APPENDIX 3

TRANSPORTATION MODEL UPDATE REPORT

City of Brantford Transportation Master Plan Update

Transportation Model Update Report

Submitted to City of Brantford
by IBI Group

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1. Introduction

IBI Group has been retained by the City of Brantford to update the Transportation Master Plan (TMP). The update provides the opportunity to review, reconfirm and/or change the plans laid out by the 2007 TMP, based on addressing issues related to the changing economy, regional transportation context, public priorities, and traffic management and calming measures. A key component to updating the 2007 TMP is the ability to forecast future conditions and answer the "what if" questions related to accommodating population and employment growth, constructing new transportation facilities, and implementing new policies that influence travel behaviour. Many of the quantitative answers to these types of questions are based upon a transportation model. To move forth with the 2013 TMP update, the transportation model was updated as follows:

- A 2011 base year, incorporating the most recent population and employment forecasts, traffic counts and transit ridership data;
- A new road layer with higher-resolution GIS data to allow better mapping and road and transit representation;
- A new auto assignment algorithm with a faster and more accurate origin-based user-equilibrium method;
- Developed a new transit model component that reflects 2011 transit operations data; and,
- A range of model network or parameter adjustments to improve base-year validation and refine future-year forecasts.

1.1 Background

The last update of the City's Transportation Master Plan took place in 2007. Due to the unavailability of 2006 Transportation Tomorrow Survey (TTS) data at the time, the recommendations were based on future travel patterns and traffic that were forecasted using the 1995 Household Travel Survey data (completed in 1997 as part of the Brantford Transportation Study) and the 2001 Census Place-of-Residence/Place-of-Work data. Although 2001 TTS data was available, the survey's data did not cover Brant County or the City of Brantford. The transportation model at the time was also limited to the p.m. peak hour due to the availability of travel data. This period was judged to be the critical scenario, however.

In 2010, the City of Brantford's transportation model was updated to reflect 2006 TTS data that included Brant County and the City of Brantford. The transportation model was expanded to include the ability to forecast both a.m. and p.m. peak hour traffic, and better characterize traffic for Brant County. These enhancements allowed for a more precise characterization of travel patterns in Brant County. For the 2013 TMP update, travel demand characteristics from the 2010 model were carried forward as described herein. TTS data for 2011 is currently being assembled and planned for release at the end of 2013. As a result, this model update utilizes 2006 TTS data.

1.2 Model Update Overview

The transportation model consists of a 4-stage model (trip generation, trip distribution, mode choice and trip assignment) developed in TransCAD and covering the geographic limits of Brant County. This report describes the model update process related to the model's 4-stage process. A new intersection operation model was developed in Synchro as part of this update. Growth factors developed from TransCAD will be used in this model to forecast intersection operations in the alternatives evaluation for the 2013 TMP update. Exhibit 1-1 and Exhibit 1-2 schematically illustrate the transportation model framework and area coverage, respectively.

Exhibit 1-1: Transportation Model Framework

Transportation Model

Travel Demand Forecasting (TransCAD)

Trip Generation	• Trip rates were developed using 2006 TTS, Census, and Wilfred Laurier and Nipissing University's enrolment data • Population and employment forecasts are used as inputs • Peak period trips are determined at this step
Trip Distribution	• Fratar method is applied to seed matrices (developed using 2006 TTS, Census and Wilfred Laurier and Nipissing University's enrolment data) to determine origin-destination matrices for the peak periods of the horizon year
Mode Choice	• Policy-based (auto driver, transit) approach is used • Mode-shares were developed using 2006 TTS and 2011 Transit Service Review data • Trip assignment matrices are determined after this step using the mode-shares and peak hour factors (derived from 2006 TTS and traffic count data)

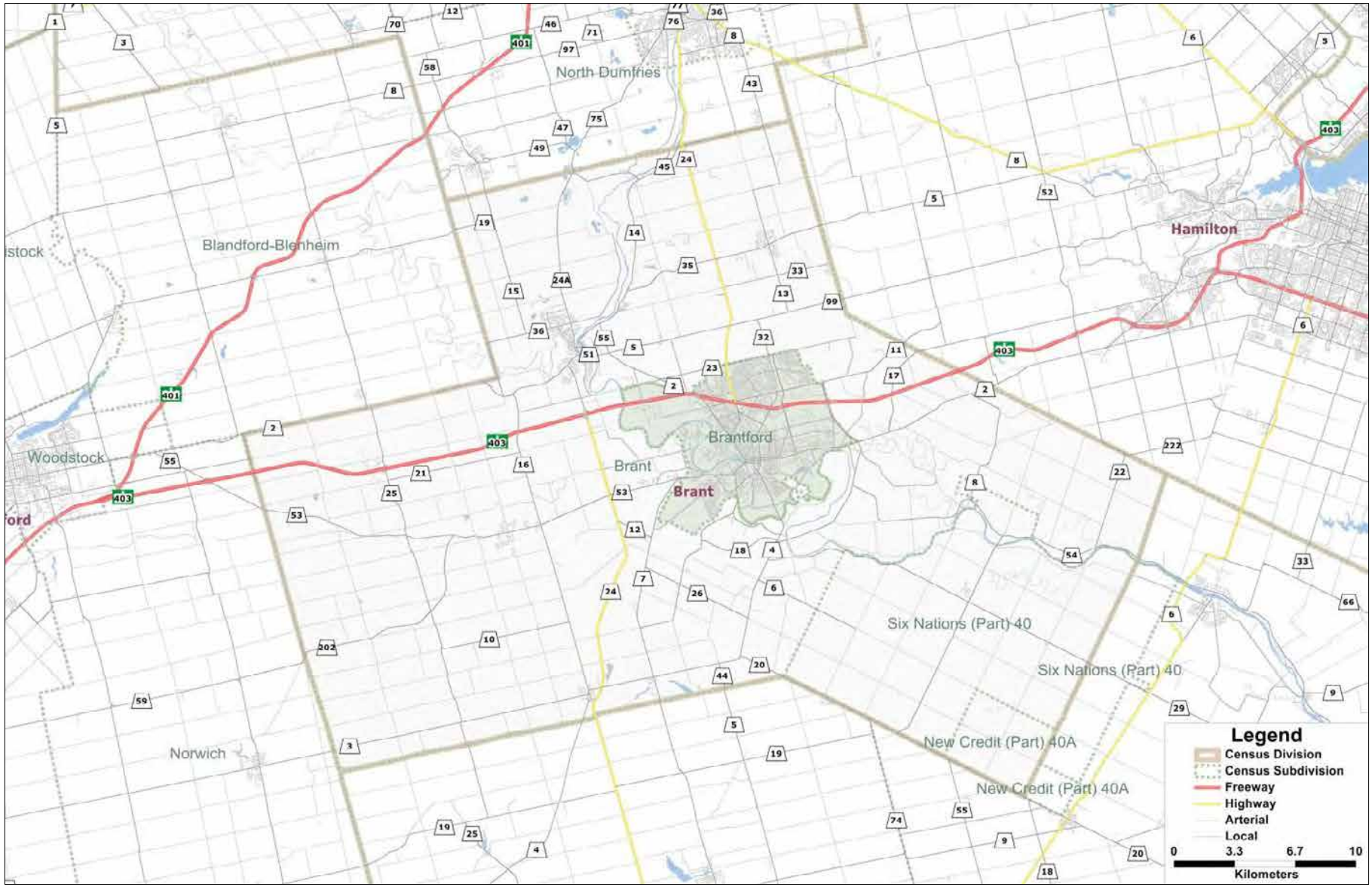
Traffic Forecasting (TransCAD)

Auto Trip Assignment	• Road network is a subset of new GIS road layer that covers that same extents as the 2010 model update • Origin-based user-equilibrium algorithm is used to allow for faster computation and reduction in spurious and inexplicable assignment effects • This step produces peak hour (a.m. and p.m.) forecasts for the road network
Transit Trip Assignment	• Transit network was developed based on 2011 Transit Service Review • Model simulates weekday peak period travel • Pathfinder algorithm is used • This step produces peak period forecasts (6 a.m. – 9 a.m., 3 p.m. – 6 p.m.)

Intersection Operation Model (Synchro)

Lanes	Signals	Stop	Roundabout

Exhibit 1-2: Road Network Coverage (shaded area labelled "Brant")



2. Model Update Process

The main motivation to update the transportation model was the availability of new information such as the observed changes between 2006 and 2011 population and employment data for the City of Brantford and Brant County. The base year of the model was accordingly updated to 2011 from 2006, which was the base year used in the 2010 model (see *Transportation Model Update Model Development & Calibration Final Report*, June 2010). The sections below describe the model was updated to reflect the recent population and employment data, traffic counts and transit ridership data.

2.1 Demographic Changes for the Base Year

Population and employment data used as input into the model were gathered as follows:

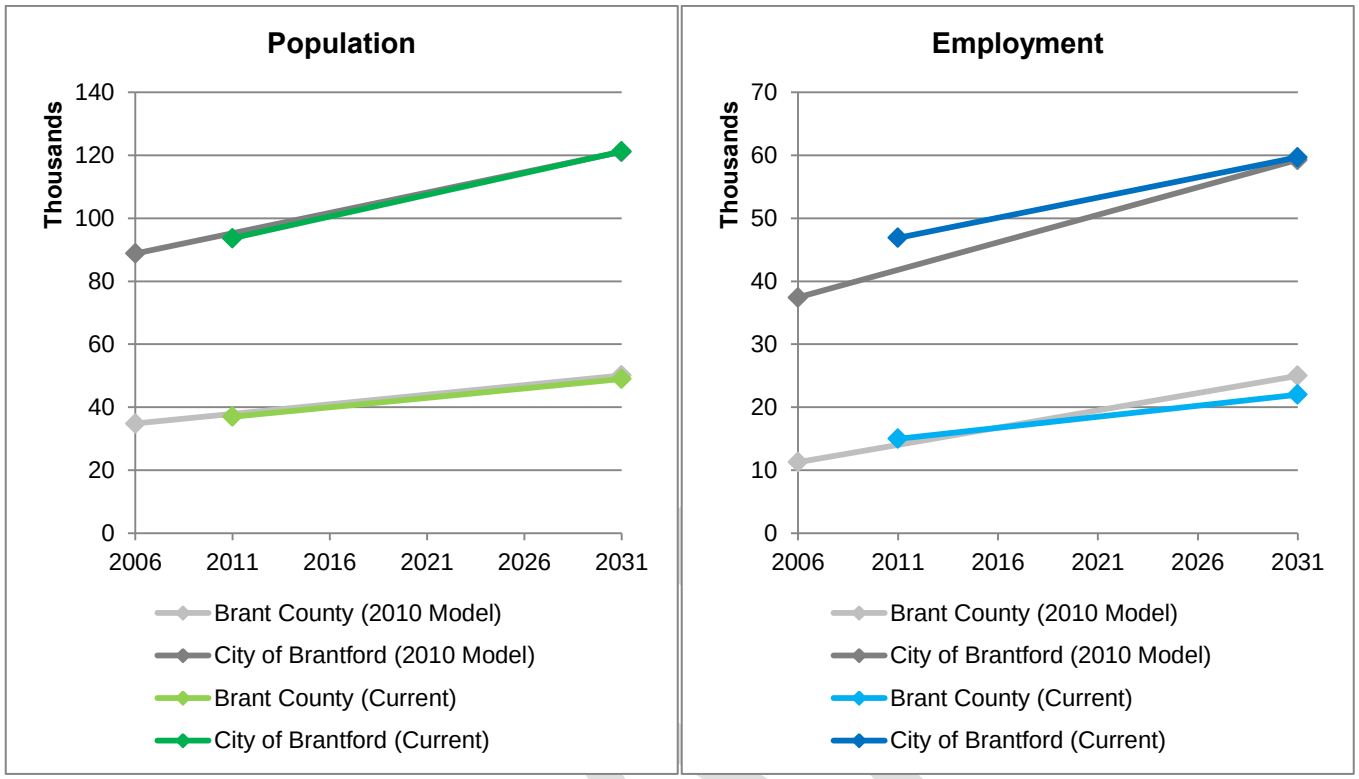
- The City of Brantford provided data for 2006 TTS traffic zones 3501-3549; and,
- Places to Grow Amendment 2 was referenced for Brant County population and employment then disaggregated to 2006 TTS traffic zones 3550-3560 according to population and employment data from the 2010 model update.

Exhibit 2-1 illustrates population and employment data for 2006 and 2011, as well as forecasts for 2031 gathered from the City of Brantford and Places to Grow Amendment 2. The following trends were observed:

- Between 2006 and 2011, population has grown by 5.5% (~4,900 persons) for the City of Brantford and 6.3% (~2,200 persons) for the rest of Brant County; employment has grown by 25.3% (~9,500 jobs) for the City of Brantford and 33.1% (~3,700 jobs) and for the rest of Brant County; and,
- Comparing the updated population data with the data used in the 2010 model shows a similar growth trend;
- Comparing the updated employment data with the data used in the 2010 model shows a slower growth trend.

Population and employment data from 2011 were carried into the model's trip generation step.

Exhibit 2-1: Comparison of Population and Employment Data



2.1 Zone System

The traffic zone system used in the 2006 TTS is coarse for Brant County and the City of Brantford, i.e. the zones are very large and do not distinguish sub-area land uses well. A model zone system was developed for the transportation model to better represent land use. The 51 traffic zones representing Brant County were disaggregated into 398 model zones: 337 zones represent the City of Brantford; 46 zones represent Brant County; and 15 zones are designated for external trips (into and out of Brant County). Exhibit 2-2 shows the correspondence between 2006 TTS traffic zones and model zones. Exhibit 2-3 (a) and (b) illustrate the zone system.

Exhibit 2-2: 2006 TTS Traffic Zone and Model Zone Correspondence

Area	2006 TTS Traffic Zone	Model Zone (Number of Zones)
City Of Brantford		
City Boundary	3501-3549	100-4906
Brant County (Excluding City of Brantford)		
Potential City of Brantford Expansion, East Growth Area	3550 (part)	5000-5100
Potential City of Brantford Expansion, Northeast Growth Area	3550 (part)	5200-5700
Potential City of Brantford Expansion, Northwest Growth Area	3550 (part)	5800-6000
Rural Brant County (outside of expansion area)	3550 (part)	7000
Rest of Brant County	3550 (rest)	7900-9300
South Paris	3551	7100
Burford	3553	9400-9700
Oakland	3554	9800
Onondaga	3555	10000
Six Nations (Part 4)	3556	9900, 10100
New Credit Six Nations	3559	10200
North Paris	3560 (part)	7200-7300
North Brant (rural and St George)	3560 (part)	7400-7800
External Zones		
Oxford County Regional Municipality of Haldimand-Norfolk Regional Municipality of Waterloo Regional Municipality of Hamilton-Wentworth	-	20000-21400

Exhibit 2-3a: Model Zone System, Full Coverage

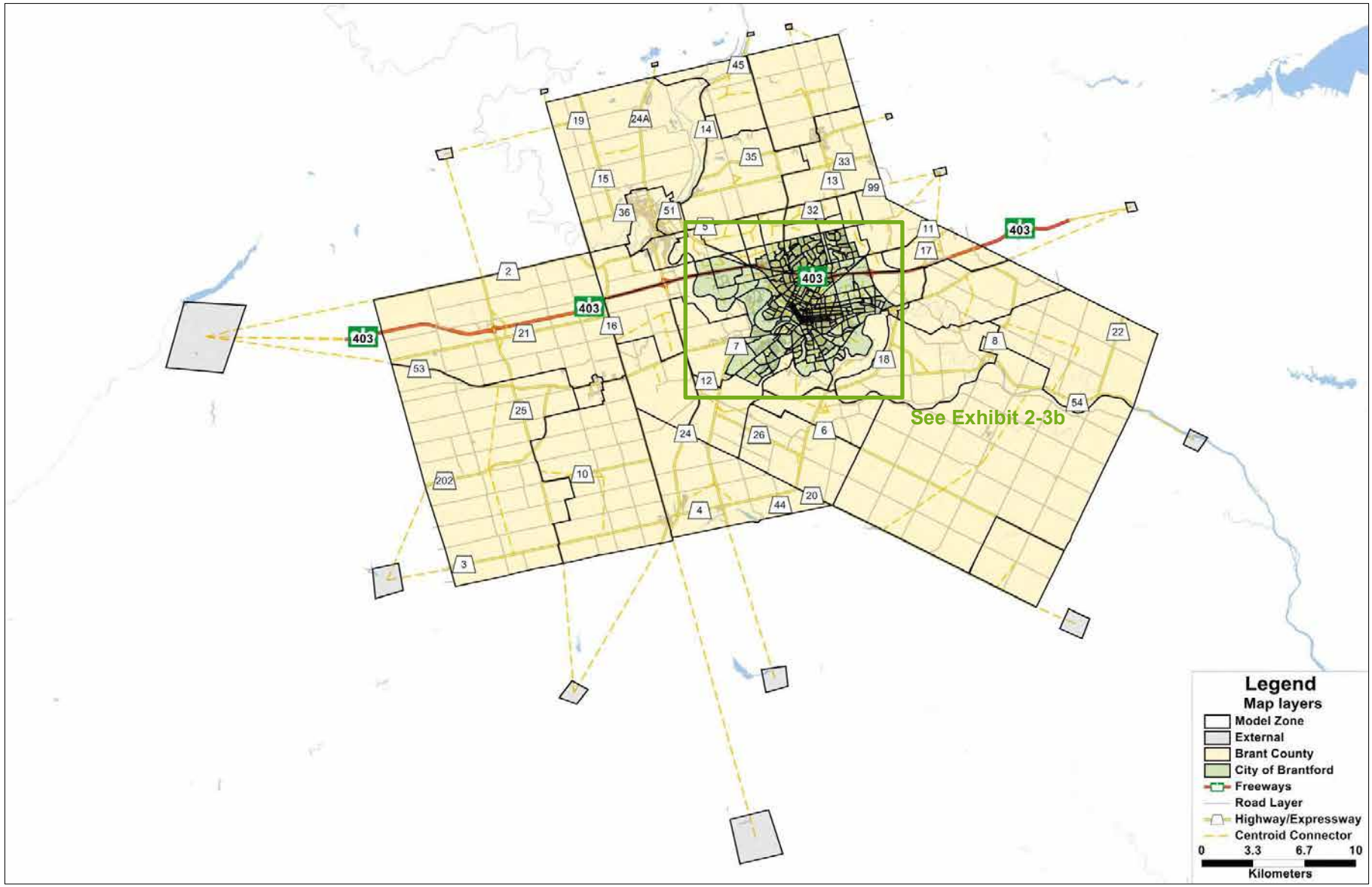
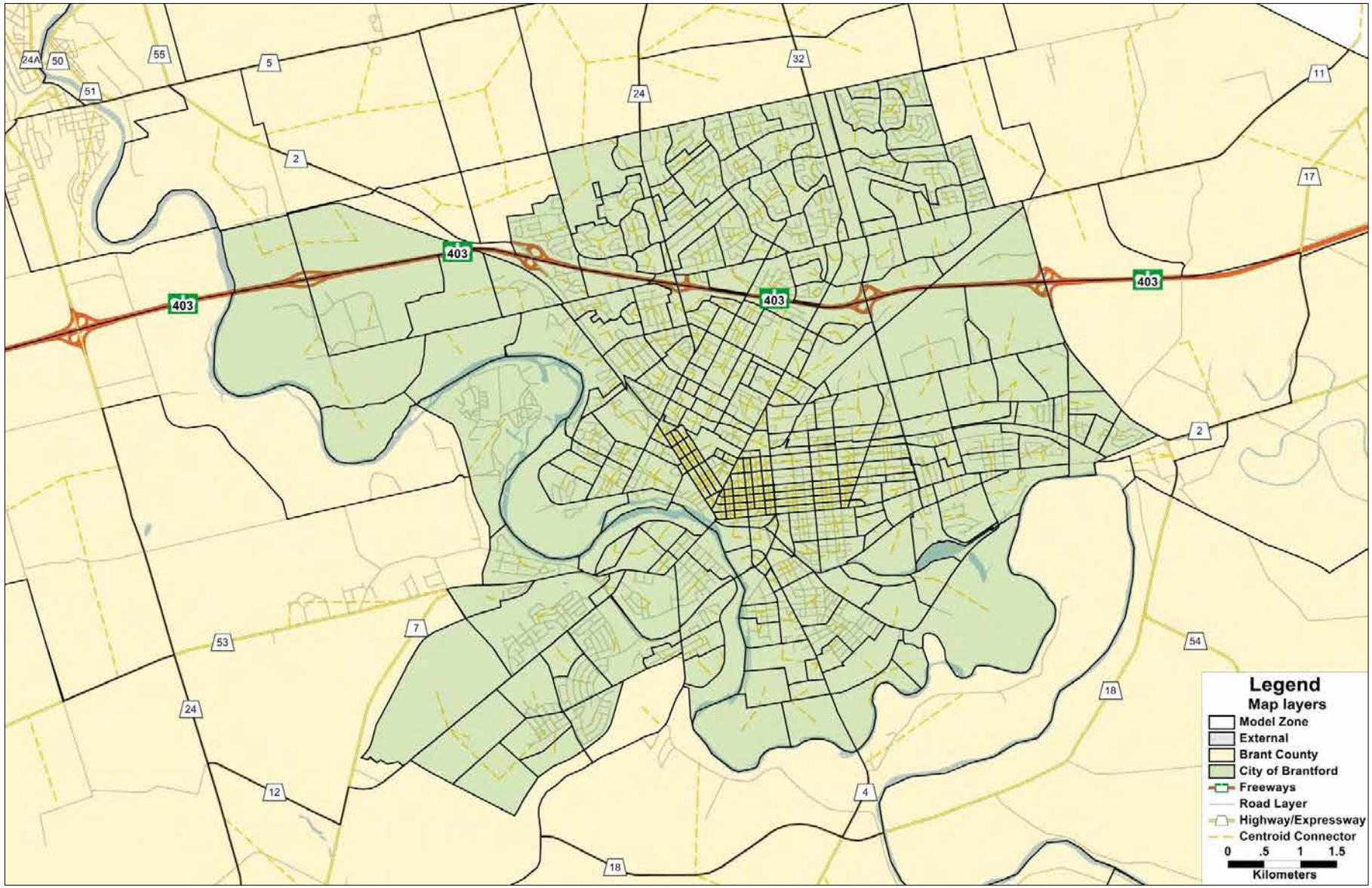


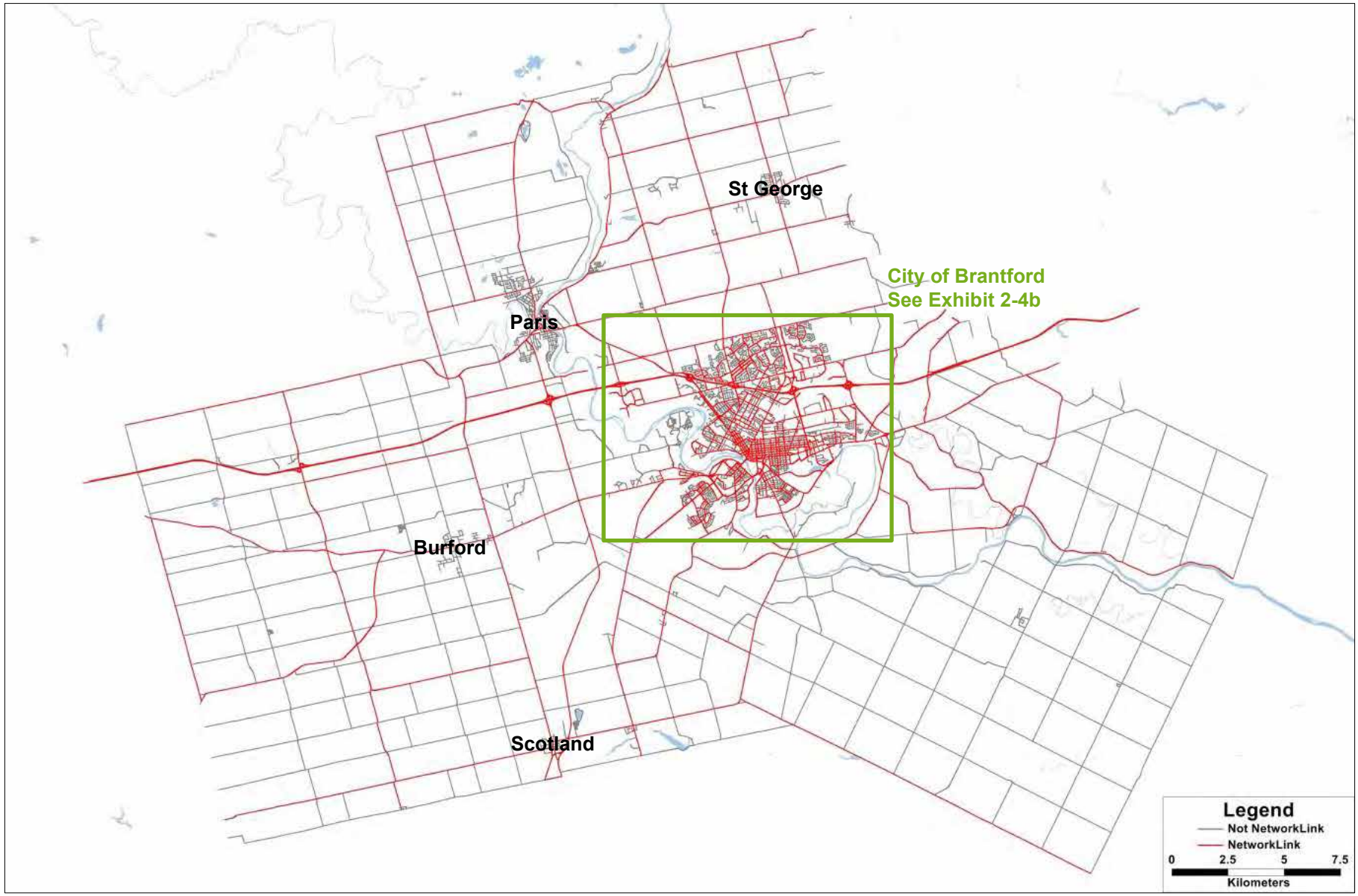
Exhibit 2.3b: Model Zone System, City of Brantford



2.1 Road Network

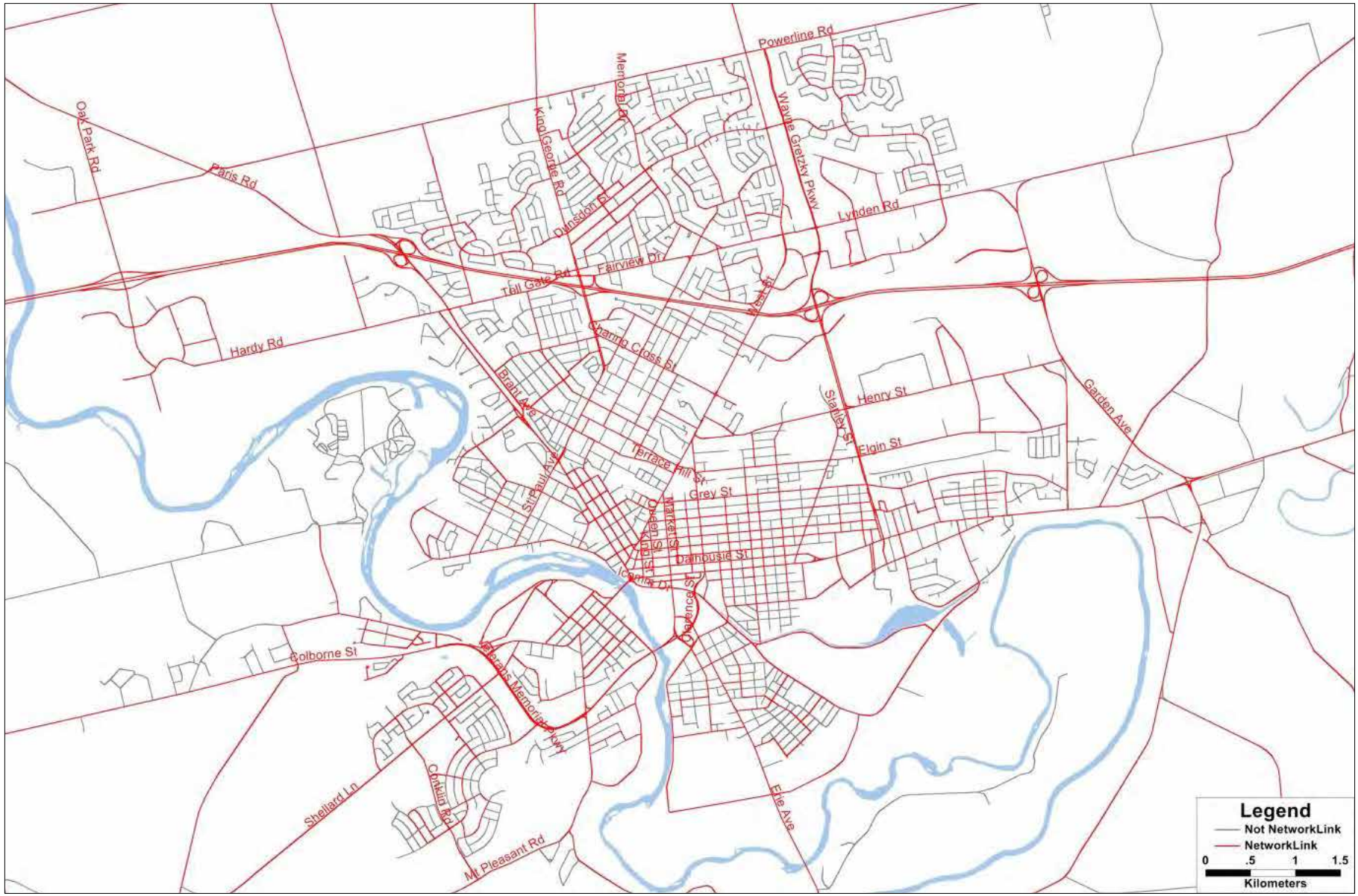
For this model update, the road network was replaced with a new higher-resolution road layer sourced from Caliper Corporation's GIS data. The new road network covers the same area and zone system as the 2010 model, but includes local roads and other municipal roads not in the prior model. The new road layer offers several enhancements to the model. First, the additional local roads can be enabled or disabled and used in assignments. This ability is needed to model existing and proposed transit routes which use some of the local roads. It also provides flexibility to model sub-areas in the future if additional model zones are developed or new roads become major route choices for travellers. The new road layer is also at a higher overall level of resolution, and includes better representation of ramps, curvature of roads, and multi-lane roads. Exhibit 2-4 (a) and (b) illustrate the model's updated road network.

Exhibit 2-4a: Model Road Network, Full Coverage



Red elements indicate roads that were enabled to model private auto and transit traffic.

Exhibit 2.4b: Model Road Network Coverage, City of Brantford



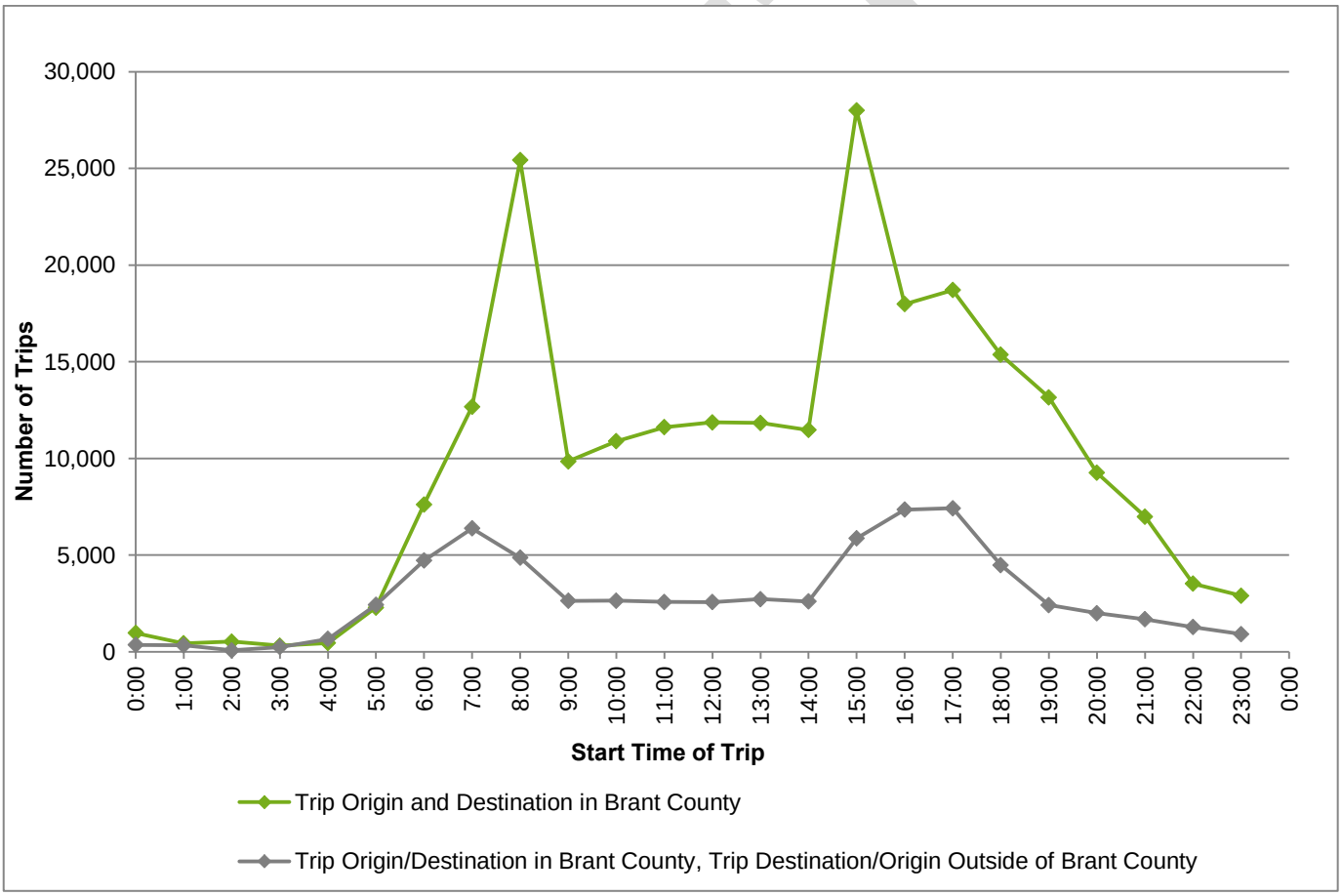
Red elements indicate roads that were enabled to model private auto and transit traffic.

2.2 Trip Generation

Trip generation rates were carried forward from the 2010 model in this update since the travel survey data (TTS 2006) upon which these rates were calibrated has not changed. The trip generation rates reflect 4 trip purposes – home-based work (HBW), home-based school (HBS), non-home-based (NHB) and home-based other (HBO).

Trip totals by trip purpose are determined from population and employment data. They also reflect 2 peak periods, which were identified from the trip start-time distribution for Brant County (including the City of Brantford), as shown in Exhibit 2-5. Accordingly, the peak period timeframes selected to determine the trip generation rates were 6 a.m. – 8:59 a.m. and 3 p.m. – 5:59 p.m.

Exhibit 2-5: Daily Trip Start-time Distribution for Brant County (includes City of Brantford)



Source: 2006 TTS

A summary of the process used in the 2010 model follows:

- Linear regression was used to develop trip rates for the 4 trip purposes (HBW, HBS, NHB, HBO) based on 2006 TTS and Census Place-of-Work/Place-of-Residence data. Explanatory variables included population and employment data, labour force data, and sub-categories of the population and employment

data (population involved persons that work in sales and services, professional and manufacturing work; employment involved work related to office, professional, sales and services and manufacturing);

- Adjustments to NHB and HBO trips were made to account for trip under-reporting in the 2006 TTS database;
- While explicit rates for HBS were not determined, adjustment to base year HBS trip totals were made to account for the difference in the number of students reported by the 2006 TTS and by Wilfred Laurier University and Nipissing University Brantford Campuses, and incorporated directly into the trip matrices;
- Trips that originate or is destined for external zones were additionally factored by the population and/or employment growth experienced by the external zone; and,
- Generated trips were determined for the 2006 TTS traffic zones then disaggregated into the model zones based on population and employment split factors.

The trip generation equations from the 2010 model give a.m. and p.m. peak period origins and destinations. The equations from the 2010 model are repeated for zones within Brant County (model zones 100-10,200).

A.M. Peak Period (6 a.m. – 9 a.m.)

$$HBO\ Origins = 0.114 \times population$$

$$HBO\ Destinations = 0.051 \times population + 0.117 \times professional\ employment + 0.352 \times sales/service\ employment$$

$$HBW\ Origins = 0.487 \times labour\ force$$

$$HBW\ Destinations = 0.515 \times employment$$

$$NHB\ Origins = 0.025 \times population + 0.06 \times professional\ employment + 0.125 \times sales/service\ employment + 0.09 \times manufacture\ employment$$

$$NHB\ Destinations = 0.0291 \times professional\ population + 0.291 \times professional\ employment + 0.095 \times sales/service\ employment + 0.0212 \times manufacture\ employment$$

P.M. Peak Period (3 p.m. – 6 p.m.)

$$HBO\ Origins = 0.1758 \times population + 1.0148 \times sales/service\ employment$$

$$HBO\ Destinations = 0.2065 \times employment + 1.003 \times sales/service\ population + 0.5074 \times professional\ population$$

$$HBW\ Origins = 0.945 \times office\ employment + 0.57 \times professional\ employment + 0.2 \times sales/service\ employment + 0.47 \times manufacture\ employment$$

$$HBW\ Destinations = 0.45 \times labour\ force$$

$$NHB\ Origins = 0.0064 \times population + 0.3048 \times professional\ employment + 0.8128 \times sales/service\ employment\ t$$

$$NHB\ Destinations = 0.1715 \times sales/service\ population + 0.9855 \times sales/service\ employment$$

For this model update new external trips were extracted from TTS in an effort to improve validation on key externals such as Highway 403 (see Section 3.1). To determine total origins and destinations for external zones, total origins and destinations were extracted from the 2006 TTS database for each peak period and scaled according to the population and/or employment forecasts for the regions they represent. Exhibit 2-6 summarizes the scaling factors used for each trip purpose.

Exhibit 2-6: Scaling Factor for External Zones

Trip Purpose	Scaling Factor
A.M. Peak Period (6 A.M. – 9 A.M.)	
HBO Origin	Population Growth
HBO Destination	Population and Employment Growth
HBW Origin	Population Growth
HBW Destination	Employment Growth
NHB Origin	Population and Employment Growth
NHB Destination	Population and Employment Growth
P.M. Peak Period (3 P.M. – 6 P.M.)	
HBO Origin	Population and Employment Growth
HBO Destination	Population and Employment Growth
HBW Origin	Employment Growth
HBW Destination	Population Growth
NHB Origin	Population and Employment Growth
NHB Destination	Population and Employment Growth

2.3 Trip Distribution

The model uses 2006 TTS and Census Place-of-Work/Place-of-Residence travel patterns (trip matrices) in the trip distribution step; seed matrices were developed from these data sources in the 2010 model. The Fratar method is applied with future trip totals determined from the trip generation step to produce future horizon

trip matrices. Seed matrices for the 4 trip purposes were carried forward from the 2010 model since the travel surveys upon which these matrices were developed has not changed. A summary of the process used in the 2010 model follows:

- Initial travel patterns based on 2006 TTS, Census Place-of-Work/Place-of-Residence data, and traffic counts;
- Represent travel within and out of Brant County (including City of Brantford) traffic zones to the surrounding regions (Oxford County, Regional Municipality of Haldimand-Norfolk, Regional Municipality of Waterloo, Regional Municipality of Hamilton-Wentworth);
- Disaggregated to model zones according to population and employment split factors – population split factors were developed using 2006 Census population and dwelling counts at the dissemination block level aggregated to the model zone system; employment split factors were carried forward from the 2007 TMP;
- Incorporate the difference in the reported number of students by adjusting origin-destination pairs for model zones in the City of Brantford's downtown core to account for students living in residence and other model zones to reflect the remainder that did not live downtown based on TTS distributions; and,
- Determined external-through trips, i.e. trips that do not originate and end within Brant County (including City of Brantford), using traffic counts.

Since travel patterns reflect 2006 TTS data, "synthetic" trip matrices for the 2011 base year were developed using the Fratar method on the seed matrices, and 2011 population and employment data. This method represents the most up-to-date data available. Accordingly, the updated base year matrices were carried forward to validate the transportation model for the 2011 base year.

A number of adjustments were made to the eastern external zone connecting to Highway 403 to calibrate the model, as explained in Section 3.1.

A summary of private auto travel patterns is given in Section 3.2.

2.4 Mode Choice

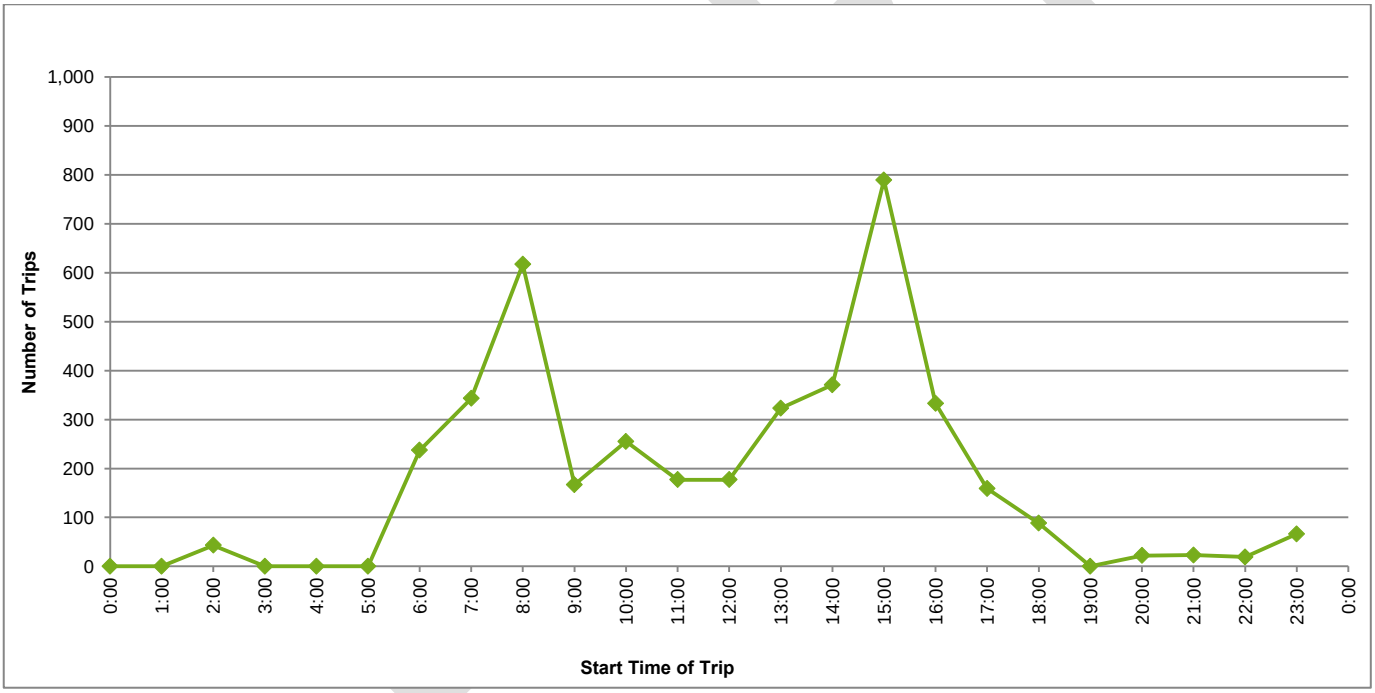
The 2006 TTS data showed that private auto mode-share (auto driver or passenger) exceeds the other modes with more than 80% of trips in Brant County (including the City of Brantford) in either peak period. Within the City of Brantford some trips use other transportation modes such as transit (approximately 3%) and walk (approximately 9%). Exhibit 2-7 summarizes the mode-share distribution for Brant County and the City of Brantford. High auto driver mode-share and surveyed participants suggested that the survey sample was very representative in terms reflecting traffic zone private auto travel.

The daily transit trip distribution by hour, as shown in Exhibit 2-8, exhibited 2 peak periods that were similar to the 3-hour peak periods in daily trip distribution by start-time. This suggested that a similar mode-share method for private auto trips could be used to determine transit assignment matrices.

Exhibit 2-7: Mode-share based on Trip Zone of Origin

Travel Mode	A.M. Peak Period (6 A.M. – 9 A.M.)			P.M. Peak Period (3 P.M. – 6 P.M.)		
	City Of Brantford	Brant County (Excl. City Of Brantford)	Brant County Overall	City Of Brantford	Brant County (Excl. City Of Brantford)	Brant County Overall
Auto Driver	69%	74%	70%	68%	74%	69%
Auto Passenger	13%	11%	12%	17%	15%	16%
Walk	9%	5%	8%	8%	6%	7%
School Bus	6%	9%	6%	5%	4%	5%
Transit excl. GO Rail	3%	0%	2%	2%	0%	2%
Cycle	1%	1%	1%	1%	1%	1%
Other	0%	-	0%	0%	-	0%
Taxi Passenger	0%	0%	0%	0%	0%	0%
GO Rail only	0%	0%	0%	0%	0%	0%
Motorcycle	0%	0%	0%	0%	0%	0%
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Exhibit 2-8: Daily Transit Trip Start-time Distribution for City of Brantford



Source: 2006 TTS

The 2010 model included a policy-based mode choice method to determine private auto and transit travel demand, but did not include transit assignment capability. The policy mode choice method stipulates mode-shares based on travel survey data, with manual adjustments to account for local conditions, development plans, or other variables affecting mode choice. The mode-shares do not change with iterations of the modelling process.

For this model update, a new transit assignment capability was needed. To run a transit assignment, a transit trip matrix for the model zone system is required, along with a disaggregated transit mode-share matrix to forecast future transit trips.

A review of the initial (2010 model) transit mode-share matrix indicated that some origin-destination pairs had unrealistic transit mode-shares (e.g. 100%); this is the result of a low sample size for transit trips in the 2006 TTS database. Applying these mode-shares to the model zones and running the transit assignment resulted in poor validation.

The *2011 Brantford Transit "Eco" Services Review – Transit Environmental Leadership Plan, September 2012* was used to adjust the mode-share data extracted from the 2006 TTS database. The TTS trips were aggregated to the 8 super-zone system used in the origin-destination survey. Then, mode share was re-calculated and copied to the corresponding zone pairs in the full matrix.

The aggregation to a larger super-zone system helped smooth the errors in transit mode split caused by the small sample size. While much improved over a direct extraction from the 2006 TTS database, this method still resulted in some unusually high mode-shares (e.g. greater than 30%). So, a cap of 25% was imposed on these zones (with a negligible impact on total transit trips). Overall, this approach allowed the transit model to validate well as detailed later in Section 3.1.

2.5 Trip Assignment

Private Auto

Road classification and operational parameters such as speed and capacity were carried from the 2010 model, but refined to reflect the City of Brantford's road classification system and posted speed limits. Exhibit 2-9 details the road network parameters for assignment. Road classification, speed and capacity diagrams are provided in the Appendix.

The 2010 model used the industry standard Frank-Wolfe assignment algorithm to complete the user equilibrium trip assignment to the network. The user-equilibrium method uses the Bureau of Public Roads volume-delay function (BPR VDF), as detailed in Exhibit 2-9.

Exhibit 2-9: Private Auto Model Parameters

Road Class	Description	Default Speed If No Posted Speed Available (km/h)	Capacity (veh/h/ln)	BPR VDF Parameter	
				α	β
1	Freeway	100	1800	0.720	6.14
2	Highway/Expressway	70	1100	0.597	5.87
3	Major Arterial	60	900	0.597	5.87
4	Minor Arterial	60	700	0.507	4.96
5	Major Collector	60	650	0.507	4.96
6	Minor Collector	50	500	0.507	4.96
7	Local	40	500	0.507	4.96
99	Centroid Connector	50	9,999	0.15	4.00

BPR Volume - Delay Function

$t_c = t_{ff}\left(1+\alpha(v/c)^{\beta}\right)$

t_c *: travel time based on volume*

t_{ff} *: free flow travel time*

v *: volume*

c *: capacity*

α, β *: calibrated link performance parameters*

Caliper Corporation has developed a new user equilibrium assignment algorithm called "origin-based user-equilibrium". This algorithm uses the same network parameters as the Frank-Wolfe algorithm. But, it has many advantages over the Franke-Wolfe algorithm[1]:

- It can compute tighter assignment convergences much faster; and,
- It eliminates spurious and inexplicable assignment effects, which result from looser assignment convergences.

The origin-based user-equilibrium algorithm was reviewed for applicability in the transportation model. Using this algorithm produced indistinguishable results compared to the previous algorithm and the above computational benefits were observed. Accordingly, the origin-based user-equilibrium algorithm was adopted as the private auto trip assignment method for the model.

The private auto assignments were validated against traffic count data provided by the City of Brantford, Brant County, and the 2010 model when not available from the previous sources. Private auto assignment is completed for the a.m. and p.m. peak hours of travel. Peak hour factors of 0.55 and 0.47 for the a.m. and p.m. peak hours, respectively, were developed using the 2006 TTS and traffic data sources. Auto occupancy factors of 1.17 and 1.25 for the a.m. and p.m. peak hours, respectively, were determined from the 2006 TTS database. These factors were applied following the mode choice step to determine the final private auto trip assignment matrices.

Transit

As mentioned in Section 2.4, a new transit assignment capability was implemented in the transportation model. The higher-resolution road network was beneficial to accurately representing the route and stop system because no new links needed to be added to accommodate the transit route system and stop locations were accurately represented. Transit operational and ridership data (bus speeds and headway, boarding and alighting counts and stop locations) were referenced from the 2011 Transit Service Review to develop the transit model. Transit assignment utilized the Pathfinder algorithm, which is native to the TransCAD platform. Exhibit

[1] Caliper Corporation. What TransCAD Users Should Know about New Static Traffic Assignment Methods. May 2010. http://www.caliper.com/press/what_transcad_users_should_know_about_traffic_assignment.pdf

summarizes the transit road system characteristics. Exhibit 2-11 illustrates the transit model network.

Since transit travel demand was developed from 2006 TTS and 2011 Transit Service Review data sources, the transit model assumed the following:

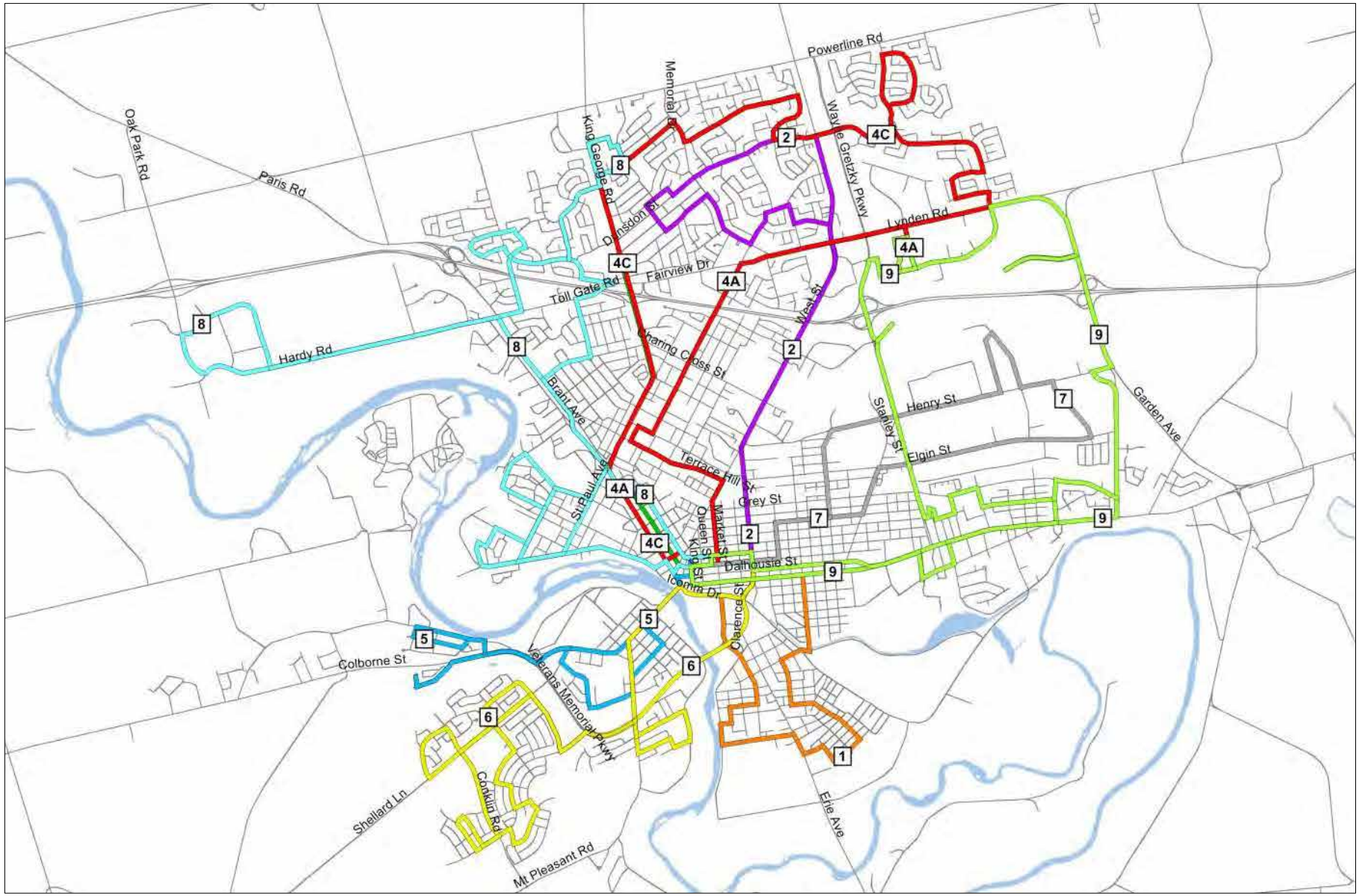
- 1 transfer, 25 min maximum access and egress times (20min default), and default Pathfinder parameters from TransCAD otherwise;
- Weekday peak period forecast by route; and,
- Lower stop-by-stop traffic forecast resolution due to the layout of centroid connectors.

The transit assignments were validated against ridership data collected in the 2011 Transit Service Review.

Exhibit 2-10: Route System Characteristics

Route		Length (km)	Headway (A.M. and P.M.)	Stops
Number	Name			
1	Eagle Place	9.7	30	35
2	Mall Link	21.1	30	62
4A	Mall Link	24.1	30	77
4C	West Brant/Oakhill	24.2	30	73
5	West Brant/Shellard	12.2	30	33
6	East Ward/Braneida	21.2	30	48
7	Holmedale/Mayfair	12.5	30	36
8	Echo Place	32.5	30	88
9	West Street/Brier Park	27.3	30	70

Exhibit 2-11: Brantford Transit Network, Weekday Peak Period Service



3. 2011 Validation and Analysis

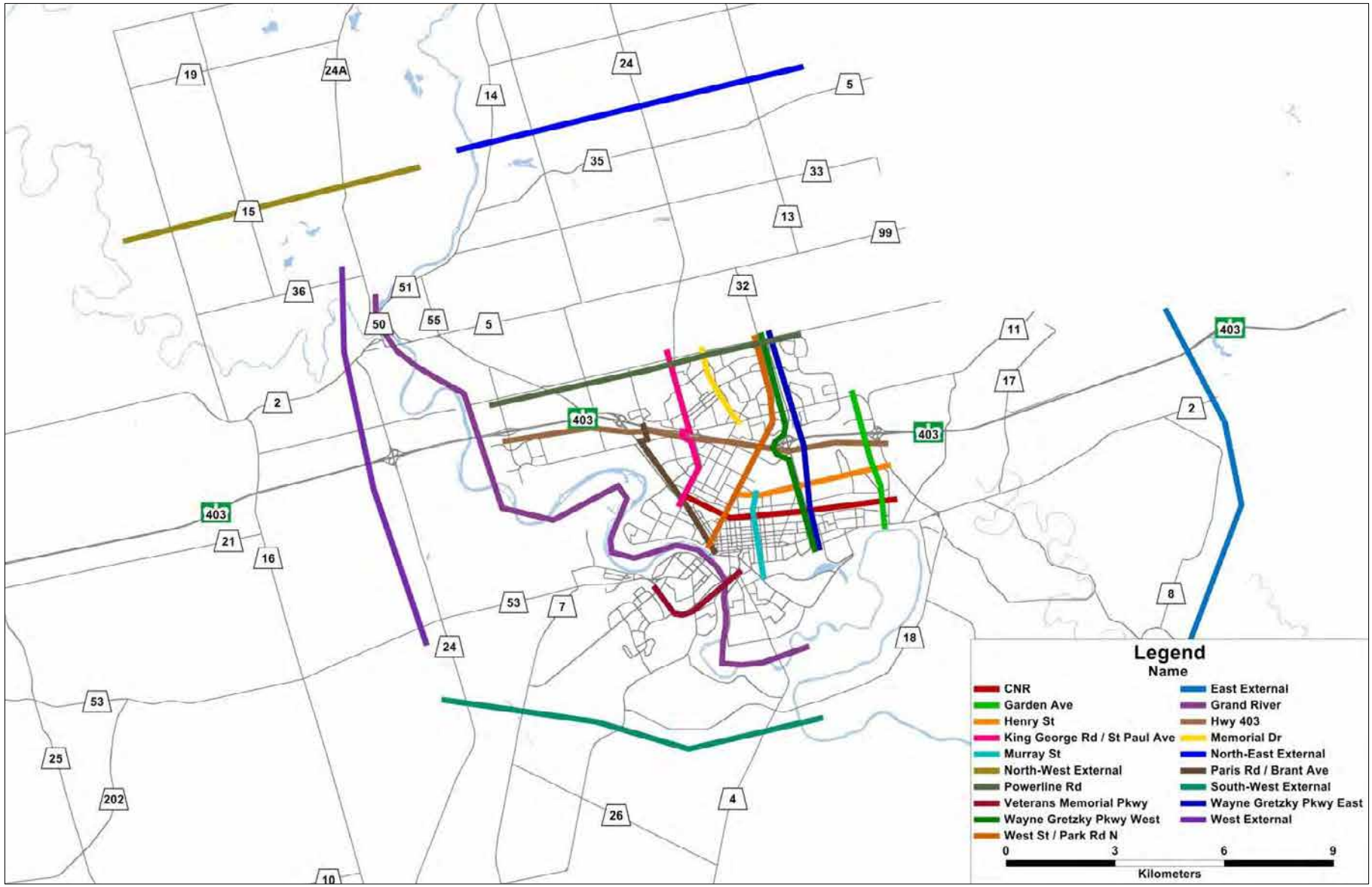
3.1 Validation

Private Auto

The private auto traffic forecasts were validated against a.m. and p.m. peak hour traffic counts provided by the City of Brantford, Brant County, and the 2010 model when not available from the previous sources. Traffic data sources are provided in the Appendix. Exhibit 3-1 illustrates the screenlines used to validate the traffic forecasts. Screenlines from the 2010 model were carried forward and supplemented with:

- 4 new screenlines along Paris Road / Brant Avenue, Wayne Gretzky Parkway West and Veterans Memorial Parkway and Henry Street; and,
- Additional spots along 2010 screenlines.

Exhibit 3-1: Private Auto Traffic Screenlines



An extensive effort was undertaken to calibrate the traffic model. Adding screenline locations was part of this effort. While the synthetic matrix approach utilizes the most recent travel demand data, the following observations were initially noted prior to calibrating the model:

- Using peak hour factors developed for the 2010 model update resulted in under-simulation across the screenlines;
- Highway 403 was over-simulated between King George Road and Garden Avenue, and towards the east external connecting to Highway 403; and,
- Many non-direct and turn-heavy route choices were simulated since the majority of roads in the downtown core have posted speed limits of 50 km/h.

The following adjustments were tested and implemented to address the above observations, in order to validate the model:

- The peak hour factors were raised to 0.55 and 0.47 for the a.m. and p.m. peak hours, respectively. The need for this change is likely caused by the increase in employment described in Section 2.1. Trip origins based on population and labour force are used to balance trip destinations, which are based on employment. Compared to the demographic data used in the 2010 model, 2011 population has more or less remained stable whereas employment has significantly increased (see Exhibit 2-1). As a result of balancing, trip destinations generated by the increased employment were under-estimated. The peak hour factor was raised to address this effect.
- The initial validation for trips to external zones especially those that used Highway 403 showed over-simulation. Therefore, new auto occupancy factors (1.17 and 1.25 for the a.m. and p.m. peak hours, respectively) based on zone of origin trip characteristics were determined from the 2006 TTS database. These auto occupancy factors were applied to trips starting or ending in external zones to reflect the traffic counts.
- In the model, travel times are the main determinant for trip routes. In 2011, Highway 403 is generally under-capacity, which results in very fast travel times since it was coded with the posted 100 km/h speed. As a result, the assignment procedure loaded Highway 403 for many local trips, which would realistically use other east-west roads. Therefore, the link speed along Highway 403 between King George Road and Garden Avenue was lowered to 90 km/h to simulate local travel choices. Analogously, some roads near the downtown had travel speeds lowered from the posted speed limit of 50 km/h to 40 km/h to achieve the preferred travel paths along West Street, Wayne Gretzky Parkway, Colborne Street and Dalhousie Streets, and better validate the model.
- For the external zone connecting to Highway 403 on the east end of the model (model zone 20,000), the trip destinations were scaled in the a.m. peak hour and the trip origins were scaled in the p.m. peak hour to match traffic counts along Highway 403. The scaling values, i.e. the difference before and after scaling, will be applied to future scenarios.

The ratios between simulated-to-observed auto traffic were compared to illustrate how well the model simulates traffic. As shown in Exhibit 3-2, peak hour auto traffic forecasts validated well with an overall validation of 1.03 and 1.00 for the a.m. and

p.m. peak hours, respectively. Internal screenlines, validated well at 1.02 and 1.00 in the a.m. and p.m. peak hours, respectively. External screenlines validated acceptably at 1.08 and 0.99 in the a.m. and p.m. peak hours, respectively.

The Memorial Drive and Veterans Memorial Parkway validated low. One possible cause was noted in that there was a difference between the travel survey and count dates. The travel survey was completed as part of the 2006 TTS, which is now more than 5 years old, and may have not reflected the recent developments in the vicinity of these screenlines. The counts were undertaken more recently (2011 and later) and reflected the newer residential developments in the vicinity of these screenlines.

The greater variation in the external screenline validations can be attributed to the wide range of traffic counts received from the City of Brantford and Brant County used for the validation process. Theses counts were generally from 2006, which by now is more than 5 years old. No growth factors were applied to the counts since an accurate growth factor could not be determined. Spot checks were performed on major links such as Highway 403 and Highway 24 that are part of these screenlines. As a result of the above adjustments, Highway 403 validated acceptably. Highway 24 validated slightly high at around 1.20, which is acceptable since the counts were old.

All-in-all, the model simulates travel patterns and volumes quite accurately for private auto traffic. Accordingly, the updated model will be used to base future forecasts.

Exhibit 3-5 (a) and (b) illustrate the a.m. and p.m. peak hour model assignments, respectively, which are shown later in Section 3.2 to facilitate the assessment of traffic conditions.

Exhibit 3-2: Private Auto Screenline Validation, 2011 Base-Year

A.M. Peak Hour

Screenline	Observed			Simulated			Simulated/Observed		
	EB/NB	WB/SB	Total	EB/NB	WB/SB	Total	EB/NB	WB/SB	Total
Grand River	3,821	2,959	6,780	5,368	3,060	8,428	1.40	1.03	1.24
Hwy 403	3,908	4,719	8,627	4,391	5,213	9,604	1.12	1.10	1.11
Paris Rd / Brant Ave	2,598	2,493	5,091	3,108	2,520	5,628	1.20	1.01	1.11
King George Rd / St Paul Ave	2,991	2,218	5,209	2,678	1,902	4,580	0.90	0.86	0.88
Wayne Gretzky Pkwy East	3,999	4,031	8,031	5,259	3,796	9,055	1.31	0.94	1.13
Wayne Gretzky Pkwy West	4,286	4,323	8,610	5,317	3,543	8,860	1.24	0.82	1.03
Memorial Dr	901	1,158	2,059	476	814	1,290	0.53	0.70	0.63
West St / Park Rd N	3,054	2,506	5,560	2,443	1,846	4,289	0.80	0.74	0.77
Henry St	2,407	2,190	4,597	3,107	1,822	4,929	1.29	0.83	1.07
CNR	2,875	2,577	5,452	3,823	2,647	6,469	1.33	1.03	1.19
Garden Ave	2,621	2,740	5,362	3,152	2,545	5,696	1.20	0.93	1.06
Powerline Rd	1,556	1,977	3,533	1,707	2,044	3,751	1.10	1.03	1.06
Murray St	1,366	1,480	2,846	1,309	617	1,926	0.96	0.42	0.68
Veterans Memorial Pkwy	1,759	1,438	3,197	1,505	805	2,310	0.86	0.56	0.72
INTERNALS	**38,142**	**36,810**	**74,953**	**43,642**	**33,174**	**76,816**	**1.14**	**0.90**	**1.02**
West External	1,140	937	2,077	926	1,143	2,069	0.81	1.22	1.00
South-West External	378	433	811	339	380	719	0.90	0.88	0.89
East External	2,261	2,070	4,331	2,451	2,392	4,843	1.08	1.16	1.12
North-East External	478	471	949	776	507	1,283	1.62	1.08	1.35
North-West External	605	491	1,096	516	547	1,063	0.85	1.11	0.97
EXTERNALS	**4,862**	**4,402**	**9,264**	**5,007**	**4,970**	**9,977**	**1.03**	**1.13**	**1.08**
TOTAL	**43,004**	**41,212**	**84,217**	**48,650**	**38,144**	**86,794**	**1.13**	**0.93**	**1.03**

P.M. Peak Hour

Screenline	Observed			Simulated			Simulated/Observed		
	EB/NB	WB/SB	Total	EB/NB	WB/SB	Total	EB/NB	WB/SB	Total
Grand River	3,815	4,553	8,368	4,355	6,348	10,704	1.14	1.39	1.28
Hwy 403	5,935	5,333	11,268	6,719	5,778	12,497	1.13	1.08	1.11
Paris Rd / Brant Ave	3,088	3,283	6,371	3,127	3,292	6,419	1.01	1.00	1.01
King George Rd / St Paul Ave	3,233	3,549	6,782	2,830	3,285	6,115	0.88	0.93	0.90
Wayne Gretzky Pkwy East	5,091	5,714	10,805	5,295	6,280	11,574	1.04	1.10	1.07
Wayne Gretzky Pkwy West	5,012	5,875	10,887	4,992	6,227	11,219	1.00	1.06	1.03
Memorial Dr	1,139	1,480	2,619	1,013	819	1,832	0.89	0.55	0.70
West St / Park Rd N	3,129	4,049	7,178	2,639	3,042	5,681	0.84	0.75	0.79
Henry St	2,777	3,130	5,907	3,235	2,953	6,188	1.16	0.94	1.05
CNR	3,725	4,196	7,921	3,925	4,988	8,912	1.05	1.19	1.13
Garden Ave	3,440	3,369	6,809	3,386	3,361	6,747	0.98	1.00	0.99
Powerline Rd	2,735	2,613	5,348	2,636	2,464	5,100	0.96	0.94	0.95
Murray St	1,869	2,024	3,893	1,093	1,532	2,625	0.58	0.76	0.67
Veterans Memorial Pkwy	1,592	2,070	3,662	886	1,567	2,453	0.56	0.76	0.67
INTERNALS	**46,582**	**51,237**	**97,819**	**46,129**	**51,937**	**98,066**	**0.99**	**1.01**	**1.00**
West External	1,334	1,423	2,757	1,341	1,114	2,455	1.00	0.78	0.89
South-West External	570	513	1,083	412	374	786	0.72	0.73	0.73
East External	2,568	2,755	5,323	3,064	2,476	5,541	1.19	0.90	1.04
North-East External	579	671	1,250	784	953	1,737	1.35	1.42	1.39
North-West External	739	838	1,577	713	662	1,375	0.97	0.79	0.87
EXTERNALS	**5,790**	**6,200**	**11,990**	**6,314**	**5,579**	**11,894**	**1.09**	**0.90**	**0.99**
TOTAL	**52,372**	**57,437**	**109,809**	**52,443**	**57,517**	**109,960**	**1.00**	**1.00**	**1.00**

Transit

Transit assignment flows were validated against peak period ridership data gathered from the 2011 Transit Service Review. The ratio of simulated-to-observed ridership was compared at the route resolution due to transit trip assignment assumptions. Exhibit 3-3 summarizes the route validation. Overall, the model forecasts a.m. peak period transit travel optimistically, and the p.m. peak period travel generally on-par compared to observed ridership data. The validation for individual routes varied considerably for the following reasons:

- The 2006 TTS data from which the transit travel demand was developed has a very aggregate zone system resulting in sample size and representation bias when examining low proportion mode-shares such as transit; and,

- The 2011 Transit Service Review reflects improved route services that have been implemented after 2006.

When the model was initially tested, the default maximum access and egress walk time of 20 min was found to not fully capture the transit demand. A long walk time is generally needed in macro models for transit assignments because the zone system is coarse near the local trip ends such as employment centres or housing divisions, which would cause slightly longer travel times. Accordingly, the access and egress walk time was increased to 25 min and was found to better capture the travel demand.

Transit assignments using the Pathfinder algorithm are not capacity constrained as in the user-equilibrium assignment for private auto traffic. Transit assignments are dependent on the trip time, which includes access and egress to the transit route, waiting for the transit vehicle and in-vehicle travel time. As a result, the model tended to load trips onto more direct routes. In consideration of the varied validation by route, the model should be more appropriately used as a tool to measure the relative effects of the transit routes. Absolute ridership forecasts should be scrutinized; however, growth along a particular route can be more or less extracted from the model. Section 3.2 will discuss how the transit model compares to the ridership operations reported in the 2011 Transit Service Review. The comparison will provide insight on the forecasting strength of the model as described above.

The above considerations indicate that the transit model is acceptably validated. Exhibit 3-6 (a) and (b) illustrate the a.m. and p.m. peak period model assignments, respectively, which are shown later in Section 3.2 to facilitate the assessment of ridership conditions.

Exhibit 3-3: Transit Route Validation, 2011 Base-Year

	A.M. Peak Period (6 A.M. – 9 A.M.)						P.M. Peak Period (3 P.M. – 6 P.M.)					
	Observed		Simulated		Simulated / Observed		Observed		Simulated		Simulated / Observed	
Route	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off
1	136	109	148	148	1.09	1.36	226	221	155	155	0.69	0.70
2	82	84	196	196	2.39	2.34	157	205	300	300	1.91	1.46
4A	109	109	168	168	1.54	1.54	199	271	243	243	1.22	0.90
4C	170	141	131	131	0.77	0.93	210	239	260	260	1.24	1.09
5	37	28	34	34	0.93	1.23	31	65	54	54	1.73	0.83
6	69	28	61	61	0.89	2.19	77	71	58	58	0.75	0.81
7	96	131	179	179	1.87	1.37	80	97	142	142	1.77	1.46
8	83	90	99	99	1.20	1.11	62	105	182	182	2.93	1.73
9	185	184	192	192	1.04	1.04	254	324	144	144	0.57	0.44
TOTAL	**967**	**904**	**1,209**	**1,209**	**1.25**	**1.34**	**1,296**	**1,598**	**1,538**	**1,538**	**1.19**	**0.96**

3.2 Analysis

Private Auto

Based on aggregating the model zones to super-zones representing the City of Brantford, the rest of Brant County and externals, the following observations were made regarding the distribution of private auto traffic in the model:

- A large portion (30%-35%) of private auto traffic in the model travels within the City of Brantford;
- A large portion (45%-50%) of private auto traffic originates or is destined for the City of Brantford;
- A large portion (30%) of private auto traffic originates or is destined for the external zones
- Travel between the City of Brantford and the rest of the model zones make up 65% of private auto traffic;
- Travel between zones outside of the City of Brantford, i.e. the rest of Brant County and external zones, make up 35% of private auto traffic;
- A large portion (20%) of private auto traffic in the model travels between external zones only; and,
- Less than 20% of private auto traffic travels between the rest of Brant County and external zones.

These traffic distributions indicate that the City of Brantford serves as a hub for private auto traffic in the model, and external through trips make up a large proportion of private auto traffic that the road network must accommodate. Exhibit 3-4 summarizes the traffic distributions.

Exhibit 3-4: Private Auto Traffic Distribution, 2011

A.M. Peak Hour

Origin	Destination			
	City of Brantford	Rest of Brant County	External	Total
City of Brantford	32%	6%	9%	**46%**
Rest of Brant County	7%	8%	5%	**20%**
External	10%	3%	21%	**34%**
Total	**49%**	**17%**	**35%**	**100%**

P.M. Peak Hour

Origin	Destination			
	City of Brantford	Rest of Brant County	External	Total
City of Brantford	35%	8%	8%	**52%**
Rest of Brant County	6%	8%	3%	**18%**
External	7%	4%	20%	**30%**
Total	**48%**	**20%**	**31%**	**100%**

The following remarks were noted for the road network conditions after private auto trips were assigned in the model. Exhibit 3-5 (a) and (b) visualize the traffic conditions:

- The p.m. peak hour traffic is more congested than the a.m. peak hour traffic;
- In both peak hours, the King George Road and Wayne Gretzky Parkway interchanges are the main routes that traffic from Highway 403 uses to get into the City, which results in high and near-capacity traffic flows near these interchanges;
- From and to the King George Road interchange, traffic generally proceeds along King George Road and Brant Avenue to access the downtown core;
- From and to the Wayne Gretzky Parkway interchange, traffic generally proceeds along Wayne Gretzky Parkway and Colborne Street, which provides access to the 1-way couplet of Colborne Street and Dalhousie Street to access the downtown core;
- West Street is also a highly utilized north-south road;
- North of Highway 403, King George Road and Wayne Gretzky Parkway serve as the main north-south accesses with vehicles then feeding to Fairview Road, Powerline Road and Dunsdon Street to go east-west; and,
- Colborne Street and Veterans Memorial Parkway provide the main connections into the City from the southwest.

An important remark about the model concerns Colborne Street and Veterans Memorial Parkway in the southwest portion of the City. While Veterans Memorial Parkway provides a more continuous route than Colborne Street, it does not

provide access for the subdivisions north of Veterans Memorial, which contributes to higher traffic volumes along Colborne Street as these subdivisions feed onto Colborne Street in the model. However, since the 2006 TTS, the Shellard Lane and Conklin Road subdivisions (southwest of Veterans Memorial Parkway and west of the Grand River) have grown significantly, as noted by the City of Brantford. Spot checks were performed along several links south of Veterans Memorial Parkway and showed a modelled-to-observed traffic ratio of approximately 0.70. The under-representation may be a result of recent growth in these areas not fully accounted for in the trip rates or demographic data. To forecast traffic, the pivot approach is recommended for these areas rather than using model forecasts directly. The pivot approach involves forecasting growth using the model then adding it to existing traffic counts.

As outlined by the transportation model framework (Exhibit 1-1), an additional intersection assessment model was created in Synchro to enhance the above road network assessments. However, the discussion on traffic operations will be reserved for the alternatives modelling for the TMP update. This report only focuses on updates undertaken for the TransCAD model.

Exhibit 3-5a: Private Auto Traffic Assignment, 2011 A.M. Peak Hour

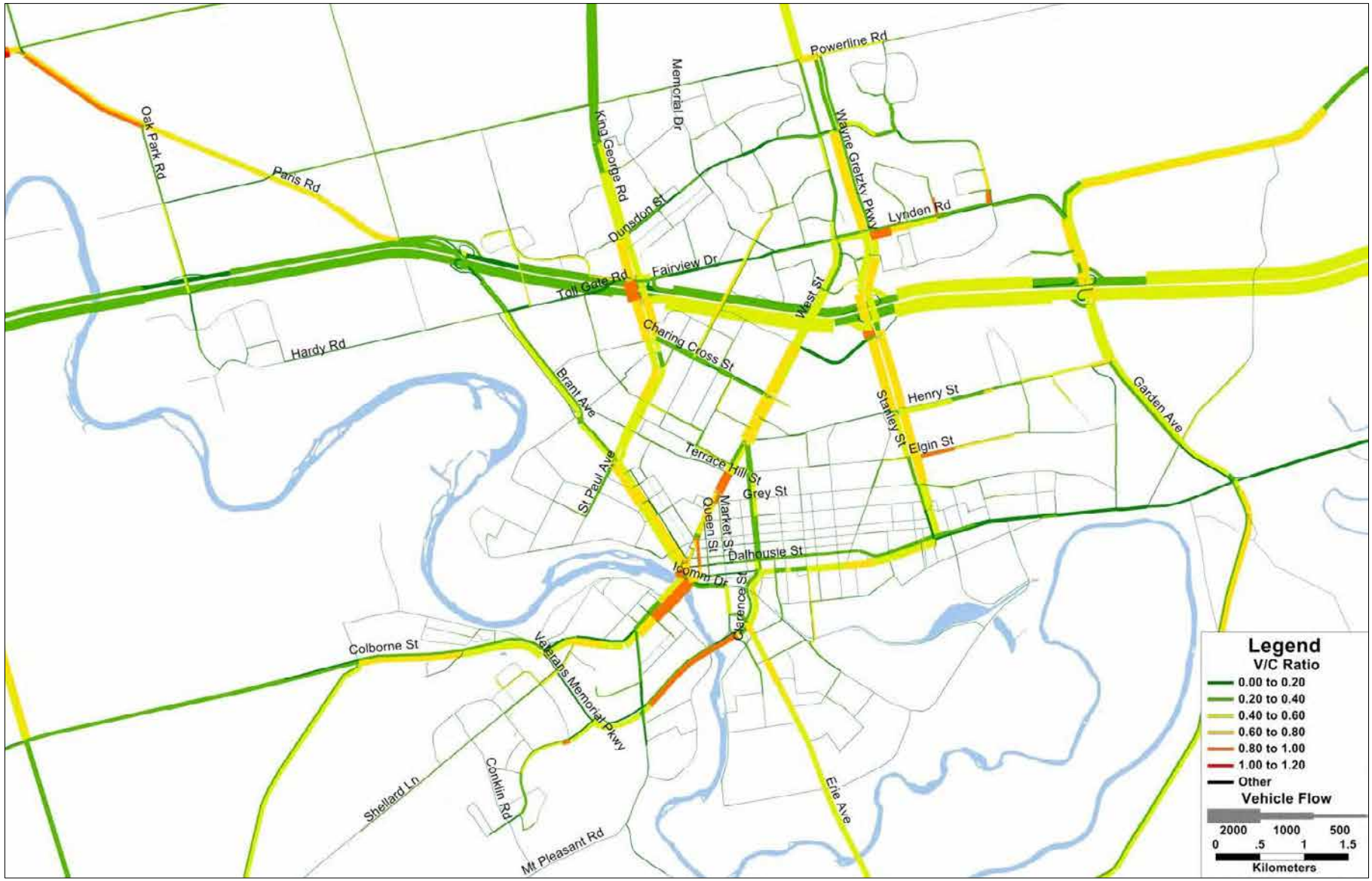


Exhibit 3.5b: Private Auto Traffic Assignment, 2011 P.M. Peak Hour

Transit

With the validated transit model, the following remarks were noted regarding modelled ridership for 2011 (see Exhibit 3-6 (a) and (b) for context):

- Overall, the transit trips were well captured given the good validation;
- In both peak periods, routes 1, 2, 4A, 4C, 7 and 9 showed good utilization with more than 100 riders on each route;
- Route 8 only showed good utilization with more than 100 riders in the PM peak period; and,
- Routes 5 and 6 showed poor utilization with less than 100 people riding on each route in each peak period.

These remarks were compared to the analysis undertaken in the 2011 Transit Service Review, as shown in Exhibit 3-7. In general, the model is consistent with the statements about route performance.

However, routes 2 and 4A were modelled optimistically. This effect can be explained by the transit assignment algorithm, which minimizes trip cost of which travel and wait time are significant factors, and the directness of these routes between major trip generating nodes – the directness of the route makes these transit routes very attractive for travel in the model.

Route 9 was modelled slightly pessimistically. Although route 9 was modelled to show good utilization, the modelled ridership on the route indicated lower than observed ridership in the PM peak hour. This can be attributed to the trip generation process – like the Shellard Lane and Conklin Road subdivisions, trip activity along Grey Street, Lyndhurst Street and near the St. Joseph's Lifecare Centre may be under-represented by the trip generation rates. Spot checks undertaken on private auto traffic west of Garden Avenue and east of Wayne Gretzky Parkway confirmed this observation.

Exhibit 3-6a: Transit Traffic Assignment, 2011 A.M. Peak Period

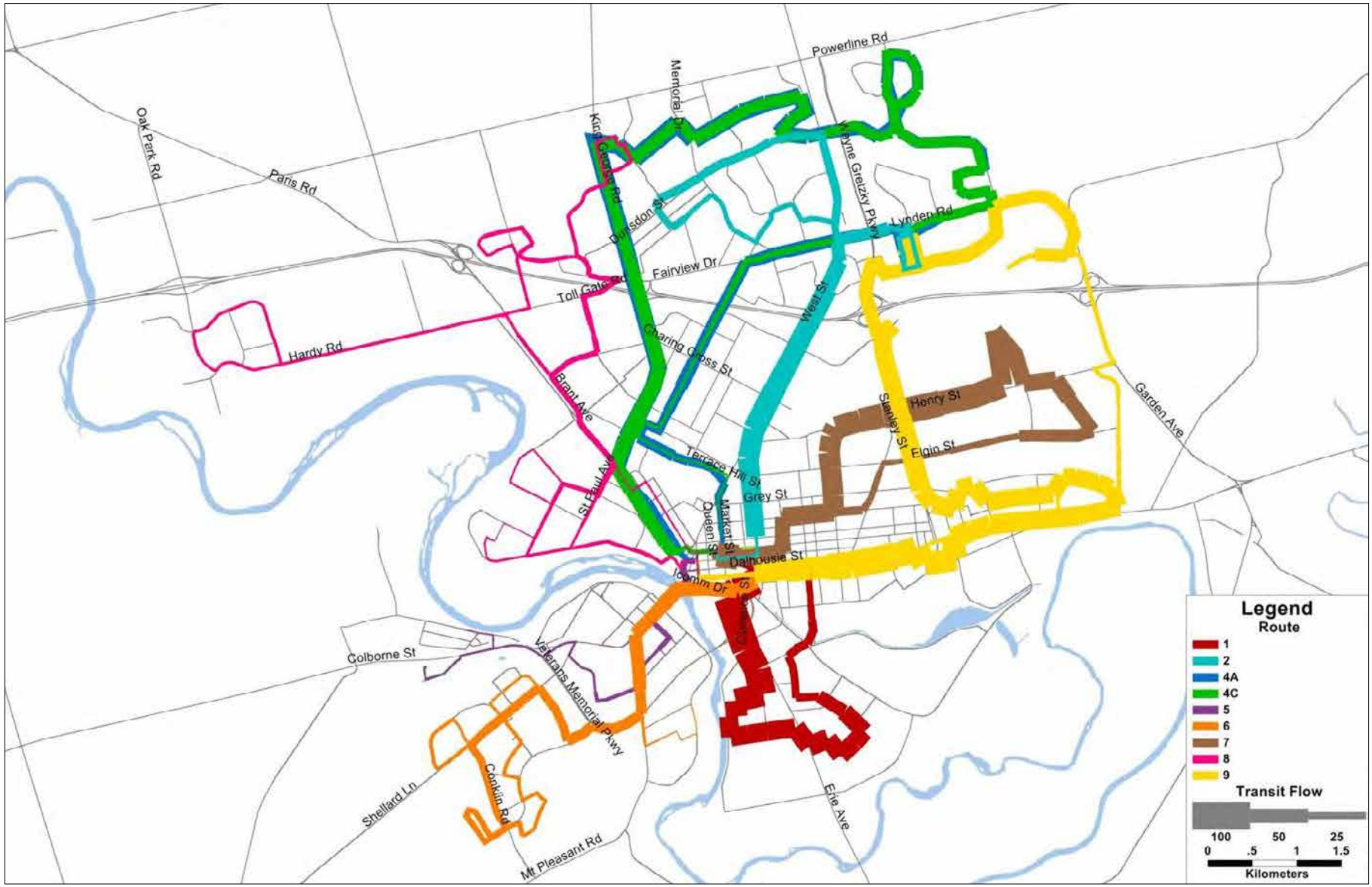


Exhibit 3.6b: Transit Traffic Assignment, 2011 P.M. Peak Period

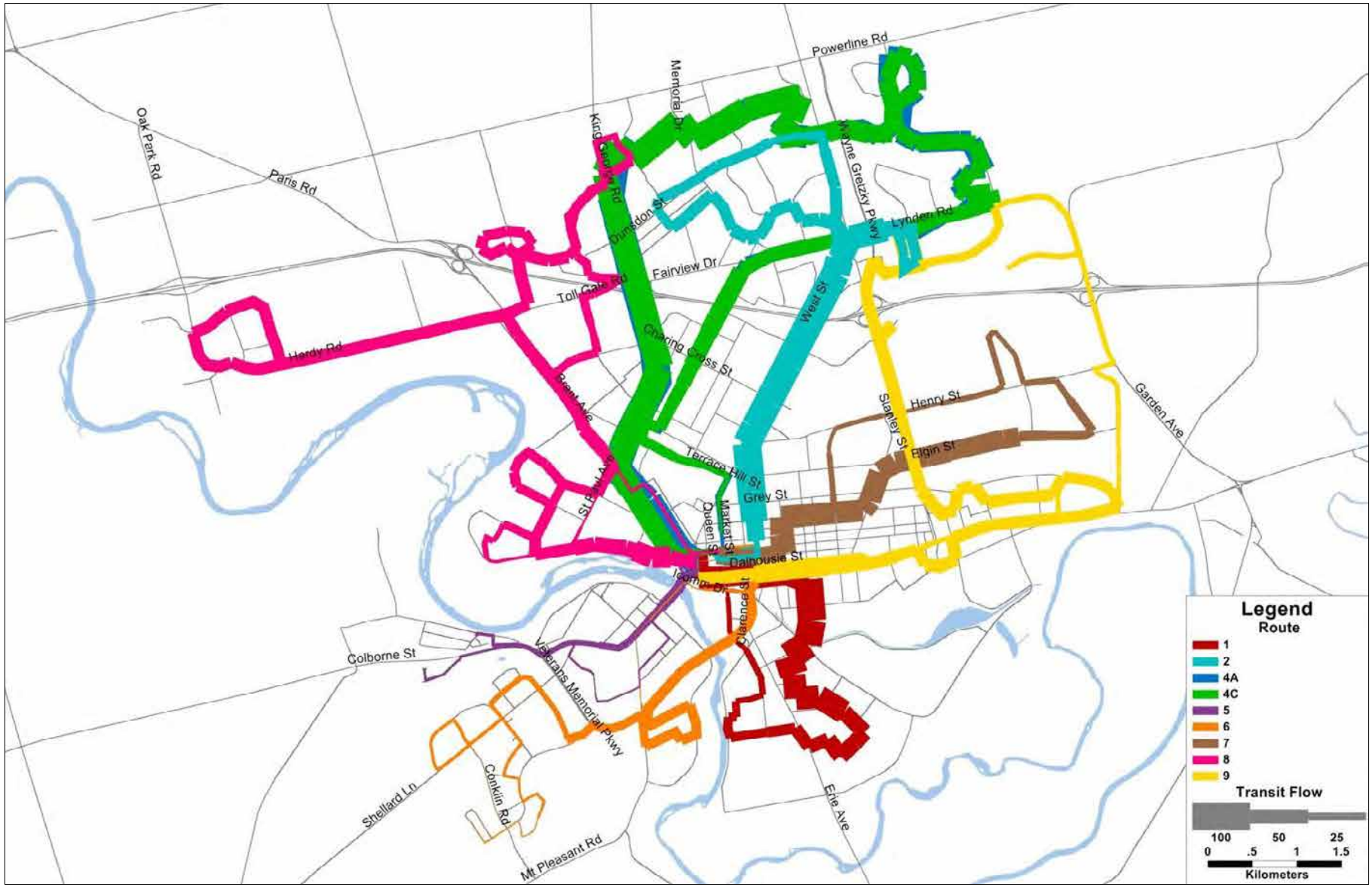


Exhibit 3-7: Comparison of Model to 2011 Transit Service Review Analysis

Route	Modelled			2011 Transit Service Review		Consistency
	Utilization	Ridership		Revenue-Cost Ratio	Analysis	
		A.M. Peak Period	P.M. Peak Period			
1	Good	148	155	0.91	• Well performing	Consistent
2	Good	196	300	0.50	• Average performing • Segment between Downtown Terminal and Lynden Park accounts for the majority of ridership as a direct route is provided • Service through Brier Park is poor performing	Model optimistic
4A	Good	168	243	0.61	• Average performing • Major activity areas include Brantford General Hospital, North Park Collegiate/Wayne Gretzky Sports Centre, Brantford Centre, Lynden Park Mall and Brantford Commons	Model optimistic
4C	Good	131	260	0.62	• Average performing • Significantly high activity in Brantwood Park area reflecting travel from Brantwood park to Lynden Park Mall • Ridership slightly higher than 4A because it provides the most direct route from the Downtown Terminal to Brantford Commons	Consistent
5	Poor	34	54	0.50	• Relatively under-performing • Performs well in West Brant area along Colborne Street corridor and Hillcrest areas • Does not perform well through Oakhill Drive and D'Augbigny Road • West Brant area along Colborne Street is a major node of transit but network may not be effectively serving	Consistent
6	Poor	61	58	0.26	• Lowest performing • Major trip generators include Assumption College, residential areas along Diana Avenue and Mount Pleasant Road/Colborne Street corridor through west Brant • Segment to Conklin Road & McGuiness Drive is well utilized • Long and circuitous	Consistent
7	Good	179	142	0.95	• Top performing • Large ridership as a result of Mohawk College and Braneida Industrial Park • Large number of transfers from Route 8 indicating cross-town travel from North Ward, Henderson and Carolina Park Areas	Consistent
8	Good (P.M. only)	99	182	0.38	• Poor performing • Circuitous • Service to northwest industrial area is well used	Consistent
9	Good	192	144	0.93	• High performing • Heavily travelled along Colborne Street and major destinations such as St. Joseph's Lifecare Centre, Lynden Park Mall, Brantford Medical Centre and Pauline Johnson Collegiate	Model pessimistic

4. Base Scenario Forecast and Analysis

4.1 Travel Demand Forecast

Population and employment forecasts for Brant County and the City of Brantford indicate significant growth in the next 20 years. As mentioned previously, the population and employment is expected to grow by 30% and 32%, respectively, for Brant County (including the City of Brantford). Exhibit 4-2 (a) and (b) illustrate the population and employment growth by traffic zones for the City of Brantford – the zone numbers indicate the classification used by the City of Brantford, which is consistent with the 2006 TTS traffic zones for zones 1-49 only. The following population and employment trends were indicated:

- High employment growth in the Oak Park Road & Hardy Road (Northwest Industrial Park) and Henry Street & Wayne Gretzky (Braneida Industrial Park) areas;
- High population growth in the southern zones surrounding Shellard Lane, Erie Avenue and Mohawk Street; and,
- High population and employment growth in the downtown core.

Exhibit 4-1 summarizes the forecasted population and employment data.

Exhibit 4-2 (a) and (b) illustrate the population and employment growth by traffic zones for the City of Brantford – the zone numbers indicate the classification used by the City of Brantford, which is consistent with the 2006 TTS traffic zones for zones 1-49 only. The following population and employment trends were indicated:

- High employment growth in the Oak Park Road & Hardy Road (Northwest Industrial Park) and Henry Street & Wayne Gretzky (Braneida Industrial Park) areas;
- High population growth in the southern zones surrounding Shellard Lane, Erie Avenue and Mohawk Street; and,
- High population and employment growth in the downtown core.

Exhibit 4-1: Population and Employment Forecasts, 2011 to 2031

Demographic / Area	2011	2031	Growth
Population			
Brant County (excl. City of Brantford)	37,000	49,000	32%
City of Brantford	93,650	121,265	29%
Total	**130,650**	**170,265**	**30%**
Employment			
Brant County (excl. City of Brantford)	15,000	22,000	47%
City of Brantford	46,892	59,676	27%
Total	**61,892**	**81,676**	**32%**

Source(s): City of Brantford and Places to Grow Amendment 2 (June 2013), Ministry of Infrastructure Ontario.

Exhibit 4-2a: Population and Employment Growth for City of Brantford

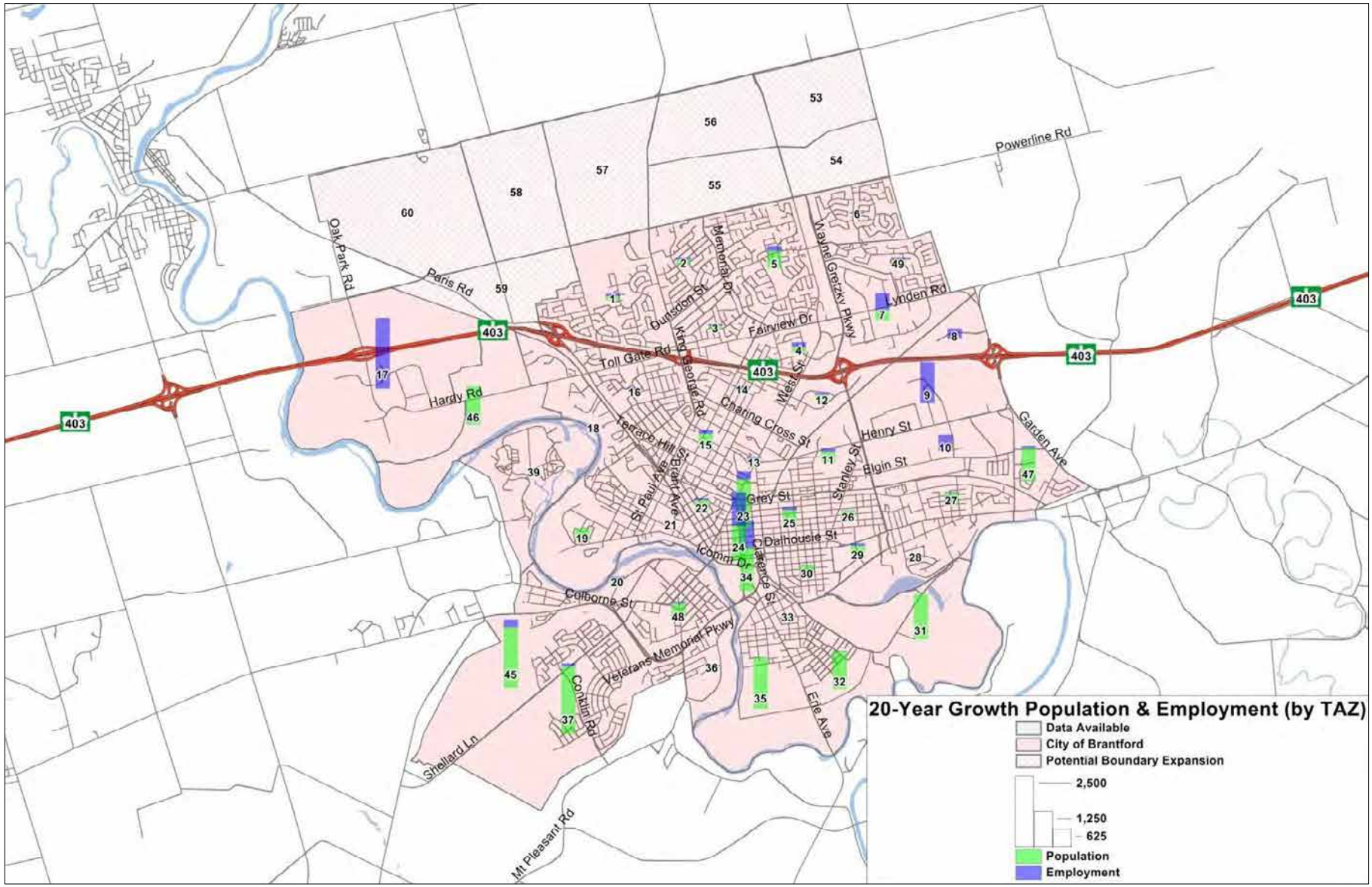
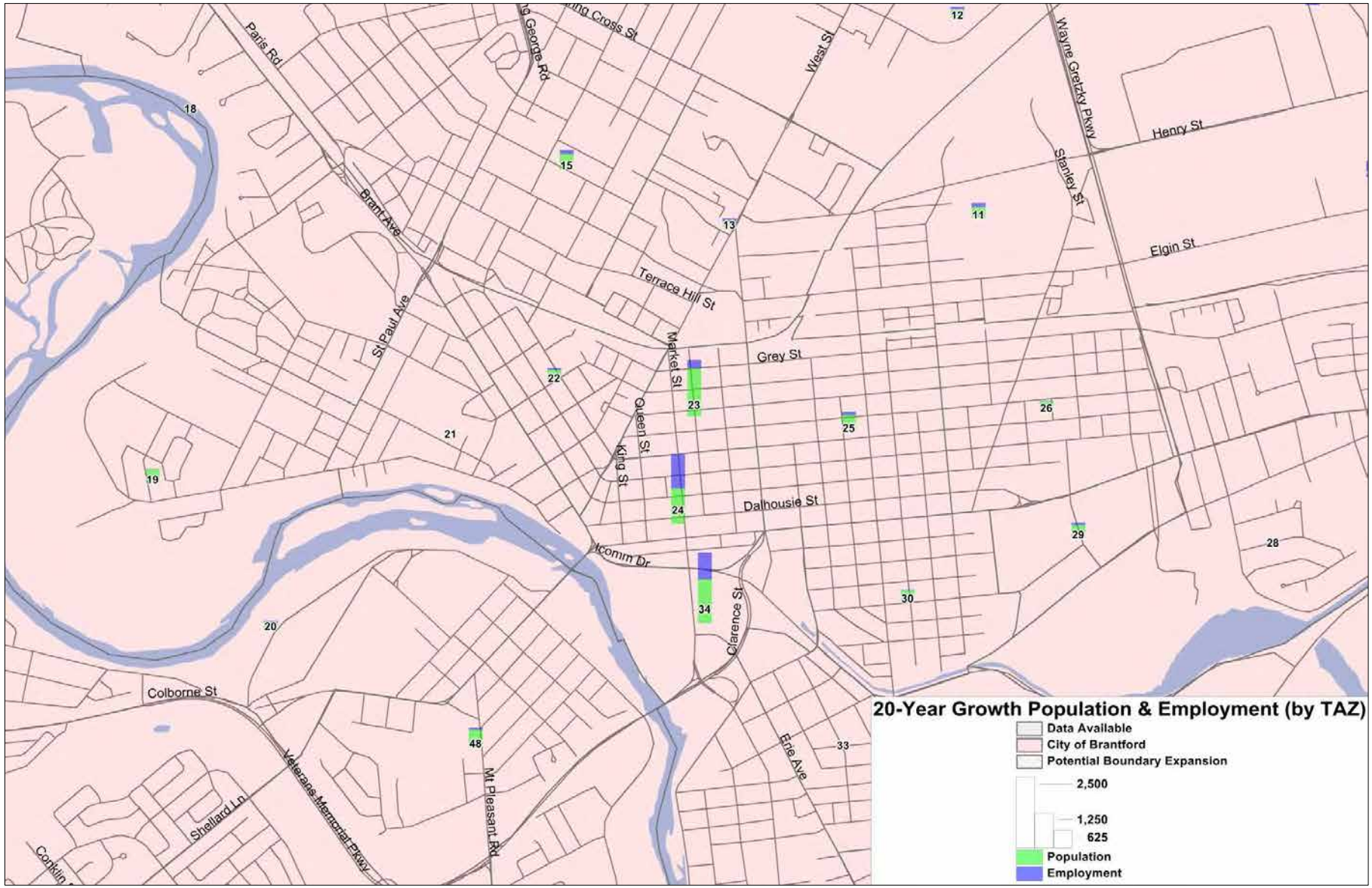


Exhibit 4.2b: Population and Employment Growth for City of Brantford, Zoom-in to Downtown



The Fratar method was applied to the 2011 synthetic matrices with the 2031 trip totals to produce 2031 matrices. Mode choices from 2011 were applied reflecting "do-nothing" changes to mode-shares. 2011 peak hour and auto occupancy factors were applied for private auto trips for the same reason.

The forecasted modal growths are consistent with population and employment growth, as shown in Exhibit 4-3. It should be noted that the transit growth is less than population growth for the base scenario as a result of this growth occurring in areas not currently served by transit.

Exhibit 4-3: Private Auto and Transit Trip Total Forecasts

Mode / Period	2011	2031	Growth
Private Auto			
A.M. Peak Hour			
Brant County (excl. City of Brantford)	15,205	19,650	29%
City of Brantford	16,709	20,439	22%
Total	**31,914**	**40,089**	**26%**
P.M. Peak Hour			
Brant County (excl. City of Brantford)	18,241	23,694	30%
City of Brantford	25,467	32,592	27%
Total	**43,708**	**56,286**	**29%**
Transit			
A.M. Peak Period	1,259	1,640	30%
P.M. Peak Period	1,460	1,739	19%

Note(s): Trip totals shown above were aggregated to the super-zone system used in 2011 Transit Service Review and to disaggregate the 2006 TTS data for transit trips. Transit demand reflects transit travel predominantly done within the City of Brantford.

4.2 2031 Assignment

Private Auto Traffic

Exhibit 4-5 (a) and (b) illustrate the assignment of private auto vehicles to the network. The growth in private auto traffic resulted in the following network performances:

- The percentage growths in a.m. and p.m. peak hour delay and vehicle-kilometres travelled are similar (see Exhibit 4-4). In absolute terms, a.m. delay was forecasted to increase moderately to 95 min. However, p.m. delay was forecasted to increase significantly to 245 min. Exhibit 4-6 illustrates the extent of vehicle growth;

- There is continued capacity stress on key existing corridors – King George Road, Brant Avenue, West Street, Wayne Gretzky Avenue, Colborne Street and Veterans Memorial Parkway;

- New capacity stress on Brant Avenue between Toll Gate Road and King George Road was observed;

- New capacity stress on Clarence Street that continues north of Veterans Memorial Parkway was observed;

- New capacity stress on Shellard Lane and Blackburn drive leading into the southwest subdivisions was observed; and,

- New capacity stress on the 1-way couplets of Colborne Street and Dalhousie Street west of Wayne Gretzky Parkway was observed.

Exhibit 4-7 (a) and (b) summarize the modelled growth across the screenlines. Exhibit 4-8 illustrates the modelled growth across the screenlines for the a.m. and p.m. peak hours, respectively. In general, the total modelled traffic follows the travel demand and demographic trends. As indicated by the arrows in Exhibit 4-7 (a) and (b), there is directionality in forecasted traffic growth.

In the a.m. peak hour:

- While there is moderate growth in east-west traffic within the City of Brantford, much of the traffic originating from the City of Brantford will be attracted to external destinations to the east, west and south; and,

- There is growth in commuter traffic coming from the north along Highway 24A and 24 and entering the City of Brantford;

In the p.m. peak hour:

- The opposite commuter trend growth was observed where much of the east, west and south traffic are attracted to destinations within the City of Brantford; and,

- Highway 24 serves as a well utilized route for traffic entering and exiting the City of Brantford.

Exhibit 4-4: Network Growth Statistics, 2011 to 2031

Peak Period / Aggregate Network Statistic	2011	2031	Growth
A.M. Peak Hour			
Delay (min)	31.3	96.4	208%
Vehicle-Kilometre Travelled (veh-km)	482,188	611,002	27%
P.M. Peak Hour			
Delay (min)	72.6	244.4	237%
Vehicle-Kilometre Travelled (veh-km)	593,268	775,107	31%

Exhibit 4-5a: 2031 Private Auto Traffic Forecast, A.M. Peak Hour

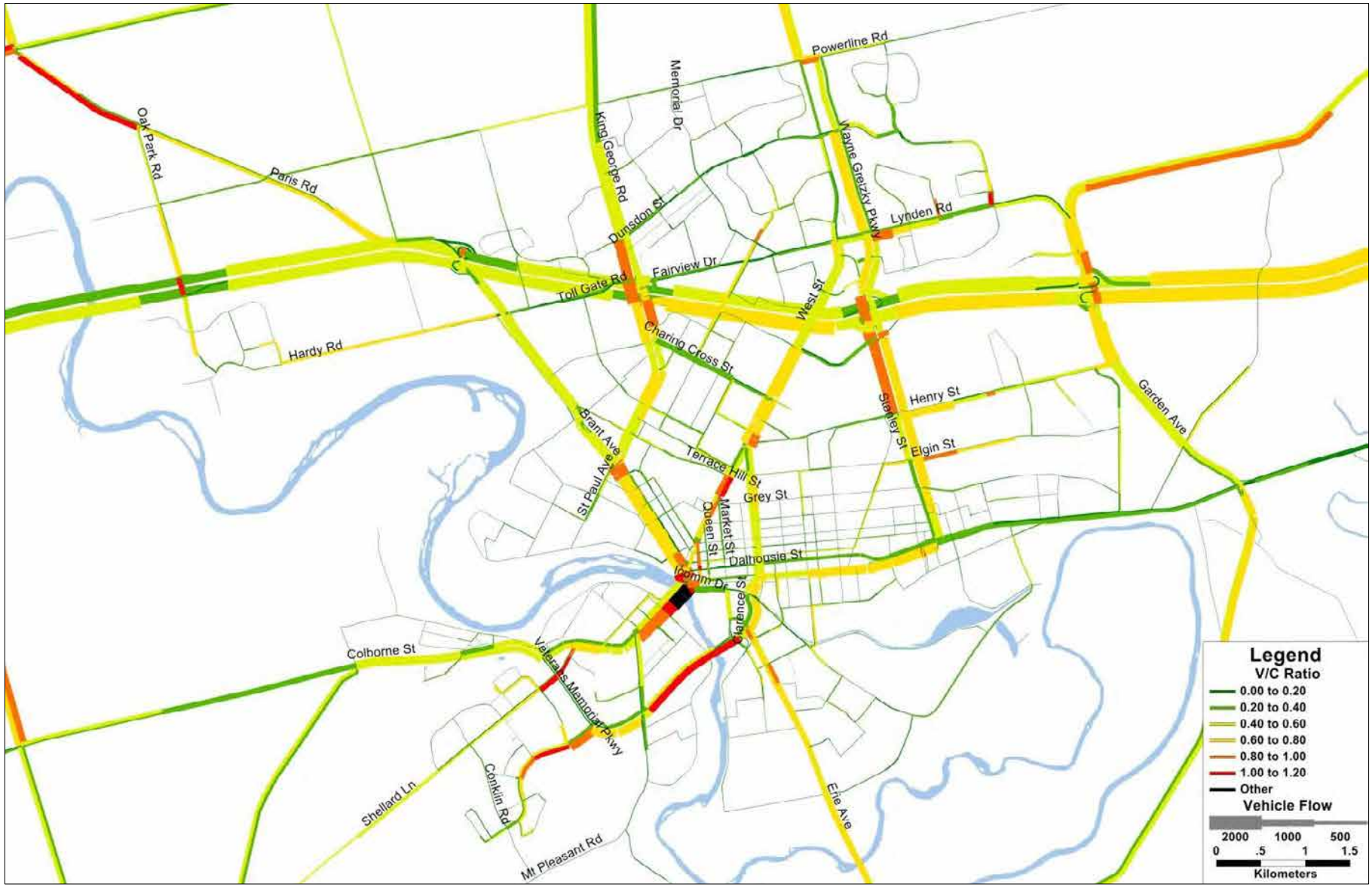


Exhibit 4.6b: 2031 Private Auto Traffic Forecast, P.M. Peak Hour

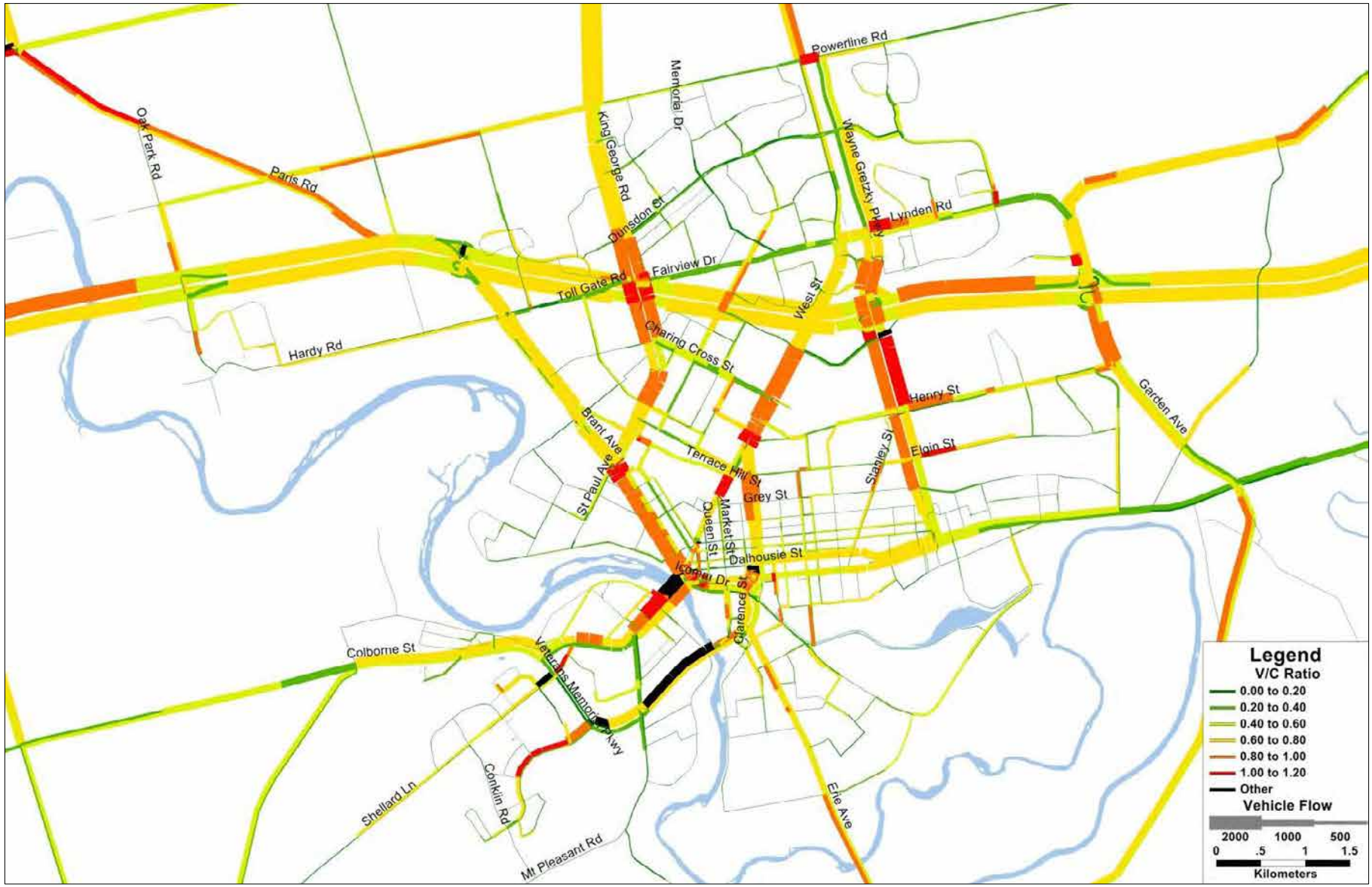


Exhibit 4-6: Vehicle Growth from 2011 to 2031, P.M. Peak Hour

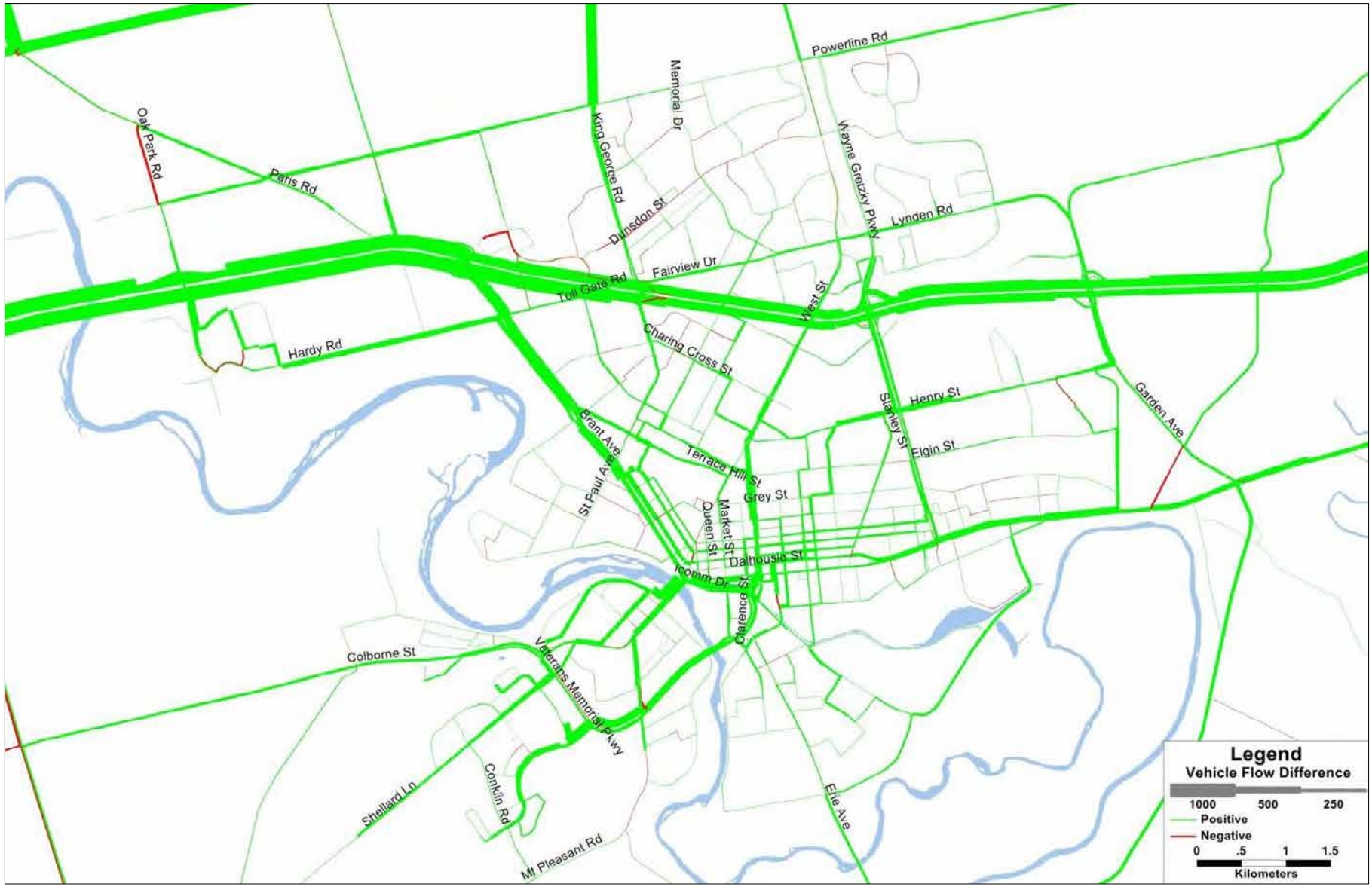
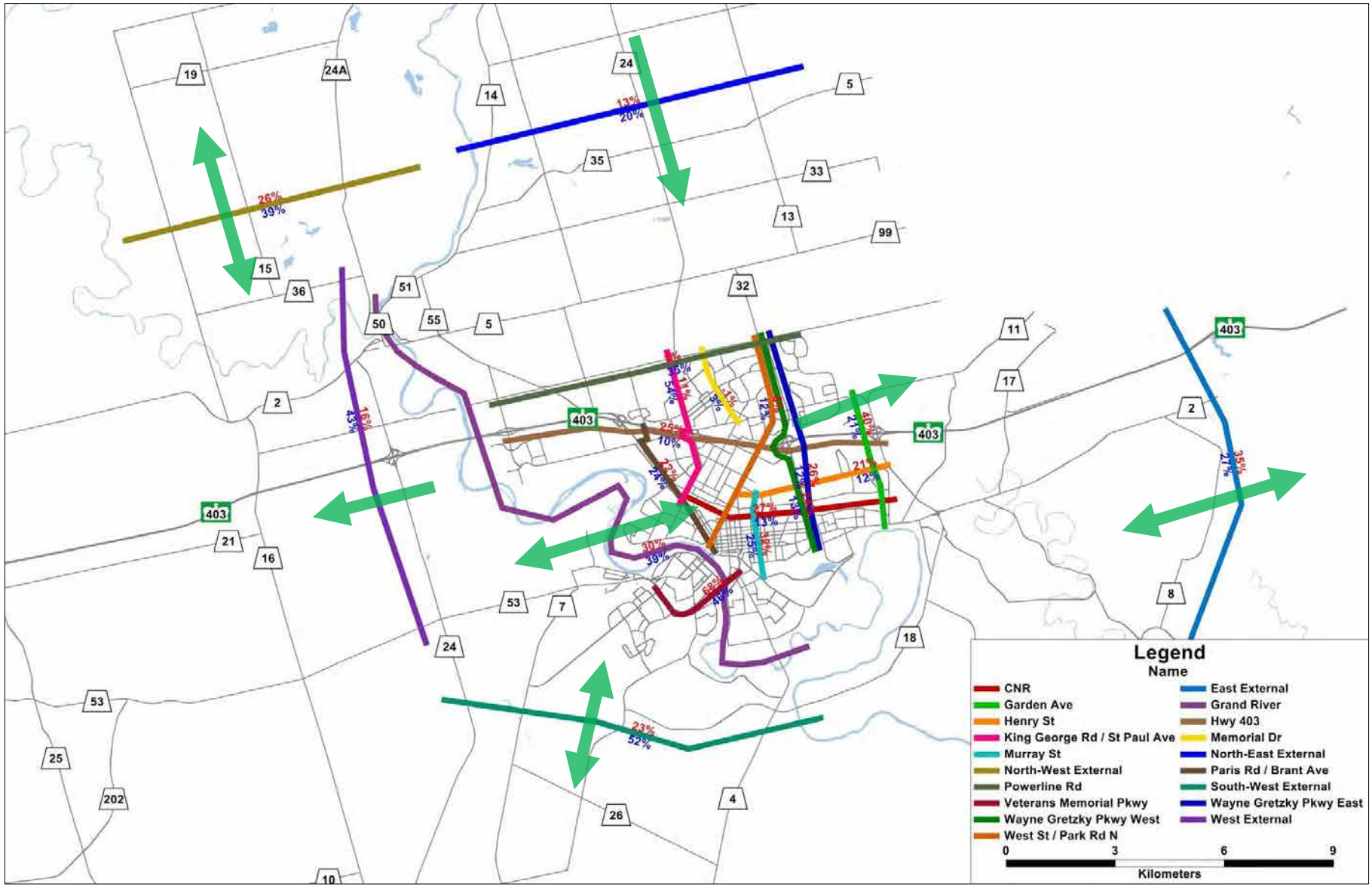
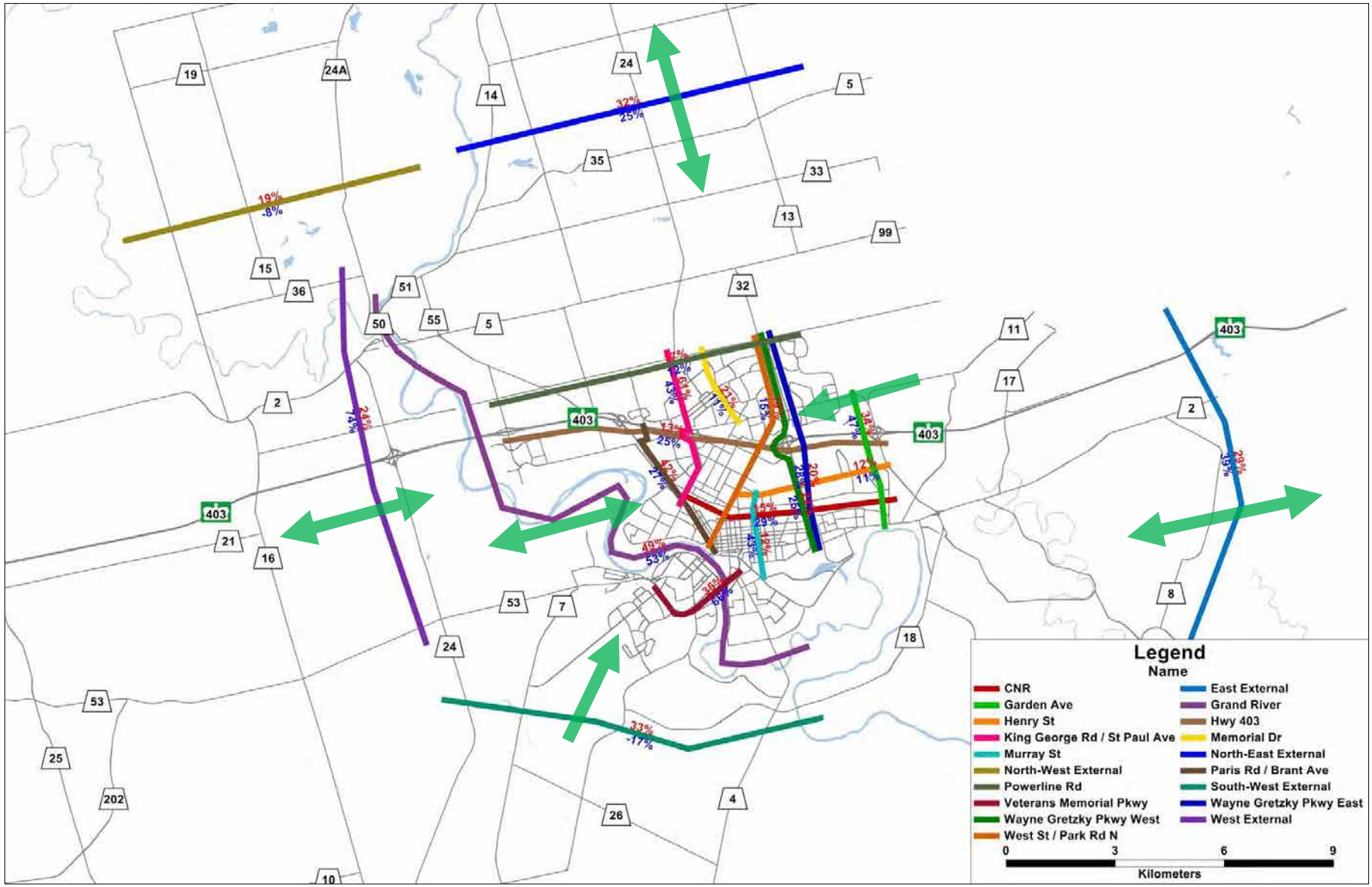


Exhibit 4-7a: Screenline Growth, 2011 to 2031, A.M. Peak Hour



Red indicates eastbound/northbound growth. Blue indicates westbound/southbound growth. Green arrows indicate general growth directions.

Exhibit 4.8b: Screenline Growth, 2011 to 2031, P.M. Peak Hour



Red indicates eastbound/northbound growth. Blue indicates westbound/southbound growth. Green arrows indicate general growth directions.

Exhibit 4-8: Screenline Growth, 2011 to 2031

A.M. Peak Hour

Screenline	2011			2031			Growth		
	EB/NB	WB/SB	Total	EB/NB	WB/SB	Total	EB/NB	WB/SB	Total
Grand River	5,368	3,060	8,428	6,969	4,251	11,220	30%	39%	33%
Hwy 403	4,391	5,213	9,604	5,511	5,753	11,264	25%	10%	17%
Paris Rd / Brant Ave	3,108	2,520	5,628	3,792	3,120	6,912	22%	24%	23%
King George Rd / St Paul Ave	2,678	1,902	4,580	2,973	2,931	5,905	11%	54%	29%
Wayne Gretzky Pkwy East	5,259	3,796	9,055	6,645	4,257	10,902	26%	12%	20%
Wayne Gretzky Pkwy West	5,317	3,543	8,860	6,601	4,004	10,604	24%	13%	20%
Memorial Dr	476	814	1,290	472	842	1,314	-1%	3%	2%
West St / Park Rd N	2,443	1,846	4,289	2,591	2,074	4,666	6%	12%	9%
Henry St	3,107	1,822	4,929	3,769	2,036	5,805	21%	12%	18%
CNR	3,823	2,647	6,469	4,866	2,997	7,863	27%	13%	22%
Garden Ave	3,152	2,545	5,696	4,397	3,086	7,483	40%	21%	31%
Powerline Rd	1,707	2,044	3,751	1,726	2,764	4,490	1%	35%	20%
Murray St	1,309	617	1,926	1,726	769	2,495	32%	25%	30%
Veterans Memorial Pkwy	1,505	805	2,310	2,525	1,177	3,701	68%	46%	60%
INTERNALS	**43,642**	**33,174**	**76,816**	**54,563**	**40,059**	**94,621**	**25%**	**21%**	**23%**
West External	926	1,143	2,069	1,077	1,634	2,711	16%	43%	31%
South-West External	339	380	719	417	577	994	23%	52%	38%
East External	2,451	2,392	4,843	3,320	3,031	6,350	35%	27%	31%
North-East External	776	507	1,283	873	607	1,480	13%	20%	15%
North-West External	516	547	1,063	650	759	1,409	26%	39%	32%
EXTERNALS	**5,007**	**4,970**	**9,977**	**6,336**	**6,608**	**12,944**	**27%**	**33%**	**30%**
TOTAL	**48,650**	**38,144**	**86,794**	**60,899**	**46,666**	**107,565**	**25%**	**22%**	**24%**

P.M. Peak Hour

Screenline	2011			2031			Growth		
	EB/NB	WB/SB	Total	EB/NB	WB/SB	Total	EB/NB	WB/SB	Total
Grand River	4,355	6,348	10,704	6,487	9,703	16,190	49%	53%	51%
Hwy 403	6,719	5,778	12,497	7,580	7,224	14,803	13%	25%	18%
Paris Rd / Brant Ave	3,127	3,292	6,419	4,449	4,178	8,628	42%	27%	34%
King George Rd / St Paul Ave	2,830	3,285	6,115	4,564	4,682	9,246	61%	43%	51%
Wayne Gretzky Pkwy East	5,295	6,280	11,574	6,357	8,066	14,424	20%	28%	25%
Wayne Gretzky Pkwy West	4,992	6,227	11,219	6,105	7,809	13,914	22%	25%	24%
Memorial Dr	1,013	819	1,832	1,225	906	2,131	21%	11%	16%
West St / Park Rd N	2,639	3,042	5,681	3,123	3,494	6,617	18%	15%	16%
Henry St	3,235	2,953	6,188	3,614	3,268	6,882	12%	11%	11%
CNR	3,925	4,988	8,912	4,508	6,420	10,928	15%	29%	23%
Garden Ave	3,386	3,361	6,747	4,525	4,937	9,462	34%	47%	40%
Powerline Rd	2,636	2,464	5,100	3,071	2,757	5,827	17%	12%	14%
Murray St	1,093	1,532	2,625	1,228	2,184	3,412	12%	43%	30%
Veterans Memorial Pkwy	886	1,567	2,453	1,192	2,603	3,794	35%	66%	55%
INTERNALS	**46,129**	**51,937**	**98,066**	**58,027**	**68,230**	**126,257**	**26%**	**31%**	**29%**
West External	1,341	1,114	2,455	1,663	1,933	3,596	24%	74%	46%
South-West External	412	374	786	549	310	859	33%	-17%	9%
East External	3,064	2,476	5,541	3,966	3,437	7,402	29%	39%	34%
North-East External	784	953	1,737	1,032	1,193	2,225	32%	25%	28%
North-West External	713	662	1,375	848	607	1,455	19%	-8%	6%
EXTERNALS	**6,314**	**5,579**	**11,894**	**8,058**	**7,480**	**15,538**	**28%**	**34%**	**31%**
TOTAL	**52,443**	**57,517**	**109,960**	**66,085**	**75,710**	**141,795**	**26%**	**32%**	**29%**

Transit

Transit ridership showed significant growth for routes 1, 6, 7 and 9, as summarized in Exhibit 4-9. Strong growth along routes 1, 6 and 9 can be attributed to the strong population growth observed zones surrounding these lines. Growth on route 7 is strong but slightly less than the other routes owing to employment growth in the Braneida Park area. As noted by the 2011 Transit Service Review, route 7 receives a lot of cross-town traffic, which when combined with the employment growth at Braneida Park resulted in strong growth for the route. Exhibit 4-10 (a) and (b) illustrate the ridership forecasts by route for the a.m. and p.m. peak periods, respectively.

Exhibit 4-9: Ridership Growth, 2011 to 2031

Route	A.M. Peak Period (6 A.M. – 9 A.M.)			P.M. Peak Period (3 P.M. – 6 P.M.)		
	Ridership		Growth	Ridership		Growth
	2011	2031		2011	2031	
1	148	216	46%	155	199	28%
2	196	223	14%	300	329	10%
4A	168	172	3%	243	257	6%
4C	131	140	7%	260	260	0%
5	34	38	9%	54	62	15%
6	61	95	55%	58	111	92%
7	179	252	41%	142	170	20%
8	99	90	-10%	182	168	-8%
9	192	309	61%	144	172	20%
TOTAL	**1,209**	**1,534**	**27%**	**1,538**	**1,729**	**12%**

Exhibit 4-10a: 2031 Transit Traffic Assignment, A.M. Peak Period

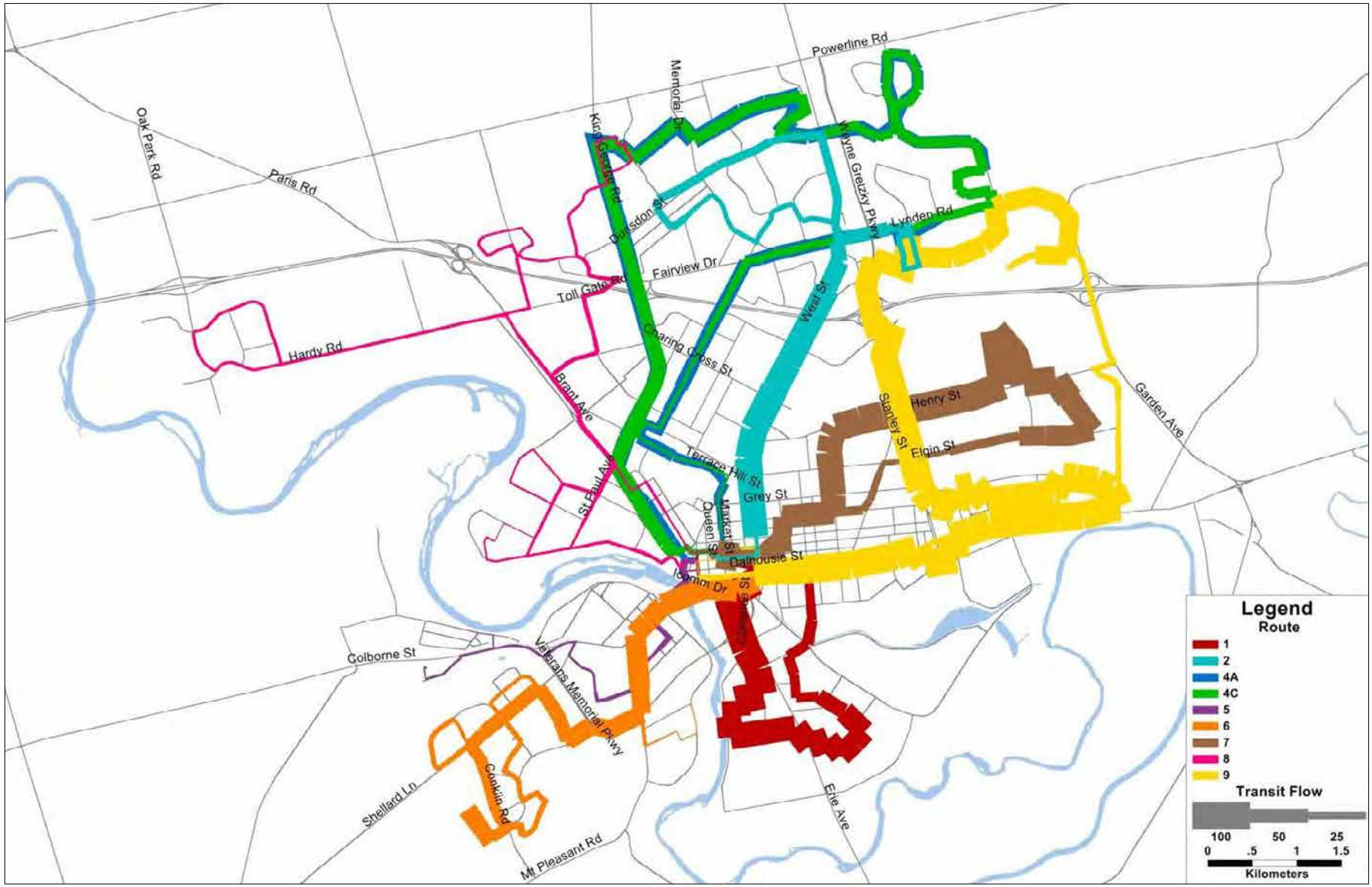
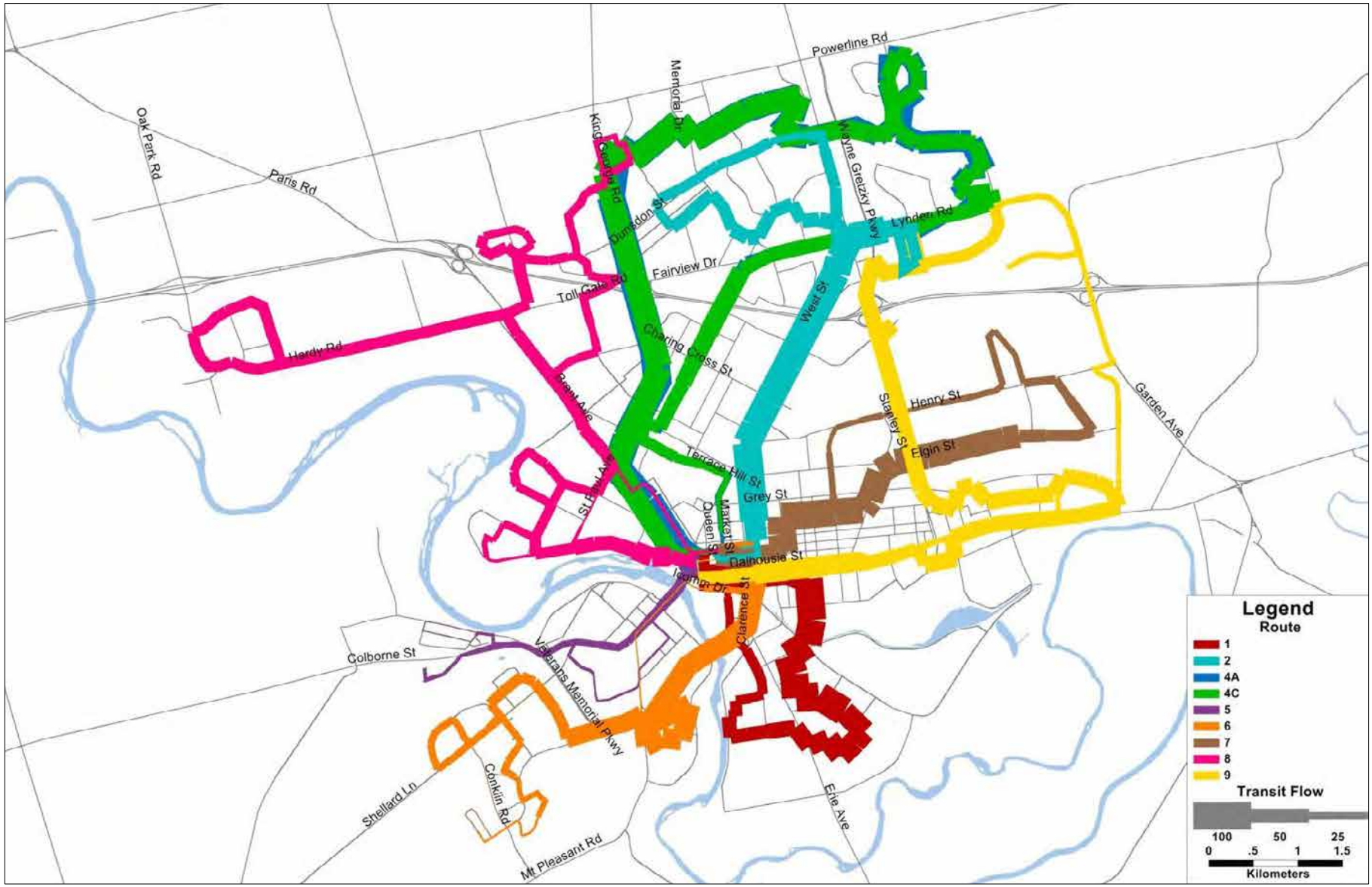


Exhibit 4.11b: 2031 Transit Traffic Assignment, P.M. Peak Period



4.3 Additional Horizon Analysis

The City provided projected population and employment projections for the 2021, 2026, and 2041 time horizons. Model runs for for each of the interim horizons were undertaken to determine the interim response of the transportation network with and without the improvements identified for the 2031 TMP. Results were used to prioritize improvements (with input from the City) as described in TMP section 4.5.1. Long range 2041 forecasts included extensive population and employment growth focused on areas north of the current municipal boundary and also including growth in the rest of the City. Sample model output plots for the p.m. peak hour for 2021, 2026 and 2041 are provided on the following exhibits.

Exhibit 4-11 : 2021 Do-Nothing Flow and V/C, PM Peak Hour

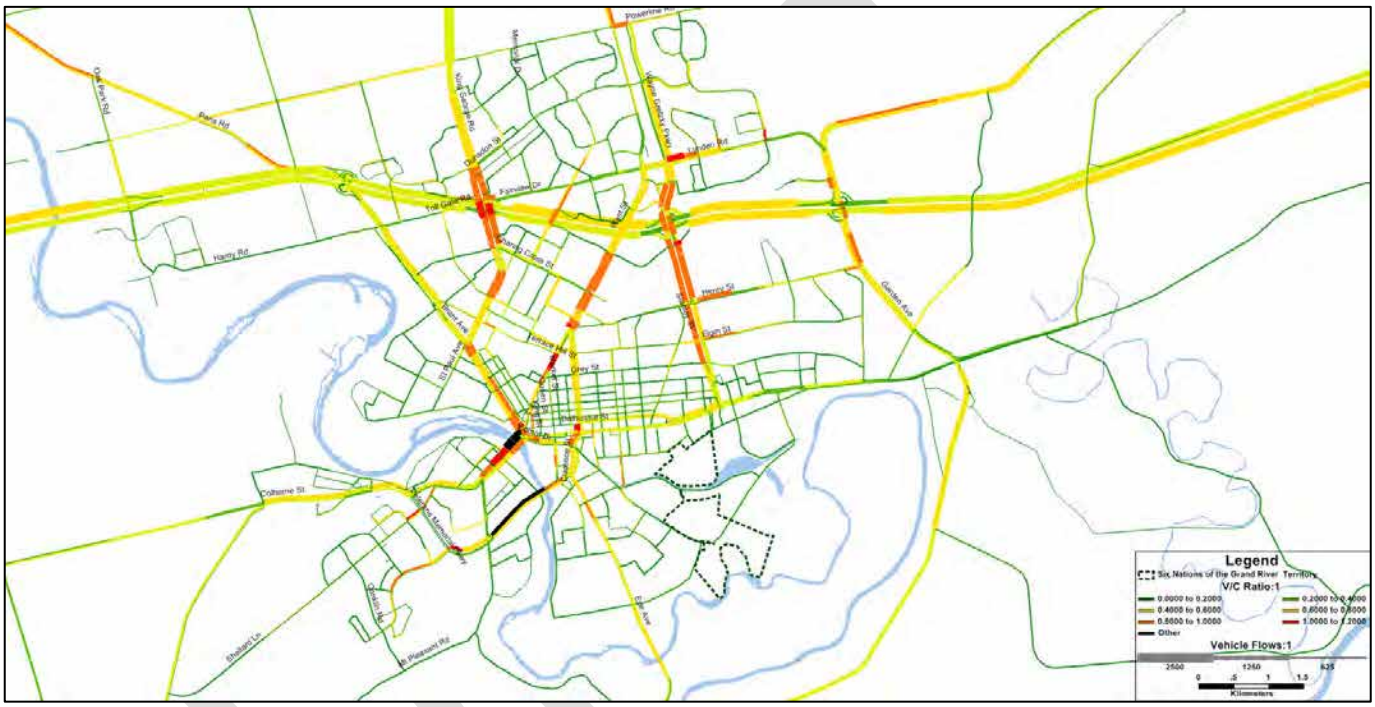


Exhibit 4-12: 2021 Scenario 3 (TMP) Flow and VC, PM Peak Hour

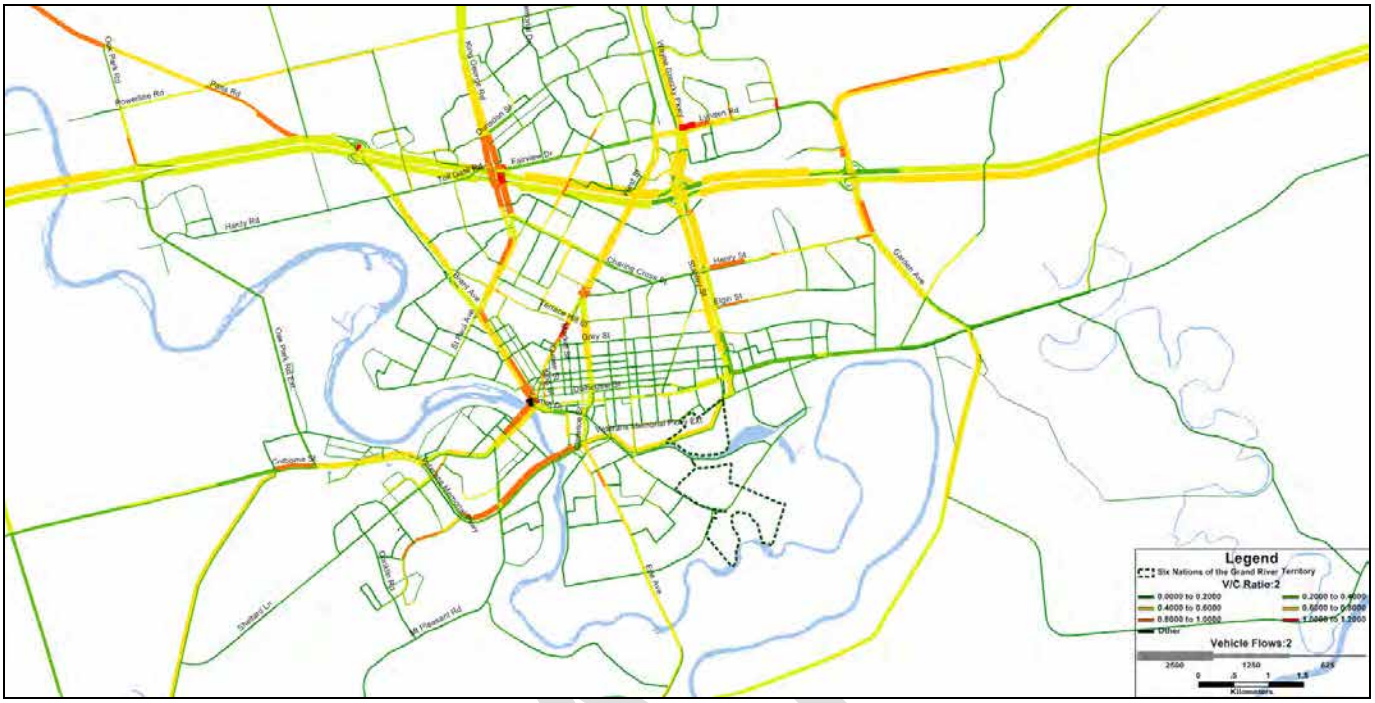


Exhibit 4-13: 2026 Do Nothing Flow and VC, PM Peak Hour

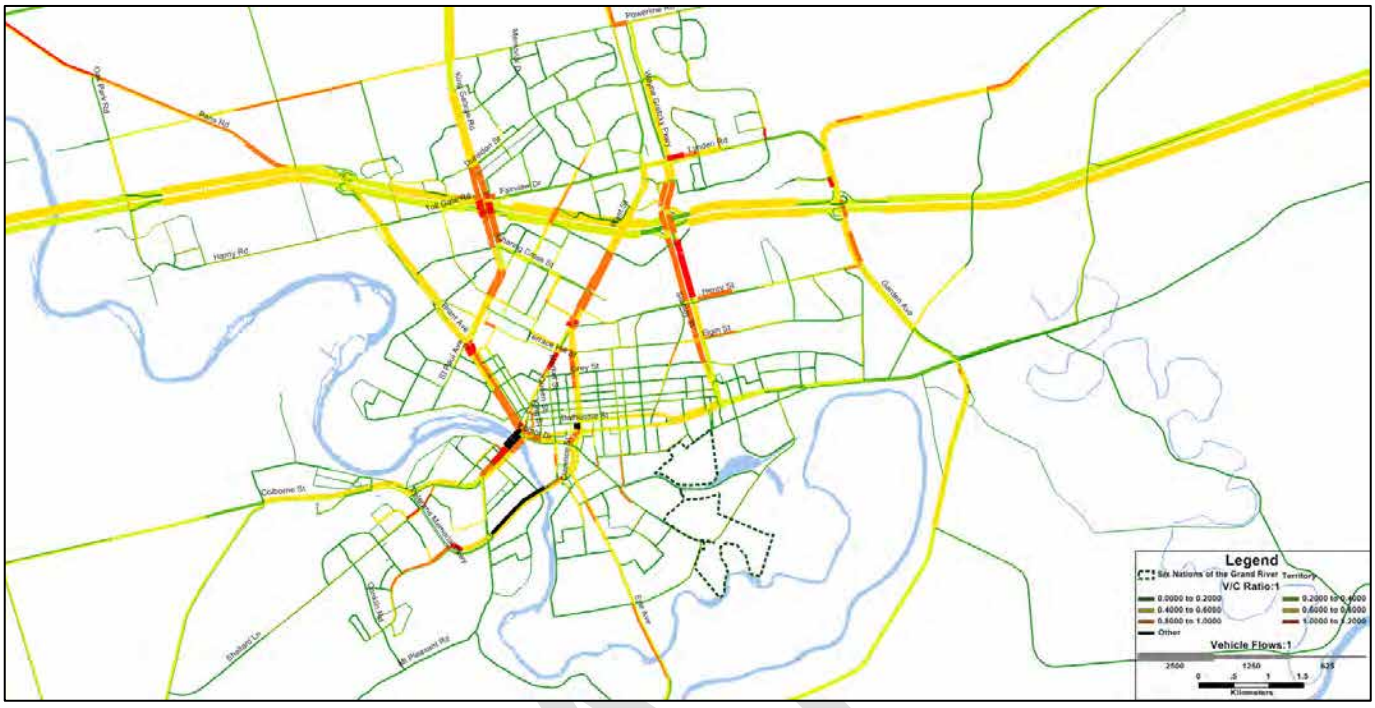


Exhibit 4-14: 2026 Scenario 3 (TMP) Flow and VC, PM Peak Hour

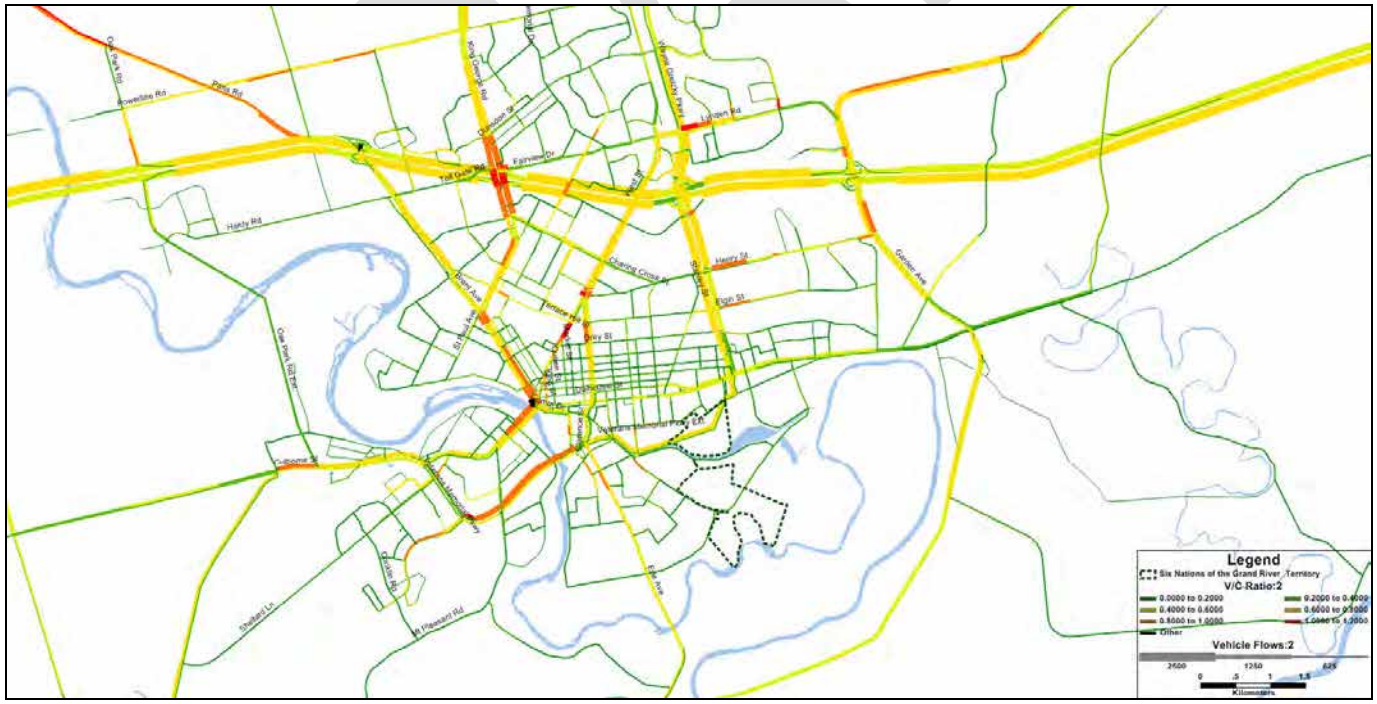


Exhibit 4-15: 2041 Do-Nothing Flow and VC, PM Peak Hour

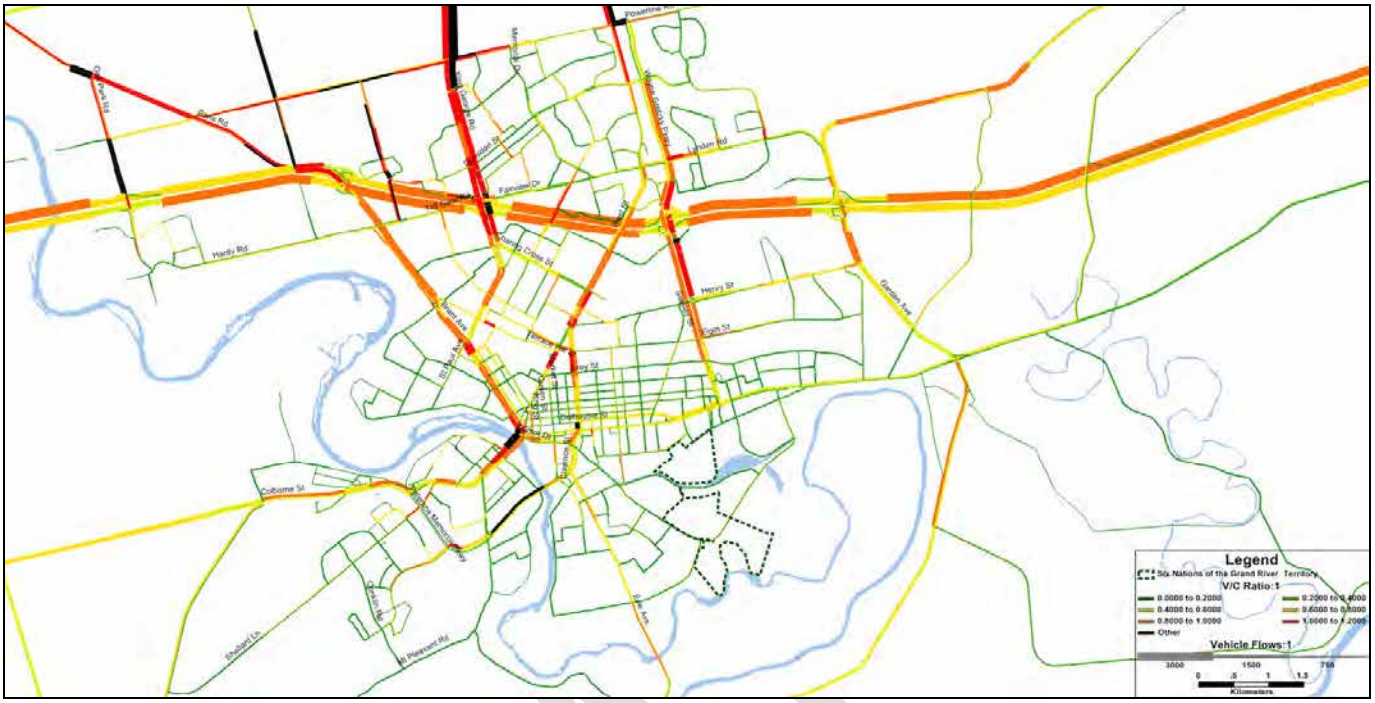
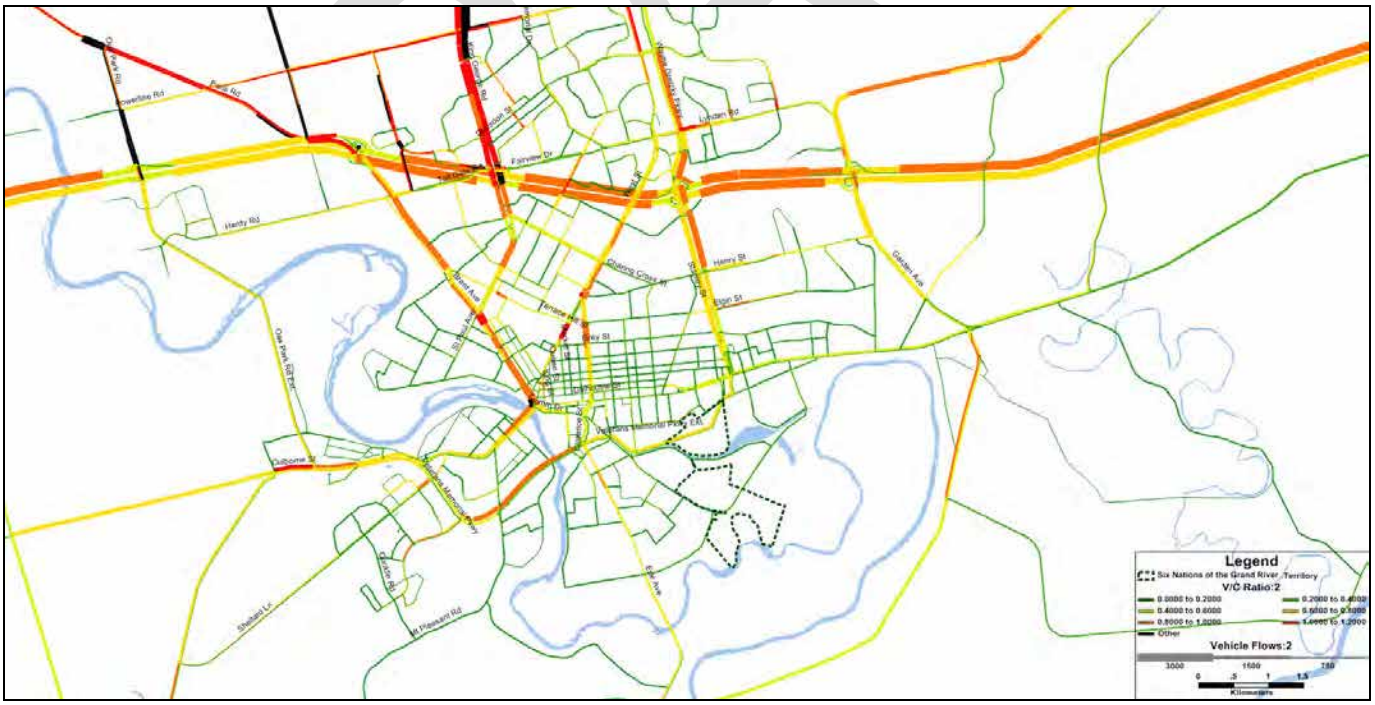


Exhibit 4-16: 2041 Scenario 3 (TMP) Flow and VC, PM Peak Hour



5. Summary

The City of Brantford's TransCAD travel demand model was updated for the 2013 Transportation Master Plan. The updates detailed in this report include:

- A 2011 base year, incorporating the most recent population and employment forecasts, traffic counts and transit ridership data;
- A new road layer with higher-resolution GIS data to allow better mapping and road and transit representation;
- A new auto assignment algorithm with a faster and more accurate origin-based user-equilibrium method;
- Developed a new transit model component that reflects 2011 transit operations data; and,
- A range of model network or parameter adjustments to improve base-year validation and refine future-year forecasts.

The auto-mode of the model was validated against 19 screenlines with extensive updated traffic count data. For transit, the model was validated at the overall ridership scope and on individual routes against data in the *2011 Transit Service Review*. The model is limited in forecasting stop-by-stop boardings and alightings due to the layout of centroid connectors shared with the private auto traffic network. Nevertheless, many of the routes were consistently modelled with trends observed.

According to population and employment forecasts, the City of Brantford is expected to growth by 29% and 27%, respectively, between 2011 and 2031. A 20-year horizon with a "do-nothing" policy (no road improvements or mode-share changes) was modelled according to the new model processes. The following network results were observed:

- There is significant growth for travel within the City of Brantford, with a 27% to 29% increase in vehicle-kilometers of travel, and a 200% increase in traffic delay;
- Commuter travel continues to play a key role for travel both into and out of the City, with trips towards the west, east and south showing strong growth;
- City roads continue to serve trips that bypass the City, i.e. trips that travel between zones in Brant County;
- Highway 24 will continue to be an important route for northbound traffic into and out of the City;
- There will be continued capacity stress on key existing corridors – King George Road, Brant Avenue, West Street, Wayne Gretzky Avenue, Colborne Street and Veterans Memorial Parkway;
- New capacity stresses were observed on Brant Avenue between Toll Gate Road and King George Road; Clarence Street north of Veterans Memorial Parkway; Shellard Lane and Blackburn drive leading into the southwest

subdivisions; and the 1-way couplets of Colborne Street and Dalhousie Street west of Wayne Gretzky Parkway; and,

- There were significant increases in ridership along routes 1, 6, 7 and 9.

These observations were generally consistent with the 2010 model findings for the 2031 horizon. However, King George Road, West Street and Wayne Gretzky Parkway were observed to be operating nearer to capacity than forecasted in the 2010 model for both peak hours. The noted stresses on the road and transit network and differences with the 2010 model forecasts should be noted for the 2013 TMP update.

Appendix