

**Appendix A:
Transportation Demand Information**

Technical Memorandum

To: File
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Date: 18 June 2015
Project: TO3188TOB

Re: Downtown Ottawa Truck Tunnel Feasibility Assessment of Transportation Demand (Part I/II)

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Appendix A: TRANS Model Output (2031 Select Link AM Peak Hour)

Appendix B: Bluetooth® Data (Hourly)



1. Background

To assess the feasibility of a truck tunnel through downtown Ottawa linking the Highway 417 Corridor to the Macdonald-Cartier Bridge, it is important to understand the existing transportation demand characteristics, including the vehicle composition (cars, light trucks, heavy trucks, etc.), routing, typical hourly profiles throughout the day, notable origin-destination pairs, etc. Many of these transportation issues, as they relate to truck travel, have been studied extensively as part of previous work, namely:

- King Edward Avenue Renewal EA (2002)
- Interprovincial Roadside Truck Survey (2007)
- NCR Interprovincial Crossing EA (2013)

The ensuing section of this report provides a high-level summary of the relevant findings of these landmark trucking-related studies, while Section 3 provides a review of the existing and projected travel trends provided by the TRANS regional travel demand model (used as basis of the City of Ottawa's Transportation Master Plan). Section 4 outlines the supplemental data collection effort that was conducted in Fall 2014 to support the existing knowledge base from previous study.















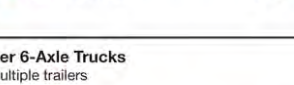





1.1 Definition of a Truck

According to the City's Traffic and Parking By-law (2003-530), a heavy truck is defined as a motor vehicle having a carrying capacity in excess of one (1) tonne or any vehicle having a gross weight in excess of four and one-half (4.5) tonnes, but does not include a public transit vehicle travelling on an established transit route, an ambulance or a school bus.

The U.S. Federal Highway Administration (FHWA) vehicle classification chart, which provides a good visual summary that is consistent with the convention adopted by the Ontario Ministry of Transportation (MTO), is included as Exhibit 1. For the purpose of this study, heavy trucks are assumed to be vehicles with six or more wheels on two or more axles. Given this definition, Categories 5 to 13 in the following figure are considered heavy trucks.

With regard to light trucks, the City of Ottawa defines these as vehicles, such as cars (including police, government and public utility cars), pick-up trucks, vans and sport utility vehicles (SUVS) that show evidence of commercial use through special license plate, commercial lettering logos, commercial equipment, etc. A car, pick-up truck, van or SUVs that shows no evidence of commercial use would be defined as an automobile according to the City of Ottawa.

Exhibit 1: FHWA Vehicle Classification

| FHWA Vehicle Classifications | | | |
|---|--|---|---|
| 1. Motorcycles 2 axles, 2 or 3 tires  | 2. Passenger Cars 2 axles, can have 1- or 2-axle trailers  | 3. Pickups, Panels, Vans 2 axles, 4-tire single units Can have 1 or 2 axle trailers  | 4. Buses 2 or 3 axles, full length  |
| 5. Single Unit 2-Axle Trucks 2 axles, 6 tires (dual rear tires), single-unit  | 6. Single Unit 3-Axle Trucks 3 axles, single unit  | 7. Single Unit 4 or More-Axle Trucks 4 or more axles, single unit  | 8. Single Trailer 3- or 4-Axle Trucks 3 or 4 axles, single trailer  |
| 9. Single Trailer 5-Axle Trucks 5 axles, single trailer  | 10. Single Trailer 6 or More-Axle Trucks 6 or more axles, single trailer  |  |  |
| 11. Multi-Trailer 5 or Less-Axle Trucks 5 or less axles, multiple trailers  | 12. Multi-Trailer 6-Axle Trucks 6 axles, multiple trailers  |  |  |
| 13. Multi-Trailer 7 or More-Axle Trucks 7 or more axles, multiple trailers  |  |  |  |

Source: http://onlinemanuals.txdot.gov/txdotmanuals/tri/images/FHWA_Classification_Chart_FINAL.png

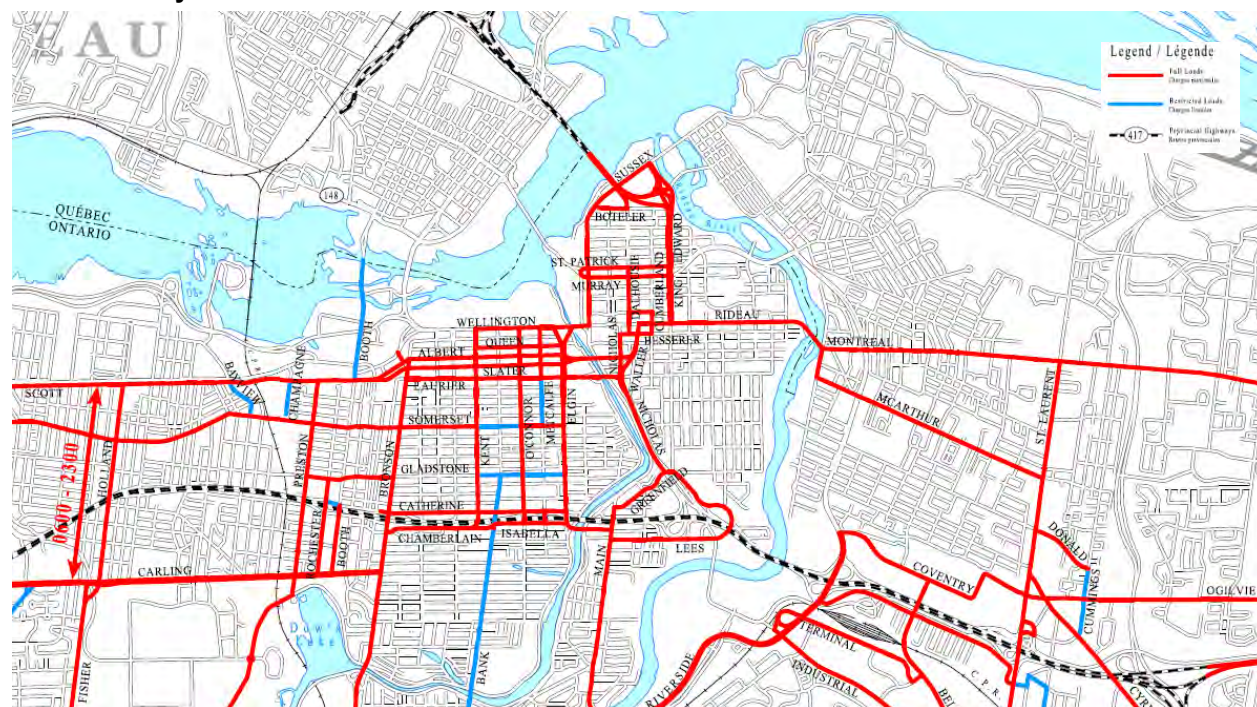
1.2 City of Ottawa Urban Truck Route

Exhibit 2 represents the City of Ottawa's Urban Truck Route, which is applicable to heavy trucks/vehicles. The City's Traffic and Parking By-law indicates that heavy vehicles are obliged to travel on truck routes until such time the operator needs to:

- (a) make a delivery to premises not abutting a truck route;
- (b) perform services requiring the heavy vehicle at premises not abutting a truck route
- (c) house, store or have the heavy vehicle repaired at a garage or other premises not abutting a truck route, or
- (d) perform a service for the City of Ottawa.

Such deviations from truck routes are to be direct (i.e. made from the point on a truck route nearest by highway distance to the premises referred to above). When successive deliveries are made in an area bounded by truck routes, after the last such delivery, the heavy vehicle must be driven to the nearest truck route.

Exhibit 2: City of Ottawa Urban Truck Route



Source: City of Ottawa

North of the Highway 417 Corridor and east of the Rideau Canal (5km), the Urban Truck Route is comprised of the following major north-south roadways: St. Laurent Boulevard, Nicholas Street, King Edward Avenue, Dalhousie Street (south of St. Patrick), and Sussex Drive

North of the Highway 417 Corridor and west of the Rideau Canal (5km), the Urban Truck Route is comprised of the following major north-south roadways: Holland Avenue, Preston Street, Bronson Avenue, Kent Street (one-way NB); O'Connor Street (one-way SB), and Elgin Street.

The shortest distance interprovincial truck route (Highway 417 Corridor and the Macdonald-Cartier Bridge) is the King Edward-Rideau-Waller-Nicholas (KERWN) Corridor, which is approximately 3.8km in length, and is therefore a very popular routing for trucks between this origin-destination pair.

It is important to recognize, however, that many trucks have origins or destinations in Ottawa's Downtown Core, and a limited access tunnel linking Highway 417 and the Macdonald-Cartier Bridge would be of little benefit for this truck demand. This issue is revisited and explored in further sections of this report.

2. Review of Background Material

2.1 King Edward Avenue Renewal Environmental Assessment (2002)

The King Edward Avenue Renewal EA was completed in 2002 by Delcan, a Parsons Company, and assessed the impact of heavy vehicles along the King Edward Corridor (between Rideau Street and the Macdonald-Cartier Bridge). For the purpose of the EA study, heavy vehicles were defined as tractor-trailer trucks, buses, recreational trailers and multi-axle vehicles.

Based on Automatic Traffic Recorder (ATR) counts and classification surveys, the report outlines total traffic volumes along the King Edward Corridor was in the range of 4,500 to 4,600 veh/h in the peak direction. The heavy vehicle demand was observed as approximately 5% of the 12-hour inbound flow, which equates to approximately 100 heavy vehicles during the morning and afternoon peak hours (peak direction) and 1,000 heavy vehicles per day (approximately 2,000 two-way heavy vehicles per day).

The study notes that major operational issues exist at the King Edward/Rideau intersection as a result of high truck volumes maneuvering between King Edward Avenue and Rideau Street along the interprovincial truck route. These operational issues affect pedestrians and other vehicles causing extreme congestion in the confines of the downtown core.

The study also notes that the poor levels of service at the King Edward/Murray and King Edward/St. Patrick intersections are a result of high volumes of heavy vehicles turning onto/off of King Edward Avenue at these locations.

It is important to note that heavy vehicles recorded in this survey travelled along King Edward Avenue, however, their origins and destinations were not recorded and as such it is unknown if these heavy vehicles travelled between the Macdonald-Cartier Bridge and Highway 417 or had other origins/destinations.

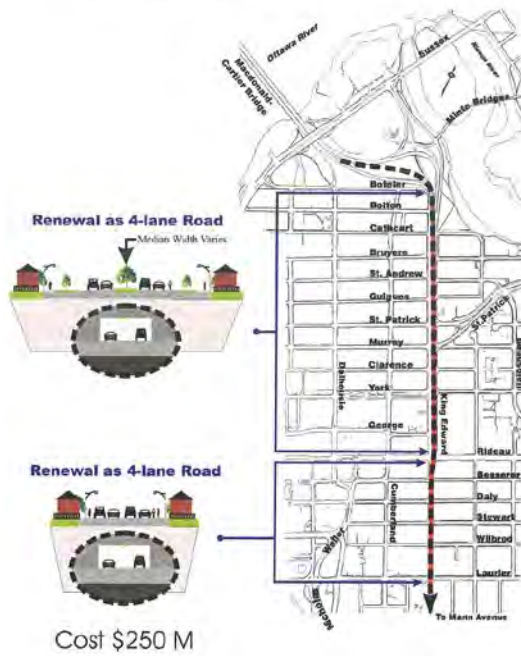
2.1.1 Renewal Options

As part of the evaluation of renewal options, six different tunnel alternatives were proposed and assessed. The underlying rationale for the proposed tunnel was to remove 'through' trucks and 'through' vehicles that currently use King Edward Avenue. Tunnel Alternatives #1 to 4 considered a tunnel parallel to King Edward Avenue and Alternatives #5 and 6 considered a tunnel that connects the Macdonald-Cartier Bridge and Vanier Parkway. These alternatives are outlined in Exhibit 3 below.

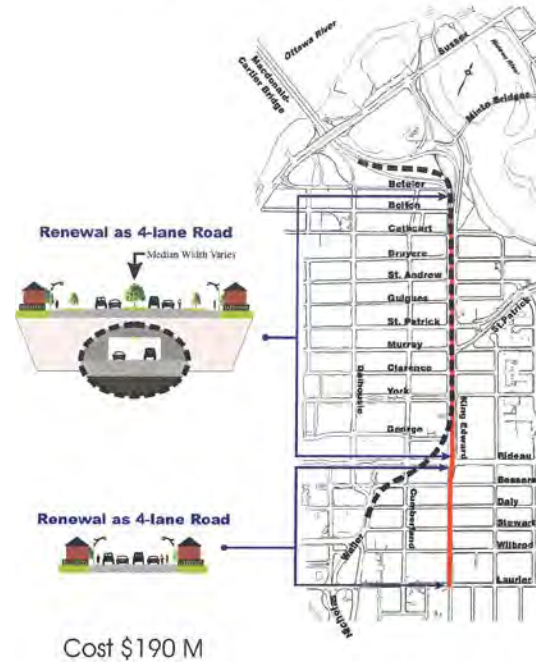


Exhibit 3: Tunnel Alternatives Considered in King Edward Avenue Renewal EA

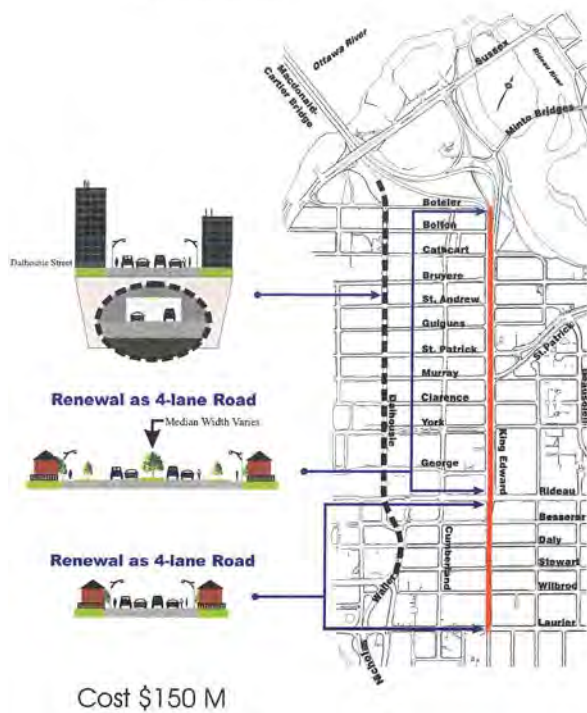
Tunnel Alternative #1: From Macdonald-Cartier Bridge to Mann Avenue Beneath King Edward Avenue



Tunnel Alternative #2: From Macdonald-Cartier Bridge to Waller Street Beneath King Edward Avenue and Waller Street



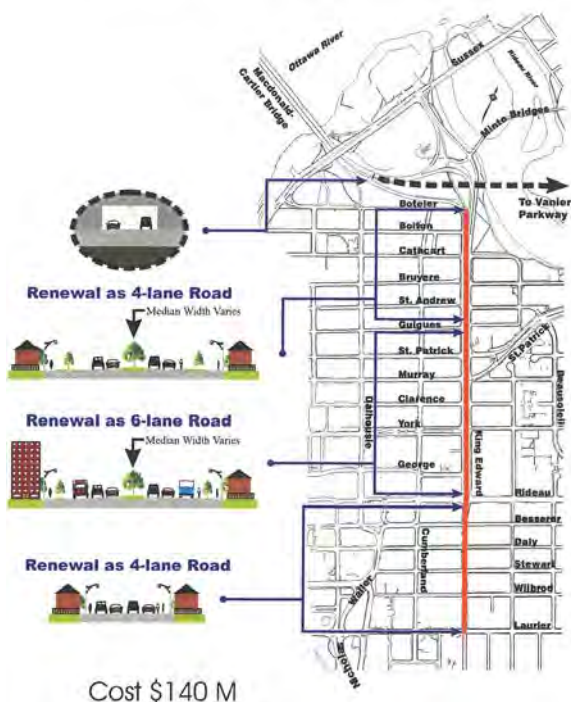
Tunnel Alternative #3: From Macdonald-Cartier Bridge to Waller Street Beneath Dalhousie Street



Tunnel Alternative #4: From St. Patrick to Waller Street Beneath King Edward Avenue



Tunnel Alternative #5: From Macdonald-Cartier Bridge to the Vanier Parkway Beneath the Rideau River



Source: King Edward Avenue Renewal EA (2002)

Tunnel Alternative #6: From Macdonald-Cartier Bridge to St. Patrick / Beausoleil Beneath the Park



For Alternatives #1 to #4, potential tunnel traffic was determined by recording the number of Quebec licences plates at the Nicholas/Laurier, Mann/King Edward, and Vanier/Coventry intersections during the peak hours in the peak direction. Assuming 90% of these recorded vehicles travel directly from Highway 417 to the Macdonald-Cartier Bridge without making a stop, the resultant volume of traffic (all vehicles) that would potentially use a tunnel is 1,040 and 1,130 veh/h in the peak direction during the morning and afternoon peak hours, respectively. These volumes represented approximately 32% to 37% of peak directional vehicles along King Edward Avenue (north of St. Andrew Street) at the time.

An alternative method to estimate the amount of potential tunnel traffic considered the existing turning count data at intersections along the south section of King Edward Avenue (from Rideau Street to Mann Avenue) and the City's count data for the KERWN "goods movement route". From these data sources, it was derived that approximately 30% of the morning peak hour inbound traffic and 34% of the afternoon peak hour outbound traffic would use a tunnel connection. This method achieved a similar result as that described above using license plate information.

The study notes that vehicles currently using a different bridge to travel to/from Gatineau from/to Highway 417 might alter their route to use a new tunnel connection. It also notes that any vehicle needing to make a stop downtown would not use a potential tunnel.

The tunnel alternatives were evaluated based on natural environmental, economic, social environmental and transportation criteria. The main transportation factors for Alternatives #1 to 4 are outlined below:

- capacity:

- at-grade King Edward Avenue would operate acceptably between the tunnel's entrance/exit locations;
- issues with the capacity at intersections south of the tunnel entrance/exit location, either the King Edward/Mann or Laurier/Nicholas intersection were noted as being close to capacity and would operate above capacity with the projected increase in vehicles accessing the tunnel;
- Lane Reductions:
 - South end of the tunnel:
 - right-of-way constraints would reduce the existing number of lanes along Waller Street or King Edward Avenue as the tunnel connection would likely eliminate 3 surface lanes. As the majority of traffic along these routes is local traffic not accessing the tunnel, the lane reduction would cause congestion and back-ups at the entrance/exit location;
 - North end of the tunnel:
 - the Macdonald-Cartier Bridge has three northbound lanes and cannot be widened to four lanes. As there are currently three lanes approaching the bridge (two lanes on King Edward Avenue, one lane from Sussex Drive) a fourth lane exiting the tunnel would cause a lane imbalance;
- Trucks:
 - truck mobility would improve, although delays may be experienced at the tunnel entrance/exit locations because of capacity issues;
- Pedestrian and Cyclists:
 - pedestrian and cyclist mobility would be compromised within the vicinity of the tunnel entrance/exit;
- Visual:
 - the appearance of the tunnel entrance/exit would be “unacceptable to many”.

As a result of the above-mentioned transportation related issues and the high construction cost of \$110 to \$250 million (included in Figure 3), the Tunnel Alternatives #1 to 4 were not recommended. Tunnel Alternatives #5 and 6 would remove ‘through’ vehicles from the King Edward Corridor, however, as trucks are currently not permitted on the Vanier Parkway, these Alternatives would not reduce the amount of ‘through’ truck traffic along King Edward Avenue. In addition, required intersection and road network modifications along with construction costs of \$85 to \$140 million and the “unresolvable lane imbalance” mentioned above resulted in these Tunnel Alternatives #5 and 6 not being recommended.

2.1.2 Over-Night Truck Ban

As part of the King Edward Avenue Renewal EA, studies were completed by the City of Ottawa and Ray Barton Associates to assess the feasibility of an over-night heavy truck ban along King Edward Avenue, Sussex Drive, Booth Street and Cameron Street. Within the studies, a 1997 count revealed that approximately 200 heavy trucks travelled along King Edward between the hours of 11PM to 6AM. Of this total, approximately 40% of the trucks were noted as articulated trucks. A year 2000 count revealed that the number of trucks on King Edward Avenue had increased by 20% (approximately 240 trucks) and articulated trucks accounted for 50% of that total.

The over-night truck ban was initiated because of concerns with residential property value and business opportunities along King Edward Avenue and Rideau Street where heavy truck traffic affected the quality of life. The trucking industry expressed concerns that implementing the ban would have a negative effect on their businesses. The over-night truck ban was not implemented, however, the truck industry agreed



to reduce over-night truck traffic by 20% and the City agreed to commence work on the feasibility of a new interprovincial bridge that would help address some of the problems with the downtown truck route.

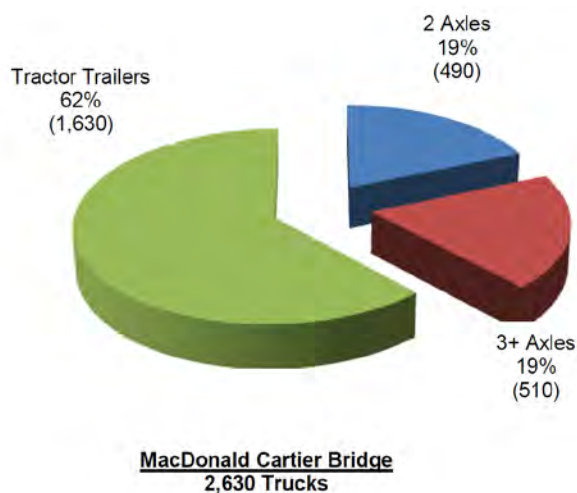
2.2 Interprovincial Roadside Truck Survey (2007)

In 2007, the Interprovincial Roadside Truck Survey was conducted by Earth Tech Canada Inc. for the Ministry of Transportation of Ontario (MTO) and funded by the TRANS Committee (a body which coordinates efforts between the major transportation planning agencies of the National Capital Region). Two of the five interprovincial bridges were included in the survey, the Macdonald-Cartier Bridge and the Chaudière Crossing, which are the only two bridges identified as truck routes within the City of Ottawa. Origin-destination and volume data was collected in the summer of 2007.

The survey identifies a 'heavy truck' as vehicles with 6 or more wheels on 2 or more axels. Heavy trucks were grouped into three sub-categories; 2 axle straight trucks, 3+ axle straight trucks, and tractor trailer trucks.

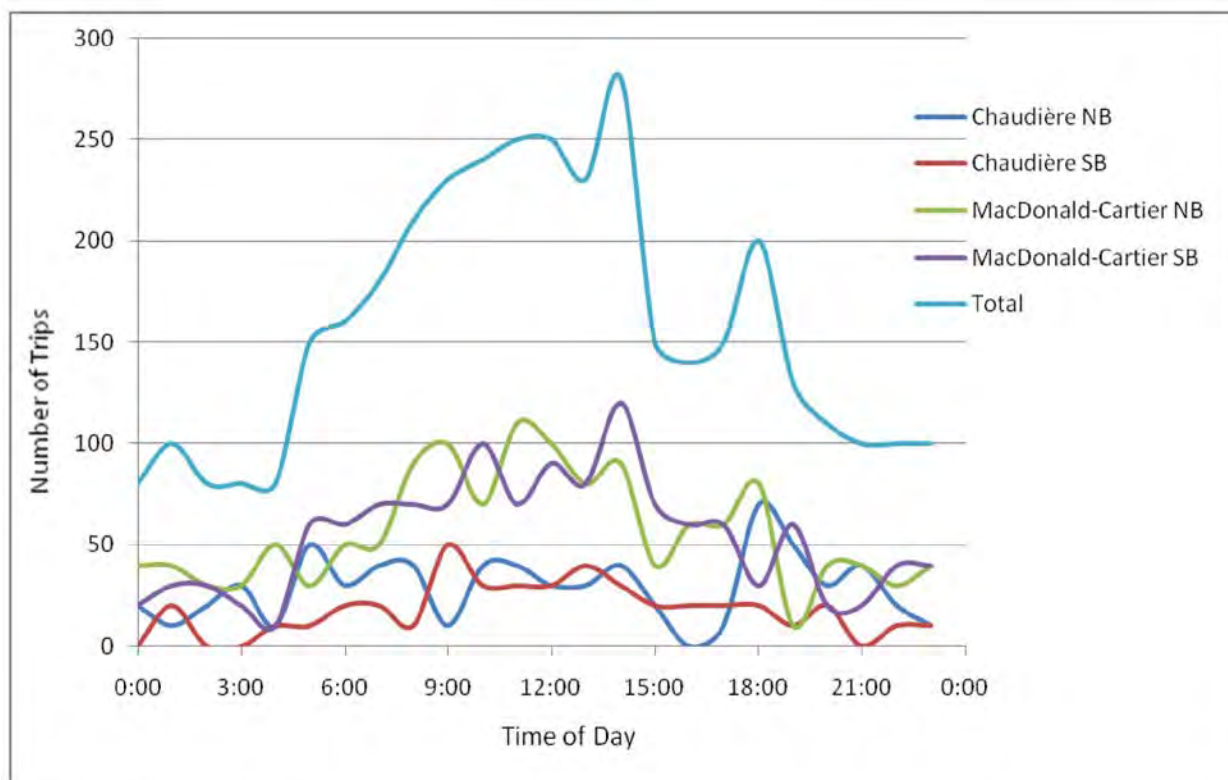
Along the Macdonald-Cartier Bridge, approximately 2,630 trucks per day were observed. As shown in the following Exhibit 4, 19% were classified as 2 axle straight trucks, 19% were classified as 3+ axle straight trucks, and the majority, 62% were classified as tractor trailer trucks.

Exhibit 4: Daily Truck Volumes by Classification



Source: *Interprovincial Roadside Truck Survey (2007)*

With regard to the travel time of day, according to the survey approximately 23% of the truck traffic travels across the Macdonald-Cartier Bridge during the weekday morning and afternoon peak hours. During the night time period (6PM to 7AM), 34% of daily truck activity travelled across the Macdonald-Cartier Bridge. The peak travel time was identified as being the midday off-peak hours (9AM to 3:30PM) with 43% of trucks travelling during this time. This equates to approximately 175 to 210 two-way trucks/h across the Macdonald-Cartier Bridge during the midday peak hours, which can be seen in the following Exhibit 5.

Exhibit 5: Hourly Trip Variation of Trucks (by bridge and direction)

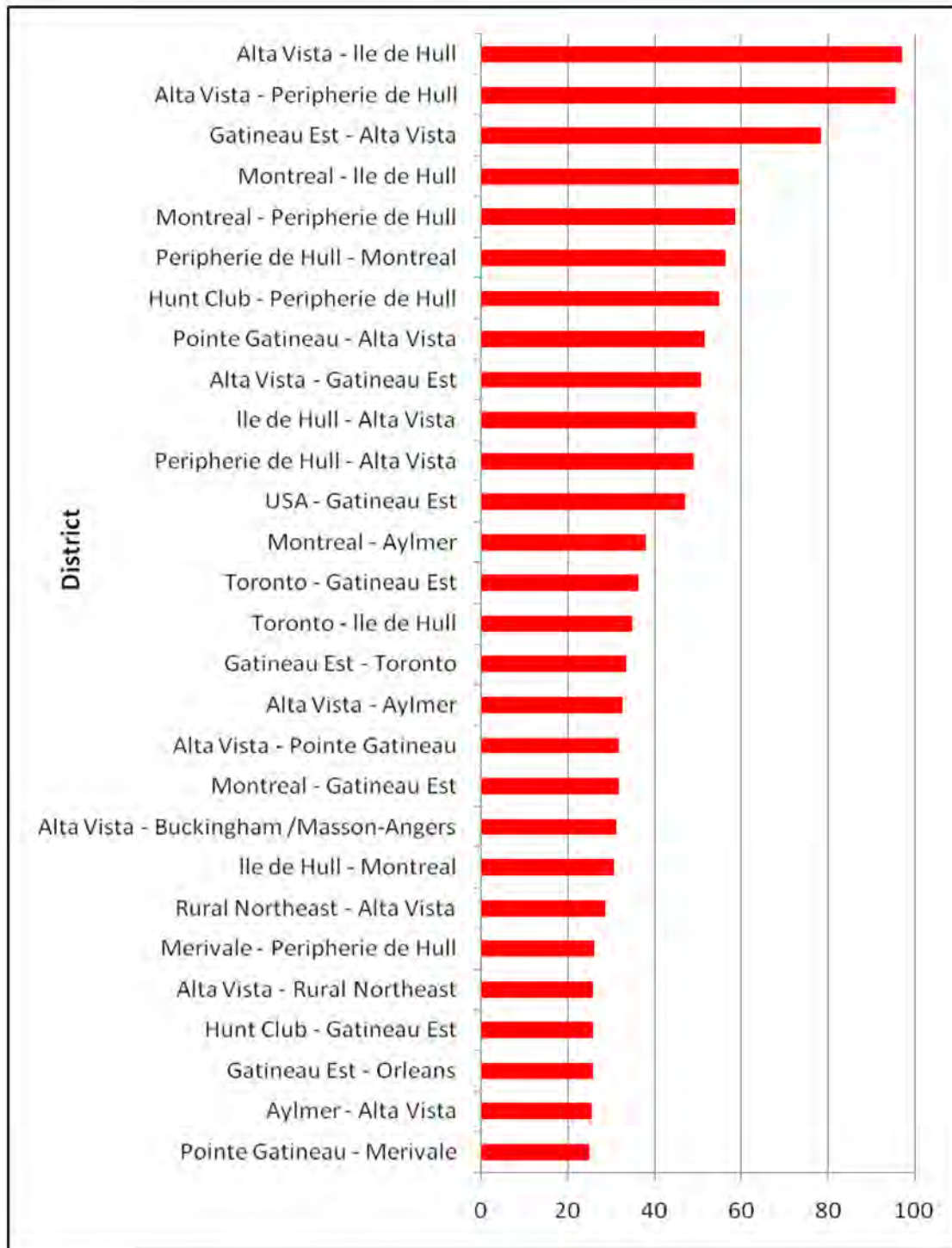
Source: *Interprovincial Roadside Truck Survey (2007)*

With regard to the origins and destinations of the trucks travelling across the interprovincial bridges, the survey breaks down the recorded O-Ds using the TRANS districts and external zones. The most common origins/destinations for trucks were Alta Vista, Gatineau Est, Peripherie de Hull, and Ile de Hull. This is outlined in Exhibit 6 below.

It can be seen in Exhibit 6 that none of the trucks have origins from or destinations to the Ottawa Centre or Ottawa Inner Area Districts, indicating that all trucks accessing the Macdonald-Cartier Bridge would likely have used the designated truck route along King Edward Avenue, Rideau Street, Waller Street, and Nicholas Street (KERWN Corridor). It is noteworthy, however, that this study only recorded the *initial* origins and *final* destinations. Therefore, if a truck made a stop/delivery downtown while en-route to its final destination, this would not have been recorded. As such, a more detailed survey was performed in 2011 for the Interprovincial Crossing EA and is outlined in Section 2.3.

In December 2012 the completion of the final section of Highway 50 between Gatineau and Montreal, as a two-lane limited access highway, now provides a travel route between these two destinations that is an alternative to the former Route 148 along the Ottawa River or to Highway 417 on the Ontario side; truck travel along this new highway may have some impact on the usage of the KERWN Corridor.

Exhibit 6: Major Desired Lines of Trucks



Source: Interprovincial Roadside Truck Survey (2007)



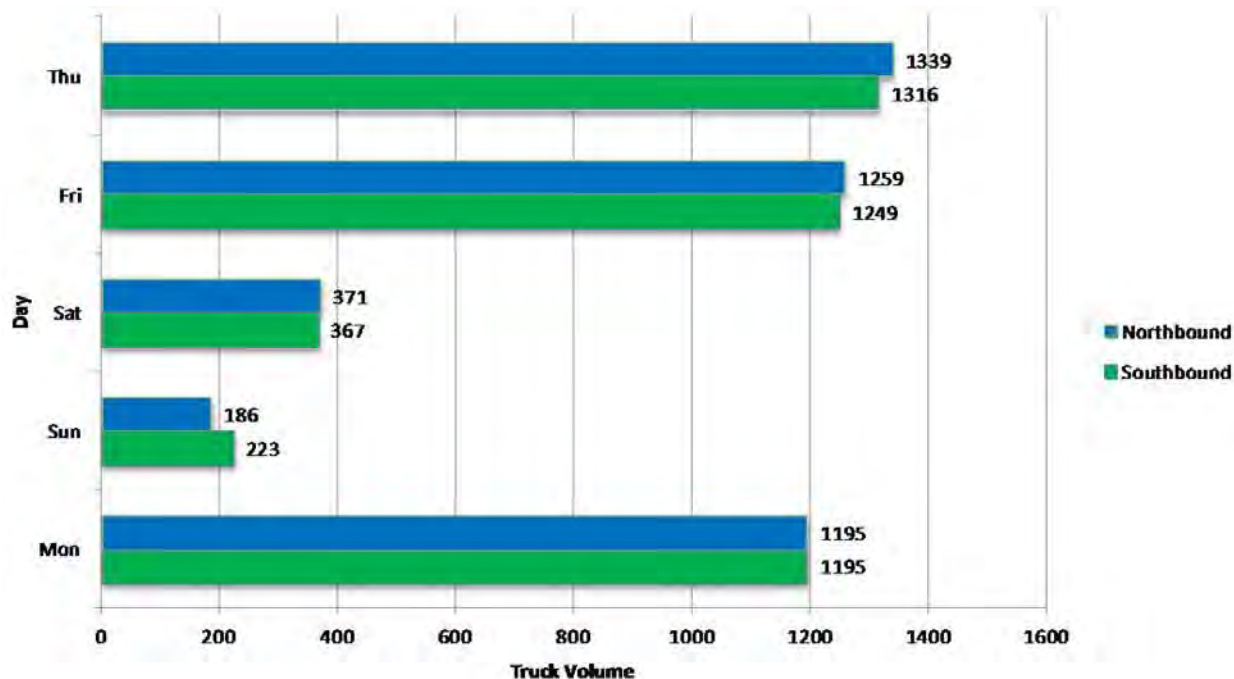
2.3 Interprovincial Crossing Environment Assessment – Truck Analysis Report (2013)

As part of the Interprovincial Crossing EA, Roche-GENIVAR in 2011 performed a roadside origin-destination (O-D) survey of trucks travelling along the KERWN Corridor. The KERWN Corridor is the official City of Ottawa Truck Route linking Highway 417 in Ottawa to Highway 5 in Gatineau via King Edward Avenue, Rideau Street, Waller Street, and Nicholas Street. As mentioned previously, one of the main objectives of this survey was to capture the truck trips that do not travel continuously along the KERWN Corridor (i.e. trucks that make a stop/delivery downtown then continue to their final destination via the KERWN Corridor).

For the purpose of this roadside O-D survey, medium/light trucks were defined as vehicles with “2 axles and dual rear tires” or “single-unit vehicles with more than 2 axles” (buses and cars with trailers were excluded) and heavy trucks were defined as any tractor-trailer.

The findings of this survey reveal weekday truck traffic along the Macdonald-Cartier Bridge in the range of 1,200 to 1,340 trucks in the north and southbound directions, totalling daily volume of 2,655 two-way trucks. These volumes are summarized in Exhibit 7. Of the total truck traffic travelling along the KERWN Corridor, 43% are identified as heavy trucks (tractor-trailers).

Exhibit 7: Daily Truck Volume by Direction on Macdonald-Cartier Bridge (2011)



Source: *Interprovincial Crossing Environment Assessment – Truck Analysis Report (2013)*

Weekday morning and afternoon peak hour truck traffic ranges from 150 to 160 trucks per hour, whereas midday off-peak traffic volumes (between 9AM and 3PM) range from 175 to 240 trucks per hour. With regard to truck traffic along the KERWN Corridor during the weekend, the two-way daily volumes varied from 400 to 750 trucks per day. It can be seen that the weekday truck traffic is significantly higher than the weekend truck traffic.

With regard to the type of trips made by trucks along this route, the following Exhibit 8 indicates that 65% of truck trips are 'through' trips and 35% are 'local' trips. 'Through' trips are defined as trips that travel continuously along the KERWIN Corridor and 'local' trips are defined as trips that make stops in the downtown core before continuing along the KERWIN Corridor to their final destination. During the day (7AM to 7PM) the percentage of 'through' trips is slightly lower at 63% and during the night (7PM to 7AM) the 'through' traffic is noted as 74%.

Exhibit 8: Truck Use of the Macdonald-Cartier Bridge (2011)

| Time | Trip Type | Direction | | Total |
|--------------|-----------|------------|------------|-------------|
| | | Southbound | Northbound | |
| 24 h | Through | 901 | 807 | 1,707 (65%) |
| | Local | 402 | 513 | 916 (35%) |
| 7 am to 7 pm | Through | 723 | 589 | 1,312 (63%) |
| | Local | 333 | 454 | 787 (37%) |
| 7 pm to 7 am | Through | 202 | 235 | 437 (74%) |
| | Local | 79 | 73 | 152 (26%) |

Source: *Interprovincial Crossing Environment Assessment – Truck Analysis Report (2013)*

It is important to recognize the amount of trucks that make 'through' trips as these trucks would utilize a downtown truck tunnel. 'Local' trips would have to continue to use the existing downtown truck route as they would require access to downtown streets to make their stops/deliveries and would not benefit from a truck tunnel. The percentages noted above equates to approximately 1,707 trucks that would potentially use a truck tunnel and by-pass the downtown/KERWIN Corridor.

With regard to heavy trucks (tractor-trailers) only 12% of heavy trucks make 'local' trips off the KERWIN Corridor. This results in approximately 1,000 heavy trucks daily that would be removed from the TRANS Model.

3. TRANS Regional Travel Demand Model

The TRANS regional transportation model, housed in an EMME/3 software environment, is used to replicate existing trip patterns and travel choices, and to simulate the effects of future scenarios featuring alternative transportation policies, facilities, services, and varying population/employment growth. For the subject downtown tunnel, City of Ottawa staff conducted a number of simulations using this model to identify travel patterns within the potential tunnel corridors and how the introduction of a tunnel would influence area travel patterns.

3.1 Select Link Analyses

Using the TRANS model, an AM peak hour select link analysis was conducted for a number of locations within the study area for the projected 2031 planning horizon. The results of this select link analysis, included as Appendix A, provided a general indication of the origins and destinations of traffic on the following specific links:

- Macdonald-Cartier Bridge;
- King Edward Avenue (north of Rideau);
- Nicholas Street (south of Laurier); and
- Vanier Parkway (south of Montreal).



In terms of general projected travel patterns during the AM peak hour, the following was revealed from the select link analysis:

Northbound

- Northbound traffic on the Macdonald-Cartier Bridge originates from a combination of eastbound Sussex (50%) and northbound King Edward (50%, with an equal contribution from St. Patrick/Vanier and further south on King Edward);
- Northbound traffic on King Edward Avenue (north of Rideau) originates from a combination of King Edward (50%), eastbound Rideau (25%) and westbound Rideau (25%);
- The vast majority of northbound traffic on Nicholas Street originates from westbound HWY 417;
- Northbound traffic on the Vanier Parkway originates from a combination of eastbound HWY 417 (20%), westbound HWY 417 (30%), westbound Coventry (10%) and northbound Riverside (40%)

Southbound

- Southbound traffic on the Macdonald-Cartier Bridge is destined for a combination of eastbound Sussex (15%), southbound Sussex (10%), southbound Dalhousie (10%), and southbound King Edward (65%, with one third headed for St. Patrick/ Murray/Vanier and two thirds headed further south on King Edward);
- Southbound traffic on King Edward Avenue (north of Rideau) is destined for a combination of King Edward (50%), eastbound Rideau (35%) and westbound Rideau (15%);
- The vast majority of southbound traffic on Nicholas Street is destined to eastbound HWY 417;
- Southbound traffic on the Vanier Parkway (approaching Coventry) is destined for a combination of westbound HWY 417 (20%), eastbound HWY 417 (10%), westbound Coventry (35%) and southbound Riverside (35%)

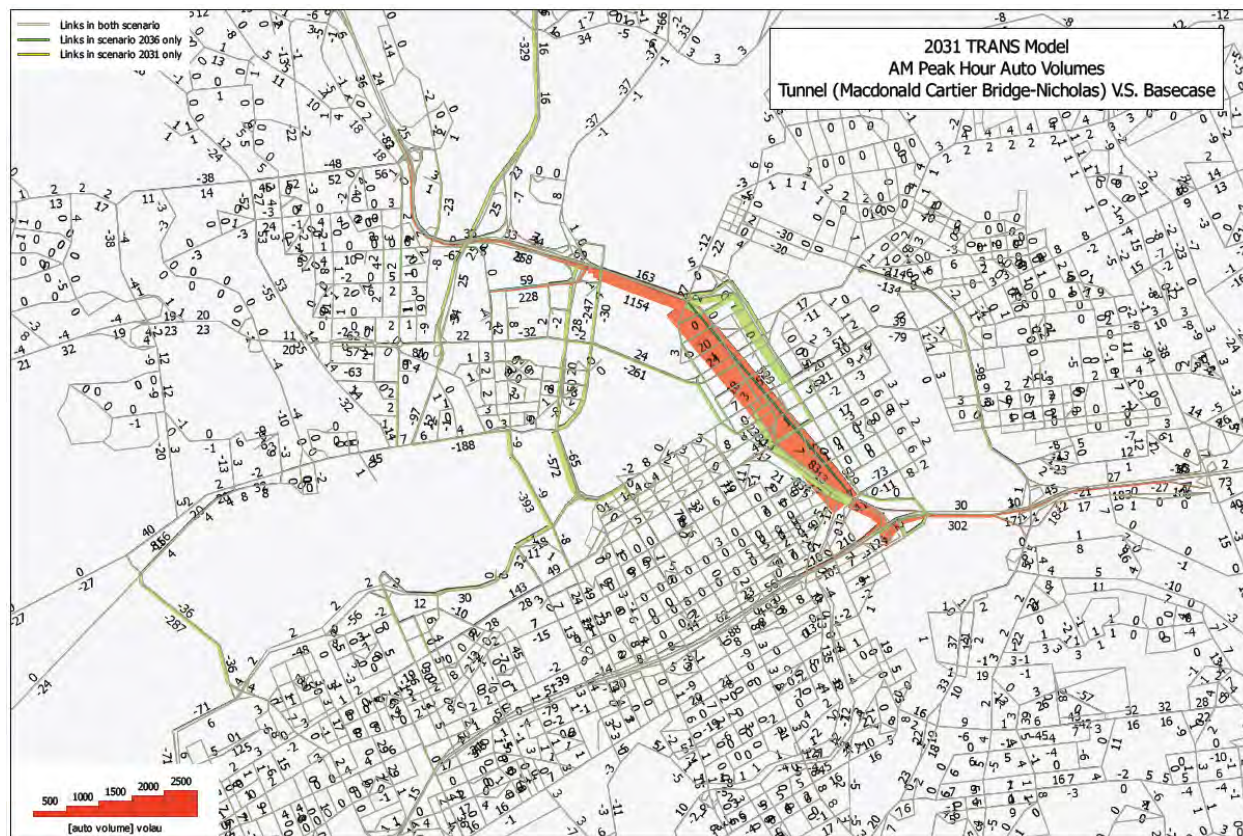
3.2 Tunnel Scenarios

A new link representing a tunnel linking the Macdonald-Cartier Bridge to the Highway 417 Corridor was introduced within two future scenarios at the 2031 planning horizon. The first scenario made the southerly tunnel connection at Nicholas Street (south of Laurier), and the second scenario made the southerly tunnel connection at the Vanier Parkway (north of Coventry). In both cases, the assumed capacity of the tunnel was 2,000 veh/h, and the cross-section of King Edward Avenue was reduced to 4-lanes. The findings for each scenario, in terms of projected volume changes relative to the Baseline 2031 scenario during the AM peak hour at 2031, are shown in Exhibit 9 and Exhibit 10, respectively.

For the Nicholas Street Scenario, the TRANS model is forecasting an increase in southbound trips across the Macdonald-Cartier Bridge of 1,150 veh/h, and projections of just under 2,400 veh/h using the tunnel. This is noted to be more than the assumed capacity of 2,000 veh/h. The model indicates projected volume reductions of between 300 and 500 veh/h on portions of King Edward Avenue and Nicholas Street, but smaller reductions of less than 100 veh/h on the likes of Rideau Street. Of particular note is the forecasted reduction of traffic demand on the competing inter-Provincial bridges totalling approximately 1,500 veh/h, namely Champlain (-290 veh/h), Chaudière (-390 veh/h), Portage (-570 veh/h), and Alexandra (-260 veh/h).



Exhibit 9: Tunnel Scenario 1 (Nicholas) – Projected Change in Traffic Volume (compared to 2031 Baseline)

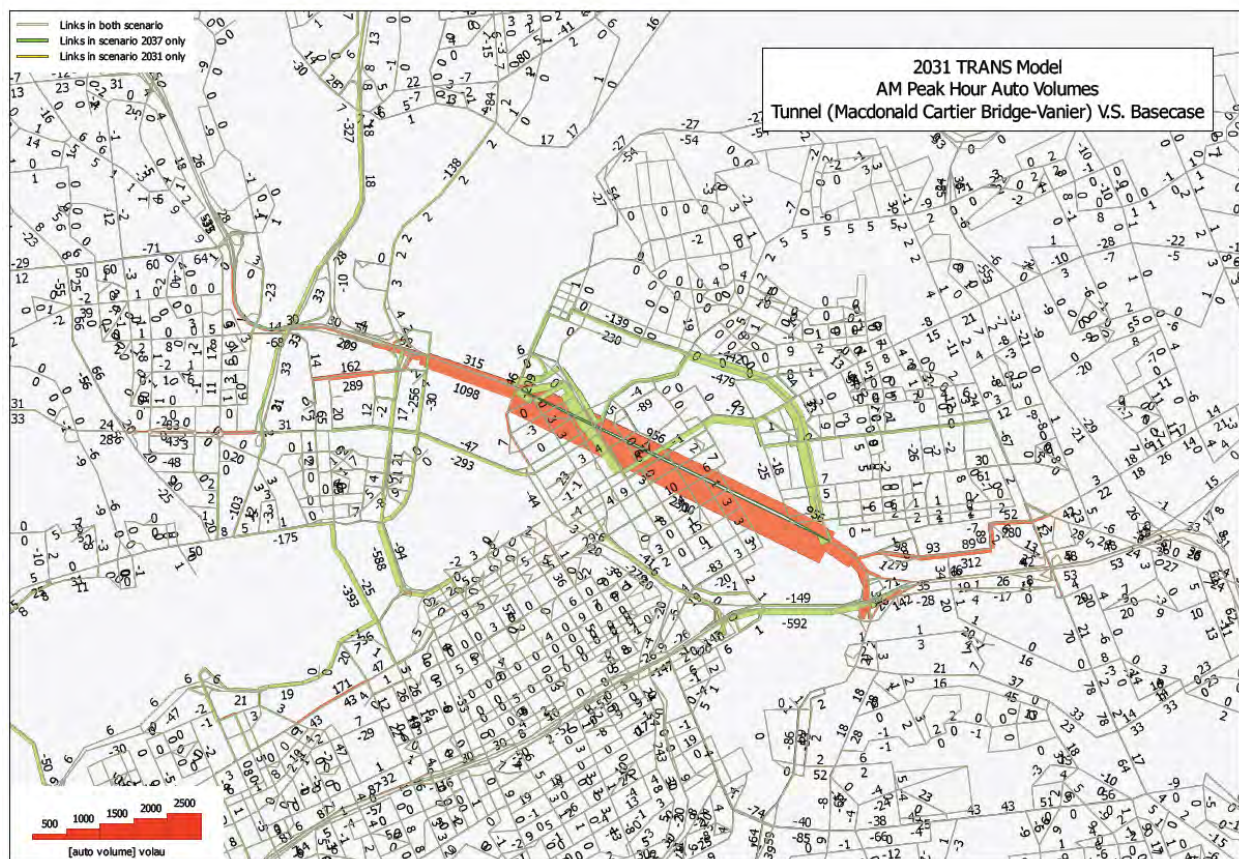


Source: City of Ottawa Strategic Transportation Planning (2015)

For the Vanier Parkway Scenario, the TRANS model is forecasting an increase in southbound trips across the Macdonald-Cartier Bridge of 1,100 veh/h, and projections of 2,300 veh/h using the tunnel. The model is projected volume reductions of between 300 and 500 veh/h on portions of King Edward Avenue and Nicholas Street, but smaller reductions of less than 100 veh/h on the likes of Rideau Street. Again, traffic volume reductions are being forecasted the competing inter-Provincial bridges totalling approximately 1,500 veh/h.

In sum, both scenarios indicate that a tunnel would attract sufficient vehicles in the peak hour that equal or exceed the available capacity. It is also noteworthy that the projected volume-to-capacity (v/c) ratio of the Macdonald-Cartier Bridge at 2031 for both scenarios is approximately 1.3, whereas in the absence of the tunnel the projected v/c ratio is 1.1. The projected year 2031 performance of the interprovincial screenline is approximately 1.3 for the base case and both tunnel scenarios, which is confirmation of the need for additional capacity across the Ottawa River. Consideration must be given possible measures to accommodate the potential increase in forecasted demand approaching/crossing the Macdonald-Cartier Bridge, as well as opportunities to manage the demand (i.e., tolling).

Exhibit 10: Tunnel Scenario 1 (Vanier) – Projected Change in Traffic Volume (compared to 2031 Baseline)



Source: City of Ottawa Strategic Transportation Planning (2015)

4. Supplemental Data Sources

4.1 Ontario Ministry of Transportation (MTO)

The Ontario Ministry of Transportation has assembled a variety of historical, real-time, and forecast information in transportation and land use planning. The following data layers are currently available in *iCorridor* – a map-based data visualization and information sharing tool maintained by MTO:

- transit planning;
- land use planning;
- road travel speed and performance indices;
- transportation planning and forecasting;
- Provincial Highways; and
- multi-Jurisdictional transportation collaboration projects.

The majority of the data provided within *iCorridor* reflects conditions on the Provincial Highway System. However, there are some data sources that capture conditions on the Municipal Road Network, including for example commercial vehicle surveys and tracking data. Other layers provide indices that reflect road travel speeds/performance for various time periods.

The following Exhibit 11 summarizes the Average Annual Daily Traffic (AADT) and the Average Annual Daily Truck Traffic (AADTT) along HWY 417 near the Nicholas interchange, provided by the Ontario Ministry of Transportation for the year 2008.

Exhibit 11: MTO Highway 417 Data (2008)

| HWY 417 | AADT | AADTT | % Truck Traffic |
|------------------------------|---------|--------|-----------------|
| East of Nicholas Interchange | 157,800 | 11,205 | 7% |
| West of Nicholas Interchange | 151,600 | 8,641 | 6% |

Source: <http://www.mto.gov.on.ca/iCorridor/>

As shown in Exhibit 11, approximately 6% to 7% of traffic along HWY 417 at the Nicholas interchange is truck traffic.

4.2 King Edward Avenue Lane Utilization (2013)

The City of Ottawa performed a survey in June 2013 along King Edward Avenue between Cathcart Street and St. Patrick Street, recording the speed, type and length of vehicles in each lane. The vehicles were categorized according to the length of the vehicle as defined in Exhibit 12.

Exhibit 12: KEA Lane Utilization - Vehicle Categories

| Length (m) | Vehicle Type |
|-------------|------------------------|
| 0.0 – 6.5 | Passenger Vehicle |
| 6.6 – 8.6 | Vans and Pickup Trucks |
| 8.7 – 12.3 | Buses and Trucks |
| 12.4 – 24.0 | Tractor Trailer Trucks |

Source: King Edward Lane Utilization study (2013)

Heavy trucks are defined as vehicles for 6 or more wheels on 2 or more axels. As the data does not provide this information, heavy trucks were assumed to be vehicles greater than 8.6 m in length (buses, trucks, and tractor trailers). The following Exhibit 13 summarizes the survey results at the count station on King Edward Avenue located 60 m north of Cathcart Street (which is the closest station to the Macdonald-Cartier Bridge).

Exhibit 13: Vehicle Count – King Edward Avenue (60m North of Cathcart Street)

| 24-hour | Total Vehicles and Buses (>8.6m) | Total Heavy Trucks and Buses (>8.6m) | Percent Heavy Trucks and Buses (>8.6m) |
|---------------------------------|----------------------------------|--------------------------------------|--|
| Northbound | | | |
| Curb Lane | 11,018 | 264 | 2.4% |
| Centre Lane | 13,523 | 867 | 6.4% |
| Median Lane ⁽¹⁾ | 471 | 7 | 1.5% |
| Total Northbound Traffic | 25,012 | 1,138 | 4.5% |
| Southbound | | | |
| Curb Lane | 1,256 | 308 | 25% |
| Centre Lane | 9,003 | 1,119 | 12% |
| Median Lane | 12,148 | 177 | 1.5% |
| Total Southbound Traffic | 22,407 | 1,604 | 7.1% |
| Total Two-way | 47,419 | 2,742 | 5.7% |

⁽¹⁾ Data is incomplete/corrupted - does not account for 24 hours.

Source: King Edward Lane Utilization Study (2013)



As shown in Exhibit 13, approximately 2,750 two-way heavy trucks were observed along King Edward Avenue north of Cathcart Street within the 24-hour period. The northbound and southbound curb lanes provide access to Sussex Drive and do not continue along the Macdonald-Cartier Bridge. As such, the total number of two-way heavy trucks continuing onto the Macdonald-Cartier Bridge is noted as approximately 2,170 heavy trucks within the 24-hour period.

The foregoing data must be reviewed with caution as the northbound median lane data appears incomplete/corrupt. Furthermore, heavy trucks were assumed to be vehicles that are longer than 8.6 m which includes buses as well as heavy trucks and excludes any pick-up trucks that have two rear wheels. Similar to the King Edward EA data, it is not certain that these heavy trucks originate or are destined to Highway 417. However, the data is generally consistent with the related findings of approximately 2,000 to 2,500 two-way heavy vehicles along the King Edward corridor within a 24-hour period.

4.3 Classification and Occupancy Data (2009 – 2013)

The following Exhibit 14 summarizes the City of Ottawa's Classification and Occupancy data from 2009 – 2013 (5 year period) at the Macdonald-Cartier Bridge. For the purpose of the classification data, heavy trucks are defined as vehicles with 6 or more wheels on two or more axles (Categories 5 to 13 as noted on Exhibit 1).

Light trucks were defined as vehicles with commercial equipment (i.e. ladders, lawn movers etc.), commercial vehicles with lettering/logos (i.e. FedEx vans, police cars, etc.), and panel vans with no windows. Light trucks would be classified in "Category 3 – Pickups, panels, vans" from Exhibit 1, however vehicles within Category 3 that have no lettering/logos on the vehicle would be classified as passenger vehicles.

Exhibit 14: Classification Count Data – Macdonald-Cartier Bridge (5-year trend 2009-2013)

| 12-hour | Passenger (veh) | Taxis (veh) | Light Trucks (veh) | Heavy Trucks (veh) | All Buses (veh) | Other Veh (veh) | Total Vehicle (veh) | Heavy Trucks (%) |
|-------------|-----------------|-------------|--------------------|--------------------|-----------------|-----------------|---------------------|------------------|
| 2013 | | | | | | | | |
| Inbound | 20,144 | 309 | 579 | 1,057 | 524 | 148 | 22,761 | 4.6% |
| Outbound | 19,865 | 178 | 740 | 916 | 456 | 173 | 22,328 | 4.1% |
| 2012 | | | | | | | | |
| Inbound | 19,869 | 243 | 772 | 1,006 | 485 | 190 | 22,565 | 4.5% |
| Outbound | 17,746 | 222 | 926 | 1,131 | 566 | 205 | 20,796 | 5.4% |
| 2011 | | | | | | | | |
| Inbound | 22,717 | 274 | 655 | 958 | 580 | 3 | 25,187 | 3.8% |
| Outbound | 23,182 | 290 | 1051 | 802 | 301 | 0 | 25,626 | 3.1% |
| 2010 | | | | | | | | |
| Inbound | 28,201 | 278 | 641 | 898 | 543 | 151 | 30,712 | 2.9% |
| Outbound | 23,790 | 431 | 901 | 962 | 180 | 170 | 26,434 | 3.6% |
| 2009 | | | | | | | | |
| Inbound | 21,648 | 351 | 582 | 955 | 319 | 211 | 24,066 | 4.0% |
| Outbound | 22,018 | 337 | 787 | 1,004 | 284 | 51 | 24,481 | 4.1% |

Source: Classification/Occupancy Counts (2009 - 2013) – City of Ottawa

As shown in Exhibit 14, over a 12-hour count period, approximately 3% to 5% of traffic travelling across the Macdonald-Cartier Bridge is classified as heavy trucks. This equates to 1,750 to 2,100 two-way heavy trucks per 12-hours.



Classification and occupancy count data is also available along Nicholas Street just south of Laurier Avenue for the year 2013. The Nicholas Street data compared with the 2013 data along the Macdonald-Cartier Bridge are summarized in Exhibit 15 below to estimate the amount of 'through' vehicle and truck trips from Nicholas Street to the Macdonald-Cartier Bridge.

Exhibit 15: Macdonald-Cartier Bridge and Nicholas Street Classification Count Data

| 12-hour | Passenger (veh) | Taxis (veh) | Light Trucks (veh) | Heavy Trucks (veh) | All Buses (veh) | Other Veh (veh) | Total Vehicle (veh) | Heavy Trucks (%) |
|---|-----------------|-------------|--------------------|--------------------|-----------------|-----------------|---------------------|------------------|
| Macdonald-Cartier Bridge – 2013 | | | | | | | | |
| Inbound | 20,144 | 309 | 579 | 1,057 | 524 | 148 | 22,761 | 4.6% |
| Outbound | 19,865 | 178 | 740 | 916 | 456 | 173 | 22,328 | 4.1% |
| Total | - | - | - | 1,973 | - | - | - | - |
| Nicholas Street (south of Laurier Avenue) – 2013 | | | | | | | | |
| Inbound | 13,712 | 643 | 791 | 1,373 | 131 | 51 | 16,701 | 8.2% |
| Outbound | 10,677 | 581 | 662 | 1,323 | 135 | 24 | 13,402 | 9.9% |
| Total | - | - | - | 2,696 | - | - | - | - |

Source: Classification/Occupancy Counts (2013) – City of Ottawa

As shown in Exhibit 15, approximately 2,700 heavy trucks travel to/from Highway 417 via Nicholas Street within a 12-hour period. Of these 2,700 heavy trucks, a **maximum** of 1,973 are destined to/originated from the Macdonald-Cartier Bridge along the KERWN Corridor, meaning they may have potentially all chosen to travel along this corridor. However, the total is most likely less because of deliveries/stops downtown and alternatives routes other than the KERWN Corridor or only parts thereof.

5. Bluetooth® Monitoring (2014)

5.1 Background

Bluetooth® communication technology is used by mobile telephones, hands-free sets, GPS navigators and more. All of these Bluetooth® emitting devices have a unique, but anonymous MAC address, which in essence means that they leave a unique digital footprint behind without revealing information about the owner that can put into jeopardy his or her privacy. As the vehicles circulate a network equipped with road-side Bluetooth® monitoring sensors, these signals are picked up and can be used to track a variety of valuable traffic data with a wide range of potential applications. For example, within transportation mobility and infrastructure planning studies, the technology has been used to calculate travel times, border wait times, and origin-destination patterns. The latter is the application being considered for this study.

It is important to note, however, that the traffic data captured using the Bluetooth® sensors represents only a sample of the total population, namely that portion equipped with a Bluetooth® emitting devices operating in discovery mode. It is understood that a typical Bluetooth® penetration rate is between 5% and 10%¹, which is considered a very good sample size to provide very accurate traffic information. To determine a location-specific penetration rate, a vehicle "trap" is established as part of the overall data collection activities. A "trap" consists of two closely spaced sensors in a location where there are no opportunities for traffic to leave the network between the sensors (e.g. a sensor at both ends of the Macdonald-Cartier Bridge). The data collected between the two sensors is then compared to an actual

¹ The current percentage of the population with Bluetooth® emitting devices is obviously much greater than 10% (and growing rapidly each year), but only a portion of the devices operate permanently in discovery mode.



ground count to determine the penetration rate of vehicles with Bluetooth® emitting devices entering/exiting the study area network.

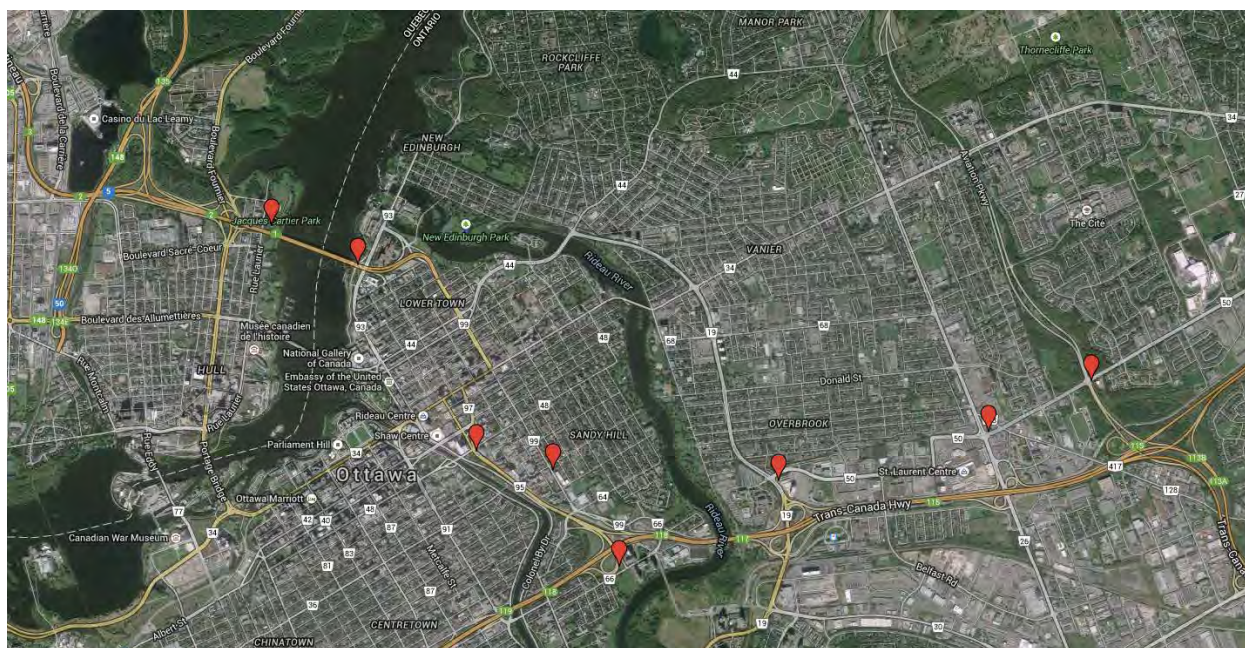
One other notable limitation of the technology is the inability to distinguish between vehicle types. Therefore, the data collected reflects a combination of passenger cars, vans, trucks, etc. This constraint was considered acceptable given a relatively strong understanding of the interprovincial truck demand has already been established as part of previous studies.

5.2 Sensor Placement Strategy

In support of this study, TPA North America was engaged to deploy Bluetooth® sensors road-side at strategic locations within the study area. The sensors continuously gathered data for a 14-day period between November 26th, 2014 and December 9th, 2014. The approximate locations of the seven sensors are described below and are depicted in Exhibit 16:

- St. Laurent Boulevard (just north of HWY 417)
- Vanier Parkway (just north of HWY 417)
- King Edward Avenue (near Ottawa U)
- Nicholas Street (approaching Laurier)
- HWY 417 eastbound on/off-ramp near Lees Avenue
- Macdonald-Cartier Bridge (Ottawa side)
- Macdonald-Cartier Bridge (Gatineau side)

Exhibit 16: Location of Bluetooth® Sensors



The two Bluetooth® sensors located on the Macdonald-Cartier Bridge were used to establish the local penetration rate of vehicles with Bluetooth® emitting devices (i.e. the vehicle “trap”). The analysis, which compared the collected Bluetooth® data to the most recent Macdonald-Cartier Bridge Classification and Occupancy traffic count (June 19, 2013), revealed an approximate inbound penetration rate of 8%, and

outbound penetration rate of 9% (see Exhibit 17). For analysis purposes, these penetration rates are considered to be a very good sample size.

Exhibit 17: Derivation of Local Bluetooth Penetration Rate (Macdonald-Cartier Bridge)

| Time | Classification & Occupancy Data (veh) | Average Bluetooth Data (veh) | Penetration Rate (%) |
|--------------------------------------|---------------------------------------|------------------------------|----------------------|
| INBOUND (Gatineau to Ottawa) | | | |
| 12-hour | 22,761 | 1,851 | 8.1% |
| 8-hour | 16,430 | 1,361 | 8.3% |
| 07:00-08:00 | 3,343 | 289 | 8.6% |
| 07:00-09:30 | 7,182 | 639 | 8.9% |
| 15:45-16:45 | 1,741 | 142 | 8.2% |
| 15:30-18:00 | 4,079 | 364 | 8.9% |
| OUTBOUND (Ottawa to Gatineau) | | | |
| 12-hour | 22,328 | 2,036 | 9.1% |
| 8-hour | 16,063 | 1,465 | 9.1% |
| 08:30-09:30 | 1,585 | 163 | 10.3% |
| 07:00-09:30 | 3,637 | 353 | 9.7% |
| 15:30-16:30 | 2,970 | 187 | 6.3% |
| 15:30-18:00 | 6,757 | 649 | 9.6% |

As summarized in Exhibit 17, there is a notable imbalance in peak hour inbound versus outbound vehicle traffic (e.g. there are more inbound trips leaving Gatineau during the morning peak hour than there are outbound trips returning to Gatineau during the afternoon peak hour). This can be attributed to drivers selecting alternative bridge crossings to possibly avoid peak hour traffic congestion (e.g. a driver selecting the Macdonald-Cartier Bridge during the morning peak hour and the same driver returning via the Alexandria Bridge during the afternoon peak hour).

5.3 Data Analysis

The data collected over the 14-day monitoring period for all Bluetooth® emitting vehicles, was compiled and processed to obtain existing traffic volumes travelling between HWY 417 and the Macdonald-Cartier Bridge. *It is important to note that the volumes estimated include all vehicle types, including cars, trucks, buses, etc.*

Processing the data, it was assumed that any travel times greater than 1 hour for routes originating/destined to the Macdonald-Cartier Bridge were filtered out, as any travel times greater than 1 hour would likely be due to multiple destinations between sensors (e.g. a delivery vehicle originating from HWY 417 making several delivery stops downtown Ottawa before crossing the Macdonald-Cartier Bridge). It is important to filter out routes with multiple destinations between sensors, as these routes will not be attracted to a new limited access tunnel that by-passes downtown Ottawa.

In addition to filtering out trips with travel times greater than 1 hour, routes that were not destined to/originated from the Macdonald-Cartier Bridge were also filtered out. It should be noted that given the limited project scope, a 16% sample of the most popular routes (149 routes out of 929 unique routes captured) were manually classified as “good” or “bad” routes. This accounted for approximately 92% of the total number of Bluetooth® emitting vehicles captured (56,402 vehicles were classified as “good” or

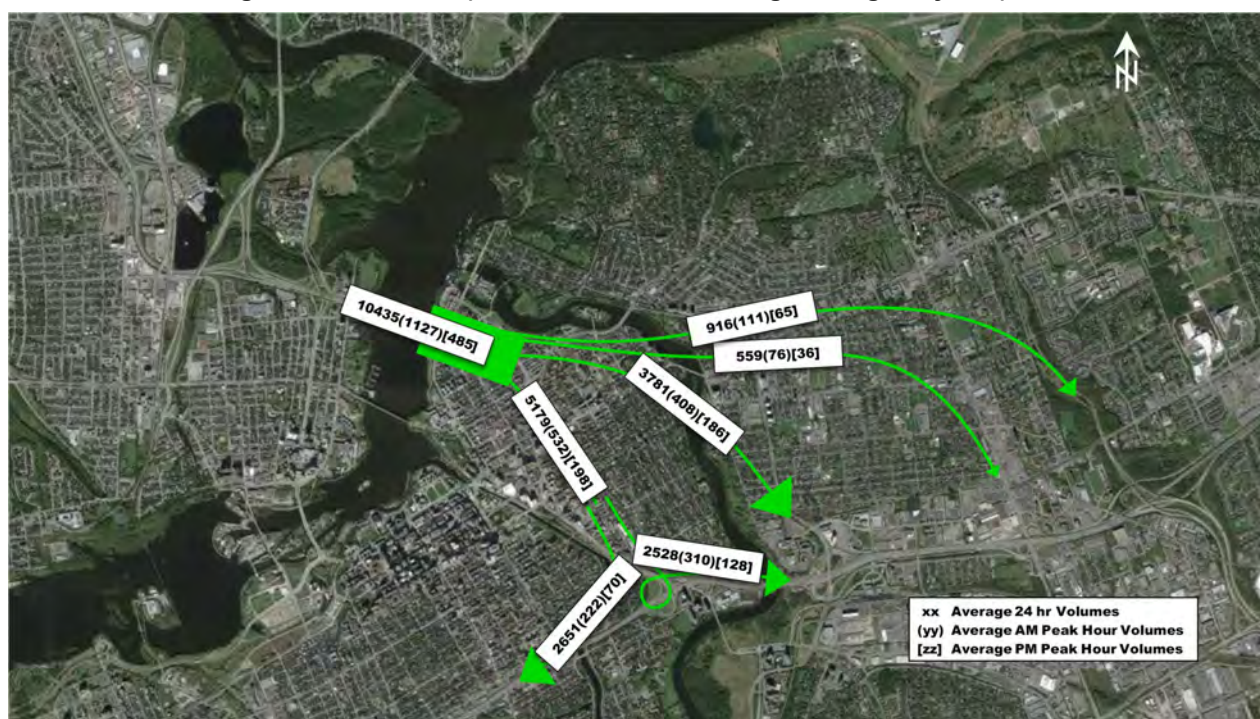


“bad” out of 60,977 vehicles captured). This is considered a very good sample size to provide very accurate traffic information.

The identified “good” routes were any routes that are likely to be diverted to a new downtown Ottawa tunnel (e.g. a route between the Vanier Parkway sensor and the Macdonald-Cartier Bridge sensor). The “bad” routes were the routes that are likely not to be diverted by a new downtown Ottawa tunnel (e.g. a route between the St. Laurent Boulevard sensor and the Vanier Parkway sensor).

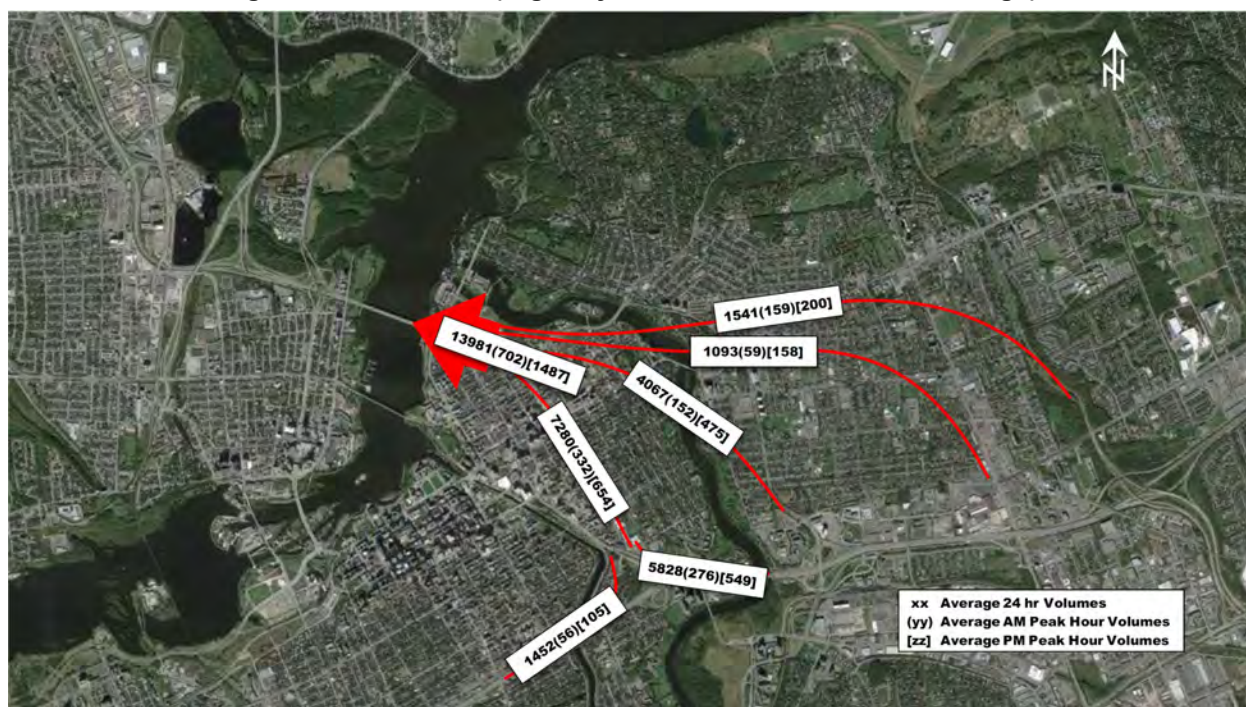
Lastly, the remaining unfiltered data was factored up by the calculated penetration rate (9%) to estimate the number of existing inbound (Gatineau to Ottawa) and outbound (Ottawa to Gatineau) trips that would likely benefit from/divert to a new downtown Ottawa tunnel. The following Exhibits 18 and 19 depict existing inbound and outbound traffic, respectively.

Exhibit 18: Existing Inbound Traffic (Macdonald-Cartier Bridge to Highway 417)



As depicted in Figure 18, the total inbound volumes (Gatineau to Ottawa) are highest in the morning peak period between 6-7AM at close to 1,100 veh/h, levelling off near 600 veh/h through the mid-day and tapering off considerably into the evening/early morning hours.

Exhibit 19: Existing Outbound Traffic (Highway 417 to Macdonald-Cartier Bridge)



As depicted in Exhibit 19, the total outbound volumes (Ottawa to Gatineau) increase throughout the day, stabilizing near 800 veh/h between mid-morning/early afternoon, and are highest in the afternoon peak period between 3-4PM, at approximately 1,500 veh/h.

With regard to the average 24-hr daily total vehicle demand between HWY 417 and the Macdonald-Cartier Bridge, it is currently in the order of approximately 25,000 vehicles per day, with Nicholas Street/King Edward Avenue corridors and the Vanier Parkway being the predominant route choices. During the commuter peak hours, these predominant routes attract 150-650 veh/h, with notable contributions of 100-200 veh/h from the secondary Aviation Parkway and St. Laurent Boulevard routes.

The “peak hour” volumes shown in the previous Exhibits 18 and 19 should be considered a representative “peak hour” volume, as the temporal breakdown of the raw data (see Appendix B) indicates variability in hourly traffic volumes. This variability in hourly traffic volumes is directly attributed to congestion. As congestion along the study area routes increases during peak hours, drivers will select alternative routes. It should also be noted that increased congestion can cause variability in data by limiting the amount of vehicles being processed within an hour timeframe (i.e. if traffic is not moving, it is not counted).

In terms of a percent breakdown by route, the following Exhibits 20 and 21 depict existing inbound and outbound study area traffic by percent, respectively.

Exhibit 20: Existing Inbound Traffic by Percent (Macdonald-Cartier Bridge to Highway 417)

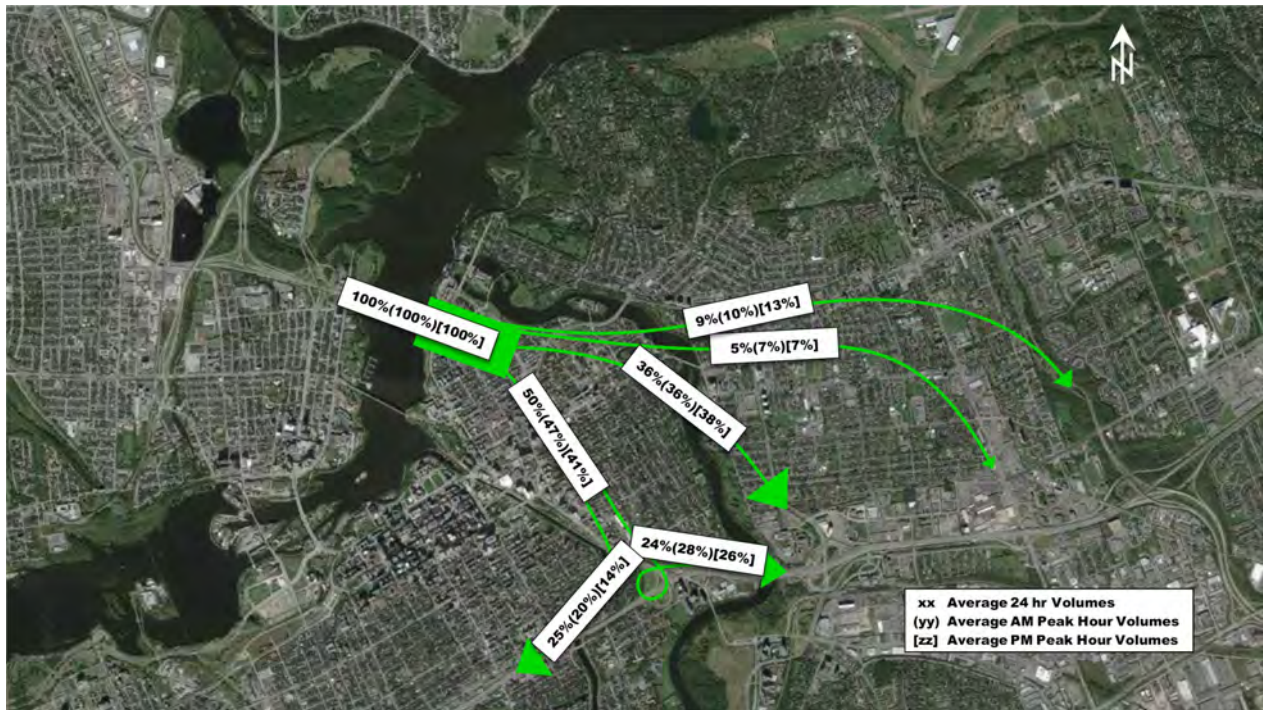
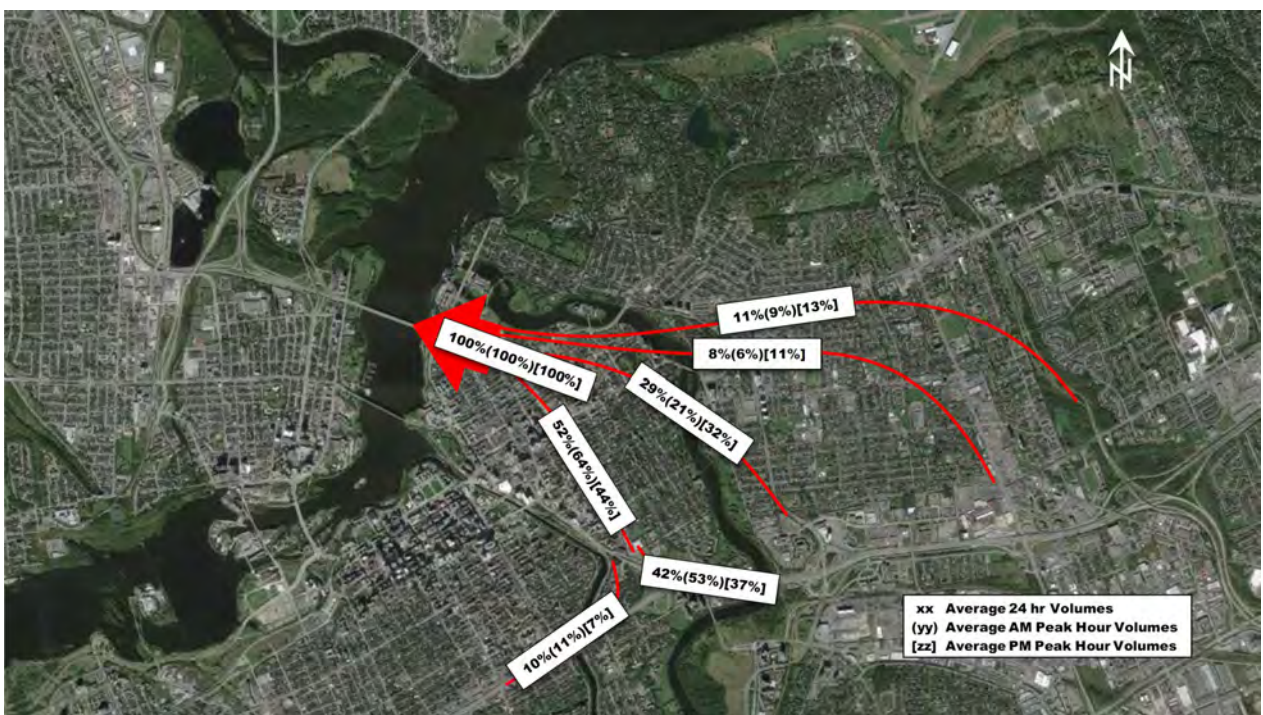


Exhibit 21: Existing Outbound Traffic by Percent (Highway 417 to Macdonald-Cartier Bridge)



As depicted in Exhibits 20 and 21, the previously mentioned imbalance in existing peak hour inbound versus outbound vehicle trips predominantly occurs on the Nicholas Street/King Edward Avenue corridors and the Vanier Parkway study area routes. This can be attributed to a combination of traffic congestion



along these routes and the current lack of access to HWY 417 eastbound via King Edward Avenue (i.e. the Lees Avenue HWY 417 eastbound on-ramp is currently closed due to construction).

6. Summary of Background Reports/Surveys

The following is a summary of the key findings of the background reports and supplemental data sources provided in the foregoing sections of the report.

6.1 Traffic Volumes on the Existing Road Network

Macdonald Cartier Bridge

- total daily traffic volumes on the Macdonald-Cartier Bridge range between 55,000 to 65,000 vehicles two-way;
- average annual daily truck traffic ranges between 2,200 and 2,700 two-way ($\approx 4-5\%$);
- 35% of truck activity is considered local (i.e., interim/final origin or destination in the downtown core), and 65% is considered through;
- hourly truck volumes during the busy commuter peak periods is estimated at 150 trucks per hour two-way, but increases to between 175 and 240 trucks per hour two-way during the midday time periods; during evening and overnight, hourly truck volumes are in the order of 50 trucks per hour two-way;

King Edward Avenue

- total daily traffic volumes on Nicholas Street (north of Rideau Street) is approximately 47,000 vehicles two-way;
- average daily truck traffic is approximately 2,700 ($\approx 5-6\%$)

Rideau Street

- total daily traffic volumes on Rideau Street (between Nicholas and King Edward) is approximately 13,500 vehicles two-way;

Nicholas Street

- total daily traffic volumes on Nicholas Street (south of Laurier) is approximately 30,000 vehicles two-way;
- average daily truck traffic is approximately 2,700 ($\approx 9\%$)

Hurdman Bridge

- total daily traffic volumes on Highway 417 crossing the Rideau River at the Hurdman Bridge range between 150,000 to 160,000 vehicles two-way (2031 forecast AADT is approximately 185,000)
- average daily truck traffic currently slightly more than 11,000 ($\approx 7\%$)

6.2 Potential Tunnel Usage

Heavy Trucks

- 1,700 trucks per day (900 southbound and 800 northbound) currently
- an estimated 900 more trucks are considered 'local'



All Vehicles

- between 1,000 and 1,150 veh/h during peak hours (KEA Renewal EA 2002)
- based on the estimated penetration rate and the number of captured Bluetooth® emitting vehicles within the study area, it is estimated that approximately 25,000 vehicles per day would likely benefit from the addition of a tunnel connection between HWY 417 and the Macdonald-Cartier Bridge. During peak hours, traffic that would likely benefit from the addition of a new downtown tunnel connection is estimated to be 1,000 to 1,500 veh/h in the peak directions.
- Based on the TRANS Regional Model, the addition of a tunnel connection between HWY 417 and the Macdonald-Cartier Bridge is expected to attract approximately 2,300 to 2,400 vehicles per hour in the peak direction at the 2031 planning horizon, including an estimated 1,500 vehicles per hour diverted from competing inter-Provincial bridges. Such modeling findings are subject to further study and refinement but provide a useful indication of potential travel changes.