

December 2014

Technical Support Document #9

TRAFFIC IMPACT STUDY



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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

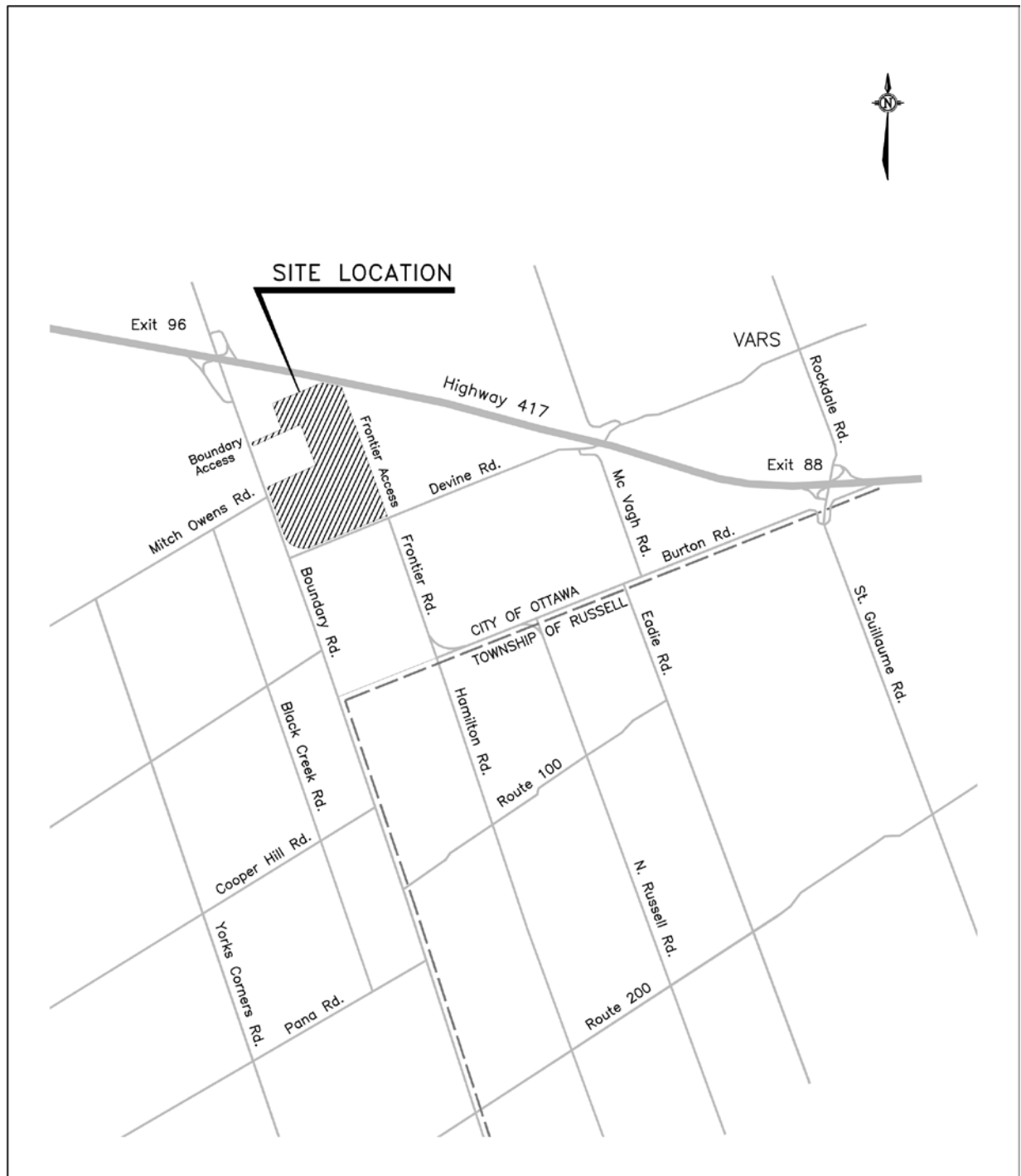
The road network in the area of the CRRRC is shown on Figure 1.1.

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.



NOT TO SCALE

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.

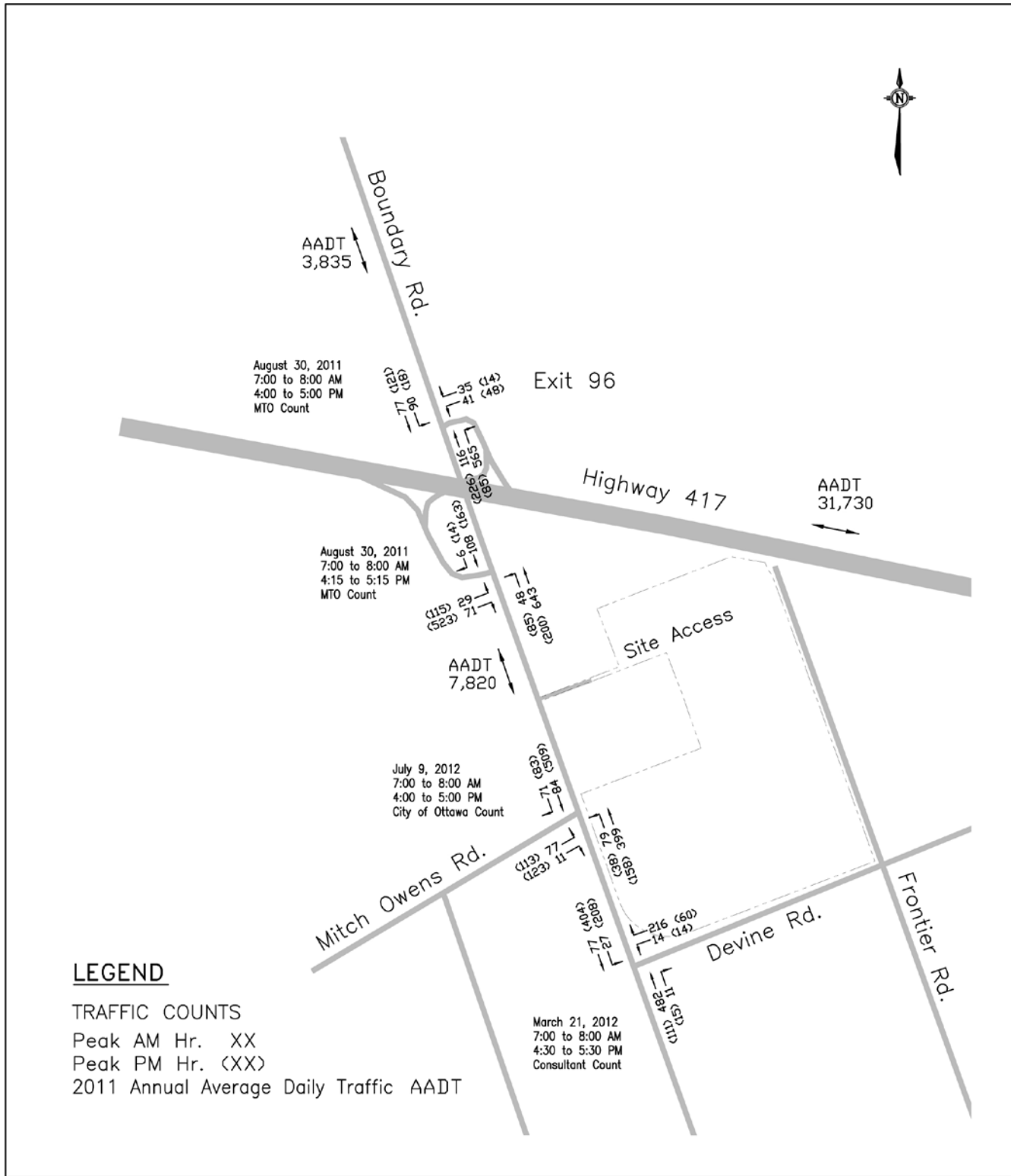


Figure 2.1: Weekday Peak AM and PM Hour Traffic Counts

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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 m³/year when the Site is fully developed. The estimated maximum material for treatment would be 230,000 m³/year of landfill leachate and 35,000 m³/year of digested organics processing liquor, for a total of 265,000 m³/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 m³ per year/250 days per year @ 40 m³ 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

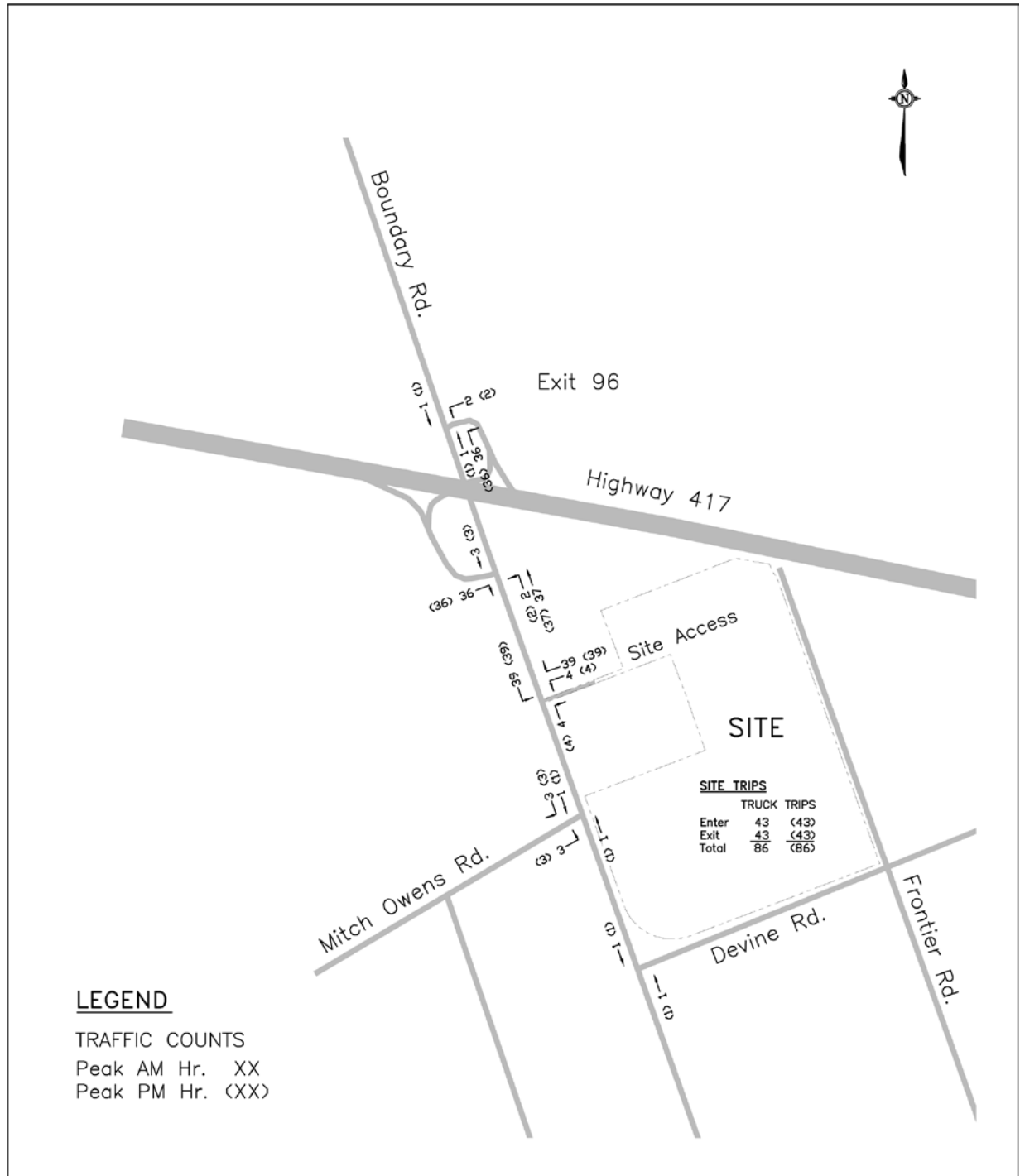
| TRIPS | WEEKDAY PEAK AM HOUR | | | WEEKDAY PEAK PM HOUR | | |
|-------------|----------------------|-------|------|----------------------|-------|------|
| | Total | Enter | Exit | Total | Enter | Exit |
| Truck Trips | 86 | 43 | 43 | 86 | 43 | 43 |

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.



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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

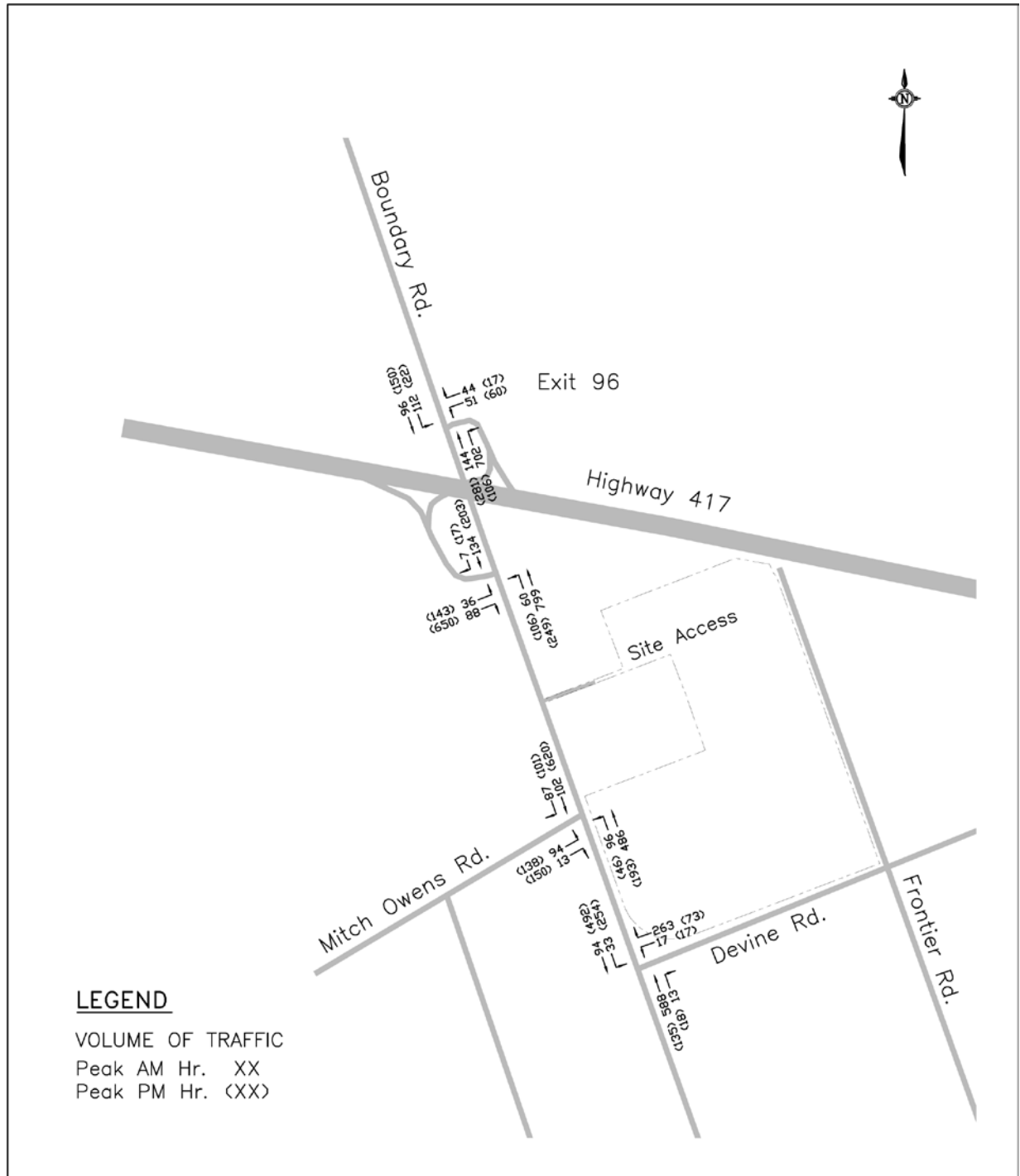
The above growth factors were applied to the existing traffic volume counts shown in Figure 2.1 to produce the expected 2022 background traffic volumes shown in Figure 4.1 for the weekday peak AM and PM hours.

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.

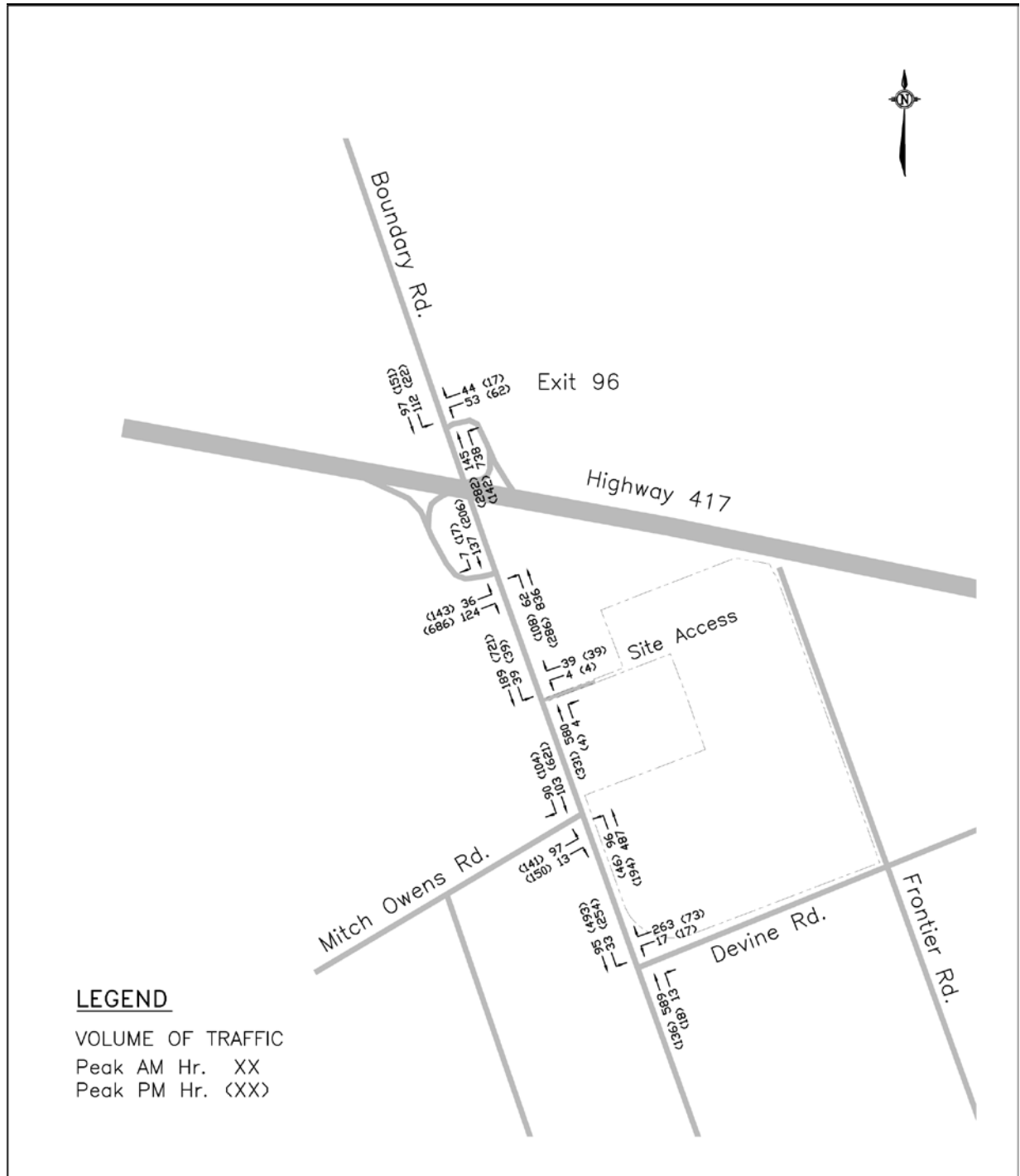
5.0 FUTURE TRAFFIC VOLUMES

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).



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



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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:

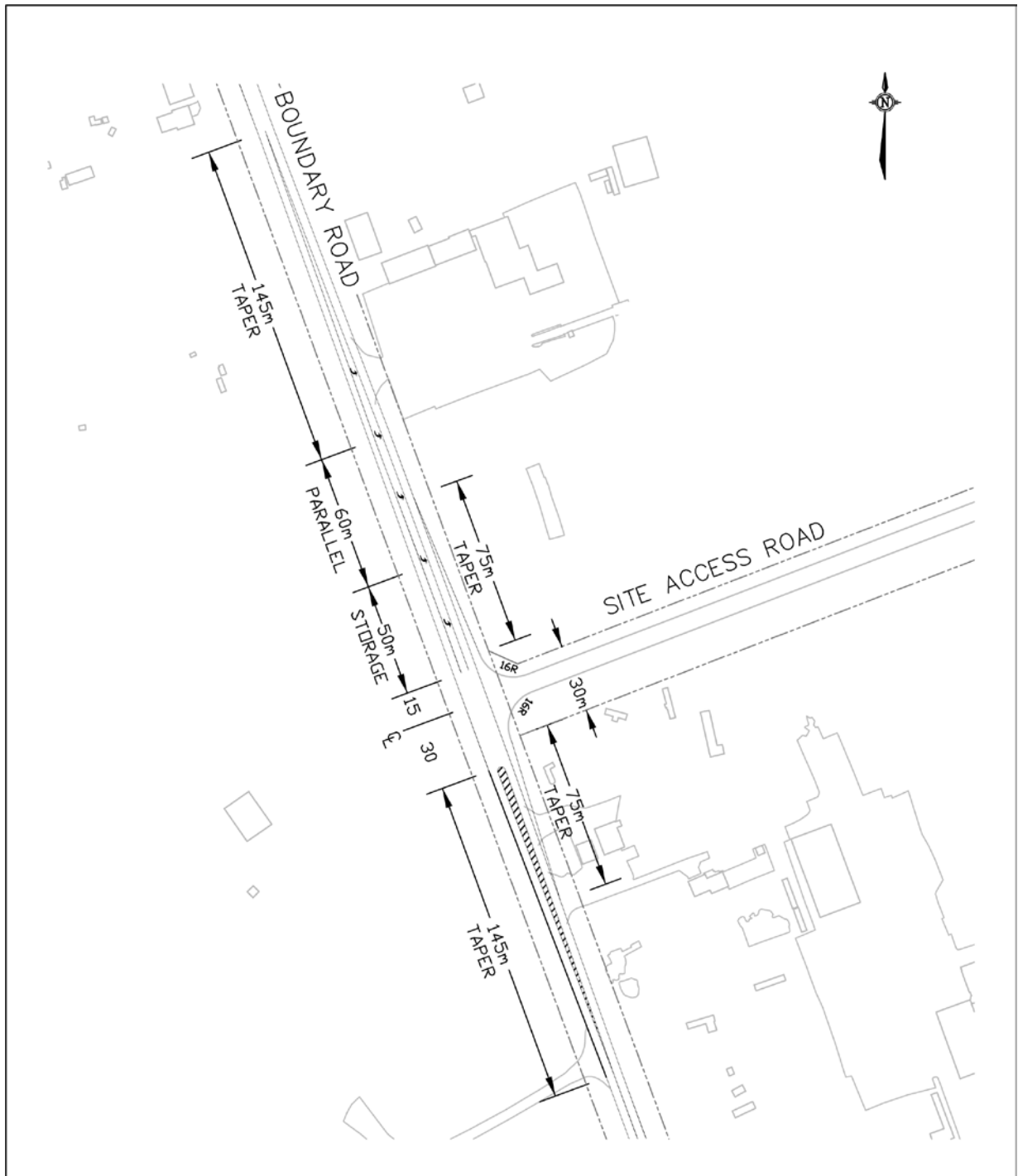
- Northbound Boundary Road One shared through/right lane
- Southbound Boundary Road One through lane
One exclusive left turn lane
- Westbound Site Access One shared left and right turn lane

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 |



NOT TO SCALE

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



Public Works and Services Department

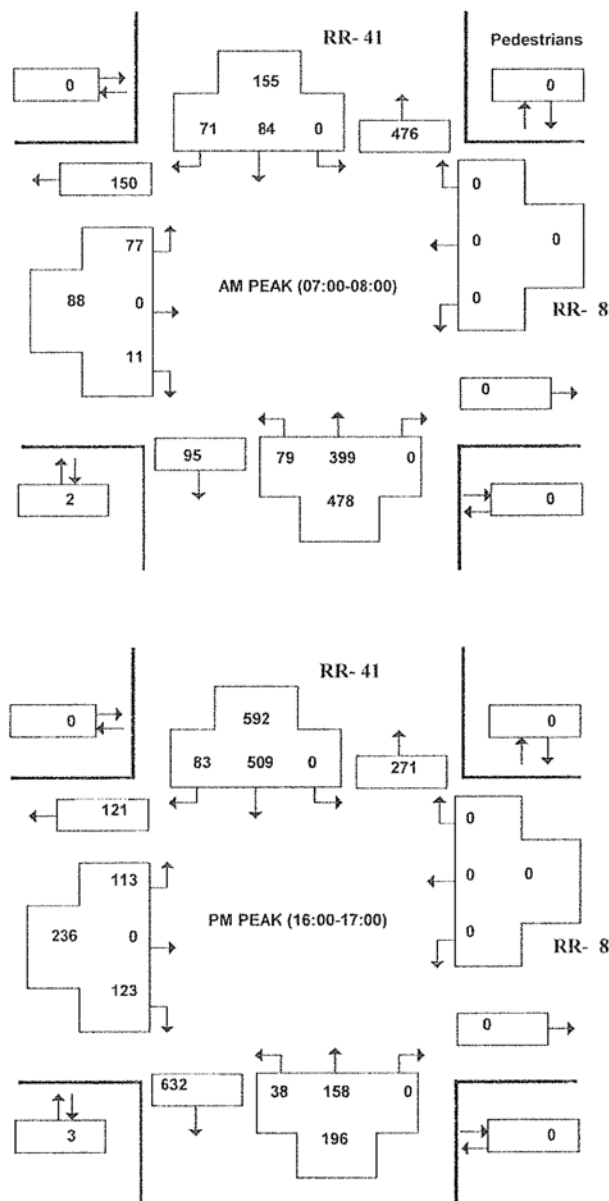
Count ID: 3043

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



BOUNDARY RD IC-96 @ Hwy. 417

Eastern

Intersection ID:493400000(--S--)

Count Day: Tuesday

Count Date: 30-Aug-2011

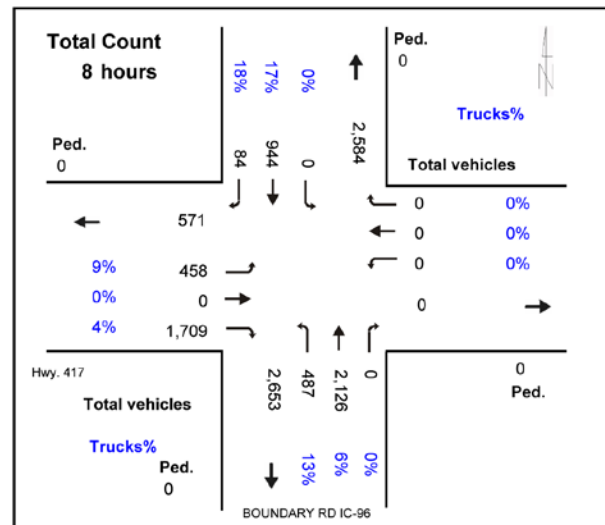
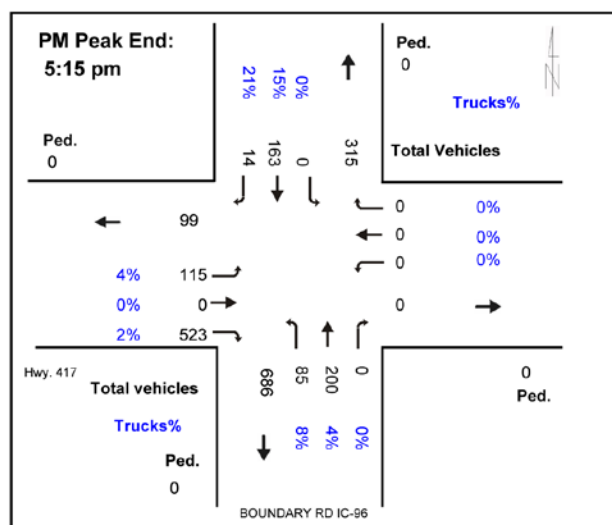
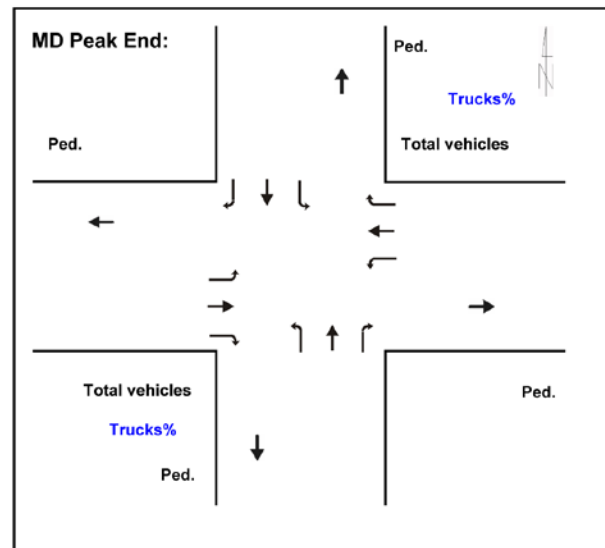
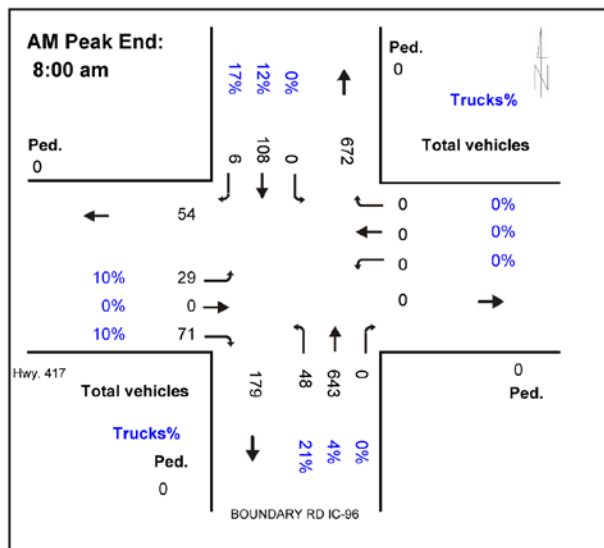


Exhibit 3: Year 2011 Peak AM and PM Hour Traffic Counts – Boundary/Westbound 417 Ramps



BOUNDARY RD IC-96 @ Hwy. 417

Eastern

Intersection ID:493400000(--N--)

Count Day: Tuesday

Count Date: 30-Aug-2011

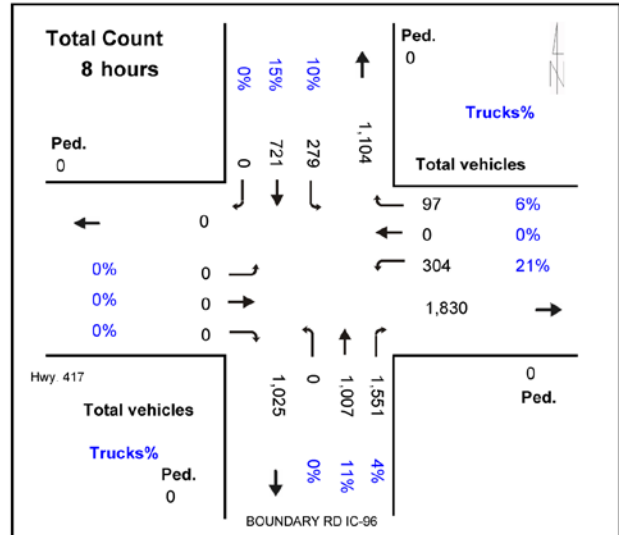
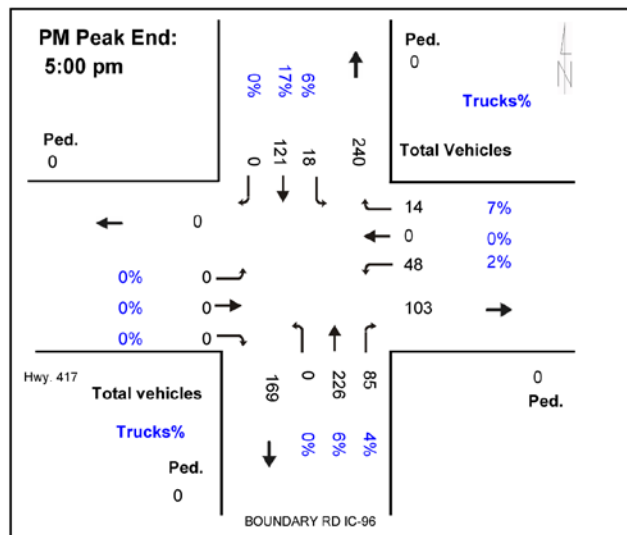
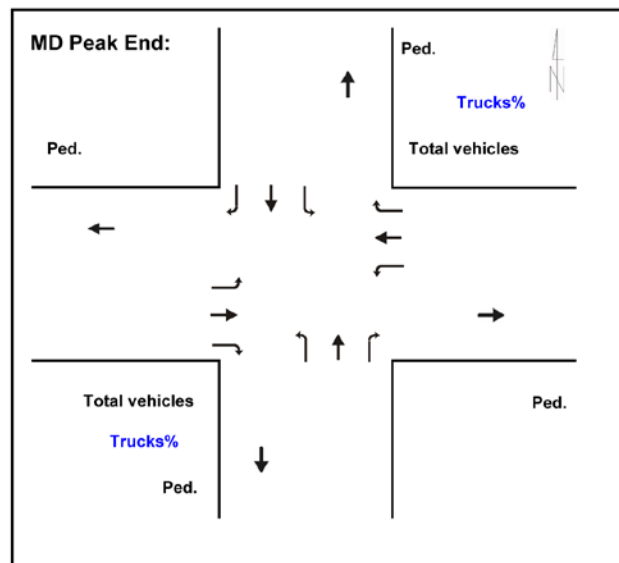
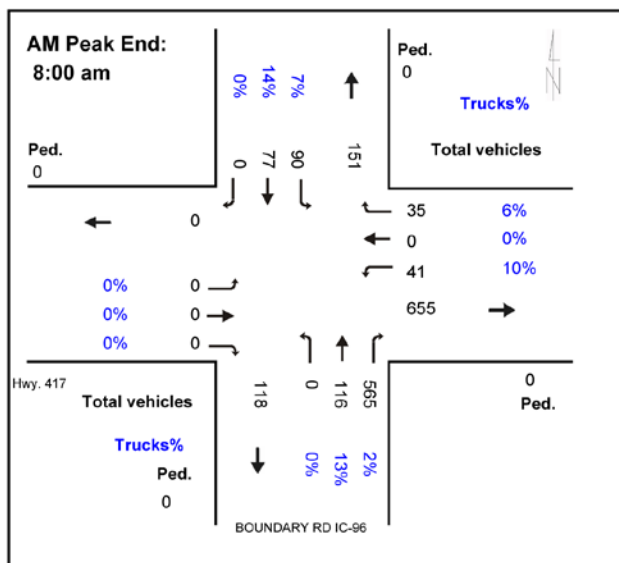


Exhibit 4: Year 2012 Peak AM Hour Traffic Count Analysis – Boundary/Mitch Owens

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 Movement | Northbound | | | | Southbound | |
| | | 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 Movement | Westbound | | | | Eastbound | |
|----------------------------------|-------------------|-----------|---|---|------|-----------|------|
| | | 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 |
| 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 Movement | Northbound | | | | Southbound | |
| | | 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 Movement | Westbound | | | | Eastbound | |
|----------------------------------|-------------------|-----------|---|---|------|-----------|------|
| | | 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 |
| 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 Movement | Northbound | | | | Southbound | |
| | | 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 Movement | Westbound | | | | Eastbound | |
|----------------------------------|-------------------|-----------|---|---|------|-----------|------|
| | | 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 |
| 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 Movement | Northbound | | | | Southbound | |
| | | 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 Movement | Westbound | | | | Eastbound | |
|----------------------------------|-------------------|-----------|---|---|------|-----------|------|
| | | 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 |
| 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 Movement | Northbound | | | Southbound | | |
| | | 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 Movement | Westbound | | | Eastbound | | |
|----------------------------------|-------------------|-----------|---|------|-----------|----|----|
| | | 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 | 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 Movement | Northbound | | | Southbound | | |
| | | 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 Movement | Westbound | | | Eastbound | | |
|----------------------------------|-------------------|-----------|---|------|-----------|----|----|
| | | 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 Movement | Northbound | | | Southbound | | |
| | | 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 Movement | Westbound | | | Eastbound | | |
|----------------------------------|-------------------|-----------|---|------|-----------|----|----|
| | | 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 Movement | Northbound | | | | Southbound | |
| | | 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 Movement | Westbound | | | | Eastbound | |
|----------------------------------|-------------------|-----------|---|---|------|-----------|------|
| | | 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 Movement | Northbound | | | Southbound | | |
| | | 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 Movement | Westbound | | | Eastbound | | |
|----------------------------------|-------------------|-----------|---|---|-----------|----|--------|
| | | 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 Movement | Northbound | | | | Southbound | |
| | | 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 Movement | Westbound | | | | Eastbound | |
| | | 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 Movement | Northbound | | | Southbound | | |
| | | 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 Movement | Westbound | | | Eastbound | | |
|----------------------------------|-------------------|-----------|---|---|-----------|----|--------|
| | | 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 Movement | Northbound | | | Southbound | | |
| | | 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 Movement | Westbound | | | Eastbound | | |
|----------------------------------|-------------------|-----------|----|------|-----------|----|----|
| | | 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 |
| Lane Config | | LT | | LR | | | 12 |
| 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 | LT | LT | LR | LT | LT | LT | LT |
| 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 Movement | Northbound | | | Southbound | | |
| | | 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 Movement | Westbound | | | Eastbound | | |
|----------------------------------|-------------------|-----------|---|------|-----------|----|----|
| | | 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 |
| Lane Config | | LT | | LR | | | 12 |
| 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 | LT | LT | LR | LT | LT | LT | LT |
| 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

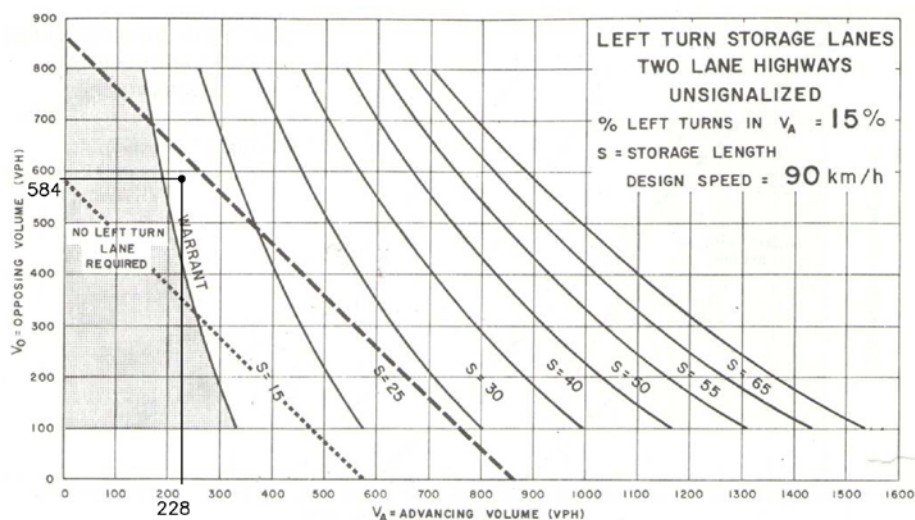
$$\frac{V_L}{V_A} = 17.1\%$$

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

$$\frac{V_L}{V_A} = 5.1\%$$

POSTED SPEED
80 km/h

WARRANT

25 METRE LEFT
TURN LANE REQUIRED

**SOUTHBOUND LEFT
PEAK PM HOUR**

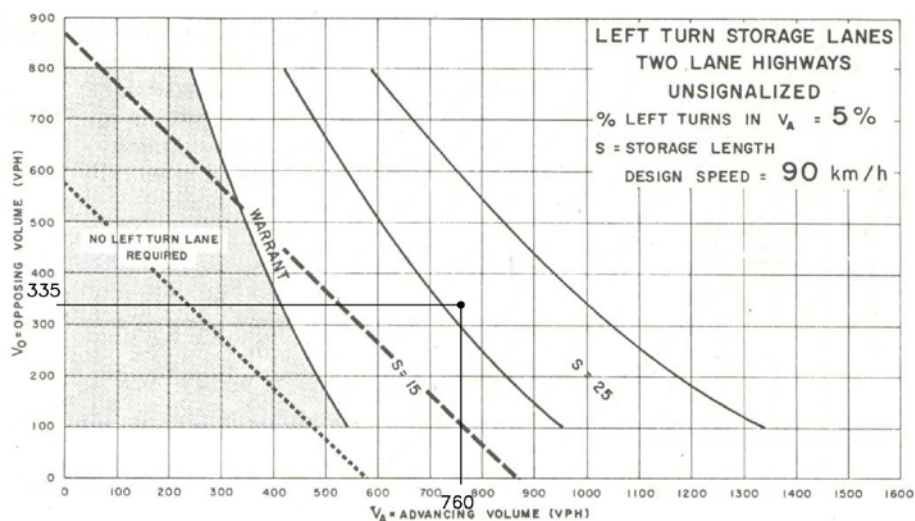


Exhibit 21: Year 2022 Peak AM Hour Traffic Analysis – Boundary/Site Access

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 Movement | Northbound | | | Southbound | | |
| | | 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 Movement | Westbound | | | Eastbound | | |
|----------------------------------|-------------------|-----------|----|------|-----------|----|----|
| | | 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 | 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 | | | |