat distance of approximately 10-15 metres for all four (4) driveway connections. It is recommended that the driveway connections be designed to include 25 metres of clear throat length.

The underground parking Ramp #3 to Building A-B is located on the inside of the Winston Road curve. To maintain clear sightlines, the area between the ramp and the parking spaces to the west should be kept clear of all obstructions or relocated on site.

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[11] Transportation Association of Canada, Geometric Design Guide for Canadian Roads (2017) Table 2.5.2:
Stopping Sight Distance on level roadways for Automobiles
[12] Transportation Association of Canada, Geometric Design Guide for Canadian Roads (2017), chapters 8.9.10 Clear Throat Lengths
8 Transportation Association

It is expected that the site's design and layout will be further defined during the Site Plan Approval stage.

6.5 Queue Length Assessment

6.5.1 North Service Road Queueing

The Winston Road driveway is located approximately 225 metres (CL to CL) east of the signalized Casablanca Boulevard intersection. The operational conditions outlined in **Section 4** and **Section 5** indicates that the queuing of vehicles generated by the signalized intersection will extend approximately 15-25 metres. Queue lengths of this extent are not expected to impact the normal operation of the Winston Road driveway connection. Moreover, no additional storage is recommended for the eastbound left-turn movement from the North Service Road to Casablanca Boulevard.

6.5.2 Site Driveway Queueing

The operational conditions outline in **Section 4** and **Section 5** indicate queuing conditions on the site driveway approaches to the North Service Road are forecast to range between 10-20 metres. As outlined in **Section 6.4** each driveway should be designed with a clear throat length of at least 25 metres to allow for a no conflict and storage zone on the driveway approaches. Failure to provide sufficient throat length results in frequent blocking of on-site circulation roads which can in turn create queues of entering vehicles.

7 Transportation Demand Management

Transportation Demand Management (TDM) refers to ways of making the capacity of our roads more efficient by reducing the demand for single occupancy vehicles. TDM approaches consider how people's choices of travel mode are affected by factors such as land use patterns, development design, parking availability, parking cost, and the relative cost, convenience and availability of alternative modes of travel. TDM is one of the tools that municipalities are using to create more vibrant and sustainable communities. Using policies and programs to make active and sustainable transportation more convenient, a TDM approach to transportation can deliver long-term environmental sustainability, improve public health, create stronger communities, and build more prosperous and livable cities. Various TDM strategies are used to influence these factors so that the alternatives are more competitive with driving alone, thus reducing reliance on motor vehicles.

TDM strategies can be divided into two basic categories:

- **Pre-occupancy:** actions that can be done while a development is being designed and built, and
- **Post-occupancy**: actions that can be done once people are using the development.

The pre-occupancy actions are critical because they are most likely to determine how attractive, convenient and safe alternative travel will be once the site is occupied. Actions such as modifying the site plan to improve pedestrian safety and convenience or reducing the number of provided parking stalls can encourage a reduction in vehicle trips to the site. After the development is built, further strategies include transit or rideshare subsidies and providing convenient information about where and how to use these alternatives. It should be noted that the actions taken after development will not be as effective if TDM strategies are not initially implemented in the site planning stages.

7.1 Potential TDM Measures

7.1.1 Walking

The accessibility of a development is essential in helping to ensure that those that can walk, do. Proper pedestrian connections from the community to the site should be available to ensure safety and to increase the experience of those that choose to walk.

The site plan includes provisions for sidewalks on at least one side of all internal roadways. Multi-use paths and sidewalk connections are proposed to the waterfront trail across the site's northern frontage.

To support cycling and pedestrian traffic crossing the QEW interchange, a multi-use path is proposed along the west side of Casablanca Boulevard between the North Service Road and the South Service Road. This path is proposed to be separated from vehicle traffic and will help provide cycling and pedestrian connectivity across the interchange.

To enhance the attractiveness of walking, proper lighting and weather protection should be provided at the main building entrances. The landscaping plan should consider enhancing the common amenity areas to include pedestrian amenities such as benches or seating areas.

7.1.2 Cycling

To create an environment that supports pedestrian and cycling activity, the public space must be accessible, safe and comfortable to encourage movement on the street and in the surrounding areas.

Casablanca Boulevard and North Service Road are currently noted as bike routes in the Town of Grimsby's Official Plan[13]. In addition, the Class EA indicates that a multi-use trail will be developed on the west side of Casablanca Boulevard across the QEW interchange.

Town of Grimsby should consider developing on-street bicycle lanes across the site's North Service Road frontage to connect to the existing cycling infrastructure west of Casablanca Boulevard and to the cycling infrastructure proposed as part of the Casablanca Boulevard and GO Station EA.

Providing safe and secure bicycle storage in the first underground parking level or within the buildings on the main floor should be considered in the site design.

Short-term bicycle parking near the building entrance(s) should be provided for visitors to the site. In addition, shower and change facilities should be considered for the non-residential land uses consistent with LEED requirements. The Town of Grimsby zoning by-law[14] recommends the following bicycle parking rates:

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[13] *Town of Grimsby Official Plan, Schedule C – Transportation and Trails, August 2018.*
[14] *Town of Grimsby Zoning By-Law 14-45, May 2012.*

- Apartments: 0.30 bicycle parking spaces per unit; and
- Office and Commercial: 7% of the vehicle parking spaces required.

Based on this, approximately 383 bicycle parking spaces are required for the residential land uses and 18 bicycle parking spaces for the office and commercial components of the development.

7.1.3 Transit

The availability of convenient and desirable transit options can reduce the number of personal automobile trips. As previously noted, there is no local transit service provided in the Town of Grimsby. A GO Transit bus station is located at near the Casablanca Boulevard intersection with the South Service Road. Information about GO transit services could be provided within the main lobbies for all buildings on-site.

A Shuttle service between the future GO Transit Station and/or other high demand centres in the Town of Grimsby could be considered by the site operator.

7.1.4 Parking Management

Managing parking supply helps to reduce the undesirable impacts of parking demand on local and regional traffic levels and can result in positive impacts on community livability and design.

To encourage residents to use sustainable travel modes, the development could consider selling parking spaces separately from the cost of a unit. This is more equitable and efficient since occupants are not forced to pay for parking they do not need and allows consumers to adjust their parking supply to reflect their needs. This is an important factor that supports reducing the parking supply as residents are notified at the onset of the project that parking will be provided on a limited basis as an additional cost in lieu of the price to purchase a unit. If residents are unwilling to change their travel behaviour, they will not purchase a unit.

If the number of parking spaces is reduced, caution should be given to providing adequate accessibility to other transportation modes. Additional provisions should be made, such as providing suitable bike parking, providing suitable access to transit service, and enhancing pedestrian and bike connections to ensure that other modes of transportation are readily accessible.

The development should consider the use of shared parking for residential visitors, office and commercial user groups. Shared parking

allows parking spaces to be used more efficiently as different user groups have different utilization patterns.

7.1.5 Carpooling and Carshare

Ride-share involves two or more people sharing a vehicle for a trip. The cost of the journey (fuel, tolls, parking, etc.) can be split between the driver and passengers, resulting in savings for all concerned. This also reduces the number of vehicle trips and parking demands.

There are several tools available such as Carpool World, which set up online ride sharing databases. These databases enable people to enter their daily journey so that the database can automatically search out coworkers whose journeys match. A less formal option would be installing notice boards in the lobby of the buildings for residents who may organize informal carpools.

Car sharing is used as a means of reducing automobile dependence by providing access to a car on an as-need basis and reducing the need to own a vehicle. The provision of secured car-share spaces in private lots can result in a reduction in residential parking requirements. Car-share appeals to a broad range of households from young urban professionals to families who want a lifestyle that is not tied to owning and maintaining a private vehicle. It also attracts those that want to retain the option to drive for non-work trip purposes.

7.1.6 Travel Planning

The following measures could be implemented to inform residents of existing transit and active transportation opportunities and encourage their usage:

- Ensuring up-to-date bus routes and maps are available within the lobbies of the buildings and providing information on next available bus, cost of trip and where to purchase passes;
- Helping residents in signing up for and arranging carpool services; and
- Highlight TDM elements in marketing materials: proximity to Go transit, cycling facilities, carshare/bikeshare facilities, etc.

The above TDM measures can assist in further mitigating the site's impact on the adjacent road network, promote a strong and vibrant economy, and create a livable community that has a balanced transportation network that accommodates all modes of transportation.

7.2 TDM Summary

In summary, the following TDM measures are appropriate for the proposed development:

- Provision of safe and attractive pedestrian connections to existing and new pedestrian facilities (sidewalks/multi-use trail);
- Consideration be given to the installation of additional lighting, benching and weather protection at entrances on the subject site to promote walking;
- Bicycle parking be provided on site per the Town of Grimsby zoning by-law requirements;
- End of trip change facilities (locker room/changeroom and showers) be considered for the non-residential land uses consistent with LEED requirements;
- Rent/sell parking spaces separate to the cost of the unit to reduce the number of parking spaces that are not needed;
- Shuttles service between the future GO Station and/or other high demand centres may be considered by the site operator.
- Consideration be given to provide on-site car-share spaces or nearby car-share vehicles; and
- Providing travel planning resources including signage and assistance.

8 Conclusions and Recommendations

8.1 Conclusions

Based on the investigations carried out, it is concluded that:

- **Existing Traffic Conditions:** All study area intersections are operating at acceptable levels of service;
- **Background Traffic Conditions:** All study area intersections are forecast to operate with acceptable levels of service;
- **Development Generated Traffic:** The subject site is forecast to generate approximately 600 new vehicle trips during the AM peak hour and approximately 644 new vehicle trips during the PM peak hour;
- **Total Traffic Conditions:** All study area intersections are forecast to operate with acceptable levels of service.

  From a capacity perspective, four full move driveways to the North Service Road are not viewed as necessary to support the site generated traffic. Two of the driveway connections should be designed to function as right-in/right-out driveways.
- **Remedial Measures**: Auxiliary left-turn lanes with 25-metres of storage are warranted at the North Service Road intersection with the Winston Road driveway and at the proposed Driveway B intersection.
- **Transportation Demand Management:** to encourage sustainable travel choices TDM measures be reviewed at the Site Plan Approval stage.

8.2 Recommendations

Based on the findings of this study, it is recommended that:

- Auxiliary left-turn lanes with 25-metres of storage be developed at the North Service Road intersection with the Winston Road driveway and at the proposed Driveway B intersection.
- Site Driveway A and Driveway C be restricted to right-in/right-out connections. Left-turn restrictions should be enforced by raised centre medians on the North Service Road.
- All site driveways operate under stop control for the driveway approach to the North Service Road.

- To encourage sustainable travel choices TDM measures should be incorporated into the overall development design and program.
- The final site design and layout be addressed at the Site Plan Approval stage.
- The Town of Grimsby should consider developing on-street bicycle lanes across the site's North Service Road frontage to connect to the existing cycling infrastructure west of Casablanca Boulevard and to the cycling infrastructure proposed as part of the Casablanca Boulevard and GO Station EA.
- Due to the increasing urbanization of the North Service Road corridor, the Town of Grimsby consider lowering the posted speed limit on the North Service Road across the site's frontage to 50 km/h.

Appendix A

Town Comments

Memorandum

Date: April 11, 2019

To: Losani Homes

From: Bob LeRoux P.Eng.
Michael Palomba C.E.T.

CC: Paradigm Ltd
MHBC Planning Ltd

Subject: Fifth Wheel Redevelopment Site Traffic and Parking Study Comments

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Introduction

The Town of Grimsby's Public Works staff have completed a review of the submitted Traffic Impact Study Brief and Parking Study for the Fifth Wheel Development site. In addition to the staff review, the Town retained CIMA+ to conduct a peer review of both reports to provide further insight. Based on the review of the submitted documents, Town staff have compiled their comments and recommendations for your information.

Traffic Impact Study Brief Review:

After review of the *Traffic Impact Study Brief* completed by Paradigm Ltd, Town staff have determined that the brief cannot be approved at this time. Due to the size of the proposed development, a comprehensive transportation impact study (TIS) is required in order to assess the future impacts of the site on the Town of Grimsby's transportation network. Based on the submission type, there are a number of outstanding items that have not been provided but are required in order to move forward with the development application. A complete transportation impact study (TIS) will need to be completed in order to provide the required outstanding information. Below is a list of comments and recommendations from the initial review:

- Town staff are in agreement with a number of the findings are recommendations that are outlined in the traffic brief such as;
  - Requirement of a secondary access for emergency services at the east end of the development site;
  - Redesign of site accesses in order to provide proper clear throat distances to improve site operations;
  - Location of underground parking ramps will need to be reconsidered in order to provide proper sight distances and prevent operational issues;

- Consideration of Driveway A and C turning restrictions (right-in, right-out operation) in order to provide appropriate left turning lanes along North Service Road;
- Additional justification will be required in order to consider the reduction of the proposed parking supply.

- In order to complete the traffic submission requirements, revise the report in accordance with the format recommended within the Niagara Region TIS Guidelines;
- Revise the footnote provided on Page 1 of the report to reference the correct version of the ITE Trip Generation Manual;
- Provide further clarification or justification as to why the average rate was selected for the Shopping Center (820 Land Use Code) land use type compared to the regression equation;
- Provide clarification as to how the internal trip capture was determined using NCHRP Report 684 and TTS modal split data for the Town of Grimsby. Include calculations within the appendices of the report;
- Results of the transportation analysis and the parameters utilized must comply with the Niagara Region TIS guidelines. Clarify details regarding signal timing and optimizations considered at the intersection of Casablanca Boulevard & North Service Road/Winston Road;
- Additional information should be provided regarding existing traffic volumes and operations;
- Provide clarification of future traffic volume details considered from the CIMA+ report within the future traffic volume assumptions;
- The traffic impact brief should utilize the latest report completed by CIMA+, which estimates traffic volume generated for the surrounding area. It would be beneficial to conduct current turning movement counts at the intersection of Casablanca Boulevard & North Service Road/Winston Road in order to establish a comparison to assumptions developed by CIMA+; and
- Provide clarification as to how the pass-by trip volumes were applied to specific turning movements within the study area during the PM peak hour;
- Considerations will need to be made as to the possibility of site-generated traffic being attracted eastbound along the North Service Road towards Olive St and Christie St.

Parking Study Review:

Town of Grimsby Public works staff reviewed the *Fifth Wheel Development Site Parking Study* submitted by MHBC Planning Ltd. and have provided the following comments for your review:

- The parking study provides a consistent approach for the potential reduction of parking requirements, however, it is not clear how the proposed 20% reduction on parking requirements for apartment dwelling units was estimated;
- The different elements considered for potential parking reduction suggest a range between 1% to 11% could be considered by Town staff, however based on existing timelines for construction it should be noted that the completed compounded effect of transit and active transportation improvements will not take place until the 2041 horizon year;
- The proposed 190 parking spaces provided in the MTO lands cannot be considered in the parking supply requirements by Town staff;
- Confirm and state any discussions with Town Staff regarding the proposed change of land use and acceptance of any development incentives;
- Confirm how the 20% reduction on parking requirements for apartment dwelling units was estimated;
- Further justification of the proposed parking reduction is required. Additional information should be provided as to the expected future parking demand, in order to evaluate the proposed parking supply.

Please review the comments and recommendations provided and contact us if there are any comments or concerns. If you would like to set up a meeting to discuss, Town staff are more than willing to get together to provide further clarification.

Sincerely,

R. LeRoux, P. Eng.
Director of Public Works

Michael Palomba, C.E.T.
Transportation Engineering Technologist

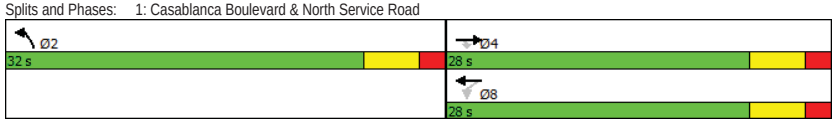
Appendix B

Existing Traffic Operations Reports

Lane Group	EBT	EBR	WBL	WBT	NBL
Lane Configurations					
Traffic Volume (vph)	39	243	103	59	162
Future Volume (vph)	39	243	103	59	162
Turn Type	NA	Perm	Perm	NA	Prot
Protected Phases	4			8	2
Permitted Phases		4	8		
Detector Phase	4	4	8	8	2
Switch Phase					
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	28.0	28.0	28.0	28.0	28.0
Total Split (s)	28.0	28.0	28.0	28.0	32.0
Total Split (%)	46.7%	46.7%	46.7%	46.7%	53.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	None	None	None	Max
Act Effct Green (s)	11.5	11.5	11.5	11.5	29.8
Actuated g/C Ratio	0.23	0.23	0.23	0.23	0.60
v/c Ratio	0.12	0.49	0.38	0.17	0.26
Control Delay	14.4	5.8	18.7	15.0	5.2
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	14.4	5.8	18.7	15.0	5.2
LOS	B	A	B	B	A
Approach Delay	7.0			17.3	5.2
Approach LOS	A			B	A

Intersection Summary			
Cycle Length: 60			
Actuated Cycle Length: 49.4			
Natural Cycle: 60			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.49			
Intersection Signal Delay: 8.9		Intersection LOS: A	
Intersection Capacity Utilization 33.5%		ICU Level of Service A	
Analysis Period (min) 15			

Splits and Phases: 1: Casablanca Boulevard & North Service Road



Lane Group	EBT	EBR	WBL	WBT	NBL
Lane Group Flow (vph)	42	264	112	64	246
v/c Ratio	0.12	0.49	0.38	0.17	0.26
Control Delay	14.4	5.8	18.7	15.0	5.2
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	14.4	5.8	18.7	15.0	5.2
Queue Length 50th (m)	2.9	0.0	8.2	4.5	6.8
Queue Length 95th (m)	8.5	13.2	18.8	11.7	19.1
Internal Link Dist (m)	120.4			206.5	218.5
Turn Bay Length (m)		60.0	160.0		
Base Capacity (vph)	741	845	622	775	957
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.06	0.31	0.18	0.08	0.26

Intersection Summary

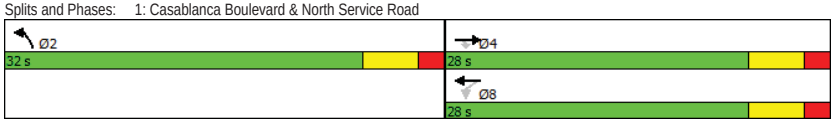
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	39	243	103	59	162	64
Future Volume (vph)	39	243	103	59	162	64
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	0.85	1.00	1.00	0.96	
Flt Protected	1.00	1.00	0.95	1.00	0.97	
Satd. Flow (prot)	1522	1458	1662	1591	1556	
Flt Permitted	1.00	1.00	0.73	1.00	0.97	
Satd. Flow (perm)	1522	1458	1277	1591	1556	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	42	264	112	64	176	70
RTOR Reduction (vph)	0	202	0	0	18	0
Lane Group Flow (vph)	42	62	112	64	228	0
Heavy Vehicles (%)	15%	2%	0%	10%	5%	3%
Turn Type	NA	Perm	Perm	NA	Prot	
Protected Phases	4			8	2	
Permitted Phases		4	8			
Actuated Green, G (s)	9.5	9.5	9.5	9.5	27.8	
Effective Green, g (s)	11.5	11.5	11.5	11.5	29.8	
Actuated g/C Ratio	0.23	0.23	0.23	0.23	0.60	
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	355	340	297	371	940	
v/s Ratio Prot	0.03			0.04	c0.15	
v/s Ratio Perm		0.04	c0.09			
v/c Ratio	0.12	0.18	0.38	0.17	0.24	
Uniform Delay, d1	14.9	15.1	15.9	15.1	4.5	
Progression Factor	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.1	0.3	0.8	0.2	0.6	
Delay (s)	15.1	15.4	16.7	15.3	5.1	
Level of Service	B	B	B	B	A	
Approach Delay (s)	15.3			16.2	5.1	
Approach LOS	B			B	A	

Intersection Summary				
HCM 2000 Control Delay	12.1	HCM 2000 Level of Service	B	
HCM 2000 Volume to Capacity ratio	0.28			
Actuated Cycle Length (s)	49.3	Sum of lost time (s)	8.0	
Intersection Capacity Utilization	33.5%	ICU Level of Service	A	
Analysis Period (min)	15			
c Critical Lane Group				

Lane Group	EBT	EBR	WBL	WBT	NBL
Lane Configurations					
Traffic Volume (vph)	66	254	67	40	294
Future Volume (vph)	66	254	67	40	294
Turn Type	NA	Perm	Perm	NA	Prot
Protected Phases	4			8	2
Permitted Phases		4	8		
Detector Phase	4	4	8	8	2
Switch Phase					
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	28.0	28.0	28.0	28.0	28.0
Total Split (s)	28.0	28.0	28.0	28.0	32.0
Total Split (%)	46.7%	46.7%	46.7%	46.7%	53.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	None	None	None	None	Max
Act Effct Green (s)	10.4	10.4	10.4	10.4	29.8
Actuated g/C Ratio	0.22	0.22	0.22	0.22	0.62
v/c Ratio	0.20	0.52	0.27	0.11	0.43
Control Delay	15.7	6.5	17.5	14.7	6.5
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	15.7	6.5	17.5	14.7	6.5
LOS	B	A	B	B	A
Approach Delay	8.4			16.5	6.5
Approach LOS	A			B	A

Intersection Summary			
Cycle Length: 60			
Actuated Cycle Length: 48.2			
Natural Cycle: 60			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.52			
Intersection Signal Delay: 8.5		Intersection LOS: A	
Intersection Capacity Utilization 42.5%		ICU Level of Service A	
Analysis Period (min) 15			

Splits and Phases: 1: Casablanca Boulevard & North Service Road



Lane Group	EBT	EBR	WBL	WBT	NBL
Lane Group Flow (vph)	72	276	73	43	443
v/c Ratio	0.20	0.52	0.27	0.11	0.43
Control Delay	15.7	6.5	17.5	14.7	6.5
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	15.7	6.5	17.5	14.7	6.5
Queue Length 50th (m)	5.0	0.0	5.2	2.9	14.2
Queue Length 95th (m)	12.7	13.8	13.4	8.7	36.5
Internal Link Dist (m)	120.4			206.5	218.5
Turn Bay Length (m)		60.0	160.0		
Base Capacity (vph)	858	860	621	875	1019
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.08	0.32	0.12	0.05	0.43

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	66	254	67	40	294	113
Future Volume (vph)	66	254	67	40	294	113
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	
Frt	1.00	0.85	1.00	1.00	0.96	
Flt Protected	1.00	1.00	0.95	1.00	0.97	
Satd. Flow (prot)	1716	1444	1662	1750	1621	
Flt Permitted	1.00	1.00	0.71	1.00	0.97	
Satd. Flow (perm)	1716	1444	1243	1750	1621	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	72	276	73	43	320	123
RTOR Reduction (vph)	0	217	0	0	16	0
Lane Group Flow (vph)	72	59	73	43	427	0
Heavy Vehicles (%)	2%	3%	0%	0%	0%	1%
Turn Type	NA	Perm	Perm	NA	Prot	
Protected Phases	4			8	2	
Permitted Phases		4	8			
Actuated Green, G (s)	8.3	8.3	8.3	8.3	27.8	
Effective Green, g (s)	10.3	10.3	10.3	10.3	29.8	
Actuated g/C Ratio	0.21	0.21	0.21	0.21	0.62	
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	367	309	266	374	1004	
v/s Ratio Prot	0.04			0.02	c0.26	
v/s Ratio Perm		0.04	c0.06			
v/c Ratio	0.20	0.19	0.27	0.11	0.42	
Uniform Delay, d1	15.5	15.5	15.8	15.2	4.7	
Progression Factor	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	0.3	0.3	0.6	0.1	1.3	
Delay (s)	15.8	15.8	16.3	15.4	6.0	
Level of Service	B	B	B	B	A	
Approach Delay (s)	15.8			16.0	6.0	
Approach LOS	B			B	A	

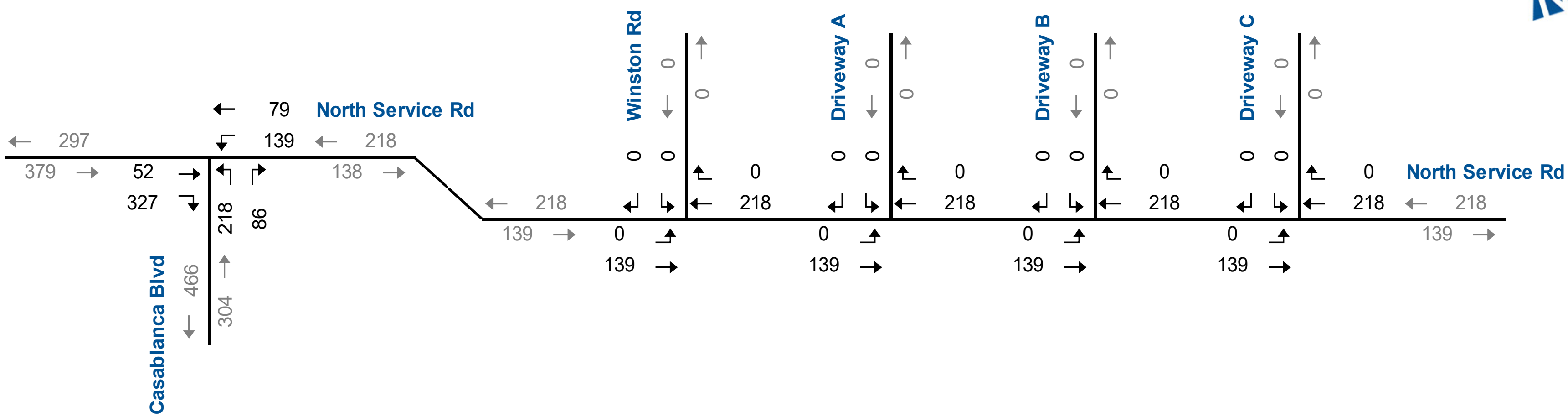
Intersection Summary

HCM 2000 Control Delay	11.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	48.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	42.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

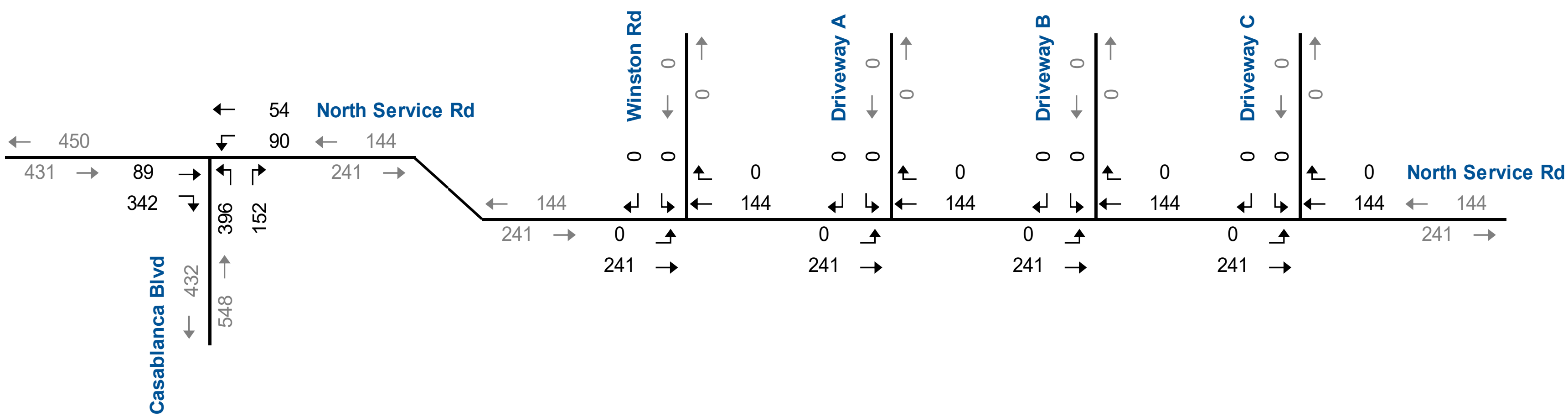
Appendix C

Background Development Traffic Volumes

AM Peak Hour



PM Peak Hour



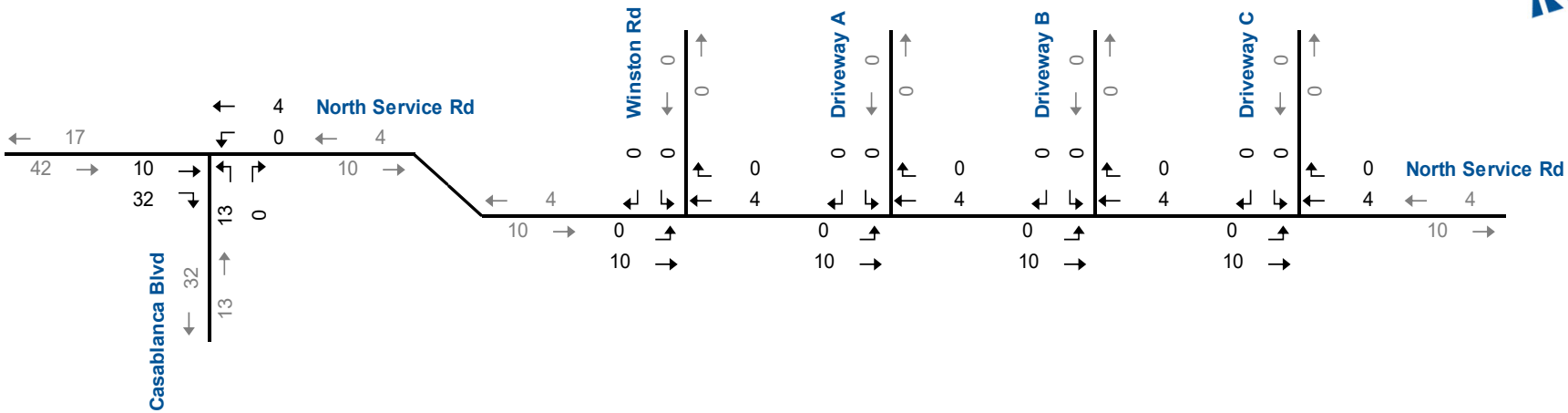
NTS

Background General Growth

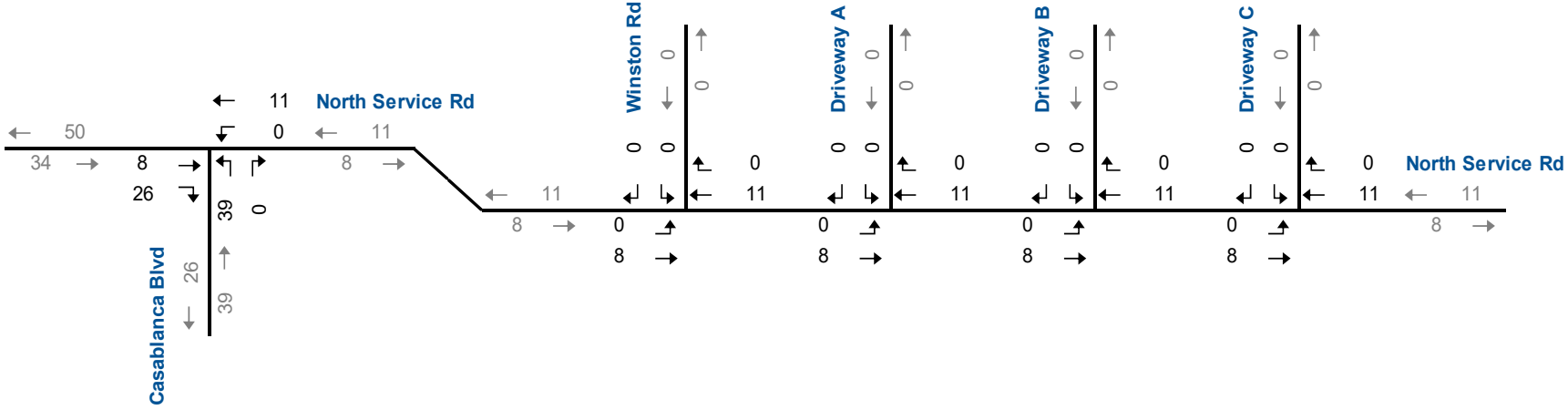
Appendix B

398 North Service Road Fifth Wheel Site, Grimsby TIS
190563

AM Peak Hour

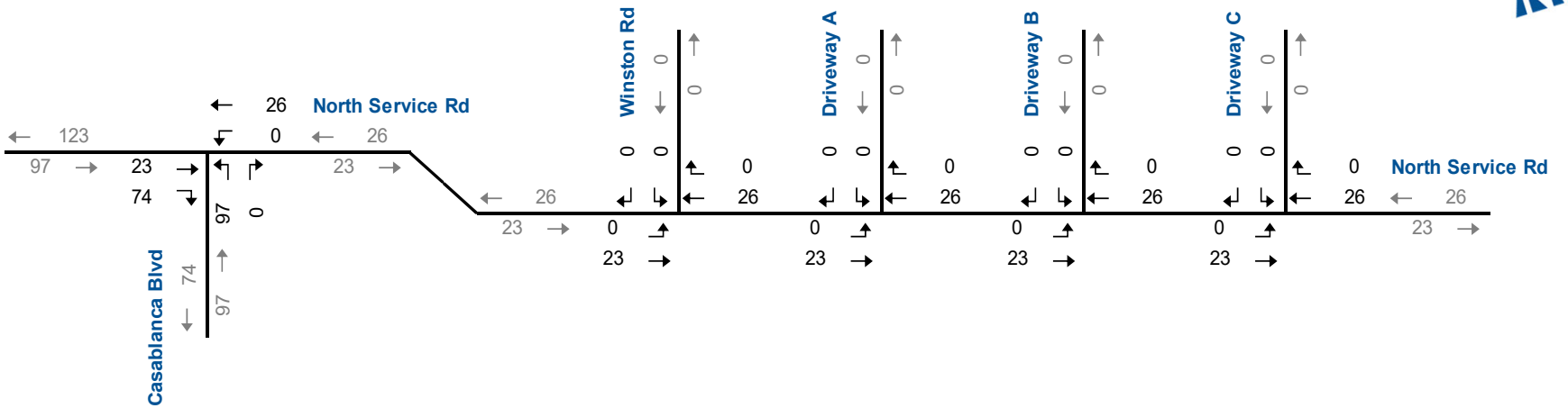


PM Peak Hour

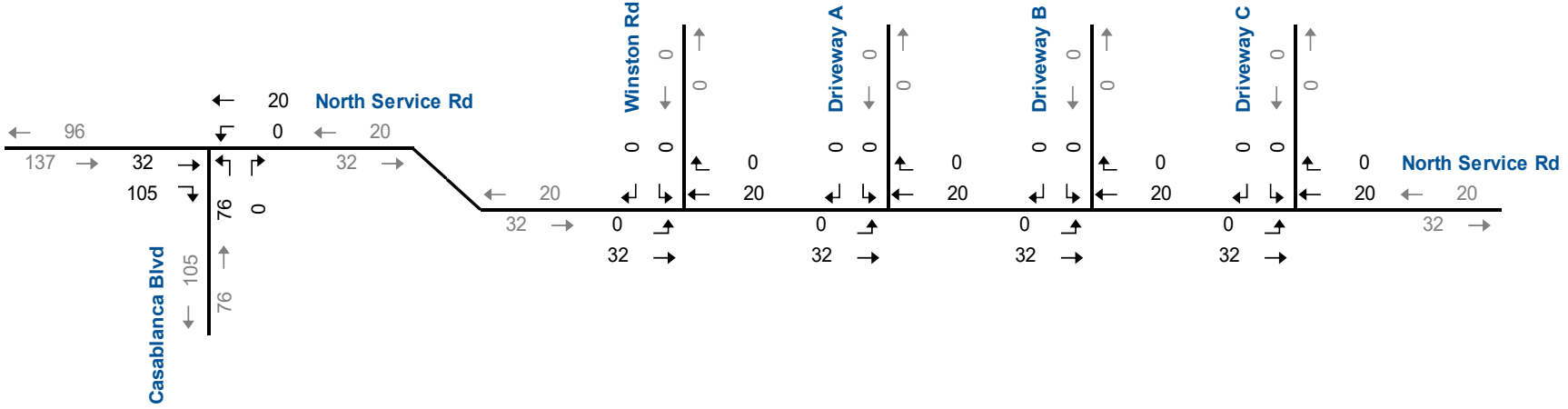


NTS

AM Peak Hour



PM Peak Hour



NTS

Background Development Volumes – Aqua Zul

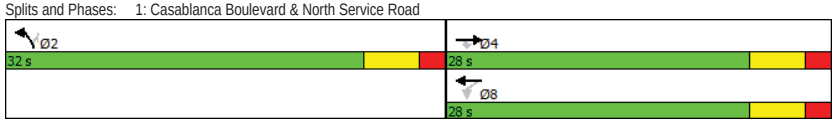
Appendix D

Background Traffic Operations Reports

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	39	243	103	59	162	64
Future Volume (vph)	39	243	103	59	162	64
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Detector Phase	4	4	8	8	2	2
Switch Phase						
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	28.0	28.0	28.0	28.0	28.0	28.0
Total Split (s)	28.0	28.0	28.0	28.0	32.0	32.0
Total Split (%)	46.7%	46.7%	46.7%	46.7%	53.3%	53.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	6.0
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	11.5	11.5	11.5	11.5	29.8	27.8
Actuated g/C Ratio	0.23	0.23	0.23	0.23	0.60	0.56
v/c Ratio	0.12	0.49	0.38	0.17	0.18	0.08
Control Delay	14.4	5.8	18.7	15.0	5.8	2.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	14.4	5.8	18.7	15.0	5.8	2.4
LOS	B	A	B	B	A	A
Approach Delay	7.0			17.3	4.8	
Approach LOS	A			B	A	

Intersection Summary			
Cycle Length: 60			
Actuated Cycle Length: 49.4			
Natural Cycle: 60			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.49			
Intersection Signal Delay: 8.8		Intersection LOS: A	
Intersection Capacity Utilization 29.3%		ICU Level of Service A	
Analysis Period (min) 15			

Splits and Phases: 1: Casablanca Boulevard & North Service Road



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	42	264	112	64	176	70
v/c Ratio	0.12	0.49	0.38	0.17	0.18	0.08
Control Delay	14.4	5.8	18.7	15.0	5.8	2.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	14.4	5.8	18.7	15.0	5.8	2.4
Queue Length 50th (m)	2.9	0.0	8.2	4.5	5.9	0.0
Queue Length 95th (m)	8.5	13.2	18.8	11.7	15.9	4.6
Internal Link Dist (m)	120.4			206.5	218.5	
Turn Bay Length (m)		60.0	160.0			
Base Capacity (vph)	741	845	622	775	956	844
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	0.06	0.31	0.18	0.08	0.18	0.08

Intersection Summary

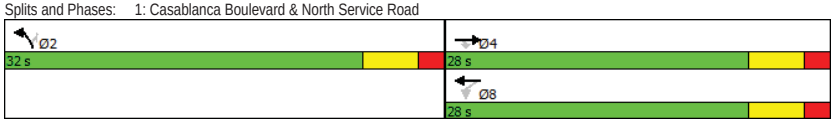
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	39	243	103	59	162	64
Future Volume (vph)	39	243	103	59	162	64
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	6.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	1522	1458	1662	1591	1583	1444
Flt Permitted	1.00	1.00	0.73	1.00	0.95	1.00
Satd. Flow (perm)	1522	1458	1277	1591	1583	1444
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	42	264	112	64	176	70
RTOR Reduction (vph)	0	202	0	0	0	31
Lane Group Flow (vph)	42	62	112	64	176	39
Heavy Vehicles (%)	15%	2%	0%	10%	5%	3%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	9.5	9.5	9.5	9.5	27.8	27.8
Effective Green, g (s)	11.5	11.5	11.5	11.5	29.8	27.8
Actuated g/C Ratio	0.23	0.23	0.23	0.23	0.60	0.56
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	355	340	297	371	956	814
v/s Ratio Prot	0.03			0.04	c0.11	
v/s Ratio Perm		0.04	c0.09			0.03
v/c Ratio	0.12	0.18	0.38	0.17	0.18	0.05
Uniform Delay, d1	14.9	15.1	15.9	15.1	4.3	4.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	0.3	0.8	0.2	0.4	0.1
Delay (s)	15.1	15.4	16.7	15.3	4.8	4.9
Level of Service	B	B	B	B	A	A
Approach Delay (s)	15.3			16.2	4.8	
Approach LOS	B			B	A	

Intersection Summary				
HCM 2000 Control Delay	12.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.24		
Actuated Cycle Length (s)	49.3	Sum of lost time (s)	8.0
Intersection Capacity Utilization	29.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	129	473	90	85	511	152
Future Volume (vph)	129	473	90	85	511	152
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Detector Phase	4	4	8	8	2	2
Switch Phase						
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	28.0	28.0	28.0	28.0	28.0	28.0
Total Split (s)	28.0	28.0	28.0	28.0	32.0	32.0
Total Split (%)	46.7%	46.7%	46.7%	46.7%	53.3%	53.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	6.0
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	12.6	12.6	12.6	12.6	28.2	26.2
Actuated g/C Ratio	0.26	0.26	0.26	0.26	0.58	0.54
v/c Ratio	0.32	0.68	0.33	0.20	0.58	0.19
Control Delay	16.0	6.9	17.1	14.6	11.1	2.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	16.0	6.9	17.1	14.6	11.1	2.5
LOS	B	A	B	B	B	A
Approach Delay	8.8			15.9	9.1	
Approach LOS	A			B	A	

Intersection Summary		
Cycle Length: 60		
Actuated Cycle Length: 48.9		
Natural Cycle: 60		
Control Type: Semi Act-Uncoord		
Maximum v/c Ratio: 0.68		
Intersection Signal Delay: 9.8	Intersection LOS: A	
Intersection Capacity Utilization 53.5%	ICU Level of Service A	
Analysis Period (min) 15		

Splits and Phases: 1: Casablanca Boulevard & North Service Road



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	140	514	98	92	555	165
v/c Ratio	0.32	0.68	0.33	0.20	0.58	0.19
Control Delay	16.0	6.9	17.1	14.6	11.1	2.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	16.0	6.9	17.1	14.6	11.1	2.5
Queue Length 50th (m)	10.2	0.0	7.1	6.5	24.5	0.0
Queue Length 95th (m)	20.8	16.6	16.4	14.5	78.4	8.6
Internal Link Dist (m)	120.4			206.5	218.5	
Turn Bay Length (m)		60.0	160.0			
Base Capacity (vph)	849	974	578	866	960	866
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	0.16	0.53	0.17	0.11	0.58	0.19

Intersection Summary

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	129	473	90	85	511	152
Future Volume (vph)	129	473	90	85	511	152
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	6.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	1716	1444	1662	1750	1662	1473
Flt Permitted	1.00	1.00	0.67	1.00	0.95	1.00
Satd. Flow (perm)	1716	1444	1168	1750	1662	1473
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	140	514	98	92	555	165
RTOR Reduction (vph)	0	382	0	0	0	76
Lane Group Flow (vph)	140	132	98	92	555	89
Heavy Vehicles (%)	2%	3%	0%	0%	0%	1%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	10.6	10.6	10.6	10.6	26.3	26.3
Effective Green, g (s)	12.6	12.6	12.6	12.6	28.3	26.3
Actuated g/C Ratio	0.26	0.26	0.26	0.26	0.58	0.54
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	442	372	300	450	961	792
v/s Ratio Prot	0.08			0.05	c0.33	
v/s Ratio Perm		c0.09	0.08			0.06
v/c Ratio	0.32	0.36	0.33	0.20	0.58	0.11
Uniform Delay, d1	14.7	14.8	14.7	14.2	6.5	5.6
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.4	0.6	0.6	0.2	2.5	0.3
Delay (s)	15.1	15.4	15.4	14.4	9.0	5.8
Level of Service	B	B	B	B	A	A
Approach Delay (s)	15.3			14.9	8.3	
Approach LOS	B			B	A	

Intersection Summary				
HCM 2000 Control Delay	12.1	HCM 2000 Level of Service	B	
HCM 2000 Volume to Capacity ratio	0.51			
Actuated Cycle Length (s)	48.9	Sum of lost time (s)	8.0	
Intersection Capacity Utilization	53.5%	ICU Level of Service	A	
Analysis Period (min)	15			
c Critical Lane Group				

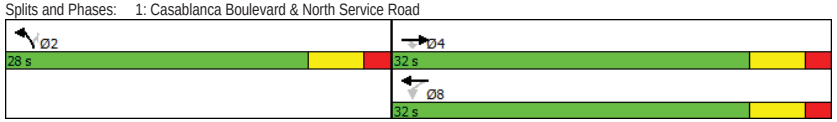
Appendix E

Total Traffic Operations Reports

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	98	433	366	162	328	273
Future Volume (vph)	98	433	366	162	328	273
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Detector Phase	4	4	8	8	2	2
Switch Phase						
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	28.0	28.0	28.0	28.0	28.0	28.0
Total Split (s)	32.0	32.0	32.0	32.0	28.0	28.0
Total Split (%)	53.3%	53.3%	53.3%	53.3%	46.7%	46.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	6.0
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	23.4	23.4	23.4	23.4	24.2	22.2
Actuated g/C Ratio	0.42	0.42	0.42	0.42	0.43	0.40
v/c Ratio	0.17	0.53	0.79	0.26	0.52	0.39
Control Delay	10.3	3.7	26.7	11.2	16.2	3.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	10.3	3.7	26.7	11.2	16.2	3.8
LOS	B	A	C	B	B	A
Approach Delay	4.9			22.0	10.6	
Approach LOS	A			C	B	

Intersection Summary			
Cycle Length: 60			
Actuated Cycle Length: 55.7			
Natural Cycle: 60			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.79			
Intersection Signal Delay: 12.4		Intersection LOS: B	
Intersection Capacity Utilization 57.8%		ICU Level of Service B	
Analysis Period (min) 15			

Splits and Phases: 1: Casablanca Boulevard & North Service Road

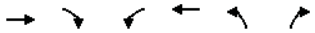


Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	107	471	398	176	357	297
v/c Ratio	0.17	0.53	0.79	0.26	0.52	0.39
Control Delay	10.3	3.7	26.7	11.2	16.2	3.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	10.3	3.7	26.7	11.2	16.2	3.8
Queue Length 50th (m)	6.7	0.0	34.5	11.4	28.8	0.0
Queue Length 95th (m)	14.5	13.6	#76.3	22.4	54.4	13.5
Internal Link Dist (m)	120.4			206.5	218.5	
Turn Bay Length (m)		60.0	160.0			
Base Capacity (vph)	771	971	610	806	688	754
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	0.14	0.49	0.65	0.22	0.52	0.39

Intersection Summary
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
1: Casablanca Boulevard & North Service Road

Total AM
190563

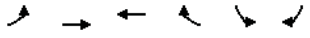


Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	98	433	366	162	328	273
Future Volume (vph)	98	433	366	162	328	273
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	6.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	1522	1458	1662	1591	1583	1444
Flt Permitted	1.00	1.00	0.69	1.00	0.95	1.00
Satd. Flow (perm)	1522	1458	1204	1591	1583	1444
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	107	471	398	176	357	297
RTOR Reduction (vph)	0	273	0	0	0	178
Lane Group Flow (vph)	107	198	398	176	357	119
Heavy Vehicles (%)	15%	2%	0%	10%	5%	3%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	21.4	21.4	21.4	21.4	22.2	22.2
Effective Green, g (s)	23.4	23.4	23.4	23.4	24.2	22.2
Actuated g/C Ratio	0.42	0.42	0.42	0.42	0.44	0.40
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	640	613	506	669	689	576
v/s Ratio Prot	0.07			0.11	c0.23	
v/s Ratio Perm		0.14	c0.33			0.08
v/c Ratio	0.17	0.32	0.79	0.26	0.52	0.21
Uniform Delay, d1	10.0	10.8	13.9	10.5	11.4	10.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	0.3	7.9	0.2	2.8	0.8
Delay (s)	10.2	11.1	21.8	10.7	14.2	11.7
Level of Service	B	B	C	B	B	B
Approach Delay (s)	10.9			18.4	13.1	
Approach LOS	B			B	B	

Intersection Summary				
HCM 2000 Control Delay	14.1	HCM 2000 Level of Service	B	
HCM 2000 Volume to Capacity ratio	0.65			
Actuated Cycle Length (s)	55.6	Sum of lost time (s)	8.0	
Intersection Capacity Utilization	57.8%	ICU Level of Service	B	
Analysis Period (min)	15			
c Critical Lane Group				

HCM Unsignalized Intersection Capacity Analysis
2: North Service Road & Winston Road

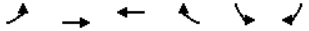
Total AM
190563



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	71	301	429	18	25	99
Future Volume (Veh/h)	71	301	429	18	25	99
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	77	327	466	20	27	108
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		230				
pX, platoon unblocked						
vC, conflicting volume	486				957	476
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	486				957	476
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				90	82
cM capacity (veh/h)	1087				268	593

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	404	486	135
Volume Left	77	0	27
Volume Right	0	20	108
cSH	1087	1700	477
Volume to Capacity	0.07	0.29	0.28
Queue Length 95th (m)	1.8	0.0	9.2
Control Delay (s)	2.2	0.0	15.5
Lane LOS	A		C
Approach Delay (s)	2.2	0.0	15.5
Approach LOS			C

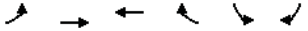
Intersection Summary			
Average Delay	2.9		
Intersection Capacity Utilization	65.3%	ICU Level of Service	C
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	4	322	442	1	1	5
Future Volume (Veh/h)	4	322	442	1	1	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	4	350	480	1	1	5
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		381				
pX, platoon unblocked						
vC, conflicting volume	481				838	480
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	481				838	480
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	99
cM capacity (veh/h)	1092				338	590

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	354	481	6
Volume Left	4	0	1
Volume Right	0	1	5
cSH	1092	1700	524
Volume to Capacity	0.00	0.28	0.01
Queue Length 95th (m)	0.1	0.0	0.3
Control Delay (s)	0.1	0.0	11.9
Lane LOS	A		B
Approach Delay (s)	0.1	0.0	11.9
Approach LOS			B

Intersection Summary			
Average Delay		0.1	
Intersection Capacity Utilization		35.3%	ICU Level of Service A
Analysis Period (min)		15	



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	119	204	276	29	42	167
Future Volume (Veh/h)	119	204	276	29	42	167
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	129	222	300	32	46	182
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	332				796	316
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	332				796	316
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	90				86	75
cM capacity (veh/h)	1239				321	729

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	351	332	228
Volume Left	129	0	46
Volume Right	0	32	182
cSH	1239	1700	581
Volume to Capacity	0.10	0.20	0.39
Queue Length 95th (m)	2.8	0.0	14.9
Control Delay (s)	3.7	0.0	15.2
Lane LOS	A		C
Approach Delay (s)	3.7	0.0	15.2
Approach LOS			C

Intersection Summary			
Average Delay		5.2	
Intersection Capacity Utilization		60.2%	ICU Level of Service B
Analysis Period (min)		15	

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	6	240	296	2	2	9
Future Volume (Veh/h)	6	240	296	2	2	9
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	7	261	322	2	2	10
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	324				598	323
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	324				598	323
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				100	99
cM capacity (veh/h)	1247				466	723

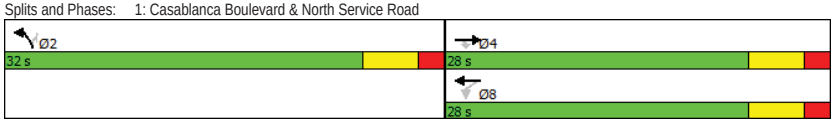
Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	268	324	12
Volume Left	7	0	2
Volume Right	0	2	10
cSH	1247	1700	662
Volume to Capacity	0.01	0.19	0.02
Queue Length 95th (m)	0.1	0.0	0.4
Control Delay (s)	0.3	0.0	10.5
Lane LOS	A		B
Approach Delay (s)	0.3	0.0	10.5
Approach LOS			B

Intersection Summary			
Average Delay		0.3	
Intersection Capacity Utilization		29.0%	ICU Level of Service A
Analysis Period (min)		15	

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	146	473	283	130	511	412
Future Volume (vph)	146	473	283	130	511	412
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Detector Phase	4	4	8	8	2	2
Switch Phase						
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	28.0	28.0	28.0	28.0	28.0	28.0
Total Split (s)	28.0	28.0	28.0	28.0	32.0	32.0
Total Split (%)	46.7%	46.7%	46.7%	46.7%	53.3%	53.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	6.0
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	20.2	20.2	20.2	20.2	28.1	26.1
Actuated g/C Ratio	0.36	0.36	0.36	0.36	0.50	0.46
v/c Ratio	0.26	0.61	0.75	0.22	0.67	0.49
Control Delay	13.6	4.9	28.7	13.2	16.9	3.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	13.6	4.9	28.7	13.2	16.9	3.4
LOS	B	A	C	B	B	A
Approach Delay	7.0			23.8	10.9	
Approach LOS	A			C	B	

Intersection Summary		
Cycle Length: 60		
Actuated Cycle Length: 56.4		
Natural Cycle: 60		
Control Type: Semi Act-Uncoord		
Maximum v/c Ratio: 0.75		
Intersection Signal Delay: 12.4		Intersection LOS: B
Intersection Capacity Utilization 66.1%		ICU Level of Service C
Analysis Period (min) 15		

Splits and Phases: 1: Casablanca Boulevard & North Service Road



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	159	514	308	141	555	448
v/c Ratio	0.26	0.61	0.75	0.22	0.67	0.49
Control Delay	13.6	4.9	28.7	13.2	16.9	3.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	13.6	4.9	28.7	13.2	16.9	3.4
Queue Length 50th (m)	11.7	0.0	28.1	10.3	45.7	0.0
Queue Length 95th (m)	23.1	16.3	#62.1	20.7	83.1	14.3
Internal Link Dist (m)	120.4			206.5	218.5	
Turn Bay Length (m)		60.0	160.0			
Base Capacity (vph)	734	912	491	748	829	923
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	0.22	0.56	0.63	0.19	0.67	0.49

Intersection Summary

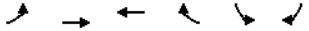
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	146	473	283	130	511	412
Future Volume (vph)	146	473	283	130	511	412
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	6.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	1716	1444	1662	1750	1662	1473
Flt Permitted	1.00	1.00	0.66	1.00	0.95	1.00
Satd. Flow (perm)	1716	1444	1148	1750	1662	1473
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	159	514	308	141	555	448
RTOR Reduction (vph)	0	330	0	0	0	240
Lane Group Flow (vph)	159	184	308	141	555	208
Heavy Vehicles (%)	2%	3%	0%	0%	0%	1%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	18.2	18.2	18.2	18.2	26.2	26.2
Effective Green, g (s)	20.2	20.2	20.2	20.2	28.2	26.2
Actuated g/C Ratio	0.36	0.36	0.36	0.36	0.50	0.46
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	614	517	411	626	831	684
v/s Ratio Prot	0.09			0.08	c0.33	
v/s Ratio Perm		0.13	c0.27			0.14
v/c Ratio	0.26	0.36	0.75	0.23	0.67	0.30
Uniform Delay, d1	12.8	13.3	15.9	12.6	10.6	9.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.4	7.3	0.2	4.2	1.1
Delay (s)	13.0	13.7	23.2	12.8	14.8	10.6
Level of Service	B	B	C	B	B	B
Approach Delay (s)	13.6			19.9	12.9	
Approach LOS	B			B	B	

Intersection Summary

HCM 2000 Control Delay	14.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	56.4	Sum of lost time (s)	8.0
Intersection Capacity Utilization	66.1%	ICU Level of Service	C
Analysis Period (min)	15		

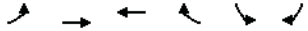
c Critical Lane Group



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	105	453	325	28	28	88
Future Volume (Veh/h)	105	453	325	28	28	88
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	114	492	353	30	30	96
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		230				
pX, platoon unblocked						
vC, conflicting volume	383				1088	368
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	383				1088	368
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	90				86	86
cM capacity (veh/h)	1187				218	682

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	606	383	126
Volume Left	114	0	30
Volume Right	0	30	96
cSH	1187	1700	452
Volume to Capacity	0.10	0.23	0.28
Queue Length 95th (m)	2.5	0.0	9.0
Control Delay (s)	2.5	0.0	16.0
Lane LOS	A		C
Approach Delay (s)	2.5	0.0	16.0
Approach LOS			C

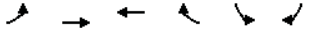
Intersection Summary			
Average Delay		3.2	
Intersection Capacity Utilization		70.2%	ICU Level of Service
Analysis Period (min)		15	



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	7	474	347	2	3	6
Future Volume (Veh/h)	7	474	347	2	3	6
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	8	515	377	2	3	7
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		381				
pX, platoon unblocked						
vC, conflicting volume	379				909	378
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	379				909	378
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				99	99
cM capacity (veh/h)	1191				306	673

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	523	379	10
Volume Left	8	0	3
Volume Right	0	2	7
cSH	1191	1700	495
Volume to Capacity	0.01	0.22	0.02
Queue Length 95th (m)	0.2	0.0	0.5
Control Delay (s)	0.2	0.0	12.4
Lane LOS	A		B
Approach Delay (s)	0.2	0.0	12.4
Approach LOS			B

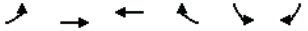
Intersection Summary			
Average Delay		0.3	
Intersection Capacity Utilization		43.2%	ICU Level of Service
Analysis Period (min)		15	



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	180	297	199	50	51	150
Future Volume (Veh/h)	180	297	199	50	51	150
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	196	323	216	54	55	163
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	270				958	243
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	270				958	243
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	85				78	80
cM capacity (veh/h)	1305				245	801

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	519	270	218
Volume Left	196	0	55
Volume Right	0	54	163
cSH	1305	1700	509
Volume to Capacity	0.15	0.16	0.43
Queue Length 95th (m)	4.2	0.0	17.0
Control Delay (s)	4.1	0.0	17.3
Lane LOS	A		C
Approach Delay (s)	4.1	0.0	17.3
Approach LOS			C

Intersection Summary			
Average Delay		5.8	
Intersection Capacity Utilization		65.6%	ICU Level of Service C
Analysis Period (min)		15	



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	9	339	242	2	2	7
Future Volume (Veh/h)	9	339	242	2	2	7
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	10	368	263	2	2	8
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	265				652	264
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	265				652	264
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				100	99
cM capacity (veh/h)	1311				432	780

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	378	265	10
Volume Left	10	0	2
Volume Right	0	2	8
cSH	1311	1700	672
Volume to Capacity	0.01	0.16	0.01
Queue Length 95th (m)	0.2	0.0	0.4
Control Delay (s)	0.3	0.0	10.4
Lane LOS	A		B
Approach Delay (s)	0.3	0.0	10.4
Approach LOS			B

Intersection Summary			
Average Delay		0.3	
Intersection Capacity Utilization		37.2%	ICU Level of Service A
Analysis Period (min)		15	

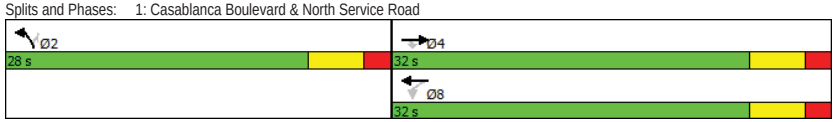
Appendix F

Total Traffic Operations Reports – Sensitivity Analysis

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	98	433	366	162	328	273
Future Volume (vph)	98	433	366	162	328	273
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Detector Phase	4	4	8	8	2	2
Switch Phase						
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	28.0	28.0	28.0	28.0	28.0	28.0
Total Split (s)	32.0	32.0	32.0	32.0	28.0	28.0
Total Split (%)	53.3%	53.3%	53.3%	53.3%	46.7%	46.7%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	6.0
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	23.4	23.4	23.4	23.4	24.2	22.2
Actuated g/C Ratio	0.42	0.42	0.42	0.42	0.43	0.40
v/c Ratio	0.17	0.53	0.79	0.26	0.52	0.39
Control Delay	10.3	3.7	26.7	11.2	16.2	3.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	10.3	3.7	26.7	11.2	16.2	3.8
LOS	B	A	C	B	B	A
Approach Delay	4.9			22.0	10.6	
Approach LOS	A			C	B	

Intersection Summary			
Cycle Length: 60			
Actuated Cycle Length: 55.7			
Natural Cycle: 60			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.79			
Intersection Signal Delay: 12.4		Intersection LOS: B	
Intersection Capacity Utilization 57.8%		ICU Level of Service B	
Analysis Period (min) 15			

Splits and Phases: 1: Casablanca Boulevard & North Service Road

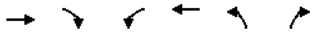


Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	107	471	398	176	357	297
v/c Ratio	0.17	0.53	0.79	0.26	0.52	0.39
Control Delay	10.3	3.7	26.7	11.2	16.2	3.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	10.3	3.7	26.7	11.2	16.2	3.8
Queue Length 50th (m)	6.7	0.0	34.5	11.4	28.8	0.0
Queue Length 95th (m)	14.5	13.6	#76.3	22.4	54.4	13.5
Internal Link Dist (m)	120.4			206.5	218.5	
Turn Bay Length (m)		60.0	160.0			
Base Capacity (vph)	771	971	610	806	688	754
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	0.14	0.49	0.65	0.22	0.52	0.39

Intersection Summary
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis
1: Casablanca Boulevard & North Service Road

Total AM
190563

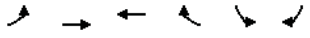


Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	98	433	366	162	328	273
Future Volume (vph)	98	433	366	162	328	273
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	6.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	1522	1458	1662	1591	1583	1444
Flt Permitted	1.00	1.00	0.69	1.00	0.95	1.00
Satd. Flow (perm)	1522	1458	1204	1591	1583	1444
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	107	471	398	176	357	297
RTOR Reduction (vph)	0	273	0	0	0	178
Lane Group Flow (vph)	107	198	398	176	357	119
Heavy Vehicles (%)	15%	2%	0%	10%	5%	3%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	21.4	21.4	21.4	21.4	22.2	22.2
Effective Green, g (s)	23.4	23.4	23.4	23.4	24.2	22.2
Actuated g/C Ratio	0.42	0.42	0.42	0.42	0.44	0.40
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	640	613	506	669	689	576
v/s Ratio Prot	0.07			0.11	c0.23	
v/s Ratio Perm		0.14	c0.33			0.08
v/c Ratio	0.17	0.32	0.79	0.26	0.52	0.21
Uniform Delay, d1	10.0	10.8	13.9	10.5	11.4	10.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	0.3	7.9	0.2	2.8	0.8
Delay (s)	10.2	11.1	21.8	10.7	14.2	11.7
Level of Service	B	B	C	B	B	B
Approach Delay (s)	10.9			18.4	13.1	
Approach LOS	B			B	B	

Intersection Summary				
HCM 2000 Control Delay	14.1	HCM 2000 Level of Service	B	
HCM 2000 Volume to Capacity ratio	0.65			
Actuated Cycle Length (s)	55.6	Sum of lost time (s)	8.0	
Intersection Capacity Utilization	57.8%	ICU Level of Service	B	
Analysis Period (min)	15			
c Critical Lane Group				

HCM Unsignalized Intersection Capacity Analysis
2: North Service Road & Winston Road

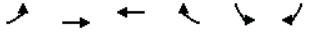
Total AM
190563



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	75	297	429	18	26	99
Future Volume (Veh/h)	75	297	429	18	26	99
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	82	323	466	20	28	108
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		230				
pX, platoon unblocked						
vC, conflicting volume	486				963	476
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	486				963	476
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	92				89	82
cM capacity (veh/h)	1087				264	593

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	405	486	136
Volume Left	82	0	28
Volume Right	0	20	108
cSH	1087	1700	472
Volume to Capacity	0.08	0.29	0.29
Queue Length 95th (m)	2.0	0.0	9.4
Control Delay (s)	2.4	0.0	15.7
Lane LOS	A		C
Approach Delay (s)	2.4	0.0	15.7
Approach LOS			C

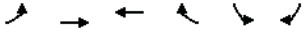
Intersection Summary			
Average Delay	3.0		
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	323	442	1	0	5
Future Volume (Veh/h)	0	323	442	1	0	5
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	351	480	1	0	5
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		381				
pX, platoon unblocked						
vC, conflicting volume	481				832	480
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	481				832	480
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	99
cM capacity (veh/h)	1092				342	590

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	351	481	5
Volume Left	0	0	0
Volume Right	0	1	5
cSH	1700	1700	590
Volume to Capacity	0.21	0.28	0.01
Queue Length 95th (m)	0.0	0.0	0.2
Control Delay (s)	0.0	0.0	11.2
Lane LOS			B
Approach Delay (s)	0.0	0.0	11.2
Approach LOS			B

Intersection Summary			
Average Delay		0.1	
Intersection Capacity Utilization		35.3%	ICU Level of Service
Analysis Period (min)		15	



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	125	198	276	29	44	167
Future Volume (Veh/h)	125	198	276	29	44	167
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	136	215	300	32	48	182
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	332				803	316
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	332				803	316
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	89				85	75
cM capacity (veh/h)	1239				316	729

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	351	332	230
Volume Left	136	0	48
Volume Right	0	32	182
cSH	1239	1700	573
Volume to Capacity	0.11	0.20	0.40
Queue Length 95th (m)	3.0	0.0	15.4
Control Delay (s)	3.8	0.0	15.4
Lane LOS	A		C
Approach Delay (s)	3.8	0.0	15.4
Approach LOS			C

Intersection Summary			
Average Delay		5.4	
Intersection Capacity Utilization		60.3%	ICU Level of Service
Analysis Period (min)		15	

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	242	296	2	0	9
Future Volume (Veh/h)	0	242	296	2	0	9
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	263	322	2	0	10
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	324				586	323
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	324				586	323
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	99
cM capacity (veh/h)	1247				476	723

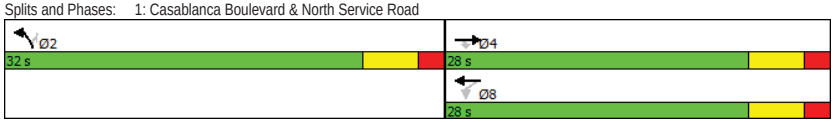
Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	263	324	10
Volume Left	0	0	0
Volume Right	0	2	10
cSH	1700	1700	723
Volume to Capacity	0.15	0.19	0.01
Queue Length 95th (m)	0.0	0.0	0.3
Control Delay (s)	0.0	0.0	10.1
Lane LOS			B
Approach Delay (s)	0.0	0.0	10.1
Approach LOS			B

Intersection Summary				
Average Delay		0.2		
Intersection Capacity Utilization		27.0%	ICU Level of Service	A
Analysis Period (min)		15		

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	146	473	283	130	511	412
Future Volume (vph)	146	473	283	130	511	412
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Detector Phase	4	4	8	8	2	2
Switch Phase						
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	28.0	28.0	28.0	28.0	28.0	28.0
Total Split (s)	28.0	28.0	28.0	28.0	32.0	32.0
Total Split (%)	46.7%	46.7%	46.7%	46.7%	53.3%	53.3%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	-2.0	-2.0	-2.0	-2.0	-2.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	6.0
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	None	None	None	None	Max	Max
Act Effct Green (s)	20.2	20.2	20.2	20.2	28.1	26.1
Actuated g/C Ratio	0.36	0.36	0.36	0.36	0.50	0.46
v/c Ratio	0.26	0.61	0.75	0.22	0.67	0.49
Control Delay	13.6	4.9	28.7	13.2	16.9	3.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	13.6	4.9	28.7	13.2	16.9	3.4
LOS	B	A	C	B	B	A
Approach Delay	7.0			23.8	10.9	
Approach LOS	A			C	B	

Intersection Summary			
Cycle Length: 60			
Actuated Cycle Length: 56.4			
Natural Cycle: 60			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.75			
Intersection Signal Delay: 12.4		Intersection LOS: B	
Intersection Capacity Utilization 66.1%		ICU Level of Service C	
Analysis Period (min) 15			

Splits and Phases: 1: Casablanca Boulevard & North Service Road



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Group Flow (vph)	159	514	308	141	555	448
v/c Ratio	0.26	0.61	0.75	0.22	0.67	0.49
Control Delay	13.6	4.9	28.7	13.2	16.9	3.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	13.6	4.9	28.7	13.2	16.9	3.4
Queue Length 50th (m)	11.7	0.0	28.1	10.3	45.7	0.0
Queue Length 95th (m)	23.1	16.3	#62.1	20.7	83.1	14.3
Internal Link Dist (m)	120.4			206.5	218.5	
Turn Bay Length (m)		60.0	160.0			
Base Capacity (vph)	734	912	491	748	829	923
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	0.22	0.56	0.63	0.19	0.67	0.49

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

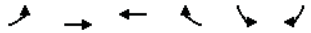
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	146	473	283	130	511	412
Future Volume (vph)	146	473	283	130	511	412
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	6.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	1.00	1.00	0.85
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	1716	1444	1662	1750	1662	1473
Flt Permitted	1.00	1.00	0.66	1.00	0.95	1.00
Satd. Flow (perm)	1716	1444	1148	1750	1662	1473
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	159	514	308	141	555	448
RTOR Reduction (vph)	0	330	0	0	0	240
Lane Group Flow (vph)	159	184	308	141	555	208
Heavy Vehicles (%)	2%	3%	0%	0%	0%	1%
Turn Type	NA	Perm	Perm	NA	Prot	Perm
Protected Phases	4			8	2	
Permitted Phases		4	8			2
Actuated Green, G (s)	18.2	18.2	18.2	18.2	26.2	26.2
Effective Green, g (s)	20.2	20.2	20.2	20.2	28.2	26.2
Actuated g/C Ratio	0.36	0.36	0.36	0.36	0.50	0.46
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	614	517	411	626	831	684
v/s Ratio Prot	0.09			0.08	c0.33	
v/s Ratio Perm		0.13	c0.27			0.14
v/c Ratio	0.26	0.36	0.75	0.23	0.67	0.30
Uniform Delay, d1	12.8	13.3	15.9	12.6	10.6	9.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	0.4	7.3	0.2	4.2	1.1
Delay (s)	13.0	13.7	23.2	12.8	14.8	10.6
Level of Service	B	B	C	B	B	B
Approach Delay (s)	13.6			19.9	12.9	
Approach LOS	B			B	B	

Intersection Summary

HCM 2000 Control Delay	14.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	56.4	Sum of lost time (s)	8.0
Intersection Capacity Utilization	66.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis — Total PM
2: North Service Road & Winston Road — 190563

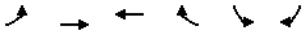


Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	112	446	325	28	31	88
Future Volume (Veh/h)	112	446	325	28	31	88
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	122	485	353	30	34	96
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		230				
pX, platoon unblocked						
vC, conflicting volume	383				1097	368
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	383				1097	368
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	90				84	86
cM capacity (veh/h)	1187				213	682

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	607	383	130
Volume Left	122	0	34
Volume Right	0	30	96
cSH	1187	1700	433
Volume to Capacity	0.10	0.23	0.30
Queue Length 95th (m)	2.7	0.0	10.0
Control Delay (s)	2.6	0.0	16.8
Lane LOS	A		C
Approach Delay (s)	2.6	0.0	16.8
Approach LOS			C

Intersection Summary			
Average Delay	3.4		
Intersection Capacity Utilization	70.4%	ICU Level of Service	C
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis — Total PM
3: North Service Road & Driveway A — 190563



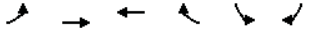
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	477	347	2	0	6
Future Volume (Veh/h)	0	477	347	2	0	6
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	518	377	2	0	7
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		381				
pX, platoon unblocked						
vC, conflicting volume	379				896	378
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	379				896	378
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	99
cM capacity (veh/h)	1191				313	673

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	518	379	7
Volume Left	0	0	0
Volume Right	0	2	7
cSH	1700	1700	673
Volume to Capacity	0.30	0.22	0.01
Queue Length 95th (m)	0.0	0.0	0.3
Control Delay (s)	0.0	0.0	10.4
Lane LOS			B
Approach Delay (s)	0.0	0.0	10.4
Approach LOS			B

Intersection Summary			
Average Delay	0.1		
Intersection Capacity Utilization	30.6%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
4: North Service Road & Driveway B

Total PM
190563



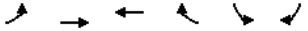
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	189	288	199	50	53	150
Future Volume (Veh/h)	189	288	199	50	53	150
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	205	313	216	54	58	163
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	270				966	243
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	270				966	243
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	84				76	80
cM capacity (veh/h)	1305				240	801

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	518	270	221
Volume Left	205	0	58
Volume Right	0	54	163
cSH	1305	1700	496
Volume to Capacity	0.16	0.16	0.45
Queue Length 95th (m)	4.5	0.0	18.1
Control Delay (s)	4.2	0.0	17.9
Lane LOS	A		C
Approach Delay (s)	4.2	0.0	17.9
Approach LOS			C

Intersection Summary				
Average Delay		6.1		
Intersection Capacity Utilization		65.7%	ICU Level of Service	C
Analysis Period (min)		15		

HCM Unsignalized Intersection Capacity Analysis
5: North Service Road & Driveway C

Total PM
190563



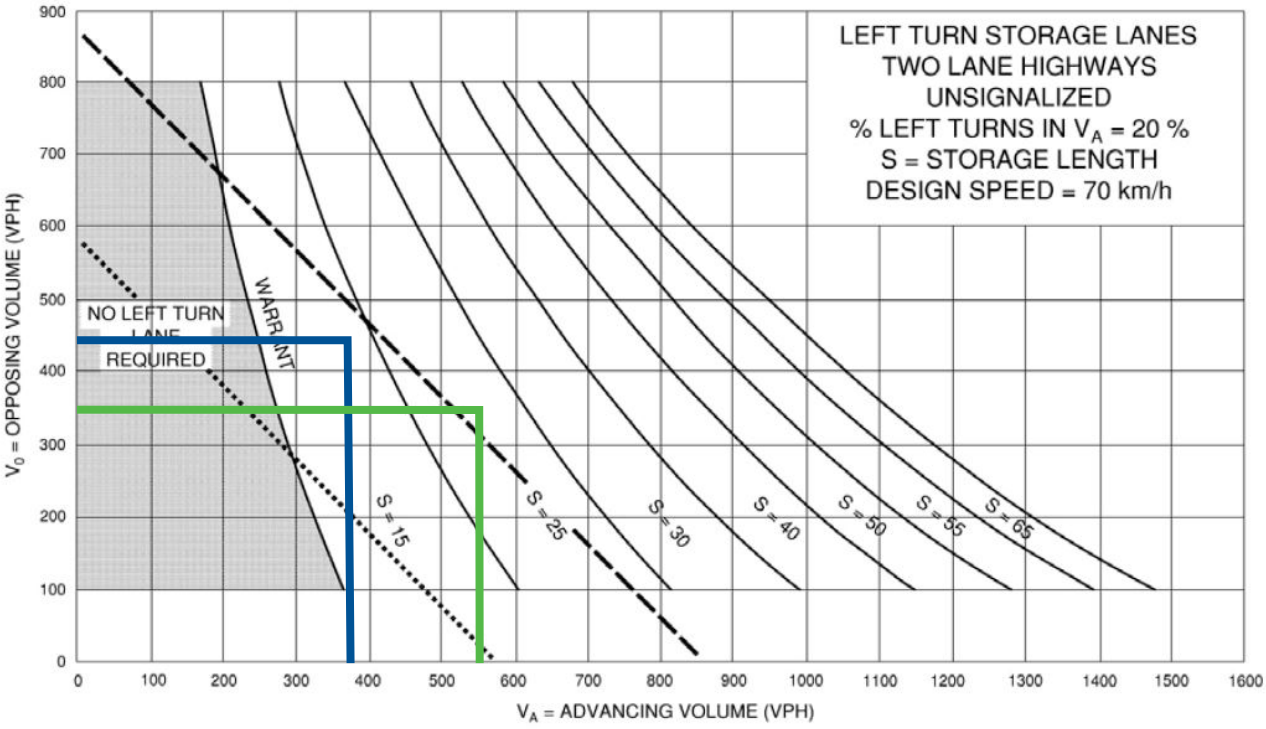
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	341	242	2	0	7
Future Volume (Veh/h)	0	341	242	2	0	7
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	371	263	2	0	8
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	265				635	264
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	265				635	264
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	99
cM capacity (veh/h)	1311				446	780

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	371	265	8
Volume Left	0	0	0
Volume Right	0	2	8
cSH	1700	1700	780
Volume to Capacity	0.22	0.16	0.01
Queue Length 95th (m)	0.0	0.0	0.2
Control Delay (s)	0.0	0.0	9.7
Lane LOS			A
Approach Delay (s)	0.0	0.0	9.7
Approach LOS			A

Intersection Summary				
Average Delay		0.1		
Intersection Capacity Utilization		24.0%	ICU Level of Service	A
Analysis Period (min)		15		

Appendix G

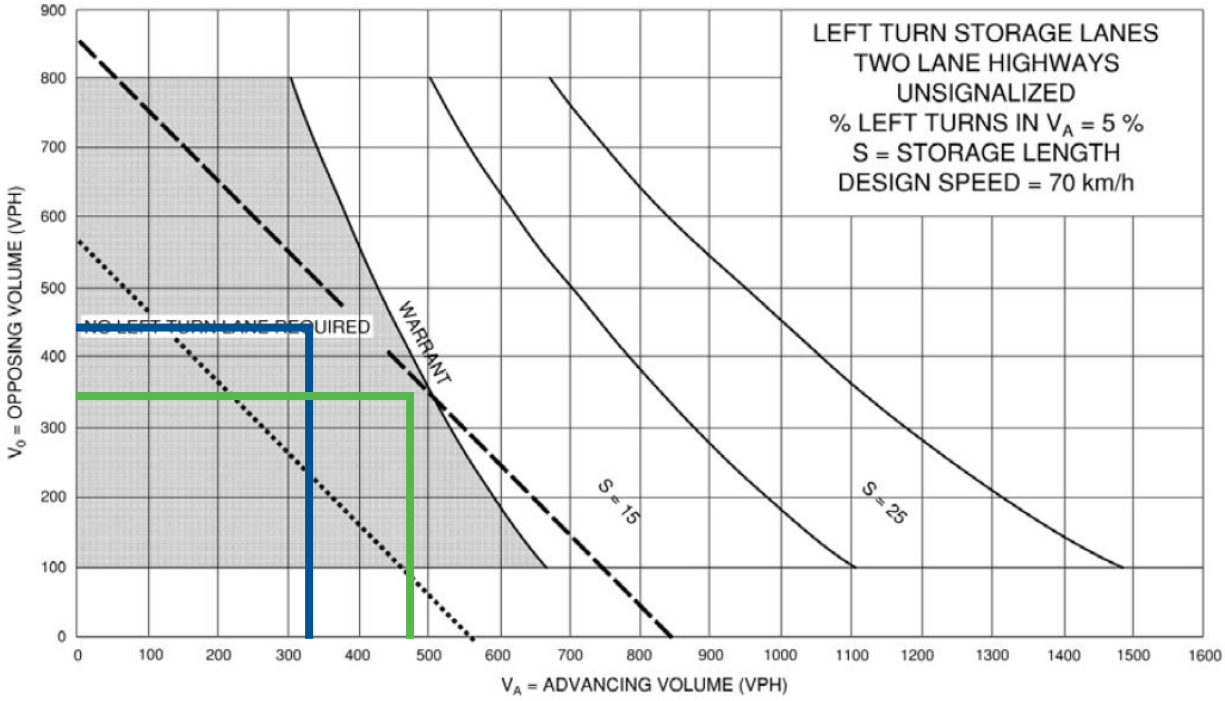
Left-Turn Lane Warrants



AM Peak Hour PM Peak Hour

paradigm TRANSPORTATION SOLUTIONS LIMITED

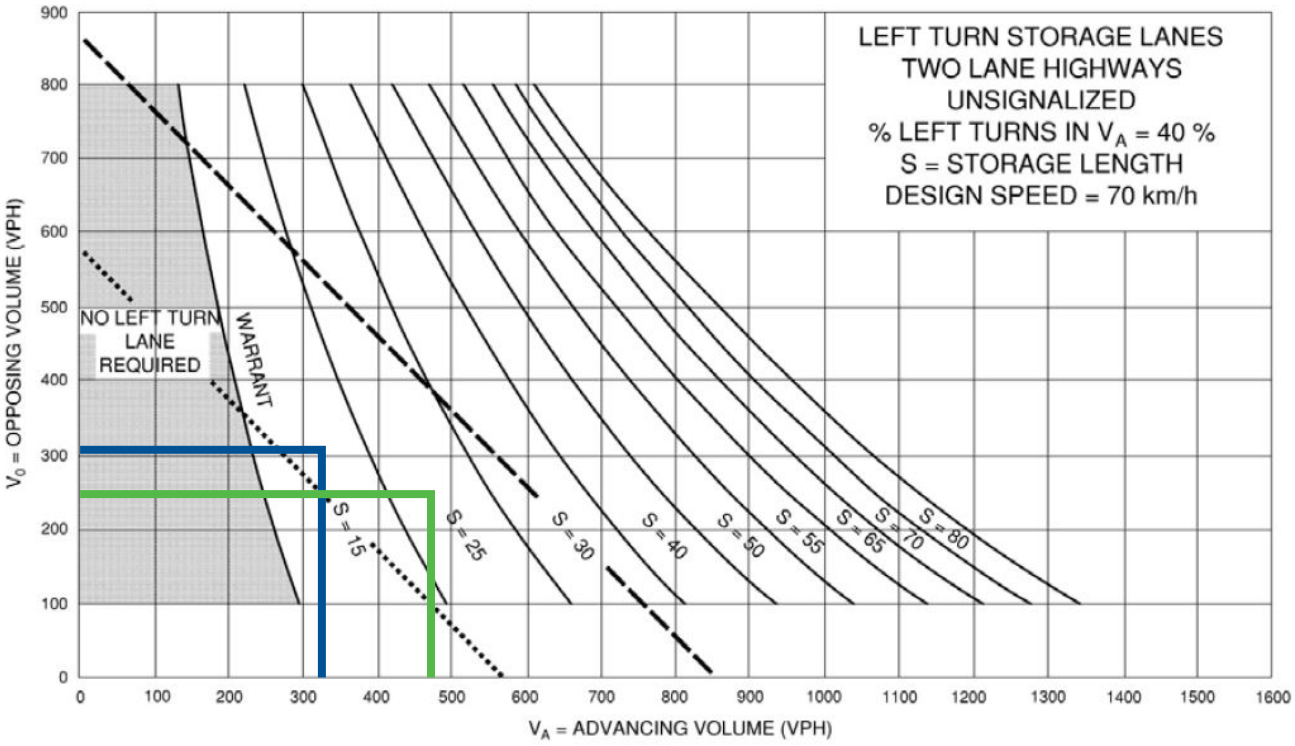
Location: North Service Road & Winston Road
Direction: Eastbound
Horizon Year: 2034 Total Traffic



AM Peak Hour PM Peak Hour

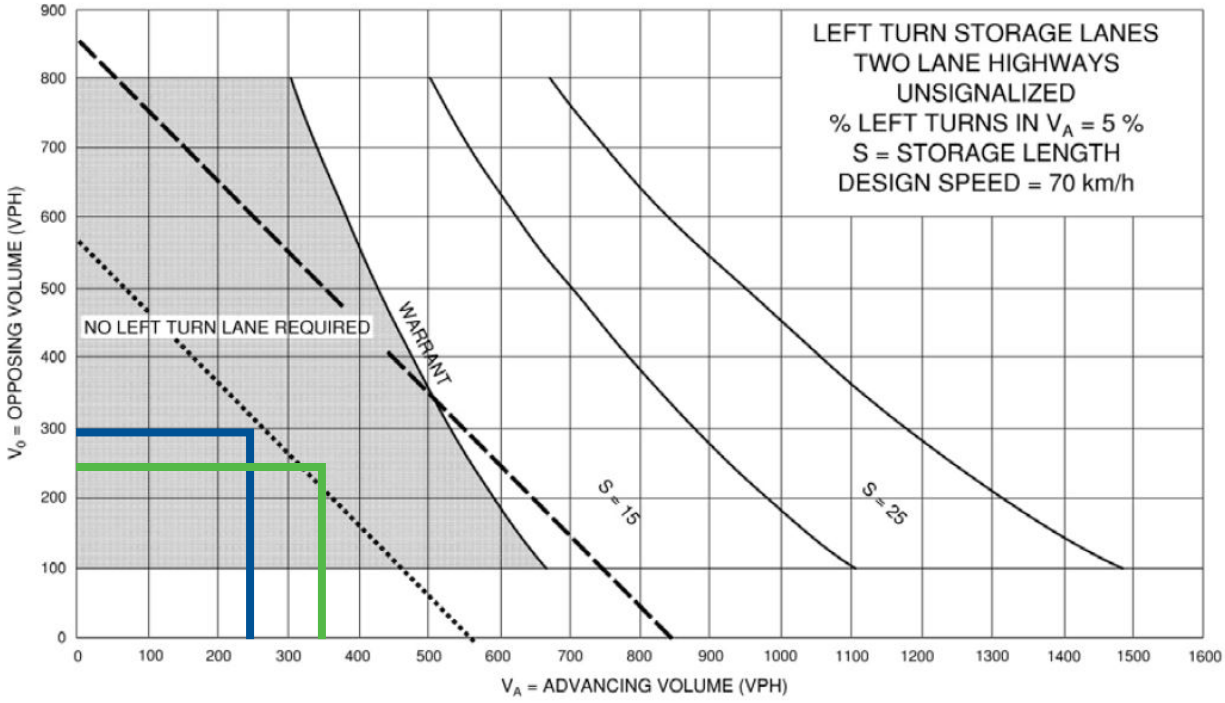
paradigm TRANSPORTATION SOLUTIONS LIMITED

Location: North Service Road & Driveway A
Direction: Eastbound
Horizon Year: 2034 Total Traffic



AM Peak Hour PM Peak Hour

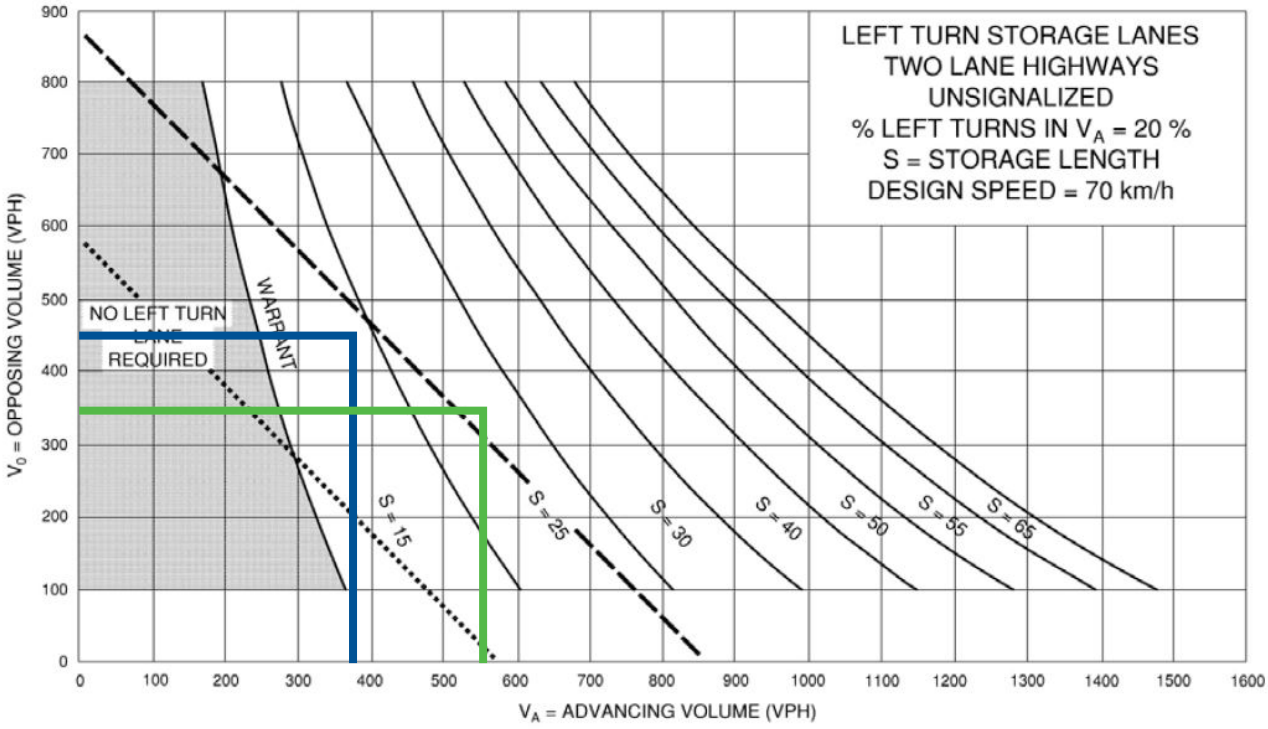
Location: North Service Road & Driveway B
Direction: Eastbound
Horizon Year: 2034 Total Traffic



AM Peak Hour PM Peak Hour

paradigm TRANSPORTATION SOLUTIONS LIMITED

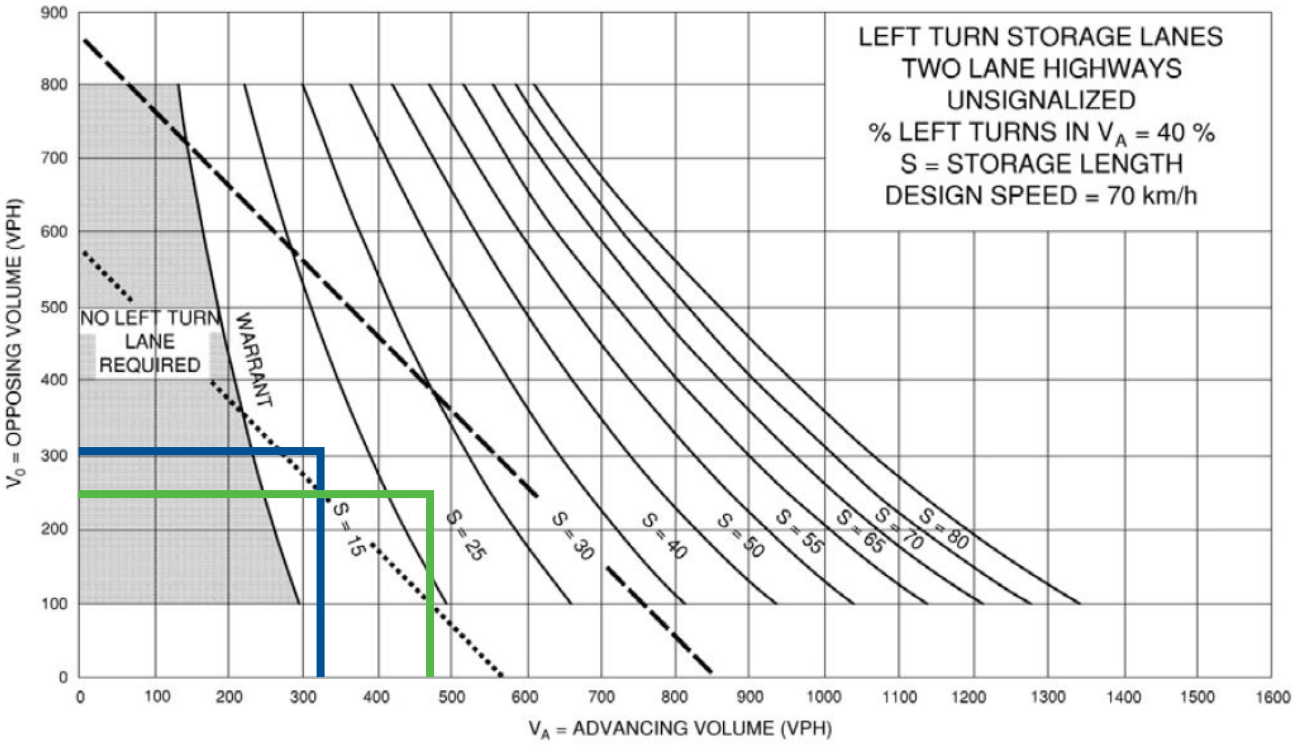
Location: North Service Road & Driveway C
Direction: Eastbound
Horizon Year: 2034 Total Traffic



AM Peak Hour PM Peak Hour

Sensitivity Analysis – Driveway A & C Right-In/Right-Out

Location: North Service Road & Winston Road
Direction: Eastbound
Horizon Year: 2034 Total Traffic – Reduced Access



AM Peak Hour PM Peak Hour

Sensitivity Analysis – Driveway A & C Right-In/Right-Out

Location: North Service Road & Driveway B
Direction: Eastbound
Horizon Year: 2034 Total Traffic – Reduced Access