Impact of Intercity Trucking on Urban Environment
Greater Toronto and Hamilton Area Case Study

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Abstract
Trucking is the dominant mode for transportation of goods in Ontario. More than 200,000 trucks travel on Ontario highways every day and carry about $3 billion worth of goods. As many as 40,000 trucks travel every day at the busiest point on Highway 401 in Toronto. The Ontario Ministry of Transportation (MTO) has invested in comprehensive freight data collection efforts to improve our understanding of freight demand and road performance in order to make informed investment decisions. Recently completed 2006 Commercial Vehicle Survey (CVS) program and the ongoing GPS probe road performance data collection efforts are the two main two main data collection initiatives undertaken by the province.

This paper investigates geographical and temporal distribution of long distance trucking, which primarily constitutes of medium and large trucks, in the Greater Toronto and Hamilton Area(GTHA). Truck Trip data from the 2006 CVS/NRS, along with the road performance data derived from GPS polling are used in this paper to evaluate potential conflicts between truck and commuter movements. The characteristics and distribution of intercity trucks that enter the GTHA boundaries are examined to understand the location of truck nodes, their proximity to residential areas, truck movement patterns, and temporal distribution patterns.

1. Introduction

The Greater Toronto and Hamilton Area (GTHA) is the largest metropolitan planning area in Canada with the population of more than 6 million people (1). Highway 401, which is considered the busiest highway in North America, also runs through this region. This highway not only serves as the main artery for commuter movements, it also carries significant volumes of trucks that serve both international and domestic trade. At its busiest location in Toronto, Hwy. 401 carries as many as 40,000 trucks every day (2). Inter-regional trucking makes up a large proportion of the heavy truck movement along the major corridors and 85% of these trucks have origins or destinations within the GTHA.

Detailed address information collected in the 2006 Commercial Vehicle Survey(CVS), as part of the National Roadside Survey (NRS), enables us to drill down into urban areas to locate truck concentration nodes. Even though some address information were collected in the 2001 CVS with limited success, most of the surveys in the 2006 surveys were geocoded to sub-municipal level details for most urban areas.

Ontario Ministry of Transportation (MTO) also acquired GPS polling data through a partnership with a service provider of electronic onboard data collection for commercial vehicle operators. For the GTHA, the data is available for all freeway segments and major arterials in Peel Region and Toronto. This is an invaluable source for developing road performance measures for trucks throughout the day.

This paper presents an analysis of geographical distribution of inter-regional truck trips and the usage of arterials to access their origins or destinations. Tractor and trailer combinations make significant portion of these trips and ease of access to freeways would be an important factor to minimise the time spent on arterials. This is especially important during peak periods to avoid unsafe conditions, as most large trucks will not be able to keep up with autos under stop and go conditions.

Due to incomplete coverage of intra-GTHA trips from the CVS, only trips with at least one trip-end is outside of GTHA, including through trips with both trip ends outside of the study area, were included in this study.

2 Background

The Greater Toronto and Hamilton Area is centrally located with ease of access to all of Ontario's trading partners. It is well connected to the rest of the province and other trade gateways through a network of freeways.

- Highway 401 is the primary corridor for truck movements that connects Quebec and Maritime provinces in the east, and Michigan and western United States in the west. As part of the Ontario –Quebec Continental Trade Corridor, it is also an important corridor for Quebec trade with the United States. Most of this trade travel through the Greater Toronto Area.

- The Queen Elizabeth Way provides a direct connection to the Niagara Gateways connecting New York, Pennsylvania and Ohio and other southern states.
- Highways 400 and 11 connect GTHA to Northern Ontario and western provinces.

Due to the absence of any major congestion hotspots of significance outside of the GTHA boundaries, trucks leaving or entering GTHA have mostly unimpeded access to most trade gateways.

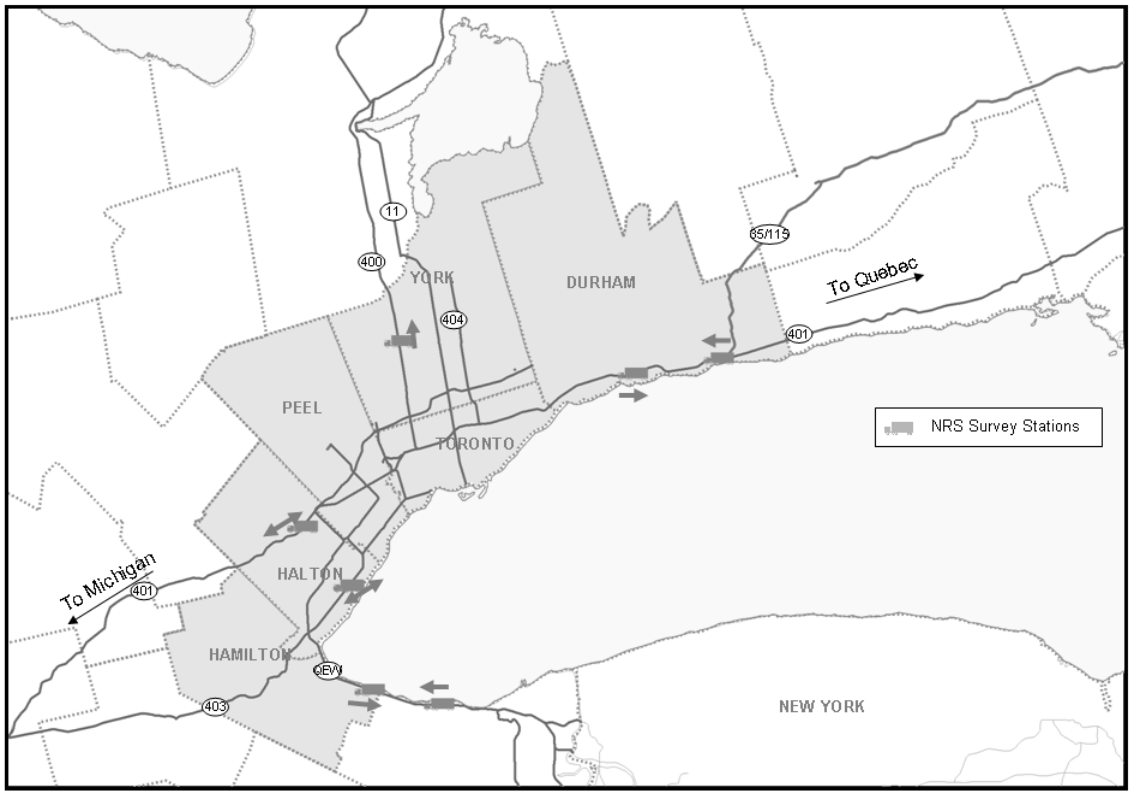

Figure 1: Study Area and NRS Survey Sites

3 Data Sources

3.1 National Roadside Survey/Commercial Vehicle Survey Data

The 2006 National Roadside Survey collected more than 104,000 surveys between Fall 2005 and Fall 2007 across Canada, of which about 80,000 were collected in Ontario representing 647,000 weekly trips across the province. Surveys were conducted at 104 roadside locations on major truck routes and international border crossings across Ontario. An improvement made to the software in 2006 was to integrate MapPoint routing application into the survey software to verify address of various trip-stop data collected in the survey. Even though the 2001 CVS attempted to collect address level data for trip-stops, due to software limitations, valid addresses were obtained for only a fraction of the surveys. Integrating MapPoint into the survey software in the latest survey enabled the surveyors to verify the accuracy and the routes with truck drivers during the

survey. This approach produced high quality sub-municipal level trip and commodity origin and destination data.

In order to study the temporal distribution of commercial vehicles, it was imperative that the surveys sample would be representative of the intercity truck traffic at various times of the day within the study area. Therefore, only 36,200 surveys collected from nine directional sites in the study area, as shown in Figure 1, were used for this study. All these sites have travel time less than two hours of the central area of the study region during peak periods. Since most survey sites are at the peripheries of the region, intra-GTHA trips would be under represented in the sample. For consistency, all trips with both origin and destination within the GTHA were excluded from the study.

3.2 GPS Data

The GPS data used in this study is component of the larger database of acquired by MTO as part of the on going layering of freight data collection undertaken by the ministry. The vendor operates more than 10,000 GPS units on trucks across North America that are used by fleet management companies to monitor the operations of their vehicles.

These units simply record the position of the vehicle and other engine related data at intervals of less than a minute and stores in the unit's memory. The vendor uses two ways to download the data form the units. The first is to use Bluetooth enabled cell phones to transmit the data frequently so that the operator will have access to the data on real time basis. The other options is to automatically download the data when the truck passes a "base" station, through a Bluetooth connection, installed at selected locations and transmitted to the vendor through the internet. In either case, there is no vehicle operator interaction is required to operate these units. Due to the finer nature of the positional data collected by these units, and very high sampling rate at most urban locations, performance measures could be developed for road segments as small as few hundred meters long.

The GPS polling data used for this study was collected from more than 4000 trucks over a three-month period between August and October 2008. The sample contains more than 4 million polls on all freeway segments across the study area major arterials in Toronto, Durham, Peel and York Regions. Even though there was no gap in data collection activity, some arterials segments had limited coverage during afterhours due to reduced commercial vehicle movement from our vendor's sample.

4 Trip Patterns

As shown in Figure 2, 310,000 truck trips cross the study area boundaries every week. About 85% of these trips have at least on trip-end inside the region. In addition to these trips, there are significant numbers of light and medium commercial vehicle trips made within the study area. Because vehicles with less than 4,500 kilograms are not part of the CVS and insufficient coverage of other intra-GTHA trucks, all trips made within the GTHA area are not within the scope of this paper.

There are three automobile manufacturing facilities, several truck-rail intermodal facilities and an international airport located within the study area. Moreover, about 65% of the trips crossing the study area boundaries use the Highway 401 corridor to access the area. Trade between Ontario and two largest trading partners, Quebec and Michigan, travel on this corridor.

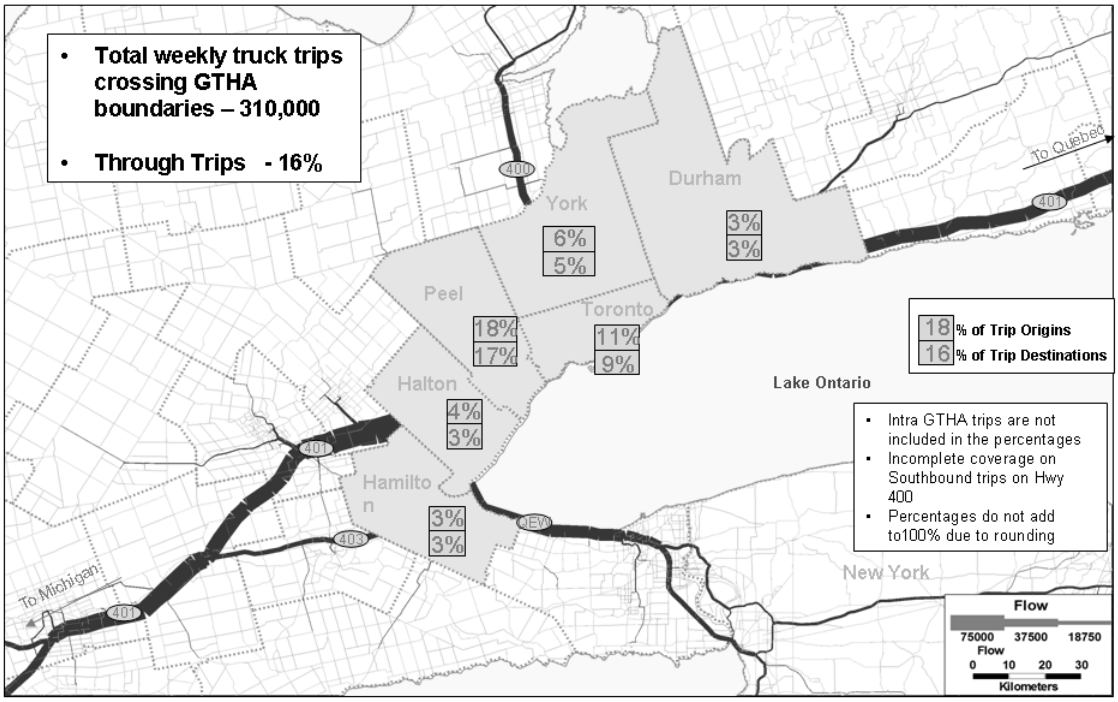

Figure 2: Weekly Trip Distribution

Regional Breakdown

More than 50% of the trips related to the study area have either origin or destination in Peel or Toronto, with Peel receiving 35% of the total trips. Especially, cities of Mississauga and Brampton are the core of the trucking activity in this region. On average, Peel Region has a trip density of 197 trips per sq. km every week compared to only 31 trips per sq. km for the whole region. The area covering about 7 km radius centered on Pearson International Airport in northern Mississauga and parts of Brampton are exclusively industrial with some residential zones on its peripheries. Peel is also the home of a large intermodal terminal, and a Chrysler automobile manufacturing facility located in Brampton in the northern end of this industrial zone. As shown in Figure 3, this area is bounded by Highways 410, 427 and 410. Even though Highways 427 and 410 provide high-order north-south access to this area, there is no such east-west connection through Brampton.

Despite large trucking activity related to Peel Region. The only municipal roads showing heightened truck volumes are around the airport. Truck traffic destined to Brampton, which is further away from Hwy. 401, use Highways 410 and 427 and enter the municipal roads to reach large manufacturing and distribution centres. Congestion on Hwy 401 also plays a role in determining which access trucks take to reach Brampton.

Even though the industrial corridor along the Airport Road in Brampton is reasonably closer to Highway 427, the majority of the traffic to/from the west uses Hwy. 410, because of Hwy. 401 congestion throughout the day between Hwy. 410 and Hwy. 427. Lack of east-west freeway corridor in Brampton puts tremendous stress on the municipal system. This can be clearly seen in Figure 3 through the heavy volume on Regional Road 7 in Brampton. This former Hwy. 7 is now a municipal road that runs parallel to Hwy. 401 through Brampton and York Region. The segment between Hwy. 410 and Hwy. 404 runs through major truck nodes and acts as the main feeder of truck traffic from freeways. Employment of Peel Region is expected to grow by 65% between 2001 and 2031 and York Region by 200% in the same period (4). As freeways reach their capacity, these growth rates will put increasing pressure on the municipal infrastructure.

Next to Peel, Toronto is the second largest destination of trucks within the study area. Despite being the largest city in Canada, Toronto receives less than 20% of the intercity trucking activity. Unlike Peel Region with relatively high truck-trip generation rates per capita, Toronto's service sector generates and attracts only a fraction of freight activity of the region. Most freight related nodes are located along the freeway corridors that require very little activity on municipal roads. Municipal expressways, Don Valley Parkway (DVP) and Fredrick G. Gardiner Expressway (FGGE), connect Hwy. 427 and Hwy. 401 through downtown Toronto. These are mostly commuter access routes that also serve light commercial activity supporting the service sector in the downtown area.

Through Traffic

The GTHA is in the middle of the largest trade corridor in Canada. About 16% of the trips entering GTHA boundaries are through trips with no trip-ends within the region. All Quebec trips travelling to Western New York, Michigan and other western states use Highway 401 to reach the Niagara and the Windsor/Sarnia gateways. These trips make 24% of the trucks travelling through the area. There are also another 2,000 trips between United States origins and destinations travel through the region.

5 Temporal Distribution

Traffic Patterns

Figures 4 and 5 show sample traffic patterns of freeway and arterial segments. It can be clearly seen that auto and truck traffic have entirely different patterns throughout the day. While, in most cases, auto volumes peak during commuter peak hours, the truck volumes reach the maximum during the mid day at around 12:00 noon. This pattern is consistent for both arterials and freeways.

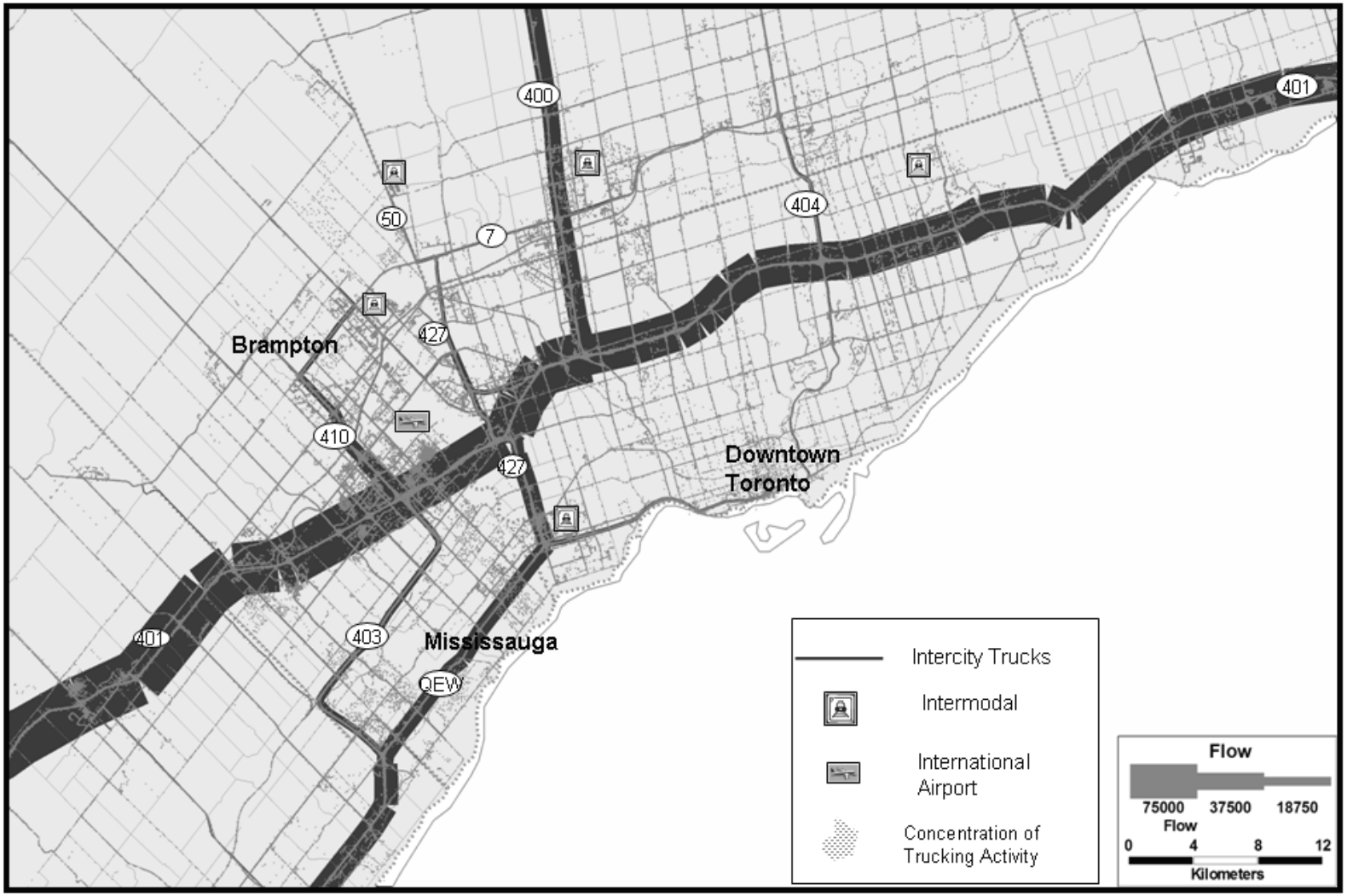

Figure 3: Weekly Intercity Truck Volumes

One difference between these two categories is that, truck traffic on freeways does not begin to pick up until the end of the morning peak period and the volume in the afternoon peak is almost twice as high as the morning peak. There is a surge of activity between 10:00 a.m. and 3:00 p.m. On arterials, on the other hand, the truck activities increase at the same pace as the auto traffic in the morning peak, but the decline begins around the same time as freeways.

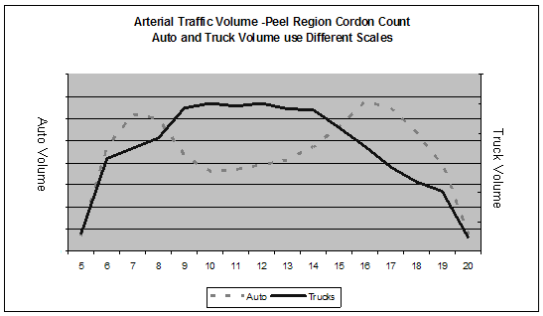

Figure 5: Example of Arterial Traffic Pattern

The rapid decline seen in arterials at the end of the afternoon peak is not evident on freeways. At the end of the business day, there would be very little intra-urban commercial activity, which explains the rapid decline of commercial movement on arterials. Even after the end of the business day, intercity truck movement continues on freeways, maintaining higher volumes. The lowest volume on freeways is observed just before the beginning of the morning peak. The auto volumes are also the lowest at this time.

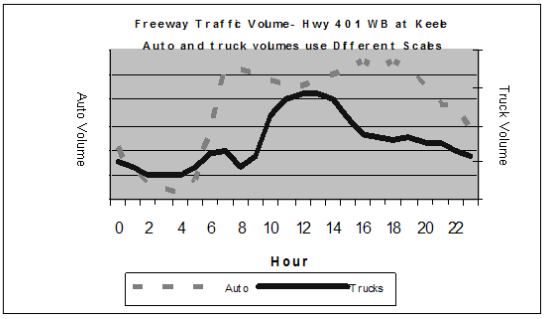

Figure 4: Example of Freeway Traffic Pattern

Intercity Trucks

The analysis of surveys only from the NRS survey sites in and around the study area made it possible to look at temporal distribution of trucks at different times of the day. On an average weekday, approximately 1,100 trucks enter or leave the study area every hour. Corresponding to general traffic patterns, trucks crossing the boundaries are also lower during the peak hours than the mid-day period. The mid-day trip rates are almost twice as high as the peak periods.

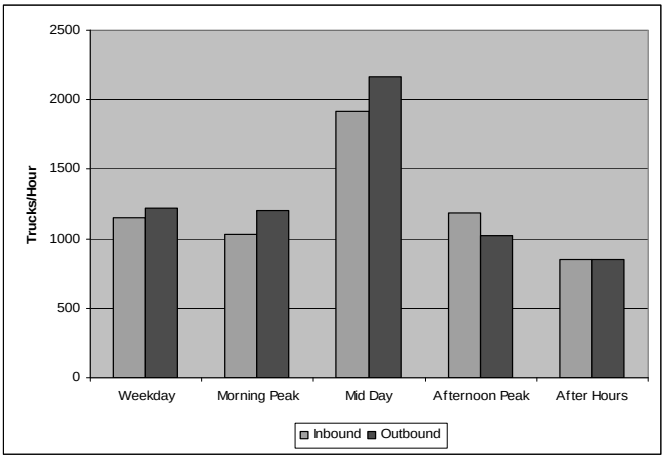

Figure 6: Distribution of Intercity Trucks by Time of Day

The direction of flow also appears to be different through out the day. There is a net outbound traffic until the afternoon peak and flow reverses until the next morning. Most trucks leave their bases during the day to

make deliveries or pickups during normal business hours and return to their bases at the end of the day. This explains the disparity in directional flows at different times of the day.

There are also differences in the proportion of trips with trip-ends in the study area and through trips. During morning peak and mid-day periods, more trips cross the study area boundaries with one trip-end within the area than the other periods. As seen in the traffic distribution, there are very few trucks on the road immediately prior to the morning peak period. Therefore, one may conclude that most trips during the morning peak have originated in the study area, resulting in net outbound trips in the morning. These ratios also support the inbound and outbound comparison shown in Figure 6.

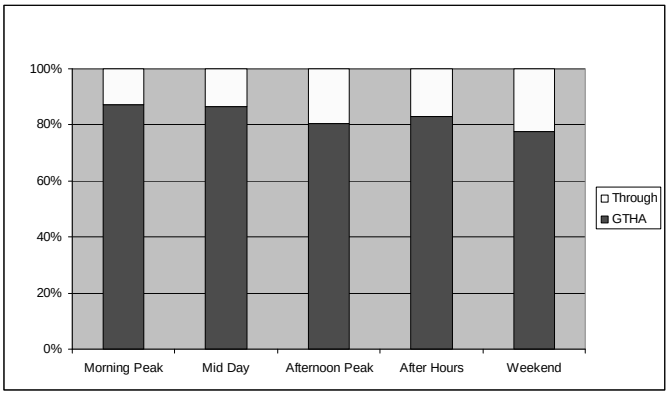

Figure 7: Comparison of Through Trips and GTAH Trip-Ends

Trucks travel on weekends, late evening and night times are usually long distance in nature. Due to the absence of regular business activities, the proportions of through trips are larger at these times. There were 86,400 trips with travel distance of 500 km or more enter/leave the study area weekly. Of this, 38,600 were observed after 7:00p.m and on weekends. More than 14,000 of the long distance (>500 km) trips are through trips with 60% of them travelling during late evenings and weekends. This is a clear indication of longer distance trips avoiding the GTHA congestion whether they have trip-ends within the study area or travelling elsewhere through the study area.

6 Performance Measures

The Ontario-Quebec Continental Gateway Network Performance Study (3) found that, on average, trucks spend additional 10%-12% of time to travel during the morning peak period on the Highway 401 corridor between Quebec and Windsor, Ontario. Once these trucks enter the municipal system, there would be additional delays, depending on the time of day. As about 86% of the trips crossing the study area boundaries have at least one trip-end within the study area, delays faced by these trucks on municipal roads could affect their trip times significantly.

During the morning peak period, severely congested segments are mostly freeway segments with high commuter traffic. There are bottlenecks on the freeway system leading into central and downtown Toronto that suffer degradation in speed by more than 40%. All trucks entering the study area would also encounter this congestion. However, as seen in Figures 8 and 9, they would not face any widespread speed related issues once they enter the municipal system. The municipal roads around the airport, which have the highest concentration of trucking activity, experiences 20%-40% reduction in speed

compared to the free flow conditions. As these arterials are not on major commuter access routes, and the truck activity does not reach peak levels during morning peak, these speed reductions could be a reflection of “normal” conditions experienced by trucks throughout the day on these truck dominated segments.

During the afternoon peak, there is more congestion on roads due to elevated truck and passenger movements, including non-commuter trips. The hotspots are on major commuter routes, but in the opposite direction of the morning congestion. Again, truck concentrated areas near the Pearson International Airport show only slightly higher level of performance degradation than morning peak, indicating that the commuter activity does not affect the performance of this area significantly.

7 Conclusions

This study focused on the nature of intercity truck trips in the urban context. The 2006 Commercial Vehicle Survey data and the GPS probe data provided useful information about the urban component of the truck travel characteristics. While the CVS data provided detailed origin-destination patterns and temporal distribution of trucks entering and leaving the study area, the GPS data was used to evaluate the performance of the road system that serve these trucks and commuters.

It was found that the trucking activity is mainly concentrated in certain areas of GTHA and there is no significant conflict between intercity trucking and commuter movements on urban roads. It was also found that more 90% of the vehicle kilometres of non-through trips were spent on the provincial highway system. This is a strong indication of intercity trips not penetrating deeply into the municipal infrastructure.

The Peel Region accounts for almost 35% of the intercity trips in the study area. Cities of Mississauga and Brampton, while occupying only 7% of the area of the GTHA, account for almost all of these trips. Due to convenient access to the freeway system, commuters and trucks are mostly separated on the municipal infrastructure. However, on freeways, especially on Highway 401, the commuter traffic poses significant impediment to truck traffic.

As population and employment in GTHA is expected to grow by 50% between 2001 and 2031(4), it has become increasingly urgent to face traffic issues that will significantly affect the economic growth and prosperity of the province. In order to address these issues, Ontario has developed a Growth Plan for the Greater Golden Horseshoe Area that covers GTHA and the surrounding areas through the Places to Grow Act.

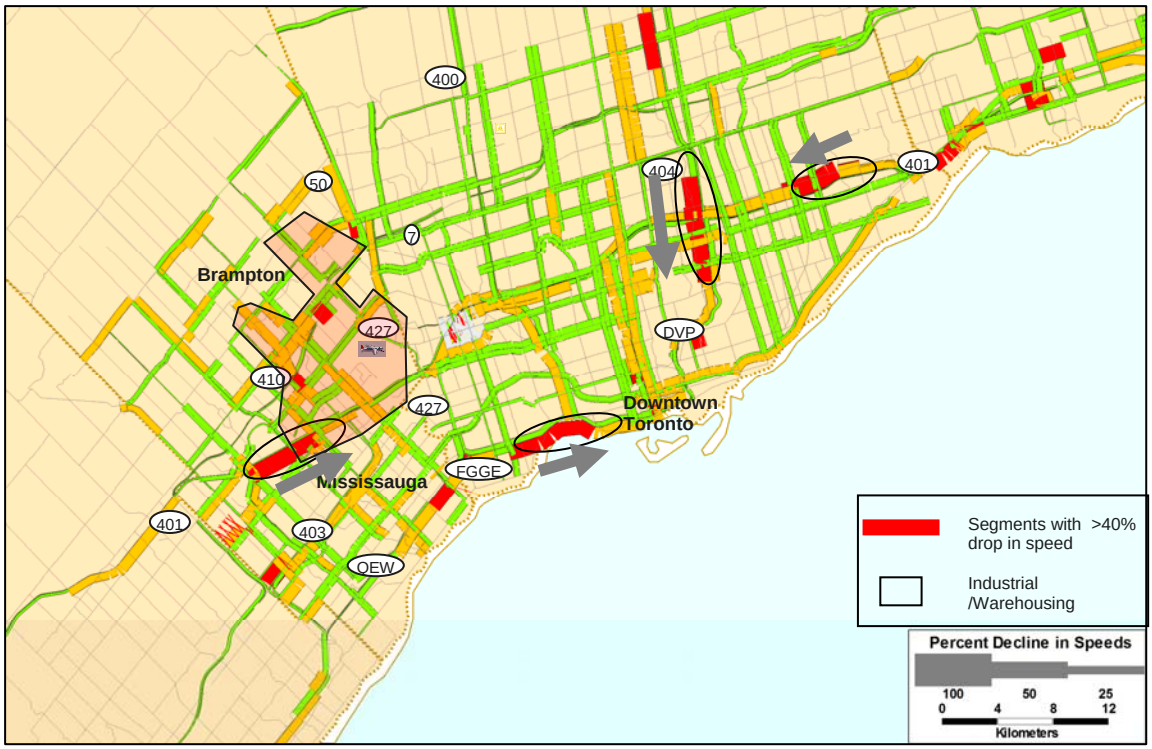

Figure 8: Percentage Decline in Speed During Morning Peak

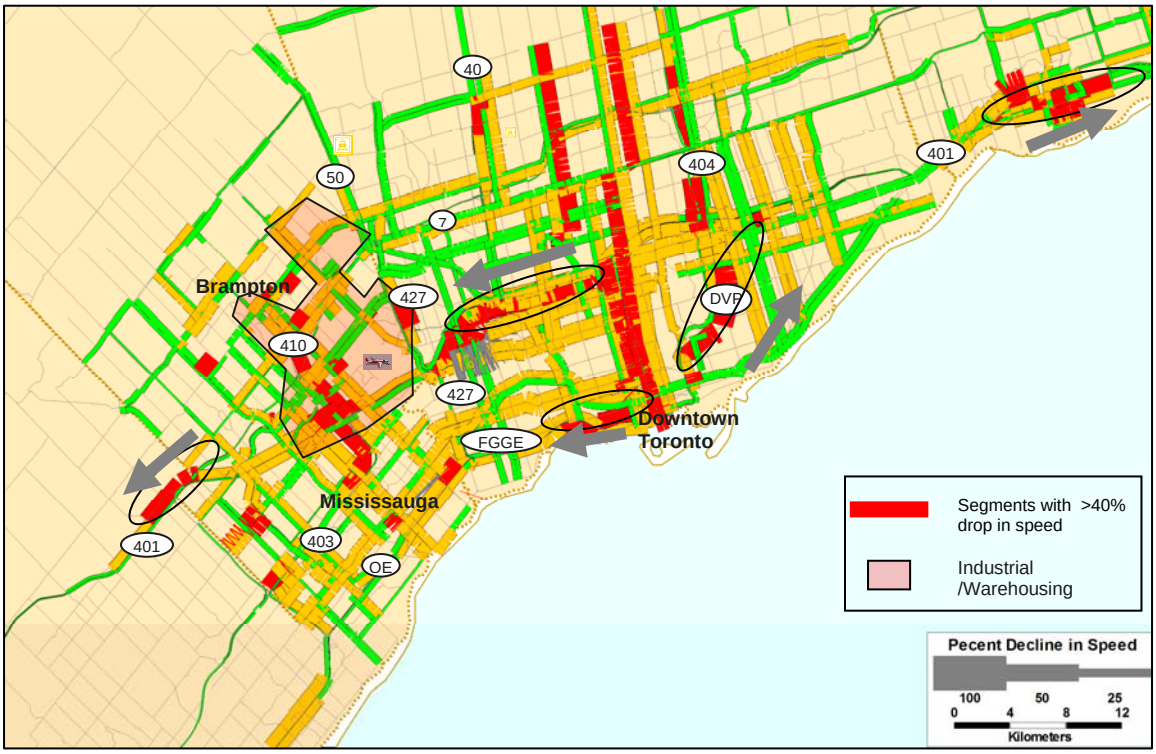

Figure 9: Percentage Decline in Speed During Afternoon Peak

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