Claremont North Business Park
Durham Region, Ontario
Traffic Impact Study

Paradigm Transportation Solutions Limited

June 2019

Project Summary

Project Number
160300

June 2019

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Traffic Impact Study

List of Revisions

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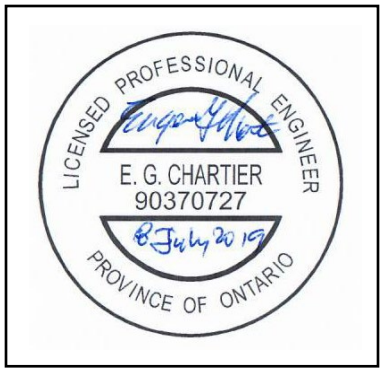
1	May 2018	Draft for Comment
2	June 2019	Final

Signatures and Seals



Signature

Engineer's Seal

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Executive Summary

Content

Paradigm Transportation Solutions Limited (Paradigm) has been retained by S. Larkin Developments Inc.to prepare a Traffic Impact Study (TIS) for a proposed business park development in the City of Pickering, Regional Municipality of Durham. The subject lands are located west of Brock Road (Regional Road 1) and east of Old Brock Road, immediately south of Uxbridge Pickering Townline in the village of Claremont. The City requires a Zoning By-law Amendment to recognize the existing and future employment uses on site.

The TIS includes an analysis of existing traffic conditions, an assessment of the preferred location for a new access on Brock Road, traffic forecasts and analysis for a horizon year corresponding to full build-out/occupancy of the site (2028), and identification of the road and traffic control improvements necessary to accommodate the traffic forecasts.

Development Concept

The proposed development is located at the municipal addresses of 5435, 5455, and 5475 Old Brock Road. To complement the existing on-site industrial uses, it is proposed that new development be added to the site including an industrial building for contractor-type services as well as a gas station complex with a car wash, quick serve drive-through restaurant, and convenience store. The site access would be via several driveways on Old Brock Road (as it is today) and via a new access on Brock Road.

Conclusions

The conclusions of the TIS are as follows:

- The study area intersections operate at acceptable levels of service and well within capacity under 2018 base year conditions;
- The proposed site access on Brock Road, which is shown on the site plan to be located approximately 280 metres north of the Canadian Pacific Railway Havelock Subdivision at-grade rail crossing, would provide acceptable sightline conditions for a three-quarter access operation (i.e. would allow northbound left in, southbound right in, and eastbound right out, but would restrict eastbound left out);
- The Brock Road site access intersection would require a northbound left turn lane, a southbound right turn lane, and a channelizing island within the throat of the access to restrict the eastbound left turn out movement. This lane configuration has been illustrated in a

functional design drawing prepared in accordance with Regional standards; and

- With full development and occupancy of the site by 2028, the study area intersections would operate at acceptable levels of service and well within capacity under 2028 forecast conditions. The only road or traffic control improvements required to accommodate full development would be at the proposed Brock Road site access.

Recommendations

The recommendations of the TIS are as follows:

- From a traffic perspective, the required Zoning By-law Amendment to permit the proposed uses should be approved; and
- The propose new site access on Brock Road (Regional Road 1) should be permitted.

Contents

Appendices

Figures

Tables

1 Introduction

Paradigm Transportation Solutions Limited (Paradigm) has been retained by S. Larkin Developments Inc.to prepare a Traffic Impact Study (TIS) for a proposed business park development in the City of Pickering, Regional Municipality of Durham. The City requires a Zoning By-law Amendment to recognize the existing and future employment uses on site.

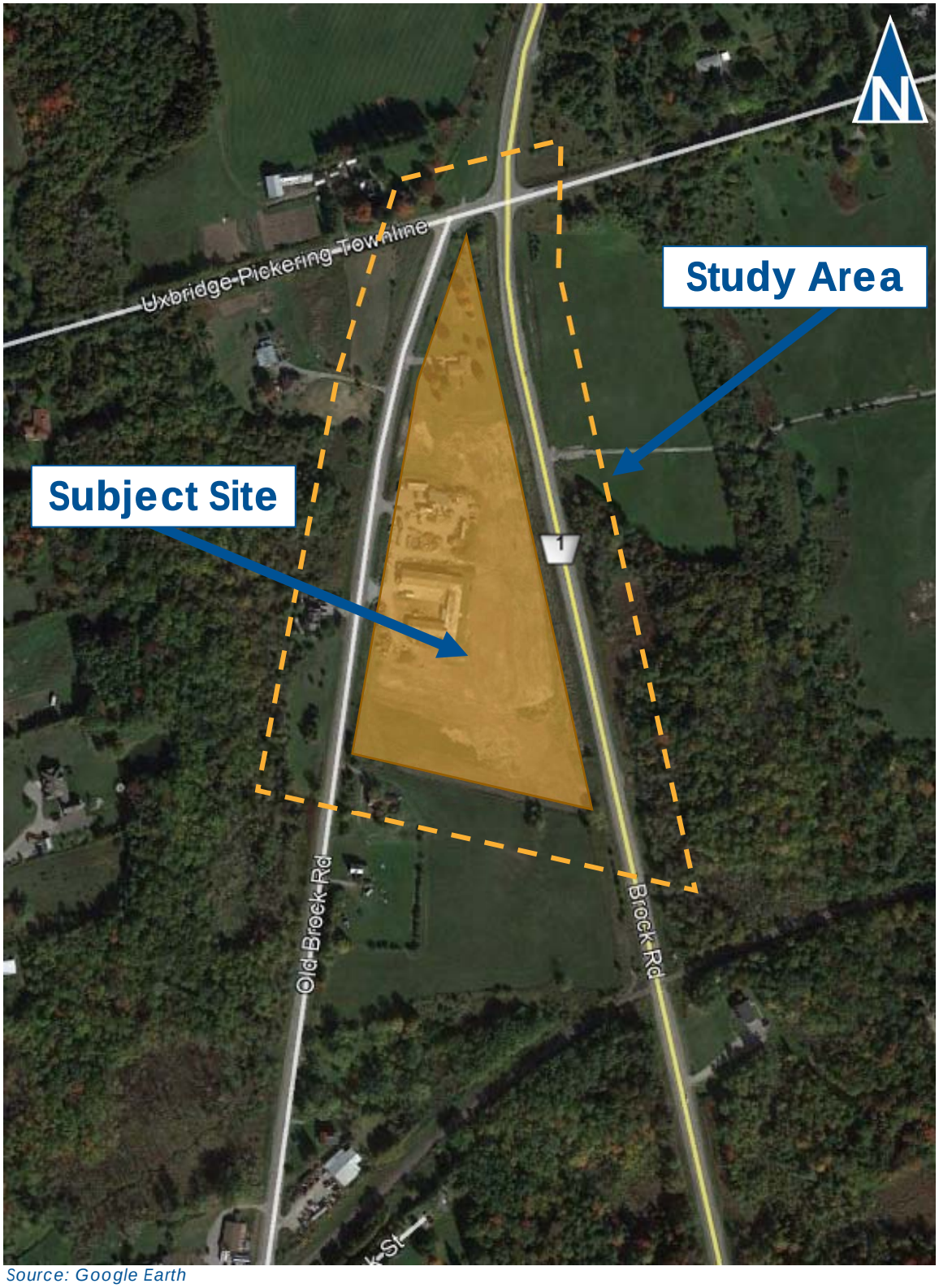
The subject lands, which have municipal addresses of 5435, 5455, and 5475 Old Brock Road, are located west of Brock Road (Regional Road 1) and east of Old Brock Road, immediately south of Uxbridge Pickering Townline in the village of Claremont. The adjacent land uses include rural residential, agricultural, and woodlots. **Figure 1.1** illustrates the site location and the study area.

The scope of the study includes an assessment of existing base year (2018) traffic conditions, future traffic conditions for a 10-year horizon (2028) representing full build-out, a sightline assessment for potential access locations on Brock Road (Regional Road 1), and recommendations for any required improvements at the following study area intersections:

- Brock Road and Uxbridge Pickering Townline;
- Old Brock Road and Uxbridge Pickering Townline;
- Old Brock Road and Driveway 1;
- Old Brock Road and Driveway 2;
- Old Brock Road and Driveway 3; and
- Brock Road and Driveway 4.

This study has been prepared in general accordance with the requirements of Durham Region's Traffic Impact Study Guidelines[1]. Paradigm exchanged e-mail correspondence with Durham Region and had follow-up discussions to confirm the scope and requirements of the TIS.

[1] Traffic Impact Study Guidelines, Regional Municipality of Durham, October 2011.



Source: Google Earth

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Study Area and Subject Development Location

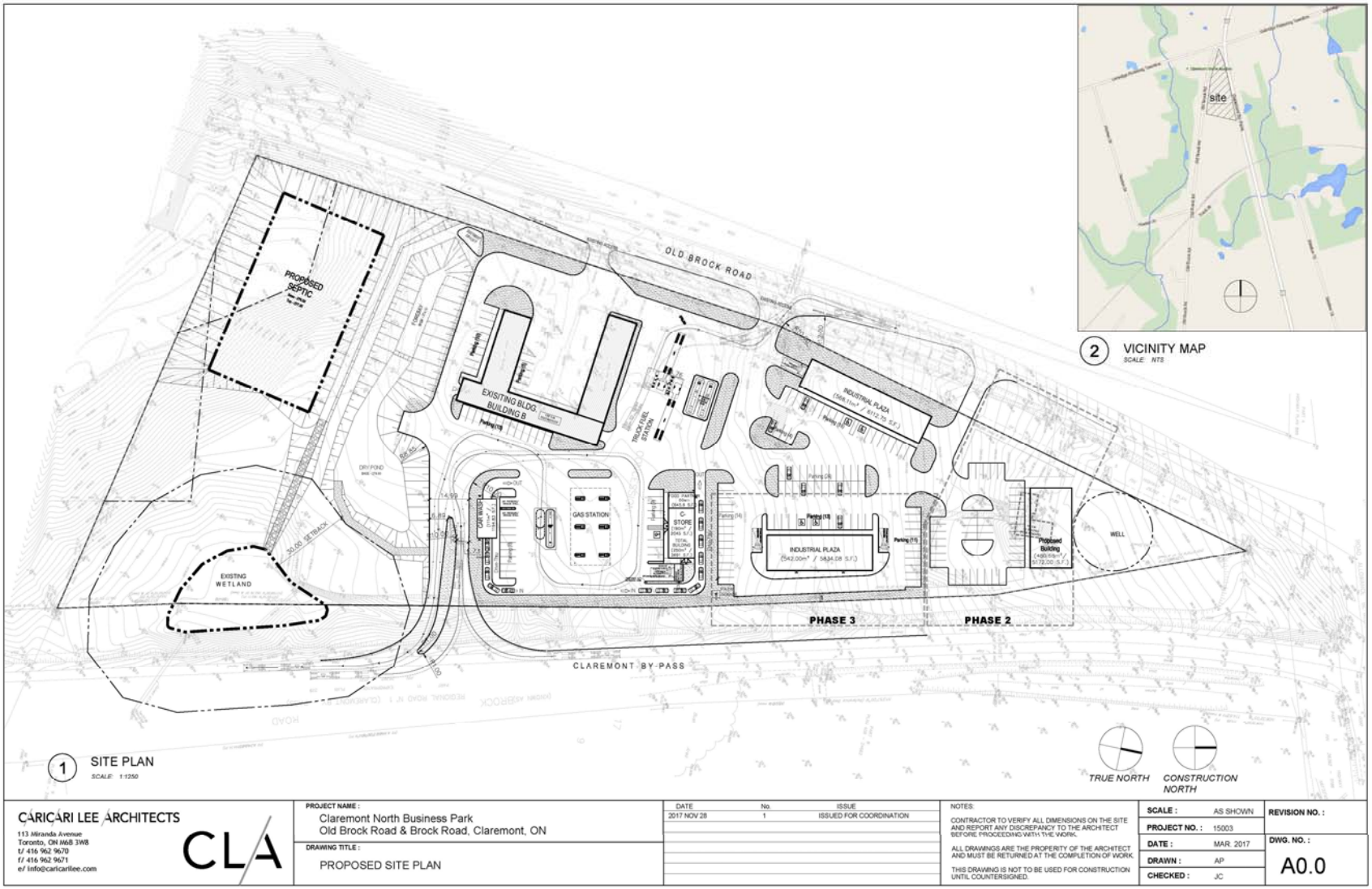
2 Development Concept

Figure 2.1 shows the proposed site plan. The development would include the following new land uses in addition to the existing industrial buildings:

- An industrial building of 17,200 ft^2 GFA for contractor-type services; and
- A gas station site with 14 fueling positions, a car wash, and an accessory building with a quick serve drive-through restaurant and a convenience store.

Site access would be via both Old Brock Road (three driveways) and Brock Road (one driveway).

Through consultation with the proponent, it is anticipated that the site will be fully built and occupied by 2028.



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Proposed Site Plan

Figure 2.1

3 Existing Conditions

3.1 Road Network

The characteristics of the study area road network are as follows:

- Brock Road (Regional Road 1) is a two-lane Type A Arterial road with a posted maximum speed limit of 80 km/h;
- Old Brock Road is a two-lane local road with a posted maximum speed limit of 40 km/h, and is under the jurisdiction of the City of Pickering; and
- Uxbridge Pickering Townline is a two-lane local road with a posted maximum speed limit of 60 km/h and is under the joint jurisdiction of the City of Pickering and the Township of Uxbridge.

Figure 3.1 displays the traffic control and lane configurations for the study area intersections, which all operate with the minor street approaches under stop control. Currently there are no sidewalks or cycling infrastructure present in the study area.

3.2 Traffic Volumes

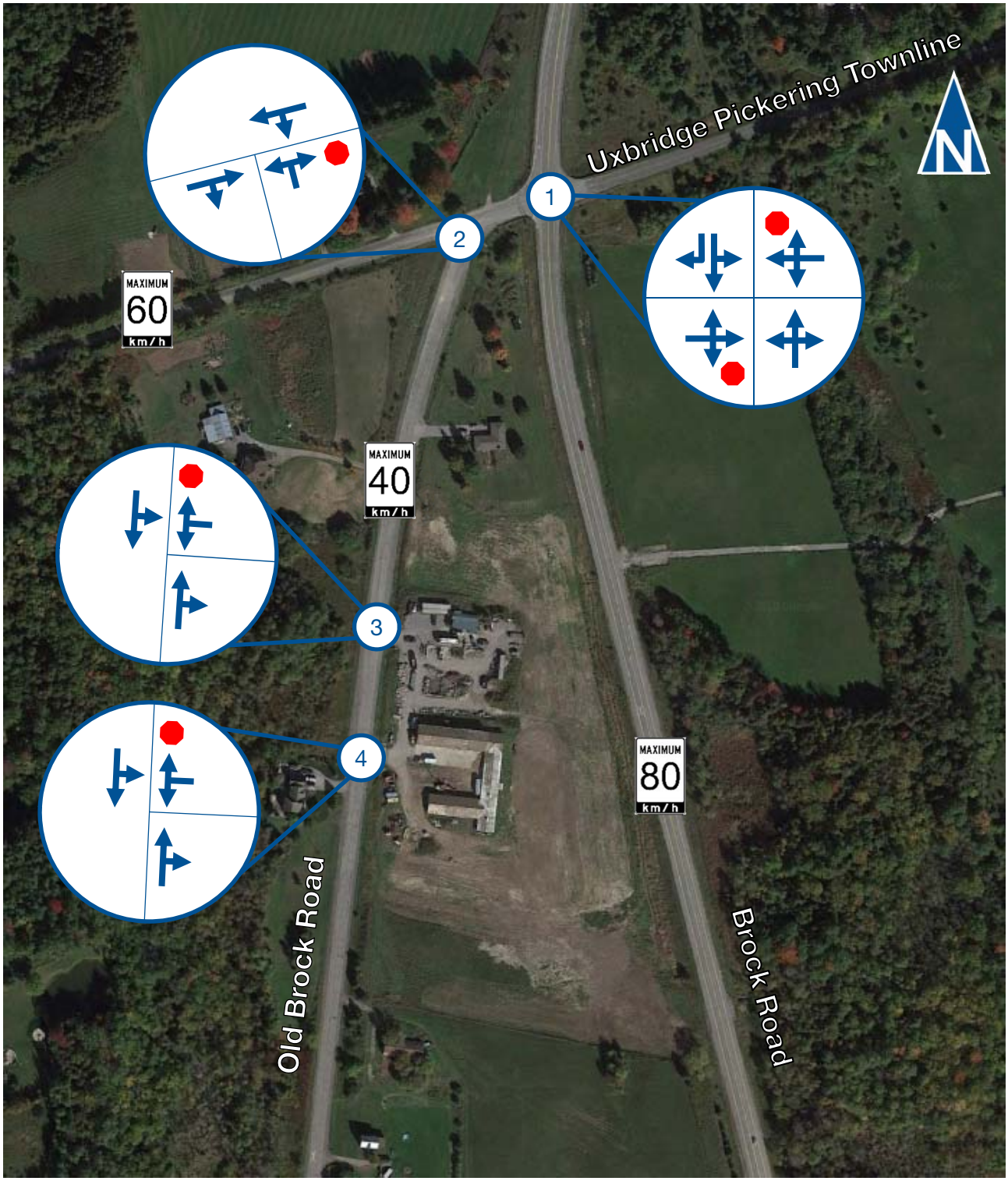
Paradigm collected turning movement count data for the study area's public road intersections in July 2016, and it was agreed with Durham Region staff that base year traffic volumes for 2018 could be estimated by applying a 2% growth factor to the traffic counts. Since traffic counts were not collected at the driveways serving the small amount of existing development (approximately 14,000 SF GFA), the AM and PM peak hour turning movements at these driveways were estimated based on the likely trip generation for the current uses and the assignment of these trips to the study area road network.

The Institute of Transportation Engineers (ITE) Trip Generation Manual (10th Edition) was used as a reference and it was determined that Land Use Code 170 (Utilities) would be a similar land use since it is defined as: "… a free-standing building that can house office space, a storage area, and electromechanical or industrial equipment that support a local electrical, communication, water supply or control, or sewage treatment utility." **Table 3.1** shows the ITE trip rates and the estimated site trips for the existing uses on the subject site.

TABLE 3.1: EXISTING DEVELOPMENT – TRIP ESTIMATES

Land Use Code	Units		AM Peak Hour				PM Peak Hour			
			Rate	In	Out	Total	Rate	In	Out	Total
170 Utilities	13.9	x 1000 sq.ft.	2.31	26	6	32	2.27	6	26	32

Figure 3.2 and **Figure 3.3** show the base year (2018) traffic volumes for the AM and PM peak hours, respectively.



Source: Google Maps

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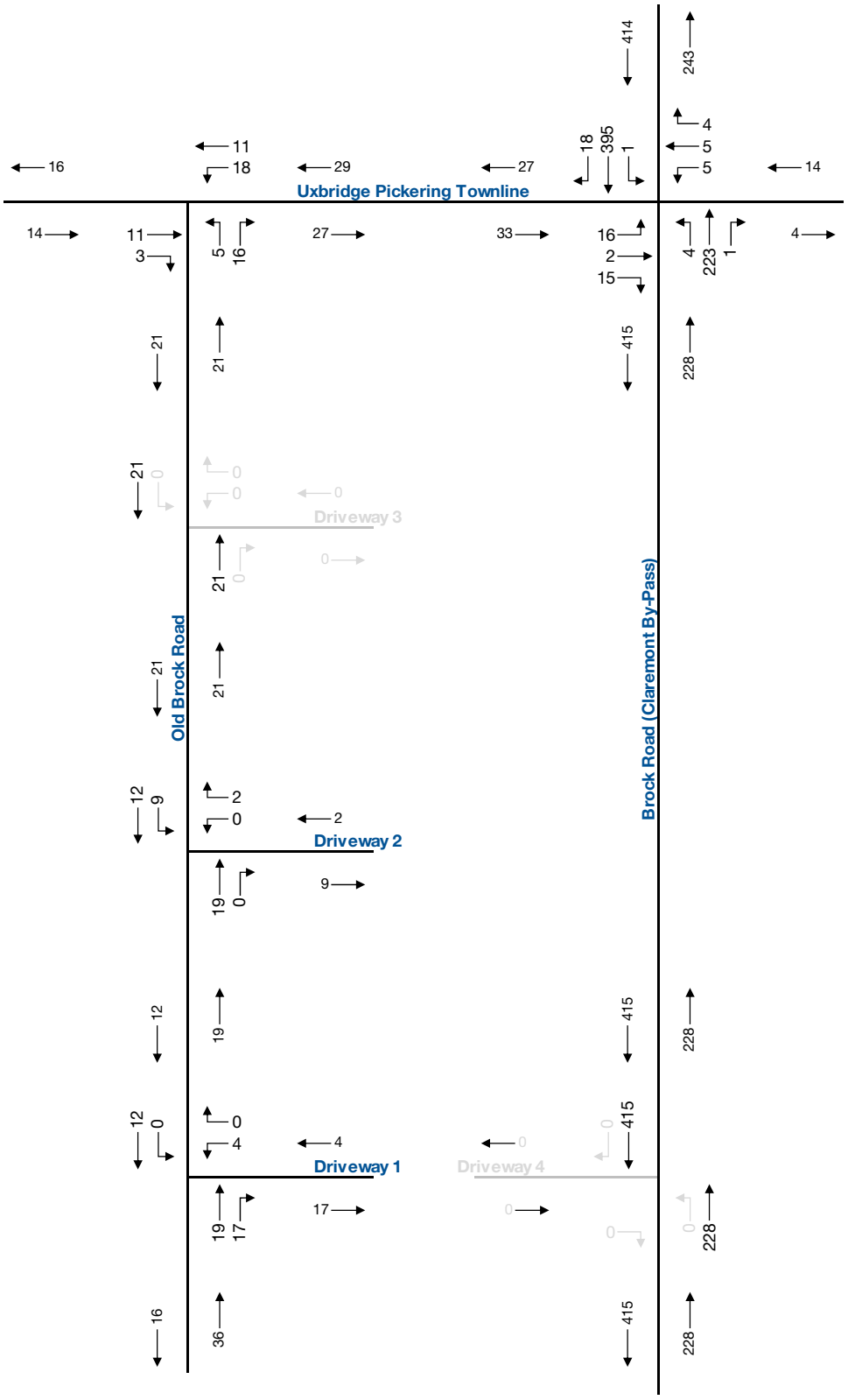
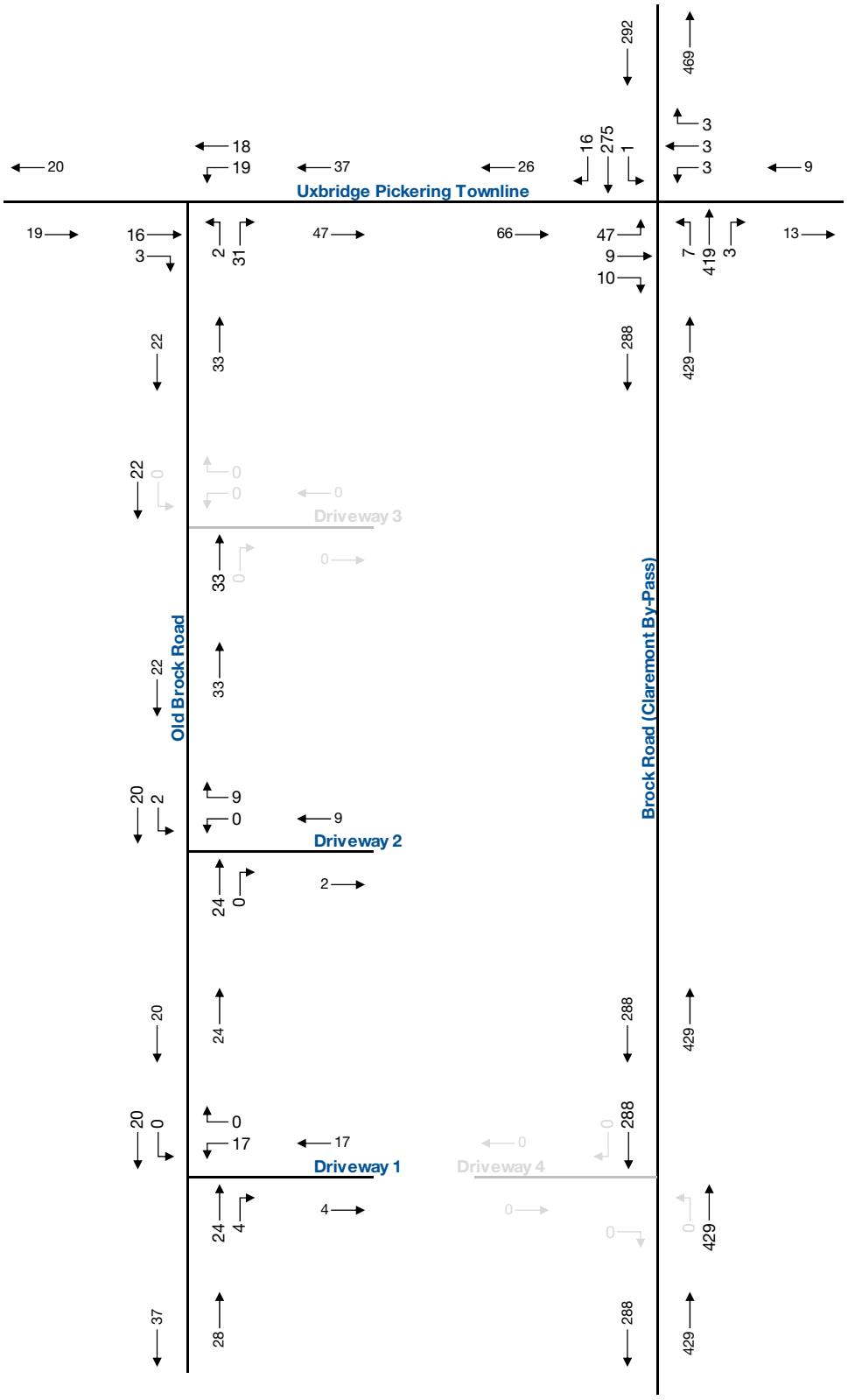
Traffic Control and Lane Configuration



2018 Existing AM Peak Hour Traffic Volumes

Claremont North Business Park, TIS
160300

Figure 3.2



2018 Existing PM Peak Hour Traffic Volumes

Claremont North Business Park, TIS
160300

Figure 3.3

3.3 Existing Traffic Operations

The quality of intersection operations at signalized intersections and unsignalized intersections is evaluated in terms of level of service (LOS) and volume to capacity (v/c) as defined by the Highway Capacity Manual (HCM). LOS is evaluated based on average control delay per vehicle and includes deceleration delay, queue move-up time, stopped delay, and final acceleration delay. For signalized intersections LOS ranges from LOS A for 10 seconds or less average delay to LOS F for average delay greater than 80 seconds. For unsignalized intersection, the LOS ranges from LOS A for 10 seconds or less average delay to LOS F for average delay greater than 50 seconds. Capacity is evaluated in terms of the ratio of demand flow to capacity with an at capacity condition represented by a v/c ratio of 1.00 (i.e. volume demand equals capacity).

In Durham Region, the desirable LOS is D or better in urban settings. While the study area is more aptly described as rural, and rural highways in the Region are expected to operate at LOS C for mid-block sections, the operation of the study area intersections is akin to urban conditions.

To assess existing peak hour conditions, an operational analysis was conducted using Synchro 9.1 software, which implements the methods of the Highway Capacity Manual. The key parameters used in the analysis include:

- Existing lane configurations;
- Heavy vehicle percentages derived from existing traffic count data (where no heavy vehicles were counted, a default 2% was used to be conservative); and
- Synchro default values for all other inputs.

Table 3.2 presents the analysis results and **Appendix A** contains the detailed Synchro output.

Under existing conditions, the traffic movements that have opposing flows were all found to operate with an acceptable LOS (C or better) and well within capacity.

TABLE 3.2: 2018 EXISTING PEAK HOUR TRAFFIC OPERATIONS

Intersection	Approach/Movement		AM Peak Hour				PM Peak Hour			
			LOS[1]	Delay[2]	V/C[3]	Q[4]	LOS[1]	Delay[2]	V/C[3]	Q[4]
Brock Road & Uxbridge Pickering Townline	EB	Left/Thru/Right	B	14	0.08	2	C	18	0.21	6
	WB	Left/Thru/Right	B	14	0.03	1	C	15	0.02	1
	NB	Left/Thru/Right	A	< 1	0.00	< 1	A	< 1	0.01	< 1
	SB	Left/Thru	A	< 1	0.00	< 1	A	< 1	0.00	< 1
		Right	Unopposed Movement				Unopposed Movement			
Old Brock Road & Uxbridge Pickering Townline	EB	Thru/Right	Unopposed Movement				Unopposed Movement			
	WB	Left/Thru	A	5	0.01	< 1	A	4	0.01	< 1
	NB	Left/Right	A	9	0.02	1	A	9	0.03	1
Old Brock Road & Driveway 1	WB	Left/Right	A	9	0.00	< 1	A	9	0.02	1
	NB	Thru/Right	Unopposed Movement				Unopposed Movement			
	SB	Left/Thru	A	< 1	0.00	< 1	A	< 1	0.00	< 1
Old Brock Road & Driveway 2	WB	Left/Right	A	8	0.00	< 1	A	9	0.01	< 1
	NB	Thru/Right	Unopposed Movement				Unopposed Movement			
	SB	Left/Thru	A	3	0.00	< 1	A	1	0.00	< 1

[1] Level of Service; [2] Average vehicle delay, seconds; [3] Volume-to-capacity ratio; [4] 95th percentile queue, metres

4 Site Access Considerations

4.1 Sightline Assessment

Sightline requirements were reviewed for the proposed site accesses on Old Brock Road and on Brock Road.

It was found that the accesses on Old Brock Road meet sight distance requirements for a design speed of 50 km/h. This is appropriate considering its classification as a local road, its operating characteristics (lower speeds and traffic volumes), and that it does not have significant changes in either its horizontal or vertical alignment.

With Brock Road being a Type A Arterial road with higher operating speeds and traffic volumes, having an at-grade rail crossing to the south of the site, and significant changes in the horizontal and vertical alignment along the site frontage, a very detailed review was carried out to determine a suitable location for the proposed site access.

Appendix B contains a memorandum that provides an evaluation of potential locations along Brock Road for the proposed site access. The evaluation was based on an assessment of sightlines as well as the consideration of any turning movements restrictions that may be required. The evaluation is summarized below:

- A field visit was conducted, and sight distances were approximated from where the initial site concept plan located the access. This location was identified in the field at the current site of a Railway Crossing Ahead warning sign, which is north of the existing Canadian Pacific Railway Havelock Subdivision at-grade crossing of Brock Road;
- The sight distances were compared to relevant criteria contained in the Ministry of Transportation of Ontario (MTO) publication, "Geometric Design Standards for Ontario Highways" (GDSOH)[2]. This included Decision Sight Distance (vehicles approaching an access location) and Departure Sight Distance (vehicles exiting from an access location). The required sight distances were based on a design speed of 100 km/h (20 km/h above posted limit) with conservative adjustments for the Brock Road southbound downgrade and northbound upgrade (i.e. the downgrade was measured in the field at 5% while an adjustment factor for 6% was selected from Table C2-3 of the GDSOH due to the factors only being provided for 3%, 6%, and 9%);
- It was determined that the initially proposed access location would not meet the required sight distances for a full turns access. Therefore, different access locations were considered where sight

[2] Ontario Ministry of Transportation, *Geometric Design Standards for Ontario Highways*, 2004

lines would be acceptable for specific traffic movements as well as being an acceptable distance from the at-grade rail crossing. The following three options were considered:

- Option 1 – Right In/Right Out located 200 or 260 metres north of the at-grade rail crossing;
- Option 2 – Right In/Right Out/Left in via Slip-Around Lane located 200 or 260 metres north of the at-grade rail crossing;
- Option 3 – Right In/Right Out/Left in via Separate Left-Turn Auxiliary Lane located 280 metres north of the at-grade rail crossing;

- It was concluded that Option 1 or Option 2 would be feasible with respect to meeting the sight distance criteria for the specified movements. For Option 2, however, this also assumes that a slip-around left turn lane design for the northbound left turn lane would be acceptable; and
- Option 3, which would replace Option 2 if a separate left turn auxiliary lane is required, would have a sightline of 405 metres for southbound vehicles approaching the site. This exceeds the minimum Decision Sight Distance (335 metres) but is 20 metres short of the desirable Decision Sight Distance (425 metres). The sightline to the north for eastbound vehicles making the right turn out from the site would be 400 metres, which would be five metres short of meeting the departure sight distance (405 metres). Therefore, considering the conservative nature of the sightline analysis regarding the downgrade adjustment factor used to identify sight distance requirements, it can be concluded that Option 3 is also feasible.

Based on the information above, site traffic forecasts have been prepared that account for a three-quarter access on Brock Road and the related/ required routing of site trips destined to the north via the Old Brock Road accesses. The traffic forecasts are presented in Section 5.

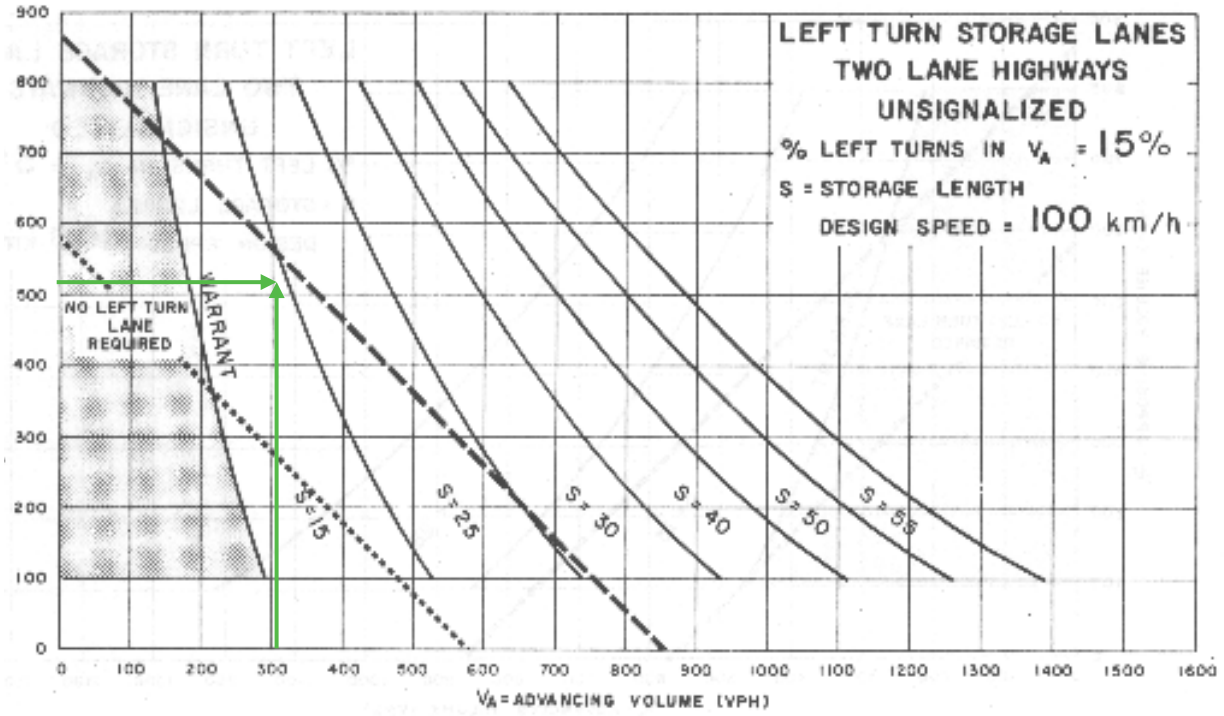
4.2 Auxiliary Turn Lanes

To assess whether a slip-around left turn lane or separate left turn auxiliary lane design would be the appropriate improvement for the proposed Brock Road access, the MTO GDSOH left turn lane warrants were reviewed. The other site access locations on Old Brock Road were not assessed due to the low overall volume of through and turning traffic.

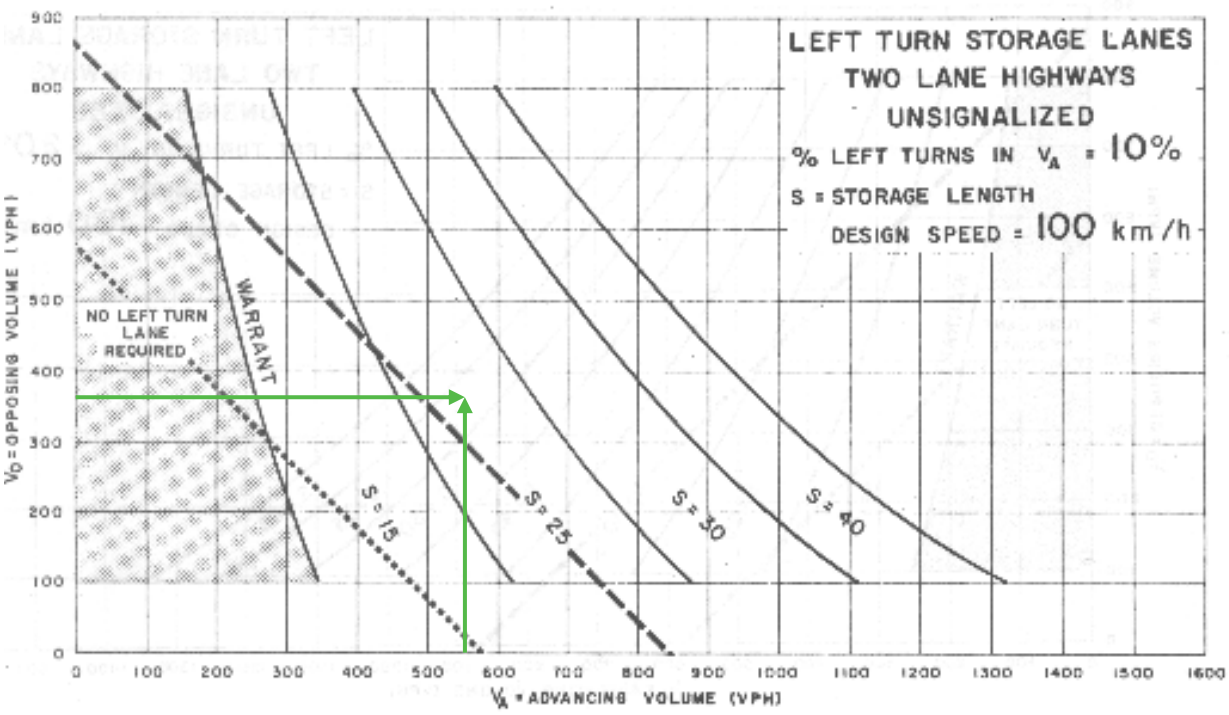
Figure 4.1 shows the MTO left turn lane nomographs applicable to the weekday AM and PM traffic forecasts (horizon year 2028) for the proposed Brock Road access. It was determined that a northbound left turn lane with 25 metres storage would be warranted. Therefore, this confirms that the Option 3 access configuration would be required.

2028 Total Traffic

AM Peak Hour



PM Peak Hour



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Left Turn Lane Warrant Analysis
Brock Road/Site Access

To assess the need for a southbound right turn lane at the proposed Brock Road access, Durham Region's "Right-Turn Lane Guideline" was reviewed. It was found that the guideline threshold of 40 vehicles per hour for Type A Arterial Roads with 70 or 80 km/h maximum speed limits would be exceeded in both the AM and PM peak hour traffic forecasts. Therefore, a southbound right turn lane would also be required.

4.3 Regional Review and Design Requirements

The evaluation of the alternative access locations and configurations for the proposed Brock Road access was reviewed by Durham Region staff. The three-quarter access with a separate northbound left turn auxiliary lane, and the eastbound left turn out restricted, was accepted. Staff advised that Transportation Association of Canada (TAC) standards should also be reviewed regarding minimum Decision Sight Distance (TAC Figure 2.3.3.6). It has been found that the TAC minimum of 300 metres for a design speed is less than the MTO minimum of 335 metres. This information assists in confirming that Option 3 is feasible and provides additional flexibility regarding the exact location of the site access.

The design requirements for the northbound left turn lane would follow the Region's standard drawing "S-300.040" and are based on a design speed of 100 km/h except where noted:

- 25 metre storage as identified in the review of the left turn lane warrants;
- 122 metre deceleration lane (based on the standard 135 metre length multiplied by a 0.9 factor to account for a 3-4% upgrade); and
- 70 metre approach and departure tapers (assuming widening Brock Road evenly about the centre line, a lateral shift of the through lane of 1.75 metres, and the standard 40:1 taper).

The design requirements for the southbound right turn lane would follow the Region's standard drawing "S-300.050" and are based on a design speed of 100 km/h except where noted:

- 15 metre storage (assumed minimum storage given the relatively low traffic forecast of <50 vehicles per hour);
- 104 metre deceleration lane (based on the standard 80 metre length multiplied by a 1.3 factor to account for a 5-4% downgrade); and
- 80 metre approach taper (Region standard for this design speed).

The Region advised that the eastbound left turn out movement should be restricted by constructing a channelizing island in the throat of the access.

A functional design drawing illustrating the proposed Brock Road access is provided in **Appendix B**.

5 Traffic Forecasts

5.1 Horizon Years and Future Background Traffic

Background traffic forecasts were prepared for a 2028 horizon year, which represent a longer-term forecast when the site is anticipated to be fully built out and occupied. In pre-consultation with Durham Region staff, it was agreed that a general traffic growth rate of 2% per annum would be used to forecast background traffic conditions. It is understood that this reflects anticipated growth in population and employment in the Region.

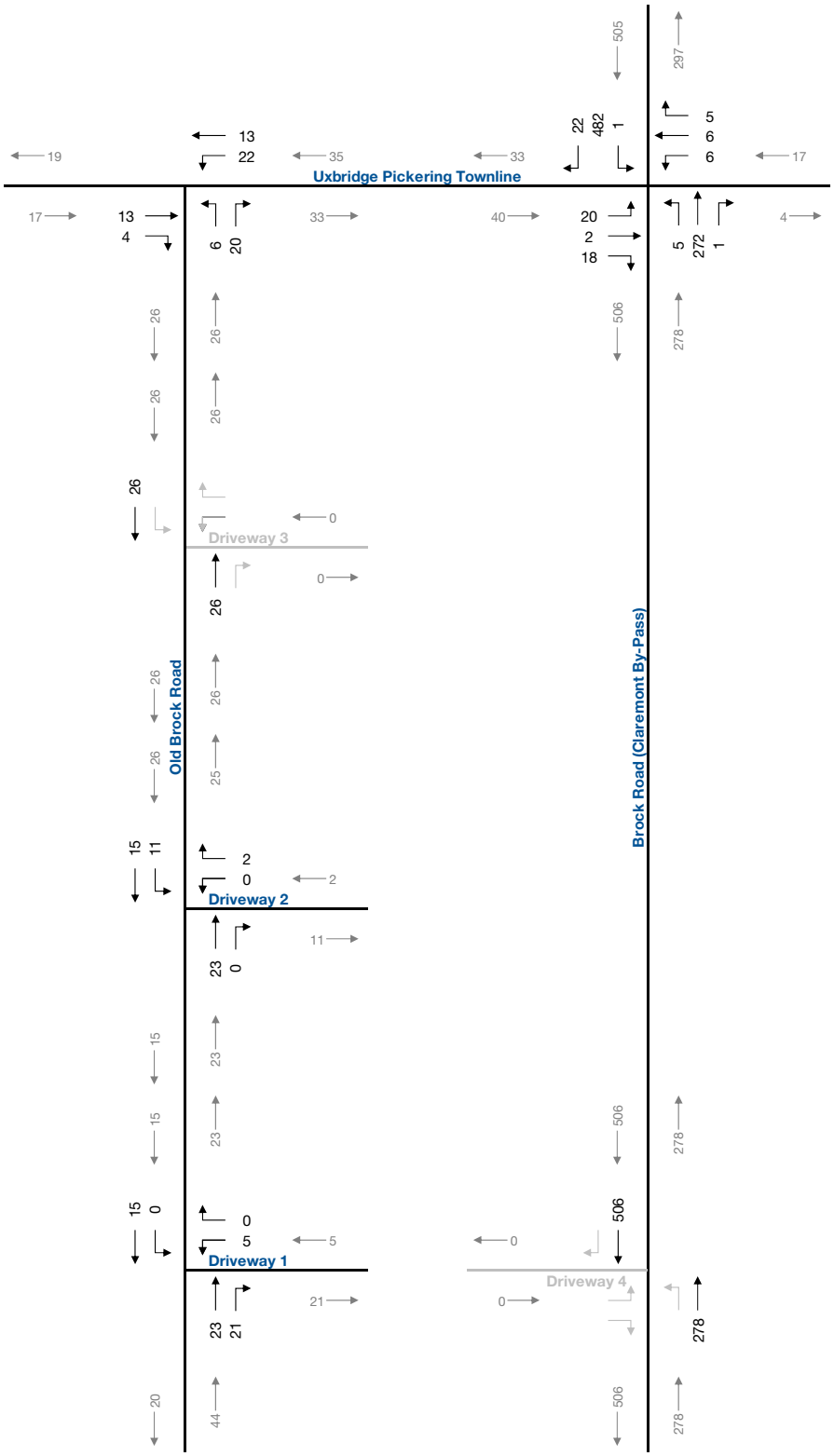
Figure 5.1 and **Figure 5.2** show the 2028 background traffic for the AM and PM peak hours, respectively.

5.2 Trip Generation

The site trip generation was based on information contained in the Institute of Transportation Engineers (ITE) Trip Generation Manual[3] and the following Land Use Codes (LUC):

- **LUC 180 (Specialty Trade Contractor):** A specialty trade contractor is a business primarily involved in providing contract repairs and services to meet industrial or residential needs. This land use includes businesses that provide the following services: plumbing, heating and cooling, machine repair, electrical and mechanical repair, industrial supply, roofing, locksmith, weed and pest control, and cleaning.
- **LUC 934 (Fast-Food Restaurant with Drive-Through Window):** This category includes fast-food restaurants with drive-through windows. This type of restaurant is characterized by a large drive-through clientele, long hours of service (some are open for breakfast, all are open for lunch and dinner, some are open late at night or 24 hours a day) and high turnover rates for eat-in customers. These limited-service eating establishments do not provide table service. Non-drive-through patrons generally order at a cash register and pay before they eat**.**
- **LUC 945 (Gas Station with Convenience):** This land use includes gasoline/service stations with convenience markets where the primary business is the fueling of motor vehicles. These service stations may also have ancillary facilities for servicing and repairing motor vehicles and may have a car wash. Some commonly sold convenience items are newspapers, coffee or other beverages, and snack items that are usually consumed in the car.

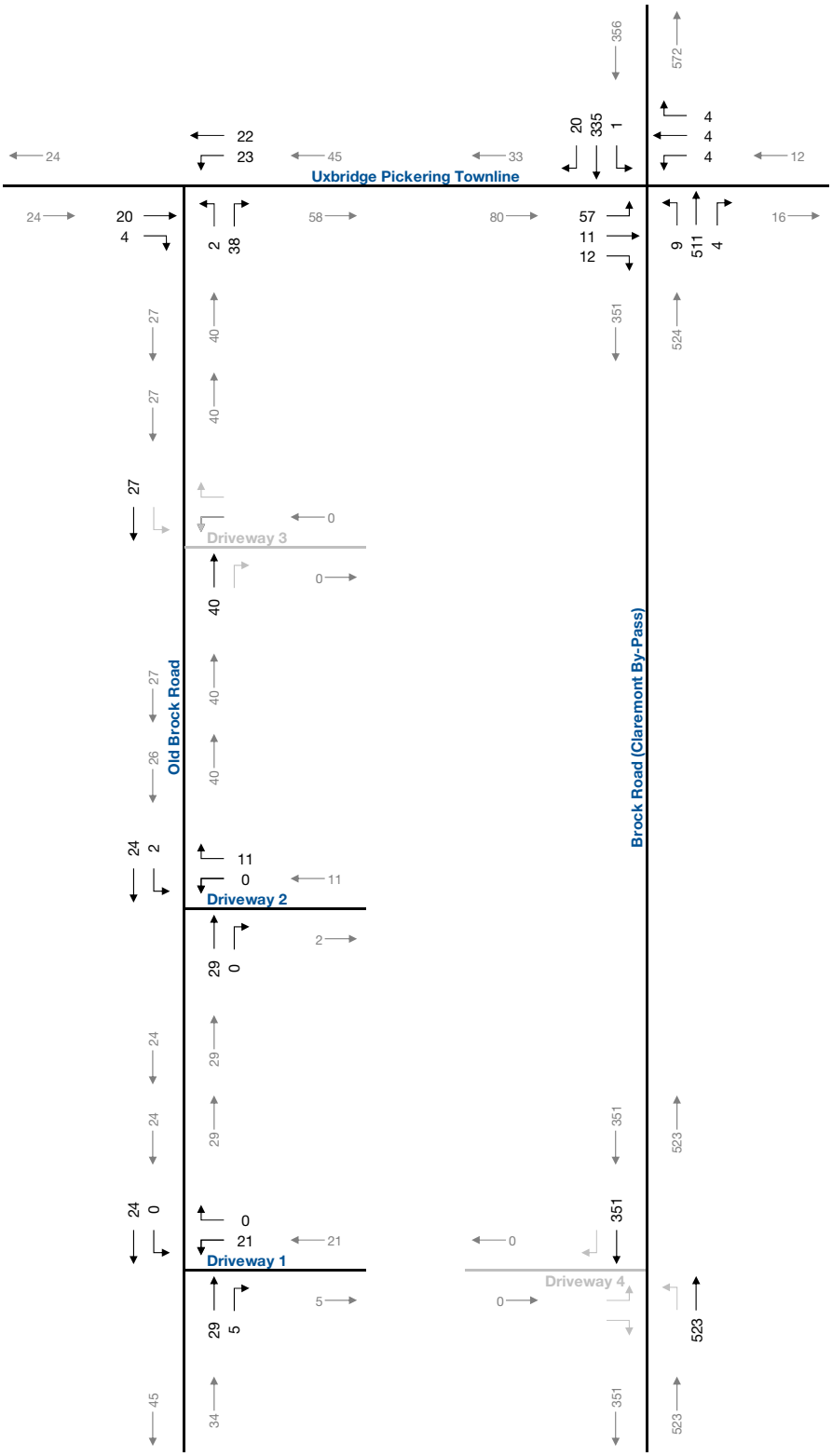
[3] Trip Generation, 10th Edition, Institute of Transportation Engineers, Washington D.C., 2017



2028 Background AM Peak Hour Traffic Volumes

Claremont North Business Park, TIS
160300

Figure 5.1



2028 Background PM Peak Hour Traffic Volumes

Claremont North Business Park, TIS
160300

Figure 5.2

Table 5.1 provides a summary of the site trip generation for the new uses and includes pass-by trip estimates in accordance with the ITE Trip Generation Handbook (3rd Edition, 2014). Pass-by trips represent traffic that is already using the study area roads and is attracted to the restaurant and gas station uses on the site.

TABLE 5.1: TRIP GENERATION

Land Use Code	Units	AM Peak Hour				PM Peak Hour			
		Rate	In	Out	Total	Rate	In	Out	Total
180 Specialty Trade Contractor	17.2 x 1000 sq.ft.	1.66	21	8	29	1.97	11	23	34
934 Fast-Food Restaurant w Drive-Through	0.65 x 1000 sq.ft.	40.19	13	13	26	32.67	11	10	21
	Passby	*49%*	*6*	*6*	*12*	*50%*	*5*	*5*	*10*
945 Gas Station with Convenience	14 x fueling positions	12.47	89	86	175	13.99	100	96	196
	Passby	*62%*	*54*	*54*	*108*	*56%*	*55*	*55*	*110*
Total Trip Generation			**123**	**107**	**230**		**122**	**129**	**251**
Passby Trip Generation			**60**	**60**	**120**		**60**	**60**	**120**
Net New Trip Generation			**63**	**47**	**110**		**62**	**69**	**131**

5.3 Trip Distribution and Assignment

The trip distribution for the site was based on the patterns evident in the existing traffic counts. **Table 5.2** shows the site trip distribution by direction for the study area roads.

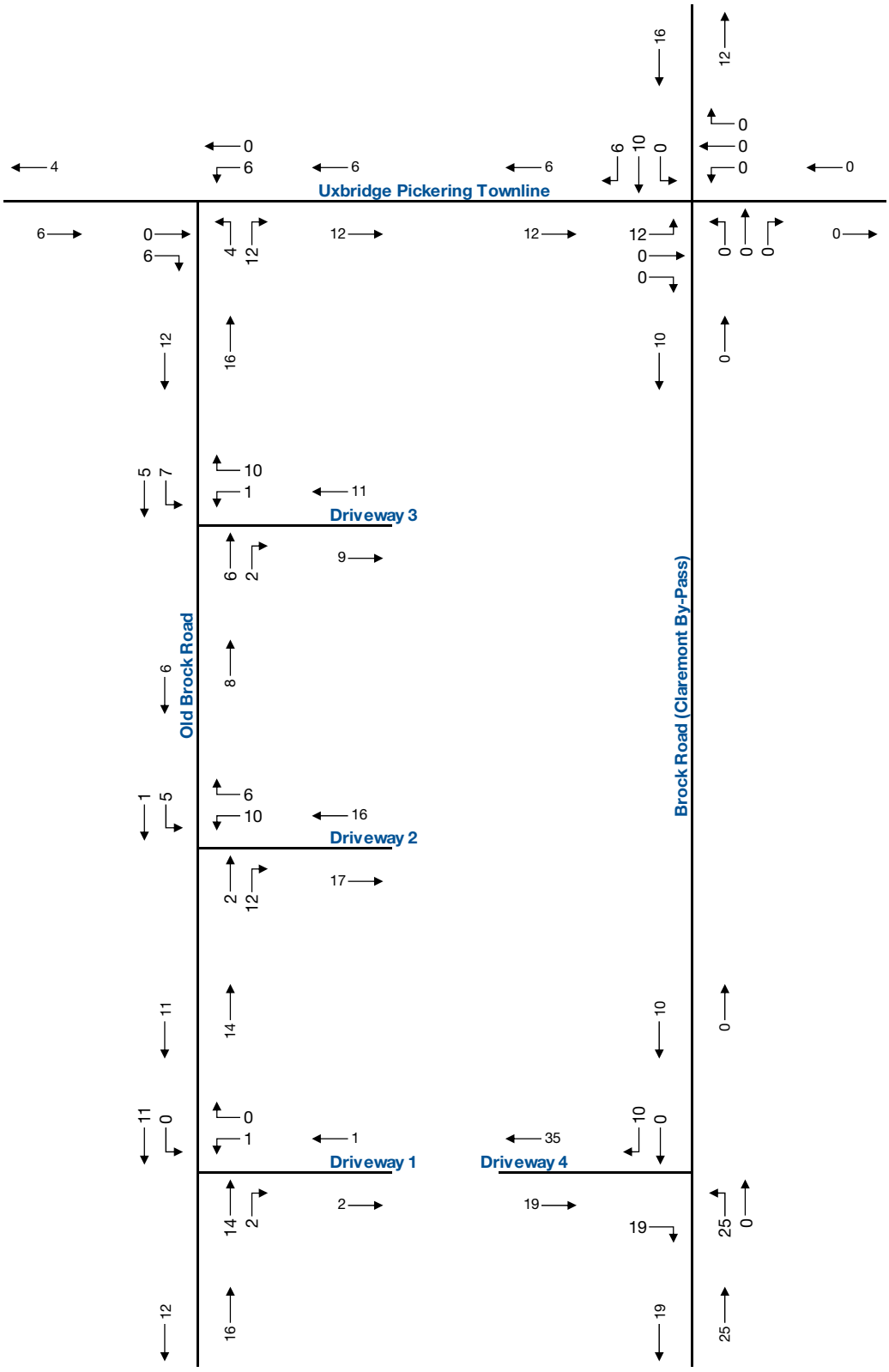
TABLE 5.2: TRIP DISTRIBUTION

Origin/Destination	Percentage
North via Brock Road	25%
South via Brock Road	40%
South via Old Brock Road	25%
East via Uxbridge Pickering Townline	0%
West via Uxbridge Pickering Townline	10%
Total	100%

The site traffic is shown in the following Figures:

- **Figure 5.3** and **Figure 5.4** – AM and PM peak hour new or additional trips on the study area roads, respectively;
- **Figure 5.5** and **Figure 5.6** – AM and PM peak hour pass-by trips drawn from the study area roads, respectively; and
- **Figure 5.7** and **Figure 5.8** - AM and PM peak hour total site trips, respectively.

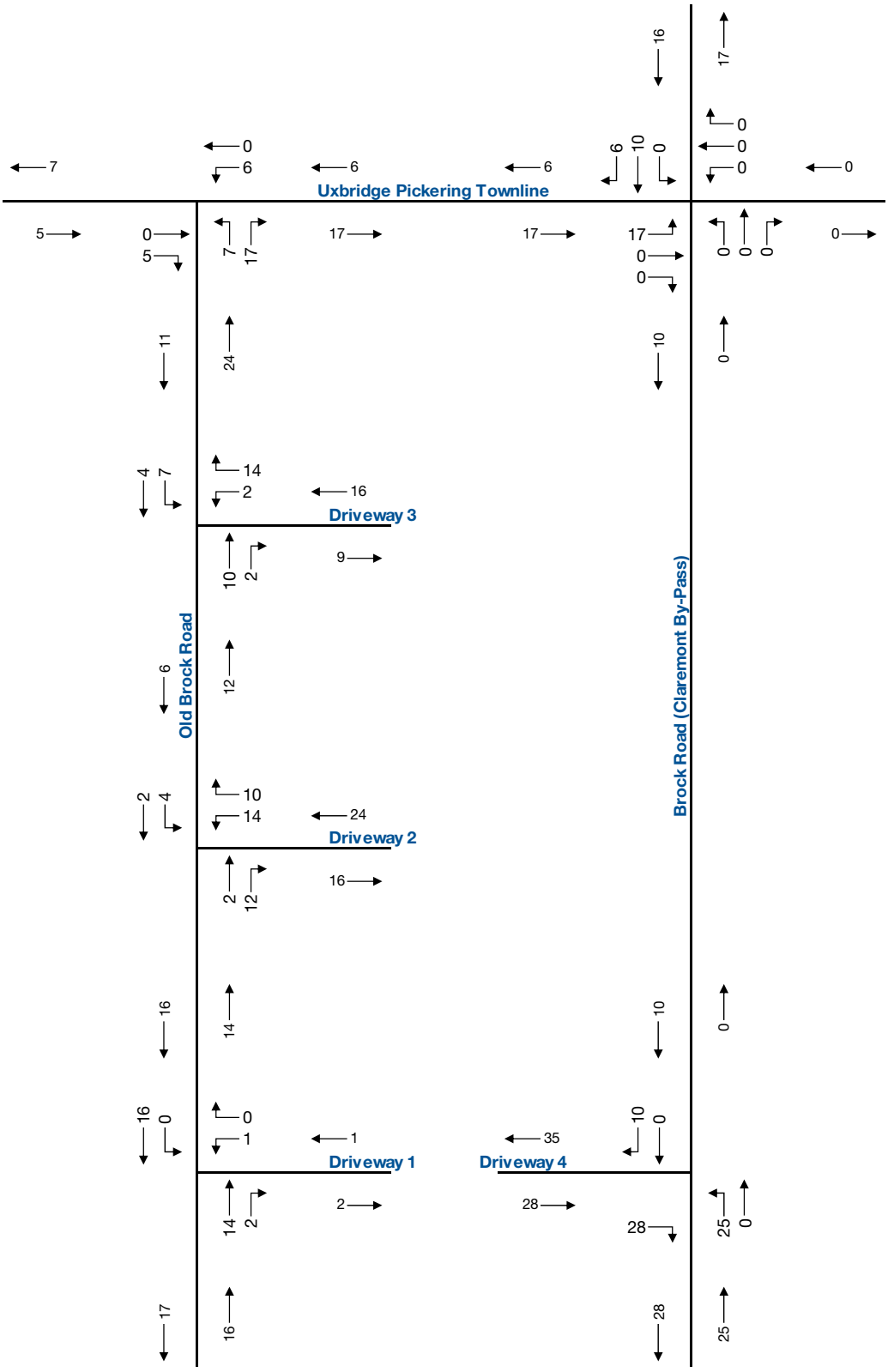
The background traffic was combined with the site traffic to produce total traffic forecasts. **Figure 5.9** and **Figure 5.10** illustrate the 2028 total traffic for the AM and PM peak hours, respectively.



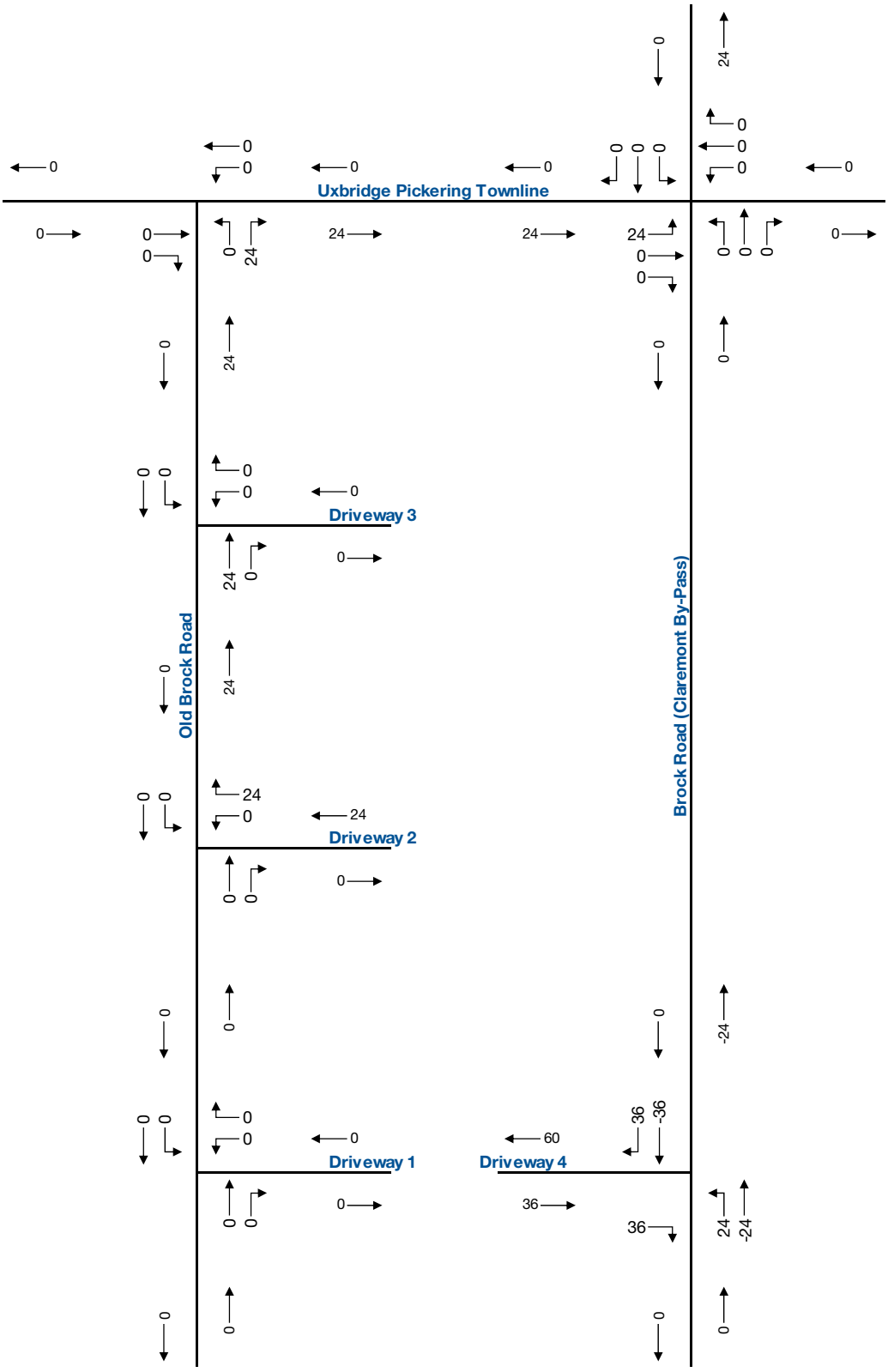
New Site Traffic AM Peak Hour

Claremont North Business Park, TIS
160300

Figure 5.3



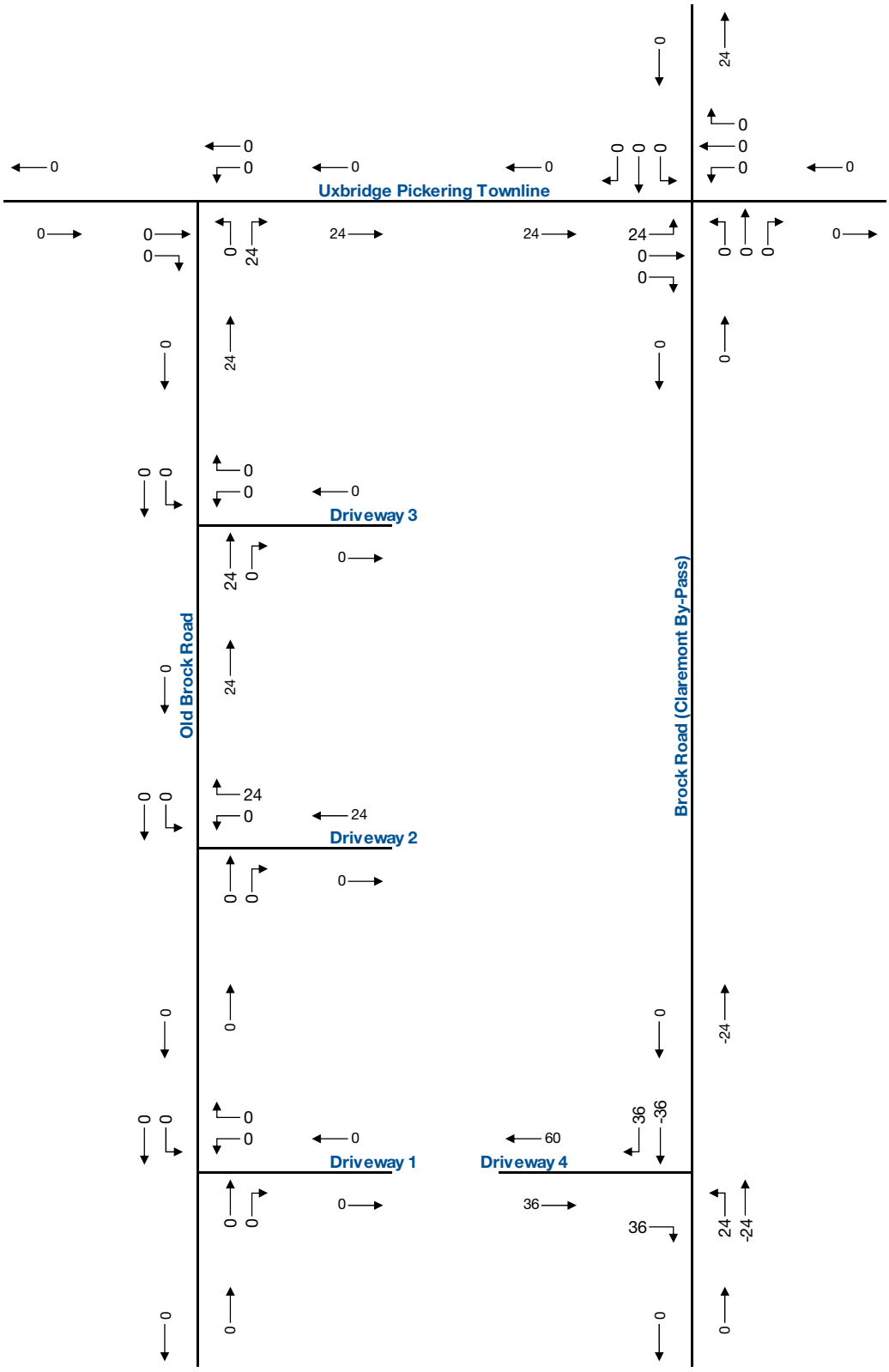
New Site Traffic
PM Peak Hour



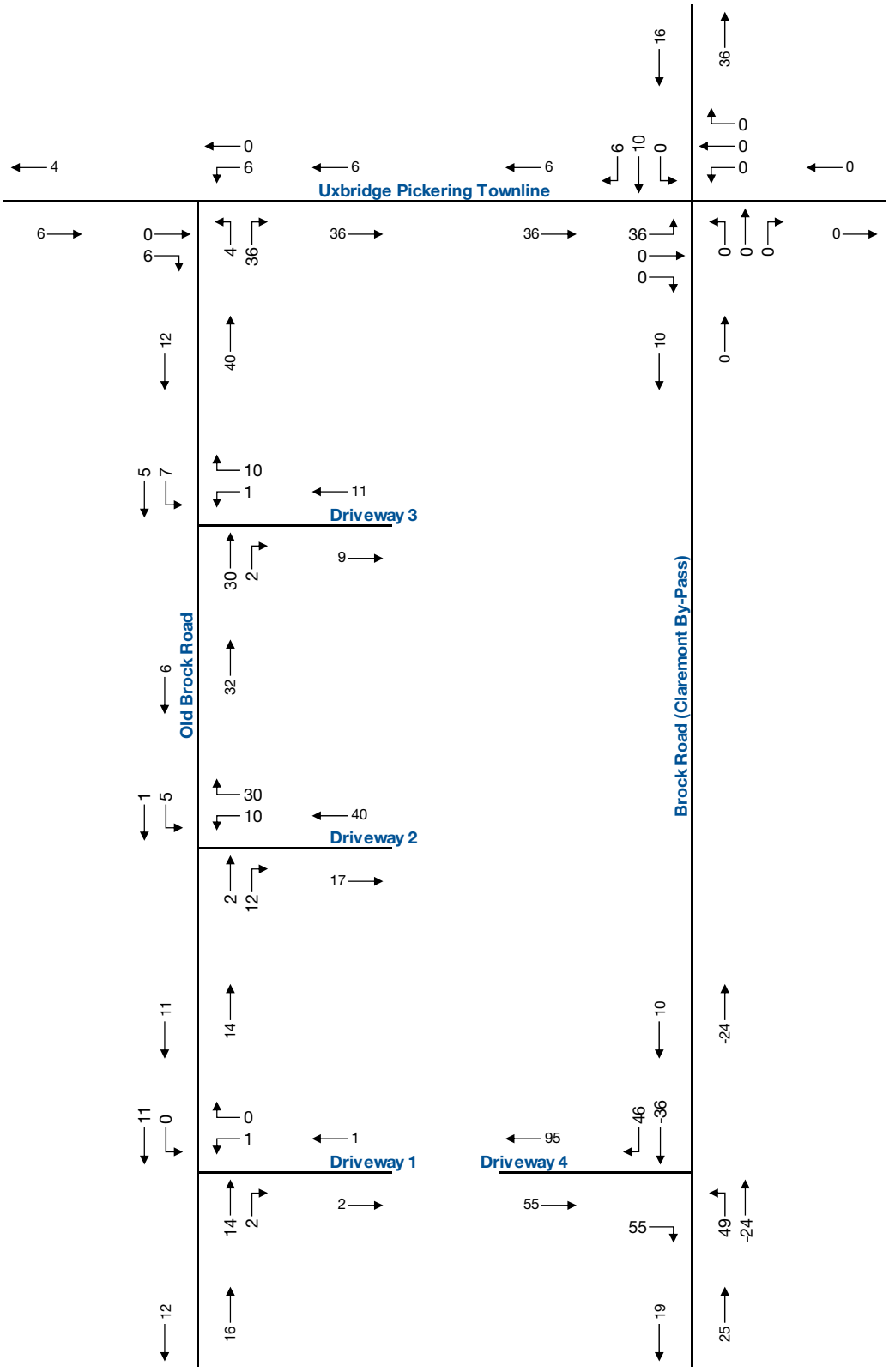
Pass-By Site Traffic
AM Peak Hour

Claremont North Business Park, TIS
160300

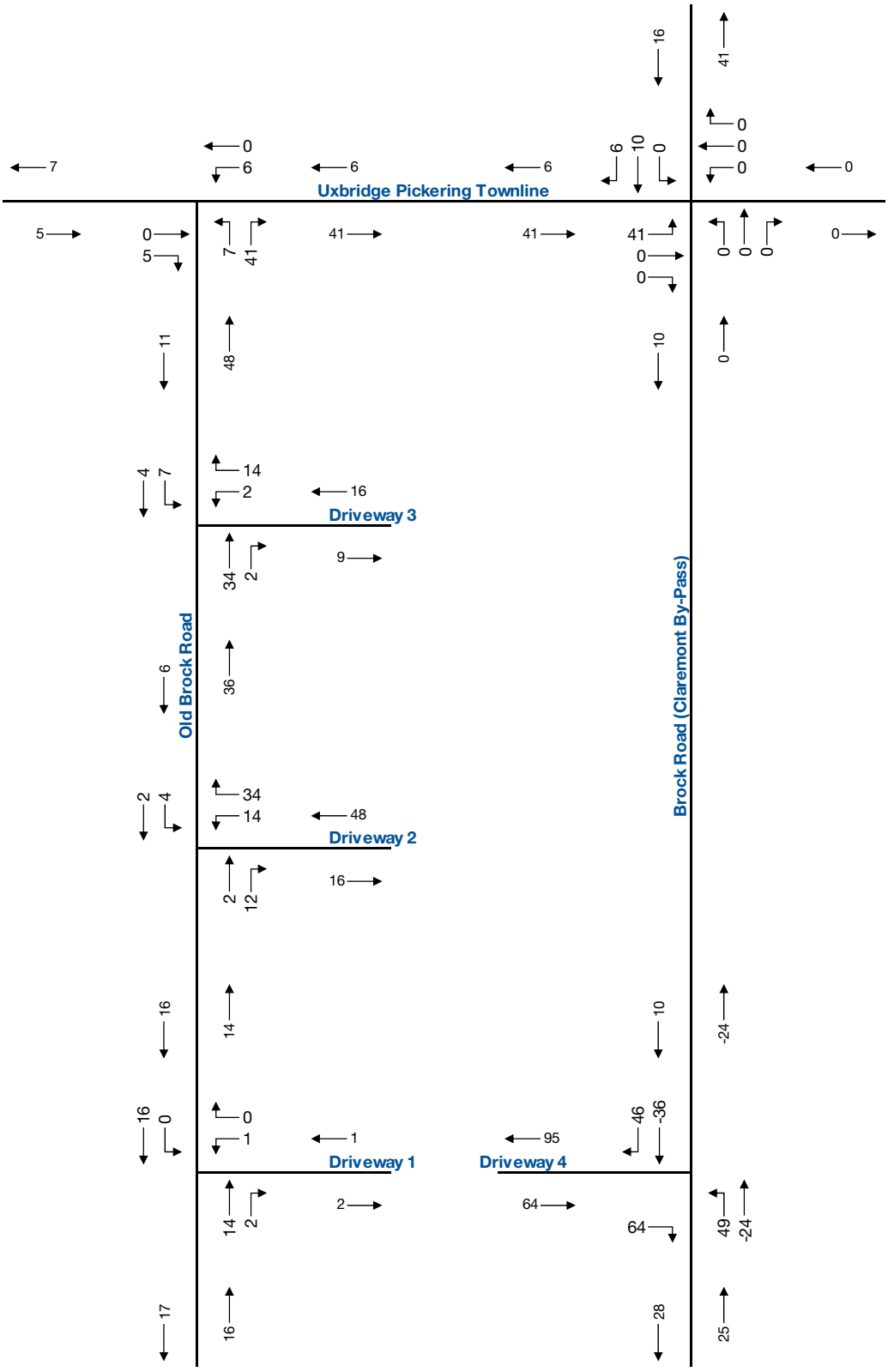
Figure 5.5



Pass-By Site Traffic
PM Peak Hour



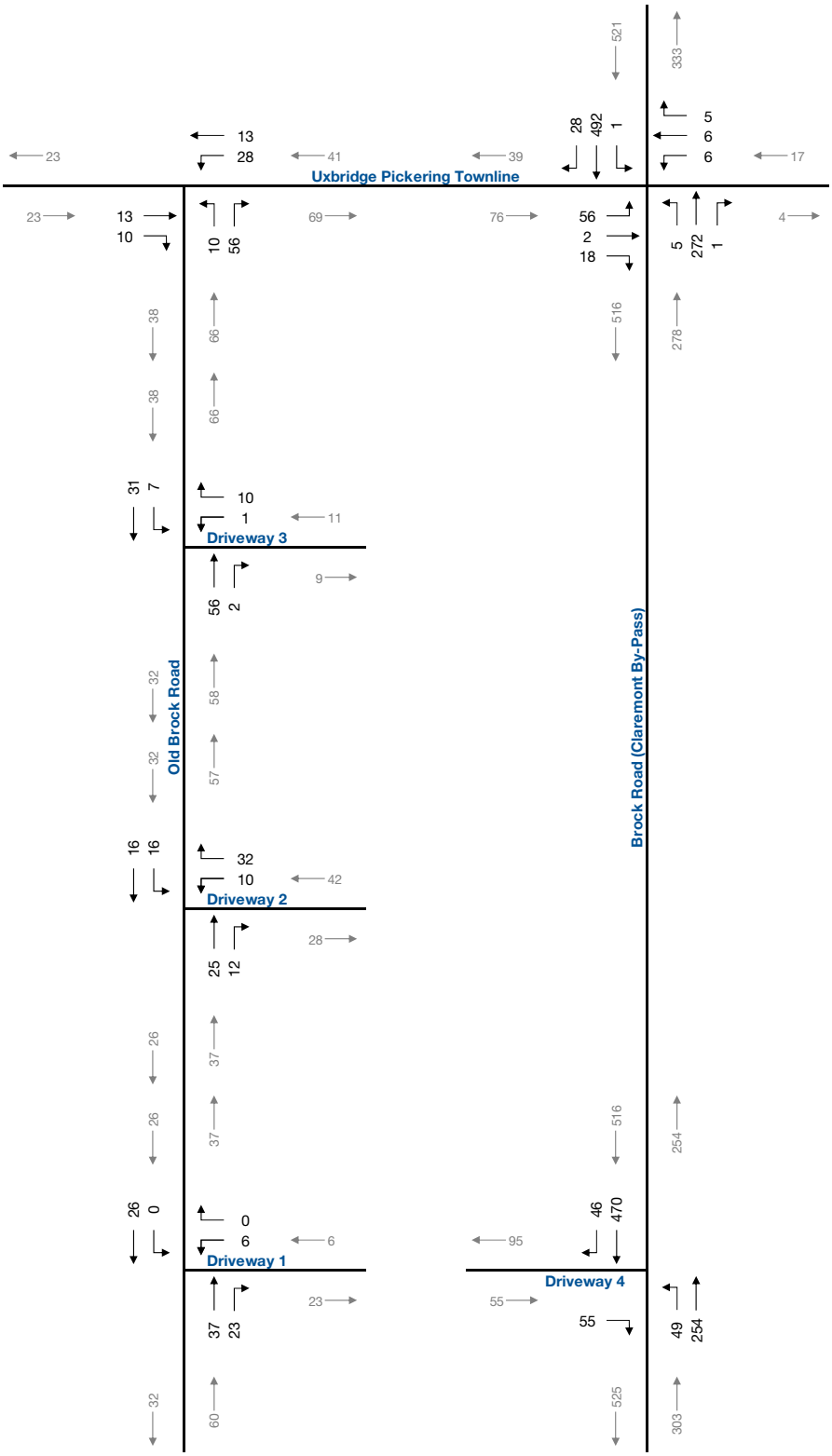
Total Site Traffic
AM Peak Hour



Total Site Traffic
PM Peak Hour

Claremont North Business Park, TIS
160300

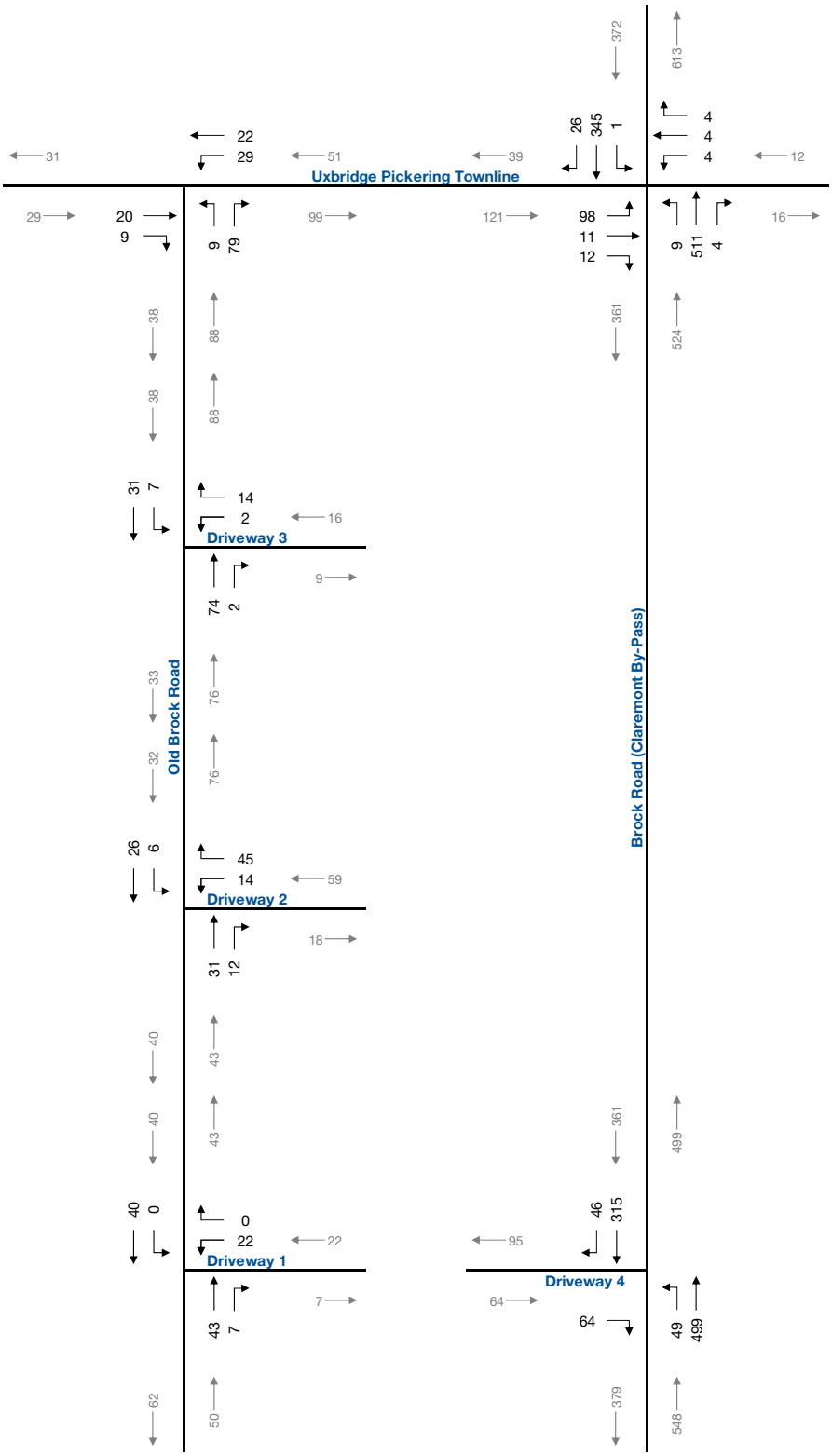
Figure 5.8



2028 Total
AM Peak Hour Traffic Volumes

Claremont North Business Park, TIS
160300

Figure 5.9



2028 Total
PM Peak Hour Traffic Volumes

Claremont North Business Park, TIS
160300

Figure 5.10

6 Future Traffic Operations

6.1 2028 Background Traffic Operations

The 2028 AM and PM peak hour background traffic volumes were analyzed based on the same parameters as those used for the analysis of existing conditions.

Table 6.1 summarizes the results of the analysis and **Appendix C** contains the detailed Synchro output.

Under 2028 background traffic conditions, the traffic movements that have opposing flows were all found to operate with an acceptable LOS (D or better) and well within capacity.

TABLE 6.1: 2028 BACKGROUND TRAFFIC OPERATIONS

Intersection	Approach/Movement		AM Peak Hour				PM Peak Hour			
			LOS[1]	Delay[2]	V/C[3]	Q[4]	LOS[1]	Delay[2]	V/C[3]	Q[4]
Brock Road & Uxbridge Pickering Townline	EB	Left/Thru/Right	C	16	0.12	3	D	25	0.33	11
	WB	Left/Thru/Right	C	16	0.06	1	C	18	0.04	1
	NB	Left/Thru/Right	A	< 1	0.00	< 1	A	< 1	0.01	< 1
	SB	Left/Thru	A	< 1	0.00	< 1	A	< 1	0.00	< 1
		Right	Unopposed Movement				Unopposed Movement			
Old Brock Road & Uxbridge Pickering Townline	EB	Thru/Right	Unopposed Movement				Unopposed Movement			
	WB	Left/Thru	A	5	0.02	< 1	A	4	0.02	< 1
	NB	Left/Right	A	9	0.03	1	A	9	0.04	1
Old Brock Road & Driveway 1	WB	Left/Right	A	9	0.01	< 1	A	9	0.02	1
	NB	Thru/Right	Unopposed Movement				Unopposed Movement			
	SB	Left/Thru	A	< 1	0.00	< 1	A	< 1	0.00	< 1
Old Brock Road & Driveway 2	WB	Left/Right	A	8	0.00	< 1	A	9	0.01	< 1
	NB	Thru/Right	Unopposed Movement				Unopposed Movement			
	SB	Left/Thru	A	3	0.01	< 1	A	1	0.00	< 1

[1] Level of Service; [2] Average vehicle delay, seconds; [3] Volume-to-capacity ratio; [4] 95th percentile queue, metres

6.2 2028 Total Traffic Operations

The 2028 AM and PM peak hour background traffic volumes were analyzed based on the same parameters as those used for the analysis of 2028 background traffic conditions except that it was assumed that trucks entering and exiting the site would be a higher percentage (10%) of traffic than that found in the general through traffic on the study area roads. This adjustment was made to reflect the industrial nature of the subject site and to contribute to a conservative analysis of the site accesses.

Table 6.2 summarizes the results of the analysis and **Appendix D** contains the detailed Synchro output.

Under 2028 total traffic conditions, the traffic movements that have opposing flows were all found to operate with an acceptable LOS (D or better) and well within capacity. A cursory review of peak period signal justification criteria based on Justification 7 in Book 12 of the Ontario Traffic Manual indicated that the traffic forecasts for the Brock Road/Uxbridge Pickering Townline intersection would be well below the thresholds for signalization.

TABLE 6.2: 2028 TOTAL TRAFFIC OPERATIONS

Intersection	Approach/Movement		AM Peak Hour				PM Peak Hour			
			LOS[1]	Delay[2]	V/C[3]	Q[4]	LOS[1]	Delay[2]	V/C[3]	Q[4]
Brock Road & Uxbridge Pickering Townline	EB	Left/Thru/Right	C	21	0.27	9	D	35	0.53	23
	WB	Left/Thru/Right	C	17	0.06	2	C	18	0.04	1
	NB	Left/Thru/Right	A	< 1	0.00	< 1	A	< 1	0.01	< 1
	SB	Left/Thru	A	< 1	0.00	< 1	A	< 1	0.00	< 1
		Right	Unopposed Movement				Unopposed Movement			
Old Brock Road & Uxbridge Pickering Townline	EB	Thru/Right	Unopposed Movement				Unopposed Movement			
	WB	Left/Thru	A	5	0.02	1	A	4	0.02	1
	NB	Left/Right	A	9	0.07	2	A	9	0.09	3
Old Brock Road & Driveway 1	WB	Left/Right	A	9	0.01	< 1	A	9	0.03	1
	NB	Thru/Right	Unopposed Movement				Unopposed Movement			
	SB	Left/Thru	A	< 1	0.00	< 1	A	< 1	0.00	< 1
Old Brock Road & Driveway 2	WB	Left/Right	A	9	0.05	1	A	9	0.07	2
	NB	Thru/Right	Unopposed Movement				Unopposed Movement			
	SB	Left/Thru	A	4	0.01	< 1	A	2	0.00	< 1
Old Brock Road & Driveway 3	WB	Left/Right	A	9	0.01	< 1	A	9	0.02	< 1
	NB	Thru/Right	Unopposed Movement				Unopposed Movement			
	SB	Left/Thru	A	1	0.01	< 1	A	2	0.01	< 1
Brock Road & Driveway 4	EB	Right	B	13	0.11	3	B	11	0.10	3
	NB	Left	A	9	0.05	1	A	8	0.05	1
		Thru	Unopposed Movement				Unopposed Movement			
	SB	Thru	Unopposed Movement				Unopposed Movement			
		Right	Unopposed Movement				Unopposed Movement			

[1] Level of Service; [2] Average vehicle delay, seconds; [3] Volume-to-capacity ratio; [4] 95th percentile queue, metres

7 Conclusions and Recommendations

7.1 Conclusions

The conclusions of the TIS are as follows:

- The study area intersections operate at acceptable levels of service and well within capacity under 2018 base year conditions;
- The proposed site access on Brock Road, which is shown on the site plan to be located approximately 280 metres north of the Canadian Pacific Railway Havelock Subdivision at-grade rail crossing, would provide acceptable sightline conditions for a three-quarter access operation (i.e. would allow northbound left in, southbound right in, and eastbound right out, but would restrict eastbound left out);
- The Brock Road site access intersection would require a northbound left turn lane, a southbound right turn lane, and a channelizing island within the throat of the access to restrict the eastbound left turn out movement. This lane configuration has been illustrated in a functional design drawing prepared in accordance with Regional standards; and
- With full development and occupancy of the site by 2028, the study area intersections would operate at acceptable levels of service and well within capacity under 2028 forecast conditions. The only road or traffic control improvements required to accommodate full development would be at the proposed Brock Road site access.

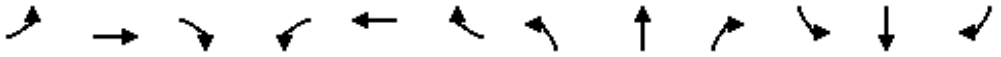
7.2 Recommendations

The recommendations of the TIS are as follows:

- From a traffic perspective, the required Zoning By-law Amendment to permit the proposed uses should be approved; and
- The propose new site access on Brock Road (Regional Road 1) should be permitted.

Appendix A

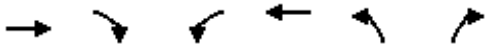
2018 Existing Traffic Operations Reports



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	16	2	15	5	5	4	4	223	1	1	395	18
Future Volume (Veh/h)	16	2	15	5	5	4	4	223	1	1	395	18
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)	17	2	16	5	5	4	4	242	1	1	429	20
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	688	682	429	698	702	242	449			243		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	688	682	429	698	702	242	449			243		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.3			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.4			2.2		
p0 queue free %	95	99	97	99	99	99	100			100		
cM capacity (veh/h)	354	370	626	343	361	796	1000			1323		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total	35	14	247	430	20
Volume Left	17	5	4	1	0
Volume Right	16	4	1	0	20
cSH	443	418	1000	1323	1700
Volume to Capacity	0.08	0.03	0.00	0.00	0.01
Queue Length 95th (m)	2.0	0.8	0.1	0.0	0.0
Control Delay (s)	13.8	13.9	0.2	0.0	0.0
Lane LOS	B	B	A	A	
Approach Delay (s)	13.8	13.9	0.2	0.0	
Approach LOS	B	B			

Intersection Summary				
Average Delay	1.0			
Intersection Capacity Utilization	31.3%	ICU Level of Service	A	
Analysis Period (min)	15			



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	11	3	18	11	5	16
Future Volume (Veh/h)	11	3	18	11	5	16
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)	12	3	20	12	5	17
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			15		66	14
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			15		66	14
tC, single (s)			4.2		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.3		3.5	3.3
p0 queue free %			99		99	98
cM capacity (veh/h)			1577		928	1067

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	15	32	22
Volume Left	0	20	5
Volume Right	3	0	17
cSH	1700	1577	1032
Volume to Capacity	0.01	0.01	0.02
Queue Length 95th (m)	0.0	0.3	0.5
Control Delay (s)	0.0	4.6	8.6
Lane LOS		A	A
Approach Delay (s)	0.0	4.6	8.6
Approach LOS			A

Intersection Summary			
Average Delay	4.9		
Intersection Capacity Utilization	18.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	4	0	19	17	0	12
Future Volume (Veh/h)	4	0	19	17	0	12
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)	4	0	21	18	0	13
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	43	30			39	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	43	30			39	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	968	1044			1571	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	4	39	13
Volume Left	4	0	0
Volume Right	0	18	0
cSH	968	1700	1571
Volume to Capacity	0.00	0.02	0.00
Queue Length 95th (m)	0.1	0.0	0.0
Control Delay (s)	8.7	0.0	0.0
Lane LOS	A		
Approach Delay (s)	8.7	0.0	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	2	19	0	9	12
Future Volume (Veh/h)	0	2	19	0	9	12
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)	0	2	21	0	10	13
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	54	21			21	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	54	21			21	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			99	
cM capacity (veh/h)	948	1056			1595	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	2	21	23
Volume Left	0	0	10
Volume Right	2	0	0
cSH	1056	1700	1595
Volume to Capacity	0.00	0.01	0.01
Queue Length 95th (m)	0.0	0.0	0.2
Control Delay (s)	8.4	0.0	3.2
Lane LOS	A		A
Approach Delay (s)	8.4	0.0	3.2
Approach LOS	A		

Intersection Summary			
Average Delay	2.0		
Intersection Capacity Utilization	17.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	0	21	0	0	21
Future Volume (Veh/h)	0	0	21	0	0	21
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	23	0	0	23
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	46	23			23	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	46	23			23	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	964	1054			1592	

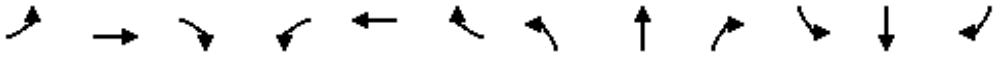
Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	0	23	23
Volume Left	0	0	0
Volume Right	0	0	0
cSH	1700	1700	1592
Volume to Capacity	0.00	0.01	0.00
Queue Length 95th (m)	0.0	0.0	0.0
Control Delay (s)	0.0	0.0	0.0
Lane LOS	A		
Approach Delay (s)	0.0	0.0	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	6.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	0	228	415	0
Future Volume (Veh/h)	0	0	0	228	415	0
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)	0	0	0	248	451	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)						
pX, platoon unblocked						
vC, conflicting volume	699	451	451			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	699	451	451			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	406	608	1109			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	0	248	451
Volume Left	0	0	0
Volume Right	0	0	0
cSH	1700	1109	1700
Volume to Capacity	0.00	0.00	0.27
Queue Length 95th (m)	0.0	0.0	0.0
Control Delay (s)	0.0	0.0	0.0
Lane LOS	A		
Approach Delay (s)	0.0	0.0	0.0
Approach LOS	A		

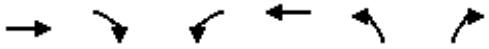
Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	25.2%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	47	9	10	3	3	3	7	419	3	1	275	16
Future Volume (Veh/h)	47	9	10	3	3	3	7	419	3	1	275	16
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)	51	10	11	3	3	3	8	455	3	1	299	17
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	778	775	299	790	790	456	316			458		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	778	775	299	790	790	456	316			458		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	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 %	83	97	99	99	99	100	99			100		
cM capacity (veh/h)	308	327	741	295	320	604	1244			1103		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total	72	9	466	300	17
Volume Left	51	3	8	1	0
Volume Right	11	3	3	0	17
cSH	341	367	1244	1103	1700
Volume to Capacity	0.21	0.02	0.01	0.00	0.01
Queue Length 95th (m)	6.3	0.6	0.2	0.0	0.0
Control Delay (s)	18.3	15.1	0.2	0.0	0.0
Lane LOS	C	C	A	A	
Approach Delay (s)	18.3	15.1	0.2	0.0	
Approach LOS	C	C			

Intersection Summary				
Average Delay	1.8			
Intersection Capacity Utilization	41.7%	ICU Level of Service	A	
Analysis Period (min)	15			



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	16	3	19	18	2	31
Future Volume (Veh/h)	16	3	19	18	2	31
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)	17	3	21	20	2	34
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			20		80	18
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			20		80	18
tC, single (s)			4.2		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.3		3.5	3.3
p0 queue free %			99		100	97
cM capacity (veh/h)			1539		909	1060

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	20	41	36
Volume Left	0	21	2
Volume Right	3	0	34
cSH	1700	1539	1050
Volume to Capacity	0.01	0.01	0.03
Queue Length 95th (m)	0.0	0.3	0.9
Control Delay (s)	0.0	3.8	8.5
Lane LOS		A	A
Approach Delay (s)	0.0	3.8	8.5
Approach LOS			A

Intersection Summary			
Average Delay	4.8		
Intersection Capacity Utilization	18.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	17	0	24	4	0	20
Future Volume (Veh/h)	17	0	24	4	0	20
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)	18	0	26	4	0	22
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	50	28			30	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	50	28			30	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	98	100			100	
cM capacity (veh/h)	959	1047			1583	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	18	30	22
Volume Left	18	0	0
Volume Right	0	4	0
cSH	959	1700	1583
Volume to Capacity	0.02	0.02	0.00
Queue Length 95th (m)	0.5	0.0	0.0
Control Delay (s)	8.8	0.0	0.0
Lane LOS	A		
Approach Delay (s)	8.8	0.0	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	2.3		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	9	24	0	2	20
Future Volume (Veh/h)	0	9	24	0	2	20
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)	0	10	26	0	2	22
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	52	26			26	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	52	26			26	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	955	1050			1588	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	10	26	24
Volume Left	0	0	2
Volume Right	10	0	0
cSH	1050	1700	1588
Volume to Capacity	0.01	0.02	0.00
Queue Length 95th (m)	0.2	0.0	0.0
Control Delay (s)	8.5	0.0	0.6
Lane LOS	A		A
Approach Delay (s)	8.5	0.0	0.6
Approach LOS	A		

Intersection Summary			
Average Delay	1.7		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	0	33	0	0	22
Future Volume (Veh/h)	0	0	33	0	0	22
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)	0	0	36	0	0	24
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	60	36			36	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	60	36			36	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	947	1037			1575	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	0	36	24
Volume Left	0	0	0
Volume Right	0	0	0
cSH	1700	1700	1575
Volume to Capacity	0.00	0.02	0.00
Queue Length 95th (m)	0.0	0.0	0.0
Control Delay (s)	0.0	0.0	0.0
Lane LOS	A		
Approach Delay (s)	0.0	0.0	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	6.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	0	0	429	288	0
Future Volume (Veh/h)	0	0	0	429	288	0
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)	0	0	0	466	313	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)						
pX, platoon unblocked						
vC, conflicting volume	779	313	313			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	779	313	313			
tC, single (s)	6.4	6.2	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	100	100			
cM capacity (veh/h)	364	727	1247			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	0	466	313
Volume Left	0	0	0
Volume Right	0	0	0
cSH	1700	1247	1700
Volume to Capacity	0.00	0.00	0.18
Queue Length 95th (m)	0.0	0.0	0.0
Control Delay (s)	0.0	0.0	0.0
Lane LOS	A		
Approach Delay (s)	0.0	0.0	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	25.9%	ICU Level of Service	A
Analysis Period (min)	15		

Appendix B

Access Options Memorandum and Functional Design Drawing

Memorandum

01 June 2016

File
160300
Claremont North Business Park TIS
Pickering, Ontario

To
Mr. Shaun Larkin
S. Larkin Developments Inc.

From
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Claremont North Business Park Development Brock Road Access Options

Introduction

Paradigm Transportation Solutions Limited (Paradigm) has been retained by S. Larkin Developments Inc.to prepare a Traffic Impact Study (TIS) for a proposed business park development in the City of Pickering. The subject lands are located west of Brock Road (Durham Road 1) and east of Old Brock Road, immediately south of Uxbridge Pickering Townline in the village of Claremont.

Although plans are still evolving, the proponent wishes to develop a fuel station (which will also serve large vehicles) with additional retail uses, a coffee shop/restaurant and two industrial buildings in phases on the subject property, with vehicular access to both Brock Road and Old Brock Road (two driveways). The Region of Durham has requested the TIS and a sightline analysis for the proposed Brock Road access to support the application. The sight distance review is required because of the vertical and horizontal alignment of Brock Road in this vicinity, and the proximity of the Uxbridge Pickering Townline and Brock Road intersection to a potential access location.

This memorandum summarizes the findings and recommendations of a site visit conducted on 26 May 2016 to assess sight distances along Brock Road for the proposed driveway access shown on the initial concept plan dated October 2014, and potential alternatives to the proposed location that meet visibility requirements. From the initial concept plan, the proposed driveway access was assumed to be situated at the current site of a Railway Crossing Ahead warning sign (Wc-104) positioned north of the existing Canadian Pacific Railway Havelock Subdivision crossing on Brock Road.

Sight Distance Analyses

Methodology

Measuring sight distances typically involves the use of sight distance targets to locate the boundaries of the visibility area. Available sight distance is then measured along the roadway with a measuring wheel.

Safety concerns due to the presence of high-speed traffic, limited sight distances, an intersection, a railway crossing and more complex vertical and horizontal roadway curves in the vicinity of the proposed access, required an alternative approach to determining sight visibility for the proposed access. Instead, sight distances were approximated in the field, using the base of the Railway Crossing Ahead warning sign (Wc-104) and headlights of smaller vehicles as targets. Google imagery was then referenced to measure the approximated distances.

Visibility of Proposed Access

Criteria recommended in the Ontario Ministry of Transportation (MTO) *Geometric Design Standards for Ontario Highways*[1] provided the basis for assessing the visibility of the proposed access for drivers approaching the driveway on Brock Road from the north and south. Sight distances for a design speed of 100 km/h were used given the posted speed of 80 km/h (20 km/h over posted), the rural nature of Brock Road, and the grade of the roadway in the vicinity of the proposed access, which was measured at 5% on site. Table C2-3 of the *Geometric Design Standards for Ontario Highways*[2] was used to adjust sight distances to reflect the grade. As the table only includes corrections for 3%, 6%, and 9% grades, conservative values were selected: 6% for downgrade and 3% for upgrade. **Table 1** summarizes the required sight distances for vehicles approaching the proposed access.

TABLE 1: REQUIRED SIGHT DISTANCES FOR VISIBILITY OF PROPOSED ACCESS, DESIGN SPEED OF 100 KM/H[3]

	Sight Distance on Flat Roadway	Corrected SD for 3% Upgrade (NB)	Corrected SD for 6% Downgrade (SB)
SSD (m)	185	175	215
MDSD (m)	300	290	330
DDSD (m)	395	385	425
Correction (m)	-	- 10	+ 30

[1] Ontario Ministry of Transportation, *Geometric Design Standards for Ontario Highways*, 1994, sections C.2 and E.3
[2] Ontario Ministry of Transportation, *Geometric Design Standards for Ontario Highways*, 1994, Table C2-3, p. C2-3
[3] Ontario Ministry of Transportation, *Geometric Design Standards for Ontario Highways*, 1994, Figure E3-8 and Table C2-3

Field measurements illustrated that the proposed access is visible to northbound vehicles from approximately 250 m away, while southbound drivers can observe the access from about 330 m away. Based on the values recommended in the MTO *Geometric Design Standards for Ontario Highways*[4], the available dimensions meet the minimum stopping sight distance (SSD) criteria for both directions. The available sight distance for northbound vehicles does not satisfy the minimum desirable sight distance (MDSD) and desirable decision sight distance (DDSD). The available sight distance for southbound vehicles just meets the MDSD, but does not satisfy the DDSD.

Departure Sight Distance

The departure sight distance represents the distance (time) drivers at the proposed access require to safely complete their turning manoeuver from the driveway onto Brock Road. Required distances were obtained from the *Geometric Design Standards for Ontario Highways*[5] and adjusted for grade as indicated above. **Table 2** summarizes the required departure sight distances for a two-lane roadway.

TABLE 2: REQUIRED DEPARTURE SIGHT DISTANCE FOR AT PROPOSED ACCESS, DESIGN SPEED OF 100 KM/H

	Sight Distance on Flat Roadway	Corrected SD for 3% Upgrade (NB)	Corrected SD for 6% Downgrade (SB)
Sight distance for outbound vehicle looking left (north) to turn right (m)	375	-	405
Sight distance for outbound vehicle looking right (south) to turn left (m)	375	365	-
Correction (m)	-	- 10	+ 30

Based on the field measurements, the sight distances at the proposed driveway are approximately 225 m to the right (for oncoming northbound vehicles) and approximately 325 m to the left (for oncoming southbound vehicles). These values do not meet the recommended minimum departure sight distances.

[4] Idem

[5] Ontario Ministry of Transportation, *Geometric Design Standards for Ontario Highways*, 1994, Figure E3-6

Access Location Assessment

Proposed Access Location

The proposed access location on Brock Road illustrated on the initial concept plan does not meet the recommended minimum sight distance requirements. There is no available location to move the access north or south to obtain required sight distances and allow all movements at the proposed access.

Alternative Access Configurations and Locations

With a full movements entrance not possible due to the sight distance constraints, three (3) options were considered to provide access to the site via Brock Road:

- Option 1 – Right In/Right Out
- Option 2 – Right In/Right Out/Left In via Slip Around Lane
- Option 3– Right In/Right Out/Left In via Separate Left-Turn Auxiliary Lane

It is noted that the driveway for these scenarios should be located further south on Brock Road, to a location where the grade is approximately 2%. For the purposes of the analyses, the steeper grade of 5% for the southbound direction has been utilized in calculations as a more conservative measure.

Option 1 – Right In/Right Out

One option would be to pursue a right in/right out access at a location towards the south edge of the property. Left turn movements to and from the site to Brock Road would not be permitted with this configuration.

This entrance placement would increase the visibility of the access for vehicles approaching from the north. Only the southbound visibility of the proposed access and the eastbound right turn departure sightline need to be satisfied with this scenario.

According to the *Geometric Design Standards of Ontario Roadways*[6], a deceleration lane 200 m in length would be required for southbound vehicles entering the site. For right turning vehicles exiting the site in the southbound direction, an acceleration lane

[6] Ontario Ministry of Transportation. *Geometric Design Standards for Ontario Highways,* 1994, Table E7-1, E8-4 & E8-5

between 153 m and 183 m in length would be needed, depending on traffic volumes on Brock Road. Based on these guidelines, an access could be placed at a location between 200 m and 260 m north of the existing railway crossing.

This design would increase the visibility of the entrance for southbound vehicles from 330 m to between 425 m and 485 m, thereby meeting the required 425 m for DDSD. Eastbound right turning departure sight distance would also increase, from 325 m to between 420 m and 480 m, well beyond the required 405 m. Sight distances are not required for other turning movements since these manoeuvres would be restricted.

It may be possible to provide a northbound left-turn lane at Pickering-Uxbridge Townline to allow northbound vehicles access to the site via the Townline and Old Brock Road, but sightlines at this intersection are somewhat limited and may not meet minimum requirements.

Option 2 – Right In/Right Out/Left In via Slip Around Lane

Another option would be to allow northbound left turns into the site by a slip around lane, in combination with the right in/right out access. The preferred left turn treatment – slip around lane or separate left-turn auxiliary lane – would depend on traffic volumes. Eastbound left turn movements out of the site would be restricted regardless of the treatment selected.

The *Geometric Design Standards for Ontario Highways*[7] provides guidance on the required dimensions and potential impacts of installing a slip around lane. According to the guidelines, an access could be placed at a location between 200 m and 260 m north of the railway crossing. This entrance placement would accommodate a slip around lane for northbound inbound traffic and the deceleration and acceleration lanes for exiting vehicles.

Based on the *Geometric Design Standards for Ontario Highways*[8] a slip around lane 145 m in length would be required. This access could be placed at the same location as the right in/right out access outlined in Option 1, and include deceleration and acceleration lanes. This design would increase the visibility of the entrance for southbound vehicles from 330 m to between 425 m and 485 m,

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[7] Ontario Ministry of Transportation, *Geometric Design Standards for Ontario Highways,* 1994, Table E9-1

[8] Ontario Ministry of Transportation. *Geometric Design Standards for Ontario Highways,* 1994, Table E7-1, E8-4 & E8-5

thereby meeting the required 425 m for DDSD. Eastbound right turning departure sight distance would also increase, from 325 m to between 420 m and 480 m, well beyond the required 405 m.

Option 3 – Right In/Right Out/Left In via Separate Left-Turn Auxiliary Lane

If traffic volumes warrant the provision of a separate left-turn auxiliary lane, the access would need to be placed approximately 280 m north of the railway crossing. For a design speed of 100 km/h, a left turn lane 260 m in length would be required based on the *Geometric Design Standards for Ontario Highways*[9]. This design would increase the southbound intersection visibility from 330 m to 405 m, well beyond the required 335 m for MDSD, but short of the DDSD. Eastbound right turning departure sight distance would increase from 325 m to 400 m, just short of the required 405 m.

Summary

Table 3 summarizes the access locations and the recommended and available sight distances. As noted in the table, Options 1 and 2 meet minimum requirements, whereas Option 3 falls just short of the recommended values.

TABLE 3: SUMMARY OF ALTERNATE ACCESS LOCATIONS AND SIGHT DISTANCES

	SB Vehicle Sightlines		EB Vehicle Sightlines to the North	
	Measured	Required (DDSD)	Measured	Required (DDSD)
Option 1: Right In/Right Out				
200 meters north of crossing	485 m	425 m	480 m	405 m
260 meters north of crossing	425 m	425 m	420 m	405 m
Option 2: Slip Around Lane with RI/RO				
200 meters north of crossing	485 m	425 m	480 m	405 m
260 meters north of crossing	425 m	425 m	420 m	405 m
Option 3: Left Turn Lane with RI/RO				
280 meters north of crossing	405 m	425 m	400 m	405 m

Figure 1 shows the access locations.

[9] Ibid. Table E9-1

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Location of Potential Brock Road Accesses to Claremont North Business Park

Conclusions

The sight distance analyses and location assessment for the proposed Brock Road access illustrated that:

- The existing accesses on Old Brock Road meet sight distance requirements for a design speed of 50 km/h. Pavement conditions on Old Brock Road were noted to be less than ideal.
- The proposed access onto Brock Road meets the requirements for minimum stopping sight distance (SSD), but does not satisfy the criteria for minimum decision sight distance (MDSD) and desirable decision sight distance (DDSD). The required and measured distances are as follows:
  - Northbound (on Brock Road): Required (SSD) = 175 m, Measured = 250 m approximately;
  - Southbound: Required (SSD) = 215 m, Measured = 330 m approximately.
- The proposed access onto Brock Road does not meet the requirements for departure sight distance. The required and measured distances are as follows:
  - Eastbound (exiting the site) turning right: Required = 405 m, Measured = 325 m approximately;
  - Eastbound turning left: Required = 365 m, Measured = 225 m approximately.
- A right in/right out access located between 200 m and 260 m north of the railway crossing would satisfy the required deceleration and acceleration lane lengths and meet DDSD and departure sight distances.
- If appropriate, a slip around lane for left-turn movements could be accommodated in combination with the above-noted right in/right out access at a location between 200 m and 260 m north of the railway crossing.
- Should traffic volumes warrant a full length left-turn lane, the right in/right out access should be located 280 m north of the railway crossing. However, DDSD would not be met at this location, nor would the criteria for departure sight distance.
- Regardless of access design or location, a southbound deceleration lane about 200 m in length, and a southbound

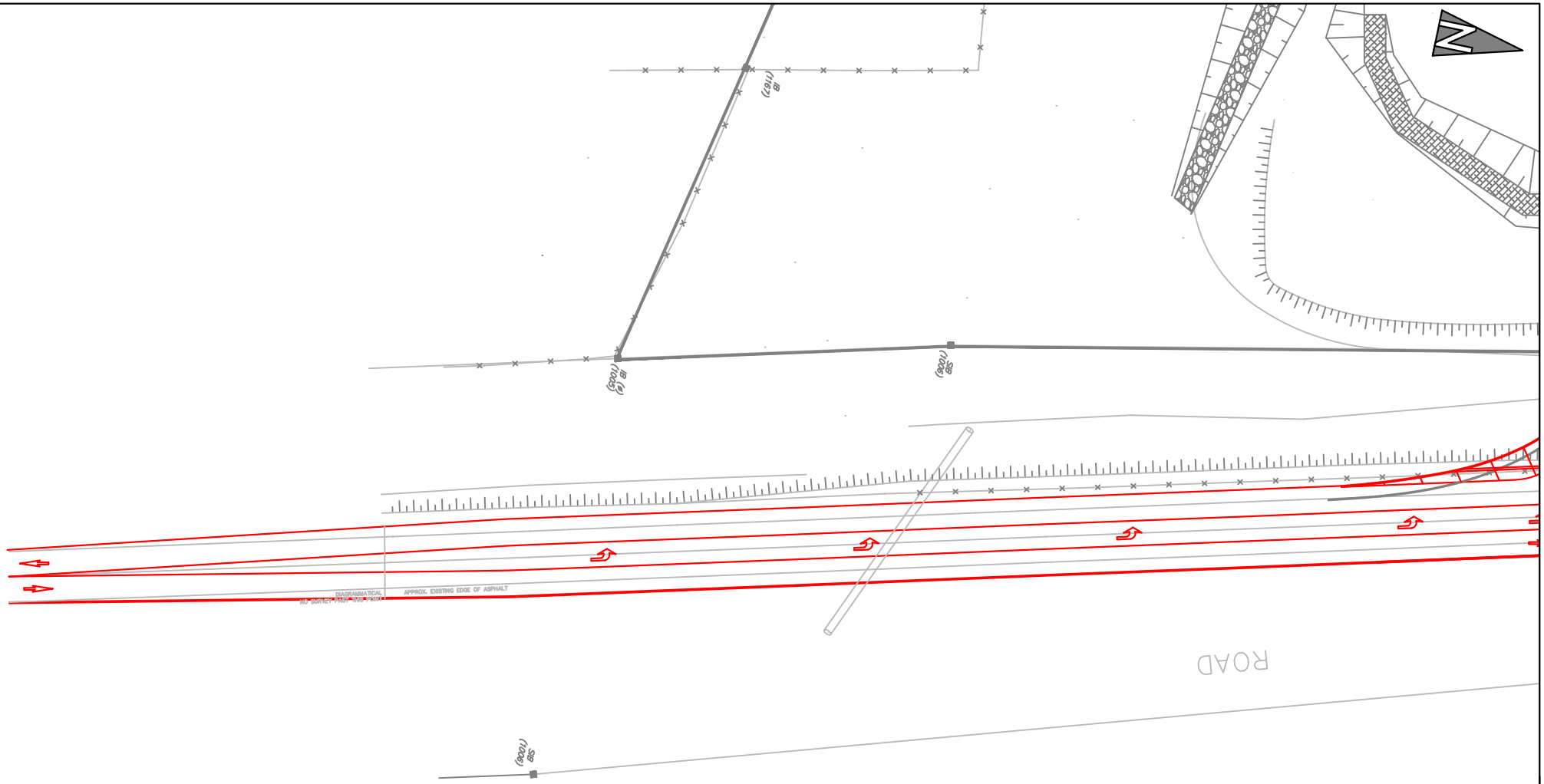
acceleration lane of between 150 m and 180 m in length, would be recommended for the proposed Brock Road access.

Please contact me should you have any questions or request clarification of this memorandum.

Yours very truly,

PARADIGM TRANSPORTATION SOLUTIONS LIMITED

Gene Chartier
M.A.Sc., P.Eng., FITE
Vice-President



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Brock Road/Site Access Intersection
Functional Design Drawing

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Project No. 160300

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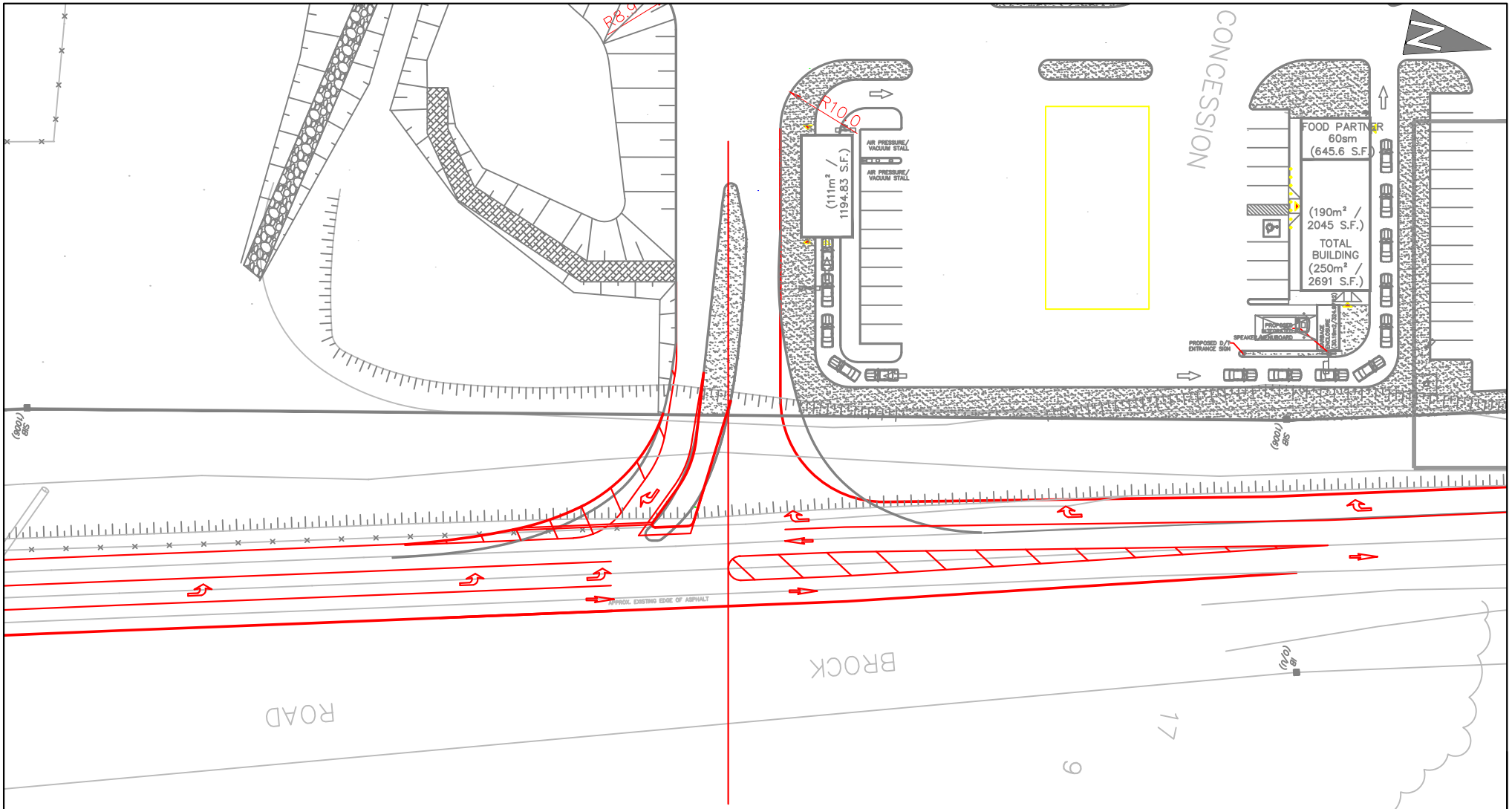

Brock Road/Site Access Intersection
Functional Design Drawing

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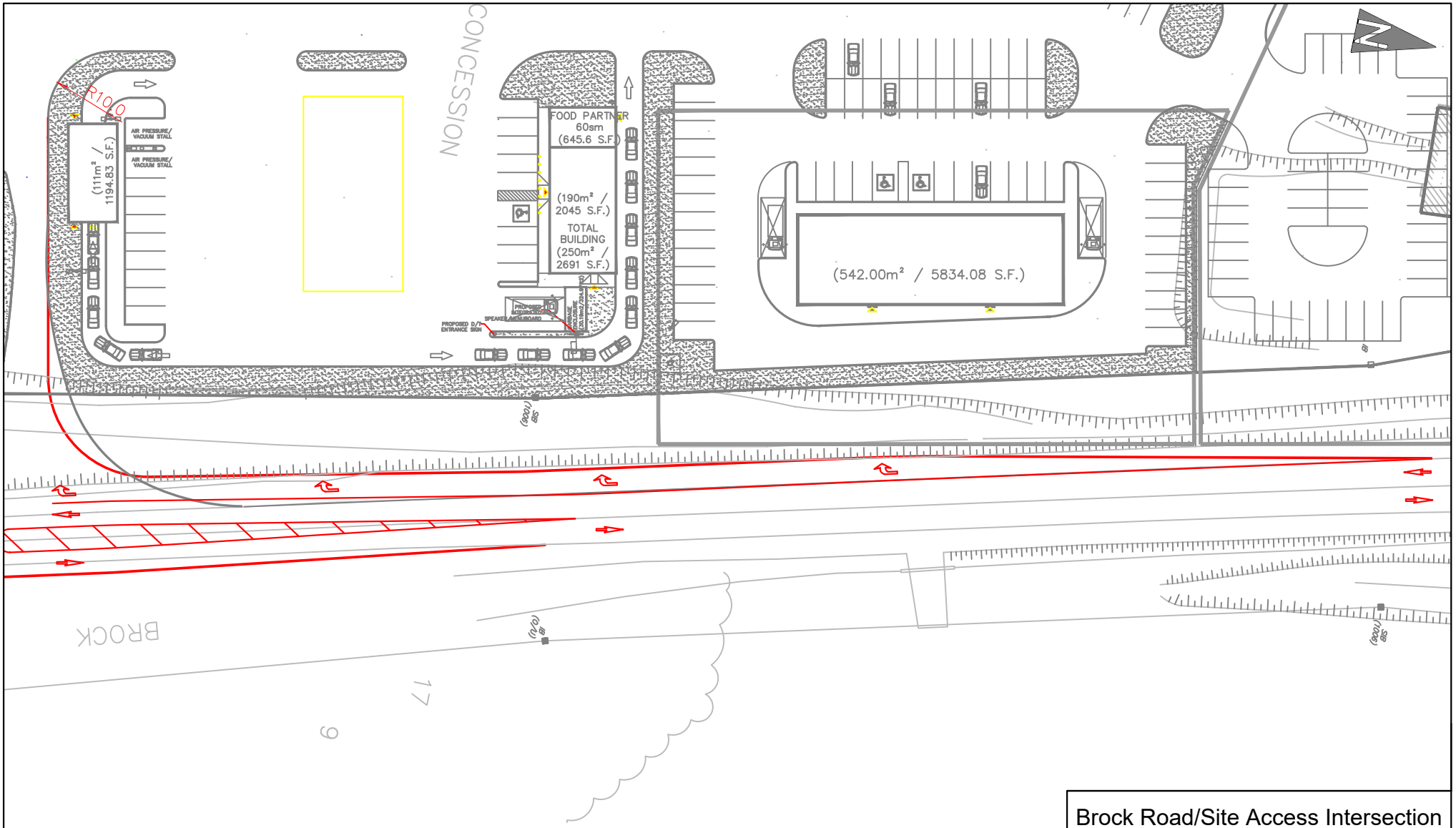

Brock Road/Site Access Intersection
Functional Design Drawing

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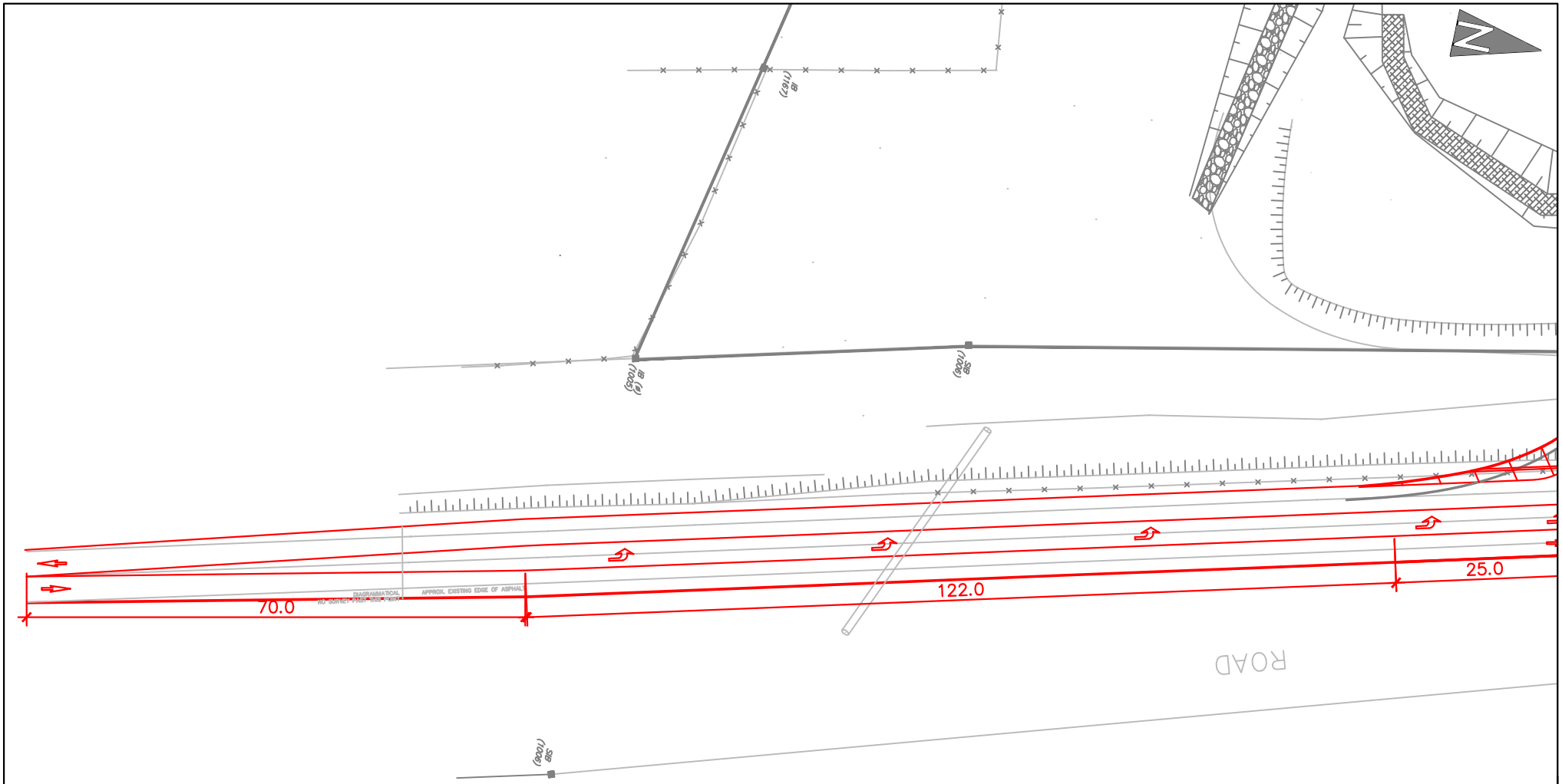

Brock Road/Site Access Intersection
Functional Design Drawing

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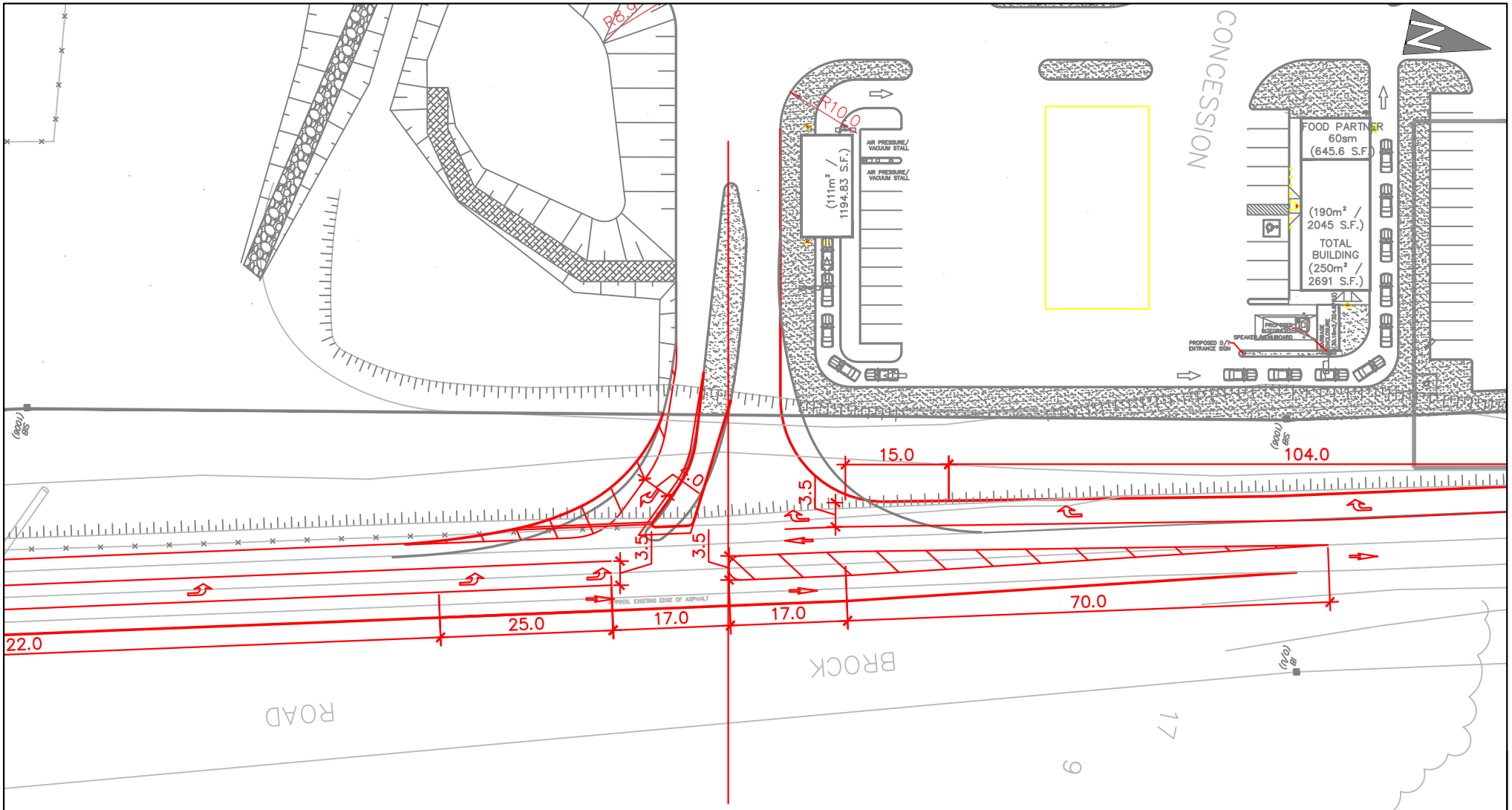

Brock Road/Site Access Intersection
Functional Design Drawing

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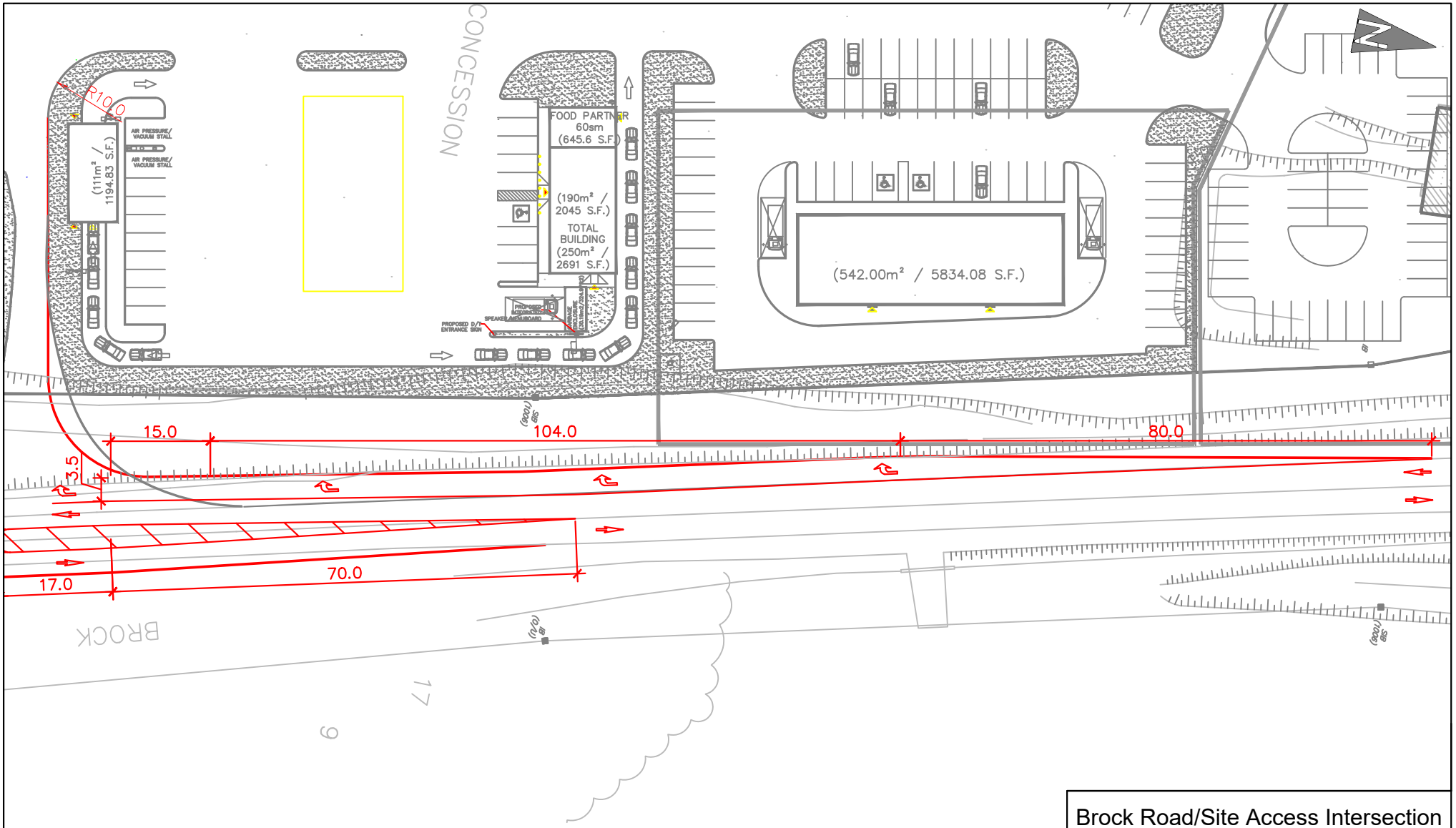

Brock Road/Site Access Intersection
Functional Design Drawing

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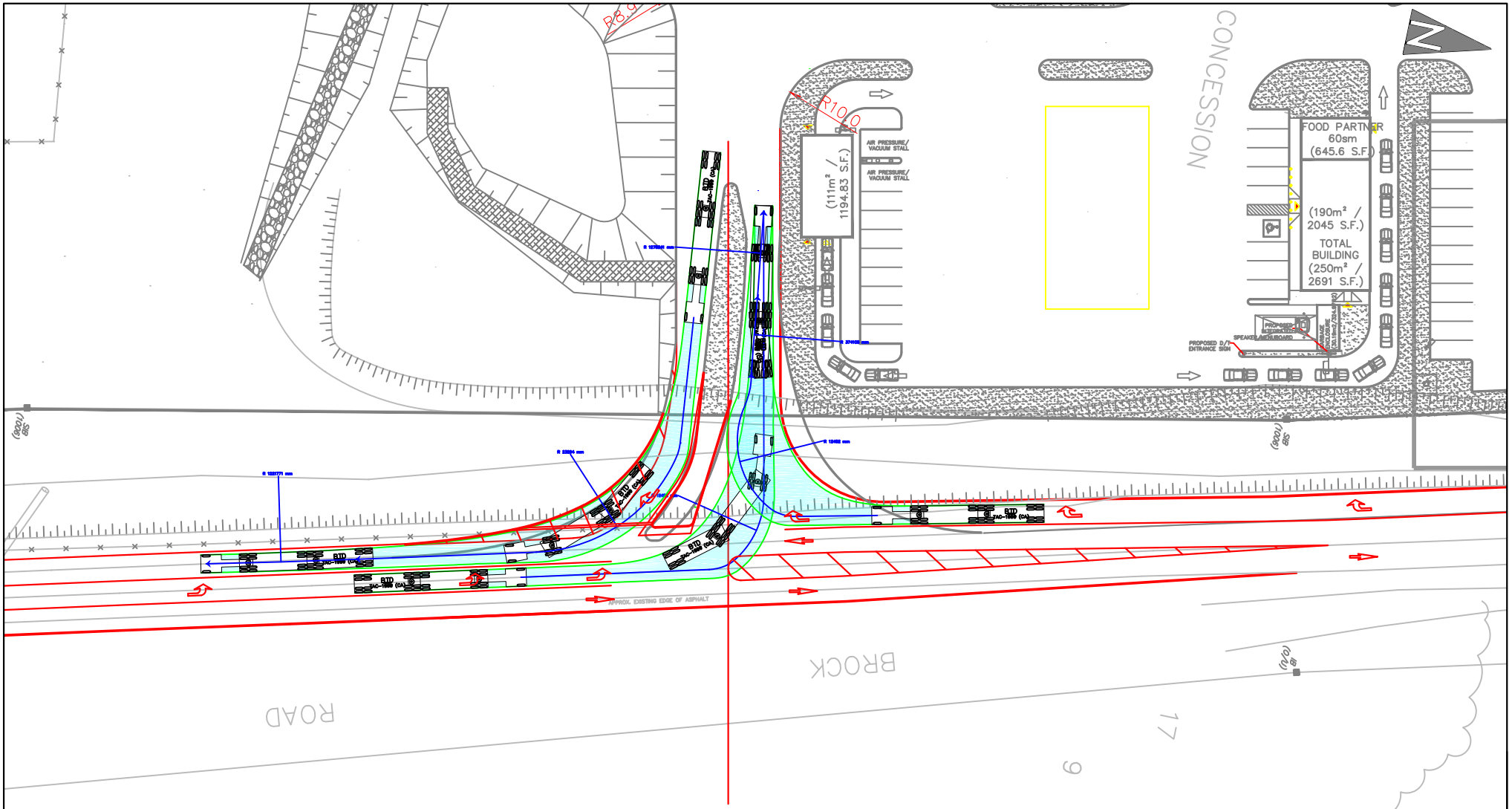

Brock Road/Site Access Intersection
Functional Design Drawing

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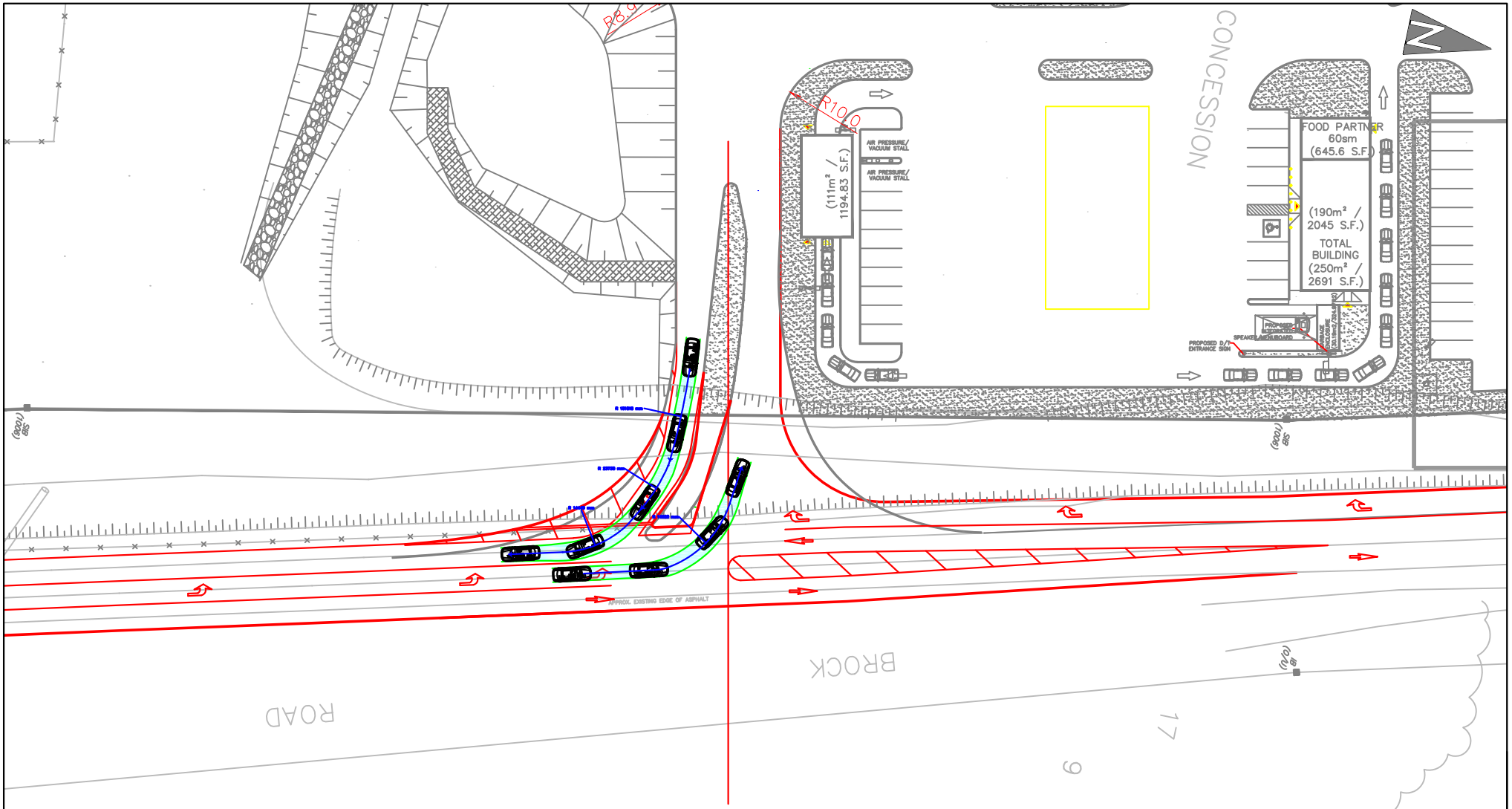

Brock Road/Site Access Intersection
Functional Design Drawing

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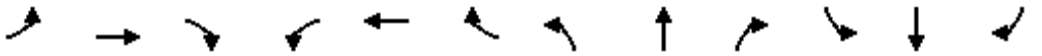
Appendix C

2028 Background Traffic Operations Reports



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	20	2	18	6	6	5	5	272	1	1	482	22
Future Volume (Veh/h)	20	2	18	6	6	5	5	272	1	1	482	22
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)	22	2	20	7	7	5	5	296	1	1	524	24
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	841	833	524	854	856	296	548			297		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	841	833	524	854	856	296	548			297		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	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 %	92	99	96	97	98	99	100			100		
cM capacity (veh/h)	276	303	553	266	293	743	1021			1264		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total	44	19	302	525	24
Volume Left	22	7	5	1	0
Volume Right	20	5	1	0	24
cSH	359	334	1021	1264	1700
Volume to Capacity	0.12	0.06	0.00	0.00	0.01
Queue Length 95th (m)	3.3	1.4	0.1	0.0	0.0
Control Delay (s)	16.4	16.4	0.2	0.0	0.0
Lane LOS	C	C	A	A	
Approach Delay (s)	16.4	16.4	0.2	0.0	
Approach LOS	C	C			

Intersection Summary				
Average Delay	1.2			
Intersection Capacity Utilization	36.1%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	13	4	22	13	6	20
Future Volume (Veh/h)	13	4	22	13	6	20
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)	14	4	24	14	7	22
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume			18		78	16
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			18		78	16
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		99	98
cM capacity (veh/h)			1599		911	1063

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	18	38	29
Volume Left	0	24	7
Volume Right	4	0	22
cSH	1700	1599	1022
Volume to Capacity	0.01	0.02	0.03
Queue Length 95th (m)	0.0	0.4	0.7
Control Delay (s)	0.0	4.6	8.6
Lane LOS		A	A
Approach Delay (s)	0.0	4.6	8.6
Approach LOS			A

Intersection Summary			
Average Delay	5.0		
Intersection Capacity Utilization	18.6%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	5	0	23	21	0	15
Future Volume (Veh/h)	5	0	23	21	0	15
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)	5	0	25	23	0	16
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	52	36			48	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	52	36			48	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	99	100			100	
cM capacity (veh/h)	956	1036			1559	

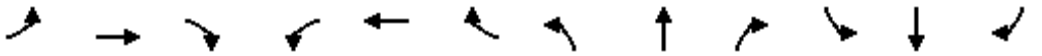
Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	5	48	16
Volume Left	5	0	0
Volume Right	0	23	0
cSH	956	1700	1559
Volume to Capacity	0.01	0.03	0.00
Queue Length 95th (m)	0.1	0.0	0.0
Control Delay (s)	8.8	0.0	0.0
Lane LOS	A		
Approach Delay (s)	8.8	0.0	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	2	23	0	11	15
Future Volume (Veh/h)	0	2	23	0	11	15
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)	0	2	25	0	12	16
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	65	25			25	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	65	25			25	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			99	
cM capacity (veh/h)	933	1051			1589	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	2	25	28
Volume Left	0	0	12
Volume Right	2	0	0
cSH	1051	1700	1589
Volume to Capacity	0.00	0.01	0.01
Queue Length 95th (m)	0.0	0.0	0.2
Control Delay (s)	8.4	0.0	3.2
Lane LOS	A		A
Approach Delay (s)	8.4	0.0	3.2
Approach LOS	A		

Intersection Summary			
Average Delay	1.9		
Intersection Capacity Utilization	18.1%	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 (veh/h)	57	11	12	4	4	4	9	511	4	1	335	20
Future Volume (Veh/h)	57	11	12	4	4	4	9	511	4	1	335	20
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)	62	12	13	4	4	4	10	555	4	1	364	22
Pedestrians												
Lane Width (m)												
Walking Speed (m/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	949	945	364	962	965	557	386			559		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	949	945	364	962	965	557	386			559		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	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 %	73	95	98	98	98	99	99			100		
cM capacity (veh/h)	234	259	681	221	252	530	1172			1012		

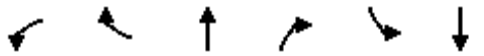
Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total	87	12	569	365	22
Volume Left	62	4	10	1	0
Volume Right	13	4	4	0	22
cSH	263	289	1172	1012	1700
Volume to Capacity	0.33	0.04	0.01	0.00	0.01
Queue Length 95th (m)	11.1	1.0	0.2	0.0	0.0
Control Delay (s)	25.3	18.0	0.2	0.0	0.0
Lane LOS	D	C	A	A	
Approach Delay (s)	25.3	18.0	0.2	0.0	
Approach LOS	D	C			

Intersection Summary				
Average Delay	2.4			
Intersection Capacity Utilization	49.8%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	20	4	23	22	2	38
Future Volume (Veh/h)	20	4	23	22	2	38
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)	22	4	25	24	2	41
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			26		98	24
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			26		98	24
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		100	96
cM capacity (veh/h)			1588		887	1052

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	26	49	43
Volume Left	0	25	2
Volume Right	4	0	41
cSH	1700	1588	1043
Volume to Capacity	0.02	0.02	0.04
Queue Length 95th (m)	0.0	0.4	1.0
Control Delay (s)	0.0	3.8	8.6
Lane LOS		A	A
Approach Delay (s)	0.0	3.8	8.6
Approach LOS			A

Intersection Summary			
Average Delay	4.7		
Intersection Capacity Utilization	19.1%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	21	0	29	5	0	24
Future Volume (Veh/h)	21	0	29	5	0	24
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)	23	0	32	5	0	26
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	60	34			37	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	60	34			37	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	98	100			100	
cM capacity (veh/h)	946	1039			1574	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	23	37	26
Volume Left	23	0	0
Volume Right	0	5	0
cSH	946	1700	1574
Volume to Capacity	0.02	0.02	0.00
Queue Length 95th (m)	0.6	0.0	0.0
Control Delay (s)	8.9	0.0	0.0
Lane LOS	A		
Approach Delay (s)	8.9	0.0	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	2.4		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

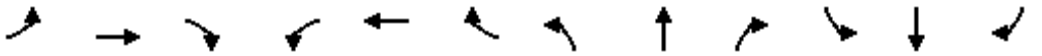
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	0	11	29	0	2	24
Future Volume (Veh/h)	0	11	29	0	2	24
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	12	32	0	2	26
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)			65			
pX, platoon unblocked						
vC, conflicting volume	62	32			32	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	62	32			32	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	943	1042			1580	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	12	32	28
Volume Left	0	0	2
Volume Right	12	0	0
cSH	1042	1700	1580
Volume to Capacity	0.01	0.02	0.00
Queue Length 95th (m)	0.3	0.0	0.0
Control Delay (s)	8.5	0.0	0.5
Lane LOS	A		A
Approach Delay (s)	8.5	0.0	0.5
Approach LOS	A		

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

Appendix D

2028 Total Traffic Operations Reports



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	56	2	18	6	6	5	5	272	1	1	492	28
Future Volume (Veh/h)	56	2	18	6	6	5	5	272	1	1	492	28
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)	61	2	20	7	7	5	5	296	1	1	535	30
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	852	844	535	864	874	296	565			297		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	852	844	535	864	874	296	565			297		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	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 %	78	99	96	97	98	99	100			100		
cM capacity (veh/h)	271	298	545	262	287	743	1007			1264		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total	83	19	302	536	30
Volume Left	61	7	5	1	0
Volume Right	20	5	1	0	30
cSH	309	328	1007	1264	1700
Volume to Capacity	0.27	0.06	0.00	0.00	0.02
Queue Length 95th (m)	8.5	1.5	0.1	0.0	0.0
Control Delay (s)	20.8	16.6	0.2	0.0	0.0
Lane LOS	C	C	A	A	
Approach Delay (s)	20.8	16.6	0.2	0.0	
Approach LOS	C	C			

Intersection Summary				
Average Delay	2.2			
Intersection Capacity Utilization	41.4%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	13	10	28	13	10	56
Future Volume (Veh/h)	13	10	28	13	10	56
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)	14	11	30	14	11	61
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			25		94	20
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			25		94	20
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		99	94
cM capacity (veh/h)			1589		889	1058

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	25	44	72
Volume Left	0	30	11
Volume Right	11	0	61
cSH	1700	1589	1029
Volume to Capacity	0.01	0.02	0.07
Queue Length 95th (m)	0.0	0.5	1.8
Control Delay (s)	0.0	5.0	8.8
Lane LOS		A	A
Approach Delay (s)	0.0	5.0	8.8
Approach LOS			A

Intersection Summary			
Average Delay		6.0	
Intersection Capacity Utilization		19.6%	ICU Level of Service
Analysis Period (min)		15	

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	6	0	37	23	0	26
Future Volume (Veh/h)	6	0	37	23	0	26
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)	7	0	40	25	0	28
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	80	52			65	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	80	52			65	
tC, single (s)	6.5	6.3			4.2	
tC, 2 stage (s)						
tF (s)	3.6	3.4			2.3	
p0 queue free %	99	100			100	
cM capacity (veh/h)	902	993			1488	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	7	65	28
Volume Left	7	0	0
Volume Right	0	25	0
cSH	902	1700	1488
Volume to Capacity	0.01	0.04	0.00
Queue Length 95th (m)	0.2	0.0	0.0
Control Delay (s)	9.0	0.0	0.0
Lane LOS	A		
Approach Delay (s)	9.0	0.0	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	13.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	10	32	25	12	16	16
Future Volume (Veh/h)	10	32	25	12	16	16
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	35	27	13	17	17
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	84	34			40	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	84	34			40	
tC, single (s)	6.5	6.3			4.2	
tC, 2 stage (s)						
tF (s)	3.6	3.4			2.3	
p0 queue free %	99	97			99	
cM capacity (veh/h)	888	1017			1520	

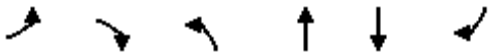
Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	46	40	34
Volume Left	11	0	17
Volume Right	35	13	0
cSH	983	1700	1520
Volume to Capacity	0.05	0.02	0.01
Queue Length 95th (m)	1.2	0.0	0.3
Control Delay (s)	8.8	0.0	3.7
Lane LOS	A		A
Approach Delay (s)	8.8	0.0	3.7
Approach LOS	A		

Intersection Summary			
Average Delay	4.4		
Intersection Capacity Utilization	18.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	1	10	56	2	7	31
Future Volume (Veh/h)	1	10	56	2	7	31
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)	1	11	61	2	8	34
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	112	62			63	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	112	62			63	
tC, single (s)	6.5	6.3			4.2	
tC, 2 stage (s)						
tF (s)	3.6	3.4			2.3	
p0 queue free %	100	99			99	
cM capacity (veh/h)	861	981			1490	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	12	63	42
Volume Left	1	0	8
Volume Right	11	2	0
cSH	970	1700	1490
Volume to Capacity	0.01	0.04	0.01
Queue Length 95th (m)	0.3	0.0	0.1
Control Delay (s)	8.8	0.0	1.4
Lane LOS	A		A
Approach Delay (s)	8.8	0.0	1.4
Approach LOS	A		

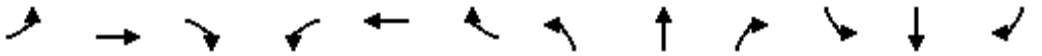
Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	17.6%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	55	49	254	470	46
Future Volume (Veh/h)	0	55	49	254	470	46
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	60	53	276	511	50
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	918	536	561			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	918	536	561			
tC, single (s)	6.4	6.3	4.2			
tC, 2 stage (s)						
tF (s)	3.5	3.4	2.3			
p0 queue free %	100	89	95			
cM capacity (veh/h)	285	529	971			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	60	329	561
Volume Left	0	53	0
Volume Right	60	0	50
cSH	529	971	1700
Volume to Capacity	0.11	0.05	0.33
Queue Length 95th (m)	3.0	1.4	0.0
Control Delay (s)	12.7	1.9	0.0
Lane LOS	B	A	
Approach Delay (s)	12.7	1.9	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	50.3%	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 (veh/h)	98	11	12	4	4	4	9	511	4	1	345	26
Future Volume (Veh/h)	98	11	12	4	4	4	9	511	4	1	345	26
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)	107	12	13	4	4	4	10	555	4	1	375	28
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	960	956	375	973	982	557	403			559		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	960	956	375	973	982	557	403			559		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	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 %	53	95	98	98	98	99	99			100		
cM capacity (veh/h)	230	256	671	217	247	530	1156			1012		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1	SB 2
Volume Total	132	12	569	376	28
Volume Left	107	4	10	1	0
Volume Right	13	4	4	0	28
cSH	248	285	1156	1012	1700
Volume to Capacity	0.53	0.04	0.01	0.00	0.02
Queue Length 95th (m)	22.8	1.1	0.2	0.0	0.0
Control Delay (s)	34.9	18.2	0.2	0.0	0.0
Lane LOS	D	C	A	A	
Approach Delay (s)	34.9	18.2	0.2	0.0	
Approach LOS	D	C			

Intersection Summary				
Average Delay	4.5			
Intersection Capacity Utilization	54.4%	ICU Level of Service		A
Analysis Period (min)	15			

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	20	9	29	22	9	79
Future Volume (Veh/h)	20	9	29	22	9	79
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)	22	10	32	24	10	86
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			32		115	27
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			32		115	27
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			98		99	92
cM capacity (veh/h)			1580		863	1048

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	32	56	96
Volume Left	0	32	10
Volume Right	10	0	86
cSH	1700	1580	1026
Volume to Capacity	0.02	0.02	0.09
Queue Length 95th (m)	0.0	0.5	2.5
Control Delay (s)	0.0	4.3	8.9
Lane LOS		A	A
Approach Delay (s)	0.0	4.3	8.9
Approach LOS			A

Intersection Summary			
Average Delay	5.9		
Intersection Capacity Utilization	21.5%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	22	0	43	7	0	40
Future Volume (Veh/h)	22	0	43	7	0	40
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)	24	0	47	8	0	43
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	94	51			55	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	94	51			55	
tC, single (s)	6.5	6.3			4.2	
tC, 2 stage (s)						
tF (s)	3.6	3.4			2.3	
p0 queue free %	97	100			100	
cM capacity (veh/h)	887	995			1500	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	24	55	43
Volume Left	24	0	0
Volume Right	0	8	0
cSH	887	1700	1500
Volume to Capacity	0.03	0.03	0.00
Queue Length 95th (m)	0.7	0.0	0.0
Control Delay (s)	9.2	0.0	0.0
Lane LOS	A		
Approach Delay (s)	9.2	0.0	0.0
Approach LOS	A		

Intersection Summary			
Average Delay	1.8		
Intersection Capacity Utilization	13.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	14	45	31	12	6	26
Future Volume (Veh/h)	14	45	31	12	6	26
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)	15	49	34	13	7	28
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	82	40			47	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	82	40			47	
tC, single (s)	6.5	6.3			4.2	
tC, 2 stage (s)						
tF (s)	3.6	3.4			2.3	
p0 queue free %	98	95			100	
cM capacity (veh/h)	896	1008			1511	

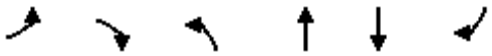
Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	64	47	35
Volume Left	15	0	7
Volume Right	49	13	0
cSH	979	1700	1511
Volume to Capacity	0.07	0.03	0.00
Queue Length 95th (m)	1.7	0.0	0.1
Control Delay (s)	8.9	0.0	1.5
Lane LOS	A		A
Approach Delay (s)	8.9	0.0	1.5
Approach LOS	A		

Intersection Summary			
Average Delay	4.3		
Intersection Capacity Utilization	16.7%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	2	14	74	2	7	31
Future Volume (Veh/h)	2	14	74	2	7	31
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)	2	15	80	2	8	34
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	131	81			82	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	131	81			82	
tC, single (s)	6.5	6.3			4.2	
tC, 2 stage (s)						
tF (s)	3.6	3.4			2.3	
p0 queue free %	100	98			99	
cM capacity (veh/h)	840	957			1466	

Direction, Lane #	WB 1	NB 1	SB 1
Volume Total	17	82	42
Volume Left	2	0	8
Volume Right	15	2	0
cSH	942	1700	1466
Volume to Capacity	0.02	0.05	0.01
Queue Length 95th (m)	0.4	0.0	0.1
Control Delay (s)	8.9	0.0	1.5
Lane LOS	A		A
Approach Delay (s)	8.9	0.0	1.5
Approach LOS	A		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	17.6%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	0	64	49	499	315	46
Future Volume (Veh/h)	0	64	49	499	315	46
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	70	53	542	342	50
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (m)						
pX, platoon unblocked						
vC, conflicting volume	1015	367	392			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1015	367	392			
tC, single (s)	6.4	6.3	4.2			
tC, 2 stage (s)						
tF (s)	3.5	3.4	2.3			
p0 queue free %	100	89	95			
cM capacity (veh/h)	252	661	1124			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	70	595	392
Volume Left	0	53	0
Volume Right	70	0	50
cSH	661	1124	1700
Volume to Capacity	0.11	0.05	0.23
Queue Length 95th (m)	2.8	1.2	0.0
Control Delay (s)	11.1	1.3	0.0
Lane LOS	B	A	
Approach Delay (s)	11.1	1.3	0.0
Approach LOS	B		

Intersection Summary			
Average Delay	1.5		
Intersection Capacity Utilization	55.0%	ICU Level of Service	B
Analysis Period (min)	15		