224 Ardagh Road
Proposed Mixed-Use Development
Traffic Brief

Paradigm Transportation Solutions Limited

May 2019

Project Summary

Project Number
180047

May 2019

Client
2596843 Ontario Inc.
c/o Marshall Smith, BES, PMP
KLM Planning Partners Inc.
64 Jardin Drive, Unit 18
Concord ON L4K 3P3

Client Contact
Marshall Smith, BES, PMP

Consultant Project Team
Adrian Soo, P.Eng
Heather Goodman, B.Eng., EIT, MITE

Paradigm Transportation Solutions Limited
5A-150 Pinebush Road
Cambridge ON N1R 8J8
p: 416.476.9684
www.ptsl.com

224 Ardagh Road
Proposed Mixed-Use Development
Traffic Brief

Signatures

Adrian Soo

Signature

Disclaimer

Executive Summary

Content

2596843 Ontario Inc. retained Paradigm Transportation Solutions Limited (Paradigm) to conduct a Traffic Brief for a proposed mixed-use residential and commercial development at 224 Ardagh Road in the City of Barrie.

This study includes an analysis of existing traffic conditions, a description of the proposed development, traffic forecasts for an opening year (2020) and a horizon of five years from full build-out (2025), an assessment of the adequacy of the proposed parking supply, and recommendations for any required roadway improvements to accommodate the future traffic conditions.

Development Concept

The proposed mixed-use development is located on the northwest corner of the intersection of Ardagh Road and Ferndale Drive South. The existing site consists of a surface parking lot and empty green space. The parking lot will be removed to accommodate the proposed development.

The proposed 1.08 hectare (2.67 acre) development comprises a six-storey mixed-use building with 292 square metres (3,143 square feet) of ground floor commercial/retail and 50 residential units within a five-storey tower, and the provision of 31 three-storey townhouse units.

The development will be constructed in a single phase and is expected to be completed in 2020. Vehicular site access is planned via two private street connections:

- **Street A** connection to Ardagh Road, approximately 100 metres west of Ferndale Drive; and
- **Street B** connection to Ferndale Drive, approximately 45 metres north of Ardagh Road.

Both street connections are planned to be stop-controlled, allowing all turns access to and from the City's road network.

Conclusions

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

Existing Transportation Conditions

Under existing traffic conditions, all study area intersections currently operate at acceptable levels of service and within capacity during the weekday AM and PM peak hours. No critical movements have been identified.

Future Transportation Conditions

For the 2020 and 20025 future conditions, all intersections and movements within the study area are forecast to operate at acceptable levels of service and within capacity during the weekday AM and PM peak hours. The proposed development can be accommodated by the existing transportation road network.

Site Access and Circulation

Left turn lanes were determined to be not warranted on Ardagh Road at Street A or on Ferndale Drive at Street B.

Minimum stopping and decision sight distance criteria are found to meet or exceed thresholds in both directions along Ardagh Road and Ferndale Street at Street A and Street B, respectively.

Passenger cars and snowplows would be able to traverse and circulate on-site and access the loading area without any issues. A heavy single unit (HSU) truck (similar to a garbage truck) would be able to navigate and circulate the site without conflict.

Parking

The City of Barrie Zoning By-law 2009-141 (the Zoning By-law) requires the provision of 132 parking spaces for the proposed development - 47 for the townhouse units (1.5 spaces per unit), 75 for the condominium units (1.5 spaces per unit) and 10 for the ground floor commercial/retail space (1 space per 30 m^2 GFA). Five (5) spaces are required to be barrier free.

The proposed parking supply of 156 spaces - 62 for the townhouse units, 8 for townhouse visitors, 76 for the condominium units and 10 for the commercial floor space satisfies the Zoning By-law requirements, resulting with a surplus of 24 spaces. Six (6) barrier free parking spaces are included in the proposed parking supply meeting the requirements outlined in the Zoning By-law.

Recommendations

Based on the findings of this study, it is recommended the City of Barrie recognise the conclusions drawn above and that the development be approved as proposed with no conditions related to off-site transportation improvements.

Contents

Appendices

Figures

Tables

1 Introduction

1.1 Overview

2596843 Ontario Inc. retained Paradigm Transportation Solutions Limited (Paradigm) to conduct a Traffic Brief for a proposed mixed-use residential and commercial development at 224 Ardagh Road in the City of Barrie. **Figure 1.1** illustrates the location of the proposed development.

The subject lands are proposed to be developed as a six-storey mixed-use building with 292 square metres (3,143 square feet) of ground floor commercial/retail and 50 residential units within a five-storey tower, and the provision of 31 three-storey townhouse units.

1.2 Purpose and Scope

The purpose of this report is to identify and assess the potential traffic and parking impacts resulting from the proposed development. The scope of the study, developed in consultation with the City of Barrie via e-mail in March 2018, includes:

- A determination and assessment of the current traffic and conditions near the existing site;
- A forecast of traffic volumes generated by the proposed development;
- A traffic impact assessment (with and without the proposed development for the opening horizon and five-years post full build-out) on the adjacent intersections of:
  - Ardagh Road and Ferndale Drive (signalized); and
  - The proposed Street A and Street B connections to Ardagh Road and Ferndale Drive, respectively (assumed Stop-controlled).
- An assessment of the site access and on-site circulation;
- An assessment of projected parking demand and the adequacy of the proposed parking supply to serve the anticipated demand; and
- Recommendations regarding any necessary remedial measures required to accommodate the traffic and parking demands in a satisfactory manner.

The traffic analysis for this report has been completed following the Traffic Impact Study Guidelines for the City of Barrie[1]. Consistent with these guidelines, the study assesses the traffic conditions corresponding to the

[1] City of Barrie. *Urban Design Manual, Appendix 2 – Transportation Impact Study Requirements.* October 2014.

2020 (assumed opening year of the development) and 2025 horizon (five years beyond build-out).

Appendix A contains the City-approved study terms of reference and comments.

Study Area and Subject Development

2 Existing Transportation Conditions

2.1 Road Network

The following describes the characteristics of the roadways in the study area. Reference was made to the City of Barrie Official Plan[2].

- **Ardagh Road** is an east-west arterial roadway with a four-lane urban cross-section and a posted speed limit of 50 km/h. Sidewalks and designated cycling lanes are provided on both sides of Ardagh Road.
- **Ferndale Drive South** is a north-south arterial roadway with a four-lane urban cross-section and a posted speed limit of 50 km/h. Sidewalks are provided on both sides of Ferndale Drive South.

Adjacent land uses in the study area are predominately residential to the north, south, east and west, two small commercial plazas are located in the northeast and southeast quadrants of the Ardagh Road and Ferndale Drive intersection, and a fire station is located immediately west of the subject site.

Figure 2.1 shows the existing lane configuration and traffic control devices in the study area. The intersection of Ardagh Road and Ferndale Drive South operates under traffic signal control.

2.2 Transit Network

Barrie Transit is the public transit operator for the City of Barrie and operates two (2) routes within the study area:

- **Route 2 Dunlop/Park Place** travels from Park Place to the Downtown Barrie Terminal with major stops at Veterans Drive with Essa Road and at Dunlop Street with Ferndale Drive. Daytime service runs from 6:00 AM Monday to Friday, and 7:00 AM Saturday, to 10:30 PM on 30-minute headways. Evening service runs from 6:30 PM to 10:30 PM Monday to Saturday on 60-minute headways. On Sundays, service operates from 9:00 AM to 9:00 PM on 60-minute headways[3].
- **Route 7 Bell Farm/Bear Creek** travels from Park Place to Rose Street at Duckworth Street (Georgian College) with major stops at Holly Community Centre, Saint Joan of Arc High School, Ardagh Road at Ferndale Drive, Allandale Waterfront Station, Downtown Barrie Terminal, Grove at St. Vincent, and Barrie View Drive (Wal-Mart). Daytime service runs from 5:25 AM Monday to Friday, and 6:55 AM Saturday, to 7:25 PM on 30-minute headways. Evening service runs from 6:25 PM to

[2] The City of Barrie. *The City of Barrie Official Plan, Schedule "D" Road Plan.* January 2017.
[3] Barrie Transit. *Route 2 Schedule.* 08 July 2018.

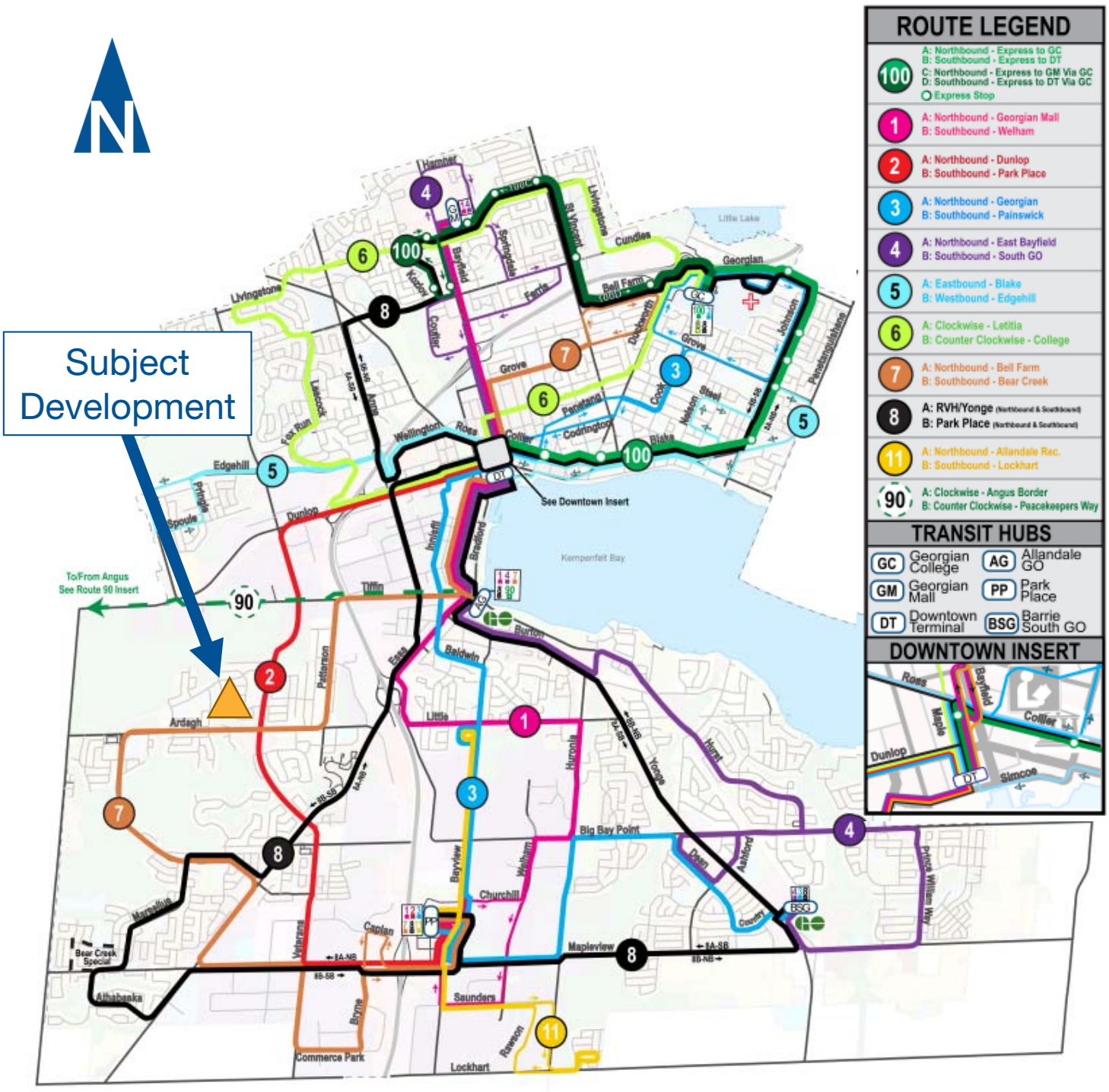
11:25 PM Monday to Saturday on 60-minute headways. On Sundays, service operates from 9:25 AM to 9:25 PM on 60-minute headways[4].

Transit stops for both routes are located within close walking distance to the site at the intersection of Ardagh Road and Ferndale Drive.

Figure 2.2 shows the existing transit network servicing the proposed development.

[4] Barrie Transit. *Route 7 Schedule.*

Existing Lane Configuration and Traffic Control



Source: Barrie Transit. *Barrie Transit System Map.* 21 March 2019.

paradigm TRANSPORTATION SOLUTIONS LIMITED

Existing Transit Network

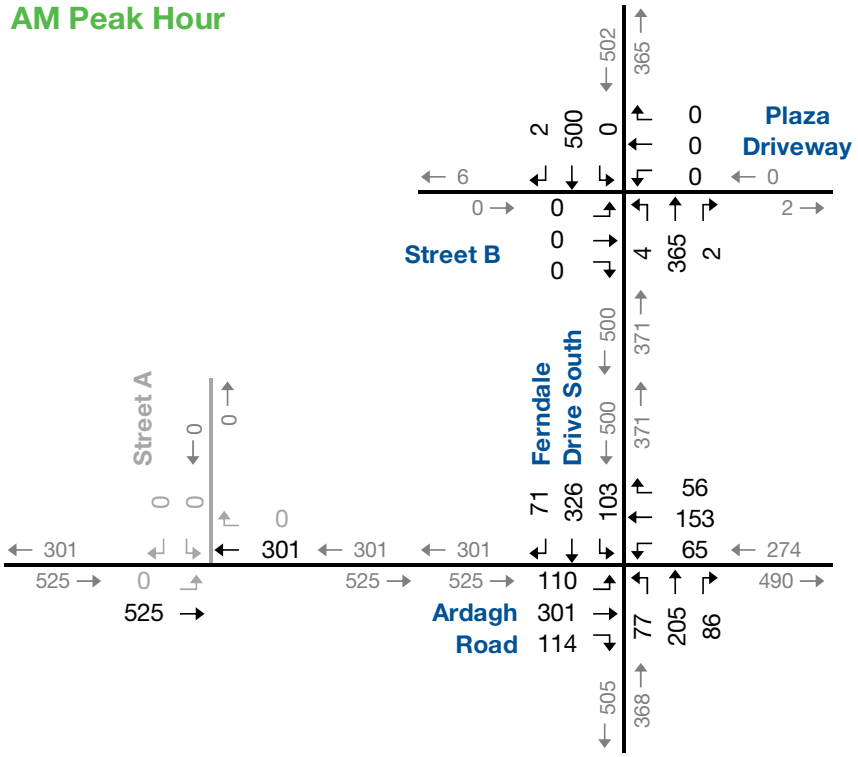
2.3 Traffic Volumes

Paradigm conducted turning movement counts at the study area intersections on Wednesday, March 7, 2018 during the morning (6:00 to 9:00 AM) and afternoon (3:00 to 6:00 PM) peak periods using Miovision Scout video collection units (VCUs). All traffic movements, including pedestrian crossings, were counted in 15-minute intervals, with vehicles classified by type.

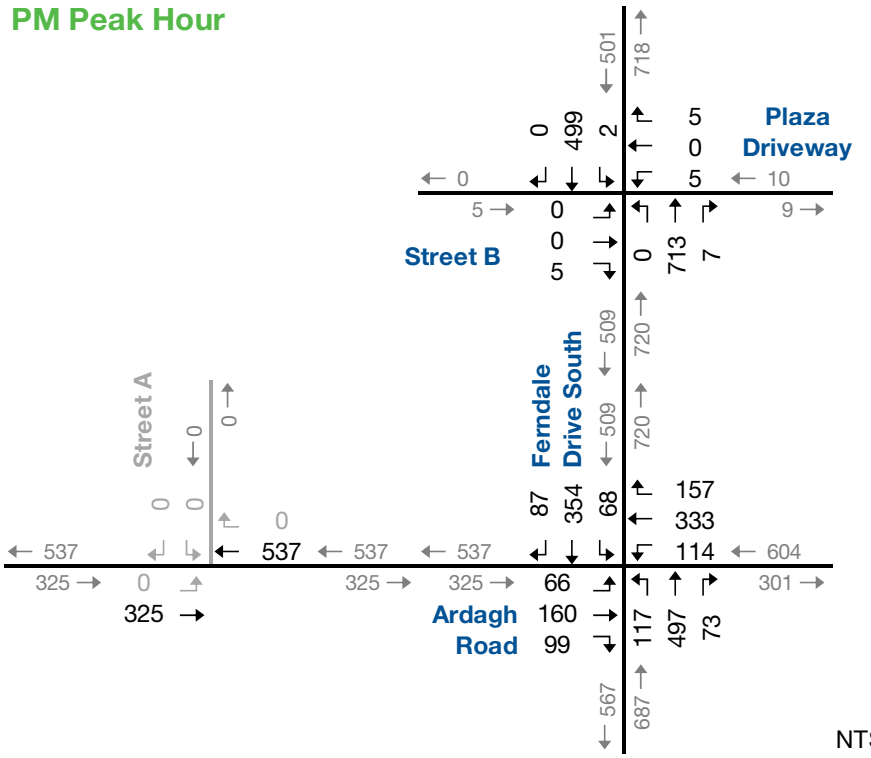
A growth rate of 2% per annum compounded was applied to all intersection volumes to adjust the counts to base year 2019 conditions. This growth rate was confirmed with the City of Barrie during pre-study consultation.

Figure 2.3 summarizes the base year (2019) AM (7:30 to 8:30) and PM (4:30 to 5:30) peak hour traffic volumes. Network traffic volumes were balanced between intersections. **Appendix B** contains the detailed count data for reference.

AM Peak Hour



PM Peak Hour



NTS

Base Year (2019) Traffic Volumes

2.4 Traffic Operations

Intersection level of service (LOS) is a recognized method of quantifying the delay experienced by drivers at intersections. The term "Level of Service" denotes how well a traffic movement operates under given traffic demands, lane arrangements, and traffic controls. Each level is determined by the average amount of control delay per vehicle. Control delay is the total delay associated with stopping for a signal or Stop sign, and includes four components: deceleration delay, stopped delay, queue move up time and final acceleration delay.

Table 2.1 contains the level of service criteria for signalized and stop-controlled intersections from the Highway Capacity Manual (HCM). LOS A indicates small average control delays (less than 10 second per vehicle), while LOS F indicates intersection failure, which results in extensive vehicular queues and long delays (over 50 seconds per vehicle at an unsignalized intersection, and over 80 seconds per vehicle at a signalized intersection). LOS D is typically considered acceptable peak-hour performance in an urban setting. Lower LOS values are tolerable for short periods during peak hours when heavier traffic volumes are expected.

TABLE 2.1: VEHICLE LEVEL OF SERVICE DEFINITIONS

Level of Service	Signalized Intersections Average Total Delay (sec/veh)	Unsignalized Intersections Average Total Delay (sec/veh)
A	< = 10	< = 10
B	> 10 & < = 20	> 10 & < = 15
C	> 20 & < = 35	> 15 & < = 25
D	> 35 & < = 55	> 25 & < = 35
E	> 55 & < = 80	> 35 & < = 50
F	> 80	> 50

The City of Barrie Urban Design Manual[5] defines critical movements or intersections as follows:

- An intersection where the overall volume to capacity (v/c) ratio exceeds 0.85 in urban areas or 0.70 in rural areas;
- An individual movement v/c ratio that exceeds 0.85 in urban areas or 0.70 in rural areas; or
- An exclusive turning movement with queues that exceed available storage.

To assess the existing peak hour operating conditions, a level of service analysis has been conducted using Synchro 9 software, which implements

[5] City of Barrie. *Urban Design Manual, Appendix 2 – Transportation Impact Study Requirements.* October 2014.

the methods of the Highway Capacity Manual (HCM). The following parameters have been utilized in the analysis:

- Existing lane configurations;
- Speed limits as posted in the field;
- Heavy vehicle percentages as derived from the existing turning movement counts;
- Calculated intersection peak hour factors (PHF);
- Existing signal timings as provided by the City of Barrie; and
- Synchro default values for all other inputs.

The operational analysis considered three separate measures of performance for each turning movement and approach, and the intersections as a whole:

- LOS;
- Delay;
- Volume to capacity (v/c) ratio; and
- 95th percentile queue lengths.

Appendix B includes the City of Barrie provided signal timings.

Table 2.2 summarizes the results of existing intersection operations in the study area, highlighting LOS, v/c ratios and 95th percentile queues experienced during the AM and PM peak hours. All intersection movements currently operate at acceptable levels of service and within capacity. It is noted that no critical movements are identified in the analysis.

Appendix C provides the detailed Synchro 9 reports.

TABLE 2.2: BASE YEAR (2019) PEAK HOUR TRAFFIC OPERATIONS SUMMARY

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	1 - Ardagh Road & Ferndale Drive South	TCS	LOS	C	D	C	C	C	C	C	C	B	B	>	B	B	C	>	B	C
			Delay	24	36	26	30	24	32	27	29	13	18	>	17	15	20	>	19	24
			V/C	0.45	0.71	0.13		0.27	0.53	0.04		0.28	0.22	>		0.22	0.34	>		0.47
			Q	24	84	0		17	40	0		16	28	>		22	45	>		
			Storage	-	-	-		-	-	50		35	-	>		40	-	>		
			Avail.	-	-	-		-	-	50		20	-	-		18	-	>		
	2 - Ferndale Drive South & Parking Lot/ Commerical Plaza	TWSC	LOS	<	A	>	A	<	A	>	A	<	A	>	A	<	A	>	A	A
			Delay	<	0	>	0	<	0	>	0	<	0	>	0	<	0	>	0	0
			V/C	<	0.00	>		<	0.00	>		<	0.12	>		<	0.16	>		
			Q	<	0	>		<	0	>		<	0	>		<	0	>		
PM Peak Hour	1 - Ardagh Road & Ferndale Drive South	TCS	LOS	C	C	C	C	C	D	C	C	B	C	>	B	B	C	>	B	C
			Delay	25	30	27	28	22	37	26	31	14	21	>	19	15	21	>	20	24
			V/C	0.36	0.42	0.07		0.32	0.74	0.11		0.35	0.45	>		0.20	0.35	>		0.54
			Q	16	45	10		27	92	14		24	69	>		15	50	>		
			Storage	-	-	-		-	-	50		35	-	>		40	-	>		
			Avail.	-	-	-		-	-	36		11	-	-		25	-	>		
	2 - Ferndale Drive South & Parking Lot/ Commerical Plaza	TWSC	LOS	<	A	>	A	<	B	>	B	<	A	>	A	<	A	>	A	A
			Delay	<	10	>	10	<	15	>	15	<	0	>	0	<	0	>	0	0
			V/C	<	0.01	>		<	0.03	>		<	0.23	>		<	0.16	>		
			Q	<	0	>		<	1	>		<	0	>		<	0	>		

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

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

TCS - Traffic Control Signal
TWSC - Two-Way Stop Control
> - Shared Right-Turn Lane

< - Shared Left-Turn Lane

3 Development Concept

3.1 Development Description

The proposed mixed-use development is located on the northwest corner of the intersection of Ardagh Road and Ferndale Drive South. The existing site consists of a surface parking lot and empty green space. The parking lot will be removed to accommodate the proposed development.

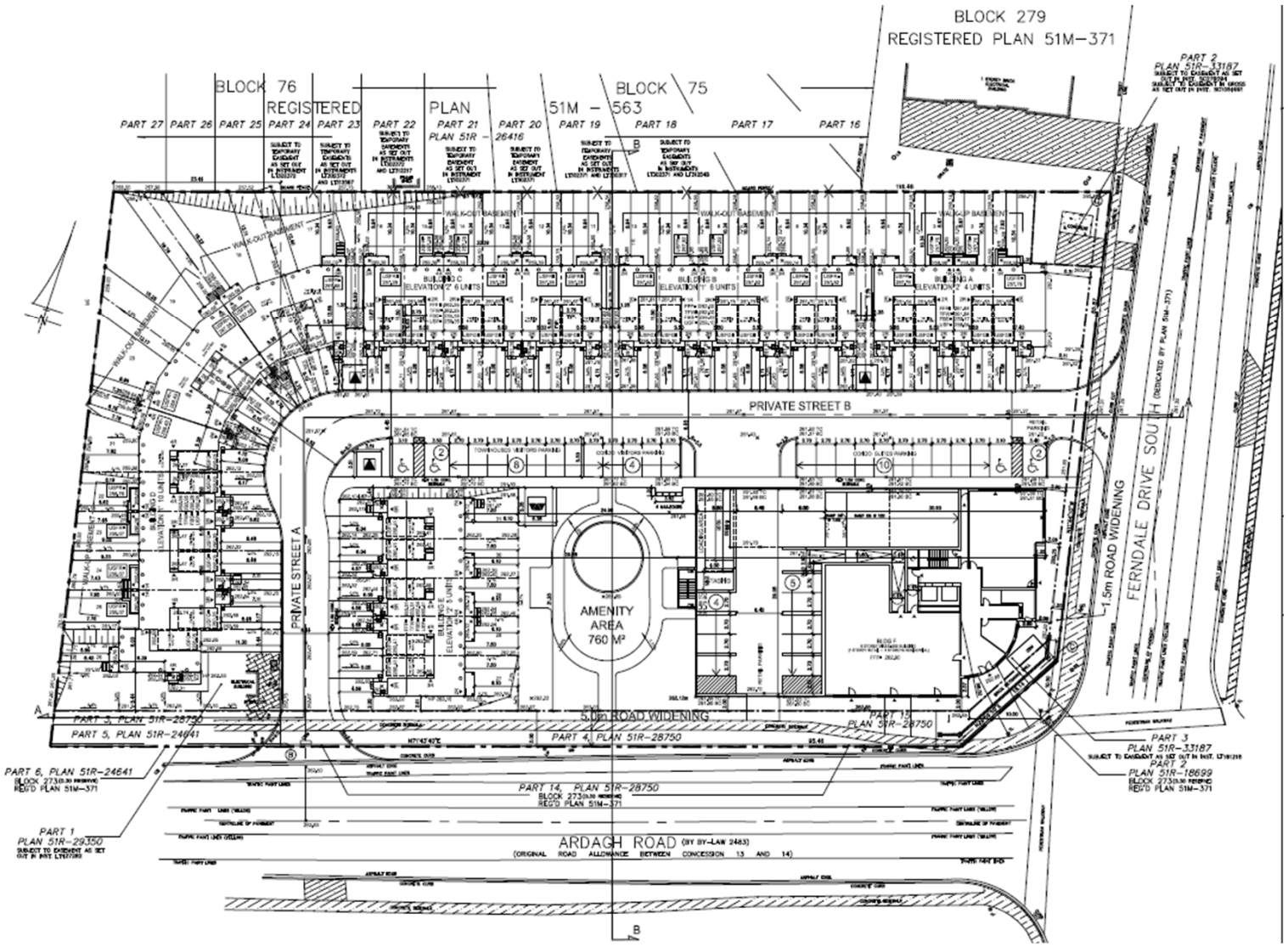
The proposed 1.08 hectare (2.67 acre) development comprises a six-storey mixed-use building with 292 square metres (3,143 square feet) of ground floor commercial/retail and 50 residential units within a five storey tower, and the provision of 31 three-storey townhouse units.

The development will be constructed in a single phase and is expected to be completed in 2020. Vehicular site access is planned via two private street connections:

- **Street A** connection to Ardagh Road, approximately 100 metres west of Ferndale Drive; and
- **Street B** connection to Ferndale Drive, approximately 45 metres north of Ardagh Road.

Both street connections are planned to be stop-controlled, allowing all turns access to and from the City's road network.

Figure 3.1 shows the development concept site plan.



paradigm TRANSPORTATION SOLUTIONS LIMITED

Development Concept Site Plan

3.2 Development Trip Generation

Trip generation data obtained from the Institute of Transportation Engineers (ITE) Trip Generation Manual (10th Edition)[6] (the ITE Manual) was used to estimate the weekday AM and PM peak hour site generated automobile trips for the proposed development of the subject lands. The following Land Use Codes (LUC) were utilized:

- **LUC 220 – Multifamily Housing (Low Rise)**: Includes apartments, townhouses, and condominiums located within the same building with at least three other dwelling units and that have one or two levels (floors).
- **LUC 221 – Multifamily House (Mid-Rise)**: Includes apartments, townhouses, and condominiums located within the same building with at least three other dwelling units and that have between three and 10 levels (floors).
- **LUC 820 – Shopping Centre**: Integrated group of commercial establishments that is planned, developed, owned and managed as a unit. The composition is related to its market area in terms of size, location and type of store. Provides on-site parking facilities adequate to serve its parking demands. Average rates were applied for the retail commercial component since all criteria for use of the equations were not met.

Table 3.1 summarizes the forecast trip generation for the subject lands. The proposed development is expected to generate 36 AM peak hour trips and 56 PM peak hour trips upon build out.

[6] Institute of Transportation Engineers. *Trip Generation Manual, 10th Edition*. 2017.

TABLE 3.1: DEVELOPMENT TRIP GENERATION

Land Use	Unit of Measure	Units/ GFA	AM Peak Hour				PM Peak Hour			
			Rate	In	Out	Total	Rate	In	Out	Total
LUC 220 - Multifamily Housing (Low-Rise)	31	Units	FCE[1]	4	12	**16**	FCE[2]	13	8	**21**
LUC 221 - Multifamily Housing (Mid-Rise)	50	Units	FCE[3]	4	13	**17**	FCE[4]	14	9	**23**
LUC 820 - Shopping Centre	3,143	GFA	0.94	2	1	**3**	3.81	6	6	**12**
		Total		**10**	**26**	**36**		**33**	**23**	**56**

[1] Ln(T) = 0.95 Ln(X) - 0.51

[2] Ln(T) = 0.89 Ln(X) - 0.02

[3] Ln(T) = 0.98 Ln(X) - 0.98

[4] Ln(T) = 0.96 Ln(X) - 0.63

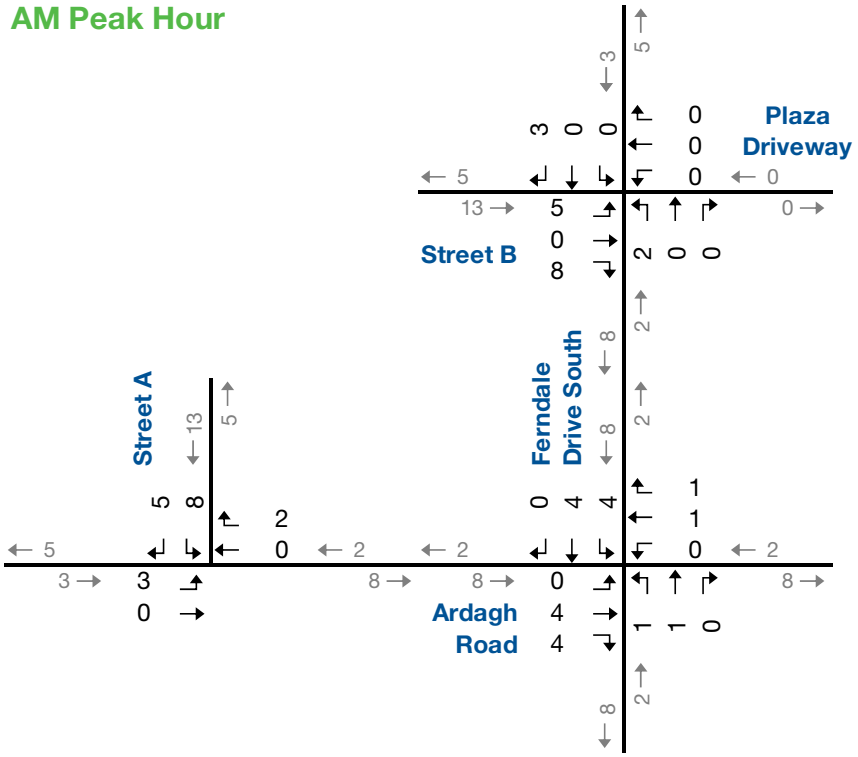
3.3 Development Trip Distribution and Assignment

The site trips generated by the development were assigned to the adjacent roadway network based on existing traffic patterns and logical routing to/from the site location. **Table 3.2** shows the resulting trip distribution. **Figure 3.2** illustrates the trip assignment for the development during the AM and PM peak hours.

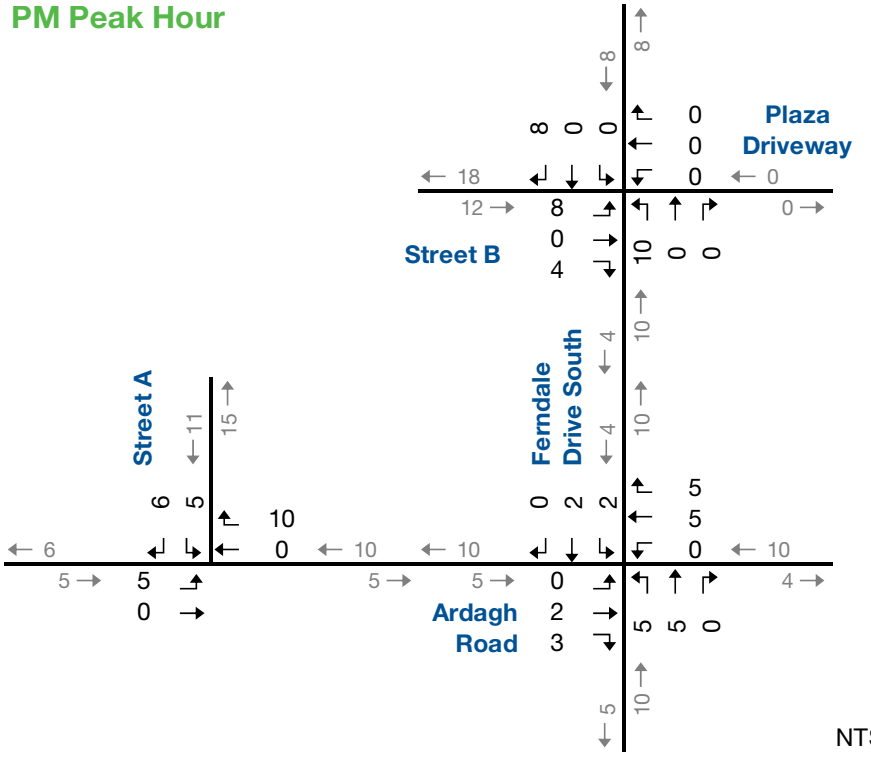
TABLE 3.2: TRIP DISTRIBUTION

Origin/Destination	AM Peak Hour		PM Peak Hour	
	IN	OUT	IN	OUT
North via Ferndale Drive South	30%	20%	25%	35%
South via Ferndale Drive South	25%	30%	30%	25%
East via Ardagh Road	15%	30%	30%	15%
West via Ardagh Road	30%	20%	15%	25%
Total	**100%**	**100%**	**100%**	**100%**

AM Peak Hour



PM Peak Hour



NTS

4 Future Transportation Conditions

4.1 Overview and Methodology

This chapter documents forecast future traffic conditions and operational issues likely to be experienced by the public travelling on roads within the study area assuming no changes are made to the existing road network.

As with existing conditions, the operational analysis of the study area intersections under forecast future traffic conditions were completed using the same methodology and procedures. No changes were made to traffic signal timings or any other parameters used in the existing conditions review (**Section 2.4**) in performing the analyses unless explicitly stated.

4.2 Assumptions

4.2.1 Horizon Years

Confirmed with the City of Barrie at the outset of the study, the future transportation conditions analysis examines two horizon years, 2020 and 2025, which represent the anticipated opening year and five (5) years following full build-out, respectively.

4.2.2 Background Traffic Growth

Background traffic volumes (non-site) are expected to increase (modestly) over time due to other development within Barrie and the surrounding area. A growth rate of 2% per year compounded annually, as confirmed by the City of Barrie, was applied to the base year peak hour volumes to forecast future year background traffic at study area intersections. This rate reflects typical annual increases within stable communities and, in this context, accounts for the general population and employment growth that may occur outside the study area.

4.2.3 Traffic Growth Due to other Planned Development

City of Barrie indicated there are no planned developments to be included as part of the background traffic forecast.

4.3 2020 Horizon Traffic Conditions

4.3.1 Traffic Forecasts

The 2% per annum growth rate compounded for one year (2% total growth) was applied to existing traffic volumes to derive the 2020 background volumes. **Figure 4.1** shows the background traffic forecasts for the AM and PM peak hours.

The development site traffic forecasts were added to the background volumes to estimate future total traffic. **Figure 4.2** shows the total 2020 traffic volumes for the AM and PM peak hours.

4.3.2 Background Traffic Operations

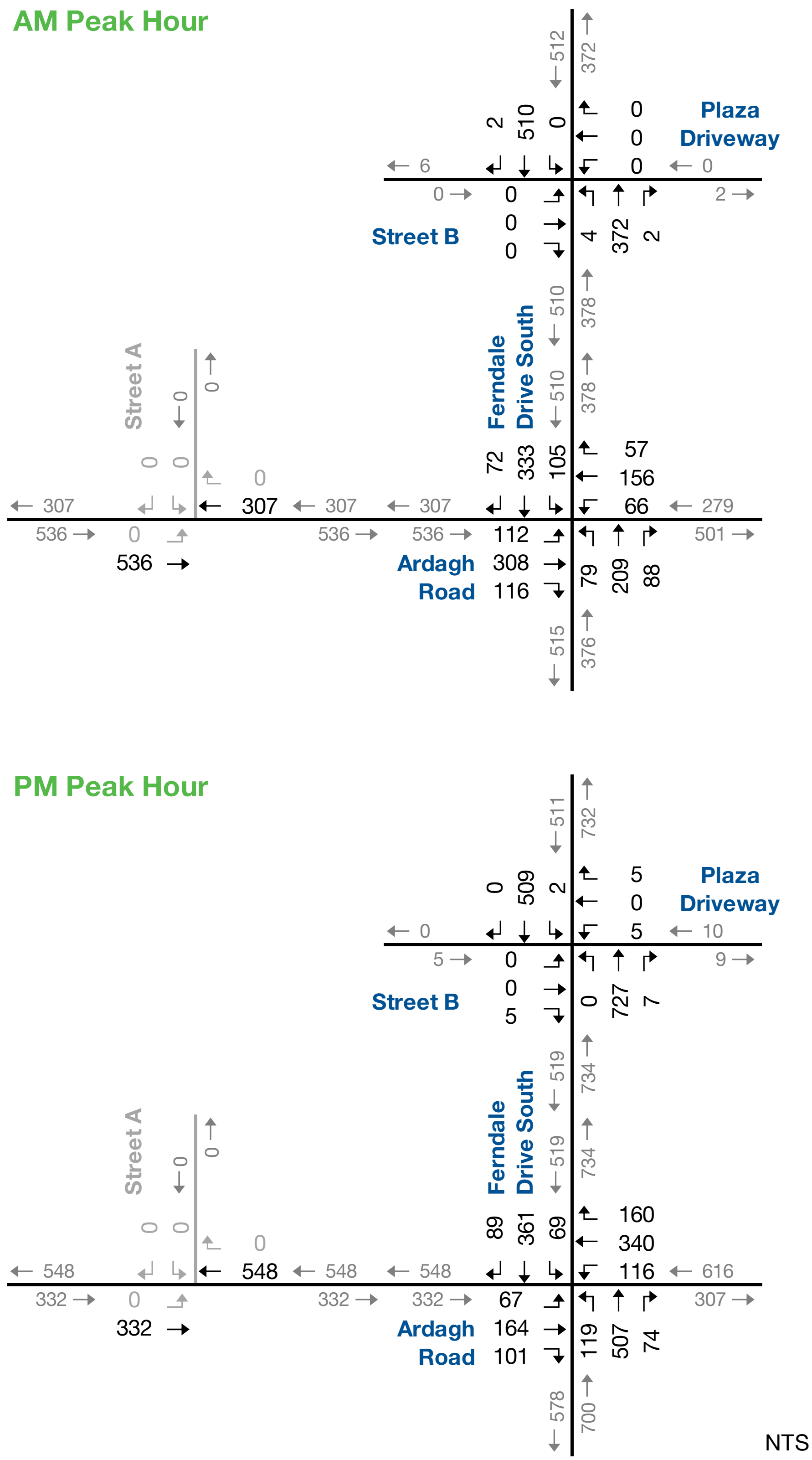
Table 4.1 summarizes the 2020 background traffic operations for the AM and PM peak hours. All intersections and movements within the study area are forecast to continue operating at acceptable levels of service and within capacity under 2020 background traffic conditions.

Appendix D contains the detailed Synchro 9 output reports for reference.

4.3.3 Total Traffic Operations

Table 4.2 summarizes the 2020 total traffic operations for the AM and PM peak hours. All intersections and movements within the study area are forecast to operate at acceptable levels of service and within capacity under 2020 total traffic conditions.

Appendix E contains the detailed Synchro 9 output reports for reference.

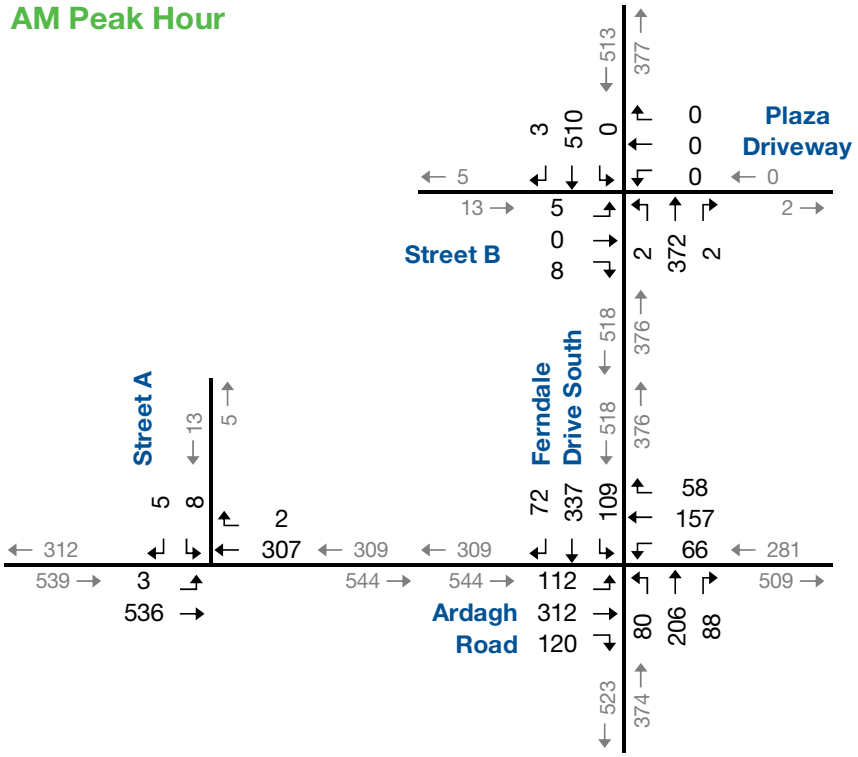


paradigm TRANSPORTATION SOLUTIONS LIMITED

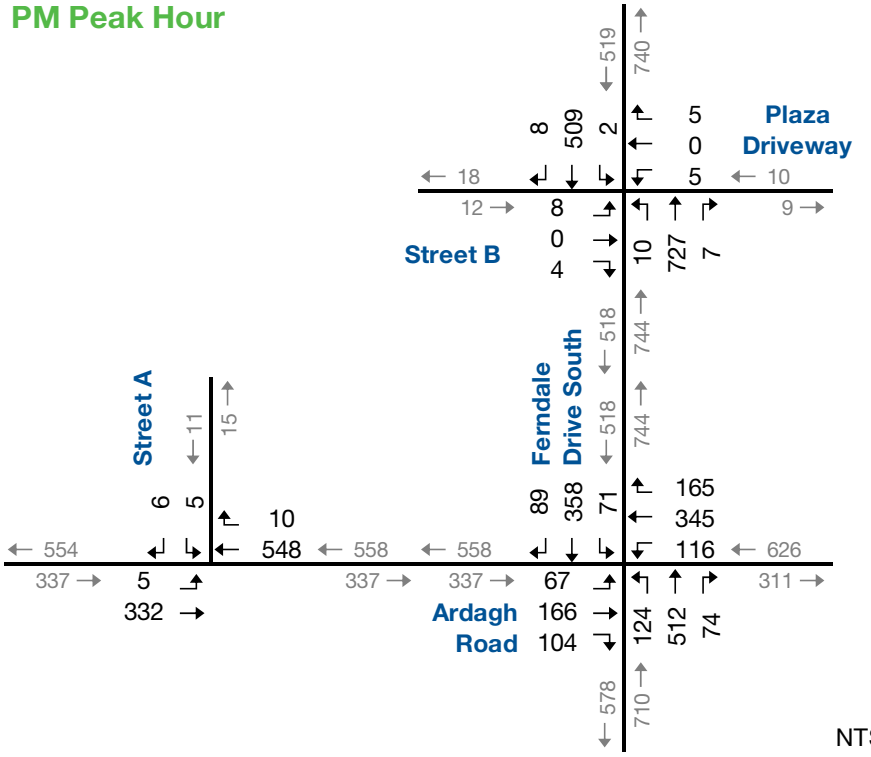
2020 Background Traffic Forecasts

Figure 4.1

AM Peak Hour



PM Peak Hour



NTS

2020 Total Traffic Forecasts

TABLE 4.1: 2020 PEAK HOUR BACKGROUND TRAFFIC OPERATIONS SUMMARY

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	1 - Ardagh Road & Ferndale Drive South	TCS	LOS	C	D	C	C	C	C	C	C	B	B	>	B	B	C	>	B	C
			Delay	24	36	26	30	24	32	27	29	14	18	>	17	15	21	>	19	24
			V/C	0.47	0.72	0.13		0.29	0.54	0.04		0.30	0.23	>		0.23	0.36	>		0.49
			Q	25	87	0		17	42	1		16	29	>		23	47	>		
			Storage	-	-	-		-	-	50		35	-	>		40	-	>		
			Avail.	-	-	-		-	-	49		19	-	-		17	-	>		
	2 - Ferndale Drive South & Parking Lot/ Commerical Plaza	TWSC	LOS	<	A	>	A	<	A	>	A	<	A	>	A	<	A	>	A	A
			Delay	<	0	>	0	<	0	>	0	<	0	>	0	<	0	>	0	0
			V/C	<	0.00	>		<	0.00	>		<	0.12	>		<	0.16	>		
			Q	<	0	>		<	0	>		<	0	>		<	0	>		
PM Peak Hour	1 - Ardagh Road & Ferndale Drive South	TCS	LOS	C	C	C	C	C	D	C	C	B	C	>	B	B	C	>	C	C
			Delay	25	30	27	28	22	37	26	31	14	21	>	20	15	21	>	20	24
			V/C	0.38	0.43	0.07		0.33	0.75	0.12		0.36	0.46	>		0.21	0.36	>		0.55
			Q	16	46	11		27	94	14		24	71	>		16	51	>		
			Storage	-	-	-		-	-	50		35	-	>		40	-	>		
			Avail.	-	-	-		-	-	36		11	-	-		24	-	>		
	2 - Ferndale Drive South & Parking Lot/ Commerical Plaza	TWSC	LOS	<	A	>	A	<	B	>	B	<	A	>	A	<	A	>	A	A
			Delay	<	10	>	10	<	15	>	15	<	0	>	0	<	0	>	0	0
			V/C	<	0.01	>		<	0.03	>		<	0.24	>		<	0.16	>		
			Q	<	0	>		<	1	>		<	0	>		<	0	>		

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

TABLE 4.2: 2020 PEAK HOUR TOTAL TRAFFIC OPERATIONS SUMMARY

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	1 - Ardagh Road & Ferndale Drive South	TCS	LOS	C	D	C	C	C	C	C	C	B	B	>	B	B	C	>	B	C
			Delay	23	36	26	30	24	31	26	29	15	19	>	18	14	21	>	20	24
			V/C	0.46	0.72	0.14		0.29	0.54	0.04		0.31	0.24	>		0.23	0.37	>		0.5
			Q	25	89	0		17	42	1		16	29	>		24	48	>		
			Storage	-	-	-		-	-	50		35	-	>		40	-	>		
			Avail.	-	-	-		-	-	49		19	-	-		16	-	>		
	2 - Ferndale Drive South & Street B/ Commerical Plaza	TWSC	LOS	<	B	>	B	<	A	>	A	<	A	>	A	<	A	>	A	A
			Delay	<	13	>	13	<	0	>	0	<	0	>	0	<	0	>	0	0
			V/C	<	0.03	>		<	0.00	>		<	0.12	>		<	0.16	>		
			Q	<	1	>		<	0	>		<	0	>		<	0	>		
	3 - Ardagh Road & Street A	TWSC	LOS	<	A		A		A	>	A					B		>	B	A
			Delay	<	0		0		0	>	0					12		>	12	0
			V/C	<	0.00				0.20	>						0.02		>		
			Q	<	0				0	>						1		>		
PM Peak Hour	1 - Ardagh Road & Ferndale Drive South	TCS	LOS	C	C	C	C	C	D	C	C	B	C	>	B	B	C	>	C	C
			Delay	25	30	27	28	22	38	26	32	14	21	>	20	15	21	>	20	24
			V/C	0.38	0.43	0.07		0.33	0.76	0.12		0.38	0.46	>		0.22	0.36	>		0.56
			Q	16	46	12		27	96	14		25	71	>		16	50	>		
			Storage	-	-	-		-	-	50		35	-	>		40	-	>		
			Avail.	-	-	-		-	-	36		10	-	-		24	-	>		
	2 - Ferndale Drive South & Street B/ Commerical Plaza	TWSC	LOS	<	C	>	C	<	B	>	B	<	A	>	A	<	A	>	A	A
			Delay	<	16	>	16	<	15	>	15	<	0	>	0	<	0	>	0	0
			V/C	<	0.04	>		<	0.03	>		<	0.24	>		<	0.17	>		
			Q	<	1	>		<	1	>		<	0	>		<	0	>		
	3 - Ardagh Road & Street A	TWSC	LOS	<	A		A		A	>	A					B		>	B	A
			Delay	<	0		0		0	>	0					12		>	12	0
			V/C	<	0.01				0.36	>						0.02		>		
			Q	<	0				0	>						1		>		

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

4.4 2025 Horizon Traffic Conditions

4.4.1 Traffic Forecasts

The 2% per annum compounded growth rate was applied to existing traffic volumes to derive the 2025 background volumes. **Figure 4.3** shows the background traffic forecasts for the AM and PM peak hours.

The development site traffic forecasts were added to the background volumes to estimate future total traffic. **Figure 4.4** shows the total 2025 traffic volumes for the AM and PM peak hours.

4.4.2 Background Traffic Operations

Table 4.3 summarizes the 2025 background traffic operations for the AM and PM peak hours. All intersections and movements within the study area are forecast to continue operating at acceptable levels of service and within capacity under 2025 background traffic conditions.

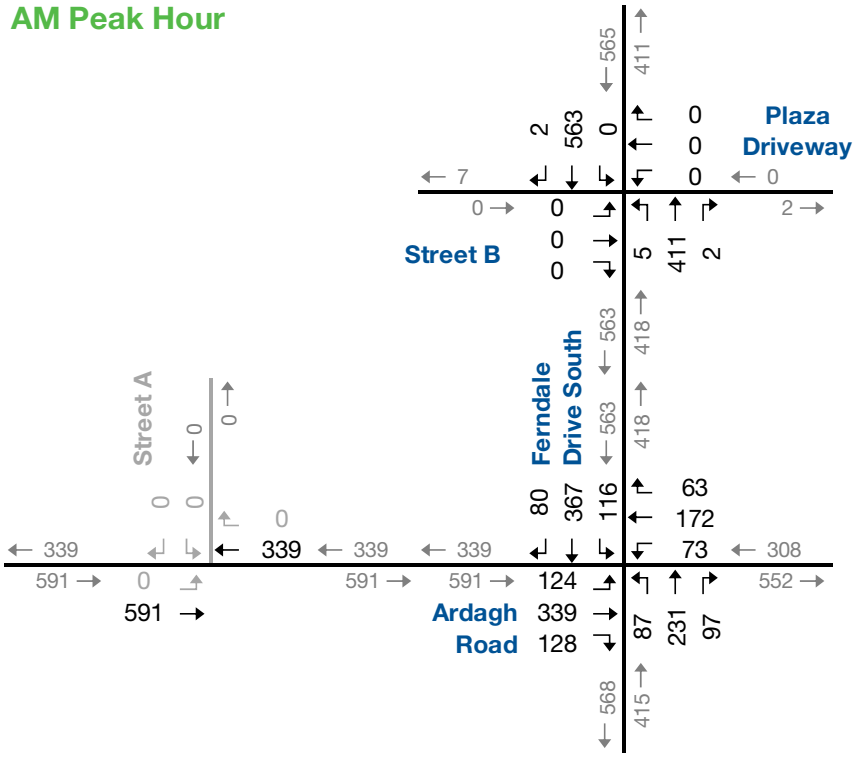
Appendix F contains the detailed Synchro 9 output reports for reference.

4.4.3 Total Traffic Operations

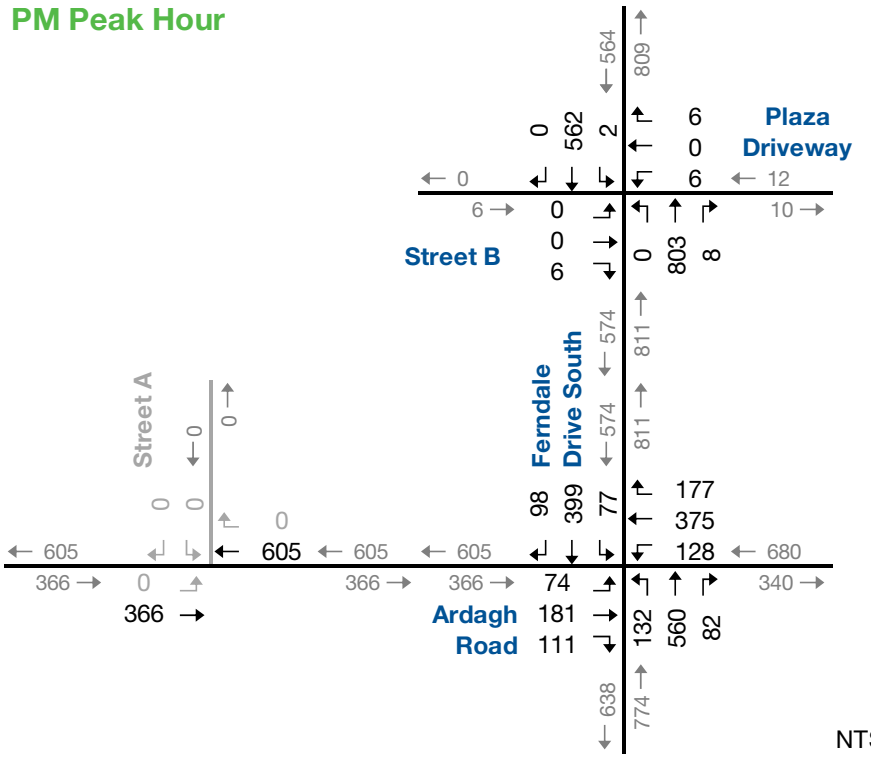
Table 4.4 summarizes the 2025 total traffic operations for the AM and PM peak hours. All intersections and movements within the study area are forecast to continue operating at acceptable levels of service and within capacity under 2025 total traffic conditions.

Appendix G contains the detailed Synchro 9 output reports for reference.

AM Peak Hour



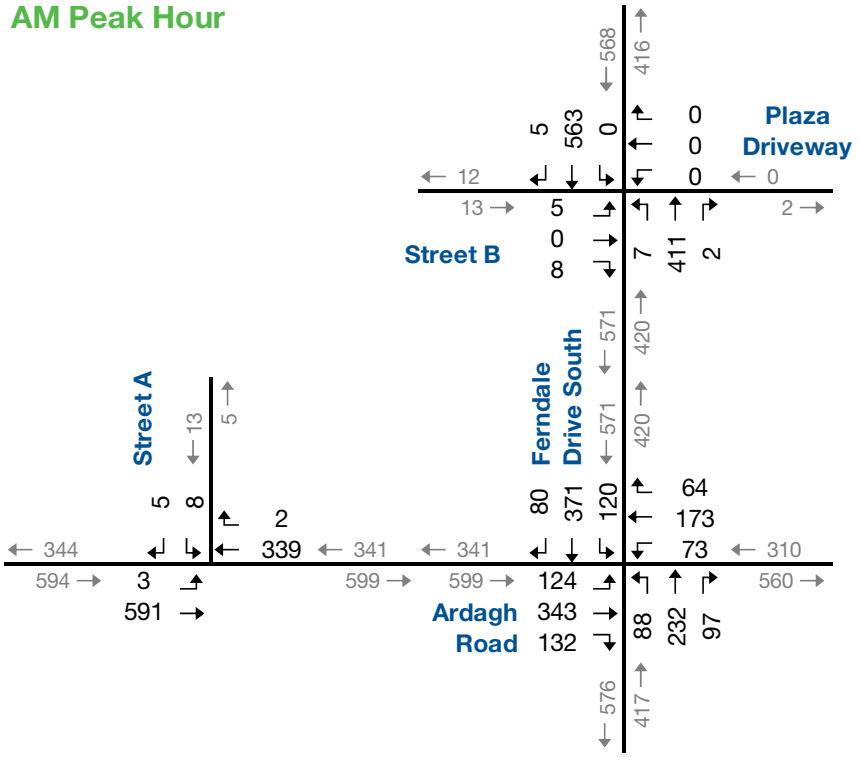
PM Peak Hour



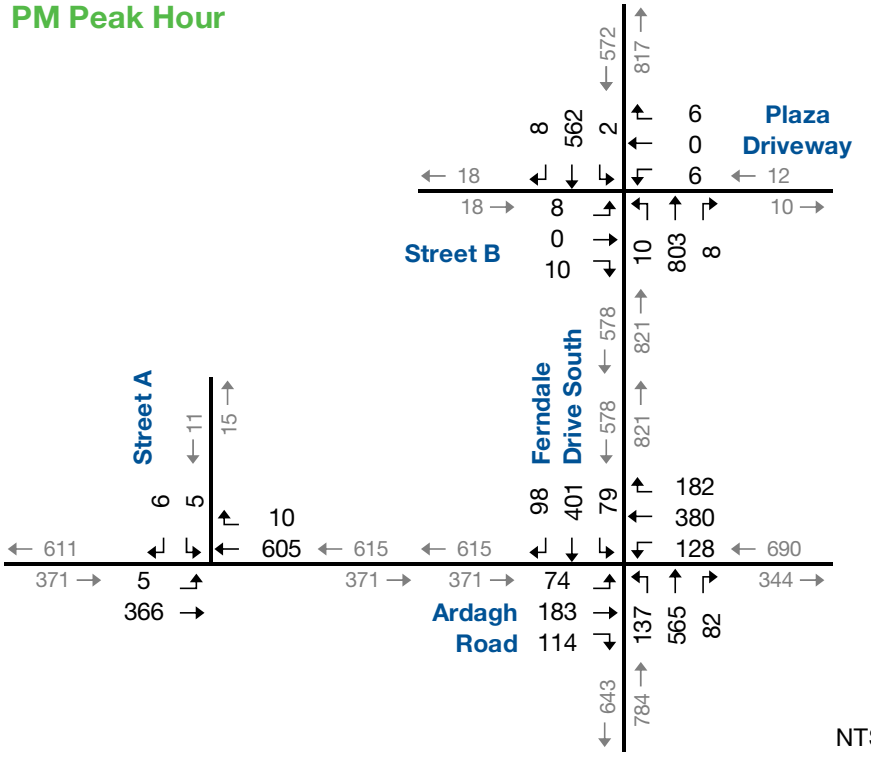
NTS

2025 Background Traffic Forecasts

AM Peak Hour



PM Peak Hour



NTS

2025 Total Traffic Forecasts

TABLE 4.3: 2025 PEAK HOUR BACKGROUND TRAFFIC OPERATIONS SUMMARY

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	1 - Ardagh Road & Ferndale Drive South	TCS	LOS	C	D	C	**C**	C	C	C	**C**	B	C	>	**B**	B	C	>	**C**	**C**
			Delay	24	37	26	**30**	24	31	26	**29**	16	20	>	**19**	15	22	>	**21**	**25**
			V/C	0.52	0.75	0.14		0.33	0.56	0.05		0.36	0.28	>		0.26	0.41	>		**0.54**
			Q	27	98	0		18	45	2		18	33	>		25	53	>		
			Storage	-	-	-		-	-	50		35	-	>		40	-	>		
			Avail.	-	-	-		-	-	48		18	-	-		15	-	>		
	2 - Ferndale Drive South & Parking Lot/ Commerical Plaza	TWSC	LOS	<	A	>	**A**	<	A	>	**A**	<	A	>	**A**	<	A	>	**A**	**A**
			Delay	<	0	>	**0**	<	0	>	**0**	<	0	>	**0**	<	0	>	**0**	**0**
			V/C	<	0.00	>		<	0.00	>		<	0.13	>		<	0.18	>		
			Q	<	0	>		<	0	>		<	0	>		<	0	>		
PM Peak Hour	1 - Ardagh Road & Ferndale Drive South	TCS	LOS	C	C	C	**C**	C	D	C	**C**	B	C	>	**C**	B	C	>	**C**	**C**
			Delay	26	30	26	**28**	22	40	26	**33**	15	23	>	**21**	16	22	>	**21**	**25**
			V/C	0.45	0.45	0.08		0.37	0.79	0.15		0.43	0.51	>		0.26	0.41	>		**0.61**
			Q	18	50	13		29	105	16		26	79	>		17	57	>		
			Storage	-	-	-		-	-	50		35	-	>		40	-	>		
			Avail.	-	-	-		-	-	34		9	-	-		23	-	>		
	2 - Ferndale Drive South & Parking Lot/ Commerical Plaza	TWSC	LOS	<	B	>	**B**	<	C	>	**C**	<	A	>	**A**	<	A	>	**A**	**A**
			Delay	<	10	>	**10**	<	16	>	**16**	<	0	>	**0**	<	0	>	**0**	**0**
			V/C	<	0.01	>		<	0.04	>		<	0.26	>		<	0.18	>		
			Q	<	0	>		<	1	>		<	0	>		<	0	>		

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

TABLE 4.4: 2025 PEAK HOUR TOTAL TRAFFIC OPERATIONS SUMMARY

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	1 - Ardagh Road & Ferndale Drive South	TCS	LOS	C	D	C	**C**	C	C	C	**C**	B	C	>	**B**	B	C	>	**C**	**C**
			Delay	24	37	26	**31**	24	31	26	**29**	16	21	>	**19**	15	22	>	**21**	**25**
			V/C	0.52	0.76	0.15		0.34	0.56	0.05		0.37	0.28	>		0.27	0.41	>		**0.55**
			Q	27	99	0		18	46	2		18	33	>		26	53	>		
			Storage	-	-	-		-	-	50		35	-	>		40	-	>		
			Avail.	-	-	-		-	-	48		17	-	-		15	-	>		
	2 - Ferndale Drive South & Street B/ Commerical Plaza	TWSC	LOS	<	B	>	**B**	<	A	>	**A**	<	A	>	**A**	<	A	>	**A**	**A**
			Delay	<	13	>	**13**	<	0	>	**0**	<	0	>	**0**	<	0	>	**0**	**0**
			V/C	<	0.03	>		<	0.00	>		<	0.13	>		<	0.18	>		
			Q	<	1	>		<	0	>		<	0	>		<	0	>		
	3 - Ardagh Road & Street A	TWSC	LOS	<	A		**A**		A	>	**A**					B		>	**B**	**A**
			Delay	<	0		**0**		0	>	**0**					12		>	**12**	**0**
			V/C	<	0.00				0.22	>						0.03		>		
			Q	<	0				0	>						1		>		
PM Peak Hour	1 - Ardagh Road & Ferndale Drive South	TCS	LOS	C	C	C	**C**	C	D	C	**C**	B	C	>	**C**	B	C	>	**C**	**C**
			Delay	26	30	26	**28**	22	40	26	**33**	16	23	>	**21**	16	22	>	**21**	**26**
			V/C	0.45	0.45	0.08		0.37	0.80	0.15		0.45	0.52	>		0.27	0.41	>		**0.62**
			Q	18	51	13		29	107	17		27	80	>		17	57	>		
			Storage	-	-	-		-	-	50		35	-	>		40	-	>		
			Avail.	-	-	-		-	-	33		8	-	-		23	-	>		
	2 - Ferndale Drive South & Street B/ Commerical Plaza	TWSC	LOS	<	B	>	**B**	<	C	>	**C**	<	A	>	**A**	<	A	>	**A**	**A**
			Delay	<	15	>	**15**	<	17	>	**17**	<	0	>	**0**	<	0	>	**0**	**1**
			V/C	<	0.05	>		<	0.04	>		<	0.26	>		<	0.18	>		
			Q	<	1	>		<	1	>		<	0	>		<	0	>		
	3 - Ardagh Road & Street A	TWSC	LOS	<	A		**A**		A	>	**A**					B		>	**B**	**A**
			Delay	<	0		**0**		0	>	**0**					13		>	**13**	**0**
			V/C	<	0.01				0.39	>						0.03		>		
			Q	<	0				0	>						1		>		

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

4 Site Access and Circulation

4.1 Left-Turn Lane Warrants

The Ministry of Transportation (MTO) Design Supplement for the Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads (GDGCR)[7] provides procedures to assess the need for auxiliary left-turn lanes at the private street connections to the City's road network. The analysis was completed using the nomographs for left-turn lanes on a four-lane undivided highway at an unsignalized intersection.

The need for a left-turn lane was assessed for the intersection based on 2025 total traffic forecasts, which reflect the "worst case scenario". If an exclusive turn lane is not justified at this horizon, installation would not be warranted by horizon year 2020.

The analysis indicates left-turn lanes are not warranted on Ardagh Road at Street A or on Ferndale Drive at Street B. **Appendix H** provides the warrant nomographs for the 2025 horizon year.

4.2 Sight Line Review

The Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads provides criteria for assessing sightlines.

Sight distance measurements were taken at the estimated location of the proposed street connections to Ardagh Road and Ferndale Drive. The measurements were taken from a point 5.0 metres from the centreline of the street connection (the rear of an entering vehicle turning into the driveway) with a target at a height of 0.6 metres (as per the Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads (GDGCR[8])) along a line of sight to the furthest point in the respective direction at 1.08 metres above the pavement (the height of a driver's eye).

Chapter 2.5 (Sight Distance) of the TAC GDGCR states that the "stopping sight distance is the sum of the distance travelled during the perception and reaction time and the braking distance" where the brake reaction time is 2.5 seconds. Section 2.5.5 (Decision Sight Distance) also states that providing just stopping sight distance is usually inadequate when drivers must make complex decisions, when information is difficult to find, when information is unusual or when unusual maneuvers are required. In those cases, decision sight distance should be used.

Table 4.1 summarizes the observed and design turning sight distances at the unsignalized intersections. Table 9.9.4 and Table 9.9.6 from the TAC

[7] Ministry of Transportation Ontario. *Design Supplement for the TAC Geometric Design Guide for Canadian Roads, Section 9.17.* June 2017.

[8] Transportation Association of Canada. *Geometric Design Guide for Canadian Roads.* June 2017.

Guide provided the design sight distance requirements for left-turn and right-turn/crossing manoeuvres from a stop, respectively. The table indicates all minor road approaches meet the design sight distance.

TABLE 4.1: TURNING SIGHT DISTANCE REQUIREMENTS

Intersection	Movement	Observed Sight Distance	Decision Sight Distance	Meets Criteria
Ardagh Road & Street A	Southbound Left-Turn	307	130	Yes
	Southbound Right-Turn	215	110	Yes
Ferndale Drive & Street B	Eastbound Left-Turn	350 +	130	Yes
	Eastbound Right-Turn	350 +	110	Yes

4.3 Site Circulation

Site access design and circulation was checked using AutoTURN. **Appendix I** provides the AutoTURN analysis. The results indicate that TAC passenger car and snowplow would be able to navigate and circulate the site with no issues. A heavy single unit (HSU) truck (similar to a garbage truck) would be able to navigate and circulate the site without conflict.

5 Parking Assessment

The applicant is proposing a zoning amendment to amend the existing zoning to permit the proposed residential uses. A parking assessment was conducted to compare the proposed parking supply to the City of Barrie Zoning By-law 2009-141[9] (the Zoning By-law) requirements.

The Zoning By-law does not define parking requirements specific to a residential zone, meaning the general provisions of Section 4.6, apply. Table 4.6 of the Zoning By-law specifies the following parking rates:

- **Townhouse Units** – For residential buildings containing more than three units, parking should be provided at a rate of 1.5 parking spaces per dwelling.
- **Apartment Units** – For residential buildings containing more than three units, parking should be provided at a rate of 1.5 parking spaces per dwelling.
- **Commercial Retail Store** – 1 space per 30 m^2 of gross floor area (GFA), minimum of 2 spaces.

Based on these rates, the proposed development requires 132 parking spaces (47 for the townhouse units, 75 for the condo units and 10 for the commercial floor space). Section 4.6.4 of the Zoning By-law further details the requirements for barrier free parking spaces. Based on the Zoning By-law parking requirements, one space plus 3% of the required parking spaces, or a total of five (5) spaces should be provided as barrier free spaces.

The applicant plans to provide the following parking supply:

- 62 townhouse parking spaces, or 2.0 spaces per unit. The spaces are provided in tandem on each townhouse lot, including one (1) surface space in the driveway and one (1) garage space;
- Eight (8) townhouse visitor parking spaces, or 0.25 spaces per unit. The surface spaces are provided on the south side of Street B;
- 76 apartment parking spaces, or 1.52 spaces per unit. A total of 62 spaces are provided in an underground parking lot and the remaining 14 surface spaces are provided along the south side of Street B; and
- Ten (10) commercial retail spaces, or 1.0 space per 30 m^2 GFA. The surface spaces are provided west of the mixed-use building and on the south side of Street B.

[9] City of Barrie. *City of Barrie Comprehensive Zoning By-law 2009-141.* Office Consolidation December 2017.

A total of 156 parking spaces are proposed for the development. Six (6) barrier free parking spaces are included in the proposed parking supply, satisfying the requirements outlined in Section 4.6.4 of the Zoning By-law.

Table 5.1 compares the Zoning By-law parking requirements to the planned on-site supply. The parking supply of 156 spaces (62 for the townhouse units, 8 for townhouse visitors, 76 for the condominium units and 10 for the commercial floor space) satisfies the Zoning By-law requirements, with a surplus of 24 spaces.

TABLE 5.1: ZONING BY-LAW PARKING REQUIREMENTS

Land Use	Number of Units/GFA	Zoning By-law		Proposed Spaces	Surplus
		Ratio	Required Spaces		
Townhouse	31 Units	1.5 per unit	47	62	15
Townhouse - Visitor		-	0	8	8
Apartment	50 Units	1.5 per unit	75	76	1
Commercial Retail	292 m^2	1.0 per 30 m^2	10	10	0
		Total	**132**	**156**	**24**

6 Conclusions and Recommendations

6.1 Conclusions

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

Existing Transportation Conditions

Under existing traffic conditions, all study area intersections currently operate at acceptable levels of service and within capacity during the weekday AM and PM peak hours. No critical movements have been identified.

Future Transportation Conditions

For the 2020 and 2025 future conditions, all intersections and movements within the study area are forecast to operate at acceptable levels of service and within capacity during the weekday AM and PM peak hours. The proposed development can be accommodated by the existing transportation road network.

Site Access and Circulation

Left turn lanes were determined to be not warranted on Ardagh Road at Street A or on Ferndale Drive at Street B.

Minimum stopping and decision sight distance criteria are found to meet or exceed thresholds in both directions along Ardagh Road and Ferndale Street at Street A and Street B, respectively.

Passenger cars and snowplows would be able to traverse and circulate on-site and access the loading area without any issues. A heavy single unit (HSU) truck (similar to a garbage truck) would be able to navigate and circulate the site without conflict.

Parking

The City of Barrie Zoning By-law 2009-141 (the Zoning By-law) requires the provision of 132 parking spaces for the proposed development - 47 for the townhouse units (1.5 spaces per unit), 75 for the condo units (1.5 spaces per unit) and 10 for the commercial floor space (1 space per 30 m^2 GFA). Five (5) spaces are required to be barrier free.

The parking supply of 156 spaces (62 for the townhouse units, 8 for townhouse visitors, 76 for the condo units and 10 for the commercial floor space) satisfies the Zoning By-law requirements, with a surplus of 24 spaces. Six (6) barrier free parking spaces are included in the proposed parking supply meeting the requirements outlined in the Zoning By-law.

6.2 Recommendations

Based on the findings of this study, it is recommended the City of Barrie recognise the conclusions drawn above and that the development be approved as proposed with no conditions related to off-site transportation improvements.

Appendix A

Terms of Reference Correspondence

From:	Justin MacDonald
To:	Heather Goodman
Cc:	Adrian Soo
Subject:	RE: 180047 (224 Ardagh TB) - Scope of Work
Date:	March 12, 2018 1:02:11 PM
Attachments:	image002.png image003.png

Good afternoon,

As per your below email.

The intersection of Ardagh Road and Ferndale Drive will be included in the study, please confirm that this is acceptable. Yes.

- Recent (within two years) turning movement counts and signal timings for the intersection of Ardagh Road and Ferndale Drive. No recent counts. I will have our staff collect the required signal timing.
- The traffic brief will be prepared to conform to the City guidelines and will assess the opening year of the development. Please confirm this is acceptable. Please also include a 5 year post build out.
- A 2% growth rate will be used for the study. Please confirm this is acceptable. Yes.
- Other in-stream or recently approved developments in the area that should be reflected in the study. None that I can think off.

Thanks,

Justin MacDonald, C.E.T.,
Senior Transportation Operations Technologist
Roads, Parks & Fleet

Barrie

City of Barrie: Barrie Operations Centre, 165 Ferndale Drive North, Barrie ON, L4N 9V9
Office: 705-739-4220 5178

From: Heather Goodman [mailto:hgoodman@ptsl.com]
Sent: Monday, March 12, 2018 12:38 PM
To: Justin MacDonald <Justin.MacDonald@barrie.ca>
Cc: Adrian Soo <asoo@ptsl.com>
Subject: RE: 180047 (224 Ardagh TB) - Scope of Work

Hi Justin,

Just following up on my previous e-mail. We would appreciate if you could provide your comments and the requested data as soon as possible.

Thanks,

Heather Goodman, B.Eng., EIT, MITE
Transportation Consultant

Paradigm Transportation Solutions Limited
p: 416.479.9684 x502
m: 905.506.0454

From: Heather Goodman
Sent: February 27, 2018 3:01 PM
To: 'Justin MacDonald' <Justin.MacDonald@barrie.ca>
Cc: Adrian Soo <asoo@ptsl.com>
Subject: 180047 (224 Ardagh TB) - Scope of Work

Hi Justin,

Paradigm would like to inform the City that we will be undertaking a Traffic Brief in support of the proposed development of ground floor commercial/retail (1,877 m2 GFA) and residential development (approximately 40 units in two to three storeys above ground floor) at 224 Ardagh Road detailed in the enclosed project overview and work plan. We ask that you please review the work plan to ensure the scope of the study is acceptable and provide comments if necessary.

In addition, we request the following information from the City for our study:

- The intersection of Ardagh Road and Ferndale Drive will be included in the study, please confirm that this is acceptable.
- Recent (within two years) turning movement counts and signal timings for the intersection of Ardagh Road and Ferndale Drive.
- The traffic brief will be prepared to conform to the City guidelines and will assess the opening year of the development. Please confirm this is acceptable.
- A 2% growth rate will be used for the study. Please confirm this is acceptable.
- Other in-stream or recently approved developments in the area that should be reflected in the study.

Due to the time sensitive nature of the project, we ask that you please provide comments at your earliest convenience. Please do not hesitate to contact me if you have questions relating to this project.

Regards,

Heather Goodman, B.Eng., EIT, MITE
Transportation Consultant

Paradigm Transportation Solutions Limited
5000 Yonge Street, Suite 1901, Toronto ON M2N 7E9
p: 416.479.9684 x502
m: 905.506.0454
e: hgoodman@ptsl.com
w: www.ptsl.com

paradigm TRANSPORTATION SOLUTIONS LIMITED

5000 Yonge Street, Suite 1901
Toronto, ON M2N 7E9
p: 416.479.9684
f: 1.855.764.7349

www.ptsl.com

27 February 2018
Project: 180047

Justin MacDonald, C.E.T.
Senior Transportation Operations Technologist
Roads, Parks and Fleet
City of Barrie
70 Collier Street, P.O. Box 400
Barrie, ON L4M 4T5

Dear Mr. MacDonald:

RE: TRAFFIC BRIEF, PROPOSED MIXED-USE DEVELOPMENT
224 ARDAGH ROAD, BARRIE, ON

Paradigm Transportation Solutions Limited (Paradigm) was retained on behalf of **KLM Planning Partners Inc.** (the Client) to carry out a Traffic Brief in support of the proposed development of ground floor commercial/retail (1,877 m^2 GFA) and residential development (approximately 40 units in two to three storeys above ground floor) at 224 Ardagh Road in Barrie, Ontario.

Work Plan

The following outlines our proposed work plan to carry out this assignment:

- **Task 1: Pre-Study Consultation** – We will contact City of Barrie transportation staff by telephone/email to confirm and refine the scope and assumptions prior to undertaking the study.
- **Task 2: Collect Data** – We will request available traffic data from City staff for the Ardagh Road/Ferndale Drive intersection. If the City does not have up-to-date traffic data, we will arrange for traffic counts. We will also conduct a site visit to observe traffic conditions during the weekday AM and PM peak hours, and to note the local transportation characteristics (number and type of lanes, active transportation facilities, bus stops, posted speed limits, etc.). During the site visit, a count will be conducted of the trips to/from the Ferndale Drive access serving the existing commercial plaza in the northeast quadrant of the Ardagh Road/Ferndale Drive intersection. This traffic is of interest since one access to the new development would be located on the opposite side of Ferndale Drive.
- **Task 3: Forecast Traffic Volumes** – It is assumed that the future horizon year for this study would represent opening day conditions for the proposed development (2019 or 2020). A general growth factor (2% per year) would be applied to base year traffic data to forecast background traffic passing the site on both Ardagh Road and Ferndale Drive. The development site traffic would be estimated based on the standard reference material (i.e. ITE Trip

Generation Manual) and assigned to the proposed accesses according to existing traffic patterns.

- **Task 4: Conduct Traffic Operations Analysis** – We will evaluate the future AM and PM peak hour operations (level of service, delay and volume to capacity ratio) for the proposed site accesses on Ardagh Road and on Ferndale Drive using Synchro 9 software incorporating Highway Capacity Manual methodologies. In consideration of the peak hour traffic forecasts, we will identify whether capacity, traffic control, and/or safety-related improvements would be required to accommodate the proposed development.
- **Task 5**: **Assess Sigh Lines** – As part of the site visit, field measurements would be taken at each proposed site access location to assist in the assessment of the adequacy of sight lines. The analysis of sight lines would consider the requirements for stopping, approach, and departure sight distance for a design speed 10 km/h above the posted maximum speed limt.
- **Task 6: Report and Recommendations** – We will prepare a report documenting the study findings and conclusions, and providing recommendations regarding the proposed development from a transportation perspective. The final report will include appendices containing relevant traffic data as well as the detailed output generated by the operational analysis software.

We trust the foregoing work plan is acceptable. If you have any questions related to this project, please contact me at (416) 479-9684 x506 or by email at gpappin@ptsl.com

Yours very truly,

PARADIGM TRANSPORTATION SOLUTIONS LIMITED

Garry Pappin
BES, CET, LEL
Senior Transportation Consultant

Appendix B

Detailed Turning Movement Count Data and Signal Timings

Paradigm Transportation Solutions Limited
22 King Street South, Suite 300

Waterloo, Ontario, Canada N2J 1N8
519-896-3163 cbowness@ptsl.com

Count Name: Ferndale Drive & Ardagh Road
Site Code:
Start Date: 03/07/2018

Turning Movement Data

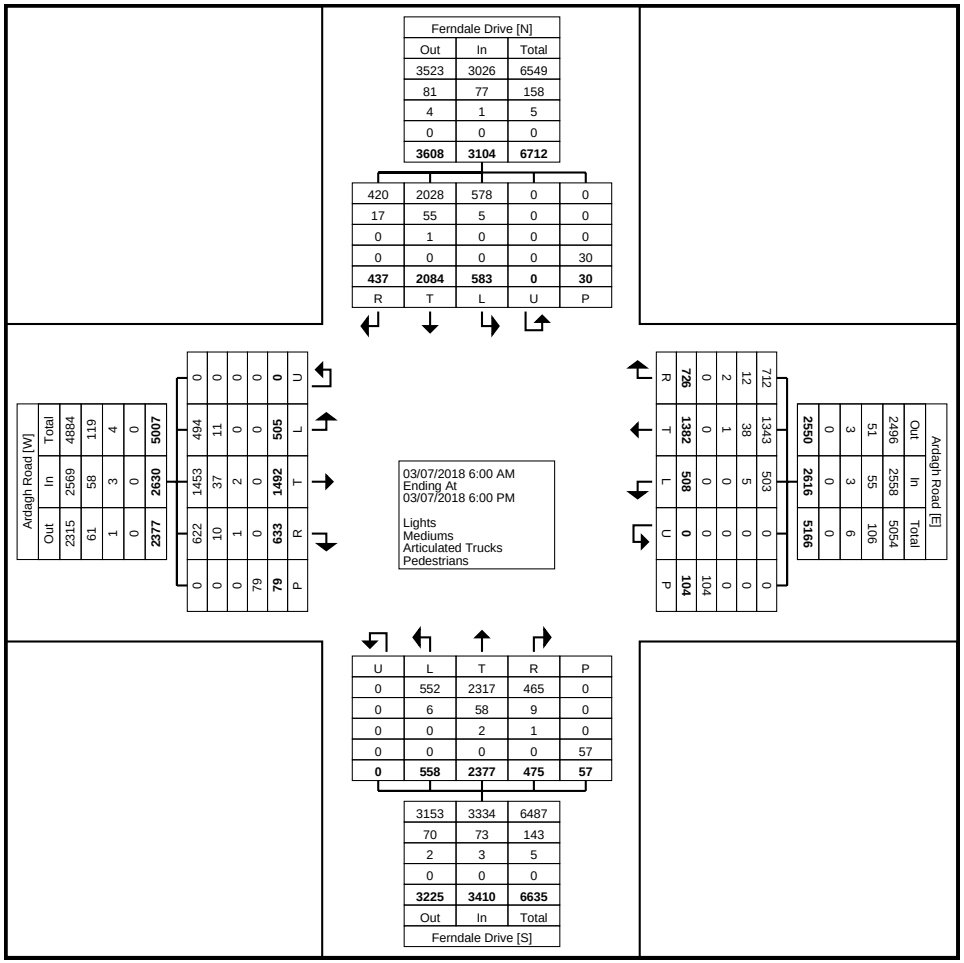
Start Time	Ardagh Road Eastbound						Ardagh Road Westbound						Ferndale Drive Northbound						Ferndale Drive Southbound						Int. Total
	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	
6:00 AM	1	49	6	0	1	56	2	9	4	0	1	15	2	15	9	0	1	26	14	22	5	0	1	41	138
6:15 AM	2	31	10	0	0	43	9	13	4	0	2	26	3	18	7	0	0	28	11	26	3	0	0	40	137
6:30 AM	6	43	6	0	0	55	4	7	0	0	1	11	1	23	10	0	0	34	16	36	2	0	0	54	154
6:45 AM	7	48	9	0	0	64	5	25	5	0	0	35	7	25	11	0	0	43	11	36	8	0	0	55	197
Hourly Total	16	171	31	0	1	218	20	54	13	0	4	87	13	81	37	0	1	131	52	120	18	0	1	190	626
7:00 AM	15	53	17	0	1	85	7	21	9	0	0	37	9	21	8	0	0	38	17	41	8	0	0	66	226
7:15 AM	15	66	24	0	1	105	12	34	11	0	1	57	11	37	11	0	4	59	19	44	13	0	2	76	297
7:30 AM	28	81	19	0	1	128	14	56	15	0	2	85	21	39	20	0	1	80	26	76	20	0	0	122	415
7:45 AM	39	82	50	0	0	171	16	43	13	0	1	72	31	54	24	0	1	109	27	92	24	0	1	143	495
Hourly Total	97	282	110	0	3	489	49	154	48	0	4	251	72	151	63	0	6	286	89	253	65	0	3	407	1433
8:00 AM	21	76	27	0	2	124	16	28	14	0	2	58	9	47	17	0	1	73	28	71	10	0	0	109	364
8:15 AM	20	56	16	0	3	92	18	23	13	0	2	54	14	61	23	0	5	98	20	80	16	0	0	116	360
8:30 AM	18	54	17	0	13	89	13	21	14	0	1	48	16	58	22	0	0	96	20	65	7	0	0	92	325
8:45 AM	23	80	34	0	15	137	13	22	25	0	16	60	19	84	16	0	5	119	27	79	14	0	3	120	436
Hourly Total	82	266	94	0	33	442	60	94	66	0	21	220	58	250	78	0	11	386	95	295	47	0	3	437	1485
*** BREAK ***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11:00 AM	13	28	12	0	1	53	14	25	15	0	2	54	11	43	11	0	2	65	16	61	7	0	1	84	256
11:15 AM	8	36	15	0	0	59	16	25	16	0	2	57	16	71	8	0	0	95	15	54	10	0	1	79	290
11:30 AM	10	29	12	0	0	51	17	31	17	0	1	65	12	68	12	0	0	92	16	68	13	0	1	97	305
11:45 AM	11	39	12	0	0	62	13	37	27	0	1	77	7	72	12	0	0	91	13	50	13	0	0	76	306
Hourly Total	42	132	51	0	1	225	60	118	75	0	6	253	46	254	43	0	2	343	60	233	43	0	3	336	1157
12:00 PM	15	33	15	0	0	63	16	33	22	0	3	71	11	93	12	0	0	116	10	54	12	0	0	76	326
12:15 PM	9	42	16	0	0	67	18	25	29	0	0	72	15	68	19	0	0	102	11	70	7	0	0	88	329
12:30 PM	10	30	18	0	0	58	8	25	19	0	2	52	19	75	10	0	0	104	15	67	8	0	0	90	304
12:45 PM	13	35	21	0	1	69	16	24	21	0	0	61	16	68	19	0	1	103	17	58	6	0	0	81	314
Hourly Total	47	140	70	0	1	257	58	107	91	0	5	256	61	304	60	0	1	425	53	249	33	0	0	335	1273
*** BREAK ***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3:00 PM	17	41	12	0	1	70	10	54	31	0	6	95	25	82	20	0	1	127	16	64	16	0	0	96	388
3:15 PM	21	49	20	0	4	90	11	63	42	0	7	116	19	96	15	0	5	130	26	47	13	0	4	86	422
3:30 PM	19	46	20	0	16	85	19	68	31	0	17	118	27	106	15	0	8	148	34	112	21	0	6	167	518
3:45 PM	18	53	32	0	3	103	22	46	37	0	10	105	26	110	18	0	1	154	17	86	25	0	5	128	490
Hourly Total	75	189	84	0	24	348	62	231	141	0	40	434	97	394	68	0	15	559	93	309	75	0	15	477	1818
4:00 PM	18	42	27	0	2	87	27	82	34	0	5	143	25	116	14	0	2	155	20	72	23	0	0	115	500
4:15 PM	22	30	26	0	7	78	20	83	44	0	4	147	17	114	16	0	5	147	15	78	14	0	1	107	479
4:30 PM	15	40	25	0	0	80	32	80	29	0	9	141	25	104	22	0	3	151	18	94	17	0	1	129	501
4:45 PM	13	46	23	0	0	82	28	88	44	0	1	160	30	113	13	0	1	156	16	84	20	0	2	120	518
Hourly Total	68	158	101	0	9	327	107	333	151	0	19	591	97	447	65	0	11	609	69	328	74	0	4	471	1998

5:00 PM	15	26	22	0	3	63	30	75	42	0	3	147	21	135	17	0	2	173	15	87	22	0	0	124	507
5:15 PM	22	45	27	0	1	94	22	83	39	0	1	144	39	135	20	0	3	194	18	82	26	0	1	126	558
5:30 PM	16	35	22	0	2	73	26	71	36	0	1	133	22	104	12	0	3	138	20	72	13	0	0	105	449
5:45 PM	25	48	21	0	1	94	14	62	24	0	0	100	32	122	12	0	2	166	19	56	21	0	0	96	456
Hourly Total	78	154	92	0	7	324	92	291	141	0	5	524	114	496	61	0	10	671	72	297	82	0	1	451	1970
Grand Total	505	1492	633	0	79	2630	508	1382	726	0	104	2616	558	2377	475	0	57	3410	583	2084	437	0	30	3104	11760
Approach %	19.2	56.7	24.1	0.0	-	-	19.4	52.8	27.8	0.0	-	-	16.4	69.7	13.9	0.0	-	-	18.8	67.1	14.1	0.0	-	-	-
Total %	4.3	12.7	5.4	0.0	-	22.4	4.3	11.8	6.2	0.0	-	22.2	4.7	20.2	4.0	0.0	-	29.0	5.0	17.7	3.7	0.0	-	26.4	-
Lights	494	1453	622	0	-	2569	503	1343	712	0	-	2558	552	2317	465	0	-	3334	578	2028	420	0	-	3026	11487
% Lights	97.8	97.4	98.3	-	-	97.7	99.0	97.2	98.1	-	-	97.8	98.9	97.5	97.9	-	-	97.8	99.1	97.3	96.1	-	-	97.5	97.7
Mediums	11	37	10	0	-	58	5	38	12	0	-	55	6	58	9	0	-	73	5	55	17	0	-	77	263
% Mediums	2.2	2.5	1.6	-	-	2.2	1.0	2.7	1.7	-	-	2.1	1.1	2.4	1.9	-	-	2.1	0.9	2.6	3.9	-	-	2.5	2.2
Articulated Trucks	0	2	1	0	-	3	0	1	2	0	-	3	0	2	1	0	-	3	0	1	0	0	-	1	10
% Articulated Trucks	0.0	0.1	0.2	-	-	0.1	0.0	0.1	0.3	-	-	0.1	0.0	0.1	0.2	-	-	0.1	0.0	0.0	0.0	-	-	0.0	0.1
Pedestrians	-	-	-	-	79	-	-	-	-	-	104	-	-	-	-	-	57	-	-	-	-	-	30	-	-
% Pedestrians	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-

Paradigm Transportation Solutions Limited
22 King Street South, Suite 300

Waterloo, Ontario, Canada N2J 1N8
519-896-3163 cbowness@ptsl.com

Count Name: Ferndale Drive & Ardagh Road
Site Code:
Start Date: 03/07/2018



Turning Movement Data Plot

Paradigm Transportation Solutions Limited
22 King Street South, Suite 300

Waterloo, Ontario, Canada N2J 1N8
519-896-3163 cbowness@ptsl.com

Count Name: Ferndale Drive & Ardagh Road
Site Code:
Start Date: 03/07/2018

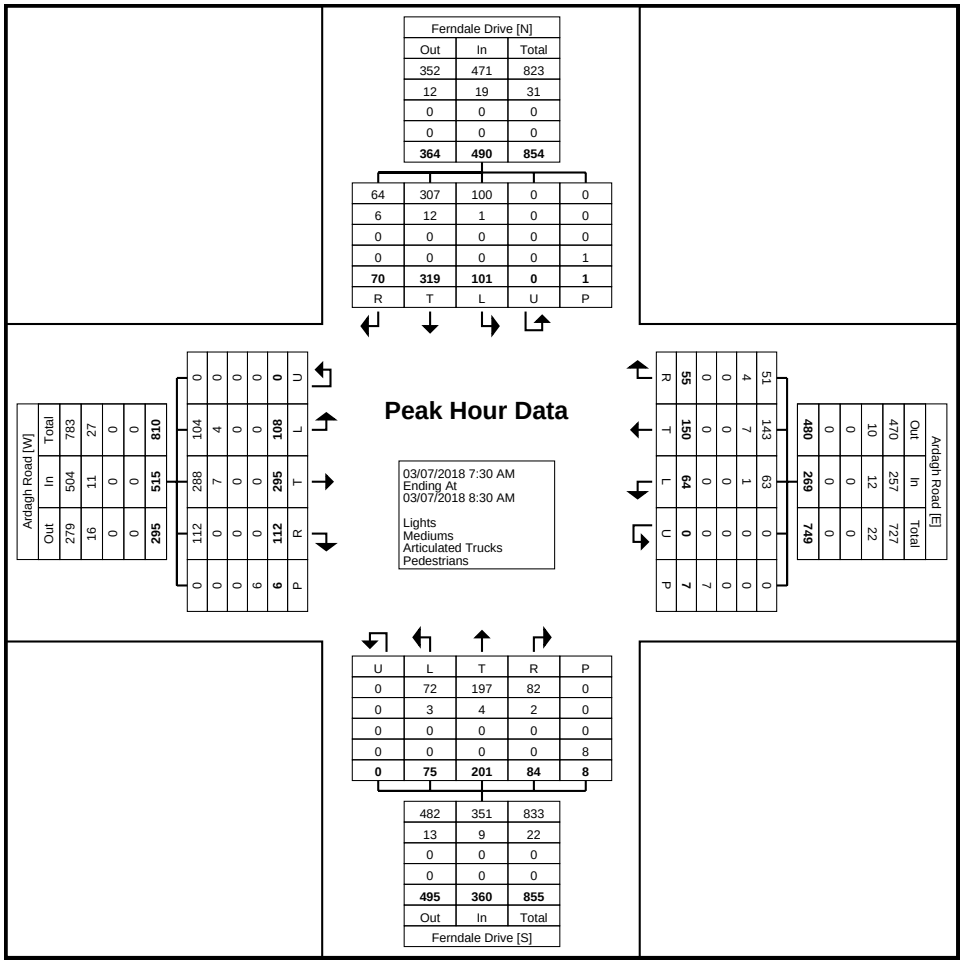
Turning Movement Peak Hour Data (7:30 AM)

Start Time	Ardagh Road Eastbound						Ardagh Road Westbound						Ferndale Drive Northbound						Ferndale Drive Southbound						
	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Int. Total
7:30 AM	28	81	19	0	1	128	14	56	15	0	2	85	21	39	20	0	1	80	26	76	20	0	0	122	415
7:45 AM	39	82	50	0	0	171	16	43	13	0	1	72	31	54	24	0	1	109	27	92	24	0	1	143	495
8:00 AM	21	76	27	0	2	124	16	28	14	0	2	58	9	47	17	0	1	73	28	71	10	0	0	109	364
8:15 AM	20	56	16	0	3	92	18	23	13	0	2	54	14	61	23	0	5	98	20	80	16	0	0	116	360
Total	108	295	112	0	6	515	64	150	55	0	7	269	75	201	84	0	8	360	101	319	70	0	1	490	1634
Approach %	21.0	57.3	21.7	0.0	-	-	23.8	55.8	20.4	0.0	-	-	20.8	55.8	23.3	0.0	-	-	20.6	65.1	14.3	0.0	-	-	-
Total %	6.6	18.1	6.9	0.0	-	31.5	3.9	9.2	3.4	0.0	-	16.5	4.6	12.3	5.1	0.0	-	22.0	6.2	19.5	4.3	0.0	-	30.0	-
PHF	0.692	0.899	0.560	0.000	-	0.753	0.889	0.670	0.917	0.000	-	0.791	0.605	0.824	0.875	0.000	-	0.826	0.902	0.867	0.729	0.000	-	0.857	0.825
Lights	104	288	112	0	-	504	63	143	51	0	-	257	72	197	82	0	-	351	100	307	64	0	-	471	1583
% Lights	96.3	97.6	100.0	-	-	97.9	98.4	95.3	92.7	-	-	95.5	96.0	98.0	97.6	-	-	97.5	99.0	96.2	91.4	-	-	96.1	96.9
Mediums	4	7	0	0	-	11	1	7	4	0	-	12	3	4	2	0	-	9	1	12	6	0	-	19	51
% Mediums	3.7	2.4	0.0	-	-	2.1	1.6	4.7	7.3	-	-	4.5	4.0	2.0	2.4	-	-	2.5	1.0	3.8	8.6	-	-	3.9	3.1
Articulated Trucks	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0
% Articulated Trucks	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0
Pedestrians	-	-	-	-	6	-	-	-	-	-	7	-	-	-	-	-	8	-	-	-	-	-	1	-	-
% Pedestrians	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-

Paradigm Transportation Solutions Limited
22 King Street South, Suite 300

Waterloo, Ontario, Canada N2J 1N8
519-896-3163 cbowness@ptsl.com

Count Name: Ferndale Drive & Ardagh Road
Site Code:
Start Date: 03/07/2018



Turning Movement Peak Hour Data Plot (7:30 AM)

Paradigm Transportation Solutions Limited
22 King Street South, Suite 300

Waterloo, Ontario, Canada N2J 1N8
519-896-3163 cbowness@ptsl.com

Count Name: Ferndale Drive & Ardagh Road
Site Code:
Start Date: 03/07/2018

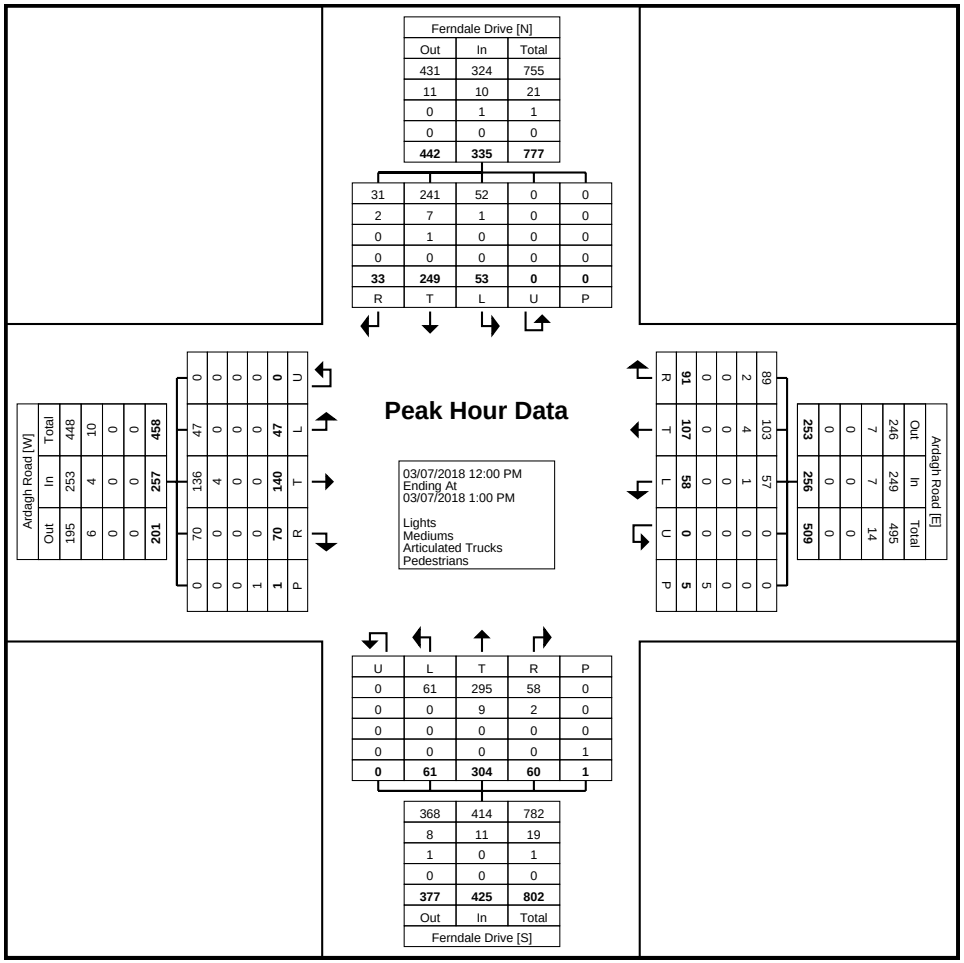
Turning Movement Peak Hour Data (12:00 PM)

Start Time	Ardagh Road Eastbound						Ardagh Road Westbound						Ferndale Drive Northbound						Ferndale Drive Southbound						
	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Int. Total
12:00 PM	15	33	15	0	0	63	16	33	22	0	3	71	11	93	12	0	0	116	10	54	12	0	0	76	326
12:15 PM	9	42	16	0	0	67	18	25	29	0	0	72	15	68	19	0	0	102	11	70	7	0	0	88	329
12:30 PM	10	30	18	0	0	58	8	25	19	0	2	52	19	75	10	0	0	104	15	67	8	0	0	90	304
12:45 PM	13	35	21	0	1	69	16	24	21	0	0	61	16	68	19	0	1	103	17	58	6	0	0	81	314
Total	47	140	70	0	1	257	58	107	91	0	5	256	61	304	60	0	1	425	53	249	33	0	0	335	1273
Approach %	18.3	54.5	27.2	0.0	-	-	22.7	41.8	35.5	0.0	-	-	14.4	71.5	14.1	0.0	-	-	15.8	74.3	9.9	0.0	-	-	-
Total %	3.7	11.0	5.5	0.0	-	20.2	4.6	8.4	7.1	0.0	-	20.1	4.8	23.9	4.7	0.0	-	33.4	4.2	19.6	2.6	0.0	-	26.3	-
PHF	0.783	0.833	0.833	0.000	-	0.931	0.806	0.811	0.784	0.000	-	0.889	0.803	0.817	0.789	0.000	-	0.916	0.779	0.889	0.688	0.000	-	0.931	0.967
Lights	47	136	70	0	-	253	57	103	89	0	-	249	61	295	58	0	-	414	52	241	31	0	-	324	1240
% Lights	100.0	97.1	100.0	-	-	98.4	98.3	96.3	97.8	-	-	97.3	100.0	97.0	96.7	-	-	97.4	98.1	96.8	93.9	-	-	96.7	97.4
Mediums	0	4	0	0	-	4	1	4	2	0	-	7	0	9	2	0	-	11	1	7	2	0	-	10	32
% Mediums	0.0	2.9	0.0	-	-	1.6	1.7	3.7	2.2	-	-	2.7	0.0	3.0	3.3	-	-	2.6	1.9	2.8	6.1	-	-	3.0	2.5
Articulated Trucks	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0	1	0	0	-	1	1
% Articulated Trucks	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.4	0.0	-	-	0.3	0.1
Pedestrians	-	-	-	-	1	-	-	-	-	-	5	-	-	-	-	-	1	-	-	-	-	-	0	-	-
% Pedestrians	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-

Paradigm Transportation Solutions Limited
22 King Street South, Suite 300

Waterloo, Ontario, Canada N2J 1N8
519-896-3163 cbowness@ptsl.com

Count Name: Ferndale Drive & Ardagh Road
Site Code:
Start Date: 03/07/2018



Turning Movement Peak Hour Data Plot (12:00 PM)

Paradigm Transportation Solutions Limited
22 King Street South, Suite 300

Waterloo, Ontario, Canada N2J 1N8
519-896-3163 cbowness@ptsl.com

Count Name: Ferndale Drive & Ardagh Road
Site Code:
Start Date: 03/07/2018

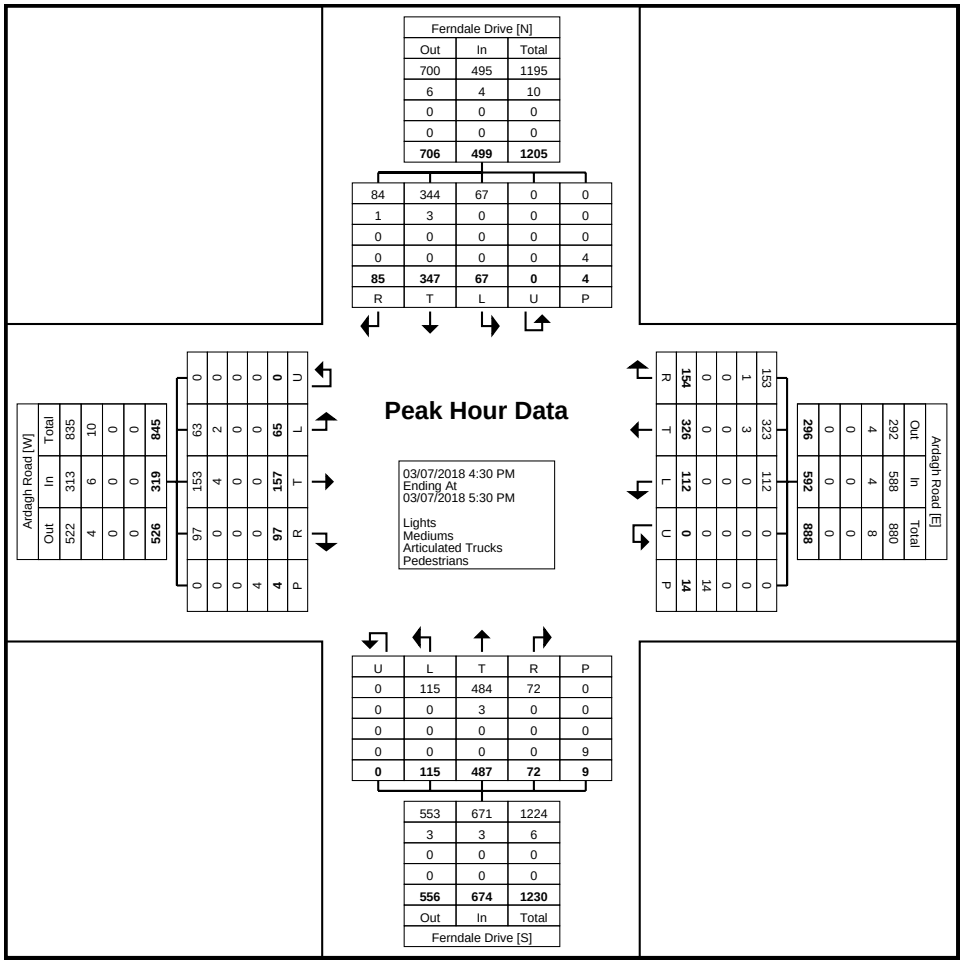
Turning Movement Peak Hour Data (4:30 PM)

Start Time	Ardagh Road Eastbound						Ardagh Road Westbound						Ferndale Drive Northbound						Ferndale Drive Southbound						
	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Left	Thru	Right	U-Turn	Peds	App. Total	Int. Total
4:30 PM	15	40	25	0	0	80	32	80	29	0	9	141	25	104	22	0	3	151	18	94	17	0	1	129	501
4:45 PM	13	46	23	0	0	82	28	88	44	0	1	160	30	113	13	0	1	156	16	84	20	0	2	120	518
5:00 PM	15	26	22	0	3	63	30	75	42	0	3	147	21	135	17	0	2	173	15	87	22	0	0	124	507
5:15 PM	22	45	27	0	1	94	22	83	39	0	1	144	39	135	20	0	3	194	18	82	26	0	1	126	558
Total	65	157	97	0	4	319	112	326	154	0	14	592	115	487	72	0	9	674	67	347	85	0	4	499	2084
Approach %	20.4	49.2	30.4	0.0	-	-	18.9	55.1	26.0	0.0	-	-	17.1	72.3	10.7	0.0	-	-	13.4	69.5	17.0	0.0	-	-	-
Total %	3.1	7.5	4.7	0.0	-	15.3	5.4	15.6	7.4	0.0	-	28.4	5.5	23.4	3.5	0.0	-	32.3	3.2	16.7	4.1	0.0	-	23.9	-
PHF	0.739	0.853	0.898	0.000	-	0.848	0.875	0.926	0.875	0.000	-	0.925	0.737	0.902	0.818	0.000	-	0.869	0.931	0.923	0.817	0.000	-	0.967	0.934
Lights	63	153	97	0	-	313	112	323	153	0	-	588	115	484	72	0	-	671	67	344	84	0	-	495	2067
% Lights	96.9	97.5	100.0	-	-	98.1	100.0	99.1	99.4	-	-	99.3	100.0	99.4	100.0	-	-	99.6	100.0	99.1	98.8	-	-	99.2	99.2
Mediums	2	4	0	0	-	6	0	3	1	0	-	4	0	3	0	0	-	3	0	3	1	0	-	4	17
% Mediums	3.1	2.5	0.0	-	-	1.9	0.0	0.9	0.6	-	-	0.7	0.0	0.6	0.0	-	-	0.4	0.0	0.9	1.2	-	-	0.8	0.8
Articulated Trucks	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	-	0	0
% Articulated Trucks	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0	0.0	0.0	-	-	0.0	0.0
Pedestrians	-	-	-	-	4	-	-	-	-	-	14	-	-	-	-	-	9	-	-	-	-	-	4	-	-
% Pedestrians	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-

Paradigm Transportation Solutions Limited
22 King Street South, Suite 300

Waterloo, Ontario, Canada N2J 1N8
519-896-3163 cbowness@ptsl.com

Count Name: Ferndale Drive & Ardagh Road
Site Code:
Start Date: 03/07/2018



Turning Movement Peak Hour Data Plot (4:30 PM)

THE CORPORATION OF THE CITY OF BARRIE

March 19, 2018 File: T07-SI

Dear Mr. Soo,

RE: Traffic Signal Timings – Ferndale Drive S/Ardagh Road

With respect to your inquiry on February 23, 2018, the above intersection traffic signal timings are as follows:

		Vehicular Indications				Pedestrian Indications	
Roadway	**Direction**	**Minimum Green**	**Maximum Green**	**Amber**	**All Red**	**Walk**	**Flashing Don't Walk**
Ferndale Dr. South (Main Street)	Advanced Northbound/ Southbound Left Turn	7	7	3	1	N/A	N/A
Ferndale Dr. South (Main Street)	Northbound/ Southbound	34	34	4	2	12	17
Ardagh Rd (Side Street)	Advanced Eastbound/ Westbound Left Turn	7	7	3	1	N/A	N/A
Ardagh Rd (Side Street)	Eastbound/ Westbound	10	30	4	2	11	16

NOTE: All times are recorded in seconds, based on full demand.

The side street phases are actuated; meaning a vehicle or pedestrian must be present on the side street before the side street is given a green indication. Actuation at this intersection occurs in two ways: first, for vehicles a loop detector is imbedded into the roadway at the painted stop bar; and secondly, pushbuttons are located on each corner for pedestrians to activate their movement. Vehicle presence only on the side street would result in a possible green time of between the minimum and maximum times noted above, depending on demand.

Pedestrian "Walk" and "Flashing Don't Walk" times on the side street as noted would be used in the event that the pedestrian push button was activated. Should there be no demand on the actuated phases; the signals would rest in a green indication for the main street.

Roads, Parks and Fleet Department ▪ P.O. Box 400, Barrie, ON L4M 4T5

P (705) 726-4242 ▪ **F** (705) 739-4235 ▪ barrie.ca

Should you require any further information please feel free to contact me at (705) 739-4220 ext. 5178.

Yours truly,

Justin MacDonald, C.E.T.
Senior Transportation Operations Technologist

180047 - 224 Ardagh Road TIS
March 7, 2018 Data Collection

Parking Lot
Ferndale Drive

	IN		OUT	
	Left	Right	Left	Right
7:30-7:45	0	0	0	0
7:45-8:00	1	1	0	0
8:00-8:15	3	1	0	0
8:15-8:30	0	0	0	0

Plaza Driveway
Ferndale Drive

	IN		OUT	
	Left	Right	Left	Right
7:30-7:45	0	0	0	0
7:45-8:00	0	0	0	0
8:00-8:15	0	1	0	0
8:15-8:30	0	1	0	0

	IN		OUT	
	Left	Right	Left	Right
4:30-4:45	0	0	0	0
4:45-5:00	0	0	0	1
5:00-5:15	0	0	0	4
5:15-5:30	0	0	0	0

	IN		OUT	
	Left	Right	Left	Right
4:30-4:45	1	1	3	1
4:45-5:00	0	0	0	2
5:00-5:15	1	0	2	2
5:15-5:30	0	6	0	0

Appendix C

Base Year (2019) Traffic Operations Reports

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	157	328	200	72	224	60	125	340	112	463
v/c Ratio	0.43	0.69	0.36	0.24	0.55	0.14	0.27	0.24	0.20	0.36
Control Delay	22.8	38.8	5.9	19.2	34.9	0.7	13.6	16.0	13.0	19.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	22.8	38.8	5.9	19.2	34.9	0.7	13.6	16.0	13.0	19.7
Queue Length 50th (m)	18.8	54.9	0.0	8.2	35.3	0.0	10.6	17.0	9.4	27.8
Queue Length 95th (m)	24.0	83.7	0.0	16.6	40.0	0.2	15.5	27.9	22.0	45.4
Internal Link Dist (m)		85.5			159.1			146.2		32.5
Turn Bay Length (m)	50.0		60.0	50.0		50.0	35.0		40.0	
Base Capacity (vph)	361	636	672	306	618	589	467	1432	561	1303
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.43	0.52	0.30	0.24	0.36	0.10	0.27	0.24	0.20	0.36

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	108	295	112	64	150	55	75	201	84	101	319	70
Future Volume (vph)	108	295	112	64	150	55	75	201	84	101	319	70
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.99	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.96		1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1735	1863	1583	1767	1810	1490	1732	3362		1781	3310	
Flt Permitted	0.47	1.00	1.00	0.36	1.00	1.00	0.43	1.00		0.55	1.00	
Satd. Flow (perm)	862	1863	1583	668	1810	1490	787	3362		1026	3310	
Peak-hour factor, PHF	0.69	0.90	0.56	0.89	0.67	0.92	0.60	0.82	0.88	0.90	0.87	0.73
Adj. Flow (vph)	157	328	200	72	224	60	125	245	95	112	367	96
RTOR Reduction (vph)	0	0	150	0	0	46	0	38	0	0	22	0
Lane Group Flow (vph)	157	328	50	72	224	14	125	302	0	112	441	0
Confl. Peds. (#/hr)	1		8	8		1	6		7	7		6
Heavy Vehicles (%)	4%	2%	0%	2%	5%	7%	4%	2%	2%	1%	4%	9%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)	29.5	22.5	22.5	26.5	21.0	21.0	43.7	36.7		40.7	35.2	
Effective Green, g (s)	29.5	22.5	22.5	26.5	21.0	21.0	43.7	36.7		40.7	35.2	
Actuated g/C Ratio	0.33	0.25	0.25	0.29	0.23	0.23	0.48	0.41		0.45	0.39	
Clearance Time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	349	464	394	263	421	346	454	1367		508	1291	
v/s Ratio Prot	c0.03	c0.18		0.02	0.12		c0.02	0.09		0.01	c0.13	
v/s Ratio Perm	0.11		0.03	0.06		0.01	0.11			0.09		
v/c Ratio	0.45	0.71	0.13	0.27	0.53	0.04	0.28	0.22		0.22	0.34	
Uniform Delay, d1	22.6	30.8	26.2	23.8	30.3	26.8	13.0	17.4		14.5	19.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.9	4.9	0.1	0.6	1.3	0.0	0.3	0.4		0.2	0.7	
Delay (s)	23.6	35.7	26.4	24.4	31.6	26.8	13.4	17.8		14.7	20.1	
Level of Service	C	D	C	C	C	C	B	B		B	C	
Approach Delay (s)		30.2			29.3			16.6			19.0	
Approach LOS		C			C			B			B	

Intersection Summary					
HCM 2000 Control Delay	23.9	HCM 2000 Level of Service		C	
HCM 2000 Volume to Capacity ratio	0.47				
Actuated Cycle Length (s)	90.2	Sum of lost time (s)		20.0	
Intersection Capacity Utilization	73.8%	ICU Level of Service		D	
Analysis Period (min)	15				

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	0	0	0	4	360	2	0	490	2
Future Volume (Veh/h)	0	0	0	0	0	0	4	360	2	0	490	2
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	0	0	0	4	391	2	0	533	2
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)								56				
pX, platoon unblocked	0.99	0.99		0.99	0.99	0.99				0.99		
vC, conflicting volume	738	935	268	666	935	196	535			393		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	708	908	268	636	908	160	535			359		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	100	100	100			100		
cM capacity (veh/h)	320	273	737	361	273	852	1043			1195		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	0	0	200	198	266	268
Volume Left	0	0	4	0	0	0
Volume Right	0	0	0	2	0	2
cSH	1700	1700	1043	1700	1195	1700
Volume to Capacity	0.00	0.00	0.00	0.12	0.00	0.16
Queue Length 95th (m)	0.0	0.0	0.1	0.0	0.0	0.0
Control Delay (s)	0.0	0.0	0.2	0.0	0.0	0.0
Lane LOS	A	A	A			
Approach Delay (s)	0.0	0.0	0.1		0.0	
Approach LOS	A	A				

Intersection Summary				
Average Delay	0.0			
Intersection Capacity Utilization	16.9%	ICU Level of Service	A	
Analysis Period (min)	15			

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	89	188	110	130	358	178	158	641	73	491
v/c Ratio	0.31	0.43	0.24	0.31	0.73	0.33	0.34	0.44	0.18	0.37
Control Delay	20.3	31.6	5.4	20.1	40.0	5.9	14.9	21.6	13.4	20.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	20.3	31.6	5.4	20.1	40.0	5.9	14.9	21.6	13.4	20.1
Queue Length 50th (m)	10.2	28.8	0.0	15.3	60.9	0.0	14.2	44.3	6.3	30.4
Queue Length 95th (m)	15.9	44.7	10.4	26.6	91.8	14.1	23.6	69.0	15.4	49.8
Internal Link Dist (m)		85.5			159.1			146.2		32.5
Turn Bay Length (m)	50.0		60.0	50.0		50.0	35.0		40.0	
Base Capacity (vph)	287	630	615	413	635	649	464	1444	410	1342
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.31	0.30	0.18	0.31	0.56	0.27	0.34	0.44	0.18	0.37

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	66	160	99	114	333	157	117	497	73	68	354	87
Future Volume (vph)	66	160	99	114	333	157	117	497	73	68	354	87
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.98	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98		1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1751	1863	1581	1799	1881	1573	1803	3484		1800	3439	
Flt Permitted	0.32	1.00	1.00	0.54	1.00	1.00	0.41	1.00		0.35	1.00	
Satd. Flow (perm)	585	1863	1581	1021	1881	1573	776	3484		666	3439	
Peak-hour factor, PHF	0.74	0.85	0.90	0.88	0.93	0.88	0.74	0.90	0.82	0.93	0.92	0.82
Adj. Flow (vph)	89	188	110	130	358	178	158	552	89	73	385	106
RTOR Reduction (vph)	0	0	84	0	0	132	0	12	0	0	24	0
Lane Group Flow (vph)	89	188	26	130	358	46	158	629	0	73	467	0
Confl. Peds. (#/hr)	4		9	9		4	4		14	14		4
Heavy Vehicles (%)	3%	2%	0%	0%	1%	1%	0%	1%	0%	0%	1%	1%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)	27.2	21.8	21.8	30.4	23.4	23.4	43.7	36.7		40.5	35.1	
Effective Green, g (s)	27.2	21.8	21.8	30.4	23.4	23.4	43.7	36.7		40.5	35.1	
Actuated g/C Ratio	0.30	0.24	0.24	0.33	0.26	0.26	0.48	0.40		0.45	0.39	
Clearance Time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	244	446	379	401	484	404	452	1406		364	1327	
v/s Ratio Prot	0.02	0.10		c0.02	c0.19		c0.03	c0.18		0.01	0.14	
v/s Ratio Perm	0.09		0.02	0.08		0.03	0.14			0.08		
v/c Ratio	0.36	0.42	0.07	0.32	0.74	0.11	0.35	0.45		0.20	0.35	
Uniform Delay, d1	24.0	29.2	26.7	21.8	31.0	25.8	13.6	19.7		14.7	19.8	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.9	0.6	0.1	0.5	5.9	0.1	0.5	1.0		0.3	0.7	
Delay (s)	24.9	29.9	26.8	22.3	36.8	25.9	14.1	20.8		15.0	20.6	
Level of Service	C	C	C	C	D	C	B	C		B	C	
Approach Delay (s)		27.9			31.1			19.4			19.8	
Approach LOS		C			C			B			B	

Intersection Summary						
HCM 2000 Control Delay	24.1	HCM 2000 Level of Service	C			
HCM 2000 Volume to Capacity ratio	0.54					
Actuated Cycle Length (s)	90.9	Sum of lost time (s)	20.0			
Intersection Capacity Utilization	75.5%	ICU Level of Service	D			
Analysis Period (min)	15					

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	5	5	0	5	0	713	7	2	499	0
Future Volume (Veh/h)	0	0	5	5	0	5	0	713	7	2	499	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	5	5	0	5	0	775	8	2	542	0
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)								56				
pX, platoon unblocked	0.88	0.88		0.88	0.88	0.88				0.88		
vC, conflicting volume	938	1329	271	1059	1325	392	542			783		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	651	1096	271	788	1092	28	542			474		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	99	98	100	99	100			100		
cM capacity (veh/h)	312	188	733	248	190	919	1037			964		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	5	10	388	396	273	271
Volume Left	0	5	0	0	2	0
Volume Right	5	5	0	8	0	0
cSH	733	391	1037	1700	964	1700
Volume to Capacity	0.01	0.03	0.00	0.23	0.00	0.16
Queue Length 95th (m)	0.2	0.6	0.0	0.0	0.0	0.0
Control Delay (s)	9.9	14.5	0.0	0.0	0.1	0.0
Lane LOS	A	B			A	
Approach Delay (s)	9.9	14.5	0.0		0.0	
Approach LOS	A	B				

Intersection Summary					
Average Delay	0.2				
Intersection Capacity Utilization	31.7%	ICU Level of Service		A	
Analysis Period (min)	15				

Appendix D

2020 Background Traffic Operations Reports

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	162	342	207	74	233	62	132	355	117	482
v/c Ratio	0.45	0.71	0.37	0.25	0.56	0.14	0.29	0.25	0.21	0.37
Control Delay	23.2	39.4	5.9	19.3	35.0	0.8	14.1	16.4	13.2	20.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	23.2	39.4	5.9	19.3	35.0	0.8	14.1	16.4	13.2	20.2
Queue Length 50th (m)	19.5	57.7	0.0	8.4	36.9	0.0	11.5	18.3	10.1	29.8
Queue Length 95th (m)	24.5	87.4	0.0	16.8	41.5	0.7	16.2	29.2	22.9	47.4
Internal Link Dist (m)		85.5			159.1			146.2		32.5
Turn Bay Length (m)	50.0		60.0	50.0		50.0	35.0		40.0	
Base Capacity (vph)	357	632	673	300	614	586	453	1425	551	1295
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.45	0.54	0.31	0.25	0.38	0.11	0.29	0.25	0.21	0.37

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	112	308	116	66	156	57	79	209	88	105	333	72
Future Volume (vph)	112	308	116	66	156	57	79	209	88	105	333	72
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.99	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.96		1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1735	1863	1583	1767	1810	1490	1733	3360		1781	3311	
Flt Permitted	0.46	1.00	1.00	0.34	1.00	1.00	0.42	1.00		0.54	1.00	
Satd. Flow (perm)	834	1863	1583	636	1810	1490	759	3360		1011	3311	
Peak-hour factor, PHF	0.69	0.90	0.56	0.89	0.67	0.92	0.60	0.82	0.88	0.90	0.87	0.73
Adj. Flow (vph)	162	342	207	74	233	62	132	255	100	117	383	99
RTOR Reduction (vph)	0	0	154	0	0	47	0	39	0	0	22	0
Lane Group Flow (vph)	162	342	53	74	233	15	132	316	0	117	460	0
Confl. Peds. (#/hr)	1		8	8		1	6		7	7		6
Heavy Vehicles (%)	4%	2%	0%	2%	5%	7%	4%	2%	2%	1%	4%	9%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)	30.0	23.0	23.0	26.8	21.4	21.4	43.7	36.7		40.5	35.1	
Effective Green, g (s)	30.0	23.0	23.0	26.8	21.4	21.4	43.7	36.7		40.5	35.1	
Actuated g/C Ratio	0.33	0.25	0.25	0.30	0.24	0.24	0.48	0.41		0.45	0.39	
Clearance Time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	346	473	402	255	428	352	441	1362		498	1284	
v/s Ratio Prot	c0.04	c0.18		0.02	0.13		c0.02	0.09		0.01	c0.14	
v/s Ratio Perm	0.12		0.03	0.07		0.01	0.12			0.09		
v/c Ratio	0.47	0.72	0.13	0.29	0.54	0.04	0.30	0.23		0.23	0.36	
Uniform Delay, d1	22.5	30.8	26.0	23.8	30.3	26.6	13.2	17.7		14.8	19.7	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.0	5.4	0.1	0.6	1.4	0.0	0.4	0.4		0.2	0.8	
Delay (s)	23.5	36.2	26.2	24.4	31.7	26.7	13.6	18.1		15.0	20.5	
Level of Service	C	D	C	C	C	C	B	B		B	C	
Approach Delay (s)		30.4			29.4			16.9			19.4	
Approach LOS		C			C			B			B	

Intersection Summary					
HCM 2000 Control Delay	24.2	HCM 2000 Level of Service		C	
HCM 2000 Volume to Capacity ratio	0.49				
Actuated Cycle Length (s)	90.5	Sum of lost time (s)		20.0	
Intersection Capacity Utilization	74.3%	ICU Level of Service		D	
Analysis Period (min)	15				

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	0	0	0	4	372	2	0	510	2
Future Volume (Veh/h)	0	0	0	0	0	0	4	372	2	0	510	2
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	0	0	0	4	404	2	0	554	2
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)								56				
pX, platoon unblocked	0.99	0.99		0.99	0.99	0.99				0.99		
vC, conflicting volume	765	969	278	690	969	203	556			406		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	735	942	278	659	942	166	556			371		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	100	100	100			100		
cM capacity (veh/h)	306	261	725	347	261	845	1025			1182		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	0	0	206	204	277	279
Volume Left	0	0	4	0	0	0
Volume Right	0	0	0	2	0	2
cSH	1700	1700	1025	1700	1182	1700
Volume to Capacity	0.00	0.00	0.00	0.12	0.00	0.16
Queue Length 95th (m)	0.0	0.0	0.1	0.0	0.0	0.0
Control Delay (s)	0.0	0.0	0.2	0.0	0.0	0.0
Lane LOS	A	A	A			
Approach Delay (s)	0.0	0.0	0.1		0.0	
Approach LOS	A	A				

Intersection Summary					
Average Delay	0.0				
Intersection Capacity Utilization	17.5%	ICU Level of Service		A	
Analysis Period (min)	15				

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	91	193	112	132	366	182	161	653	74	501
v/c Ratio	0.32	0.44	0.24	0.32	0.74	0.33	0.35	0.45	0.18	0.37
Control Delay	20.5	31.7	5.6	20.2	40.4	5.8	15.2	21.9	13.6	20.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	20.5	31.7	5.6	20.2	40.4	5.8	15.2	21.9	13.6	20.4
Queue Length 50th (m)	10.5	29.7	0.0	15.5	62.7	0.0	14.7	45.8	6.4	31.5
Queue Length 95th (m)	16.3	45.9	10.7	26.9	94.1	14.2	24.2	70.5	15.7	50.8
Internal Link Dist (m)		85.5			159.1			146.2		32.5
Turn Bay Length (m)	50.0		60.0	50.0		50.0	35.0		40.0	
Base Capacity (vph)	283	627	613	411	633	650	457	1440	403	1337
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.32	0.31	0.18	0.32	0.58	0.28	0.35	0.45	0.18	0.37

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	67	164	101	116	340	160	119	507	74	69	361	89
Future Volume (vph)	67	164	101	116	340	160	119	507	74	69	361	89
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.98	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98		1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1751	1863	1581	1799	1881	1573	1803	3485		1800	3438	
Flt Permitted	0.31	1.00	1.00	0.53	1.00	1.00	0.40	1.00		0.34	1.00	
Satd. Flow (perm)	565	1863	1581	1007	1881	1573	762	3485		650	3438	
Peak-hour factor, PHF	0.74	0.85	0.90	0.88	0.93	0.88	0.74	0.90	0.82	0.93	0.92	0.82
Adj. Flow (vph)	91	193	112	132	366	182	161	563	90	74	392	109
RTOR Reduction (vph)	0	0	85	0	0	135	0	12	0	0	25	0
Lane Group Flow (vph)	91	193	27	132	366	47	161	641	0	74	476	0
Confl. Peds. (#/hr)	4		9	9		4	4		14	14		4
Heavy Vehicles (%)	3%	2%	0%	0%	1%	1%	0%	1%	0%	0%	1%	1%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)	27.5	22.1	22.1	30.7	23.7	23.7	43.7	36.7		40.5	35.1	
Effective Green, g (s)	27.5	22.1	22.1	30.7	23.7	23.7	43.7	36.7		40.5	35.1	
Actuated g/C Ratio	0.30	0.24	0.24	0.34	0.26	0.26	0.48	0.40		0.44	0.38	
Clearance Time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	240	451	383	399	488	408	445	1402		356	1323	
v/s Ratio Prot	0.02	0.10		c0.03	c0.19		c0.03	c0.18		0.01	0.14	
v/s Ratio Perm	0.09		0.02	0.09		0.03	0.15			0.08		
v/c Ratio	0.38	0.43	0.07	0.33	0.75	0.12	0.36	0.46		0.21	0.36	
Uniform Delay, d1	24.0	29.2	26.6	21.7	31.0	25.8	13.8	20.0		14.9	20.0	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.0	0.7	0.1	0.5	6.4	0.1	0.5	1.1		0.3	0.8	
Delay (s)	25.0	29.9	26.7	22.2	37.4	25.9	14.3	21.0		15.2	20.8	
Level of Service	C	C	C	C	D	C	B	C		B	C	
Approach Delay (s)		27.9			31.4			19.7			20.1	
Approach LOS		C			C			B			C	

Intersection Summary				
HCM 2000 Control Delay	24.3	HCM 2000 Level of Service	C	
HCM 2000 Volume to Capacity ratio	0.55			
Actuated Cycle Length (s)	91.2	Sum of lost time (s)	20.0	
Intersection Capacity Utilization	75.9%	ICU Level of Service	D	
Analysis Period (min)	15			

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	5	5	0	5	0	727	7	2	509	0
Future Volume (Veh/h)	0	0	5	5	0	5	0	727	7	2	509	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	5	5	0	5	0	790	8	2	553	0
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)								56				
pX, platoon unblocked	0.87	0.87		0.87	0.87	0.87				0.87		
vC, conflicting volume	957	1355	276	1080	1351	399	553			798		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	663	1118	276	803	1114	25	553			481		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	99	98	100	99	100			100		
cM capacity (veh/h)	304	182	727	241	183	920	1027			955		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	5	10	395	403	278	276
Volume Left	0	5	0	0	2	0
Volume Right	5	5	0	8	0	0
cSH	727	382	1027	1700	955	1700
Volume to Capacity	0.01	0.03	0.00	0.24	0.00	0.16
Queue Length 95th (m)	0.2	0.6	0.0	0.0	0.1	0.0
Control Delay (s)	10.0	14.7	0.0	0.0	0.1	0.0
Lane LOS	A	B			A	
Approach Delay (s)	10.0	14.7	0.0		0.0	
Approach LOS	A	B				

Intersection Summary					
Average Delay	0.2				
Intersection Capacity Utilization	32.1%	ICU Level of Service		A	
Analysis Period (min)	15				

Appendix E

2020 Total Traffic Operations Reports

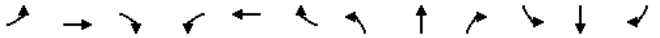
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	162	347	214	74	234	63	133	351	121	486
v/c Ratio	0.45	0.72	0.38	0.25	0.56	0.14	0.29	0.26	0.22	0.38
Control Delay	23.1	39.7	5.8	19.3	34.9	0.9	14.2	16.8	13.3	20.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	23.1	39.7	5.8	19.3	34.9	0.9	14.2	16.8	13.3	20.3
Queue Length 50th (m)	19.5	58.7	0.0	8.4	37.0	0.0	11.7	18.0	10.6	30.3
Queue Length 95th (m)	24.5	89.1	0.0	16.8	41.7	0.9	16.3	28.7	23.6	47.8
Internal Link Dist (m)		85.5			159.1			146.2		32.5
Turn Bay Length (m)	50.0		60.0	50.0		50.0	35.0		40.0	
Base Capacity (vph)	358	631	677	299	613	585	456	1329	548	1293
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.45	0.55	0.32	0.25	0.38	0.11	0.29	0.26	0.22	0.38

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	112	312	120	66	157	58	80	206	88	109	337	72
Future Volume (vph)	112	312	120	66	157	58	80	206	88	109	337	72
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.99	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.96		1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1735	1863	1583	1767	1810	1490	1732	3358		1781	3313	
Flt Permitted	0.46	1.00	1.00	0.34	1.00	1.00	0.43	1.00		0.54	1.00	
Satd. Flow (perm)	839	1863	1583	631	1810	1490	785	3358		1005	3313	
Peak-hour factor, PHF	0.69	0.90	0.56	0.89	0.67	0.92	0.60	0.82	0.88	0.90	0.87	0.73
Adj. Flow (vph)	162	347	214	74	234	63	133	251	100	121	387	99
RTOR Reduction (vph)	0	0	159	0	0	48	0	41	0	0	22	0
Lane Group Flow (vph)	162	347	55	74	234	15	133	310	0	121	464	0
Confl. Peds. (#/hr)	1		8	8		1	6		7	7		6
Heavy Vehicles (%)	4%	2%	0%	2%	5%	7%	4%	2%	2%	1%	4%	9%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)	30.1	23.1	23.1	26.9	21.5	21.5	41.2	34.2		41.2	34.2	
Effective Green, g (s)	30.1	23.1	23.1	26.9	21.5	21.5	41.2	34.2		41.2	34.2	
Actuated g/C Ratio	0.34	0.26	0.26	0.30	0.24	0.24	0.46	0.38		0.46	0.38	
Clearance Time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	351	479	407	257	433	357	434	1280		522	1263	
v/s Ratio Prot	c0.04	c0.19		0.02	0.13		c0.02	0.09		0.02	c0.14	
v/s Ratio Perm	0.12		0.03	0.07		0.01	0.12			0.09		
v/c Ratio	0.46	0.72	0.14	0.29	0.54	0.04	0.31	0.24		0.23	0.37	
Uniform Delay, d1	22.1	30.4	25.6	23.4	29.8	26.2	14.3	18.9		14.1	20.0	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.0	5.4	0.2	0.6	1.4	0.0	0.4	0.4		0.2	0.8	
Delay (s)	23.0	35.8	25.8	24.0	31.2	26.2	14.7	19.4		14.3	20.8	
Level of Service	C	D	C	C	C	C	B	B		B	C	
Approach Delay (s)		30.0			28.9			18.1			19.5	
Approach LOS		C			C			B			B	

Intersection Summary				
HCM 2000 Control Delay	24.2	HCM 2000 Level of Service	C	
HCM 2000 Volume to Capacity ratio	0.50			
Actuated Cycle Length (s)	89.7	Sum of lost time (s)	20.0	
Intersection Capacity Utilization	74.7%	ICU Level of Service	D	
Analysis Period (min)	15			

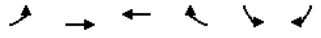
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	0	8	0	0	0	2	372	2	0	510	3
Future Volume (Veh/h)	5	0	8	0	0	0	2	372	2	0	510	3
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	0	9	0	0	0	2	404	2	0	554	3
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)								56				
pX, platoon unblocked	0.99	0.99		0.99	0.99	0.99				0.99		
vC, conflicting volume	762	966	278	695	966	203	557			406		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	733	940	278	666	940	168	557			373		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	100	99	100	100	100	100			100		
cM capacity (veh/h)	308	262	725	340	262	843	1024			1181		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	14	0	204	204	277	280
Volume Left	5	0	2	0	0	0
Volume Right	9	0	0	2	0	3
cSH	488	1700	1024	1700	1181	1700
Volume to Capacity	0.03	0.00	0.00	0.12	0.00	0.16
Queue Length 95th (m)	0.7	0.0	0.0	0.0	0.0	0.0
Control Delay (s)	12.6	0.0	0.1	0.0	0.0	0.0
Lane LOS	B	A	A			
Approach Delay (s)	12.6	0.0	0.1		0.0	
Approach LOS	B	A				

Intersection Summary					
Average Delay		0.2			
Intersection Capacity Utilization		24.2%	ICU Level of Service		A
Analysis Period (min)		15			



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	536	307	2	8	5
Future Volume (Veh/h)	3	536	307	2	8	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)	3	583	334	2	9	5
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		TWLTL	TWLTL			
Median storage veh)		2	2			
Upstream signal (m)			109			
pX, platoon unblocked	0.92				0.92	0.92
vC, conflicting volume	336				924	335
vC1, stage 1 conf vol					335	
vC2, stage 2 conf vol					589	
vCu, unblocked vol	234				874	233
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)					5.4	
tF (s)	2.2				3.5	3.3
p0 queue free %	100				98	99
cM capacity (veh/h)	1237				499	746

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	586	336	14
Volume Left	3	0	9
Volume Right	0	2	5
cSH	1237	1700	566
Volume to Capacity	0.00	0.20	0.02
Queue Length 95th (m)	0.1	0.0	0.6
Control Delay (s)	0.1	0.0	11.5
Lane LOS	A		B
Approach Delay (s)	0.1	0.0	11.5
Approach LOS			B

Intersection Summary				
Average Delay		0.2		
Intersection Capacity Utilization		40.6%	ICU Level of Service	A
Analysis Period (min)		15		

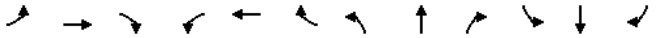
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	91	195	116	132	371	188	168	659	76	498
v/c Ratio	0.32	0.44	0.25	0.32	0.74	0.34	0.37	0.46	0.19	0.37
Control Delay	20.5	31.7	6.0	20.1	40.6	5.8	15.5	22.1	13.8	20.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	20.5	31.7	6.0	20.1	40.6	5.8	15.5	22.1	13.8	20.4
Queue Length 50th (m)	10.5	30.0	0.0	15.5	63.7	0.0	15.5	46.6	6.7	31.5
Queue Length 95th (m)	16.3	46.2	11.5	26.9	95.6	14.4	25.1	71.3	16.0	50.4
Internal Link Dist (m)		85.5			159.1			146.2		32.5
Turn Bay Length (m)	50.0		60.0	50.0		50.0	35.0		40.0	
Base Capacity (vph)	281	626	612	411	632	653	457	1439	399	1334
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.32	0.31	0.19	0.32	0.59	0.29	0.37	0.46	0.19	0.37

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	67	166	104	116	345	165	124	512	74	71	358	89
Future Volume (vph)	67	166	104	116	345	165	124	512	74	71	358	89
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.98	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98		1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1752	1863	1581	1799	1881	1573	1803	3486		1801	3437	
Flt Permitted	0.30	1.00	1.00	0.53	1.00	1.00	0.40	1.00		0.34	1.00	
Satd. Flow (perm)	553	1863	1581	1002	1881	1573	765	3486		642	3437	
Peak-hour factor, PHF	0.74	0.85	0.90	0.88	0.93	0.88	0.74	0.90	0.82	0.93	0.92	0.82
Adj. Flow (vph)	91	195	116	132	371	188	168	569	90	76	389	109
RTOR Reduction (vph)	0	0	88	0	0	139	0	12	0	0	25	0
Lane Group Flow (vph)	91	195	28	132	371	49	168	647	0	76	473	0
Confl. Peds. (#/hr)	4		9	9		4	4		14	14		4
Heavy Vehicles (%)	3%	2%	0%	0%	1%	1%	0%	1%	0%	0%	1%	1%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)	27.7	22.3	22.3	30.9	23.9	23.9	43.7	36.7		40.5	35.1	
Effective Green, g (s)	27.7	22.3	22.3	30.9	23.9	23.9	43.7	36.7		40.5	35.1	
Actuated g/C Ratio	0.30	0.24	0.24	0.34	0.26	0.26	0.48	0.40		0.44	0.38	
Clearance Time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	238	454	385	399	491	411	445	1399		352	1319	
v/s Ratio Prot	0.02	0.10		c0.03	c0.20		c0.03	c0.19		0.01	0.14	
v/s Ratio Perm	0.09		0.02	0.09		0.03	0.15			0.08		
v/c Ratio	0.38	0.43	0.07	0.33	0.76	0.12	0.38	0.46		0.22	0.36	
Uniform Delay, d1	24.0	29.2	26.6	21.7	31.1	25.7	13.9	20.1		15.0	20.1	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.0	0.7	0.1	0.5	6.5	0.1	0.5	1.1		0.3	0.8	
Delay (s)	25.0	29.8	26.7	22.2	37.6	25.9	14.4	21.2		15.3	20.9	
Level of Service	C	C	C	C	D	C	B	C		B	C	
Approach Delay (s)		27.8			31.5			19.8			20.1	
Approach LOS		C			C			B			C	

Intersection Summary				
HCM 2000 Control Delay	24.4	HCM 2000 Level of Service	C	
HCM 2000 Volume to Capacity ratio	0.56			
Actuated Cycle Length (s)	91.4	Sum of lost time (s)	20.0	
Intersection Capacity Utilization	76.4%	ICU Level of Service	D	
Analysis Period (min)	15			

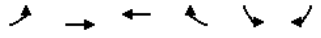
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	8	0	4	5	0	5	10	727	7	2	509	8
Future Volume (Veh/h)	8	0	4	5	0	5	10	727	7	2	509	8
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	9	0	4	5	0	5	11	790	8	2	553	9
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)								56				
pX, platoon unblocked	0.87	0.87		0.87	0.87	0.87				0.87		
vC, conflicting volume	984	1382	281	1100	1382	399	562			798		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	689	1145	281	823	1145	19	562			476		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	97	100	99	98	100	99	99			100		
cM capacity (veh/h)	289	173	722	231	173	926	1019			957		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	13	10	406	403	278	286
Volume Left	9	5	11	0	2	0
Volume Right	4	5	0	8	0	9
cSH	354	370	1019	1700	957	1700
Volume to Capacity	0.04	0.03	0.01	0.24	0.00	0.17
Queue Length 95th (m)	0.9	0.7	0.3	0.0	0.1	0.0
Control Delay (s)	15.6	15.0	0.3	0.0	0.1	0.0
Lane LOS	C	B	A		A	
Approach Delay (s)	15.6	15.0	0.2		0.0	
Approach LOS	C	B				

Intersection Summary				
Average Delay	0.4			
Intersection Capacity Utilization	37.4%	ICU Level of Service	A	
Analysis Period (min)	15			



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	5	332	548	10	5	6
Future Volume (Veh/h)	5	332	548	10	5	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)	5	361	596	11	5	7
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		TWLTL	TWLTL			
Median storage veh)		2	2			
Upstream signal (m)			109			
pX, platoon unblocked	0.77				0.77	0.77
vC, conflicting volume	607				972	602
vC1, stage 1 conf vol					602	
vC2, stage 2 conf vol					371	
vCu, unblocked vol	344				817	337
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)					5.4	
tF (s)	2.2				3.5	3.3
p0 queue free %	99				99	99
cM capacity (veh/h)	947				486	548

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	366	607	12
Volume Left	5	0	5
Volume Right	0	11	7
cSH	947	1700	521
Volume to Capacity	0.01	0.36	0.02
Queue Length 95th (m)	0.1	0.0	0.6
Control Delay (s)	0.2	0.0	12.1
Lane LOS	A		B
Approach Delay (s)	0.2	0.0	12.1
Approach LOS			B

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	39.4%	ICU Level of Service	A
Analysis Period (min)	15		

Appendix F

2025 Background Traffic Operations Reports

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	180	377	229	82	257	68	145	392	129	532
v/c Ratio	0.51	0.75	0.38	0.29	0.58	0.15	0.34	0.30	0.25	0.42
Control Delay	24.6	40.6	5.6	19.7	35.2	1.4	15.5	18.1	14.2	21.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	24.6	40.6	5.6	19.7	35.2	1.4	15.5	18.1	14.2	21.6
Queue Length 50th (m)	21.9	65.2	0.0	9.4	41.3	0.0	13.5	21.8	11.8	35.2
Queue Length 95th (m)	27.0	97.8	0.0	18.2	45.4	1.8	17.5	32.6	24.9	52.8
Internal Link Dist (m)		85.5			159.1			146.2		32.5
Turn Bay Length (m)	50.0		60.0	50.0		50.0	35.0		40.0	
Base Capacity (vph)	351	621	680	287	603	578	422	1310	512	1273
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.51	0.61	0.34	0.29	0.43	0.12	0.34	0.30	0.25	0.42

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	124	339	128	73	172	63	87	231	97	116	367	80
Future Volume (vph)	124	339	128	73	172	63	87	231	97	116	367	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.99	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.96		1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1735	1863	1583	1768	1810	1490	1733	3361		1782	3310	
Flt Permitted	0.43	1.00	1.00	0.30	1.00	1.00	0.39	1.00		0.50	1.00	
Satd. Flow (perm)	786	1863	1583	564	1810	1490	720	3361		937	3310	
Peak-hour factor, PHF	0.69	0.90	0.56	0.89	0.67	0.92	0.60	0.82	0.88	0.90	0.87	0.73
Adj. Flow (vph)	180	377	229	82	257	68	145	282	110	129	422	110
RTOR Reduction (vph)	0	0	167	0	0	51	0	40	0	0	23	0
Lane Group Flow (vph)	180	377	62	82	257	17	145	352	0	129	510	0
Confl. Peds. (#/hr)	1		8	8		1	6		7	7		6
Heavy Vehicles (%)	4%	2%	0%	2%	5%	7%	4%	2%	2%	1%	4%	9%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)	31.6	24.6	24.6	28.4	23.0	23.0	41.2	34.2		41.2	34.2	
Effective Green, g (s)	31.6	24.6	24.6	28.4	23.0	23.0	41.2	34.2		41.2	34.2	
Actuated g/C Ratio	0.35	0.27	0.27	0.31	0.25	0.25	0.45	0.38		0.45	0.38	
Clearance Time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	345	502	426	246	456	375	403	1260		488	1241	
v/s Ratio Prot	c0.04	c0.20		0.02	0.14		c0.03	0.10		0.02	c0.15	
v/s Ratio Perm	0.14		0.04	0.08		0.01	0.13			0.10		
v/c Ratio	0.52	0.75	0.14	0.33	0.56	0.05	0.36	0.28		0.26	0.41	
Uniform Delay, d1	22.0	30.5	25.3	23.3	29.7	25.8	15.1	19.9		14.8	21.1	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.4	6.2	0.2	0.8	1.6	0.1	0.6	0.6		0.3	1.0	
Delay (s)	23.5	36.7	25.5	24.1	31.3	25.8	15.6	20.4		15.1	22.1	
Level of Service	C	D	C	C	C	C	B	C		B	C	
Approach Delay (s)		30.4			28.9			19.2			20.7	
Approach LOS		C			C			B			C	

Intersection Summary					
HCM 2000 Control Delay	25.0	HCM 2000 Level of Service		C	
HCM 2000 Volume to Capacity ratio	0.54				
Actuated Cycle Length (s)	91.2	Sum of lost time (s)		20.0	
Intersection Capacity Utilization	76.2%	ICU Level of Service		D	
Analysis Period (min)	15				

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	0	0	0	5	411	2	0	563	2
Future Volume (Veh/h)	0	0	0	0	0	0	5	411	2	0	563	2
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	0	0	0	5	447	2	0	612	2
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)								56				
pX, platoon unblocked	0.97	0.97		0.97	0.97	0.97				0.97		
vC, conflicting volume	846	1072	307	764	1072	224	614			449		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	786	1018	307	701	1018	147	614			377		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	100	100	100	99			100		
cM capacity (veh/h)	277	231	695	319	231	856	975			1160		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	0	0	228	226	306	308
Volume Left	0	0	5	0	0	0
Volume Right	0	0	0	2	0	2
cSH	1700	1700	975	1700	1160	1700
Volume to Capacity	0.00	0.00	0.01	0.13	0.00	0.18
Queue Length 95th (m)	0.0	0.0	0.1	0.0	0.0	0.0
Control Delay (s)	0.0	0.0	0.2	0.0	0.0	0.0
Lane LOS	A	A	A			
Approach Delay (s)	0.0	0.0	0.1		0.0	
Approach LOS	A	A				

Intersection Summary					
Average Delay	0.1				
Intersection Capacity Utilization	19.0%	ICU Level of Service		A	
Analysis Period (min)	15				

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	100	213	123	145	403	201	178	722	83	554
v/c Ratio	0.38	0.46	0.25	0.36	0.78	0.35	0.42	0.51	0.23	0.42
Control Delay	21.4	31.7	6.3	20.5	42.1	6.4	17.1	23.6	14.7	21.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	21.4	31.7	6.3	20.5	42.1	6.4	17.1	23.6	14.7	21.8
Queue Length 50th (m)	11.6	33.1	0.0	17.2	70.7	1.4	17.4	54.4	7.7	37.5
Queue Length 95th (m)	17.6	50.3	12.8	29.2	105.2	16.3	26.4	79.3	17.2	57.1
Internal Link Dist (m)		85.5			159.1			146.2		32.5
Turn Bay Length (m)	50.0		60.0	50.0		50.0	35.0		40.0	
Base Capacity (vph)	264	618	606	405	623	649	421	1419	363	1317
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.38	0.34	0.20	0.36	0.65	0.31	0.42	0.51	0.23	0.42

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	74	181	111	128	375	177	132	560	82	77	399	98
Future Volume (vph)	74	181	111	128	375	177	132	560	82	77	399	98
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.98	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98		1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1752	1863	1581	1800	1881	1573	1803	3484		1802	3438	
Flt Permitted	0.26	1.00	1.00	0.50	1.00	1.00	0.36	1.00		0.30	1.00	
Satd. Flow (perm)	478	1863	1581	953	1881	1573	690	3484		566	3438	
Peak-hour factor, PHF	0.74	0.85	0.90	0.88	0.93	0.88	0.74	0.90	0.82	0.93	0.92	0.82
Adj. Flow (vph)	100	213	123	145	403	201	178	622	100	83	434	120
RTOR Reduction (vph)	0	0	92	0	0	139	0	12	0	0	24	0
Lane Group Flow (vph)	100	213	31	145	403	62	178	710	0	83	530	0
Confl. Peds. (#/hr)	4		9	9		4	4		14	14		4
Heavy Vehicles (%)	3%	2%	0%	0%	1%	1%	0%	1%	0%	0%	1%	1%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)	28.9	23.5	23.5	32.1	25.1	25.1	43.8	36.8		40.6	35.2	
Effective Green, g (s)	28.9	23.5	23.5	32.1	25.1	25.1	43.8	36.8		40.6	35.2	
Actuated g/C Ratio	0.31	0.25	0.25	0.35	0.27	0.27	0.47	0.40		0.44	0.38	
Clearance Time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	223	472	400	393	509	425	410	1383		319	1305	
v/s Ratio Prot	0.03	0.11		c0.03	c0.21		c0.03	c0.20		0.02	0.15	
v/s Ratio Perm	0.11		0.02	0.10		0.04	0.17			0.10		
v/c Ratio	0.45	0.45	0.08	0.37	0.79	0.15	0.43	0.51		0.26	0.41	
Uniform Delay, d1	24.1	29.2	26.3	21.7	31.4	25.7	14.6	21.2		15.7	21.1	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.4	0.7	0.1	0.6	8.2	0.2	0.7	1.4		0.4	0.9	
Delay (s)	25.6	29.9	26.4	22.3	39.6	25.8	15.4	22.5		16.1	22.0	
Level of Service	C	C	C	C	D	C	B	C		B	C	
Approach Delay (s)		27.9			32.6			21.1			21.3	
Approach LOS		C			C			C			C	

Intersection Summary					
HCM 2000 Control Delay	25.4	HCM 2000 Level of Service		C	
HCM 2000 Volume to Capacity ratio	0.61				
Actuated Cycle Length (s)	92.7	Sum of lost time (s)		20.0	
Intersection Capacity Utilization	78.2%	ICU Level of Service		D	
Analysis Period (min)	15				

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	6	6	0	6	0	803	8	2	562	0
Future Volume (Veh/h)	0	0	6	6	0	6	0	803	8	2	562	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	7	7	0	7	0	873	9	2	611	0
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)								56				
pX, platoon unblocked	0.85	0.85		0.85	0.85	0.85				0.85		
vC, conflicting volume	1058	1497	306	1194	1492	441	611			882		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	726	1240	306	885	1235	3	611			520		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	99	97	100	99	100			100		
cM capacity (veh/h)	267	151	696	205	152	927	978			902		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	7	14	436	446	308	306
Volume Left	0	7	0	0	2	0
Volume Right	7	7	0	9	0	0
cSH	696	335	978	1700	902	1700
Volume to Capacity	0.01	0.04	0.00	0.26	0.00	0.18
Queue Length 95th (m)	0.2	1.0	0.0	0.0	0.1	0.0
Control Delay (s)	10.2	16.2	0.0	0.0	0.1	0.0
Lane LOS	B	C			A	
Approach Delay (s)	10.2	16.2	0.0		0.0	
Approach LOS	B	C				

Intersection Summary					
Average Delay	0.2				
Intersection Capacity Utilization	35.2%	ICU Level of Service		A	
Analysis Period (min)	15				

Appendix G

2025 Total Traffic Operations Reports

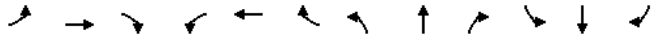
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	180	381	236	82	258	70	147	393	133	536
v/c Ratio	0.51	0.75	0.39	0.29	0.58	0.15	0.35	0.30	0.26	0.42
Control Delay	24.6	40.9	5.6	19.7	35.1	1.6	15.7	18.2	14.4	21.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	24.6	40.9	5.6	19.7	35.1	1.6	15.7	18.2	14.4	21.7
Queue Length 50th (m)	21.9	66.0	0.0	9.4	41.5	0.0	13.8	22.0	12.3	35.7
Queue Length 95th (m)	27.0	98.8	0.0	18.2	45.6	2.2	17.8	32.8	25.5	53.2
Internal Link Dist (m)		85.5			159.1			146.2		32.5
Turn Bay Length (m)	50.0		60.0	50.0		50.0	35.0		40.0	
Base Capacity (vph)	351	620	684	284	603	577	419	1308	511	1271
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.51	0.61	0.35	0.29	0.43	0.12	0.35	0.30	0.26	0.42

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	124	343	132	73	173	64	88	232	97	120	371	80
Future Volume (vph)	124	343	132	73	173	64	88	232	97	120	371	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.99	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.96		1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1735	1863	1583	1768	1810	1490	1733	3361		1782	3311	
Flt Permitted	0.43	1.00	1.00	0.30	1.00	1.00	0.39	1.00		0.50	1.00	
Satd. Flow (perm)	784	1863	1583	553	1810	1490	714	3361		935	3311	
Peak-hour factor, PHF	0.69	0.90	0.56	0.89	0.67	0.92	0.60	0.82	0.88	0.90	0.87	0.73
Adj. Flow (vph)	180	381	236	82	258	70	147	283	110	133	426	110
RTOR Reduction (vph)	0	0	172	0	0	52	0	40	0	0	23	0
Lane Group Flow (vph)	180	381	64	82	258	18	147	353	0	133	513	0
Confl. Peds. (#/hr)	1		8	8		1	6		7	7		6
Heavy Vehicles (%)	4%	2%	0%	2%	5%	7%	4%	2%	2%	1%	4%	9%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)	31.7	24.7	24.7	28.5	23.1	23.1	41.2	34.2		41.2	34.2	
Effective Green, g (s)	31.7	24.7	24.7	28.5	23.1	23.1	41.2	34.2		41.2	34.2	
Actuated g/C Ratio	0.35	0.27	0.27	0.31	0.25	0.25	0.45	0.37		0.45	0.37	
Clearance Time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	345	504	428	244	457	376	400	1258		486	1240	
v/s Ratio Prot	c0.04	c0.20		0.02	0.14		c0.03	0.11		0.02	c0.16	
v/s Ratio Perm	0.14		0.04	0.08		0.01	0.14			0.10		
v/c Ratio	0.52	0.76	0.15	0.34	0.56	0.05	0.37	0.28		0.27	0.41	
Uniform Delay, d1	22.0	30.5	25.3	23.3	29.7	25.8	15.2	20.0		14.9	21.1	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.4	6.4	0.2	0.8	1.6	0.1	0.6	0.6		0.3	1.0	
Delay (s)	23.5	36.9	25.5	24.1	31.3	25.8	15.7	20.5		15.2	22.2	
Level of Service	C	D	C	C	C	C	B	C		B	C	
Approach Delay (s)		30.5			28.9			19.2			20.8	
Approach LOS		C			C			B			C	

Intersection Summary				
HCM 2000 Control Delay	25.0	HCM 2000 Level of Service	C	
HCM 2000 Volume to Capacity ratio	0.55			
Actuated Cycle Length (s)	91.3	Sum of lost time (s)	20.0	
Intersection Capacity Utilization	76.6%	ICU Level of Service	D	
Analysis Period (min)	15			

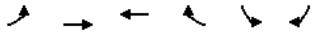
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	0	8	0	0	0	7	411	2	0	563	5
Future Volume (Veh/h)	5	0	8	0	0	0	7	411	2	0	563	5
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	0	9	0	0	0	8	447	2	0	612	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)								56				
pX, platoon unblocked	0.97	0.97		0.97	0.97	0.97				0.97		
vC, conflicting volume	854	1080	308	779	1081	224	617			449		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	791	1023	308	714	1024	143	617			374		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	100	99	100	100	100	99			100		
cM capacity (veh/h)	274	229	693	307	228	860	973			1162		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	14	0	232	226	306	311
Volume Left	5	0	8	0	0	0
Volume Right	9	0	0	2	0	5
cSH	448	1700	973	1700	1162	1700
Volume to Capacity	0.03	0.00	0.01	0.13	0.00	0.18
Queue Length 95th (m)	0.8	0.0	0.2	0.0	0.0	0.0
Control Delay (s)	13.3	0.0	0.4	0.0	0.0	0.0
Lane LOS	B	A	A			
Approach Delay (s)	13.3	0.0	0.2		0.0	
Approach LOS	B	A				

Intersection Summary				
Average Delay	0.3			
Intersection Capacity Utilization	26.4%	ICU Level of Service	A	
Analysis Period (min)	15			



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	3	591	339	2	8	5
Future Volume (Veh/h)	3	591	339	2	8	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)	3	642	368	2	9	5
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		TWLTL	TWLTL			
Median storage veh)		2	2			
Upstream signal (m)			109			
pX, platoon unblocked	0.90				0.90	0.90
vC, conflicting volume	370				1017	369
vC1, stage 1 conf vol					369	
vC2, stage 2 conf vol					648	
vCu, unblocked vol	243				963	242
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)					5.4	
tF (s)	2.2				3.5	3.3
p0 queue free %	100				98	99
cM capacity (veh/h)	1200				466	721

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	645	370	14
Volume Left	3	0	9
Volume Right	0	2	5
cSH	1200	1700	533
Volume to Capacity	0.00	0.22	0.03
Queue Length 95th (m)	0.1	0.0	0.6
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	0.2		
Intersection Capacity Utilization	43.5%	ICU Level of Service	A
Analysis Period (min)	15		

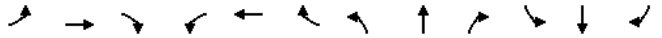
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	100	215	127	145	409	207	185	728	85	556
v/c Ratio	0.38	0.46	0.26	0.36	0.78	0.36	0.44	0.51	0.24	0.42
Control Delay	21.5	31.7	6.2	20.5	42.5	6.7	17.6	23.7	14.9	21.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	21.5	31.7	6.2	20.5	42.5	6.7	17.6	23.7	14.9	21.9
Queue Length 50th (m)	11.6	33.5	0.0	17.2	72.0	1.8	18.3	55.3	7.9	37.9
Queue Length 95th (m)	17.6	50.7	12.8	29.2	107.1	17.0	27.4	79.9	17.4	57.2
Internal Link Dist (m)		85.5			159.1			146.2		32.5
Turn Bay Length (m)	50.0		60.0	50.0		50.0	35.0		40.0	
Base Capacity (vph)	261	616	607	405	622	650	418	1417	359	1314
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.38	0.35	0.21	0.36	0.66	0.32	0.44	0.51	0.24	0.42

Intersection Summary

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	74	183	114	128	380	182	137	565	82	79	401	98
Future Volume (vph)	74	183	114	128	380	182	137	565	82	79	401	98
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95		1.00	0.95	
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	0.98	1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.98		1.00	0.97	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1752	1863	1581	1800	1881	1573	1803	3485		1802	3439	
Flt Permitted	0.25	1.00	1.00	0.50	1.00	1.00	0.36	1.00		0.29	1.00	
Satd. Flow (perm)	464	1863	1581	948	1881	1573	687	3485		558	3439	
Peak-hour factor, PHF	0.74	0.85	0.90	0.88	0.93	0.88	0.74	0.90	0.82	0.93	0.92	0.82
Adj. Flow (vph)	100	215	127	145	409	207	185	628	100	85	436	120
RTOR Reduction (vph)	0	0	95	0	0	141	0	12	0	0	24	0
Lane Group Flow (vph)	100	215	32	145	409	66	185	716	0	85	532	0
Confl. Peds. (#/hr)	4		9	9		4	4		14	14		4
Heavy Vehicles (%)	3%	2%	0%	0%	1%	1%	0%	1%	0%	0%	1%	1%
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)	29.1	23.7	23.7	32.3	25.3	25.3	43.8	36.8		40.6	35.2	
Effective Green, g (s)	29.1	23.7	23.7	32.3	25.3	25.3	43.8	36.8		40.6	35.2	
Actuated g/C Ratio	0.31	0.26	0.26	0.35	0.27	0.27	0.47	0.40		0.44	0.38	
Clearance Time (s)	4.0	6.0	6.0	4.0	6.0	6.0	4.0	6.0		4.0	6.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	220	475	403	393	512	428	407	1380		316	1303	
v/s Ratio Prot	0.03	0.12		c0.03	c0.22		c0.03	c0.21		0.02	0.15	
v/s Ratio Perm	0.12		0.02	0.10		0.04	0.18			0.10		
v/c Ratio	0.45	0.45	0.08	0.37	0.80	0.15	0.45	0.52		0.27	0.41	
Uniform Delay, d1	24.1	29.1	26.3	21.6	31.4	25.7	14.8	21.3		15.8	21.2	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.5	0.7	0.1	0.6	8.5	0.2	0.8	1.4		0.5	0.9	
Delay (s)	25.6	29.8	26.4	22.2	39.9	25.8	15.6	22.7		16.3	22.1	
Level of Service	C	C	C	C	D	C	B	C		B	C	
Approach Delay (s)		27.9			32.7			21.3			21.4	
Approach LOS		C			C			C			C	

Intersection Summary				
HCM 2000 Control Delay	25.5	HCM 2000 Level of Service	C	
HCM 2000 Volume to Capacity ratio	0.62			
Actuated Cycle Length (s)	92.9	Sum of lost time (s)	20.0	
Intersection Capacity Utilization	78.7%	ICU Level of Service	D	
Analysis Period (min)	15			

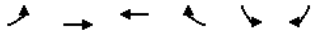
c Critical Lane Group



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	8	0	10	6	0	6	10	803	8	2	562	8
Future Volume (Veh/h)	8	0	10	6	0	6	10	803	8	2	562	8
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	9	0	11	7	0	7	11	873	9	2	611	9
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)								56				
pX, platoon unblocked	0.85	0.85		0.85	0.85	0.85				0.85		
vC, conflicting volume	1085	1524	310	1220	1524	441	620			882		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	752	1267	310	911	1267	0	620			514		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	96	100	98	96	100	99	99			100		
cM capacity (veh/h)	253	143	692	193	143	929	970			905		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	20	14	448	446	308	314
Volume Left	9	7	11	0	2	0
Volume Right	11	7	0	9	0	9
cSH	389	320	970	1700	905	1700
Volume to Capacity	0.05	0.04	0.01	0.26	0.00	0.18
Queue Length 95th (m)	1.3	1.1	0.3	0.0	0.1	0.0
Control Delay (s)	14.8	16.8	0.3	0.0	0.1	0.0
Lane LOS	B	C	A		A	
Approach Delay (s)	14.8	16.8	0.2		0.0	
Approach LOS	B	C				

Intersection Summary				
Average Delay	0.5			
Intersection Capacity Utilization	39.5%	ICU Level of Service	A	
Analysis Period (min)	15			



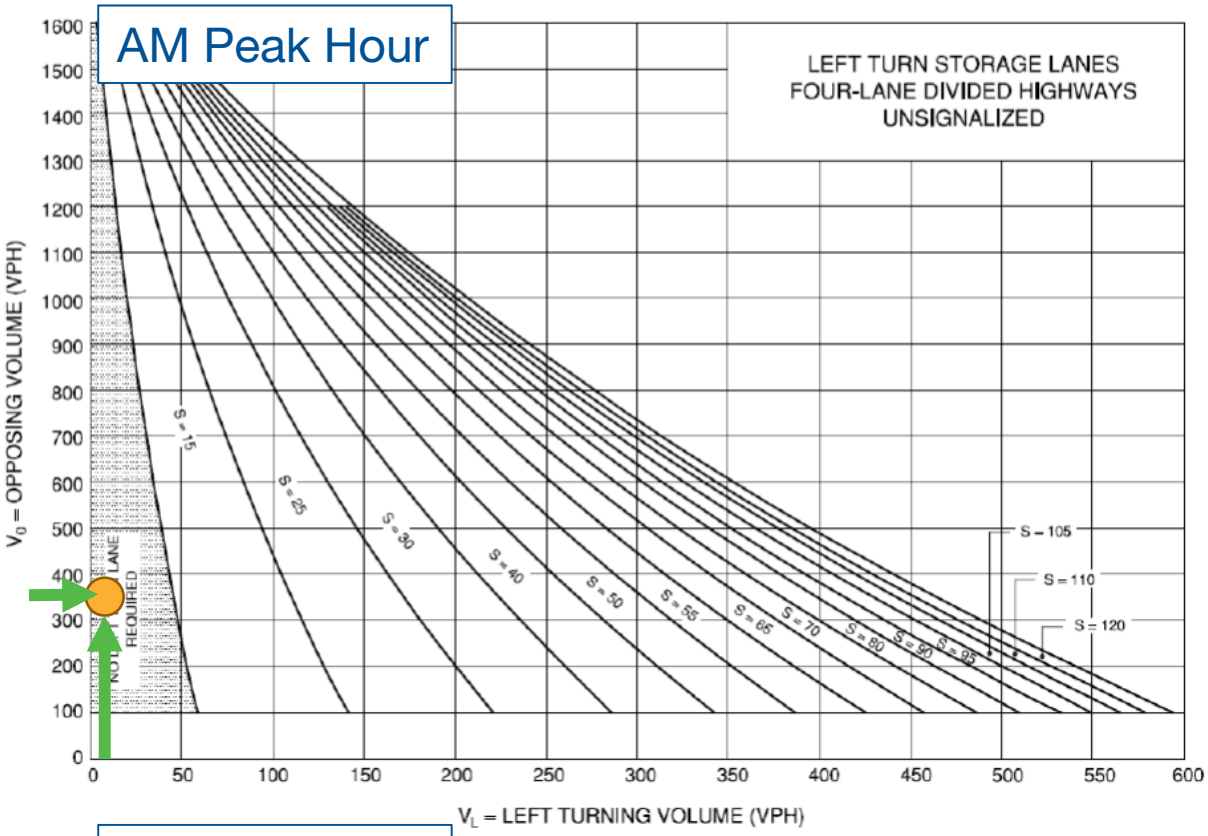
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	5	366	605	10	5	6
Future Volume (Veh/h)	5	366	605	10	5	6
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	398	658	11	5	7
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		TWLTL	TWLTL			
Median storage veh)		2	2			
Upstream signal (m)			109			
pX, platoon unblocked	0.74				0.74	0.74
vC, conflicting volume	669				1072	664
vC1, stage 1 conf vol					664	
vC2, stage 2 conf vol					408	
vCu, unblocked vol	379				922	372
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)					5.4	
tF (s)	2.2				3.5	3.3
p0 queue free %	99				99	99
cM capacity (veh/h)	883				447	503

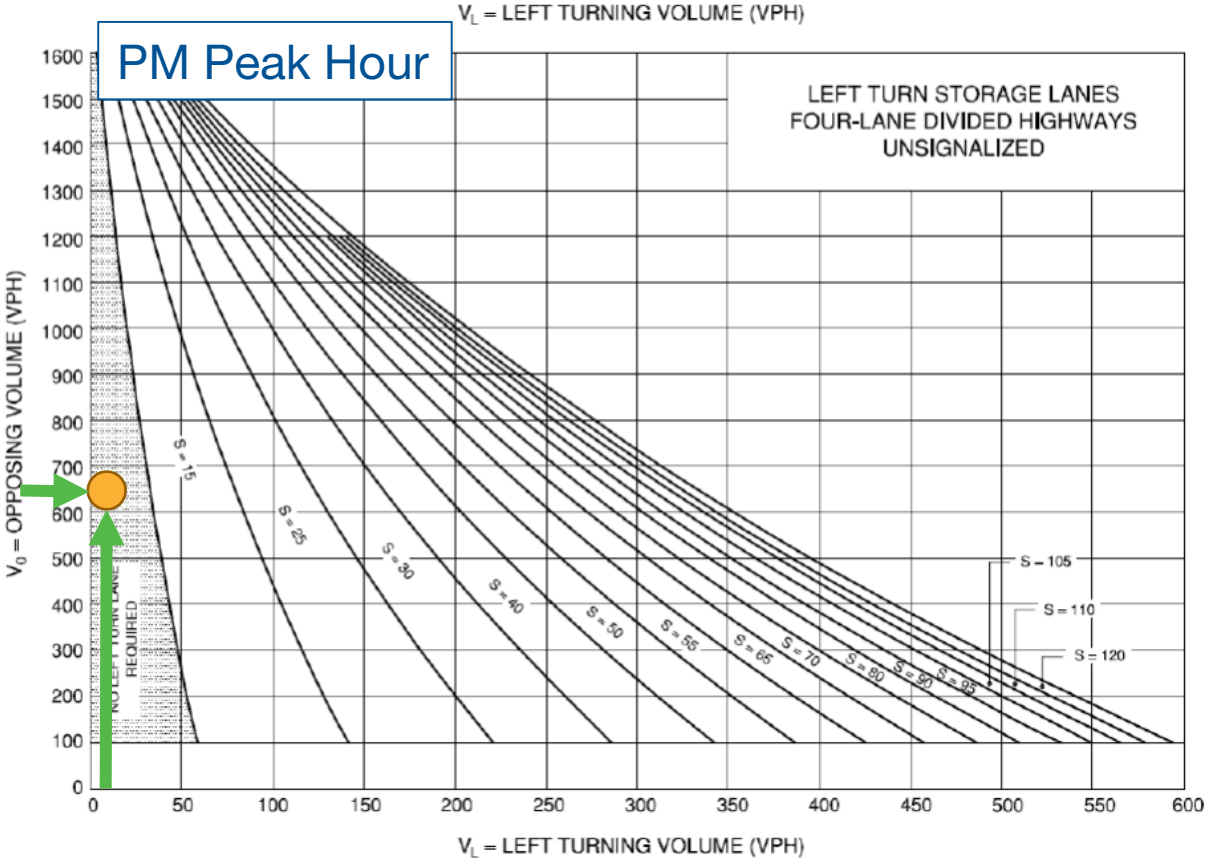
Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	403	669	12
Volume Left	5	0	5
Volume Right	0	11	7
cSH	883	1700	478
Volume to Capacity	0.01	0.39	0.03
Queue Length 95th (m)	0.1	0.0	0.6
Control Delay (s)	0.2	0.0	12.7
Lane LOS	A		B
Approach Delay (s)	0.2	0.0	12.7
Approach LOS			B

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	42.4%	ICU Level of Service	A
Analysis Period (min)	15		

Appendix H

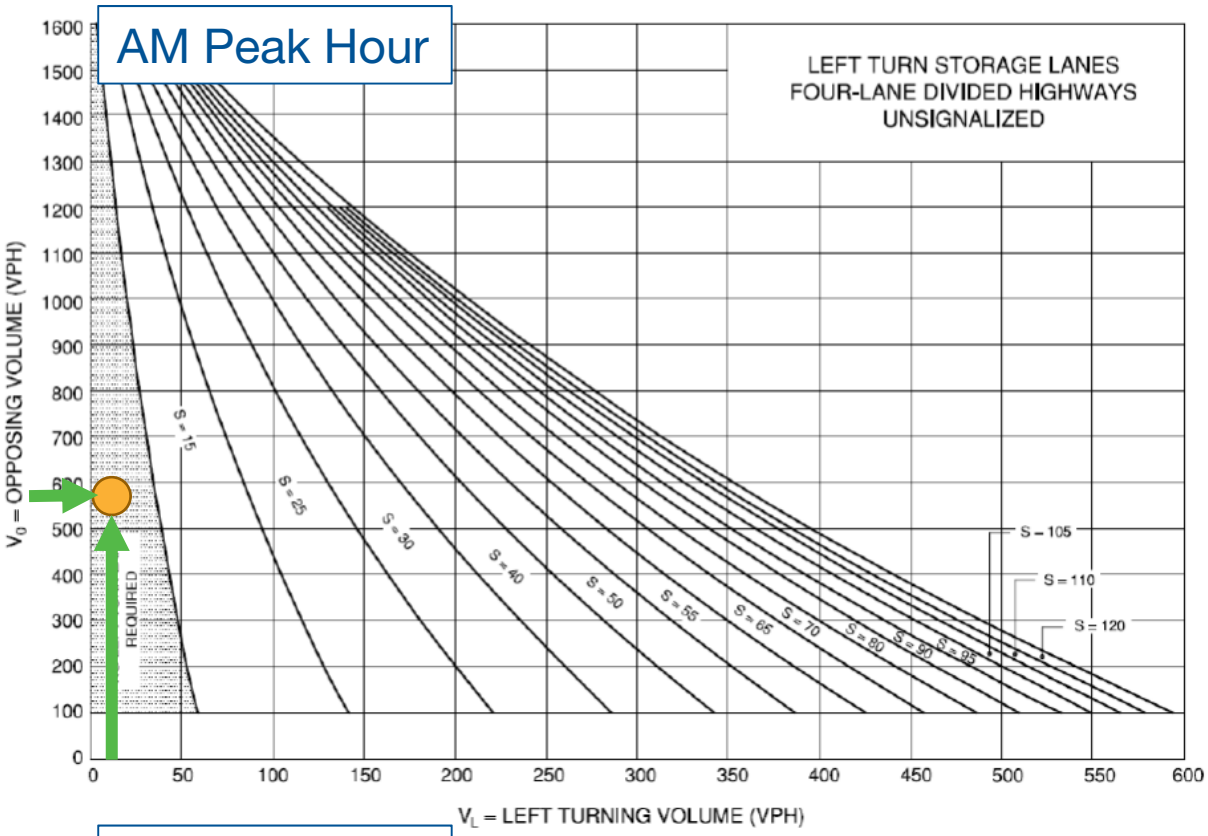
Left-Turn Lane Warrant Nomographs

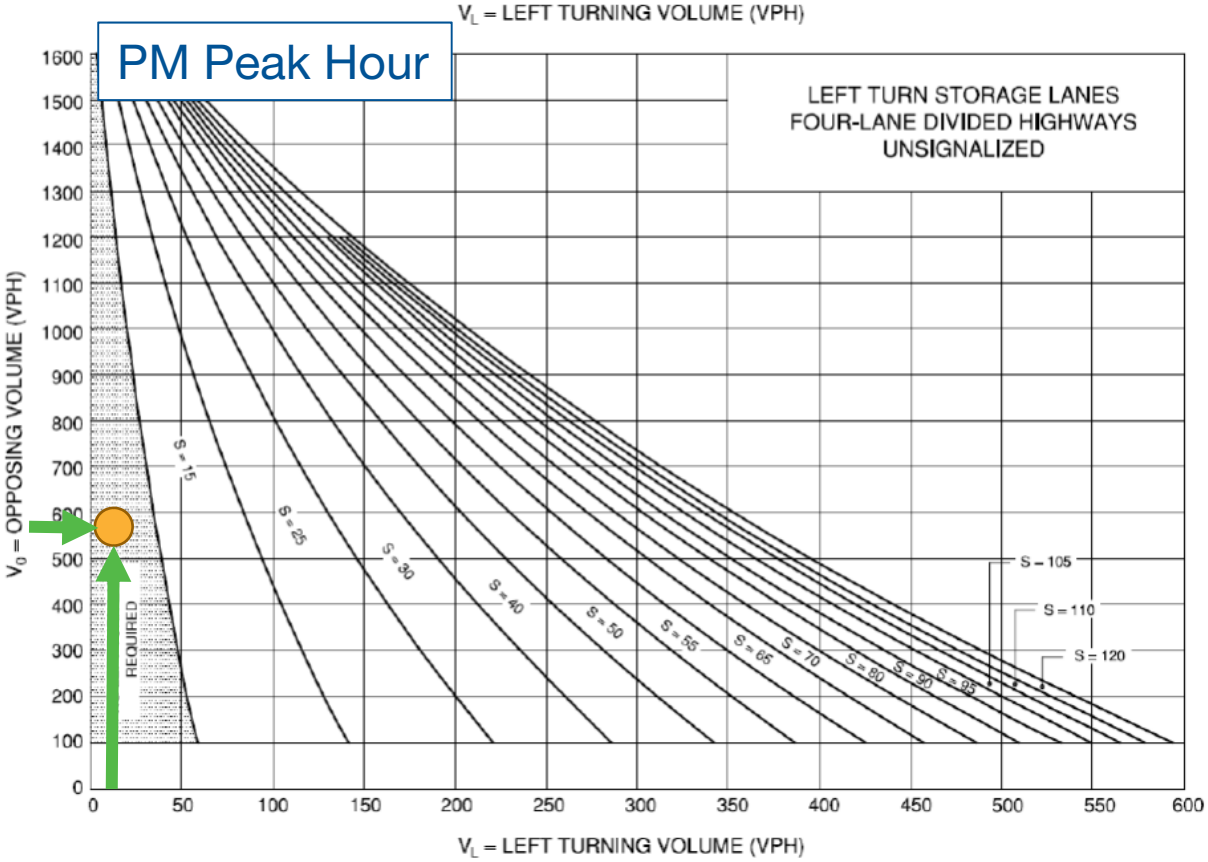




paradigm TRANSPORTATION SOLUTIONS LIMITED

2025 Total Traffic
Eastbound Left-Turn Lane Warrants,
Ardagh Road at Street A



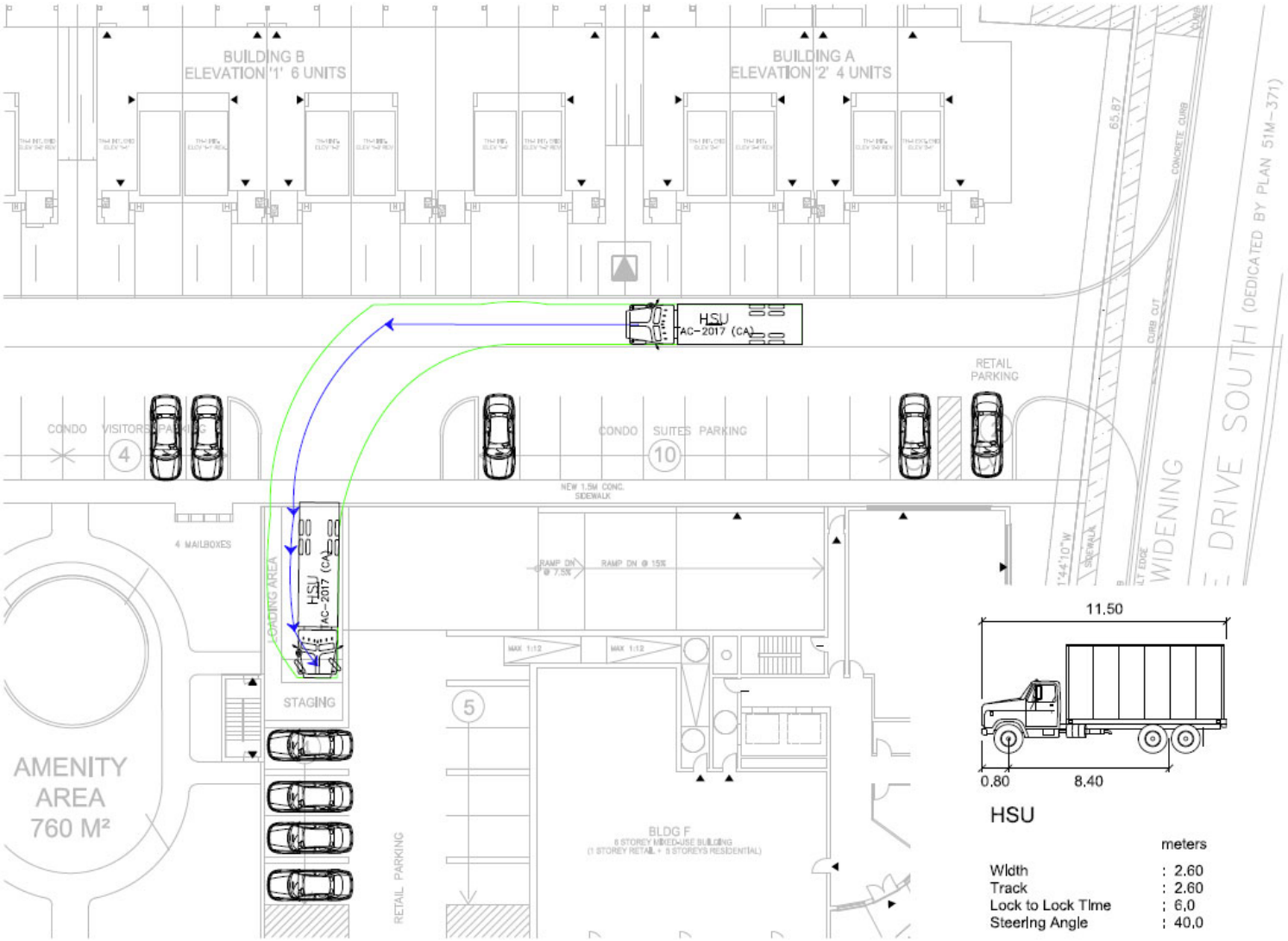


paradigm TRANSPORTATION SOLUTIONS LIMITED

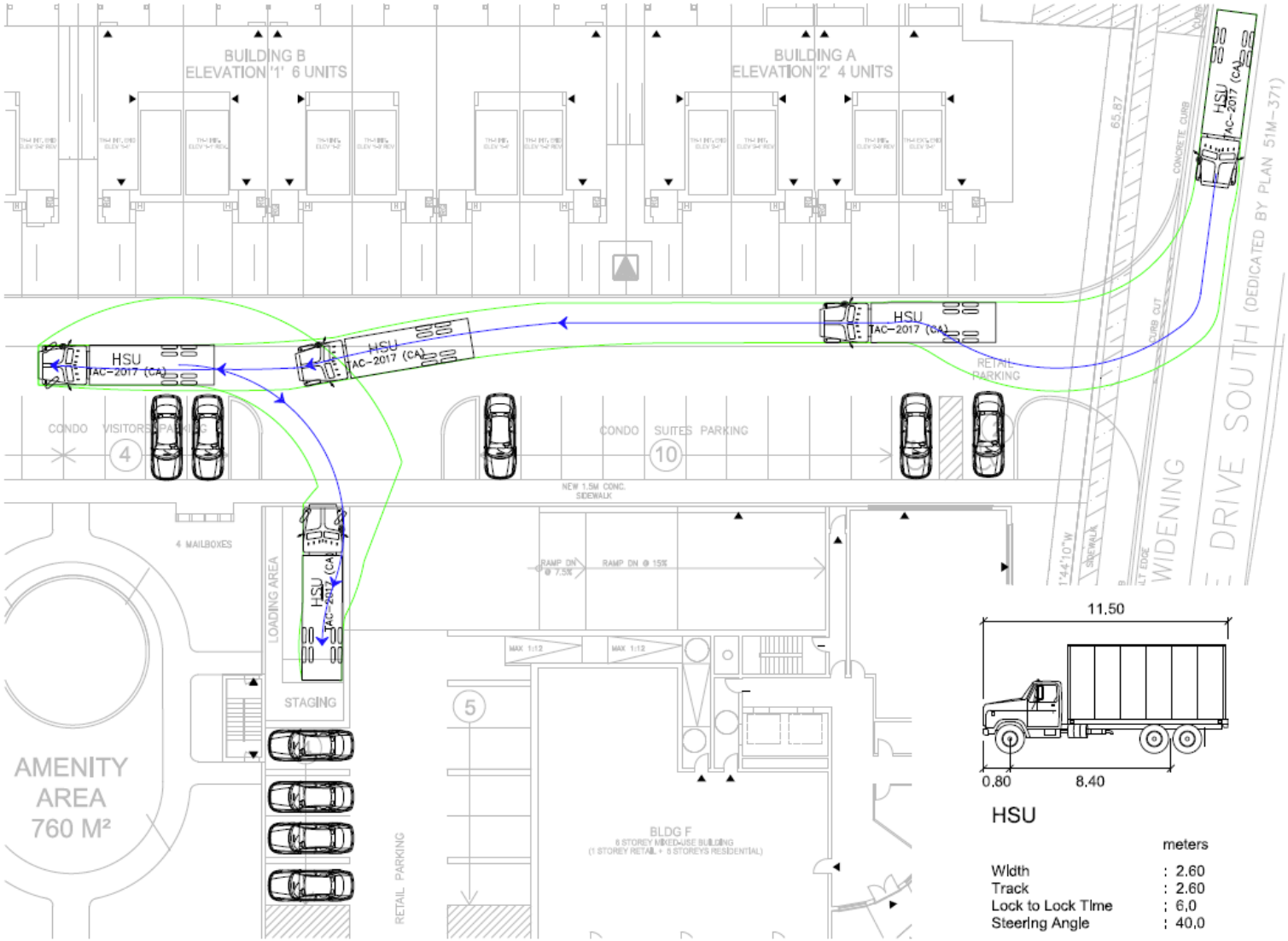
2025 Total Traffic
Northbound Left-Turn Lane Warrants,
Ferndale Drive at Street B

Appendix I

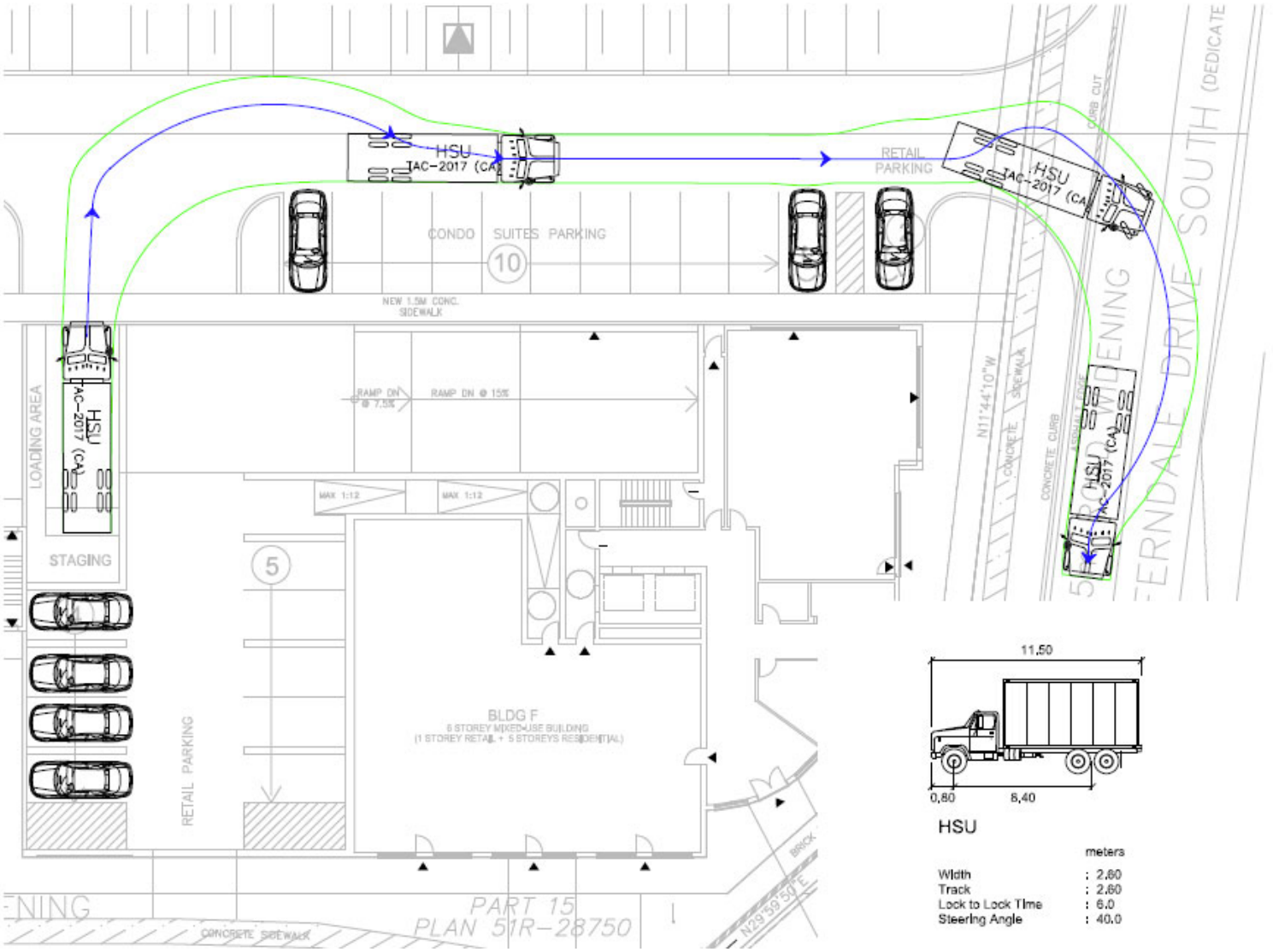
Site Circulation Assessment



HSU Entering from Ferndale Drive Forward into Loading Area

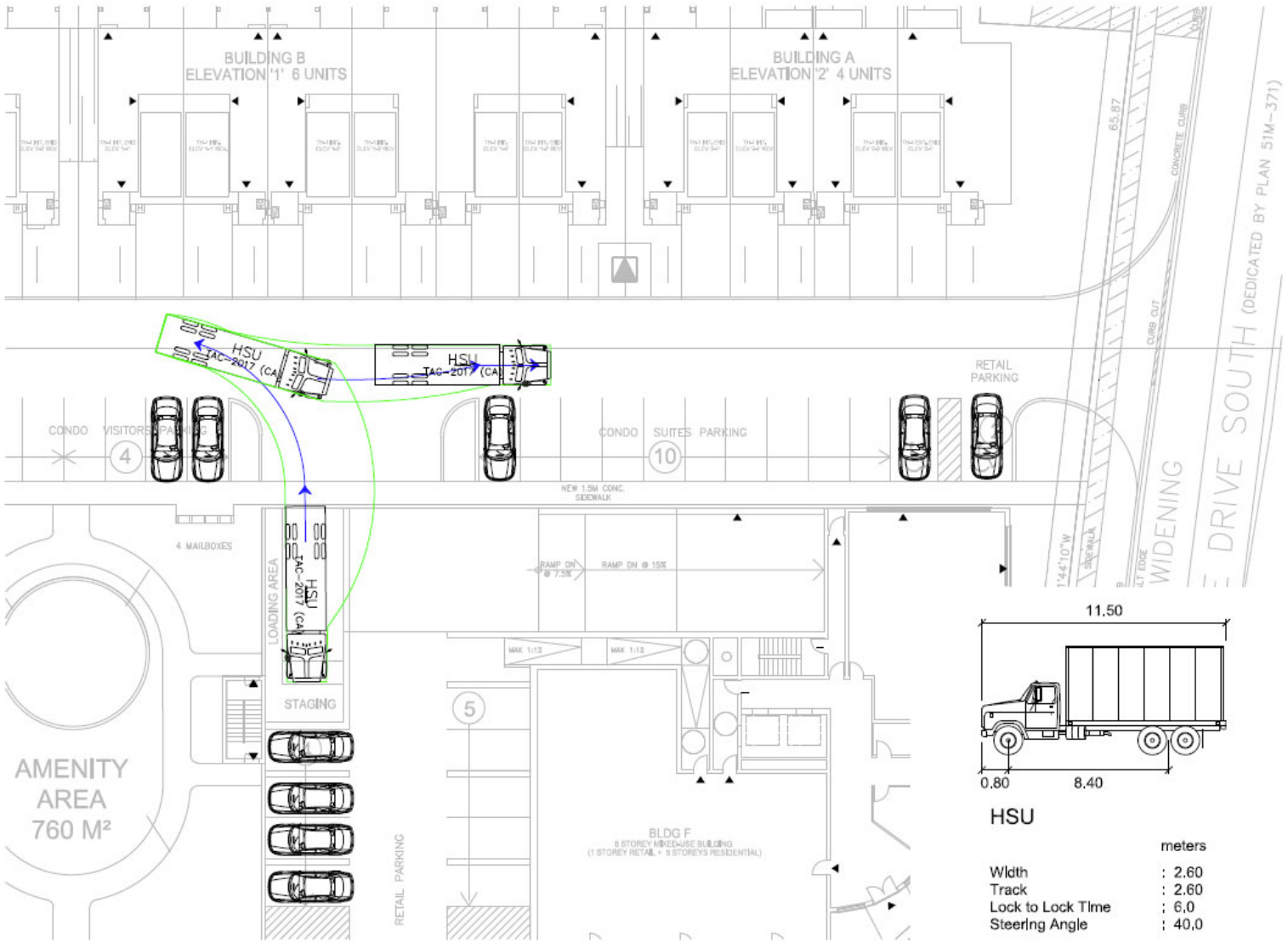


HSU Entering from Ferndale Drive Reverse into Loading Area

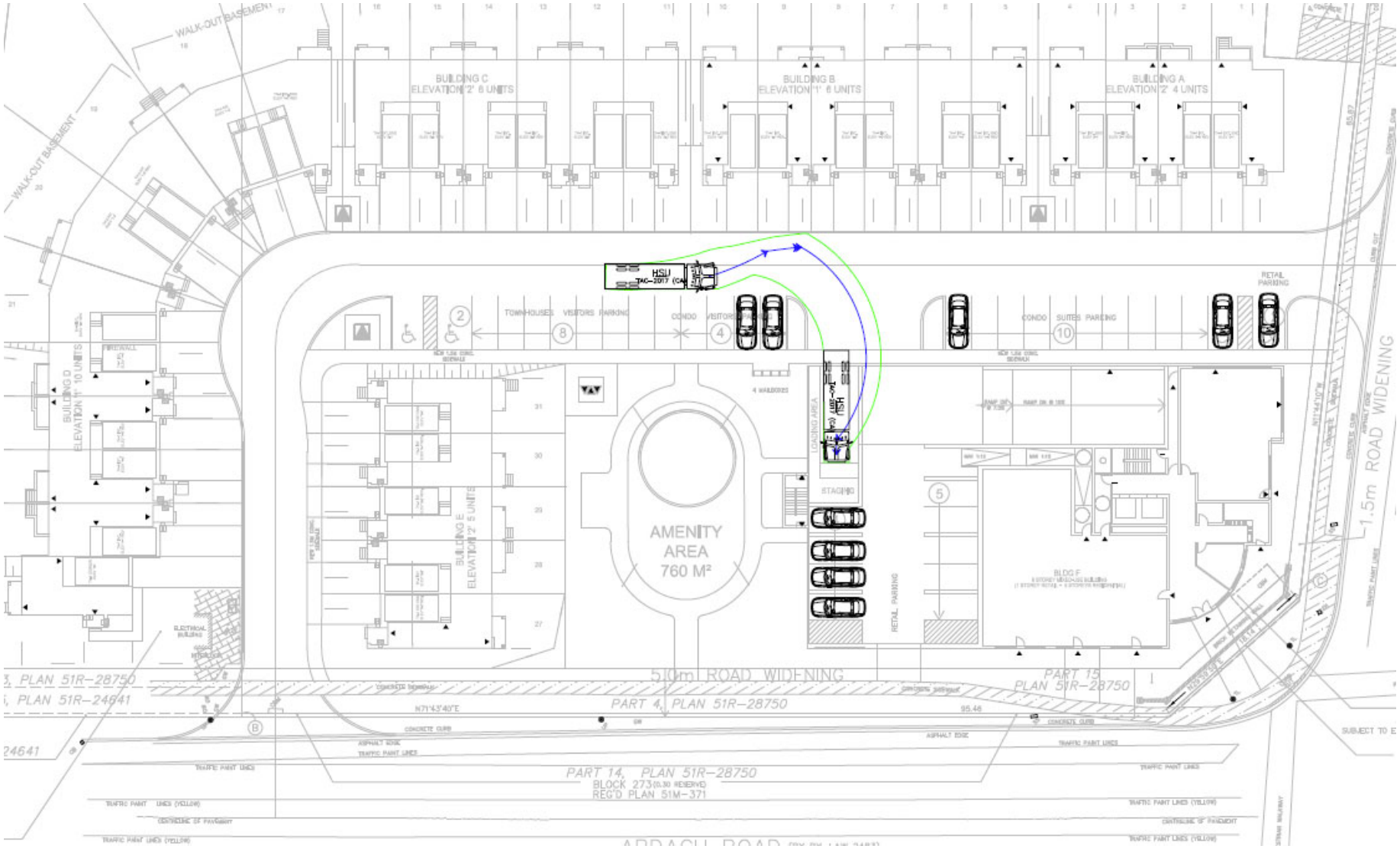


paradigm TRANSPORTATION SOLUTIONS LIMITED

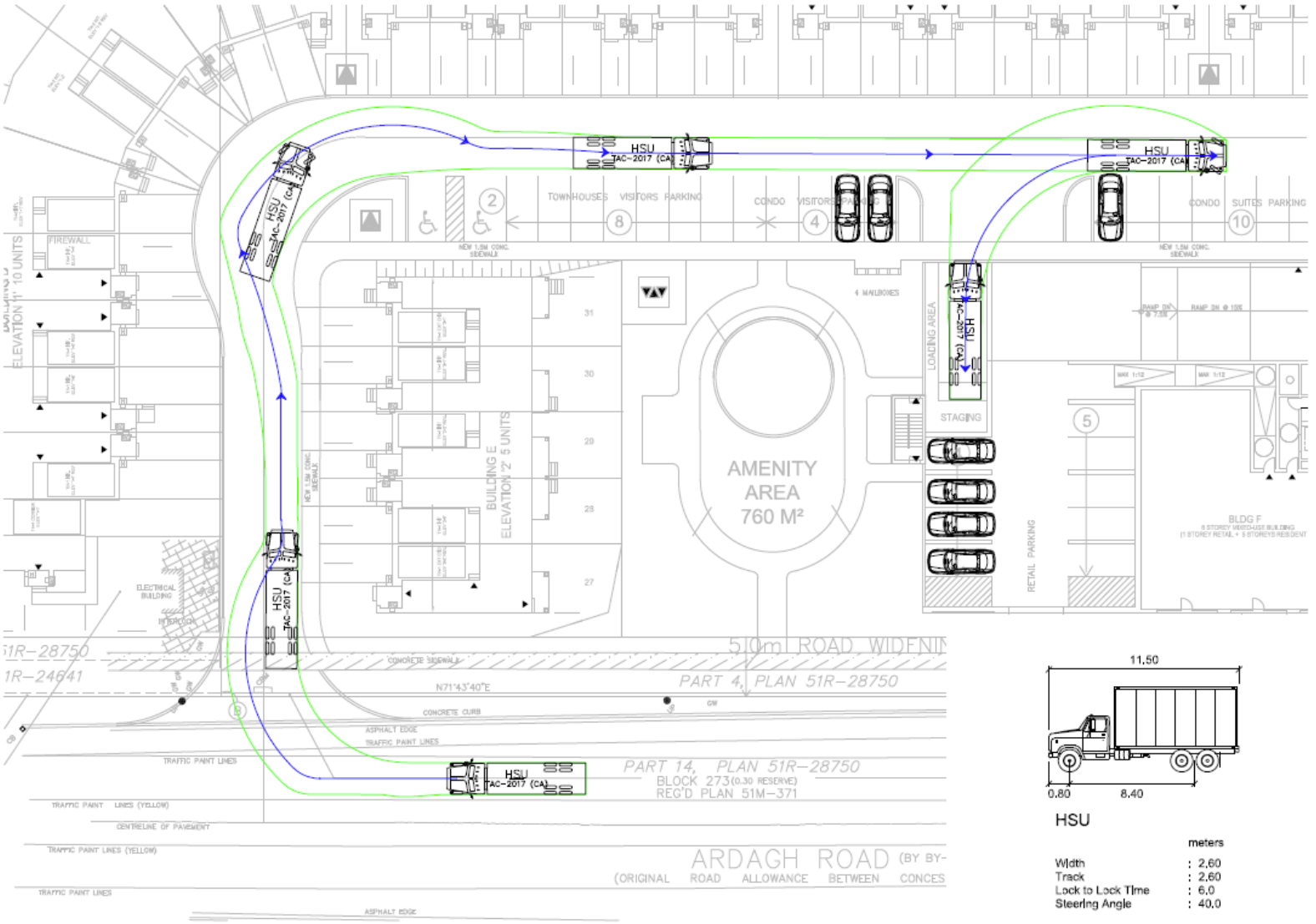
HSU Exiting to Ferndale Drive Forward from Loading Area



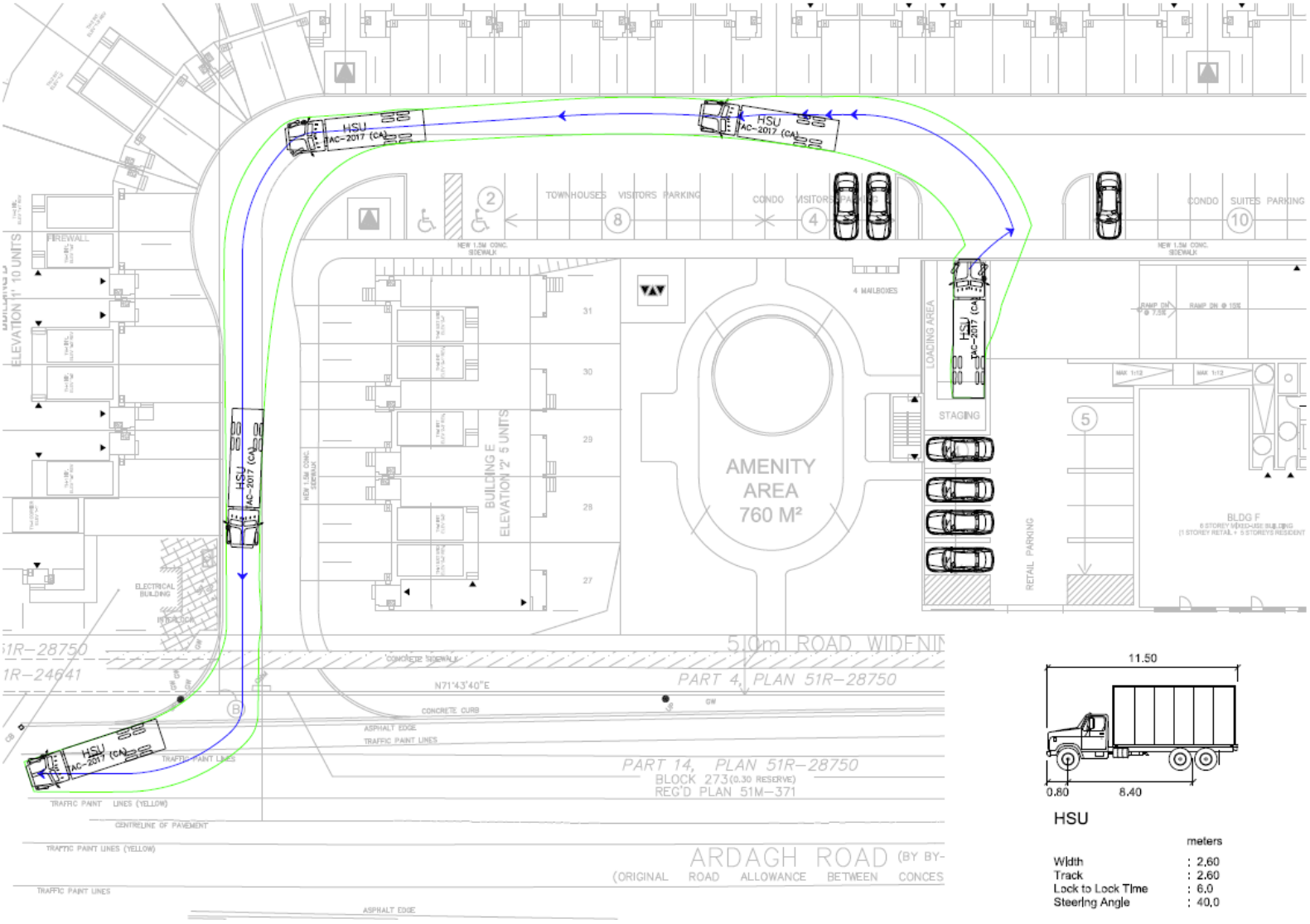
HSU Exiting to Ferndale Drive Reverse from Loading Area



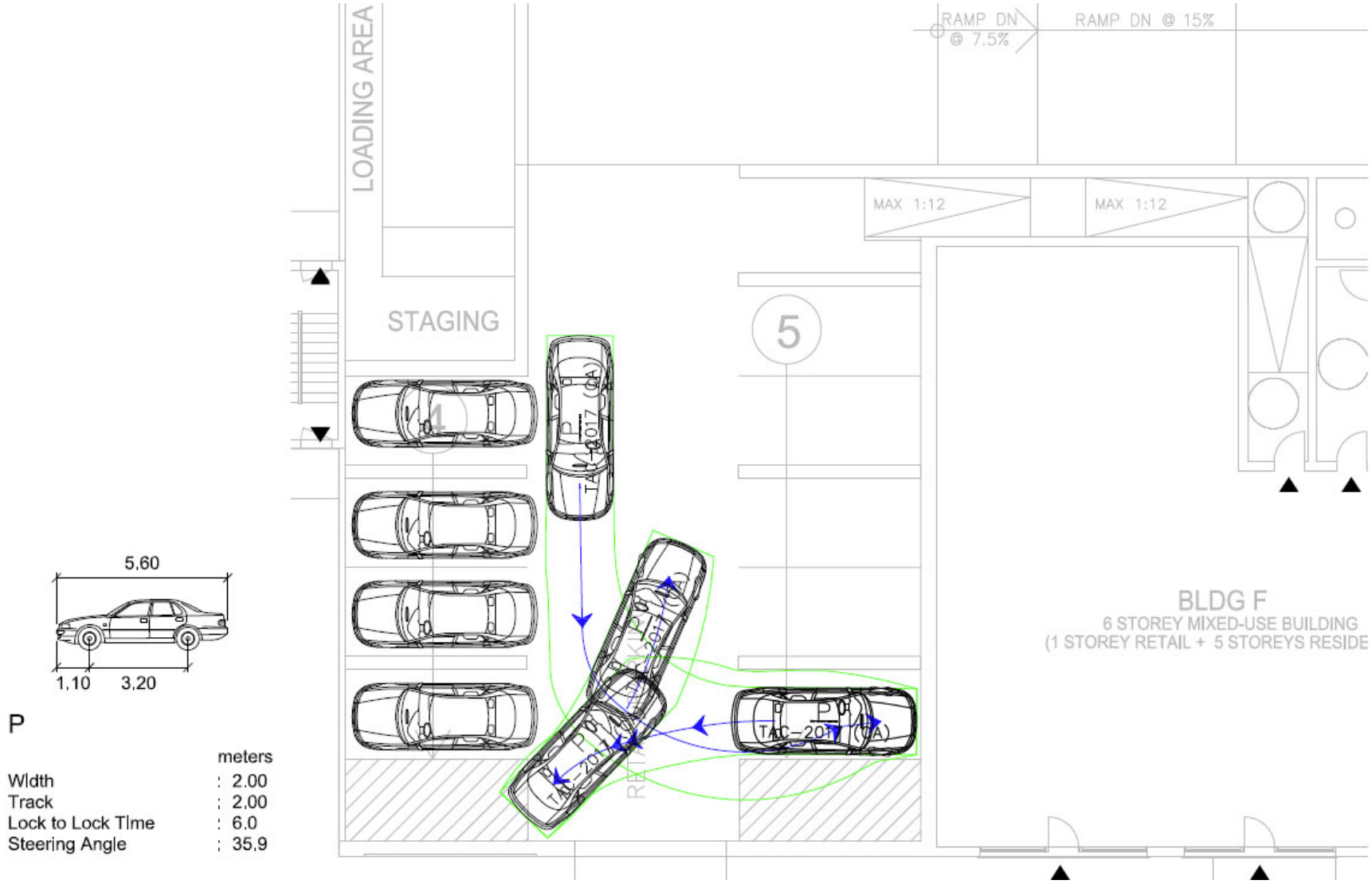
HSU Entering from Ardagh Road Forward into Loading Area



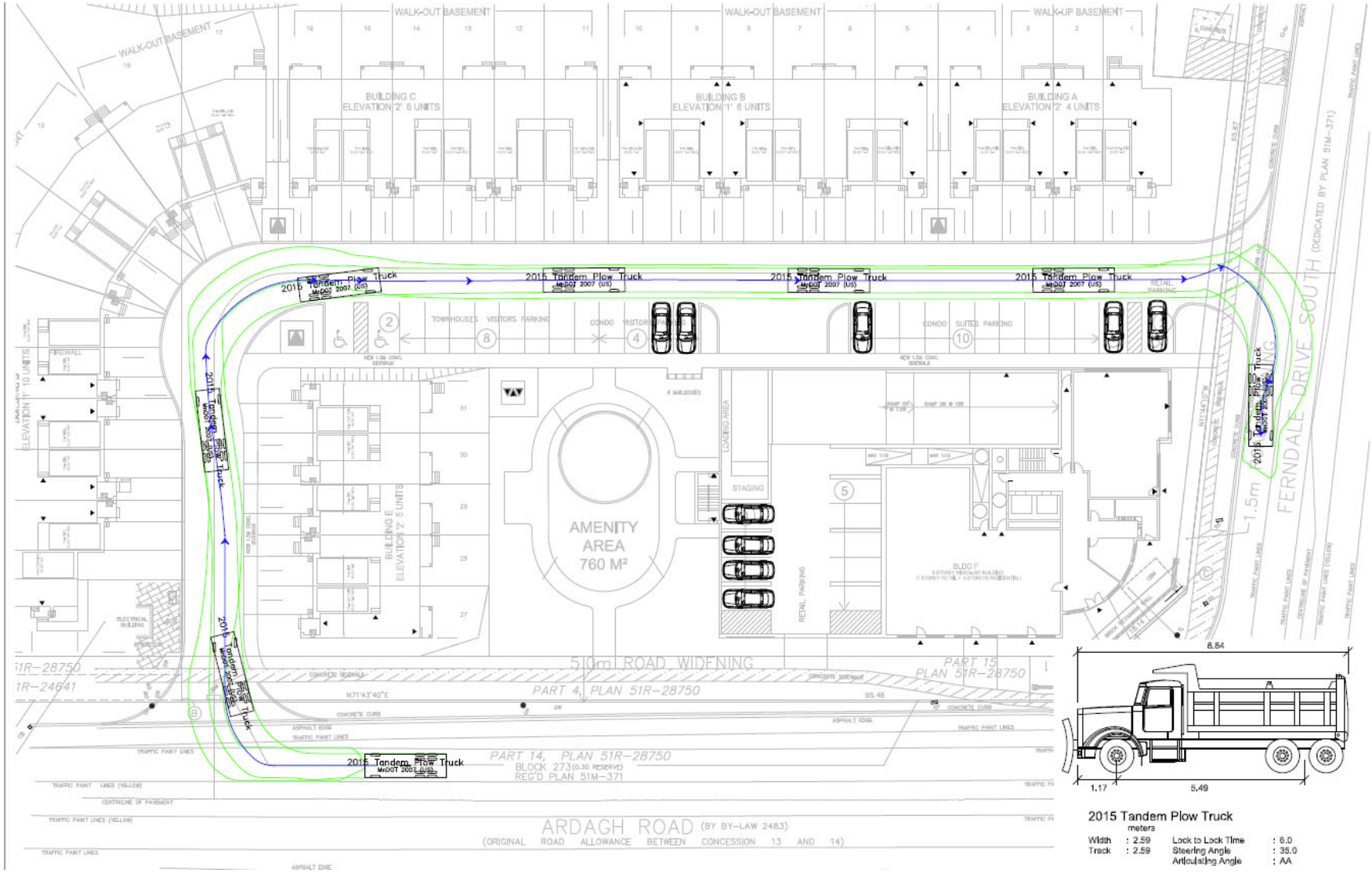
HSU Entering from Ardagh Road Reverse into Loading Area



HSU Exiting to Ardagh Road Forward from Loading Area



Passenger Car
Exiting Retail Parking Area

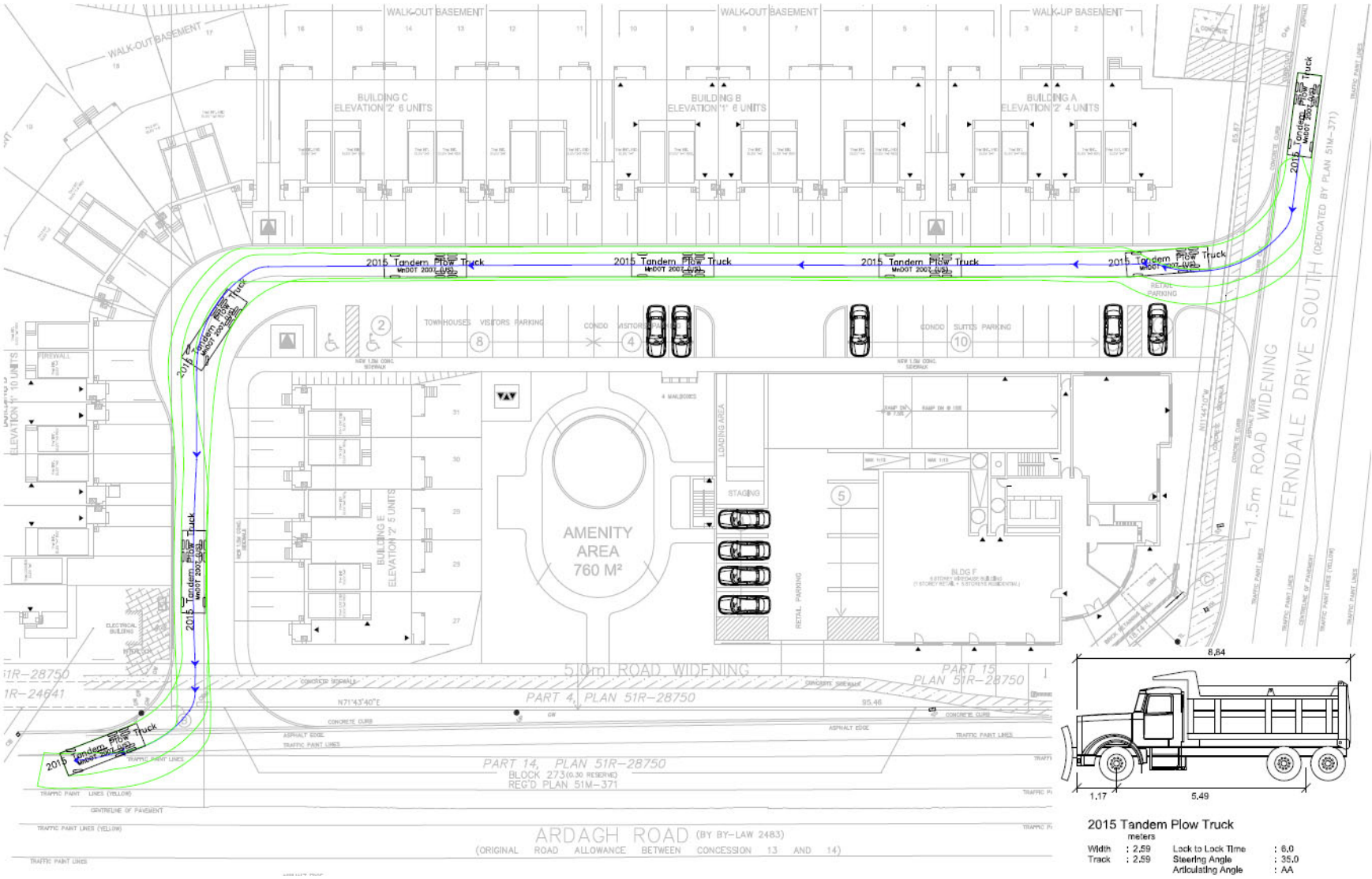


paradigm TRANSPORTATION SOLUTIONS LIMITED

Snowplow West to East

224 Ardagh Road, Proposed Mixed-Use Development Traffic Brief
180047

Figure I.9



Snowplow East to West

Figure I.10