Brampton Queen Street – York Region Highway 7 BRT Initial Business Case

October 2020

METROLINX

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Executive Summary

The Need for BRT

One of the key strategies of the 2041 Regional Transportation Plan is the implementation of the Frequent Rapid Transit Network (FRTN); establishing rapid transit on a number of key corridors across the Greater Toronto and Hamilton Area (GTHA). Included in the FRTN and also identified as Priority In-Development projects are bus rapid transit (BRT) projects along Queen Street in the City of Brampton and Highway 7 in York Region, connecting to the existing Viva Network.

There is a demonstrated need to provide rapid transit connections within the City of Brampton and through to York Region to meet current and projected demand, while supporting a shift to more sustainable modes of transport. As a growing city in Canada[1] and home to major industrial and employment lands, Brampton plays a unique role in the GTHA. Brampton is also a young city with many university and college students, and many of these commuters rely on transit to access key destinations.

To support its large employment base and growing population, the City of Brampton, Brampton Transit, Region of Peel, York Region, and Metrolinx have identified bus rapid transit (BRT) along the Queen Street – Highway 7 Corridor as a core component of the FRTN. Like many important corridors in the region, the Queen Street – Highway 7 Corridor has seen increased levels of residential intensification and mixed-use development. The Queen Street – Highway 7 Corridor is a crucial transportation corridor connecting people through the cities of Brampton and Vaughan, to and from key transportation generators such as York University, Downtown Brampton, and Downtown Toronto namely by the TTC subway Line 1 at Vaughan Metropolitan Centre station. Bus rapid transit has a proven track record in the region and the future Queen Street – Highway 7 BRT will build on this by integrating with the existing York Region Transit (YRT) Viva rapidway network on Highway 7. This corridor will connect communities and provide a link between Brampton and Vaughan to support long term growth and development.

The Brampton Queen Street – York Region Highway 7 BRT Planning Study and Initial Business Case (IBC)

This IBC defines three (3) transit service concept options and three (3) infrastructure options for the Queen Street – Highway 7 BRT. Figure 1 illustrates the approach used to develop the IBC, in conjunction with the Metrolinx Business Case Framework.

The transit service concept options were evaluated with the GGHM_v4 model which is used by Metrolinx to evaluate business cases, and a preferred option was used to inform the evaluation of the infrastructure options according to the framework, including the Strategic, Economic, Financial, and Deliverability and Operations cases. All options that were considered provided different levels of increased transit service and supportive infrastructure. The IBC recommends a preferred service option and dedicated bus infrastructure to support a BRT corridor moving into the Preliminary Design Business Case phase.

[1] Statistics Canada 2011 Census of Population. Retrieved from https://www.brampton.ca/en/City-Hall/Pages/About-Brampton.aspx.

IBC steps including scenario creation and evaluation -
Brampton Queen St-Hwy 7 York BRT corridor

A Transportation portrait - actual (2016) and future (2041) & service goals

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B Define service scenarios (3)

↓

C **EVALUATION 1:** Determine best adequate service definition scenario

↓

D Define infrastructure scenarios (3)

↓

E **EVALUATION 2:** Business Case - BRT scenario evaluation

↓

F Recommendation of preferred scenario

Figure 1: IBC steps through to recommendation of a preferred scenario

Transit Services options

The transit service options were defined in collaboration with the project team, in order to compare the benefits of different transit service levels and routes to support a future network. The goals of each service option are:

- To provide increased efficiency of transit operations including speed, reliability and capacity;
- To ensure a quality user experience with seamless connections and good comfort; and
- To support and increase urban development and density.

Service options evaluated transit demand, accessibility, impact on mode share (ability to increase the proportion of travel by transit), impact on auto travel, and transit level of service. The service options are numbered as follows in the proceeding report:

- Option 1: Single main BRT trunk route
- Option 2: Two main BRT trunk routes
- Option 3: Two main BRT trunk routes and Priority Bus routes

Based on the evaluation, the recommended service option is a single main BRT trunk route plus the addition of the feeder priority routes, a combination of service options 1 and 3. The analysis indicates that this recommended service option will have the highest number of transit boardings while increasing transit accessibility in general, meaning more people will have convenient access to a sustainable mode of transportation. The single main BRT trunk route is preferred over splitting the service into two main routes as the transit demand analysis suggests that it will have higher boardings. The addition of feeder priority routes is preferred as it makes considerable improvements to transit accessibility. Table 1 shows a summary of the evaluation of transit service definition.

Table 1: Transit service definition evaluation summary

CRITERIA	KEY FINDINGS
TRANSIT DEMAND	There is higher transit demand with BRT across all service options. However, splitting the main BRT route into two sections will impact transit demand (resulting in a reduction in demand)
TRANSIT ACCESSIBILITY	Feeder routes (as modelled in Option 3) make a significant improvement for access to employment
IMPACT ON MODE SHARE	Service options 1 and 3 result in increases in transit mode share across the corridor
IMPACT ON AUTO TRAVEL	Lane reductions suggest there is capacity on the local network across all scenarios for potential displaced traffic as a result of the removal of existing traffic capacity on Queen St. However limited analysis has been completed on this and it should be further analyzed in the preliminary design phase to understand the full impacts prior to making a determination on lane configuration.
TRANSIT LEVEL OF SERVICE	Service option 3 has the highest increase in transit VKTs due to the feeder routes

This service concept was used to evaluate the different infrastructure scenarios against a Business As Usual scenario (BAU) in 2041.

Infrastructure Scenarios

One of the many benefits of BRT systems is their flexibility to multiple environments where infrastructure and right of way constraints are varied along the length of the corridor, as with the Queen Street – Highway 7 Corridor. In general, there are two operating options for BRT systems: centre median or curbside; with the option to combine these two along the length of a corridor and create a hybrid system. Centre median operation is generally preferred where possible, as it typically offers the best reliability for transit services, and thus shorter travel times for customers. The infrastructure scenarios are numbered as follows in the proceeding report:

- Option 4: Centre median operation with conversion of one general purpose traffic lane in each direction across the corridor
- Option 5: Centre median operation with the addition of a transit lane in each direction across the corridor; except in downtown Brampton where conversion of one general purpose traffic lane in each direction is applied

- Option 6: Hybrid operation of centre median BRT on the majority of the corridor, but with buses operating in mixed traffic conditions for constrained portions (downtown Brampton, highway crossings, rail track crossings and segment between Kipling and Islington Ave). Where there is median lanes proposed, this option assumed widening of one transit lane in each direction.

This IBC has evaluated three options for BRT infrastructure along Queen St and Highway 7 with a preferred future transit service scenario. Both Options 4 and 5 provide maximum transit priority across the corridor, while Option 6 performs lower due to buses in mixed traffic along sections of the corridor. It is also recognized that prior to making a determination on whether to convert existing traffic lanes over to BRT exclusive lanes, or widen the corridor to accommodate BRT lanes; more detailed design and analysis, including understanding the implications on goods movement through the corridor, as well as extensive community and stakeholder consultation is required. This analysis should be completed as part of the future Preliminary Design Business Case and Preliminary Design phases.

Summary of Business Case Evaluation

The **Strategic Case** indicates that the Queen Street – Highway 7 BRT performs well with respect to providing increased transportation choice; shaping growth in a sustainable manner and providing the means of reducing emissions from auto travel; and connecting commuters and students to jobs and education. Options 4, 5, and 6 are compared against the 2041 BAU scenario in Table 3. A legend for the summary tables is included as Table 2. The quantitative evaluation criteria are also illustrated by the applicable numbers.

Table 2: Legend for performance ranking of scenarios

Color legend for performances (ranking):

Low performance
Medium performance - low
Medium performance - high
High performance

Table 3: Strategic Case Summary of Scenarios 4, 5 and 6, IBC Queen Street - Highway 7 BRT

Criteria		2041 BAU	Scenario 4	Scenario 5	Scenario 6
Strategic Case	Transit ridership forecasts (AM peak hour boardings)	**13,696**	**18,813**	**18,734**	**15,110**
	Transit user experience (average travel time [mins] between major O-D pairs)	**117**	**107**	**108**	**110**
	Mobility choice (transit mode share [%] in study area)	**6.85**	**7.14**	**7.18**	**7.05**
	Shaping growth				
	Public health				
	Environmental health and air quality				
	Safety & connectivity				
	Active transportation benefits				
	Community & heritage				
	Accessibility to jobs				
	Catalyzing urban land development				
	Innovation & prosperity				
	Energy use & efficiency				
	Protection of natural environment				
	Summary				

The **Financial Case** evaluation shows that Option 4 has the lowest capital costs predominately due to the conversion of existing traffic lanes, rather than widening of the corridor. This evaluation is summarized in Table 4.

Table 4: Financial case summary of Scenarios 4, 5, and 6 (60-year appraisal period, $000s present value)

IMPACT	SCENARIO 4	SCENARIO 5	SCENARIO 6
CAPITAL COST	$94,900	$491,400	$151,400
OPERATING & MAINTENANCE COSTS	$420,100	$374,500	$359,400
REHAB COST	$80,200	$80,200	$80,200
PRESENT VALUE COSTS (PVC)	$595,200	$946,100	$590,900
INCREMENTAL REVENUE	$213,900	$245,000	$173,400
NET PRESENT VALUE	-$381,400	-$701,200	-$417,500

The **Economic Case** evaluation shows that Options 4 and 5 generate more benefits than Option 6, primarily due to the increased transit priority across the entire corridor under these two options. The Benefit Cost Ratio for all options is above 1 and all Options perform better than the BAU. This evaluation is summarized in Table 5.

Table 5: Economic Case Summary (60-year appraisal period, $000s present value)

IMPACT	SCENARIO 4	SCENARIO 5	SCENARIO 6
TRANSPORTATION USER BENEFITS	$1,613,400	$2,065,200	$1,426,600
EXTERNAL BENEFITS	$146,600	$125,000	$44,200
PRESENT VALUE BENEFITS (PVB)	$1,957,200	$2,415,900	$1,630,700
CAPITAL COST	$94,600	$489,800	$150,900
OPERATING & MAINTENANCE COSTS	$412,300	$367,600	$352,700
REHAB COST	$78,400	$78,400	$78,400
PRESENT VALUE COSTS (PVC)	$585,400	$935,800	$582,000
NET PRESENT VALUE (PVB – PVC)	$1,371,900	$1,480,100	$1,048,700
BENEFIT COST RATIO (PVB / PVC)	3.3	2.6	2.8

The **Deliverability and Operations Case** evaluation shows varying levels of possible impacts and constraints across all the options compared to the BAU in Table 6. This analysis is very preliminary as options for deliverability and operation of the corridor will be determined as the project progresses into the preliminary design phase. The table highlights that there are likely more significant physical impacts with widening the corridor to incorporate additional transit lanes (Options 5 and 6) rather than converting existing general purpose lanes to transit exclusive lanes (Option 4).

Table 6: Deliverability and Operation Case Summary of Options 4, 5, and 6, IBC Queen Street – Highway 7 BRT

Criteria		**2041 BAU**	**Scenario 4**	**Scenario 5**	**Scenario 6**
Deliverability and Operations Case	Project delivery				
	Operations and Maintenance Plan				
	Procurement				
	Constraints				
	Summary				

Table 7 summarizes the IBC evaluation for the Brampton Queen Street – York Region Highway 7 BRT project.

Table 7: Initial Business Case Summary of Option 4, 5, and 6 for the Queen Street – Highway 7 BRT project

Initial Business Case Element	2041 BAU	Scenario 4	Scenario 5	Scenario 6
Strategic Case				
Financial Case				
Economic Case				
Deliverability and Operations Case				
Summary				

Next Steps

The IBC identifies several optimization strategies to be considered during the Preliminary Design Business Case for the Queen Street – Highway 7 BRT. The final solution will be defined through further analysis of the impacts, costs and benefits; some of which are outlined below:

- Transit service and operations:
  - Refinements of transit routes that feed the BRT corridor based on further analysis of overall accessibility to major origin and destination points including York University, TTC Line 1 and Pearson Airport;
  - Define more detailed levels of transit service for other time periods;
  - Ensuring the design is compatible with alternative fuels technology as it develops and is implemented by operators; and
  - Further evaluation of fleet, maintenance, and facility needs for the operation of transit services.
- Infrastructure needs and design:
  - Continue to the preliminary design phase to ensure that the final design is achieving maximum benefit while remaining sensitive to the local context;
  - Undertake detailed impacts including traffic studies and extensive consultation on options under consideration;
  - An incremental approach to implementation of the ultimate solution could be considered to provide appropriate transit priority where required;
  - Define the bus terminal facilities required or changes to existing facilities to be implemented in order to support the BRT corridor and additional service at key locations such as Brampton GO Station and Bramalea Transit Terminal; and
  - Identify and define other transit priority measures to be implemented on adjacent roads to the BRT corridor, if required.

1

Introduction

Decision History

One of the key strategies of Metrolinx's 2008 Regional Transportation Plan ("The Big Move")[2] was to establish rapid transit on a number of suburban arterial corridors in the GTHA. This includes Highway 7 through York Region, which becomes Queen Street in Brampton and serves as one of the northern GTHA's principal corridors for the movement of goods and people. The corridor is increasingly becoming a destination for employment and services for those within and outside the region. The strategy to establish rapid transit corridors led to the delivery of the Highway 7 bus rapid transit (BRT) system through York Region which forms part of York Region Transit's (YRT) Viva rapidway network, offering high frequency transit service in a rapidly growing region.

The 2041 RTP, released in 2018, built on the successes of The Big Move and aims to provide even more people with access to reliable rapid transit and accelerate mode shift to sustainable and active modes. One of the key strategies of the 2041 RTP is to continue the westward extension of the existing Highway 7 BRT infrastructure into Brampton.

Under the 2041 RTP, the Queen Street and Highway 7 West portions of BRT corridor are separate in-development projects. Given the continuous linear nature of the Queen Street – Highway 7 Corridor, ridership patterns, and importance of integration across transit agencies to better serve riders, the decision was made to combine the Queen St West Priority Bus, Queen Street and Highway 7 West BRT for study under the Brampton Queen Street – York Region Highway 7 BRT Planning Study and Initial Business Case. This will ensure the project reflects existing and future service planning and integration across transit systems as they develop. The completed viva rapidway along Highway 7 between Helen St and the Vaughn Metropolitan Centre, serves both YRT and Brampton Transit buses and Queen Street serves primarily Brampton Transit buses.

Currently, Metrolinx is working with the City of Brampton, Brampton Transit, Peel Region, York Region and the City of Vaughn to advance rapid transit along the Queen Street – Highway 7 Corridor, in the context of the existing Züm, Viva and YRT services. Using the Metrolinx Business Case framework to quantify and compare the benefits of alternative scenarios, this planning study and Initial Business Case aims to guide the Queen Street – Highway 7 BRT initiative toward an initial service and infrastructure concept that can be further refined in preliminary and detailed design, and eventually lead to construction.

Brampton Queen Street – York Region Highway 7 BRT Planning Study and Initial Business Case scope

The scope of this study is to develop and evaluate alternative approaches for introducing BRT infrastructure and service to the Queen Street – Highway 7 Corridor. Figure 2 shows the corridor study area.

The planning study involves proposing a bus network that respond to the existing and future travel needs of those who may use the corridor, identifying infrastructure changes to support the

[2] http://www.metrolinx.com/thebigmove/Docs/big_move/TheBigMove_020109.pdf

increased service (i.e. designated transit lanes), and comparing options to define the recommended future transit scenario on the corridor. Both transit service (bus routes, frequencies, stop locations) and infrastructure alternatives (roadway changes) are evaluated against a comprehensive analysis in terms of their impact on ridership, time savings, congestion, and reliability using Metrolinx's GGHM_v4 travel demand model.

The Initial Business Case is a framework for comparing scenarios and selecting a preferred alternative for further refinement and preliminary design. The objective is to identify a preferred scenario as a foundation for future planning, development and funding. The concept and design are to be further developed in the Preliminary Design Business Case and the Full Business Case, according to the Metrolinx Business Case Framework.

Figure 2: The Queen Street – Highway 7 Corridor study area extends from Mississauga Road in the West to Helen Street in the East, at the end of the extended Viva rapidway. This report is structured as follows:

- **Section 2: The Case for Change,** which provides a detailed assessment of the need for this project;
- **Section 3: Investment Options,** which outlines the service concept goals and the infrastructure scenarios developed to achieve these goals;
- **Section 4: Strategic Case,** which describes how the investment options can meet various strategic metrics in the Regional Transportation Plan;

- **Section 5: Economic Case,** which assesses the economic costs and benefits of each option;
- **Section 6: Financial Case,** which reviews the overall financial impact of each option;
- **Section 7: Deliverability and Operations Case,** which evaluates how the project can be implemented; and
- **Section 8: Business Case** Summary

2

The Case for Change

Planning Context

The 2041 RTP aims to provide even more people with access to reliable rapid transit throughout the region and accelerate mode shift to sustainable and active modes. One of the key strategies of the 2041 RTP is to continue the westward extension of the Highway 7 BRT into the City of Brampton and Region of Peel. The Highway 7 portion of the project within York Region is now complete, serving both YRT and Brampton Transit buses on the western section between the Vaughn Metropolitan Centre and Helen St, while Brampton Transit serves Queen Street in the City of Brampton.

Further, the Brampton 2040 Vision[3] identifies rapid transit on Queen Street East and highlights its potential as a 'transit spine' that will support the gradual redevelopment of the corridor.

The Queen Street – Highway 7 Corridor in Brampton has undergone a significant amount of change in recent years. As the region has grown and employment and housing opportunities have become geographically dispersed across the region, corridors have seen increased growth in both local and regional traffic, as well as new development. As corridors become more important in providing access between communities, so too has the importance in providing transit along these corridors increased, as a means of ensuring equitable access to housing, employment areas, and recreational opportunities.

Brampton Transit introduced Züm services along Queen St in 2010, as well as some BRT-Lite infrastructure including queue jump lanes, and upgrades to bus stops and facilities. This increased ridership and the corridor will be at capacity without additional transit priority provided in the future.

In addition, corridors themselves should be destinations, with a range of living, working, and recreational opportunities. This means providing pedestrian-scale and active transportation infrastructure, in light of the increased desire to provide transportation alternatives and achieve a sustainable mode split between vehicles, transit, and active modes.

A growing population in Brampton and surrounding municipalities is placing increased pressure on the transit and road networks. Therefore, the need for a business case defining the best transit solution on that corridor has been identified. Further, to support forecasted growth and increase the use of sustainable transportation modes, intensification along the Queen Street Corridor will be necessary to provide the convenient connectivity to transit that will drive increased ridership.

Project Study Area

The study area for the Queen Street – Highway 7 BRT is between Mississauga Road in Brampton and Helen Street in Vaughan (immediately west of Pine Valley Drive), as

[3] City of Brampton, 2018. "Living the Mosaic: Brampton 2040 Vision". <https://www.brampton.ca/EN/City-Hall/Documents/Brampton2040Vision/brampton2040Vision.pdf>

shown in Figure 2. The Queen Street Corridor in Brampton stretches from near the western boundary of the city at Mississauga Road to Highway 50 in the east, where the corridor enters the City of Vaughan as Highway 7 and continues east through Richmond Hill and Markham. The total length of the corridor through Brampton is approximately 18.5 kilometres. The length of the corridor through Vaughan to the terminus of the study area at Helen Street is approximately 5.5 kilometres, for a total study area length of approximately **24 kilometres.**

The corridor passes through a mix of neighbourhoods, commercial areas, and industrial employment lands. These include the Bramalea City Centre shopping mall and the area around Airport Rd. The corridor also passes through Downtown Brampton which maintains its historic character. In addition, the Claireville Conservation Area at the east end of the study area provides green space and recreational opportunities with convenient access to nearby residential neighbourhoods.

Corridor Portrait

Policy portrait

The corridor forms a key part of the FRTN, under the 2041 RTP and is also supported by City of Brampton's Vision 2040, Transportation Master Plan, and in-development Community Energy and Emissions Reduction Plan

Brampton Vision 2040 - Living the Mosaic

Vision 2040 is built around seven target vision statements. For transportation, the vision is that in 2040, Brampton will be a mosaic of safe, integrated transportation choices and new modes, contributing to civic sustainability and emphasizing walking, cycling, and transit. The vision further states that the primary direction for transportation planning in Brampton is providing travel choices as alternatives to the car and reclaiming road space for other activities. To that end, priorities in the civic transportation agenda will be: first walking, then cycling, transit, and goods movement, and then shared vehicles and private vehicles. BRT along the corridor is intended to provide the strongest impetus for mode change along the Queen Street corridor.

Two other aspects of Vision 2040 are supported by the BRT and the options under consideration within this IBC. The first is that it envisions a regional rapid transit network that is complete, with the full collaboration of Brampton, whose local network is filled out more fully and tied tightly to the regional system. The second is the clustering of buildings and activities to bring origins and destinations closer together and the mixing of uses to foster links between living, jobs, and recreation, with this leading to shorter trips, fewer auto trips, more trips by transit, foot and bike, and more mixed-mode trips. The provision of BRT on Queen Street will support achievement of the second aspect by fostering intensification at select station stops (Major Transit Station Areas) along the corridor.

The options considered within this IBC also broadly support the development of Queen's Boulevard as envisioned in Vision 2040. This is to be a grand urban boulevard, stretching from the Etobicoke Creek to Highway 410, which is centred on a rapid transit spine and which includes wide sidewalks and protected bikeways.

Transportation Master Plan

Under the Transportation Master Plan, the mode share targets of 50% trips made by sustainable modes by 2041 with 20% of those being made by transit. The options considered under this IBC support the city in achieving these targets to varying degrees.

Community Energy and Emissions Reduction Plan

Work undertaken during the on-going development of the City's Community Energy and Emissions Reduction Plan has identified transportation as the largest source of greenhouse gas emissions and as a large consumer of energy (in the form of fossil fuels) in Brampton. Key to reducing these is a shift to transit and other sustainable modes of transportation and a decrease in average trip length.

Region of Peel’s Long Range Transportation Plan 2019

The Region of Peels Travel Demand Forecasting model assumes that 6-lane portions of Queen Street under Regional jurisdiction remain 6-lanes into 2041. The Region has also adopted a 50% mode share target for travel by sustainable modes which has been adopted by the local municipalities.

Land use portrait

Land use along the Queen Street Corridor is varied but is generally characterized as residential in the western portion of the corridor, commercial through Downtown Brampton, and commercial/industrial east of downtown. South of the Queen Street Corridor, Brampton has some of the largest industrial lands in the GTHA. Throughout the corridor, blocks are generally large and designed for vehicle travel, with more historical areas of the city near Downtown Brampton retaining more walkable characteristics including a denser road network and with intermixed zoning including commercial, residential, and institutional.

Regionally significant destinations include:

- **Downtown Brampton Urban Growth Centre,** from McLaughlin Road to Highway 410 and encompassing the Queen Street Corridor and portions of Main Street north of Queen Street;
- **Brampton GO Station** within Downtown Brampton; and
- **Bramalea City Centre** with a regional bus terminal.

The Highway 7 Corridor through Vaughan presents generally the same characteristics as the eastern Queen Street Corridor, with natural areas, industrial employment lands, commercial areas, and a mix of residential development east of Martin Grove Road. Some moderate residential intensification is occurring along the Highway 7 Corridor at Kipling Avenue and opposite the terminus of the existing York Region Transit Viva BRT service at Helen Street.

Regionally significant destinations on the Highway 7 Corridor include the **TTC Vaughan Metropolitan Centre (VMC) subway station** and **York University** on the southeast part of the corridor.

Socio-demographic portrait

Brampton is a young city with a rapidly growing population. Per the Statistics Canada 2016 Census:

- Brampton grew by nearly 70,000 residents between 2011 and 2016, **over triple the rate** of the Ontario provincial average.
- 20% of Brampton residents are aged 0-14 relative to 14% in the whole of Ontario. A similar proportion, 69%, are aged 15-64, and slightly fewer are aged 65+, at 11%. **The median age of the population is 36** while in Ontario it is 41.
- **Brampton has a high proportion of immigrants** from other nations, at 46%, and the same proportion of the population has a mother tongue other than English or French.
- **The average household size is larger** in Brampton than the Ontario average, with 3.5 members as opposed to 2.6.
- **Median income tends to be lower** in Brampton than elsewhere in Ontario, by approximately 10%. However, more residents in Brampton than the Ontario average have employment income, at 73% versus 71% for the entire province. Lower overall incomes may result in a higher proportion of income spent on housing costs relative to the Ontario average, with over 30% of households spending more than a third of their income on housing.

The largest employment sectors in Brampton according to the 2016 Census are manufacturing, transportation and warehousing, and retail trade. Given Brampton's significant industrial lands relative to other GTHA municipalities, this employment portrait is to be expected. The higher proportion of people working in these sectors may also contribute to somewhat lower average incomes overall, as less of the labour force is employed in professional services and other similar higher-earning occupations. Major employers in Brampton include:

- Rogers Communications (communications services)
- Fiat Chrysler Automobiles Inc. (automotive manufacturing)
- Loblaw Companies Inc. (food and beverage)
- Canadian Tire Corp. (retail goods distribution)[4]

Large business parks, manufacturing and industrial areas, and suburban retail areas support these employers and others like them.

Given the residential and employment development patterns that have historically arisen in Brampton and the fact that many residents travel outside of the City for work, its commuting patterns are currently heavily biased in favour of private cars:

- 76% of Brampton residents drive to work and an additional 7% travel to work as a passenger in a car, relative to 72% and 6% respectively for all of Ontario.
- 14% of residents take transit to work compared to 15% for the province.
- Fewer residents than average walk or cycle to work, with less than 2% of Census respondents indicating this was their typical mode for commuting relative to a combined 6% for Ontario as a whole.

In neighbouring Vaughan, per the Statistics Canada 2016 Census:

- The population grew at a slightly faster rate than the Ontario average between 2011 and 2016.
- The median age of the population is 40, slightly above that of Brampton but lower than that of Ontario.
- Median household income is higher than the Ontario average by over $30,000.
- 78% of residents drive to work and another 6% travel to work as a passenger in a car, higher than in Ontario and in Brampton.
- 16% of residents take transit to work; one point higher than the province as a whole. Less than 1% of residents cycle to work.

Transportation portrait

Road, cycling, and pedestrian infrastructure

Road infrastructure along the Queen Street – Highway 7 Corridor is varied between Mississauga Road and Helen Street, but infrastructure is generally consistent with suburban arterial roads, particularly east of downtown Brampton. Pedestrian infrastructure is generally continuous along the corridor, with some buffer between the road and sidewalk. In eastern portions of the corridor, the south side sidewalk is paved asphalt while the north side is concrete and separated from the curb lane by an asphalt kilt strip. There is limited bicycle infrastructure along the corridor.

[4] http://www.brampton.ca/EN/Business/economic-development/Research-and-Data/Pages/Top-Employers.aspx

- Figure 3 shows the roadway configuration along Queen Street from Mississauga Road to Mill Street North.
- Figure 4 shows the roadway configuration along Queen Street from Chapel Street to Bramalea Road.
- Figure 5 shows the roadway configuration along Queen Street, Glenvale Boulevard to Highway 50.
- Figure 6 shows the roadway configuration along Queen Street/Highway 7 from Highway 427 to Weston Road.

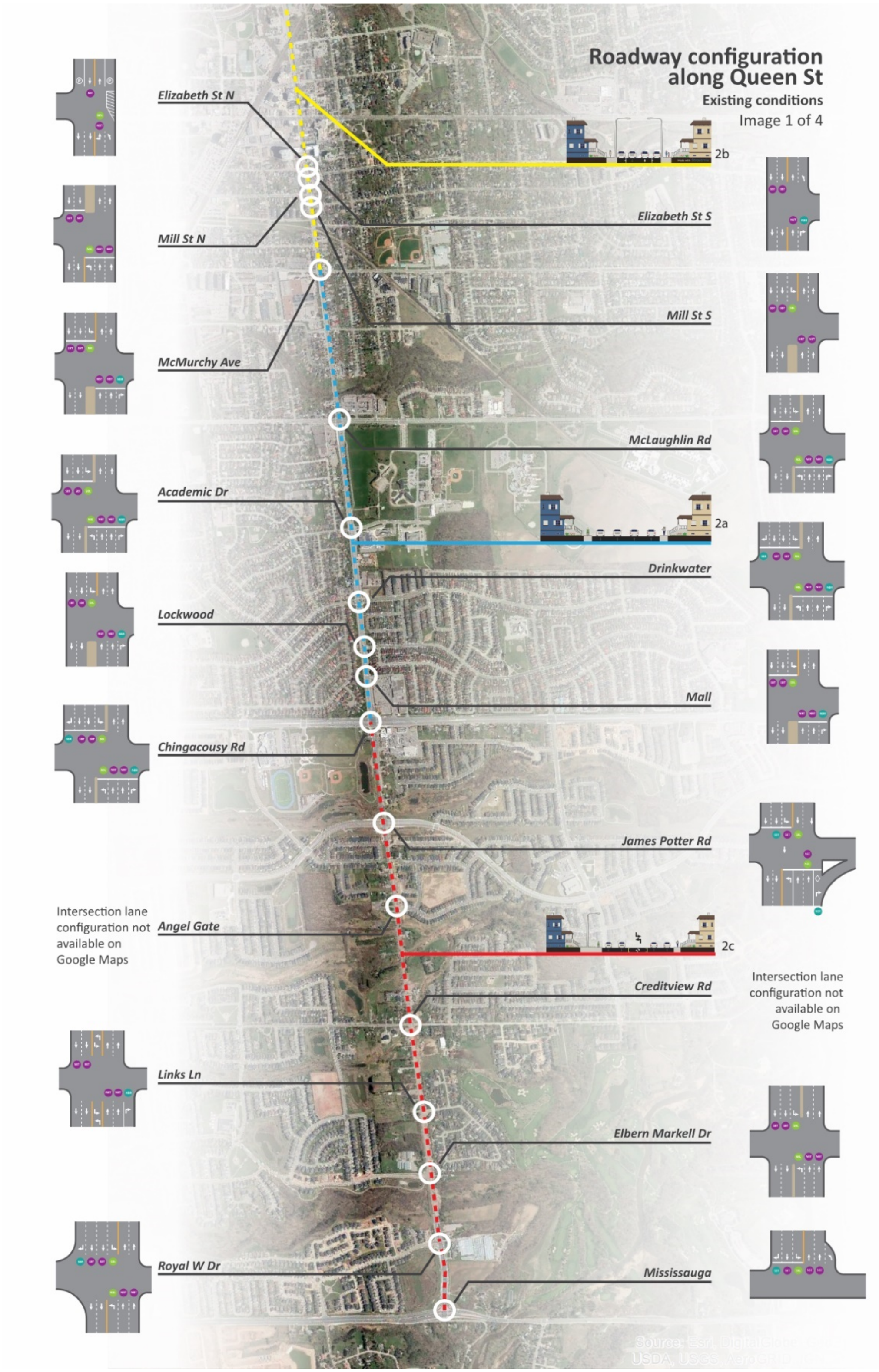


Figure 3: Roadway configuration along Queen Street, Mississauga Road to Mill Street North

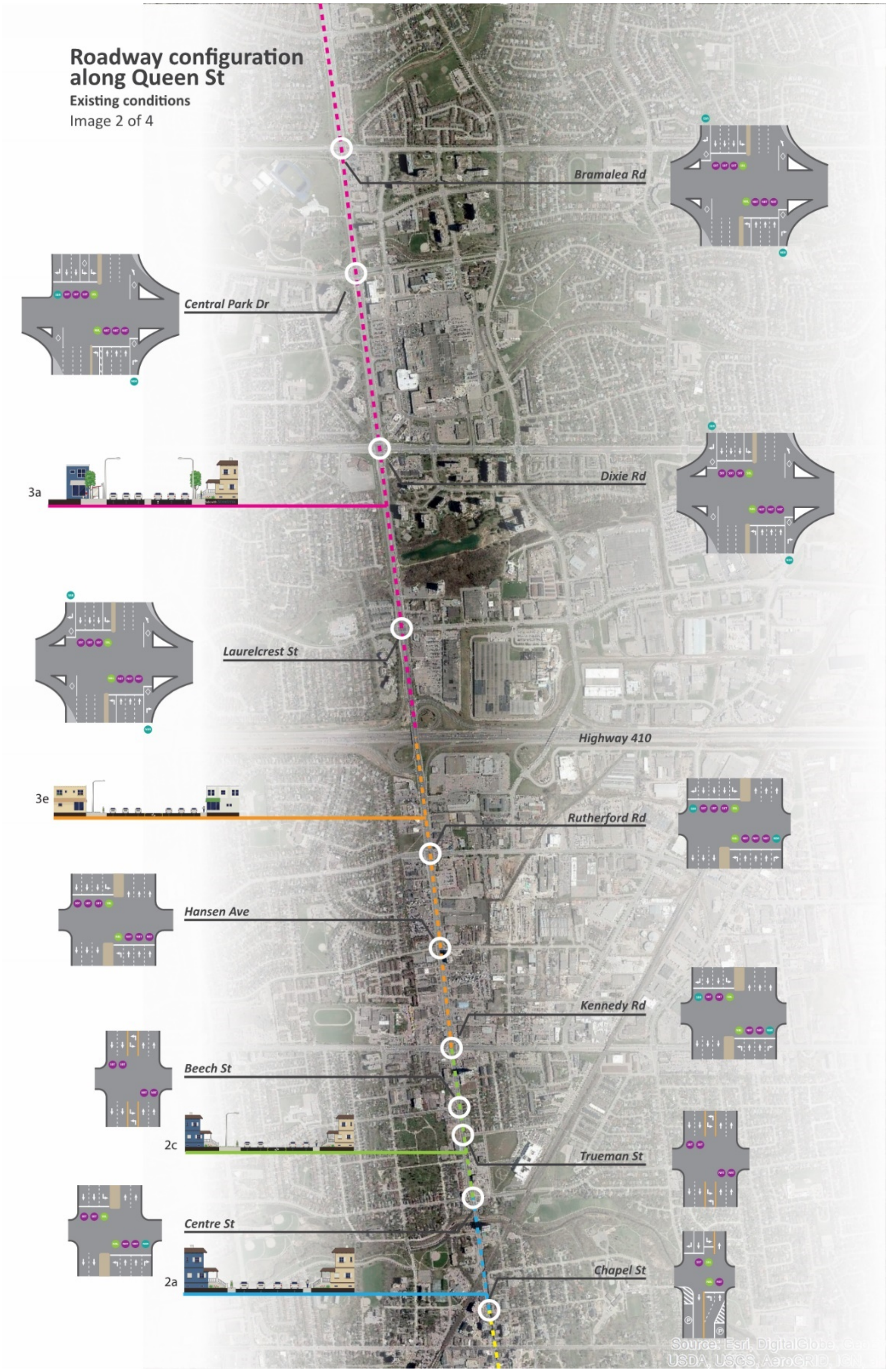


Figure 4: Roadway configuration along Queen Street, Chapel Street to Bramalea Road

Figure 5: Roadway configuration along Queen Street, Glenvale Boulevard to Highway 50

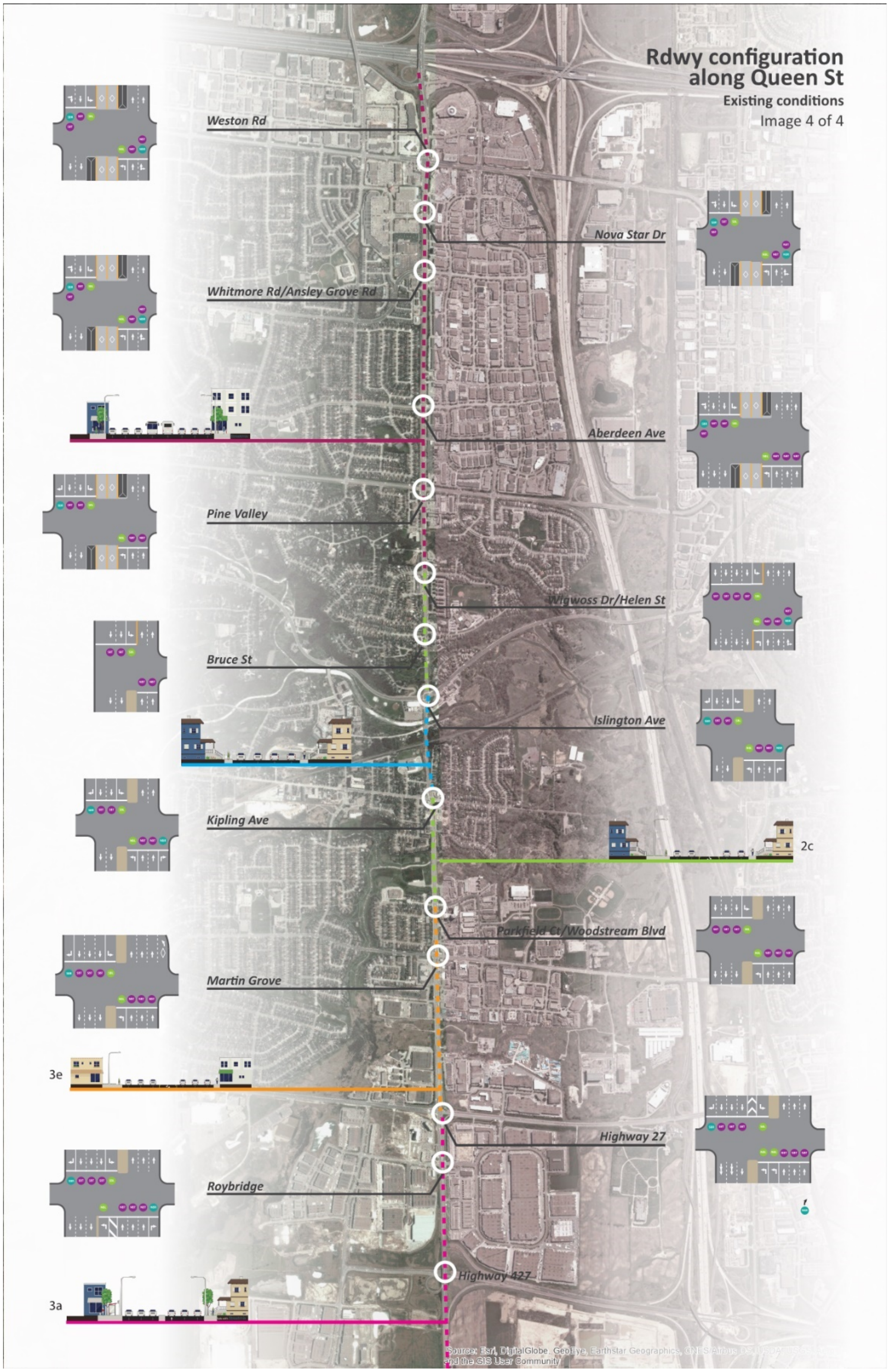


Figure 6: Roadway configuration along Queen Street/Highway 7, Highway 427 to Weston Road

Goods Movement

Queen Street between Hwy 410 and Hwy 50 is classified as a Goods Movement Corridor via Peel's Strategic Goods Movement Network. Medium and heavy trucks alone comprise about 8-12% of the total traffic on the corridor. There are also trucking movements to and from Highway 427 as well as across the Peel and York boundary at Highway 50. This presents unique challenges ensuring the efficient movement of all mode types across the corridor in the future, while ensuring priority for transit vehicles in the future.

Transit services and infrastructure

Existing transit service in the study area is provided by Brampton Transit and York Region Transit (YRT). Brampton Transit serves the Queen Street and Highway 7 Corridor and YRT serves the area immediately east of Highway 50. Services are mixed with both rapid bus (Züm/Viva) and standard service offered along the corridor. Both transit services connect to the Toronto Transit Commission (TTC) subway network at Vaughan Metropolitan Centre, the western terminus of Line 1 (Yonge-University-Spadina) which provides service to the downtown Toronto core. Züm services runs directly to York University via Queen St and Highway 407 which accounts for majority of the ridership along Queen St. Figure 7 illustrates the existing transit service along the Queen Street Corridor and Highway 7.

YRT's existing BRT service is provided through the Viva Rapid Transit network, a well-established service that entered operation in 2005 and has been continuously expanding since. The Viva BRT network currently has six routes with buses typically operating in the centre median. Some routes operate in curbside lanes. The overall Viva network stretches between Sheppard Avenue in north Toronto to the East Gwillimbury GO Station in Newmarket, a distance of over 35 kilometres, and from Martin Grove Rd in Vaughn to beyond Highway 48 at the eastern border of Markham, representing an approximately 40-kilometre east-west span. The peak period for transit ridership, according to observed boardings, is between 6:00 and 9:00 AM. The peak hour for transit ridership is between 7:00 and 8:00 AM.

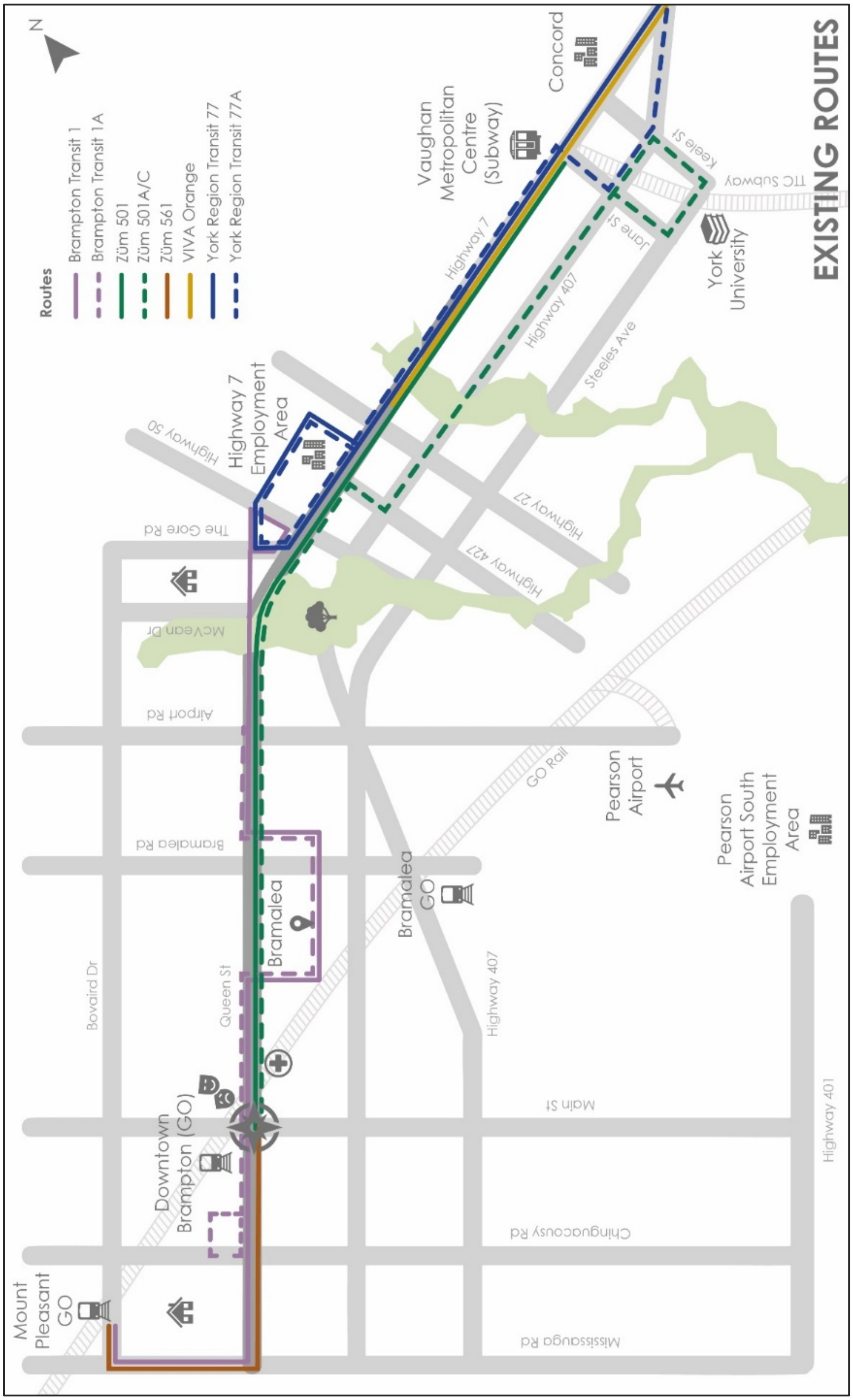


Figure 7: Transit service on Queen Street – Highway 7 Corridor, fall 2018

Where are people travelling?

The key destinations for Queen Street transit riders in the AM peak period include:

- York University, with over 50% of trips taken by students;
- Downtown Brampton and Bramalea City Centre;
- The Highway 7 area between Highway 50 and Helen Street;
- Vaughan Metropolitan Centre TTC station;
- Mississauga;
- Pearson Airport; and
- GO Stations (Mount Pleasant, Brampton, and Bramalea).

Few trips are to and from Toronto, including the downtown area, suggesting that the majority of corridor users remain within the immediate region.

Figures 7 and 8 illustrate main origins and destinations of trips using the Queen Street – Highway 7 Corridor according to 2017 TTS data in AM peak periods.

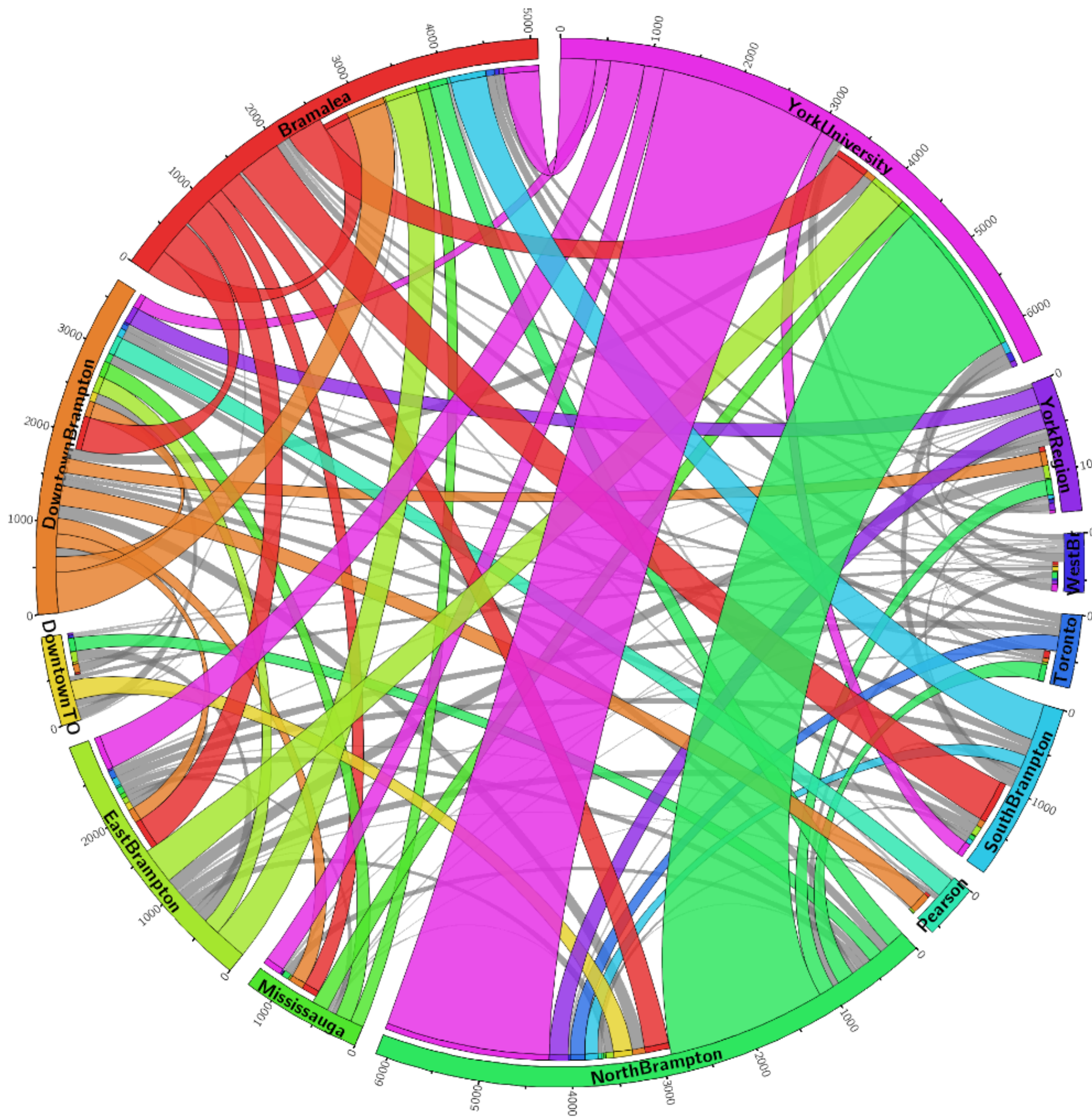


Figure 8: Key regional travel origins and destinations (Source: TTS data of all trips using Queen Street Corridor)

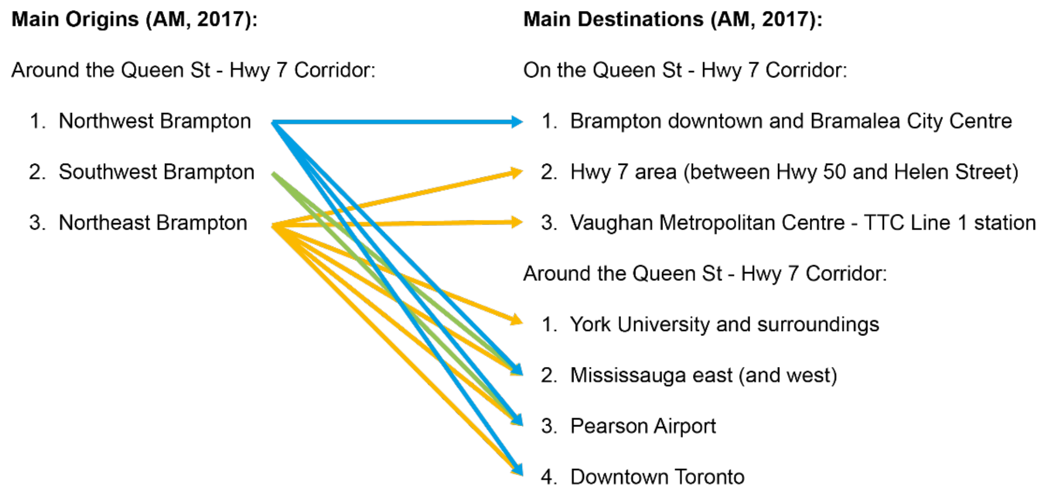


Figure 9: Main origins and destinations, AM peak period (2017) (Source: TTS data of all trips using Queen Street Corridor)

How are people travelling?

- Transit trips in Brampton are nearly all taken by bus. Of over 20,000 daily transit trips on Queen Street – Highway 7 bus routes, 90% involve bus only with no GO or subway connection.
- Only 10% of transit trips on Queen Street involve connections to non-bus modes. The proportion of transit riders relying on bus may change in the future with the recent opening of the TTC Line 1 subway extension to Vaughan Metropolitan Centre.

Figure 10 shows daily transit ridership on Queen Street buses by higher order mode.

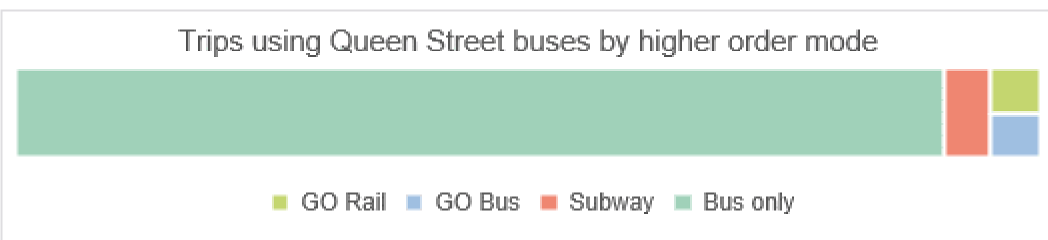


Figure 10: Trips using Queen Street buses by higher order mode (Source: TTS data of all trips using Queen Street Corridor)

Transit ridership

The Queen Street – Highway 7 Corridor is currently served by three Brampton Transit bus routes, the 1, Züm 501, and Züm 561 routes. Brampton Transit route 1 operates as a local bus while Züm routes 501 and 561 operate express service. York Region Transit (YRT) services also operate on the eastern portion of Queen Street, where passengers can transition between Brampton Transit and YRT at Queen Street East and Highway 50. YRT route 77 (express) and 77A (local) routes serve this area of Brampton. The Viva orange route uses only a portion of the Highway 7 corridor under study.

2017 AM peak hour (7:00 – 8:00 AM) ridership by direction for transit routes (excluding Viva orange) that operate in the study area shown in Table 8. Results are rounded to the nearest 5.

Table 8: 2017 AM peak hour ridership for passengers on Queen Street bus routes (Sources: Brampton Transit and YRT)

	EASTBOUND RIDERSHIP (ALL ROUTES)	WESTBOUND RIDERSHIP (ALL ROUTES)
BRAMPTON TRANSIT	930	580
YORK REGION TRANSIT[5]	985	1,790
TOTAL	1,915	2,370

Data from Brampton Transit shows that existing route 501 eastbound transit boardings and alightings are highly concentrated at key stops along Queen Street. Figure 11 shows route 501 EB boarding activity over the transit service period. There is a high concentration of boardings at Downtown Brampton Terminal and Bramalea Terminal, and of alightings at Bramalea and York University, with some activity at likely transfer points. Overall, there is minimal eastbound activity on Queen Street/Highway 7 east of Highway 50 at all periods. Figure 12 shows route 501 EB alighting activity over the transit service period.

Figure 11: Route 501 EB boardings, all day (Source: Brampton Transit, 2017)

Figure 12: Route 501 EB alightings, all day (Source: Brampton Transit, 2017)

[5] Estimated based on calculation of average service frequency and net boardings during AM peak hour as available from York Region Transit timetables.

Westbound boardings and alightings on route 501 are similarly concentrated. Boarding are highest at York University and Bramalea, with the highest activity in the mid- to late afternoon. The York University stop sees the highest boarding activity on the route, with nearly 6,000 boardings per hour in the PM peak hour between 5 and 6 p.m. Figure 13 shows route 501 WB boarding activity over the transit service period. Alightings concentrate at Downtown Brampton Terminal and Bramalea, with some other locations where transfers are likely occurring seeing activity. Figure 14 shows route 501 WB alighting activity over the transit service period.

Figure 13: Route 501WB boardings, all day (Source: Brampton Transit, 2017)

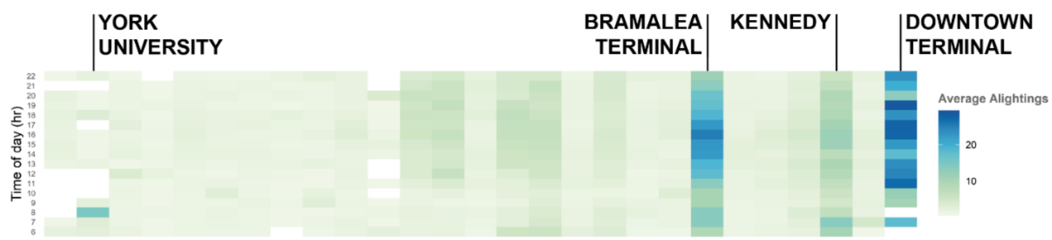


Figure 14: Route 501 WB alightings, all day (Source: Brampton Transit, 2017)

Brampton Transit route 1 shows similar concentration patterns to route 501 but with significantly lower hourly boardings and alightings (see Figures 15 and 16). Eastbound boardings and alightings show Downtown Terminal, Bramalea, and Kennedy areas have noticeably greater passenger activity than elsewhere on the route. Boardings are greatest at Bramalea in the afternoon, with some additional boarding peaks in other areas in this same period. Alightings are highest at Downtown Terminal in the early morning, with moderate activity at Bramalea in the mid-afternoon. The overall peak number of boardings and alightings per stop on route 1 in the eastbound direction is approximately 800 per hour.

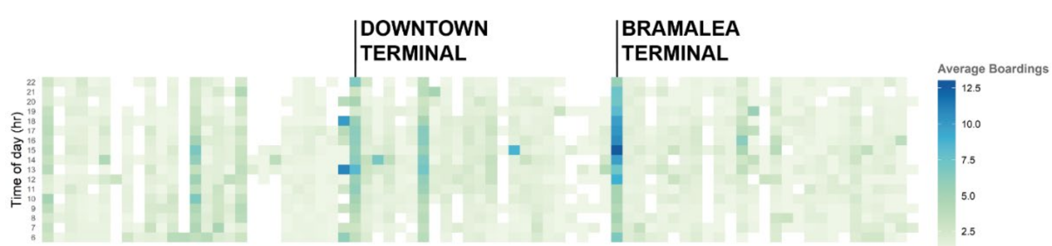


Figure 15: Route 1 EB boardings, all day (Source: Brampton Transit, 2017)

Figure 16: Route 1 EB alightings, all day (Source: Brampton Transit, 2017)

The same general activity patterns can be seen for route 1 westbound journeys (see Figures 17 and 18). Downtown Terminal, Bramalea, and Kenney have the greatest passenger activity, as was the case for eastbound riders. Westbound alighting activity tends to be spread more evenly across the day, with concentration in the AM and PM peak periods, whereas boarding activity is highly concentrated in the late afternoon.

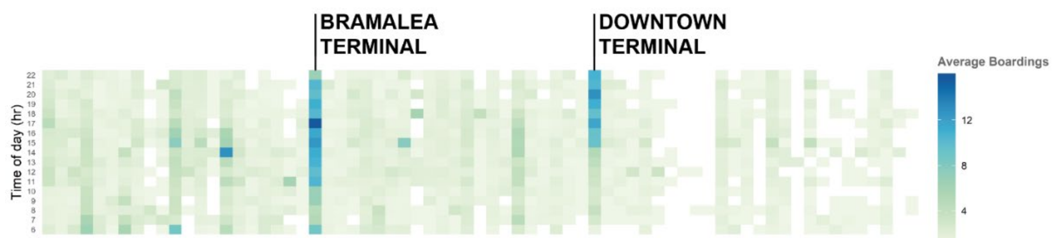


Figure 17: Route 1 WB boardings, all day (Source: Brampton Transit, 2017)

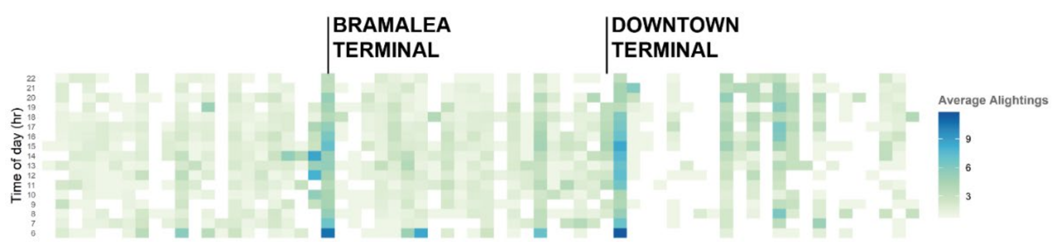


Figure 18: Route 1 WB alightings, all day (Source: Brampton Transit, 2017)

Existing transit accessibility along the Queen Street Corridor is variable, with highest transit scores in Downtown Brampton and Bramalea, as shown in Figure 19. These locations coincide with job availably within transit access, as shown in Figure 20. Job accessibility within 45 minutes of transit in Brampton is lower than more urbanized areas such as downtown Toronto, due partly to the overall higher density of employment in the downtown core relative to more suburban municipalities or areas with industrial employment, including Brampton. Improvements to transit reliability through the introduction of bus lanes will increase availability to employment as travel times become shorter and the network changes to support high frequency corridors.

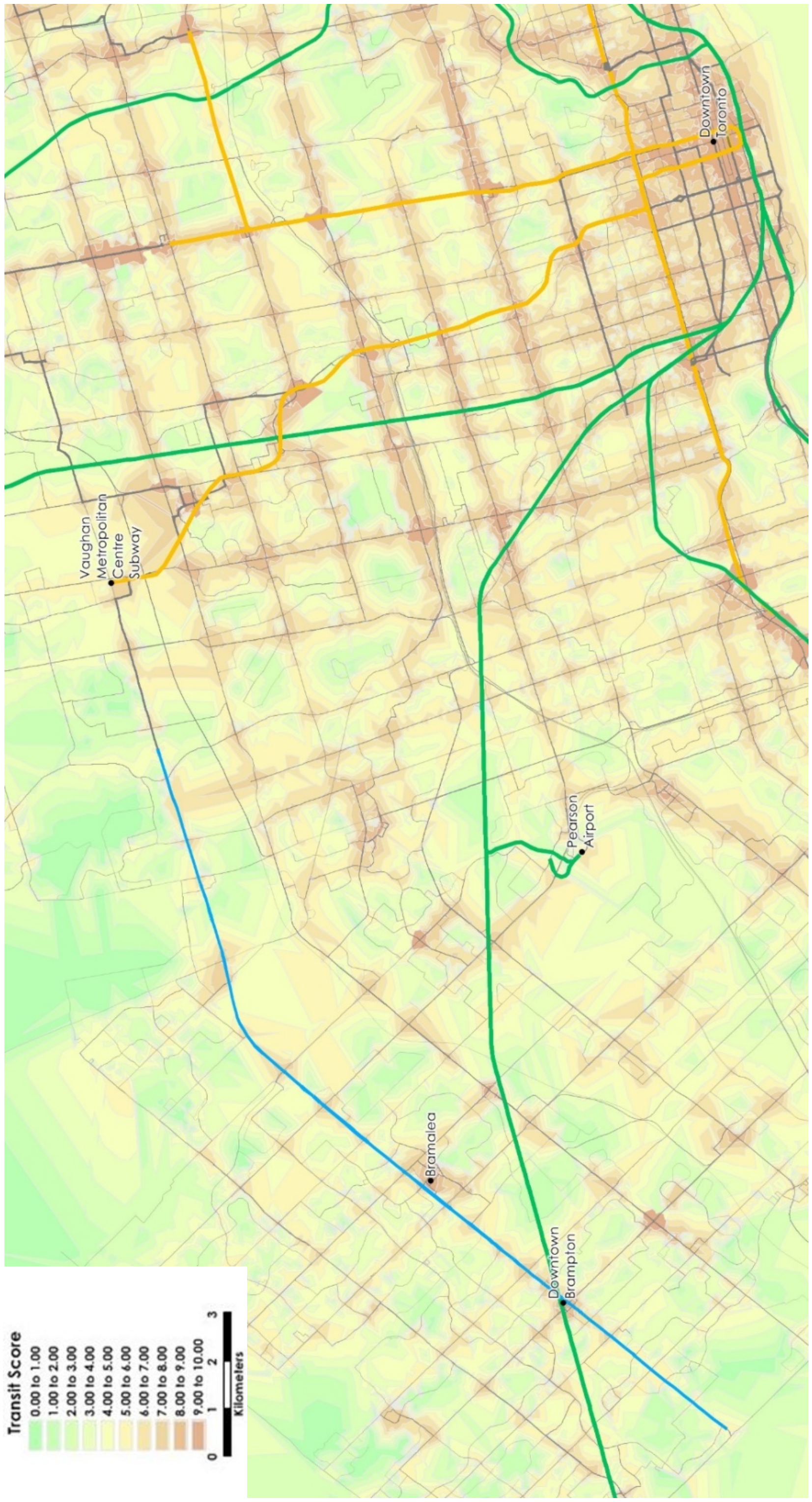


Figure 19: Transit density, with green lines showing GO Transit and yellow lines showing TTC subway (Queen Street Corridor shown as blue line) (Source: Transit Accessibility Index by Arup, based on GTFS data, fall 2017)

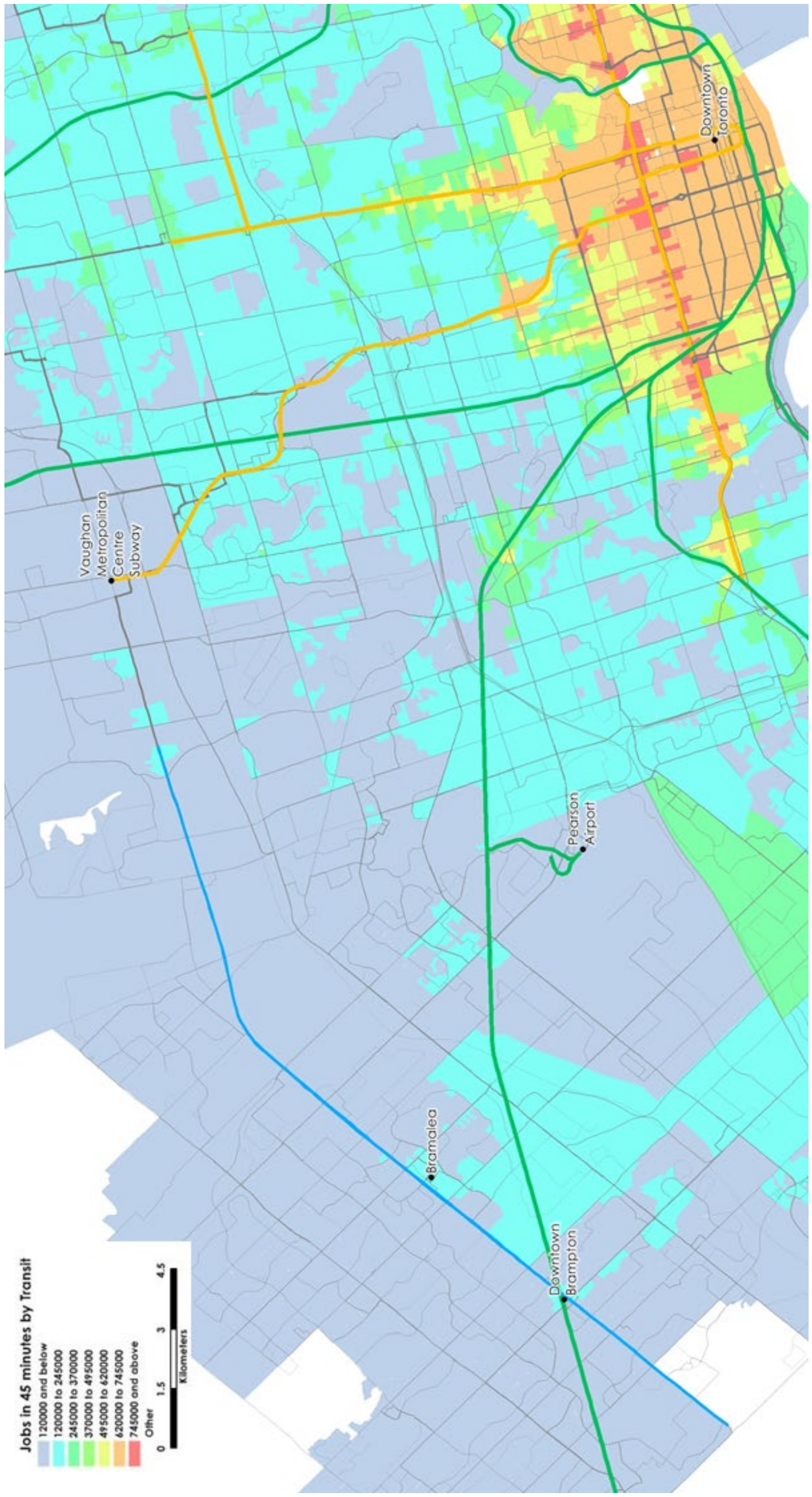


Figure 20: Job accessibility within 45 minutes of transit, with green lines showing GO Transit and yellow lines showing TTC subway (Queen Street Corridor shown as blue line) (Source: Transit Accessibility Index by Arup, based on GTFS data, fall 2017)

Who is using transit?

As a whole, the Statistics Canada 2016 Census indicates that the average Queen Street transit rider is likely to be younger and come from a household of lower income than the Brampton and Vaughan average. Riders could be employed, or be students on a part-time or full time basis. These findings indicate that the ridership may not be typical of the 9-5 employment and/or student schedule. Overall, education-related trips account for approximately 40% of overall trips for the whole of Brampton and Vaughan. Appendix C provides more details on transit rider demographics that assisted in informing this IBC.

Traffic conditions

The Queen Street Corridor is a major route for traffic including goods movement. The corridor serves both inter- and intra-municipal trips, provides direct access to 400-series highways, and is a major east-west commuter route. Overall:

- Traffic conditions are heaviest between Kennedy Road and Highway 50;
- As a whole, traffic is heavier in the eastbound direction in the AM peak period;
- As a whole, traffic is higher in the westbound direction in the PM peak period;
- Analysis shows that generally, east of Kennedy Road, the corridor is at or above capacity for vehicular traffic; and
- A wide variation in the concentration of driveways and accesses exists along the corridor.

Appendix B provides detail on traffic conditions along a major portion of the corridor.

Future Projects and Trends in Terms of Travel Demand

Future planned projects

Residential and mixed-use developments

Though Brampton's residential neighbourhoods are generally made up of single detached homes with a suburban character, many new developments are increasingly higher density in nature, and typically incorporate retail and commercial land uses. These higher density developments, as in many GTHA municipalities and regions, tend to be oriented towards transit and pedestrian-friendly urban areas. Many recent development applications are clustered in the west, close to downtown Brampton and Brampton GO Station.

As Brampton's population continues to grow, many of the most significant development projects are for residential construction. Mid-rise developments are seen as particularly suitable for the Brampton context, by supporting a pedestrian scaled and environmentally friendly urban environment and are encouraged in Brampton's Official Plan. Sites on the Queen Street Corridor which provide strong connectivity to future BRT stops offer potential for this form of development. The following areas provide adjacency to the Queen Street Corridor and are well-suited for mixed use intensification:

- Main Street North, Queen West, Four Corners, and Mobility Hub in downtown Brampton, where heritage integration is noted as an important consideration for new development.
- Queen Street East (greyfield infill) and Bramalea (intensification and infill) in Brampton's central area.
- Major Transit Station Areas (MTSA) locations along the corridor;
- Mobility Hubs and transit corridors at Hurontario-Main, Steeles and Bramalea, as well as the Queen Street Corridor itself.

Though not located on the Queen Street Corridor, Mount Pleasant Village in Brampton is one example of a large, master planned redevelopment which is an existing "urban transit village", developed around and based on active transportation and transit. The project is within walking distance of the existing Mount Pleasant GO Station.

Large natural areas along the Queen Street Corridor provide excellent natural amenities within a short distance of future BRT stations but reduce the transit-oriented development potential in certain areas. Natural areas include Norton Place Park, Donald M. Gordon Chinguacousy Park, and Claireville Conservation Area.

Committed public transportation investments

A number of local and regional transportation projects in neighbouring municipalities and regions support the Queen Street – Highway 7 BRT project by providing regional connectivity for transit riders. These projects are outlined in the Metrolinx 2041 Regional Transportation Plan. Current committed transportation projects include the following:

- Hurontario LRT, a 20 km rapid transit line that will connect Brampton with neighbouring municipalities. Three stops will be included in Brampton: Ray Lawson, Sir Lou, and Brampton Gateway Terminal. The projected opening year for the project is 2024.
- GO Expansion which will provide all-day, two-way 15-minute GO service on select routes.
- YRT Viva infrastructure between Vaughan Metropolitan Centre TTC Station and Helen Street, which is currently under construction as of summer 2019.

Figure 21 maps the existing and in-delivery regional rail and rapid transit projects across the GTHA.

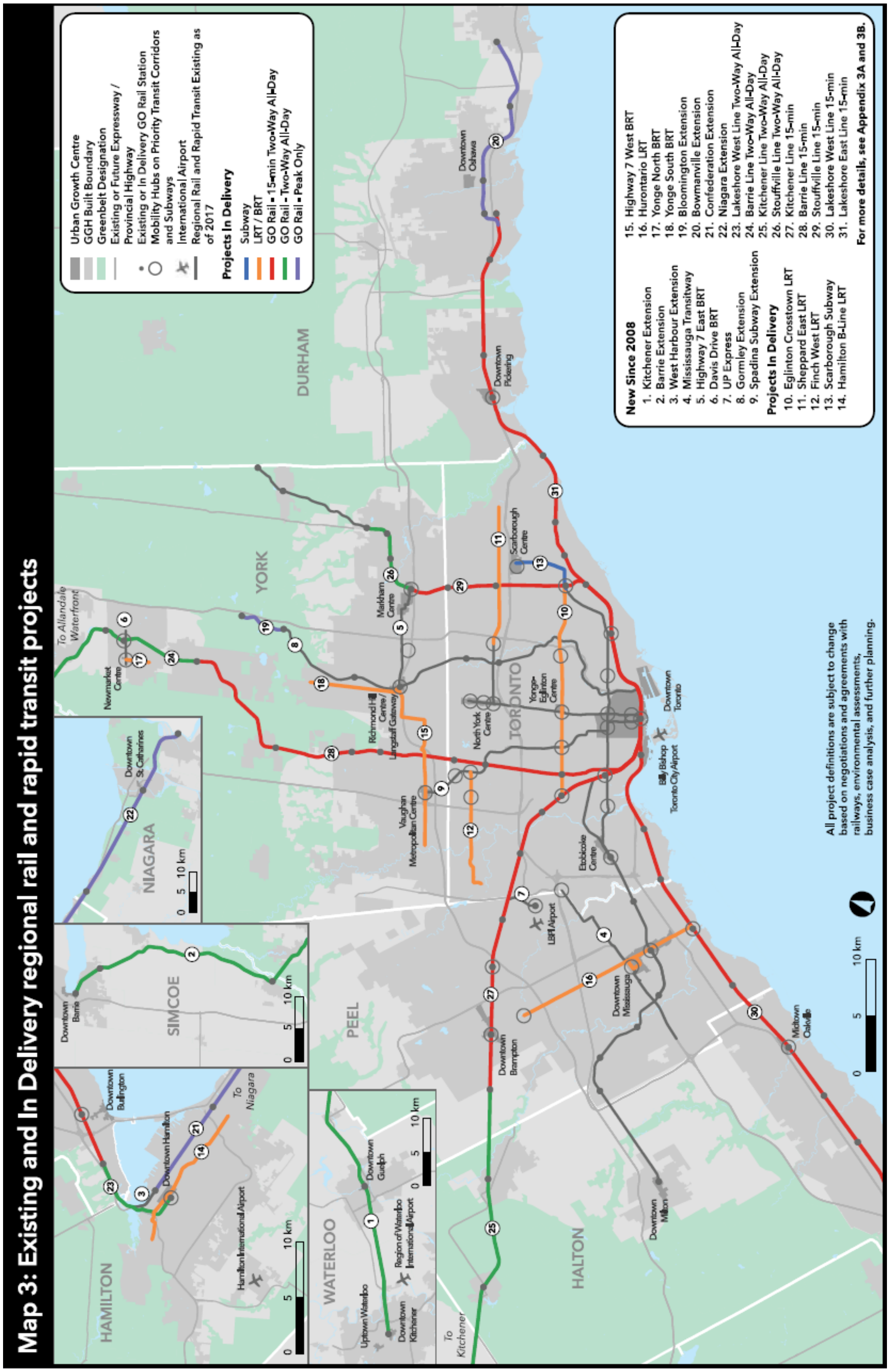


Figure 21: Metrolinx existing and in-delivery regional rail and rapid transit projects in the GTHA for 2041 (Source: Metrolinx)

Future Travel Patterns

In order to be able to test different future BRT scenarios with Metrolinx's Regional Transportation Modelling tool, future travel patterns had to be determined. The future scenario considered for 2041 is based on the inclusion of projected land uses and in-delivery transportation projects cited above, and on the total travel demand of the modelling calibration year (2011) in the Metrolinx GGHM_v4 model.

2041 business as usual scenario

The 2041 business as usual (BAU) scenario assumes projected land use and transportation projects and travel demand, as well as minimal changes to transit frequencies, routes and stopping patterns as existing services shown in Figure 22. There are no assumed changes to the local bus routes. Table 9 summarizes the assumed headways for the main routes that serve the Queen Street and Highway 7 corridors. Within the GGHM_v4 model, a number of services in the study area were recoded to reflect the existing services on Queen Street/Highway 7 for this scenario. These transit route changes are documented within Appendix E.

Table 9: Peak period and midday bus headways for transit routes on Queen Street/Highway 7 for the 2041 BAU scenario

ROUTE	ROUTE DESCRIPTION	PEAK HEADWAY (MINUTES)	MIDDAY HEADWAY (MINUTES)
ZUM 501	Queen St	16-18	18
ZUM 501A	Queen St via Hwy 407	11-18	18
ZUM 501C	Queen St / Hwy 407	26	--
ZUM 561	Queen West	15	20
BRAMPTON TRANSIT 1	Queen Street	20	28
BRAMPTON TRANSIT 1A	Queen Street	20	28
YORK REGION TRANSIT 77	Hwy 7 / Centre	15	23
YORK REGION TRANSIT 77A	Hwy 7 / Centre via Clarke	45	--
VIVA ORANGE	Highway 7	15	20

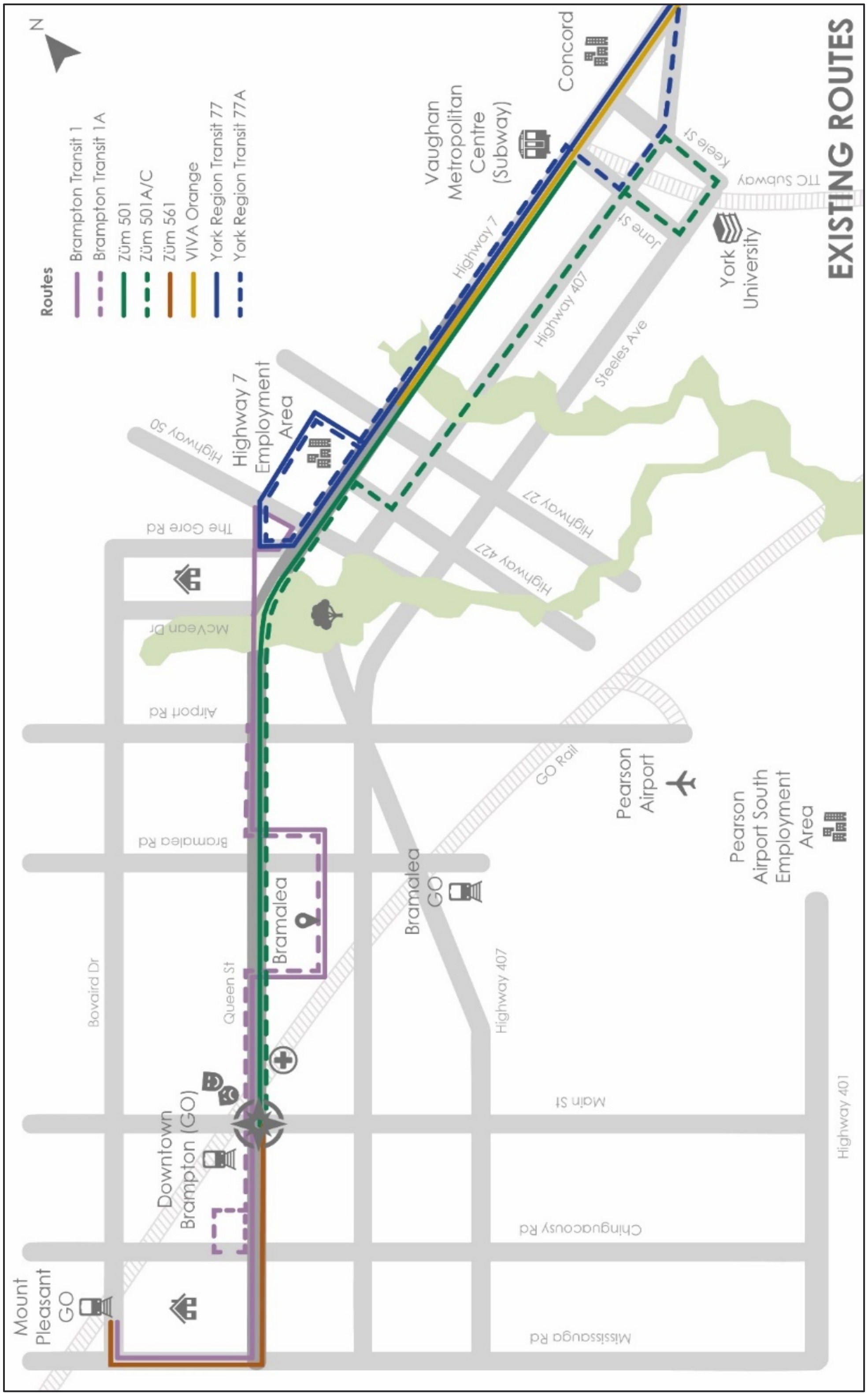


Figure 22: 2041 BAU scenario transit route map for the Queen Street – Highway 7 Corridor

Definition of Opportunity

The Queen Street – Highway 7 Corridor is a crucial transportation corridor connecting people through the regions of Brampton and Vaughan, to and from key transportation generators such as York University, Downtown Brampton, and Downtown Toronto. The corridor has varied traffic and land use conditions and constraints. The regions around the corridor are responding to future travel demand with changes to transit infrastructure and service. This new future transit service will have to respond to growing communities and their transportation demand, according to goals for sustainable development.

Problem/Opportunity Key Drivers

Challenges

- Current transit use on the Queen Street – Highway 7 Corridor is limited to what appears to be a captive market, dominated by:
  - A young population (under 30);
  - Mostly students; and
  - Medium income households of relatively large size (average 3.5 persons per household).
- Overall, there is low transit connectivity in the area, with relatively poor access to employment. Transit is not competitive with auto travel;
- There are long distances between key origins and destinations and to downtown Toronto;
- Facilitation of trucks and goods movement through the corridor;
- There are transit access issues to the Pearson Airport employment area;
- Inter-agency coordination may be a challenge as agencies need to respond to their local policies, resources, etc.; and
- Some physical constraints exist on the corridor.

Opportunities

- There is a large market that can be considered 'untapped'; i.e. who would be likely to take advantage of transit but have not yet adopted regular transit usage;
- Connections to the TTC subway and GO Transit near the corridor;
- BRT enables fast, limited stop services;
- Supporting better integration through service and infrastructure improvements across the region; and
- The current land use and infrastructure still allow for creative solutions.

The Case for BRT

As a main travel route between Peel Region and York Region municipalities, and with connections to the rest of the GTHA, the Queen Street – Highway 7 Corridor is seen as a key route for the introduction of BRT, as a means of completing a broader high frequency transit network. The corridor has both locally- and regionally-significant areas including Brampton GO Station, downtown Brampton, Bramalea City Centre, and many other employment, residential, and retail destinations.

Numerous previous studies highlight the importance of the Queen Street – Highway 7 BRT as a local and regional connector, and key to building a sustainable transportation network that connects GTHA communities. A summary of these studies is provided as Appendix A. In particular, the Queen Street – Highway 7 BRT is identified as part of overall regional transit investment in the Metrolinx 2041 Regional Transportation Plan. In addition, the Brampton 2040 Vision[6] – developed collaboratively with the participation of over 13,000 residents – identifies rapid transit on Queen Street East and highlights its potential as a 'transit spine' that will support the gradual redevelopment of the corridor.

In Brampton, the Queen Street – Highway 7 BRT would provide connections through York Region at the eastern terminus of the York Region Transit (YRT) Viva network and Toronto Transit Commission (TTC) subway, while multiple other services including GO Transit rail would connect BRT riders to major municipal centres including Union Station in Toronto.

Overall, the Queen Street – Highway 7 BRT is seen as a critical piece of the GTHA's transportation network. It will support local growth within Brampton and Vaughan while providing residents with the access to jobs and services across the region. This project will enable mode shift towards transit, decreasing the overall environmental impacts of transport in the region, including GHG emissions.

[6] City of Brampton, 2018. "Living the Mosaic: Brampton 2040 Vision". <https://www.brampton.ca/EN/City-Hall/Documents/Brampton2040Vision/brampton2040Vision.pdf>

3

Investment Options

BRT Scenario Evaluation Methods

Global approach

The Metrolinx Benefits Management Framework process is a seven-step process that assesses the rationale for investment from the strategic planning phase through to post in-service phase of a transportation project. This is shown in Figure 23. It includes Business Case studies at different stages (initial, preliminary, and full), as well as the project lifecycle.

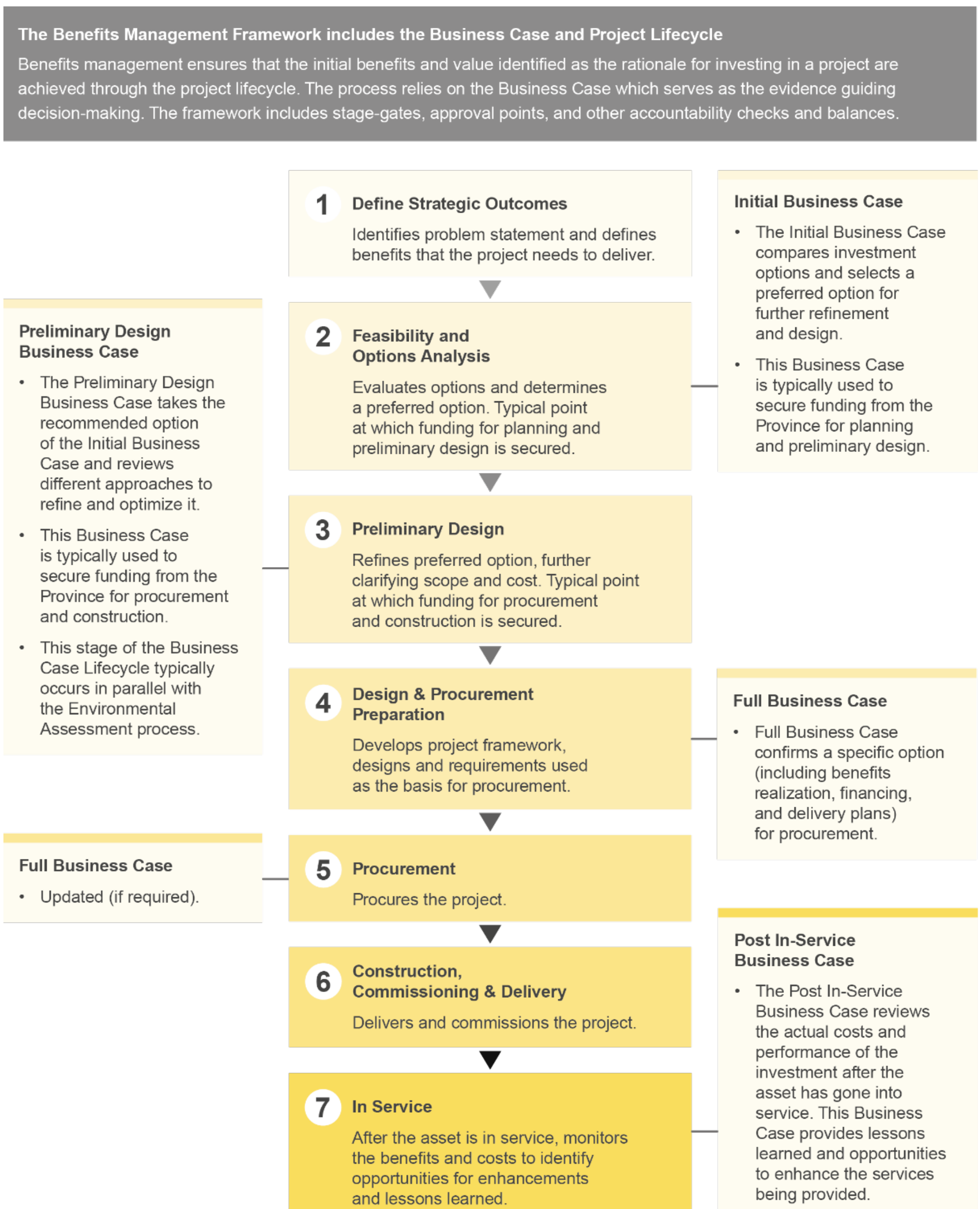


Figure 23: Metrolinx Business Case Guidance and Project Lifecycle Framework (Source: Metrolinx)

Per the Metrolinx Business Case Guidance and Project Lifecycle Framework, the current project is in Stage 2: Feasibility and Options Analysis and represents in Initial Business Case. The section below provides additional detail on this project as it relates to the Metrolinx framework:

- **Strategic planning,** where the problem statement and investment benefits are defined.
- **Options analysis,** where multiple service plans and infrastructure options are assessed to determine a preferred option. At this stage, the **Initial Business Case (IBC)** is developed to evaluate investment options and select a preferred option to proceed with design development. The present study and report consists of the IBC and planning study, including scenario evaluation of service concepts and infrastructure concepts at a high level, with the GGHM_v4 regional transportation model from Metrolinx. The approach followed in the present IBC is illustrated in Figure 24:

IBC steps including scenario creation and evaluation -
Brampton Queen St-Hwy 7 York BRT corridor

A Transportation portrait - actual (2016) and future (2041) & service goals

↓

B Define service scenarios (3)

↓

C **EVALUATION 1:** Determine best adequate service definition scenario

↓

D Define infrastructure scenarios (3)

↓

E **EVALUATION 2:** Business Case - BRT scenario evaluation

↓

F Recommendation of preferred scenario

Figure 24: IBC steps for the Brampton Queen Street – York Region Highway 7 BRT

The next steps to be achieved after this present IBC for the Brampton Queen Street – York Region Highway 7 BRT are:

- **Preliminary design,** where the preferred option is refined. At this stage, the **Preliminary Design Business Case** is developed to refine and optimize the IBC.
- **Design & procurement preparation,** where an investment framework, designs, and requirements are developed as the basis for procurement. At this stage, a **Full Business Case** is developed, confirming a specific option.

- **Procurement,** where the investment is procured, and the Full Business Case is updated if required.
- **Construction, commissioning & delivery,** where the project is delivered.
- **In service,** the post-construction phase, where monitoring and evaluation are undertaken of the transportation project. At this stage, a **Post In-Service Business** is undertaken to review the actual project costs and performance to provide lessons learned and identify service enhancement opportunities.

Evaluation methodology of the BRT scenarios with the Greater Golden Horseshoe Model

For Metrolinx business cases, the Metrolinx GGHM_v4 transportation model is used to assess the impact of transit investment on network ridership. The model encompasses local transit services (e.g. Brampton Transit, TTC) and regional transit services (GO Transit), subway, and streetcars, to evaluate how new investments may result in changes to ridership. Given the regional importance of transit, this method allows for a broad understanding of overall network ridership. The model provides an indication of the level of ridership expected in the future with and without BRT infrastructure. The model does not identify in detail impacts to traffic congestion at the intersection level. Impacts of the BRT infrastructure on local traffic etc will be further analyzed in the preliminary design phases.

The method shown in Figure 25 defines the process that is followed in the current IBC for determining a preferred BRT service and infrastructure scenario using the GGHM_v4 model.

Evaluation Methodology of the IBC for the Brampton Queen Street - York Region Highway 7 BRT

1. Definition of 3 service scenarios: scenarios 1, 2, and 3
2. Modelling of the 3 service scenarios on 2041 horizon (in order to compare efficiency of the transit network and service levels)
3. Selection of 1 **preferred BRT service scenario**
4. Definition of 3 infrastructure scenarios: scenarios 4, 5, and 6
5. Modelling of the 3 infrastructure scenarios with preferred service definition
6. Recommendation of BRT scenario

Figure 25: IBC evaluation methodology for the Brampton Queen Street – York Region Highway 7 BRT

- In **step 1,** three (3) service options are defined. These service scenarios are selected and developed based on pre-defined transit service concept goals (section 4.1), general BRT service concepts, and have been discussed with the IBC project team during IBC evaluation.
- In **step 2,** the service options are modelled with a competitive speed in the GGHM_v4 model on the 2041 horizon, in order to compare efficiency of the transit network and service levels on the BRT corridor.
- In **step 3,** the preferred BRT service option is selected. This may be, for instance, the scenario that offers the maximum transit ridership on the BRT corridor.
- In **step 4,** three (3) infrastructure scenarios are defined using the preferred service definition option. These infrastructure scenarios allow the transit service provider to meet the preferred BRT scenario selected in step 3.
- In **step 5,** the possible infrastructure scenarios are modelled with the preferred service scenario in the GGHM_v4 model.
- In **step 6,** a final recommendation is developed based on the best combination of the service and infrastructure scenarios.

This methodology aims to define a BRT project that maximizes BRT ridership as a priority, then defines the best infrastructure to support it.

The modelling of these scenarios in the AM peak period (three hours from 6 to 9 AM) has been conducted in the GGHM_v4 model by Metrolinx, with assistance from Arup in coding and analyzing the results of each scenario.

Appendix F details the modelling assumptions and results of all modelled scenarios during the IBC.

BRT Service Concept Scenarios

Three (3) service concept scenarios were defined in collaboration with the project team, composed of Metrolinx, the City of Brampton, Brampton Transit, York Region, Peel Region, and the City of Vaughn in order to compare the benefits of a range of transit service scenarios indicative of possible future operations. The objective of this step is to evaluate different service concept scenarios in order to define one scenario that maximizes the service goals that were pre-identified with the project team and that are detailed in the following section.

Service concept goals

To promote a good traveller experience, expand transit ridership, and encourage sustainable lifestyle habits, service options were defined based on the following guidelines and with the objective to maximize these goals:

1. **Increased efficiency of transit operations**

    i. Increased transit travel speed:

a. Avoid congestion: ensure that transit continues to operate smoothly despite future traffic growth
b. Design network and infrastructure to reduce transit travel time between major origin/destination pairs
c. Optimize transfer times: make transit easier to use by avoiding or streamlining transfers

ii. Improve service reliability with adequate rolling stock, IT systems, operational planning, and infrastructure
iii. Increase transit capacity

2. Ensure a quality user experience

i. Seamless transfers: simple connections for all passengers, with a maximum of one transfer for the major origin/destination pairs
ii. Integrated fare system, ensuring free movement between all transit operators using the corridor
iii. Increase comfort on platforms and in rolling stock choices

3. Support and increase urban development and density

i. Develop network coverage of existing dense neighbourhoods
ii. Integrate transit services with neighbouring communities: take advantage of overlapping services, especially connectivity with the existing transit network to the east
iii. Grow Downtown Brampton, Bramalea City Centre, and Vaughan Metropolitan Centre (VMC): support desired densification of hubs and corridors with the BRT implementation

The overarching principles of maintaining existing service coverage, increasing service levels, minimizing transfers, and serving key origins and destinations motivated the service options.

Service Concept Scenarios

Three (3) transit service scenarios on the study corridor were developed, including definition of routes, stops, and proposed service frequencies for AM peak period. Scenarios are based on 2041 ridership projections and are compared against the 2041 business as usual (BAU) scenario with the current bus routes, subject to future traffic conditions. Detailed information on the definition of the three (3) service concept scenarios is provided in Appendix D.

2041 business as usual scenario

As a reference scenario against which to compare network improvements, the business as usual (BAU) scenario (see Figure 22), consists of future transit service improvements from Metrolinx, Brampton Transit, and YRT, **without** a Queen Street – Highway 7 BRT service. It also includes In-Delivery infrastructure projects by Metrolinx outlined in the 2041 RTP. The scenario also tests the capability of the existing and future planned transit network projects to respond to future travel demand.

The 2041 BAU scenario is intended to:

- Evaluate the efficiency of the existing transit network to respond to the future travel demand in 2041, and
- Have a reference scenario for measuring network improvements, in addition to the infrastructure improvements.

Scenarios 1-3

Across all scenarios, a reduction in traffic lanes was assumed between McMurchy Road and Kennedy Road to accommodate a BRT lane. This is likely to have contributed to a reduction in vehicle kilometres traveled in this section. Downtown Brampton has been assumed to be from Centre St to McMurchy Avenue, which is larger than the section with parking restrictions. The modelled scenarios include lane reductions from 2 lanes down to 2 lanes in the section outside Theatre Lane to George St. This has an impact on VKT through the area.

- **Scenario 1** (Figure 26) proposes one main trunk route from Mississauga Road to Vaughan Metropolitan Centre TTC Station, plus the existing feeder routes. The corridor included 2 median BRT exclusive lanes (one per direction) with widening of the right-of-way (no impact on number of lanes for regular traffic), except in downtown Brampton on Queen Street.
- **Scenario 2** (Figure 27) proposes two main trunk routes on the Queen Street – Highway 7 Corridor, from Mississauga Road to Vaughan Metropolitan Centre TTC Station, added with the existing feeder routes. The corridor included 2 median BRT exclusive lanes (one per direction) with widening of the right-of-way (no impact on number of lanes for regular traffic), except in downtown Brampton on Queen Street.
- **Scenario 3** (Figure 28) proposes two main trunk routes on the Queen Street – Highway 7 Corridor, from Mississauga Road to Vaughan Metropolitan Centre TTC Station, with the addition of several Priority Bus routes using the new BRT corridor and infrastructure. The corridor included 2 median BRT exclusive lanes (one per direction) with widening of the right-of-way (no impact on number of lanes for regular traffic), except in downtown Brampton on Queen Street.

Scenario 1: Single main BRT trunk route on the Queen Street – Highway 7 Corridor

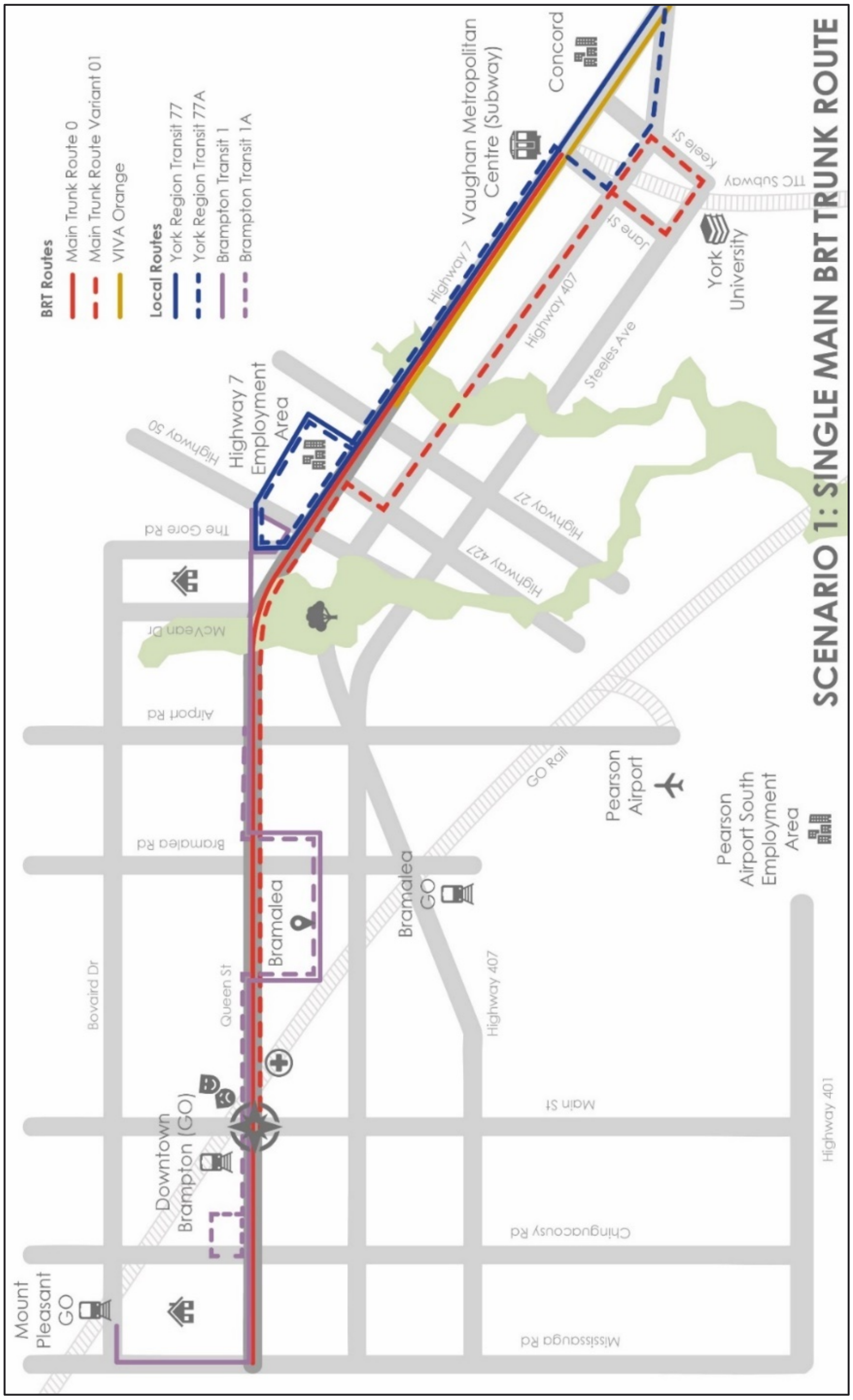


Figure 26: Scenario 1 – 2041 single main trunk route along the Queen Street – Highway 7 BRT Corridor

Scenario 2: Two main BRT trunk routes on the Queen Street – Highway 7 Corridor

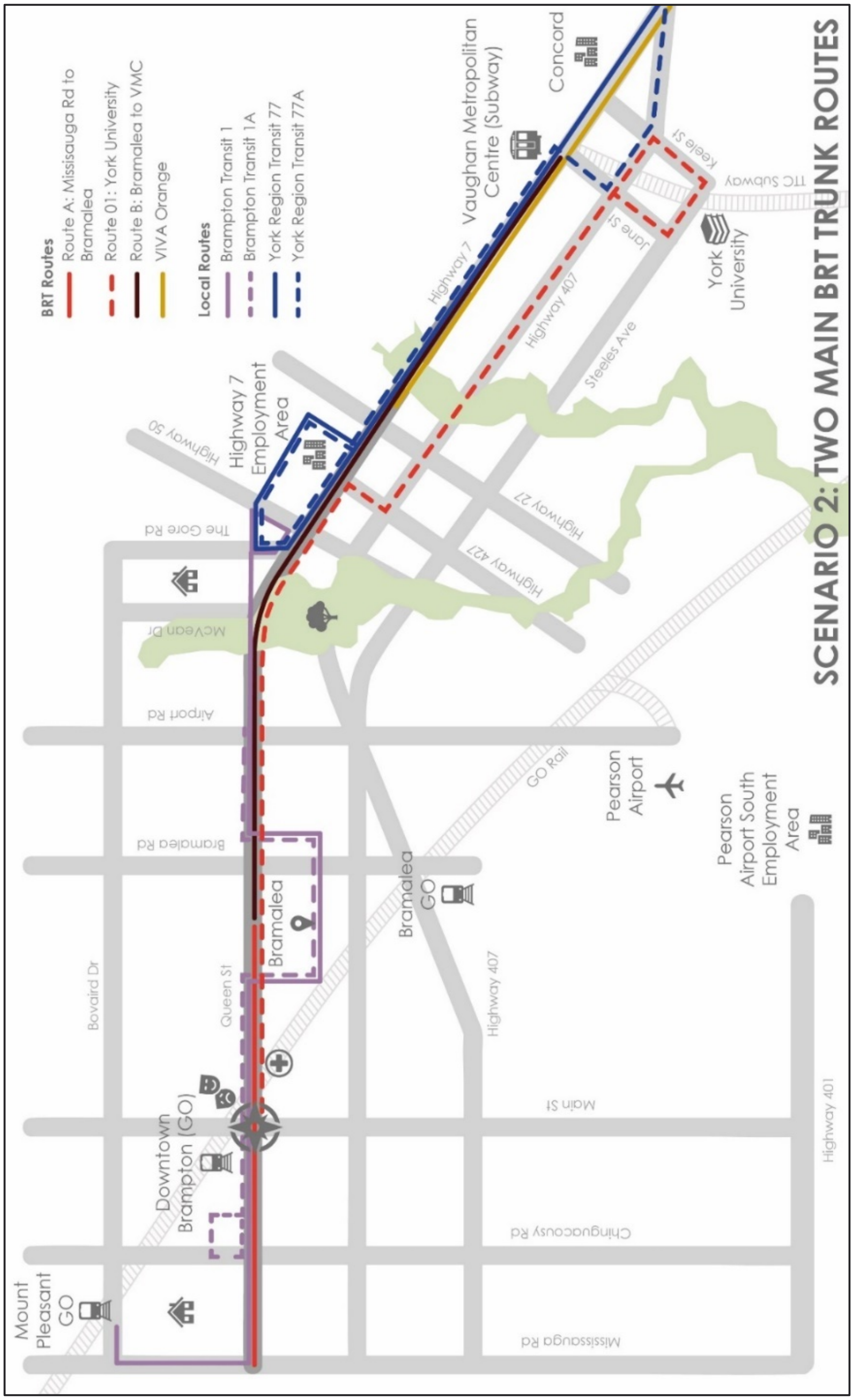


Figure 27: Scenario 2 – 2041 – Two main trunk routes along the Queen Street – Highway 7 BRT Corridor

Scenario 3: Two main BRT trunk routes and Priority Bus routes on the Queen Street – Highway 7 Corridor

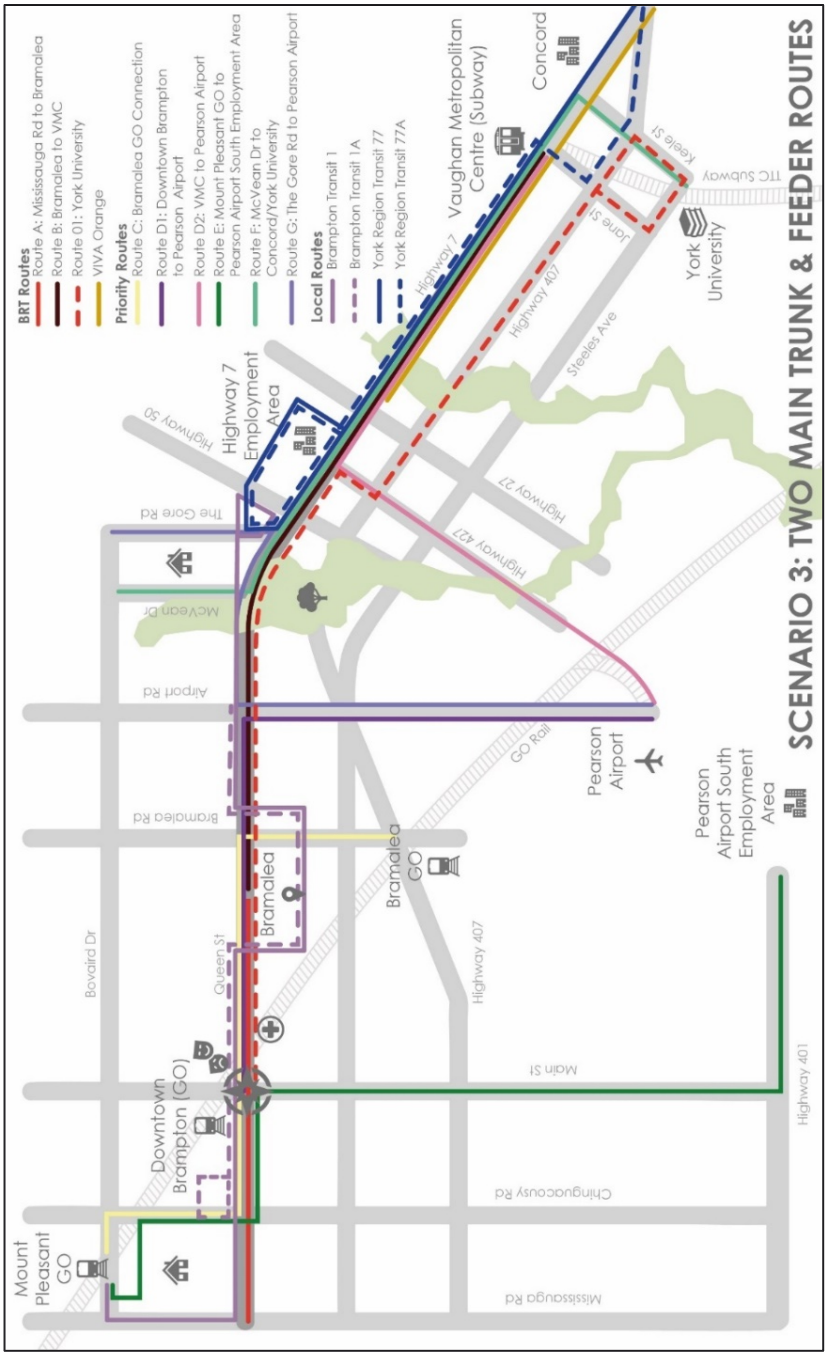


Figure 28: Scenario 3 – 2041 Two main trunk routes along the Queen Street – Highway 7 BRT Corridor, and added feeder transit routes

Service concept scenario evaluation

Evaluation framework and criteria

Each of the three (3) service concept scenarios were evaluated against the 2041 BAU Scenario using a set of criteria to determine the preferred service definition. The performance of each scenario is assessed using metrics derived from modelling results for the 2041 AM peak period (6:00-9:00 a.m.) generated by the Metrolinx GGHM_v4 model. The evaluation criteria and metrics are described in Table 10.

Table 10: Service definition evaluation criteria, objectives, and metrics

CRITERIA	OBJECTIVE	METRIC
TRANSIT DEMAND	The service concept should support higher transit usage within the study area.	2041 AM peak period boardings (6 – 9 AM)
TRANSIT ACCESSIBILITY	The service concept should improve residents' ability to travel to more destinations/activities by transit.	Percentage change in the number of jobs within 60 minutes in the AM peak period (6 – 9 AM)
IMPACT ON MODE SHARE	The service concept should encourage more people to choose transit within the study area.	Percentage change in transit mode share in study area in the AM peak period (6 – 9 AM)
IMPACT ON AUTO TRAVEL	The service concept assist in managing and reducing congestion along the corridor	Auto vehicle-kilometres and auto vehicle-hours travelled in the AM peak period (6 – 9 AM)
LEVEL OF SERVICE	The service concept should optimize the level of transit service provided including the additional operating cost.	Transit vehicle-kilometres travelled in the AM peak period (6 – 9 AM)

Evaluation of BRT service concept scenarios

All evaluation results are outputs of the Metrolinx GGHM_v4 model for the weekday AM peak period (6 – 9 AM).

- Transit demand

  The BRT service concept should support higher transit demand within the study area. Transit boardings are used in this evaluation as the measure for transit demand.

  Figure 29 illustrates the modelled 2041 AM peak period boardings for the routes serving Queen Street and Highway 7 in the study area.

Figure 29: 2041 AM Peak Boardings along the Queen Street – Highway 7 Corridor by type, for BAU Scenario and Scenarios 1, 2, and 3

All scenarios result in higher transit boardings on the corridor compared to the BAU scenario. There are increases in demand for both eastbound and westbound services. Scenario 3 has the highest number of transit boardings. This result can be attributed to the additional demand expected on the Priority Bus routes.

Further analysis of the modelled results reveals the expected transit demand for each route along the corridor. These results are summarized by direction for the local and BRT routes in Figure 30.

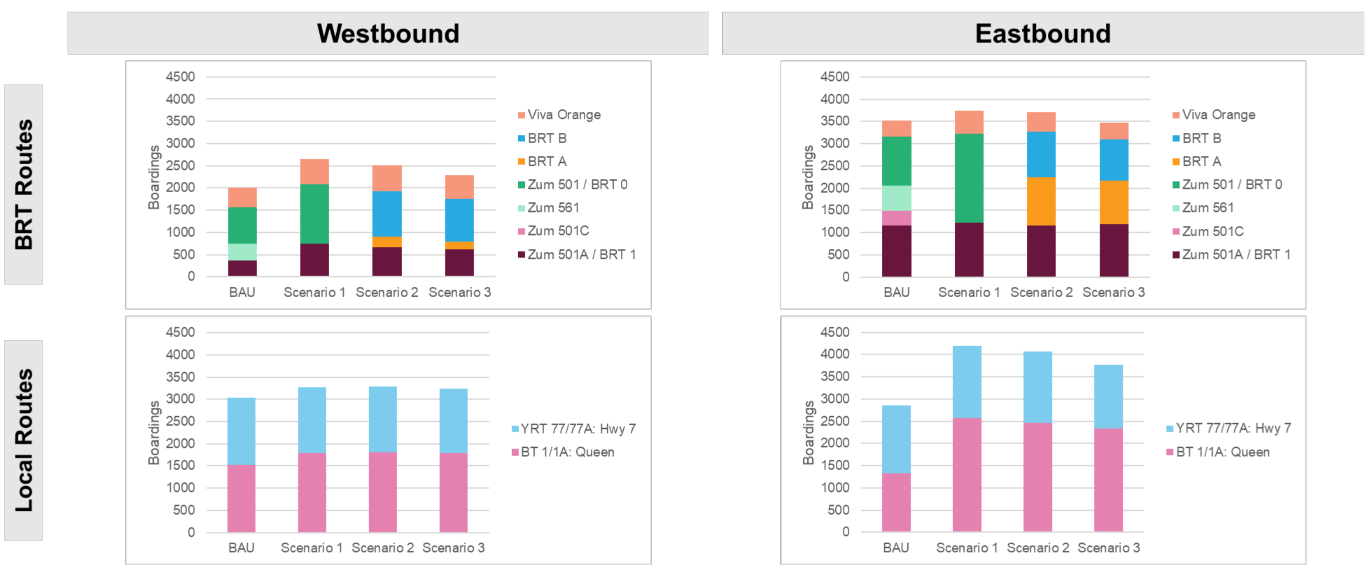
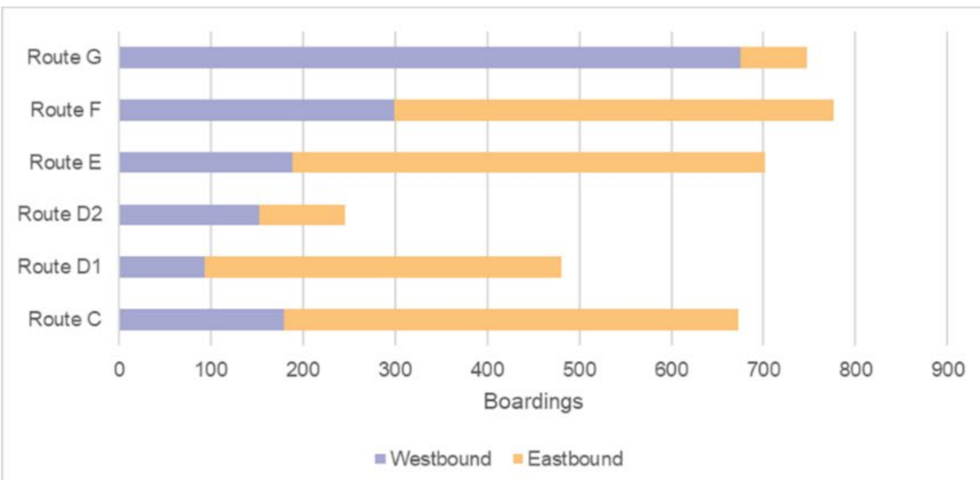


Figure 30: 2041 AM Peak boardings along the Queen Street – Highway 7 Corridor by route and direction, for BAU Scenario and Scenarios 1, 2, and 3

This analysis suggests the following:

- In Scenario 1, the growth in demand for BRT Route 0 (from Züm Route 501) largely offsets the reduction in demand from removing Züm 501C and Züm 561;
- Splitting main BRT route at Bramalea (as in Scenarios 2 and 3) would lead to a lower transit demand than a single main BRT route (as in Scenario 1);
- In Scenarios 2 and 3, there is low demand for the BRT Route A westbound (i.e. from Bramalea to Mississauga Road); and
- Across all scenarios, there are higher eastbound boardings on local Brampton Transit Route 1/1A (Queen Street) compared to the BAU.

For Scenario 3, the demand for the new priority bus routes are shown by direction in Figure 31.



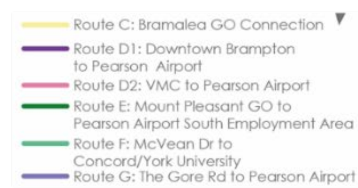


Figure 31: 2041 AM Peak Boardings for Priority Routes in Scenario 3

The Priority Routes C, E, F, and G have the highest expected demand with a combined two-way boardings between 600 and 800 passengers in the AM peak period. Two of the routes to Pearson Airport (D1: Downtown Brampton – Pearson Airport, and D2: Vaughan Metropolitan Centre – Pearson Airport) have relatively low boardings of these routes in the AM peak period. These routes could be considered for refinement and/or optimization.

Transit accessibility

The transit service concept should improve residents' ability to travel to more destinations and activities by transit. The change in access to employment is the metric for this analysis. The scenario networks were input into the Metrolinx Accessibility Toolkit to calculate the number of jobs that are accessible by transit from each Census Dissemination Area within 60 minutes. Each service concept scenario was compared to the 2041 BAU scenario to estimate the change in transit accessibility.

Table 11 summarizes the average change in access to jobs across each scenario. The changes to transit accessibility by Census Dissemination Area are illustrated in Figures 32 to 35. This analysis shows that Scenarios 1 and 2 result in small improvements in access to jobs for those along the Queen Street Corridor. In contrast, Scenario 3 results in a significant improvement as the Priority Routes, which act as main feeder routes, improve access to jobs for those living away from the Queen Street Corridor. It should be noted that the decrease in accessibility on the western end of the corridor in each figure is a result of the limited changes to transit services at this end of the corridor.

Table 11: Average jobs accessible by transit within 60 minutes during AM peak period (study area average), for 2041 BAU Scenario and Scenarios 1, 2, and 3

SCENARIO	AVERAGE NUMBER OF JOBS	% CHANGE FROM BAU
BAU	48,000	--
SCENARIO 1	48,600	1.3
SCENARIO 2	48,500	0.9
SCENARIO 3	51,500	7.2

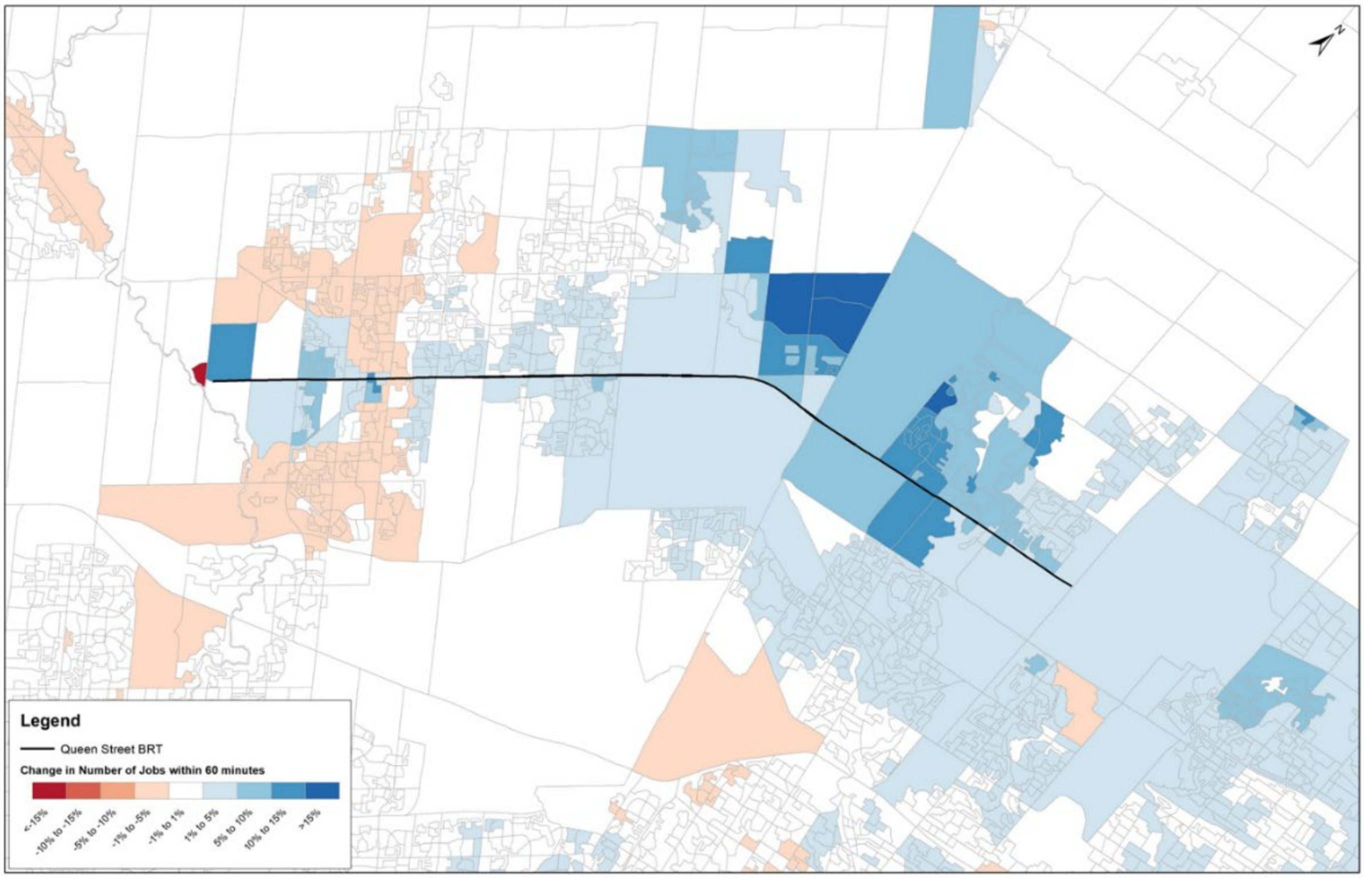


Figure 32: Change in access to jobs by transit (Scenario 1 vs 2041 BAU), AM peak period (Metrolinx Accessibility Toolkit)

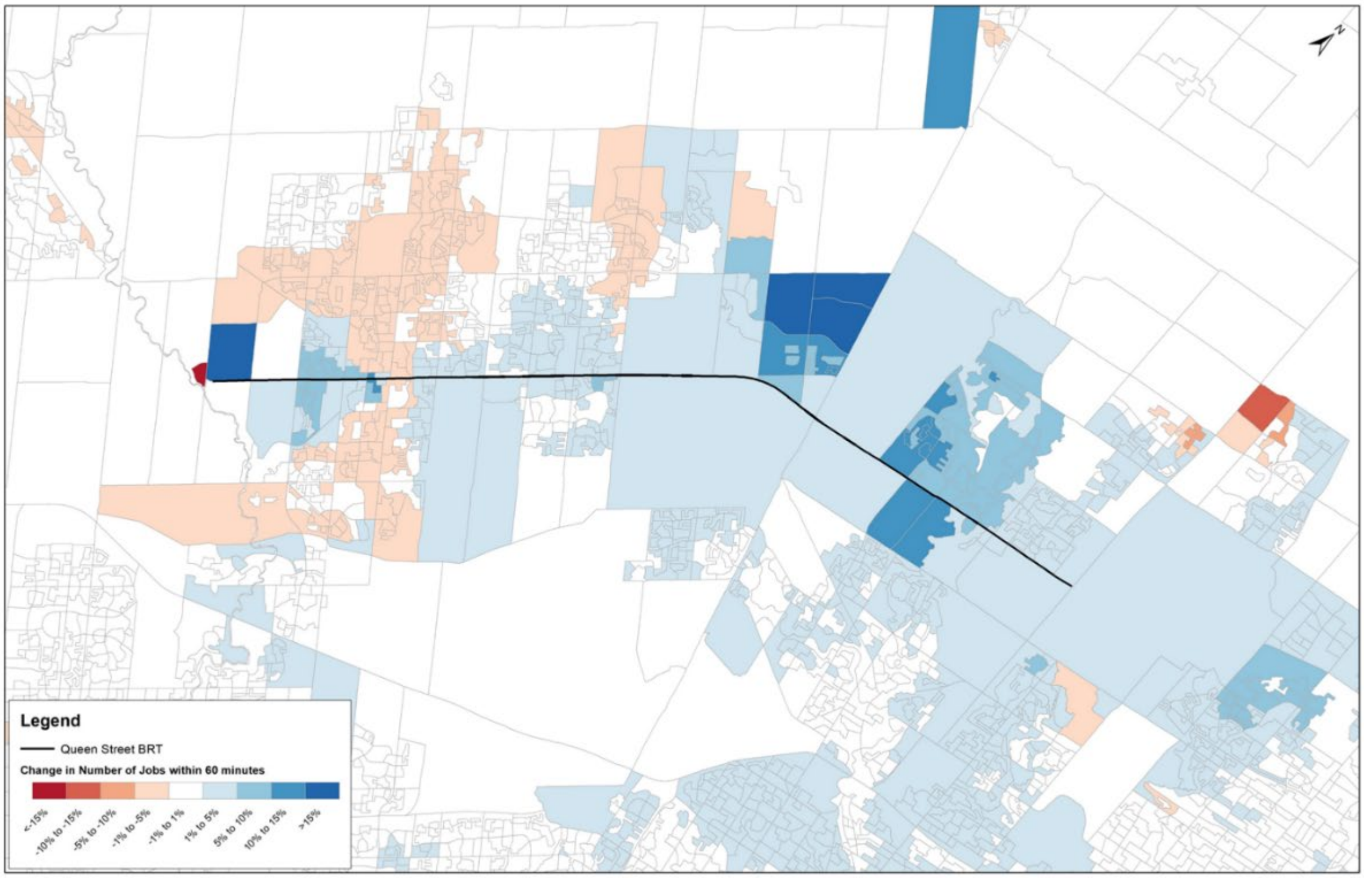


Figure 33: Change in access to jobs by transit (Scenario 2 vs 2041 BAU), AM peak period (Metrolinx Accessibility Toolkit)

Figure 34: Change in access to jobs by transit (Scenario 3 vs 2041 BAU), AM peak period (Metrolinx Accessibility Toolkit)

- Impact on mode share

  The BRT service concept should encourage more people to choose transit within the study area. This evaluation assesses the change in modelled mode share for each scenario compared to the 2041 BAU based on the results from the GGHM_v4 model. Figure 35 to Figure 37 illustrate the change in mode share by traffic analysis zone (TAZ). In each scenario, there are slight increases to transit mode share along the Queen Street – Highway 7 Corridor, with the highest increases on the west of Downtown Brampton. As shown in Figure 36, the splitting of the main BRT route into two sections in Scenario 2 appears to impact transit mode share. As shown in Figure 37, the feeder routes for Scenario 3 have a positive impact on transit mode share outside of the Queen Street Corridor, particularly in the Gore Road area.

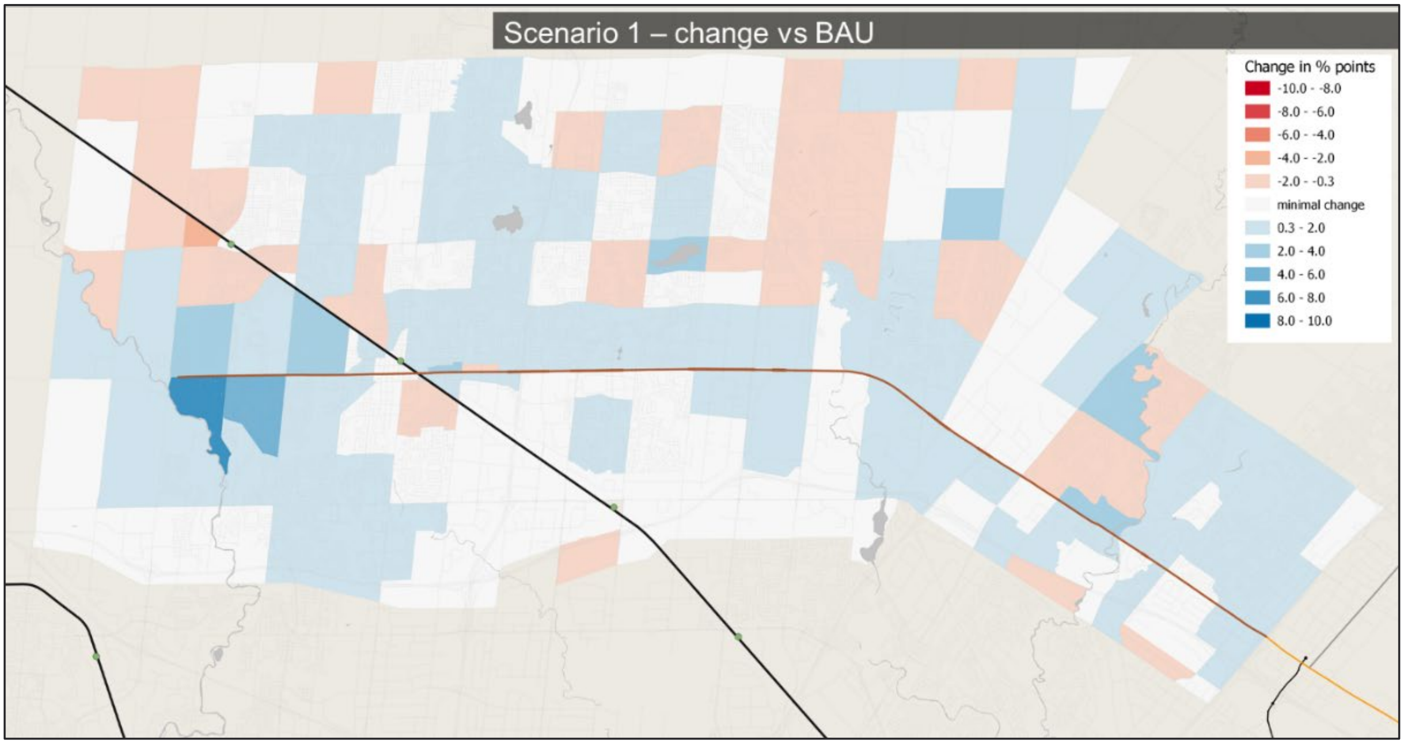


Figure 35: Change in transit mode share (Scenario 1 vs 2041 BAU), AM peak period (Metrolinx Accessibility Toolkit)

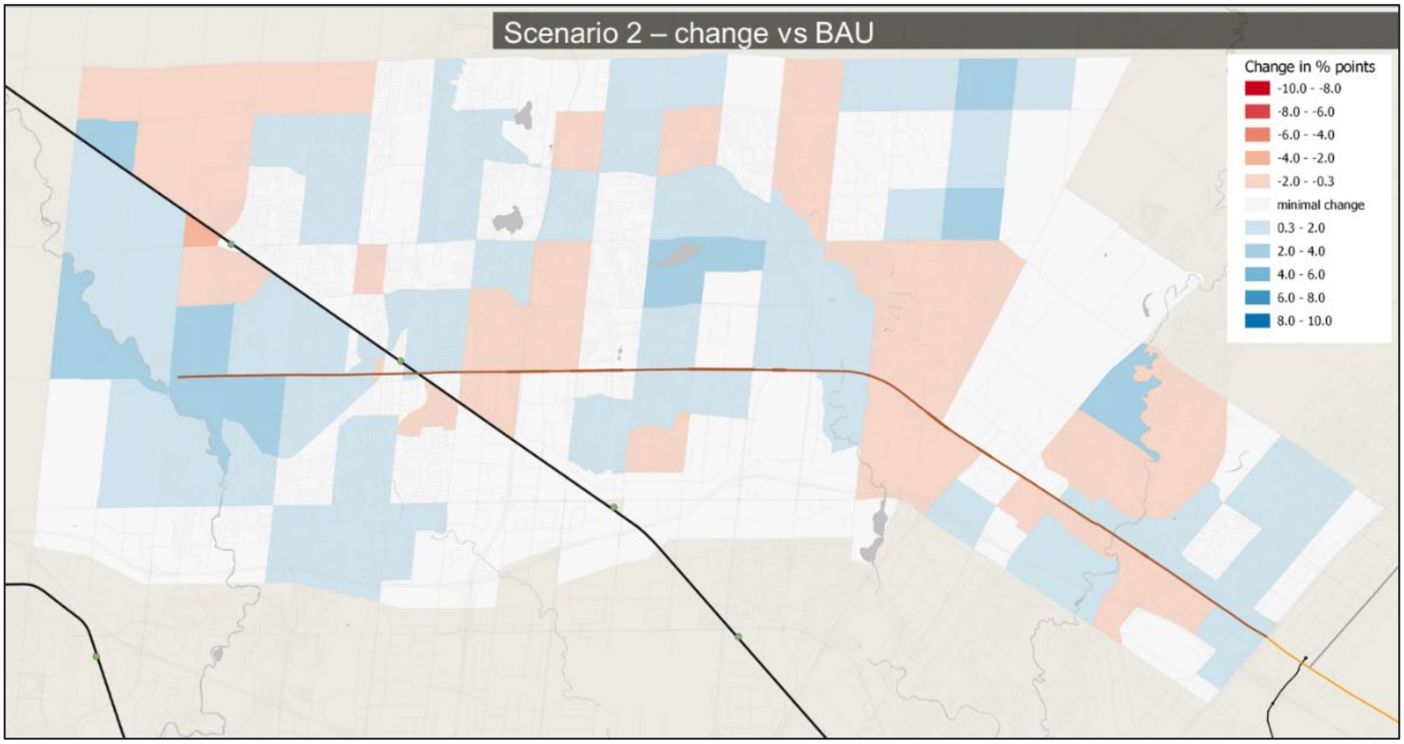


Figure 36: Change in transit mode share (Scenario 2 vs 2041 BAU), AM peak period (Metrolinx Accessibility Toolkit)

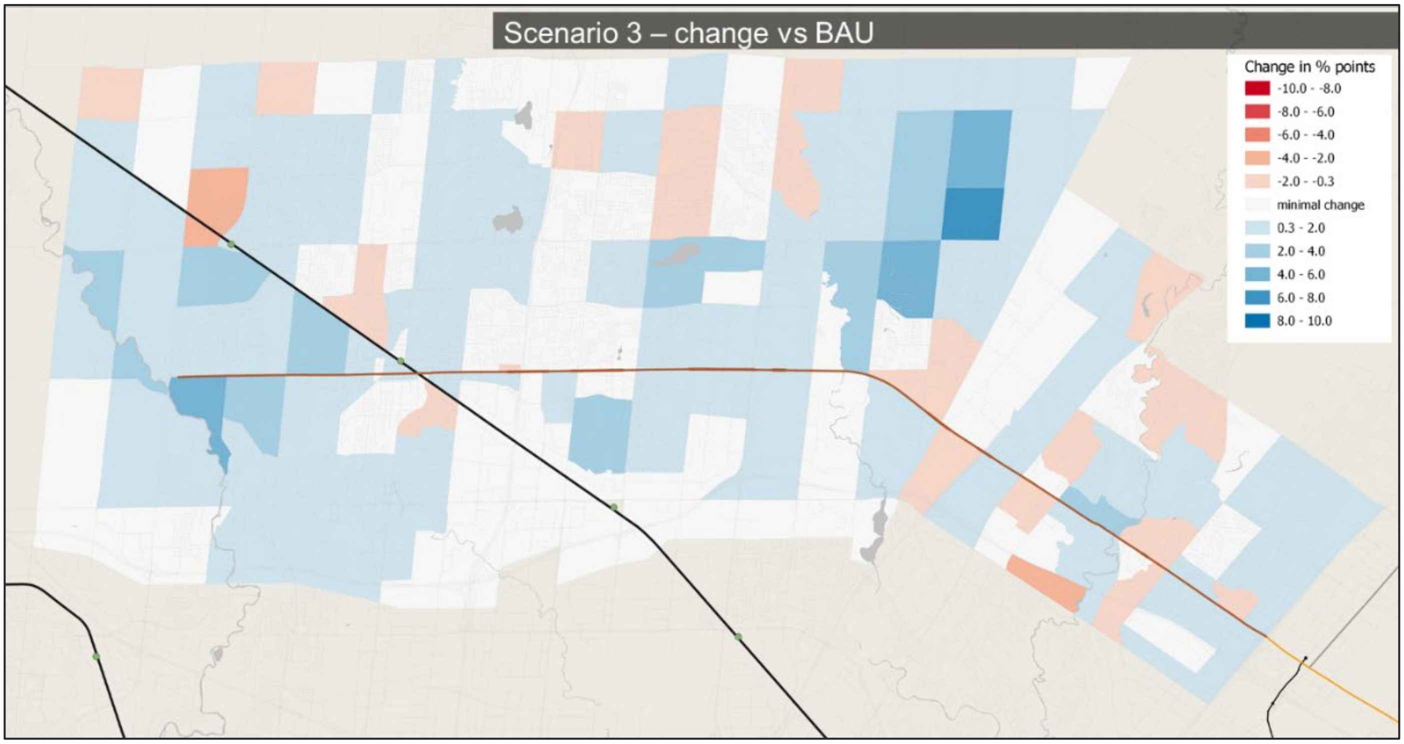


Figure 37: Change in transit mode share (Scenario 3 vs 2041 BAU), AM peak period (Metrolinx Accessibility Toolkit)

- Impacts on auto travel

  The transit service concept should reduce auto travel and assist in reducing congestion across the corridor. In this IBC this is measured using the change in vehicle-kilometres and vehicle-hours travelled in the AM peak period for each scenario compared to the 2041 BAU scenario. Additional modelling to understand the detailed impact to local traffic will be completed in the preliminary design phase. Along the corridor, each of the scenarios perform similarly. There is a reduction in vehicle kilometres and vehicle hours travelled on the sections of Queen Street within Downtown Brampton as illustrated in Figures 36 to 38, as a result of the assumed removal of one traffic lane per direction between McMurchy Road and Kennedy Road to accommodate the BRT lane.

  With the reduction in traffic lanes on Queen Street, it is expected that some vehicles may choose alternate routes to travel within Brampton. Figure 38 to Figure 40 show the change in auto vehicle-kilometres travelled by aggregate area for each scenario compared to the 2041 BAU. Across all scenarios, there are similar results. There is a 3-5% reduction in vehicle-km travelled within Downtown Brampton (that can be attributed to the reduction in travel on Queen Street due to the reduction in traffic capacity) and the higher frequency of transit service proposed. In all other study area zones, there is minimal change (i.e. less than 1%). This suggests that there may be minimal increases in vehicle traffic associated with rerouting off Queen Street into local areas, however this will be further refined in the next phases of work.

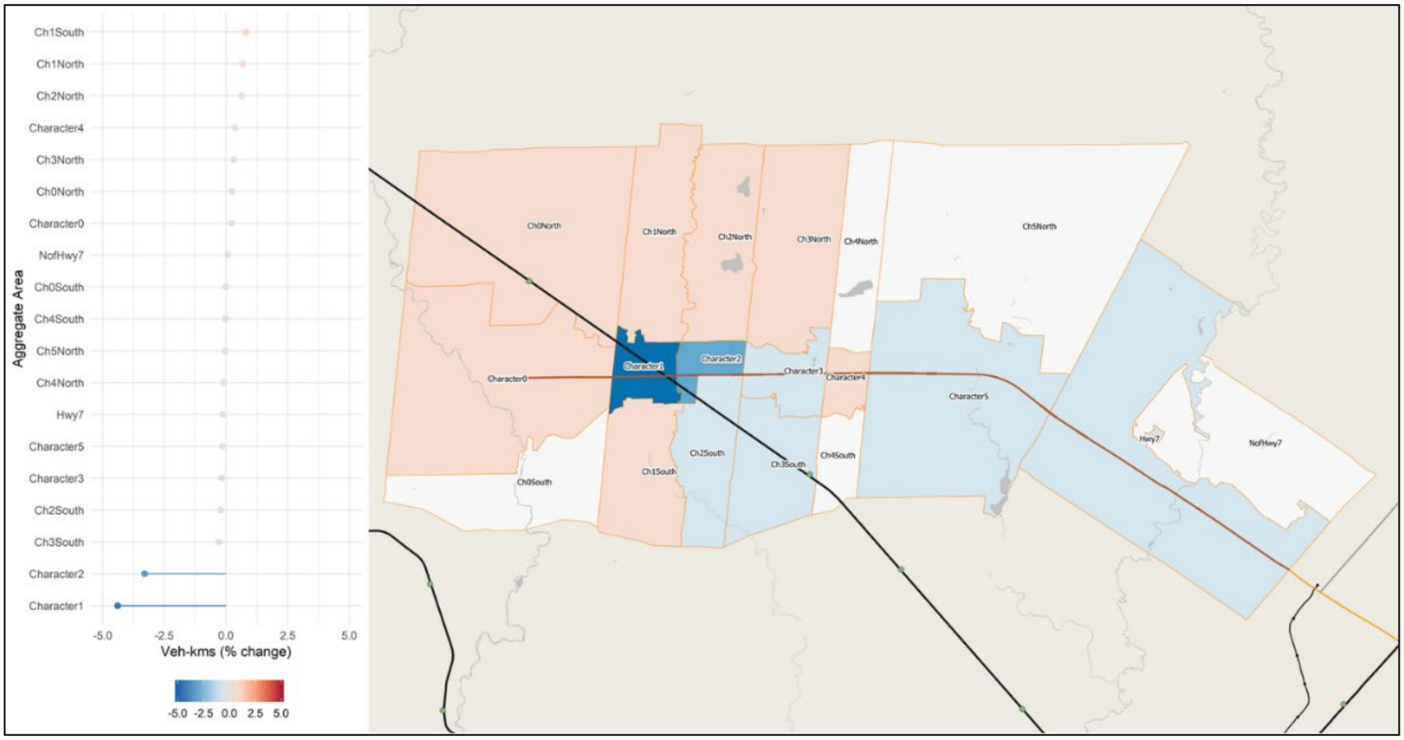


Figure 38: Change in auto vehicle-km travelled by aggregate area (Scenario 1 vs 2041 BAU), AM peak period

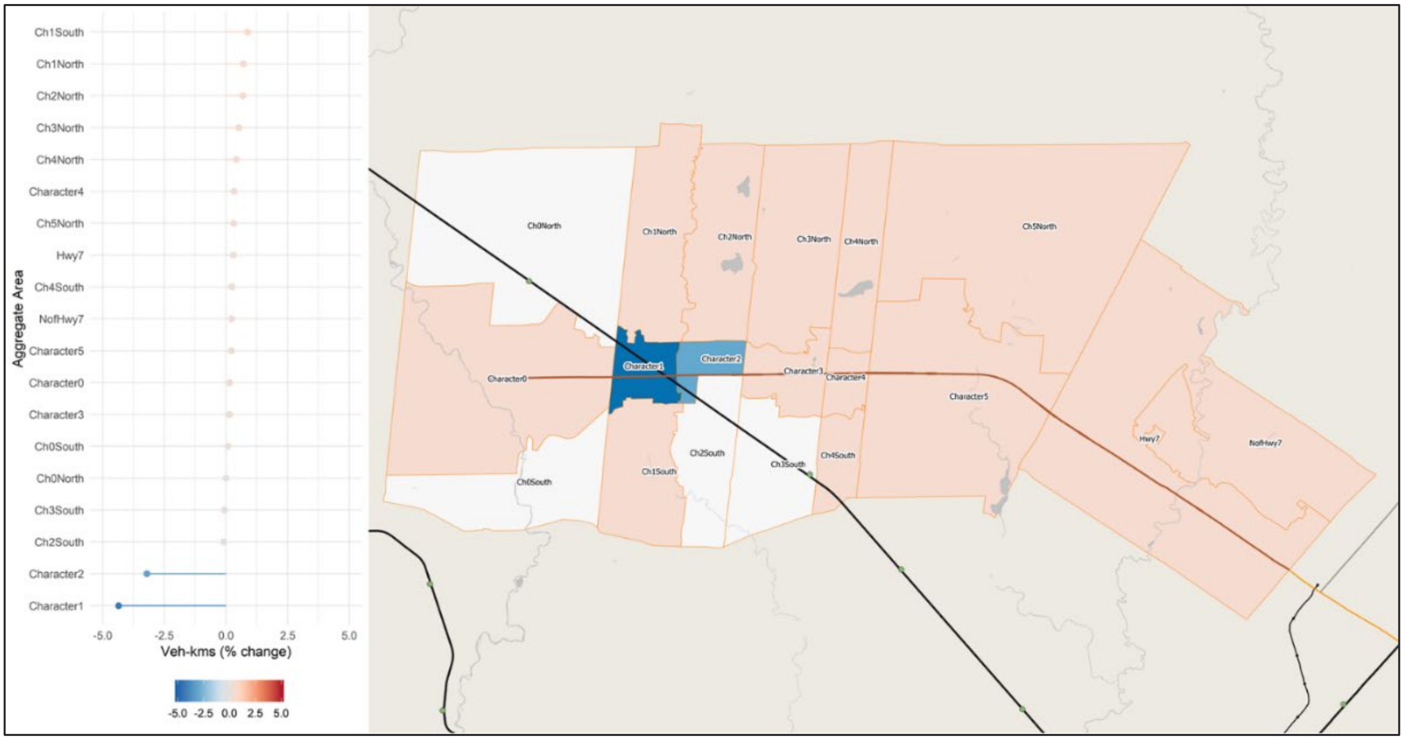


Figure 39: Change in auto vehicle-km travelled by aggregate area (Scenario 2 vs 2041 BAU), AM peak period

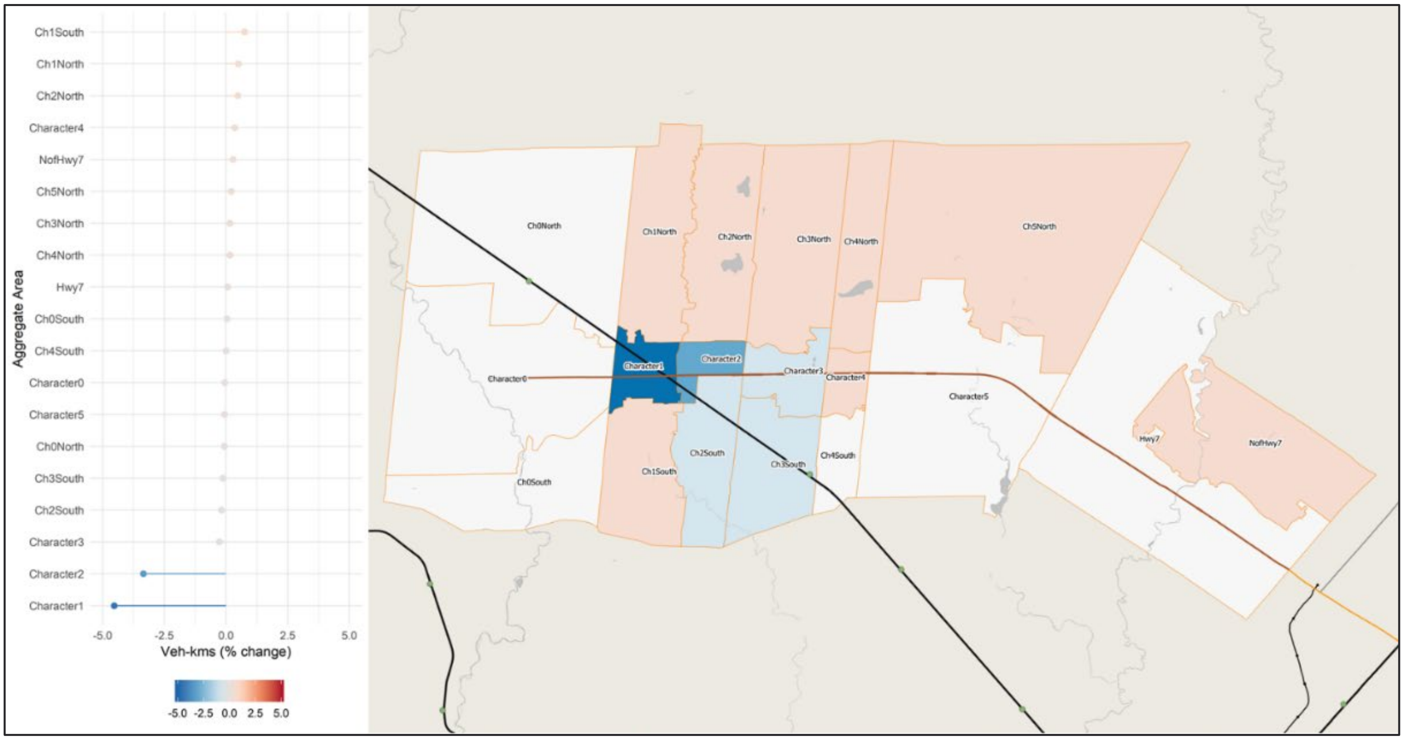


Figure 40: Change in auto vehicle-km travelled by aggregate area (Scenario 3 vs 2041 BAU), AM peak period

Figure 41 to Figure 43 show the change in auto vehicle-hours travelled by aggregate area for each scenario compared to the 2041 BAU. Across all scenarios, there are slight differences observed between the data, though they do not seem to have a major impact on the overall result and findings. These differences are largely attributed to the differences in frequency on priority bus routes that will support the BRT corridor. There is minimal change (i.e. less than 1%) in vehicle-hours travelled within downtown Brampton. There are small increases (i.e. less than 5%) in the aggregate areas surrounding Main Street. The impact of these changes on traffic congestion in these areas will be analysed through the detailed traffic assessment in the next phases of work.

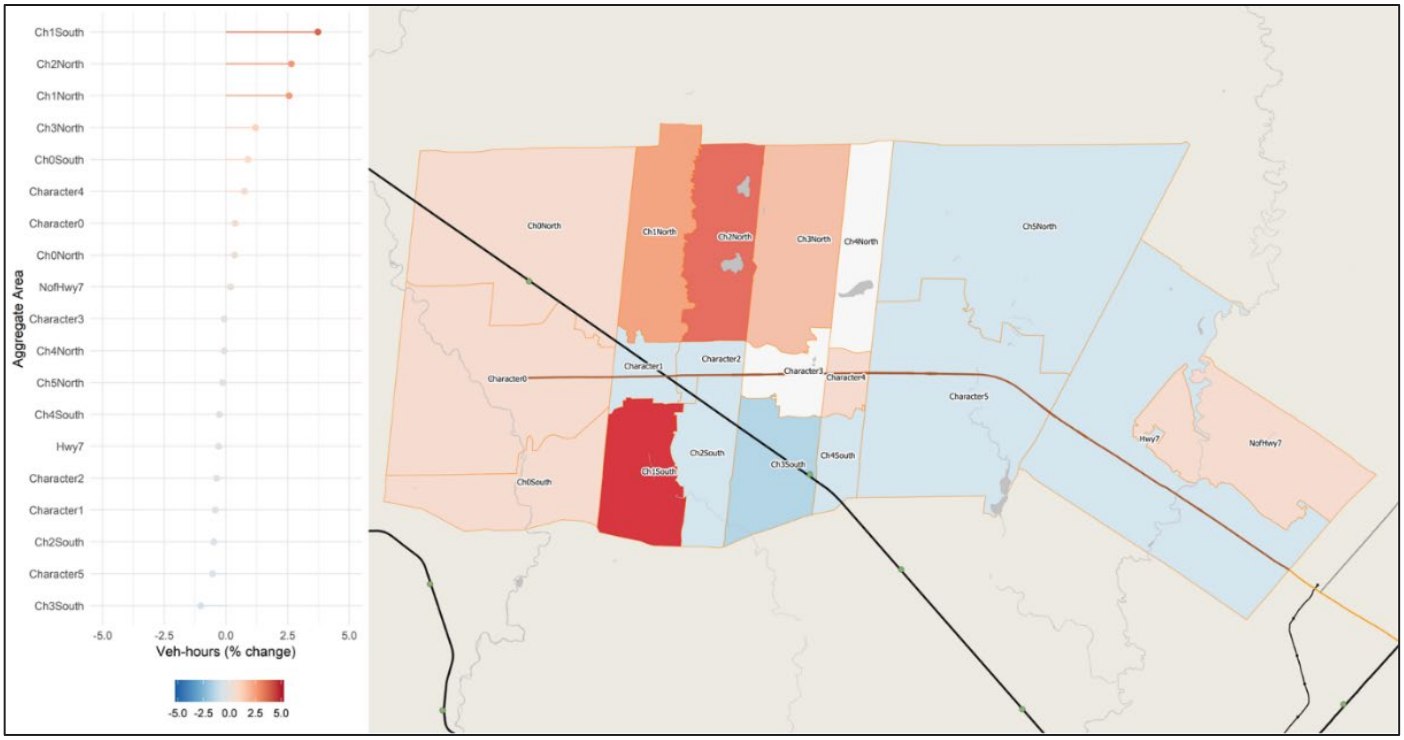


Figure 41: Change in auto vehicle-hours travelled by aggregate area (Scenario 1 vs 2041 BAU), AM peak period

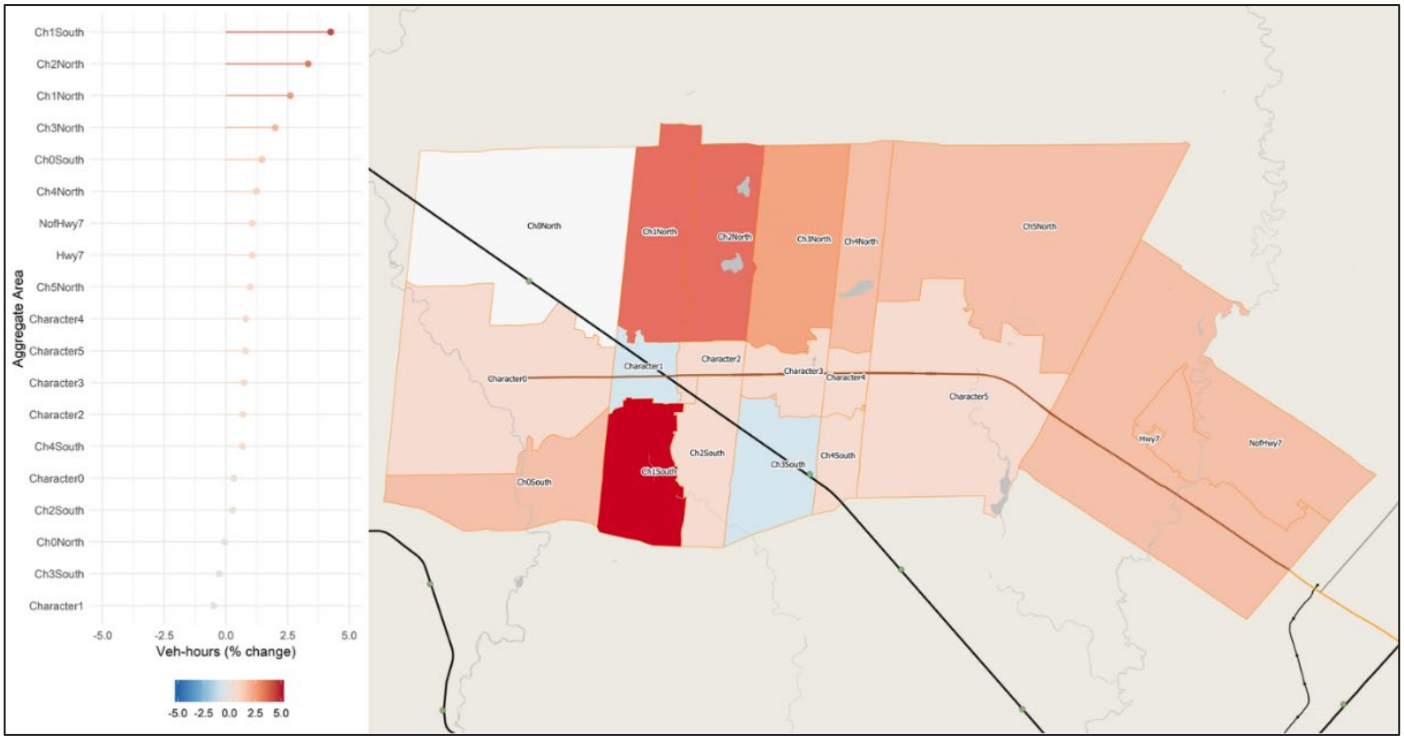


Figure 42: Change in auto vehicle-hours travelled by aggregate area (Scenario 2 vs 2041 BAU), AM peak period

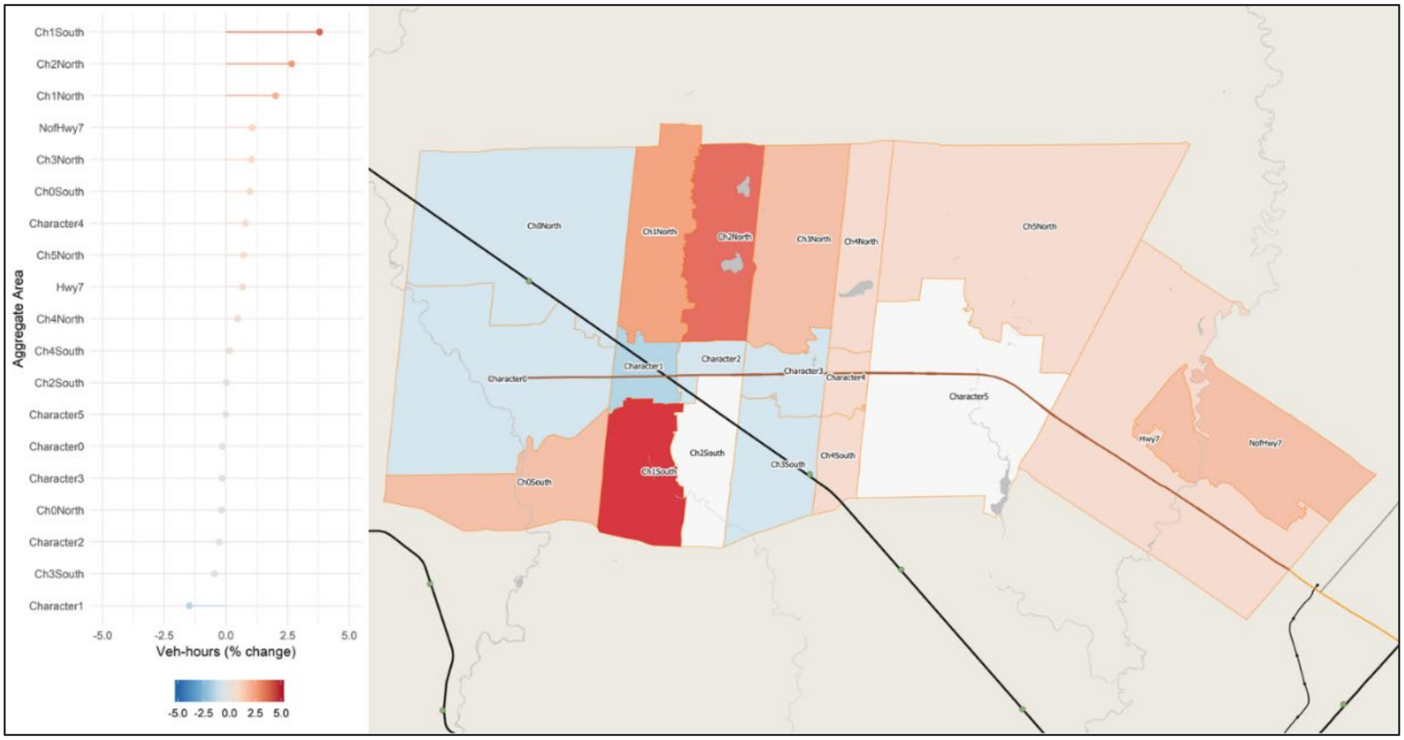


Figure 43: Change in auto vehicle-hours travelled by aggregate area (Scenario 3 vs 2041 BAU), AM peak period

- Transit Level of Service

  The transit level of service criterion is used as a proxy measure for the expected operating cost for each service scenario. This criterion is measured using the expected change in transit vehicle kilometres, which is calculated based on the route length and the proposed AM peak service headway. The analysis is focused on the routes located on Queen Street – Highway 7 Corridor. Table 12 summarizes the planned transit vehicle kilometres travelled in the AM peak period (6 – 9 AM) by scenario. Based on this analysis, Scenario 3 has the highest increase in vehicle kilometres travelled, which is expected due to the number of additional Priority Bus routes.

Table 12: Transit vehicle kilometres travelled by scenario (AM peak period)

SCENARIO	TRANSIT VKTS	CHANGE IN VKTS	% CHANGE VS BAU
BAU	3,600	--	--
SCENARIO 1	4,600	+1,000	28%
SCENARIO 2	4,600	+1,000	28%
SCENARIO 3	6,100	+2,500	69%

Recommendation of BRT service concept

Table 13 summarizes the key findings from the evaluation of the service definition.

Table 13: Transit service definition evaluation summary

CRITERIA	KEY FINDINGS
TRANSIT DEMAND	There is higher transit demand with BRT across all scenarios. However, splitting the main BRT route into two sections will impact transit demand (resulting in a reduction in demand)
TRANSIT ACCESSIBILITY	Feeder routes (as modelled in Scenario 3) make a significant improvement for access to employment
IMPACT ON MODE SHARE	Scenarios 1 and 3 result in increases in transit mode share across the corridor
IMPACT ON AUTO TRAVEL	Lane reductions suggest there is capacity on the local network across all scenarios for potential displaced traffic as a result of the removal of existing traffic capacity on Queen St. However limited analysis has been completed on this and it should be further analyzed in the preliminary design phase to understand the full impacts prior to making a determination on lane configuration
TRANSIT LEVEL OF SERVICE	Scenario 3 has the highest increase in transit VKTs due to the feeder routes

Recommended transit service definition for the IBC

Based on the evaluation, the recommended service definition is a single main BRT trunk route plus the addition of the feeder priority routes. This service definition is a combination of Scenarios 1 and 3. The single main BRT trunk route is preferred over splitting the service into two main routes as the transit demand analysis suggests that it will have higher boardings. The addition of feeder priority routes is preferred as it makes considerable improvements to transit accessibility. While the addition of priority routes is expected to increase operating costs, some of the feeder routes with low expected ridership (e.g. Routes D1 and D2) could be refined in further study stages.

The following are additional considerations and context:

- One main BRT trunk route on the corridor (instead of two) is preferable as it is shown to maximize ridership;
- The Viva Orange route from the east should not use the BRT corridor under study and should stop at Vaughan Metropolitan Centre, in order to use existing VMC facilities to ensure efficient transfers between transit services for users;
- Other transit routes and headways proposed in Scenario 3 help maximize transit ridership;
- Route 01 remains on Highway 407 for its east portion and is not shifted onto Highway 7, because that would likely increase travel times and reduce ridership; and
- Routes D1 and D2 are maintained in Scenarios 4, 5, and 6, as they are defined in Scenario 3 (routes and headways), even if the ridership of D2 is lower than the other Priority Bus routes.

They are both links to Pearson Airport and route D2 also serves the TTC subway. In further study stages, these routes and their headways can be refined.

Figure 44 shows transit service definition for Scenarios 4, 5, and 6 on the Queen Street – Highway 7 corridor.

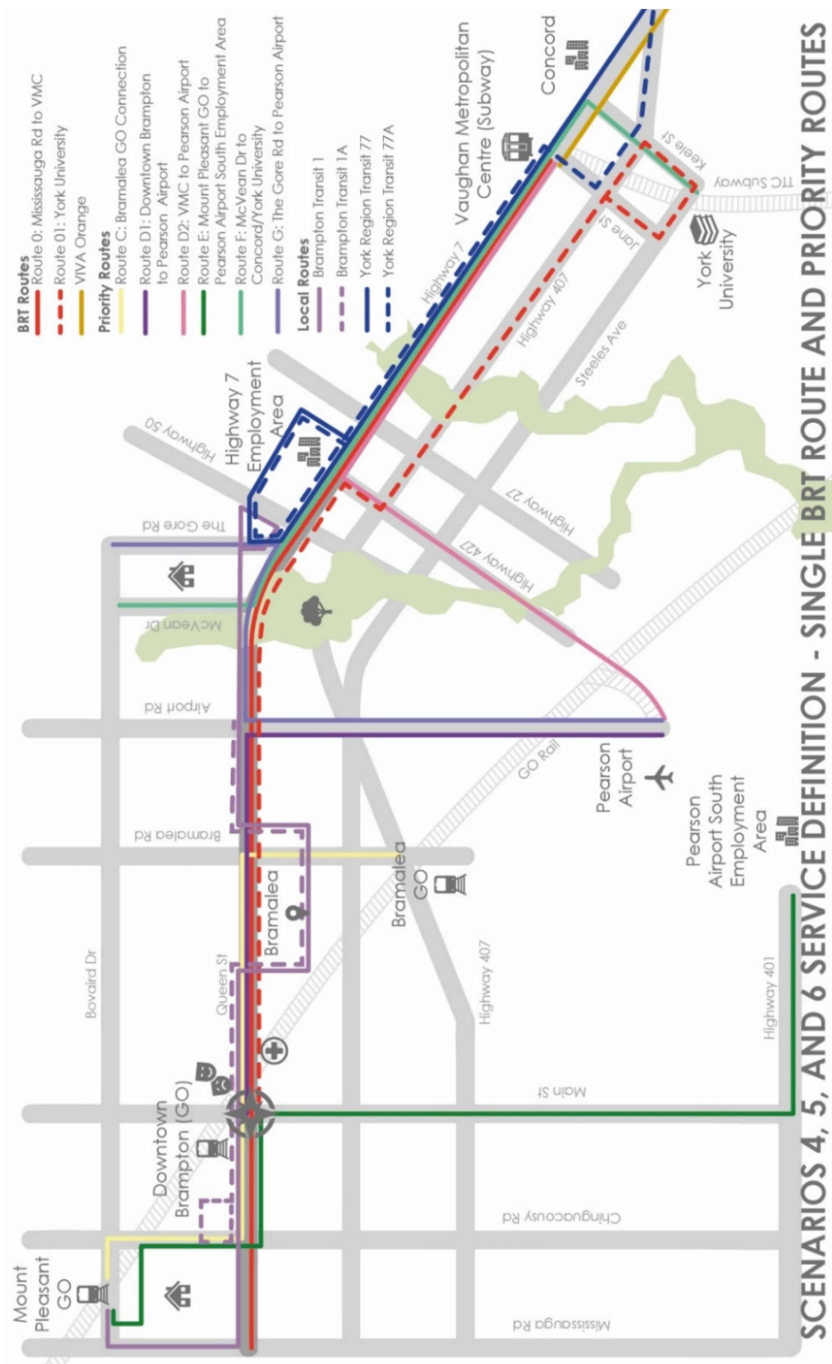


Figure 44: Transit service in Scenarios 4, 5, and 6: One main BRT route and Priority Bus routes on the Queen Street – Highway 7 BRT Corridor

Infrastructure Scenarios

BRT systems are flexible with a variety of infrastructure design options that can be accommodated within existing rights of way, and by widening rights of way, depending on the capacity, speed, and other design requirements of the BRT system. Some design options require more substantial infrastructure investments than others, with impacts to user experience and the level of service that can be achieved on the system.

Design solutions can also be combined along a corridor; for example, where there is sufficient space in the existing right of way, a centre median BRT can be deployed, while in narrow portions of a corridor, a curbside BRT system with time of day lane restrictions may be preferable.

General BRT design considerations

Right of way options

- Centre median operation

  Centre median running BRT systems apply dedicated bus lanes in the centre median along an entire corridor. Centre median BRT systems allow for efficient and reliable operation, reduced travel times, and minimizes the potential for conflict between buses and other vehicles on the roadway, particularly if the roadway has many mid-block driveways. They typically require an expanded road width or the elimination of conventional vehicle travel lane(s).

- Curbside operation

  Curbside running BRT systems use curbside platforms and operate similarly to conventional bus services in mixed traffic, but have signage dedicating exclusive use by buses in curbside lanes at certain times. Curbside operation may be preferable where rights of way are narrow and do not permit the addition of a new centre median. However, curbside operation may increase conflicts between buses and vehicles if there are many mid-block driveways, reducing reliability of the service, and potentially increasing safety risks.

  Table 14 compares centre median versus curbside operation of BRT systems.

Table 14: Right of way option comparison of BRT systems

	CENTRE MEDIAN		CURBSIDE
+	Increases reliability of transit operations	+	Increases efficiency of transit operations
+	Fewer potential conflicts with local traffic and pedestrians	-	Potential conflicts with local traffic and pedestrians
+	Minimizes conflicts with right-turning traffic and avoids merge before left turns (with traffic signal exclusive phases)	-	Impact from right-turning traffic (intersections and driveways) and need for merge before left turns
+	Can be converted to LRT if warranted	-	Not easily converted to LRT
-	Higher costs (typically)	+	Lower costs (typically)

	CENTRE MEDIAN		CURBSIDE
+	Centre median creates passenger refuge and shortens crossing distance	+	BRT accessible from sidewalks
-	Potential impact on traffic and vehicle throughput at intersections (traffic light phasing; left turn movement limitations)	+	Conflicts exist for vehicles turning right
+	Limited possibility for misuse by other road users increases transit efficiency	-	Can be used by other road users (HOV, bicycles, taxis), impacting transit efficiency and potential for misuse. Requires proper enforcement.

There are a number of important considerations with BRT options including the following:

- physical or environmental constraints limiting the potential to widen the Right-Of-Way to add lanes;
- Adjacent land uses and opportunities for changes in land use with the introduction of a BRT corridor; and
- Impacts to local traffic access, goods movement and conflicts between vehicles and buses in curb lanes.

For the purpose of this IBC, curbside BRT was not considered as a standalone option. This is because the impacts of curbside BRT on traffic, and the impacts at intersections are too detailed for this level of analysis. Detailed intersection level impacts of the BRT will be assessed at the preliminary design phase and curbside BRT may be considered in areas which are constrained, and reliability of bus service can be maintained with the implementation of curbside lanes.

Stop types, spacing, and locations

Regarding the stop types on the Queen Street – Highway 7 Corridor, the following assumptions apply to the definition of the Brampton Queen Street – York Region Highway 7 BRT project:

- When the BRT is positioned in the median section of the road, the BRT stops are similarly positioned, laid out, and equipped compared to existing stops on the Viva median BRT network in Vaughan;
- When the BRT is on the curbside, the stops are similar to the existing bus stops and with limited modifications (BRT branding, some equipment systems).

Relative to local non-BRT bus service, BRT is characterized by wider stop spacing. Less frequent stops allow the BRT to travel more reliability. Stops were selected based on a careful consideration of the following criteria:

- Using existing Züm/Viva bus stops on the Queen Street – Highway 7 Corridor where possible (to maintain familiarity with transit system and minimize throw-away costs);
- Locating stops at major intersections;
- Connecting to other transit routes;

- Connecting to major destinations (e.g. secondary schools, major employment areas); and
- Keeping average stop spacing greater than 800 m.

As a point of comparison, existing BRT services elsewhere in the GTHA use the following stop spacing:

- Viva: 1 stop per 1,000-1,600 m
- Durham Region Transit PULSE service between Oshawa and University of Toronto Scarborough: 1 stop per 550 m

Converting a lane versus adding a lane

When introducing an on-street BRT system, one important consideration is whether or not a vehicle travel lane (also known as a general purpose [GP] lane) will be removed to allow for the introduction of a transit-only lane, or the roadway will be widened or adjusted to maintain existing vehicle capacity while adding a new transit-only lane. In corridors characterized by heavy traffic volumes such as the Queen Street – Highway 7 Corridor, converting a vehicle travel lane may present a significant challenge by increasing traffic congestion and inducing pressure on adjacent local streets, unless mode shift to BRT along the same corridor is immediate.

In constrained conditions, such as in a downtown location or where existing underpasses and overpasses exist, or where there is sensitivity to adjacent land uses, vehicle travel lane reductions or mixed traffic BRT operations may be required. As noted previously, the BRT system does not necessarily require a single design solution (e.g. only adding a lane or only converting a lane) for the length of the route. Local contexts may dictate modifications as part of the design process.

Table 15 compares lane addition versus lane conversion for BRT operation.

Table 15: Lane addition versus conversion for BRT operation option comparison

	ADDING A BUS LANE		CONVERTING A LANE
+	Increases reliability of transit operations versus operating in mixed traffic and reduces travel time for customers	+	Increases reliability of transit operations versus operating in mixed traffic and reduces travel time for customers
-	Right of way widening required	+	Not likely to require substantial right of way widening (may be required at intersections where stops are proposed)
+	Maintains existing traffic capacity	-	Reduces existing traffic capacity
+	Can be curbside or median	+	Can be curbside or median
+	24hr operation	+	Flexible time of day use – 24hr or peak period operation
-	Higher costs	+	Lower costs

BRT speeds in semi-exclusive lane conditions

An Arup model for estimating speed and travel times of buses travelling on the proposed semi-exclusive corridor was developed. The resulting speed estimates were used as an input into the regional travel demand model (GGHM_v4) when modelling exclusive BRT lanes.

The approach also takes into consideration other operational characteristics including the bus acceleration and deceleration rates, the vertical gradient, traffic signal operations and the posted speed limits. The bus travel time is derived from the following components:

- The time when the bus is in motion. This includes bus acceleration, cruising and deceleration times under free-flow conditions;
- Dwell times at bus stops to board and alight passengers; and
- The time spent in a stop conditions at signalized intersections. The amount of traffic signal delay varies and is dependent on cycle length, green phases, and signal progression.

Distances between stops and intersections were measured and used to calculate the bus speeds along the corridor.

Overall, the average bus speeds on the proposed semi-exclusive corridor are 31.0 km/h and 31.2 km/h in the eastbound and westbound direction, respectively. Details are described in Table 16.

Table 16: Calculated average bus speeds on the Queen Street – Highway 7 BRT exclusive BRT lanes (Arup, 2019)

DIRECTION	CALCULATED AVERAGE BUS SPEED ON SEMI-EXCLUSIVE CORRIDOR (KM/H)
EASTBOUND	31.0 km/h
WESTBOUND	31.2 km/h
AVERAGE (BOTH DIRECTIONS)	31.1 km/h

Queen Street – Highway 7 BRT infrastructure options

Three (3) infrastructure options have been developed for the Queen Street – Highway 7 BRT Corridor, as per evaluation methods defined previously. Each scenario consists of a combination of one or all of the different BRT lane configurations: centre median with lane conversion, centre median with road widening, and buses operating in mixed traffic conditions. All options consider the provision for active transportation across the corridor as much as possible.

Scenario 4: centre median BRT operation with lane conversion

Scenario 4 proposes the conversion of a traffic lane per direction to median BRT exclusive lanes along the length of the Queen Street – Highway 7 Corridor, including downtown Brampton. This reduces the number of traffic lanes along the length of the corridor (one per direction).

- Lane configuration assumptions for the calculation of the required Right-of-Way (ROW):
    - General purpose (GP) traffic lanes' widths reduced to a minimum of 3.3 m each;

- BRT lanes at 3.5 m wide each plus a 0.6 m buffer (0.3 m between each direction of traffic);
- Two bike lanes at 2 m wide each;
- Sidewalks at current widths.

Figures 45 to 48 illustrate the BRT concept on the corridor for Scenario 4, with an illustrative cross section per segment. An analysis of the estimated ROW widths available and required along the corridor has led to the BRT concept per segment and to the evaluation of impacts on the ROW. These however are not indicative of the ROW that will be required for the BRT infrastructure; instead it was used to support the initial modelling, early concept designs and costs estimates of the infrastructure. These will be further refined in future phases of the study.

Table 17 provides a description of the configuration for road segments that are likely constrained by the width of the ROW being narrowed than what is required between outside limits of current sidewalks or between curbs/current paved areas.

Table 17: Scenario 4 configuration constrained corridor segments (Arup, 2019)

ROAD SEGMENT	SEGMENT LENGTH (M)	INFRASTRUCTURE CONSTRAINTS	CONFIGURATION
MISSISSAUGA RD TO CHINGACOUSY RD	2,710	Bridge over drain crossing (east of James Porter Rd)	Bus exclusive (1 veh lane per direction)
CHINGACOUSY RD TO MCMURCHY AVE	2,070	Bridge over creek (east of McLaughlin Rd)	Bus exclusive (1 veh lane per direction)
FLETCHERS CREEK	24	Bridge over Fletchers Creek	Bus exclusive (1 veh lane per direction)
MCMURCHY AVE TO ELIZABETH ST	320	Level rail track crossing at Elliot Street	Bus exclusive (1 veh lane per direction)
ELIZABETH ST TO CHAPEL ST	540	Downtown Brampton / Building lines along sidewalks.	Bus shared with traffic or Bus exclusive (1 veh lane per direction) if parking is removed
CHAPEL ST TO CENTRE ST	525	Rail corridor underpass, Etobicoke Bridge over creek	Bus exclusive (1 veh lane per direction)
CROSSING OF HIGHWAY 410	225	Highway overpass	Bus exclusive (2 veh lane per direction)
CROSSING OF SPRING CREEK	23	Bridge over Spring Creek	Bus exclusive (2 veh lanes per direction)

ROAD SEGMENT	SEGMENT LENGTH (M)	INFRASTRUCTURE CONSTRAINTS	CONFIGURATION
CROSSING OF DRAIN 2 IN CLAIREVILLE CONSERVATION AREA TO HIGHWAY 427 (ROAD 99)	1380		Bus exclusive (2 veh lanes per direction)
KIPLING AV TO CROSSING OF RAIL TRACKS	340		Bus exclusive (1 veh lane per direction)
AT CROSSING OF RAIL TRACKS	75	Rail corridor underpass	Bus exclusive (1 veh lane per direction)
CROSSING OF RAIL TRACKS TO HUMBER RIVER CROSSING	75		Bus exclusive (1 veh lane per direction)
HUMBER RIVER CROSSING TO ISLINGTON AVE	115	Bridge over Humber River	Bus exclusive (1 veh lane per direction)

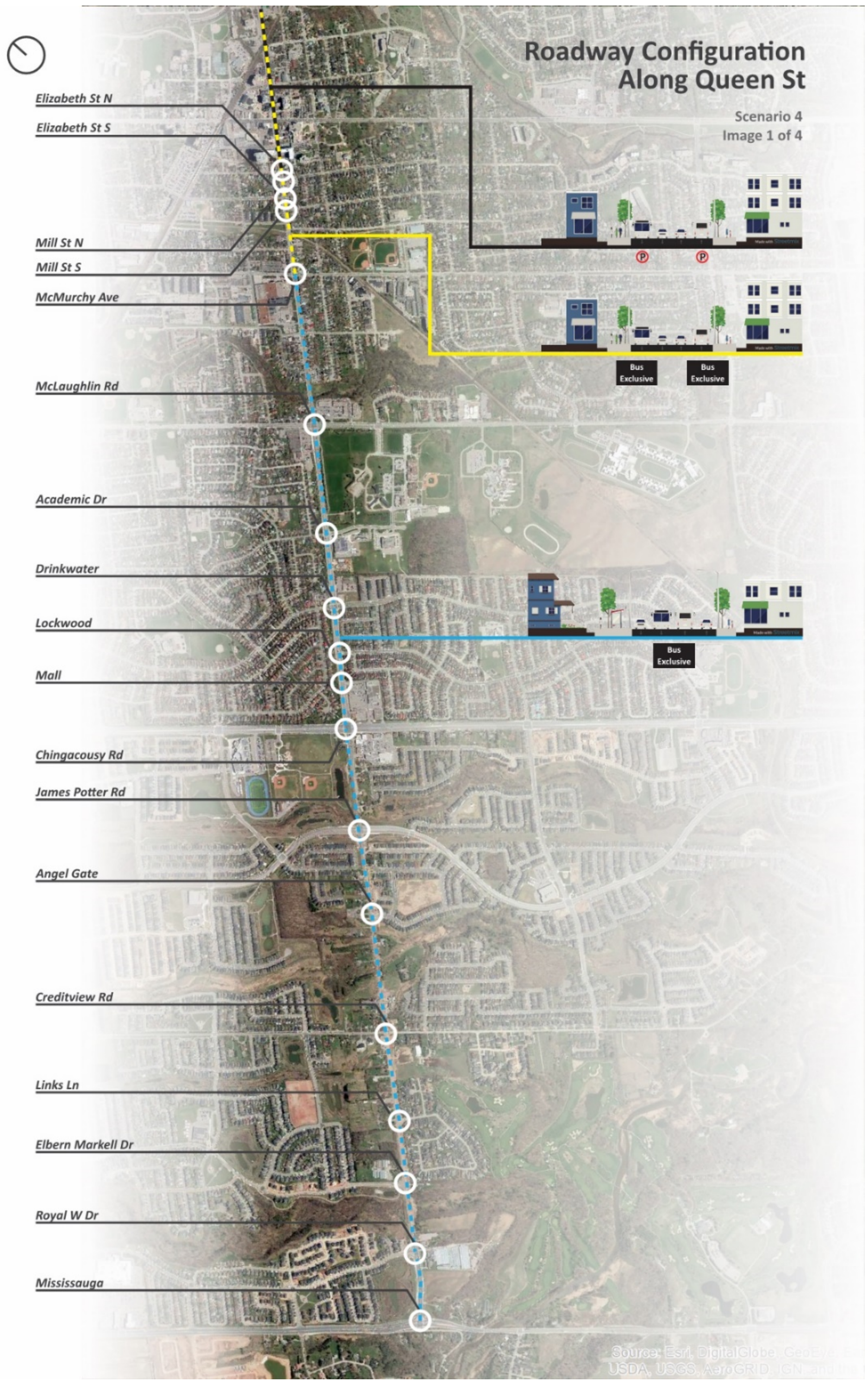


Figure 45: Scenario 4 road configuration, Mississauga Road to Mill Street North

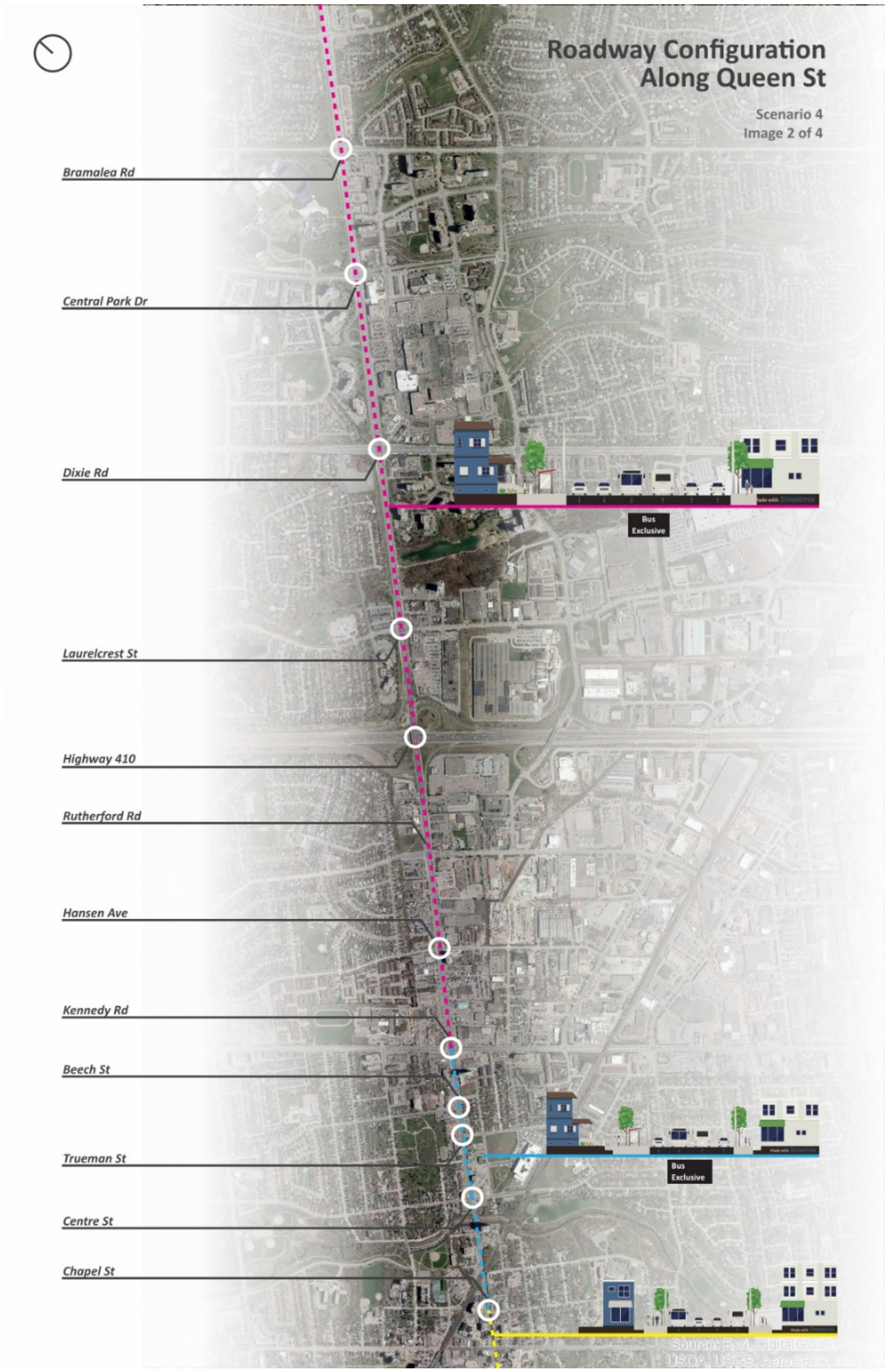


Figure 46: Scenario 4 road configuration, Chapel Street to Bramalea Road

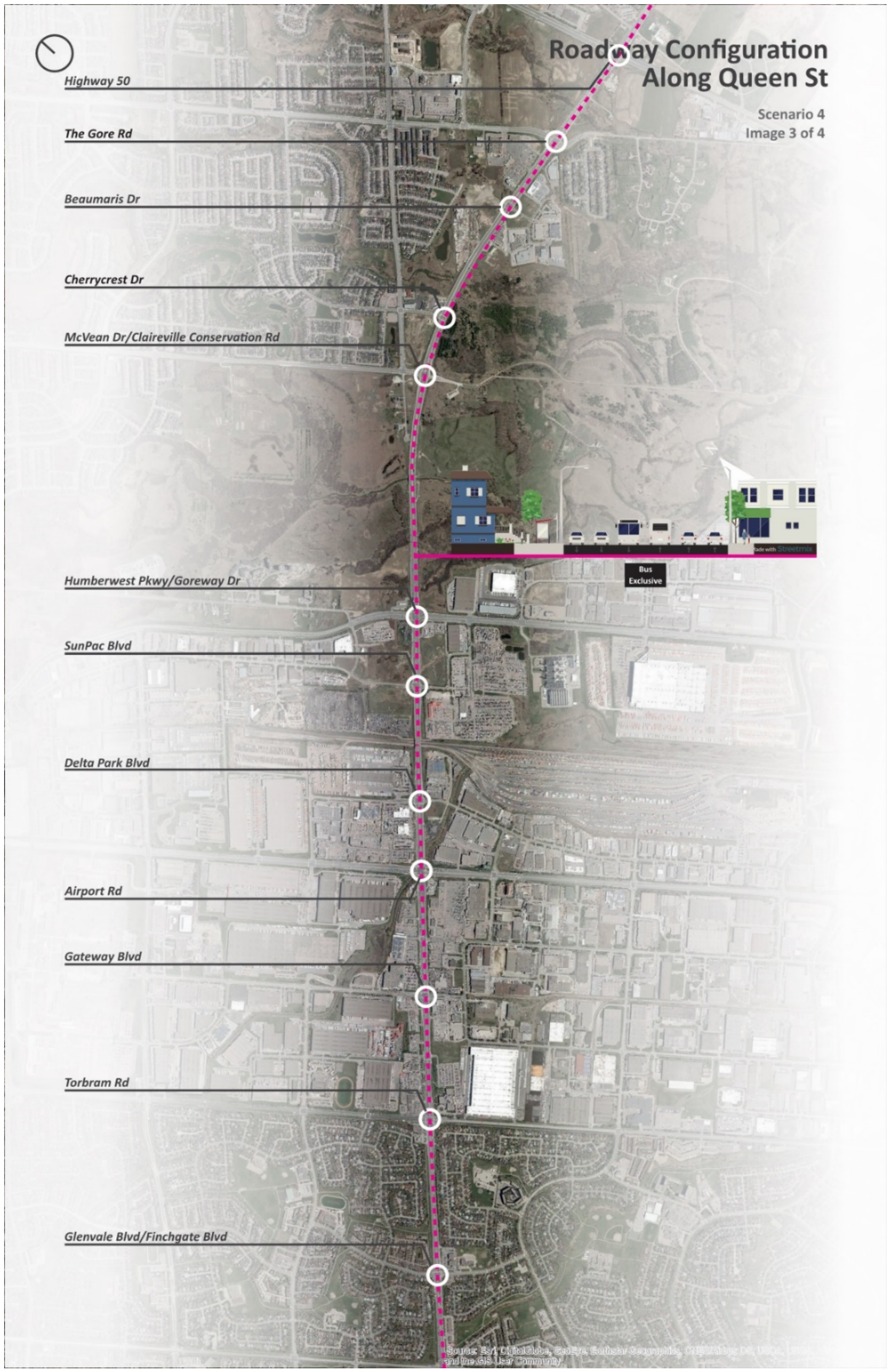


Figure 47: Scenario 4 road configuration, Glenvale Boulevard to Highway 50

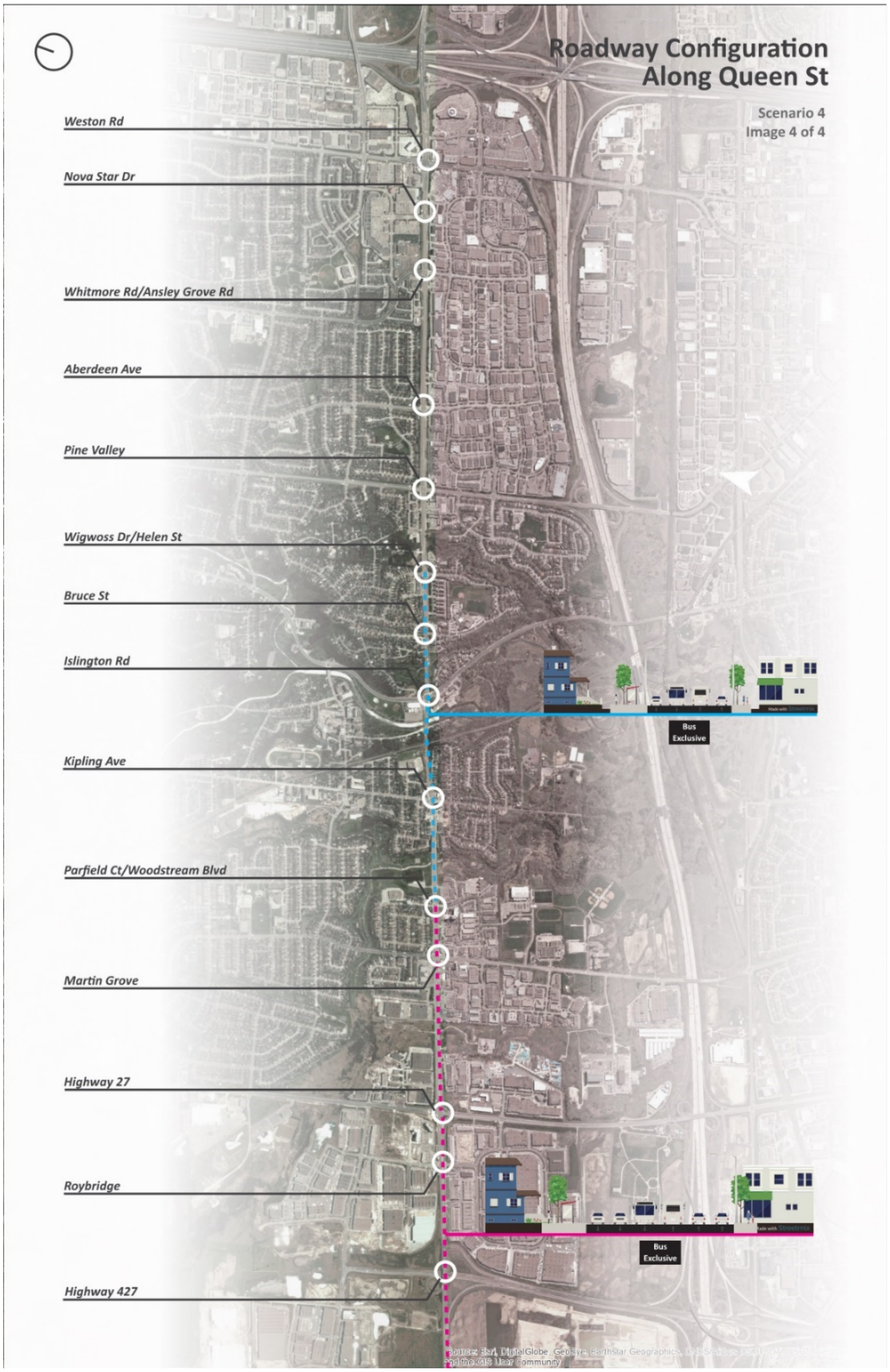


Figure 48: Scenario 4 road configuration, Highway 427 to Weston Road

Scenario 5: centre median BRT operation with lane addition

Scenario 5 proposes one median BRT exclusive lane per direction along the length of the Queen Street – Highway 7 Corridor as a result of road widening, everywhere except Downtown Brampton (Queen Street between McMurchy Avenue and Kennedy Road) where lane conversion is considered, resulting in a reduction in the number of auto travel lanes (one per direction) on that section of the corridor.

- Lane configuration assumptions for the calculation of the required Right-of-Way (ROW)
    - GP traffic lanes' widths reduced to a minimum of 3.3 m each;
    - BRT lanes at 3.5 m wide each plus a 0.6 m buffer (0.3 m between each direction of traffic);
    - Two bike lanes at 2 m wide each;
    - Sidewalks at current widths.

Figures 49 to 52 illustrate the BRT concept on the corridor for Scenario 5, with an illustrative cross section per segment. An analysis of the estimated ROW widths available and required along the corridor has led to the BRT concept per segment and to the evaluation of impacts on the ROW. These however are not indicative of the ROW that will be required for the BRT infrastructure; instead it was used to support the initial modelling, early concept designs and costs estimates of the infrastructure. These will be further refined in future phases of the study.

As a result of this analysis, Table 18 provides a description of the configuration for road segments that are likely constrained by the width of the ROW being narrowed than what is required.

Table 18: Scenario 5 configuration on constrained corridor segments (Arup, 2019)

ROAD SEGMENT	SEGMENT LENGTH (M)	INFRA-STRUCTURE CONSTRAINTS	CONFIGURATION
MISSISSAUGA RD TO CHINGUACOUSY RD	2710	Bridge over drain crossing (east of James Porter Rd)	Bus exclusive (2 veh lanes per direction)
CHINGUACOUSY RD TO MCMURCHY AVE	2,070	Bridge over creek (east of McLaughlin Rd)	Bus exclusive (2 veh lanes per direction)
FLETCHERS CREEK	24	Bridge over Fletchers Creek	Bus exclusive (2 veh lanes per direction)
MCMURCHY AVE TO ELIZABETH ST	320	Level rail track crossing at Elliot Street	Bus exclusive (2 veh lanes per direction)
ELIZABETH ST TO CHAPEL ST	540	Downtown Brampton / Building lines along sidewalks.	Bus shared with traffic or Bus exclusive (1 veh lane per direction) if parking is removed
CHAPEL ST TO CENTRE ST	525	Rail corridor underpass, Etobicoke Bridge over creek	Bus exclusive (2 veh lane per direction)
KENNEDY ROAD TO HIGHWAY 410	1,195		Bus exclusive (3 veh lane per direction)
CROSSING OF HIGHWAY 410	225	Highway overpass	Bus exclusive (3 veh lane per direction)
CROSSING OF SPRING CREEK	23	Bridge over Spring Creek	Bus exclusive (3 veh lanes per direction)
CROSSING OF BRAMALEA CITY CENTER DRIVE	28	Drive overpass	Bus exclusive (3 veh lanes per direction)
CROSSING OF AIRPORT ROAD INTERSECTION CULVERT	90	Culvert under intersection	Bus exclusive (3 veh lanes per direction)
CROSSING OF CN RAIL TRACKS	200	Rail corridor overpass	Bus exclusive (3 veh lane per direction)
CROSSING OF RIVER IN CLAIREVILLE CONSERVATION AREA	69	Bridge over river	Bus exclusive (3 veh lane per direction)

ROAD SEGMENT	SEGMENT LENGTH (M)	INFRA-STRUCTURE CONSTRAINTS	CONFIGURATION
CROSSING OF DRAIN 1 IN CLAIREVILLE CONSERVATION AREA	10	Culvert over drain	Bus exclusive (3 veh lane per direction)
CROSSING OF DRAIN 2 IN CLAIREVILLE CONSERVATION AREA	20	Culvert over drain	Bus exclusive (3 veh lane per direction)
CROSSING OF DRAIN 2 IN CLAIREVILLE CONSERVATION AREA TO HIGHWAY 427 (ROAD 99)	1,380	Rail corridor underpass, Etobicoke Bridge over creek	Bus exclusive (3 veh lanes per direction)
CROSSING OF HIGHWAY 427 (ROAD 99)	300	Bridge over highway	Bus exclusive (3 veh lanes per direction)
HIGHWAY 427 (ROAD 99) TO HIGHWAY 27	940		Bus exclusive (3 veh lanes per direction)
HIGHWAY 27 TO WOODSTREAM BLVD	1360		Bus exclusive (3 veh lanes per direction)
WOODSTREAM BLVD TO KIPLING AV	700	Bridge over creek	Bus exclusive (2 veh lanes per direction + TWLTL)
KIPLING AV TO CROSSING OF RAIL TRACKS	340		Bus exclusive (2 veh lane per direction)
CROSSING OF RAIL TRACKS	75	Rail corridor underpass	Bus exclusive (2 veh lanes per direction)
CROSSING OF RAIL TRACKS TO HUMBER RIVER CROSSING	75		Bus exclusive (2 veh lanes per direction)
HUMBER RIVER CROSSING	75	Bridge over Humber River	Bus exclusive (2 veh lanes per direction)
HUMBER RIVER CROSSING TO ISLINGTON AVE	115		Bus exclusive (2 veh lane per direction)
ISLINGTON AVE TO HELEN STREET	810		Bus exclusive (2 veh lane per direction + TWLTL)

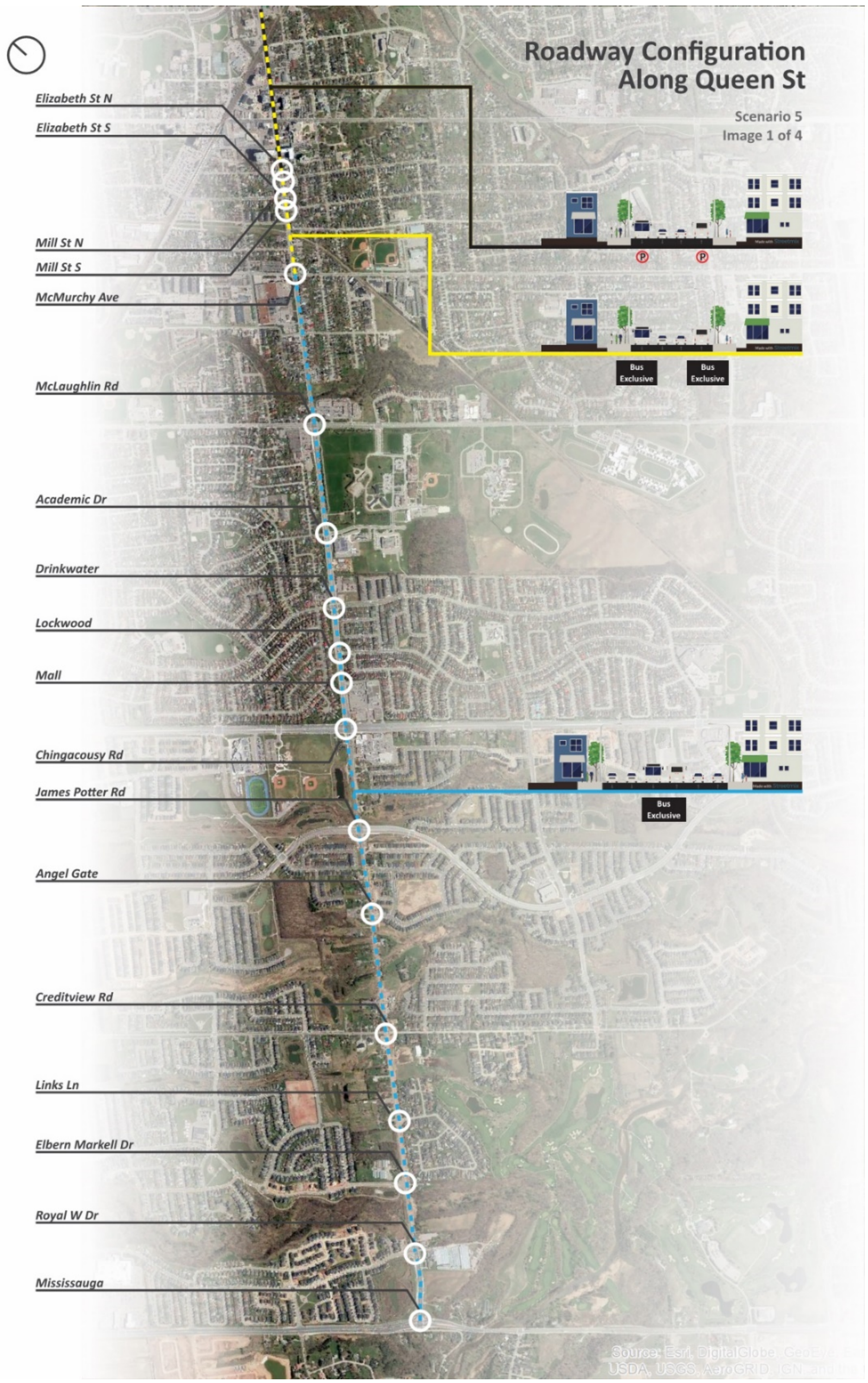


Figure 49: Scenario 5 road configuration, Mississauga Road to Mill Street North

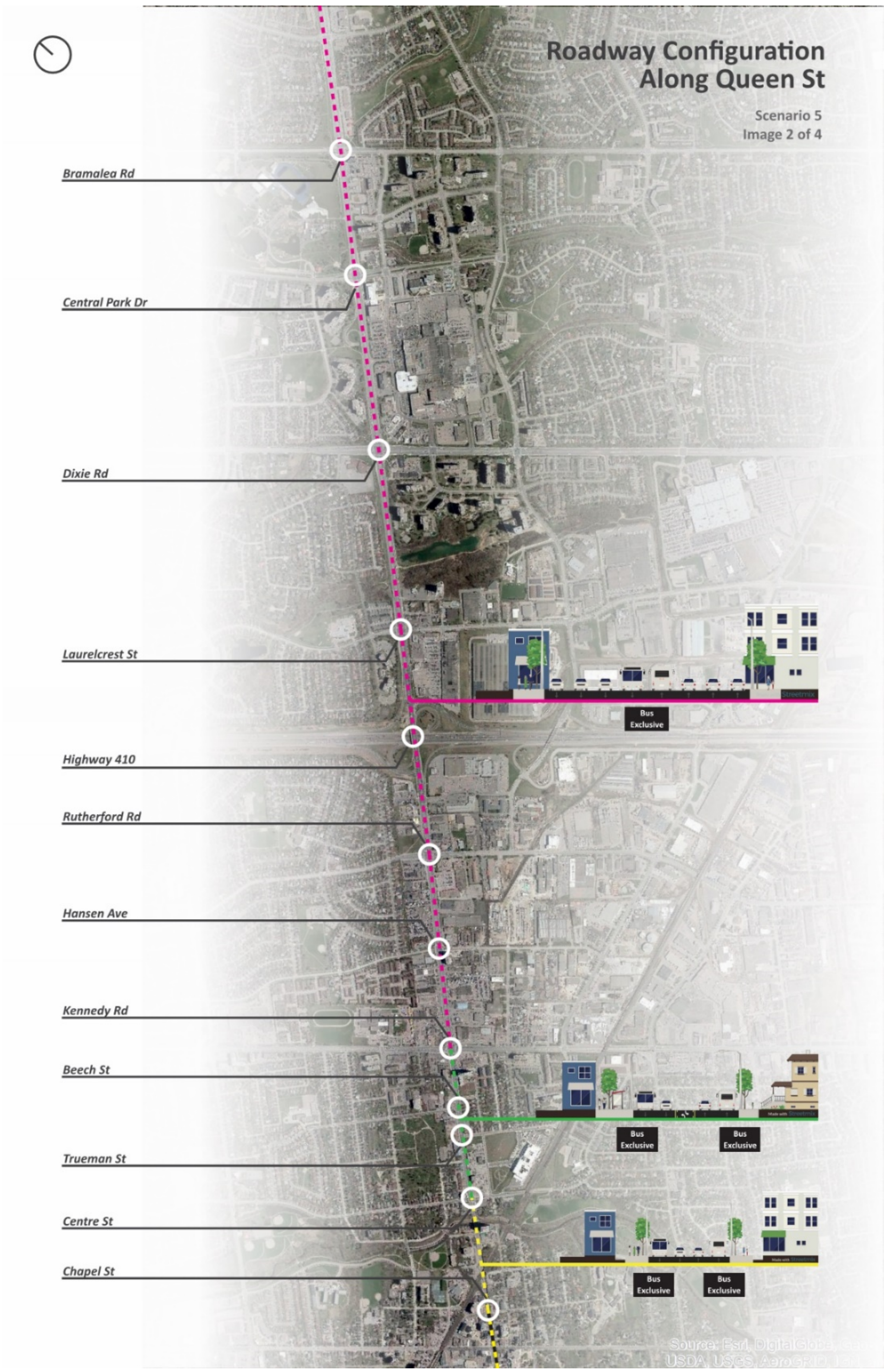


Figure 50: Scenario 5 road configuration, Chapel Street to Bramalea Road

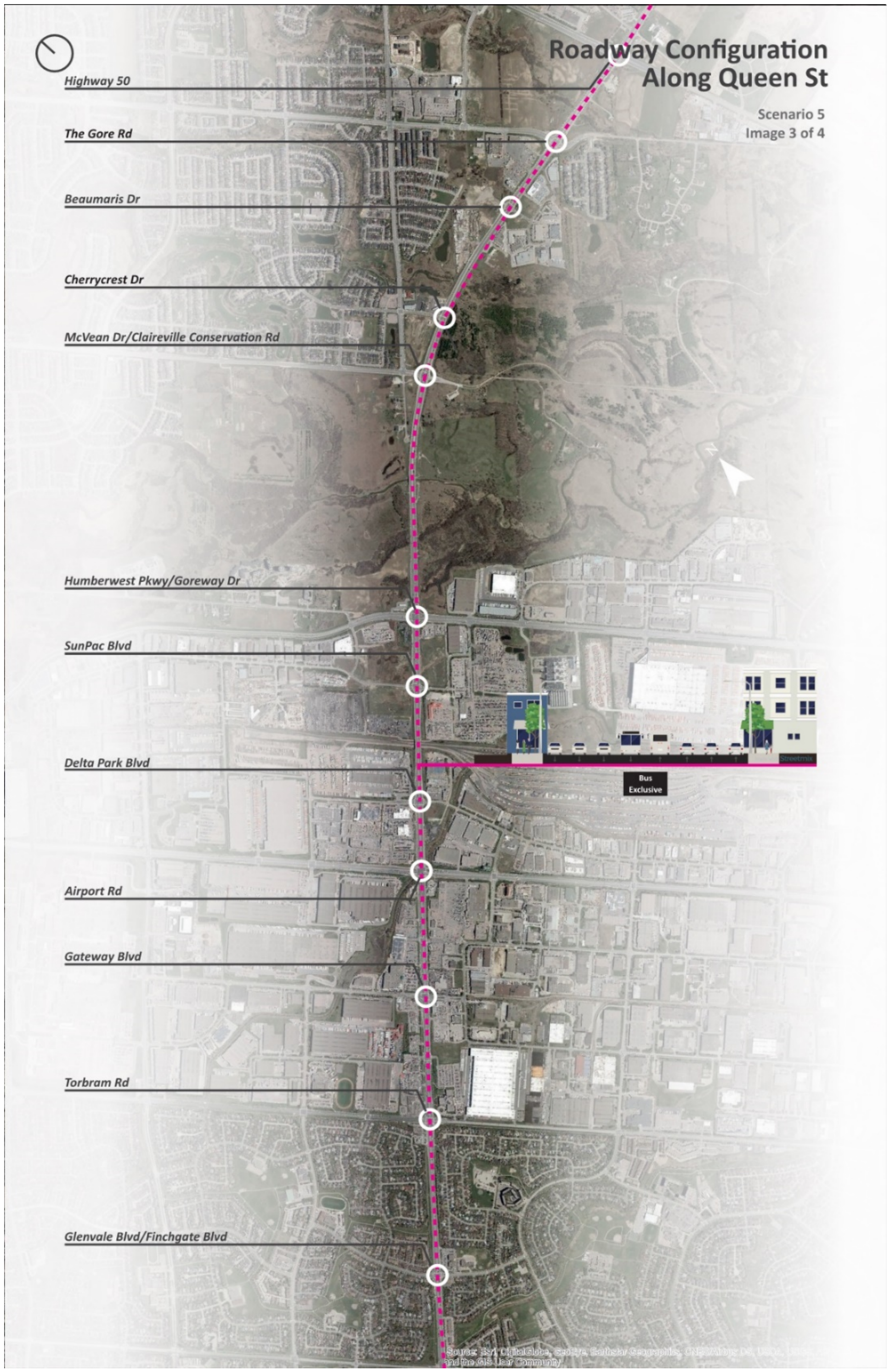


Figure 51: Scenario 5 road configuration, Glenvale Boulevard to Highway 50

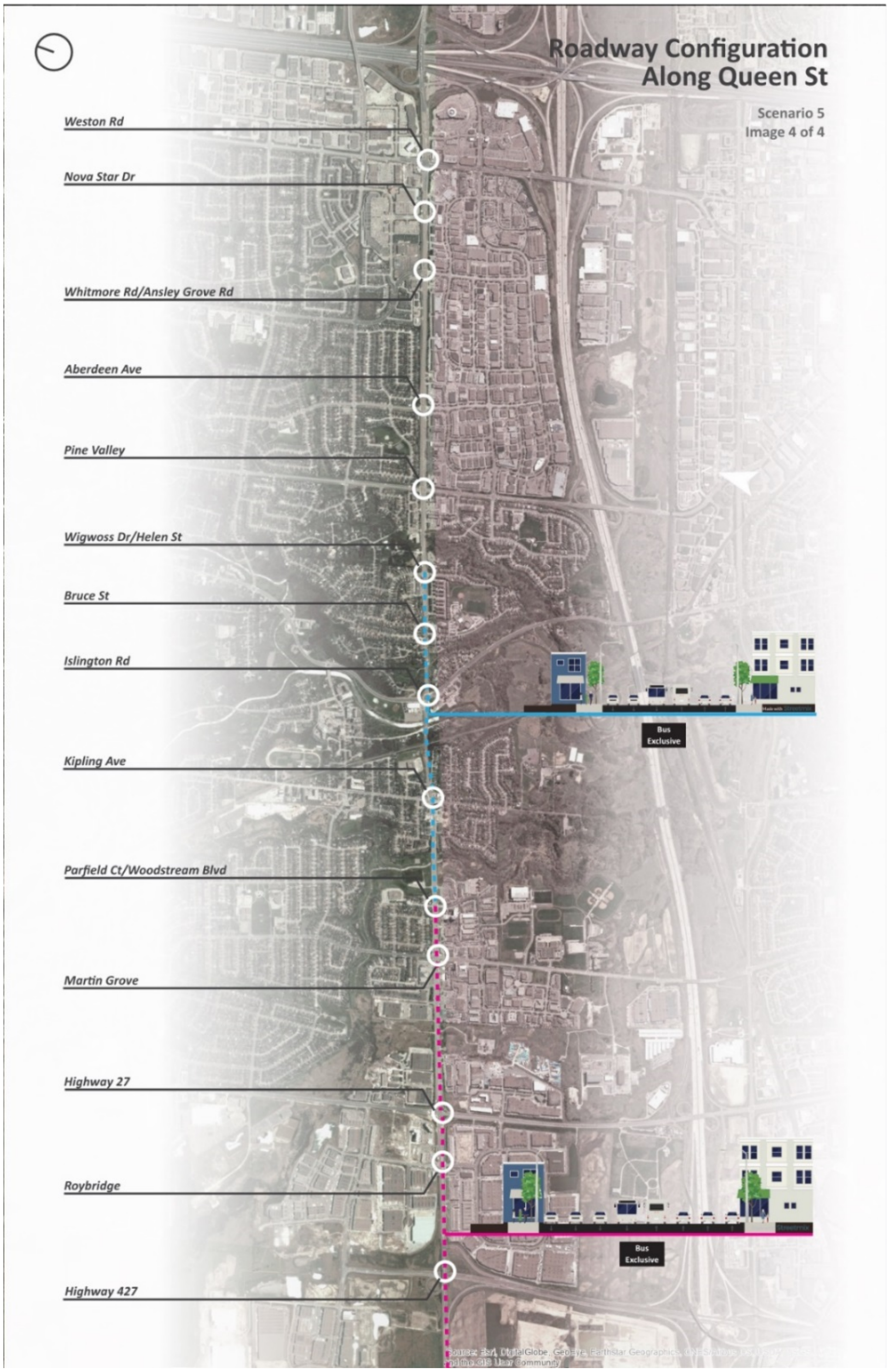


Figure 52: Scenario 5 road configuration, Highway 427 to Weston Road

Scenario 6: hybrid alternative including centre median BRT operation (lane addition) and mixed traffic segments

Scenario 6 has been defined based on the GGHM_v4 modelling results of Scenarios 4 and 5. Scenario 6 is a hybrid scenario that optimizes the following parameters:

- Preference for median exclusive BRT lanes;
- Minimize widening (impact on property and costs), based on the evaluation of the available and required right of way undertaken for Scenarios 4 and 5 (sections 5.2.1 and 5.2.2);
- Minimize impact on the built environment, based on the evaluation of the available and required right of way undertaken for Scenarios 4 and 5 (sections 5.2.1 and 5.2.2);
- Minimize impact on existing road infrastructure (impact on costs);
- Minimize high infrastructure costs (for example, at rail/highway underpasses, or river crossings);
- Minimize impact on traffic, based on the evaluation of the modelling results of Scenarios 4 and 5; and
- Maximize transit ridership based on the evaluation of the modelling results in Scenarios 1 to 5.

The following maps (Figures 53 to 55) of volume/capacity (V/C) ratios resulting from the GGHM_v4 modelling of Scenarios 4 and 5, as well as estimations of the available and required rights of way, have been used in order to define Scenario 6.

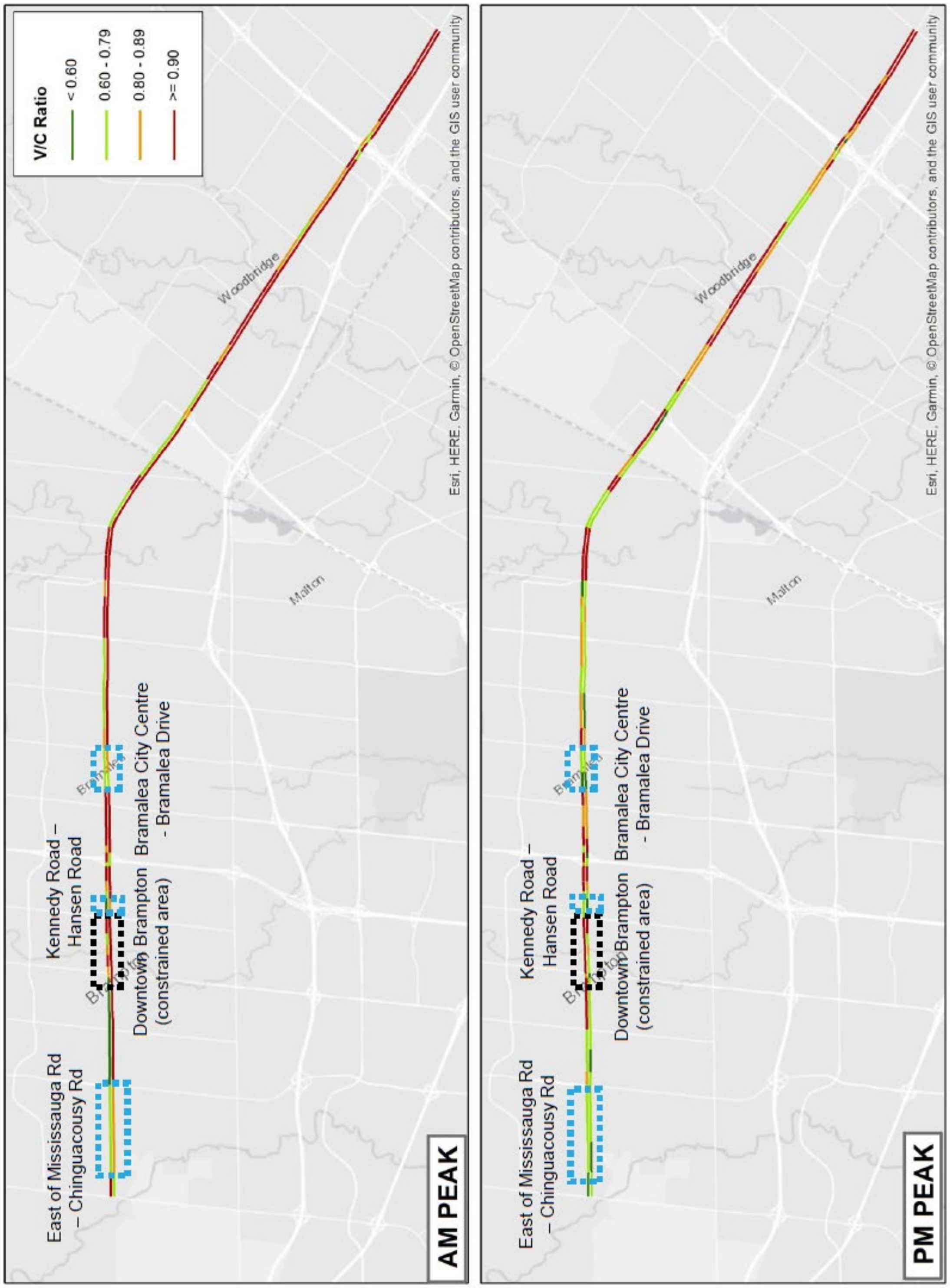


Figure 53: V/C ratios: Queen Street – Highway 7 – 2041 BAU

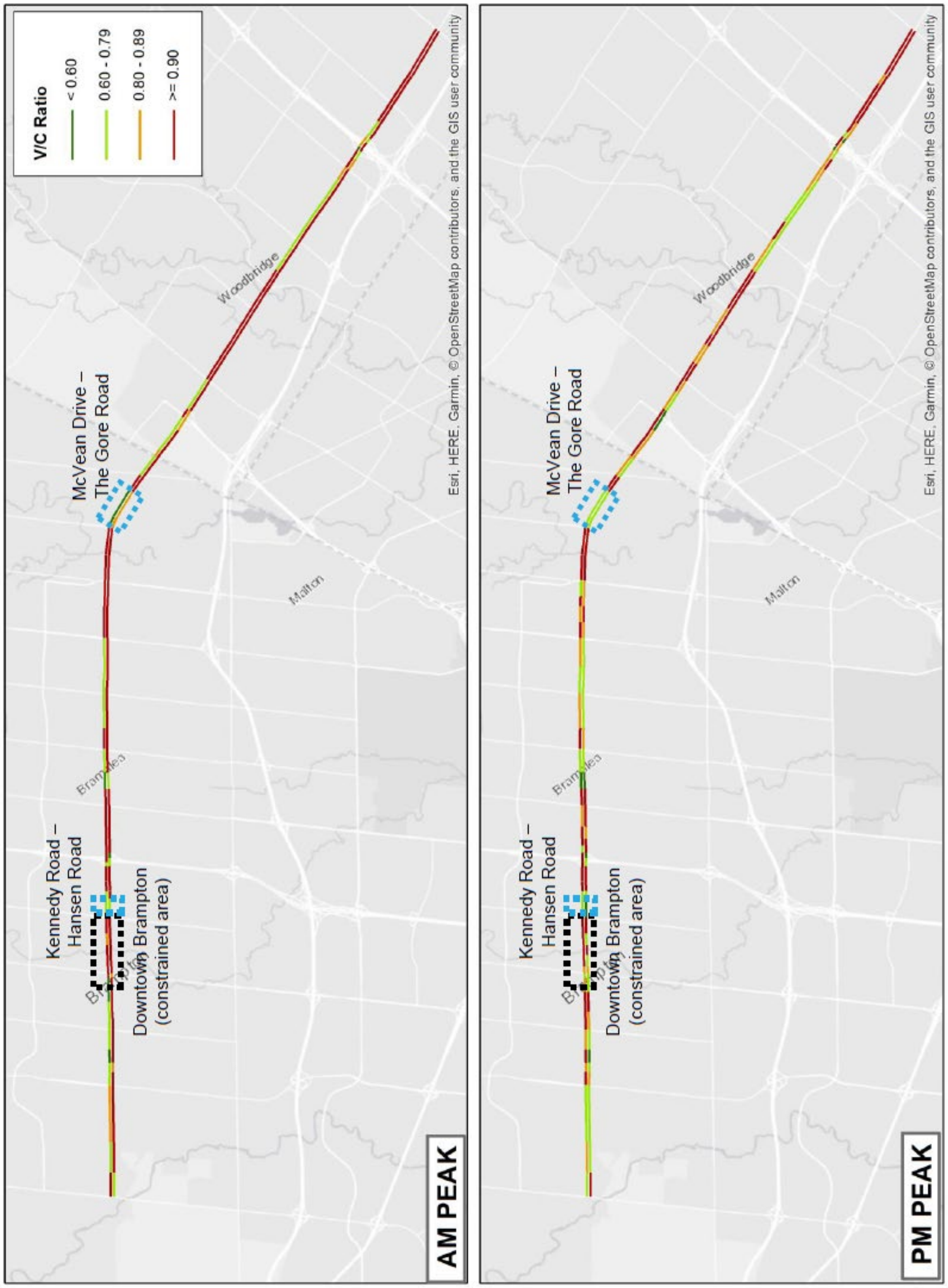


Figure 54: V/C ratios: Queen Street – Highway 7 – 2041 Scenario 4

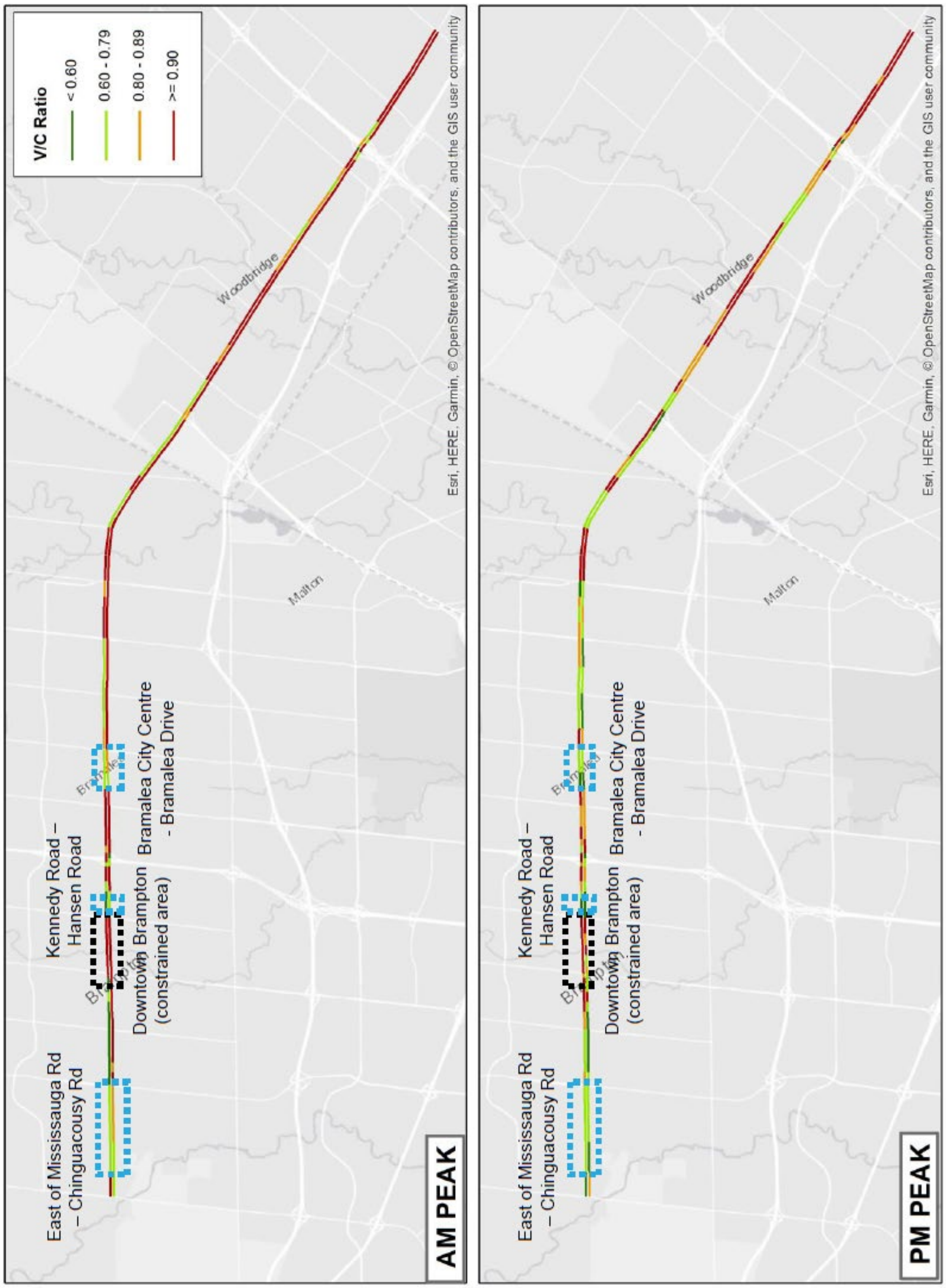


Figure 55: V/C ratios: Queen Street – Highway 7 – 2041 Scenario 5

The definition of Scenario 6 is based on the following rationale (in order): the preferred option (for transit operations performance reasons mainly) is the implementation of two (2) median exclusive BRT lanes on the corridor, by adding a BRT lane per direction (no impact on number of regular traffic lanes), which can lead to widening of the road or not (depending on available ROW), except for:

- (1) Segments that are in constrained zones (in terms of ROW: Downtown Brampton from McMurchy Avenue to Centre Street, Delta Park Blvd to Sun Pac Blvd [crossing of CN rail tracks], Hwy 410 crossing, Hwy 427 crossing, Kipling Ave to Islington Ave), where a mixed traffic solution will be evaluated, and
- (2) Segments showing remaining capacities (if their V/C is lower than 0.9) in situations with traffic lane conversion (Scenario 4) in AM and PM peaks: mixed traffic solution could also be tested on those identified segments which are:
  - A 400-metre segment in front of the Bramalea City Centre;
  - A 1,500-metre segment between McVean Drive and Gore Road; and
  - A 450-metre segment between Kennedy Road and Hansen Road.
  - However, either due to their short length or for BRT operational purposes (maximizing length of exclusive BRT lanes leads to more time savings in transit), the project team has decided to not test those segments with a mixed traffic solution in Scenario 6 in this Initial Business Case.

Figures 56 to 59 illustrate the BRT concept on the corridor for Scenario 6. An analysis of the estimated ROW widths available and required along the corridor has led to the BRT concept per segment and to the evaluation of impacts on the ROW. These however are not indicative of the ROW that will be required for the BRT infrastructure; instead it was used to support the initial modelling, early concept designs and costs estimates of the infrastructure. These will be further refined in future phases of the study.

As a result of this analysis, Table 19 provides a description of the configuration for road segments that are constrained by the width of the ROW being narrowed than what is required for BRT infrastructure.

Table 19: Scenario 6 corridor configuration and mitigation measures on constrained corridor segments

ROAD SEGMENT	SEGMENT LENGTH (M)	INFRA-STRUCTURE CONSTRAINTS	CONFIGURATION
MISSISSAUGA RD TO CHINGUACOUSY RD	2710	Bridge over drain crossing (east of James Porter Rd)	Bus exclusive (2 veh lanes per direction)
CHINGUACOUSY RD TO MCMURCHY AVE	2,060	Bridge over creek (east of McLaughlin Rd)	Bus exclusive (2 veh lanes per direction)
FLETCHERS CREEK	24	Bridge over Fletchers Creek	Bus exclusive (2 veh lanes per direction)
MCMURCHY AVE TO ELIZABETH ST	320	Level rail track crossing at Elliot Street	Bus mixed with GP traffic (2 veh lanes per direction)
ELIZABETH ST TO CHAPEL ST	540	Downtown Brampton / Building lines along sidewalks.	Bus mixed with GP traffic (1 veh + 1 parking lanes per direction)
CHAPEL ST TO CENTRE ST	525	Rail corridor underpass, Etobicoke Bridge over creek	Bus mixed with GP traffic (2 veh lanes per direction)
KENNEDY ROAD TO HIGHWAY 410	1,195		Bus exclusive (3 veh lane per direction)
CROSSING OF HIGHWAY 410	225	Highway overpass	Bus mixed with GP traffic (3 veh lane per direction)
CROSSING OF SPRING CREEK	23	Bridge over Spring Creek	Bus exclusive (3 veh lanes per direction)
CROSSING OF BRAMALEA CITY CENTER DRIVE	28	Drive overpass	Bus exclusive (3 veh lanes per direction)
CROSSING OF AIRPORT ROAD INTERSECTION CULVERT	90	Culvert under intersection	Bus exclusive (3 veh lanes per direction)
CROSSING OF CN RAIL TRACKS	200	Rail corridor overpass	Bus exclusive (3 veh lane per direction)
CROSSING OF RIVER IN CLAIREVILLE CONSERVATION AREA	69	Bridge over river	Bus exclusive (3 veh lane per direction)

ROAD SEGMENT	SEGMENT LENGTH (M)	INFRA-STRUCTURE CONSTRAINTS	CONFIGURATION
CROSSING OF DRAIN 1 IN CLAIREVILLE CONSERVATION AREA	10	Culvert over drain	Bus exclusive (3 veh lane per direction)
CROSSING OF DRAIN 2 IN CLAIREVILLE CONSERVATION AREA	20	Culvert over drain	Bus exclusive (3 veh lane per direction)
CROSSING OF DRAIN 2 IN CLAIREVILLE CONSERVATION AREA TO HIGHWAY 427 (ROAD 99)	1,380	Rail corridor underpass, Etobicoke Bridge over creek	Bus exclusive (3 veh lanes per direction)
CROSSING OF HIGHWAY 427 (ROAD 99)	300	Bridge over highway	Bus mixed with GP traffic (3 veh lanes per direction)
HIGHWAY 427 (ROAD 99) TO HIGHWAY 27	940		Bus exclusive (3 veh lanes per direction)
HIGHWAY 27 TO WOODSTREAM BLVD	1360		Bus exclusive (3 veh lanes per direction)
WOODSTREAM BLVD TO KIPLING AV	700	Bridge over creek	Bus exclusive (2 veh lanes per direction + TWLTL)
KIPLING AV TO CROSSING OF RAIL TRACKS	340		Bus exclusive (2 veh lane per direction)
CROSSING OF RAIL TRACKS	75	Rail corridor underpass	Bus mixed with GP traffic (2 veh lanes per direction)
CROSSING OF RAIL TRACKS TO HUMBER RIVER CROSSING	75		Bus exclusive (2 veh lanes per direction)
HUMBER RIVER CROSSING	75	Bridge over Humber River	Bus exclusive (2 veh lanes per direction)
HUMBER RIVER CROSSING TO ISLINGTON AVE	115		Bus exclusive (2 veh lane per direction)
ISLINGTON AVE TO HELEN STREET	810		Bus exclusive (2 veh lane per direction + TWLTL)

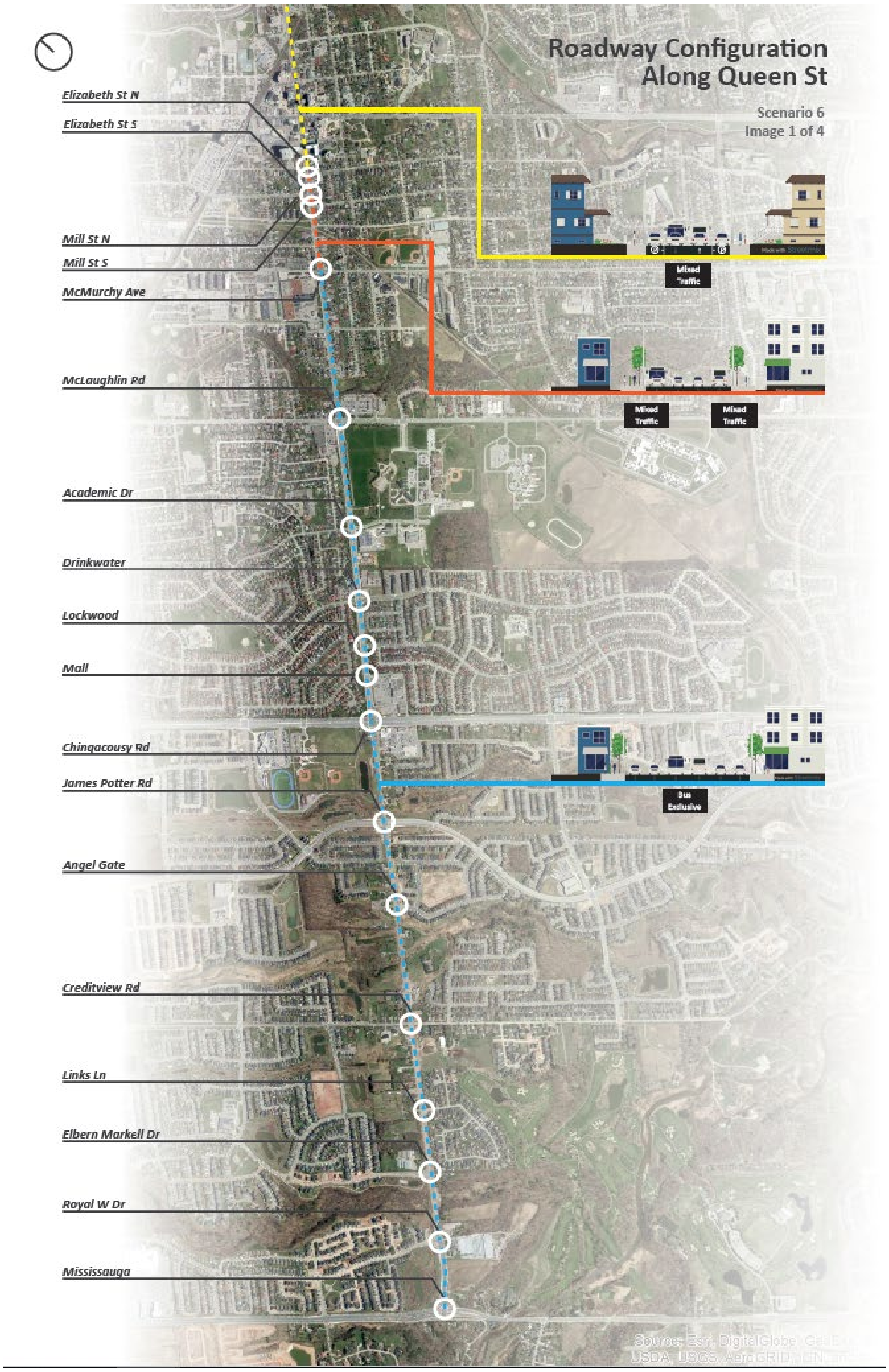


Figure 56: Scenario 6 road configuration, Mississauga Road to Mill Street North

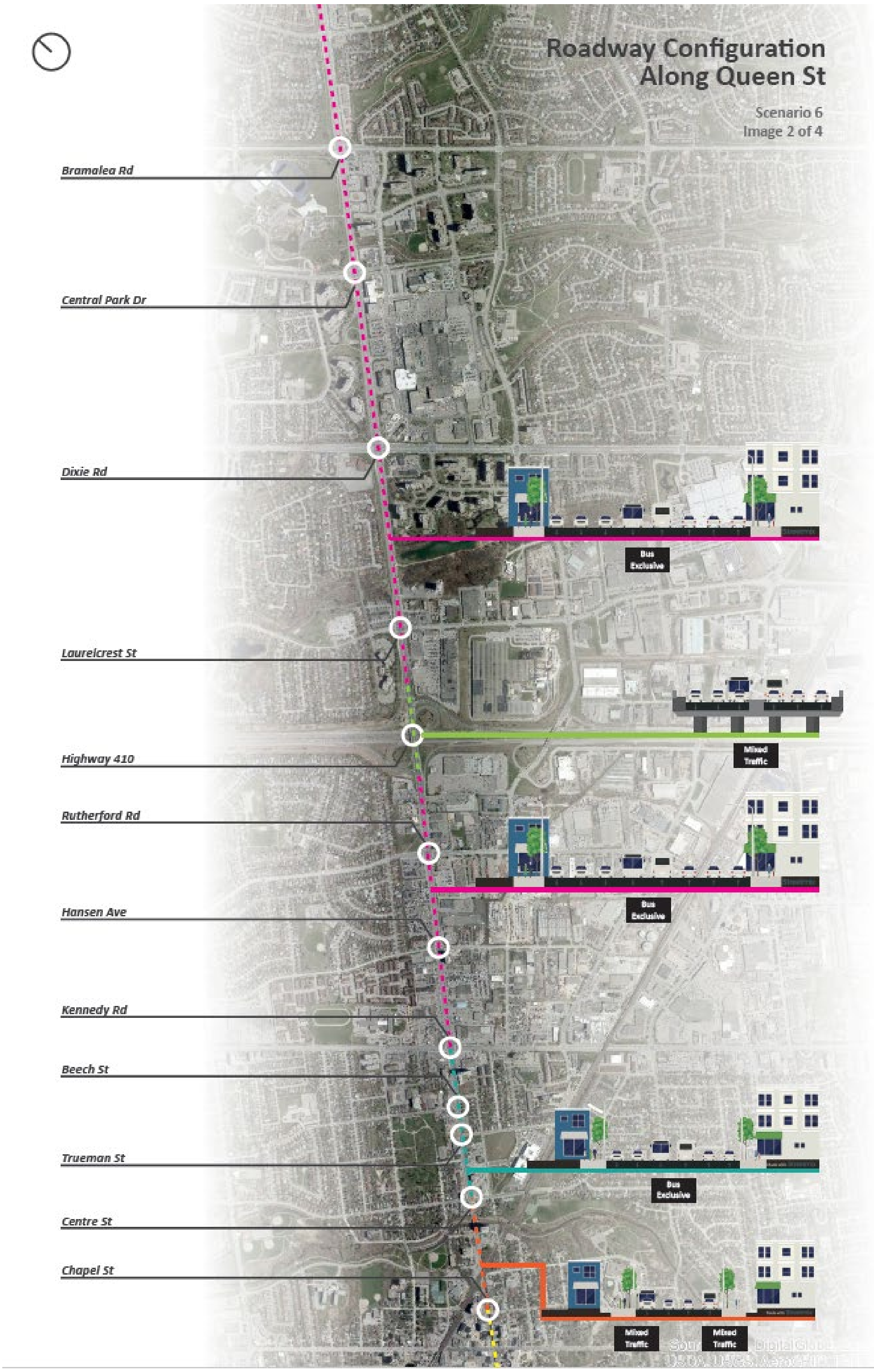


Figure 57: Scenario 6 road configuration, Chapel Street to Bramalea Road

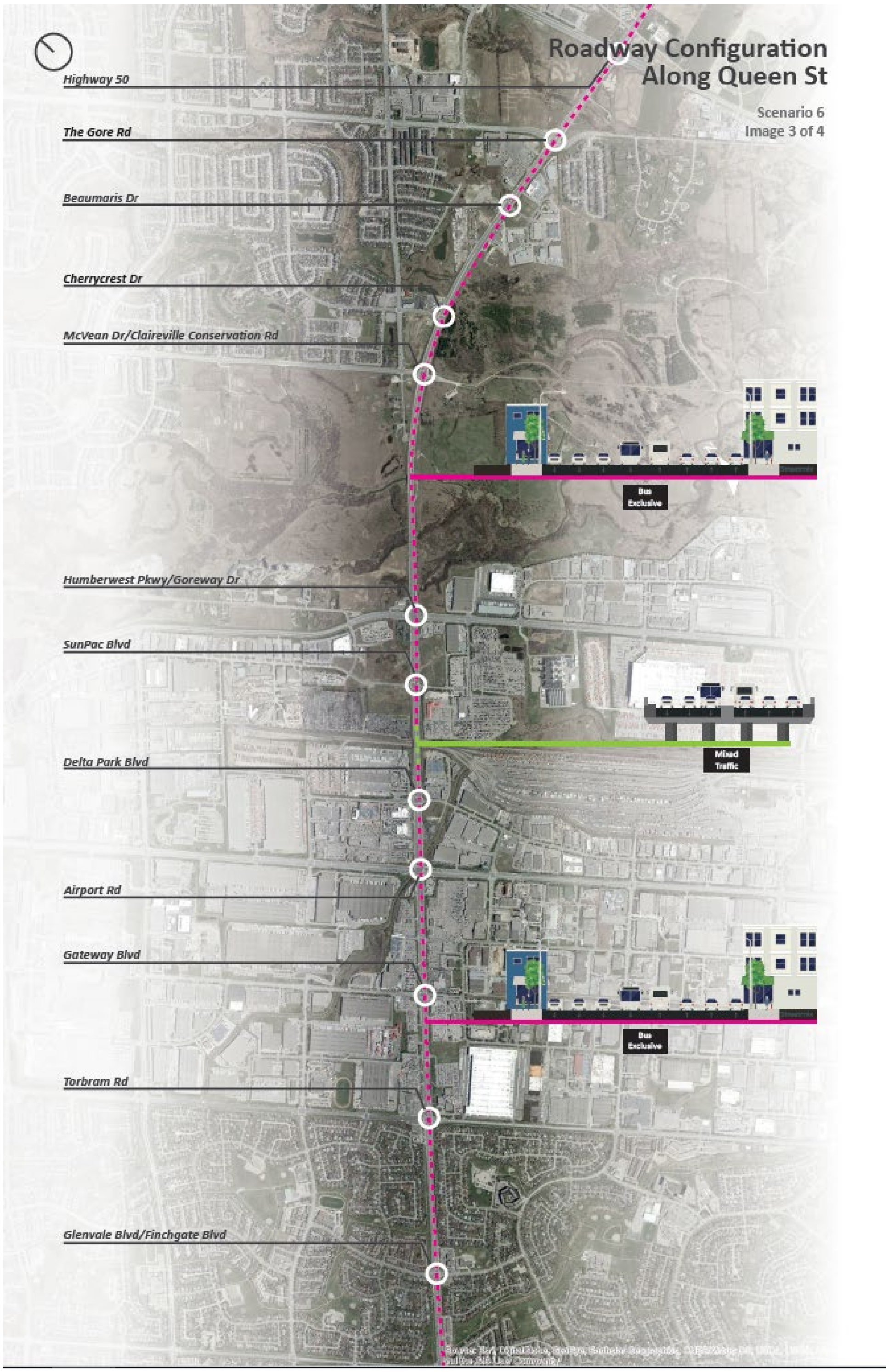


Figure 58: Scenario 6 road configuration, Glenvale Boulevard to Highway 50

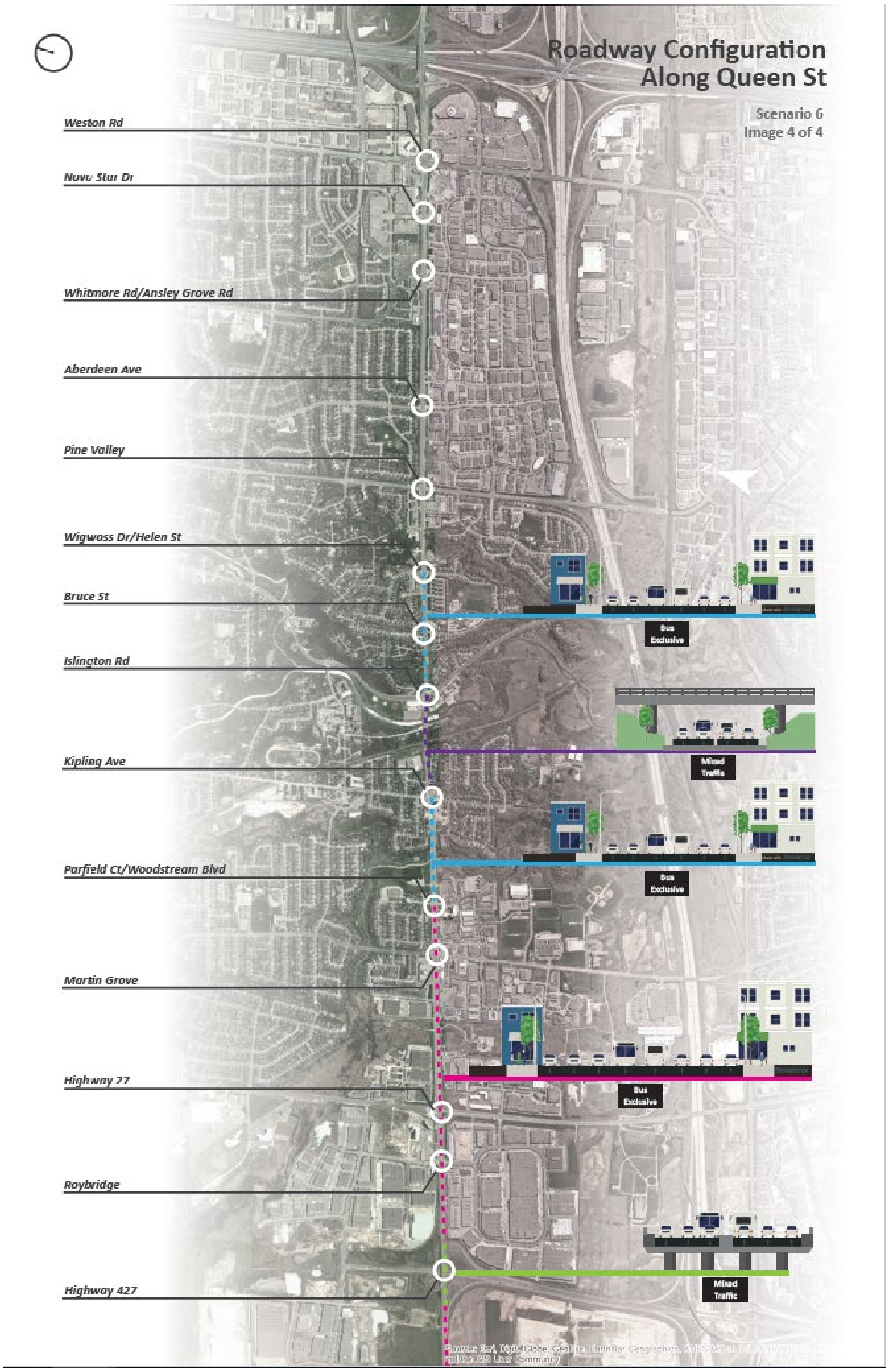


Figure 59: Scenario 6 road configuration, Highway 427 to Weston Road

4

Strategic Case

Transportation

The forecasted transit demand within the study area and during the 3-hour AM peak period is shown in Table 20, as an output of the GGHM_v4 model. Scenario 4 and 5 generates the most favourable forecast, with a 37.4% and 36.8% increase in transit ridership over the business-as-usual scenario. Scenario 6 generates slightly more marginal gains with a 10.3% improvement over the BAU.

Table 20: Transit ridership (boardings) in 2041 BAU Scenario and Scenarios 4, 5, and 6, AM peak period (6-9 AM) (GGHM_v4 model)

	2041 BAU SCENARIO	SCENARIO 4	SCENARIO 5	SCENARIO 6
TRANSIT RIDERSHIP IN STUDY AREA	13,696	18,813	18,734	15,110
DIFFERENCE WITH 2041 BAU (%)	-	37.4	36.8	10.3

2041 AM Peak Boardings along the Queen Street – Highway 7 Corridor are broken down by Type in the following graphs (Figure 60 and Figure 61). Both Scenarios 4 and 5 result in relatively higher transit boardings on the corridor with Scenario 6 numbers being closer to the BAU scenario. Both Scenarios 4 and 5 are seen as strongly supporting increased transit ridership and mixed-use intensification at transit stops that leads to shorter trips.

For reference to the transit routes, refer to Figure 22 and Figure 44.

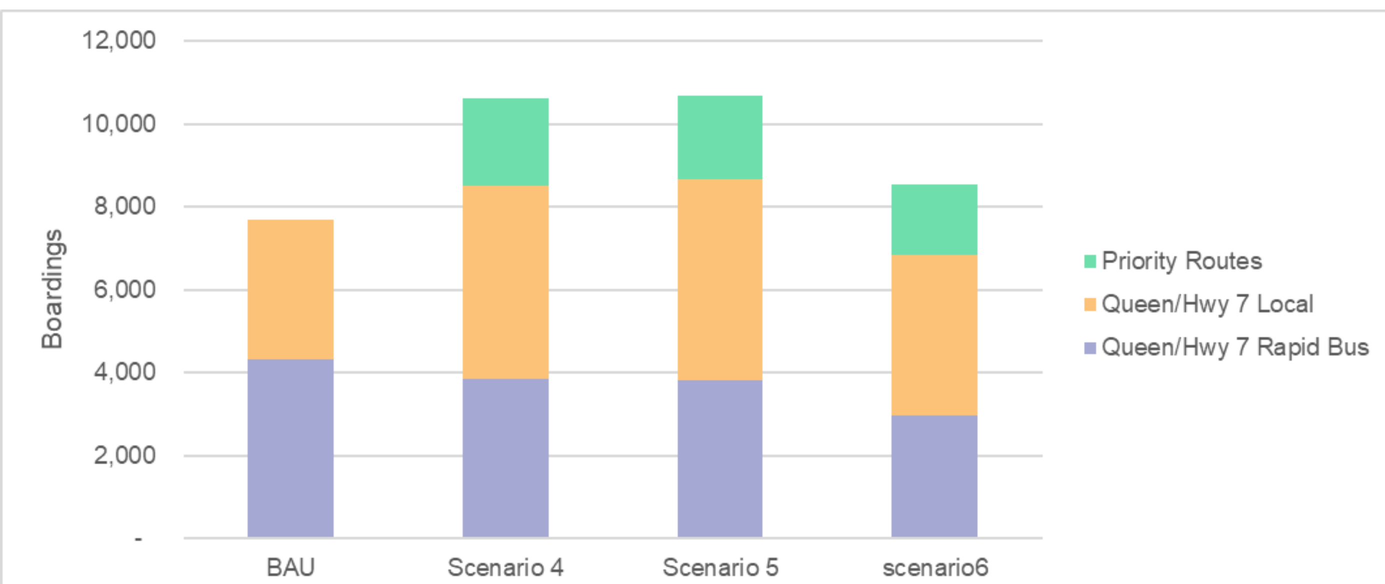


Figure 60: 2041 AM Peak Period (6-9 AM) Boardings on the Queen Street – Highway 7 Corridor by type (EB)

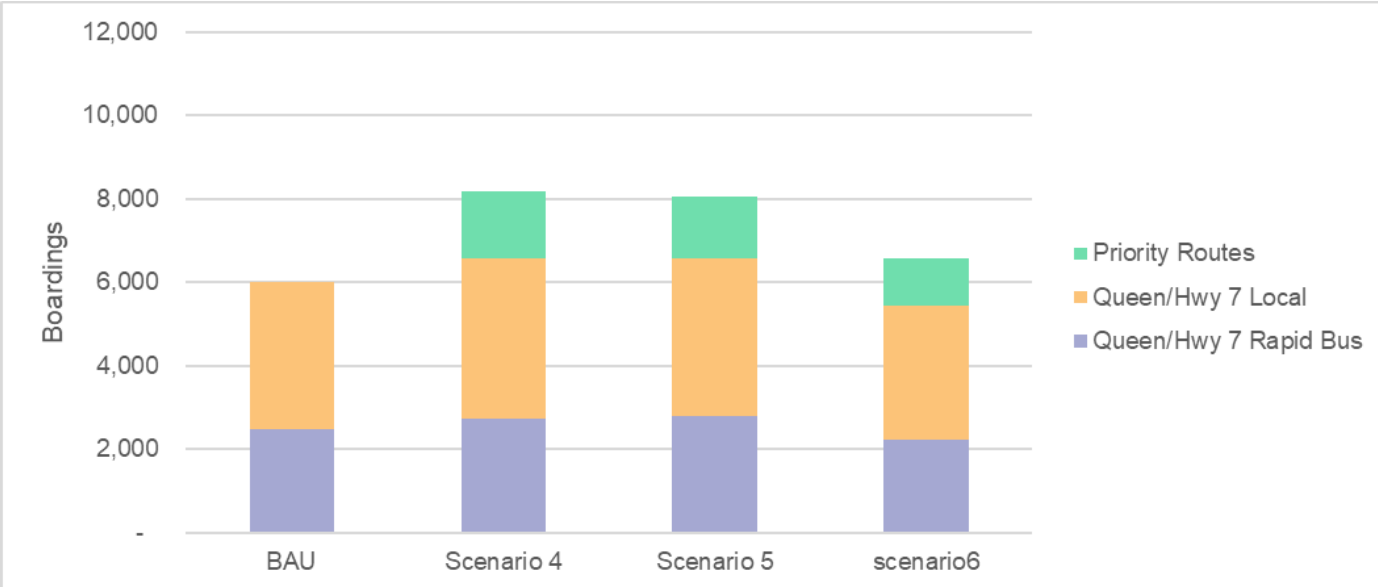


Figure 61: 2041 AM Peak Period (6-9 AM) Boardings along Queen Street – Highway 7 Corridor by type (WB)

2041 AM Peak boardings along Queen Street – Highway 7 Corridor are broken down by Route in Figure 62 to Figure 65. A slight growth in both local and BRT boardings in the westbound direction can be observed in Scenarios 4 and 5, with a slight decrease in Scenario 6. A relatively higher increase in boardings for eastbound local routes is noted, with Scenarios 4 and 5 still associated with the most noticeable gains. The observed decrease in eastbound BRT boardings may be attributed to truncation of the Viva Orange line in the model.

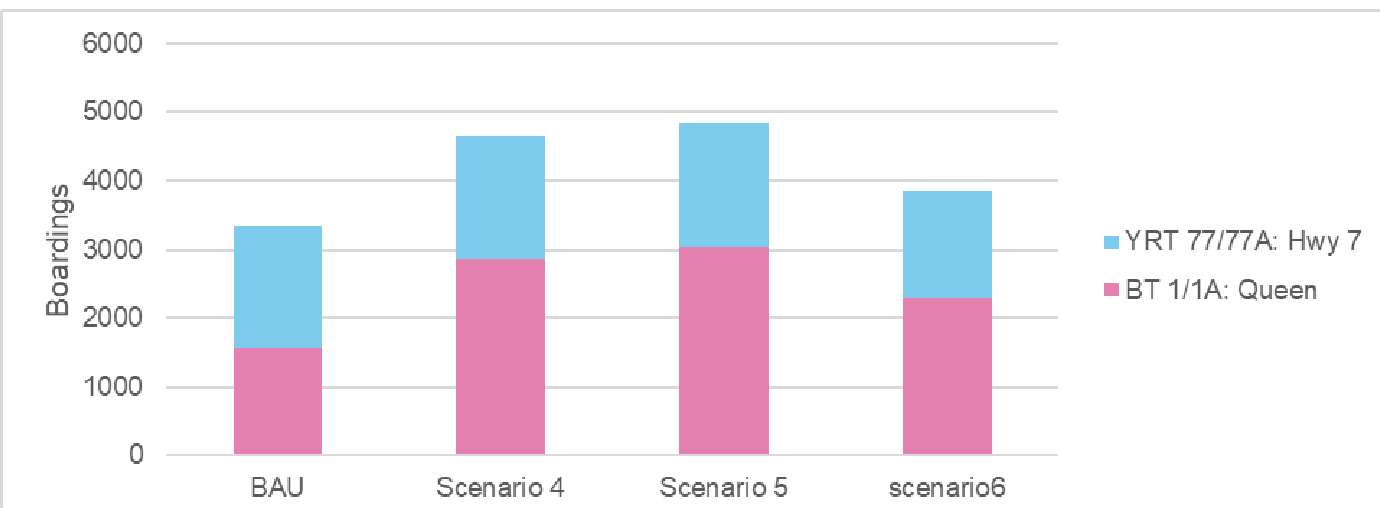


Figure 62: 2041 AM Peak Period (6-9 AM) Boardings along Queen Street – Highway 7 Corridor by Local Route (EB)

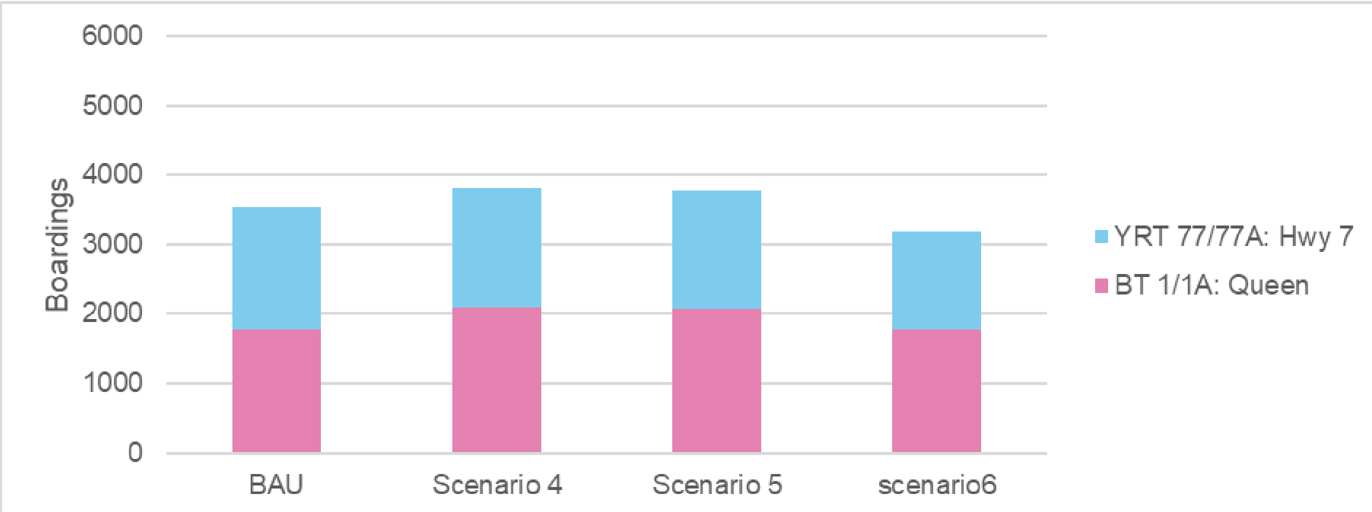


Figure 63: 2041 AM Peak Period (6-9 AM) Boardings along Queen Street – Highway 7 Corridor by Local Route (WB)

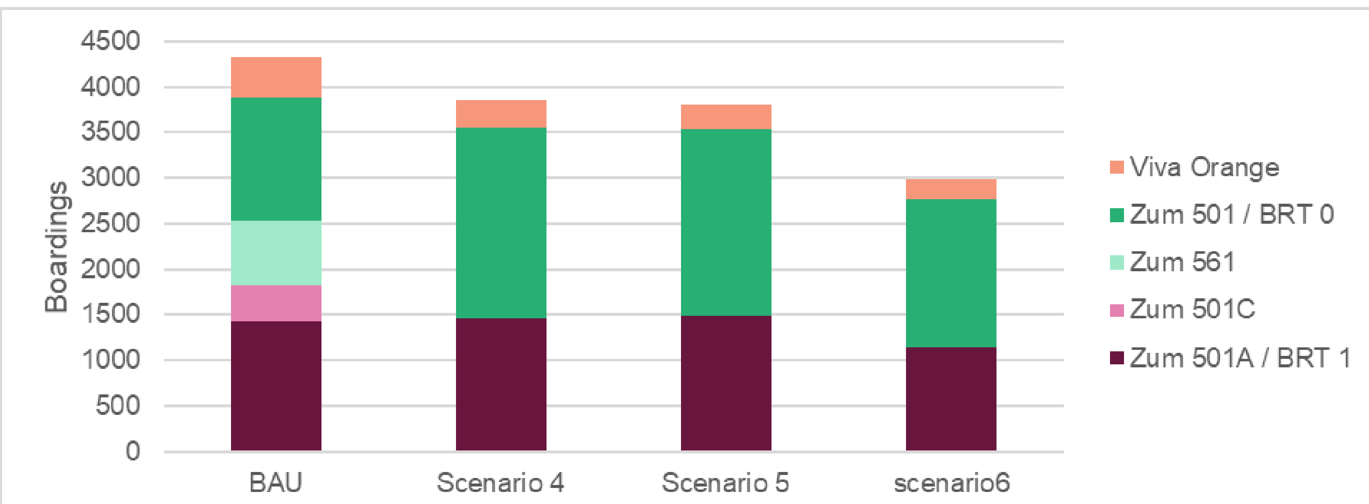


Figure 64: 2041 AM Peak Period (6-9 AM) Boardings along Queen Street – Highway 7 Corridor by BRT Route (EB)

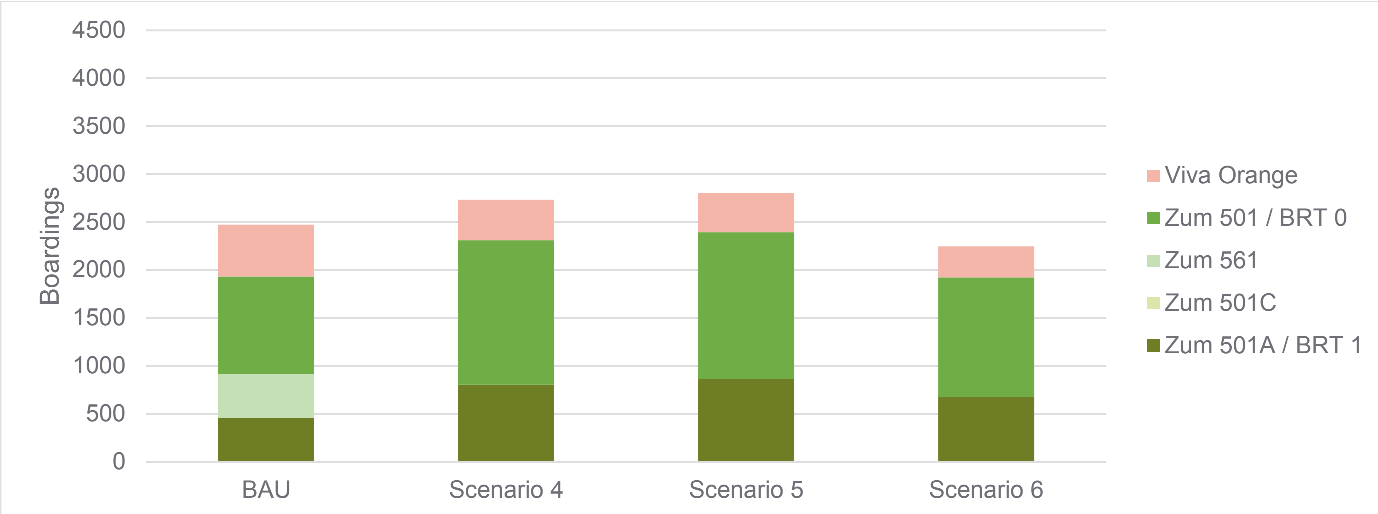


Figure 65: 2041 AM Peak Period (6-9 AM) Boardings along Queen Street – Highway 7 Corridor by BRT Route (WB)

Lastly, 2041 AM Peak boardings for Priority Routes are shown in Figure 66 to Figure 68. Priority Routes in Scenarios 4, 5, and 6 are shown to have similar ridership patterns. The slightly higher boardings in Scenario 4 for Priority Routes E, F, and G may be attributed to higher attractiveness of transit due to increased frequencies compared to auto in this scenario.

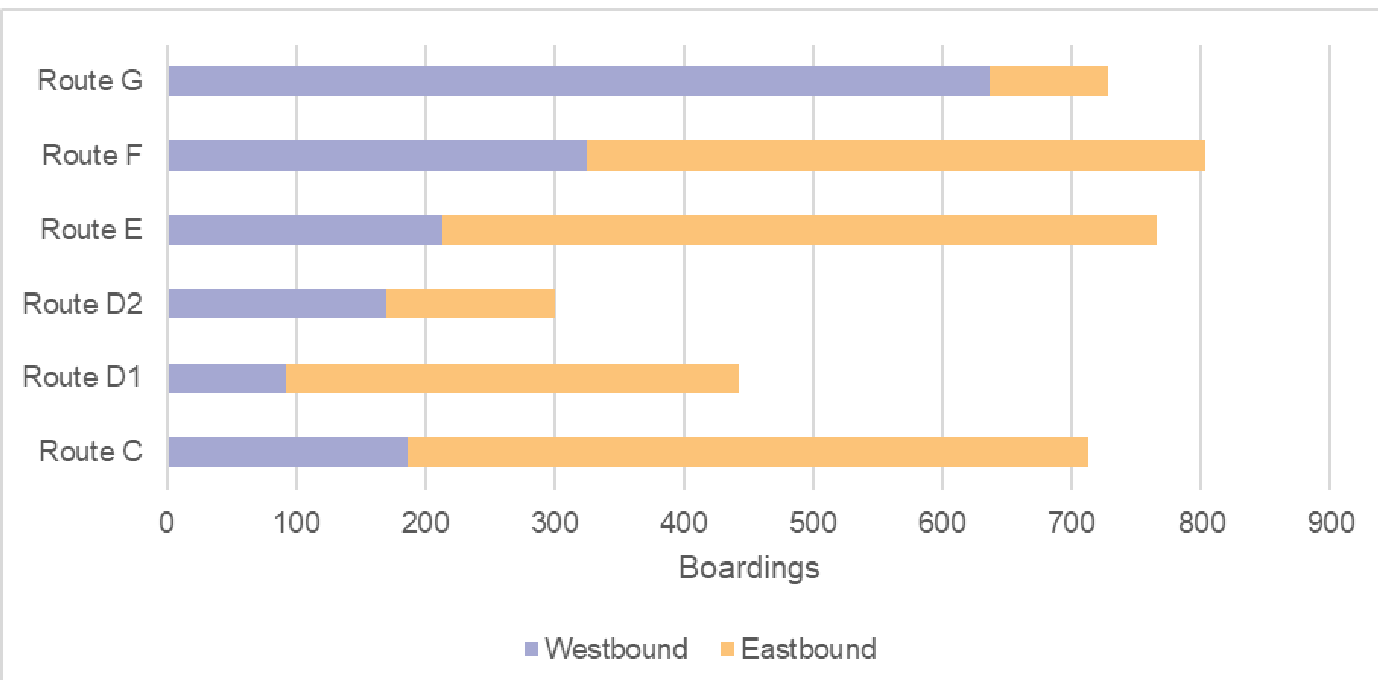


Figure 66: 2041 AM Peak Period (6-9 AM) Boardings for Priority Routes (Scenario 4)

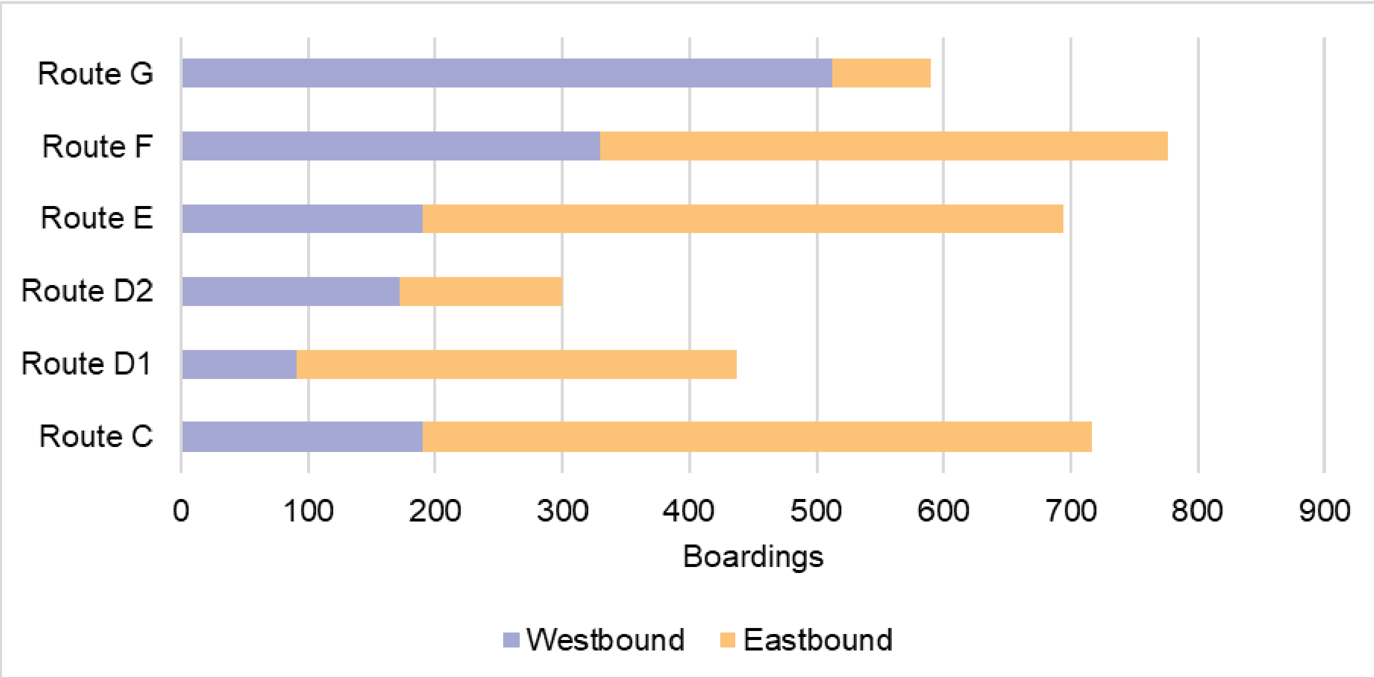


Figure 67: 2041 AM Peak Period (6-9 AM) Boardings for Priority Routes (Scenario 5)

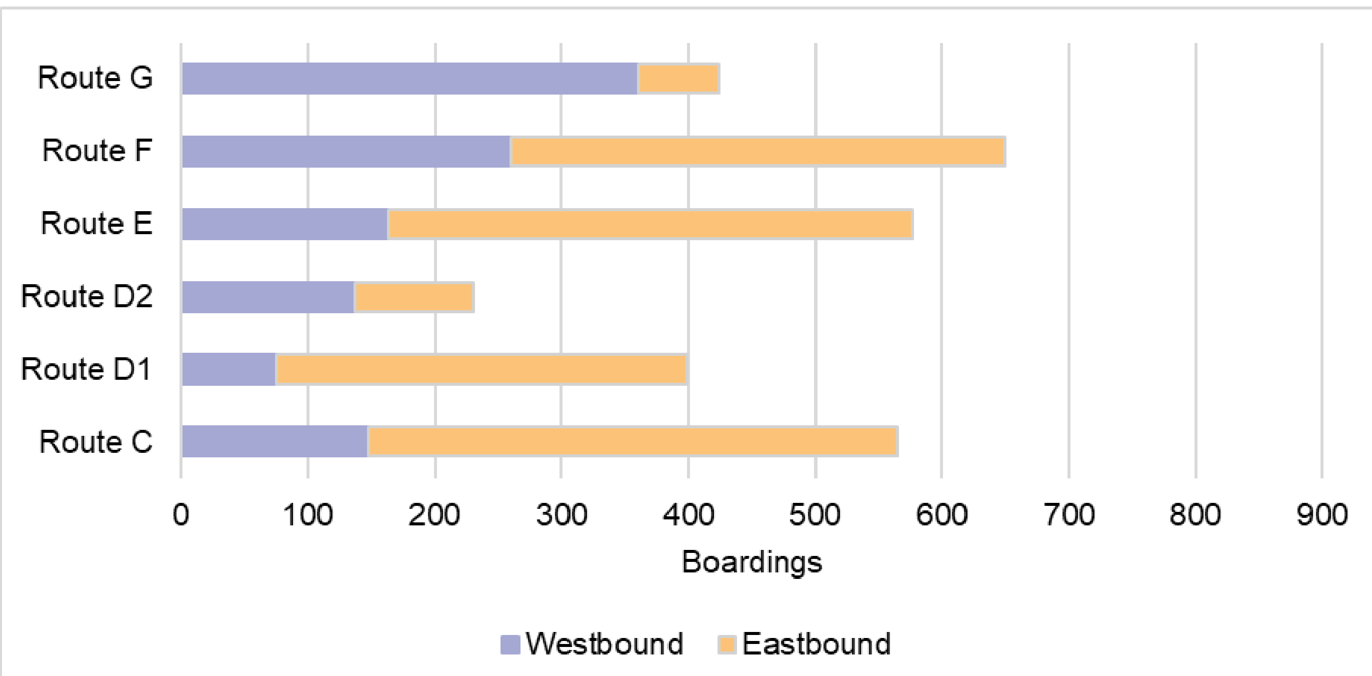


Figure 68: 2041 AM Peak Period (6-9 AM) Boardings for Priority Routes (Scenario 6)

Results show that, for the ridership forecasts and travel demand criteria, Scenario 4 and Scenario 5 perform better than Scenario 6. All scenarios perform better than 2041 BAU scenario.

Transit user experience

A main component of transit user experience is overall travel time on the transit network. This incorporates in-vehicle travel time, which is impacted by traffic congestion, as well as transfers, waiting for vehicles, and the journey to or from the transit stop.

The transit time results for major Origin/Destination pairs across Brampton, as a weighted average of perceived transit time (in minutes) in the AM peak period (6 – 9 AM), are shown in Table 21.

Table 21: Transit time results for major OD pairs across Brampton, for scenarios 2041 BAU, 4, 5 and 6, AM Peak Period (6-9 AM)

ORIGIN	DESTINATION	BAU (MINS)	SCENARIO 4 (MINS)	SCENARIO 5 (MINS)	SCENARIO 6 (MINS)
NWBRAMPTON	DTBrampton	99	80	80	81
NWBRAMPTON	Bramalea	119	94	93	94
NWBRAMPTON	MississaugaEast	171	139	139	146
NWBRAMPTON	MississaugaWest	207	165	165	160
NWBRAMPTON	Pearson	144	126	124	127
NWBRAMPTON	DTToronto	88	89	89	91
SWBRAMPTON	MississaugaEast	102	98	100	100
SWBRAMPTON	MississaugaWest	110	105	105	101
SWBRAMPTON	Pearson	119	114	117	113
NEBRAMPTON	Hwy7	152	138	141	140
NEBRAMPTON	VMC	142	119	124	143
NEBRAMPTON	YorkU	151	136	141	164
NEBRAMPTON	MississaugaEast	137	133	132	132
NEBRAMPTON	MississaugaWest	154	149	148	136
NEBRAMPTON	Pearson	139	125	127	124
NEBRAMPTON	DTToronto	94	93	93	96
WEIGHTED AVERAGE AGAINST DEMAND ON OD PAIRS		117	107	108	110

Scenarios 4 and 5 improve the transit user experience the most compared to 2041 BAU scenario, with a perceived travel time average of 107 and 108 minutes respectively, weighted against the demand on corresponding OD pairs. Scenario 6 leads to a slight improvement at an average perceived travel time of 110 minutes.

Results show that, for the transit user experience criteria, Scenarios 4 and 5 perform better than Scenario 6. All scenarios perform better than 2041 BAU scenario.

Mobility choice

Changes in Transit Mode Share in the study area are shown in Table 22. Transit mode shares between Scenarios 4 and 5 are similar, whereas Scenario 6 shows a slightly lower transit mode share in the study area. The removal of existing traffic capacity for the implementation of BRT lanes under Option 4 suggests that this will likely foster a change in modes of people who travel on the Queen St corridor. This option also strongly supports the City of Brampton's target, as expressed in its Transportation Master Plan, of having 50% of trips made by sustainable modes by 2041 (with transit`s mode share increasing to 20% by that date).

Scenarios 4 and 5 also support the development of Queen's Boulevard as envisioned in Vision 2040. This is to be a grand urban boulevard, stretching from the Etobicoke Creek to Highway 410, which is centred on a rapid transit spine and which includes wide sidewalks and protected bikeways.

Table 22: Transit mode share in the study area across Scenarios 4, 5 and 6, AM Peak Period (6-9 AM)

	2041 BAU SCENARIO	SCENARIO 4	SCENARIO 5	SCENARIO 6
TRANSIT MODE SHARE IN STUDY AREA (%)	6.85	7.14	7.18	7.05
DIFFERENCE WITH 2041 BAU (%)	-	4.3	4.8	3.0

Results show that, for the transit user experience criteria, Scenarios 4 and 5 perform better than Scenario 6. All scenarios perform better than 2041 BAU scenario.

Quality of life

Shaping growth

Transit investments are a proven method of attracting new residential and mixed-use development. Transit oriented development (TOD) is increasing across the region as families and businesses seek to locate themselves in an area that provides convenient and affordable access to the broader region. This access is important for peoples' ability to access public services, amenities, institutions, employment, and entertainment.

Globally, implementing a BRT system is a major factor of shaping growth, increasing TOD initiates on and around the BRT corridor. Scenarios 4 and 5 perform higher than Scenario 6 due to higher amount of dedicated transit infrastructure

Results show that, for the shaping growth criteria, all scenarios perform better than 2041 BAU scenario.

Public health

The public health benefits to rapid transit investment are typically two-fold; first, there is likely to be a decrease in greenhouse gas emissions from autos associated with a mode shift to transit, and second, rapid transit riders are likely to undertake increased physical activity as a result of shifting to a more sustainable mode (e.g. walking to and from their bus stop). These public health benefits provide significant value beyond and contribute to the overall economic benefit of rapid transit investment.

Rapid transit investments typically either occur in more walkable communities or promote increased walkability in the urban form through infrastructure investments that arrive alongside rapid transit. For example, station areas may include pedestrian and bicycle facilities, and be adjacent or well-connected to mixed use developments.

Globally, the BRT that is proposed in this Initial Business Case on the Queen Street – Highway 7 Corridor includes the implementation of infrastructure for active transportation (sidewalks and bicycle lanes) in each of the three (3) proposed scenarios.

Also, the benefits and costs linked to the GHG emissions per scenario are calculated in the Economic Case and show that Scenario 4 is the highest performer, followed by Scenario 5, whereas Scenario 6 performs poorly.

Results show that, for the public health criteria, Scenarios 4 and 5 perform higher than Scenario 6. All scenarios perform better than the BAU.

Environmental health and air quality

A reduction in greenhouse gas emissions is one common benefit associated with rapid transit investment such as BRT. This is driven primarily by a reduction in vehicle kilometres travelled (VKT) in private autos as mode shift to transit occurs. Increased environmental health and improved air quality are two positive results associated with the reduction in VKT. Air quality and a clean environment are also linked to physical health outcomes, meaning BRT can support a person's overall health and wellbeing as a result of encouraging mode shift and a more active lifestyle.

Additional environmental benefits may be had depending on the propulsion technology of the BRT system, whether buses are conventional diesel, diesel-electric hybrid, natural gas, or full electric powered. The preferred propulsion technology for the buses selected to serve the Queen Street – Highway 7 BRT should appropriately balance capital costs, operating and maintenance costs and knowledge, and environmental benefits.

The benefits and costs linked to the GHG emissions per scenario are calculated in the Economic Case and show that Scenario 4 is the highest performer, followed by Scenario 5, whereas Scenario 6 performs poorly.

Results show that, for the environmental health and air quality criteria, Scenario 4 performs the highest, followed by Scenarios 5 and 6.

Safety and connectivity

Brampton residents have expressed safety and connectivity concerns caused by the many wide arterial roads in the city[7]. There are locations where crossing the road at signalized intersections is a negative experience, as well as places where links in the pedestrian and bike networks are missing. Both issues result in a lower willingness to walk or bike through the city, limiting people's transport options with impacts on health and quality of life.

Schemes involving roadway reconfigurations to accommodate BRT lanes in the existing ROW create the opportunity to introduce safer and more comfortable pedestrian conditions (such as median shelters, paving materials, and visual cues that encourage slower auto speeds, and narrower auto lanes at intersections for slower turning movements and shorter crossing distances).

In terms of connectivity, all Scenarios 4, 5, and 6 will improve intersections in terms of safety and adding sidewalks, pedestrian crossings, and paths where there are currently gaps in the network. This contributes to increased safety and connectivity for all transportation mode users. Only the segments with mixed traffic conditions in Scenario 6 do not consider any changes to the 2041 BAU situation on these segments with respect to infrastructure. Further, Scenarios 5 and 6 result in negative impacts for pedestrians due to the widening of the right of way along the length of the

[7] City of Brampton, 2019. Mapped Ideas – Brampton Open Data. <http://geohub.brampton.ca/datasets/mapped-ideas>.

corridor, which results in longer crossing distances for pedestrians not using the BRT (i.e. merely crossing the road and not accessing the median stop).

Results show that, for the safety and connectivity criteria, Scenario 4 performs the highest, followed by Scenarios 5 and 6. All scenarios perform better than the 2041 BAU scenario.

Active transportation benefits

Increasingly, corridor-wide transportation investments and retrofits incorporate active transportation infrastructure such as improved sidewalks and painted or protected bicycle lanes. These investments are part of designing ‘complete streets’ or corridors that accommodate all modes safely and effectively. Accommodating active modes along rapid transit corridors investments help encourage the use of transit such as the Queen Street – Highway 7 BRT by improving the first mile/last mile condition and encouraging users to take active modes to and from the BRT. A welcoming door-to-door condition along the corridor creates a pleasant experience for existing users and can help encourage new users to shift to sustainable modes.

Metrolinx has identified the economic value of active transportation through a study of cycling interventions[8]. They found that active transportation facilities (i.e. bicycle lanes) increase cycling update, resulting in reduced vehicle-cyclist conflicts, increased physical activity and health, reduced greenhouse gas emissions, and traffic decongestion. At the same time, certain costs apply to active transportation investments, including congestion (if vehicle lanes are reduced), loss of parking, and direct facility costs.

[8] Metrolinx, January 2017. “The Economic Value of Regional Strategies to Improve Transportation Outcomes – Cycling Interventions: Economic and Financial Perspective.”

Figure 69: Artist's rendering of a 'complete street' BRT corridor designed for all modes

In terms of active transportation, Scenarios 4, 5, and 6 consider adding sidewalks, pedestrian crossings, and paths where there are currently gaps in the network, increasing safety and connectivity for all transportation mode users. Only the segments with mixed traffic solutions in Scenario 6 do not consider any changes to the 2041 BAU situation on these segments with respect to active transportation infrastructure.

Results show that, for the active transportation benefits criteria, Scenarios 4 and 5 perform the highest, followed by Scenario 6. All scenarios perform better than the 2041 BAU scenario.

Community and heritage

Investments in rapid transit present a strong opportunity to attract new, sustainable forms of development that take advantage of their rapid transit adjacency to support a mode shift towards transit for many trips. Rapid transit provides an affordable transportation option by reducing or eliminating the need to drive, while encouraging higher density developments in station areas which may be more affordable for residents to purchase or rent.

BRT systems provide resiliency to new mobility technologies, supporting stable growth and local community needs as they evolve over time. Median-running BRT systems are designed to be able to be converted to LRT technology as much as is feasible. The BRT routes themselves, because they do not have fixed rail, can accommodate a variety of vehicles, meaning they can conveniently support a switch to different styles of bus (e.g. articulated versus non-articulated), propulsion technologies (e.g. from diesel to electric), or new mobility solutions altogether (e.g. autonomous shuttles).

Implementing a BRT system is a major factor behind attracting new and sustainable forms of development on and around the BRT corridor and is an opportunity for future conversion to an LRT if warranted, or other, more sustainable BRT technologies (such as electric propulsion).

Results show that, for the community and heritage criteria, Scenarios 4, 5, and 6 perform equally and all scenarios perform better than the 2041 BAU scenario.

Economic and Regional Development

Connecting commuters to jobs

Transit is one of the primary methods of providing equitable services to a population. In Brampton as in many communities, transit riders are shown to be on average of lower income and with less stable employment than those who drive to work. From a social inclusivity and accessibility to jobs perspective, the Queen Street – Highway 7 BRT is a means of ensuring that residents of Brampton and visitors to the city are well-connected with affordable, accessible transit service.

The connecting commuters to jobs criteria is informed by an accessibility analysis that shows the change in access to employment from every model zone in the region. Figure 70 shows the change in access to Jobs by Origin Zone for Scenario 3 compared to 2041 BAU scenario. It shows that Scenario 3 greatly improves access to jobs for those living along the Queen Street – Highway 7 Corridor. The transit priority bus routes of this scenario also improve job accessibility for those living away from the corridor but with access to those routes. Scenario 3 provides transit access to 51,500 jobs within the study area, which is a 7.2% increase in accessibility to jobs compared to the 2041 BAU scenario.

Scenarios 4, 5, and 6 have a very similar transit service definition, with the only difference being the length of the Viva Orange route to the east of the study area. Therefore, their job accessibility profile is considered similar to Scenario 3 and does not vary from one scenario to another. They all perform equally on this criterion.

Results show that, for the connecting commuters to jobs criteria, Scenarios 4, 5, and 6 perform equally and all scenarios perform better than the 2041 BAU scenario.

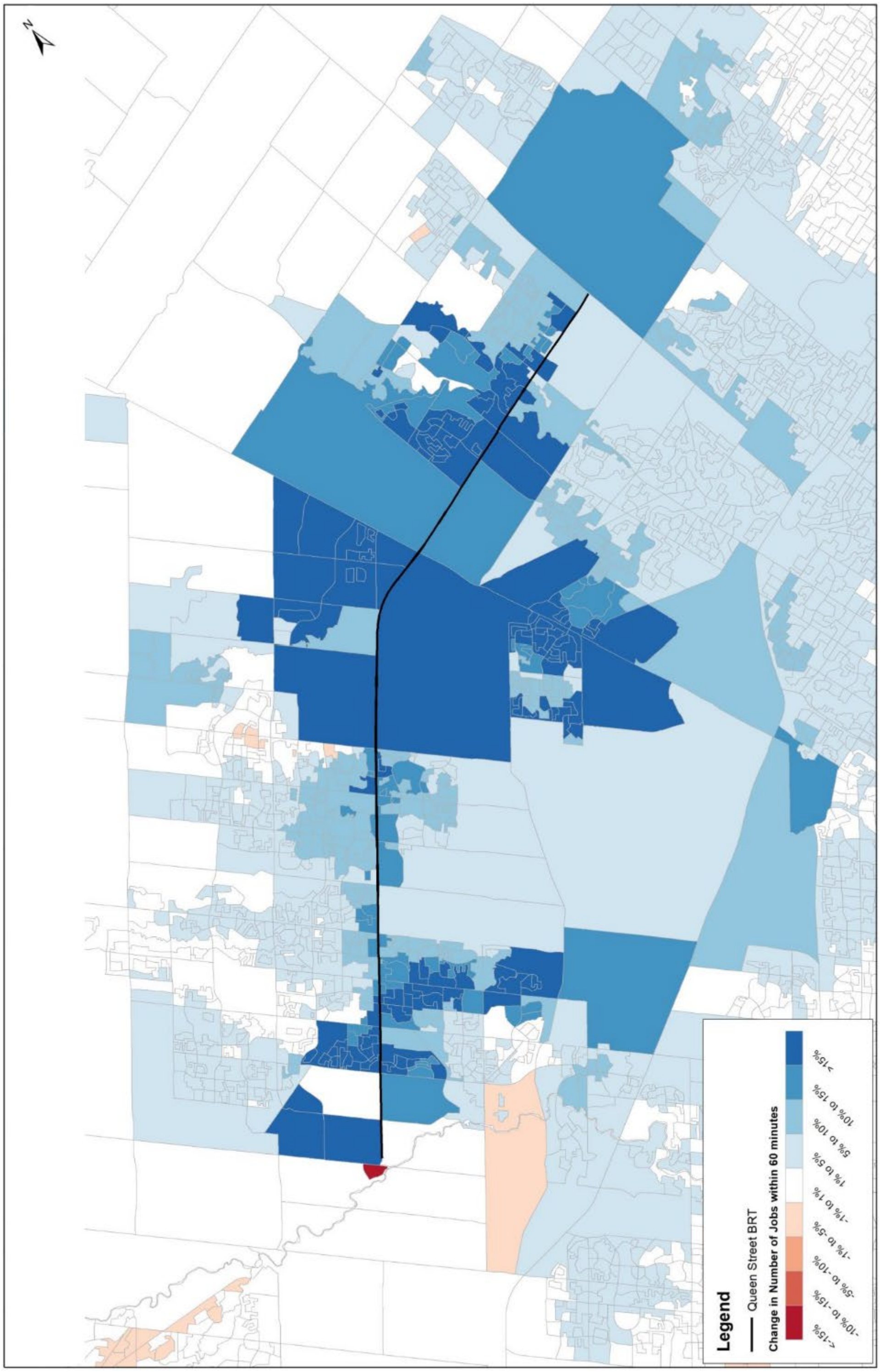


Figure 70: Change in Access to Jobs by Origin Zone (Scenario 3 vs BAU)

Catalyzing urban land development

As stated for the shaping growth criteria, transit investments are a proven method of attracting new residential and mixed-use development. They are catalyzers for urban land development and for shaping such development in a denser way. This typically generates areas that are attractive for most people, as well as for jobs, as families and businesses seek to locate themselves in an area that provides convenient and affordable access to the broader region.

Globally, implementing a BRT system is a major factor for shaping growth and increasing TOD initiates on and around the BRT corridor. It should be expected that the greater transit priority provided across the corridor, the more opportunities for urban land development, access and mobility for all.

Results show that, for the catalyzing urban land development criteria, Scenarios 4, 5 provide the most opportunity for urban land development, then Scenario 6. All scenarios perform better than the 2041 BAU scenario.

Supporting innovation and prosperity

Implementing a new transit system such as a BRT is a way of not only being able to offer transit to more users and increase transit use in the area, but also an occasion to increase the level of connectivity between major employment hubs, academic institutions, and other centres of innovation.

Scenarios 4, 5, and 6 offer the same transit service (routes and levels of service) that ensure connections throughout the major economic and academic hubs in the study area: York University, Pearson Airport employment area, downtown areas of Brampton and Bramalea, and Highway 7 employment. While level of transit service is the same for each scenario, it is expected that the provision of more dedicated infrastructure in scenario 4 and 5 will increase the level of connectivity then the limited infrastructure provided under scenario 6. The infrastructure will increase reliability and reduce travel times with the increases in service, compared with the minimal infrastructure provided under scenario 6.

Results show that, for the supporting innovation and prosperity criteria, Scenarios 4 and 5 perform better than scenario 6. All scenarios perform better than the 2041 BAU scenario.

Maintaining access to and facilitation of goods movement

The Queen St- Hwy 7 BRT corridor is a major goods movement corridor and important to the economy. Truck movements will still need to be facilitated across the corridor with the associated transit improvements. A reduction in vehicle capacity along the corridor in Scenario 4 may have a detrimental impact on goods movement compared with Scenario 5 which maintains existing vehicle capacity. Scenario 6 may also impact goods movement, due to the increases in transit service with minimal infrastructure to support or enhance reliability. The extent of this impact will be evaluated as part of the Preliminary Design and the refinement of options.

Results show that, for the maintaining access to and facilitation of goods movement criteria, Scenario 5 is least likely to have an impact on goods movement due to the maintaining of vehicle capacity, compared with Scenarios 4 and 6

Environmental Sustainability

Energy use and efficiency

Rapid transit investments like the Queen Street – Highway 7 BRT attract high ridership and support car-free forms of development and lifestyles. They aim to reduce area-wide energy use and increase energy efficiency. This criterion is measured by the total vehicle kilometres travelled (VKT) by automobile. VKT is the sum of the driving distance of all vehicles to get from their origin to their destination. Auto VKTs can vary between scenarios when the number of trips changes and/or when the path between origin-destination pairs change due to changes on the network (increased or reduced capacity, changes in journey times due to congestion etc). The calculations of VKT from the GGHM outputs is done as the sum of all the links in the network of the number of vehicles on each link, multiplied by the length of the link.

Across the modelling of Scenarios 4 and 5, a reduction in total VKT by automobile on Queen Street within downtown Brampton is observed. There is a significant reduction in auto VKT on Queen Street in Scenario 4 due to the reduction of one traffic lane. The change in auto VKT by zone in Scenarios 4 and 5 is shown in Figures 68 to 70. Downtown Brampton has been assumed to be from Centre St to McMurchy Avenue, which is larger than the section with parking restrictions. The modelled scenarios includes lane reductions from 2 lanes down to 2 lane in the section outside Theatre Lane to George St. This has an impact on VKT through the area. Both Scenarios 4 and 5 are seen as strongly supporting increased transit ridership and mixed-use intensification at transit stops that lead to shorter trips, but Scenario 4 is seen as more likely to foster a change in people's mode of travel across the corridor.

With lane reductions in Scenario 4, the results suggest there is some diversion of traffic from areas near Queen Street to areas further away from the corridor.

With widening in Scenario 5, there is a reduction in auto traffic in downtown Brampton, and minimal change (< ±1%) in all other study area zones (<±1%).

With Scenario 6, there is no appreciable decreases or increases in observed auto VKT along the Queen Street – Highway 7 corridor.

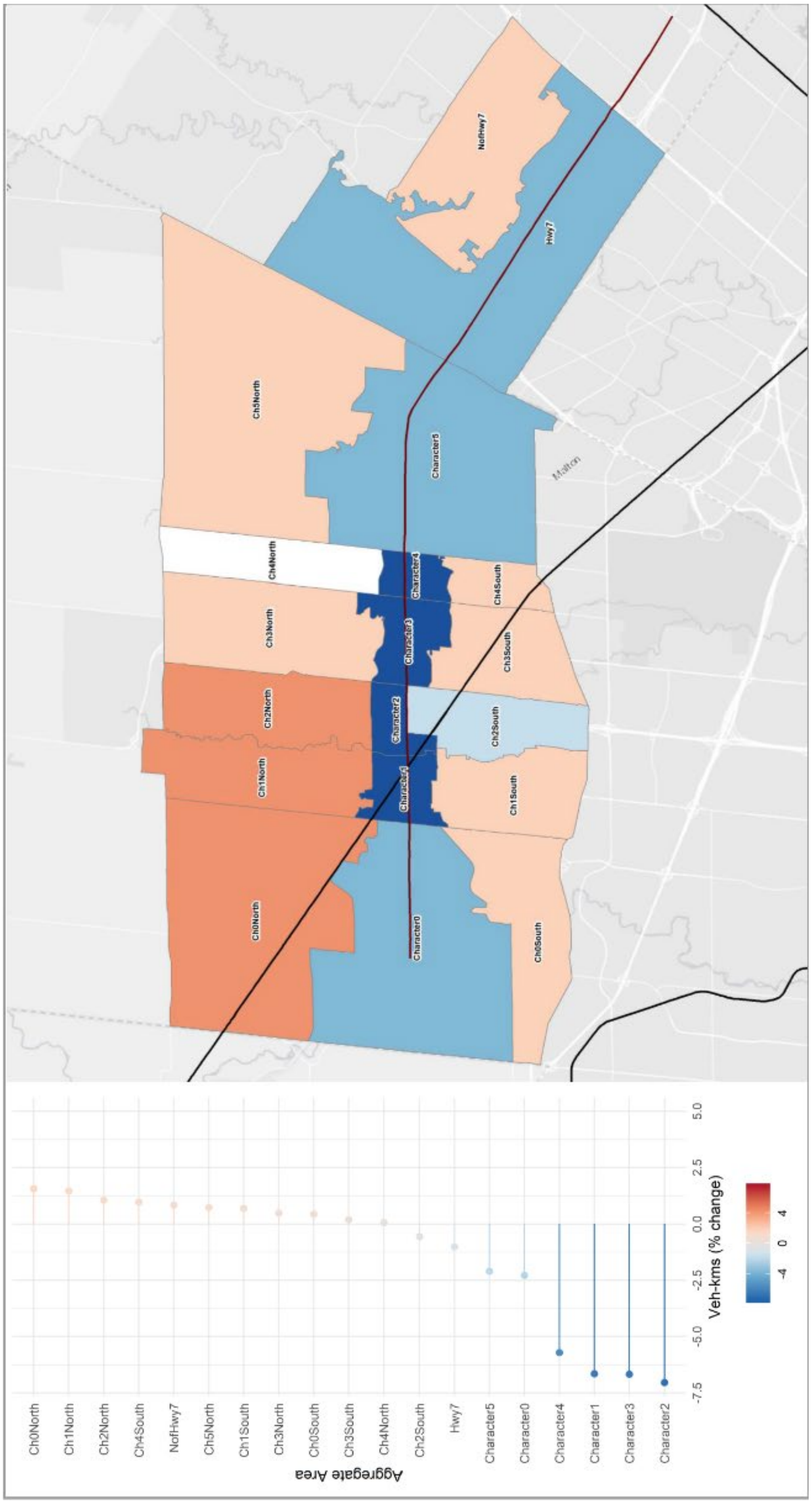


Figure 71: Scenario 4 – Change in auto vehicle-kms by zone (scenario vs BAU)

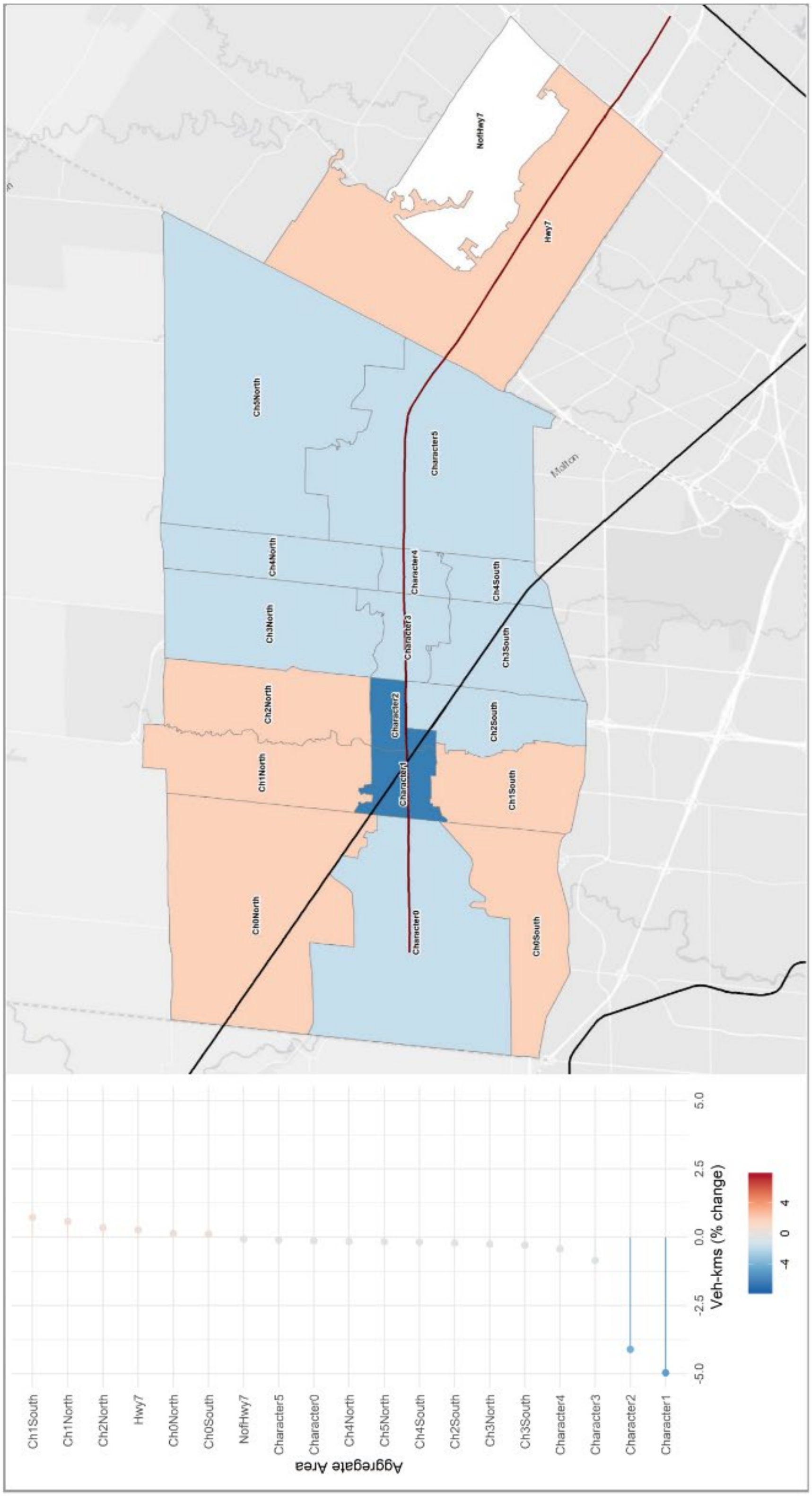


Figure 72: Scenario 5 – Change in auto vehicle-kms by zone (scenario vs BAU)

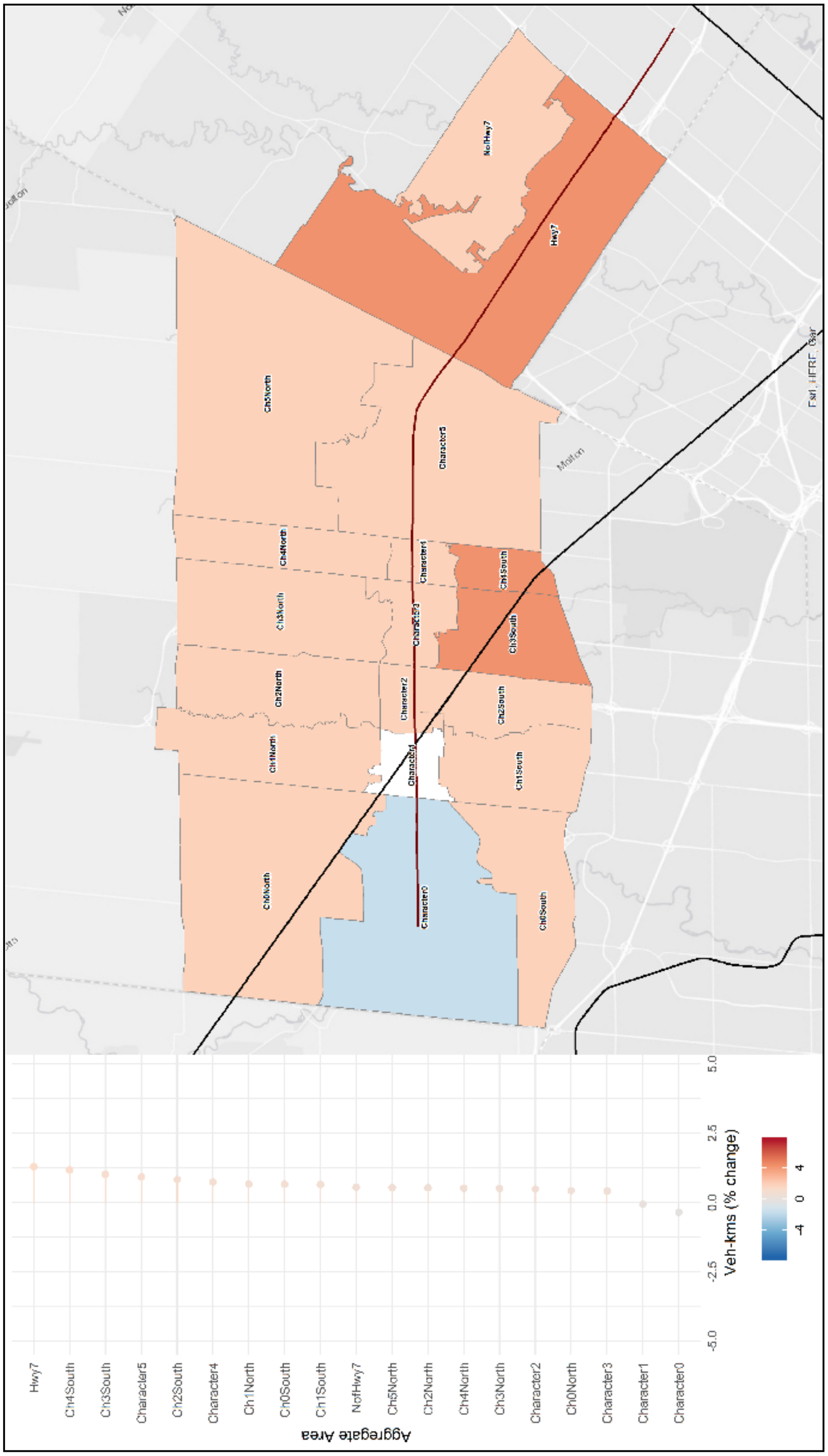


Figure 73: Scenario 6 – Change in auto vehicle-kms by zone (scenario vs BAU)

Table 23 is the legend for the zone names on the previous maps.

Table 23: Public names of assigned zones

SHORT NAME	PUBLIC NAME
CHARACTER0	Queen: Mississauga-McLaughlin
CH0NORTH	N of Queen: Mississauga-McLaughlin
CH0SOUTH	S of Queen: Mississauga-McLaughlin
CHARACTER1	Queen: McLaughlin-Centre
CH1NORTH	N of Queen: McLaughlin-Centre
CH1SOUTH	S of Queen: McLaughlin-Centre
CHARACTER2	Queen: Centre-Hwy410
CH2NORTH	N of Queen: Centre-Hwy410
CH2SOUTH	S of Queen: Centre-Hwy410
CHARACTER3	Queen: Hwy410-Bramalea
CH3NORTH	N of Queen: Hwy410-Bramalea
CH3SOUTH	S of Queen: Hwy410-Bramalea
CHARACTER4	Queen: Bramalea-Torbram
CH4NORTH	N of Queen: Bramalea-Torbram
CH4SOUTH	S of Queen: Bramalea-Torbram
CHARACTER5	Queen: Torbram-Hwy50
CH5NORTH	N of Queen: Torbram-Hwy50
CH5SOUTH	S of Queen: Torbram-Hwy50
HWY7	Hwy7: Hwy50-Hwy400
NOFHWY7	N of Hwy7

Though not considered in the present evaluation, electric buses may be considered in further stages of the project definition, as the project progresses.

Results show that, for the energy use and efficiency criteria, Scenario 4 performs the highest, followed by Scenarios 5 and 6. All scenarios perform better than the 2041 BAU scenario.

Improved or protected natural environment

Impacts to protected or environmentally-sensitive areas are anticipated with the introduction of the Queen Street – Highway 7 BRT, with an impact level that is different based on the BRT concept that is implemented. The study area includes an Environmentally Sensitive Area identified by the Toronto and Region Conservation Authority: the Claireville Conservation area, with 848 acres of natural and forested areas. Also, the corridor crosses several designated watercourses including Etobicoke Creek, Spring Creek, Mimico Creek, the Humber River, and a variety of minor tributary streams.

Minimizing impacts on these areas during construction through the careful management of debris and runoff will be an important consideration to ensure the protection of the natural environment, as with any construction project that occurs adjacent to a watercourse or natural area.

As a whole, all scenarios should include measures to try to increase natural environmental health immediately surrounding the corridor. However, Scenarios 5 and 6 include a widening of Queen Street crossing the Claireville Conservation Area and therefore perform more poorly in this criterion compared to Scenario 4.

Results show that, for the improved or protected natural environment criteria, Scenario 4 performs the highest, whereas Scenarios 5 and 6 do not perform strongly and introduce the risk of negative impacts compared to the 2041 BAU scenario.

Strategic Case Summary

Accordingly to the evaluations of the scenarios 4, 5 and 6 throughout the different criteria of the strategic case, Table 24 shows a summary evaluation based on ranking of scenarios following a colour scheme (see Table 25). The quantitative evaluation criteria are also illustrated by the applicable numbers.

Table 24: Strategic Case Summary of scenarios 4, 5 and 6, IBC Queen Street - Highway 7 BRT

Criteria		2041 BAU	Scenario 4	Scenario 5	Scenario 6
Strategic Case	Transit ridership forecasts (AM peak hour boardings)	13,696	**18,813**	**18,734**	**15,110**
Strategic Case	Transit user experience (average travel time [mins] between major O-D pairs)	117	**107**	**108**	**110**
Strategic Case	Mobility choice (transit mode share [%] in study area)	6.85	**7.14**	**7.18**	**7.05**
Strategic Case	Shaping growth				
Strategic Case	Public health				
Strategic Case	Environmental health and air quality				
Strategic Case	Safety & connectivity				
Strategic Case	Active transportation benefits				
Strategic Case	Community & heritage				

	Accessibility to jobs				
	Catalyzing urban land development				
	Innovation & prosperity				
	Energy use & efficiency				
	Protection of natural environment				
	Summary				

Table 25: Legend for performance ranking of scenarios

Colour legend for performances (ranking):
Low performance
Medium performance - low
Medium performance - high
High performance

5

Economic Case

Introduction

The Economic Case quantifies the overall impact of the proposed project to society. In this IBC, the Economic Case measures the overall benefit of the bus rapid transit project compared to the 2041 BAU scenario. The following sections outline the approach, assumptions, and results of the economic analysis.

The economic analysis presented in this section uses an approach that aligns with the latest Metrolinx Business Case Guidance (April 2019). All impacts considered here in this economic analysis are based on results derived from the Greater Golden Horseshoe Model version 4 (GGHM_v4). The proposed construction and opening years are estimates to conduct the economic analysis in this IBC. These dates may be updated in the preliminary design phase.

Key evaluation parameters used are outlined in Table 26.

Table 26: Key economic case parameters

PARAMETER	VALUE
EVALUATION AND PRESENT VALUE YEAR	2019
CONSTRUCTION YEAR	2023
OPENING YEAR	2026
EVALUATION PERIOD (AFTER OPENING YEAR)	60 years
BENEFITS PERIOD (AFTER EVALUATION YEAR)	30 years
SOCIAL DISCOUNT RATE (ECONOMIC CASE, REAL)	3.5%
BENEFIT GROWTH CAP YEAR	2049 (or 30 years from the year of evaluation)
COST ESCALATION CAP YEAR	2049 (or 30 years from the year of evaluation)

Transportation User Impacts

Transit travel time savings

Transit travel time savings are one of the primary reasons for investing in rapid transit and can be quantified to assess the value that the investment brings to its riders. Changes to headways and vehicle speeds can lead to a difference in the perceived travel time (including weighted walk, wait, and in-vehicle times).

These transit travel time benefits are accumulated by new and existing riders over the project life span to determine the total accumulated transit travel time savings benefits for the project. The travel time benefit is calculated based on the economic principle of rule-of-a-half, where new users on average experience half of the travel time savings. This benefit is monetized with a value of time of $18.06 per hour (2019 prices).

Table 27 summarizes the present value benefit for each scenario over a 60-year appraisal period. Both Scenarios 4 and 5 have significant travel time savings associated with the exclusive BRT lane in place across the entire corridor. In Scenario 6, the operation of buses within mixed traffic impacts the travel time benefit.

Table 27: Transit Travel Time Savings ($000s, 2019 prices)

IMPACT	SCENARIO 4	SCENARIO 5	SCENARIO 6
TRANSIT TRAVEL TIME SAVINGS	$2,350,500	$2,407,400	$1,724,200

Crowding, Capacity and Reliability

Rapid transit can provide a more reliable service, resulting in more consistent schedule adherence which is highly valued by transit passengers and operations. The change in the perceived transit travel time resulting from Crowding, Capacity, and Reliability (CCR) is estimated by the GGHMv4. The approach to estimate and monetize these impacts are consistent with the calculations for transit travel time savings, using both the rule-of-half and value of time.

Following the Metrolinx model assurance process, the benefits associated with CCR have not been quantified for this initial business case. It is expected that the BRT would have a positive impact to users in terms of improved reliability, however, these have not been quantified. These benefits can be estimated and captured as part of subsequent business case analyses.

Automobile Operating Cost Impact

There is a change in automobile operating costs associated with the change in vehicle kilometres travelled (VKT) by all auto users in the study area. Changes in VKT could result from a reduction in driving associated with new transit users, or from route changes by auto users within the study area network. The changes in operating cost are related to vehicle ownership that is not typically factored into day-to-day trip making choices. Metrolinx Business Case Guidance suggests a value of $0.09/VKT. This represents the average rate associated with vehicle depreciation. Fuel costs are typically perceived in the trip making decision, and therefore should not be included here as a benefit.

Table 28 summarizes the present value benefit for each scenario over a 60-year appraisal period. Scenarios 4 and 5 lead to an overall reduction in vehicle kilometres travelled and therefore a reduction in automobile operating costs.

Table 28: Auto Operating Cost Savings ($000s, 2019 prices)

IMPACT	SCENARIO 4	SCENARIO 5	SCENARIO 6
AUTO OPERATING COST	$102,900	$32,000	-$65,500

Auto Travel Time Impacts

Auto travel times are expected to change with the implementation of the BRT infrastructure. Impacts can result from the change in the number of auto lanes (as is the case in Scenario 4, and in select areas in Scenario 5), the reduction of number of auto users on the road, or from route changes by auto users within the study area network.

These impacts are derived from the auto travel time matrices from the GGHM_v4 model and calculated using the rule-of-a-half.

Changes in auto travel time are monetized using an adjusted value of time that accounts for freight traffic within the study area. The value of time suggested in the Metrolinx Business Case Guidance is typically applied to passenger trips. Similar international guidance (e.g. UK WebTAG) suggests that light and heavy vehicles have a value of time that is approximately 30% higher than cars. The adjusted auto value of time can be calculated by the proportion of light, medium, and heavy trucks within the study area. Table 29 summarizes this calculation.

Table 29: Adjusted Auto Value of Time

VEHICLE TYPE	% OF TRAFFIC[9]	VOT %INCREASE[10]	ADJUSTED VOT ($/HOUR)
CARS	78%	0%	$18.06
LIGHT TRUCKS	9%	27%	$22.97
MEDIUM TRUCKS	6%	31%	$23.67
HEAVY TRUCKS	7%	31%	$23.67
WEIGHTED AVERAGE	100%		$19.23

Table 30 summarizes the present value benefit for each scenario over a 60-year appraisal period. Across all scenarios, there is an increase in overall auto travel time in the study area, suggesting that there is congestion as traffic grows in the corridor, as well as rerouting impacts resulting from the reduction of road capacity to accommodate the BRT infrastructure in Scenario 4. Scenario 6 has the lowest impact which is expected as there are fewer impacts to road capacity in constrained sections; the impact may be a result from rerouting within the network.

Table 30: Auto Travel Time Impacts ($000s, 2019 prices)

IMPACT	SCENARIO 4	SCENARIO 5	SCENARIO 6
AUTO TRAVEL TIME IMPACTS	-$840,000	-$374,200	-$232,100

Producer Benefits

Fare Revenue Adjustment

Incremental fare revenue associated with the increase in ridership is an economic benefit to the public transit service provider. Based on Metrolinx guidance, the additional revenue is assumed to be the additional ridership forecast by the GGHMv4 multiplied by an average fare of $3.25 in 2019 prices. The resulting benefit is summarized for each scenario in the Table 31.

Table 31: Fare Revenue Adjustment

	SCENARIO 4	SCENARIO 5	SCENARIO 6
FARE REVENUE ADJUSTMENT	$197,100	$225,800	$159,800

9 Based on 2017 ATR Counts for Queen Street, east of Airport Road
10 Based on the UK WebTAG Databook Table A1.3.5

External Benefits

Health and Active Travel Benefits

There are health benefits associated with increased walking activity. Each new transit user is expected to gain a marginal benefit associated with the walk access to and from the transit stop. Across all scenarios, the average access and egress walking distance to transit is assumed to be 400 metres. This distance is multiplied with each new transit trip and a suggested health benefit parameter of $3.92 per kilometre walked.

Table 32 summarizes the health benefit over a 60-year appraisal period.

Table 32: Health and Active Travel Impacts ($000s, 2019 prices)

IMPACT	SCENARIO 4	SCENARIO 5	SCENARIO 6
HEALTH AND ACTIVE TRAVEL	$95,100	$108,900	$77,100

Road Safety Impacts

There is a lower cost to society resulting from the reduction in vehicle collisions that result in property damage, injury, or death. Metrolinx Business Case Guidance suggests the value is $0.095 per reduction in VKT. This value is reduced at a rate of -5.3% per year (in line with Metrolinx Guidance), reflecting the overall trend of improvement in road safety.

Table 33 summarizes the present value benefit for each scenario over a 60-year appraisal period. As there is a reduction in VKT in Scenarios 4 and 5, there is a benefit in terms of road safety. The increase in VKT in Scenario 6 suggests that there would be a negative impact.

Table 33: Road Safety Impacts ($000s, 2019 prices)

IMPACT	SCENARIO 4	SCENARIO 5	SCENARIO 6
ROAD SAFETY	$37,800	$11,800	-$24,100

Greenhouse Gas Emissions and Local Air Quality Impacts

Car travel emits greenhouse gases (CO2) which contributes to climate change that has major implications and costs for society. Car travel also emits pollutants, such as nitrogen oxides, sulphur dioxides, and particulate matter, that impact local air quality and are harmful to health.

With the change in vehicle distance travelled, these people would contribute less (or more) emissions into the environment. The greenhouse gas impact is monetized using the change in VKT multiplied by a suggested parameter of $0.01 per VKT. Similarly, the local air quality impact is monetized using the change in VKT multiplied by $0.02 per VKT.

Table 34 summarizes the present value benefit for each scenario over a 60-year appraisal period. As there is a reduction in VKT in Scenarios 4 and 5, there is a benefit in terms of road safety. The increase in VKT in Scenario 6 suggests that there would be a negative impact.

Table 34: Greenhouse Gas Emissions and Local Air Quality Impacts ($000s, 2019 prices)

IMPACT	SCENARIO 4	SCENARIO 5	SCENARIO 6
GREENHOUSE GAS EMISSIONS	$11,400	$3,600	-$7,300
LOCAL AIR QUALITY	$2,300	$700	-$1,500

Economic Case Summary

The present value benefits associated with each proposed scenario are compared to the present value costs to calculate net present value and benefit-cost ratio metrics, which represents the relative value of the investment to society.

Note that the costs used within the economic analysis will be slightly different to the costs presented in the financial case, for two reasons:

- The economic case analysis is conducted in real terms, and not subject to inflation; and
- The capital costs are subjected to an optimism bias of 15%.[11]

Table 35 presents the summary of the economic case.

Table 35: Economic Case Summary ($000s, 2019 prices)

IMPACT	SCENARIO 4	SCENARIO 5	SCENARIO 6
TRANSPORTATION USER BENEFITS	$1,613,500	$2,065,200	$1,426,600
FARE REVENUE ADJUSTMENT	$197,100	$225,800	$159,800
EXTERNAL BENEFITS	$146,700	$125,000	$44,300
PRESENT VALUE BENEFITS (PVB)	$1,957,200	$2,415,900	$1,630,700
CAPITAL COST	$94,600	$489,800	$150,900
OPERATING & MAINTENANCE COSTS	$412,300	$367,600	$352,700
REHAB COST	$78,400	$78,400	$78,400
PRESENT VALUE COSTS (PVC)	$585,400	$935,800	$582,000
NET PRESENT VALUE (PVB – PVC)	$1,371,900	$1,480,100	$1,048,700
BENEFIT COST RATIO (PVB / PVC)	3.3	2.6	2.8

[11] This is based on international practice for optimism bias applied on bus rapid transit projects (from UK WebTAG).

Though Scenario 6 has a higher BCR than Scenario 5, its overall benefits are lower, as demonstrated in the reduced NPV.

Figures 74 to 76 are waterfall charts that summarize the components that affect the net present value of each scenario.

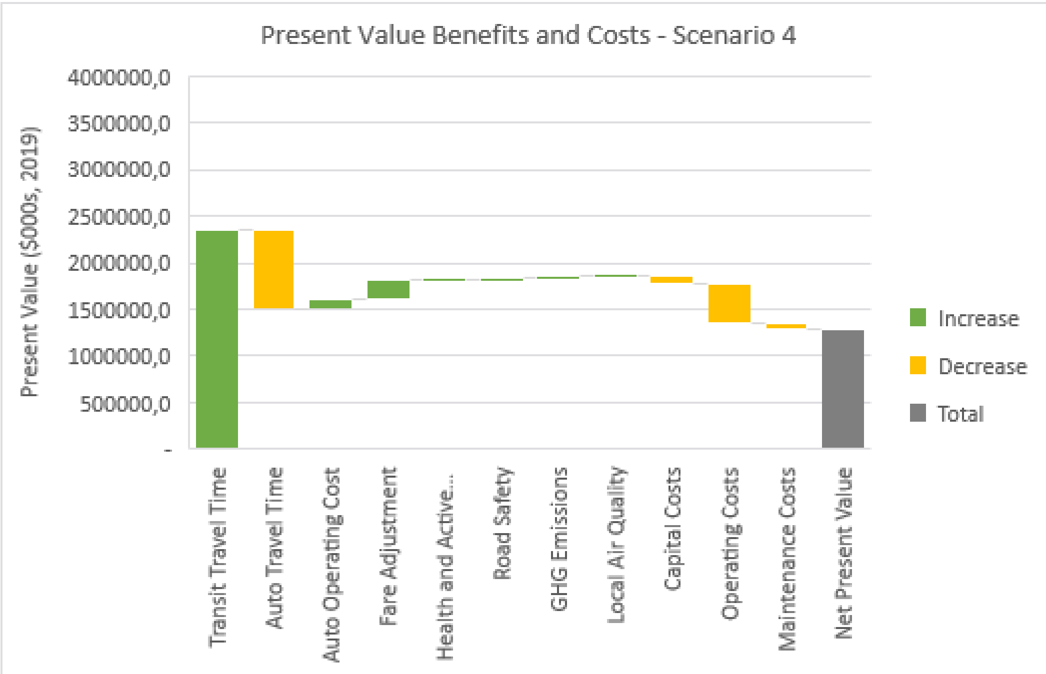


Figure 74: Scenario 4 Present Value Benefits and Costs

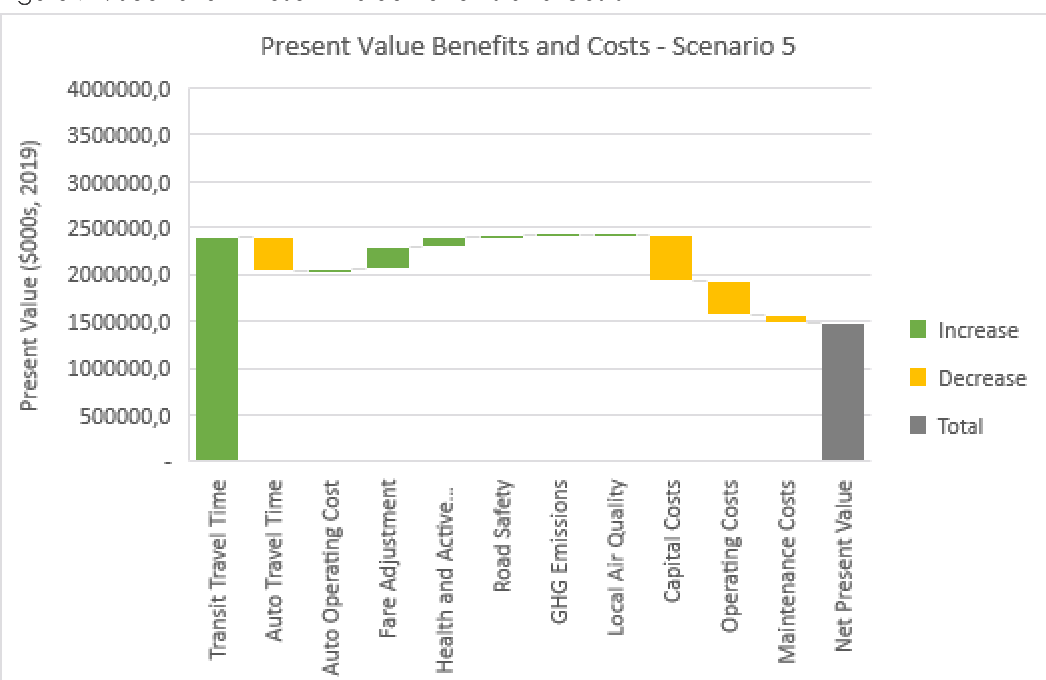


Figure 75: Scenario 5 Present Value Benefits and Costs

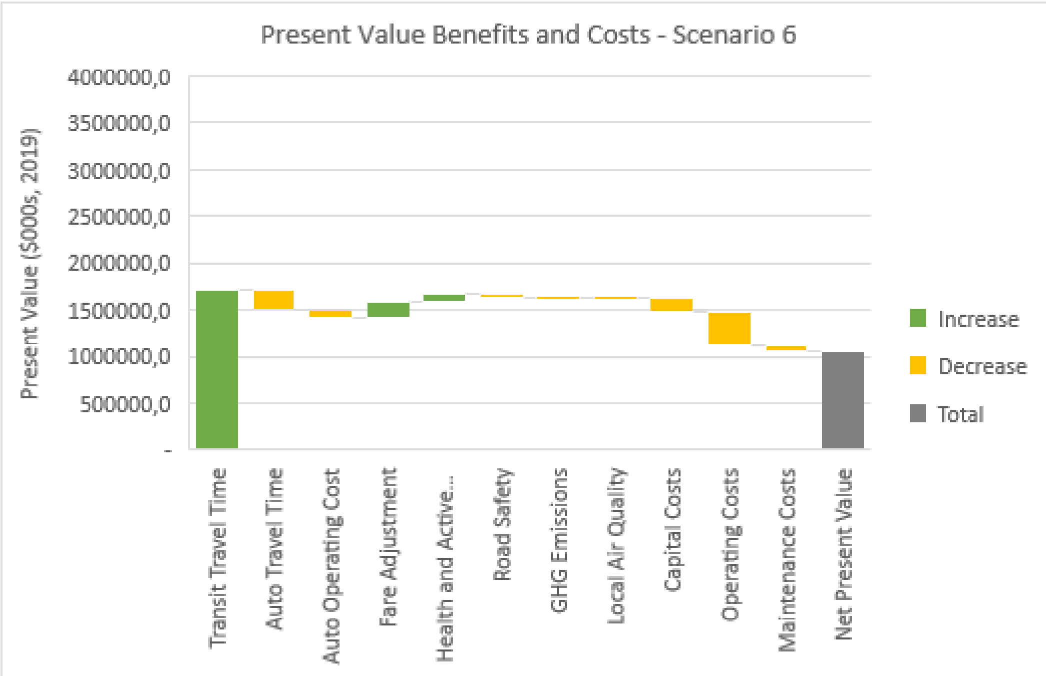


Figure 76: Scenario 6 Present Value Benefits and Costs

The Economic Case evaluation shows that with respect to overall BCR, Scenario 4 is the highest performer overall, followed by Scenario 6, then Scenario 5. However, Scenario 5 has the highest NPV. All Scenarios perform better than the 2041 BAU scenario.

6

Financial Case

Fare Revenue

Fare revenue is directly related to growth in ridership. The change in ridership in 2041 is estimated from the Metrolinx GGHM_v4 model. The incremental ridership is scaled from the opening year to the end of the appraisal period using an average growth rate of 1%.

The incremental revenue is equal to the additional demand multiplied by an average fare. For fare revenue calculations, an average fare of $3.25 is assumed for 2019, per the City of Brampton and Metrolinx. Fare integration is assumed in the study area. In this analysis, the fare is assumed to increase in nominal terms with 2.0% inflation per year, with no escalation beyond inflation.

Table 36 presents the additional annual transit ridership, annual revenues, and present value revenues (over a 60-year appraisal period) associated with each scenario.

Table 36: Change in transit ridership (trips) and revenue (000s)

	SCENARIO 4	SCENARIO 5	SCENARIO 6
2041 ANNUAL INCREMENTAL RIDERSHIP	2,992	3,428	2,426
2041 ANNUAL INCREMENTAL REVENUE ($3.25 AVERAGE FARE IN 2019 PRICES)	$9,724	$11,141	$7,884

Capital Costs

Estimating capital costs

A projection of the project costs was developed for the considered scenarios in coordination with the scope identified by the project team. The estimate was developed using industry best practices corresponding to the level of information available. The estimate is classified as Class D – Concept Sketch Design, as defined by Estimate Classification Matrix in accordance to the Association for the Advancement of Cost Engineering International (AACEi) and shown in Table 37.

Table 37: AACEi Cost Estimate Classes

ESTIMATE LEVEL	ESTIMATE DESCRIPTION	DESIGN PHASE	METHODOLOGY	ACCURACY RANGE
D	Concept Sketch Design	Planning Schematic Design	Parametric Models Capacity Factored Historical Costs	L: -20% to - 50% H: +30% to +100%
C	33% Design Development	Planning Schematic Design Design Documents	Parametric Models Equipment Factored	L: -15% to - 30% H: +20% to +50%
B	66% Design Development	Planning Schematic Design Design Documents	Unit Cost Assemblies	L: -10% to - 20% H: +10% to +20%

ESTIMATE LEVEL	ESTIMATE DESCRIPTION	DESIGN PHASE	METHODOLOGY	ACCURACY RANGE
A	100% Tender Documents	Detailed Design Engineering Construction Documents	Detailed Unit Costs Detailed Take-off	L: -2% to - 10% H: +2% to +10%

The most likely estimate includes contractor's Indirect Costs, Contractor's Overhead & Profit, and Contingency.

The developed estimate is **not intended to set the budget for the potential works,** but rather supports the comparison of the three (3) identified scenarios. Unit rates were derived using unit method of costing, which involves the use of single functional unit rates based on historical data from previous, or similar construction projects.

The scope of the civil works was identified applying a segment-by-segment calculation to obtain quantities of demolition, pavement striping, curb reconstruction, signaling works, station construction, and others. Additional unit prices were used from similar BRT infrastructure costs, like Viva.

Assumptions, Inclusions and Exclusions

- All costs include direct costs (labour, materials, and equipment), 15% of indirect costs, 15% of contractor's overhead and profit, and 20% contingency.
- The costs include Right of Way Acquisition at CAD $250/m^2.
- All costs exclude fleet acquisition.
- Demolition works occur for all required ROW in excess of what's already available. Median demolition assumes an average median width of 2.5 m.
- Restriping area includes the area of the entire corridor.
- New signaling supply occurs at all intersections except those in downtown Brampton, where only minor reconfigurations are included.
- Lane separators for the BRT have been excluded.
- All existing curbside bus stops have remained unchanged as they will serve additional bus lines.
- The costs per km exclude terminal costs (Brampton and Bramalea, if required). Metrolinx and Brampton will provide a cost estimate for this.
- Bus stop costs have been assumed to be the same as the Viva project bus stops.
- For the sections of the alignment that require widening of a rail overpass, it has been assumed full build-out of a new structure and demolition of existing one (this applies to Queen St at the intersection with Highway 410, and with Delta Park Blvd/Sun Pac Blvd)
- The scope of civil works includes: demolition, median demolition, pavement reconstruction, sidewalk reconstruction, roadway striping, utility relocation (rough estimate), new signaling

systems, signaling reconfigurations, light pole or miscellaneous relocations, curb and gutter reconstruction, manholes, refurbished curbside bus stops and new median bus stops.

- Engineering and planning costs have been included as 7% of the estimated construction cost.
- Financing costs have been excluded.

Table 38: Scenario 4 cost summary

SCENARIO 4 COST SUMMARY (CLASS D ESTIMATE)			
COST PER KILOMETRE (MID)		CAD	$3,779,000
COST PER KILOMETRE (HIGH)	+35%	CAD	$5,102,000
COST PER KILOMETRE (LOW)	-20%	CAD	$3,023,000
TOTAL ALIGNMENT LENGTH (KILOMETRES)		24.59	
TOTAL COST		CAD	$92,952,000

Table 39: Scenario 5 cost summary

SCENARIO 5 COST SUMMARY (CLASS D ESTIMATE)			
COST PER KILOMETRE (MID)		CAD	$19,565,000
COST PER KILOMETRE (HIGH)	+35%	CAD	$26,413,000
COST PER KILOMETRE (LOW)	-20%	CAD	$15,652,000
TOTAL ALIGNMENT LENGTH (KILOMETRES)		24.59	
TOTAL COST		CAD	$481,168,000

The Scenario 5 cost estimate includes the following costs:

- Those associated with the intersection of Queen Street and Highway 410. The 225 m long viaduct has been assumed to be entirely rebuilt to the required width (35.4 m). No feasibility analysis has been done to assess this.
- Those associated with the intersection of Queen Street at Delta Park Boulevard, overcrossing the CN rail corridor tracks. The length of the overpass (200 m) has been assumed to be entirely rebuilt to accommodate the required width of 35.4 m. No feasibility analysis has been done to assess this.
- The Queen Street crossing of Humber River, where the 75 m long crossing would need to accommodate a ROW of 26.3 m. No feasibility analysis has been done to assess this.
- The widening of Queen Street under the CN rail tracks in proximity to Kipling Ave. This assumes full realignment of tracks to a temporary structure, and full reconstruction of a permanent rail structure once the widening works are completed. No feasibility analysis has been done to assess this.

Table 40: Scenario 6 cost summary

SCENARIO 6 COST SUMMARY (CLASS D ESTIMATE)			
COST PER KILOMETRE (MID)		CAD	$6,930,000
COST PER KILOMETRE (HIGH)	+35%	CAD	$9,356,000
COST PER KILOMETRE (LOW)	-20%	CAD	$5,544,000
TOTAL ALIGNMENT LENGTH (KILOMETRES)		24.59	
TOTAL COST		CAD	$170,434,000

Construction phasing

For this initial business case analysis, it is assumed that construction will take place over a three-year period between 2023 and 2025. Construction costs are spread evenly across the period. (Note that capital costs are escalated by 1% per year during this period).

Maintenance Costs

Over the 60-year appraisal period, there are costs experienced at regular intervals associated with the maintenance of the BRT infrastructure. Table 41 presents the frequency and cost associated with maintaining BRT infrastructure along the corridor.

Table 41: Maintenance cost and frequency

ACTIVITY	FREQUENCY (YEARS)	COST ($000, 2019 PRICES)
RESTRIPING OF BRT LANES	5	$2,767
PAVEMENT PATCHING OF BRT LANES	2	$2,011
PAVEMENT OVERLAY REPLACEMENT OF BRT LANES	25	$40,211
REPLACE BRT STATIONS	30	$43,167

These costs are assumed to be consistent across Scenarios 4 to 6. These costs are escalated by 1% per year (above inflation) until 2031, which is the assumed cost escalation cap year.

Operating Costs

Incremental operating costs are associated with the increase in vehicle services hours to operate the proposed BRT services. The increase in peak revenue service hours is calculated from outputs from the GGHM_v4 model. These are converted to an annual value with the following assumptions and approach:

- Off-peak service hours are assumed to be 50% of the peak

- There are 6 peak and 12 off-peak service hours per weekday (251 each year)
- There are 18 off-peak service hours per weekend and holiday (114 each year)
- The above factors are used to annualize the peak service hours
- The annual service hours are multiplied by an assumed cost of $142 / service hour[12].
- Operating costs are escalated by 1.0% each year, above inflation until 2031.

Table 42: Incremental operating hours and cost

	BAU	SCENARIO 4	SCENARIO 5	SCENARIO 6
PEAK SERVICE HOURS (3 HOUR AM PEAK)	149	232	223	220
ANNUAL SERVICE HOURS	200,600	312,300	300,200	296,100
2019 OPERATING COST ($000, 2019 PRICES)	$29,339	$45,682	$43,910	$43,319
2031 OPERATING COST ($000, 2019 PRICES)	$33,060	$51,475	$49,478	$48,813

[12] Source: Viva network operational costs – York Region Transit, 2018 financial data.

Financial Case Summary

The Financial Case explores the overall financial impact of the proposed project. This includes the capital cost, incremental operating and maintenance cost, and incremental revenue. Each of the input costs and revenue described above are inflated at 2% per year, then discounted using a 5.5% rate to determine the net present value of the investment. Table 43 presents a summary of the financial case over a 60-year appraisal period.

Table 43: Financial case summary (60-year appraisal period, $000s present value)

IMPACT	SCENARIO 4	SCENARIO 5	SCENARIO 6
CAPITAL COST	$94,900	$491,400	$151,400
OPERATING & MAINTENANCE COSTS	$420,100	$374,500	$359,400
REHAB COST	$80,200	$80,200	$80,200
PRESENT VALUE COSTS (PVC)	$595,200	$946,100	$590,900
INCREMENTAL REVENUE	$213,900	$245,000	$173,400
NET PRESENT VALUE	-$381,400	-$701,200	-$417,500

Note that the costs used within the financial case will be slightly different to the costs presented in the economic case, as inflation and a different discount rate is applied here.

The Financial Case evaluation shows that Scenario 4 is the highest performer overall as it has the lowest financial impact, followed closely by Scenario 6. Scenario 5 has the highest financial impact due to the costs associated with widening the corridor

7

Deliverability and Operations Case

Introduction

The Deliverability and Operations Case evaluates the project delivery considerations, procurement options, and constraints associated with project delivery and operations. It details the technical and institutional requirements to deliver the investment.

Project Delivery

- The delivery of the Queen Street – Highway 7 BRT should consider the following:
- **Governance** – including considerations on how additional Brampton Transit and YRT projects will interface with the BRT. The role of each transit operator, of Metrolinx, and of the cities will have to be determined for the project achievement.
- **Integrated Project Team** – including thoughts on how the project team could be set up and who will be part of it, for implementation of the BRT project.
- **Project Optimization** – including various considerations for optimizing the project such as refinements to the design, operations, service planning, and cost estimates. This project optimization will take place when following the next stages of the Business Case, accordingly to the Metrolinx Business Case Guidance (April 2019). Further refinement will be required, but is not limited to:
    - The technology choice for the BRT (diesel, hybrid, 100% electric);
    - The infrastructure options on the corridor which will have to be defined through detailed design;
    - The definition of the detailed transit service (routes and levels of service) to be operated;
    - The eventual terminals to be changed or implemented in order to support the defined BRT service (Downtown Brampton Terminal, Bramalea Terminal, VMC bus terminal), as well as the detailed design of any other eventual BRT infrastructure to be implemented on roads adjacent the BRT corridor;
    - The operational plan for the transit service, including the definition of type of procurement for transit operations; and
    - The required maintenance facilities for the transit fleet depending on the operational plan and the technology choice.
- **Environmental Impact Assessment** – identification of any need for Environmental Assessment requirements, such as for the Claireville Conservation Area.
- **Public and Stakeholder Consultation** – including potential approaches for further public and stakeholder consultation as the project and designs are developed.
- **Project Readiness** – including considerations for operational readiness of the project.

Operations and Maintenance Plan

A detailed operation plan will have to be defined, based on the detailed transit service that will be operated. A preliminary high-level transit service definition has been identified in the present IBC. Based on that service level, an operational and a maintenance plan will have to be defined, including for instance:

- Roles and responsibilities for operations and maintenance;
- Required changes in regulations or legislation;
- Human resource implications; and
- Materials and equipment needed.

Procurement

Conventional Design-Build

Conventional Design-Bid-Build (DBB) procurements are commonly used to deliver public infrastructure, where requirements are clearly defined, integration risks are low, and there are specific detailed requirements and therefore limited potential for design innovation. Private contractors are selected through a competitive tender process responding to a prescriptive specification. A more permissive Design-Build (DB) model is widely used where the output requirement is clearly defined, for example a road-rail grade separation, but there may be opportunity for innovation in the detailed design.

Design-Bid-Build (DBB), or traditional procurement, appears to be the most straight-forward approach to deliver the Queen Street – Highway 7 BRT. This approach is widely used on public transit projects in the GTHA and elsewhere.

Public-Private Partnerships (PPP)

PPP models include Design-Build-Finance (DBF) PPP models where contractors must finance work during construction with payment only on substantial completion. This motivates timely project completion. It also includes Design-Build-Finance-Maintain (DBFM) model that transfers responsibility for long term maintenance, and Design-Build-Finance-Operate-Maintain (DBFOM) model that also transfers responsibility for long term operations. PPP models can transfer delivery and whole life performance risks to the contractor. To the extent these risks are transferred, specifications can be less prescriptive and more performance-based. This incentivizes contractors to optimize their design and delivery approach to maximize long term benefits and minimize life cycle costs.

Given the integrated and interconnected nature of the Brampton Transit system and existing operation of the Züm network, Alternative Financing and Procurement (AFP) may be complex to arrange. However, the Queen Street – Highway 7 BRT could be considered an independently-operated transit route under an AFP model. Complexities would arise in attempting to reach arrangements related primarily to maintenance of common infrastructure (e.g. where stops serve both the BRT system and local Brampton Transit routes). Given these complexities and the nonstandard nature of an AFP model for public transit systems in the GTHA, a traditional procurement to build the infrastructure which would then be operated by Brampton Transit appears to be the most logical approach for the BRT.

Constraints

Physical constraints

The Queen Street – Highway 7 Corridor has a number of constraints along its length, including the following:

- Rail corridor crossings;
- Highway crossings;
- Natural features;
- Narrow rights of way; and
- Multi-jurisdictional road ownership.

These constraints may impact the deliverability and operation of the Queen Street – Highway 7 BRT but none preclude the project from advancing higher-order rapid transit in the corridor. In portions with overpasses and underpasses and where there are right of way width constraints, the ability to construct new dedicated transit infrastructure is more limited than elsewhere on the corridor, potentially requiring modifications to the operation method in these areas (i.e. operation in mixed traffic for limited sections) or right of way widening.

Through these portions of the Queen Street – Highway 7 Corridor, the present IBC has identified, per scenario, these constrained segments and has proposed different solutions for them in each scenario.

Multi-jurisdictional road ownership

Queen Street – Highway 7 is a multi-jurisdictional corridor. Queen Street between McMurchy Avenue and Highway 410 is owned by the City of Brampton. Queen St between Mississauga Rd and McMurchy Ave as well as between Highway 410 and Highway 50 is owned by the Region of Peel. At Highway 50, Queen Street becomes Highway 7 and is part of the York Region regional road network, owned by York Region, and runs through the City of Vaughan. Coordination between the four (4) municipalities will be required as conceptual and detailed designs progress for the BRT to ensure consensus on standards.

Minimizing throw-away costs (rebuilding recent improvements)

All parties involved in the Queen Street – Highway 7 BRT project have made some level of investment in the existing Brampton Transit/Züm infrastructure in Brampton, as well as Viva Rapidways on Highway 7 where the Queen Street – Highway 7 BRT will connect to YRT services.

Recent improvements to York Region and Brampton Transit assets that should be considered during the planning for the Queen Street – Highway 7 BRT include:

- **Bramalea Terminal,** located at approximately the midway point on the Queen Street – Highway 7 BRT at Central Park Drive, was refurbished and opened in fall 2010 in conjunction with the introduction of Züm service along Queen Street. The value of the refurbishment project was approximately $7.5M in 2009.
- **Helen Street Viva Station,** located at the eastern terminus of the Queen Street – Highway 7 BRT, which currently serves YRT Viva passengers.
- **Highway 7 BRT infrastructure** between Vaughan Metropolitan Centre TTC station and Helen Street. As of July 2019, the construction of this infrastructure is nearing completion. The design and operation of buses on this infrastructure, particularly the integration of the BRT service west of Helen Street with the future Queen Street BRT service, will be a key consideration.
- **New fleet vehicles** have been a key component of the Brampton Transit Business Plan, resulting in the modernization and expansion of the previous 299-vehicle fleet to 407 buses to increase capacity and improve customer service.
- **New technology solutions** including digital variable message signs at Züm stops, digital displays in Transit Service Centres, and investments in mobile applications to facilitate seamless transit ridership.

Vehicle Capacity constraints

The reduction in vehicle capacity identified in scenario 4 may constrain truck and goods movement across the corridor. However it should also be noted that without adequate transit infrastructure, increases in services will also impede traffic and goods movement. The extent of this will be determined in the preliminary design phase and assist in developing the final option.

Given the value of the investments and the level of public scrutiny associated with rapid transit investments and any large-scale infrastructure works, it is important to minimize throw-away costs during construction of the Queen Street – Highway 7 BRT. This ensures appropriate value for money is achieved for new infrastructure and that continued public and stakeholder support for the project is maintained.

Conclusion

Accordingly to the evaluations of the scenarios 4, 5 and 6 throughout the different criteria of the Deliverability and Operation Case, Table 44 shows a summary evaluation based on ranking of scenarios following a colour scheme (see Table 45). This ranking is based on the expected impacts and constraints of delivering the corridor, from an IBC perspective. Majority of this analysis was qualitative and a more detailed analysis will be completed in the next phases of work.

Table 44: Deliverability and Operation Case Summary of Scenarios 4, 5, and 6, IBC Queen Street – Highway 7 BRT

Criteria		2041 BAU	Scenario 4	Scenario 5	Scenario 6
Deliverability and Operations Case	Project delivery				
	Operations and Maintenance Plan				
	Procurement				
	Constraints				
	Summary				

Table 45: Legend for performance ranking of scenarios

Colour legend for performances (ranking):

Low performance
Medium performance - low
Medium performance - high
High performance

The Deliverability and Operations Case evaluation shows that Scenario 4 could have fewer constraints then Scenario's 5 and 6, mostly due to the impact of widening the right-of-way for these two scenarios.

8

Business Case Summary

Brampton Queen St- York Region Hwy 7 BRT Initial Business Case

The Brampton Queen Street – York Region Highway 7 corridor has been identified for future rapid transit investment through the implementation of a bus rapid transit (BRT) system. The evaluation for this Initial Business Case (IBC) for the Queen Street – Highway 7 BRT corridor has been conducted with the Metrolinx regional transportation model (GGHM_v4) and with the evaluation framework defined in the Metrolinx Business Case Guidance documentation (April 2019). The project was supported by a Metrolinx project team, Arup, and a project team with representatives from each of the main stakeholders: Brampton Transit, Region of Peel, City of Brampton, York Region and City of Vaughan.

The IBC has identified:

- A supportive BRT transit service scenario including: a BRT route and priority bus networks and their peak levels of service that maximize transit ridership across the study area. This service definition is a result of an optimization exercise between different transit service scenarios using the GGHM_v4 model; and
- Three possible infrastructure scenarios for the corridor, supporting the optimized transit service definition from the first stage of the IBC. The specific infrastructure scenarios are:
    - **Scenario 4: conversion of a traffic lane** per direction to **median BRT exclusive lanes** along the length of the Queen Street – Highway 7 Corridor, except in **Downtown Brampton** where one traffic lane per direction is converted to a **curbside BRT lane**, between McMurchy Avenue and Kennedy Road;
    - **Scenario 5: median BRT lanes** (one per direction) along the length of the Queen Street – Highway 7 Corridor as a result of **road widening** (retaining the current number of traffic lanes), everywhere except **Downtown Brampton** (Queen Street between McMurchy Avenue and Kennedy Road) where **lane conversion** is considered; and
    - **Scenario 6:** implementation of two (2) **median BRT lanes** on the corridor by adding a median BRT lane per direction as a result of **widening** the road where necessary, except in segments that are in the following **constrained** zones: Downtown Brampton (McMurchy Avenue to Centre Street); Delta Park Boulevard to Sun Pac Boulevard (crossing of CN rail tracks); Highway 410 crossing; Highway 427 crossing; and Kipling Avenue to Islington Avenue, where a **mixed traffic solution** is considered.
- Scenarios 4, 5, and 6 are evaluated in this IBC through 4 cases; Strategic Case, Financial Case, Economic Case, and Deliverability and Operation Case.

The Initial Business Case evaluation for the Brampton Queen Street – York Region Highway 7 BRT project supports the need for rapid transit infrastructure and service across the corridor. Overall, Scenarios 4 and 5 offer increased transit reliability and reductions in travel times, compared with scenario 6. All scenarios perform better than the BAU.

Summary of Initial Business Case Evaluation Results

Based on the evaluations made in the Strategic, Financial, Economic, and Deliverability and Operation Cases in the present IBC for the Brampton Queen Street – York highway 7 BRT, Table 46 illustrates the IBC evaluation summary, with a simple ranking method illustrated by a colour scheme. The following main elements can be highlighted on the IBC summary:

- **Strategic Case:** The Strategic Case indicates that the Queen Street – Highway 7 BRT performs well with respect to providing increased transportation choice; shaping growth in a sustainable manner and providing the means of reducing emissions from auto travel; and connecting commuters and students to jobs and education. Scenarios 4 (conversion of a traffic lane to a BRT exclusive lane) and Scenario 5 (the addition of BRT lanes through widening the corridor) perform better than Scenario 6 which had limited BRT infrastructure.
- **Financial Case:** The Financial Case indicates that Scenarios 4 and 6 perform most highly mainly because of their capital costs being much lower than Scenario 5, which includes costs of demolition and reconstruction of major infrastructure for widening the road (highway and rail crossings). Scenario 4 performs the highest from a financial perspective as it has the least financial impact.
- **Economic Case:** The Economic Case indicates a very high benefit/cost ratio (greater than 2) for all scenarios. Scenario 4 performs the highest in terms of benefit-cost ratio while Scenario 5 performs the highest in terms of NPV. These two scenarios give the transit priority (exclusive lanes) to transit and Scenario 4 is the less expensive of the two scenarios in terms of capital costs.
- **Deliverability and Operations Case:** The Deliverability and Operations Case indicates that Scenario 4 is likely the highest performer in terms of deliverability as it presents fewer physical constraints during the construction process through conversion of a lane instead of widening the corridor. Scenario 5 requires the most substantial construction (reconstruction of constrained segments) and Scenario 6 has fewer constraints to manage during construction (due to minimal construction in constrained zones) but more during operations as mixed traffic operations will result in vehicular congestion for all road users.

Table 46 summarizes the IBC evaluation for the Queen Street – Highway 7 BRT project.

Table 46: Initial Business Case Summary of Scenarios 4, 5, and 6 for the Queen Street – Highway 7 BRT project

Initial Business Case	**2041 BAU**	**Scenario 4**	**Scenario 5**	**Scenario 6**
Strategic Case				
Financial Case				
Economic Case				
Deliverability and Operations Case				
Summary				

Table 47: Legend for performance ranking of scenarios

Color legend for performances (ranking):

Low performance
Medium performance - low
Medium performance - high
High performance

As a whole, results of the Initial Business Case evaluation for the Brampton Queen Street – York Region Highway 7 BRT project show that Scenarios 4 and 5 provide greater transit benefits than Scenario 6. The provision of dedicated transit infrastructure across the entire corridor increases transit reliability and reduces transit travel times than Scenario 6 which provides less dedicated infrastructure. All scenarios perform better than the BAU which confirms a need for BRT across the corridor.

Figure 77 identifies the next steps of the project as it enters the preliminary design phase. The project is expected to follow the Metrolinx Business Case Framework and Benefits Management process. The results of this IBC will be used as a basis for developing the scope of work for the Preliminary Design Business Case. The options presented in this IBC will be further refined to establish a preliminary design, benefits of the project as well as a more detailed cost estimate. Extensive stakeholder and public consultation will also be part of this process. Development of the Preliminary Design Business Case will include some of the following:

- Further refinement of the transit services and operations:
  - Adjustments/refinements to transit routes that feed the BRT routes such as changing the Bus Priority Routes defined for Scenarios 4, 5, and 6 and adding or removing such routes based on further analysis of overall accessibility for major origin and destination points such as York University and Pearson Airport;
  - Define levels of service for weekday PM and weekend periods for each route defined (in addition to the AM peak period which has been defined through this IBC);
  - Investigate and choose a BRT technology to operate (diesel, hybrid, or electric);
  - Evaluate fleet, maintenance, and facility needs for the operation of the transit service;
  - Define the operational plan for the transit service, including the definition of type of procurement for transit operations; and
  - Define the required changes to transit services that will feed the BRT (local Brampton Transit and York Region Transit networks).
- Preliminary design of BRT infrastructure and option development:
  - Continue into preliminary design of the corridor including detailed analyses to determine the appropriate ROW and lane configuration for the corridor, using Scenarios 4 and 5 as a baseline for this work;
  - Additional analysis required regarding the implication for removing or retaining current traffic capacities along Queen St, including understanding the implications of the movement of goods across the corridor;
  - Test multiple BRT solutions for the following constrained zones:
    - Downtown Brampton from McMurchy Avenue to Centre Street;
    - Delta Park Boulevard to Sun Pac Boulevard (crossing of CN rail tracks);
    - Highway 410 crossing;
    - Highway 427 crossing;
    - Kipling Avenue to Islington Avenue;
    - In front of Bramalea City Centre;
    - McVean Drive and Gore Road (where the corridor crosses the Claireville Conservation Area); and
    - Queen Street between Kennedy Road and Hansen Road.
  - Solutions that have the potential to further optimize costs and efficiency that can be tested on these segments with the help of other tools including meso- or micro-simulation traffic tools, include:
    - Queue jump lanes and bus priority measures for buses at intersections;
    - Transit signal priority;
    - Use of a reversible BRT lanes in certain constrained segment with traffic lights for buses; and
    - Conversion of traffic lanes to BRT lanes.

- Define the terminal facilities required or changes to existing facilities to be implemented in order to support the corridor including Brampton bus terminal, and Bramalea Bus Terminal; and

- Identify and define the detailed design required for any other bus preferential measures to be implemented on adjacent roads to the BRT corridor if required.

Planning Phase	Metrolinx Business Case Requirement	
Strategic Planning	Strategic Planning	We are here
Options Analysis	Initial Business Case	
Preliminary Design	Preliminary Design Business Case	
Design and Procurement Preparation	Full Business Case	
Procurement	Full Business Case - updated (if required)	
Construction, Commissioning and Delivery		
In Service	Post In-Service Business Case	

Figure 77: Project phases

Glossary of Terms

AACEi	Association for the Advancement of Cost Engineering International
AFP	Alternative Financing and Procurement
BAU	Business as Usual
BCR	Benefit Cost Ratio
BRT	Bus Rapid Transit
CN	Canadian National Railway
DBB	Design-Bid-Build
DBB	Design-Build
FRTN	Frequent Rapid Transit Network
GGHM	Greater Golden Horseshoe Model
GP (lane)	General Purpose Lane
GTHA	Greater Toronto and Hamilton Area
IBC	Initial Business Case
LOS	Level of Service
NPV	Net Present Value
OD	Origin-Destination
PPP	Public Private Partnership
ROW	Right-of-way
RTP	Regional Transportation Plan
TTC	Toronto Transit Commission
TTS	Transportation Tomorrow Survey
VKT	Vehicle Kilometres Travelled
VMC	Vaughan Metropolitan Centre
YRT	York Region Transit