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File 422433

October 8, 2024

Stephanie Pasquale
Pearl Builders
25 Production Road
Brampton, Ontario L6T 4N8
stephanie@pearlbuilders.com

Re: Mapleview Village, Barrie
Traffic Impact Study Addendum – North Block

Dear Stephanie:

Further to the completion of the *Mapleview & Essa Development Traffic Impact Study*[1] (TIS) dated December 2022, we have prepared this addendum letter in support of the Site Plan Approval application for the North Block of the Mapleview Village development site. The addendum letter has been completed in context of the pre-consultation comments received from City of Barrie staff.

LOCATION

The subject site is located in the northeast quadrant of the intersection of Essa Road and Mapleview Drive within the City of Barrie (illustrated in Figure 1). The overall site consists of the properties known municipally as 664 Essa Road, 674 Essa Road, 692 Essa Road, 320 Mapleview Drive West and 364 Mapleview Drive West.

A protected watercourse bisects the site, running approximately east to west across the centre of the 674 Essa Road property. This functionally divides the site into two distinct sections – a North Block and a South Block. This addendum will focus on revisions to the site plan for the North Block, the location of which within the larger site is illustrated in Figure 2. The South Block development will be subject to the requirements of a separate SPA submission.

DEVELOPMENT DETAILS

As per the site plan illustrated in Figure 3, the North Block development will consist of:

- 244 townhouse units (traditional and back-to-back) of which 66 units will have provisions for an optional secondary suite (which could result in up to 66 additional dwelling units); and

[1] *Mapleview & Essa Development Traffic Impact Study.* Tatham Engineering Limited, December 9, 2022.

- 214 mid-rise apartment units.

It is noted that development of the secondary suites is at the discretion of the individual homeowners and thus may not be realized. For the purposes of this addendum, it is assumed that all 66 secondary suites will be developed. With all secondary suites realized, the North Block will contain 524 dwelling units, representing a net increase of 58 dwelling units when compared to the previous site plan of the North Block considered in the TIS.

PHASING

As detailed in the TIS, the North Block was assumed to be fully built out by 2027. For the purposes of this addendum and as per City direction, this horizon has been maintained.

SITE ACCESS

Access to the North Block will be provided by the following two access points:

- the North Access will be located on Essa Road near the north boundary of the site; and
- the South Access will be shared with the existing access to the Mapleview Community Church via Hollyholme Farm Road.

As per the site plan, the North Access will be constructed with a 9.0 metre width, allowing for one inbound lane and one shared left/right outbound lane. The Transportation Association of Canada (TAC) *Geometric Design Guide for Canadian Roads*[2] notes that a two-way, commercial/high-volume residential driveway should provide a width between 7.2 and 12 metres. As such, the 9.0 metre width as proposed is considered appropriate.

City planning staff requested that consideration be given to a shared access with the property bordering the subject site to the north (650 Essa Road, currently home to the Holy Spirit Parish Catholic Church). Upon review of this request, a shared access is not desired for the following reasons:

- the existing church access is located approximately mid-block within 650 Essa Road and thus does not readily facilitate a shared access;
- if a new shared access were to be constructed on the common property line between the North block and 650 Essa Road (thus warranting relocation of the existing church access), the alignment of such is not perpendicular to Essa Road and thus would not readily facilitate a new access aligned 90° to the road (as is preferred for safety reasons);
- accommodating a shared access would require a redesign of the subject site which, given that the site plan for the North Block is at an advanced design stage, is not feasible; and

[2] *Geometric Design Guide for Canadian Roads, Chapter 8, Table 8.9.1*. Transportation Association of Canada, June 2017.

- the Holy Spirit Parish is a relatively new development (opened in 2013) – potential future redevelopment of this site is not likely to occur in the foreseeable future and certainly not within the anticipated timeline envisioned for the North Block.

SITE CIRCULATION

Vehicles

Circulation of vehicular traffic within the North Block will be accommodated by a series of internal roads providing access to the townhouse units and apartment buildings. The road network will maintain a minimum width of 6.5 metres in accordance with City requirements and to ensure compliance with the Ontario Building Code for a fire route (6.0 metre minimum). The fire routes within the site will also maintain minimum 12-metre centerline turn radii to facilitate the manoeuvring requirements of emergency response vehicles. In considering the proposed design of the internal road network (which is consistent with City and industry standards), the circulation of site traffic will be readily accommodated. The roads will operate as typical low volume residential roads.

A vehicle turning assessment was completed using a passenger vehicle within the underground parking areas serving the apartments. Completed vehicle turning templates are provided in Appendix A. As indicated, sufficient manoeuvring space has been provided within the underground parking area for passenger vehicles. Turning assessments of other design vehicles throughout the site have been completed by others under separate cover.

Pedestrians

Circulation of pedestrian traffic will be accommodated by a network of 1.5-metre sidewalks throughout the site, providing connectivity along the internal roads, between the entrances of each apartment building and townhouse unit, and to the external sidewalk network. The internal sidewalk network is illustrated in Figure 4.

SITE TRAFFIC

Trip Generation

The number of vehicle trips to be generated by the proposed development for the weekday AM and weekday PM peak hours has been determined based on type of use, development size and trip generation rates per the *ITE Trip Generation Manual*[3]. Based on the development proposed for the North Block, the following ITE land uses have been applied:

- single family attached (ITE 215) – townhouses and secondary suites; and

[3] *Trip Generation Manual, 11th Edition.* Institute of Transportation Engineers, September 2021.

- multifamily housing – mid-rise, not close to rail transit (ITE 221) – apartments.

Trip rates for the above noted land uses are summarized in Table 1 with associated trip estimates provided in Table 2. As indicated, the proposed North Block development is anticipated to generate approximately 230 trips during the weekday AM peak hour and 260 trips during the weekday PM peak hour. When compared to the trip generation of the North Block presented in the TIS, this represents an increase of approximately 40 trips during the weekday AM peak hour and 20 trips during the weekday PM peak hour.

Table 1: Trip Rates – North Block

LAND USE (ITE CODE)	VARIABLE	WEEKDAY AM PEAK HOUR			WEEKDAY PM PEAK HOUR		
		In	Out	Total	In	Out	Total
single family attached (ITE 215)	per unit	0.15	0.33	0.48	0.32	0.25	0.57
multifamily housing – mid-rise (ITE 221)	per unit	0.09	0.28	0.37	0.24	0.15	0.39

Table 2: Trip Estimates – North Block

LAND USE (ITE CODE)	SIZE	WEEKDAY AM PEAK HOUR			WEEKDAY PM PEAK HOUR		
		In	Out	Total	In	Out	Total
townhouses + secondary suites (ITE 215)	244+66 units	46	103	149	101	76	177
apartments (ITE 221)	214 units	18	61	79	51	32	83
Total	**522 units**	**64**	**164**	**228**	**152**	**108**	**260**

Modal Split

As detailed in the TIS, modal split is the proportion of trips to/from a specific location or area across different modes of transportation, such as automobiles, public transit, walking, cycling, etc. Based on data obtained from the 2016 *Transportation Tomorrow Survey* (TTS), the existing (i.e. 2016) modal split within the study area (assessed within *2006 GTA Zone 8523*) was determined to be:

- public transit (local, GO train or both) – 1.8%;
- active transportation (walking, cycling, etc.) – 3.7%; and
- automobile (driver or passenger) – 94.5%.

The *City's Transportation Master Plan*[4] identifies modal split targets of 7% public transit and 12% active transportation by 2041, resulting in a total non-automobile modal share of 19% of all trips city-wide. The modal splits at the 2027 horizon were determined by linear interpolation between the current (2016) modal splits and noted 2041 targets. The modal splits are summarized in Table 3.

Table 3: Modal Splits

YEAR	PUBLIC TRANSIT	ACTIVE TRANSPORTATION	AUTOMOBILE
2016	1.8%	3.7%	94.5%
2027	4.1%	7.4%	88.5%
2041	7.0%	12.0%	81.0%

Applying these rates to the trip generation determined above, the total automobile and non-automobile trips generated by the North Block can be determined, as summarized in Table 4. For the public transit and active transportation modes, the trip values presented reflect the number of automobile trips which will divert to the alternative modes.

Table 4: Modal Trip Estimates – North Block

YEAR	PUBLIC TRANSIT		ACTIVE TRANSPORTATION		AUTOMOBILE	
	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
2027	9	11	17	19	201	229

Trip Distribution & Assignment

The distribution of new automobile trips from the North Block has maintained the same distribution employed in the TIS. The resulting assignment of site traffic to the study area road network is illustrated in Figure 5.

[4] *City of Barrie Transportation Master Plan*. WSP, June 2019.

FUTURE TRAFFIC VOLUMES

Background Traffic Volumes

Future background traffic volumes at the 2027 horizon (i.e. anticipated future volumes without site-generated traffic) are illustrated in Figure 6 and reflect those presented in the TIS, considering background growth within the study area and additional volumes generated by other background developments.

Total Traffic Volumes

The site-generated traffic volumes (illustrated in Figure 5) were added to the future background volumes (illustrated in Figure 6) in order to assess the impact of the proposed development. The resulting 2027 total traffic volumes are illustrated in Figure 7.

TRAFFIC OPERATIONS

The operations of the study area intersections (as established in the initial TIS) under 2027 total conditions were reassessed considering the revised site plan and corresponding increase in site-generated traffic, whilst employing the same *HCM 2000* methodologies and road network configuration. Results of the operational reassessment are summarized in Table 5, with detailed worksheets provided in Appendix B.

Table 5: Intersection Operations – 2027 Total

INTERSECTION, MOVEMENTS & CONTROL			WEEKDAY AM PEAK HOUR			WEEKDAY PM PEAK HOUR		
			Delay	LOS	v/c	Delay	LOS	v/c
Essa Road & Mapleview Drive	EB L	signal	21	C	0.39	34	C	0.68
	EB TR	signal	38	D	**0.85**	31	C	0.56
	WB L	signal	33	C	0.66	23	C	0.63
	WB T	signal	26	C	0.33	42	D	**0.91**
	WB R	free	24	C	0.06	24	C	0.19
	NB L	signal	24	C	0.16	27	C	0.21
	NB T	signal	26	C	0.34	32	C	0.54
	NB R	signal	24	C	0.13	25	C	0.14
	SB L	signal	17	B	0.29	19	B	0.36
	SB T	signal	19	B	0.30	21	C	0.38
	SB R	signal	16	B	0.10	19	B	0.20
	overall	signal	28	C	0.58	31	C	0.71
Mapleview Drive & Hollyholme Farm Road	EB L	signal	5	A	0.01	6	A	0.06
	EB TR	signal	7	A	0.37	7	A	0.27
	WB L	signal	5	A	0.08	5	A	0.01
	WB TR	signal	6	A	0.19	9	A	0.51
	NB L	signal	41	D	0.05	34	C	0.27

INTERSECTION, MOVEMENTS & CONTROL			WEEKDAY AM PEAK HOUR			WEEKDAY PM PEAK HOUR		
			Delay	LOS	v/c	Delay	LOS	v/c
Mapleview Drive & Hollyholme Farm Road (continued)	NB TR	signal	42	D	0.01	41	D	0.01
	SB L	signal	34	C	0.18	39	D	0.18
	SB R	signal	38	D	0.01	44	D	0.00
	overall	signal	8	A	0.35	9	A	0.48
Mapleview Drive & Veterans Drive	EB L	signal	19	B	0.23	38	D	0.76
	EB TR	signal	30	C	0.66	34	C	0.70
	WB L	signal	31	C	0.78	34	C	0.79
	WB TR	signal	22	C	0.34	37	D	**0.86**
	NB L	signal	23	C	0.27	37	D	0.77
	NB TR	signal	27	C	0.24	47	D	**0.86**
	SB L	signal	24	C	0.55	36	D	0.71
	SB TR	signal	29	C	0.45	37	D	0.59
	overall	signal	27	C	0.71	**38**	**D**	**0.87**
Essa Road & Mapleton Avenue	EB L	signal	43	D	0.83	42	D	0.84
	EB TR	signal	25	C	0.39	23	C	0.32
	WB L	signal	34	C	0.16	36	D	0.19
	WB TR	signal	38	D	0.48	52	D	0.79
	NB L	signal	9	A	0.07	21	C	0.53
	NB TR	signal	12	B	0.25	19	B	0.36
	SB L	signal	10	A	0.03	16	B	0.06
	SB TR	signal	13	B	0.30	29	C	0.75
	overall	signal	21	C	0.50	30	C	0.81
Essa Road & Harvie Road	EB L	signal	41	D	0.26	40	D	0.22
	EB TR	signal	43	D	0.46	41	D	0.38
	WB L	signal	33	C	0.50	54	D	**0.90**
	WB TR	signal	30	C	0.12	29	C	0.48
	NB L	signal	9	A	0.01	11	B	0.06
	NB TR	signal	13	B	0.35	17	B	0.48
	SB L	signal	7	A	0.14	9	A	0.24
	SB TR	signal	9	A	0.21	15	B	0.47
	overall	signal	16	B	0.39	23	C	0.64
Essa Road & Veterans Drive/ Ferndale Drive	EB L	signal	25	C	0.32	28	C	0.46
	EB TR	signal	44	D	**0.87**	29	C	0.61
	WB L	signal	27	C	0.19	22	C	0.16
	WB TR	signal	32	C	0.53	64	E	**1.01**
	NB L	signal	16	B	0.25	50	D	**0.86**

INTERSECTION, MOVEMENTS & CONTROL			WEEKDAY AM PEAK HOUR			WEEKDAY PM PEAK HOUR		
			Delay	LOS	v/c	Delay	LOS	v/c
Essa Road & Veterans Drive/ Ferndale Drive (Continued)	NB TR	signal	21	C	0.30	30	C	0.36
	SB L	signal	15	B	0.50	28	C	0.65
	SB TR	signal	19	B	0.26	37	D	0.72
	overall	signal	29	C	0.64	**43**	**D**	**0.91**
Essa Road & North Access	WB LR	stop	14	B	0.16	23	C	0.20

As indicated, the study area intersections are expected to provide acceptable overall operations (LOS D or better) with individual movements at each intersection also providing acceptable operations (LOS E or better). Some movements are noted to operate near/over capacity (v/c ≥ 0.85), particularly during the weekday PM peak hour, however, such is not considered problematic recognizing that each intersection overall is demonstrated to operate with reserve capacity remaining.

The north site access to Essa Road – configured with a single shared outbound left-right turn lane operating under stop control (as per the *TIS*) – is anticipated to provide good operations (LOS C) at the 2027 horizon despite the noted increase in site-generated traffic.

TRAFFIC SIGNAL WARRANTS

At the request of City staff, traffic signal warrants were reevaluated for the North Access. An assessment was completed considering both the existing (i.e. 2-lane) and ultimate (i.e. 4-lane plus two-way left turn lane) cross-sections of Essa Road. The warrants are based on the methodologies outlined under *Justification 7* of *Ontario Traffic Manual* (OTM) *Book 12 – Traffic Signals*, considering the projected 2027 total traffic volumes. It is noted that the proposed 5-lane cross-section of Essa Road is not anticipated to be in place by the 2027 horizon (completion of the road expansion is anticipated by 2031), however, warrants have been reviewed regardless for both the existing and ultimate cross-sections.

The completed traffic signal warrants are provided in Appendix C. As indicated, traffic signals at the North Access are not warranted under either the existing or ultimate cross-section of Essa Road to support the build-out of the North Block development.

SUMMARY

This addendum has reviewed the proposed changes to the North Block development area of the subject site in context of that initially proposed in the *Mapleview & Essa Development Traffic Impact Study*. Additionally, a review of the North Access, including geometry and the need for signalization was reviewed at the request of City staff. Based on the findings of this report:

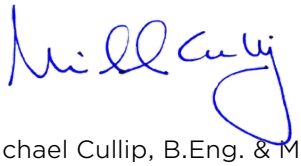
- the proposed changes to the development and corresponding increases in anticipated trip generation of the North Block do not result in meaningful additional impacts to the adjacent road network (the findings and recommendations of the TIS remain valid);
- the proposed 9.0 metre width of the North Access complies with TAC guidelines for a commercial/high-volume residential access; and
- traffic signals are not warranted at the North Access to accommodate the anticipated 2027 future total traffic volumes.

CLOSING

We trust that the above satisfies the comments provided by the City and, in context of the findings contained in the *Mapleview & Essa Development Traffic Impact Study* (which this addendum letter deems as remaining valid), is sufficient to support the Site Plan Approval application.

Yours truly,
Tatham Engineering Limited

Matthew Buttrum, B.Eng., EIT
Engineering Intern
MJB/MJC:klc



Michael Cullip, B.Eng. & Mgmt., M.Eng., P.Eng.
Vice President

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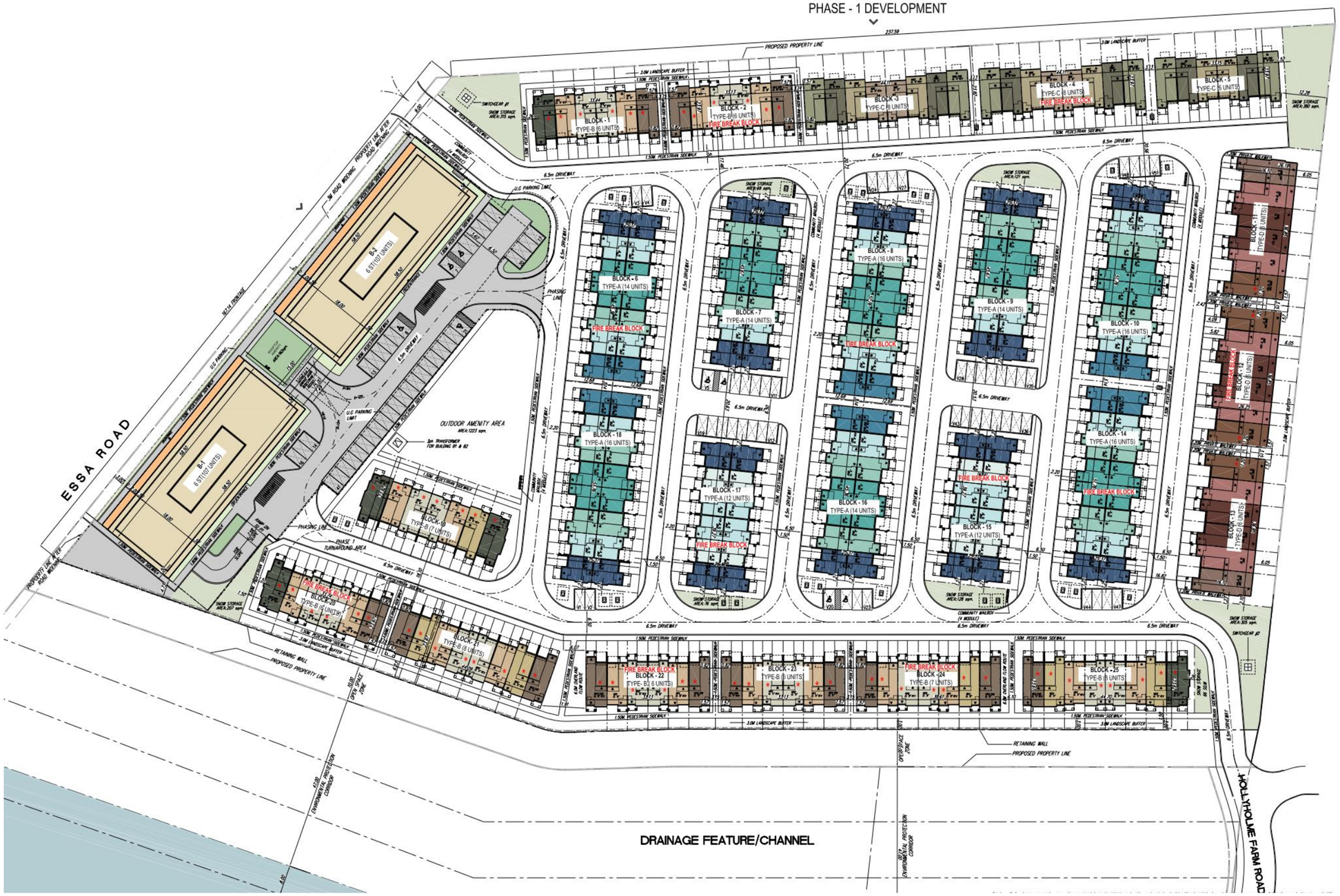
MAPLEVIEW VILLAGE – TIS ADDENDUM – NORTH BLOCK

Figure 1: Site Location

MAPLEVIEW VILLAGE – TIS ADDENDUM – NORTH BLOCK

Figure 2: Site Location – North Block

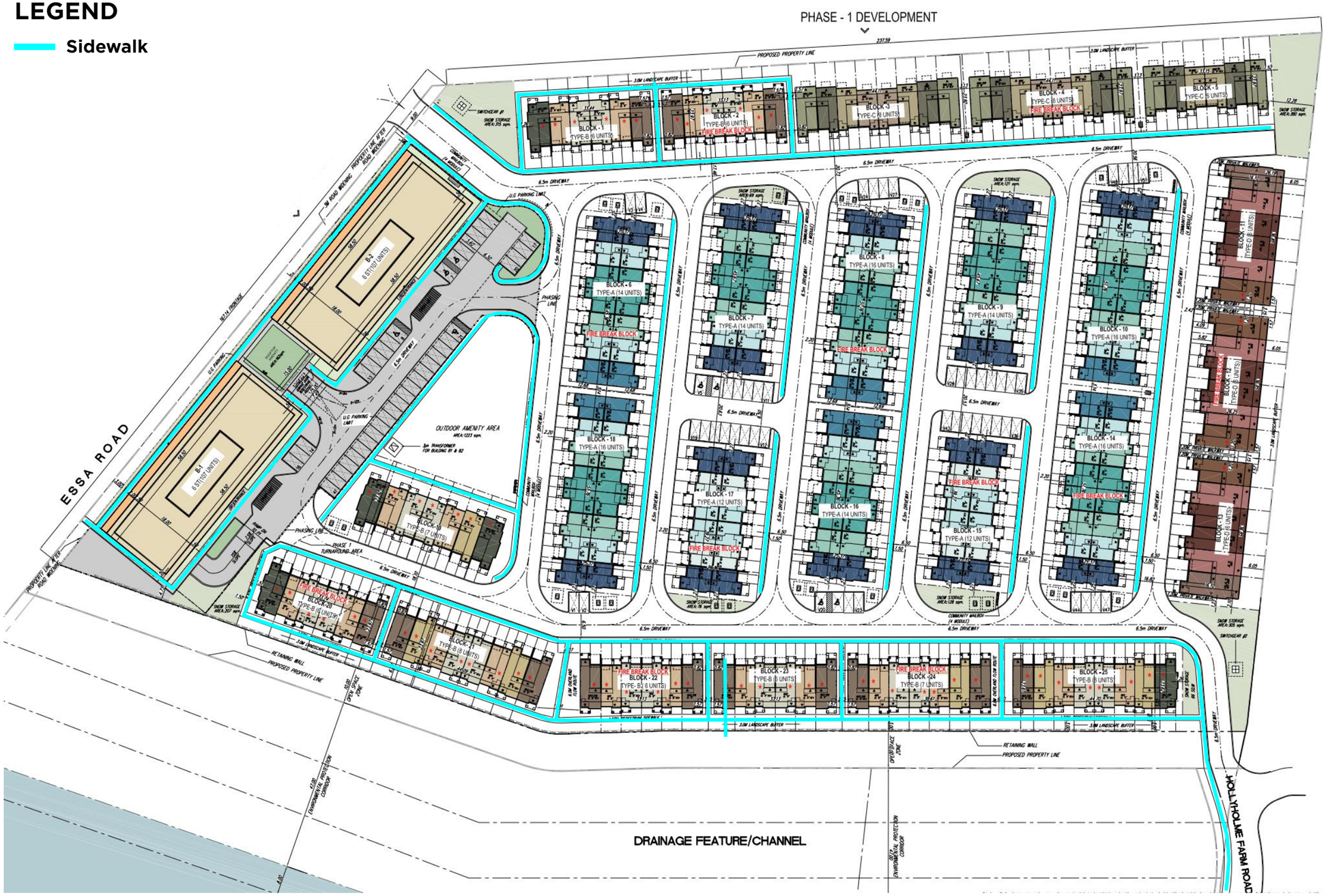


MAPLEVIEW VILLAGE – TIS ADDENDUM – NORTH BLOCK

Figure 3: Site Plan – North Block

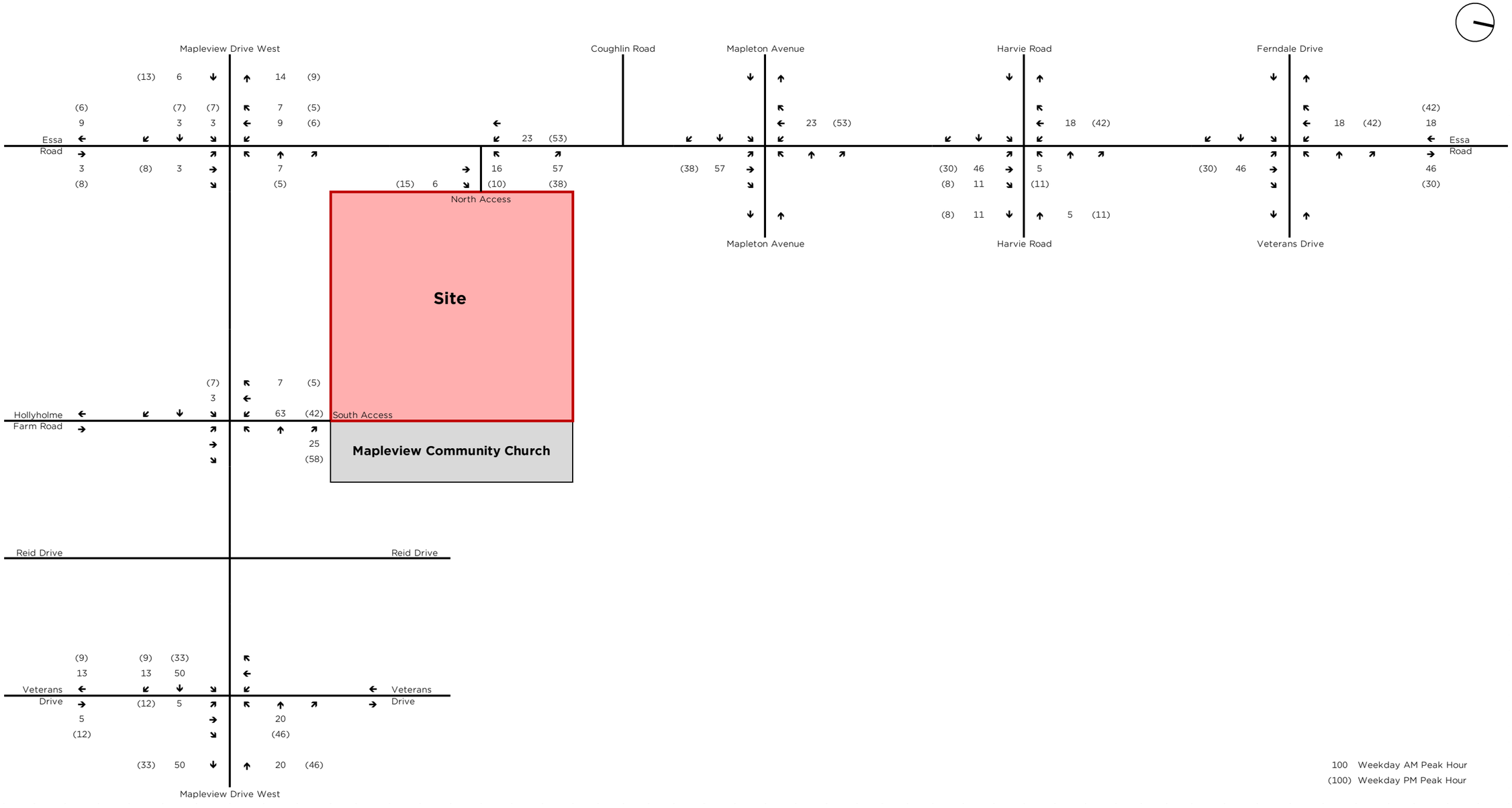
LEGEND

Sidewalk



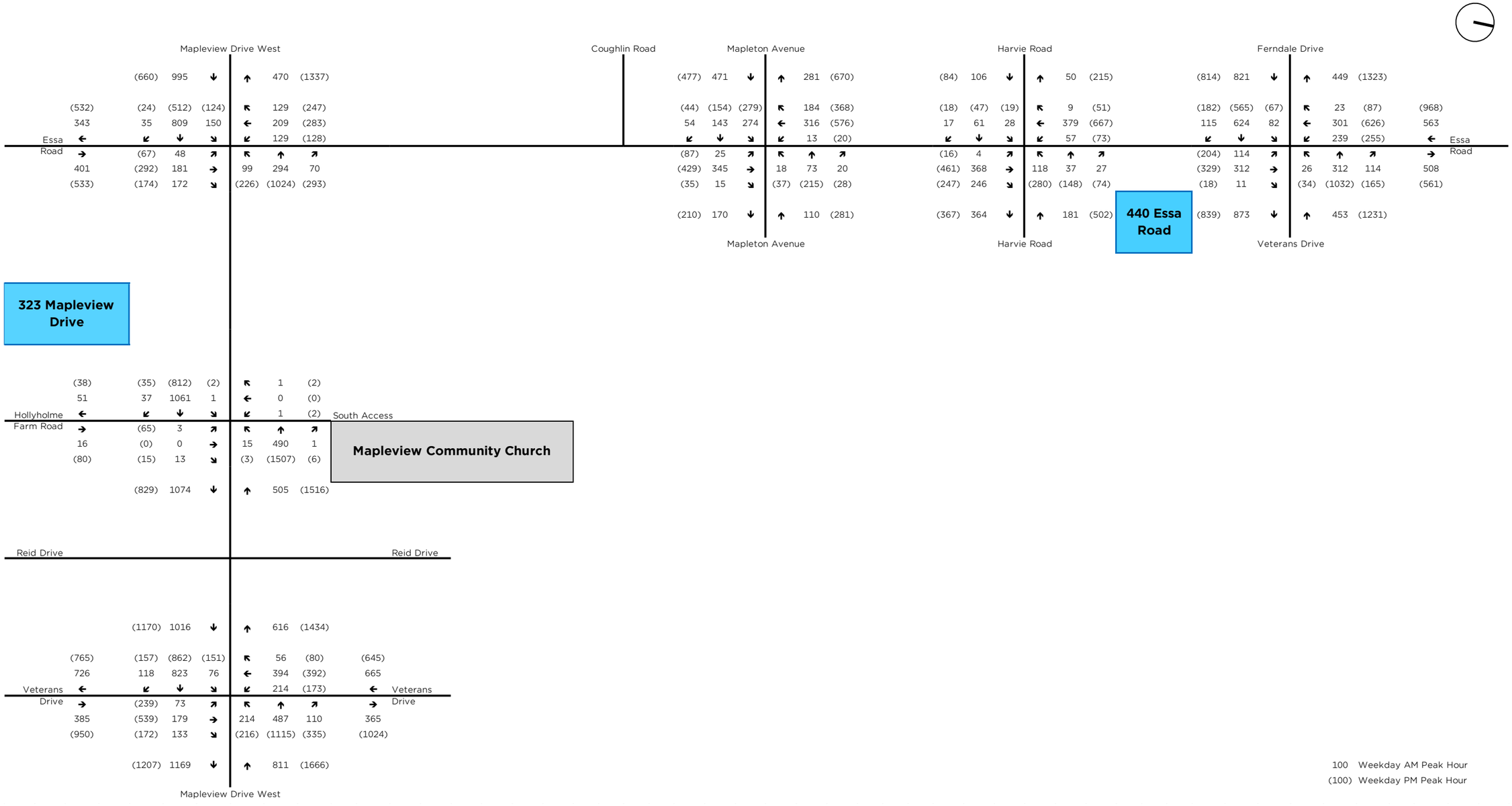
MAPLEVIEW VILLAGE – TIS ADDENDUM – NORTH BLOCK

Figure 4: Sidewalk Network



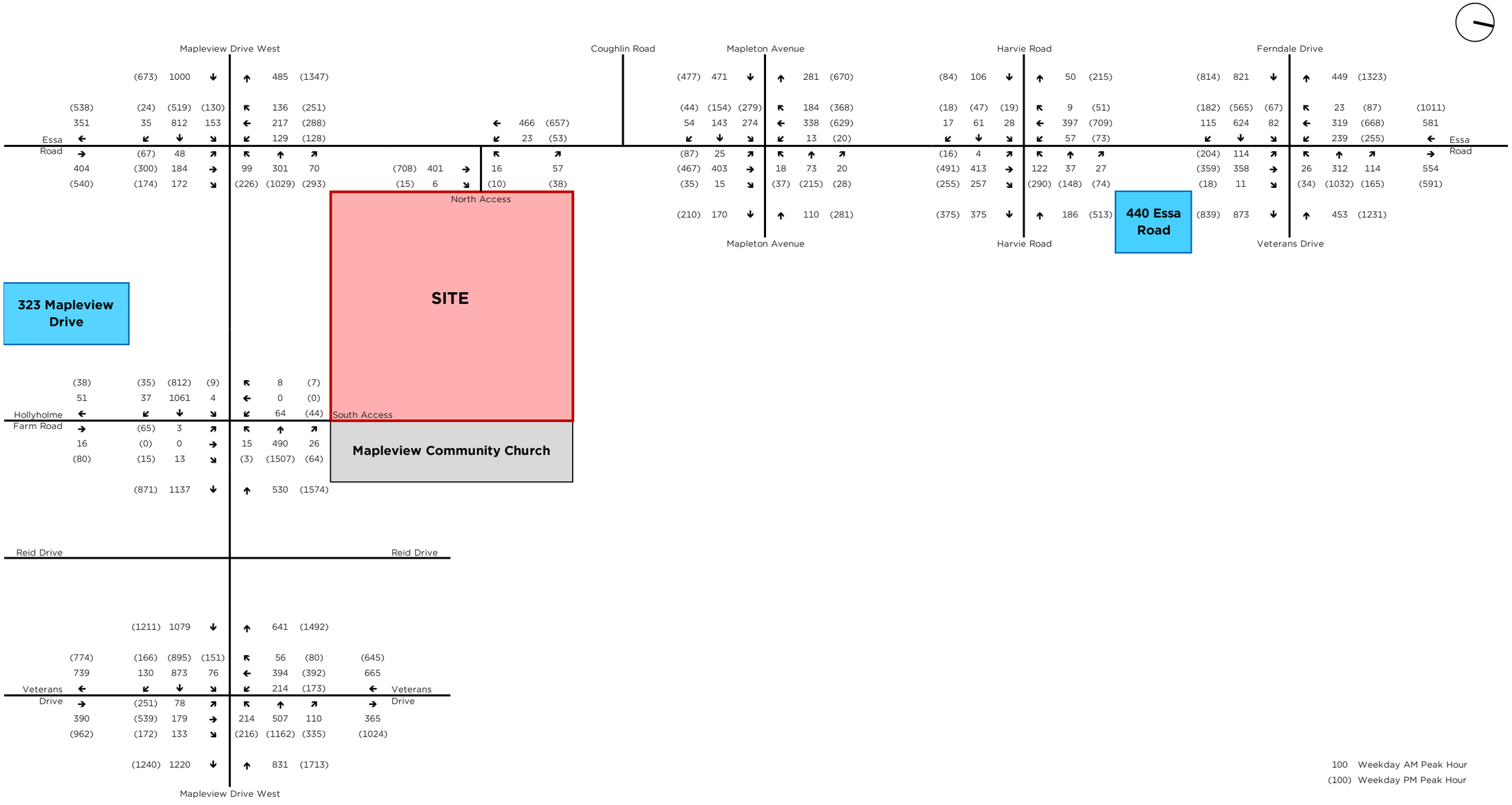
MAPLEVIEW VILLAGE – TIS ADDENDUM – NORTH BLOCK

Figure 5: Site Traffic – 2027



MAPLEVIEW VILLAGE – TIS ADDENDUM – NORTH BLOCK

Figure 6: Traffic Volumes – 2027 Background



MAPLEVIEW VILLAGE – TIS ADDENDUM – NORTH BLOCK

Figure 7: Traffic Volumes – 2027 Total

Appendix A:
Vehicle Turning Templates

TYPICAL PARKING SPACE:

Drive Aisle @ 6.4m MIN.

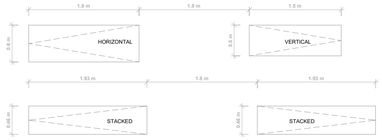
Handicap Parking Space Type - A

Handicap Parking Space Type - B

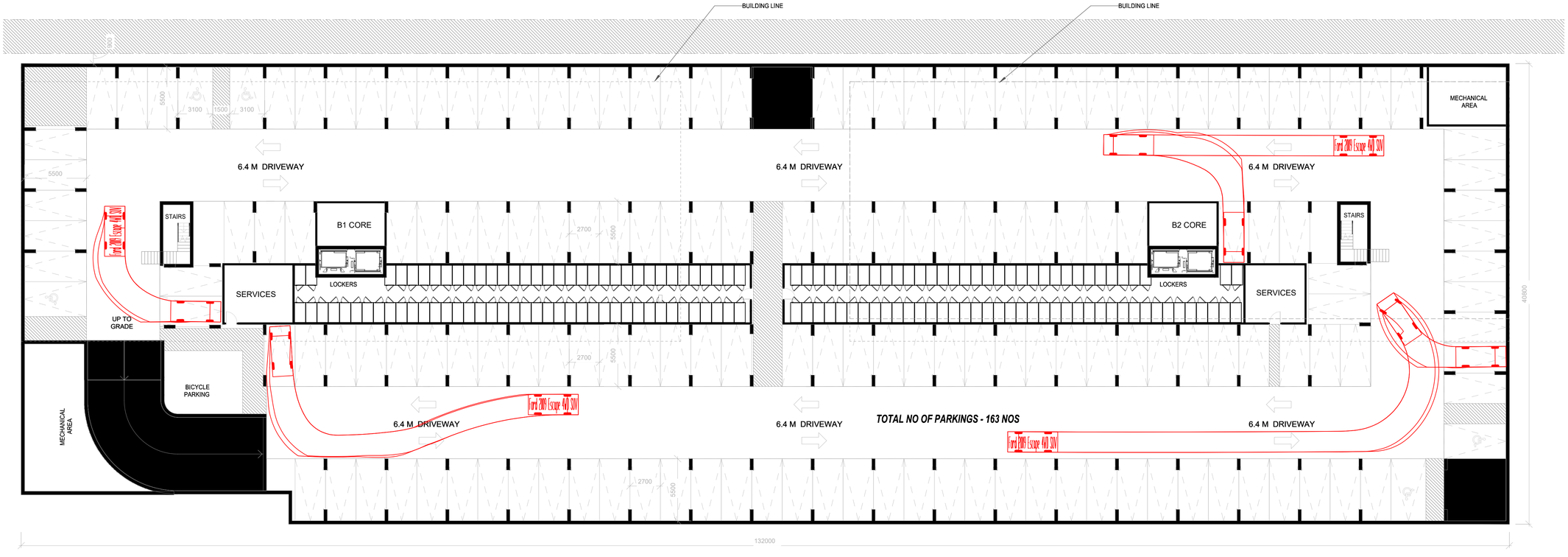
NOTES:
A - PROVIDE A 1500mm WALKWAY ON AT LEAST ONE SIDE OF A HANDICAP PARKING STALL. THIS WALKWAY MAY BE SHARED WITH ADJOINING HANDICAP SPACE.

TYPICAL BICYCLE PARKING SPACE:

WALKWAY:	MINIMUM 1800MM
VERTICAL PARKING SPACE:	1500mm (L) x 500mm (W)
HORIZONTAL PARKING SPACE:	1800mm (L) x 600mm (W)
STACKED PARKING SPACE:	1930mm (L) x 460mm (W)



Ford 2009 Escape 4WD SUV	
Overall Length	14.558ft
Overall Width	5.925ft
Overall Body Height	5.649ft
Min Body Ground Clearance	0.675ft
Track Width	5.925ft
Lock-to-lock time	4.00s
Curb to Curb Turning Radius	18.350ft

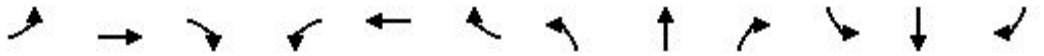


2 P1 FLOOR PLAN
1 : 200

Appendix B:
Future Operations Worksheet

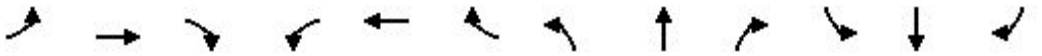
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	153	812	35	99	301	70	48	184	172	129	217	136
Future Volume (vph)	153	812	35	99	301	70	48	184	172	129	217	136
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0		4.0	6.0	6.0	7.0	7.0	7.0	4.0	7.0	7.0
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1750	3447		1526	3336	1401	1566	1807	1493	1716	1789	1551
Flt Permitted	0.51	1.00		0.14	1.00	1.00	0.61	1.00	1.00	0.54	1.00	1.00
Satd. Flow (perm)	945	3447		220	3336	1401	1006	1807	1493	974	1789	1551
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	168	892	38	109	331	77	53	202	189	142	238	149
RTOR Reduction (vph)	0	3	0	0	0	54	0	0	127	0	0	83
Lane Group Flow (vph)	168	927	0	109	331	23	53	202	62	142	238	66
Heavy Vehicles (%)	2%	2%	25%	17%	7%	14%	14%	4%	7%	4%	5%	3%
Turn Type	pm+pt	NA		pm+pt	NA	Perm	Perm	NA	Perm	pm+pt	NA	Perm
Protected Phases	7	4		3	8			2		1	6	
Permitted Phases	4			8		8	2		2	6		6
Actuated Green, G (s)	37.3	30.2		35.3	29.2	29.2	31.3	31.3	31.3	42.4	42.4	42.4
Effective Green, g (s)	37.3	30.2		35.3	29.2	29.2	31.3	31.3	31.3	42.4	42.4	42.4
Actuated g/C Ratio	0.39	0.32		0.37	0.31	0.31	0.33	0.33	0.33	0.44	0.44	0.44
Clearance Time (s)	4.0	6.0		4.0	6.0	6.0	7.0	7.0	7.0	4.0	7.0	7.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	428	1087		164	1017	427	329	591	488	486	792	687
v/s Ratio Prot	0.03	c0.27		c0.04	0.10			c0.11		0.02	c0.13	
v/s Ratio Perm	0.12			0.20		0.02	0.05		0.04	0.11		0.04
v/c Ratio	0.39	0.85		0.66	0.33	0.06	0.16	0.34	0.13	0.29	0.30	0.10
Uniform Delay, d1	19.7	30.7		22.5	25.7	23.5	22.9	24.4	22.6	16.3	17.1	15.5
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.6	6.6		9.7	0.2	0.1	1.0	1.6	0.5	0.3	1.0	0.3
Delay (s)	20.3	37.3		32.2	25.8	23.6	23.9	26.0	23.1	16.7	18.1	15.8
Level of Service	C	D		C	C	C	C	C	C	B	B	B
Approach Delay (s)		34.7			26.8			24.5			17.1	
Approach LOS		C			C			C			B	

Intersection Summary			
HCM 2000 Control Delay	27.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	95.7	Sum of lost time (s)	21.0
Intersection Capacity Utilization	99.4%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			



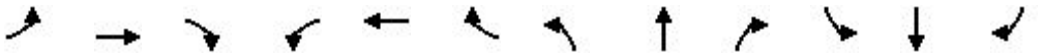
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	4	1061	37	15	490	26	3	0	13	64	0	8
Future Volume (vph)	4	1061	37	15	490	26	3	0	13	64	0	8
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0		4.0	6.0		4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	0.91		1.00	0.91		1.00	1.00		0.97	1.00	
Frt	1.00	0.99		1.00	0.99		1.00	0.85		1.00	0.85	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1750	4956		1384	4605		1750	1201		3395	1566	
Flt Permitted	0.43	1.00		0.20	1.00		1.00	1.00		0.71	1.00	
Satd. Flow (perm)	784	4956		298	4605		1842	1201		2553	1566	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	4	1179	41	17	544	29	3	0	14	71	0	9
RTOR Reduction (vph)	0	2	0	0	3	0	0	14	0	0	8	0
Lane Group Flow (vph)	4	1218	0	17	570	0	3	0	0	71	1	0
Heavy Vehicles (%)	2%	3%	2%	29%	11%	2%	2%	2%	33%	2%	2%	2%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	59.0	57.9		59.0	57.9		3.2	1.6		11.6	6.0	
Effective Green, g (s)	59.0	57.9		59.0	57.9		3.2	1.6		11.6	6.0	
Actuated g/C Ratio	0.68	0.67		0.68	0.67		0.04	0.02		0.13	0.07	
Clearance Time (s)	4.0	6.0		4.0	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	
Lane Grp Cap (vph)	546	3313		216	3078		66	22		400	108	
v/s Ratio Prot	0.00	c0.25		c0.00	0.12		0.00	0.00		c0.01	0.00	
v/s Ratio Perm	0.00			0.05			0.00			c0.01		
v/c Ratio	0.01	0.37		0.08	0.19		0.05	0.01		0.18	0.01	
Uniform Delay, d1	4.4	6.3		4.5	5.4		40.3	41.7		33.2	37.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.0	0.3		0.2	0.1		0.3	0.2		0.2	0.0	
Delay (s)	4.4	6.6		4.7	5.6		40.5	41.9		33.4	37.5	
Level of Service	A	A		A	A		D	D		C	D	
Approach Delay (s)		6.6			5.5			41.7			33.9	
Approach LOS		A			A			D			C	

Intersection Summary			
HCM 2000 Control Delay	7.7	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.35		
Actuated Cycle Length (s)	86.6	Sum of lost time (s)	20.0
Intersection Capacity Utilization	63.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



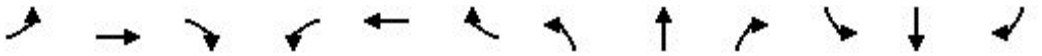
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	76	873	130	214	507	110	78	179	133	214	394	56
Future Volume (vph)	76	873	130	214	507	110	78	179	133	214	394	56
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0		4.0	6.0		4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	0.91		1.00	0.91		1.00	0.95		1.00	0.95	
Frt	1.00	0.98		1.00	0.97		1.00	0.94		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1733	4794		1716	4755		1552	3210		1716	3332	
Flt Permitted	0.40	1.00		0.15	1.00		0.43	1.00		0.51	1.00	
Satd. Flow (perm)	728	4794		267	4755		704	3210		920	3332	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	78	900	134	221	523	113	80	185	137	221	406	58
RTOR Reduction (vph)	0	20	0	0	35	0	0	97	0	0	12	0
Lane Group Flow (vph)	78	1014	0	221	601	0	80	225	0	221	452	0
Heavy Vehicles (%)	3%	4%	11%	4%	5%	5%	15%	2%	7%	4%	5%	6%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	36.4	30.8		45.3	35.7		33.4	27.8		36.2	29.2	
Effective Green, g (s)	36.4	30.8		45.3	35.7		33.4	27.8		36.2	29.2	
Actuated g/C Ratio	0.38	0.32		0.47	0.37		0.35	0.29		0.38	0.30	
Clearance Time (s)	4.0	6.0		4.0	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	
Lane Grp Cap (vph)	334	1536		284	1766		294	928		404	1012	
v/s Ratio Prot	0.01	0.21		c0.08	0.13		0.02	0.07		c0.04	0.14	
v/s Ratio Perm	0.07			c0.28			0.08			c0.17		
v/c Ratio	0.23	0.66		0.78	0.34		0.27	0.24		0.55	0.45	
Uniform Delay, d1	19.4	28.1		17.7	21.7		21.6	26.1		22.0	26.9	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.4	1.0		12.6	0.1		0.5	0.6		1.5	1.4	
Delay (s)	19.8	29.2		30.3	21.8		22.1	26.7		23.5	28.4	
Level of Service	B	C		C	C		C	C		C	C	
Approach Delay (s)		28.5			24.0			25.8			26.8	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM 2000 Control Delay	26.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	96.1	Sum of lost time (s)	20.0
Intersection Capacity Utilization	74.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			



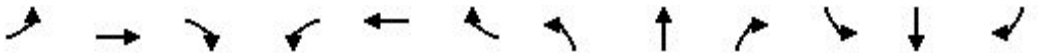
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	274	143	54	18	73	20	25	403	15	13	338	184
Future Volume (vph)	274	143	54	18	73	20	25	403	15	13	338	184
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0		6.0	6.0		4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.96		1.00	0.97		1.00	0.99		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1700	1757		1750	1769		1451	3441		1653	3242	
Flt Permitted	0.47	1.00		0.63	1.00		0.41	1.00		0.50	1.00	
Satd. Flow (perm)	844	1757		1156	1769		629	3441		864	3242	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	288	151	57	19	77	21	26	424	16	14	356	194
RTOR Reduction (vph)	0	16	0	0	12	0	0	2	0	0	62	0
Lane Group Flow (vph)	288	192	0	19	86	0	26	438	0	14	488	0
Heavy Vehicles (%)	5%	2%	4%	2%	3%	2%	23%	3%	8%	8%	5%	3%
Turn Type	pm+pt	NA		Perm	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4			8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	23.2	23.2		8.5	8.5		45.2	42.7		42.6	41.4	
Effective Green, g (s)	23.2	23.2		8.5	8.5		45.2	42.7		42.6	41.4	
Actuated g/C Ratio	0.28	0.28		0.10	0.10		0.54	0.51		0.51	0.50	
Clearance Time (s)	4.0	6.0		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	
Lane Grp Cap (vph)	345	490		118	180		366	1768		454	1615	
v/s Ratio Prot	c0.11	0.11			0.05		c0.00	0.13		0.00	c0.15	
v/s Ratio Perm	c0.13			0.02			0.04			0.02		
v/c Ratio	0.83	0.39		0.16	0.48		0.07	0.25		0.03	0.30	
Uniform Delay, d1	26.6	24.2		34.0	35.2		8.9	11.3		10.0	12.3	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	15.8	0.5		0.6	2.0		0.1	0.3		0.0	0.5	
Delay (s)	42.4	24.8		34.7	37.2		9.0	11.6		10.0	12.8	
Level of Service	D	C		C	D		A	B		A	B	
Approach Delay (s)		35.0			36.8			11.4			12.7	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM 2000 Control Delay	20.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	83.1	Sum of lost time (s)	20.0
Intersection Capacity Utilization	65.2%	ICU Level of Service	C
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 (vph)	28	61	17	122	37	27	4	413	257	57	397	9
Future Volume (vph)	28	61	17	122	37	27	4	413	257	57	397	9
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		4.0	6.0		4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.97		1.00	0.94		1.00	0.94		1.00	1.00	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1716	1767		1684	1659		1750	3240		1750	3455	
Flt Permitted	0.71	1.00		0.47	1.00		0.50	1.00		0.32	1.00	
Satd. Flow (perm)	1288	1767		841	1659		922	3240		587	3455	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	30	65	18	130	39	29	4	439	273	61	422	10
RTOR Reduction (vph)	0	11	0	0	23	0	0	82	0	0	1	0
Lane Group Flow (vph)	30	72	0	130	45	0	4	630	0	61	431	0
Heavy Vehicles (%)	4%	2%	6%	6%	3%	10%	2%	5%	2%	2%	3%	2%
Turn Type	Perm	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases		4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	8.3	8.3		20.5	20.5		52.3	51.0		60.4	55.1	
Effective Green, g (s)	8.3	8.3		20.5	20.5		52.3	51.0		60.4	55.1	
Actuated g/C Ratio	0.09	0.09		0.22	0.22		0.56	0.55		0.65	0.59	
Clearance Time (s)	6.0	6.0		4.0	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	
Lane Grp Cap (vph)	115	157		259	366		530	1778		449	2049	
v/s Ratio Prot		0.04		c0.04	0.03		0.00	c0.19		c0.01	0.12	
v/s Ratio Perm	0.02			c0.07			0.00			0.08		
v/c Ratio	0.26	0.46		0.50	0.12		0.01	0.35		0.14	0.21	
Uniform Delay, d1	39.4	40.2		30.7	29.0		8.9	11.7		6.4	8.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.2	2.1		1.5	0.2		0.0	0.6		0.1	0.2	
Delay (s)	40.7	42.3		32.2	29.2		8.9	12.3		6.5	9.0	
Level of Service	D	D		C	C		A	B		A	A	
Approach Delay (s)		41.9			31.2			12.3			8.7	
Approach LOS		D			C			B			A	

Intersection Summary			
HCM 2000 Control Delay	15.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.39		
Actuated Cycle Length (s)	92.9	Sum of lost time (s)	20.0
Intersection Capacity Utilization	67.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



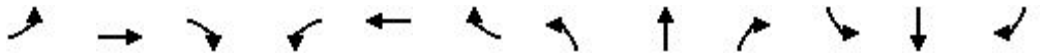
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	82	624	115	26	312	114	114	358	11	239	319	23
Future Volume (vph)	82	624	115	26	312	114	114	358	11	239	319	23
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0		4.0	6.0		4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frt	1.00	0.98		1.00	0.96		1.00	1.00		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1750	3390		1750	3202		1684	3380		1716	3417	
Flt Permitted	0.36	1.00		0.17	1.00		0.53	1.00		0.46	1.00	
Satd. Flow (perm)	663	3390		312	3202		944	3380		836	3417	
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	88	671	124	28	335	123	123	385	12	257	343	25
RTOR Reduction (vph)	0	15	0	0	38	0	0	2	0	0	5	0
Lane Group Flow (vph)	88	780	0	28	420	0	123	395	0	257	363	0
Heavy Vehicles (%)	2%	3%	2%	2%	7%	7%	6%	5%	10%	4%	3%	9%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	30.5	25.1		27.5	23.6		43.9	36.8		48.9	39.3	
Effective Green, g (s)	30.5	25.1		27.5	23.6		43.9	36.8		48.9	39.3	
Actuated g/C Ratio	0.32	0.26		0.29	0.25		0.46	0.39		0.51	0.41	
Clearance Time (s)	4.0	6.0		4.0	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	
Lane Grp Cap (vph)	273	891		148	792		489	1303		517	1407	
v/s Ratio Prot	c0.02	c0.23		0.01	0.13		0.02	0.12		c0.05	0.11	
v/s Ratio Perm	0.08			0.05			0.10			c0.20		
v/c Ratio	0.32	0.87		0.19	0.53		0.25	0.30		0.50	0.26	
Uniform Delay, d1	23.5	33.6		25.6	31.1		15.0	20.4		13.5	18.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.7	9.6		0.6	0.6		0.3	0.6		0.8	0.4	
Delay (s)	24.2	43.2		26.2	31.7		15.3	21.0		14.2	18.9	
Level of Service	C	D		C	C		B	C		B	B	
Approach Delay (s)		41.3			31.4			19.6			17.0	
Approach LOS		D			C			B			B	

Intersection Summary			
HCM 2000 Control Delay	28.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	95.4	Sum of lost time (s)	20.0
Intersection Capacity Utilization	85.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	16	57	401	6	23	466
Future Volume (Veh/h)	16	57	401	6	23	466
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	17	62	436	7	25	507
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	996	440			443	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	996	440			443	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	94	90			98	
cM capacity (veh/h)	267	622			1128	

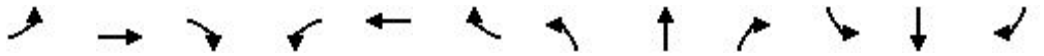
Direction, Lane #	WB 1	NB 1	SB 1	SB 2
Volume Total	79	443	25	507
Volume Left	17	0	25	0
Volume Right	62	7	0	0
cSH	484	1700	1128	1700
Volume to Capacity	0.16	0.26	0.02	0.30
Queue Length 95th (m)	4.4	0.0	0.5	0.0
Control Delay (s)	13.9	0.0	8.3	0.0
Lane LOS	B		A	
Approach Delay (s)	13.9	0.0	0.4	
Approach LOS	B			

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	35.6%	ICU Level of Service	A
Analysis Period (min)	15		



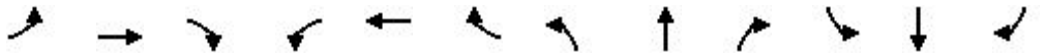
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	130	519	24	226	1029	293	67	300	174	128	288	251
Future Volume (vph)	130	519	24	226	1029	293	67	300	174	128	288	251
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0		4.0	6.0	6.0	7.0	7.0	7.0	4.0	7.0	7.0
Lane Util. Factor	1.00	0.95		1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.99		1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1750	3444		1733	3500	1566	1750	1842	1551	1716	1842	1566
Flt Permitted	0.14	1.00		0.28	1.00	1.00	0.58	1.00	1.00	0.39	1.00	1.00
Satd. Flow (perm)	258	3444		515	3500	1566	1066	1842	1551	706	1842	1566
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	134	535	25	233	1061	302	69	309	179	132	297	259
RTOR Reduction (vph)	0	4	0	0	0	201	0	0	113	0	0	126
Lane Group Flow (vph)	134	556	0	233	1061	101	69	309	66	132	297	133
Heavy Vehicles (%)	2%	3%	2%	3%	2%	2%	2%	2%	3%	4%	2%	2%
Turn Type	pm+pt	NA		pm+pt	NA	Perm	Perm	NA	Perm	pm+pt	NA	Perm
Protected Phases	7	4		3	8			2		1	6	
Permitted Phases	4			8		8	2		2	6		6
Actuated Green, G (s)	35.6	28.6		44.0	33.0	33.0	31.0	31.0	31.0	42.0	42.0	42.0
Effective Green, g (s)	35.6	28.6		44.0	33.0	33.0	31.0	31.0	31.0	42.0	42.0	42.0
Actuated g/C Ratio	0.36	0.29		0.44	0.33	0.33	0.31	0.31	0.31	0.42	0.42	0.42
Clearance Time (s)	4.0	6.0		4.0	6.0	6.0	7.0	7.0	7.0	4.0	7.0	7.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	198	994		369	1166	522	333	576	485	370	781	664
v/s Ratio Prot	0.05	0.16		c0.07	c0.30			c0.17		0.03	c0.16	
v/s Ratio Perm	0.20			0.21		0.06	0.06		0.04	0.13		0.08
v/c Ratio	0.68	0.56		0.63	0.91	0.19	0.21	0.54	0.14	0.36	0.38	0.20
Uniform Delay, d1	24.2	29.9		18.6	31.6	23.5	25.0	28.1	24.4	18.5	19.6	17.9
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	8.8	0.7		3.5	10.4	0.2	1.4	3.6	0.6	0.6	1.4	0.7
Delay (s)	33.1	30.5		22.1	42.0	23.7	26.4	31.6	25.0	19.1	21.0	18.6
Level of Service	C	C		C	D	C	C	C	C	B	C	B
Approach Delay (s)		31.0			35.6			28.8			19.7	
Approach LOS		C			D			C			B	

Intersection Summary			
HCM 2000 Control Delay	30.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	99.0	Sum of lost time (s)	21.0
Intersection Capacity Utilization	105.6%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			



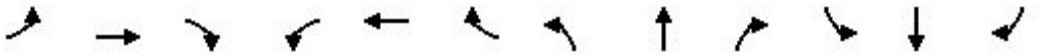
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	9	812	35	3	1507	64	65	0	15	44	0	7
Future Volume (vph)	9	812	35	3	1507	64	65	0	15	44	0	7
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0		4.0	6.0		4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	0.91		1.00	0.91		1.00	1.00		0.97	1.00	
Frt	1.00	0.99		1.00	0.99		1.00	0.85		1.00	0.85	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1750	4949		1750	4998		1750	1566		3395	1566	
Flt Permitted	0.12	1.00		0.30	1.00		0.98	1.00		1.00	1.00	
Satd. Flow (perm)	212	4949		558	4998		1797	1566		3574	1566	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	9	855	37	3	1586	67	68	0	16	46	0	7
RTOR Reduction (vph)	0	3	0	0	2	0	0	15	0	0	7	0
Lane Group Flow (vph)	9	889	0	3	1651	0	68	1	0	46	0	0
Heavy Vehicles (%)	2%	3%	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	58.9	57.8		58.9	57.8		12.5	4.1		6.5	1.1	
Effective Green, g (s)	58.9	57.8		58.9	57.8		12.5	4.1		6.5	1.1	
Actuated g/C Ratio	0.67	0.65		0.67	0.65		0.14	0.05		0.07	0.01	
Clearance Time (s)	4.0	6.0		4.0	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	
Lane Grp Cap (vph)	160	3235		386	3267		249	72		251	19	
v/s Ratio Prot	c0.00	0.18		0.00	c0.33		c0.03	0.00		0.01	0.00	
v/s Ratio Perm	0.04			0.01			c0.01			0.00		
v/c Ratio	0.06	0.27		0.01	0.51		0.27	0.01		0.18	0.00	
Uniform Delay, d1	5.5	6.5		4.9	7.9		33.9	40.2		38.5	43.1	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	0.1	0.2		0.0	0.6		0.6	0.1		0.4	0.1	
Delay (s)	5.6	6.7		4.9	8.5		34.5	40.3		38.9	43.2	
Level of Service	A	A		A	A		C	D		D	D	
Approach Delay (s)		6.7			8.5			35.6			39.4	
Approach LOS		A			A			D			D	

Intersection Summary			
HCM 2000 Control Delay	9.3	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.48		
Actuated Cycle Length (s)	88.4	Sum of lost time (s)	20.0
Intersection Capacity Utilization	65.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



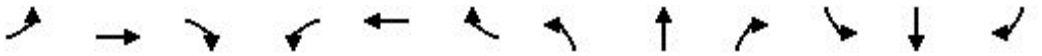
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	151	895	166	216	1162	335	251	539	172	173	392	80
Future Volume (vph)	151	895	166	216	1162	335	251	539	172	173	392	80
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0		4.0	6.0		4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	0.91		1.00	0.91		1.00	0.95		1.00	0.95	
Frt	1.00	0.98		1.00	0.97		1.00	0.96		1.00	0.97	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1750	4895		1700	4860		1716	3373		1733	3411	
Flt Permitted	0.12	1.00		0.12	1.00		0.31	1.00		0.16	1.00	
Satd. Flow (perm)	214	4895		213	4860		560	3373		287	3411	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	161	952	177	230	1236	356	267	573	183	184	417	85
RTOR Reduction (vph)	0	23	0	0	46	0	0	28	0	0	16	0
Lane Group Flow (vph)	161	1106	0	230	1546	0	267	728	0	184	486	0
Heavy Vehicles (%)	2%	2%	4%	5%	2%	2%	4%	2%	2%	3%	2%	2%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	43.1	34.4		51.8	39.1		39.2	26.5		37.0	25.4	
Effective Green, g (s)	43.1	34.4		51.8	39.1		39.2	26.5		37.0	25.4	
Actuated g/C Ratio	0.41	0.32		0.49	0.37		0.37	0.25		0.35	0.24	
Clearance Time (s)	4.0	6.0		4.0	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	
Lane Grp Cap (vph)	213	1590		292	1794		345	844		258	818	
v/s Ratio Prot	0.06	0.23		c0.10	c0.32		c0.09	c0.22		0.08	0.14	
v/s Ratio Perm	0.24			0.29			0.19			0.17		
v/c Ratio	0.76	0.70		0.79	0.86		0.77	0.86		0.71	0.59	
Uniform Delay, d1	23.5	31.2		21.4	30.9		25.4	38.0		26.6	35.7	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	14.1	2.5		13.1	5.7		10.3	9.0		9.0	1.2	
Delay (s)	37.7	33.7		34.5	36.6		35.8	47.0		35.6	36.8	
Level of Service	D	C		C	D		D	D		D	D	
Approach Delay (s)		34.2			36.4			44.1			36.5	
Approach LOS		C			D			D			D	

Intersection Summary			
HCM 2000 Control Delay	37.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.87		
Actuated Cycle Length (s)	105.9	Sum of lost time (s)	20.0
Intersection Capacity Utilization	84.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			



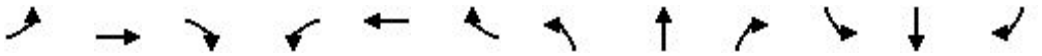
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	279	154	44	37	215	28	87	467	35	20	629	368
Future Volume (vph)	279	154	44	37	215	28	87	467	35	20	629	368
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0		6.0	6.0		4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.97		1.00	0.98		1.00	0.99		1.00	0.94	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1750	1761		1750	1806		1716	3463		1750	3306	
Flt Permitted	0.27	1.00		0.62	1.00		0.11	1.00		0.42	1.00	
Satd. Flow (perm)	491	1761		1143	1806		205	3463		774	3306	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	310	171	49	41	239	31	97	519	39	22	699	409
RTOR Reduction (vph)	0	10	0	0	5	0	0	4	0	0	76	0
Lane Group Flow (vph)	310	210	0	41	265	0	97	554	0	22	1032	0
Heavy Vehicles (%)	2%	2%	7%	2%	2%	4%	4%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA		Perm	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4			8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	37.5	37.5		18.7	18.7		50.1	44.7		44.5	41.9	
Effective Green, g (s)	37.5	37.5		18.7	18.7		50.1	44.7		44.5	41.9	
Actuated g/C Ratio	0.37	0.37		0.19	0.19		0.50	0.44		0.44	0.42	
Clearance Time (s)	4.0	6.0		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	
Lane Grp Cap (vph)	367	655		212	335		182	1535		366	1374	
v/s Ratio Prot	c0.12	0.12			0.15		c0.03	0.16		0.00	c0.31	
v/s Ratio Perm	c0.19			0.04			0.24			0.02		
v/c Ratio	0.84	0.32		0.19	0.79		0.53	0.36		0.06	0.75	
Uniform Delay, d1	25.2	22.6		34.7	39.2		17.4	18.6		15.9	25.0	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	16.1	0.3		0.4	12.0		3.0	0.7		0.1	3.8	
Delay (s)	41.4	22.9		35.1	51.2		20.4	19.2		16.0	28.8	
Level of Service	D	C		D	D		C	B		B	C	
Approach Delay (s)		33.7			49.1			19.4			28.6	
Approach LOS		C			D			B			C	

Intersection Summary			
HCM 2000 Control Delay	29.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	100.8	Sum of lost time (s)	20.0
Intersection Capacity Utilization	84.3%	ICU Level of Service	E
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 (vph)	19	47	18	290	148	74	16	491	255	73	709	51
Future Volume (vph)	19	47	18	290	148	74	16	491	255	73	709	51
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0		4.0	6.0		4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95		1.00	0.95	
Frt	1.00	0.96		1.00	0.95		1.00	0.95		1.00	0.99	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1750	1766		1750	1750		1750	3309		1733	3465	
Flt Permitted	0.60	1.00		0.47	1.00		0.29	1.00		0.25	1.00	
Satd. Flow (perm)	1114	1766		864	1750		531	3309		461	3465	
Peak-hour factor, PHF	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Adj. Flow (vph)	21	53	20	326	166	83	18	552	287	82	797	57
RTOR Reduction (vph)	0	16	0	0	20	0	0	58	0	0	4	0
Lane Group Flow (vph)	21	57	0	326	229	0	18	781	0	82	850	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	3%	3%	2%	2%
Turn Type	Perm	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases		4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	7.8	7.8		24.8	24.8		47.0	44.4		52.4	47.1	
Effective Green, g (s)	7.8	7.8		24.8	24.8		47.0	44.4		52.4	47.1	
Actuated g/C Ratio	0.09	0.09		0.27	0.27		0.52	0.49		0.58	0.52	
Clearance Time (s)	6.0	6.0		4.0	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	
Lane Grp Cap (vph)	96	152		364	479		310	1623		341	1803	
v/s Ratio Prot		0.03		c0.13	0.13		0.00	0.24		c0.01	c0.25	
v/s Ratio Perm	0.02			c0.12			0.03			0.12		
v/c Ratio	0.22	0.38		0.90	0.48		0.06	0.48		0.24	0.47	
Uniform Delay, d1	38.5	39.1		30.0	27.4		10.8	15.4		9.3	13.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.2	1.6		23.4	0.8		0.1	1.0		0.4	0.9	
Delay (s)	39.7	40.6		53.3	28.2		10.8	16.4		9.7	14.7	
Level of Service	D	D		D	C		B	B		A	B	
Approach Delay (s)		40.4			42.5			16.3			14.2	
Approach LOS		D			D			B			B	

Intersection Summary			
HCM 2000 Control Delay	22.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	90.5	Sum of lost time (s)	20.0
Intersection Capacity Utilization	76.9%	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 (vph)	67	565	182	34	1032	165	204	359	18	255	668	87
Future Volume (vph)	67	565	182	34	1032	165	204	359	18	255	668	87
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	6.0		4.0	6.0		4.0	6.0		4.0	6.0	
Lane Util. Factor	1.00	0.95		1.00	0.95		1.00	0.95		1.00	0.95	
Frt	1.00	0.96		1.00	0.98		1.00	0.99		1.00	0.98	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1750	3364		1750	3427		1750	3475		1750	3439	
Flt Permitted	0.10	1.00		0.23	1.00		0.18	1.00		0.46	1.00	
Satd. Flow (perm)	179	3364		431	3427		334	3475		846	3439	
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	71	601	194	36	1098	176	217	382	19	271	711	93
RTOR Reduction (vph)	0	27	0	0	11	0	0	3	0	0	10	0
Lane Group Flow (vph)	71	768	0	36	1263	0	217	398	0	271	794	0
Heavy Vehicles (%)	2%	2%	3%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	46.7	41.2		43.9	39.8		44.1	35.1		44.1	35.1	
Effective Green, g (s)	46.7	41.2		43.9	39.8		44.1	35.1		44.1	35.1	
Actuated g/C Ratio	0.43	0.38		0.40	0.36		0.40	0.32		0.40	0.32	
Clearance Time (s)	4.0	6.0		4.0	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	
Lane Grp Cap (vph)	155	1266		222	1246		251	1114		415	1103	
v/s Ratio Prot	c0.02	0.23		0.01	c0.37		c0.07	0.11		0.05	0.23	
v/s Ratio Perm	0.17			0.06			c0.28			0.21		
v/c Ratio	0.46	0.61		0.16	1.01		0.86	0.36		0.65	0.72	
Uniform Delay, d1	25.2	27.5		20.9	34.8		24.6	28.5		24.2	32.8	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.1	0.8		0.3	28.8		25.1	0.9		3.7	4.1	
Delay (s)	27.3	28.4		21.2	63.6		49.8	29.4		27.9	36.9	
Level of Service	C	C		C	E		D	C		C	D	
Approach Delay (s)		28.3			62.5			36.5			34.6	
Approach LOS		C			E			D			C	

Intersection Summary			
HCM 2000 Control Delay	42.9	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.91		
Actuated Cycle Length (s)	109.4	Sum of lost time (s)	20.0
Intersection Capacity Utilization	99.6%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	10	38	708	15	53	657
Future Volume (Veh/h)	10	38	708	15	53	657
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	41	770	16	58	714
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	1608	778			786	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1608	778			786	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	90	90			93	
cM capacity (veh/h)	109	400			842	

Direction, Lane #	WB 1	NB 1	SB 1	SB 2
Volume Total	52	786	58	714
Volume Left	11	0	58	0
Volume Right	41	16	0	0
cSH	255	1700	842	1700
Volume to Capacity	0.20	0.46	0.07	0.42
Queue Length 95th (m)	5.7	0.0	1.7	0.0
Control Delay (s)	22.7	0.0	9.6	0.0
Lane LOS	C		A	
Approach Delay (s)	22.7	0.0	0.7	
Approach LOS	C			

Intersection Summary			
Average Delay	1.1		
Intersection Capacity Utilization	54.0%	ICU Level of Service	A
Analysis Period (min)	15		

Appendix C: Traffic Signal Warrant Worksheets

TATHAM ENGINEERING

TRAFFIC SIGNAL WARRANT

Project & No.: Mapleview & Essa Development 422433

GENERAL INFORMATION

Analyst	MJB	**Jurisdiction/Area**	City of Barrie	**Date**	Oct 2024
Agency or Company	Tatham Engineering Limited	**East-West Street**	North Access		
Analysis Period	2027 - existing Essa x-section	**North-South Street**	Essa Road		
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South		
T Intersection	Yes	**Approach Lanes per Direction**	1		
		Existing or Planned Intersection	planned intersection		

Additional Comments

TRAFFIC & PEDESTRIAN VOLUMES

	AM Peak Hour			PM Peak Hour			Average Hour (AM+PM) ÷ 4		
	right	thru	left	right	thru	left	right	thru	left
MAJOR STREET									
Northbound	6	401	0	15	708	0	**5**	**277**	**0**
Southbound	0	466	23	0	657	53	**0**	**281**	**19**
MINOR STREET									
Eastbound	0	0	0	0	0	0	**0**	**0**	**0**
Westbound	57	0	16	38	0	10	**24**	**0**	**7**
PEDESTRIANS									
crossing MAJOR street		5			5			**3**	
crossing MINOR street		5			5			**3**	

	AM Peak Hour			PM Peak Hour			Average Hour (AM+PM) ÷ 4		
	major	minor	total	major	minor	total	major	minor	total
APPROACH VOLUMES	896	73	969	1433	48	1482	**582**	**30**	**613**
CROSSING VOLUMES			21			15			**9**

JUSTIFICATION 7 - PROJECTED VOLUMES

Justification	Description	Warrant Level			Warrant Adjustment	Sectional Numerical	Sectional Compliance	Entire Compliance
1. MINIMUM VEHICULAR VOLUMES	A. Vehicle volume, all approaches (average hour)	720 (1 lane approach on main road)	or	900 (2 or more lane approach on main road)	**150%**	**613**	**57%**	8%
	B. Vehicle volume, along minor streets (average hour)	170 (full intersection)	or	255 (tee intersection)	**150%**	**30**	**8%**	
2. DELAY TO CROSS TRAFFIC	A. Vehicle volume, major street (average hour)	720 (1 lane approach on main road)	or	900 (2 or more lane approach on main road)	**150%**	**582**	**54%**	8%
	B. Combined vehicle and pedestrian volume crossing artery from minor streets	75 (1 lane approach on main road)	or	170 (2 or more lane approach on main road)	**150%**	**9**	**8%**	

Signals are warranted if BOTH Justification 1A and Justification 1B OR Justification 2A and Justification 2B are 100% compliant.	Not Warranted
Signals are warranted if THE LESSER of Justification 1A or 1B AND the lesser of Justification 2A or Justification 2B are 80% compliant.	Not Warranted

Notes:

Restricted Flow Conditions
- roads with operating speeds less than 70 km/h
- normally encountered in urban areas where the traffic volumes approach or exceed practical working capacity of road

Free Flow Conditions
- roads with operating speeds greater than or equal to 70 km/h
- normally encountered in rural areas
- may also be used at intersections within the built-up area of a community with < 10 000 people and outside the commuting influence of a large urban centre, even if the speed is less than 70 km/h

TATHAM ENGINEERING

TRAFFIC SIGNAL WARRANT

Project & No.: Mapleview & Essa Development 422433

GENERAL INFORMATION

Analyst	MJB	**Jurisdiction/Area**	City of Barrie	**Date**	Oct 2024
Agency or Company	Tatham Engineering Limited	**East-West Street**	North Access		
Analysis Period	2027 - future Essa x-section	**North-South Street**	Essa Road		
Flow Conditions	Restricted flow (urban)	**Major Street**	North-South		
T Intersection	Yes	**Approach Lanes per Direction**	2		
		Existing or Planned Intersection	planned intersection		

Additional Comments

TRAFFIC & PEDESTRIAN VOLUMES

	AM Peak Hour			PM Peak Hour			Average Hour (AM+PM) ÷ 4		
	right	thru	left	right	thru	left	right	thru	left
MAJOR STREET									
Northbound	6	401	0	15	708	0	**5**	**277**	**0**
Southbound	0	466	23	0	657	53	**0**	**281**	**19**
MINOR STREET									
Eastbound	0	0	0	0	0	0	**0**	**0**	**0**
Westbound	57	0	16	38	0	10	**24**	**0**	**7**
PEDESTRIANS									
crossing MAJOR street		5			5			**3**	
crossing MINOR street		5			5			**3**	

	AM Peak Hour			PM Peak Hour			Average Hour (AM+PM) ÷ 4		
	major	minor	total	major	minor	total	major	minor	total
APPROACH VOLUMES	896	73	969	1433	48	1482	**582**	**30**	**613**
CROSSING VOLUMES			21			15			**9**

JUSTIFICATION 7 - PROJECTED VOLUMES

Justification	Description	Warrant Level			Warrant Adjustment	Sectional Numerical	Sectional Compliance	Entire Compliance
1. MINIMUM VEHICULAR VOLUMES	A. Vehicle volume, all approaches (average hour)	720 (1 lane approach on main road)	or	900 (2 or more lane approach on main road)	**150%**	**613**	**45%**	8%
	B. Vehicle volume, along minor streets (average hour)	170 (full intersection)	or	255 (tee intersection)	**150%**	**30**	**8%**	
2. DELAY TO CROSS TRAFFIC	A. Vehicle volume, major street (average hour)	720 (1 lane approach on main road)	or	900 (2 or more lane approach on main road)	**150%**	**582**	**43%**	4%
	B. Combined vehicle and pedestrian volume crossing artery from minor streets	75 (1 lane approach on main road)	or	170 (2 or more lane approach on main road)	**150%**	**9**	**4%**	

Signals are warranted if BOTH Justification 1A and Justification 1B OR Justification 2A and Justification 2B are 100% compliant.	Not Warranted
Signals are warranted if THE LESSER of Justification 1A or 1B AND the lesser of Justification 2A or Justification 2B are 80% compliant.	Not Warranted

Notes:

Restricted Flow Conditions
- roads with operating speeds less than 70 km/h
- normally encountered in urban areas where the traffic volumes approach or exceed practical working capacity of road

Free Flow Conditions
- roads with operating speeds greater than or equal to 70 km/h
- normally encountered in rural areas
- may also be used at intersections within the built-up area of a community with < 10 000 people and outside the commuting influence of a large urban centre, even if the speed is less than 70 km/h