June 15, 2018 Project No. 1787048

Ms. Amira Shehata
City of Ottawa
Planning and Growth Management Department
110 Laurier Avenue West, 4th Floor
Ottawa, Ontario

PROPOSED ROADWAY MODIFICATION OF BOUNDARY ROAD
CAPITAL REGION RESOURCE RECOVERY CENTRE
BOUNDARY ROAD, OTTAWA, ONTARIO

We are pleased to submit the following Roadway Modification Approval package prepared in support of the Site Plan application for the above development. This package includes Figures detailing the Site and proposed modifications, a Transportation Impact Study (TIS) and associated Addendums #1 and #2 previously issued and accepted by the City, a Geotechnical investigation memorandum providing recommendations for the pavement structure, and engineering drawings providing details of the proposed roadway modifications.

The initial Transportation Impact Study (TIS) was prepared for the subject site by Taggart-Miller dated December 2014. D.J. Halpenny & Associates was retained to prepare the traffic component of the impact assessment. Addendum 1 was issued February 2015 based on a request from the Ministry of Transportation Ontario (MTO) that the intersection of Boundary Road and Thunder Road be considered in the TIS report. The addendum addresses the operation of the intersection of Boundary Road and Thunder Road during the weekday peak AM and PM hours. Addendum 2 was issued May 2015 in response to address comments provided by the Ministry of Transportation on the initial TIS.

The Key Plan, Context Plan, and Proposed Roadway Modifications Plan have been prepared based on City of Ottawa Transportation Impact Assessment (TIA) Guidelines for the proposed modifications. A Removals Plan and Plan and Profile Drawings of the modification area are also included. A Technical Memorandum is provided which summarizes the geotechnical investigation of the existing road and the proposed modifications to the existing road structure and the proposed structure for the widened areas.

Golder Associates Ltd.
683 Innovation Drive, Unit 1, Kingston, Ontario, K7K 7E6, Canada T: +1 613 542 0029 F: +1 613 542-0689

We trust that the enclosed meets the requirements of the Site Plan application. If you should have any questions, please do not hesitate to contact the undersigned.

Golder Associates Ltd.

Matt Knowles, P.Eng., PMP
Civil/Environmental Engineer and PM

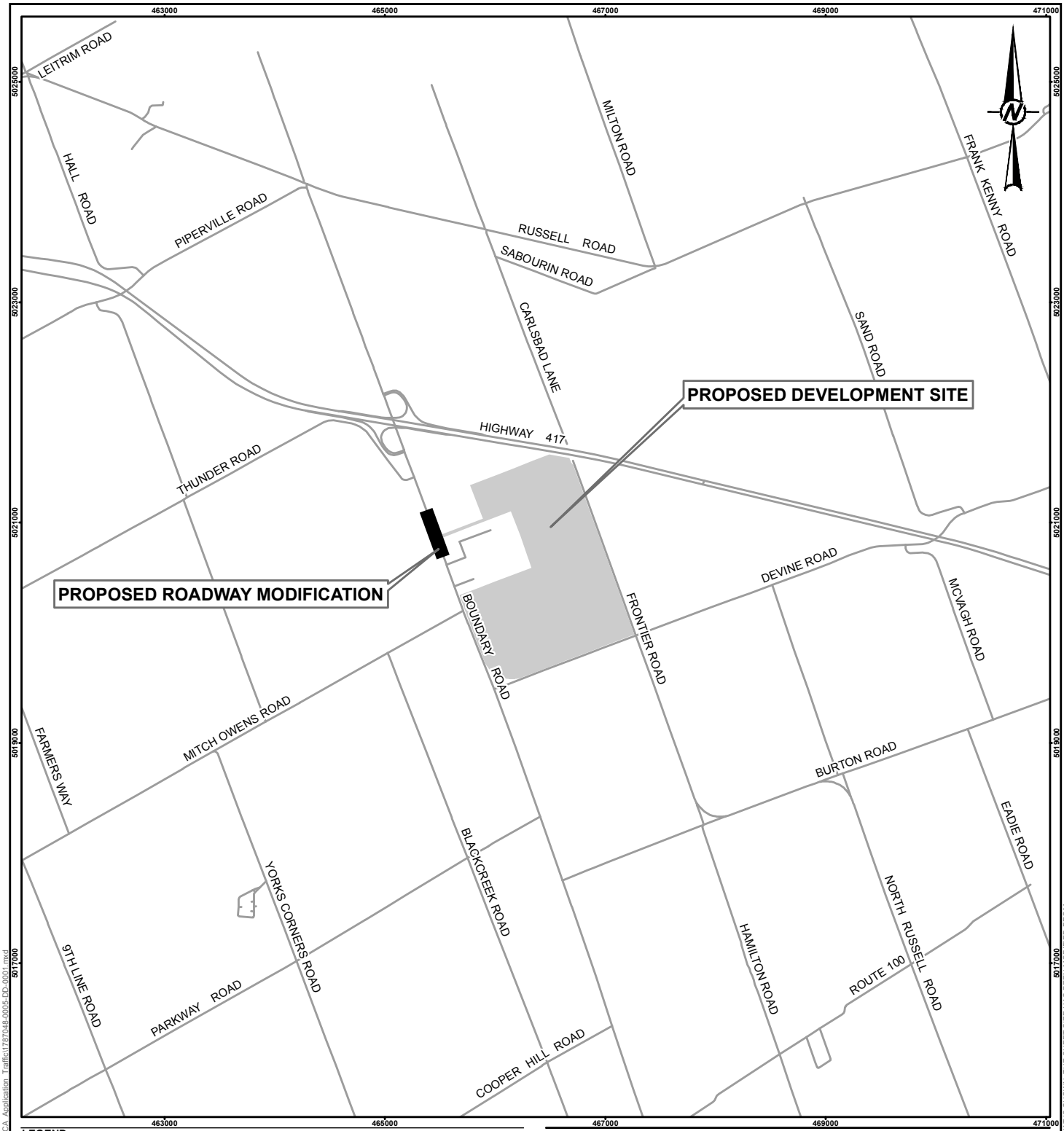
Douglas V. Kerr, P.Eng.
Associate, Senior Civil Engineer

MHK/DVK/mvrd
https://golderassociates.sharepoint.com/sites/18733g/technical work/phase 500 detailed design/task 5.1 civil engineering/traffic impact study/cover letter - traffic impact study - for site plan application 2018.06.15.docx

Attachments:	Attachment A	Figures 1787048-0005-DD-0001 through 1787048-0005-DD-0003
	Attachment B	Traffic Impact Study, dated December 2014
	Attachment C	Addendum #1 to Traffic Impact Study, dated February 2015 Addendum #2 to Traffic Impact Study, dated May 2015
	Attachment D	Geotechnical/Pavement Investigation – Proposed Boundary Road Improvements, dated April 10, 2018
	Attachment E	Drawings 1787048-0005-CW-0001 through 1787048-0005-CW-0003

ATTACHMENT A

Figures 1787048-005-DD-0001 through 1787048-005-DD -0003



LEGEND

- PROPOSED ROADWAY MODIFICATION
- PROPOSED DEVELOPMENT SITE

0 500 1,000 2,000

1:50,000 METRES

NOTE(S)
1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)
1. BASE DATA – NRVIS, ONTARIO MINISTRY OF NATURAL RESOURCES
© QUEENS PRINTER 2011
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18 VERTICAL DATUM: CGVD28

CLIENT
TAGGART MILLER ENVIRONMENTAL SERVICES

PROJECT
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
KEY MAP

CONSULTANT
GOLDER

YYYY-MM-DD	2018-06-14
DESIGNED	PJM
PREPARED	PJM
REVIEWED	MHK
APPROVED	DVK

PROJECT NO.	CONTROL	REV.	FIGURE
1787048	0005	0	1

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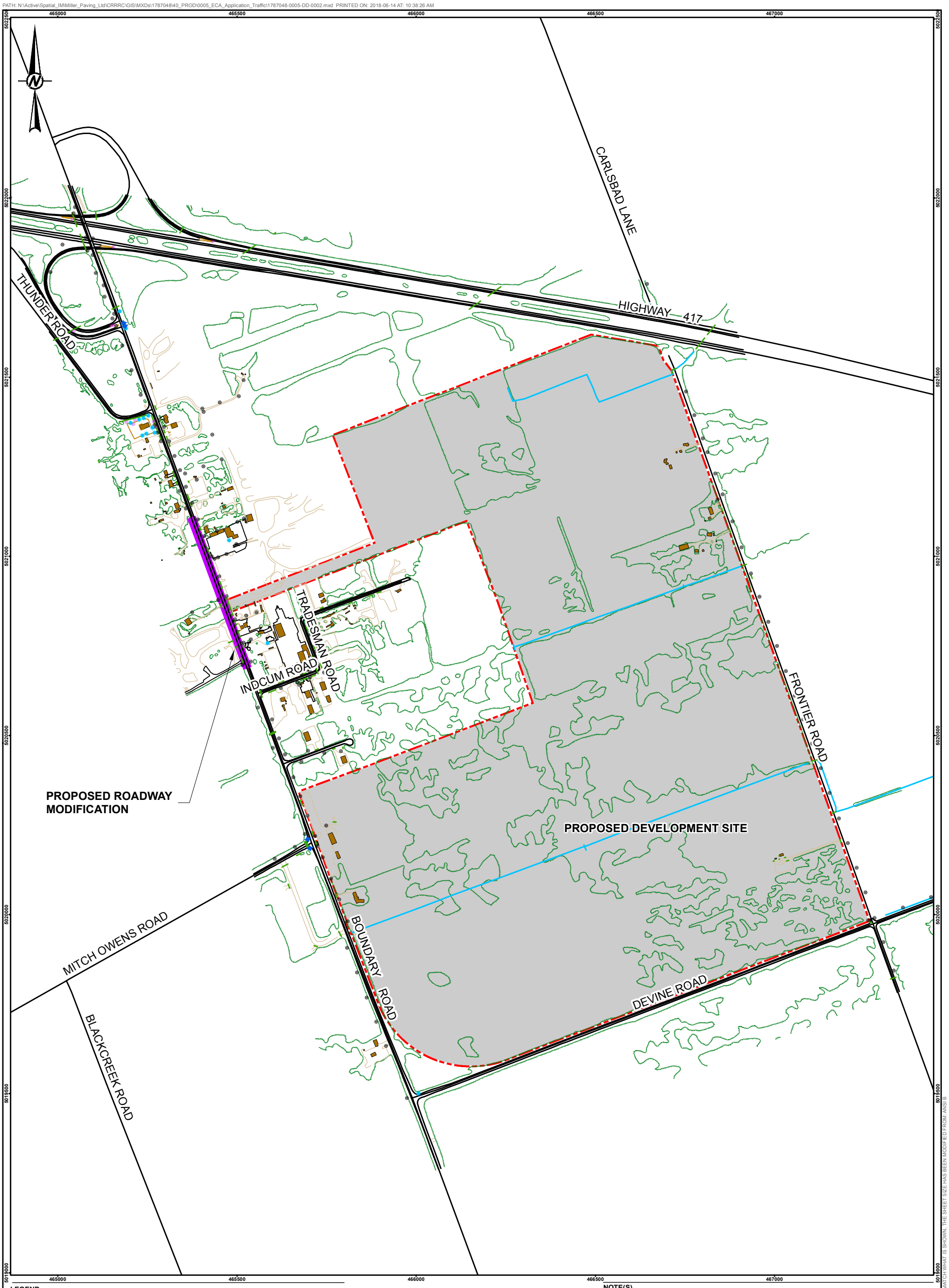

LEGEND

- TRAFFIC LIGHT
- STREET LIGHT
- HYDRO POLE
- CATCH BASIN
- SURFACE WATER FEATURE
- CULVERT
- CURB
- TREE LINE
- PAVED ROAD
- PAVED DRIVEWAY
- GRAVEL DRIVEWAY
- PROPOSED ROADWAY MODIFICATION
- BUILDINGS
- PROPOSED DEVELOPMENT SITE
- PROPERTY BOUNDARY

0 100 200 400
1:10,000 METRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. BASE DATA – BASEMAPPING LIMITED
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18 VERTICAL DATUM: CGVD28

CLIENT
TAGGART MILLER ENVIRONMENTAL SERVICES

PROJECT
CAPITAL REGION RESOURCE RECOVERY CENTRE

CONSULTANT
GOLDER

YYYY-MM-DD	2018-06-14
DESIGNED	PJM
PREPARED	PJM/BR
REVIEWED	MHK
APPROVED	DVK

TITLE
CONTEXT PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
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TIE PROPOSED DITCH INTO EXISTING DITCH

PROPOSED THROUGH LANE

PROPOSED THROUGH LANE

TIE PROPOSED DITCH INTO EXISTING DITCH

PROPOSED LEFT TURN LANE

PROPOSED 18.3 m - 600 mmØ CSP CULVERT

TAPER

PROPOSED 42.0 m - 600 mmØ CSP CULVERT

SITE ACCESS ROAD

PROPOSED 11.8 m - 600 mmØ CSP CULVERT

PROPOSED 12.4 m - 600 mmØ CSP CULVERT

TAPER

PROPOSED 12.4 m - 600 mmØ CSP CULVERT

PROPOSED THROUGH LANE

TIE PROPOSED DITCH INTO EXISTING DITCH

PROPOSED THROUGH LANE

PROPOSED 11.5 m - 600 mmØ CSP CULVERT

PROPOSED 17.8 m - 600 mmØ CSP CULVERT

TIE PROPOSED DITCH INTO EXISTING DITCH

BOUNDARY ROAD

INDCUM ROAD

LEGEND

- STREET LIGHT
- HYDRO POLE
- CULVERT
- CURB
- PAVED ROAD
- PAVED DRIVEWAY
- GRAVEL DRIVEWAY
- BUILDINGS
- PROPOSED DEVELOPMENT SITE
- PROPERTY BOUNDARY
- PROPERTY PARCEL
- AREA OF ROAD MODIFICATION

0 15 30 60

1:1,500 METRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. BASE DATA – BASEMAPPING LIMITED
2. PROPERTY PARCEL DATA DIGITIZED ON 2018-06-07 FROM THE CITY OF OTTAWA GEOOTTAWA WEBSITE
3. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 18 VERTICAL DATUM: CGVD28

CLIENT
TAGGART MILLER ENVIRONMENTAL SERVICES

PROJECT
CAPITAL REGION RESOURCE RECOVERY CENTRE

CONSULTANT
GOLDER

YYYY-MM-DD	2018-06-14
DESIGNED	PJM
PREPARED	PJM/BR
REVIEWED	MHK
APPROVED	DVK

TITLE
PROPOSED ROADWAY MODIFICATIONS

PROJECT NO.	CONTROL	REV.	FIGURE
1787048	0005	0	3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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ATTACHMENT B

Traffic Impact Study, dated December 2014

December 2014

Technical Support Document #9

TRAFFIC IMPACT STUDY

TAGGART GROUP OF COMPANIES

THE MILLER GROUP

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Exhibits 4 to 19, 21 and 22 – Operational Analyses

Exhibit 20 – Left Turn Lane Warrants

1.0 INTRODUCTION

The site of the proposed Capital Region Resource Recovery Centre (CRRRC) is located near the east central boundary of the City of Ottawa. The Site fronts onto Boundary Road to the west and Devine Road to the south. The location of the Site is shown in Figure 1.1.

The CRRRC is proposed as a waste management facility consisting of various waste diversion facilities and a landfill component for the disposal of residual waste materials. The Site is approximately 192 hectares in size. The Site's main access would be directly onto Boundary Road would be used as the primary access for trucks entering and exiting the waste management facility. A secondary access would be provided onto Frontier Road that could be mainly used by Site operations and maintenance vehicles and staff.

D.J. Halpenny & Associates were retained to prepare the traffic component of the impact assessment.

1.1 Scope of Work

The traffic study area included the roadways and intersections in the area of the Site. The intersections examined consist of the main Site access location off Boundary Road, and the Boundary/Mitch Owens, Boundary/Devine, Boundary/eastbound (EB) 417 Ramp, and Boundary/westbound (WB) 417 Ramp intersections.

The traffic impact analysis examined the intersections for the peak hour of traffic on the adjacent roads which would occur during the weekday peak AM and PM hours. The horizon year of the analysis is the year 2022, which represents five years beyond the 2017 date when the facility is assumed to be open and operational. The facility will operate six days a week year round.

2.0 EXISTING ROADS AND INTERSECTIONS

The road network in the area of the CRRRC is shown on Figure 1.1.

The CRRRC facility will have one access directly onto Boundary Road (refer to Figure 1.1), which would be used mainly by trucks entering and exiting the Site. 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 metres plus gravel shoulders. The posted speed limit along the road in the vicinity of the Site is 80 km/h.

The Site will have a secondary access from Frontier Road, which borders the east limit of the Site. North of Devine Road, Frontier Road is a two lane local road with a gravel surface and "No Exit" signs posted (terminates at Highway 417). South of Devine Road, Frontier Road is a two lane rural collector road under the jurisdiction of the City of Ottawa with a posted speed limit of 80 km/h.

The south property limit of the facility borders onto Devine Road. Devine Road (Ottawa Road 8) is a City of Ottawa two lane rural arterial road with the west limit connecting to Boundary Road (Ottawa Road 41) and the east limit terminating at the east side of Vars. The road has an asphalt surface with gravel shoulders. Devine Road has an unposted speed limit of 80 km/h.

Mitch Owens Road (Ottawa Road 8) is an east-west two lane arterial road located approximately 770 metres north of Devine Road. Mitch Owens Road (Ottawa Road 8) has an asphalt surface and gravel shoulders, with a posted speed limit of 80 km/h.

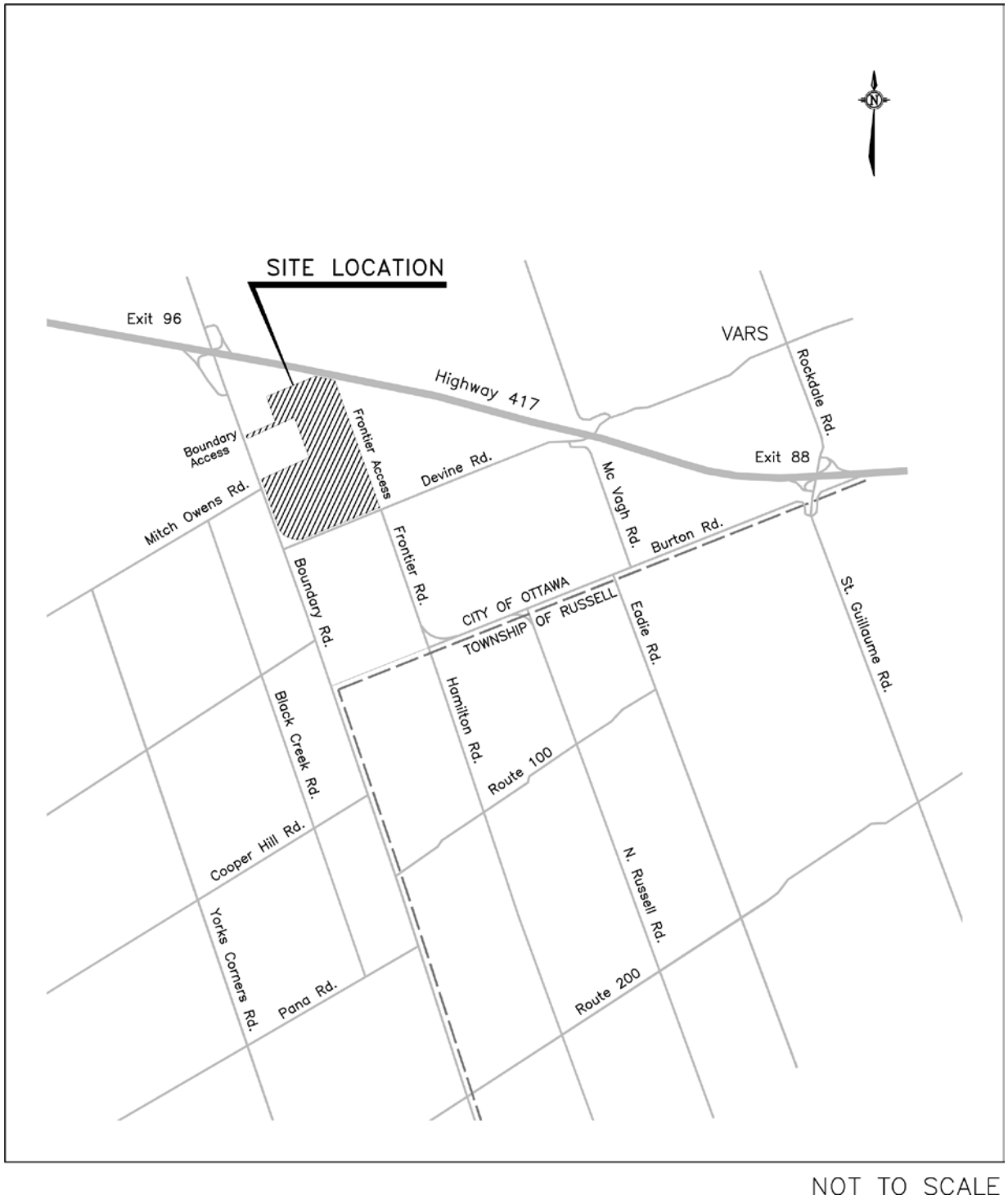


Figure 1.1: Site Location Plan

Bordering a portion of the north limit of the Site is Highway 417. Highway 417 is a four lane divided road under the jurisdiction of the Ministry of Transportation Ontario (MTO). The highway has two interchanges with Boundary Road (Exit 96) for the both the eastbound and westbound on/off ramps.

The intersection of Boundary Road and Mitch Owens Road is a "T" intersection located approximately 770 metres north of Devine Road. Boundary Road forms the northbound and southbound approaches, and Mitch Owens Road the eastbound approach. The intersection is controlled by a stop sign at the eastbound Mitch Owens Road approach. The 2012 City of Ottawa peak hour traffic counts are provided in Appendix A as Exhibit 1. The intersection has the following lane configuration:

- Northbound Boundary Road — One shared left/through lane
- Southbound Boundary Road — One through lane
  One exclusive right turn lane (20 m parallel lane)
- Eastbound Mitch Owens Road — One exclusive left turn lane (40 m storage)
  One exclusive right turn lane

The intersection of Devine Road and Boundary Road is located approximately 1.4 kilometres west of Frontier Road. The intersection is a "T" intersection with Devine Road forming the westbound approach and Boundary Road the northbound and southbound approaches. The intersection is controlled by a stop sign at the westbound Devine Road approach. The intersection has the following lane configuration:

- Northbound Boundary Road — One shared through/right lane
- Southbound Boundary Road — One exclusive left turn lane (20 m storage)
  One through lane
- Westbound Devine Road — One exclusive left turn lane (40 m storage)
  One exclusive right turn lane

The intersection of Boundary Road and the Highway 417 eastbound on/off ramp is located on the south side of Highway 417 approximately 1,550 metres north of Mitch Owens Road. The intersection is a "T" intersection with Boundary Road forming the northbound and southbound approaches, and the Highway 417 on/off ramp the eastbound divided approach. The 2011 MTO traffic counts are provided as Exhibit 2. The intersection has the following lane configuration:

- Northbound Boundary Road — One shared left/through lane
- Southbound Boundary Road — One shared through/right lane
- Eastbound 417 On/Off Ramp — One shared left/right turn lane (flared approach)

The intersection of Boundary Road and the Highway 417 westbound on/off ramp is located on the north side of Highway 417 approximately 2,100 metres north of Mitch Owens Road. The intersection is a "T" intersection with Boundary Road forming the northbound and southbound approaches, and the Highway 417 on/off ramp the westbound divided approach. The 2011 MTO traffic counts are provided as Exhibit 3. The intersection has the following lane configuration:

- Northbound Boundary Road — One shared through/right lane
- Southbound Boundary Road — One shared left/through lane
- Westbound 417 On/Off Ramp — One shared left/right turn lane (flared approach)

Figure 2.1 shows the weekday peak AM and PM hour traffic counts taken at the intersections that are examined in the study. The Annual Average Daily Traffic (AADT) is shown along Boundary Road both north and south of Highway 417. The AADT is the total annual traffic volumes divided by the number of days in the year. The figure also shows the date the counts were taken and the peak hour of the counts. The intersection counts at Boundary/Mitch Owens were obtained from the City of Ottawa, the Highway 417 on/off ramps from the MTO, and the Boundary/Devine counts were taken for this study by the consultant. The traffic counts determined that over an 8 hour period, trucks represent approximately 9.5 percent of the traffic along Boundary Road between Mitch Owens Road and the eastbound Highway 417 on/off ramps.

3.0 PROPOSED CAPITAL REGION RESOURCE RECOVERY CENTRE

The proposed CRRRC Site will be located on lands on the north side of Devine Road and east of Boundary Road in the City of Ottawa. The lands are described as part of Lots 23, 24 and 25, Concession XI, Township of Cumberland, and are zoned General Rural and Rural Heavy Industrial.

The land uses along Boundary Road in the vicinity of the Site are mainly commercial/industrial with eight residential houses largely along the west side of the road between Devine Road and Highway 417. Along Devine Road the land use is rural or agricultural with no houses between Boundary Road and Frontier Road. To the east of Frontier Road and north of Devine Road, the land use is agricultural with no houses. Land use in the area surrounding the Site is primarily industrial to the west and northwest and rural / agricultural in other directions.

The proposed use of the Site is a waste management facility consisting of various waste diversion facilities and a landfill component for disposal of residual waste materials. The Site will have one access onto Boundary Road located approximately 850 metres south of the eastbound Highway on/off ramp and 700 metres 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 the north end of Frontier Road; this access would be used infrequently by vehicles associated with Site operations, maintenance or emergency, resulting in a low volume of traffic entering and exiting the Site at that location, often at off-peak hours. Frontier Road forms the north approach (southbound approach) to the Devine/Frontier intersection.

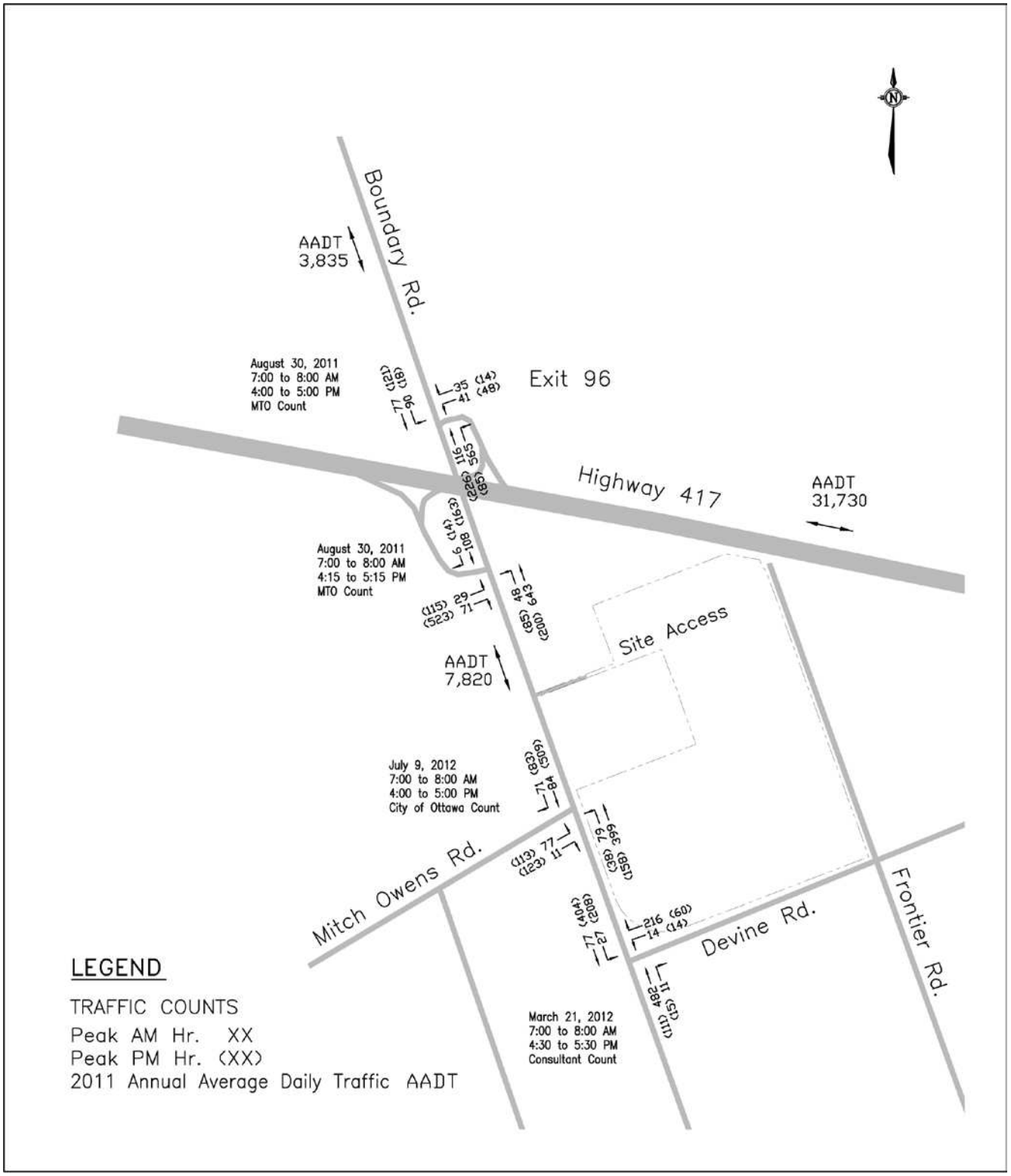


Figure 2.1: Weekday Peak AM and PM Hour Traffic Counts

The Site will operate six days a week (Monday through Saturday), and will be open between 7:00 AM and 6:00 PM.

There are no material agricultural land uses along Boundary Road between Highway 417 and the Site access location. As such, the CRRRC Site-related traffic along this section of Boundary Road will not affect the use of agricultural Site entrances or farm vehicle movements. The low usage of Frontier Road associated with the proposed secondary Site access onto the north end of Frontier Road is unlikely to adversely affect the usage of this road or Devine Road by agricultural traffic.

3.1 Trip Generation

The number of expected Site generated trips was determined by considering the amount and types of recyclable material/waste expected to be received at the Site, the anticipated diversion, and other Site activities. The Site generated trips would consist of loaded trucks entering the Site hauling waste material and surplus and impacted soils, and loaded trucks exiting the Site hauling pre-processed and composted organics and other diverted materials. The analysis examined the impact of the Site trips during the peak AM and PM hours of traffic along the adjacent roads. The calculations have assumed that the facility is operating at a maximum annual capacity of 450,000 tonnes per year of incoming material/waste. Assuming the Site operates about 300 days per year, on a typical day the Site would receive an average of 1,500 tonnes per day of various materials/waste.

It was however recognized that on some days there could be receipt of surplus or contaminated soil from excavation and/or remediation projects in addition to typical IC&I and C&D materials/waste received, as such projects are by definition episodic and event-driven. In order to account for this event-related soil traffic, for purposes of traffic analysis it was assumed that the Site might on a peak day receive 1,300 tonnes of IC&I and C&D wastes, and in addition 1,700 tonnes of soil. Therefore, to ensure potential traffic impacts were fully considered, the traffic analysis assumed a maximum 3,000 tonnes per day of materials at the CRRRC (but within the overall assumed maximum of 450,000 tonnes per year of incoming material). The analysis has assumed that employees of the facility arrive and depart outside the peak hours of the adjacent roads. The facility may operate about 300 days per year with estimated daily truck trips as follows:

- Waste Trips (IC&I and Organics) – 290,000 t per year/300 days per year @ 10 t per truck = 97 Trucks
- Waste C&D Trips – 100,000 t per year/300 days per year @ 3 t per truck = 111 Trucks
- Soil Trips – 60,000 t per year. Assume event-related 1,700 t per day @ 34 t per truck = 50 Trucks
- Diversion – Organics Diversion – 10,000 t per year/300 days @ 30 t per truck = 1 Trucks
    - C&D Wood – 30,000 t per year/300 days @ 20 t per truck = 5 Trucks
    - C&D Other – 5,000 t per year/300 days @ 30 t per truck = 1 Trucks
    - IC&I Diversion – 35,000 t per year/300 days @ 21 t per truck = 6 Trucks

The total assumed maximum daily number of trucks per day is 271 trucks entering and exiting the Site. Assuming a 10 hour day, and applying a 1.45 peaking factor to all trips entering and exiting the Site to account for random arrivals, the total assumed number of peak hour trips are:

- 271 trips per day/10 hours per day x 1.45 Peaking Factor = **40 Trips per hour** entering and exiting

In addition, the Site will generate landfill leachate that will require treatment, with the preferred option being off-Site treatment at the City of Ottawa Robert O Pickard Environmental Centre (ROPEC). The quantity of leachate would be small during the first few years of operation of the facility, but will increase to a maximum of approximately 230,000 m^3/year when the Site is fully developed. The estimated maximum material for treatment would be 230,000 m^3/year of landfill leachate and 35,000 m^3/year of digested organics processing liquor, for a total of 265,000 m^3/year. It is assumed this would be transported 250 days per year and would enter and leave the Site at regular intervals. For this reason a random arrival peaking factor was not applied. The trips related to the leachate treatment are:

- ROPEC Trips – 265,000 m^3 per year/250 days per year @ 40 m^3 per truck = 26 Trips per day

For a 10 hour day the expected trips relating to leachate treatment are:

- 26 Trips per day/10 hours per day = **3 Trips per hour** entering and exiting

The total peak hour trips would be **43 Truck Trips per hour** entering and exiting the Site.

Table 3.1 shows the corresponding peak hour number of truck trips entering and exiting the Site, which was used in the traffic analysis for both the peak AM and PM hours.

Table 3.1: Peak Hour Site Trips Generated

TRIPS	WEEKDAY PEAK AM HOUR			WEEKDAY PEAK PM HOUR		
	Total	Enter	Exit	Total	Enter	Exit
Truck Trips	86	43	43	86	43	43

3.2 Trip Distribution

The distribution of Site generated trips was assigned to the adjacent roads by examination of the most convenient and efficient route(s) to and from major developed and populated areas. The vast majority of the trips will utilize the Highway 417 interchange and Boundary Road, which is the direct route to/from Highway 417. The study has allocated the trips as per the following distribution:

- To/From the North (along Boundary Road) 2 percent
- To/From the West (along Highway 417) 83 percent
- To/From the East (along Highway 417) 5 percent
- To/From the West (along Mitch Owens Road) 7 percent
- To/From the South (along Boundary Road) 3 percent

The Site generated trips shown in Table 3.1 were distributed to the adjacent roads at the above proportions. Figure 3.1 shows the expected weekday peak AM and PM hour Site generated trips.

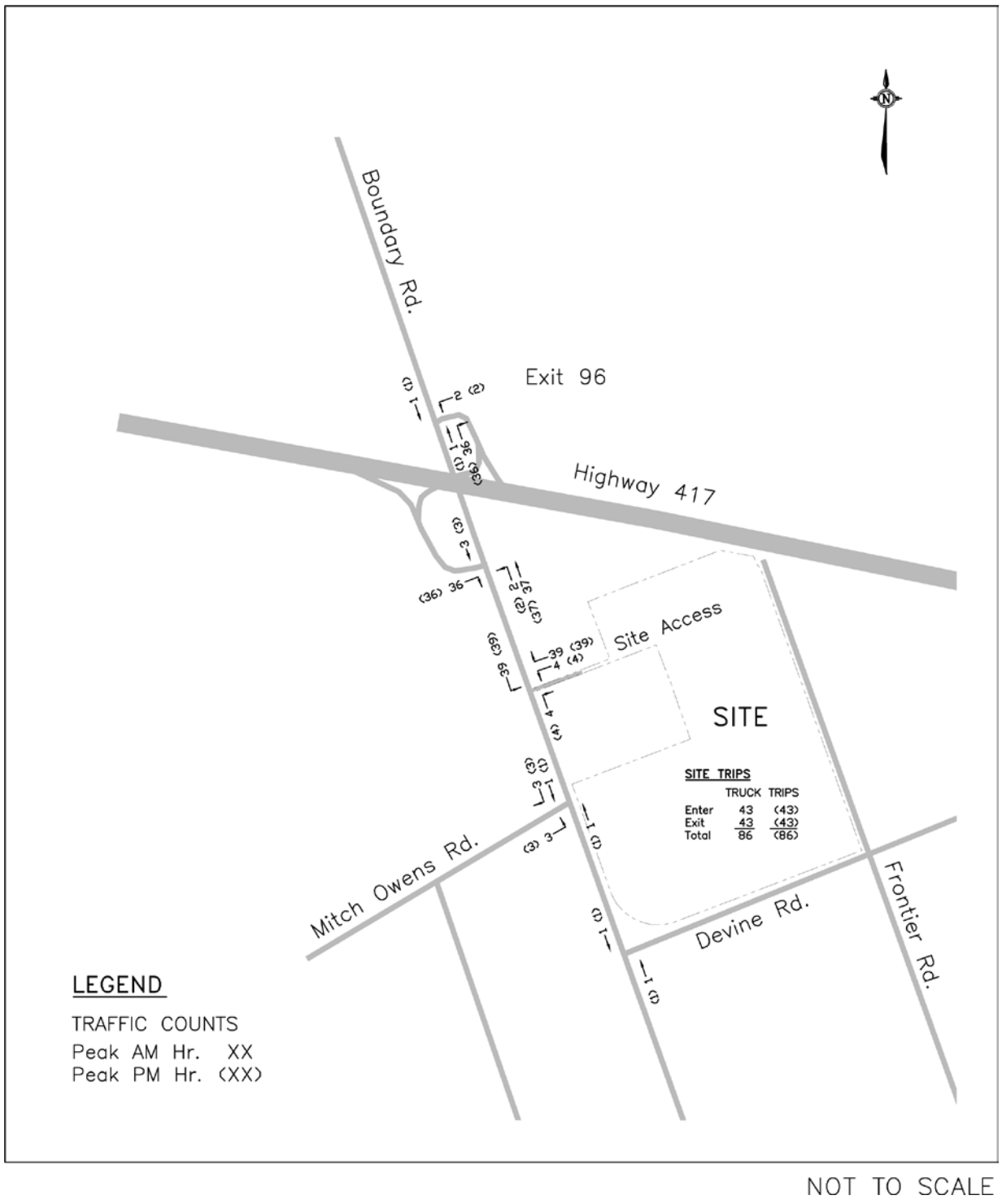


Figure 3.1: Weekday Peak AM and PM Hour Site Generated Trips

Highway 417 is a major provincial highway and Boundary Road is an arterial road, both of which have pavement structures designed to carry large volumes of traffic and heavy vehicles. Because of their function, their pavement structures are expected to be appropriate to carry CRRRC Site-related traffic. As described previously, Frontier Road will only provide a secondary access to the Site, and Devine Road will also only receive limited Site-related traffic (and not heavy vehicles on a routine basis). As such, a determination and evaluation of the expected performance of the pavement structures on Frontier and Devine Roads was not deemed necessary as part of this traffic assessment.

4.0 FUTURE TRAFFIC VOLUMES

4.1 Background Traffic Volumes

The background traffic volumes consist of the expected increase in traffic that does not include traffic associated with the development of the CRRRC facility. The increase in background traffic would be the result of new traffic generated by future development within and outside the study area.

To determine the expected increase in traffic volumes, historical and current traffic counts at the intersection of Boundary Road and Mitch Owens Road were examined. Counts taken by the City of Ottawa for the years 2010 and 2011, and counts taken by the consultant at the south approach to the intersection in 2012 showed that the traffic volumes remained essentially constant with slight increases and decreases in traffic when comparing the approaches at various years. Typically in rural areas the annual growth rate in traffic is approximately 1 to 2 percent. The study therefore conservatively assumed an annual compounded growth rate of 2 percent, which was applied to all lane movements shown in the traffic counts presented in Figure 2.1 for the weekday peak AM and PM hour. This would be represented by the following growth factor to project the 2011 and 2012 existing traffic counts at a 2 percent annual growth to the expected year 2022 background traffic volumes:

- Existing 2011 counts to 2022 background traffic volumes = 1.243
- Existing 2012 counts to 2022 background traffic volumes = 1.219

The above growth factors were applied to the existing traffic volume counts shown in Figure 2.1 to produce the expected 2022 background traffic volumes shown in Figure 4.1 for the weekday peak AM and PM hours.

4.2 Total Traffic Volumes

The expected total traffic volumes at the year 2022 were determined by the addition of the expected background traffic of Figure 4.1 and the expected Site generated trips of Figure 3.1. Figure 4.2 shows the expected 2022 weekday total peak AM and PM hour traffic volumes. Given the total volume of traffic along Boundary Road adjacent to the CRRRC, the truck traffic from the CRRRC at maximum daily receipts would represent approximately 8 percent of the peak hour traffic along Boundary Road.

5.0 FUTURE TRAFFIC VOLUMES

The assessment examined the operation of the Site access point onto Boundary Road, and the intersections of Devine/Boundary, Boundary/Mitch Owens, the eastbound Highway 417 on/off ramps, and the westbound Highway 417 on/off ramps. The analysis used the Highway Capacity Software (University of Florida, N.D.), which utilizes the intersection capacity analysis procedure as documented in the Highway Capacity Manual (Transportation Research Board, 2010).

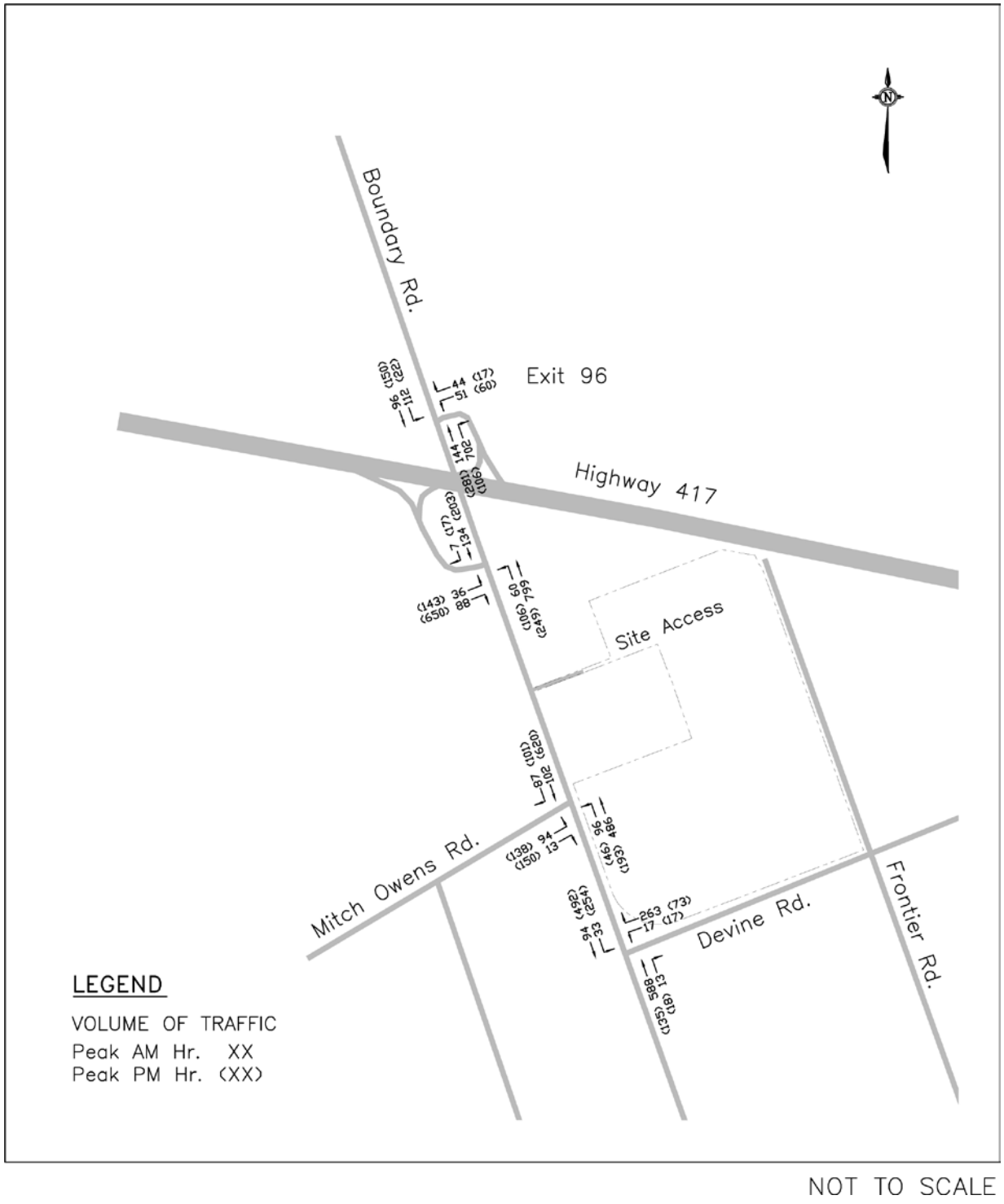


Figure 4.1: 2022 Weekday Peak AM and PM Hour Background Traffic

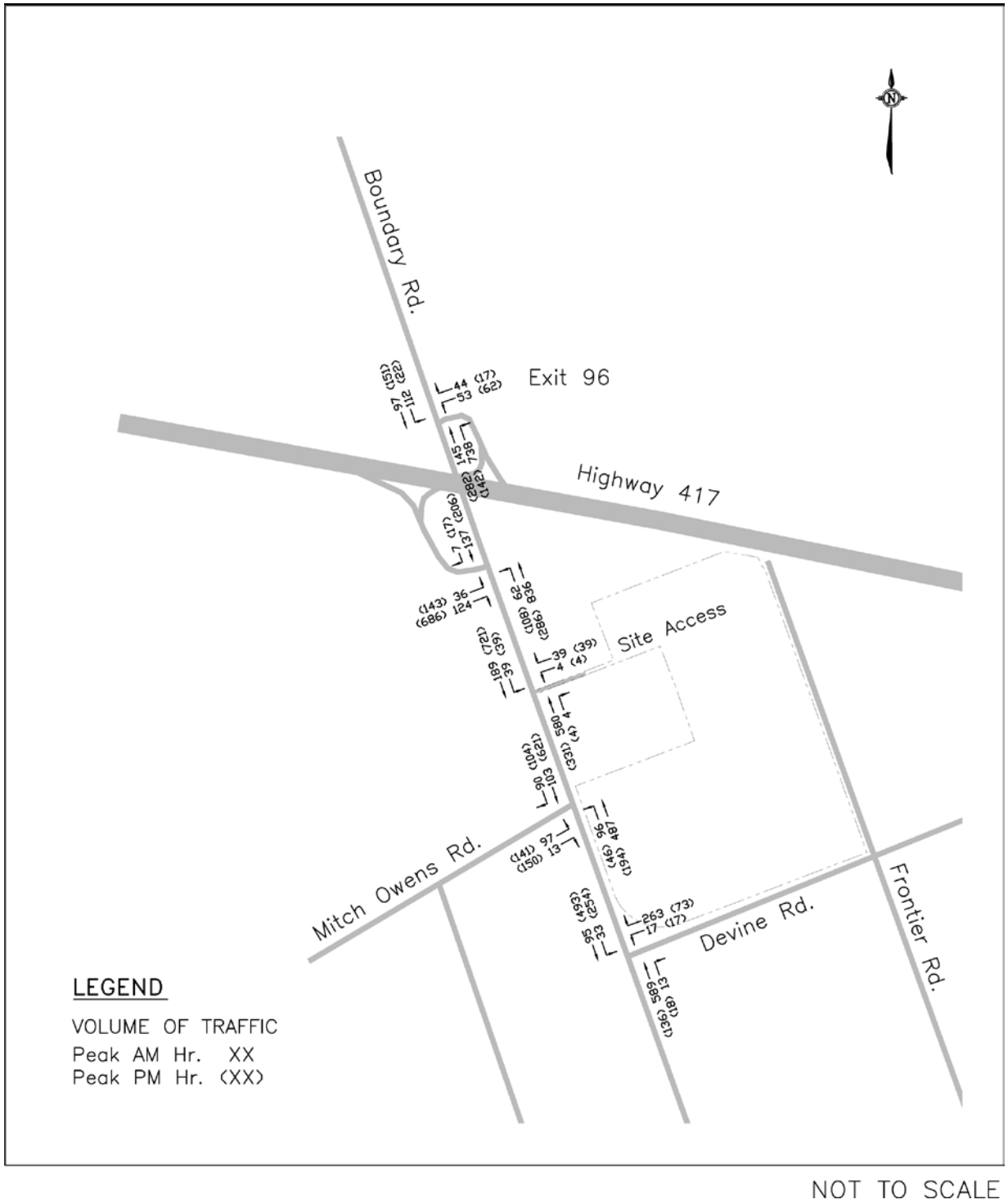


Figure 4.2: 2022 Weekday Peak AM and PM Hour Total Traffic

For unsignalized intersections, the level of service of each lane movement is determined as a function of the delay of vehicles at the approach. The following relates the level of service of each lane movement with the expected delay at the approach, which was utilized in the analysis of the operation of the Site access point and intersections within the study area:

- LEVEL OF SERVICE DELAY
  - Level of Service A 0 – 10 sec./vehicle Little or No Delay
  - Level of Service B >10 – 15 sec./vehicle Short Traffic Delays
  - Level of Service C >15 – 25 sec./vehicle Average Traffic Delays
  - Level of Service D >25 – 35 sec./vehicle Long Traffic Delays
  - Level of Service E >35 – 50 sec./vehicle Very Long Traffic Delays
  - Level of Service F >50 sec./vehicle Extreme Delays – Demand exceeds Capacity

The expected length of queue at the critical lane movements for an unsignalized intersection was determined by the calculation of the 95th percentile queue at the lane approach. The 95th percentile queue length is the calculated 95th greatest queue length out of 100 occurrences at a movement during a 15-minute peak period. The 95th percentile queue length is a function of the capacity of a movement and the total expected traffic, with the calculated value determining the magnitude of the queue by representing the queue length as fractions of vehicle lengths (where a vehicle length is taken as 7 metres).

5.1 Traffic Analysis

The study has conducted an operational analysis for the existing intersections within the area studied to establish the current operation of the intersections. The analysis utilized the traffic counts taken in 2011 and 2012 and the existing lane geometry and traffic controls at the intersection approaches.

To determine the expected operation of the Site access and intersections within the area studied, the study has established horizon years for the analysis which would examine the intersection for future traffic volumes including the traffic generated by the CRRRC. The facility has been assumed to be substantially completed and operational by the year 2017. Although completed, the facility would not be expected to be operating at maximum annual capacity for several years following completion. For this reason the study has examined the Site access point and surrounding intersections within the study area for the year 2022, which represents five years beyond completion of the facility. The analysis at the year 2022 assumes that the facility would be operating at capacity. The following discusses the operation of the intersections.

Boundary Road and Mitch Owens Road Intersection

The intersection of Boundary Road and Mitch Owens Road is located approximately 700 metres south of the proposed Boundary Road Site access. The “T” intersection is controlled by a stop sign at the eastbound Mitch Owens Road approach. The 2012 traffic counts determined that during the peak AM hour the northbound Boundary shared left/through movement functioned at a Level of Service (LoS) “A”, the eastbound Mitch Owens left turn movement at a LoS “C” and right turn movement at a LoS “A”. During the peak PM hour the northbound shared left/through movement functioned at a Level of Service (LoS) “A”, the eastbound left turn movement at a

LoS "C" and right turn movement at a LoS "B". The 95th percentile queue at the eastbound Mitch Owens left turn lane was 1.64 vehicles during the peak PM hour. Table 5.1 summarizes the operation of the intersection with the analysis sheets provided in Appendix A as Exhibit 4 for the peak AM hour and Exhibit 5 for the peak PM hour.

Table 5.1: Boundary/Mitch Owens – LoS and 95th Percentile Queue

Intersection Approach	Weekday Peak AM Hour 2012 Existing (2022 Total)		Weekday Peak PM Hour 2012 Existing (2022 Total)	
	LoS	Q_{95} (Veh.)	LoS	Q_{95} (Veh.)
Northbound (NB) Left/Through – Boundary	*A* (A)	*0.19* (0.25)	*A* (A)	*0.14* (0.19)
EB Left – Mitch Owens	*C* (C)	*0.82* (1.50)	*C* (E)	*1.64* (3.48)
EB Right – Mitch Owens	*A* (A)	*0.03* (0.05)	*B* (C)	*0.99* (1.64)

At the year 2022, which represents five years beyond start of operations of the CRRRC facility, the facility was assumed to be operating at capacity. The analysis at the Boundary/Mitch Owens intersection using the expected 2022 traffic volumes, which includes the Site generated trips, determined that during the peak AM hour the intersection operated at the same level of service as the 2012 traffic counts. The northbound Boundary shared left/through movement functioned at a LoS "A", the eastbound Mitch Owens left turn movement at a LoS "C" and right turn movement at a LoS "C". During the peak PM hour the northbound shared left/through movement functioned at a Level of Service (LoS) "A", the eastbound left turn movement at a LoS "E" and right turn movement at a LoS "C". The eastbound Mitch Owens left turn movement (LoS "E") would experience an approach delay of 37.7 seconds, with a 95th percentile queue of 3.48 vehicles (28 metres) with 40 metres provided in the exclusive left turn lane. Table 5.1 summarizes the operation of the intersection with the analysis sheets provided as Exhibit 6 for the 2022 peak AM hour and Exhibit 7 for the 2022 peak PM hour.

The level of service at the eastbound Boundary left turn movement shifted from a LoS "C" using the 2012 peak PM hour traffic counts to a LoS "E" for the expected 2022 peak PM hour traffic. The reduction in level of service was due to the increase in background traffic, with the CRRRC contributing only 3 trucks to the movement during the peak PM hour. There would be no requirement for modifications to the Boundary/Mitch Owens intersection due to the truck traffic from the proposed CRRRC facility.

Boundary Road and Devine Road Intersection

The intersection of Boundary Road and Devine Road is located approximately 1,460 metres south of the proposed Site access onto Boundary Road. Devine Road forms the westbound approach (stop controlled) to the "T" intersection, and Boundary Road the northbound and southbound approaches. Using the 2012 peak AM hour traffic counts, the southbound Boundary left turn movement functioned at a LoS "A", the westbound Devine left turn movement at a LoS "B" and right turn movement at a LoS "C". During the peak PM hour the southbound left turn movement functioned at a Level of Service (LoS) "A", the westbound left turn movement at a LoS "C" and right turn movement at a LoS "A". Table 5.2 summarizes the operation of the intersection with the analysis sheets provided as Exhibit 8 for the 2022 peak AM hour and Exhibit 9 for the 2022 peak PM hour.

Table 5.2: Boundary/Devine – LoS and 95th Percentile Queue

Intersection Approach	Weekday Peak AM Hour 2012 Existing (2022 Total)		Weekday Peak PM Hour 2012 Existing (2022 Total)	
	LoS	Q_{95} (Veh.)	LoS	Q_{95} (Veh.)
Southbound (SB) Left – Boundary	*A* (A)	*0.09* (0.12)	*A* (A)	*0.55* (0.73)
WB Left – Devine	*B* (C)	*0.11* (0.17)	*C* (D)	*0.21* (0.38)
WB Right – Devine	*C* (C)	*2.10* (3.90)	*A* (A)	*0.23* (0.29)

At the year 2022 the southbound Boundary left turn movement would function at a LoS "A" during the peak AM hour, the westbound Devine left turn movement at a LoS "C" and right turn movement at a LoS "C". During the peak PM hour the southbound left turn movement would function at a Level of Service (LoS) "A" during the peak AM hour, the westbound Devine left turn movement at a LoS "D" and right turn movement at a LoS "A". Truck trips from the CRRRC would not be using Devine Road to link with locations to the east or south. Any trips to the south would be assigned to Boundary Road. Table 5.2 summarizes the operation of the intersection for the expected 2022 traffic volumes, with the analysis sheets provided as Exhibits 10 and 11.

There would be no requirement for modifications to the Boundary/Devine intersection due to the truck traffic from the proposed CRRRC facility.

Intersection of Boundary Road and Highway 417 Eastbound on/off Ramps

The Boundary/417 eastbound on/off ramps intersection is located approximately 850 metres north of the proposed Boundary Road access to the CRRRC Site. The intersection is a "T" intersection with Boundary Road forming the northbound and southbound approaches, and the Highway 417 on/off ramps the eastbound approach. The intersection is controlled by a stop sign at the eastbound 417 off ramp approach.

The 2011 traffic counts at the intersection were obtained from the MTO. The peak AM hour counts determined that the northbound Boundary shared left/through movement would function at a LoS "A" during the peak AM hour and the eastbound Highway 417 off ramp approach at a LoS "B". During the peak PM hour the northbound Boundary shared left/through movement would function at a LoS "A" and the eastbound Highway 417 off ramp approach at a LoS "C". Table 5.3 summarizes the operation of the intersection for the 2011 traffic volumes with the analysis sheets provided as Exhibit 12 and Exhibit 13.

Table 5.3: Boundary/Eastbound 417 Ramps – LoS and 95th Percentile Queue

Intersection Approach	Weekday Peak AM Hour 2011 Existing (2022 Total)		Weekday Peak PM Hour 2011 Existing (2022 Total)	
	LoS	Q_{95} (Veh.)	LoS	Q_{95} (Veh.)
NB Left/Through – Boundary	*A* (A)	*0.11* (0.15)	*A* (A)	*0.22* (0.29)
EB Left/Right – 417 Ramp	*B* (B)	*0.36* (0.75)	*C* (E)	*5.35* (16.59)

The analysis for the year 2022 traffic volumes determined that during the peak AM hour of the adjacent roads the northbound Boundary left/through movement functioned at a LoS "A" and eastbound 417 off ramp shared left/right movement at a LoS "B". For the expected peak PM hour traffic volumes the northbound Boundary shared left/through movement would function at a LoS A", and eastbound 417 off ramp shared left/right movement at a LoS "E" with an approach delay of 43.3 seconds and 95th percentile queue of 16.59 vehicles (119 metres). Table 5.3 summarizes the operation of the intersection for the 2022 traffic volumes with the analysis sheets provided as Exhibit 14 and Exhibit 15.

The eastbound 417 right turn movement was determined to function at a LoS "E" with an approach delay of 43.3 seconds during the 2012 peak PM hour. The shift from the current LoS "C" to a LoS "E" at the year 2022 was mainly due to an increase in background traffic with the CRRRC contributing approximately 5 percent of the traffic to the movement. There would be no requirement for modifications to the Boundary/Eastbound 417 Ramps intersection due to the truck traffic from the proposed CRRRC facility.

Intersection of Boundary Road and Highway 417 Westbound on/off Ramps

The intersection of Boundary Road and the Highway 417 westbound on/off ramps is located on the north side of Highway 417 approximately 1,400 metres north of the proposed CRRRC access onto Boundary Road. For the 2011 peak AM hour and peak PM hour the southbound Boundary shared left/through movement would function at a LoS "A" and the westbound 417 off ramp shared left/right turn movement at a LoS "B". Table 5.4 summarizes the operation of the intersection for the 2011 traffic volumes with the analysis sheets provided as Exhibit 16 for the peak AM hour and Exhibit 17 for the peak PM hour.

For the expected 2022 traffic volumes, the southbound Boundary shared left/through movement is expected to operate at a LoS "B" and westbound off ramp shared left/right turn movement at a LoS "C" during the peak AM hour. During the peak PM hour the southbound shared left/through movement is expected to operate at a LoS "A" and westbound shared left/right turn movement at a LoS "B". The 95th percentile queue at the westbound Highway 417 off ramp is expected to be 0.84 vehicles (7 metres) during the peak AM hour. Table 5.4 summarizes the operation of the intersection for the 2022 traffic volumes with the analysis sheets provided as Exhibit 18 and Exhibit 19.

Table 5.4: Boundary/Westbound 417 Ramps – LoS and 95th Percentile Queue

Intersection Approach	Weekday Peak AM Hour 2011 Existing (2022 Total)		Weekday Peak PM Hour 2011 Existing (2022 Total)	
	LoS	Q_{95} (Veh.)	LoS	Q_{95} (Veh.)
SB Left/Through – Boundary	*A* (B)	*0.38* (0.60)	*A* (A)	*0.05* (0.06)
WB Left/Right – 417 Ramp	*B* (C)	*0.42* (0.84)	*B* (B)	*0.31* (0.51)

There would be no requirement for modifications to the Boundary/Westbound 417 Ramps intersection due to the truck traffic from the proposed CRRRC facility.

Boundary Road and Site Access Intersection

The proposed Site access to the CRRRC is located on Boundary Road towards the north end of the Site, closest to Highway 417. The access is situated along a stretch of Boundary Road which is approximately midway between the main intersections of Mitch Owens Road and the Highway 417 eastbound on/off ramps.

An operational analysis was conducted at the proposed location of the Site access using the 2022 traffic volumes and expected Site generated trips at full capacity of the Site and maximum daily traffic (Figure 4.2). To determine the lane configuration at the access, a left turn lane warrant analysis as documented in the MTO publication, *Geometric Design Standards for Ontario Highways* (MTO, 1985), was conducted to determine if a southbound Boundary Road left turn lane was required at the access. The warrant analysis, which is presented in Appendix A as Exhibit 20, determined that a southbound left turn lane into the Site is warranted. The proposed lane configuration at the Site access is as follows:

- Northbound Boundary Road — One shared through/right lane
- Southbound Boundary Road — One through lane
  One exclusive left turn lane
- Westbound Site Access — One shared left and right turn lane

The warrant graph determined the length of the left turn lane to be 25 metres for passenger cars during the peak PM hour. Utilizing a passenger car equivalent for heavy vehicles of 2.0 as documented in the MTO publication, *Geometric Design Standards for Ontario Highways* (MTO, 1985), the required length of the southbound left turn lane at the truck access would be 50 metres. The left turn lane would also require a 60 metre parallel lane and 145 metre taper for a 90 kilometre design speed. In order to reduce gravel spillage onto Boundary Road from turning trucks and help in the deceleration and acceleration of trucks, 75 metre tapers are proposed along the east side of Boundary Road at the Site access. Figure 5.1 shows the proposed lane geometry at the CRRRC access.

The operational analysis for the 2022 traffic volumes for the peak AM hour traffic counts determined that the southbound Boundary left turn movement would function at a LoS “B”, the westbound Site access left/right turn movement at a LoS “C”. During the peak PM hour the southbound left turn movement would function at a LoS “A”, the westbound left/right turn movement at a LoS “C”. Table 5.5 summarizes the operation of the intersection with the analysis sheets provided as Exhibit 21 for the peak AM hour and Exhibit 22 for the peak PM hour total traffic.

Table 5.5: Boundary/Site Access – 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.)
SB Left – Boundary	B	0.22	A	0.16
WB Left/Right – Access	C	0.50	C	0.39

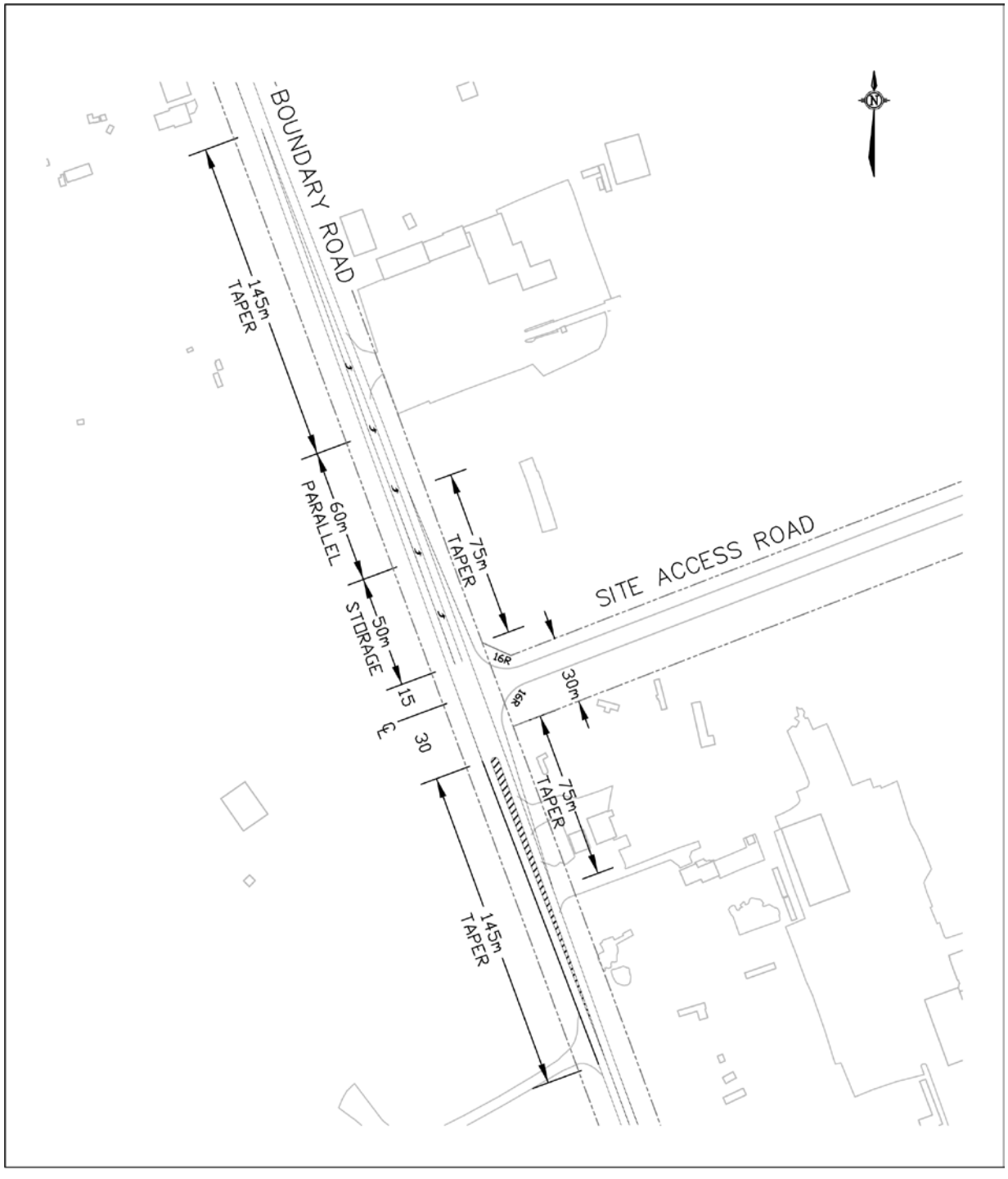


Figure 5.1: Proposed Boundary Road/Site Access Geometry

6.0 FINDINGS AND RECOMMENDATIONS

The Site of the proposed CRRRC is located on lands at the northeast corner of the intersection of Boundary Road and Devine Road in the City of Ottawa. The Site would be approximately 192 hectares in size and would operate as a waste management facility consisting of various waste diversion facilities and a landfill component for disposal of residual waste materials. The Site will have one access onto Boundary Road, which would be mainly used for trucks entering and exiting the Site. A secondary access would be located on Frontier Road north of Devine Road, and would be used primarily for vehicles associated with Site operations and maintenance, and for emergency purposes.

The Traffic Impact Study examined the operation of the Boundary Road Site access during the weekday peak hours of the adjacent roads, using traffic counts provided by the City of Ottawa and the MTO, supplemented by counts obtained specifically for this study. The Frontier Road access would generate a low number of service and employee trips that would generally occur outside the peak hours of the adjacent roads and the analysis period of the traffic study.

The main operations of the CRRRC would be between 7:00 AM and 6:00 PM Monday to Saturday. The facility was assumed to be completed and operational by the year 2017. The Traffic Impact Study has examined the proposed Boundary Road Site access and intersections within the area studied for the expected traffic volumes at the year 2022. The year 2022 represents five years beyond the completion of the construction of the CRRRC and would account for trips associated with the full operation of the facility.

The CRRRC is expected to generate a combination of waste trips, soil trips, and diversion trips. During the operation of the Site for a 10 hour day and at a maximum daily waste and soil receipt of 3,000 tonnes per day, the Site would generate a maximum of approximately 40 truck trips entering and 40 trips exiting the Site per peak hour (assuming a 1.45 peaking factor). Including the expected 3 trucks per hour that would transport leachate to ROPEC for treatment, the total maximum number of trucks would be 43 trucks entering and 43 exiting the Site during the peak AM and PM hours of the adjacent roads. The analysis has examined the impact of truck trips during the weekday peak AM and PM hours. The findings and recommendations of the study are summarized in the following:

1. The following is the proportion of truck trips used in the analysis:

   - To/From the North (along Boundary Road) 2 percent
   - To/From the West (along Highway 417) 83 percent
   - To/From the East (along Highway 417) 5 percent
   - To/From the West (along Mitch Owens Road) 7 percent
   - To/From the South (along Boundary Road) 3 percent

   The truck traffic from the CRRRC at maximum daily waste and soil receipts would represent approximately 8 percent of the total volume of traffic along Boundary Road between the Site access and Highway 417.

2. The operational analysis using the expected 2022 traffic volumes determined that all of the existing intersections within the study area operate at an acceptable Level of Service (LoS) during the weekday peak AM and PM hours, with no intersections requiring modifications due to the truck trips from the CRRRC. The intersections comprise the following:

   - Boundary Road and Mitch Owens Road
   - Boundary Road and Devine Road
   - Boundary Road and the eastbound Highway 417 on/off ramps
   - Boundary Road and the westbound Highway 417 on/off ramps

3. The CRRRC proposes that the main Site access onto Boundary Road be located approximately 700 metres north of Mitch Owens Road and 850 metres south of the eastbound Highway 417 on/off ramps. This access was examined for operations at maximum daily waste and soil receipts, which would correspond to 1,300 tonnes per day of IC&I and C&D waste materials and 1,700 tonnes per day of soils, plus trucks associated with leachate under normal operations. The southbound Boundary Road left turn movement would function at a LoS "B" and westbound Site exit shared left/right movement at a LoS "C" during the peak AM hour. During the peak PM hour the southbound Boundary Road left turn movement would function at a LoS "A" and westbound Site exit shared left/right movement at a LoS "C". A left turn lane warrant analysis was conducted for the southbound Boundary Road movement, which determined that a left turn lane was warranted using the 2022 maximum Site related traffic volumes. Following is the proposed intersection geometry at the Boundary Road Site access, as shown in Figure 5.1:

   - 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)

   The proposed intersection geometry would also include a northbound Boundary Road deceleration taper of 75 metres and northbound Boundary Road acceleration taper of 75 metres. The tapers would also reduce gravel spillage onto the roadway from turning vehicles.

4. The access into the Site would have a pavement width of 8.0 metres. The access road itself would provide a driveway length of approximately 450 metres between Boundary Road and the gate to the CRRRC facility. In addition to the proposed separate truck queuing lane area, the clear throat length of the access road would provide adequate space for trucks to park prior to the opening of the facility so that traffic would not back up onto Boundary Road.

REFERENCES

Ministry of Transportation Ontario (MTO). (1985). Geometric Design Standards for Ontario Highways Manual.

Transportation Research Board. (2010). Highway Capacity Manual 2010. National Research Council, Washington, D.C.

University of Florida. (N.D.). Highway Capacity Software. McTrans Center, Gainesville, Florida.

APPENDIX A

Exhibits 1 to 3 – Traffic Counts
Exhibits 4 to 19, 21 and 22 – Operational Analyses
Exhibit 20 – Left Turn Lane Warrants

Exhibit 1: Year 2012 Peak AM and PM Hour Traffic Counts – Boundary/Mitch Owens

Ottawa — *Public Works and Services Department*

Count ID 3043

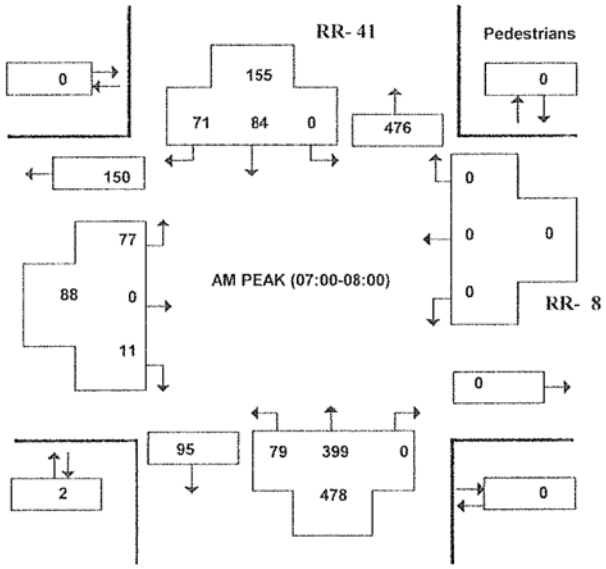
MITCH OWENS RD and BOUNDARY RD

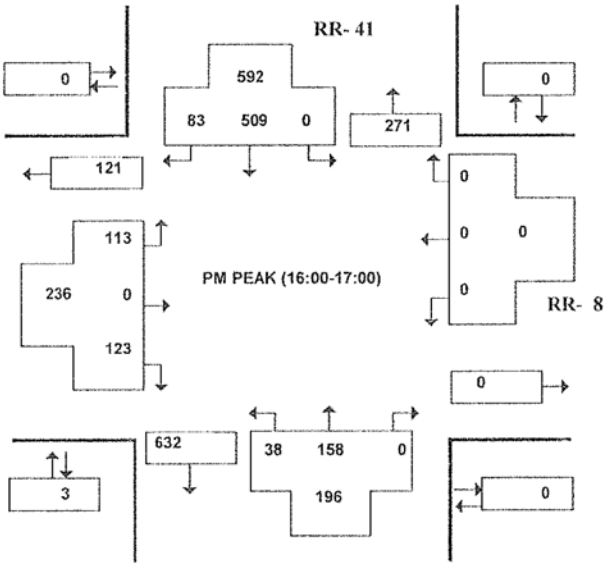
(ULRS Listing RR- 8 & RR- 41)

Survey Date: Monday 9 July 2012
Conditions: dry
Start Time: 0700

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

AADT Factor
Monday in July is 1





Approved by : DT

Printed on : 16/04/2013

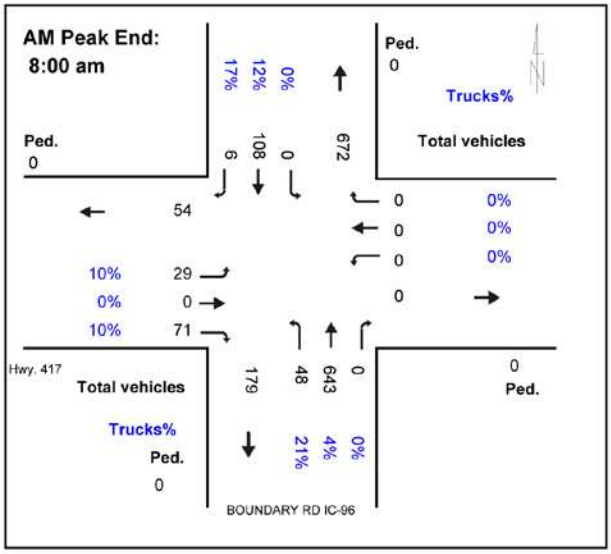
Exhibit 2: Year 2011 Peak AM and PM Hour Traffic Counts – Boundary/Eastbound 417 Ramps

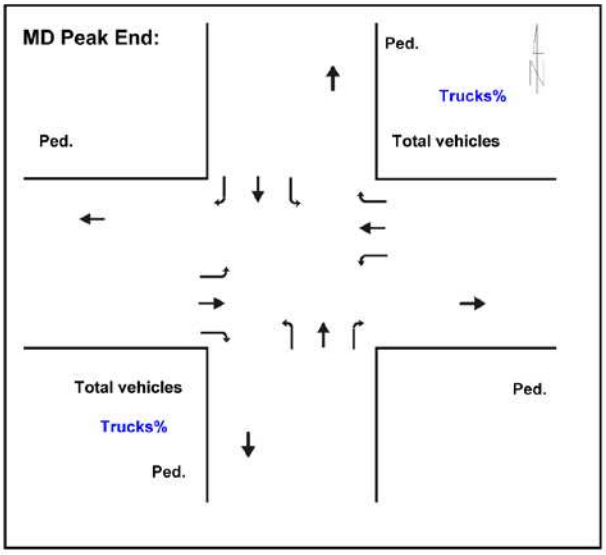
Ontario

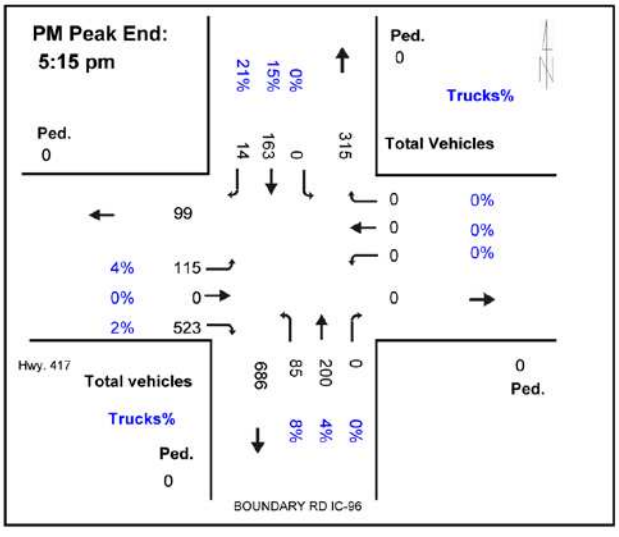
BOUNDARY RD IC-96 @ Hwy. 417

Eastern

Intersection ID:493400000(--S--) **Count Day: Tuesday** **Count Date: 30-Aug-2011**







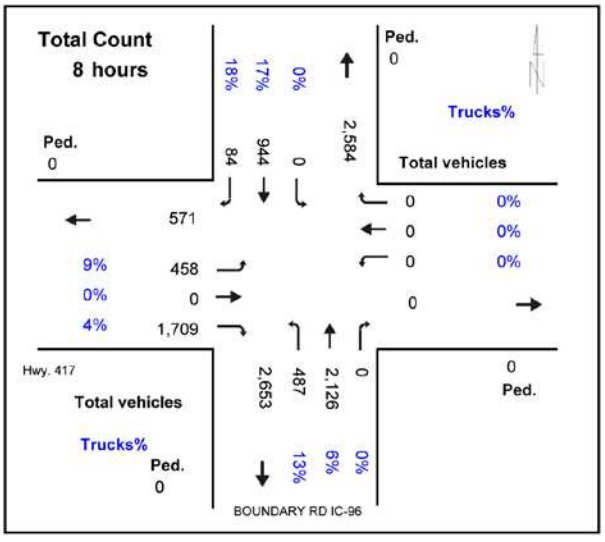


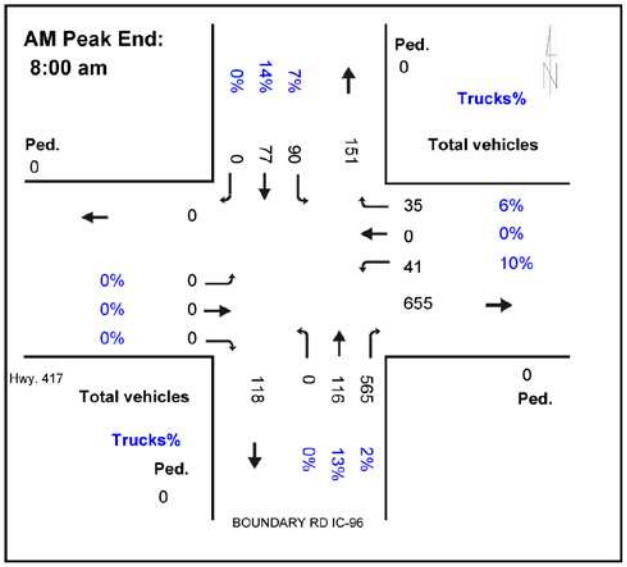
Exhibit 3: Year 2011 Peak AM and PM Hour Traffic Counts – Boundary/Westbound 417 Ramps

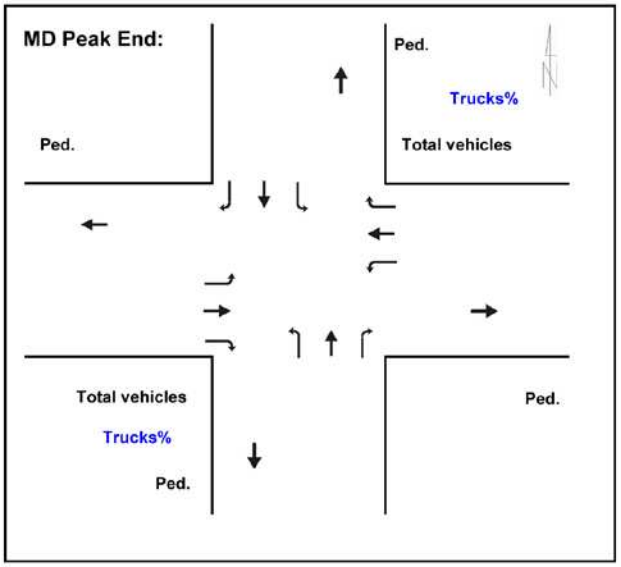
Ontario

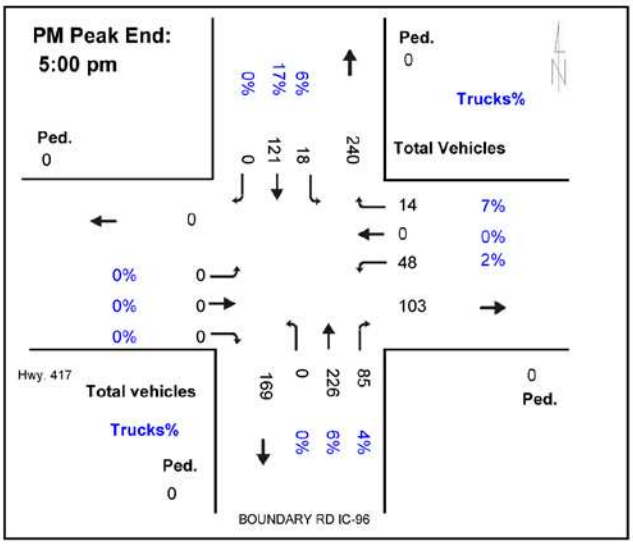
BOUNDARY RD IC-96 @ Hwy. 417

Eastern

Intersection ID:493400000(--N--) **Count Day: Tuesday** **Count Date: 30-Aug-2011**







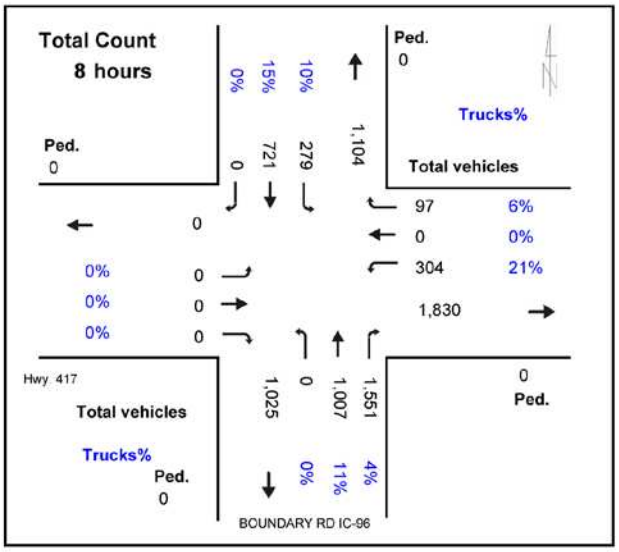


Exhibit 4: Year 2012 Peak AM Hour Traffic Count Analysis – Boundary/Mitch Owens

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak AM Hour**
Intersection: **Boundary/Mitch Owens**
Analysis Year: **July 9, 2012**
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	79	399			84	71
Peak-Hour Factor, PHF	0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR	85	433			91	77
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				77		11
Peak Hour Factor, PHF				0.92		0.92
Hourly Flow Rate, HFR				83		11
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)	85					83		11
C(m) (vph)	1392					379		958
v/c	0.06					0.22		0.01
95% queue length	0.19					0.82		0.03
Control Delay	7.8					17.1		8.8
LOS	A					C		A
Approach Delay							16.2	
Approach LOS							C	

Exhibit 5: Year 2012 Peak PM Hour Traffic Count 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: **July 9, 2012**
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	38	158			509	83
Peak-Hour Factor, PHF	0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR	41	171			553	90
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				113		123
Peak Hour Factor, PHF				0.92		0.92
Hourly Flow Rate, HFR				122		133
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)	41					122		133
C(m) (vph)	928					332		527
v/c	0.04					0.37		0.25
95% queue length	0.14					1.64		0.99
Control Delay	9.1					22.0		14.1
LOS	A					C		B
Approach Delay							17.9	
Approach LOS							C	

Exhibit 6: 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	96	487			103	90
Peak-Hour Factor, PHF	0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR	104	529			111	97
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				97		13
Peak Hour Factor, PHF				0.92		0.92
Hourly Flow Rate, HFR				105		14
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)	104					105		14
C(m) (vph)	1345					303		934
v/c	0.08					0.35		0.01
95% queue length	0.25					1.50		0.05
Control Delay	7.9					23.1		8.9
LOS	A					C		A
Approach Delay							21.4	
Approach LOS							C	

Exhibit 7: 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	46	194			621	104
Peak-Hour Factor, PHF	0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR	49	210			674	113
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				141		150
Peak Hour Factor, PHF				0.92		0.92
Hourly Flow Rate, HFR				153		163
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)	49					153		163
C(m) (vph)	819					257		449
v/c	0.06					0.60		0.36
95% queue length	0.19					3.48		1.64
Control Delay	9.7					37.7		17.5
LOS	A					E		C
Approach Delay							27.3	
Approach LOS							D	

Exhibit 8: Year 2012 Peak AM Hour Traffic Count Analysis – Boundary/Devine

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak AM Hour**
Intersection: **Boundary/Devine**
Analysis Year: **March 21, 2012**
Project ID: CRRRC Site
East/West Street: Devine 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		482	11	27	77	
Peak-Hour Factor, PHF		0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR		523	11	29	83	
Percent Heavy Vehicles		--	--	5	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	1	1	
Configuration			TR	L	T	
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	14		216			
Peak Hour Factor, PHF	0.92		0.92			
Hourly Flow Rate, HFR	15		234			
Percent Heavy Vehicles	0		1			
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)		29	15		234			
C(m) (vph)		1019	414		552			
v/c		0.03	0.04		0.42			
95% queue length		0.09	0.11		2.10			
Control Delay		8.6	14.0		16.2			
LOS		A	B		C			
Approach Delay				16.1				
Approach LOS				C				

Exhibit 9: Year 2012 Peak PM Hour Traffic Count Analysis – Boundary/Devine

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak PM Hour**
Intersection: **Boundary/Devine**
Analysis Year: **March 21, 2012**
Project ID: CRRRC Site
East/West Street: Devine 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		111	15	208	404	
Peak-Hour Factor, PHF		0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR		120	16	226	439	
Percent Heavy Vehicles		--	--	2	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	1	1	
Configuration		TR		L	T	
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	14		60			
Peak Hour Factor, PHF	0.92		0.92			
Hourly Flow Rate, HFR	15		65			
Percent Heavy Vehicles	1		2			
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)		226	15		65			
C(m) (vph)		1448	223		922			
v/c		0.16	0.07		0.07			
95% queue length		0.55	0.21		0.23			
Control Delay		7.9	22.3		9.2			
LOS		A	C		A			
Approach Delay				11.7				
Approach LOS				B				

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

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak AM Hour**
Intersection: **Boundary/Devine**
Analysis Year: **Year 2022**
Project ID: CRRRC Site
East/West Street: Devine 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		589	13	33	95	
Peak-Hour Factor, PHF		0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR		640	14	35	103	
Percent Heavy Vehicles		--	--	5	--	--
Median Type/Storage	Undivided			/		
RT Channelized?						
Lanes		1	0	1	1	
Configuration			TR	L	T	
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	17		263			
Peak Hour Factor, PHF	0.92		0.92			
Hourly Flow Rate, HFR	18		285			
Percent Heavy Vehicles	0		1			
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)		35	18		285			
C(m) (vph)		919	334		473			
v/c		0.04	0.05		0.60			
95% queue length		0.12	0.17		3.90			
Control Delay		9.1	16.4		23.5			
LOS		A	C		C			
Approach Delay				23.1				
Approach LOS				C				

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

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak PM Hour**
Intersection: **Boundary/Devine**
Analysis Year: **Year 2022**
Project ID: CRRRC Site
East/West Street: Devine 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		136	18	254	493	
Peak-Hour Factor, PHF		0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR		147	19	276	535	
Percent Heavy Vehicles		--	--	2	--	--
Median Type/Storage	Undivided		/			
RT Channelized?						
Lanes		1	0	1	1	
Configuration		TR		L	T	
Upstream Signal?		No			No	

Minor Street: Approach	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume	17		73			
Peak Hour Factor, PHF	0.92		0.92			
Hourly Flow Rate, HFR	18		79			
Percent Heavy Vehicles	1		2			
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)		276	18		79			
C(m) (vph)		1412	156		890			
v/c		0.20	0.12		0.09			
95% queue length		0.73	0.38		0.29			
Control Delay		8.2	31.1		9.4			
LOS		A	D		A			
Approach Delay			13.5					
Approach LOS			B					

Exhibit 12: Year 2011 Peak AM Hour Traffic Count Analysis – Boundary/Eastbound 417 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: **August 30, 2011**
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	48	643			108	6
Peak-Hour Factor, PHF	0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR	52	698			117	6
Percent Heavy Vehicles	5	--	--		--	--
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				29		71
Peak Hour Factor, PHF				0.92		0.92
Hourly Flow Rate, HFR				31		77
Percent Heavy Vehicles				5		5
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)	52						108	
C(m) (vph)	1446						993	
v/c	0.04						0.11	
95% queue length	0.11						0.36	
Control Delay	7.6						12.1	
LOS	A						B	
Approach Delay							12.1	
Approach LOS							B	

Exhibit 13:Year 2011 Peak PM Hour Traffic Count Analysis – Boundary/Eastbound 417 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: **August 30, 2011**
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	85	200			163	14
Peak-Hour Factor, PHF	0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR	92	217			177	15
Percent Heavy Vehicles	5	--	--		--	--
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				115		523
Peak Hour Factor, PHF				0.92		0.92
Hourly Flow Rate, HFR				124		568
Percent Heavy Vehicles				5		5
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)	92						692	
C(m) (vph)	1364						1037	
v/c	0.07						0.67	
95% queue length	0.22						5.35	
Control Delay	7.8						17.1	
LOS	A						C	
Approach Delay							17.1	
Approach LOS							C	

Exhibit 14: Year 2022 Peak AM Hour Traffic Analysis – Boundary/Eastbound 417 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	62	836			137	7
Peak-Hour Factor, PHF	0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR	67	908			148	7
Percent Heavy Vehicles	5	--	--		--	--
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				36		124
Peak Hour Factor, PHF				0.92		0.92
Hourly Flow Rate, HFR				39		134
Percent Heavy Vehicles				5		5
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)	67						173	
C(m) (vph)	1407						856	
v/c	0.05						0.20	
95% queue length	0.15						0.75	
Control Delay	7.7						14.0	
LOS	A						B	
Approach Delay							14.0	
Approach LOS							B	

Exhibit 15: Year 2022 Peak PM Hour Traffic Analysis – Boundary/Eastbound 417 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	108	286			206	17
Peak-Hour Factor, PHF	0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR	117	310			223	18
Percent Heavy Vehicles	5	--	--		--	--
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				143		686
Peak Hour Factor, PHF				0.92		0.92
Hourly Flow Rate, HFR				155		745
Percent Heavy Vehicles				5		5
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)	117						900	
C(m) (vph)	1308						930	
v/c	0.09						0.97	
95% queue length	0.29						16.59	
Control Delay	8.0						43.3	
LOS	A						E	
Approach Delay							43.3	
Approach LOS							E	

Exhibit 16: Year 2011 Peak AM Hour Traffic Analysis – Boundary/Westbound 417 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: **August 30, 2011**
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		116	565	90	77	
Peak-Hour Factor, PHF		0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR		126	614	97	83	
Percent Heavy Vehicles		--	--	2	--	--
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	41		35			
Peak Hour Factor, PHF	0.92		0.92			
Hourly Flow Rate, HFR	44		38			
Percent Heavy Vehicles	1		2			
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)		97		82				
C(m) (vph)		867		665				
v/c		0.11		0.12				
95% queue length		0.38		0.42				
Control Delay		9.7		14.0				
LOS		A		B				
Approach Delay				14.0				
Approach LOS				B				

Exhibit 17: Year 2011 Peak PM Hour Traffic Analysis – Boundary/Westbound 417 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: **August 30, 2011**
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		226	85	18	121	
Peak-Hour Factor, PHF		0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR		245	92	19	131	
Percent Heavy Vehicles		--	--	2	--	--
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	48		14			
Peak Hour Factor, PHF	0.92		0.92			
Hourly Flow Rate, HFR	52		15			
Percent Heavy Vehicles	2		2			
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)		19		67				
C(m) (vph)		1222		709				
v/c		0.02		0.09				
95% queue length		0.05		0.31				
Control Delay		8.0		11.7				
LOS		A		B				
Approach Delay				11.7				
Approach LOS				B				

Exhibit 18: Year 2022 Peak AM Hour Traffic Analysis – Boundary/Westbound 417 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		145	738	112	97	
Peak-Hour Factor, PHF		0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR		157	802	121	105	
Percent Heavy Vehicles		--	--	2	--	--
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	53		44			
Peak Hour Factor, PHF	0.92		0.92			
Hourly Flow Rate, HFR	57		47			
Percent Heavy Vehicles	1		2			
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)		121		104				
C(m) (vph)		717		467				
v/c		0.17		0.22				
95% queue length		0.60		0.84				
Control Delay		11.0		18.3				
LOS		B		C				
Approach Delay				18.3				
Approach LOS				C				

Exhibit 19: Year 2022 Peak PM Hour Traffic Analysis – Boundary/Westbound 417 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	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume		282	142	22	151	
Peak-Hour Factor, PHF		0.92	0.92	0.92	0.92	
Hourly Flow Rate, HFR		306	154	23	164	
Percent Heavy Vehicles		--	--	2	--	--
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	62		17			
Peak Hour Factor, PHF	0.92		0.92			
Hourly Flow Rate, HFR	67		18			
Percent Heavy Vehicles	2		2			
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)		23		85				
C(m) (vph)		1101		581				
v/c		0.02		0.15				
95% queue length		0.06		0.51				
Control Delay		8.3		13.4				
LOS		A		B				
Approach Delay				13.4				
Approach LOS				B				

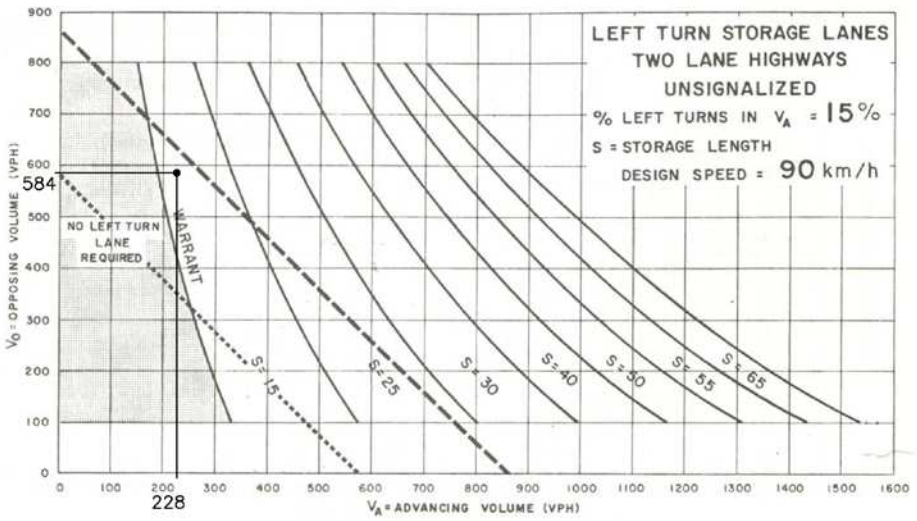
Exhibit 20: Year 2022 Southbound Left Turn Lane Warrants – Boundary/Site Access

TRAFFIC

V_O = 584 vph
V_A = 228 vph
V_L = 39 vph

V_L/V_A = 17.1%

POSTED SPEED
80 km/h



WARRANT

15 METRE LEFT
TURN LANE REQUIRED

SOUTHBOUND LEFT
PEAK AM HOUR

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

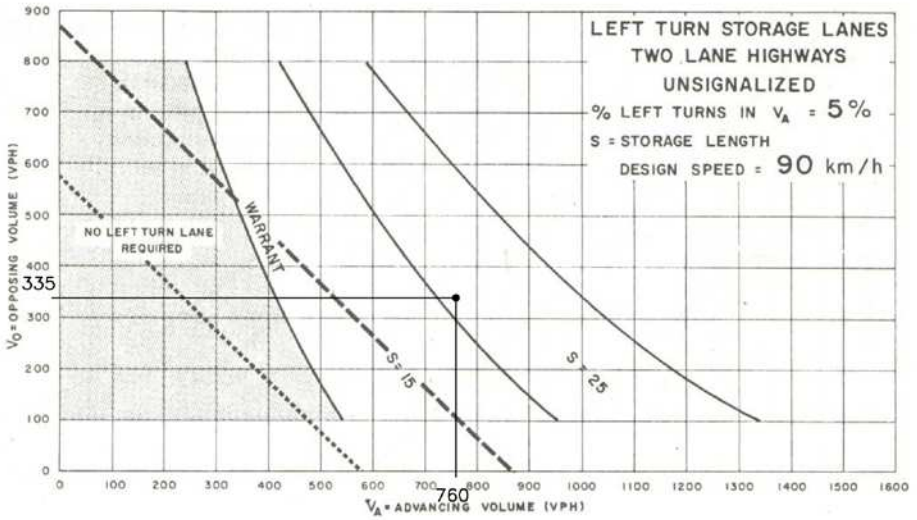
TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

TRAFFIC

V_O = 335 vph
V_A = 760 vph
V_L = 39 vph

V_L/V_A = 5.1%

POSTED SPEED
80 km/h



WARRANT

25 METRE LEFT
TURN LANE REQUIRED

SOUTHBOUND LEFT
PEAK PM HOUR

Exhibit 21: Year 2022 Peak AM Hour Traffic Analysis – Boundary/Site 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

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	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	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	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 22: Year 2022 Peak PM Hour Traffic Analysis – Boundary/Site 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

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	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	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	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				

ATTACHMENT C

Addendum #1 to Traffic Impact Study, dated February 2015

Addendum #2 to Traffic Impact Study, dated May 2015

February 2015

Addendum to Technical Support Document #9

TRAFFIC IMPACT STUDY

TAGGART GROUP OF COMPANIES

THE MILLER GROUP

1.0 BACKGROUND

The site for the Capital Region Resource Recovery Centre (CRRRC) is proposed 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 for the disposal of residual waste materials. The proposed Site access location is directly onto Boundary Road approximately 1,130 m south of Highway 417..

A Traffic Impact Study (TIS) report for the proposed CRRRC was prepared, as reported in Technical Support Document #9, and is a component of the December 2014 Environmental Assessment (EA) report. The traffic study 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 that comprised the intersections of rural arterial roads that could be impacted by additional traffic from the Site. The City of Ottawa was consulted on the intersections to be addressed in the TIS. 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 Site-related trips to Thunder Road and Thunder Road is not an arterial road.

Thunder Road is located approximately 600 m north of the proposed CRRRC site access location off Boundary Road. Thunder Road is a rural collector road as designated in the City of Ottawa Transportation Master Plan. Thunder Road is a two lane rural road that links Boundary Road to Ramsayville Road to the west. Observations and aerial photographs have shown Thunder Road to have a low volume of traffic and would be mainly used by local residents to access farm lands and rural residential homes. The intersection of Thunder Road and Boundary Road is also sometimes used as an access point to the Petro-Canada service station located at the southwest corner of the intersection; however, the Petro-Canada station also has a direct access onto Boundary Road.

Following a review of the December 2014 EA report, staff of the Ministry of Transportation Ontario has requested that the intersection of Boundary Road and Thunder Road be considered in the TIS report. This Addendum addresses the operation of the intersection of Boundary Road and Thunder Road during the weekday peak AM and PM hours. Consistent with the assessment presented in the TIS, the time period for the analysis uses the existing traffic counts and the expected volume of traffic at the year 2022. The year 2022 represents five years beyond the anticipated commencement of the CRRRC site operations, with the traffic analysis being conducted for the 2022 background traffic (without the expected CRRRC trips) and for the total 2022 volume of traffic.

2.0 EXISTING BOUNDARY ROAD / THUNDER ROAD INTERSECTION

Thunder Road is a two lane collector road with gravel shoulders and a rural cross section. The road provides access to farm land and rural residential homes, and forms part of the grid of rural collector roads. Thunder Road has a posted speed limit of 60 km./h. in the vicinity of Boundary Road.

The east limit of Thunder Road terminates at Boundary Road. The Boundary/Thunder Road intersection is a “T” intersection with Boundary Road forming the northbound and southbound approaches, and Thunder Road the eastbound approach. The intersection has the following lane configuration:

Northbound Boundary Road one shared left/through lane

Southbound Boundary Road	one shared through/right lane
Eastbound Thunder Road	one shared left/right turn lane

The intersection is a two-way stop controlled intersection with a "Stop" sign placed at the eastbound Thunder Road approach to the intersection.

A Petro-Canada service station is located at the southwest corner of the intersection. The service station has one access onto Thunder Road located approximately 40 m west of the intersection (centreline to centreline), and an access directly onto Boundary Road located approximately 55 m south of the intersection (centreline to centreline).

Traffic counts were obtained from the City of Ottawa for the Boundary/Thunder Road intersection. The counts were taken on October 13, 2010 with the peak AM and PM hour counts provided in the Appendix as Exhibit 1. Examination of the traffic counts determined that there was an unusually high volume of traffic on northbound Boundary Road during the peak AM hour. This high volume of traffic was not consistent with other traffic counts taken at the Highway 417 interchange by MTO and at the Boundary/Mitch Owens Road intersection by the City of Ottawa. The observation of this high traffic volume is also described in a Traffic Impact Study prepared by Dillon Consulting Limited dated October 2014 for East Gateway Properties Limited, who attributed it to construction on nearby roadways at that time. The volume of traffic for the Boundary Road through movements were therefore adjusted by balancing the traffic with the August 30, 2011 traffic counts taken at the south approach to the eastbound Highway 417 on/off ramps by the MTO (Exhibit 2). Figure 2.1 presents the existing weekday peak AM and PM hour traffic counts.

3.0 TRAFFIC ANALYSIS

3.1 Background Traffic

The background traffic was determined for the year 2022, which represents five years beyond the full development of the site. The volume of traffic was calculated for the weekday peak AM and PM hours. The annual increase in background traffic was determined to be 2.0 percent as documented in the Traffic Impact Study of the December 2014 EA. The 2.0 percent compounded increase was applied to the 2010 traffic movements to/from Thunder Road, and to the 2011 through traffic movements along Boundary Road at the Boundary/Thunder Road intersection, and at the eastbound and westbound on/off ramps of Highway 417. Figure 3.1 presents the expected 2022 peak hour background traffic at the Boundary/Thunder intersection and Highway 417 on/off ramps.

3.2 Total Traffic

The total 2022 volume of traffic is the addition of the 2022 background traffic (Figure 3.1) and the expected CRRRC Site generated trips. The Site generated trips are presented in Figure 3.2, which are the same as presented in the December 2014 EA with the modification of showing the traffic at the Boundary/Thunder Road intersection. The Site generated trips at this intersection are northbound and southbound along Boundary Road with no trips expected or applied to Thunder Road. Figure 3.3 shows the total 2022 peak hour traffic including the trips associated with CRRRC facility.

Figure 2.1: Weekday Peak AM and PM Hour Traffic Counts

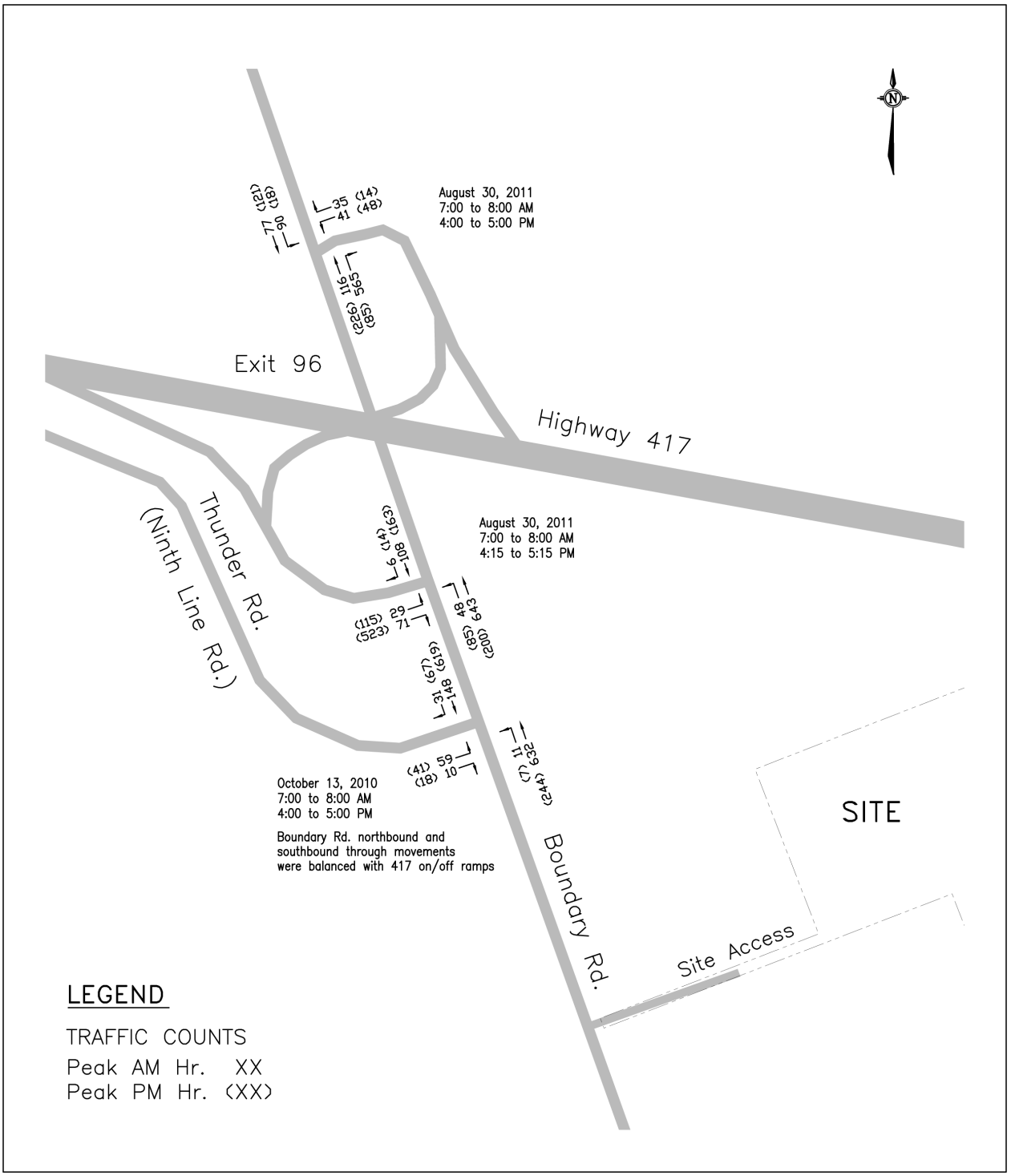
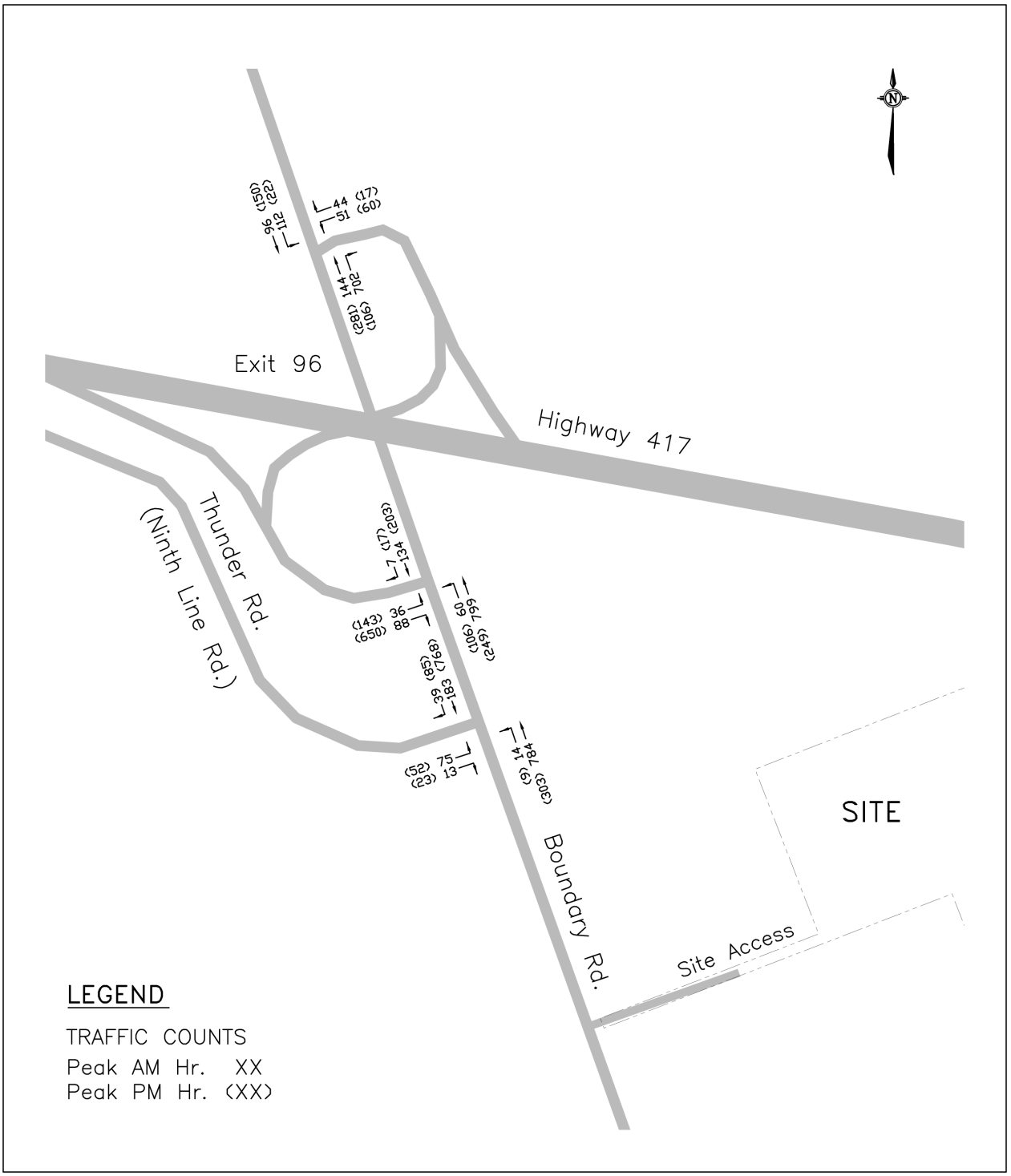


Figure 3.1: Weekday Peak AM and PM Hour Background Traffic



NOT TO SCALE

Figure 3.2: Weekday Peak AM and PM Hour Site Generated Trips

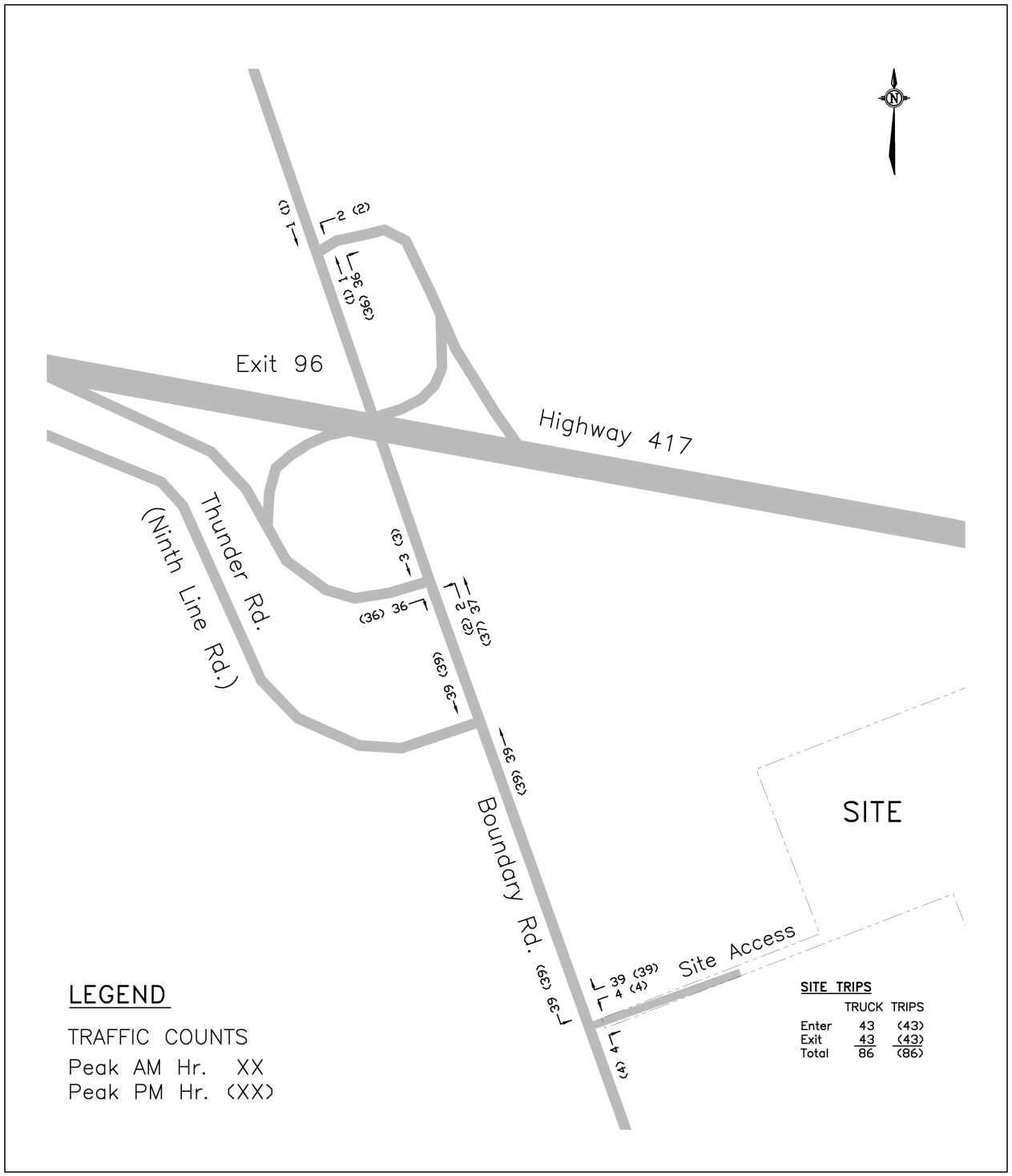
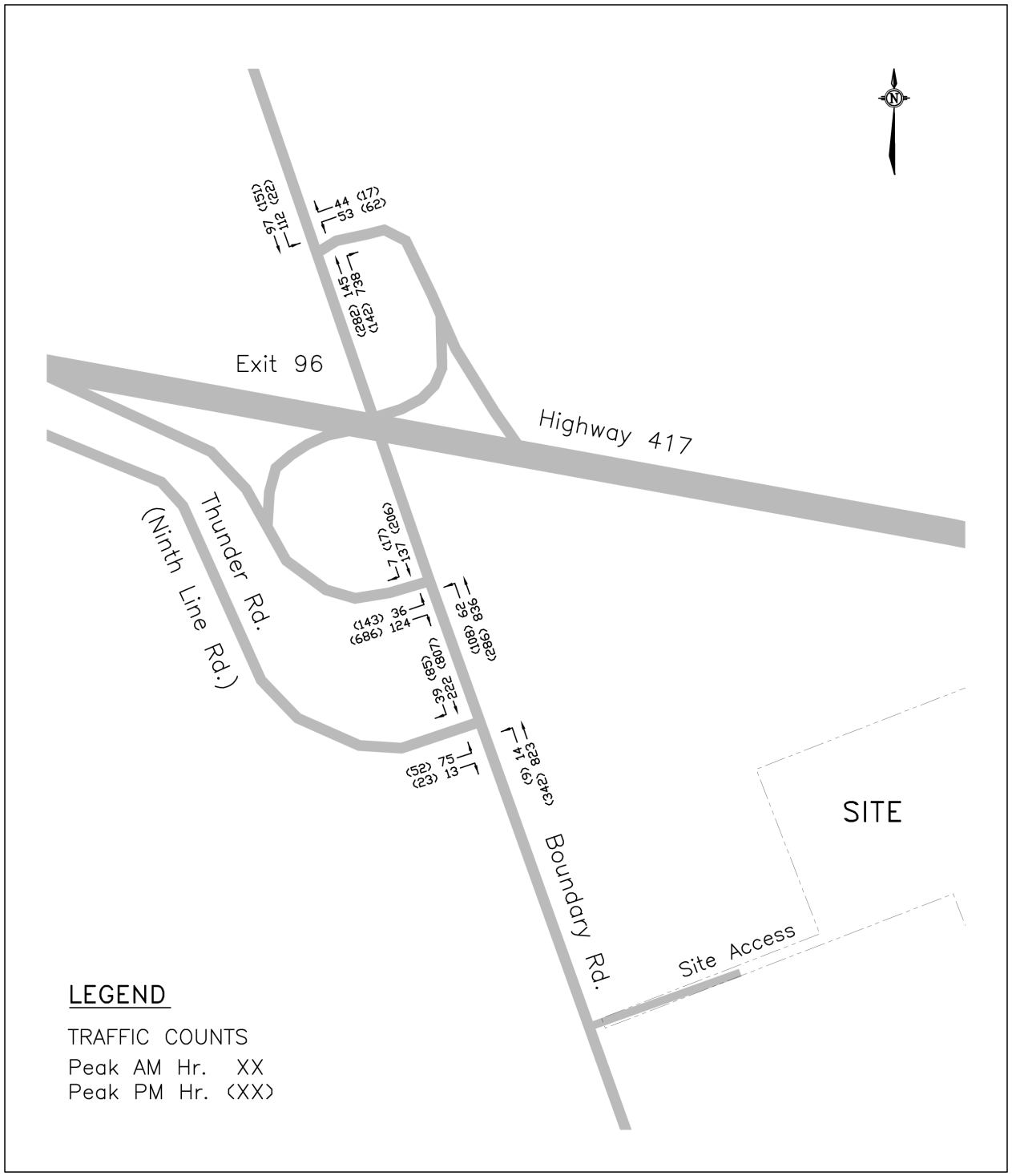


Figure 3.3: Weekday Peak AM and PM Hour Total Traffic



NOT TO SCALE

3.3 Traffic Analysis

The traffic analysis was conducted for the peak AM and PM hours at three time periods comprising the existing traffic counts, 2022 background traffic (not including CRRRC), and 2022 total traffic. This Addendum only examines the operation of the intersection of Boundary Road and Thunder Road, as the assessment of operations of all other intersections are contained within the December 2014 EA report and the findings and recommendation of that report remain valid.

The operational analysis for the existing 2010/2011 traffic counts at the Boundary/Thunder Road intersection determined that the northbound Boundary Road left/through movement would function at a Level of Service (LoS) "A" and the eastbound Thunder Road left/right turn movement at a LoS "C" during both the peak AM and PM hours. Table 3.1 summarizes the operation of the intersection with the analysis sheets provided in the Appendix as Exhibit 3 for the peak AM hour and Exhibit 4 for the peak PM hour.

For the expected 2022 background traffic (not including the CRRRC facility), the northbound Boundary Road left/through movement would operate at a LoS "A" and the eastbound Thunder Road approach at a LoS "D" during both the peak AM and PM hours as summarized in Table 3.1. Exhibits 5 and 6 present the operational analysis sheets.

For the total traffic expected in 2022 (including the CRRRC facility), the northbound Boundary Road approach would function at a LoS "A" and eastbound Thunder Road approach at a LoS "D" during the peak AM hour, and during the peak PM hour the northbound Boundary Road approach would function at a LoS "B" and eastbound Thunder Road approach at a LoS "D". Table 3.1 summarizes the 2022 operation of the intersection which shows that during the peak PM hour the control delay at the northbound Boundary Road approach would be 10.1 seconds and 34.3 seconds at the eastbound Thunder Road approach. Exhibit 7 and Exhibit 8 present the operational analysis sheets for the peak hours. A traffic signal warrant analysis was conducted for the expected total 2022 traffic, which determined that the intersection would only meet 64 percent of the warrants for the installation of traffic control signals. Signals are therefore not warranted, even for the projected 2022 traffic. The traffic signal warrant analysis is provided as Exhibit 9.

Table 3.1 Boundary/Thunder – LoS and Delay

Intersection Approach	Weekday Peak AM Hour *Existing* 2022 Background (Total 2022)		Weekday Peak PM Hour *Existing* 2022 Background (Total 2022)	
	LoS	Delay (sec.)	LoS	Delay (sec.)
NB Left/Through	*A* A (A)	*7.6* 7.7 (7.8)	*A* A (B)	*9.2* 9.9 (10.1)
EB Left/Right	*C* D (D)	*18.4* 26.7 (31.1)	*C* D (D)	*19.7* 29.7 (34.3)

4.0 FINDINGS

The operational analysis of the intersection of Boundary Road and Thunder Road determined that the additional traffic expected from the CRRRC facility would result in a minor impact on the operation of the Boundary/Thunder Road intersection. There would be no requirement for intersection modifications due to the CRRRC facility.

APPENDIX

Traffic Counts

Operational Analysis

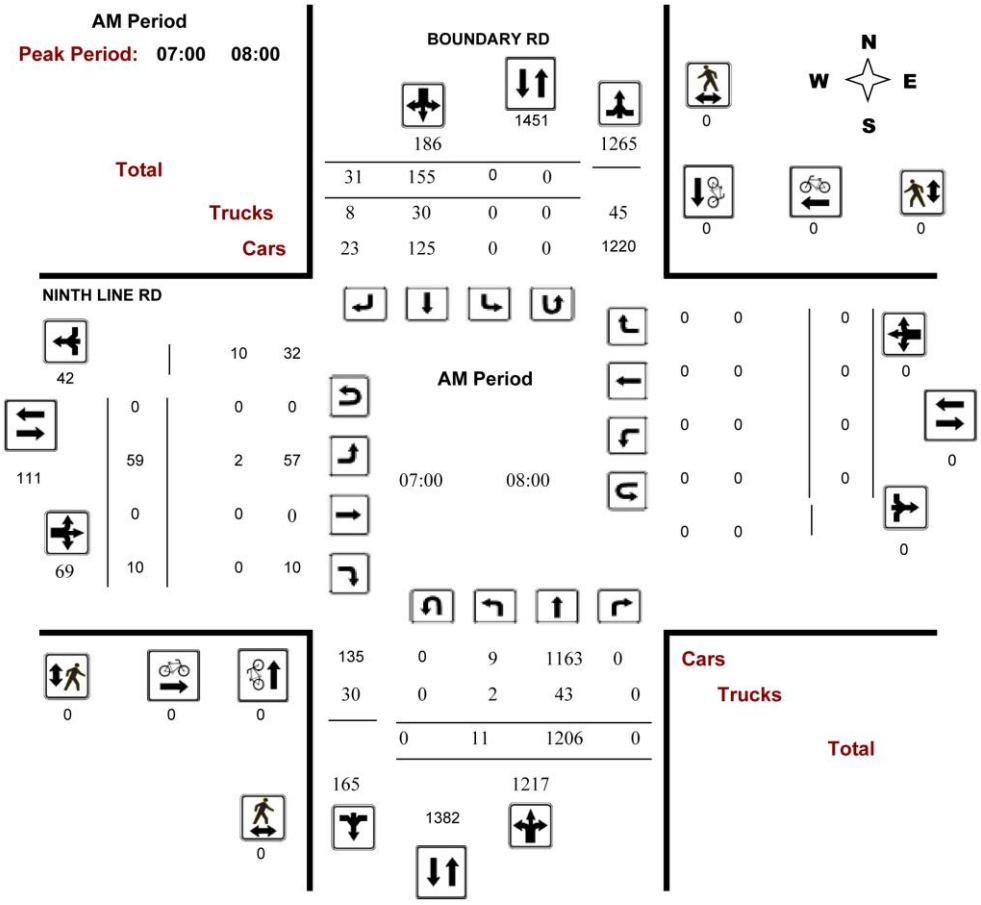
Exhibit 1 Year 2010 Peak AM and PM Hour Traffic Counts – Boundary/Thunder

Public Works - Traffic Services

Turning Movements Count - Peak Period Diagram

BOUNDARY RD @ NINTH LINE RD

Survey Date: Wednesday, October 13, 2010 **WO No:** 38
Start Time: 07:00 **Device:** Miovision



Validation Note: Results generated Apr 26, 2014. All records still in violation were set to Edited.

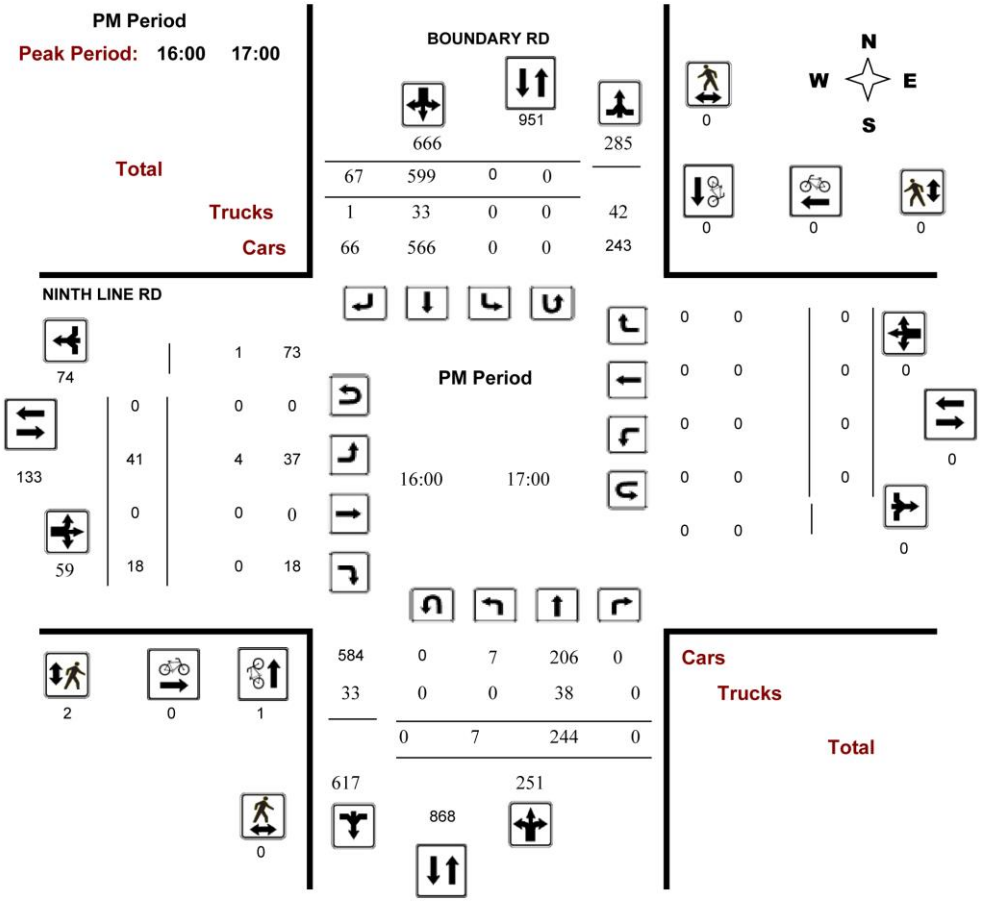
Public Works - Traffic Services

Turning Movements Count - Peak Period Diagram

BOUNDARY RD @ NINTH LINE RD

Survey Date: Wednesday, October 13, 2010 **WO No:** 38

Start Time: 07:00 **Device:** Miovision



Validation Note: Results generated Apr 26, 2014. All records still in violation were set to Edited.

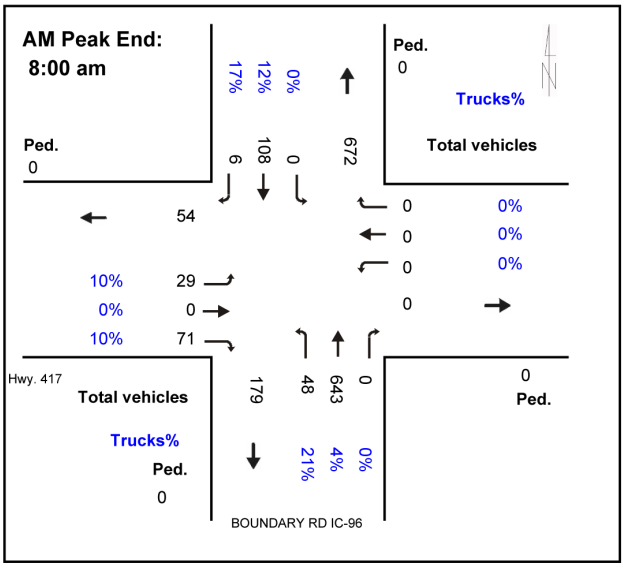
Exhibit 2 Year 2011 Peak AM and PM Hour Traffic Counts – Boundary/Eastbound 417 Ramps

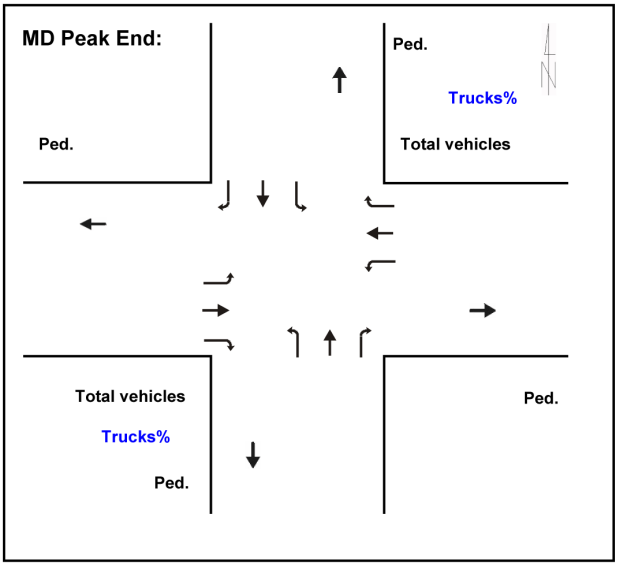
Ontario

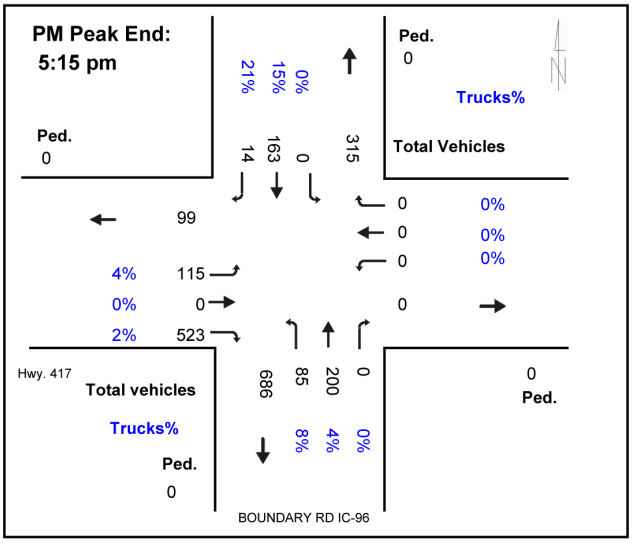
BOUNDARY RD IC-96 @ Hwy. 417

Eastern

Intersection ID:493400000(--S--) **Count Day: Tuesday** **Count Date: 30-Aug-2011**







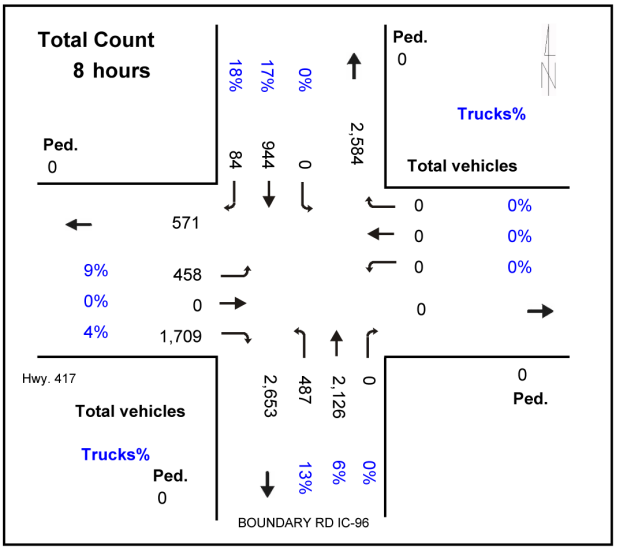


Exhibit 3 Existing 2010/2011 Peak AM Hour Traffic Count Analysis – Boundary/Thunder

HCS+: Unsignalized Intersections Release 5.6

TWO-WAY STOP CONTROL SUMMARY

Analysis Time Period: **Peak AM Hour**
Intersection: **Boundary/Thunder**
Analysis Year: **Existing 2010/2011**
Project ID: CRRRC Site - **Traffic Counts**
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	632			148	31
Peak-Hour Factor, PHF	0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR	11	686			160	33
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				59		10
Peak Hour Factor, PHF				0.92		0.92
Hourly Flow Rate, HFR				64		10
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)	11						74	
C(m) (vph)	1380						343	
v/c	0.01						0.22	
95% queue length	0.02						0.81	
Control Delay	7.6						18.4	
LOS	A						C	
Approach Delay							18.4	
Approach LOS							C	

Exhibit 4 Existing 2010/2011 Peak PM Hour Traffic Count 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: **Existing 2010/2011**
Project ID: CRRRC Site - **Traffic Counts**
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	7	244			619	67
Peak-Hour Factor, PHF	0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR	7	265			672	72
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				41		18
Peak Hour Factor, PHF				0.92		0.92
Hourly Flow Rate, HFR				44		19
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)	7						63	
C(m) (vph)	864						307	
v/c	0.01						0.21	
95% queue length	0.02						0.76	
Control Delay	9.2						19.7	
LOS	A						C	
Approach Delay							19.7	
Approach LOS							C	

Exhibit 5 Year 2022 Peak AM Hour Background 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 - **Background 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	784			183	39
Peak-Hour Factor, PHF	0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR	15	852			198	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)	1327						259	
v/c	0.01						0.37	
95% queue length	0.03						1.61	
Control Delay	7.7						26.7	
LOS	A						D	
Approach Delay							26.7	
Approach LOS							D	

Exhibit 6 Year 2022 Peak PM Hour Background 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 - **Background 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	303			768	85
Peak-Hour Factor, PHF	0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR	9	329			834	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)	738						224	
v/c	0.01						0.36	
95% queue length	0.04						1.54	
Control Delay	9.9						29.7	
LOS	A						D	
Approach Delay							29.7	
Approach LOS							D	

Exhibit 7 Year 2022 Peak AM Hour Total 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	823			222	39
Peak-Hour Factor, PHF	0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR	15	894			241	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)	1279						231	
v/c	0.01						0.41	
95% queue length	0.04						1.89	
Control Delay	7.8						31.1	
LOS	A						D	
Approach Delay							31.1	
Approach LOS							D	

Exhibit 8 Year 2022 Peak PM Hour Total 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	342			807	85
Peak-Hour Factor, PHF	0.92	0.92			0.92	0.92
Hourly Flow Rate, HFR	9	371			877	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)	711						201	
v/c	0.01						0.40	
95% queue length	0.04						1.78	
Control Delay	10.1						34.3	
LOS	B						D	
Approach Delay							34.3	
Approach LOS							D	

Exhibit 9 Year 2022 Traffic Signal Warrant Analysis – Boundary/Thunder

MINIMUM WARRANTS FOR INSTALLATION OF TRAFFIC SIGNAL USING PROJECTED VOLUME

Location Boundary Road **of** Thunder Road (Ninth Line Road)
(Roadway) **(Intersecting Road)**

Municipality City of Ottawa **Projected Volume** Year 2022

WARRANT	DESCRIPTION	MINIMUM REQUIREMENT FOR 2 LANE HIGHWAYS		COMPLIANCE		
		2. FREE FLOW	3. RESTRICT. FLOW	SECTIONAL NUMBER	SECTIONAL %	4. ENTIRE %
1. VEHICULAR VOLUME	1. A. Vehicle volume all approaches (Average hour)	(480)	720	626	100	23%
	B. Vehicle volume, along minor roads, (Average hour)	(180) ~~120~~	170	41	23	
2. DELAY TO CROSS TRAFFIC	1. A. Vehicle volume, along artery (Average hour)	(480)	720	585	100	(64%)
	B. Combined vehicle and pedestrian volume crossing artery from minor roads, (Average hour)	(50)	75	32	64	

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.

May 2015

Addendum 2 to Technical Support Document #9

TRAFFIC IMPACT STUDY

TAGGART GROUP OF COMPANIES

THE MILLER GROUP

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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.

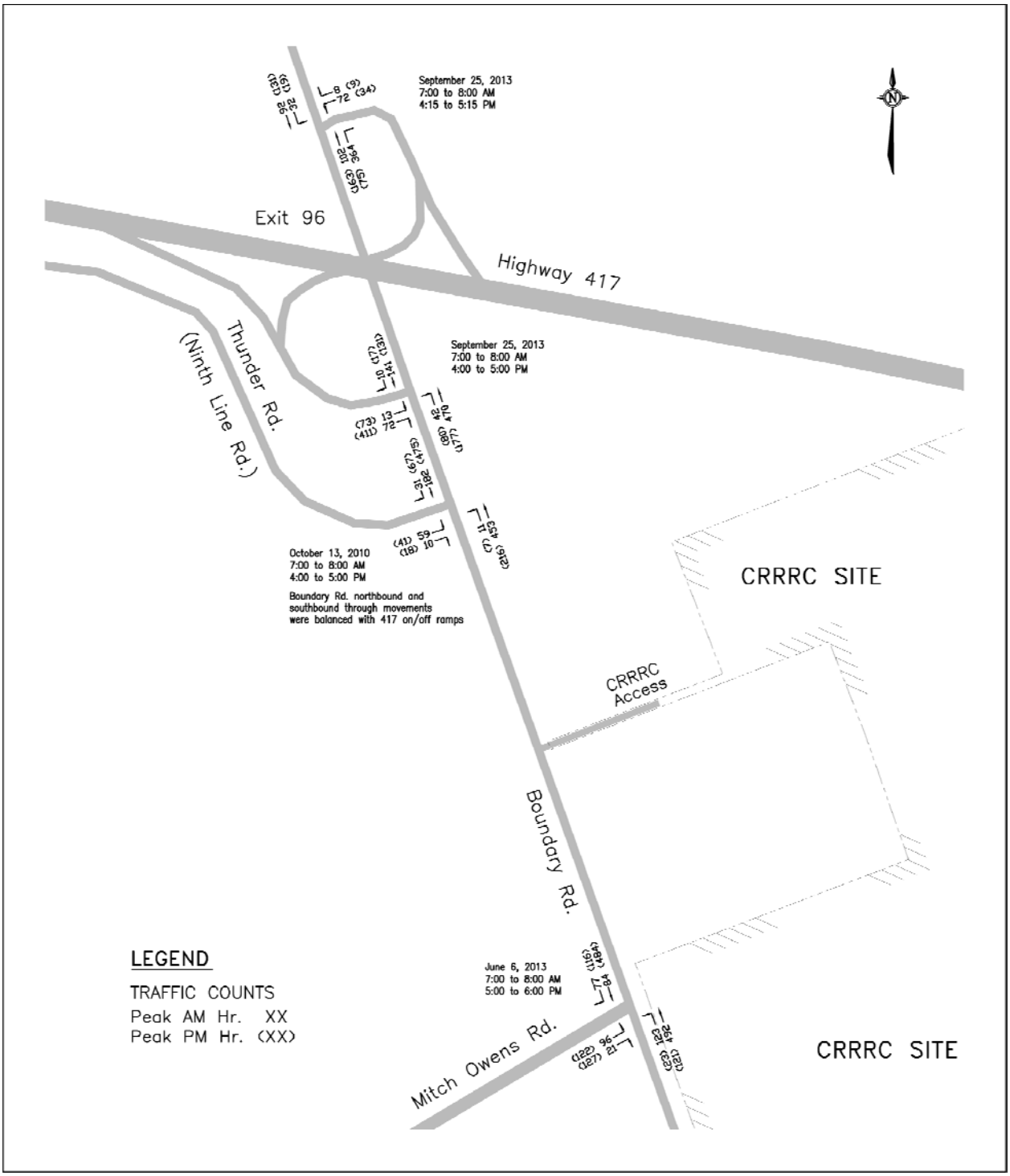


Figure 2.1: Weekday Peak AM and PM Hour Traffic Counts

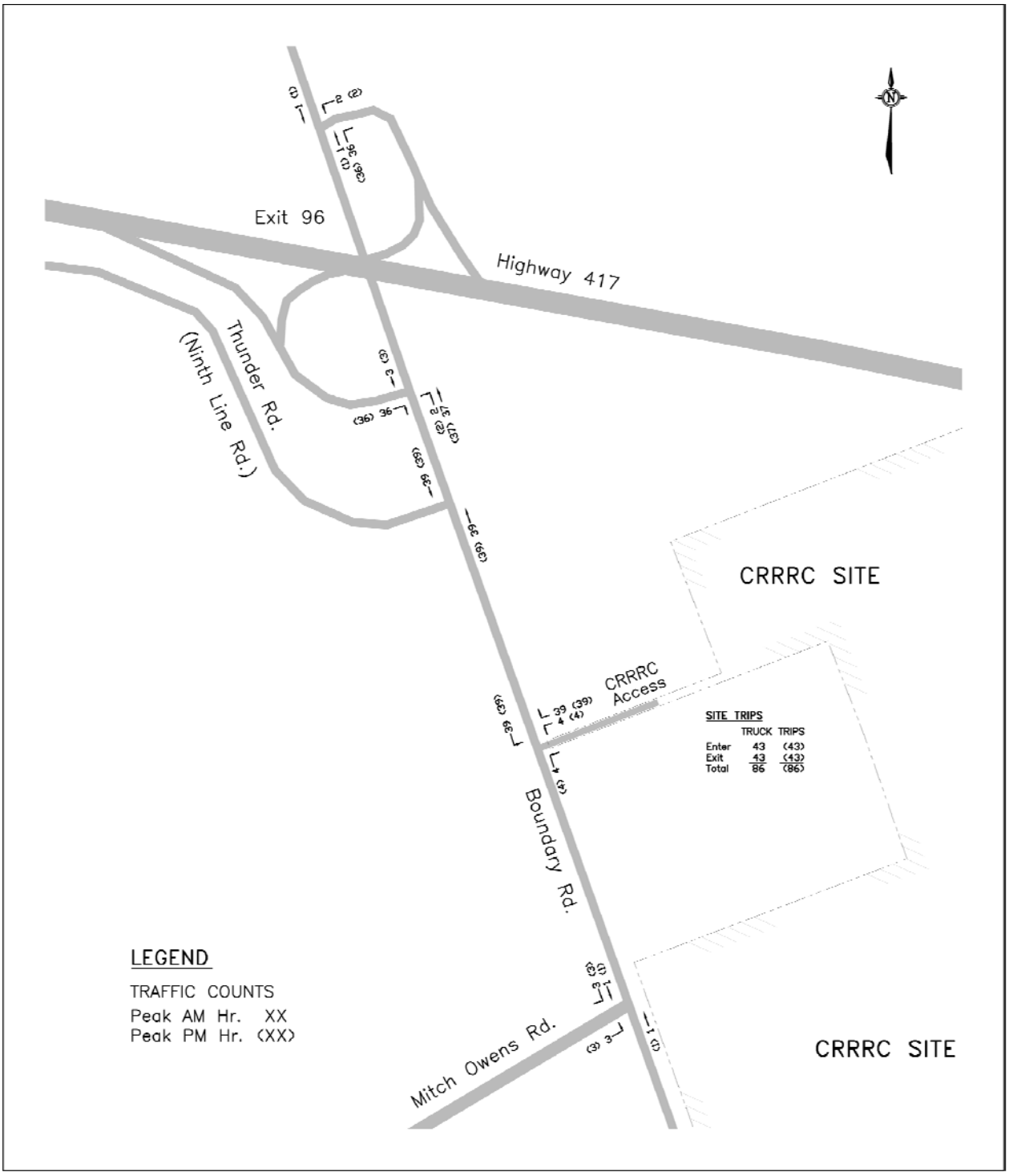


Figure 3.1: Weekday Peak AM and PM Hour Site Generated Trips

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.

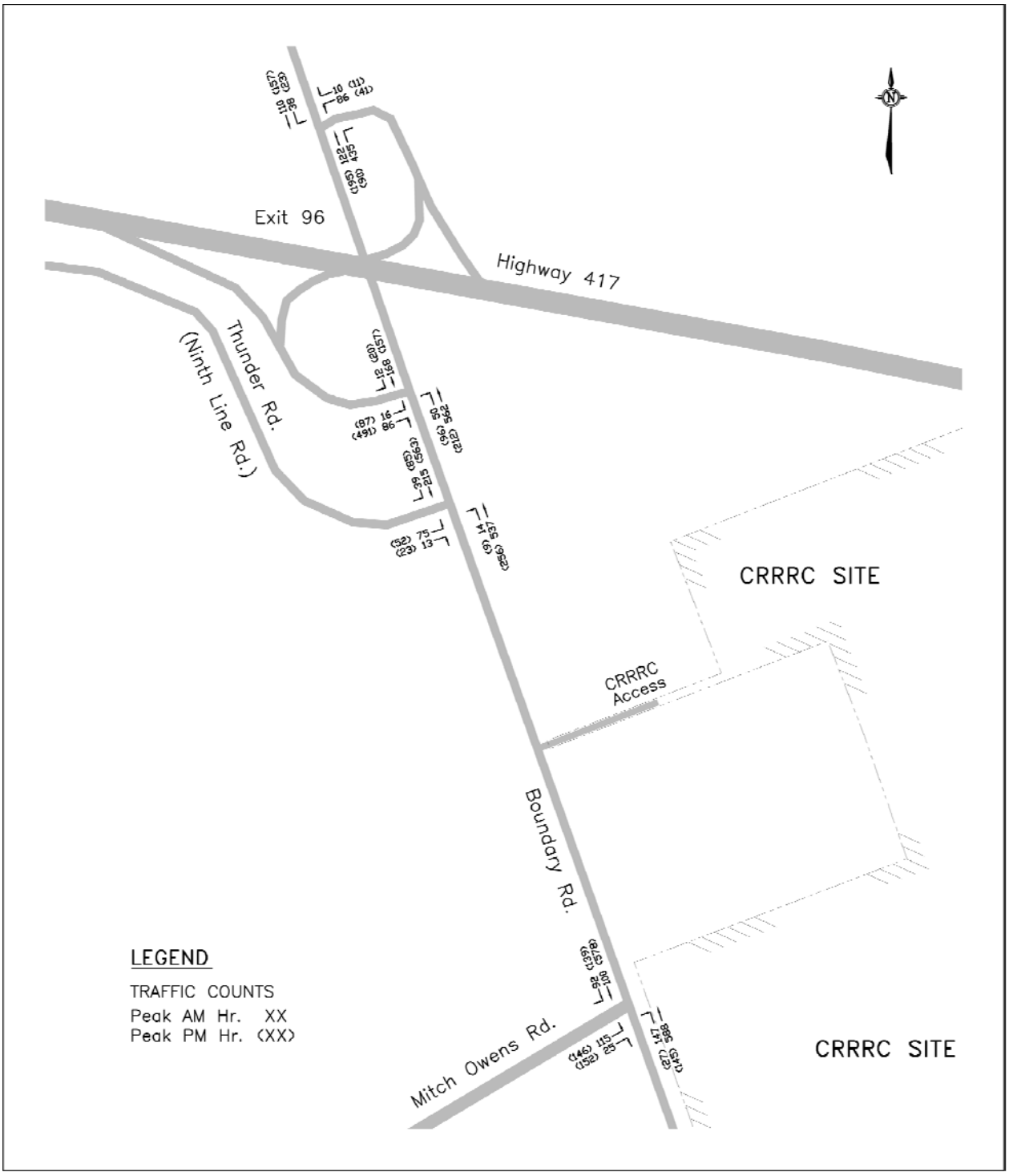


Figure 4.1: 2022 Weekday Peak AM and PM Hour Background Traffic

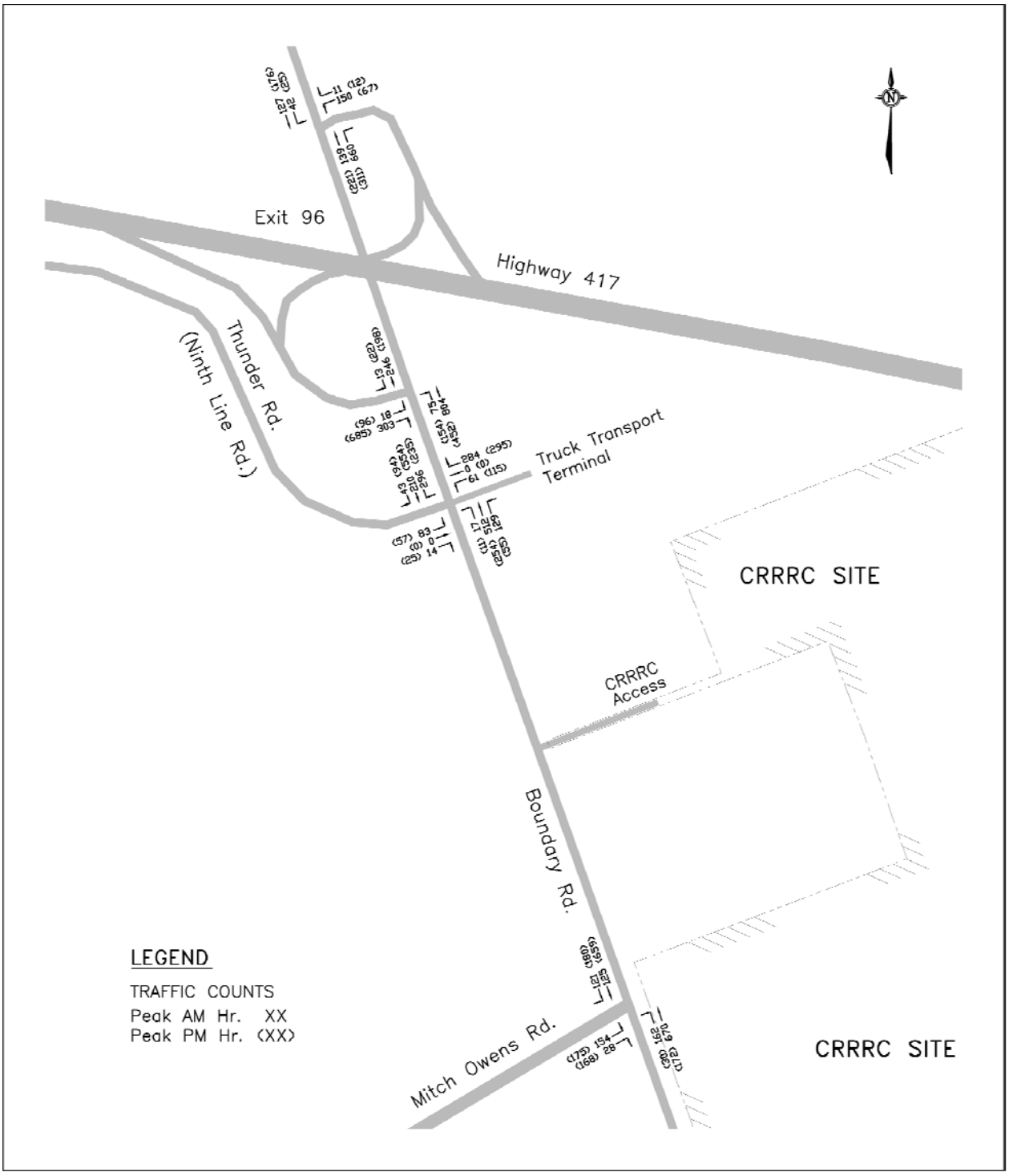


Figure 4.2: 2027 Weekday Peak AM and PM Hour Background Traffic

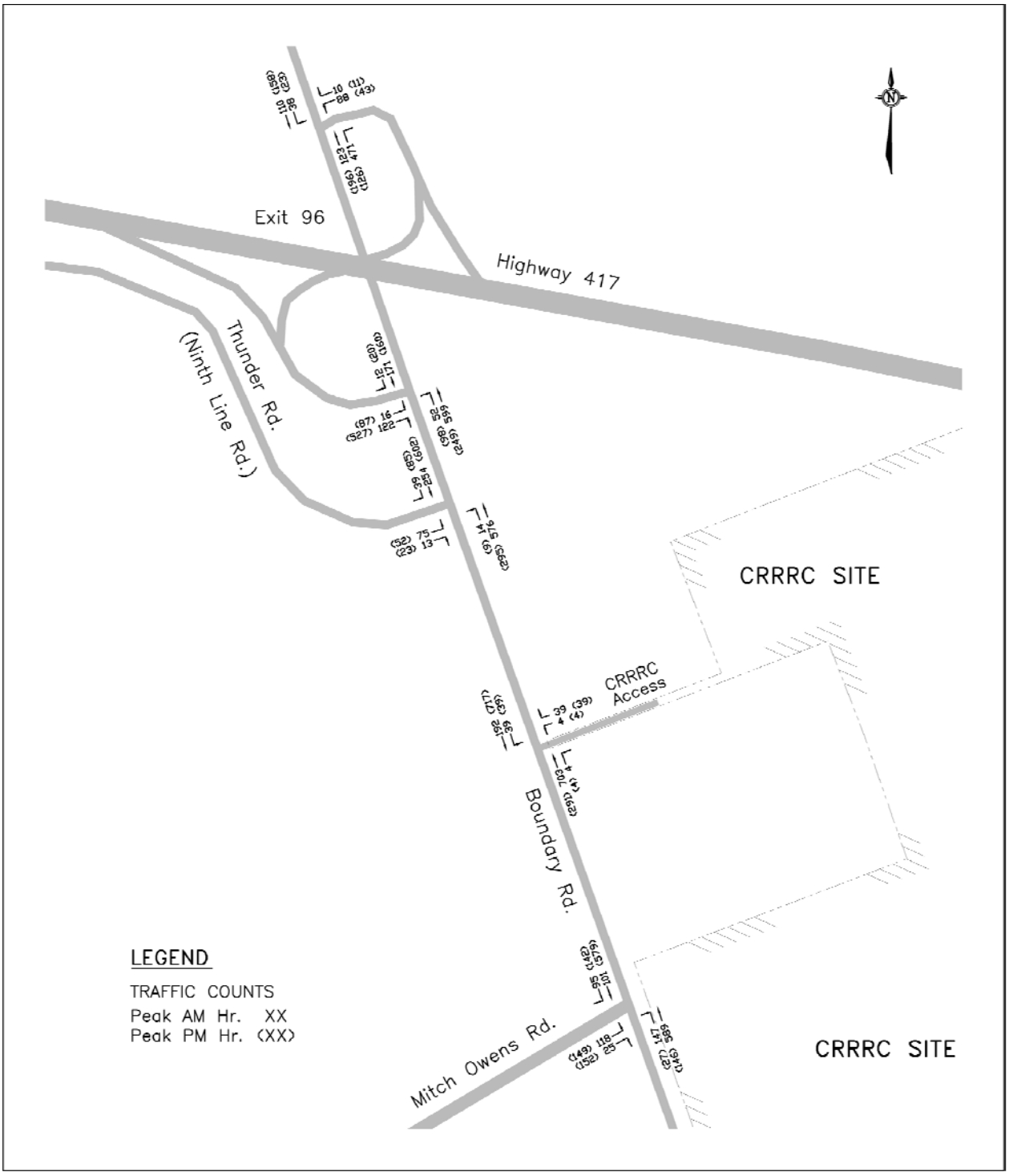


Figure 4.3: 2022 Weekday Peak AM and PM Hour Total Traffic

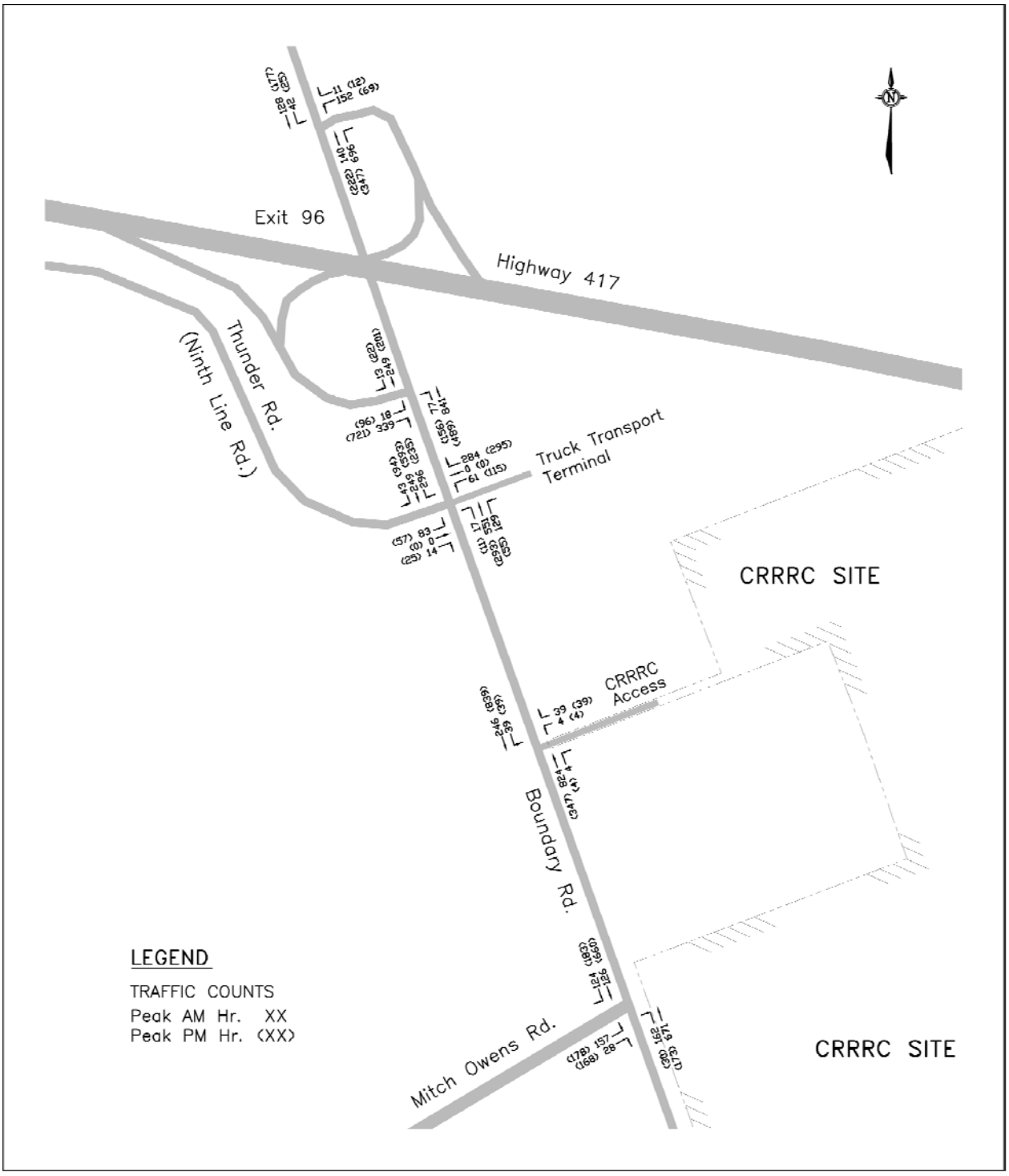


Figure 4.4: 2027 Weekday Peak AM and PM Hour Total Traffic

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)

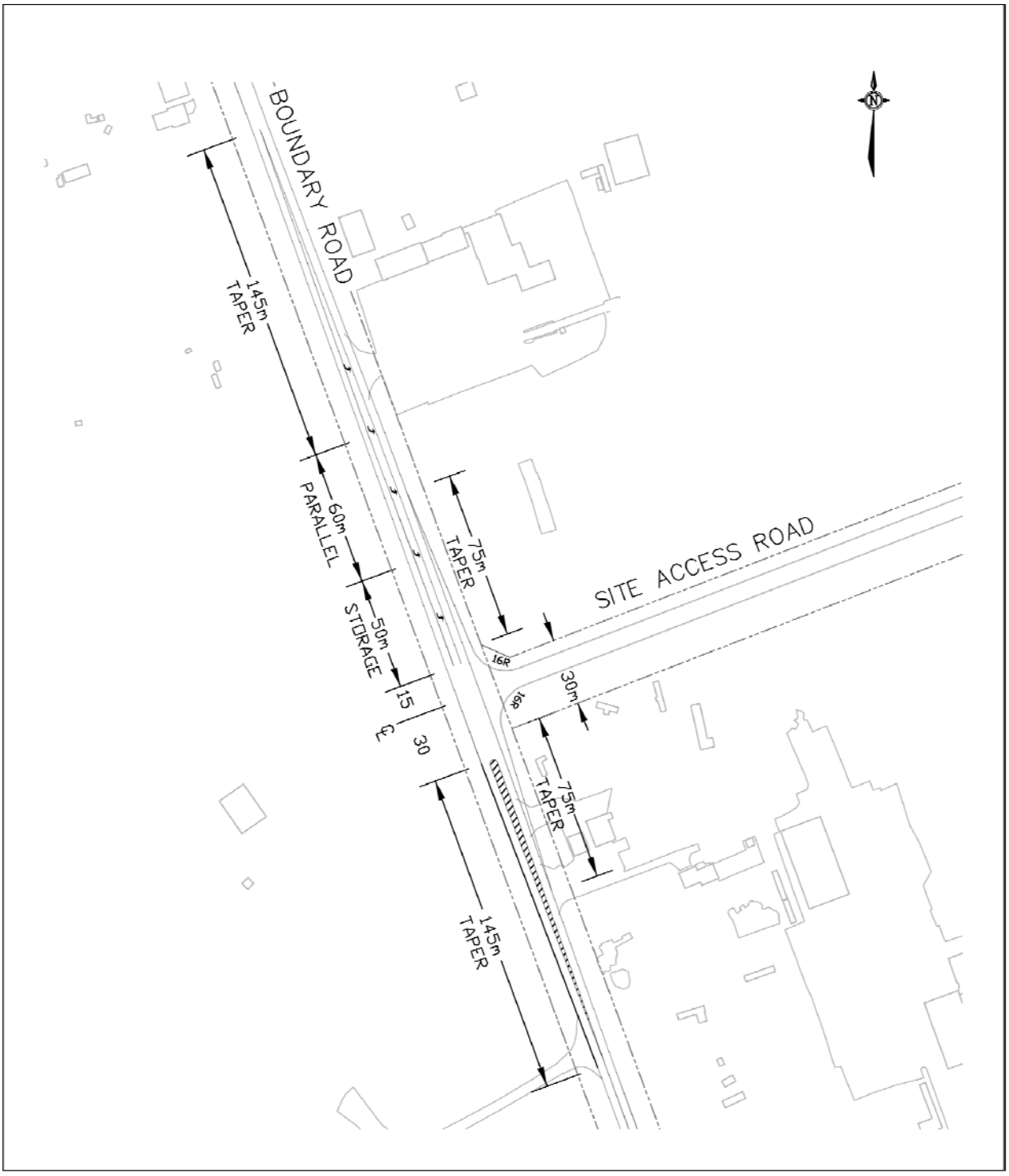


Figure 4.5: Proposed Boundary Road/CRRRC Access Geometry

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

Ottawa — *Public Works and Services Department*

Count ID 3164

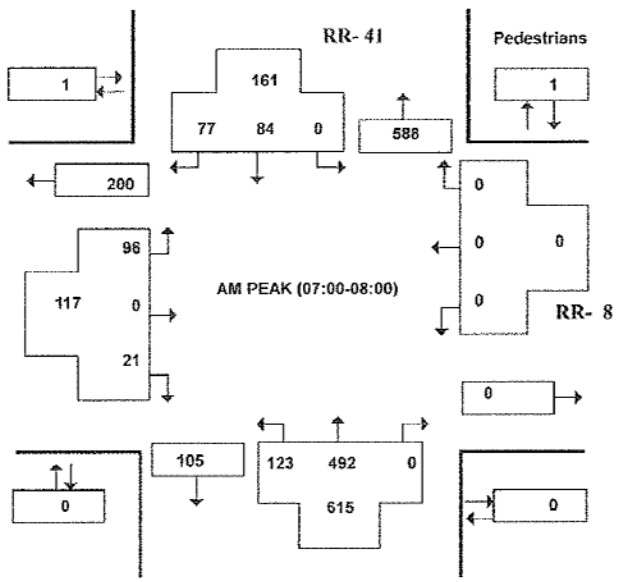
MITCH OWENS RD and BOUNDARY RD

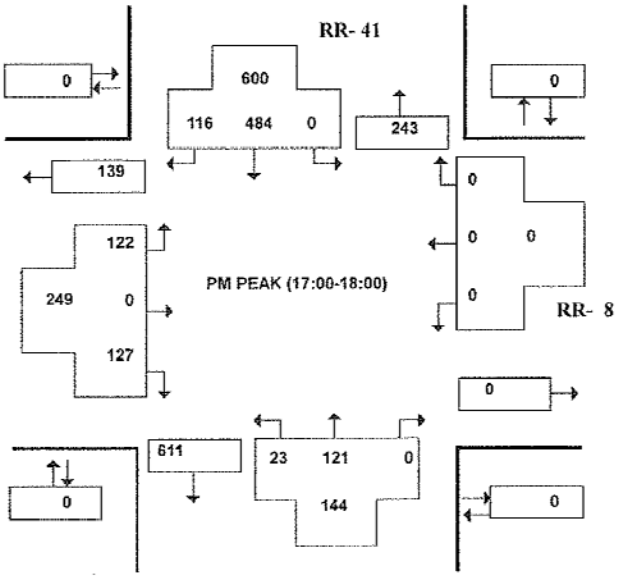
(ULRS Listing RR- 8 & RR- 41)

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

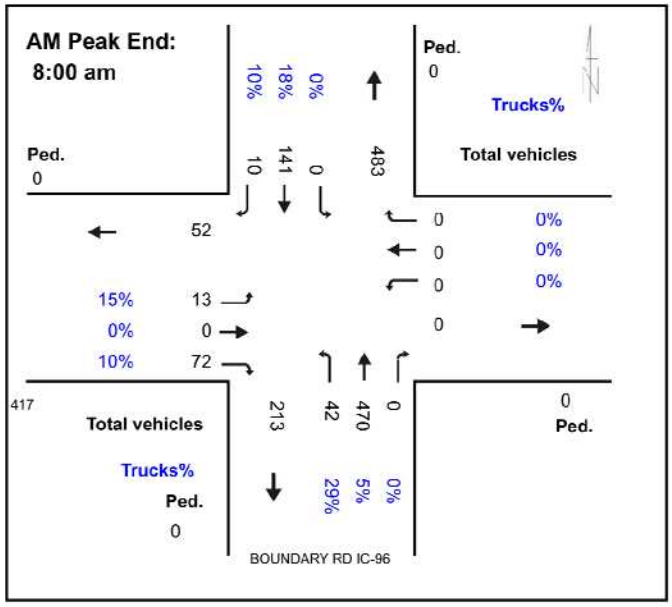
Exhibit 2: Year 2013 Peak AM and PM Hour Traffic Counts – Boundary/Eastbound 417 Ramps

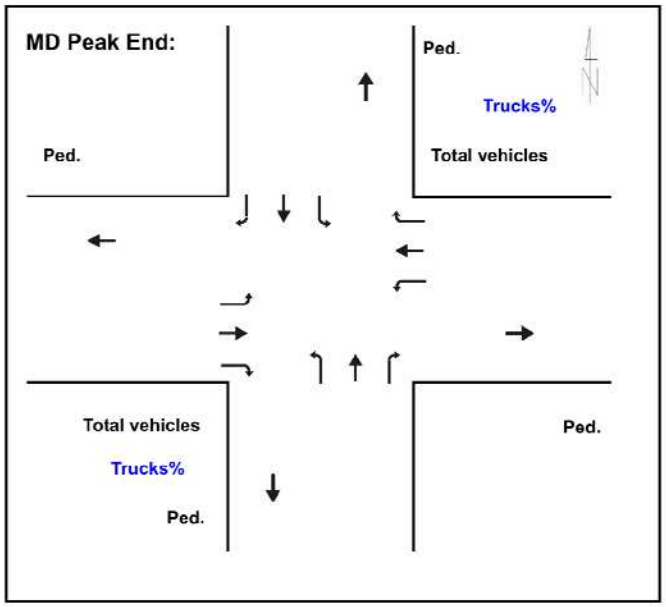
Ontario

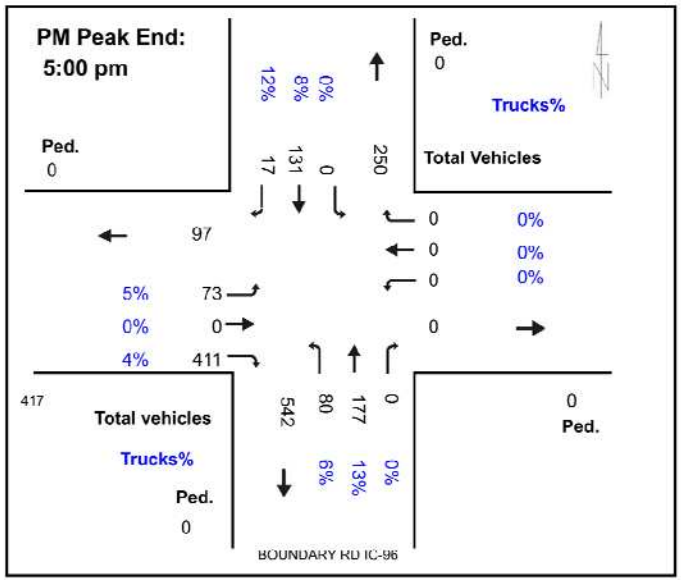
HWY 417 @ BOUNDARY RD IC-96

Eastern

Intersection ID:493400000(--S--) **Count Day: Wednesday** **Count Date: 25-Sep-2013**







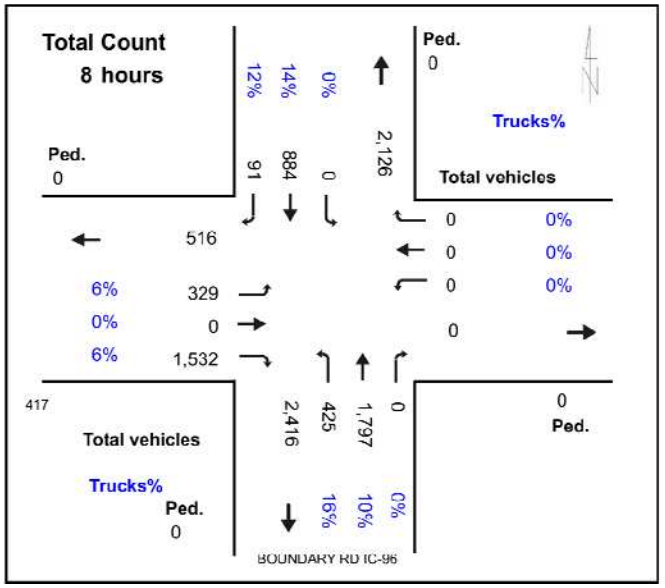


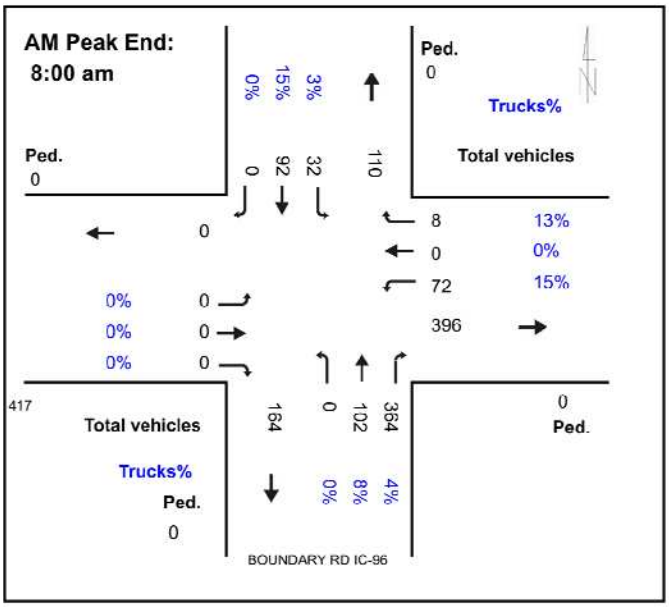
Exhibit 3: Year 2013 Peak AM and PM Hour Traffic Counts – Boundary/Westbound 417 Ramps

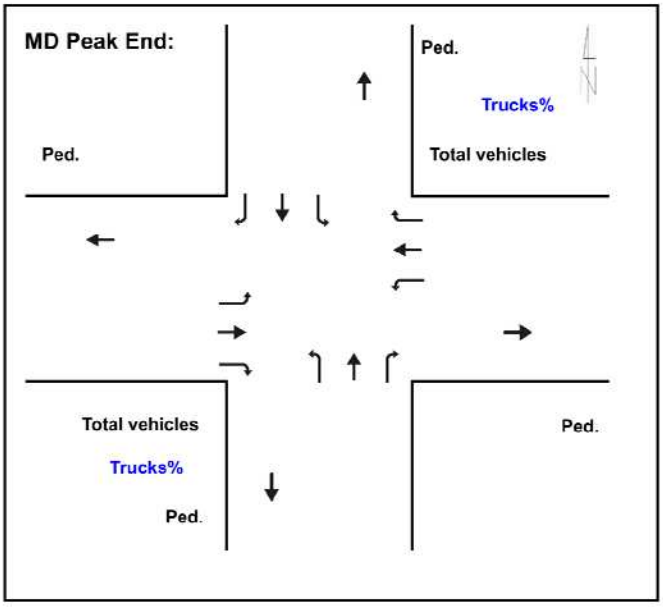
Ontario

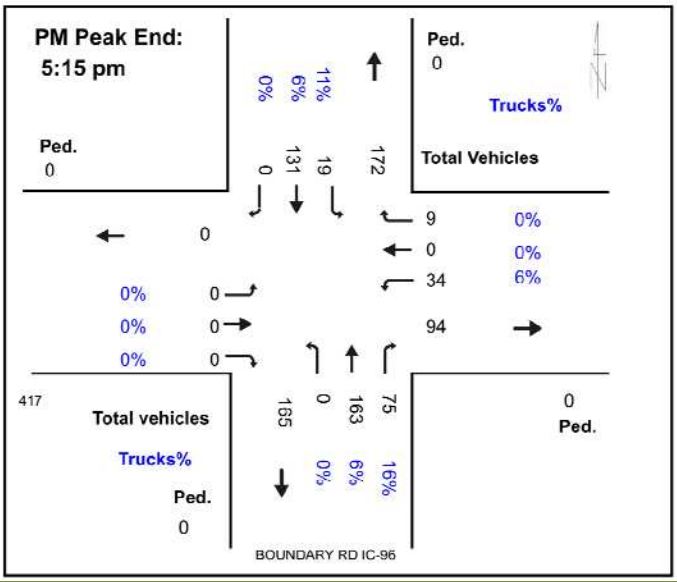
HWY 417 @ BOUNDARY RD IC-96

Eastern

Intersection ID:493400000(--N--) **Count Day: Wednesday** **Count Date: 25-Sep-2013**







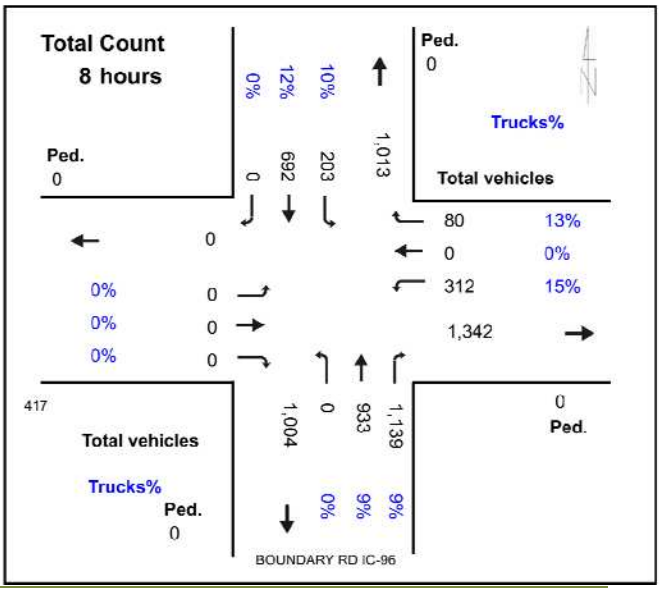
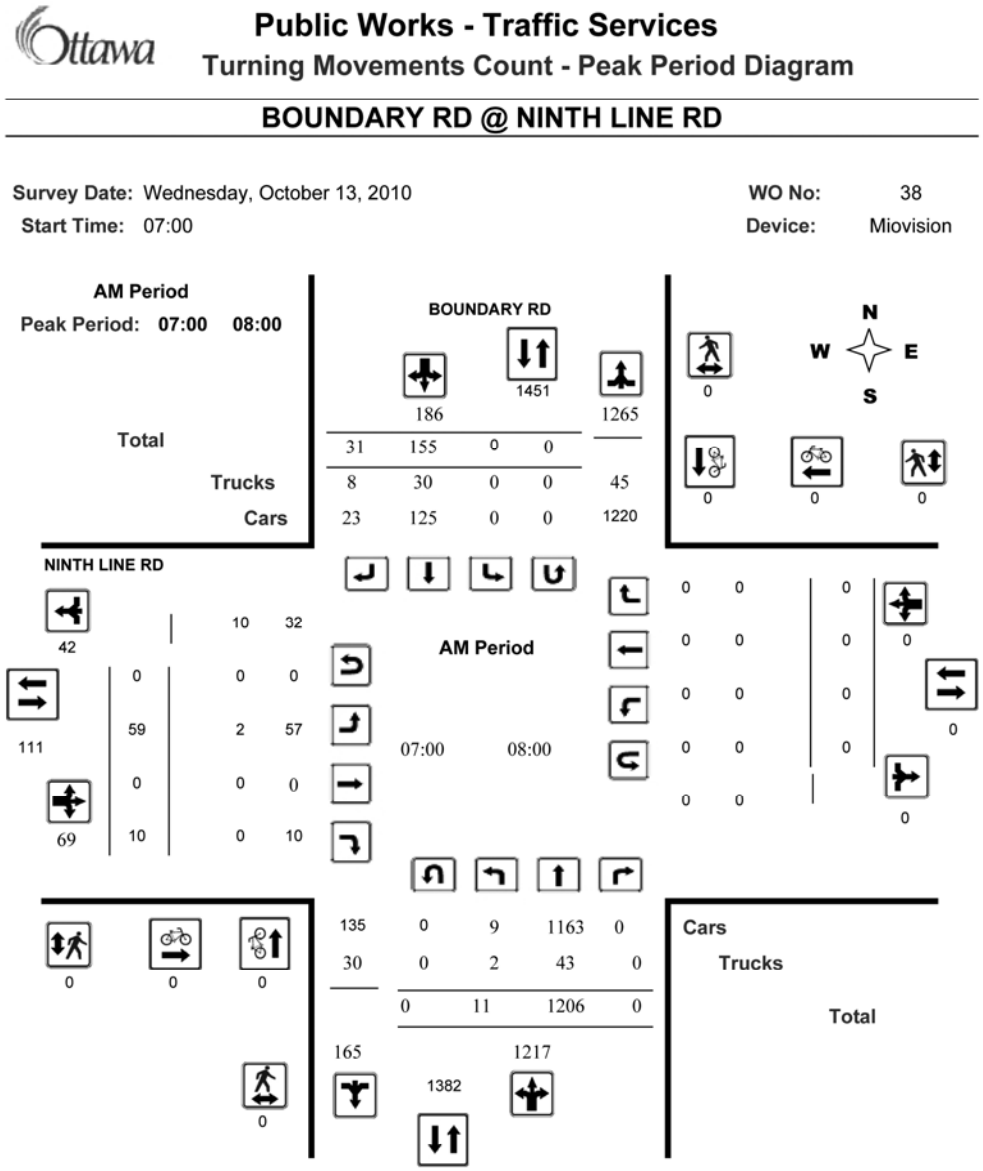


Exhibit 4: Year 2010 Peak AM and PM Hour Traffic Counts – Boundary/Thunder



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

BOUNDARY RD @ NINTH LINE RD

Survey Date: Wednesday, October 13, 2010 **WO No:** 38
Start Time: 07:00 **Device:** Miovision

AM Period
Peak Period: **07:00** **08:00**

BOUNDARY RD

Total	31	155	0	0	1265
Trucks	8	30	0	0	45
Cars	23	125	0	0	1220

186 1451

N W E S

0 0 0 0

NINTH LINE RD

42 111 69

10	32		
0	0	0	0
59	2	57	
0	0	0	
10	0	10	

AM Period
07:00 08:00

0	0			
0	0			
0	0			
0	0			
0	0			

0				
0				
0				
0				
0				

0 0 0 0 0 0

Cars	135	0	9	1163	0
Trucks	30	0	2	43	0
Total		0	11	1206	0

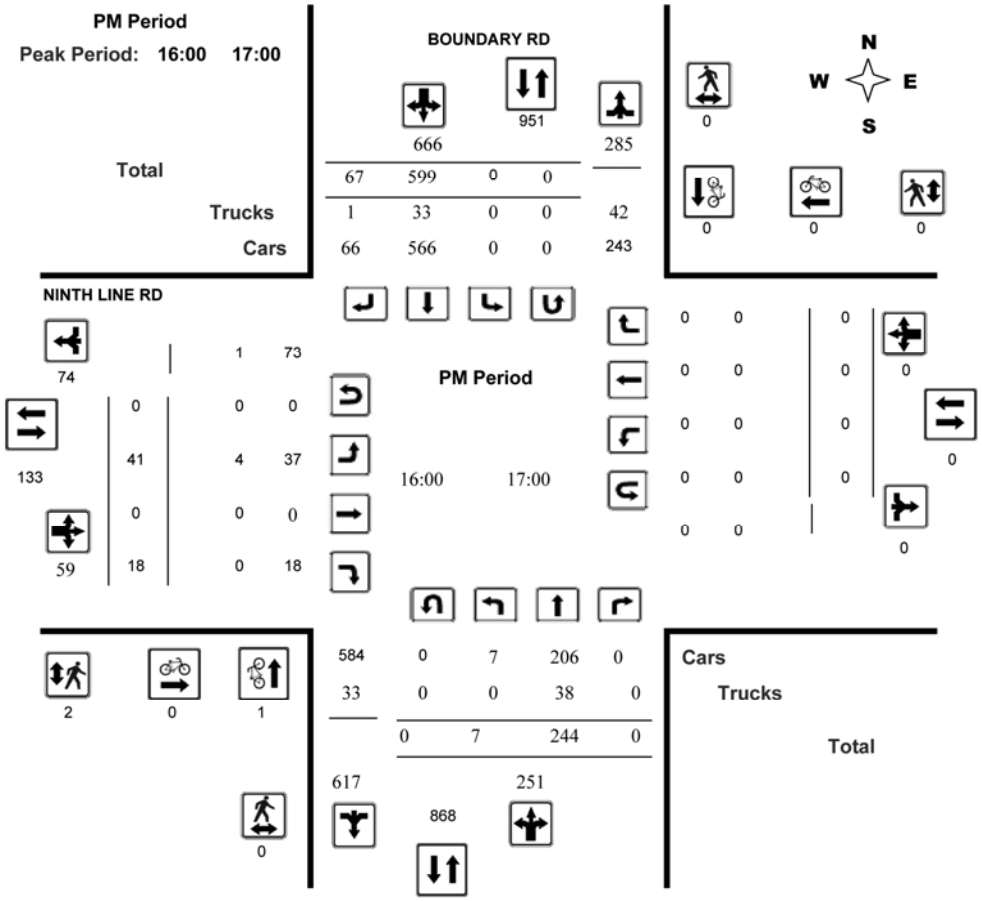
165 1382 1217

Validation Note: Results generated Apr 26, 2014. All records still in violation were set to Edited.

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

BOUNDARY RD @ NINTH LINE RD

Survey Date: Wednesday, October 13, 2010 **WO No:** 38
Start Time: 07:00 **Device:** Miovision



Validation Note: Results generated Apr 26, 2014. All records still in violation were set to Edited.

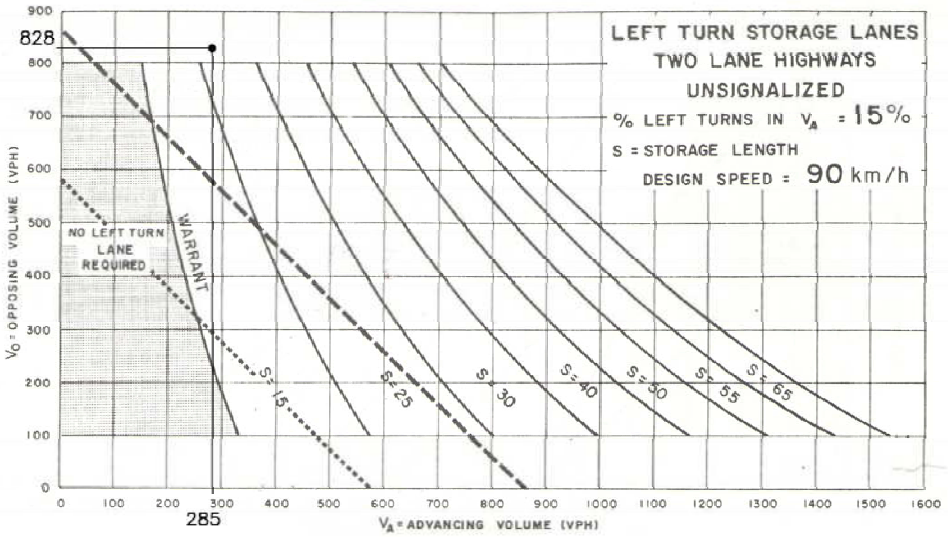
Exhibit 5: Year 2027 Peak AM and PM Hour Left Turn Lane Warrants – Boundary/CRRRC Access

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

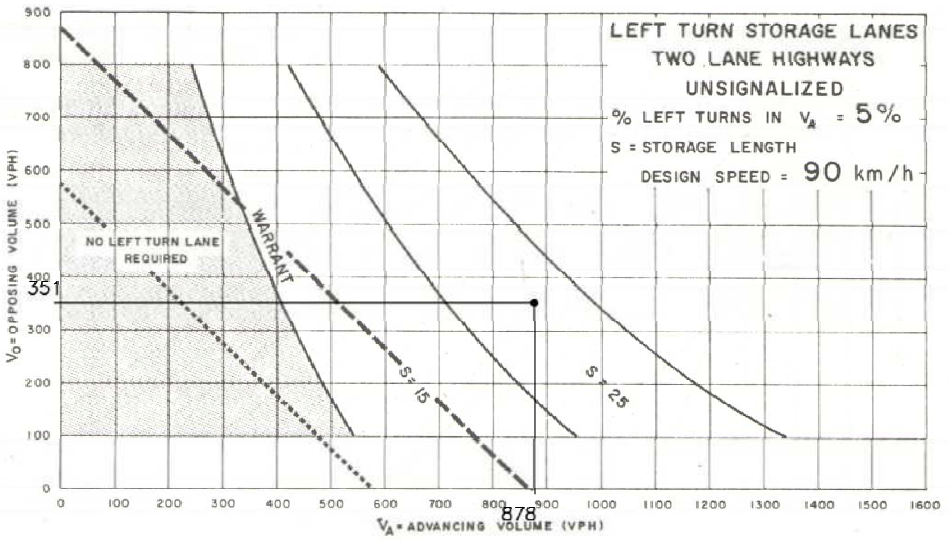
TRAFFIC SIGNALS MAY BE WARRANTED IN "FREE FLOW" URBAN AREAS

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

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	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	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	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

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	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	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	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

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	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	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	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

Major Street: Approach	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	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	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	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 (Roadway) **of** Mitch Owens Road (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 NUMBER	SECTIONAL %	4. ENTIRE %
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:

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 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 (Roadway) **of** Thunder Road (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 NUMBER	SECTIONAL %	4. ENTIRE %
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:

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 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 (Roadway) **of** Highjway 417 Eastbound Ramps (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 NUMBER	SECTIONAL %	4. ENTIRE %
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/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- 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/ Mvmt	Lane Group	Adj Flow Rate (v)	Adj Sat Flow Rate (s)	Flow Ratio (v/s)	Green Ratio (g/C)	--Lane Group-- Capacity (c)	v/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	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	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	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	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	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	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	Westbound			Eastbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	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				

ATTACHMENT D

Geotechnical/Pavement Investigation – Proposed Boundary Road Improvements, dated April 10, 2018

TECHNICAL MEMORANDUM

DATE April 10, 2018 **Project No.** 1787048-400-4.4

TO Doug Kerr, P.Eng.
Golder Associates Ltd.

FROM Kimberley MacDonald, E.I.T.
Terry Nicholas, P.Eng.

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GEOTECHNICAL/PAVEMENT INVESTIGATION
PROPOSED BOUNDARY ROAD IMPROVEMENTS
CAPITAL REGION RESOURCE RECOVERY CENTRE (CRRRC)

Introduction

The Capital Region Resource Recovery Centre (CRRRC) is to be located on the east side of Boundary Road to the northeast of Boundary Road and Devine Road in Ottawa, Ontario. The facility will provide waste diversion activities and a landfill component. Site access to the facility is proposed directly onto Boundary Road at a location approximately 1,130 metres south of Highway 417 and approximately 600 metres south of Thunder Road. This technical memorandum provides geotechnical and pavement engineering services for the proposed improvements to Boundary Road at the site access location.

Scope of Work

The proposed pavement design aspects of the project consist of a geotechnical investigation and pavement design guidelines for the proposed improvements to Boundary Road as follows:

- The widening to the west of Boundary Road SBL approaching the site access location to provide for a separate Left Turn Lane to the site access road; and,
- The widening to the east of Boundary Road NBL approaching the site access road location for a new Right Turn taper.

Traffic Volumes

The following traffic volumes were provided by D.J. Halpenny & Associates on November 23, 2017:

Location	AADT	Commercial	Growth	Design Life
Boundary Road from Highway 417 to Mitch Owens Road	8,000	7%	1%	20 Years

Physiography and Topography

The CRRRC site is located in the Physiographic Region of Southern Ontario known as the Russell and Prescott Sand Plain. Boundary Road lies within a boundary between the offshore marine deposits of silty clay and clayey silt, and deltaic and estuary deposits of sand.

Based on existing information from previous investigations and geological mapping in the area, the local bedrock within the project is of the Carlsbad formation consisting of shale. Bedrock underlies the site area at depths of 33 to 41 metres.

Boundary Road is a rural cross-section with roadside ditches, with cross-drainage of Boundary Road currently provided by culverts.

Procedure

The field work for this investigation was carried out on November 26 and 27, 2017. During that time, a total of seven augerholes (numbered AH 17-01 to 17-03, inclusive, 17-05 to 17-08, inclusive), seven manual hand-augerholes (numbered HAH 17-101 to 17-107, inclusive) and one deeper borehole (numbered BH 17-04) were put down at the approximate locations shown on Figure 1.

The test holes were advanced to depths of about 0.2 to 5.8 metres below the existing ground surface. Borehole 17-04 and all augerholes (AH 17-01 to 17-03, inclusive, and 17-05 to 17-08, inclusive) were advanced through the existing Boundary Road main lanes and gravel shoulder within the area of the proposed widening. Hand-augerholes 17-101 to 17-107, inclusive, were advanced along the toe of slope within the proposed widening areas. The purpose of the hand augerholes was to determine the thickness of organic deposits that are within the footprint of the proposed widening.

The boreholes and augerholes were advanced using a truck-mounted hollow-stem auger drill rig supplied and operated by CCC Geotechnical & Environmental Drilling of Greely, Ontario. Hand-augerholes were put down using portable augering equipment.

Within the augerholes and hand-augerholes, the soils exposed on the sides of the open holes were sampled and classified by visual and tactile examination. Within borehole 17-04, samples of the soil were obtained at near continuous intervals of depth using 50 millimetre outside diameter split-spoon samplers. Where possible, in situ shear vane testing was carried out within the silty clay.

The fieldwork was supervised by engineering personnel from our staff who located the test holes, directed the drilling operations, logged the test holes and samples, and took custody of the samples retrieved. On completion of the drilling operations, samples of the subsoil obtained from the test holes were transported to our laboratory for examination by the project engineer.

The test hole locations were selected, and located in the field, and subsequently surveyed by Golder Associates personnel. The positions and ground surface elevations at the borehole locations were measured using a Trimble R8 GPS survey unit. The elevations are referenced to Geodetic datum.

Subsurface Conditions

The information is presented as follows:

- Record of Augerholes, Hand-Augerholes are contained in Tables 1 and 2 in Attachment A.

- Record of Borehole 17-04 is contained in Attachment A.
- Grain Size Distribution Curves are presented on Figures 2, 3 and 4.

Based on the results of the geotechnical field investigation, the existing pavement structure and the subgrade soil types encountered along the existing roadway are summarized in the following sub-sections.

Existing Pavement Structure and Fill

Based on the results of the pavement engineering field investigation, the existing pavement structure and the subgrade soil types within the project limits are as follows:

Roadway Section	Existing Pavement Structure	
	Pavement Structure Component Thickness (millimetres)	Subgrade Soil Types
Boundary Road (Main Lanes)	155 Asphalt (Range: 150 – 170) 300 Gravelly Sand Base (Range: 230 – 400) 485 Sandy Gravel Subbase (Range: 420 - 570)	Silty Sand over Silty Clay
Boundary Road (Gravel Shoulder)	370 Gravelly Sand Base (Range: 230-500) 565 Sandy Gravel Subbase (Range: 350-720)	Silty Sand over Silty Clay

Based on the test hole information, an angular gravelly sand granular base, overlying an angular sandy gravel subbase is present beneath the asphalt surfacing. One grain size distribution test carried out on the granular base (gravelly sand) indicates that the material on Boundary Road would not meet the gradation requirements for Ontario Provincial Standard Specification (OPSS) Granular A (fines content larger than 10%).

One grain size distribution test carried out on the subbase (angular sandy gravel) indicates that the sandy material encountered meets the gradation requirements for OPSS Granular B, Type II.

The results from gradation testing carried out on samples of the granular base and subbase are included in the augerhole logs and on Figures 2 and 3, respectively.

Beneath the pavement structure in augerholes 17-06 and 17-08 as well as borehole 17-04, there is a thin layer of fill, consisting of silty sand to sand. The fill was proven to extend to depths ranging from 1.0 to 1.4 metres below existing ground surface. One standard penetration test carried out within the fill layer gave a value of 17 blows per 0.3 metres of penetration, indicating a compact state of packing.

Topsoil, Peat and Organic Material

Topsoil, consisting of brown silty sandy organic material, was encountered at surface at hand-augerholes 17-102 and 17-104. The topsoil is about 330 millimetres thick.

A thin layer of peat exists at surface at hand-augerholes 17-101, 17-103, 17-105 to 17-107, inclusive, as well as beneath the fill in augerholes 17-02, 17-05 and 17-06. The peat encountered at the ground surface is about 200 to 450 millimetres thick. Within the augerholes, the peat exists at depths of about 0.9 to 1.3 metres below existing road surface and is about 200 millimetres thick.

Native Sand, Sandy Silty, Silty Sand and Silty Clay

Native soil within the project limits consist of silty sand/sandy silt overlying silty clay to clay with clayey silt layers.

The silty sand, sandy silt and sands were encountered underneath the pavement structure and/or fill, and/or peat at all of the augerhole and borehole locations at depths of about 0.8 to 1.4 metres below existing ground surface. The silty sand was fully penetrated at borehole 17-04 and augerhole 17-06 at depths of 1.8 and 2.1 metres below existing roadway surface. One standard penetration test carried out within the silty sand to sandy silt layer gave an 'N' value of 13 blows per 0.3 metres of penetration, indicating a compact state of packing. The natural water content of one sample of the silty sand was about 22 percent.

The results of grain size distribution testing carried out on one sample of the silty sand to sandy silt is provided on Figure 4.

Underlying the silty sand, sandy silt and sand, where fully penetrated at borehole 17-04 and augerhole 17-06, there is a deposit of silty clay to clay, containing a clayey silt layer. The silty clay deposit was encountered at depths of 1.8 to 2.1 metres below existing ground surface. Borehole 17-04 and augerhole 17-06 were terminated within the silty clay deposit at depths of 5.8 and 2.1 metres, respectively.

At borehole 17-04, the upper 0.9 metres of the silty clay has been weathered to a grey-brown crust. The weathered crust extends to a depth of about 3.0 metres below existing ground surface. One standard penetration test carried out within the weathered silty clay layer gave an 'N' value of 1 blow per 0.3 metres of penetration, indicating a stiff to firm consistency. The natural water content of one sample of the weathered clay was about 48 percent.

Beneath the upper weathered zone, the silty clay is grey in colour and was not fully penetrated, but proven to extend to a depth of 5.8 metres below existing ground surface. It is known that the silty clay deposit extends to a depth of about 30 metres. The results of the in situ shear vane testing carried out within the deposit measured undrained shear strengths of 23 and 27 kilopascals, indicating a generally soft consistency. The natural water content of one sample of the silty clay was about 68 percent

Groundwater

A monitoring well was sealed into borehole 17-04. The groundwater level in the monitoring well was measured on February 9, 2018 at a depth of 1.6 metres below ground surface (elevation 76.05 metres above sea level).

Groundwater seepage was observed in augerhole 17-08 at a depth of about 1.3 metres below ground surface.

It should be noted that groundwater levels in the area are subject to fluctuations both seasonally and with precipitation events.

Frost Susceptibility

Based on the borehole information, the silty sand and sandy silt subgrade is moderate to highly frost susceptible. The underlying silty clay with clayey silt is also considered to be highly frost susceptible.

Pavement Design and Recommendations

It is understood that this project involves only pavement widening within the proposed limits of work on Boundary Road in the area north and south of the proposed site access location, as well as an assessment of the existing pavement conditions on Boundary Road in the area of the proposed improvements.

Location	AADT	Commercial	Growth	ESALs	Required S_N
Boundary Road from Highway 417 to Mitch Owens Road	8,000	7%	1%	4,597,200	138 millimetres

Note: ESAL- Equivalent Single Axle Loads

The following design parameters were used in the AASHTO analysis:

- Initial Serviceability – 4.4
- Terminal Serviceability – 2.2
- Reliability Level – 90 %
- Overall Standard Deviation – 0.45
- Subgrade Resilient Modulus – 25 MPa (based on Silty Sand and Silty Clay subgrade)

Existing Boundary Road (Proposed Overlay)

The existing pavement structure along Boundary Road main lanes is not sufficient to carry the anticipated design traffic loading and strengthening is required by overlay.

- Mill 50 millimetres of existing Hot Mix Asphalt (HMA);
- Add 90 millimetres new Hot Mix Asphalt (HMA) consisting of:
  - 40 millimetres SP 12.5 FC 2, Traffic Category D, PGAC 64-34; and,
  - 50 millimetres SP 19.0, Traffic Category D, PGAC 64-34.

The resulting grade raise of the road would be about 40 millimetres.

Boundary Road Widening

- Within the existing shoulder, excavate full depth starting at the edge of pavement and remove all organic material and topsoil;
- Place 150 millimetres HMA:

  - 40 millimetres SP 12.5 FC 2, Traffic Category D, PGAC 64-34; and,
  - 100 (50+50) millimetres SP 19.0, Traffic Category D, PGAC 64-34.
- Place 250 millimetres new Granular A to match existing under traffic lane;
- Provide 680 millimetres of new Granular B Type II to match bottom of existing under traffic lane; and,
- Provide for a 40 millimetre deep by 300 millimetre wide longitudinal step joint when tying into the existing pavement structure.

Paved Shoulders (Boundary Road)

Partially paved and fully paved shoulders (where required) should be provided as the follows:

- Partially and fully paved shoulders to consist of 40 millimetres Superpave 12.5 FC1 over 50 millimetres Superpave 19.0 upper binder course.

If it is anticipated that traffic may use the fully paved shoulder as a turning lane or slip-around lane, then both the binder and surface course asphalt lifts should be placed over the full shoulder width.

Hot Mix and Granular Conversion Factors

- Superpave 12.5 FC2 – 2.390 t/m^3 ;
- Superpave 19.0 – 2.460 t/m^3;
- Granular A – 2.4 t/m^3; and,
- Granular B Type II – 2.4 t/m^3.

Granular Pavement Materials

The granular base and subbase for new construction should consist of (OPSS.MUNI 1010) Granular A and Granular B Type II, respectfully.

Subgrade fill, if required could consist of Select Subgrade Material in accordance with OPSS.MUNI 1010.

Embankment Widening Beyond Existing Platform and Subgrade Preparation

Given that the composition of the existing base is variable and does not meet the gradation requirements for Granular A, the widening should be initiated from the edge of the existing traffic lane. Within the widened sections, the pavement subgrade will consist of new embankment fill placed over the native silty sand or silty clay subgrade. The existing topsoil and peat will need to be removed prior to the placement of embankment fill. The average topsoil/peat thickness varies from 230 to 450 millimetres and averages about 320 millimetres.

The existing fill subgrade, and the native subgrade within the widened sections, should be proof rolled prior to the placement of new fill. The purpose of the proof rolling is to provide surficial densification of the existing subgrade and to identify any isolated areas of soft or loose subgrade soil, which would require subexcavation and replacement with suitable fill.

Widening should be carried out in conformance to OPSD 209.010 or 209.011 as appropriate. Embankment construction and sections requiring backfilling of existing ditches to the proposed subgrade level (i.e., following subexcavation of loose/soft soil) should be carried out using acceptable Select Subgrade Material (OPSS 1010).

All fill should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment.

The granular base and subbase should be compacted to 100 percent of the Standard Proctor maximum dry density.

Below the pavement structure, frost compatibility must be maintained across any pavement tie-ins.

The subsoil should be inspected by qualified geotechnical personnel to check for the potential for differential frost heaving, such that appropriate design modifications can be made, if required.

Tie-into Existing Pavement at Limits of Construction

There will be a grade raise along this section of Boundary Road with the proposed overlay design. Provide for the following to tie-into the existing pavement:

Tie-in Description and Proposed Pavement Thickness	Pavement Profile at Tie-in	Recommended Pavement Transition
Tie-in at Project Limits	40 millimetre increase in vertical profile	Provide for a transverse 50 millimetre deep joint in the upper binder course at the project limits stepped back 300 millimetres Step the 40 millimetre surface course by 5 metres per OPSS 313.07.09.03 The transition in grade should be carried out gradually. A suggested length of transition should be based on a 400H: 1V slope which would result in a transition length of 16 metres.
Tie-in at site access road and Boundary Road	+/- 1.8 metre grade raise to current ground surface elevation	Provide a 10:1 horizontal to vertical taper for tie-in of granular materials

Frost Penetration Depth

The depth of frost penetration (from the profile grade) on this project should be 1.8 metres (Figure 3.2.2 of MTO *Pavement Design and Rehabilitation Manual-Second Edition, 2012*). This depth should be used when designing frost tapers in accordance with the OPSD 803 series.

Transition Zone Treatment

Transition zones should be treated in accordance with the applicable OPSD 205 series. The transition treatment depth, "t", should be taken as 1.8 metres and the depth of organic, leached and accumulated layers, "D_a", is 300 millimetres.

Erosion Control

Normal erosion and sediment control practices (seeding and mulching, hydro seeding, straw bale flow checks, rock flow checks, and silt fencing) should be considered for use on the project, as appropriate. Exposed slopes should not be permitted over extended periods of time or over the winter. Erosion control blankets should be provided on earth slopes steeper than 2H:1V or greater than 3 metres in height with no benching.

Closure

We trust that the recommendations in this Pavement Design Report provide sufficient detail to complete the design of the project. If you have any questions regarding the contents of this report, please do not hesitate to contact the undersigned.

Kimberly MacDonald, E.I.T.
Geotechnical Engineer-in-Training

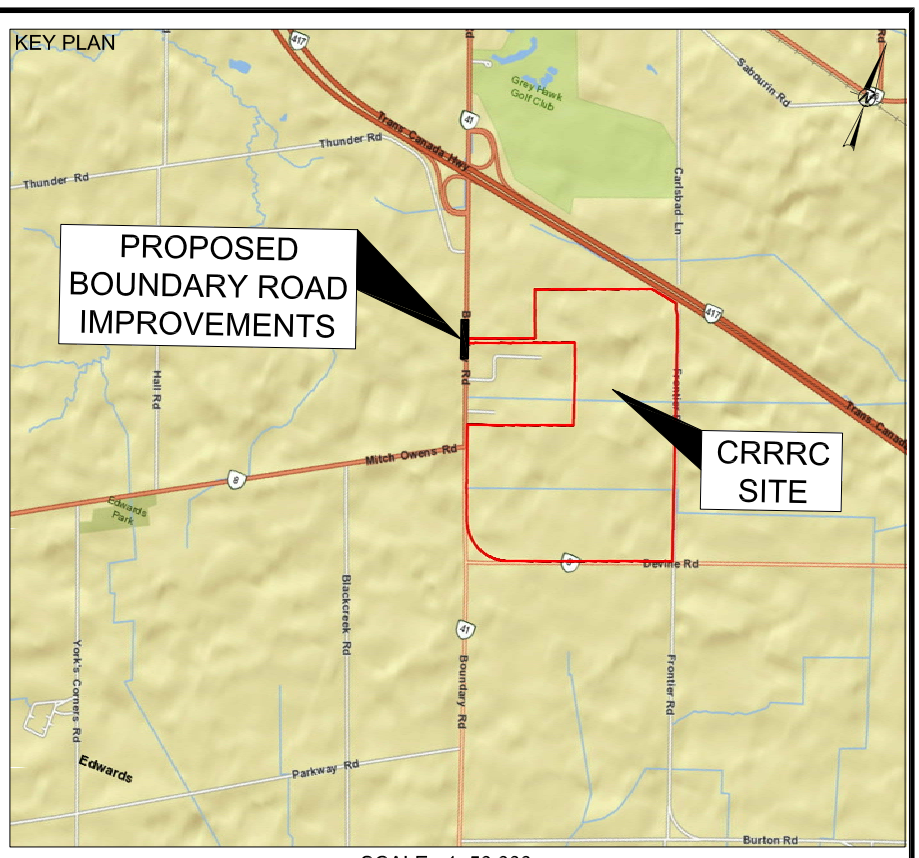
Terry Nicholas, P.Eng.
Senior Geotechnical Consultant

KM/TJN/SAT/mvrd
https://golderassociates.sharepoint.com/sites/18733g/deliverables/phase 400 tsk 4.4 report/memos & letters/1787048-400-4.4 tm-001_crrrc 2018apr10.docx

Attachments: Figures 1 to 4
Appendix A

PLOT DATE: April 10, 2018
FILENAME: N:\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\GIS\MXDs\1787048\40_PROD\0003_Geotech\1787048-0003-BG-0001.dwg

KEY PLAN



SCALE : 1: 50,000

BOUNDARY ROAD

AREA OF PROPOSED BOUNDARY ROAD IMPROVEMENTS

HAH 17-101
AH 17-01
AH 17-02
HAH 17-102
HAH 17-103
AH 17-03
BH 17-04
HAH 17-104
AH 17-05
HAH 17-105
AH 17-06
HAH 17-106
AH 17-08
AH 17-07
HAH 17-107

PROPOSED CRRRC SITE ACCESS ROAD

OUT-BOUND SCALE

TRUCK QUEUING AREA

CLEAN LOAD DROP-OFF BUNKER AREA

SMALL DRO

REC

ADMINISTRATIC BUILDING

ENTREPRENEUR CRES.

TRADESMAN RD.

INDCUM RD.

LEGEND

- APPROXIMATE BOREHOLE LOCATION
- APPROXIMATE MANUAL AUGERHOLE LOCATION
- APPROXIMATE AUGERHOLE LOCATION
- PROPERTY BOUNDARY

0 50 100
1:2,500 METRES

Golder Associates
Ottawa, Ontario, Canada

SCALE	AS SHOWN
DATE	28 Feb. 2018
DESIGN	MLF
CAD	ABD/JM
CHECK	---
REVIEW	---

FILE No. 1787048-0003-BG-0001.dwg
PROJECT No. 1787048 REV.

TITLE

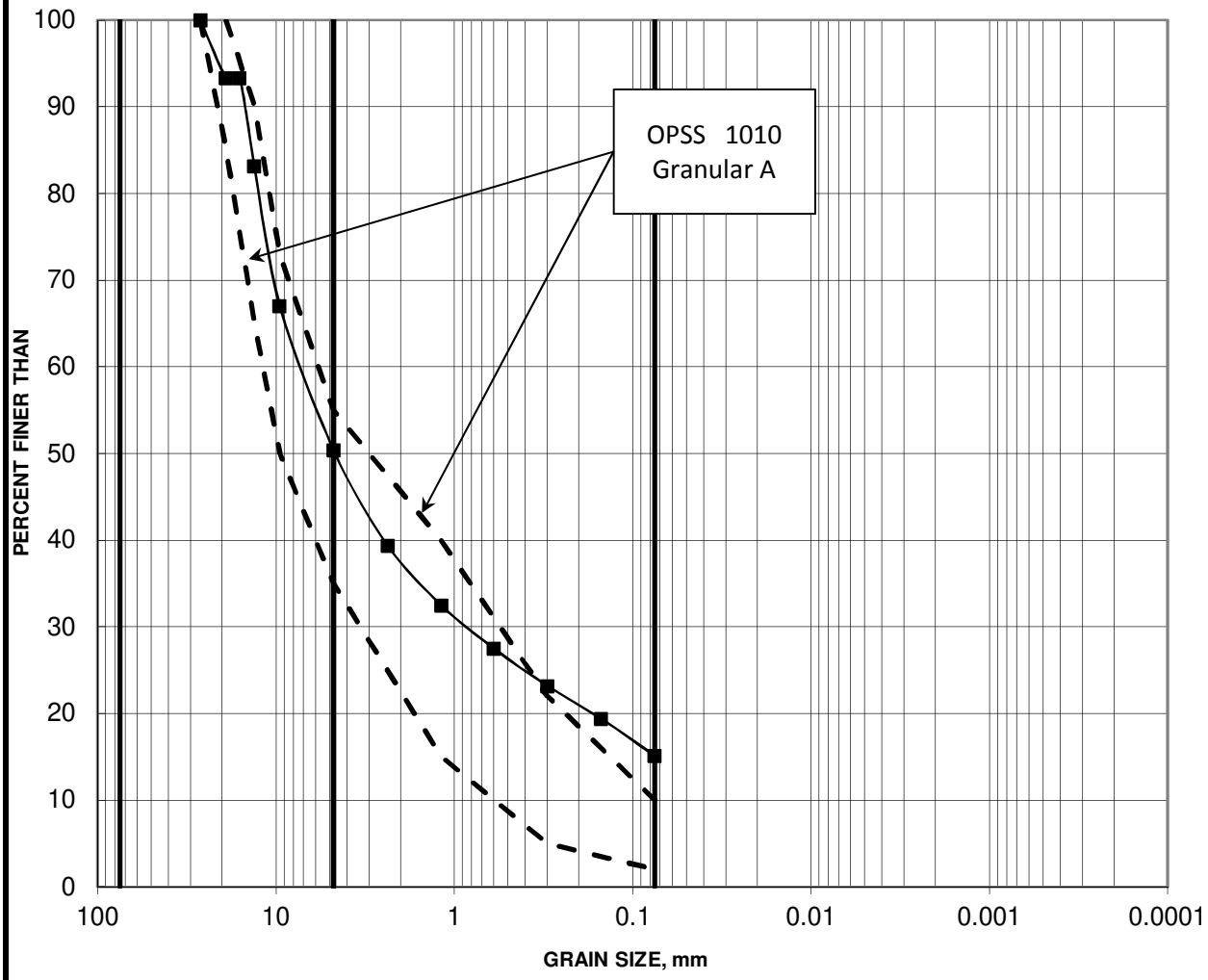
GEOTECHNICAL INVESTIGATION
PROPOSED BOUNDARY ROAD IMPROVEMENTS

CAPITAL REGION RESOURCE RECOVERY CENTRE

FIGURE 1

GRAIN SIZE DISTRIBUTION	FIGURE 2

GRANULAR BASE



Cobble	coarse	fine	coarse	medium	fine	SILT AND CLAY
Size	GRAVEL SIZE		SAND SIZE			

Auger Hole	Sample	Depth (m)
17-05	1	0.10-0.30

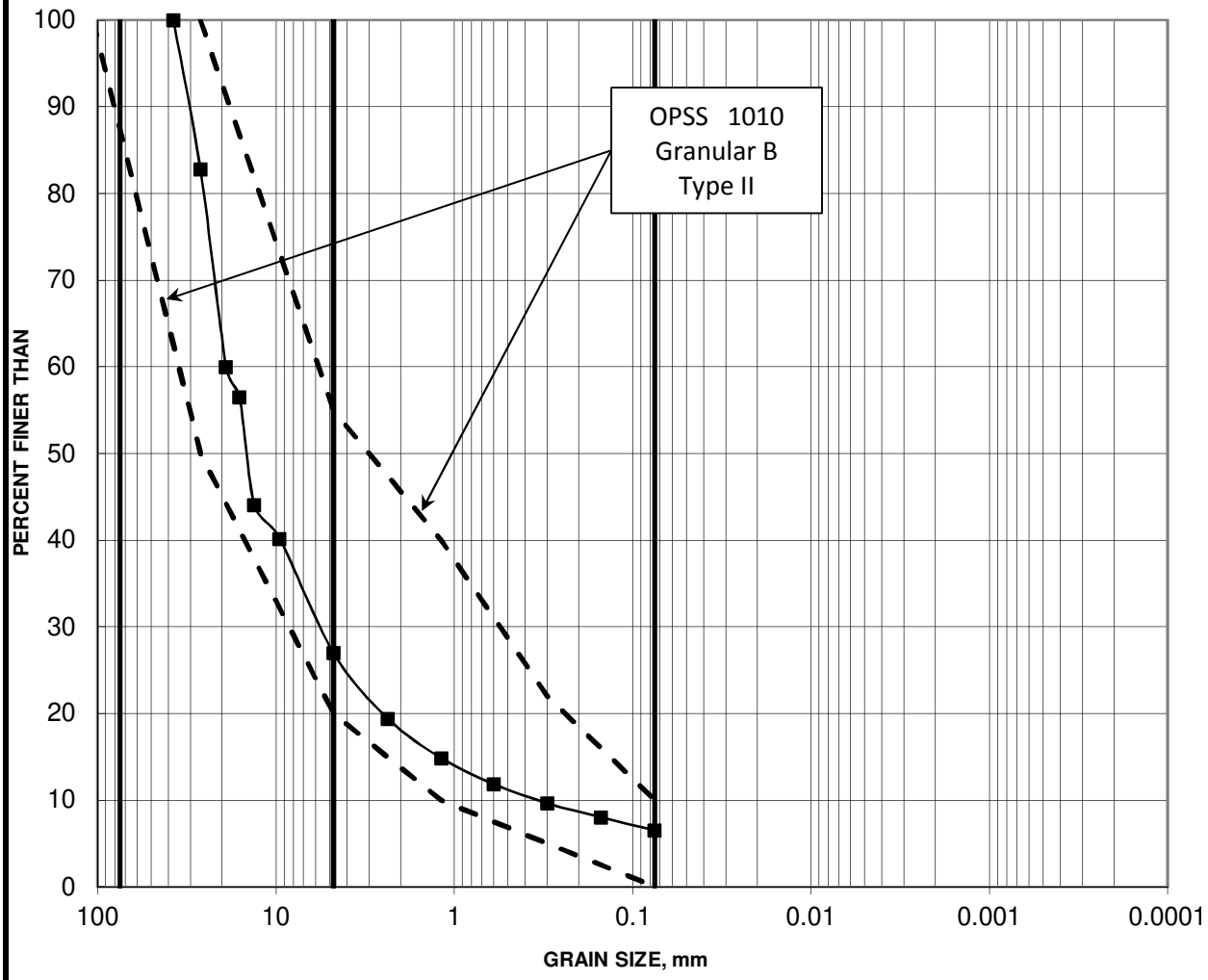
Project: 1787048 /400 /4.4

Golder Associates

Created by: CNM
Checked by: MI

GRAIN SIZE DISTRIBUTION	FIGURE 3

GRANULAR SUBBASE



Cobble	coarse	fine	coarse	medium	fine	SILT AND CLAY
Size	GRAVEL SIZE		SAND SIZE			

Auger Hole	Sample	Depth (m)
AH 17-04	2A	0.76-0.97

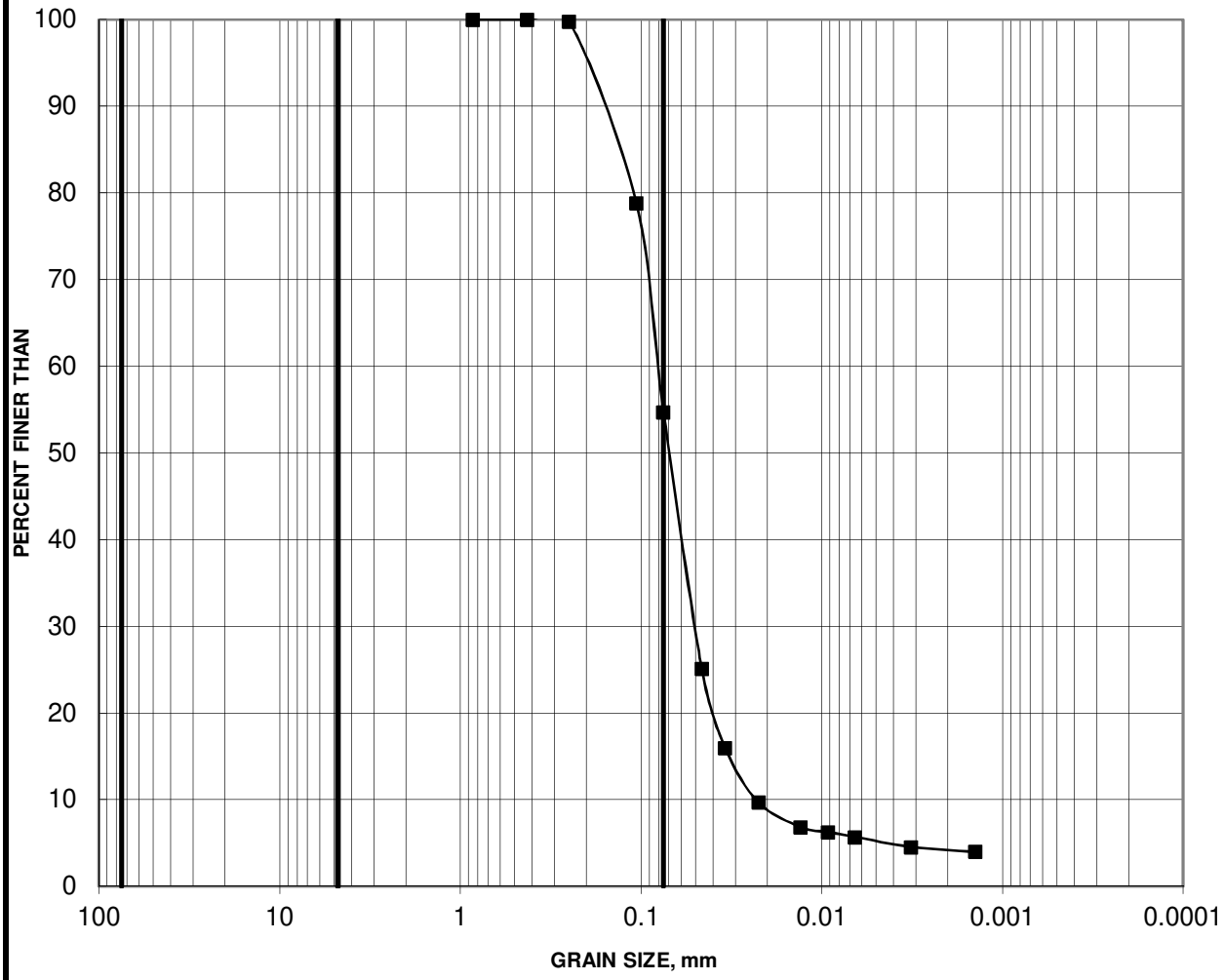
Project: 1787048 /400 /4.4

Golder Associates

Created by: CNM
Checked by: MI

GRAIN SIZE DISTRIBUTION	FIGURE 4

SILTY SAND to Sandy SILT



Cobble	coarse	fine	coarse	medium	fine	SILT AND CLAY
Size	GRAVEL SIZE		SAND SIZE			

Auger Hole	Sample	Depth (m)
AH 17-04	3	1.52-2.13

Project: 1787048 /400 /4.4

Golder Associates

Created by: CNM
Checked by: MI

APPENDIX A

Record of Borehole Sheet
Table 1 – Record of Augerholes
Table 2 – Record of Hand-Augerholes

PROJECT: 1787048

RECORD OF BOREHOLE: 17-4

SHEET 1 OF 1

LOCATION: N 5022850.9 ;E 387805.9

BORING DATE: October 26, 2017

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		77.64							
0	Power Auger 200 mm Diam. (Hollow Stem)	FILL - (SW) gravelly SAND, angular; grey (PAVEMENT STRUCTURE); moist		0.00 / 77.39	1	GRAB	-				
		FILL - (GW) sandy GRAVEL, angular; grey (PAVEMENT STRUCTURE); moist		0.25 / 76.67							Bentonite Seal
1		FILL - (SP/SM) SILTY SAND; brown; non-cohesive, moist, compact		0.97 / 76.27	2	SS	17			M	
		(SM/ML) SILTY SAND to sandy SILT; brown; non-cohesive, moist, compact		1.37 / 75.54	3	SS	13			MH	Silica Sand; 50 mm Dian. PVC #10 Slot Screen
2		(CL/CI) SILTY CLAY; grey brown, reddish (WEATHERED CRUST); cohesive, w>PL, firm		2.10 / 74.59	4	SS	1				
3		(CI/CH) SILTY CLAY; grey; cohesive, w>PL, firm to soft		3.05 / 73.07	5	SS	WH				
4								⊕ + / ⊕ +			Cave
		(ML) sandy CLAYEY SILT; grey; non-cohesive, wet		4.57 / 72.46	6	SS	WH				
5		(CI/CH) SILTY CLAY; grey; cohesive, w>PL, firm to soft		5.18 / 71.85				⊕ + / ⊕ +			
		End of Borehole		5.79							W.L. in Screen at Elev. 76.05 on Feb. 9, 2018
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DG

CHECKED: KM

MIS-BHS 001 1787048.GPJ GAL-MIS.GDT 3/14/18 ZS

TABLE 1

RECORD OF AUGERHOLES

Augerhole Number (Elevation)	Depth (metres)	Description
17-01 (77.89 metres)	0.00 – 0.50	FILL – (SW) gravelly SAND, angular; grey (PAVEMENT STRUCTURE); non-cohesive, moist
	0.50 – 1.10	FILL – (GW) sandy GRAVEL, angular; grey (PAVEMENT STRUCTURE); non-cohesive, moist
	1.10 – 1.52	(SM) SILTY SAND; brown; non-cohesive, moist
	1.52	END OF AUGERHOLE

Notes: Augerhole was dry upon completion

Sample	Depth (m)
1	0.25 – 0.45
2	0.75 – 1.00
3	1.25 – 1.45

17-02	0.00 – 0.17	ASPHALTIC CONCRETE
(77.86 metres)	0.17 – 0.40	FILL – (SW) gravelly SAND, angular; grey (PAVEMENT STRUCTURE); non-cohesive, moist
	0.40 – 0.97	FILL – (GW) sandy GRAVEL, angular; grey (PAVEMENT STRUCTURE); non-cohesive, moist
	0.97 – 1.15	(PT) PEAT– grey; non-cohesive, moist
	1.15 – 1.52	(SM) SILTY SAND; brown; non-cohesive, moist
	1.52	END OF AUGERHOLE

Notes: Augerhole was dry upon completion.

Sample	Depth (m)
1	0.20 – 0.35
2	0.50 – 0.80
3	1.00 – 1.15
4	1.25 – 1.45

TABLE 1

RECORD OF AUGERHOLES

Augerhole Number (Elevation)	Depth (metres)	Description
17-03	0.00 – 0.15	ASPHALTIC CONCRETE
(77.76 metres)	0.15 – 0.55	FILL – (SW) gravelly SAND, angular; grey (PAVEMENT STRUCTURE); non-cohesive, moist
	0.55 – 1.00	FILL – (GW) sandy GRAVEL, angular; grey (PAVEMENT STRUCTURE); non-cohesive, moist
	1.00 – 1.52	(SM) SILTY SAND; light brown; non-cohesive, moist
	1.52	END OF AUGERHOLE

Notes: Augerhole was dry upon completion.

Sample	Depth (m)
1	0.20 – 0.45
2	0.60 – 0.90
3	1.25 – 1.45

17-05	0.00 – 0.35	FILL – (SW) gravelly SAND, angular; grey (PAVEMENT STRUCTURE); non-cohesive, moist
(77.61 metres)	0.35 – 0.93	FILL – (GW) sandy GRAVEL, angular; grey (PAVEMENT STRUCTURE); non-cohesive, moist
	0.93 – 1.15	(PT) PEAT– dark grey; non-cohesive, moist
	1.15 – 1.52	(SM) SILTY SAND; brown; non-cohesive, moist
	1.52	END OF AUGERHOLE

Notes: Augerhole was dry upon completion.

Sample	Depth (m)
1	0.10 – 0.30 (**Figure 2)**
2	0.50 – 0.90
3	0.95 – 1.10
4	1.20 – 1.35

TABLE 1

RECORD OF AUGERHOLES

Augerhole Number (Elevation)	Depth (metres)	Description
17-06	0.00 – 0.15	ASPHALTIC CONCRETE
(77.68 metres)	0.15 – 0.50	FILL – (SW) gravelly SAND, angular; grey (PAVEMENT STRUCTURE); non-cohesive, moist
	0.50 – 1.00	FILL – (GW) sandy GRAVEL, angular; grey (PAVEMENT STRUCTURE); non-cohesive, moist
	1.00 – 1.30	FILL – (SP) SAND, fine to medium; brown; non-cohesive, moist
	1.30 – 1.52	(PT) PEAT – dark grey; non-cohesive, moist
	1.52 – 1.82	(SP) SAND, fine, some non-plastic fines; brown; non-cohesive, moist
	1.82 – 2.13	(CI/CH) SILTY CLAY; grey brown, (WEATHERED CRUST); cohesive, w>PL
	2.13	END OF AUGERHOLE

Notes: Augerhole was dry upon completion.

Sample	Depth (m)
1	0.20 – 0.45
2	0.60 – 0.90
3	1.30 – 1.40
4A	1.60 – 1.80
4B	1.90 – 2.00

TABLE 1

RECORD OF AUGERHOLES

Augerhole Number (Elevation)	Depth (metres)	Description
17-07	0.00 – 0.15	ASPHALTIC CONCRETE
(77.58 metres)	0.15 – 0.38	FILL – (SW) gravelly SAND, angular; grey (PAVEMENT STRUCTURE); non-cohesive, moist
	0.38 – 0.80	FILL – (GW) sandy GRAVEL, angular; grey (PAVEMENT STRUCTURE); non-cohesive, moist
	0.80 – 1.20	(SM/ML) SILTY SAND to sandy SILT; grey, contains organic matter; non-cohesive, moist
	1.20 – 1.52	(SM) SILTY SAND; brown; non-cohesive, wet
	1.52	END OF AUGERHOLE

Sample	Depth (m)
1	0.20 – 0.30
2	0.45 – 0.80
3	0.80 – 1.00
4	1.25 – 1.40

17-08	0.00 – 0.40	FILL – (SW) gravelly SAND, angular; grey (PAVEMENT STRUCTURE); non-cohesive, moist
(77.48 metres)	0.40 – 0.75	FILL – (GW) sandy GRAVEL, angular; grey (PAVEMENT STRUCTURE); non-cohesive, moist
	0.75 – 1.05	FILL – (SM) SILTY SAND, fine; grey, contains organic matter; non-cohesive, moist
	1.05 – 1.52	(SP) SAND, fine; brown; non-cohesive, wet
	1.52	END OF AUGERHOLE

Notes: Seepage at 1.25 metres depth

Sample	Depth (m)
1	0.10 – 0.30
2	0.50 – 0.70
3	0.75 – 1.00
4	1.10 – 1.20

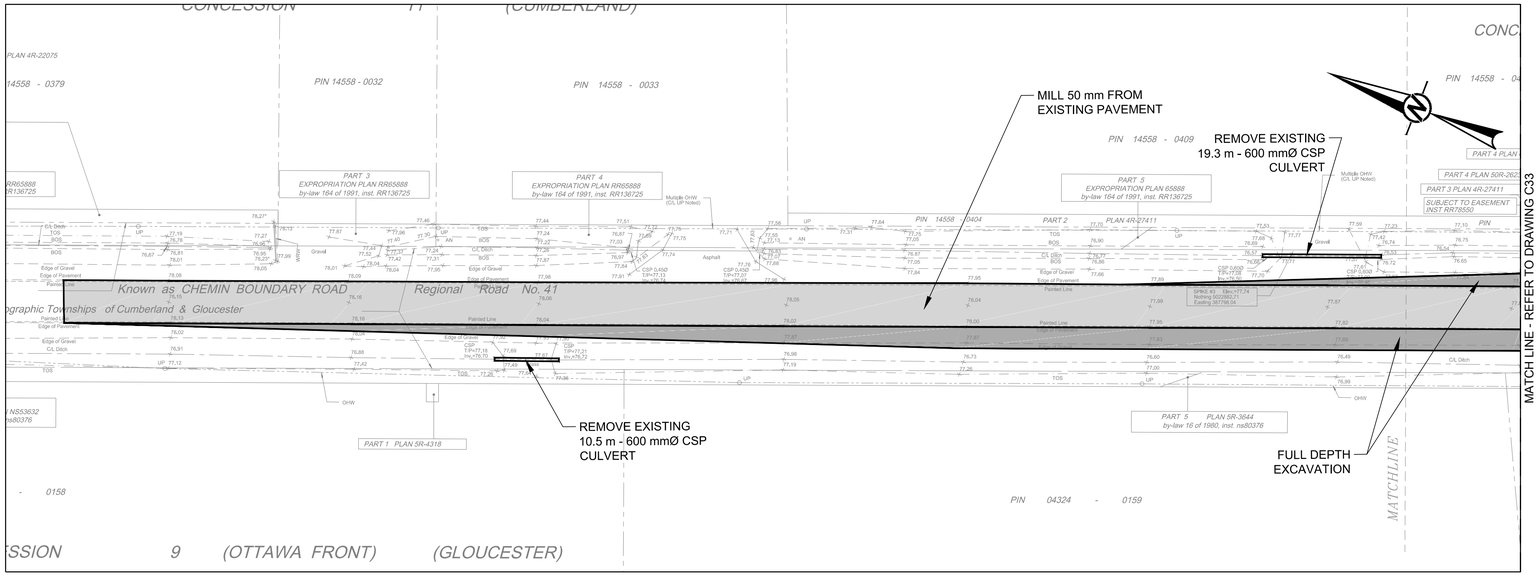
TABLE 2

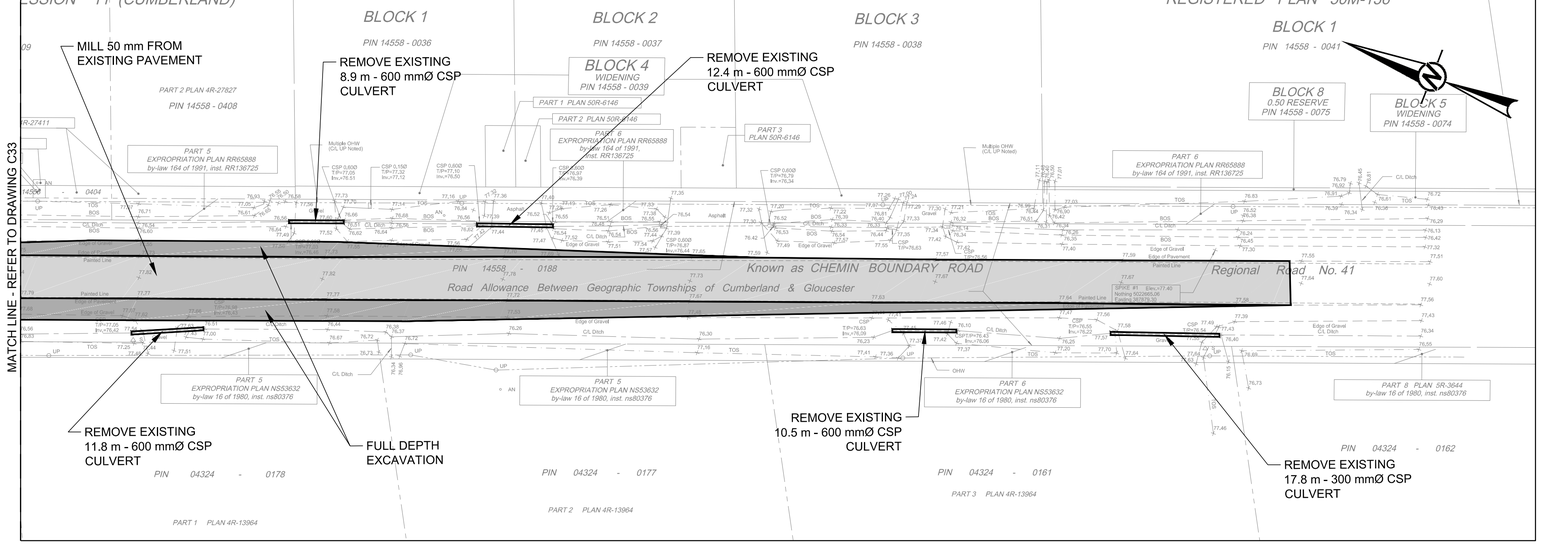
RECORD OF HAND-AUGERHOLES

Hand-Augerhole Number (Elevation)	Depth to Bottom of Topsoil/ organics (millimetres)	Description
17-101	0 – 280	(PT) PEAT
(76.73 metres)	280	(SM) SILTY SAND; brown; non-cohesive, moist
	280	END OF HAND-AUGERHOLE
17-102	0 – 330	TOPSOIL – (SM) SILTY SAND; dark brown; wet
(76.76 metres)	330	(SM) SILTY SAND; brown; non-cohesive, moist
	330	END OF HAND-AUGERHOLE
17-103	0 – 200	(PT) PEAT
(76.45 metres)	200	(SM) SILTY SAND; brown; non-cohesive, moist
	200	END OF HAND-AUGERHOLE
17-104	0 – 330	TOPSOIL – (SM) SILTY SAND; dark brown; wet
(76.61 metres)	330	(SM) SILTY SAND; brown; non-cohesive, moist
	330	END OF HAND-AUGERHOLE
17-105	0 – 200	(PT) PEAT
(76.46 metres)	200	(SM) SILTY SAND; brown; non-cohesive, moist
	200	END OF HAND-AUGERHOLE
17-106	0 – 450	(PT) PEAT
(76.53 metres)	450	(SM) SILTY SAND; brown; non-cohesive, moist
	450	END OF HAND-AUGERHOLE
17-107	0 – 430	(PT) PEAT
(76.41 metres)	430	(SM) SILTY SAND; brown; non-cohesive, moist
	430	END OF HAND-AUGERHOLE

ATTACHMENT E

Drawings 1787048-0005-CW-0001 through 1787048-0005-CW-0003





NOTE(S)

OVERLAY

THE EXISTING PAVEMENT STRUCTURE ALONG BOUNDARY ROAD MAIN LANES IS NOT SUFFICIENT TO CARRY THE ANTICIPATED DESIGN TRAFFIC LOADING AND STRENGTHENING IS REQUIRED BY OVERLAY.

- MILL 50 MILLIMETRES OF EXISTING HOT MIX ASPHALT (HMA)
- ADD 90 MILLIMETRES NEW HOT MIX ASPHALT (HMA) CONSISTING OF
  - 40 MILLIMETRES SP 12.5 FC 2, TRAFFIC CATEGORY D, PGAC 64-34; AND,
  - 50 MILLIMETRES SP 19.0, TRAFFIC CATEGORY D, PGAC 64-34.

*THE RESULTING GRADE RAISE WOULD BE ABOUT 40 MILLIMETRES

WIDENING

- WITHIN THE EXISTING SHOULDER EXCAVATE FULL DEPTH STARTING AT THE EDGE OF PAVEMENT AND REMOVE ALL ORGANIC MATERIAL AND TOPSOIL;
- PLACE 150 MILLIMETRES HMA
  - 40 MILLIMETRES SP 12.5 FC 2, TRAFFIC CATEGORY D, PGAC 64-34; AND,
  - 100 (50+50) MILLIMETRES SP 19.0, TRAFFIC CATEGORY D, PGAC 64-34.
- PLACE 250 MILLIMETRES NEW GRANULAR A TO MATCH EXISTING UNDER TRAFFIC LANE;
- PROVIDE 680 MILLIMETRES OF NEW GRANULAR B TYPE II TO MATCH BOTTOM OF EXISTING UNDER TRAFFIC LANE.
- PROVIDE FOR A 40 MILLIMETRES DEEP BY 300 MILLIMETRES WIDE LONGITUDINAL STEP JOINT WHEN TYING INTO THE EXISTING PAVEMENT.

SITE ACCESS ROAD

- REMOVE ALL ORGANIC MATERIAL AND TOPSOIL (ABOUT 320 MILLIMETRES)
- PROVIDE 150 MILLIMETRES (40+50+50) NEW HMA
  - 50 MILLIMETRES SP 12.5 FC 2, TRAFFIC CATEGORY D, PGAC 64-34; AND,
  - 100 (50+50) MILLIMETRES SP 19.0, TRAFFIC CATEGORY D, PGAC 64-34.
- PROVIDE 150 MILLIMETRES NEW GRANULAR A,
- PROVIDE 500 MILLIMETRES NEW GRANULAR B TYPE II

PAVED SHOULDERS

PARTIALLY PAVED AND FULLY PAVED SHOULDERS (WHERE REQUIRED) SHOULD BE PROVIDED AS THE FOLLOWS:

- PARTIALLY AND FULLY PAVED SHOULDERS TO CONSIST OF 40 MILLIMETRES SUPERPAVE 12.5 FC1 OVER 50 MILLIMETRES SUPERPAVE 19.0 UPPER BINDER COURSE.

IF IT IS ANTICIPATED THAT TRAFFIC MAY USE THE FULLY PAVED SHOULDER AS A TURNING LANE OR SLIP-AROUND LANE, THEN BOTH THE BINDER AND SURFACE COURSE ASPHALT LIFTS SHOULD BE PLACED OVER THE FULL SHOULDER WIDTH.

HOT MIX AND GRANULAR CONVERSION FACTORS

- SUPERPAVE 12.5 FC2 - 2.390 T/M3 ;
- SUPERPAVE 19.0 - 2.460 T/M3
- GRANULAR A - 2.4 T/M3 ; AND,
- GRANULAR B TYPE II - 2.4 T/M3.

GRANULAR PAVEMENT MATERIALS

THE GRANULAR BASE AND SUBBASE FOR NEW CONSTRUCTION SHOULD CONSIST OF (OPSS.MUNI 1010) GRANULAR A AND GRANULAR B TYPE II, RESPECTFULLY.

SUBGRADE FILL, IF REQUIRED COULD CONSIST OF SELECT SUBGRADE MATERIAL IN ACCORDANCE WITH OPSS.MUNI 1010.

REFERENCE(S)

1. TOPOGRAPHIC SURVEY PROVIDED IN A DIGITAL FORMAT BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD., JOB No. XRF-AOV-2017_Survey_BoundaryRD, FIELD WORK COMPLETED ON November 22, 2017.
2. PROPOSED BOUNDARY ROAD SITE ACCESS GEOMETRY PROVIDED BY TAGGART GROUP OF COMPANIES, TECHNICAL SUPPORT DOCUMENT #9, TRAFFIC IMPACT STUDY.
3. COORDINATE SYSTEM, HORIZONTAL DATUM MTM ZN9, VERTICAL DATUM: CGVD28.

0 20 40
1:500 METRES

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
1	2018-06-15	ISSUED FOR SITE PLAN APPROVAL	MHK	MLF	DVK	DVK

SEAL

LICENSED PROFESSIONAL ENGINEER
June 15, 2018
M.H.H. KNOWLES
100113290
PROVINCE OF ONTARIO

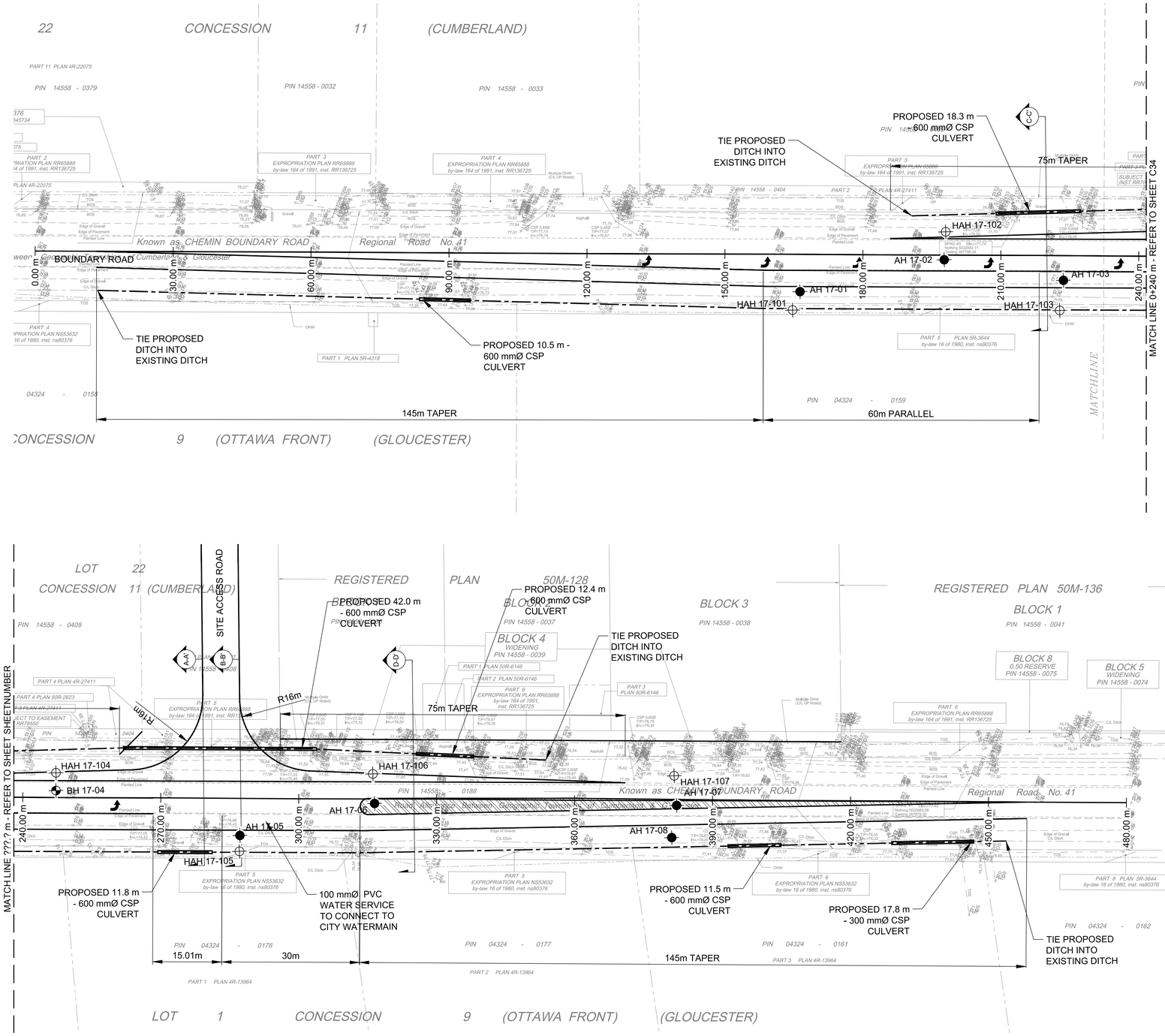
CLIENT
TAGGART MILLER ENVIRONMENTAL SERVICES

CONSULTANT
GOLDER
GOLDER ASSOCIATES LTD.
1931 ROBERSON ROAD
OTTAWA, ONTARIO
CANADA
[+1] (613) 592 9600
www.golder.com

PROJECT
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
BOUNDARY ROAD EXISTING CONDITION AND REMOVALS PLAN

PROJECT NO.	CONTROL	REV.	of	DRAWING
1787048	0005	A		C33



PLAN VIEW OF BOUNDARY ROAD ACCESS

SCALE 1:500 m

LEGEND

- APPROXIMATE BOREHOLE LOCATION
- APPROXIMATE MANUAL AUGERHOLE LOCATION
- APPROXIMATE AUGERHOLE LOCATION

REFERENCE(S)

1. TOPOGRAPHIC SURVEY PROVIDED IN A DIGITAL FORMAT BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD., JOB No. XRF-AOV-2017_Survey_BoundaryRD, FIELD WORK COMPLETED ON November 22, 2017.
2. PROPOSED BOUNDARY ROAD SITE ACCESS GEOMETRY PROVIDED BY TAGGART GROUP OF COMPANIES, TECHNICAL SUPPORT DOCUMENT #9, TRAFFIC IMPACT STUDY.
3. COORDINATE SYSTEM, HORIZONTAL DATUM MTM ZN9, VERTICAL DATUM: CGVD28.
4. GEOTECHNICAL/PAVEMENT INVESTIGATION, PROPOSED BOUNDARY ROAD IMPROVEMENTS, CAPITAL REGION RESOURCE CENTRE (CRRRC). GOLDER ASSOCIATES LTD., DATED APRIL 10, 2018.

0 20 40
1:500 METRES

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
1	2018-06-15	ISSUED FOR SITE PLAN APPROVAL	MHK	MLF	DVK	DVK

SEAL

LICENSED PROFESSIONAL ENGINEER
June 15, 2018
M. H. H. KNOWLES
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CANADA
[+1] (613) 592 9600
www.golder.com

PROJECT
CAPITAL REGION RESOURCE RECOVERY CENTRE

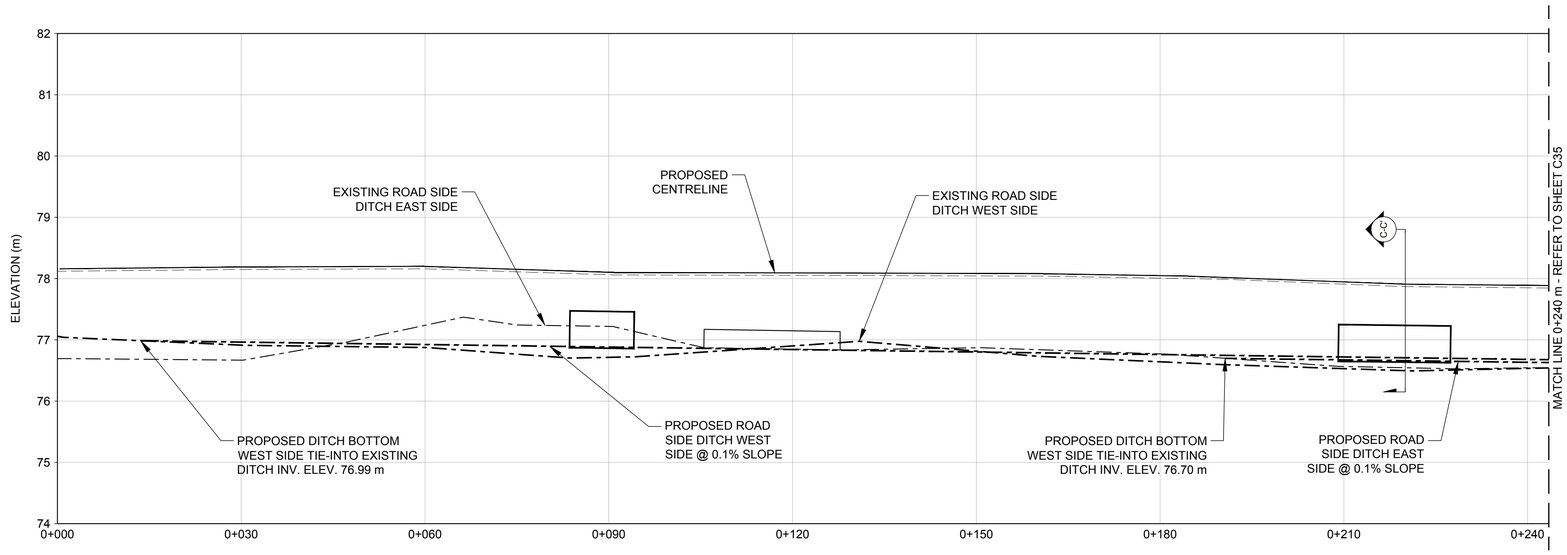
TITLE
BOUNDARY ROAD ACCESS PLAN, PROFILE AND SECTIONS

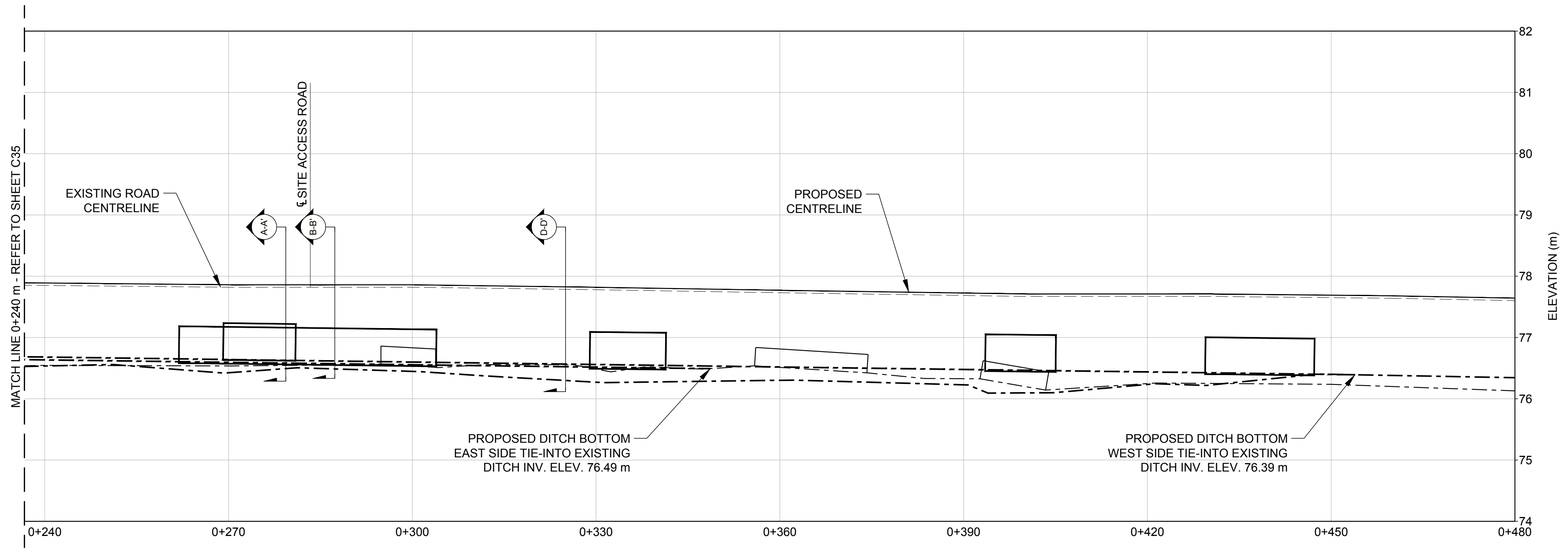
PROJECT NO.	CONTROL	REV.	of	DRAWING
1787048	0005	A		C34

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

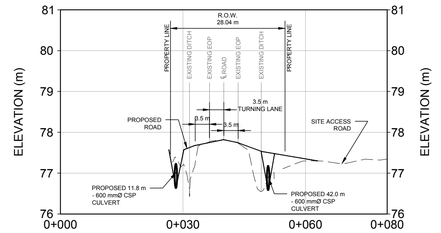
0 25 mm

Path: \\golder.gds\gal\ottawa\Active\Spatial_IM\Miller_Paving_Ltd\CRRRC\ACAD\1787048\40_PROD\0005_Boundary_Road_Access\ | File Name: 1787048-0005-CW-0003.dwg | Last Edited By: mforget Date: 2018-06-14 Time:3:55:00 PM | Printed By: mforget Date: 2018-06-14 Time:3:59:11 PM

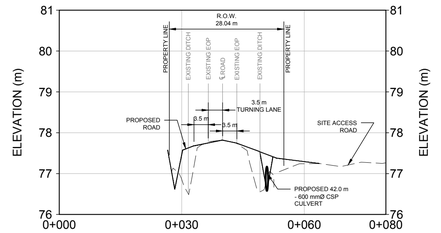




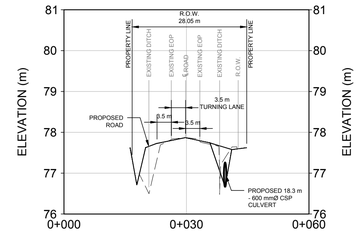
BOUNDARY ROAD PROFILE
SCALE 1:500 m



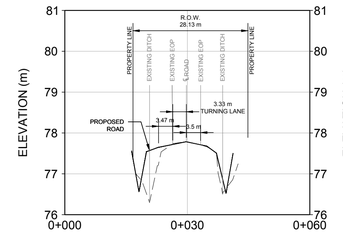
SCALE 1:750 m A-A' CROSS-SECTION



SCALE 1:750 m B-B' CROSS-SECTION



SCALE 1:750 m C-C' CROSS-SECTION



SCALE 1:750 m D-D' CROSS-SECTION

0 20 40
1:500 METRES

0 25 50
1:750 METRES

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
1	2018-06-15	ISSUED FOR SITE PLAN APPROVAL	MHK	MLF	DVK	DVK

SEAL

LICENSED PROFESSIONAL ENGINEER
June 15, 2018
M. H. H. KNOWLES
100113790
PROVINCE OF ONTARIO

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PROJECT
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
BOUNDARY ROAD PROFILE AND SECTIONS

PROJECT NO.	CONTROL	REV.	of	DRAWING
1787048	0005	----		C35

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D
0 25 mm

Path: \\golder.gds\gal\ottawa\Active\Spatial_MM\Miller_Paving_Ltd\CRRRC\ACAD\1787048\40_PROD\0005_Boundary_Road_Access\ | File Name: 1787048-0005-CW-0004.dwg | Last Edited By: mforget Date: 2018-06-14 Time:3:56:50 PM | Printed By: mforget Date: 2018-06-14 Time:3:59:33 PM