TRANSPORTATION IMPACT STUDY

IMPERIAL OIL ESSO STATION

1545 WOODROFFE AVE

OTTAWA

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1. INTRODUCTION

Imperial Oil Limited is proposing to redevelop the existing service station at the northeast corner of Woodroffe Avenue and Medhurst Drive in the City of Ottawa. Figure 1 shows the site location.

An application for Site Plan approval is being submitted. Read, Voorhees & Associates Limited has been retained to prepare a transportation impact study (TIS) in support of the Site Plan application.

An initial report dated March 2015 was submitted in support of the application, and comments on the report have been provided by the City. This update is to provide any additional information requested, respond to the comments, and to incorporate any changes to the site plan that have been made since the initial submission.

2. REPORT CONTEXT

The street address is 1545 Woodroffe Avenue. The site is located in the north-east quadrant of the intersection of Woodroffe Avenue and Medhurst Drive.

Figure 2 shows the site plan for the redeveloped site. The proposed uses comply with the current zoning, so the application is for site plan approval.

Right-of-way widening is provided on both adjacent streets. The right-of-way on Woodroffe Avenue will be 22.25m from centreline of pavement, and the right-of-way on Medhurst Drive will be 12m from centreline of pavement.

The site is currently operating as a service station, with ten fuelling positions, an attendant's kiosk, and a car wash on the site. There is also a free standing Tim Horton's outlet on the property, sharing the site access driveways.

The modified station will continue to provide fuel sales at ten fuelling positions but in a relocated position, and will have a retail convenience store of 344 m^2 (3700 ft^2). The convenience store will have the normal 'On The Run' goods and facilities that are available at

newer Esso sites. There will be a Tim Horton's drive through service provided in the convenience store, and there will also be a Tim Horton's seating area provided.

The existing free standing Tim Horton's outlet will be removed. The current seating capacity at this facility is 70 persons, but there is no drive through window. The area within the convenience store will have seating capacity for 30 persons, approximately half of the current capacity, but as noted there will also be a drive through window service.

The drive through lane has 15 stacking spaces, which is an increase from the previous plan with 13 spaces, achieved by moving the convenience store slightly to the north. Reversal of the direction of the drive through lane is not possible because of the orientation of the store and the need to have the driver's side adjacent to the back of the store where the pickup window is located.

The existing car wash will continue operation on the site in a relocated location.

Redevelopment of the site is scheduled for 2016.

The site presently has three access driveways on the adjacent streets, two right-in/right-out driveways on Woodroffe Avenue and one full moves driveway on Medhurst Drive. The redeveloped service station will maintain the same driveway configuration with the same permitted movements. The driveways will be reconstructed in essentially the same locations, although the Medhurst driveway and the south Woodroffe driveway will be slightly wider to better accommodate the turning path of the tanker delivery truck.

Twenty-four parking spaces, one of which is a handicap parking space, are to be provided. Fourteen of the parking spaces, including the handicap space, are located immediately in front of and adjacent to the convenience store. The other ten spaces are near the carwash facility, along with two additional spaces provided at the vacuum pumps. There is also a loading area provided adjacent to the convenience store for garbage bins and collection. This area can be used as a loading space for other deliveries as well. The zoning by-law requirement for parking for the development is 15 spaces.

There are existing sidewalks along the Woodroffe Avenue and Medhurst Drive frontages, which will remain in place with reconstruction of the station. A 1.5m pedestrian connection will be provided on the site between the convenience store and the Medhurst Drive sidewalk. Bicycle racks are also provided on site beside the pedestrian path connection.

Woodroffe Avenue adjacent to the site is a Bus Rapid Transit (BRT) corridor, and bus shelters are located on Woodroffe Avenue between the two site driveways on the west edge of the site. The BRT facilities will be maintained in this location.

The hours of analysis are the weekday a.m. and p.m. peak hours. These are the busiest traffic conditions at the site driveways and at the intersections in the area.

The horizon year is a 5 year period to 2020.

The study area consists of the site access driveways on the two adjacent streets, Woodroffe Avenue and Medhurst Drive, and the signalized intersection of Woodroffe Avenue and Medhurst Drive. The change in traffic generation at the site will be minor, and no other intersections beyond the noted study area will be affected.

3. EXISTING CONDITIONS

3.1 Street System

Woodroffe Avenue is a six lane arterial road with a centre median that provides north-south service to the area. Two of the lanes are exclusive bus lanes. Left turn lanes are provided at main intersections. The posted speed is 60 km/h.

Medhurst Drive is a two lane collector road providing east-west service through the neighbourhood north of Hunt Club Road. It joins into Knoxdale Road which continues the collector road function west of Woodroffe Avenue. The posted speed on Medhust Drive is 40 km/h.

The intersection of Woodroffe Avenue and Medhurst Drive is signalized. There are separate left turn lanes on both Medhurst Drive and Woodroffe Avenue, with the eastbound direction having a double left turn lane configuration.

No changes to the existing road system are planned for the area, and no new facilities are proposed.

3.2 Traffic Volume

Figure 3 shows the existing a.m. and p.m. peak hour traffic volumes at the site driveways and at the Woodroffe Avenue and Medhurst Drive intersection. The volumes are from a count at the signalized intersection carried out by Ottawa in June 2012, and counts at the site driveways were carried out by Read Voorhees in December 2014.

3.3 Transit Service

Transit service operates along Woodroffe Avenue, which as noted operates with exclusive bus lanes. Transit usage is obviously not a significant factor for the service station use, but bus stops are located at the intersection with Medhurst Drive.

As noted above, the bus stop adjacent of the service station on Woodroffe Avenue will be maintained in its current location.

3.4 Pedestrian and Bicycle Facilities

As discussed earlier, there are sidewalks along both Woodroffe Avenue and Medhurst Drive.

Bicycle lanes are provided on Woodroffe Avenue.

3.5 Major Trip Generators in Study Area

Woodroffe Avenue is a major arterial road serving the west side of Ottawa. However, there are no major shopping centres or other major trip generators located in the immediate vicinity of the site,

4. TRAFFIC FORECASTS

4.1 Background Traffic

The Development Application Search Tool was used to identify any applications for new development in the general vicinity of the site. There are no applications within a kilometre of the subject site, and no applications of notable size within several kilometres of the site.

As a conservatively high growth forecast the 2020 horizon year traffic forecast for Woodroffe Avenue has been based on a general 1.5% annual growth rate, which is a total growth factor of 1.12 over the 2012 volumes. No growth is anticipated on Medhurst Drive which serves a residential area that is essentially built out.

The 2020 background a.m. and p.m. peak hour volumes are shown in Figure 4.

4.2 Site Traffic

Read Voorhees has carried out site traffic counts in the Greater Toronto Area (GTA) at various Esso gas stations with Tim Horton's drive through windows, all of which have a good market draw and have been used as representative of a 'design' site. Most of the locations have 12 fuelling positions. The site trip patterns indicate that in the a.m. peak period a substantial number of site trips are also being attracted to the Tim Horton's drive through service, separate from gas purchases. Traffic through the Tim Horton's drive through in the p.m. peak hour is much less than in the a.m. peak hour.

Table 1 shows the a.m. site peak hour volumes counted recently at nine Esso stations with a Tim Horton's drive through service. The surveys indicate an average of 18.0 and 17.0 cars for the total site entry and exit volumes per filling position, and an average of 109 cars passing through the Tim Horton's drive through in the a.m. peak hour. This is equivalent to about 9 trips per filling position.

Traffic counts were also taken in December 2014 in Ottawa at the Innes Road and Belcourt Blvd Esso station that was rebuilt in 2010 with a Tim Horton's drive through added to the site. The results are also shown in Table 1. The volume of traffic in and out of the Ottawa site, and through the Tim Horton's drive through, are similar to the GTA volumes. However, with only 8 fuelling positions the average rates at the Innes Road and Belcourt Blvd station are higher than the rates calculated for the GTA locations with 12 fuelling positions.

Table 1 - A.M. Peak Hour Volumes at Stations with Tim Horton's Drive Through

Location	Total Site Inbound Traffic	Total Site Outbound Traffic	Volume Passing Through the Drive Through Lane
Kennedy and Ellesmere (10 pos.)	189	183	103
Lawrence and Midland	157	148	86
Kingston Road and Saunders	198	186	132
Markham and Ellesmere	197	201	101
Lake Shore and Carlaw	241	227	123
Bathurst and Drewry	244	241	104
Markham and Sheppard (10 pos.)	205	199	109
Speers and Dorval (16 pos.)	299	264	81
Jane and Major Mackenzie	213	182	138
AVERAGE	216	203	109
Rate per fuelling position (12)	18.0	16.9	9.1
Innes and Belcourt (8 positions)	192	199	119
Rate per fuelling position (8)	24.0	24.9	14.9

Table 2 shows the p.m. site peak hour volumes counted at five of the nine Esso stations listed in Table 1. The surveys indicate an average of 12.1 and 11.5 cars for the total site entry and exit volumes per filling position, and an average of 36 cars passing through the Tim Horton's drive through in the p.m. peak hour. This is equivalent to about 3 trips per filling position.

The p.m. peak hour results for the Innes and Belcourt station on a per fuelling position basis are about the same as the GTA surveyed stations.

Table 2 - P.M. Peak Hour Volumes at Stations with Tim Horton's Drive Through

Location	Total Site Inbound Traffic	Total Site Outbound Traffic	Volume Passing Through the Drive Through Lane
Kennedy and Ellesmere	145	160	56
Lawrence and Midland	124	128	26
Kingston Road and Saunders	95	82	27
Markham and Ellesmere	140	124	36
Lake Shore and Carlaw	198	173	36
AVERAGE	140	133	36
Rate per fuelling position (12)	11.7	11.1	3.0
Innes and Belcourt (8 positions)	88	92	17
Rate per fuelling position (8)	11.0	11.5	2.1

The total site traffic is less in the p.m. peak hour, largely due to the traffic through a Tim Horton's drive through window being much less than in the a.m. peak hour, a difference of about 6 trips per filling position.

Removal of the Tim Horton's trip generation component gives a resultant fuelling trip rate calculated at about 9.0 trips per filling position in both the a.m. and p.m. peak hours. This applies to the GTA data as well as the Innes Road and Belcourt Blvd data. These rates are higher than the ITE trip rates for service stations presented in the Trip Generation Manual Eighth Edition.

The Tim Horton's trip generation number seems to be less related to number of fuelling positions. A total volume of 110 to 120 trips in the drive through lane seems to be representative of a busy location regardless of the number of filling positions.

Table 3 shows the existing traffic at the existing Woodroffe Avenue and Medhurst Drive station, and traffic forecast for the redeveloped service station. This represents the traffic at the driveways, and includes both the fuel sales traffic and the Tim Horton's drive through traffic.

Table 3 also shows for information purposes the ITE trip rates from the Trip Generation Manual Eighth Edition for land use code 945, Gasoline/Service Station with Convenience Market. The existing trip rates for the Woodroffe and Medhurst Esso station are substantially higher than the ITE rates, but this is primarily because rather than just a convenience store on site there is a free standing Tim Horton's outlet on the site which generates more traffic independent of the service station.

It is estimated that at this site that the existing fuel sales is in the order of 7 trips per fuelling position, which divides the traffic about equally between fuel sales and the Tim Horton's facility. The number of fuelling positions will remain at 10, and it is anticipated that the fuel sales market will not change to any noticeable extent.

The Tim Horton's seating capacity will decrease by over 50%, but it is anticipated that two-thirds (67%) of the sit down traffic will continue to come to the site, either as sit down customers or drive through customers. The additional Tim Horton's drive through traffic forecast is based on the count from the Innes and Belcourt site, namely 119 trips in the a.m. peak hour and 17 trips in the p.m. peak hour. The actual number of drive though lane trips will be higher than just the Innes and Belcourt site numbers since the expanded menu should attract more trips that are usually attracted to an Esso drive through.

The net change in site traffic is calculated by subtracting the existing site generated traffic that is already in the traffic pattern at the site from the forecasted total trips. This gives an increase of approximately 90 to 95 trips each way in and out of the site in the a.m. peak hour, and there is essentially no change in the p.m. peak hour.

Table 3 - Site Trip Generation

USE	Fuelling Positions	A.M. Peak Hour				P.M. Peak Hour			
		Rate		Trips		Rate		Trips	
		In	Out	In	Out	In	Out	In	Out
ITE Trip Rates (LU 945)		5.08	5.08			6.69	6.69		
Existing Station (10 fuelling positions)	10	14.9	14.3	149	143	14.1	13.9	141	139
Existing Esso Station Fuel sales		7.0	7.0	70	70	7.0	7.0	70	70
Existing Tim Horton's Traffic		7.9	7.3	79	73	7.1	6.9	71	69
Future Esso Station Fuel Sales	10	7.0	7.0	70	70	7.0	7.0	70	70
Tim Horton's Seating Area Traffic				53	49			48	46
Tim Horton's Drive Through Traffic				119	119			17	17
TOTAL FUTURE SITE TRAFFIC	10			242	238			135	133
EXISTING SITE TRAFFIC				149	143			141	139
NET NEW SITE TRAFFIC				93	95			- 7	- 6
NEW PASSBY TRIPS		62%	62%	58	59	56%	56%	0	0
NEW DESTINED TRIPS		38%	38%	35	36	44%	44%	0	0

Much of the new site traffic will be passby traffic, vehicles already on the adjacent roadways, and some will be new traffic attracted to the site. For the site traffic forecast the passby trip percentage is taken from the ITE Trip Generation Handbook, which for land use category 945 is an average of 62% in the a.m. peak hour and 56% in the p.m. peak hour. The remaining traffic constitutes 'new traffic' to the site and includes trips which may already be on the road system in the general area, but will be diverted to Woodroffe Avenue or Medhurst Drive to access the site.

In the a.m. peak hour the passby component is assigned 60% coming from the south on Woodroffe Avenue, 30% coming from the west on Medhurst Drive, and 10% coming from the east on Medhurst Drive. In the p.m. peak hour the existing site traffic is maintained as is.

The destined 'new' traffic attracted to the site is assumed to be distributed the same as existing traffic at the service station. It is recognized that this distribution includes existing passby trips, but it is not possible to distinguish the trip type just from counts that were taken.

Figure 5 shows the peak hour passby site traffic at the driveways, and Figure 6 shows the destined site traffic at the driveways and through the signalized intersection at Woodroffe Avenue and Medhurst Drive.

4.3 Total Traffic

Figure 7 shows total future 2020 traffic with the redeveloped service station in place.

5. TRAFFIC IMPACT

The study area intersections have been analyzed using the Synchro 7 program. The Synchro output is included in Appendix A to the report, and the electronic files will be provided to the City under separate cover.

5.1 Signalized Intersection

The current signal timing at the Woodroffe Avenue and Medhurst Drive intersection as provided by the City Traffic Operations Division has been maintained for all scenarios. The saturation flow rate used is 1800 vphg.

Table 4 shows the v/c ratios at the signalized intersection for current and future conditions.

Table 4 - Signalized Intersection Capacity Analysis

Intersection / Condition	Scenario											
	Existing Traffic				Future Background Traffic 2020				Future Total Traffic 2020			
A.M. Peak Hour	Del. (sec)	Syn. LOS	v/c	City LOS	Del. (sec)	Syn. LOS	v/c	City LOS	Del. (sec)	Syn. LOS	v/c	City LOS
Woodroffe and Medhurst	**33.2**	**C**	**0.71**	**C**	**31.6**	**C**	**0.72**	**C**	**34.4**	**C**	**0.75**	**C**
P.M. Peak Hour												
Woodroffe and Medhurst	**31.4**	**C**	**0.53**	**A**	**31.6**	**C**	**0.53**	**A**	**31.6**	**C**	**0.53**	**A**

The existing v/c ratios are calculated to be 0.71 in the a.m. peak hour, and 0.53 in the p.m. peak hour. The overall intersection level of service based on the Synchro average vehicle delay calculation is level C in the a.m. peak hour and level C in the p.m. peak hour. The overall intersection level of service based on the City methodology using the v/c ratio calculation is level C in the a.m. peak hour and level A in the p.m. peak hour.

There are no through movements with v/c ratios over 0.80 (LOS C) or turning movements over 0.70 (LOS B) at the intersection in either peak hour.

If background traffic on Woodroffe Avenue increases by 1.5% annually, the overall intersection v/c ratios with the existing signal phasing and timing increase by 0.01 to 0.72 for the a.m. peak hour, and remains unchanged at 0.53 for the p.m. peak hour. For the Synchro analysis the level of service remains at level C in the a.m. peak hour, and remains at level C in the p.m. peak hour. For the City methodology the level of service remains at level C in the a.m. peak hour, and remains at level A in the p.m. peak hour.

With the small difference in service station traffic that is anticipated in the a.m. peak hour upon reconstruction of the site, the v/c ratio increases by 0.03 to 0.75 in the a.m. peak hour, and is unchanged in the p.m. peak hour at 0.53. The level of service based on Synchro delay for the a.m. peak hour remains unchanged at level C and remains unchanged at level C in the p.m. peak hour. The level of service for the City methodology remains at level C in the a.m. peak hour and at level A in the p.m. peak hour.

There is no change in site traffic for the p.m. peak hour, so conditions will remain unchanged from the 2020 background conditions.

No mitigation at the Woodroffe Avenue and Medhurst Drive intersection is required for either the 2020 background traffic or for the 2020 total traffic forecast with the Esso site.

5.2 Site Driveway Operation

Table 5 shows the level of service at the site driveways. It is noted that the redeveloped service station will have the same three driveways as now serve the site, and the volumes are expected to remain in the same order of magnitude as existing traffic at the site.

The site driveways on Woodroffe Avenue presently operate with little conflict since only right turns are permitted. The level of service for the outbound right turn at both driveways is level A in the a.m. peak hour and level A in the p.m. peak hour.

Site traffic coming out to Medhurst Drive and making a left turn is delayed more than vehicles making a right turn, but the level of service for the combined movements is level B in both the a.m. and the p.m. peak hours. The eastbound left turn/through lane carrying traffic into the site operates at level of service A in both peak hours.

Table 5 - Driveway Intersection Level of Service

Movement	A.M.			P.M.		
	Volume	Delay	LOS	Volume	Delay	LOS
Existing Traffic						
Medhurst Drive Driveway						
SB left/right	68	13.8	B	73	11.9	B
EB left/thru	93 / 30	6.8	A	68 / 165	2.7	A
Woodroffe South Driveway						
WB right	3	9.2	A	8	9.0	A
Woodroffe North Driveway						
WB right	72	9.7	A	58	9.3	A
2020 Background Traffic						
Medhurst Drive Driveway						
SB left/right	68	13.8	B	73	11.9	B
EB left/thru	93 / 30	6.8	A	68 / 165	2.7	A
Woodroffe South Driveway						
WB right	3	9.4	A	8	9.2	A
Woodroffe North Driveway						
WB right	72	9.9	A	58	9.4	A
2020 Total Traffic						
Medhurst Drive Driveway						
SB left/right	108	15.7	C	73	11.9	B
EB left/thru	131 / 25	7.7	A	68 / 165	2.7	A
Woodroffe South Driveway						
WB right	5	9.2	A	8	9.2	A
Woodroffe North Driveway						
WB right	125	10.1	B	58	9.4	A

With background traffic increases to 2020 there is a minor increase in delay at the driveways on Woodroffe Avenue. The higher northbound through volumes increase delay to driveway traffic slightly, but level of service remains at level A at both driveways in both peak hours.

There is no change on Medhurst Drive for 2020 background conditions since there is no change in the traffic forecast.

With the reconstructed site the volumes are forecast to be almost the same as present volumes, with a small increase in the a.m. peak hour. The level of service at the Woodroffe Avenue south driveway remains at level A in both peak hours, and at the north driveway the level of service in the a.m. peak hour changes just slightly above 10 seconds of average vehicle delay which is the boundary between level A and level B. Level of service in the p.m. peak hour remains at level A.

Based on volume the level of service at the Medhurst Drive driveway changes to level C in the a.m. peak hour since the average vehicle delay increases to 15.2 seconds which crosses the 15 second boundary between levels B and C. Level of service remains at level B in the p.m. peak hour.

However, queuing affects operation at the Medhurst driveway. This is discussed in the following section.

5.3 Queue Analysis

As noted above, the Woodroffe Avenue and Medhurst Drive signalized intersection, and the Medhurst Drive site driveway, are found to have quite sufficient capacity based on the volumes carried during the peak hours, but queue lengths have been evaluated since this impacts the operation along Medhurst Drive. The queue lengths have been generated using the Sim-Traffic program, with a seeding time of 10 minutes, an analysis period of 60 minutes, over an average of five runs.

Table 6 shows the queuing on the two westbound lanes and the one eastbound lane on Medhurst Drive which are the critical lanes for queues. The table shows the average queue lengths and the 95th percentile values as calculated by the Sim-Traffic program, for existing conditions, and for the horizon year conditions of 2020 background and 2020 total traffic.

Table 6. Queue Lengths (metres)

Medhurst Drive						
EXISTING						
Time	WB left turn lane queue		WB through/right lane queue		EB left/through lane queue	
	Average	95th percentile	Average	95th percentile	Average	95th percentile
A.M. peak hour	43.2	53.1	50.5	66.2	13.2	34.5
P.M. peak hour	38.1	54.1	39.2	69.0	16.1	47.9
2020 BACKGROUND						
A.M. peak hour	42.5	53.6	50.1	67.3	14.3	34.6
P.M. peak hour	36.5	52.3	34.2	60.2	8.1	26.8
2020 TOTAL						
A.M. peak hour	44.0	50.8	53.8	67.4	21.1	48.9
P.M. peak hour	36.4	52.1	34.7	60.3	8.2	26.2

The storage length available on Medhurst Drive from the stop bar at Woodroffe Avenue and the driveway to the Esso site is 40 metres. Westbound there are two lanes, one for left turns and one for through/right movements. Eastbound there is one wide lane that can accommodate a left turning vehicle and a through vehicle, depending on where the left turning vehicle is positioned.

For existing conditions the average queue lengths on the two westbound lanes are just over 40 metres in the a.m. peak hour, and the 95th percentile queue length which is the desirable design standard exceeds the available storage length. In the p.m. peak hour the average queue lengths are just under 40 metres, but the 95th percentile queue length exceeds 40 metres.

The average queue length in the left turn lane is 43.2 metres in the a.m. peak hour, and 38.1 metres in the p.m. peak hour. The 95th percentile queue length is calculated as 53.1 metres in the a.m. peak hour, and 54.1 metres in the p.m. peak hour. Similarly, for the through/right lane the average queue length is 50.5 metres in the a.m. peak hour, and 39.2 metres in the p.m. peak hour. The 95th percentile queue length is calculated as 66.2 metres in the a.m. peak hour, and 69.0 metres in the p.m. peak hour.

Driveway traffic is able to use some gaps in traffic as the traffic signal goes through the phases in a cycle, but in addition driveway traffic is able to use courtesy gaps both entering and leaving the site provided by traffic on Medhurst Drive. At times there can be delays if a gap is not made available, but overall the volume counts show that traffic is getting in and out during the peak hours.

The eastbound queues are shorter, and these are created by a combination of left turns into the site waiting for a gap in westbound traffic, and eastbound through traffic waiting to get past a left turning vehicle. The average queue lengths are well within the 40 metre distance that is available, but the 95th percentile can exceed the 40 metre distance.

The eastbound lane on Medhurst Drive at the driveway is wide enough to let a through vehicle get past a waiting left turn vehicle, but this depends on where the left turn vehicle is positioned. Widening the eastbound roadway to create a full left turn lane for eastbound site traffic would let eastbound through traffic pass the driveway and eliminate this component of the queuing. However, the eastbound through volume in the a.m. peak period is very minor in the range of 30vph. Eastbound through volume is more substantial in the p.m. period in the range of 165 vph, but the proposed redevelopment does not change the p.m. peak hour volumes from the current condition.

The proposed development results in minor changes in the queue lengths, but queues do extend back though the Medhurst driveway location during the peak hours and courtesy gaps will continue to be part of the on-going character and operation. Widening the eastbound roadway would be an improvement to current conditions, but the change to existing conditions would be relatively minor since the eastbound volume on Medhurst Drive in the a.m. peak hour when the site is busiest is quite small.

5.4 Woodroffe Avenue Northbound Transit Lane Analysis

The northbound curb lane on Woodroffe Avenue is a transit only lane. There are two driveways on this frontage that serve the Esso site, with a transit shelter located between the driveways. Operation at these two driveways has been reviewed to determine any impact on the bus lanes resulting from the proposed redevelopment.

The existing traffic counts show that the south driveway is used primarily for inbound site traffic, and the north driveway is used primarily for outbound site traffic. There are only 3 vehicles exiting the site at the south driveway and only 3 vehicles entering the site at the north driveway in the a.m. peak hour. Similarly there are only 8 vehicles exiting the site at the south driveway and only 11 vehicles entering the site at the north driveway in the p.m. peak hour.

Therefore site traffic does not utilize the bus lane adjacent to the site to any noticeable extent. The south driveway is very close to the Medhurst Drive intersection, and outbound traffic at the north driveway crosses the bus lane and enters the other northbound through lanes.

The anticipated increase in site traffic upon redevelopment is 2 additional cars exiting the site at the south driveway and 6 additional cars entering the site at the north driveway over the full a.m. peak hour. There is no change in site traffic forecast for the p.m. peak hour.

Therefore there will be nominal change in traffic utilizing the northbound bus lane on Woodroffe Avenue. The additional 6 cars that may pass by the transit shelter area over a one hour period will not impact bus operation.

There will be an additional 35 cars entering the site at the south and an additional 53 cars exiting the site at the north driveway in the a.m. peak hour. As noted earlier these movements do not travel along the northbound bus lane to any extent.

5.5 On Site Circulation

The on-site circulation consists primarily of vehicles driving to and from the pump islands, and to and from the Tim Horton's drive through lane. The pumps are directly accessible from both streets, and the revised layout results in cars driving around the outside of the pumps to select a filling position and minimizes driving between the pumps.

Tanker delivery will occur with entry off Woodroffe Avenue northbound, and with exit to Medhurst Drive westbound. The Medhurst Drive driveway has been widened from the existing condition, with the widening about equal on both side which leaves the centreline of the driveway the same as it is for the existing driveway. Traffic entering and leaving the site will have the same turning paths as they have now, but with more lane width available.

Vehicles will enter the Tim Horton's drive-through on the east side of the site. Vehicles exiting the drive through can proceed to the pumps or to any of the driveways.

The stacking capacity for the Tim Horton's drive through is 15 spaces. The zoning by-law requirement is 11 spaces. There is room on-site for 3 additional cars to line up between the stacking lane and Medhurst Drive and still be clear of Medhurst Drive traffic going past the driveway. A total of 18 cars could stack on site without affecting operation on Medhurst Drive.

The 15 spaces in the stacking queue is sufficient for the anticipated flow at the drive through window, which peaks in the a.m. peak hour. Drive through volume in the p.m. peak hour is much lower, and requires less stacking length.

Read Voorhees has previously analyzed a number of Esso service station sites with drive through windows in the Toronto area and elsewhere in the province. Every site is unique in terms of the local market and convenience to drivers, but a queue length of 11 cars typically has been found to be adequate for Tim Horton's drive through facilities. The City of Mississauga has also carried out a survey of drive through facilities at service stations, and the study concluded that a 10 space queue covered 95% of the stacking demand.

Queuing surveys in the a.m. peak hours from 7 to 9 a.m. have been carried out in the Greater Toronto Area at a number of Esso stations with Tim Horton's drive through windows. The surveyed sites have been categorized as being on the 'go to work' side of the road, or on the 'home-bound' side.

The surveys measured the number of cars in the drive through window queue every minute for the two hour period of 7 a.m. to 9 a.m. Table 6 shows the 50^{th} percentile queue length over the period between 7 a.m. and 9 a.m., and the 95^{th} percentile queue length for the two hour survey period.

Counts were also taken in December 2014 in Ottawa at the Innes Road and Belcourt Blvd Esso station at the Tim Horton's drive through that was rebuilt in 2010 with a drive through added to the site. Based on the commuter pattern on Innes Road the site is considered to be a 'go to work' site. The results for this survey are also shown in Table 6. The queue lengths at the site, and the volume through the Tim Horton's drive through, are similar to the GTA survey results.

The queuing survey for the Innes Road and Belcourt Blvd Esso station is in Appendix B.

Table 7 - A.M. Peak Period Queuing at Esso Drive Through Windows

Site		Go-to-work Side		Homebound Side	
		Queue of cars		Queue of cars	
	1 hour peak volume	50th percentile	95th percentile	50th percentile	95th percentile
Jane and Finch		5.3	9		
Markham and Ellesmere	101			7.0	9
Markham and Sheppard	109			6.8	9
Lakeshore and Carlaw	123			10.1	13
Elgin Mills and Leslie		8.5	11		
Lawrence and Midland	86			3.0	7
Victoria Park and McNicoll		8.3	11		
McCowan and Buroak		7.1	10		
Bayly and Westney		4.7	9		
Kingston and Saunders	132	5.8	10		
Kennedy and Ellesmere	103			0.6	3
Highway 2 and Sheppard		9.4	12		
Thickson and Winchester		5.9	13		
AVERAGES		**6.9**	**10.6**	**5.5**	**8.2**
Innes and Belcourt	119	8.0	10		

The Tim Horton's drive through service is used most heavily in the a.m. peak hour, and especially when a site is directly accessed by a right turn from the heavy direction of traffic. The Woodroffe and Medhurst site has the peak traffic flow in the a.m. peak hour southbound and in the p.m. peak hour northbound, which therefore considers this to be a 'home-bound' site.

The 'go-to-work' defined sites show a higher average queue length, 6.9 versus 5.5 cars, and a higher average 95th percentile queue length at 10.6 versus 8.2 cars.

The maximum queues observed at the surveyed sites occurred for a 1 minute interval. In all locations the maximum queue lengths occurred for only one minute at a time within the survey period. The peaks were quickly absorbed into the drive through flow in the following minute.

The 95th percentile values for the surveyed sites indicate that a design queue length of just under 11 cars will typically cover the 95th percentile queue length. The 50th percentile queue length value is just under 7 cars. As a 'homebound side' site the expectation for Woodroffe and Medhurst is a 95th percentile queue of 8 or 9 cars. At the Innes Road and Belcourt Blvd site 'go to work side' site the 95th percentile value for the Tim Horton's queue was 10 cars. The 50th percentile queue length value was 8 cars.

It is possible that the drive through queue at Woodroffe and Medhurst will be longer than the 'normal' queue that would be expected at an Esso station because of the additional menu item availability at the Woodroffe and Medhurst site that will be provided because of the increased seating capacity. The difference could increase the queue length up to the 11 cars used for a 'go to work side' site.

A queue of 15 to 18 cars is not expected to occur at this site as shown by the site surveys, including the survey at Innes Road and Belcourt Blvd. Nevertheless, such storage length is available within the site with the layout proposed should it be required, ensuring that there is no risk of the drive through queue affecting Medhurst Drive. The drive through lane is well removed from the Woodroffe Avenue driveways.

With respect to on-site parking, based on experience at similar sites elsewhere, the twenty-four parking spaces will be adequate to meet the demand anticipated for the uses planned on this site. The zoning by-law requirement for the site is 15 spaces.

6. CONCLUSIONS

Imperial Oil is proposing to redevelop the existing service station in the north-east corner at Woodroffe Avenue and Medhurst Drive. The station will continue to have ten fuelling positions. The existing carwash will be relocated within the site, and the existing free standing Tim Horton's outlet will be removed, and will be replaced by a smaller seating area and a drive through window facility in the Esso convenience store.

Site access will consist of the same driveway configuration as is now on the site, two right-in/right-out driveways on Woodroffe Avenue, and one full moves driveway on Medhurst Drive.

Surveys at other existing Esso service stations have been used as a basis for forecasting site traffic, including the Esso station in Ottawa at Innes Road and Belcourt Blvd. Since the Tim Horton's outlet on the site will include a seating area, which is not the case for most other Esso stations, the trip generation forecast has taken that condition into account by maintaining existing site traffic as a base. The forecast indicates a minor traffic increase in site traffic in the a.m. peak hour and no change in the p.m. peak hour. A large proportion of site traffic at service stations is passby traffic, or vehicles already on the road system. Therefore only about half of any site traffic increase will be new traffic added to the adjacent road system.

The additional volume of new traffic through the signalized intersection at Woodroffe Avenue and Medhurst Drive is negligible and has minor impact on the intersection operation. The existing intersection operates at a good level of service in both peak hours. There will be no change in the level of service at the intersection with the site redeveloped in either the a.m. peak hour or the p.m. peak hour.

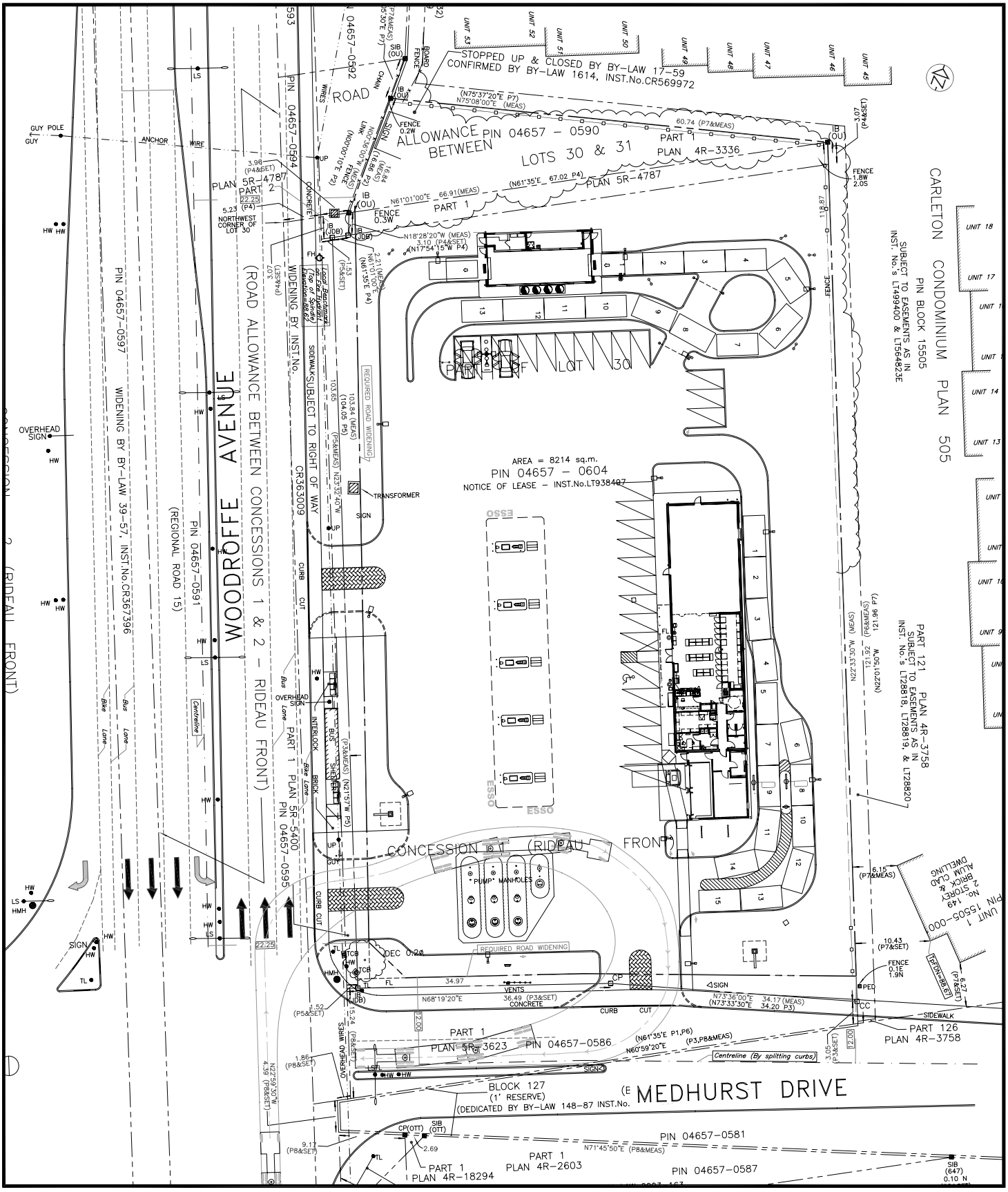
The two driveways on Woodroffe Avenue will continue to operate at good level of service. The driveway on Medhurst Drive will operate about the same as it does currently, having adequate capacity in terms of volume but impacted by queuing on Medhurst Drive. During the peak hours driveway traffic uses gaps in through traffic on Medhurst Drive, but also relies on courtesy gaps provided by Medhust Drive traffic when queues extend across the driveway intersection.

The northbound curb lane on Woodroffe Avenue is a transit only lane. There will be additional traffic entering and exiting the site at the two driveways on Woodroffe Avenue and crossing the bus lane, but these movements do not travel along the northbound bus lane to any extent. The anticipated increase in site traffic utilizing the northbound bus lane on Woodroffe Avenue is 6 cars that may pass by the transit shelter area between the driveways over a one hour period in the a.m. peak hour. This will not impact bus operation. There is no change in site traffic for the p.m. peak hour.

The on-site circulation will operate efficiently, with no impact on traffic on the adjacent streets from internal queuing at the Tim Horton's drive through. Surveys at other Esso service stations with drive through facilities, including data from the drive through lane at the Innes Road and Belcourt Blvd Esso station, indicate that a queue length of 11 cars will meet the peak queuing requirements for a Tim Horton's drive through facility. This is also the zoning by-law requirement. The site plan has a drive through queue storage length of 15 cars which can accommodate the traffic that is expected in the drive through lane. There is also space for 3 additional cars to stack within the site, further mitigating any risk of the drive through queue affecting Medhurst Drive. The drive through lane is well removed from the Woodroffe Avenue driveways.

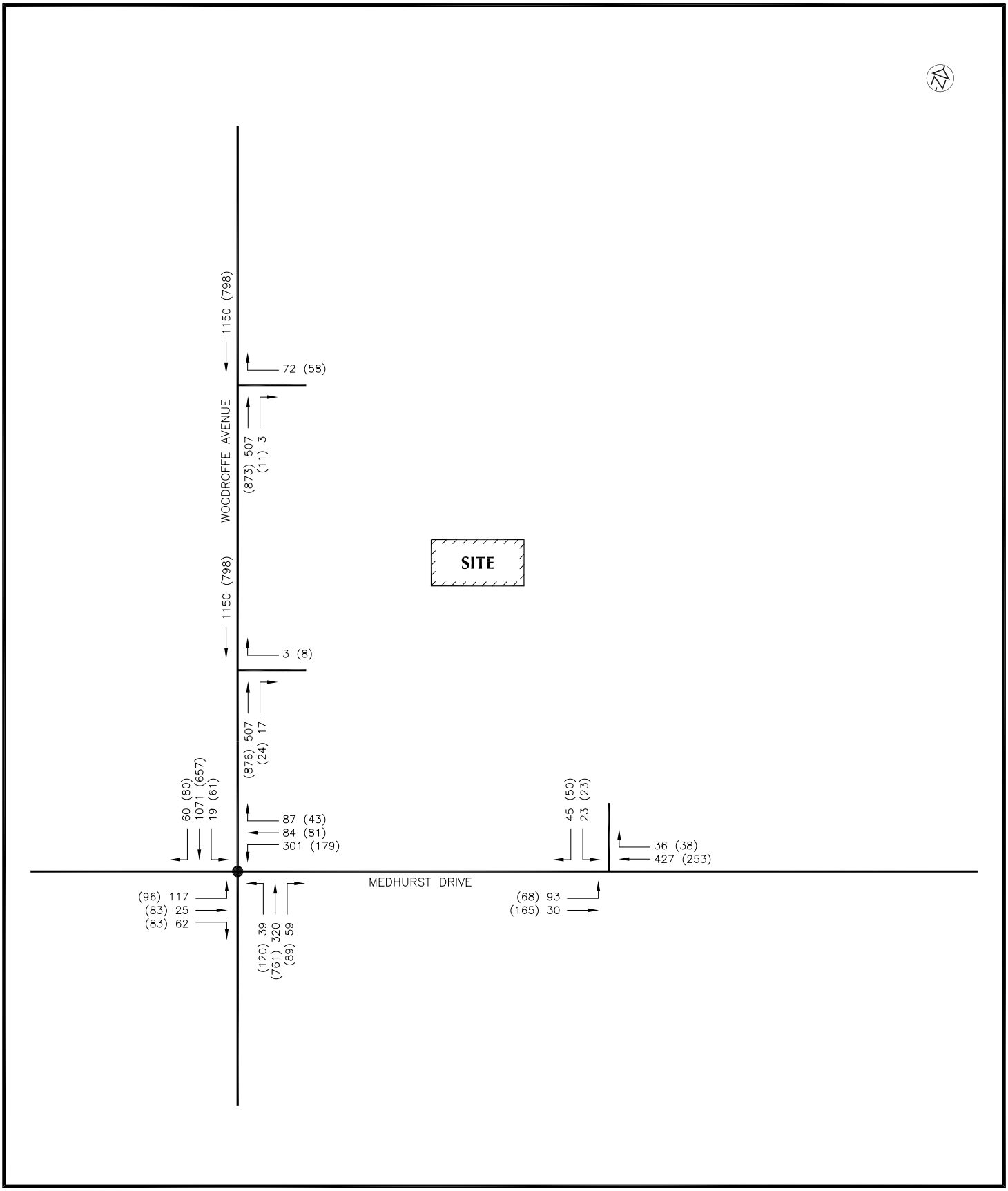
LOCATION PLAN

FIGURE 1



SITE PLAN

FIGURE 2



LEGEND

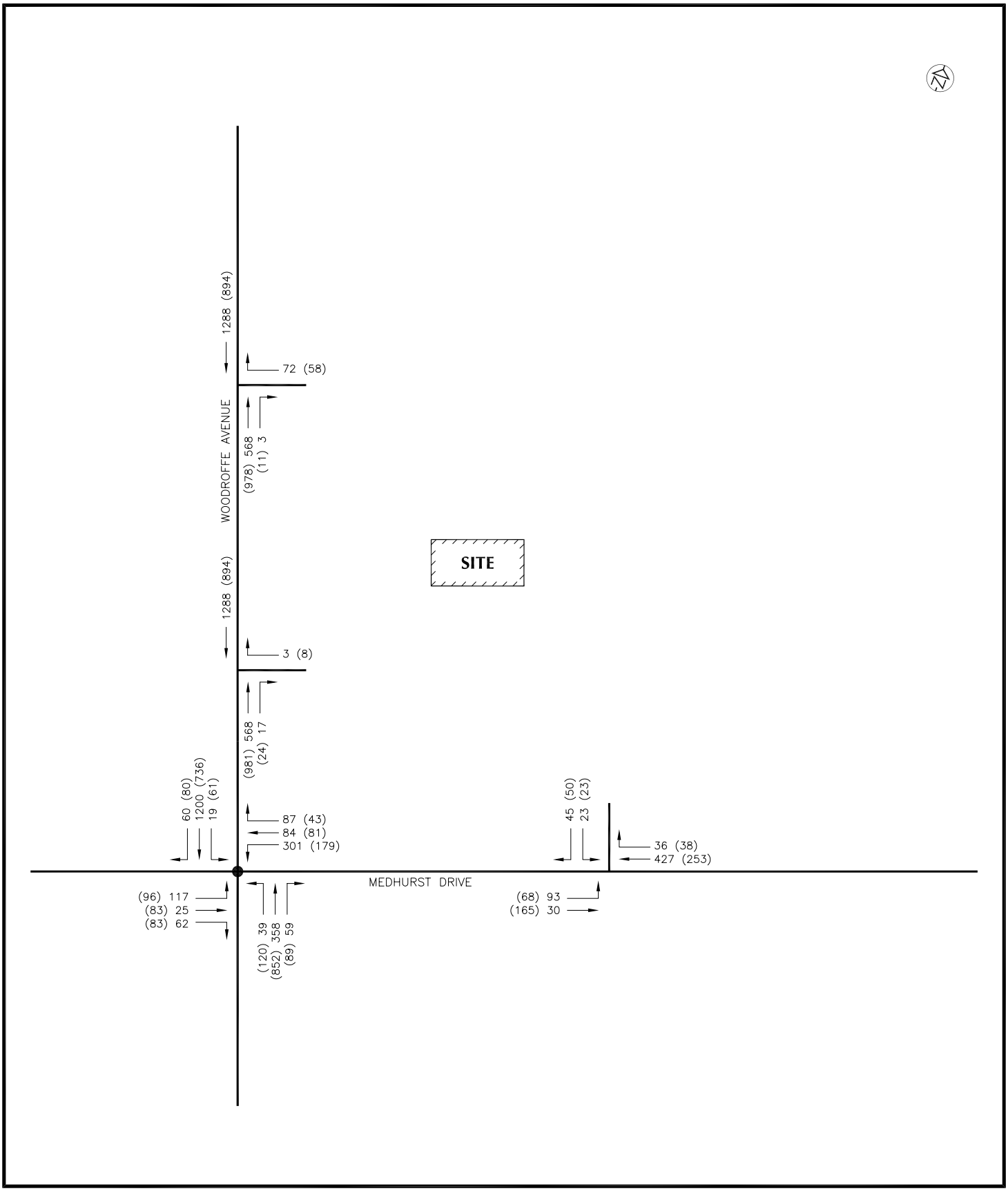
48 A.M. PEAK HOUR VOLUME

(11) P.M. PEAK HOUR VOLUME

● SIGNALIZED INTERSECTION

EXISTING TRAFFIC

FIGURE 3



LEGEND

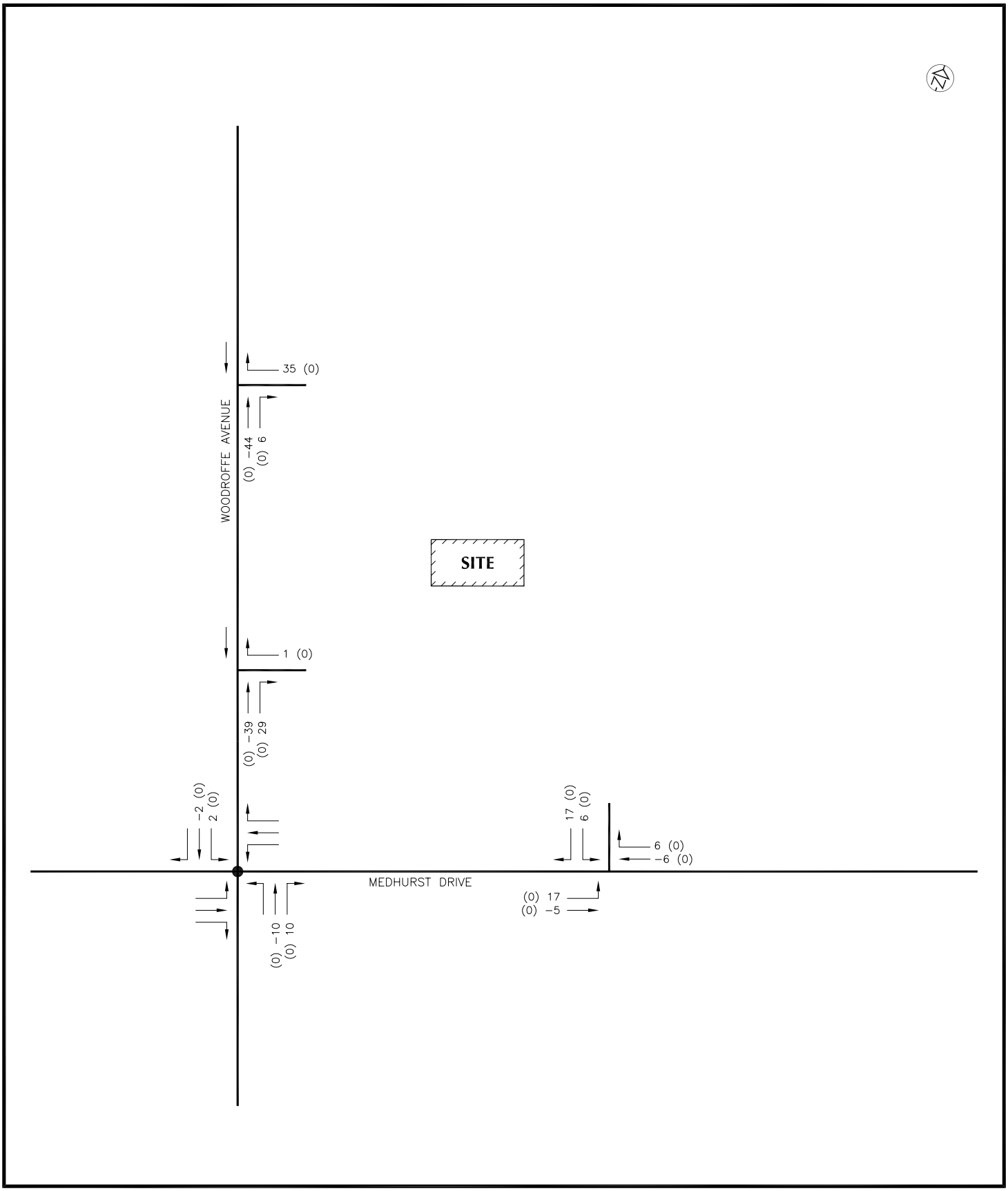
48 A.M. PEAK HOUR VOLUME

(11) P.M. PEAK HOUR VOLUME

● SIGNALIZED INTERSECTION

2020 BACKGROUND TRAFFIC

FIGURE 4



LEGEND

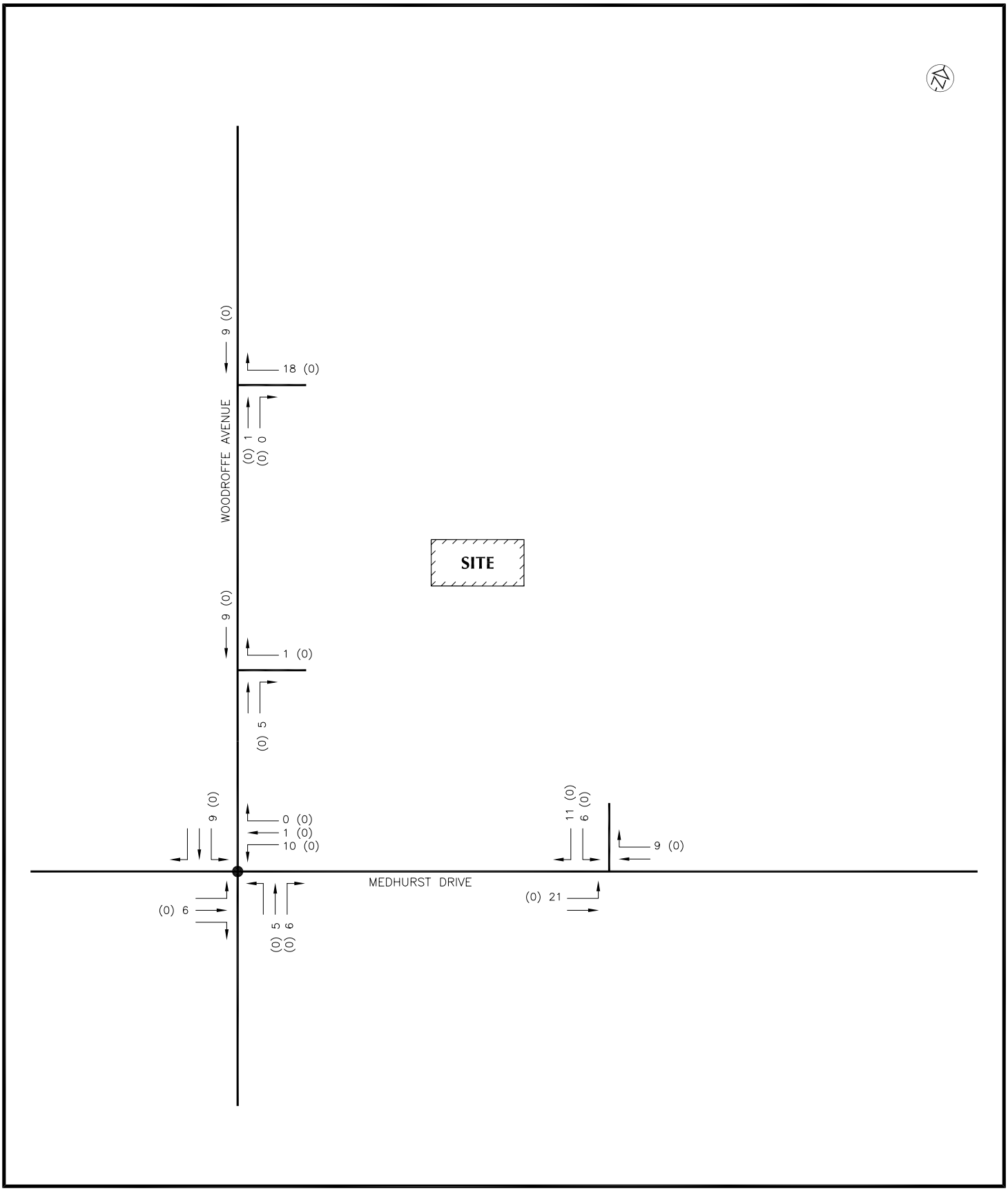
48 A.M. PEAK HOUR VOLUME

(11) P.M. PEAK HOUR VOLUME

● SIGNALIZED INTERSECTION

NEW PASSBY SITE TRAFFIC

FIGURE 5



LEGEND

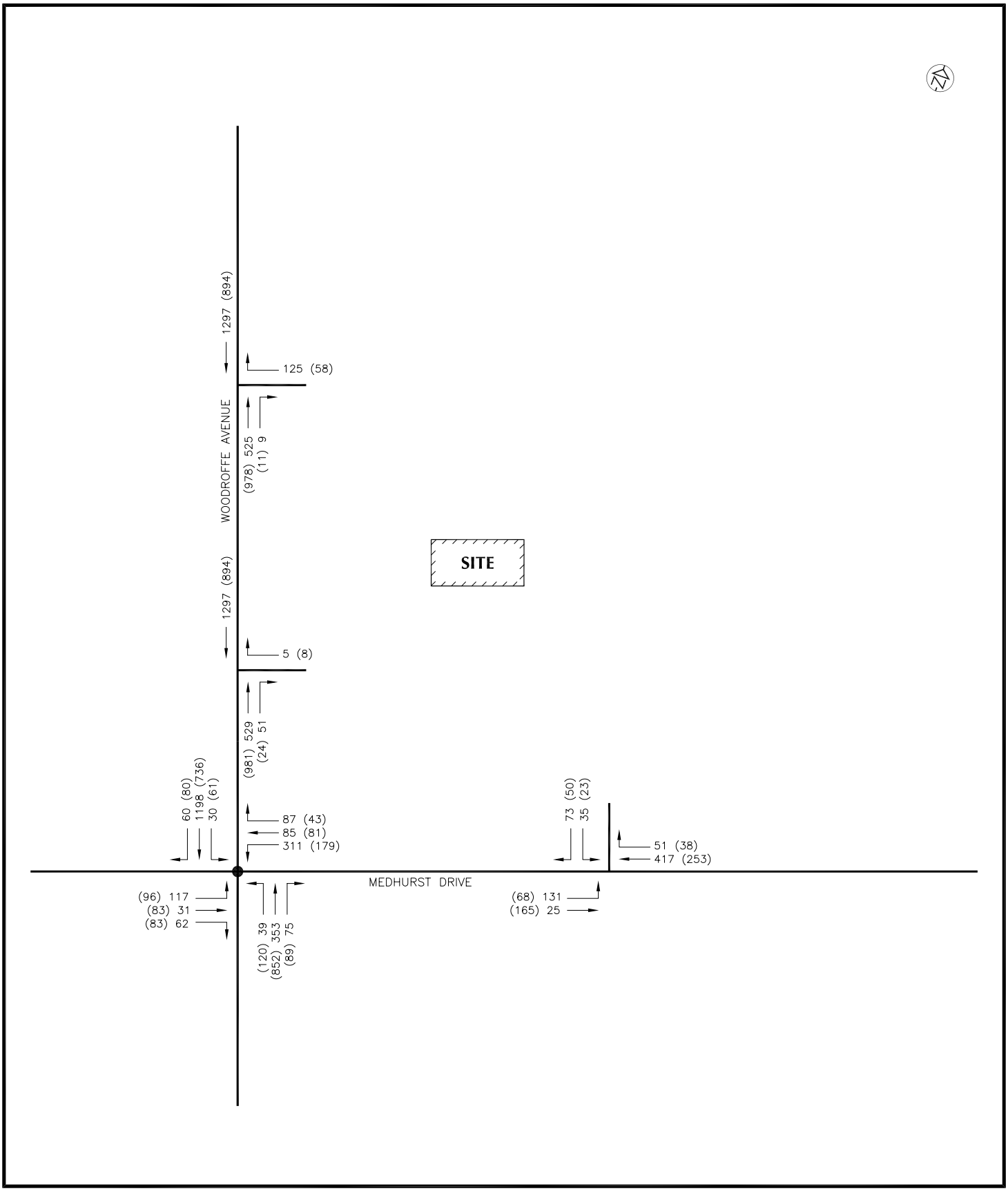
48 A.M. PEAK HOUR VOLUME

(11) P.M. PEAK HOUR VOLUME

● SIGNALIZED INTERSECTION

NEW DESTINED SITE TRAFFIC

FIGURE 6



LEGEND

48 A.M. PEAK HOUR VOLUME

(11) P.M. PEAK HOUR VOLUME

● SIGNALIZED INTERSECTION

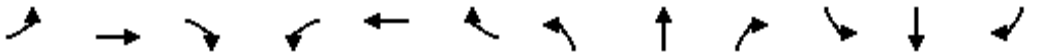
2020 TOTAL TRAFFIC

FIGURE 7

APPENDIX

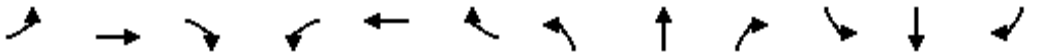
SYNCHRO OUTPUT

SIGNALIZED INTERSECTIONS



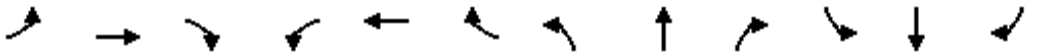
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	117	25	62	300	84	86	39	320	59	19	1071	60
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	7.0	7.0	7.0	7.0	7.0		6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	0.97	1.00	1.00	1.00	1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00	0.98	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3281	1780	1513	1691	1623		1691	3382	1450	1688	3382	1474
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.13	1.00	1.00	0.53	1.00	1.00
Satd. Flow (perm)	3281	1780	1513	1691	1623		234	3382	1450	940	3382	1474
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	127	27	67	326	91	93	42	348	64	21	1164	65
RTOR Reduction (vph)	0	0	43	0	31	0	0	0	33	0	0	33
Lane Group Flow (vph)	127	27	24	326	153	0	42	348	31	21	1164	32
Confl. Peds. (#/hr)	3					3	2		1	1		2
Heavy Vehicles (%)	0%	0%	0%	0%	0%	1%	0%	0%	2%	0%	0%	0%
Turn Type	Prot		Perm	Prot			Perm		Perm	Perm		Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases			4				2		2	6		6
Actuated Green, G (s)	30.0	7.1	7.1	40.3	17.4		62.6	62.6	62.6	62.6	62.6	62.6
Effective Green, g (s)	30.0	7.1	7.1	40.3	17.4		62.6	62.6	62.6	62.6	62.6	62.6
Actuated g/C Ratio	0.23	0.05	0.05	0.31	0.13		0.48	0.48	0.48	0.48	0.48	0.48
Clearance Time (s)	7.0	7.0	7.0	7.0	7.0		6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	757	97	83	524	217		113	1629	698	453	1629	710
v/s Ratio Prot	0.04	0.02		c0.19	c0.09			0.10			c0.34	
v/s Ratio Perm			0.02				0.18		0.02	0.02		0.02
v/c Ratio	0.17	0.28	0.29	0.62	0.70		0.37	0.21	0.04	0.05	0.71	0.04
Uniform Delay, d1	40.0	59.0	59.0	38.3	53.8		21.3	19.5	17.9	17.9	26.6	17.9
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	1.6	2.0	2.3	9.9		9.1	0.3	0.1	0.2	2.7	0.1
Delay (s)	40.1	60.6	61.0	40.6	63.8		30.4	19.8	18.0	18.1	29.3	18.0
Level of Service	D	E	E	D	E		C	B	B	B	C	B
Approach Delay (s)		49.0			49.0			20.5			28.6	
Approach LOS		D			D			C			C	

Intersection Summary			
HCM Average Control Delay	33.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	71.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



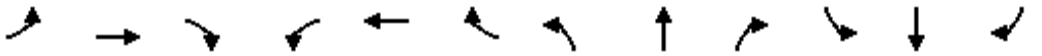
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	96	83	83	179	81	43	120	761	89	61	657	80
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	7.0	7.0	7.0	7.0	7.0		6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	0.97	1.00	1.00	1.00	1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.99	1.00	0.99		1.00	1.00	1.00	1.00	1.00	0.93
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3281	1780	1493	1691	1660		1668	3382	1498	1691	3382	1403
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.30	1.00	1.00	0.25	1.00	1.00
Satd. Flow (perm)	3281	1780	1493	1691	1660		525	3382	1498	446	3382	1403
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	104	90	90	195	88	47	130	827	97	66	714	87
RTOR Reduction (vph)	0	0	82	0	17	0	0	0	52	0	0	47
Lane Group Flow (vph)	104	90	8	195	118	0	130	827	45	66	714	40
Confl. Peds. (#/hr)	18		1	1		18	19					19
Heavy Vehicles (%)	0%	0%	0%	0%	0%	1%	1%	0%	1%	0%	0%	0%
Turn Type	Prot		Perm	Prot			pm+pt		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4				2		2	6		6
Actuated Green, G (s)	22.5	11.9	11.9	25.1	14.5		67.4	60.4	60.4	66.6	60.0	60.0
Effective Green, g (s)	22.5	11.9	11.9	25.1	14.5		67.4	60.4	60.4	66.6	60.0	60.0
Actuated g/C Ratio	0.17	0.09	0.09	0.19	0.11		0.52	0.46	0.46	0.51	0.46	0.46
Clearance Time (s)	7.0	7.0	7.0	7.0	7.0		6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	568	163	137	326	185		334	1571	696	292	1561	648
v/s Ratio Prot	0.03	0.05		c0.12	c0.07		c0.02	c0.24		0.01	0.21	
v/s Ratio Perm			0.01				0.18		0.03	0.10		0.03
v/c Ratio	0.18	0.55	0.06	0.60	0.64		0.39	0.53	0.06	0.23	0.46	0.06
Uniform Delay, d1	45.9	56.5	53.9	47.8	55.2		17.1	24.7	19.2	17.2	23.9	19.4
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	4.0	0.2	2.9	7.0		0.8	1.3	0.2	0.4	1.0	0.2
Delay (s)	46.1	60.5	54.1	50.8	62.3		17.9	25.9	19.4	17.6	24.9	19.6
Level of Service	D	E	D	D	E		B	C	B	B	C	B
Approach Delay (s)		53.2			55.5			24.3			23.8	
Approach LOS		D			E			C			C	

Intersection Summary			
HCM Average Control Delay	31.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	66.0%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



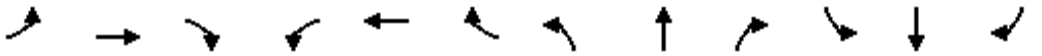
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	117	25	62	301	84	87	39	358	59	19	1200	60
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	5.0	6.0	6.0	5.0	6.0		6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	0.97	1.00	1.00	1.00	1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00	0.98	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3354	1820	1547	1729	1658		1729	3458	1482	1726	3458	1507
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.11	1.00	1.00	0.51	1.00	1.00
Satd. Flow (perm)	3354	1820	1547	1729	1658		195	3458	1482	918	3458	1507
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	127	27	67	327	91	95	42	389	64	21	1304	65
RTOR Reduction (vph)	0	0	36	0	32	0	0	0	31	0	0	28
Lane Group Flow (vph)	127	27	31	327	154	0	42	389	33	21	1304	37
Confl. Peds. (#/hr)	3					3	2		1	1		2
Heavy Vehicles (%)	0%	0%	0%	0%	0%	1%	0%	0%	2%	0%	0%	0%
Turn Type	Prot		Perm	Prot			Perm		Perm	Perm		Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases			4				2		2	6		6
Actuated Green, G (s)	29.0	7.4	7.4	38.8	17.2		66.8	66.8	66.8	66.8	66.8	66.8
Effective Green, g (s)	29.0	7.4	7.4	38.8	17.2		66.8	66.8	66.8	66.8	66.8	66.8
Actuated g/C Ratio	0.22	0.06	0.06	0.30	0.13		0.51	0.51	0.51	0.51	0.51	0.51
Clearance Time (s)	5.0	6.0	6.0	5.0	6.0		6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	748	104	88	516	219		100	1777	762	472	1777	774
v/s Ratio Prot	0.04	0.01		c0.19	c0.09			0.11			c0.38	
v/s Ratio Perm			0.02				0.22		0.02	0.02		0.02
v/c Ratio	0.17	0.26	0.35	0.63	0.70		0.42	0.22	0.04	0.04	0.73	0.05
Uniform Delay, d1	40.8	58.7	59.0	39.5	54.0		19.6	17.3	15.7	15.7	24.7	15.8
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	1.3	2.4	2.5	9.8		12.4	0.3	0.1	0.2	2.7	0.1
Delay (s)	40.9	60.0	61.4	42.0	63.7		32.0	17.6	15.8	15.9	27.4	15.9
Level of Service	D	E	E	D	E		C	B	B	B	C	B
Approach Delay (s)		49.5			49.9			18.6			26.7	
Approach LOS		D			D			B			C	

Intersection Summary			
HCM Average Control Delay	31.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	17.0
Intersection Capacity Utilization	70.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



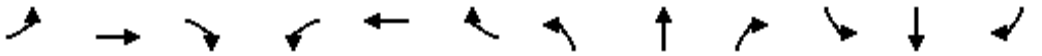
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	96	83	83	179	81	43	120	852	89	61	736	80
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	7.0	7.0	7.0	7.0	7.0		6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	0.97	1.00	1.00	1.00	1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.99	1.00	0.99		1.00	1.00	1.00	1.00	1.00	0.93
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3354	1820	1526	1729	1697		1708	3458	1532	1729	3458	1435
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.26	1.00	1.00	0.21	1.00	1.00
Satd. Flow (perm)	3354	1820	1526	1729	1697		464	3458	1532	379	3458	1435
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	104	90	90	195	88	47	130	926	97	66	800	87
RTOR Reduction (vph)	0	0	82	0	17	0	0	0	52	0	0	47
Lane Group Flow (vph)	104	90	8	195	118	0	130	926	45	66	800	40
Confl. Peds. (#/hr)	18		1	1		18	19					19
Heavy Vehicles (%)	0%	0%	0%	0%	0%	1%	1%	0%	1%	0%	0%	0%
Turn Type	Prot		Perm	Prot			pm+pt		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4				2		2	6		6
Actuated Green, G (s)	22.7	11.8	11.8	25.2	14.3		67.4	60.4	60.4	66.6	60.0	60.0
Effective Green, g (s)	22.7	11.8	11.8	25.2	14.3		67.4	60.4	60.4	66.6	60.0	60.0
Actuated g/C Ratio	0.17	0.09	0.09	0.19	0.11		0.52	0.46	0.46	0.51	0.46	0.46
Clearance Time (s)	7.0	7.0	7.0	7.0	7.0		6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	586	165	139	335	187		308	1607	712	263	1596	662
v/s Ratio Prot	0.03	0.05		c0.11	c0.07		c0.02	c0.27		0.01	0.23	
v/s Ratio Perm			0.01				0.20		0.03	0.12		0.03
v/c Ratio	0.18	0.55	0.06	0.58	0.63		0.42	0.58	0.06	0.25	0.50	0.06
Uniform Delay, d1	45.7	56.5	54.0	47.6	55.3		17.5	25.4	19.2	17.7	24.5	19.4
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	3.7	0.2	2.6	6.8		0.9	1.5	0.2	0.5	1.1	0.2
Delay (s)	45.8	60.2	54.2	50.2	62.1		18.5	27.0	19.4	18.2	25.6	19.6
Level of Service	D	E	D	D	E		B	C	B	B	C	B
Approach Delay (s)		53.0			55.1			25.4			24.6	
Approach LOS		D			E			C			C	

Intersection Summary			
HCM Average Control Delay	31.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	68.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	117	31	62	311	85	87	39	353	75	30	1198	60
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	7.0	7.0	7.0	7.0	7.0		6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	0.97	1.00	1.00	1.00	1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	0.99		1.00	1.00	0.98	1.00	1.00	0.97
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3354	1820	1547	1729	1659		1729	3458	1482	1726	3458	1507
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.09	1.00	1.00	0.50	1.00	1.00
Satd. Flow (perm)	3354	1820	1547	1729	1659		167	3458	1482	915	3458	1507
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	127	34	67	338	92	95	42	384	82	33	1302	65
RTOR Reduction (vph)	0	0	30	0	31	0	0	0	43	0	0	30
Lane Group Flow (vph)	127	34	37	338	156	0	42	384	39	33	1302	35
Confl. Peds. (#/hr)	3					3	2		1	1		2
Heavy Vehicles (%)	0%	0%	0%	0%	0%	1%	0%	0%	2%	0%	0%	0%
Turn Type	Prot		Perm	Prot			Perm		Perm	Perm		Perm
Protected Phases	7	4		3	8			2			6	
Permitted Phases			4				2		2	6		6
Actuated Green, G (s)	30.0	7.7	7.7	39.7	17.4		62.6	62.6	62.6	62.6	62.6	62.6
Effective Green, g (s)	30.0	7.7	7.7	39.7	17.4		62.6	62.6	62.6	62.6	62.6	62.6
Actuated g/C Ratio	0.23	0.06	0.06	0.31	0.13		0.48	0.48	0.48	0.48	0.48	0.48
Clearance Time (s)	7.0	7.0	7.0	7.0	7.0		6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	774	108	92	528	222		80	1665	714	441	1665	726
v/s Ratio Prot	0.04	0.02		c0.20	c0.09			0.11			c0.38	
v/s Ratio Perm			0.02				0.25		0.03	0.04		0.02
v/c Ratio	0.16	0.31	0.40	0.64	0.70		0.52	0.23	0.06	0.07	0.78	0.05
Uniform Delay, d1	40.0	58.6	58.9	39.0	53.8		23.4	19.7	18.0	18.1	28.0	17.9
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	1.7	2.9	2.6	9.6		22.5	0.3	0.1	0.3	3.7	0.1
Delay (s)	40.1	60.3	61.8	41.6	63.4		45.9	20.0	18.1	18.5	31.8	18.0
Level of Service	D	E	E	D	E		D	B	B	B	C	B
Approach Delay (s)		49.5			49.4			21.8			30.8	
Approach LOS		D			D			C			C	

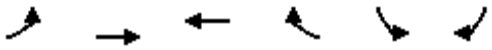
Intersection Summary			
HCM Average Control Delay	34.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.75		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	73.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	96	83	83	179	81	43	120	852	89	61	736	80
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Total Lost time (s)	7.0	7.0	7.0	7.0	7.0		6.0	6.0	6.0	6.0	6.0	6.0
Lane Util. Factor	0.97	1.00	1.00	1.00	1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.99	1.00	0.99		1.00	1.00	1.00	1.00	1.00	0.93
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	0.95		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3354	1820	1526	1729	1697		1708	3458	1532	1729	3458	1435
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.26	1.00	1.00	0.21	1.00	1.00
Satd. Flow (perm)	3354	1820	1526	1729	1697		464	3458	1532	379	3458	1435
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	104	90	90	195	88	47	130	926	97	66	800	87
RTOR Reduction (vph)	0	0	82	0	17	0	0	0	52	0	0	47
Lane Group Flow (vph)	104	90	8	195	118	0	130	926	45	66	800	40
Confl. Peds. (#/hr)	18		1	1		18	19					19
Heavy Vehicles (%)	0%	0%	0%	0%	0%	1%	1%	0%	1%	0%	0%	0%
Turn Type	Prot		Perm	Prot			pm+pt		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4				2		2	6		6
Actuated Green, G (s)	22.7	11.8	11.8	25.2	14.3		67.4	60.4	60.4	66.6	60.0	60.0
Effective Green, g (s)	22.7	11.8	11.8	25.2	14.3		67.4	60.4	60.4	66.6	60.0	60.0
Actuated g/C Ratio	0.17	0.09	0.09	0.19	0.11		0.52	0.46	0.46	0.51	0.46	0.46
Clearance Time (s)	7.0	7.0	7.0	7.0	7.0		6.0	6.0	6.0	6.0	6.0	6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	586	165	139	335	187		308	1607	712	263	1596	662
v/s Ratio Prot	0.03	0.05		c0.11	c0.07		c0.02	c0.27		0.01	0.23	
v/s Ratio Perm			0.01				0.20		0.03	0.12		0.03
v/c Ratio	0.18	0.55	0.06	0.58	0.63		0.42	0.58	0.06	0.25	0.50	0.06
Uniform Delay, d1	45.7	56.5	54.0	47.6	55.3		17.5	25.4	19.2	17.7	24.5	19.4
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.1	3.7	0.2	2.6	6.8		0.9	1.5	0.2	0.5	1.1	0.2
Delay (s)	45.8	60.2	54.2	50.2	62.1		18.5	27.0	19.4	18.2	25.6	19.6
Level of Service	D	E	D	D	E		B	C	B	B	C	B
Approach Delay (s)		53.0			55.1			25.4			24.6	
Approach LOS		D			E			C			C	

Intersection Summary			
HCM Average Control Delay	31.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	13.0
Intersection Capacity Utilization	68.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

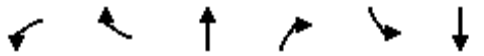
UNSIGNALIZED INTERSECTIONS



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	93	30	427	36	23	45
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)	101	33	464	39	25	49
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		66				
pX, platoon unblocked						
vC, conflicting volume	503				718	484
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	503				718	484
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	90				93	92
cM capacity (veh/h)	1061				358	583

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	134	503	74
Volume Left	101	0	25
Volume Right	0	39	49
cSH	1061	1700	481
Volume to Capacity	0.10	0.30	0.15
Queue Length 95th (m)	2.4	0.0	4.1
Control Delay (s)	6.8	0.0	13.8
Lane LOS	A		B
Approach Delay (s)	6.8	0.0	13.8
Approach LOS			B

Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	45.4%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	3	507	17	0	1150
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	3	551	18	0	1250
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)			30			
pX, platoon unblocked	0.94	0.94			0.94	
vC, conflicting volume	1176	276			570	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1068	114			425	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	205	866			1067	

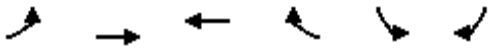
Direction, Lane #	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	3	276	276	18	625	625
Volume Left	0	0	0	0	0	0
Volume Right	3	0	0	18	0	0
cSH	866	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.16	0.16	0.01	0.37	0.37
Queue Length 95th (m)	0.1	0.0	0.0	0.0	0.0	0.0
Control Delay (s)	9.2	0.0	0.0	0.0	0.0	0.0
Lane LOS	A					
Approach Delay (s)	9.2	0.0			0.0	
Approach LOS	A					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	36.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	72	507	3	0	1150
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	78	551	3	0	1250
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)			80			
pX, platoon unblocked	0.95	0.95			0.95	
vC, conflicting volume	1176	276			554	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1078	129			423	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	91			100	
cM capacity (veh/h)	202	851			1075	

Direction, Lane #	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	78	276	276	3	625	625
Volume Left	0	0	0	0	0	0
Volume Right	78	0	0	3	0	0
cSH	851	1700	1700	1700	1700	1700
Volume to Capacity	0.09	0.16	0.16	0.00	0.37	0.37
Queue Length 95th (m)	2.3	0.0	0.0	0.0	0.0	0.0
Control Delay (s)	9.7	0.0	0.0	0.0	0.0	0.0
Lane LOS	A					
Approach Delay (s)	9.7	0.0			0.0	
Approach LOS	A					

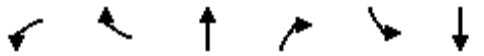
Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	36.9%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	68	165	253	38	23	50
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)	74	179	275	41	25	54
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		66				
pX, platoon unblocked					0.95	
vC, conflicting volume	316				623	296
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	316				573	296
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	94				94	93
cM capacity (veh/h)	1244				428	744

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	253	316	79
Volume Left	74	0	25
Volume Right	0	41	54
cSH	1244	1700	604
Volume to Capacity	0.06	0.19	0.13
Queue Length 95th (m)	1.4	0.0	3.4
Control Delay (s)	2.7	0.0	11.9
Lane LOS	A		B
Approach Delay (s)	2.7	0.0	11.9
Approach LOS			B

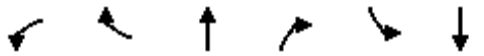
Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	44.2%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	8	876	24	0	798
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	9	952	26	0	867
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)			30			
pX, platoon unblocked	0.83	0.83			0.83	
vC, conflicting volume	1386	476			978	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1052	0			560	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	184	898			835	

Direction, Lane #	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	9	476	476	26	434	434
Volume Left	0	0	0	0	0	0
Volume Right	9	0	0	26	0	0
cSH	898	1700	1700	1700	1700	1700
Volume to Capacity	0.01	0.28	0.28	0.02	0.26	0.26
Queue Length 95th (m)	0.2	0.0	0.0	0.0	0.0	0.0
Control Delay (s)	9.0	0.0	0.0	0.0	0.0	0.0
Lane LOS	A					
Approach Delay (s)	9.0	0.0			0.0	
Approach LOS	A					

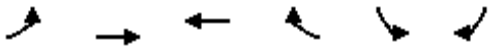
Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	35.6%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	58	873	11	0	798
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	63	949	12	0	867
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)			80			
pX, platoon unblocked	0.83	0.83			0.83	
vC, conflicting volume	1383	474			961	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1055	0			547	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	93			100	
cM capacity (veh/h)	184	901			847	

Direction, Lane #	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	63	474	474	12	434	434
Volume Left	0	0	0	0	0	0
Volume Right	63	0	0	12	0	0
cSH	901	1700	1700	1700	1700	1700
Volume to Capacity	0.07	0.28	0.28	0.01	0.26	0.26
Queue Length 95th (m)	1.7	0.0	0.0	0.0	0.0	0.0
Control Delay (s)	9.3	0.0	0.0	0.0	0.0	0.0
Lane LOS	A					
Approach Delay (s)	9.3	0.0			0.0	
Approach LOS	A					

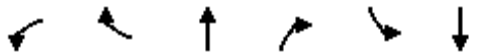
Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	35.9%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	93	30	427	36	23	45
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)	101	33	464	39	25	49
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		66				
pX, platoon unblocked					1.00	
vC, conflicting volume	503				718	484
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	503				718	484
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	90				93	92
cM capacity (veh/h)	1061				358	583

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	134	503	74
Volume Left	101	0	25
Volume Right	0	39	49
cSH	1061	1700	481
Volume to Capacity	0.10	0.30	0.15
Queue Length 95th (m)	2.4	0.0	4.1
Control Delay (s)	6.8	0.0	13.8
Lane LOS	A		B
Approach Delay (s)	6.8	0.0	13.8
Approach LOS			B

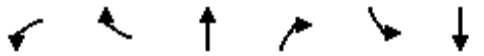
Intersection Summary			
Average Delay	2.7		
Intersection Capacity Utilization	47.4%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	3	568	17	0	1288
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	3	617	18	0	1400
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)			30			
pX, platoon unblocked	0.94	0.94			0.94	
vC, conflicting volume	1317	309			636	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1212	140			488	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	100			100	
cM capacity (veh/h)	164	830			1008	

Direction, Lane #	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	3	309	309	18	700	700
Volume Left	0	0	0	0	0	0
Volume Right	3	0	0	18	0	0
cSH	830	1700	1700	1700	1700	1700
Volume to Capacity	0.00	0.18	0.18	0.01	0.41	0.41
Queue Length 95th (m)	0.1	0.0	0.0	0.0	0.0	0.0
Control Delay (s)	9.4	0.0	0.0	0.0	0.0	0.0
Lane LOS	A					
Approach Delay (s)	9.4	0.0			0.0	
Approach LOS	A					

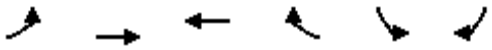
Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	40.9%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	72	568	3	0	1288
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	78	617	3	0	1400
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)			80			
pX, platoon unblocked	0.95	0.95			0.95	
vC, conflicting volume	1317	309			621	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1220	153			483	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	90			100	
cM capacity (veh/h)	163	819			1017	

Direction, Lane #	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	78	309	309	3	700	700
Volume Left	0	0	0	0	0	0
Volume Right	78	0	0	3	0	0
cSH	819	1700	1700	1700	1700	1700
Volume to Capacity	0.10	0.18	0.18	0.00	0.41	0.41
Queue Length 95th (m)	2.4	0.0	0.0	0.0	0.0	0.0
Control Delay (s)	9.9	0.0	0.0	0.0	0.0	0.0
Lane LOS	A					
Approach Delay (s)	9.9	0.0			0.0	
Approach LOS	A					

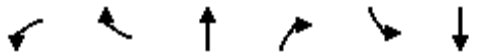
Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	40.9%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	68	165	253	38	23	50
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)	74	179	275	41	25	54
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		66				
pX, platoon unblocked					0.95	
vC, conflicting volume	316				623	296
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	316				573	296
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	94				94	93
cM capacity (veh/h)	1244				428	744

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	253	316	79
Volume Left	74	0	25
Volume Right	0	41	54
cSH	1244	1700	604
Volume to Capacity	0.06	0.19	0.13
Queue Length 95th (m)	1.4	0.0	3.4
Control Delay (s)	2.7	0.0	11.9
Lane LOS	A		B
Approach Delay (s)	2.7	0.0	11.9
Approach LOS			B

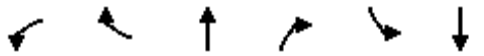
Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	44.2%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	8	981	24	0	894
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	9	1066	26	0	972
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)			30			
pX, platoon unblocked	0.80	0.80			0.80	
vC, conflicting volume	1552	533			1092	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1201	0			630	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	143	873			763	

Direction, Lane #	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	9	533	533	26	486	486
Volume Left	0	0	0	0	0	0
Volume Right	9	0	0	26	0	0
cSH	873	1700	1700	1700	1700	1700
Volume to Capacity	0.01	0.31	0.31	0.02	0.29	0.29
Queue Length 95th (m)	0.2	0.0	0.0	0.0	0.0	0.0
Control Delay (s)	9.2	0.0	0.0	0.0	0.0	0.0
Lane LOS	A					
Approach Delay (s)	9.2	0.0			0.0	
Approach LOS	A					

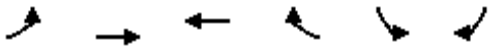
Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	38.6%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	58	978	11	0	894
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	63	1063	12	0	972
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)			80			
pX, platoon unblocked	0.81	0.81			0.81	
vC, conflicting volume	1549	532			1075	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1201	0			613	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	93			100	
cM capacity (veh/h)	143	875			776	

Direction, Lane #	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	63	532	532	12	486	486
Volume Left	0	0	0	0	0	0
Volume Right	63	0	0	12	0	0
cSH	875	1700	1700	1700	1700	1700
Volume to Capacity	0.07	0.31	0.31	0.01	0.29	0.29
Queue Length 95th (m)	1.8	0.0	0.0	0.0	0.0	0.0
Control Delay (s)	9.4	0.0	0.0	0.0	0.0	0.0
Lane LOS	A					
Approach Delay (s)	9.4	0.0			0.0	
Approach LOS	A					

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	39.0%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	131	25	417	51	35	73
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)	142	27	453	55	38	79
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		66				
pX, platoon unblocked					0.99	
vC, conflicting volume	509				793	481
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	509				788	481
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	87				88	86
cM capacity (veh/h)	1056				309	585

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	170	509	117
Volume Left	142	0	38
Volume Right	0	55	79
cSH	1056	1700	454
Volume to Capacity	0.13	0.30	0.26
Queue Length 95th (m)	3.5	0.0	7.8
Control Delay (s)	7.7	0.0	15.7
Lane LOS	A		C
Approach Delay (s)	7.7	0.0	15.7
Approach LOS			C

Intersection Summary			
Average Delay	4.0		
Intersection Capacity Utilization	52.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	5	529	51	0	1297
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	5	575	55	0	1410
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)			30			
pX, platoon unblocked	0.94	0.94			0.94	
vC, conflicting volume	1280	288			630	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1169	113			478	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	175	863			1015	

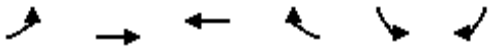
Direction, Lane #	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	5	288	288	55	705	705
Volume Left	0	0	0	0	0	0
Volume Right	5	0	0	55	0	0
cSH	863	1700	1700	1700	1700	1700
Volume to Capacity	0.01	0.17	0.17	0.03	0.41	0.41
Queue Length 95th (m)	0.1	0.0	0.0	0.0	0.0	0.0
Control Delay (s)	9.2	0.0	0.0	0.0	0.0	0.0
Lane LOS	A					
Approach Delay (s)	9.2	0.0			0.0	
Approach LOS	A					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	41.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	125	525	9	0	1297
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	136	571	10	0	1410
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)			80			
pX, platoon unblocked	0.95	0.95			0.95	
vC, conflicting volume	1276	285			580	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1177	131			443	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	84			100	
cM capacity (veh/h)	174	846			1054	

Direction, Lane #	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	136	285	285	10	705	705
Volume Left	0	0	0	0	0	0
Volume Right	136	0	0	10	0	0
cSH	846	1700	1700	1700	1700	1700
Volume to Capacity	0.16	0.17	0.17	0.01	0.41	0.41
Queue Length 95th (m)	4.3	0.0	0.0	0.0	0.0	0.0
Control Delay (s)	10.1	0.0	0.0	0.0	0.0	0.0
Lane LOS	B					
Approach Delay (s)	10.1	0.0			0.0	
Approach LOS	B					

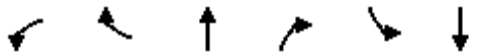
Intersection Summary			
Average Delay	0.6		
Intersection Capacity Utilization	41.2%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	68	165	253	38	23	50
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)	74	179	275	41	25	54
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (m)		66				
pX, platoon unblocked					0.95	
vC, conflicting volume	316				623	296
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	316				573	296
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	94				94	93
cM capacity (veh/h)	1244				428	744

Direction, Lane #	EB 1	WB 1	SB 1
Volume Total	253	316	79
Volume Left	74	0	25
Volume Right	0	41	54
cSH	1244	1700	604
Volume to Capacity	0.06	0.19	0.13
Queue Length 95th (m)	1.4	0.0	3.4
Control Delay (s)	2.7	0.0	11.9
Lane LOS	A		B
Approach Delay (s)	2.7	0.0	11.9
Approach LOS			B

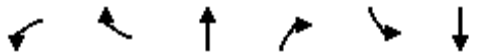
Intersection Summary			
Average Delay	2.5		
Intersection Capacity Utilization	44.2%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	8	981	24	0	894
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	9	1066	26	0	972
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)			30			
pX, platoon unblocked	0.80	0.80			0.80	
vC, conflicting volume	1552	533			1092	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1201	0			630	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	99			100	
cM capacity (veh/h)	143	873			763	

Direction, Lane #	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	9	533	533	26	486	486
Volume Left	0	0	0	0	0	0
Volume Right	9	0	0	26	0	0
cSH	873	1700	1700	1700	1700	1700
Volume to Capacity	0.01	0.31	0.31	0.02	0.29	0.29
Queue Length 95th (m)	0.2	0.0	0.0	0.0	0.0	0.0
Control Delay (s)	9.2	0.0	0.0	0.0	0.0	0.0
Lane LOS	A					
Approach Delay (s)	9.2	0.0			0.0	
Approach LOS	A					

Intersection Summary			
Average Delay	0.0		
Intersection Capacity Utilization	38.6%	ICU Level of Service	A
Analysis Period (min)	15		



Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	0	58	978	11	0	894
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	63	1063	12	0	972
Pedestrians						
Lane Width (m)						
Walking Speed (m/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None			None
Median storage veh)						
Upstream signal (m)			80			
pX, platoon unblocked	0.81	0.81			0.81	
vC, conflicting volume	1549	532			1075	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1201	0			613	
tC, single (s)	6.8	6.9			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	100	93			100	
cM capacity (veh/h)	143	875			776	

Direction, Lane #	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2
Volume Total	63	532	532	12	486	486
Volume Left	0	0	0	0	0	0
Volume Right	63	0	0	12	0	0
cSH	875	1700	1700	1700	1700	1700
Volume to Capacity	0.07	0.31	0.31	0.01	0.29	0.29
Queue Length 95th (m)	1.8	0.0	0.0	0.0	0.0	0.0
Control Delay (s)	9.4	0.0	0.0	0.0	0.0	0.0
Lane LOS	A					
Approach Delay (s)	9.4	0.0			0.0	
Approach LOS	A					

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	39.0%	ICU Level of Service	A
Analysis Period (min)	15		

APPENDIX B

QUEUE SURVEYS

Location: *ESSO at Innes Rd & Belcourt Blvd, Ottawa* *Queue length at Tim Horton's*

Date: December 18, 2014

Start time	Queue
7:00	1
7:01	1
7:02	2
7:03	4
7:04	2
7:05	6
7:06	4
7:07	7
7:08	6
7:09	5
7:10	7
7:11	5
7:12	2
7:13	1
7:14	3
7:15	5
7:16	4
7:17	5
7:18	5
7:19	6
7:20	4
7:21	2
7:22	3
7:23	3
7:24	2
7:25	6
7:26	9
7:27	5
7:28	5
7:29	4
7:30	2
7:31	3
7:32	5
7:33	6
7:34	8
7:35	8
7:36	6
7:37	8
7:38	8
7:39	8

Start time	Queue
7:40	8
7:41	7
7:42	8
7:43	8
7:44	7
7:45	9
7:46	1
7:47	9
7:48	10
7:49	8
7:50	10
7:51	10
7:52	8
7:53	9
7:54	8
7:55	8
7:56	7
7:57	10
7:58	9
7:59	10
8:00	10
8:01	10
8:02	10
8:03	9
8:04	8
8:05	9
8:06	9
8:07	7
8:08	6
8:09	8
8:10	9
8:11	8
8:12	8
8:13	6
8:14	5
8:15	4
8:16	4
8:17	5
8:18	6
8:19	4

Start time	Queue
8:20	1
8:21	6
8:22	6
8:23	10
8:24	11
8:25	10
8:26	8
8:27	10
8:28	7
8:29	7
8:30	6
8:31	7
8:32	5
8:33	8
8:34	7
8:35	9
8:36	8
8:37	7
8:38	10
8:39	9
8:40	11
8:41	10
8:42	10
8:43	10
8:44	8
8:45	10
8:46	9
8:47	9
8:48	10
8:49	10
8:50	8
8:51	10
8:52	8
8:53	7
8:54	6
8:55	5
8:56	5
8:57	3
8:58	1
8:59	0

Start time	Queue
9:00	1
9:01	0
9:02	1
9:03	1
9:04	0
9:05	2
9:06	2
9:07	4
9:08	5
9:09	6
9:10	5
9:11	3
9:12	3
9:13	4
9:14	3
9:15	4
9:16	3
9:17	2
9:18	2
9:19	0
9:20	0
9:21	1
9:22	2
9:23	1
9:24	1
9:25	0
9:26	2
9:27	2
9:28	2
9:29	1
9:30	2

Location: *ESSO at Innes Rd & Belcourt Blvd, Ottawa* *Queue length at Tim Horton's*

Date: December 18, 2014

Start time	Queue
16:00	2
16:01	
16:02	1
16:03	1
16:04	
16:05	
16:06	
16:07	1
16:08	
16:09	
16:10	
16:11	
16:12	
16:13	
16:14	
16:15	
16:16	2
16:17	
16:18	
16:19	
16:20	
16:21	
16:22	
16:23	
16:24	
16:25	
16:26	
16:27	
16:28	
16:29	
16:30	
16:31	
16:32	1
16:33	
16:34	
16:35	
16:36	1
16:37	
16:38	
16:39	

Start time	Queue
16:40	
16:41	
16:42	
16:43	
16:44	1
16:45	
16:46	1
16:47	
16:48	1
16:49	
16:50	
16:51	1
16:52	
16:53	
16:54	
16:55	
16:56	
16:57	1
16:58	
16:59	
17:00	
17:01	
17:02	
17:03	1
17:04	
17:05	
17:06	
17:07	
17:08	
17:09	
17:10	
17:11	
17:12	
17:13	
17:14	
17:15	
17:16	
17:17	1
17:18	2
17:19	

Start time	Queue
17:20	1
17:21	2
17:22	
17:23	
17:24	1
17:25	
17:26	
17:27	
17:28	
17:29	
17:30	2
17:31	
17:32	1
17:33	
17:34	
17:35	
17:36	
17:37	
17:38	1
17:39	
17:40	
17:41	
17:42	1
17:43	
17:44	
17:45	
17:46	
17:47	
17:48	1
17:49	
17:50	2
17:51	
17:52	
17:53	
17:54	
17:55	1
17:56	
17:57	
17:58	
17:59	