

May 2015

Addendum 2 to Technical Support Document #9

TRAFFIC IMPACT STUDY



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1.0 BACKGROUND

The Site for the proposed Capital Region Resource Recovery Centre (CRRRC) is to be located on the east side of Boundary Road at the northeast corner of Boundary Road and Devine Road. The facility would provide waste diversion activities and a landfill component. Site access is proposed directly onto Boundary Road located approximately 1,130 m south of Highway 417 and approximately 600 m south of Thunder Road.

A Traffic Impact Study (TIS) report (TSD #9) was prepared as a supporting document of the December 2014 Environmental Assessment (EA) report. The TIS examined the operation of the Site access onto Boundary Road and the impact that the trips generated from the Site would have on the operation of the surrounding intersections. The report examined key intersections, namely the intersections of rural arterial roads that would be impacted by additional traffic from the Site. The report did not consider the intersection of Boundary Road and Thunder Road, formally named Ninth Line Road, as the Site was not assigning any expected trips to Thunder Road and Thunder Road is not an arterial road. The study examined the operation of the surrounding intersections at the year 2022, which represents five years beyond the opening of the Site, which is anticipated to be the year 2017. The study acknowledged but did not assess the expected traffic from the proposed East Gateway Properties truck transfer terminal as the traffic study and Site information for that development was not available at the time the CRRRC Traffic Impact Study report was being prepared and build out of the truck transfer terminal was understood to be beyond the original 2022 horizon year of the study.

The Ministry of Transportation reviewed the TIS. Their review is contained in a March 9, 2015 letter from the Corridor Management Section to the Environmental Approvals Branch. A meeting was subsequently held with staff of the Ministry of Transportation and City of Ottawa on April 22, 2015 to discuss the comments. This Addendum addresses the comments of both the Ministry of Transportation and City of Ottawa as discussed at the April 22 meeting.

This Addendum addresses the following comments that were listed in the Ministry of Transportation letter dated March 9, 2015:

1. That the proponent incorporates traffic expected to be generated by the Plan of Subdivision development opposite Thunder Road (East Gateway Properties truck transfer terminal).
2. That the proponent uses a more realistic truck percentage for its traffic analysis.
3. That the proponent provides both a 5 year and 10 year beyond opening date traffic analysis.
4. That the proponent review the need to add traffic generated by maintenance and workers to and from the Site in addition to the truck trips generated.
5. That the proponent assesses the impact of the improvements necessary to Boundary Road to determine whether they can in fact be safely and efficiently implemented and considers MTO's suggestions with respect to the relocation of the main point of access for the Site.
6. That the proponent creates a plan to monitor the traffic and operation of the traffic generated by the Site after the opening and at a reasonable interval after opening to determine if further improvements are required.
7. That the proponent proposes mitigation measures to reduce the visual distraction of the Secondary Digester Flare.

2.0 ROADS AND INTERSECTIONS

This Addendum further considers the operation of the following intersections in relation to traffic from the proposed CRRRC Site:

1. Proposed Site Access and Boundary Road
2. Boundary Road and Mitch Owens Road
3. Boundary Road and Thunder Road (Ninth Line Road)
4. Boundary Road and Highway 417 Eastbound Ramps
5. Boundary Road and Highway 417 Westbound Ramps

The above intersections all intersect with Boundary Road. Boundary Road is a north-south two lane arterial road under the jurisdiction of the City of Ottawa (Ottawa Road 41). The road has an asphalt surface with a width of approximately 7.5 m plus gravel shoulders. The posted speed limit along the road in the vicinity of the Site is 80 km/h.

The study utilizes the most recent traffic counts, which differ in some cases from those used in the original TIS.

Figure 2.1 shows the most recent traffic counts taken at the intersections examined in this Addendum. The traffic counts are provided in the Appendix as Exhibit 1 for the Boundary/Mitch Owens intersection, Exhibit 2 for the Boundary/Highway 417 Eastbound Ramp intersection, Exhibit 3 for the Boundary/Highway 417 Westbound Ramp intersection, and Exhibit 4 for the Boundary/Thunder intersection.

3.0 PROPOSED CAPITAL REGION RESOURCE RECOVERY CENTRE

The proposed CRRRC Site is located on approximately 192 hectares of land. The Site will operate six days a week (Monday through Saturday), and will be open for material and waste receipts between 6:00 AM and 6:00 PM.

The Site will have one access onto Boundary Road located approximately 1,130 m south of Highway 417, 850 m south of the eastbound Highway on/off ramp, 600 m south of Thunder Road and 700 m north of Mitch Owens Road. This access would be mainly used for truck access/egress from the Site. A secondary Site access is located onto Frontier Road, which would be used by vehicles associated with Site operations, maintenance or emergency. The Frontier Road access would be low volume (maintenance and workers entering and exiting the Site) and would mainly occur outside the peak hours of the adjacent roads. It was therefore considered appropriate to not assign worker-related traffic using the Frontier Road access in the peak hour traffic analysis.

The number of expected Site generated trips was determined by the proponent by considering the amount and types of waste expected to be received at the Site, the anticipated diversion, and other Site activities. This Addendum has utilized the same trip generation and distribution as the TIS, namely 43 truck trips entering and 43 exiting the Site during both the weekday peak AM and PM hours. The expected Site generated trips at full development are shown in Figure 3.1.

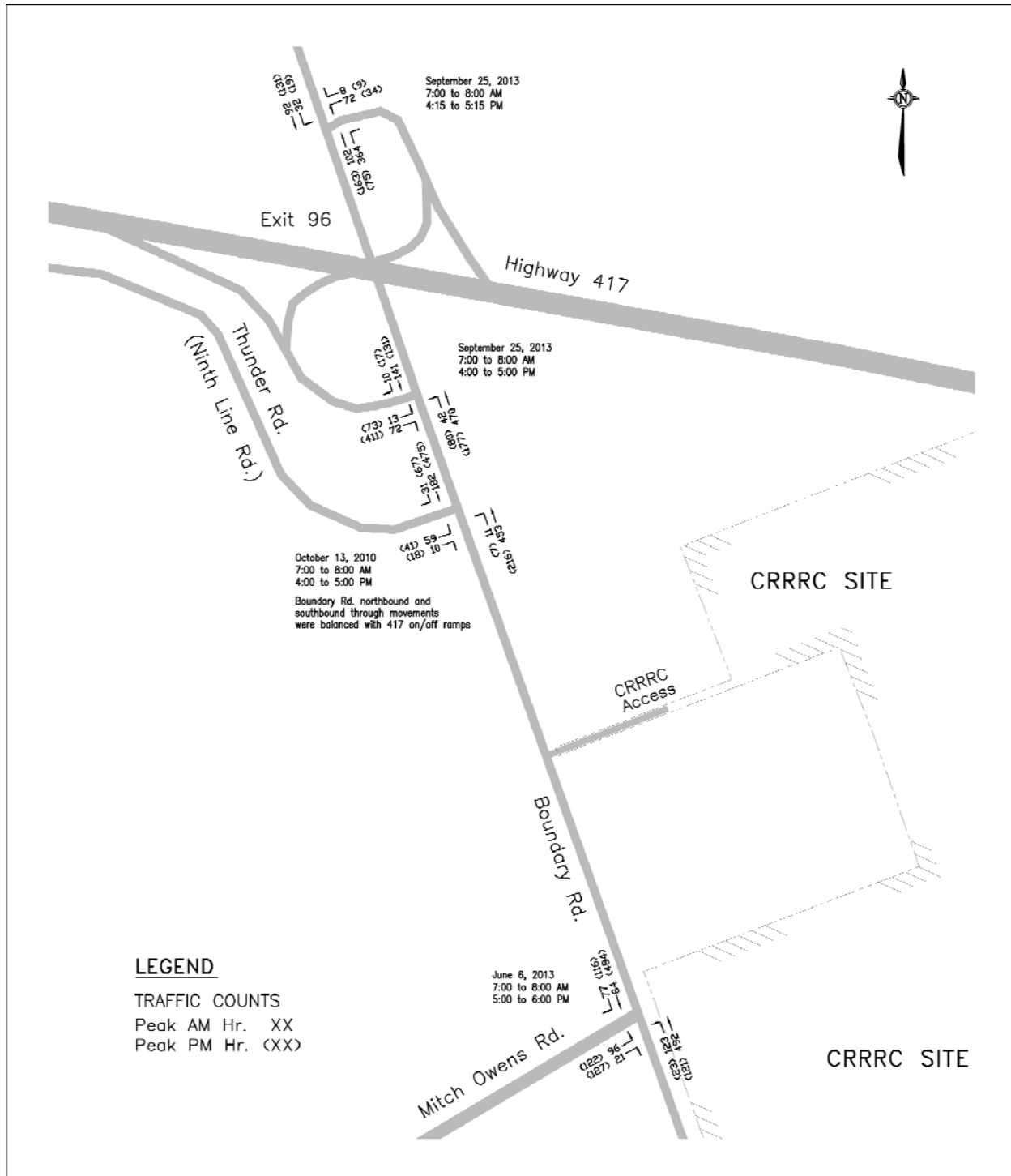


Figure 2.1: Weekday Peak AM and PM Hour Traffic Counts

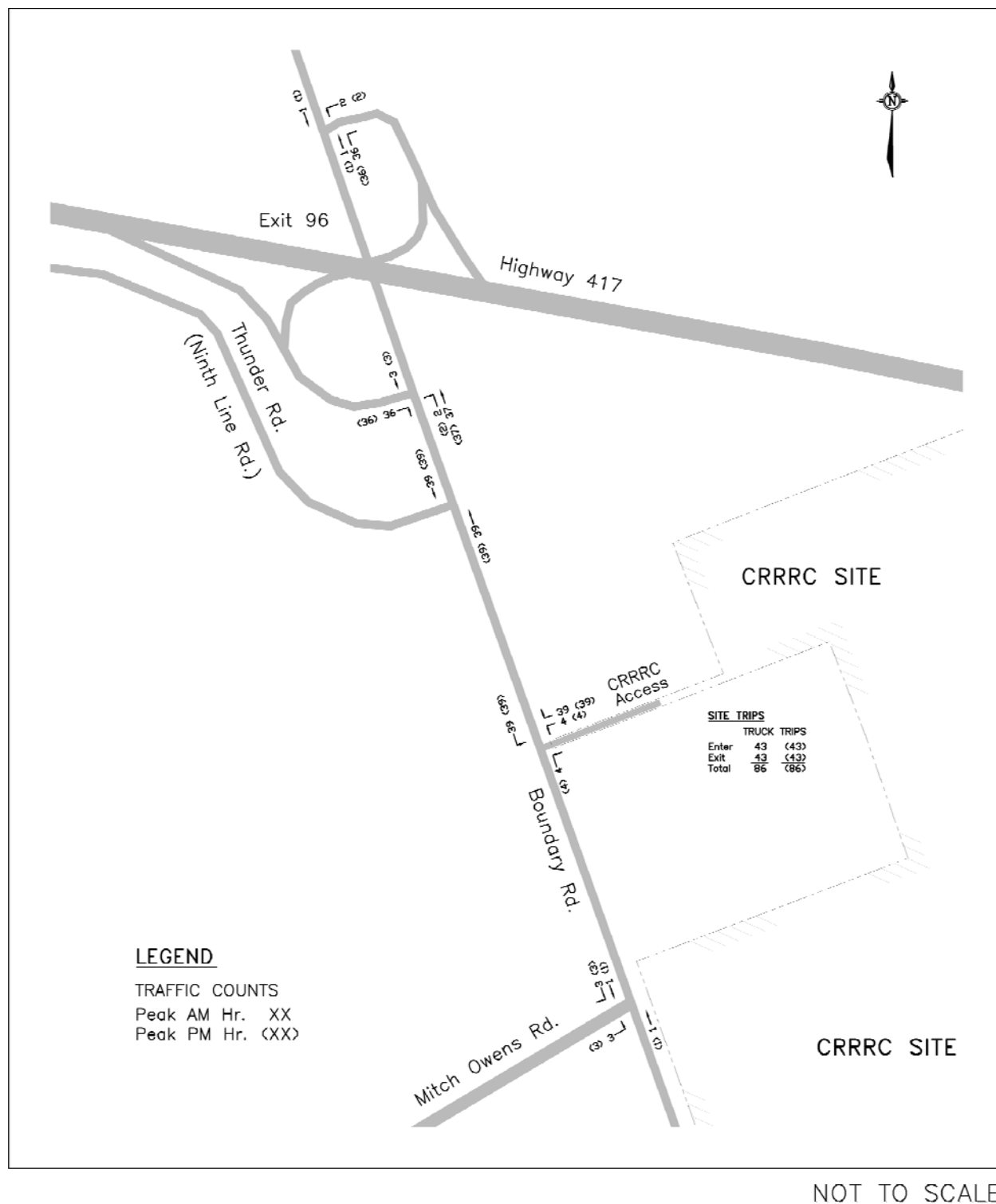


Figure 3.1: Weekday Peak AM and PM Hour Site Generated Trips

4.0 FUTURE TRAFFIC VOLUMES

This Addendum has assumed an annual compounded growth rate of 2 percent as discussed in the TIS. The growth rate was applied to all lane movements shown in the traffic counts presented in Figure 2.1 for the weekday peak AM and PM hour. Figure 4.1 shows the expected 2022 background traffic, which would represent traffic five years beyond build out from growth outside the immediate area.

The East Gateway Properties truck transfer terminal is proposed to be located on the east side of Boundary Road north of the CRRRC Site. The truck transfer terminal will have an access that will form the east access to the intersection of Boundary Road and Thunder Road. It is understood that the terminal facility expects build out by the year 2026. For the expected background traffic at the year 2027, which represents ten years beyond opening of the CRRRC Site, this Addendum has increased the existing traffic (Figure 2.1) at a 2 percent compounded rate to the year 2027, and added the expected traffic from the truck transfer terminal. The volume and distribution of trips from the proposed terminal were determined from the Transportation Impact Study report dated October 2014 for 5341 Boundary Road Transport prepared by Dillon Consulting Limited (Dillon). The Dillon TIS examined both a “Low Building Coverage” and a “High Building Coverage” scenario. As discussed at the meeting of April 22, 2015, this Addendum has utilized the traffic associated with the average of both scenarios and added the expected terminal trips to the 2027 background traffic, which is shown in Figure 4.2.

The expected total traffic volumes at the year 2022, which are shown in Figure 4.3, were determined by the addition of the expected background traffic of Figure 4.1 and the expected Site generated trips of Figure 3.1. For the expected 2027 total traffic shown in Figure 4.4, the 2027 background traffic (Figure 4.2) was added to the Site generated trips (Figure 3.1).

4.1 Traffic Analysis

The following are the results of the intersection analysis at the year 2022 (5 years beyond CRRRC Site opening), and at the year 2027 (10 years beyond opening), including the East Gateway Properties truck transfer terminal trips.

Boundary Road and CRRRC Site Access

A left turn lane warrant analysis was conducted at the Site access using the procedure documented in the MTO publication, *Geometric Design Standards for Ontario Highways*. The analysis utilized the expected 2027 traffic and a design speed of 90 km/h. (80 km/h. posted speed) at the access. The warrant analysis, which is presented in the Appendix as Exhibit 5, determined that a southbound left turn lane with 25 m for passenger car storage was required during the both the peak AM and PM hour. Utilizing a passenger car equivalent for heavy vehicles of 2.0 as documented in the MTO publication, the required length of the southbound left turn lane at the CRRRC truck access would therefore be 50 m. The following is the recommended lane configuration:

- Northbound Boundary Road One shared through/right lane
- Southbound Boundary Road One through lane
One exclusive left turn lane
 - 50 m vehicular storage
 - 60 m parallel lane
 - 145 m taper
- Westbound Site Access One shared left and right turn lane (8 m in width)

This required lane configuration at the Site access location is the same as presented in the original TIS. The design and construction of the Site access location would be the responsibility of Taggart Miller.

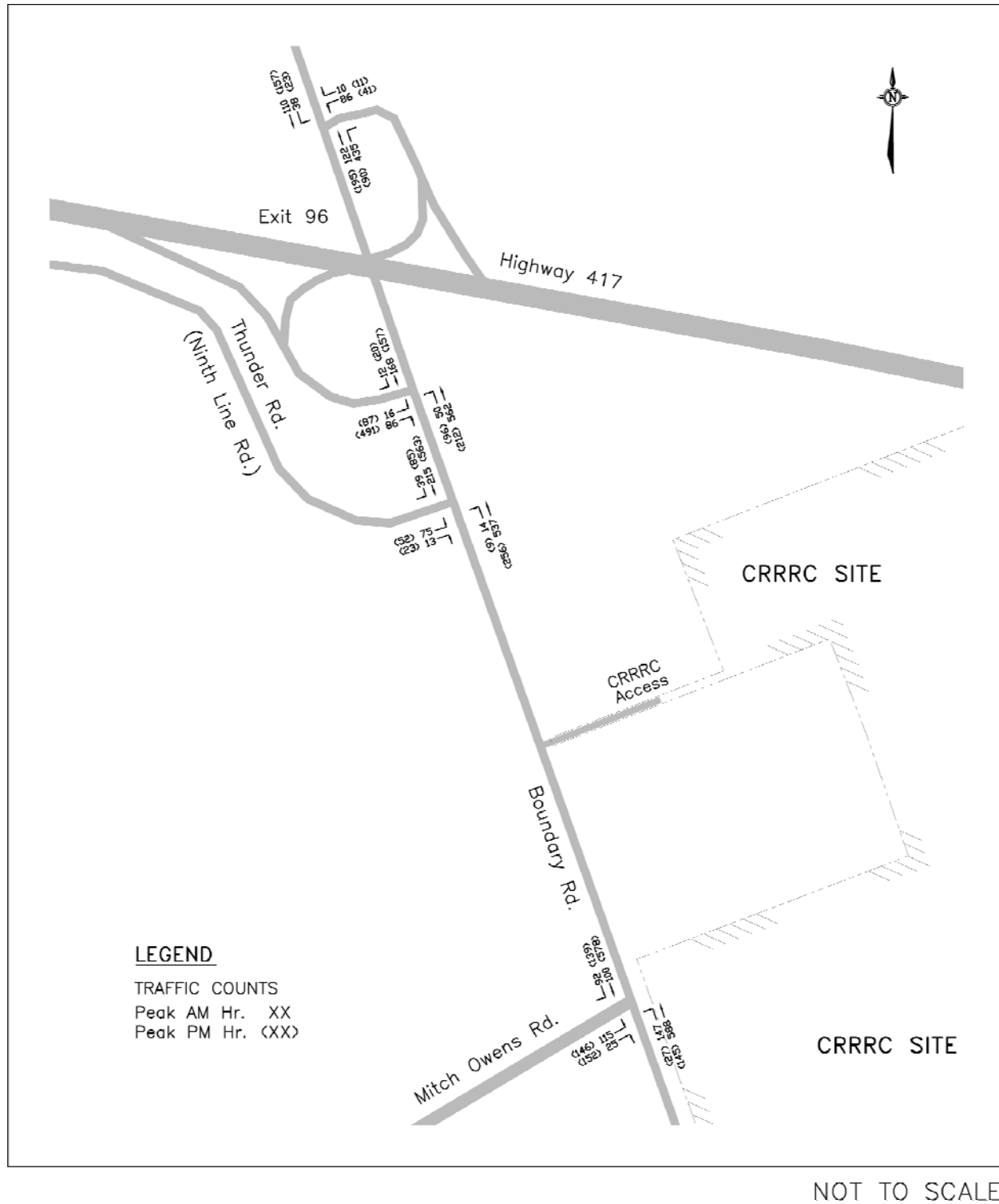


Figure 4.1: 2022 Weekday Peak AM and PM Hour Background Traffic

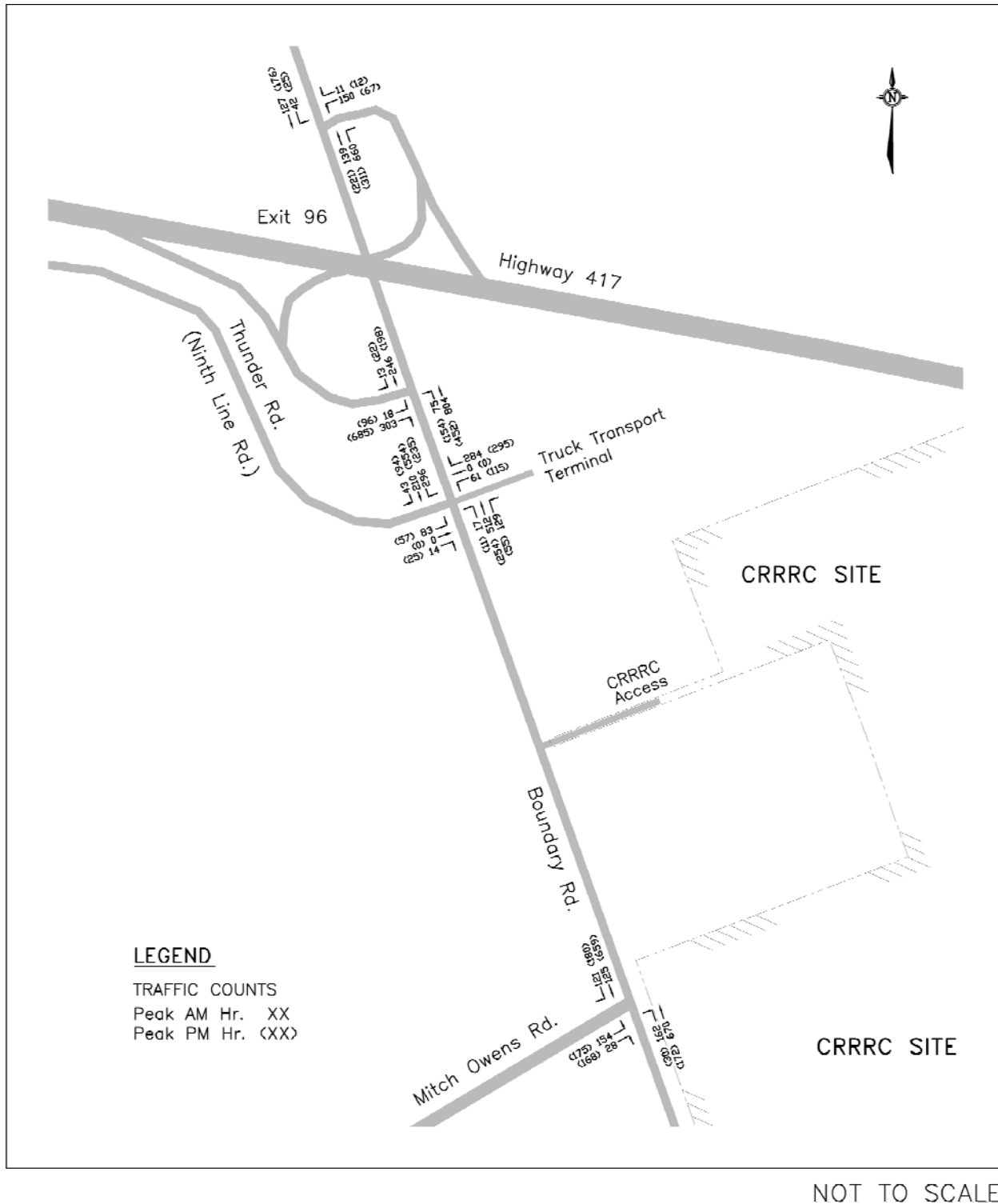


Figure 4.2: 2027 Weekday Peak AM and PM Hour Background Traffic

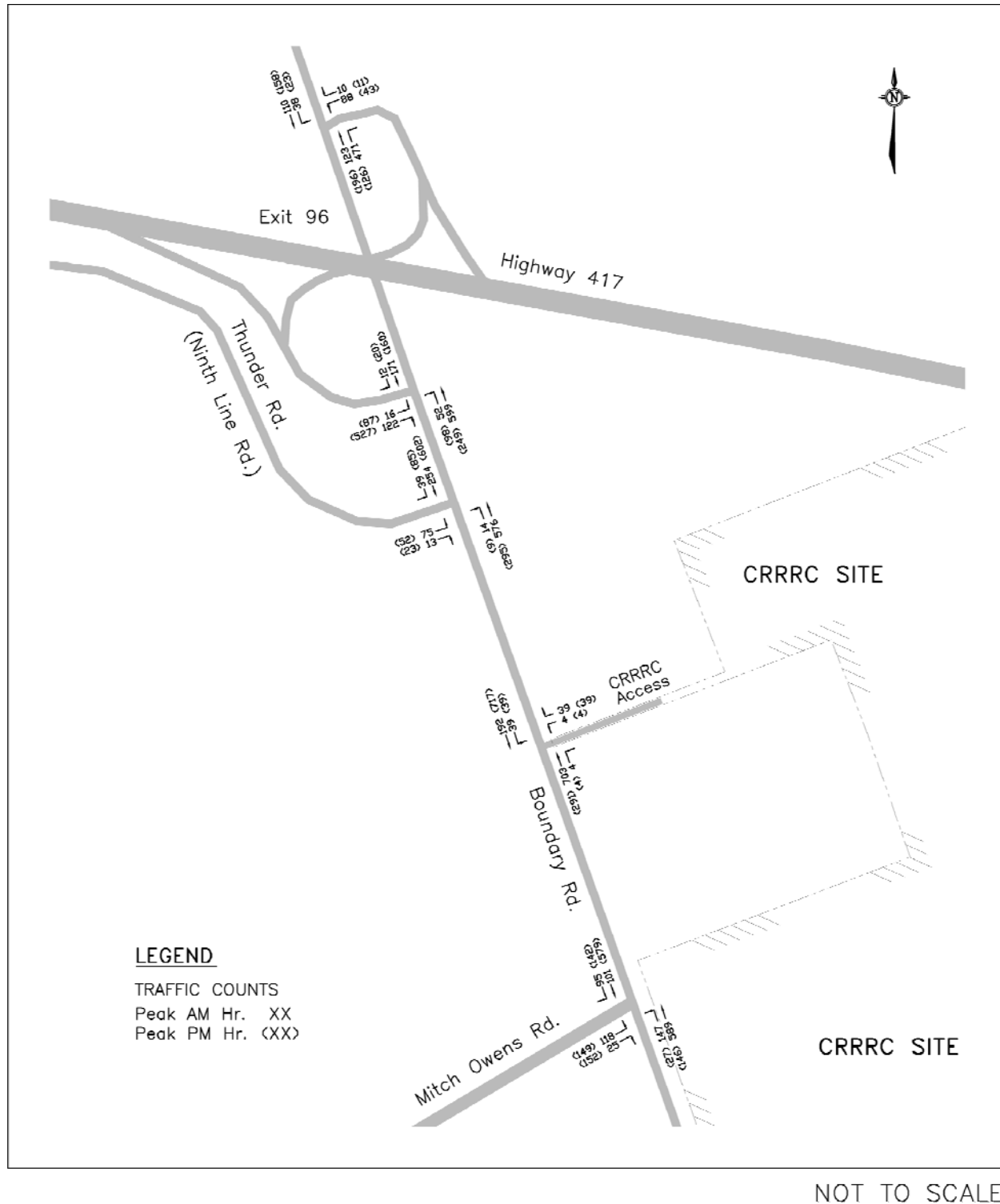


Figure 4.3: 2022 Weekday Peak AM and PM Hour Total Traffic

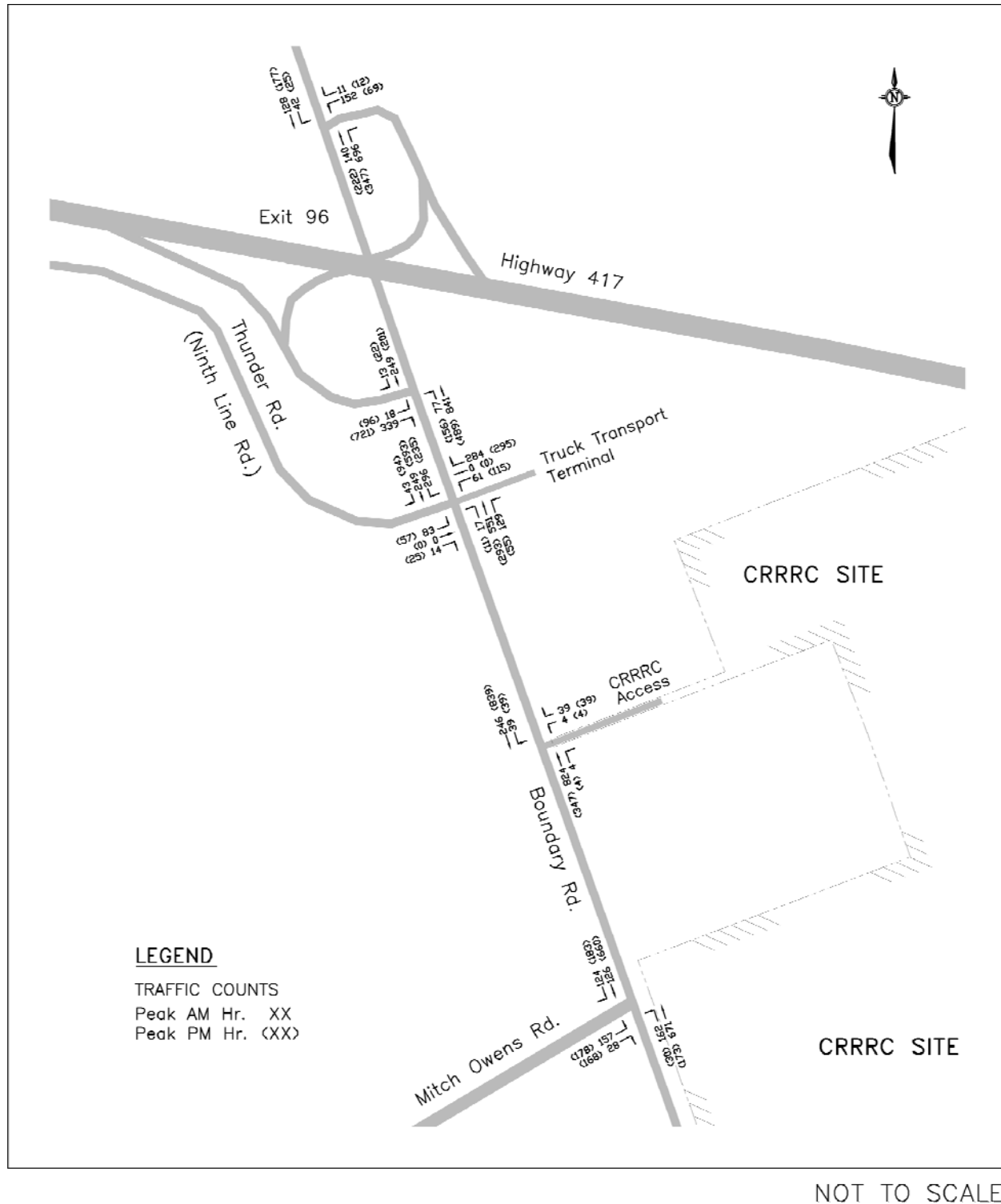


Figure 4.4: 2027 Weekday Peak AM and PM Hour Total Traffic

In order to reduce gravel spillage onto Boundary Road from turning trucks and help in the deceleration and acceleration of trucks, 75 m tapers are proposed along the east side of Boundary Road at the Site access. Figure 4.5 shows the proposed lane geometry at the CRRRC access. The 600 m separation between the CRRRC access and Thunder Road is sufficient to accommodate the Site's southbound left turn lane and a proposed future northbound Boundary Road left turn lane onto Thunder Road (as described in the Dillon TIS for East Gateway Properties).

The analysis determined that the CRRRC access is predicted to operate at an acceptable level of service with all lane movements functioning at a Level of Service (LoS) "A" to "C" at both years 2022 and 2027. The expected 95th percentile queue at the southbound Boundary Road left turn movement would be 0.29 vehicles during the 2027 peak AM hour, which can be accommodated in the 50 m storage lane provided. Table 4.1 summarizes the operation of the intersection with the analysis sheets provided as Exhibit 6 to Exhibit 9.

Table 4.1: Boundary/CRRRC Access – LoS and 95th Percentile Queue

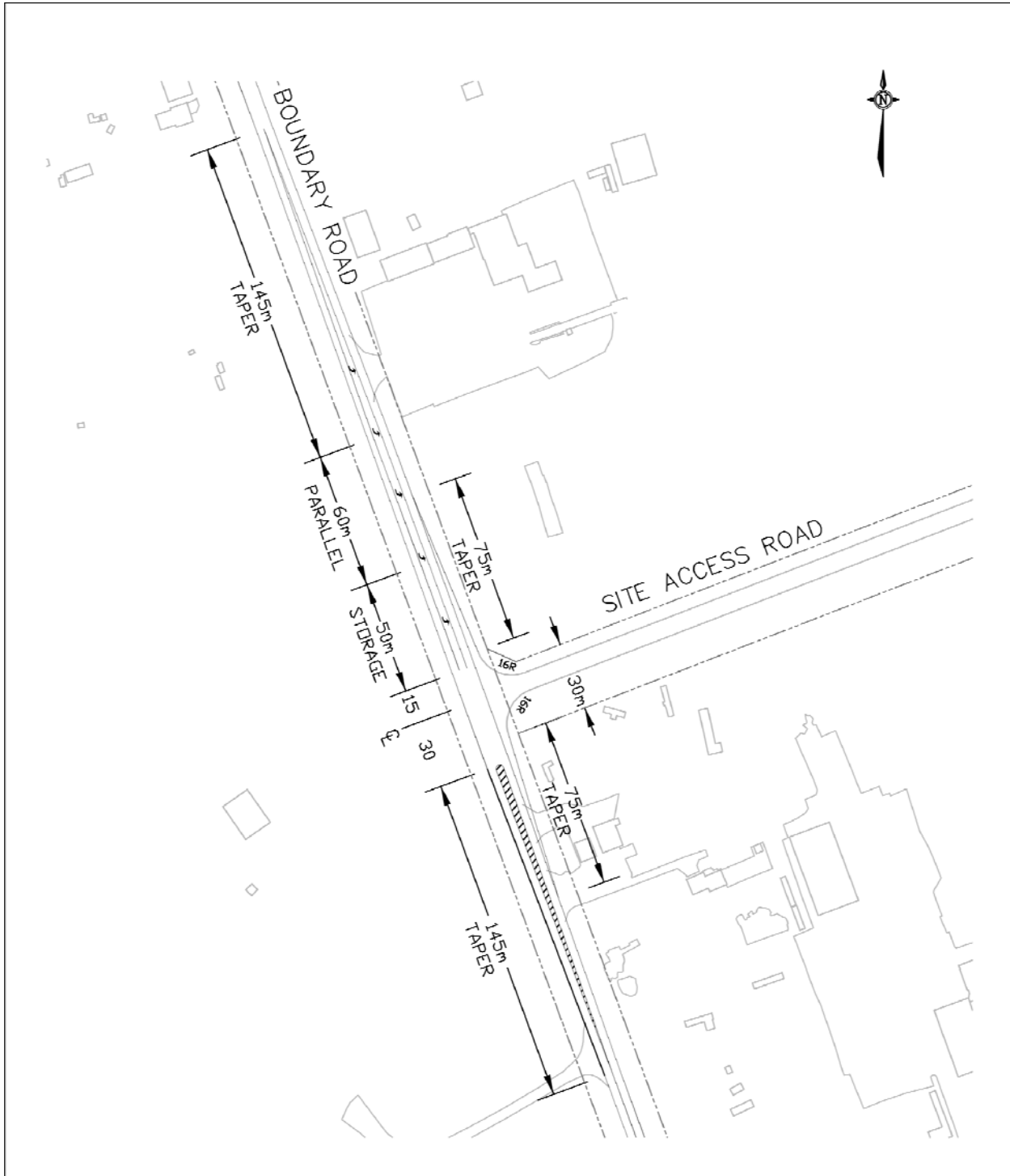
Intersection Approach	Weekday Peak AM Hour 2022 Total (2027 Total)		Weekday Peak PM Hour 2022 Total (2027 Total)	
	LoS	Q ₉₅ (Veh.)	LoS	Q ₉₅ (Veh.)
SB Left – Boundary	B (B)	0.22 (0.29)	A (A)	0.16 (0.17)
EB Left/Right – Site Access	C (D)	0.50 (0.80)	C (C)	0.39 (0.43)

Boundary Road and Mitch Owens Road

The Boundary/Mitch Owens intersection is an unsignalized "T" intersection with Boundary Road forming the northbound and southbound approaches and Mitch Owens Road the eastbound approach. A traffic analysis was completed for the Boundary/Mitch Owens intersection for the expected 2022 traffic. The operational analysis determined that the eastbound Mitch Owens Road left turn movement would function at a LoS "E" during the peak AM hour with an approach delay at the movement of 44.1 sec. The 2022 analysis, which includes the CRRRC Site and growth in background traffic, is provided in Exhibit 10 for the peak AM hour and Exhibit 11 for the peak PM hour and summarized in Table 4.2.

Table 4.2: Boundary/Mitch Owens – LoS and 95th Percentile Queue

Intersection Approach	Weekday Peak AM Hour 2022 Total (2027 Total)		Weekday Peak PM Hour 2022 Total (2027 Total)	
	LoS	Q ₉₅ (Veh.)	LoS	Q ₉₅ (Veh.)
NB Left/Through – Boundary	A (A)	0.40 (0.48)	A (B)	0.11 (0.14)
EB Left – Mitch Owens	E (F)	3.39 (8.05)	D (E)	2.72 (5.12)
EB Right – Mitch Owens	A (A)	0.09 (0.10)	C (C)	1.53 (2.10)



NOT TO SCALE

Figure 4.5: Proposed Boundary Road/CRRRC Access Geometry

At the year 2027, which includes an increase in background traffic plus the expected trips from the truck transfer terminal, all movements function well with the exception of the eastbound Mitch Owens Road left turn movement, which functions at a LoS “F” with an approach delay of 125.8 sec during the peak AM hour. Exhibit 12 and 13 shows the operation of the intersection at the year 2027, which is summarized in Table 4.2. A traffic signal warrant analysis was prepared (Exhibit 14), which determined that the intersection meet the warrants for the installation of traffic control signals for the expected traffic at the year 2027.

There would be no requirement for modifications to the intersection due to the development of the CRRRC Site alone, as the CRRRC adds only a minimal volume of traffic to the intersection. Background traffic at this intersection should however be monitored to determine if traffic signals should be installed in the future, as the analysis determined that they may be warranted by the year 2027 due to the increase in background traffic..

Boundary Road and Thunder Road (Ninth Line Road)

The intersection of Boundary Road and Thunder Road is a “T” intersection with Boundary Road forming the northbound and southbound approaches and Thunder Road the eastbound approach. There would be no requirement for modifications to the intersection due to the development of the CRRRC Site since the CRRRC adds only a minimal volume of traffic to the intersection. The 2022 operation of the intersection is shown in Table 4.3 with the analysis work sheets provided as Exhibits 15 and 16.

Table 4.3: Boundary/Thunder – Year 2022 LoS and 95th Percentile Queue

Intersection Approach	Weekday Peak AM Hour 2022 Total		Weekday Peak PM Hour 2022 Total	
	LoS	Q ₉₅ (Veh.)	LoS	Q ₉₅ (Veh.)
NB Left/Through – Boundary	A	0.04	A	0.03
EB Left/Right – Thunder	C	1.26	C	1.10

By the year 2027 the truck transfer terminal will be completed. The terminal access would form the westbound approach to the Boundary/Thunder intersection. Utilizing the proposed intersection lane configuration proposed by Dillon Consulting Limited (East Gateway Properties consultant) and an unsignalized intersection with stop signs at the eastbound and westbound Thunder Road approaches, the intersection was determined to operate at a LoS “F” at both the eastbound and westbound approaches during the peak AM and PM hours. Table 4.4 summarizes the operation of the intersection with the analysis sheets provided as Exhibit 17 and Exhibit 18. A traffic signal warrant analysis (Exhibit 19) determined that traffic signals and modifications to the lane configuration would be warranted when the East Gateway Properties truck transfer terminal is developed. The design and construction of these intersection modifications at Boundary/Thunder Road would be the responsibility of East Gateway Properties Limited.

Table 4.4: Boundary/Thunder – Year 2027 LoS and 95th Percentile Queue

Intersection Approach	Weekday Peak AM Hour (2027 Total)		Weekday Peak PM Hour (2027 Total)	
	LoS	Q ₉₅ (Veh.)	LoS	Q ₉₅ (Veh.)
NB Left – Boundary	(A)	(0.04)	(A)	(0.04)
SB Left – Boundary	(B)	(1.89)	(A)	(0.86)
WB Left/Through – Access	(F)	(5.50)	(F)	(11.16)
WB Right – Terminal Access	(C)	(4.34)	(B)	(2.42)
EB Left/Through/Right – Thunder	(F)	(13.64)	(F)	(9.21)

Boundary Road and Highway 417 Eastbound on/off Ramps

The Boundary/EB Highway 417 Ramp is an unsignalized “T” intersection with Boundary Road forming the northbound and southbound approaches and Highway 417 on/off ramps the eastbound approach. Using the expected 2022 traffic (including the CRRRC Site trips) and the existing lane geometry, the intersection would function at an acceptable level of service (LoS “A” to “C”). The analysis assumes an eastbound flared approach allowing the storage for 8 right turning vehicles. The approach has sufficient width for the flared intersection and an observation during peak hour confirms the lane usage. Table 4.5 summarizes the operation of the intersection with the analysis sheets provided as Exhibit 20 and Exhibit 21.

Table 4.5: Boundary/Eastbound 417 Ramp – Year 2022 LoS and 95th Percentile Queue

Intersection Approach	Weekday Peak AM Hour 2022 Total		Weekday Peak PM Hour 2022 Total	
	LoS	Q ₉₅ (Veh.)	LoS	Q ₉₅ (Veh.)
NB Left/Through – Boundary	A	0.14	A	0.25
EB Left/Right – 417 off ramp	B	0.56	C	5.40

For the year 2027 analysis, the study has used the expected background traffic, which includes the truck transfer terminal, and the proposed intersection lane configuration proposed by Dillon Consulting Limited (East Gateway Properties consultant) and an unsignalized intersection with stop signs at the eastbound 417 off ramp approach. The intersection modifications would include an exclusive northbound Boundary Road left turn lane and exclusive eastbound left and right turn lanes. The intersection was determined to operate at an acceptable level of service during the peak AM hour, but during the 2027 peak PM hour the eastbound 417 left turn lane would function at a LoS “E” and right turn lane at a LoS “F”. Table 4.6 summarizes the operation of the intersection with the analysis sheets provided as Exhibits 22 and 23.

Table 4.6: Boundary/Eastbound 417 Ramp – Year 2027 LoS and 95th Percentile Queue

Intersection Approach	Weekday Peak AM Hour (2027 Total)		Weekday Peak PM Hour (2027 Total)	
	LoS	Q ₉₅ (Veh.)	LoS	Q ₉₅ (Veh.)
NB Left – Boundary	(A)	(0.24)	(A)	(0.45)
EB Left – 417 off ramp	(D)	(0.45)	(E)	(2.62)
EB Right – 417 off ramp	(B)	(2.85)	(F)	(16.58)

A traffic signal warrant analysis, which is provided as Exhibit 24, determined that the intersection did meet the warrants for the installation of traffic control signals. With the installation of traffic signals, the operational analysis shown in Exhibit 25 determined that the intersection would function at a volume to capacity ratio relating to a LoS “C” ($v/c = 0.76$) during the peak AM hour with a signal cycle of 100 seconds. During the peak PM hour the intersection was determined to function at a LoS “D” ($v/c = 0.84$) as shown in Exhibit 26.

The analysis indicates that the intersection of Boundary Road and eastbound Highway 417 Ramp needs to be modified in the future with additional turning lanes and traffic control signals that would increase the capacity of the intersection to handle the anticipated traffic. The intersection modifications would be comprised of the lane configuration and traffic signals as proposed by Dillon Consulting Limited on behalf of East Gateway Properties. The apportionment of costs for modifications at this intersection will be determined through the City approvals process for the East Gateway Properties development.

Boundary Road and Highway 417 Westbound on/off Ramps

The Boundary/WB Highway 417 Ramp is an unsignalized “T” intersection with Boundary Road forming the northbound and southbound approaches and the Highway 417 Ramp the westbound approach. The operational analysis using the existing lane configuration and stop sign at the westbound approach determined that the intersection operated at an acceptable level of service (LoS “A” to “C”) during the peak hours for the expected traffic at 2022 and 2027. Table 4.7 summarizes the operation of the intersection with the analysis sheets provided as Exhibits 27 to 30. There would be no requirement to modify the intersection within the time line of this study.

Table 4.7: Boundary/Westbound 417 Ramp – Year 2027 LoS and 95th Percentile Queue

Intersection Approach	Weekday Peak AM Hour 2022 Total (2027 Total)		Weekday Peak PM Hour 2022 Total (2027 Total)	
	LoS	Q ₉₅ (Veh.)	LoS	Q ₉₅ (Veh.)
SB Left/Through – Boundary	A (B)	0.14 (0.19)	A (A)	0.06 (0.09)
WB Left/Right – 417 off ramp	C (C)	0.84 (2.61)	B (C)	0.30 (0.67)

5.0 FINDINGS AND RECOMMENDATIONS

This Addendum has addressed the comments of Ministry of Transportation (MTO) staff in their letter dated March 9, 2015, as further discussed on April 22. The study has re-evaluated the intersections within the scope of work of the original Traffic Impact Study (TIS) report. The following is a summary of the responses to MTO comments:

1. The analysis has examined the operation of the intersections for the expected traffic at the year 2022, which represents five years beyond opening of the CRRRC Site. The study has also examined the intersections at a time period of ten years beyond opening, which includes the expected trips from the Plan of Subdivision development (proposed East Gateway Properties truck transfer terminal) that will be completed by the year 2026. The Addendum has used more recent traffic counts provided by the City of Ottawa and Ministry of Transportation.
2. The analysis has utilized the truck percentage at the intersections as documented in the City of Ottawa and MTO traffic counts, as well as the percentage of trucks determined in the Dillon Transportation Impact Study for the proposed truck transfer terminal.
3. The traffic analysis has examined the impact of the CRRRC Site at both 5 and 10 years beyond the 2017 opening date.
4. The hours of the facility for material and waste receipt at the CRRRC Site are from 6:00 AM to 6:00 PM. Because the workers would arrive and leave outside the peak hours of the adjacent roads, their trips were not considered in the peak AM and PM hour traffic analysis.
5. The proposed CRRRC access is located approximately 600 m south of Thunder Road. As discussed with MTO, this distance would be sufficient to provide a southbound Boundary Road left turn lane into the CRRRC Site and a northbound Boundary Road left turn lane onto Thunder Road.
6. The number of truck trips will be recorded as part of the operation of the facility and the average number of peak hour trucks will be compared to that assumed in the traffic study, and can be reported annually in the Site monitoring report.
7. The viewpoint projection from Highway 417 of the proposed flare and power generation units (there is no Secondary Digester Flare) is shown on Figure 11.6.3-2 of Volume I of the EA submission package. The proposed berm and tree screen for the flare and power generation units will be slightly higher than the units themselves, and will therefore provide an effective screen of the units from Highway 417.

APPENDIX

Exhibits 1 to 5 – Traffic Counts

**Exhibits 6 to 30 – Operational Analysis, Left Turn Lane
Warrants and Traffic Signal Warrants**

Exhibit 1: Year 2013 Peak AM and PM Hour Traffic Counts – Boundary/Mitch Owens



Public Works and Services Department

Count ID 3164

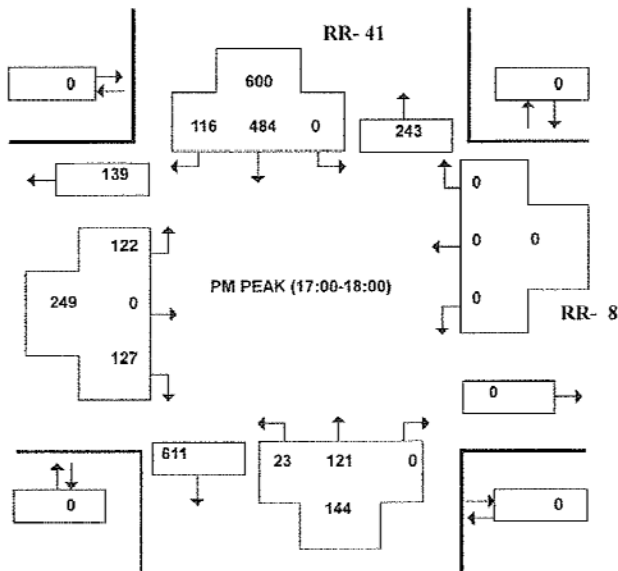
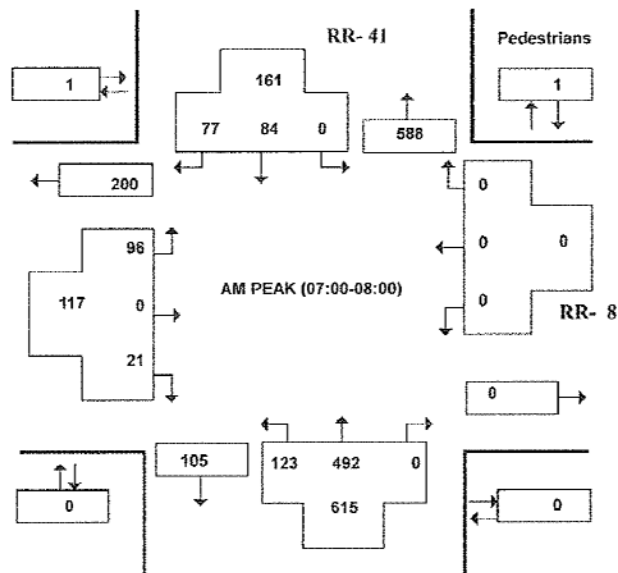
MITCH OWENS RD and BOUNDARY RD

(ULRS Listing RR- 8 & RR- 41)

Survey Date: Thursday 6 June 2013
Conditions: dry
Start Time: 0700

Total Observed U-Turns
Northbound: 0 Southbound: 0
Eastbound: 0 Westbound: 0

AADT Factor
Thursday in June is
0.9



Approved by : MO

Printed on : 08/07/2014

Exhibit 2: Year 2013 Peak AM and PM Hour Traffic Counts – Boundary/Eastbound 417 Ramps



HWY 417 @ BOUNDARY RD IC-96

Eastern

Intersection ID:493400000(--S--)

Count Day: Wednesday

Count Date: 25-Sep-2013

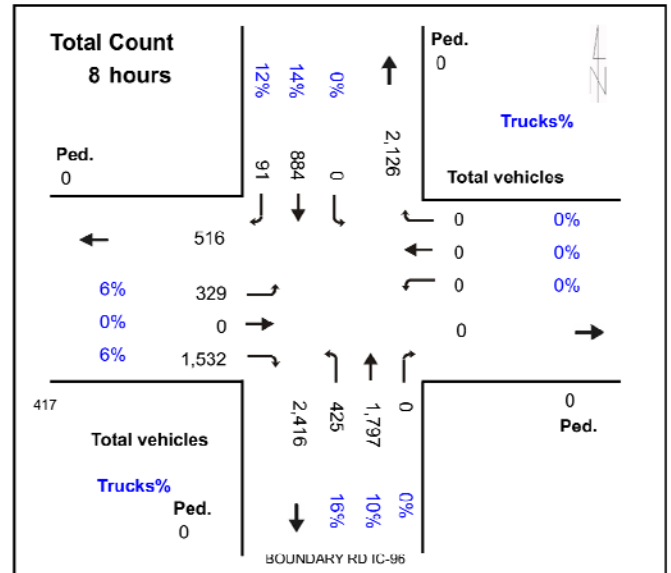
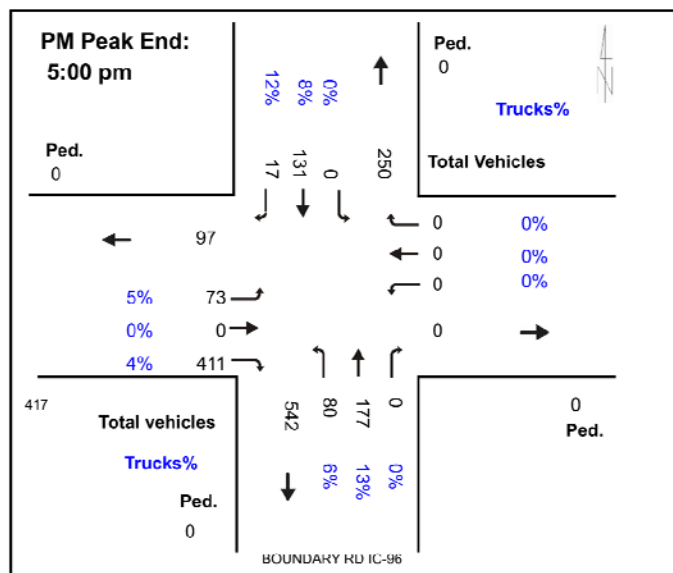
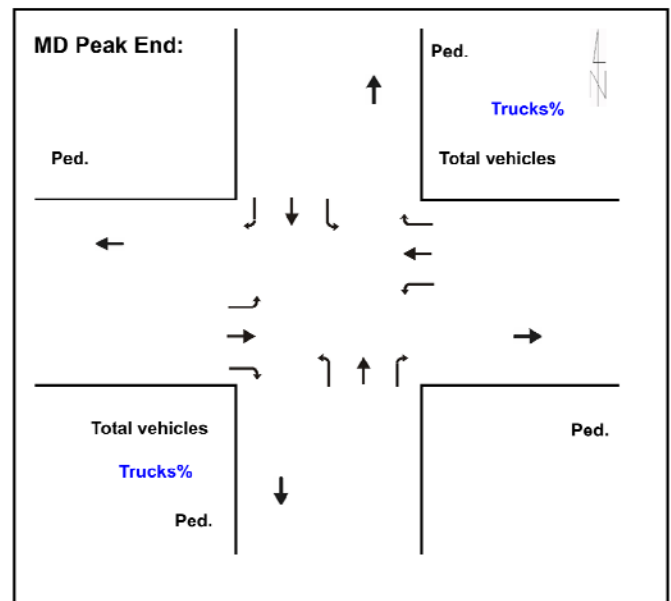
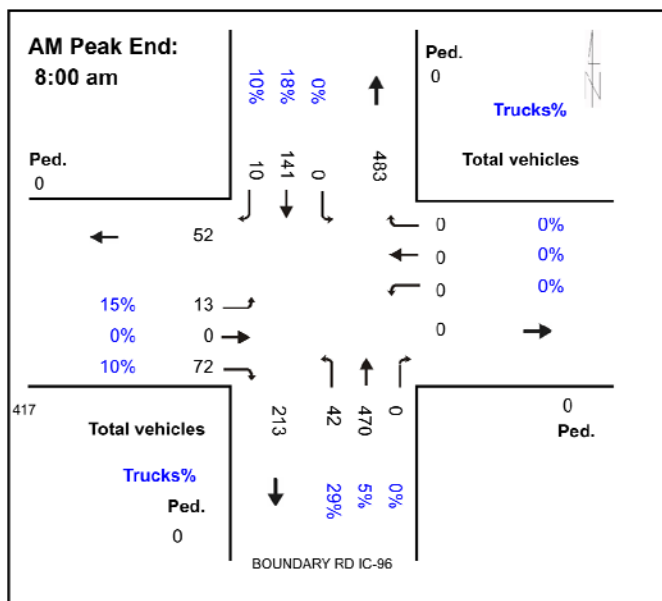


Exhibit 3: Year 2013 Peak AM and PM Hour Traffic Counts – Boundary/Westbound 417 Ramps



HWY 417 @ BOUNDARY RD IC-96

Eastern

Intersection ID:493400000(--N--)

Count Day: Wednesday

Count Date: 25-Sep-2013

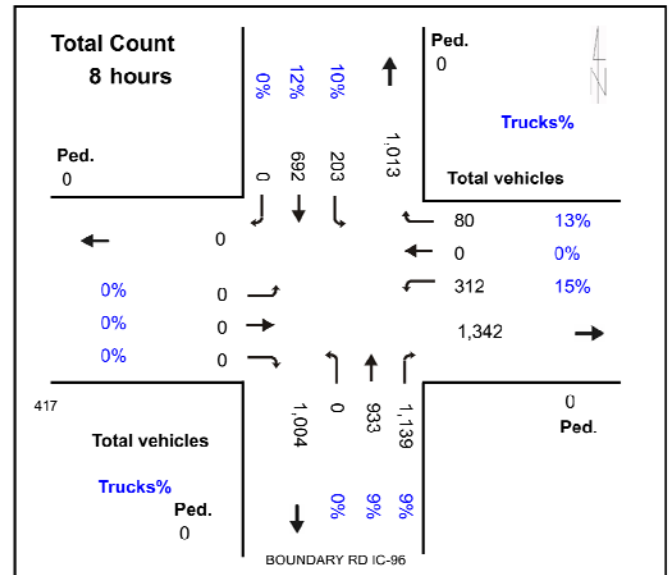
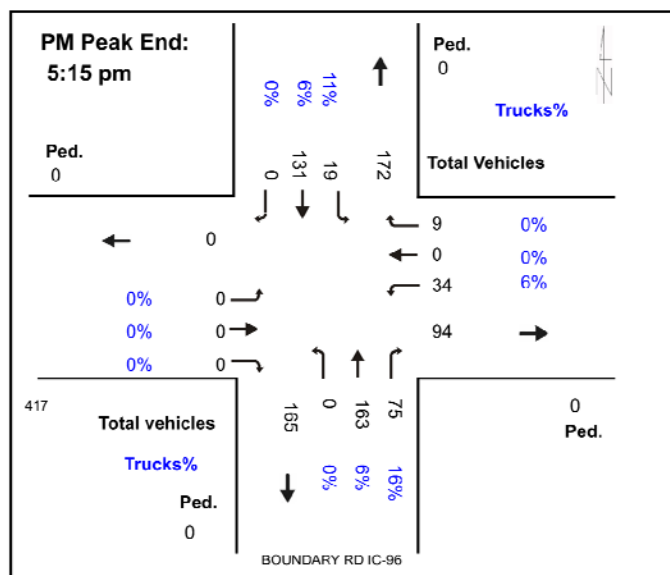
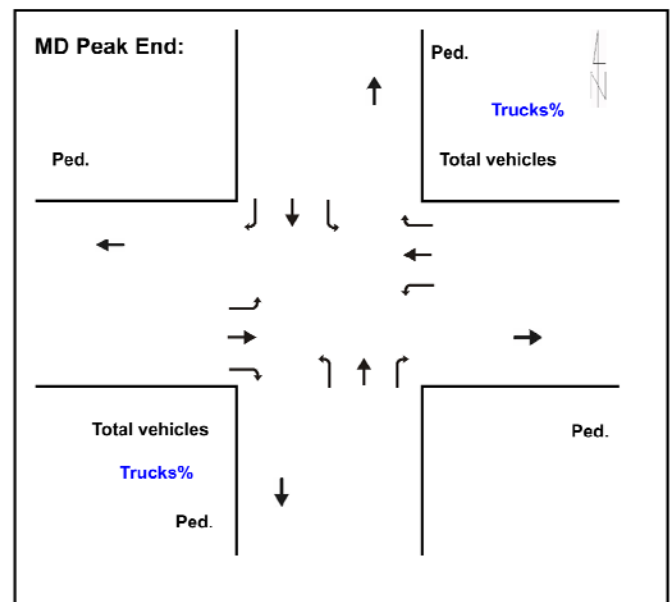
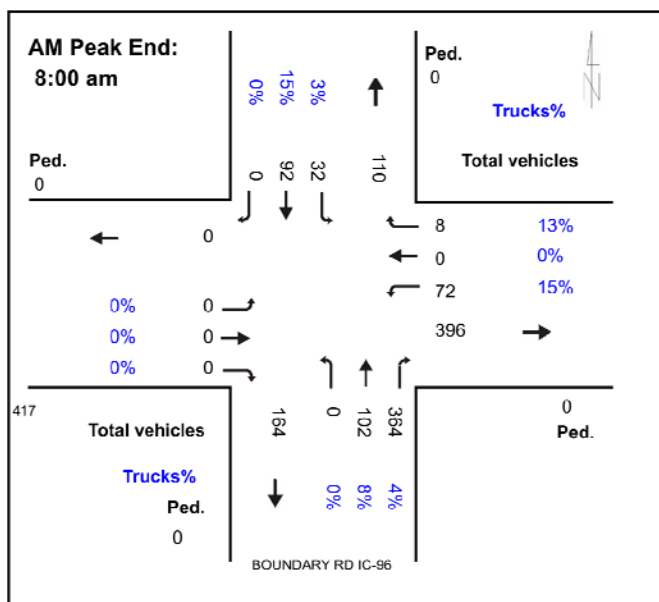


Exhibit 4: Year 2010 Peak AM and PM Hour Traffic Counts – Boundary/Thunder

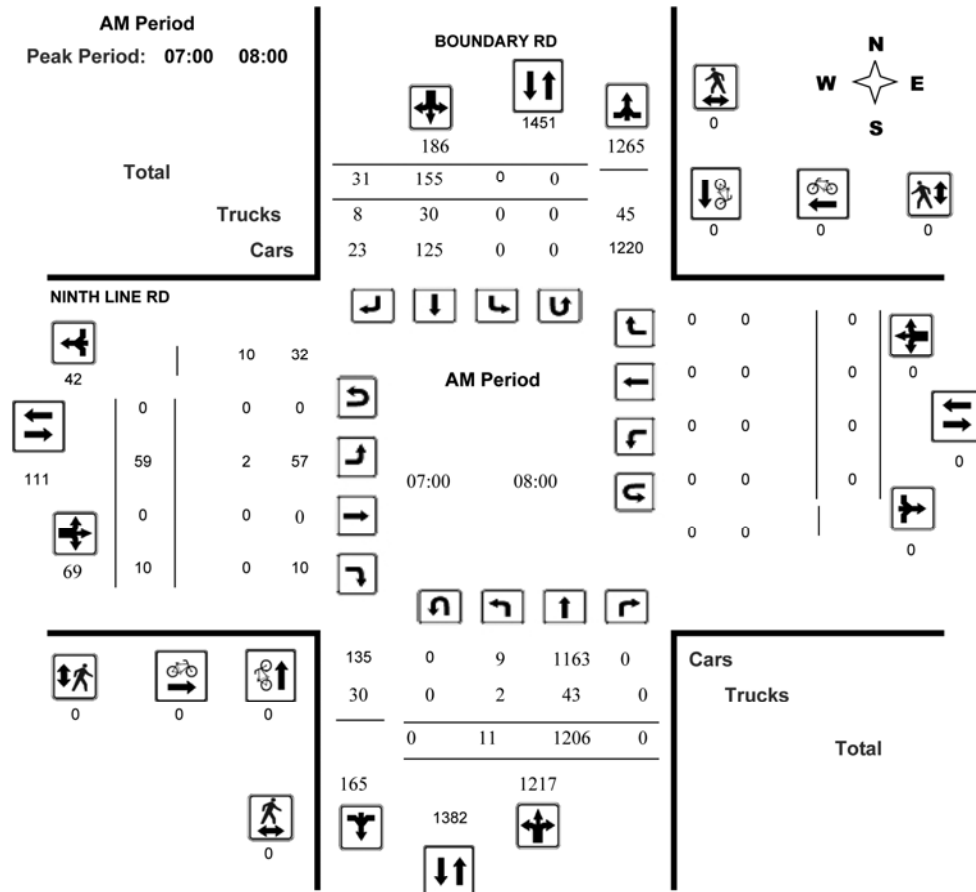


Public Works - Traffic Services
Turning Movements Count - Peak Period Diagram

BOUNDARY RD @ NINTH LINE RD

Survey Date: Wednesday, October 13, 2010
Start Time: 07:00

WO No: 38
Device: Miovision





Public Works - Traffic Services
Turning Movements Count - Peak Period Diagram

BOUNDARY RD @ NINTH LINE RD

Survey Date: Wednesday, October 13, 2010
Start Time: 07:00

WO No: 38
Device: Miovision

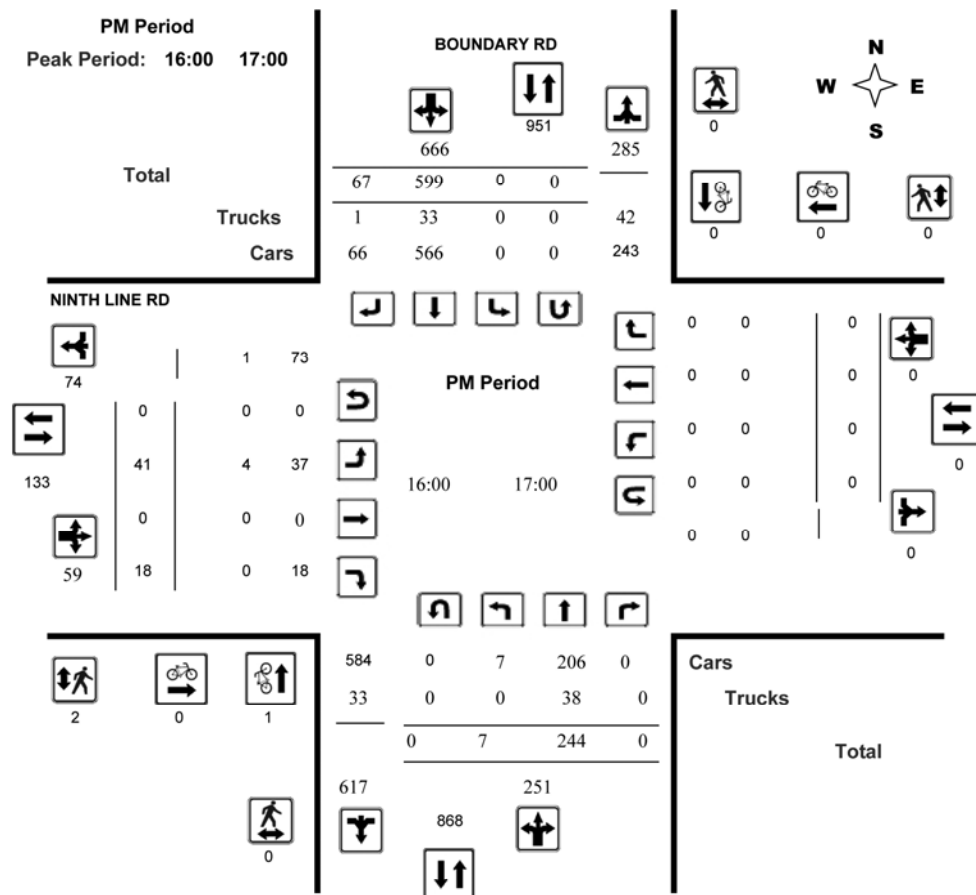


Exhibit 5: Year 2027 Peak AM and PM Hour Left Turn Lane Warrants – Boundary/CRRRC Access

TRAFFIC

$V_o = 828$ vph
 $V_A = 285$ vph
 $V_L = 39$ vph

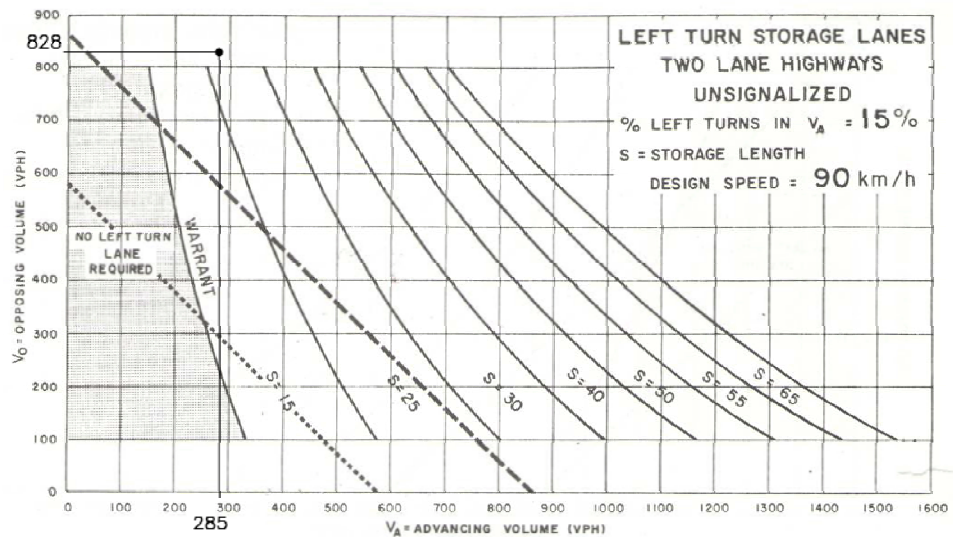
$V_L/V_A = 13.7\%$

POSTED SPEED
80 km/h

WARRANT

25 METRE LEFT
TURN LANE REQUIRED

**SOUTHBOUND LEFT
PEAK AM HOUR**



--- TRAFFIC SIGNALS MAY BE WARRANTED IN RURAL
AREAS OR URBAN AREAS WITH RESTRICTED FLOW

..... TRAFFIC SIGNALS MAY BE WARRANTED IN
"FREE FLOW" URBAN AREAS

TRAFFIC

$V_o = 351$ vph
 $V_A = 878$ vph
 $V_L = 39$ vph

$V_L/V_A = 4.4\%$

POSTED SPEED
80 km/h

WARRANT

25 METRE LEFT
TURN LANE REQUIRED

**SOUTHBOUND LEFT
PEAK PM HOUR**

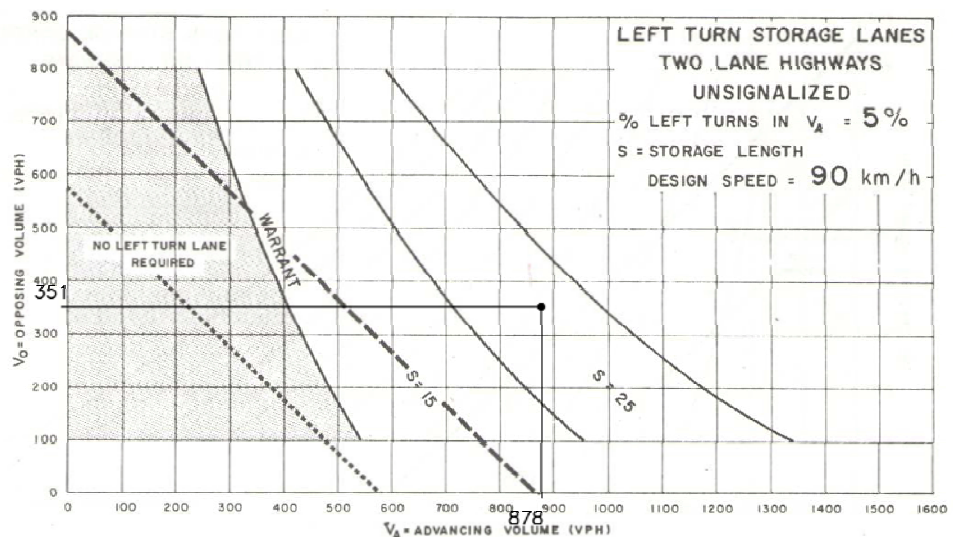


Exhibit 6: Year 2022 Peak AM Hour Traffic Analysis – Boundary/CRRRC Access

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak AM Hour**
 Intersection: **Boundary/Site Access**
 Analysis Year: **Year 2022**
 Project ID: CRRRC Site
 East/West Street: Site Access
 North/South Street: Boundary Road
 Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Vehicle Volumes and Adjustments							
Major Street:	Approach Movement	Northbound			Southbound		
		1 L	2 T	3 R	4 L	5 T	6 R
Volume			580	4	39	189	
Peak-Hour Factor, PHF			0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR			630	4	42	205	
Percent Heavy Vehicles			--	--	100	--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes			1	0		1	1
Configuration			TR			L	T
Upstream Signal?			No			No	

Minor Street:	Approach Movement	Westbound			Eastbound		
		7 L	8 T	9 R	10 L	11 T	12 R
Volume		4		39			
Peak Hour Factor, PHF		0.92		0.92			
Hourly Flow Rate, HFR		4		42			
Percent Heavy Vehicles		100		100			
Percent Grade (%)			0			0	
Flared Approach: Exists?/Storage				No	/		/
Lanes		0		0			
Configuration			LR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		L		LR				
v (vph)		42		46				
C(m) (vph)		614		320				
v/c		0.07		0.14				
95% queue length		0.22		0.50				
Control Delay		11.3		18.1				
LOS		B		C				
Approach Delay				18.1				
Approach LOS				C				

Exhibit 7: Year 2022 Peak PM Hour Traffic Analysis – Boundary/CRRRC Access

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak PM Hour**
 Intersection: **Boundary/Site Access**
 Analysis Year: **Year 2022**
 Project ID: CRRRC Site
 East/West Street: Site Access
 North/South Street: Boundary Road
 Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Vehicle Volumes and Adjustments							
Major Street:	Approach Movement	Northbound			Southbound		
		1 L	2 T	3 R	4 L	5 T	6 R
Volume			331	4	39	721	
Peak-Hour Factor, PHF			0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR			359	4	42	783	
Percent Heavy Vehicles			--	--	100	--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes			1	0		1	1
Configuration			TR			L	T
Upstream Signal?			No			No	

Minor Street:	Approach Movement	Westbound			Eastbound		
		7 L	8 T	9 R	10 L	11 T	12 R
Volume		4		39			
Peak Hour Factor, PHF		0.92		0.92			
Hourly Flow Rate, HFR		4		42			
Percent Heavy Vehicles		100		100			
Percent Grade (%)			0			0	
Flared Approach: Exists?/Storage				No	/		/
Lanes		0		0			
Configuration			LR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		L		LR				
v (vph)		42		46				
C(m) (vph)		809		398				
v/c		0.05		0.12				
95% queue length		0.16		0.39				
Control Delay		9.7		15.2				
LOS		A		C				
Approach Delay				15.2				
Approach LOS				C				

Exhibit 8: Year 2027 Peak AM Hour Traffic Analysis – Boundary/CRRRC Access

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak AM Hour**
 Intersection: **Boundary/Site Access**
 Analysis Year: **Year 2027**
 Project ID: CRRRC Site
 East/West Street: Site Access
 North/South Street: Boundary Road
 Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Vehicle Volumes and Adjustments							
Major Street:	Approach Movement	Northbound			Southbound		
		1 L	2 T	3 R	4 L	5 T	6 R
Volume			824	4	39	246	
Peak-Hour Factor, PHF			0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR			895	4	42	267	
Percent Heavy Vehicles			--	--	100	--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes			1	0		1	1
Configuration			TR			L	T
Upstream Signal?			No			No	

Minor Street:	Approach Movement	Westbound			Eastbound		
		7 L	8 T	9 R	10 L	11 T	12 R
Volume		4		39			
Peak Hour Factor, PHF		0.92		0.92			
Hourly Flow Rate, HFR		4		42			
Percent Heavy Vehicles		100		100			
Percent Grade (%)			0			0	
Flared Approach: Exists?/Storage				No	/		/
Lanes		0		0			
Configuration			LR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		L		LR				
v (vph)		42		46				
C(m) (vph)		467		211				
v/c		0.09		0.22				
95% queue length		0.29		0.80				
Control Delay		13.5		26.8				
LOS		B		D				
Approach Delay				26.8				
Approach LOS				D				

Exhibit 9: Year 2027 Peak PM Hour Traffic Analysis – Boundary/CRRRC Access

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak PM Hour**
 Intersection: **Boundary/Site Access**
 Analysis Year: **Year 2027**
 Project ID: CRRRC Site
 East/West Street: Site Access
 North/South Street: Boundary Road
 Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Vehicle Volumes and Adjustments							
Major Street:	Approach Movement	Northbound			Southbound		
		1 L	2 T	3 R	4 L	5 T	6 R
Volume			347	4	39	839	
Peak-Hour Factor, PHF			0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR			377	4	42	911	
Percent Heavy Vehicles			--	--	100	--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes			1	0		1	1
Configuration			TR			L	T
Upstream Signal?			No			No	

Minor Street:	Approach Movement	Westbound			Eastbound		
		7 L	8 T	9 R	10 L	11 T	12 R
Volume		4		39			
Peak Hour Factor, PHF		0.92		0.92			
Hourly Flow Rate, HFR		4		42			
Percent Heavy Vehicles		100		100			
Percent Grade (%)			0			0	
Flared Approach: Exists?/Storage				No	/		/
Lanes		0		0			
Configuration			LR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		L		LR				
v (vph)		42		46				
C(m) (vph)		794		363				
v/c		0.05		0.13				
95% queue length		0.17		0.43				
Control Delay		9.8		16.4				
LOS		A		C				
Approach Delay				16.4				
Approach LOS				C				

Exhibit 10: Year 2022 Peak AM Hour Traffic Analysis – Boundary/Mitch Owens

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak AM Hour**
Intersection: **Boundary/Mitch Owens**
Analysis Year: **Year 2022**
Project ID: CRRRC Site
East/West Street: Mitch Owens Road
North/South Street: Boundary Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		147	589			101	95
Peak-Hour Factor, PHF		0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR		159	640			109	103
Percent Heavy Vehicles		5	--	--		--	--
Median Type/Storage		Undivided			/		
RT Channelized?					No		
Lanes		0	1			1	1
Configuration		LT			T R		
Upstream Signal?		No			No		

Minor Street:	Approach	Westbound			Eastbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume					118		25
Peak Hour Factor, PHF					0.92		0.92
Hourly Flow Rate, HFR					128		27
Percent Heavy Vehicles					5		5
Percent Grade (%)		0			0		
Flared Approach: Exists?/Storage					/		
Lanes					1		1
Configuration					L		R

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT					L		R
v (vph)	159					128		27
C(m) (vph)	1341					214		937
v/c	0.12					0.60		0.03
95% queue length	0.40					3.39		0.09
Control Delay	8.0					44.1		9.0
LOS	A					E		A
Approach Delay							38.0	
Approach LOS							E	

Exhibit 11: Year 2022 Peak PM Hour Traffic Analysis – Boundary/Mitch Owens

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak PM Hour**
Intersection: **Boundary/Mitch Owens**
Analysis Year: **Year 2022**
Project ID: CRRRC Site
East/West Street: Mitch Owens Road
North/South Street: Boundary Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		27	146			579	142
Peak-Hour Factor, PHF		0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR		29	158			629	154
Percent Heavy Vehicles		5	--	--		--	--
Median Type/Storage		Undivided			/		
RT Channelized?					No		
Lanes		0	1			1	1
Configuration		LT			T R		
Upstream Signal?		No			No		
Minor Street:	Approach	Westbound			Eastbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume					149		152
Peak Hour Factor, PHF					0.92		0.92
Hourly Flow Rate, HFR					161		165
Percent Heavy Vehicles					5		5
Percent Grade (%)		0			0		
Flared Approach: Exists?/Storage					/		
Lanes					1		1
Configuration					L		R

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT					L		R
v (vph)	29					161		165
C(m) (vph)	822					317		477
v/c	0.04					0.51		0.35
95% queue length	0.11					2.72		1.53
Control Delay	9.5					27.5		16.5
LOS	A					D		C
Approach Delay							21.9	
Approach LOS							C	

Exhibit 12: Year 2027 Peak AM Hour Traffic Analysis – Boundary/Mitch Owens

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak AM Hour**
 Intersection: **Boundary/Mitch Owens**
 Analysis Year: **Year 2027**
 Project ID: CRRRC Site
 East/West Street: Mitch Owens Road
 North/South Street: Boundary Road
 Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		162	671			126	124
Peak-Hour Factor, PHF		0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR		176	729			136	134
Percent Heavy Vehicles		5	--	--		--	--
Median Type/Storage		Undivided			/		
RT Channelized?					No		
Lanes		0	1			1	1
Configuration		LT			T R		
Upstream Signal?		No			No		

Minor Street:	Approach	Westbound			Eastbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume					157		28
Peak Hour Factor, PHF					0.92		0.92
Hourly Flow Rate, HFR					170		30
Percent Heavy Vehicles					6		5
Percent Grade (%)		0			0		
Flared Approach: Exists?/Storage					/		
Lanes					1		1
Configuration					L		R

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT					L		R
v (vph)	176					170		30
C(m) (vph)	1276					169		905
v/c	0.14					1.01		0.03
95% queue length	0.48					8.05		0.10
Control Delay	8.3					125.8		9.1
LOS	A					F		A
Approach Delay							108.3	
Approach LOS							F	

Exhibit 13: Year 2027 Peak PM Hour Traffic Analysis – Boundary/Mitch Owens

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak PM Hour**
Intersection: **Boundary/Mitch Owens**
Analysis Year: **Year 2027**
Project ID: CRRRC Site
East/West Street: Mitch Owens Road
North/South Street: Boundary Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		30	173			660	183
Peak-Hour Factor, PHF		0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR		32	188			717	198
Percent Heavy Vehicles		5	--	--		--	--
Median Type/Storage		Undivided			/		
RT Channelized?					No		
Lanes		0	1			1	1
Configuration		LT			T R		
Upstream Signal?		No			No		

Minor Street:	Approach	Westbound			Eastbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume					178		168
Peak Hour Factor, PHF					0.92		0.92
Hourly Flow Rate, HFR					193		182
Percent Heavy Vehicles					6		5
Percent Grade (%)		0			0		
Flared Approach: Exists?/Storage					/		
Lanes					1		1
Configuration					L		R

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT					L		R
v (vph)	32					193		182
C(m) (vph)	733					265		425
v/c	0.04					0.73		0.43
95% queue length	0.14					5.12		2.10
Control Delay	10.1					47.9		19.7
LOS	B					E		C
Approach Delay							34.2	
Approach LOS							D	

Exhibit 14: Year 2027 Traffic Signal Warrant Analysis – Boundary/Mitch Owens

**MINIMUM WARRANTS FOR INSTALLATION OF TRAFFIC SIGNAL
USING PROJECTED VOLUME**

Location Boundary Road **of** Mitch Owens Road
(Roadway) **(Intersecting Road)**

Municipality City of Ottawa **Projected Volume** Year 2027

WARRANT	DESCRIPTION	MINIMUM REQUIREMENT FOR 2 LANE HIGHWAYS		COMPLIANCE		
		2. FREE FLOW	3. RESTRICT. FLOW	SECTIONAL		4. ENTIRE %
				NUMBER	%	
1. VEHICULAR VOLUME	1. A. Vehicle volume all approaches (Average hour)	(480)	720	665	100	74%
	B. Vehicle volume, along minor roads, (Average hour)	(180) 120	170	133	74	
2. DELAY TO CROSS TRAFFIC	1. A. Vehicle volume, along artery (Average hour)	(480)	720	532	100	(100%)
	B. Combined vehicle and pedestrian volume crossing artery from minor roads, (Average hour)	(50)	75	84	100	

Projected Average Hour - Use the sum of the AM and PM Peak volumes divided by 4

NOTES:

- Vehicle volume warrants (1A) and (2A) for intersections of roadways having two or more moving lanes in one direction, should be 25% higher than the values given above.
- Warrant values for free flow apply when the 85 percentile speed of artery traffic equals or exceeds 70 Km/h or when the intersection lies within the built-up area of an isolated community having a population of less than 10,000.
- Warrant values for restricted flow apply to large urban communities when the 85 percentile speed of artery traffic does not exceed 70 Km/h.
- The lowest sectional percentage governs the entire Warrant.
- For "T" intersections the warrant values for minor road should be increased by 50 % (Warrant 1B only).
- The crossing volumes are defined as:
 - Left turns from both minor road approaches
 - The heaviest through volume from the minor road
 - 50% of the heavier left turn movement from major road when both of the following are met:
 - the left turn volume > 120 vph.
 - the left turn volume plus the opposing volume > 720 vph.
 - Pedestrians crossing the major road.

Exhibit 15: Year 2022 Peak AM Hour Traffic Analysis – Boundary/Thunder

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak AM Hour**
 Intersection: **Boundary/Thunder**
 Analysis Year: **Year 2022**
 Project ID: CRRRC Site - Total Traffic
 East/West Street: Thunder Road
 North/South Street: Boundary Road
 Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		14	576			254	39
Peak-Hour Factor, PHF		0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR		15	626			276	42
Percent Heavy Vehicles		2	--	--		--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes		0	1			1	0
Configuration		LT			TR		
Upstream Signal?		No			No		
Minor Street:	Approach	Westbound			Eastbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume					75		13
Peak Hour Factor, PHF					0.92		0.92
Hourly Flow Rate, HFR					81		14
Percent Heavy Vehicles					2		2
Percent Grade (%)		0			0		
Flared Approach: Exists?/Storage		/			No /		
Lanes					0		0
Configuration					LR		

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	15						95	
C(m) (vph)	1242						312	
v/c	0.01						0.30	
95% queue length	0.04						1.26	
Control Delay	7.9						21.5	
LOS	A						C	
Approach Delay							21.5	
Approach LOS							C	

Exhibit 16: Year 2022 Peak PM Hour Traffic Analysis – Boundary/Thunder

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak PM Hour**
 Intersection: **Boundary/Thunder**
 Analysis Year: **Year 2022**
 Project ID: CRRRC Site - Total Traffic
 East/West Street: Thunder Road
 North/South Street: Boundary Road
 Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		9	295			602	85
Peak-Hour Factor, PHF		0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR		9	320			654	92
Percent Heavy Vehicles		2	--	--		--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes		0	1			1	0
Configuration		LT			TR		
Upstream Signal?		No			No		
Minor Street:	Approach	Westbound			Eastbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume					52		23
Peak Hour Factor, PHF					0.92		0.92
Hourly Flow Rate, HFR					56		24
Percent Heavy Vehicles					2		2
Percent Grade (%)		0			0		
Flared Approach: Exists?/Storage		/			No /		
Lanes					0		0
Configuration					LR		

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	9						80	
C(m) (vph)	862						290	
v/c	0.01						0.28	
95% queue length	0.03						1.10	
Control Delay	9.2						22.1	
LOS	A						C	
Approach Delay							22.1	
Approach LOS							C	

Exhibit 17: Year 2027 Peak AM Hour Traffic Analysis – Boundary/Thunder

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak AM Hour**
Intersection: **Boundary/Thunder**
Analysis Year: **Year 2027**
Project ID: CRRRC Site - Total Traffic
East/West Street: Thunder Road
North/South Street: Boundary Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments							
Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		17	551	129	296	249	43
Peak-Hour Factor, PHF		0.92	0.92	0.92	0.92	0.92	0.92
Hourly Flow Rate, HFR		18	598	140	321	270	46
Percent Heavy Vehicles		2	--	--	14	--	--
Median Type/Storage		Undivided			/		
RT Channelized?		No					
Lanes		1	1	1	1	1	0
Configuration		L	T	R	L		TR
Upstream Signal?		No			No		
Minor Street:	Approach	Westbound			Eastbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume		61	0	284	83	0	14
Peak Hour Factor, PHF		0.92	0.92	0.92	0.92	0.92	0.92
Hourly Flow Rate, HFR		66	0	308	90	0	15
Percent Heavy Vehicles		9	0	11	2	0	2
Percent Grade (%)		0			0		
Flared Approach: Exists?/Storage					/ No /		
Lanes		0	1	1	0	1	0
Configuration		LT		R	LTR		

Delay, Queue Length, and Level of Service								
Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L	L	LT		R		LTR	
v (vph)	18	321	66		308		105	
C(m) (vph)	1244	816	58		486		19	
v/c	0.01	0.39	1.14		0.63		5.53	
95% queue length	0.04	1.89	5.50		4.34		13.64	
Control Delay	7.9	12.2	279.1		24.4		2441	
LOS	A	B	F		C		F	
Approach Delay				69.3			2441	
Approach LOS				F			F	

Exhibit 18: Year 2027 Peak PM Hour Traffic Analysis – Boundary/Thunder

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak PM Hour**
Intersection: **Boundary/Thunder**
Analysis Year: **Year 2027**
Project ID: CRRRC Site - Total Traffic
East/West Street: Thunder Road
North/South Street: Boundary Road
Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		11	293	55	235	593	94
Peak-Hour Factor, PHF		0.92	0.92	0.92	0.92	0.92	0.92
Hourly Flow Rate, HFR		11	318	59	255	644	102
Percent Heavy Vehicles		2	--	--	11	--	--
Median Type/Storage		Undivided			/		
RT Channelized?		No					
Lanes		1	1	1	1	1	0
Configuration		L	T	R	L		TR
Upstream Signal?		No			No		

Minor Street:	Approach	Westbound			Eastbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume		115	0	295	57	0	25
Peak Hour Factor, PHF		0.92	0.92	0.92	0.92	0.92	0.92
Hourly Flow Rate, HFR		124	0	320	61	0	27
Percent Heavy Vehicles		7	0	13	2	0	2
Percent Grade (%)		0			0		
Flared Approach: Exists?/Storage					/ No /		
Lanes		0	1	1	0	1	0
Configuration		LT		R	LTR		

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L	L	LT		R		LTR	
v (vph)	11	255	124		320		88	
C(m) (vph)	862	1134	68		698		43	
v/c	0.01	0.22	1.82		0.46		2.05	
95% queue length	0.04	0.86	11.16		2.42		9.21	
Control Delay	9.2	9.1	522.1		14.4		688.3	
LOS	A	A	F		B		F	
Approach Delay				156.2			688.3	
Approach LOS				F			F	

Exhibit 19: Year 2027 Traffic Signal Warrant Analysis – Boundary/Thunder

**MINIMUM WARRANTS FOR INSTALLATION OF TRAFFIC SIGNAL
USING PROJECTED VOLUME**

Location Boundary Road of Thunder Road
(Roadway) (Intersecting Road)

Municipality City of Ottawa **Projected Volume** Year 2027

WARRANT	DESCRIPTION	MINIMUM REQUIREMENT FOR 2 LANE HIGHWAYS		COMPLIANCE		
		2. FREE FLOW	3. RESTRICT. FLOW	SECTIONAL		4. ENTIRE %
				NUMBER	%	
1. VEHICULAR VOLUME	1. A. Vehicle volume all approaches (Average hour)	(480)	720	875	100	(100%)
	B. Vehicle volume, along minor roads, (Average hour)	(120)	170	234	100	
2. DELAY TO CROSS TRAFFIC	1. A. Vehicle volume, along artery (Average hour)	(480)	720	642	100	100%
	B. Combined vehicle and pedestrian volume crossing artery from minor roads, (Average hour)	(50)	75	79	100	

Projected Average Hour - Use the sum of the AM and PM Peak volumes divided by 4

NOTES:

- Vehicle volume warrants (1A) and (2A) for intersections of roadways having two or more moving lanes in one direction, should be 25% higher than the values given above.
- Warrant values for free flow apply when the 85 percentile speed of artery traffic equals or exceeds 70 Km/h or when the intersection lies within the built-up area of an isolated community having a population of less than 10,000.
- Warrant values for restricted flow apply to large urban communities when the 85 percentile speed of artery traffic does not exceed 70 Km/h.
- The lowest sectional percentage governs the entire Warrant.
- For "T" intersections the warrant values for minor road should be increased by 50 % (Warrant 1B only).
- The crossing volumes are defined as:
 - Left turns from both minor road approaches
 - The heaviest through volume from the minor road
 - 50% of the heavier left turn movement from major road when both of the following are met:
 - the left turn volume > 120 vph.
 - the left turn volume plus the opposing volume > 720 vph.
 - Pedestrians crossing the major road.

Exhibit 20: Year 2022 Peak AM Hour Traffic Analysis – Boundary/Highway 417 Eastbound Ramps

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak AM Hour**
 Intersection: **Boundary/417 EB Ramp**
 Analysis Year: **Year 2022**
 Project ID: CRRRC Site
 East/West Street: Highway 417 EB Ramp
 North/South Street: Boundary Road
 Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		52	599			171	12
Peak-Hour Factor, PHF		0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR		56	651			185	13
Percent Heavy Vehicles		29	--	--		--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes		0	1			1	0
Configuration		LT			TR		
Upstream Signal?		No			No		
Minor Street:	Approach	Westbound			Eastbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume					16		122
Peak Hour Factor, PHF					0.92		0.92
Hourly Flow Rate, HFR					17		132
Percent Heavy Vehicles					15		10
Percent Grade (%)		0			0		
Flared Approach: Exists?/Storage					/ Yes /8		
Lanes					0	0	
Configuration					LR		

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	56						149	
C(m) (vph)	1229						937	
v/c	0.05						0.16	
95% queue length	0.14						0.56	
Control Delay	8.1						11.3	
LOS	A						B	
Approach Delay							11.3	
Approach LOS							B	

Exhibit 21: Year 2022 Peak PM Hour Traffic Analysis – Boundary/Highway 417 Eastbound Ramps

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak PM Hour**
 Intersection: **Boundary/417 EB Ramp**
 Analysis Year: **Year 2022**
 Project ID: CRRRC Site
 East/West Street: Highway 417 EB Ramp
 North/South Street: Boundary Road
 Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		98	249			160	20
Peak-Hour Factor, PHF		0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR		106	270			173	21
Percent Heavy Vehicles		6	--	--		--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes		0	1			1	0
Configuration		LT			TR		
Upstream Signal?		No			No		
Minor Street:	Approach	Westbound			Eastbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume					87		527
Peak Hour Factor, PHF					0.92		0.92
Hourly Flow Rate, HFR					94		572
Percent Heavy Vehicles					5		4
Percent Grade (%)		0			0		
Flared Approach: Exists?/Storage					/ Yes /8		
Lanes					0	0	
Configuration					LR		

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	106						666	
C(m) (vph)	1355						993	
v/c	0.08						0.67	
95% queue length	0.25						5.40	
Control Delay	7.9						17.3	
LOS	A						C	
Approach Delay							17.3	
Approach LOS							C	

Exhibit 22: Year 2027 Peak AM Hour Traffic Analysis – Boundary/Highway 417 Eastbound Ramps

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak AM Hour**
 Intersection: **Boundary/417 EB Ramp**
 Analysis Year: **Year 2027**
 Project ID: CRRRC Site
 East/West Street: Highway 417 EB Ramp
 North/South Street: Boundary Road
 Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		77	841			249	13
Peak-Hour Factor, PHF		0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR		83	914			270	14
Percent Heavy Vehicles		29	--	--		--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes		1	1			1	0
Configuration		L	T				TR
Upstream Signal?		No			No		
Minor Street:	Approach	Westbound			Eastbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume					18		339
Peak Hour Factor, PHF					0.92		0.92
Hourly Flow Rate, HFR					19		368
Percent Heavy Vehicles					15		15
Percent Grade (%)		0			0		
Flared Approach: Exists?/Storage		/			/		
Lanes					1		1
Configuration					L		R

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L					L		R
v (vph)	83					19		368
C(m) (vph)	1138					143		732
v/c	0.07					0.13		0.50
95% queue length	0.24					0.45		2.85
Control Delay	8.4					34.0		14.8
LOS	A					D		B
Approach Delay							15.7	
Approach LOS							C	

Exhibit 23: Year 2027 Peak PM Hour Traffic Analysis – Boundary/Highway 417 Eastbound Ramps

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak PM Hour**
 Intersection: **Boundary/417 EB Ramp**
 Analysis Year: **Year 2027**
 Project ID: CRRRC Site
 East/West Street: Highway 417 EB Ramp
 North/South Street: Boundary Road
 Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume		156	489			201	22
Peak-Hour Factor, PHF		0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR		169	531			218	23
Percent Heavy Vehicles		6	--	--		--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes		1	1			1	0
Configuration		L	T				TR
Upstream Signal?		No			No		

Minor Street:	Approach	Westbound			Eastbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume					96		721
Peak Hour Factor, PHF					0.92		0.92
Hourly Flow Rate, HFR					104		783
Percent Heavy Vehicles					5		9
Percent Grade (%)		0			0		
Flared Approach: Exists?/Storage					/		
Lanes					1		1
Configuration					L		R

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config	L					L		R
v (vph)	169					104		783
C(m) (vph)	1302					202		792
v/c	0.13					0.51		0.99
95% queue length	0.45					2.62		16.58
Control Delay	8.2					40.3		52.0
LOS	A					E		F
Approach Delay							50.7	
Approach LOS							F	

Exhibit 24: Year 2027 Traffic Signal Warrant Analysis – Boundary/Highway 417 Eastbound Ramps

**MINIMUM WARRANTS FOR INSTALLATION OF TRAFFIC SIGNAL
USING PROJECTED VOLUME**

Location Boundary Road **of** Highway 417 Eastbound Ramps
(Roadway) **(Intersecting Road)**

Municipality City of Ottawa **Projected Volume** Year 2027

WARRANT	DESCRIPTION	MINIMUM REQUIREMENT FOR 2 LANE HIGHWAYS		COMPLIANCE		
		2. FREE FLOW	3. RESTRICT. FLOW	SECTIONAL		4. ENTIRE %
				NUMBER	%	
1. VEHICULAR VOLUME	1. A. Vehicle volume all approaches (Average hour)	(480)	720	806	100	(100%)
	B. Vehicle volume, along minor roads, (Average hour)	(180) 120	170	294	100	
2. DELAY TO CROSS TRAFFIC	1. A. Vehicle volume, along artery (Average hour)	(480)	720	512	100	58%
	B. Combined vehicle and pedestrian volume crossing artery from minor roads, (Average hour)	(50)	75	29	58	

Projected Average Hour - Use the sum of the AM and PM Peak volumes divided by 4

NOTES:

1. Vehicle volume warrants (1A) and (2A) for intersections of roadways having two or more moving lanes in one direction, should be 25% higher than the values given above.
2. Warrant values for free flow apply when the 85 percentile speed of artery traffic equals or exceeds 70 Km/h or when the intersection lies within the built-up area of an isolated community having a population of less than 10,000.
3. Warrant values for restricted flow apply to large urban communities when the 85 percentile speed of artery traffic does not exceed 70 Km/h.
4. The lowest sectional percentage governs the entire Warrant.
5. For "T" intersections the warrant values for minor road should be increased by 50 % (Warrant 1B only).
6. The crossing volumes are defined as:
 - (a) Left turns from both minor road approaches
 - (b) The heaviest through volume from the minor road
 - (c) 50% of the heavier left turn movement from major road when both of the following are met:
 - (i) the left turn volume > 120 vph.
 - (ii) the left turn volume plus the opposing volume > 720 vph.
 - (d) Pedestrians crossing the major road.

Exhibit 25: Year 2027 Peak AM Hour Signal Analysis – Boundary/Highway 417 Eastbound Ramps

HCS+: Signalized Intersections Release 5.4

Analyst: Inter.: **Boundary/417 EB Ramps**
 Period: **Peak AM Hour** Year: **Year 2027**
 Project ID: CRRRC Site - Total Traffic - **Traffic Signals**
 E/W St: Highway 417 EB Ramp N/S St:

SIGNALIZED INTERSECTION SUMMARY													
	Eastbound			Westbound			Northbound			Southbound			
	L	T	R	L	T	R	L	T	R	L	T	R	
No. Lanes	1	0	1	0	0	0	1	1	0	0	1	0	
LGConfig	L		R				L	T			TR		
Volume	18		339				17	841		249	13		
Lane Width	3.6		3.6				3.6	3.6		3.6			
RTOR Vol			125								13		
Duration	0.25	Area Type: All other areas											
Signal Operations													
Phase Combination	1	2	3	4			5	6	7	8			
EB Left	A						NB Left	P	A				
Thru							Thru	P	A				
Right	A						Right						
Peds							Peds	X	X				
WB Left							SB Left						
Thru							Thru	P					
Right							Right	P					
Peds	X						Peds						
NB Right							EB Right						
SB Right							WB Right						
Green		22.0						50.0	10.0				
Yellow		3.7						3.7	3.7				
All Red		2.3						2.3	2.3				
Cycle Length: 100.0 secs													

CAPACITY AND LOS WORKSHEET							
Capacity Analysis and Lane Group Capacity							
Appr/	Lane	Flow Rate	Adj Sat	Flow	Green	--Lane Group--	
Mvmt	Group	(v)	(s)	Ratio (v/s)	Ratio (g/C)	Capacity (c)	v/c Ratio
Eastbound							
Prot							
Perm							
Left	L	20	1487	0.01	0.23	342	0.06
Prot							
Perm							
Thru							
Right	R	233	1330	# 0.18	0.23	306	0.76
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot		0	1326	0.00	0.160	212	0.00
Perm		18	656	0.03	0.570	374	0.05
Left	L	18			0.73	586	0.03
Prot							
Perm							
Thru	T	914	1636	# 0.56	0.73	1194	0.77
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	271	1525	0.18	0.51	778	0.35
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.73
 Total lost time per cycle, L = 4.00 sec
 Critical flow rate to capacity ratio, **Xc = (Yc)(C)/(C-L) = 0.76**

Exhibit 26: Year 2027 Peak PM Hour Signal Analysis – Boundary/Highway 417 Eastbound Ramps

HCS+: Signalized Intersections Release 5.4

Analyst: Inter.: **Boundary/417 EB Ramps**
 Period: **Peak PM Hour** Year: **Year 2027**
 Project ID: CRRRC Site - Total Traffic - **Traffic Signals**
 E/W St: Highway 417 EB Ramp N/S St:

SIGNALIZED INTERSECTION SUMMARY

	Eastbound			Westbound			Northbound			Southbound		
	L	T	R	L	T	R	L	T	R	L	T	R
No. Lanes	1	0	1	0	0	0	1	1	0	0	1	0
LGConfig	L		R				L	T			TR	
Volume	96		721				156	489		201	22	
Lane Width	3.6		3.6				3.6	3.6		3.6		
RTOR Vol			125								22	

Duration	0.25	Area Type: All other areas										
		Signal				Operations						
Phase Combination	1	2	3	4	5	6	7	8				
EB Left	A				NB Left	P	A					
Thru					Thru	P	A					
Right	A				Right							
Peds					Peds	X	X					
WB Left					SB Left							
Thru					Thru	P						
Right					Right	P						
Peds	X				Peds							
NB Right					EB Right							
SB Right					WB Right							
Green	48.0					24.0	10.0					
Yellow	3.7					3.7	3.7					
All Red	2.3					2.3	2.3					
Cycle Length: 100.0 secs												

CAPACITY AND LOS WORKSHEET

Capacity Analysis and Lane Group Capacity							
Appr/	Lane	Adj	Adj Sat	Flow	Green	--Lane Group--	
Mvmt	Group	Flow Rate	Flow Rate	Ratio	Ratio	Capacity	v/c
		(v)	(s)	(v/s)	(g/C)	(c)	Ratio
Eastbound							
Prot							
Perm							
Left	L	104	1629	0.06	0.49	798	0.13
Prot							
Perm							
Thru							
Right	R	648	1404	# 0.46	0.49	688	0.94
Westbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru							
Right							
Northbound							
Prot		5	1613	0.00	0.160	258	0.02
Perm		165	532	0.31	0.310	165	1.00
Left	L	170			0.47	423	0.40
Prot							
Perm							
Thru	T	532	1525	# 0.35	0.47	717	0.74
Right							
Southbound							
Prot							
Perm							
Left							
Prot							
Perm							
Thru	TR	218	1667	0.13	0.25	417	0.52
Right							

Sum of flow ratios for critical lane groups, Yc = Sum (v/s) = 0.81
 Total lost time per cycle, L = 4.00 sec
 Critical flow rate to capacity ratio, $Xc = (Yc)(C)/(C-L) = 0.84$

Exhibit 27: Year 2022 Peak AM Hour Traffic Analysis – Boundary/Highway 417 Westbound Ramps

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak AM Hour**
 Intersection: **Boundary/417 WB Ramp**
 Analysis Year: **Year 2022**
 Project ID: CRRRC Site
 East/West Street: Highway 417 WB Ramp
 North/South Street: Boundary Road
 Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume			123	471	38	110	
Peak-Hour Factor, PHF			0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR			133	511	41	119	
Percent Heavy Vehicles			--	--	3	--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes			1	0		0	1
Configuration			TR			LT	
Upstream Signal?			No			No	

Minor Street:	Approach	Westbound			Eastbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume		88		10			
Peak Hour Factor, PHF		0.92		0.92			
Hourly Flow Rate, HFR		95		10			
Percent Heavy Vehicles		15		13			
Percent Grade (%)			0			0	
Flared Approach: Exists?/Storage				Yes	/2		/
Lanes		0		0			
Configuration			LR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		41		105				
C(m) (vph)		936		475				
v/c		0.04		0.22				
95% queue length		0.14		0.84				
Control Delay		9.0		15.3				
LOS		A		C				
Approach Delay				15.3				
Approach LOS				C				

Exhibit 28: Year 2022 Peak PM Hour Traffic Analysis – Boundary/Highway 417 Westbound Ramps

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak PM Hour**
 Intersection: **Boundary/417 WB Ramp**
 Analysis Year: **Year 2022**
 Project ID: CRRRC Site
 East/West Street: Highway 417 WB Ramp
 North/South Street: Boundary Road
 Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach Movement	Northbound			Southbound		
		1 L	2 T	3 R	4 L	5 T	6 R
Volume			196	126	23	158	
Peak-Hour Factor, PHF			0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR			213	136	24	171	
Percent Heavy Vehicles			--	--	11	--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes			1	0		0	1
Configuration			TR			LT	
Upstream Signal?			No			No	
Minor Street:	Approach Movement	Westbound			Eastbound		
		7 L	8 T	9 R	10 L	11 T	12 R
Volume		43		11			
Peak Hour Factor, PHF		0.92		0.92			
Hourly Flow Rate, HFR		46		11			
Percent Heavy Vehicles		6		1			
Percent Grade (%)			0			0	
Flared Approach: Exists?/Storage				Yes	/2		/
Lanes		0		0			
Configuration			LR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		24		57				
C(m) (vph)		1161		634				
v/c		0.02		0.09				
95% queue length		0.06		0.30				
Control Delay		8.2		12.2				
LOS		A		B				
Approach Delay				12.2				
Approach LOS				B				

Exhibit 29: Year 2027 Peak AM Hour Traffic Analysis – Boundary/Highway 417 Westbound Ramps

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak AM Hour**
 Intersection: **Boundary/417 WB Ramp**
 Analysis Year: **Year 2027**
 Project ID: CRRRC Site
 East/West Street: Highway 417 WB Ramp
 North/South Street: Boundary Road
 Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach Movement	Northbound			Southbound		
		1 L	2 T	3 R	4 L	5 T	6 R
Volume			140	696	42	128	
Peak-Hour Factor, PHF			0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR			152	756	45	139	
Percent Heavy Vehicles			--	--	3	--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes			1	0		0	1
Configuration			TR			LT	
Upstream Signal?			No			No	

Minor Street:	Approach Movement	Westbound			Eastbound		
		7 L	8 T	9 R	10 L	11 T	12 R
Volume		152		11			
Peak Hour Factor, PHF		0.92		0.92			
Hourly Flow Rate, HFR		165		11			
Percent Heavy Vehicles		15		13			
Percent Grade (%)			0			0	
Flared Approach: Exists?/Storage				Yes	/2		/
Lanes		0		0			
Configuration			LR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		45		176				
C(m) (vph)		746		357				
v/c		0.06		0.49				
95% queue length		0.19		2.61				
Control Delay		10.1		24.9				
LOS		B		C				
Approach Delay				24.9				
Approach LOS				C				

Exhibit 30: Year 2027 Peak PM Hour Traffic Analysis – Boundary/Highway 417 Westbound Ramps

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak PM Hour**
 Intersection: **Boundary/417 WB Ramp**
 Analysis Year: **Year 2027**
 Project ID: CRRRC Site
 East/West Street: Highway 417 WB Ramp
 North/South Street: Boundary Road
 Intersection Orientation: NS Study period (hrs): 0.25

Vehicle Volumes and Adjustments

Major Street:	Approach	Northbound			Southbound		
	Movement	1	2	3	4	5	6
		L	T	R	L	T	R
Volume			222	347	25	177	
Peak-Hour Factor, PHF			0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR			241	377	27	192	
Percent Heavy Vehicles			--	--	11	--	--
Median Type/Storage		Undivided			/		
RT Channelized?							
Lanes			1	0	0	1	
Configuration				TR		LT	
Upstream Signal?			No			No	
Minor Street:	Approach	Westbound			Eastbound		
	Movement	7	8	9	10	11	12
		L	T	R	L	T	R
Volume		69		12			
Peak Hour Factor, PHF		0.92		0.92			
Hourly Flow Rate, HFR		74		13			
Percent Heavy Vehicles		6		1			
Percent Grade (%)			0			0	
Flared Approach: Exists?/Storage				Yes	/2		/
Lanes		0		0			
Configuration			LR				

Delay, Queue Length, and Level of Service

Approach	NB	SB	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Config		LT		LR				
v (vph)		27		87				
C(m) (vph)		920		471				
v/c		0.03		0.18				
95% queue length		0.09		0.67				
Control Delay		9.0		15.2				
LOS		A		C				
Approach Delay				15.2				
Approach LOS				C				