METROLINX

DURHAM-SCARBOROUGH BUS RAPID TRANSIT STUDY

INITIAL BUSINESS CASE REPORT

IBI

Prepared for Metrolinx
by IBI Group

Spring 2018

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Executive Summary

Introduction

The Highway 2 BRT corridor is a crucial transportation corridor connecting people through the Region of Durham and Scarborough. With rapid growth in the past decade and an expectation for this growth to continue into the future, demand for travel along the corridor will continue to increase and a higher capacity form of transit will be needed to link communities and employment on both sides of the Toronto-Durham boundary.

The 2041 Regional Transportation Plan for the Greater Toronto and Hamilton Area (2041 RTP) identifies the Durham-Scarborough BRT as an In Development project, with advanced stages of planning and design, and required to meet the needs of the region in the near term. The project forms a key part of the 2041 Regional Frequent Rapid Transit Network (FRTN) that will ensure:

- Frequent 15-minute headway or better service, all day, seven days a week;
- Reliable service due to separation from traffic and signal priority measures;
- High speeds due to wide spacing of stops; and
- Efficient transfers between routes, enabling a traveller to get anywhere in the GTHA easily and reliably without looking at a schedule.

Advancing In Development projects, which include the Durham-Scarborough BRT, is a priority in the 2041 RTP, as captured in Strategy 1: Complete the Delivery of Current Regional Transit Projects, and Strategy 2: Connect More of the Region with Frequent Rapid Transit through the FRTN, as noted above.

The province, through Metrolinx, has committed $10 million in funding to finalize the planning and design of the corridor, including TPAP preparation and approval.

Study Overview

Method of Analysis

Metrolinx has undertaken this Planning Study and Initial Business Case (IBC) in partnership with the Region of Durham, Durham Region Transit (DRT), the City of Toronto, and the Toronto Transit Commission (TTC) to identify a preferred rapid transit corridor between Durham Region and the City of Toronto.

The Metrolinx Business Case Approach has been applied to the Durham Scarborough BRT Project. It sets out the rationale for why an investment should be implemented to solve a problem or address an opportunity. Business Cases provide evidence to decision-makers, stakeholders and the public as a crucial part of transparent and evidence-based decision making processes.

The rapid transit alternatives analyzed in this IBC include:

- Centre Median BRT;
- Curbside BRT; and
- Hybrid BRT alternative, combining dedicated transit lanes in the centre median or curbside, and transit priority measures in constrained locations.

The business case approach evaluates rapid transit alternatives according to four cases to understand the benefits, costs and impacts of a transportation investment. The four cases of this evaluation are:

- **Strategic Case** – addresses how a project achieves transportation objectives; establishes 'how the project will change the way people move throughout the region';
- **Financial Case** – assesses the capital and resource requirements; establishes 'how much the project will cost' in financial terms;
- **Economic Case** – assesses the economic cost and benefits of the proposal; establishes 'what the benefit to society' is in economic terms; and
- **Deliverability and Operations Case** – provides evidence on the feasibility and constructability of project options and considers risks; establishes 'what is required to deliver and operate' the project.

Rapid transit alternatives are evaluated against an identified base case. The base case for this IBC assumes the existing DRT PULSE service that currently operates along the corridor between Downtown Oshawa and the University of Toronto Scarborough Campus (UTSC) in predominately mixed-traffic conditions, with the exception of curbside operations in selection locations along the corridor in Durham Region.

Rapid Transit Alternatives Development and Recommendations

The BRT service concepts were developed under an integrated service delivery approach of TTC, DRT and GO Transit bus operations. They were developed based on the service levels required to meet the demand of the corridor in 2041, and maximizing benefits to the existing service networks in Durham Region and the City of Toronto. The service concepts assumed fare integration.

The BRT infrastructure and service recommendations include:

- BRT Routing Options – the existing 'PULSE' route between Highway 2 and Ellesmere Road, with an extension to Scarborough Centre.
- BRT Service Options – combining features of trunk services and branched services across the corridor. This concept best meets forecasted passenger demand along the corridor, and provides increased connectivity to destinations adjacent to the BRT corridor in both the City of Toronto and Durham Region.
- BRT Right-of-way Options – a mix of centre median, curbside and mixed traffic with queue jump lane in strategic locations was adopted in the development of the business case alternatives.
- BRT Stop Spacing/Location – an average station spacing of 700-800 m was adopted.

A map of the preferred service concept is provided in Exhibit E.2

Opportunities for future connections to the Lakeshore East GO Rail extension to Bowmanville and to Smart Track/RER services along the Stouffville GO Rail Line were not included in the analysis for this IBC; however, they are an important consideration for the Preliminary Design Business Case.

Ridership

Ridership forecasts to the year 2041 were generated using the Greater Golden Horseshoe Model v4 (GGHM v4) used by Metrolinx. Forecasts were generated for the 2041 base case and with full BRT implementation between downtown Oshawa and Scarborough Centre.

All three BRT alternatives shows significant ridership increases along the corridor with the implementation of rapid transit, relative to the base case alternative. The Centre Median and Hybrid alternatives generate more ridership than the Curbside alternative. The 2041 a.m. peak corridor ridership is summarized in Exhibit E.1.

Exhibit E.1: 2041 AM 2-hour Peak Period BRT Corridor Ridership

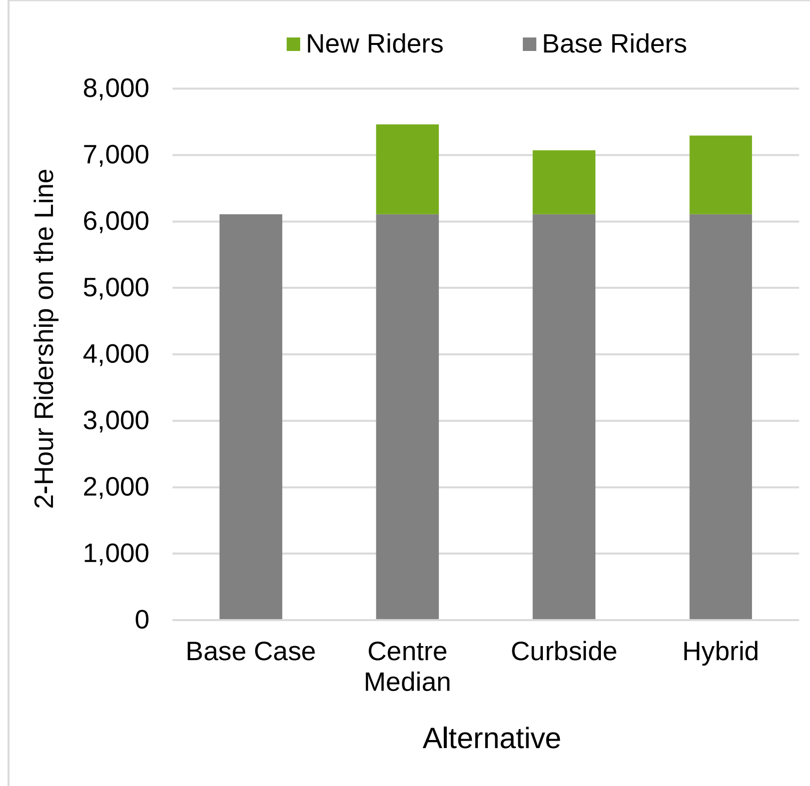
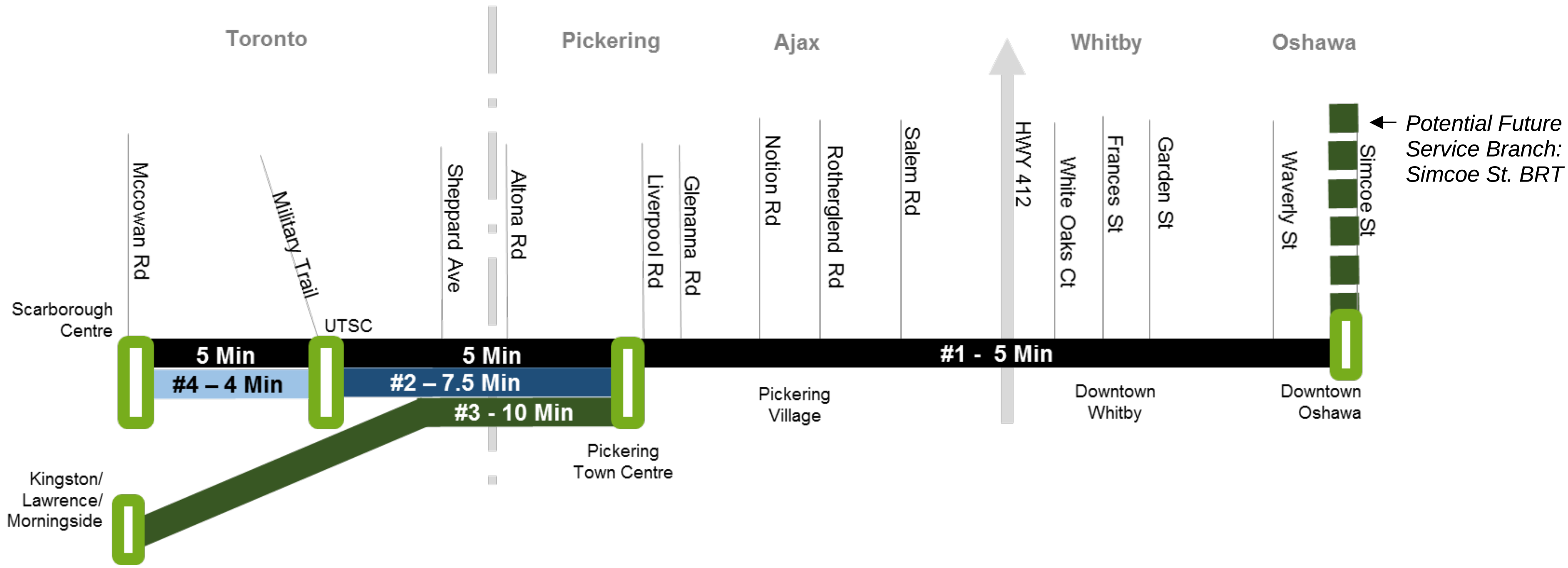


Exhibit E.2: Recommended Service Concept



Business Case Results

The Centre Median and Hybrid alternatives performed higher in the business case evaluation than the Curbside alternative. Both these alternatives show significant benefit to providing BRT infrastructure along the corridor to better connect the Region of Durham and Scarborough.

A summary of the business case results is provided in Exhibits E.3 and E.4.

The Hybrid alternative, shown in Exhibit E.5, recommends a combination of centre-median and curbside BRT infrastructure, as well as transit priority measures in constrained locations. This approach optimizes the value of investment by considering what right-of-way treatment is most suited for the context of each corridor segment. The Hybrid and Centre Median are the best performing alternatives, with the Hybrid alternative having a higher benefit-cost ratio (BCR) and lower capital cost. It reflects that curbside operations is preferred over centre median operations in the Oshawa section of the corridor where there is a one-way road couplet operation, and centre median operations is preferred in the east section with higher ridership and ability to provide centre-median bus lanes.

It is recommended that the Hybrid alternative be carried through to the Preliminary Design Business Case.

Exhibit E.3: Summary of Business Case Evaluation

	Centre Median	Curbside	Hybrid
Strategic Case			
People	✓✓✓✓✓✓	✓✓✓✓	✓✓✓✓✓
Places	✓✓✓	✓✓	✓✓✓
Prosperity and Resilience	✓✓✓✓✓	✓✓✓✓✓	✓✓✓✓✓✓
Financial and Economic Case			
Total Economic Benefits ($PV Millions)	$723	$606	$686
Operating Costs ($PV Millions)	$75	$97	$84
Capital Costs ($PV Millions)	$496	$439	$450
Total Costs ($PV Millions)	$571	$536	$533
Net Present Value ($ Millions)	$153	$69	$153
BCR	**1.27**	**1.13**	**1.29**
Deliverability and Operations Case			
Deliverability and Operations	✓	✓✓	✓✓✓

Exhibit E.4: Project Costs and Benefits Summary- Hybrid Alternative

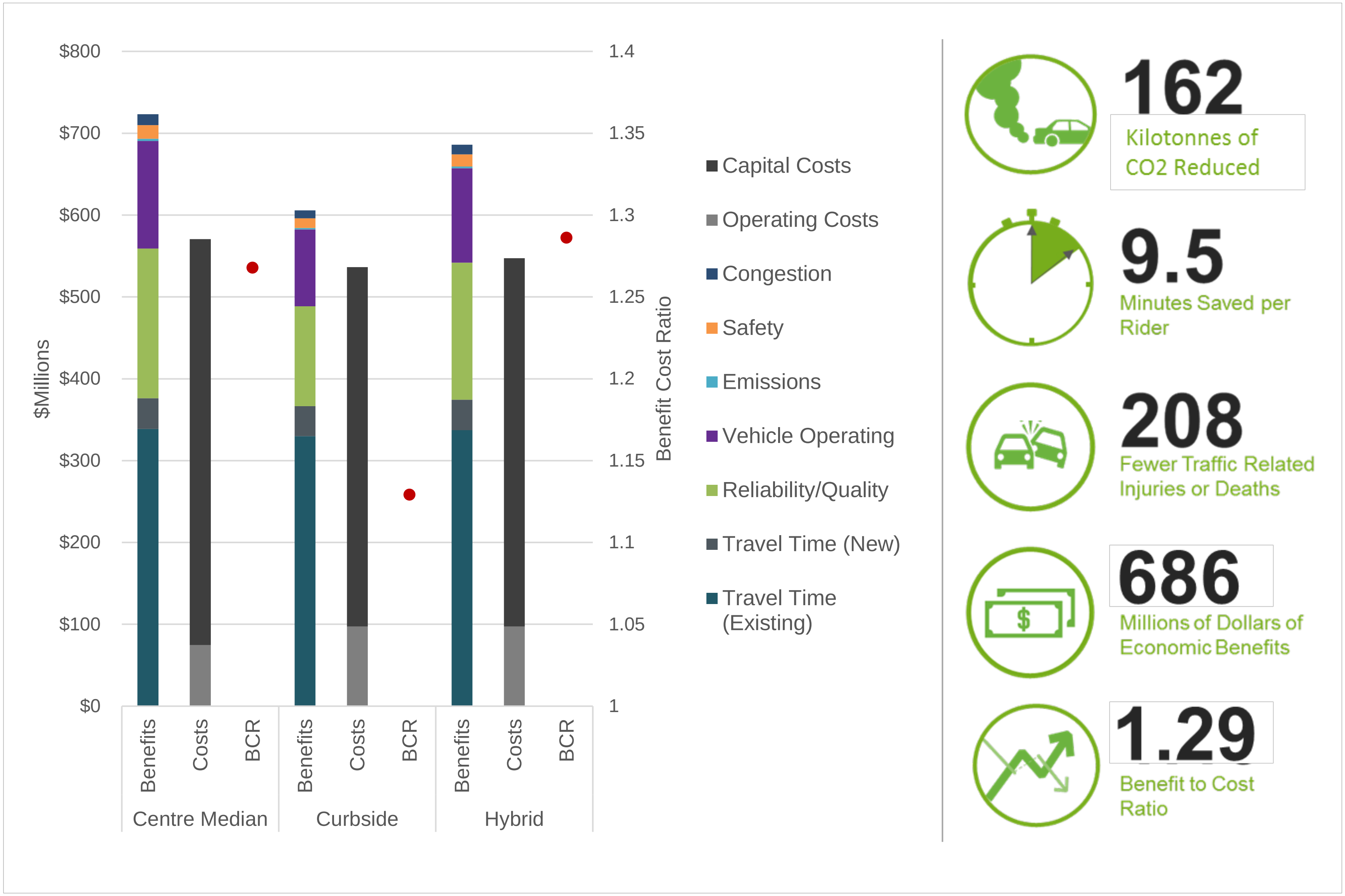
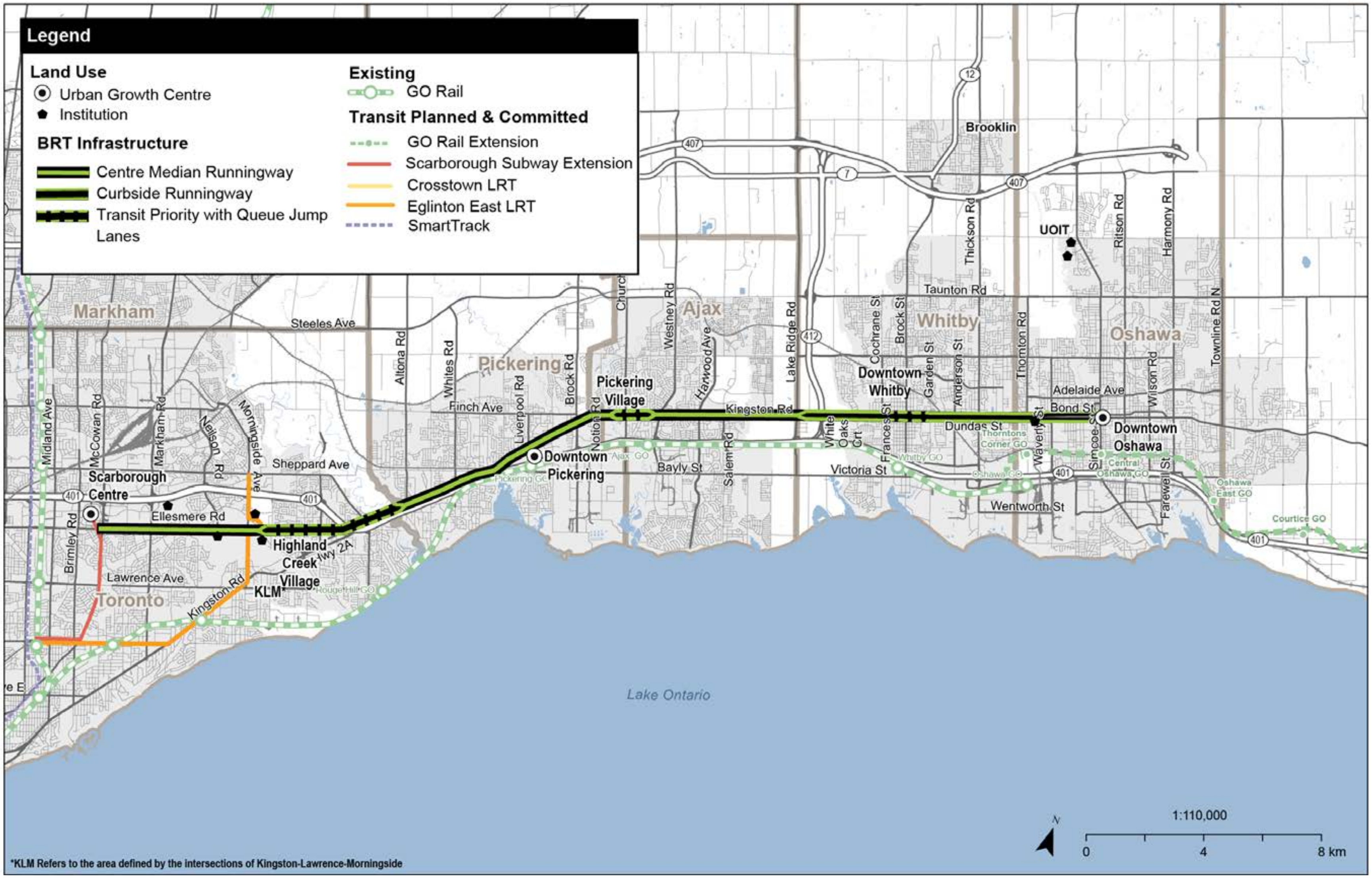


Exhibit E.5: Hybrid Alternative Concept



Problem and Opportunity Statement

The Highway 2 BRT corridor is a crucial transportation corridor connecting people through the Region of Durham and Scarborough. The corridor has varied traffic, land use conditions and constraints. With rapid growth in the past decade and an expectation for this growth to continue into the future, demand for travel along the corridor will continue to increase and a higher capacity form of transit will be needed to link communities and employment on both sides of the Toronto-Durham boundary.

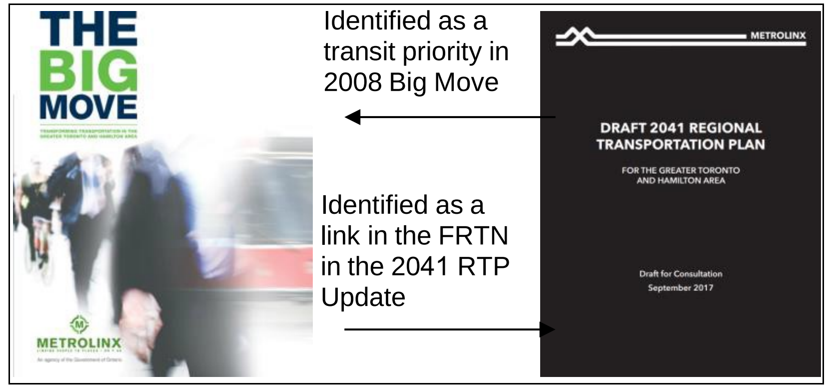
1 Introduction

1.1 Background

The Greater Toronto and Hamilton Area's Regional Transportation Plan, The Big Move, was adopted in 2008 and set out a 25-year vision for supporting growth in the region. It put forward policies and programs that advance the sustainable movement of people and goods across the region and identified needed investments in building regional rapid transit, including the transformation of the GO Transit service to Regional Express Rail (RER), and new subways, Light rail transit (LRT) and Bus rapid transit (BRT). The Big Move recognized the Durham-Scarborough corridor as a priority 'Next Wave' project.

The 2041 Regional Transportation Plan (RTP) for the Greater Toronto and Hamilton Area was approved in March 2018 and identifies the Durham-Scarborough BRT as a priority In Development project in advanced stages of planning and design. The project forms a key part of the 2041 Regional Frequent Rapid Transit Network (FRTN) that will ensure:

- Frequent 15-minute headway or better service, all day, seven days a week;
- Reliable service due to separation from traffic and signal priority measures;
- High speeds due to wide spacing of stops; and
- Efficient transfers between routes, enabling a traveller to get anywhere in the GTHA easily and reliably without looking at a schedule.



Advancing key In Development projects, including the Durham-Scarborough BRT, is a priority action key in the 2041 RTP, captured in Strategy 1: Complete the Delivery of Current Regional Transit Projects, and Strategy 2: Connect More of the Region with Frequent Rapid Transit through the FRTN.

The province, through Metrolinx, has committed $10 million in funding to finalize the planning and design of the corridor, including TPAP preparation and approval.

1.2 The Metrolinx Business Case Framework

This Planning Study and Initial Business Case will identify the highest performing alternatives to provide a BRT connection between Durham Region and the City of Toronto, through an evaluation of the strategic, economic, financial, and deliverability and operations needs and impacts of each alternative:

- **Strategic Case** – addresses how a project achieves transportation objectives; Establishes 'how the project will change the way people move throughout the region';

- **Financial Case** – assesses the capital and resource requirements. Establishes 'how much the project will cost' in financial terms;
- **Economic Case** – assesses the economic cost and benefits of the proposal; Establishes 'what the benefit to society' is in economic terms;
- **Deliverability and Operations Case** – provides evidence on the feasibility and constructability of project options and considers risks; Establishes 'what is required to deliver and operate' the project.

The IBC is mandatory for all major Metrolinx capital projects and programs at or above $50 million. Recommendations from this IBC will be taken through to the next phase of work, the Preliminary Design Business Case (PDBC). The PDBC will refine the preferred alternative and project costs to secure funding for procurement and construction. The PDBC will also prepare the project for an Environmental Assessment or Transit Project Assessment Process (TPAP) to be undertaken. These studies are then updated to produce a full business case, in preparation for construction and operation of the BRT corridor.

1.3 Corridor History

A rapid transit corridor connecting Durham Region and Scarborough was first proposed in 2007 in response to federal and provincial funding programs to improve mobility in the GTHA. This resulted in the province providing $82.3 million to Durham Region to support the introduction of the PULSE BRT service between Oshawa and the University of Toronto Scarborough Campus (UTSC), Durham Region Transit (DRT) commenced operations of PULSE along Highway 2 in Durham and Kingston Road and Ellesmere Road in Toronto in June 2013 with high-frequency, high-speed service, operated with new buses, facilities, road and traffic improvements, upgraded stops and branded shelters.

The Region's 2010 Long Term Transit Strategy (LTTS) confirmed a rapid transit corridor in the Highway 2 corridor, connecting to Scarborough Centre via Ellesmere Road. The Metrolinx Durham-Scarborough Bus Rapid Transit Benefits Case was also completed in 2010 and concluded that the project would generate significant transportation, environmental and socio-economic benefits.

Durham Region has continually invested in transit priority along the Highway 2 corridor, with LTTS Phase 1 improvements implemented through the Highway 2 Transit Priority Measures Environmental Assessment (completed 2012, amended 2014). This has resulted in Curbside bus lane operations and transit signal priority along three sections of Highway 2; in Ajax (from Harwood Avenue to Salem Road) and Pickering (from west of Liverpool Road to Glenanna Road), and around Brock Road. Westney Road in Ajax and Whites Road in Pickering are under construction to be completed in 2018.

Within the City of Toronto, Ellesmere Road, between Scarborough Centre and the Toronto-Durham border, has been identified as a higher order rapid transit corridor. Local and express TTC bus service is provided, and, west of Military Trail, the transit service is part of the TTC's Ten Minute Network.

1.4 Study Overview

1.4.1 Study Need

The Highway 2 BRT corridor is a crucial transportation corridor connecting people through the Region of Durham and Scarborough. The corridor has varied traffic patterns, land use conditions and physical constraints. Rapid growth in the past decade has increased travel demand across the Toronto-Durham boundary and as growth continues into the foreseeable future, the resulting increase in demand for travel along the study corridor will require a higher capacity form of transit to link communities and employment on both sides of the Toronto-Durham boundary.

Studies and investment to date in the Durham-Scarborough corridor represent important first steps towards a robust and continuous rapid transit corridor. Finalizing the corridor, through a business case which identifies the long term benefits and costs is required before a preferred alignment can be taken to preliminary design and presented for approval.

Recent changes to transit planning that may influence the evolution of the corridor and considered as part of this study include

- Eglinton East LRT (EELRT) implementation;
- Scarborough Subway Extension implementation;
- Lakeshore East GO RER implementation;
- New priority transit corridors in Durham Region and Scarborough (as identified in the 2017 Durham Transportation Master Plan and Metrolinx 2041 RTP); and,
- In progress planning studies for UTSC and Scarborough Centre transit facilities.

Lessons learned from the current PULSE, other BRT systems, recent transportation, land use and operational data for the corridor; provide the opportunity to enhance the understanding of a rapidly-evolving and complex corridor.

1.4.2 Method of Analysis

Metrolinx has undertaken this Planning Study and Initial Business Case (IBC) in collaboration with the Region of Durham, DRT, the City of Toronto, and the TTC to identify the highest performing BRT alternative between Durham Region and the City of Toronto. Three BRT alternatives were considered in the evaluation against an established ‘base case’:

- Centre Median BRT operations;
- Curbside BRT operations; and
- Hybrid alternative, combining centre median and curbside BRT operations and transit priority measures in constrained locations.

The Base Case assumes the existing DRT PULSE service that currently operates along the corridor between Oshawa and UTSC in predominately mixed-traffic conditions, with the exception of curbside operations in selection locations along the corridor.

This IBC considers a 30-year planning period, with a 2041 horizon year used for forecasting and analysis purposes and benefits accumulating to the year 2058.

1.5 Corridor Description

The Durham-Scarborough BRT will provide a rapid transit connection between Durham Region and the City of Toronto, enhancing intra-regional mobility and connecting residents and employment across both sides of the boundary. The BRT will connect local and regionally significant areas including:

- Provincially-designated Urban Growth Centres (UGC's) of Scarborough Centre; Downtown Pickering and Downtown Oshawa;
- University of Toronto Scarborough Campus (UTSC);
- Trent University (Oshawa Campus);
- University of Ontario Institute of Technology (UOIT) (Oshawa Campus);
- Downtown Whitby and Downtown Oshawa;
- Scarborough Centre; and
- TTC subway service at Scarborough Centre (Line 2) and future LRT connection at UTSC (Eglinton East LRT).

The study area identified for this IBC is defined by traffic analysis zones within a 2 km buffer on each side of the BRT corridor, and shown in Exhibit 1.1. The BRT corridor is approximately 36 km in length between Downtown Oshawa (Simcoe St) and Scarborough Centre. Scarborough Centre is the assumed terminus point for the Durham-Scarborough BRT for IBC purposes, but connections further westbound to future SmartTrack/GO RER services on the Stouffville Rail Line are possible.

1.5.1 Durham Region Section

The corridor is referred to as Kingston Road in Ajax and Pickering, Dundas Street in Whitby, and King and Bond Streets in Oshawa. The roadway cross-section is typically 4 lanes for general traffic across Durham Region, but operates as a one-way couplet in Downtown Oshawa. The corridor is urbanized through most of its length, with the exception of a 3.5 km stretch of low density rural land uses between Salem Road and Highway 412 in Ajax. Even in this area, however, there are some trip attractors, most notably Ajax Downs and Casino Ajax. The historic downtown areas of Pickering Village, Downtown Whitby and Downtown Oshawa represent unique challenges in implementing BRT infrastructure within the corridor right- of-way. There are also two CN Rail bridge crossings of Highway 2 located in Pickering and at Pickering Village in Ajax that may present physical challenges to BRT implementation at these locations. Maintaining reliability of the BRT corridor through these sections will be important to the overall success of the project.

1.5.2 City of Toronto Section

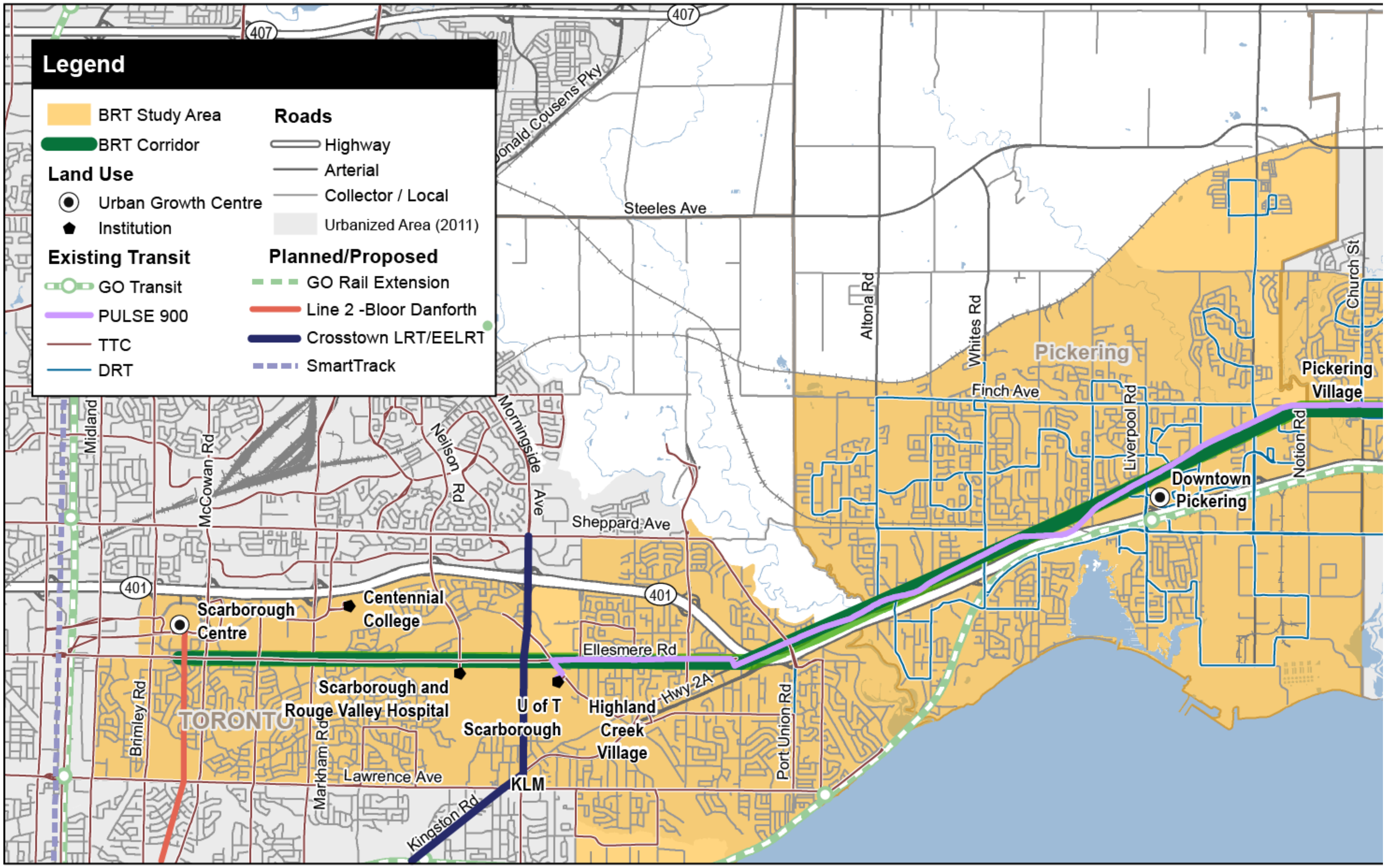
The corridor in the City of Toronto extends from the Durham-Toronto boundary to Scarborough Centre predominantly along Ellesmere Road, as recommended in previous Durham- Scarborough BRT studies, and the 2041 RTP.

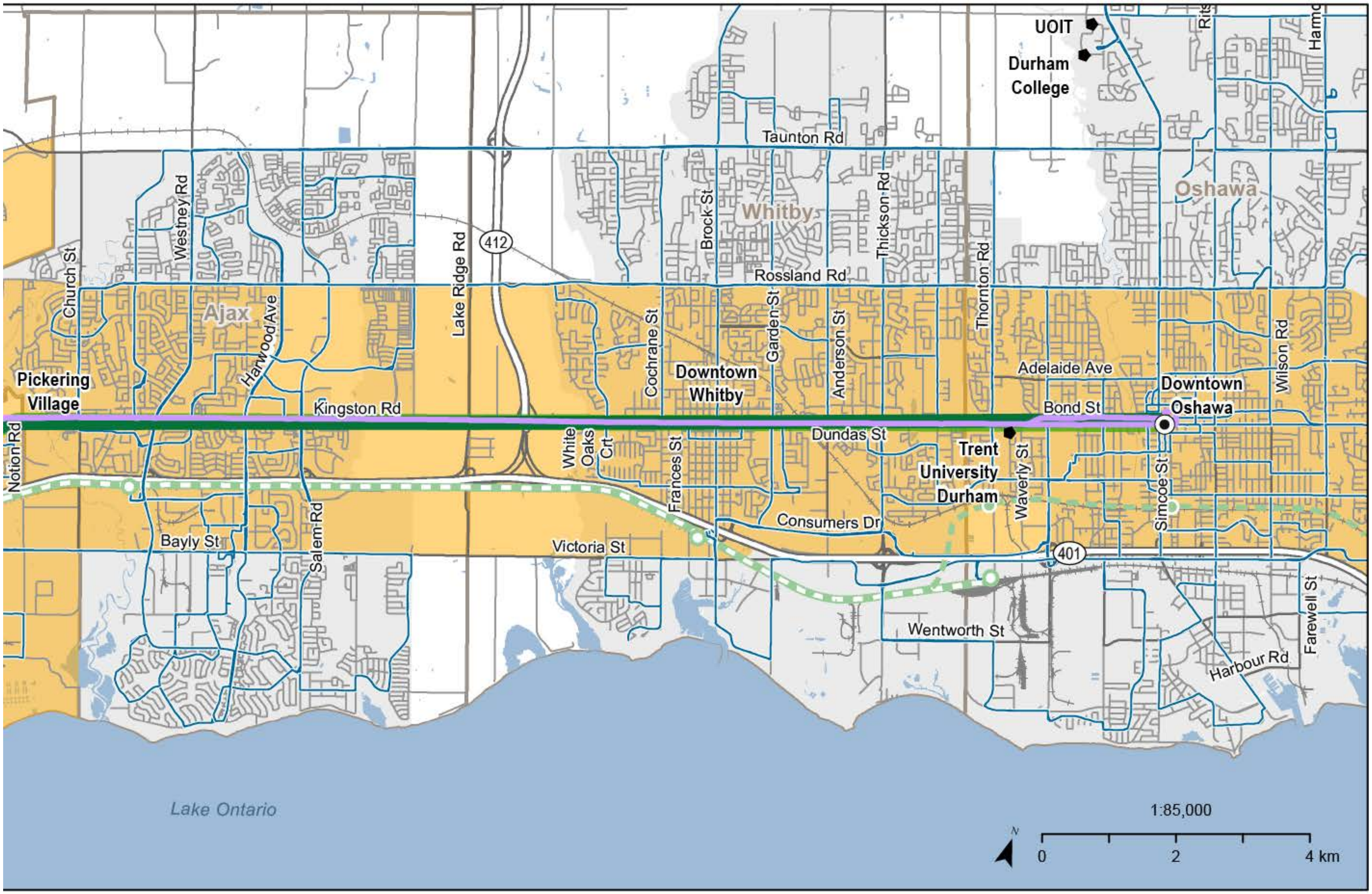
Westbound from the Toronto-Durham Boundary, the corridor connects to Ellesmere Road from Kingston Road. Between the boundary to UTSC, the corridor comprises of stable residential neighbourhoods with a wide 2-lane cross section.

Between UTSC and Scarborough Centre, Ellesmere Road includes commercial and residential development with a 4/5-lane roadway cross-section.

In addition to the Ellesmere Road, the study area for this IBC was extended to encompass the Kingston Road/Morningside Avenue/Lawrence Avenue area, reflecting recent initiatives by the City of Toronto to advance the Eglinton East LRT, and the potential to support growth and development at Highland Creek Village. This extension is considered in this IBC as part of a future service initiative, to maximize potential benefits obtained from BRT infrastructure along Ellesmere Road and resulting changes to bus services to provide better service across the network.

Exhibit 1.1: Area Context Map




UOIT
Durham College
Taunton Rd
Oshawa
Whitby
Westney Rd
Church St
Brock St
Thickson Rd
Thornton Rd
Lake Ridge Rd
412
Rossland Rd
Ajax
Harwood Ave
Garden St
Anderson St
Cochrane St
Adelaide Ave
Wilson Rd
Pickering Village
Downtown Whitby
Downtown Oshawa
Kingston Rd
Bond St
Dundas St
Notion Rd
White Oaks Crt
Frances St
Trent University Durham
Waverly St
Simcoe St
Consumers Dr
Salem Rd
Bayly St
Victoria St
401
Wentworth St
Harbour Rd
Farewell St
Lake Ontario
1:85,000
0
2
4 km

2 Corridor Context

2.1 Planning Context

The BRT Corridor has undergone significant study over the past decade, with numerous corridor-related studies and provincial and regional investments made in recent years.

The Durham-Scarborough BRT is considered a priority In Development project under the 2041 RTP. It is also identified in the Durham Transportation Master Plan as an integral part of the Region of Durham's 2031 Higher-Order Transit Network, operating as a BRT between Simcoe St and the Durham-Toronto boundary with an assumed connection to Scarborough Centre.

Within the City of Toronto, Ellesmere Road is considered a higher-order transit corridor, with an expected BRT connection into Scarborough Centre. The corridor is also included within the Scarborough Centre Transportation Master Plan currently underway, and planned Scarborough Subway Station and bus terminal design.

A summary of these studies and initiatives to provide an overall planning context for the corridor is presented in Appendix A.

2.2 Land Use

2.2.1 Corridor Overview

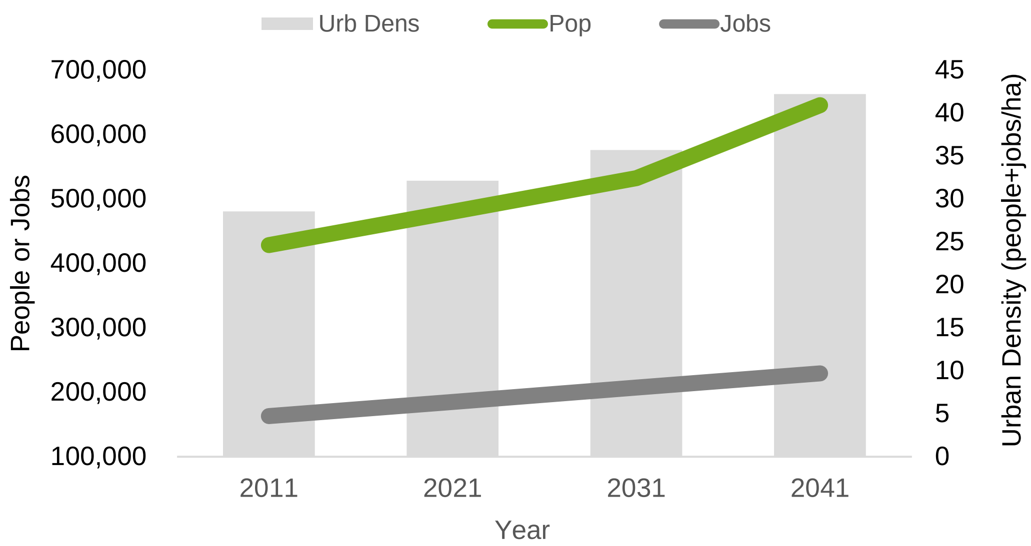
The corridor serves local and regional significant areas, has a diverse mix of land uses, including residential neighbourhoods, "big-box" retail centres, industrial employment lands, institutional lands, downtown heritage areas and agricultural lands.

Significant population and employment growth is expected in the corridor in the next 25 years. Based on the Metrolinx 2041 model forecasts, the corridor is expected to host approximately 215,000 more residents and 66,000 more jobs corresponding to a 51% and 41% increases, respectively. This growth[1] is graphed in Exhibit 2.1.

This increase in residents and jobs along the corridor results in a 48% increase in urban density, as corridor density is forecasted to reach 42 persons + jobs/hectare, increasing from 29 in 2011. It should be noted that this value represents an average across the study area and much higher densities, exceeding 80 persons + jobs/hectare will exist in Scarborough, Downtown Pickering, Ajax, Downtown Whitby and Downtown Oshawa. The year 2041 population and employment density is mapped in Exhibit 2.2. The growth areas mentioned above and described in more detail below are especially noticeable on this map.

[1] Based on the 2041 'Market Scenario' as identified in the RTP.

Exhibit 2.1: Population and Employment Forecasts in the BRT Study Area to the Year 2041



51%

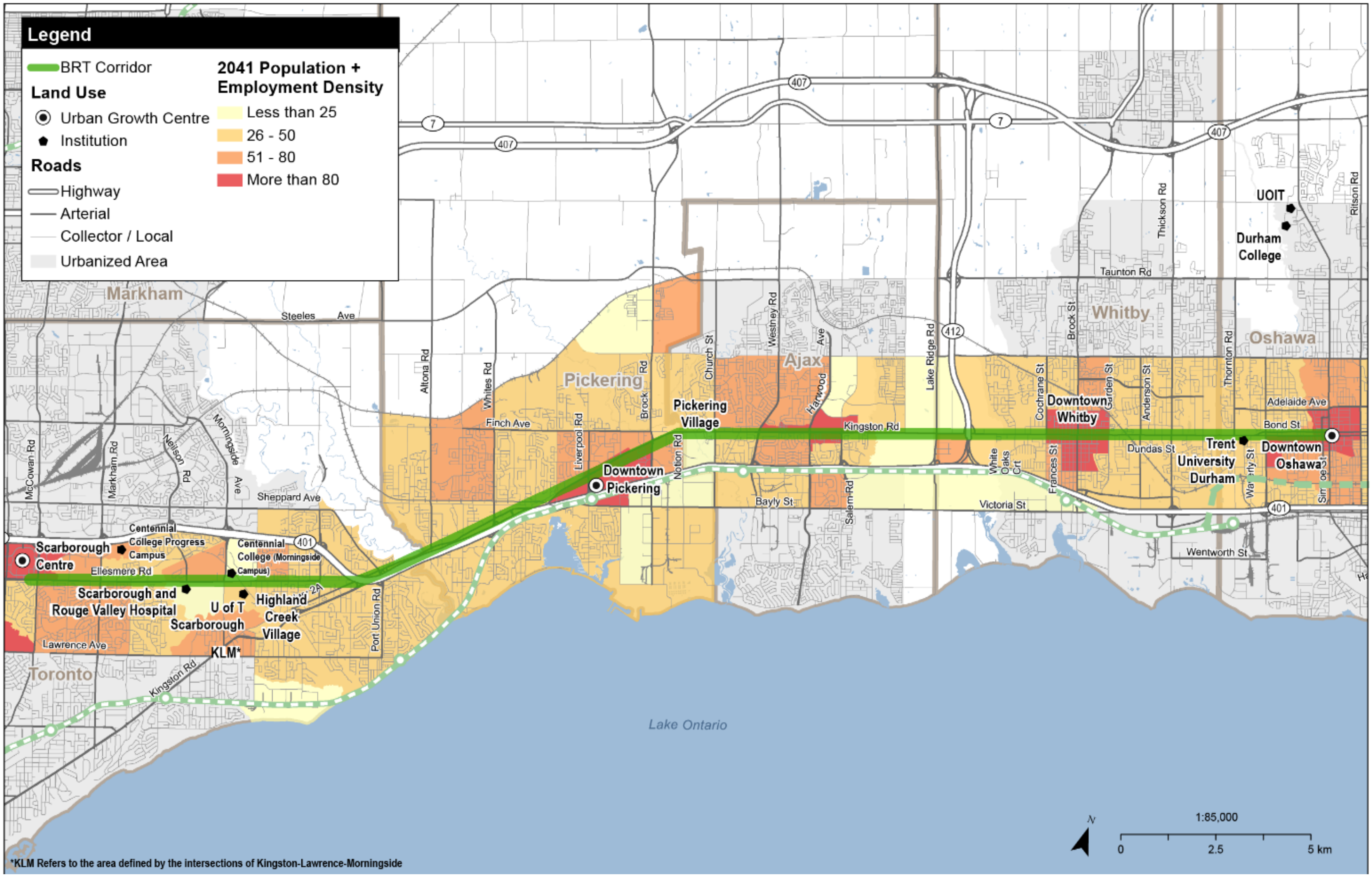
Population Growth From 2011-2041

41%

Employment Growth From 2011-2041

Source: GGHM v4

Exhibit 2.2: 2041 Population and Employment Density in the BRT Study Area



Source: GGHM v4

2.2.2 Downtown Pickering

Downtown Pickering is a provincially-designated UGC and Metrolinx Mobility Hub, with an urban density target of 200 combined persons and jobs per hectare by 2031, as outlined by the Growth Plan for the Greater Golden Horseshoe. This level of density will be achieved through a built form vision which will encourage high density development along Kingston Road, around Pickering Town Centre, and around the Pickering GO Station.

Based on the Metrolinx 2041 forecasts, the traffic analysis zones around Downtown Pickering are projected to increase by 33,000 persons and jobs between 2011 and 2041 density is expected to surpass the Growth Plan targets.

The growth has already started to take shape around Downtown Pickering, as the population has increased by 10% between 2009 and 2014.

2.2.3 Downtown Oshawa

Downtown Oshawa is a provincially designated UGC and Metrolinx Mobility Hub with an urban density target of 200 combined persons and jobs per hectare by 2031.

As outlined by Downtown Oshawa Urban Growth Centre Community Improvement Plan 2016, the area will undergo a transformation with intensified mixed use development and the institution of a Business Improvement Area.

Based on the Metrolinx 2041 forecasts, the traffic analysis zones around Downtown Oshawa are projected to host 20,000 new persons and jobs between 2011 and 2041 and density is expected to surpass the 2031 Growth Plan density targets.

2.2.4 Scarborough Centre

Scarborough Centre is a provincially-designated UGC and Metrolinx Mobility Hub, and will undergo a significant intensification of residents and jobs into 2031 and beyond. Based on Metrolinx 2041 forecasts, the traffic analysis zones surrounding Scarborough Centre are projected to increase by 29,000 persons and jobs between 2011 and 2041. This growth has already started to take shape as the population increased by 18% between 2009 and 2014.

While TTC subway, bus and the Scarborough RT services are available within Scarborough Centre, 81% of people that access the Scarborough Centre Mobility Hub in the 3-hour a.m. peak period drive. The BRT corridor will provide additional connections between residential, employment and educational facilities within Scarborough, and be crucial in achieving increases in transit mode shift.

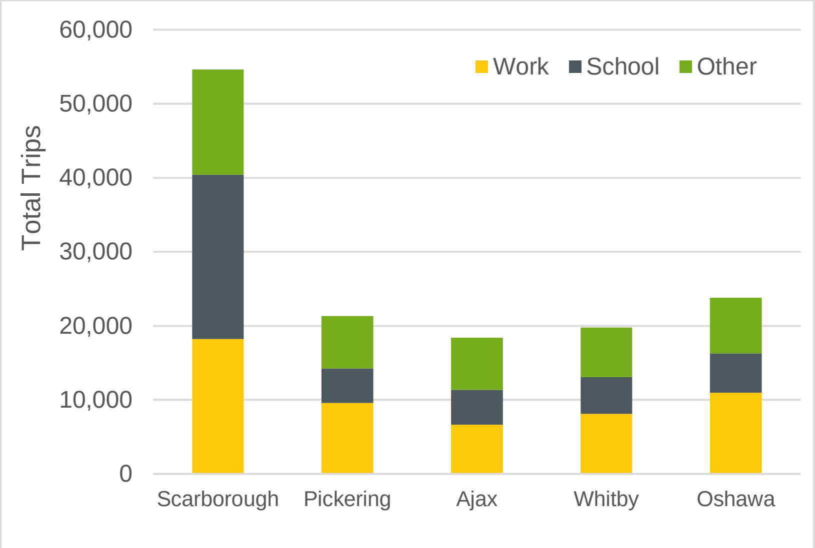
2.3 Existing Travel Market

Existing travel patterns in and around the BRT study area were analyzed using 2011 Transportation Tomorrow Survey (TTS) data.

2.3.1 Why are people travelling in the study area?

Exhibit 2.3 provides a breakdown of trip purpose in the a.m. peak period by each local area or municipality within the study area. The total number of trips destined to Scarborough (54,600) during the 3-hour a.m. peak period far exceeds the number of trips destined to all other areas within the study area. Trips to school represent 40% of all trips due to the presence of Centennial College, UTSC and TTC Line 2 subway service in Scarborough.

Exhibit 2.3: 2011 Trip Purpose in the BRT Study Area

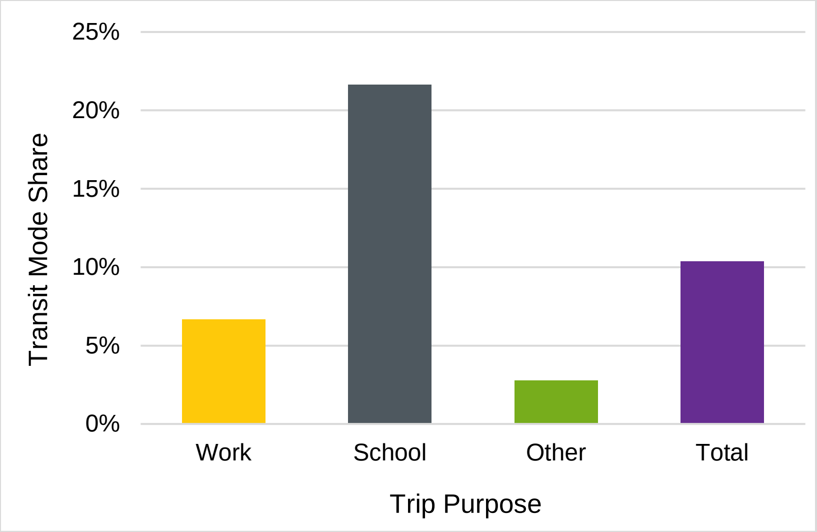


Source: 2011 Transportation Tomorrow Survey

2.3.2 How are people travelling in the study area?

Travel to school has the highest transit mode share at 22%, followed by trips to work at 7% and “other” trips at 3%. As a whole, the mode share for all trips destined to the study area in the 3-hour a.m. peak period is 10% as shown in Exhibit 2.4.

Exhibit 2.4: Transit Mode Share by Trip Purpose



Source: 2011 Transportation Tomorrow Survey

2.3.3 Where are people travelling to and from in the study area?

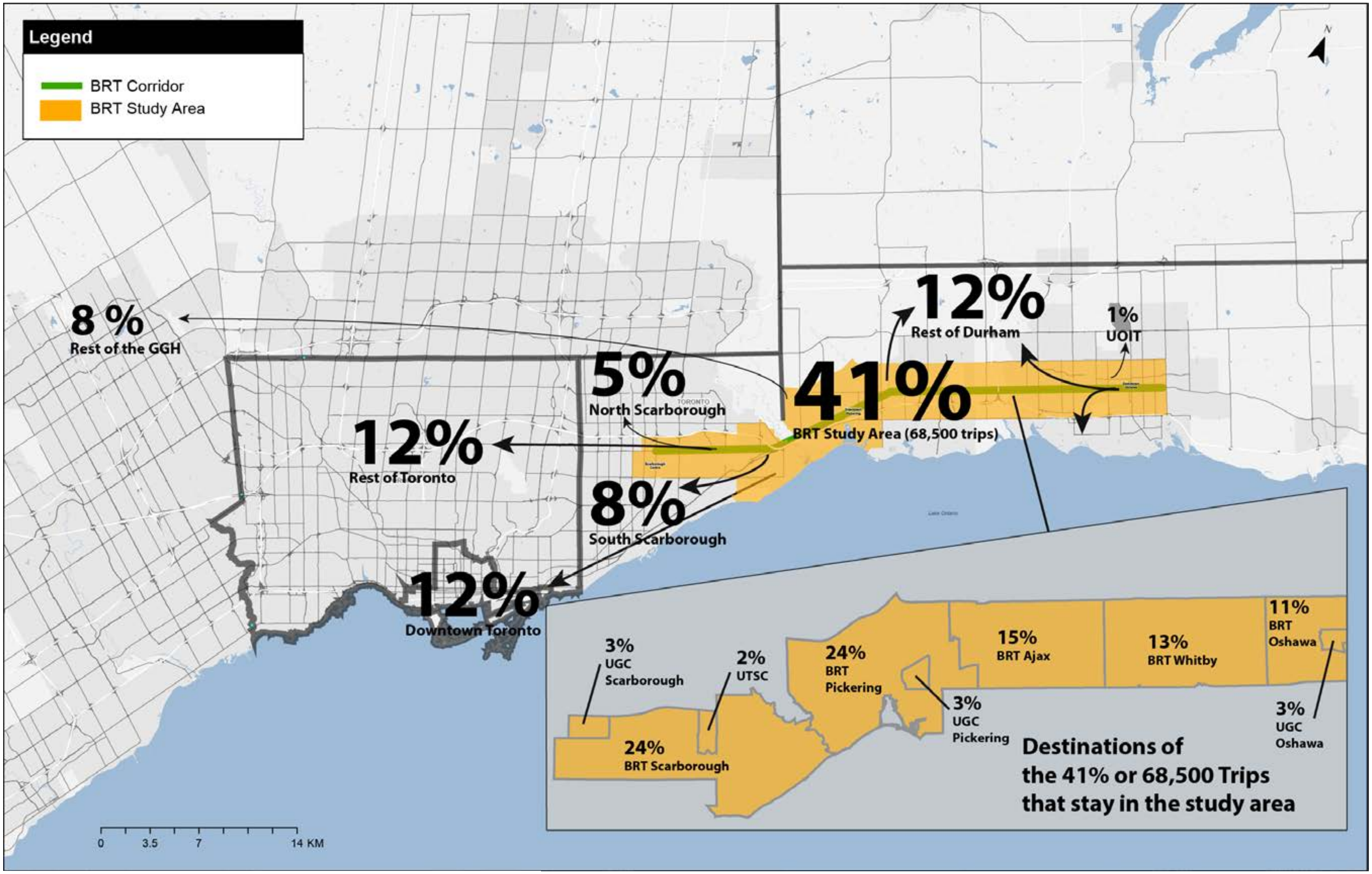
Travel in the study area is highly directional with a strong westbound flow in the a.m. peak reflecting the higher employment areas in the western section of the corridor. Overall, 41% of 3-hour a.m. peak trips (169,000 trips) generated in the study area stay within the study area. The rest of the trips, which are destined for locations outside the study area, are destined to south Scarborough (8%), north Scarborough (5%), Downtown Toronto (12%), the rest of Toronto (12%), the rest of Durham Region (12%), and elsewhere in the GGH (8%). It is important to recognize that the general sentiment that all travel from Durham Region is destined to Downtown Toronto is not actually the case – 41% of trips beginning in the study area during the 3-hour a.m. peak period also end within the study area. This suggests the need for a high quality BRT connection, between Durham Region and Scarborough, and to the broader Regional Frequent Transit Network, as defined in the 2041 RTP.

A map showing the distribution of a.m. peak trip destinations that originate in the study area is provided in Exhibit 2.5.

Although the main UOIT/Durham College campus is not located within the study area, there are over 900 trips from the study area to the UOIT/Durham College campus at a transit mode share of 51%.

It is also important to recognize that the 2011 TTS data was comprised prior to the implementation of PULSE. The 2011 data shows that transit demand from Durham Region to UTSC was low (100 trips). The majority of trips to UTSC are from other areas of Toronto. However, 2011 Metrolinx ridership data shows that there are approximately 1,400 total trips destined for UTSC that originate in the study area during the 3-hour a.m. peak, suggesting there is a market for travel to this destination from other places along the corridor.

Exhibit 2.5: Distribution of 3-hour AM Peak Trip Destinations (All Modes) Originating in the BRT Corridor



Source: 2011 Transportation Tomorrow Survey

2.4 Transit Ridership

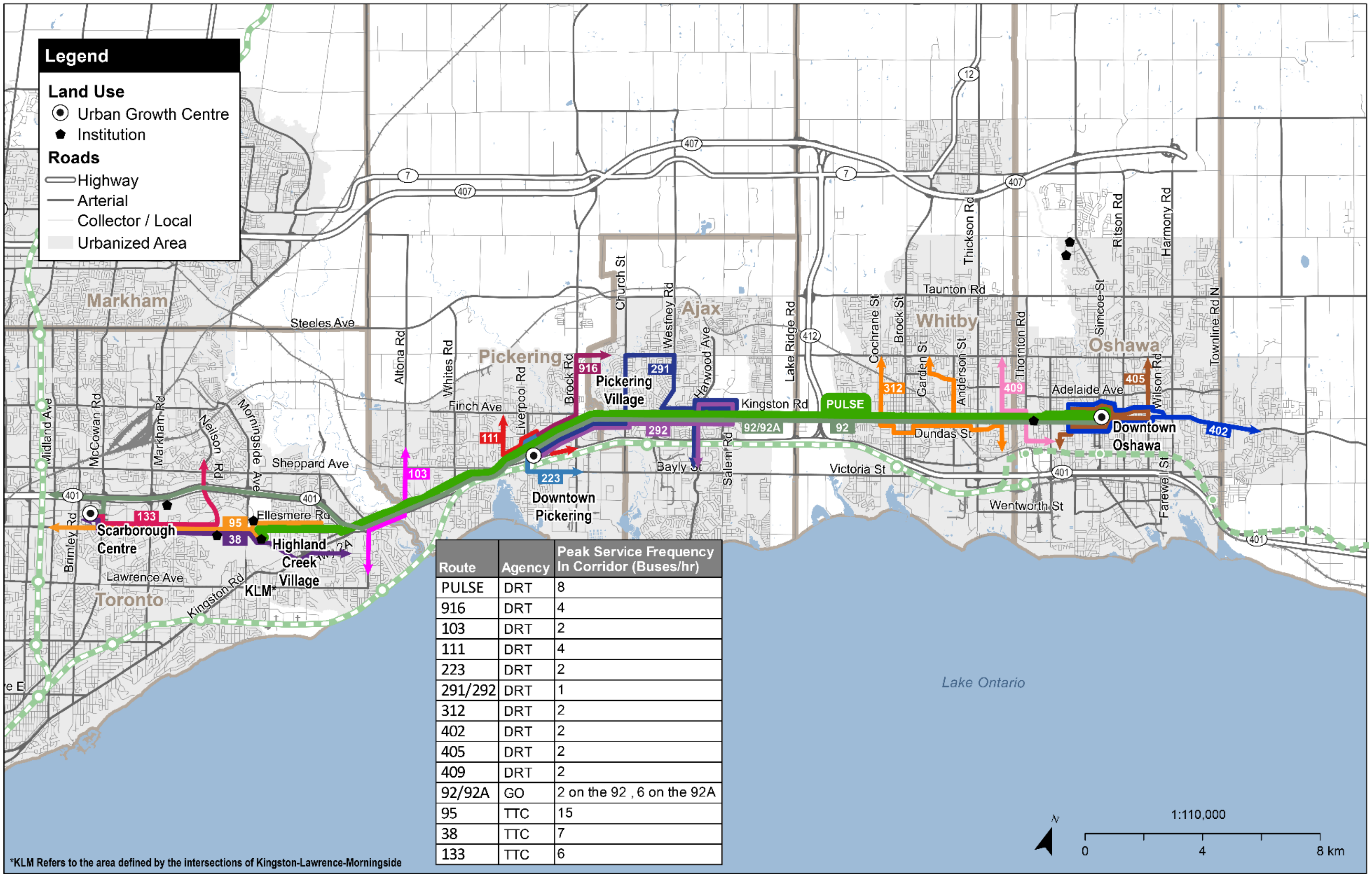
Existing ridership varies considerably throughout the corridor and is spread between GO Transit Bus, TTC and DRT services. The a.m. peak direction is primarily westbound, with steady increase in passenger load between Oshawa and Scarborough. Travel, between the Toronto-Durham boundary and Scarborough Centre represents a significantly large proportion of the total corridor ridership, due to the frequent TTC services in that section.

While the UTSC and Scarborough Centre have the most boardings and alightings, there are destinations in Durham Region with high concentration of boardings and alightings in the a.m. peak period in both the eastbound and westbound direction. They are:

- Centre Street, Downtown Oshawa
- Brock Street, Downtown Whitby
- Harwood Road, Ajax
- Westney Road, Ajax
- Glenanna Road, Downtown Pickering
- Whites Road, Pickering

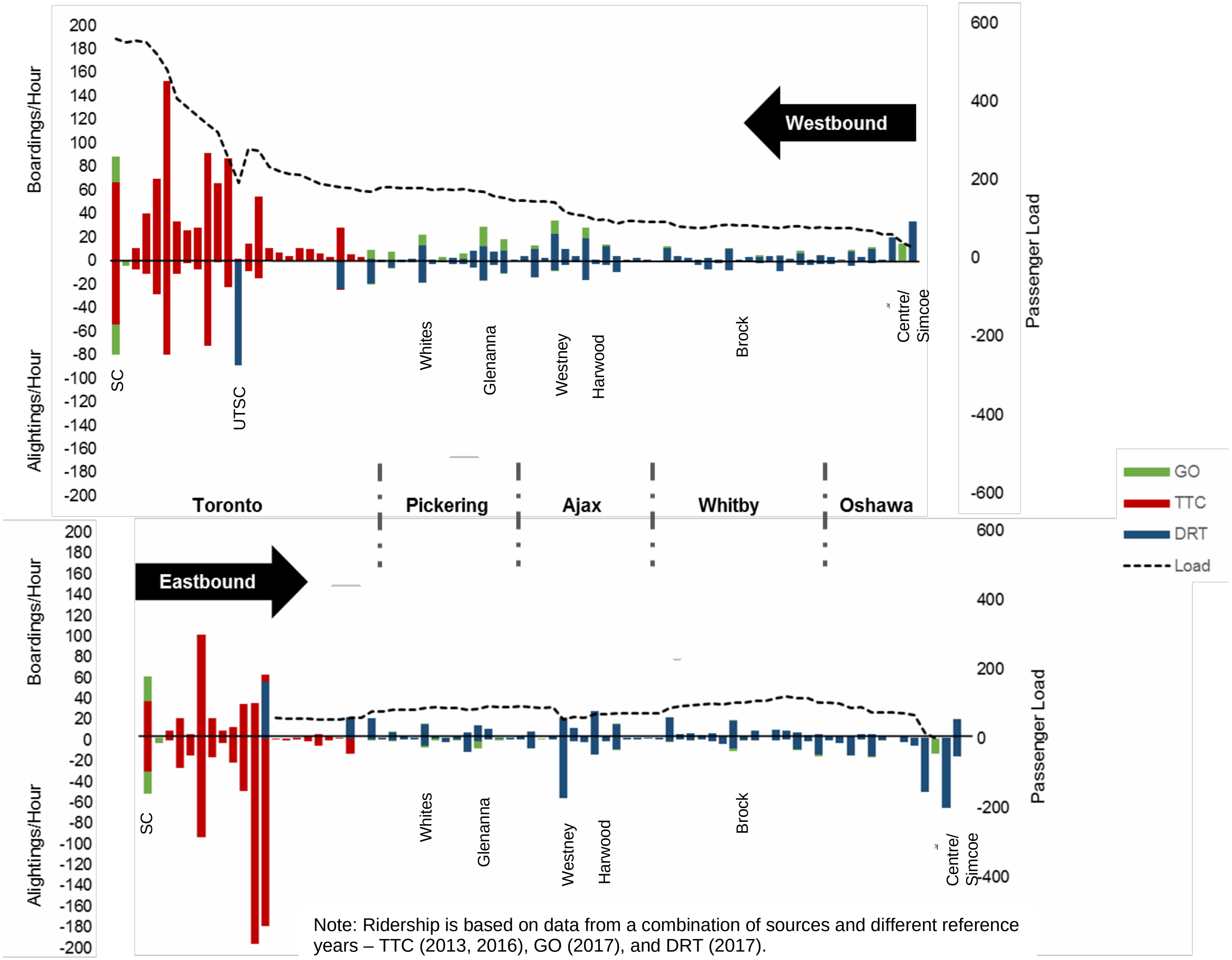
A summary of the existing transit routes that traverse the BRT corridor and their a.m. peak period service frequency are provided in Exhibit 2.6. The existing a.m. peak hour boardings, alightings and passenger load profile for all corridor transit services in are shown in Exhibit 2.7. For a detailed description of current bus operations within the corridor, refer to Appendix A.

Exhibit 2.6: Summary of Existing Transit Services on the BRT Corridor



Route	Agency	Peak Service Frequency In Corridor (Buses/hr)
PULSE	DRT	8
916	DRT	4
103	DRT	2
111	DRT	4
223	DRT	2
291/292	DRT	1
312	DRT	2
402	DRT	2
405	DRT	2
409	DRT	2
92/92A	GO	2 on the 92 , 6 on the 92A
95	TTC	15
38	TTC	7
133	TTC	6

Exhibit 2.7: Existing Peak Hour Transit Demand along the BRT corridor



Note: Ridership is based on data from a combination of sources and different reference years – TTC (2013, 2016), GO (2017), and DRT (2017).

2.5 Traffic Conditions

The BRT corridor through Durham Region currently serves as a major arterial connection moving a high volume of traffic and providing access to the business and residents along it.

The corridor serves both inter- and intra-municipal trips and is a main east-west commuter route.

The BRT corridor in the City of Toronto is currently less defined as a rapid transit route, however the existing DRT PULSE service currently operates in mixed traffic along Kingston Road and Ellesmere Road to UTSC.

Alternative BRT routing concepts were developed in the City of Toronto to connect with Scarborough Centre, however Ellesmere Road was recommended as the preferred corridor. A description of each of these is provided in Appendix A and a detailed evaluation is provided in Appendix B.

There are several constrained sections or ‘pinch points’ along the corridor, where rights-of-way are constrained by adjacent land uses, natural areas, or overpassing structures. Widening the existing roadway at these locations is faced with significant constructability challenges. These pinch points are identified in Exhibit 2.8.

Exhibit 2.8: Constrained Sections

Section	Description
Ellesmere Road (east of Military Trail)	Residential neighbourhood with shallow lot frontages
Rouge Valley Crossing	Large structure crossing an environmentally sensitive area
CN Rail Crossing (east of Liverpool)	Rail overpass with no space to widen the roadway without significant structure re-construction and disruption to rail activity
Pickering Village	Historic downtown neighbourhood with street-front retail
Downtown Whitby	Historic downtown neighbourhood with street-front retail and designated historic properties
CP Rail Crossing (west of Garden Street)	Rail overpass with no room to widen the roadway without significant structure re-construction and disruption to rail activity
Downtown Oshawa	Historic downtown neighbourhood with street-front retail

2.5.1 Existing and Future Traffic Volumes

The BRT corridor, is a primary east-west commuter route between Durham Region and the City of Toronto. It is also the designated emergency detour route through Ajax and Pickering for closures of Highway 401.

In the a.m. and p.m. peak periods, the high traffic volumes combined with frequent intersections and driveways, create localized areas of congestion on the corridor. Areas that approach or exceed capacity include Pickering Village, the section between Ajax and Whitby, and downtown Whitby.

Traffic demand forecasts to 2031 and 2041 show many sections along the corridor will exceed capacity, during peak periods. These forecasted traffic volumes and volume to capacity (v/c) ratios, compared to existing volumes are presented in Exhibit 2.9. By 2031, traffic demand in the majority of the corridor will exceed capacity and by 2041, almost the entire corridor will be operating near or above capacity with the exception of Downtown Oshawa. This indicates that BRT infrastructure, including transit priority measures in constrained locations will be required to maintain reliability and quality of the service in the future.

2.5.2 Intersection Operations

There are 72 signalized and 62 unsignalized intersections along the corridor, which equates to an average intersection spacing of 270 metres. This spacing plus the additional impacts of frequent driveways creates conflicts in the flow of traffic.

While the previous section addressed the high volumes of east-west flows on the corridor, the intersection operations reflects how these flows interact with the high north-south traffic demands crossing the corridor to access Highway 401 and major development areas.

Most of the major intersections along the corridor perform at an LOS ‘D’ or better (≤ 55 s of control delay), but there are six intersections having an LOS ‘E’ (> 55 s control delay) in the p.m. peak hour and one intersection, Glenanna Road and Kingston Road in Pickering, operating with an LOS ‘F’ (> 80 s control delay) during the p.m. peak hour. The analysis indicates that existing high demands on multiple approaches are competing for green time and will be an important consideration during preliminary and detailed design of BRT treatments across intersections to ensure reliability of the service is maintained. A map of major intersections and delay-based level of service at each intersection is provided in Exhibit 2.10.

2.5.3 Pedestrian and Cycling Traffic

Cycling and pedestrian traffic varies throughout the corridor with generally low volumes. In Durham Region, average annual daily cycling volumes[2] range from 45 in low volumes areas to 80 around Pickering Town Centre.

The cycling and pedestrian volumes in City of Toronto, especially around UTSC and Scarborough Town Centre are considerably higher, with annual average daily pedestrian volumes exceeding 2,500[3] at the intersection of Military Trail and Ellesmere Road. This intersection is the only pedestrian crossing point between the portion of the UTSC campus south of Ellesmere Road and the portion of the campus, including parking lots, to the north of Ellesmere Road.

2.5.4 Driveways and Accesses

The corridor currently provides access to a high concentration of both residential and commercial driveways. Overall there are approximately 320 commercial driveways and 100 residential driveways along the corridor, which is an average of 12 driveways per kilometre, or one driveway every 80 metres.

[2] Durham Region Cycling Counts, August 2016

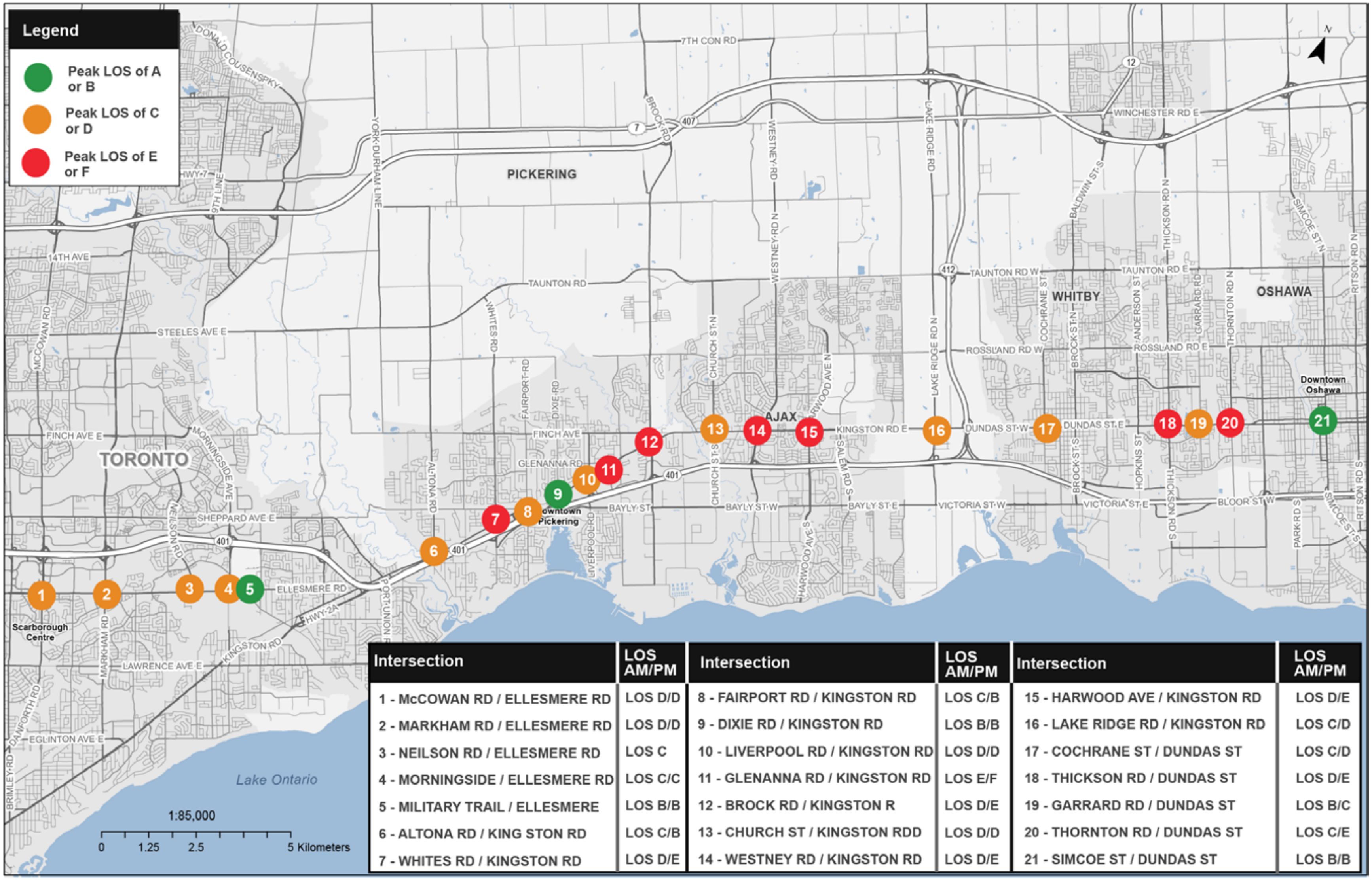
[3] City of Toronto Open Data, 2016

Exhibit 2.9: AM Peak Hour Westbound Traffic Volume and Volume/Capacity Ratio

Section		Existing[4]		2031		2041	
		Volume	V/C Ratio	Volume	V/C Ratio	Volume	V/C Ratio
1	Ellesmere: SC to UTSC	1,600	0.67	1,850	0.76	2,000	0.84
2A	Ellesmere: UTSC to Kingston	1,000	0.64	1,250	0.77	1,500	0.95
3	Kingston: Ellesmere to Toronto- Durham boundary	1,400	0.88	1,700	>1.0	2,050	>1.0
4	Kingston: Toronto-Durham boundary to Altona	1,400	0.78	1,700	0.95	2,050	>1.0
5	Kingston: Altona Road to west of Liverpool	1,350	0.85	1,650	>1.0	1,950	>1.0
6	Kingston: west of Liverpool to Glenanna	1,050	0.65	1,450	0.91	1,550	0.96
7	Kingston: Glenanna to Notion	1,800	>1.0	1,800	>1.0	2,250	>1.0
8	Kingston: Notion to Church	1,600	>1.0	1,600	>1.0	1,800	>1.0
9	Kingston: Church to Rotherglen	1,500	0.92	1,500	0.95	1,500	0.92
10	Kingston: Rotherglen to west of Harwood	1,350	0.83	1,500	0.95	1,600	>1.0
11	Kingston: west of Harwood to Salem	1,350	0.83	1,400	0.88	1,450	0.91
12	Kingston: Salem to White Oaks	1,800	>1.0	1,800	>1.0	2,000	>1.0
13	Dundas: White Oaks to Frances	1,150	>1.0	1,150	>1.0	1,250	>1.0
14	Dundas: Frances to Brock Street	800	0.80	800	0.80	800	0.80
15	Dundas: Brock Street to Garden	1,500	0.92	1,550	0.98	1,600	>1.0
16	Dundas: Garden to Waverly	1,700	>1.0	1,800	>1.0	2,050	>1.0
17	King/Bond: Waverly to Simcoe	1,350	0.48	1,400	0.50	1,550	0.56

[4] Estimates based on existing traffic counts collected between 2013 and 2016

Exhibit 2.10: Intersection Level of Service (LOS) along the BRT Corridor



Intersection	LOS AM/PM
1 - McCOWAN RD / ELLESMERE RD	LOS D/D
2 - MARKHAM RD / ELLESMERE RD	LOS D/D
3 - NEILSON RD / ELLESMERE RD	LOS C
4 - MORNINGSIDE / ELLESMERE RD	LOS C/C
5 - MILITARY TRAIL / ELLESMERE	LOS B/B
6 - ALTONA RD / KING STON RD	LOS C/B
7 - WHITES RD / KINGSTON RD	LOS D/E
8 - FAIRPORT RD / KINGSTON RD	LOS C/B
9 - DIXIE RD / KINGSTON RD	LOS B/B
10 - LIVERPOOL RD / KINGSTON RD	LOS D/D
11 - GLENANNA RD / KINGSTON RD	LOS E/F
12 - BROCK RD / KINGSTON R	LOS D/E
13 - CHURCH ST / KINGSTON RDD	LOS D/D
14 - WESTNEY RD / KINGSTON RD	LOS D/E
15 - HARWOOD AVE / KINGSTON RD	LOS D/E
16 - LAKE RIDGE RD / KINGSTON RD	LOS C/D
17 - COCHRANE ST / DUNDAS ST	LOS C/D
18 - THICKSON RD / DUNDAS ST	LOS D/E
19 - GARRARD RD / DUNDAS ST	LOS B/C
20 - THORNTON RD / DUNDAS ST	LOS C/E
21 - SIMCOE ST / DUNDAS ST	LOS B/B

3 Development of Rapid Transit Alternatives

A number of assumptions were decided upon and agreed to by the agencies involved in this study prior to the development of this IBC. These assumptions reflect the Metrolinx Business Case Framework, and the principles and objectives of delivering an integrated and high value rapid transit corridor. These assumptions were to:

- Identify the best performing infrastructure and service concept alternative through an alternative analysis and initial business case. A Preliminary Design Business Case (PDBC) is required for full project funding.
- Adopt an integrated fare structure and service delivery concept. This included the assumption that TTC, DRT and GO Transit operators would have access to the corridor to maximize investment of the infrastructure.

Development of the BRT alternatives for evaluation considered the following:

- BRT Routing Options (infrastructure within the City of Toronto);
- BRT Service Concepts;
- BRT Right-of-way Options;
- Taking a lane versus adding a lane; and
- Constrained sections.

3.1 BRT Routing Options

The ‘route’ for the purpose of this study is defined as the corridor which will connect Durham Region and the City of Toronto via a high quality BRT corridor.

Defining this route incorporated multiple services which provide connections to key nodes adjacent to the corridor. Highway 2 and Ellesmere Road were considered the optimal BRT routing for the corridor, as it is an established rapid transit corridor, and provides greater benefits in connecting residents and employment to the wider transit network then the other options.

A summary of the evaluation of the route options is provided in Exhibits 3.1 and 3.2 and the detailed evaluation is provided in Appendix B.

Exhibit 3.1: City of Toronto BRT Routing Options

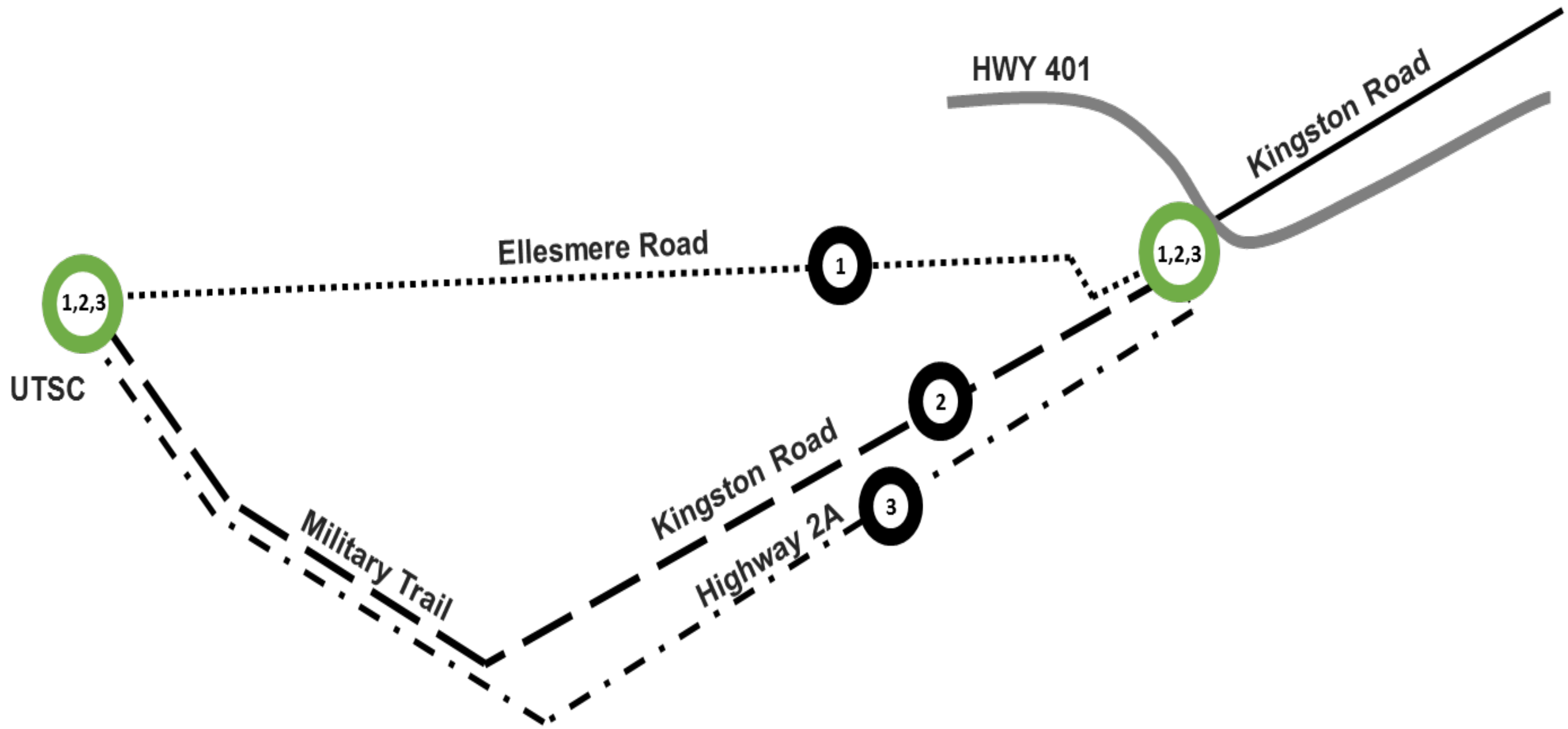


Exhibit 3.2: Summary of Route Options Evaluation

Criteria	1) Ellesmere	2) Military Trail via Kingston Rd	3) Military Trail via Highway 2A
People and Jobs	◐	●	○
New Riders	◐	●	◐
Transit Travel Time	◐	○	●
Traffic Flow	●	○	◐
Property Impacts	◐	○	○
City Building	○	◐	●
Implementability	●	○	◐
Capital Cost	◐	◐	○

3.2 BRT Service Concept

The BRT service concepts were developed under an integrated service delivery approach of TTC, DRT and GO Transit bus operations. They were developed based on the service levels required to meet the demand of the corridor in 2041, and maximizing benefits to the existing service networks in Durham Region and City of Toronto. The service concepts assumed fare integration.

Traditionally, BRT service strategies fall into two categories[5]; Trunk and Feeder, and Branch and Blend. These were adopted in the development of two main service concepts that were considered for the corridor:

1. Trunk and Feeder Service – a main trunk service operating end to end on the corridor with supporting feeder routes that transfer riders to the trunk route.
2. Branch and Blend Service – multiple routes from different origins to different destinations that overlap service on the corridor providing more opportunities for a single-seat trip without transfers.

A third service option was also developed that considered future transit planning initiatives under the 2041 RTP and best met the forecasted demand along the corridor:

3. Two-Branch Service – combining the features of the above options that worked best in Durham (trunk service) and in Toronto (branch service). This concept best meets forecasted passenger demand along the corridor, and provides increased connectivity to destinations adjacent to the BRT corridor in both the City of Toronto and Durham Region

[5] TCRP Bus Rapid Transit Implementation Guidelines, 2016

These three service options are mapped in Exhibit 3.3, Exhibit 3.4 and Exhibit 3.5.

The Two-Branch service option is the preferred Durham-Scarborough BRT service concept for the following reasons:

- It provides the most direct connection between Downtown Oshawa and Scarborough Centre;
- It maximizes access to the corridor for the existing service network in both the City of Toronto and Durham Region; and
- It will provide connections to future service planning initiatives including the proposed Eglinton East LRT at Kingston Road and Morningside Avenue, and the Simcoe St BRT in Downtown Oshawa.

Additional services could also be introduced in the future, which may include a connection to Lakeshore East GO Rail extension to Bowmanville and to Smart Track/RER services along the Stouffville GO Rail Line.

This service strategy assumes all TTC routes can utilize the infrastructure, as well as DRT and GO Transit buses connecting into Durham Region.

The service concept and recommended service headways are provided Exhibit 3.6. With this service strategy, there will be 12 articulated BRT buses with a 90 person capacity operating along the corridor. Of the existing TTC buses, 15 buses per hour are assumed to be operating between Scarborough Centre and UTSC, reduced from 29 buses today.

Exhibit 3.3: Trunk and Feeder Service Concept

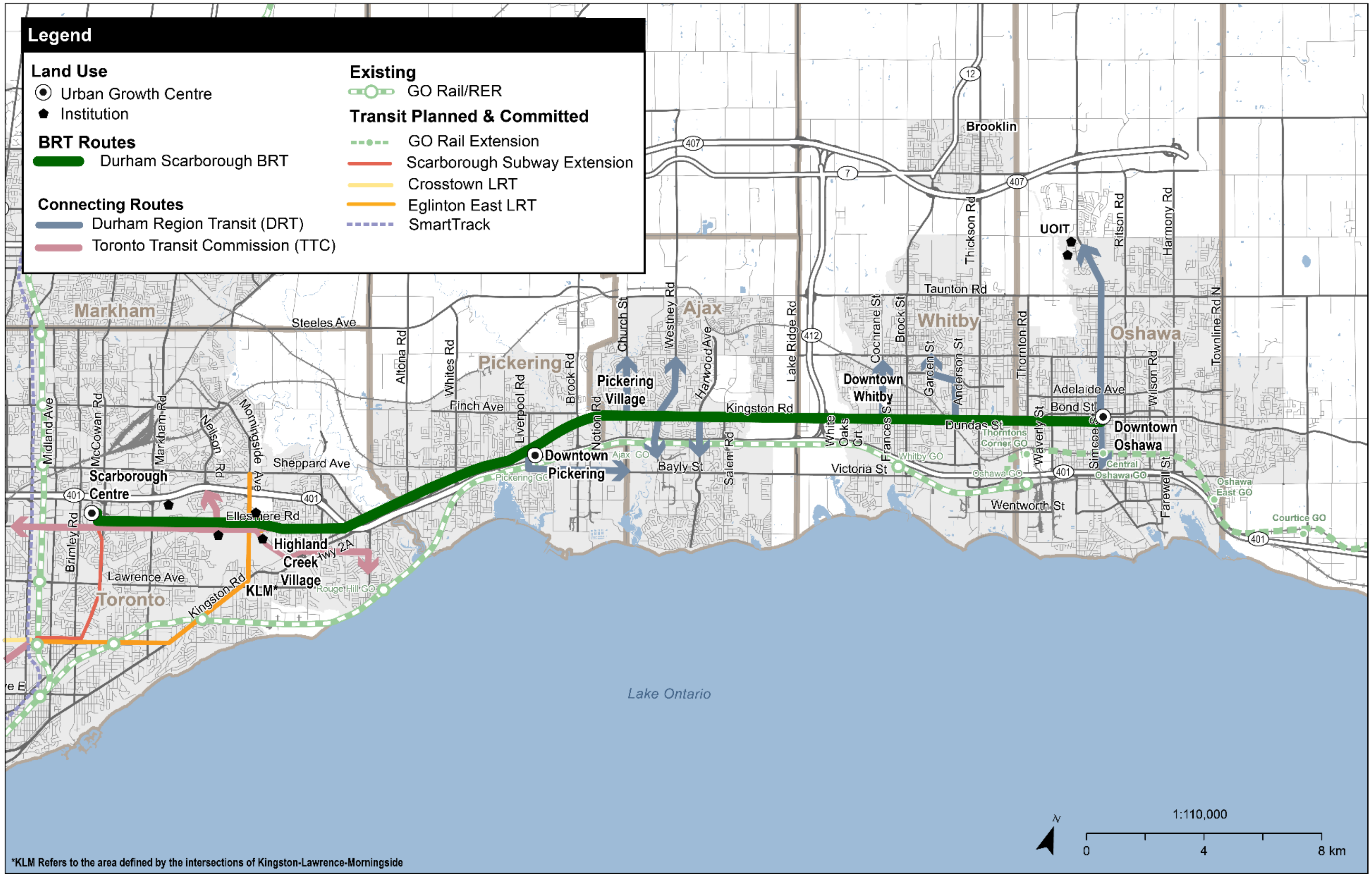


Exhibit 3.4: Branch and Blend Service Concept

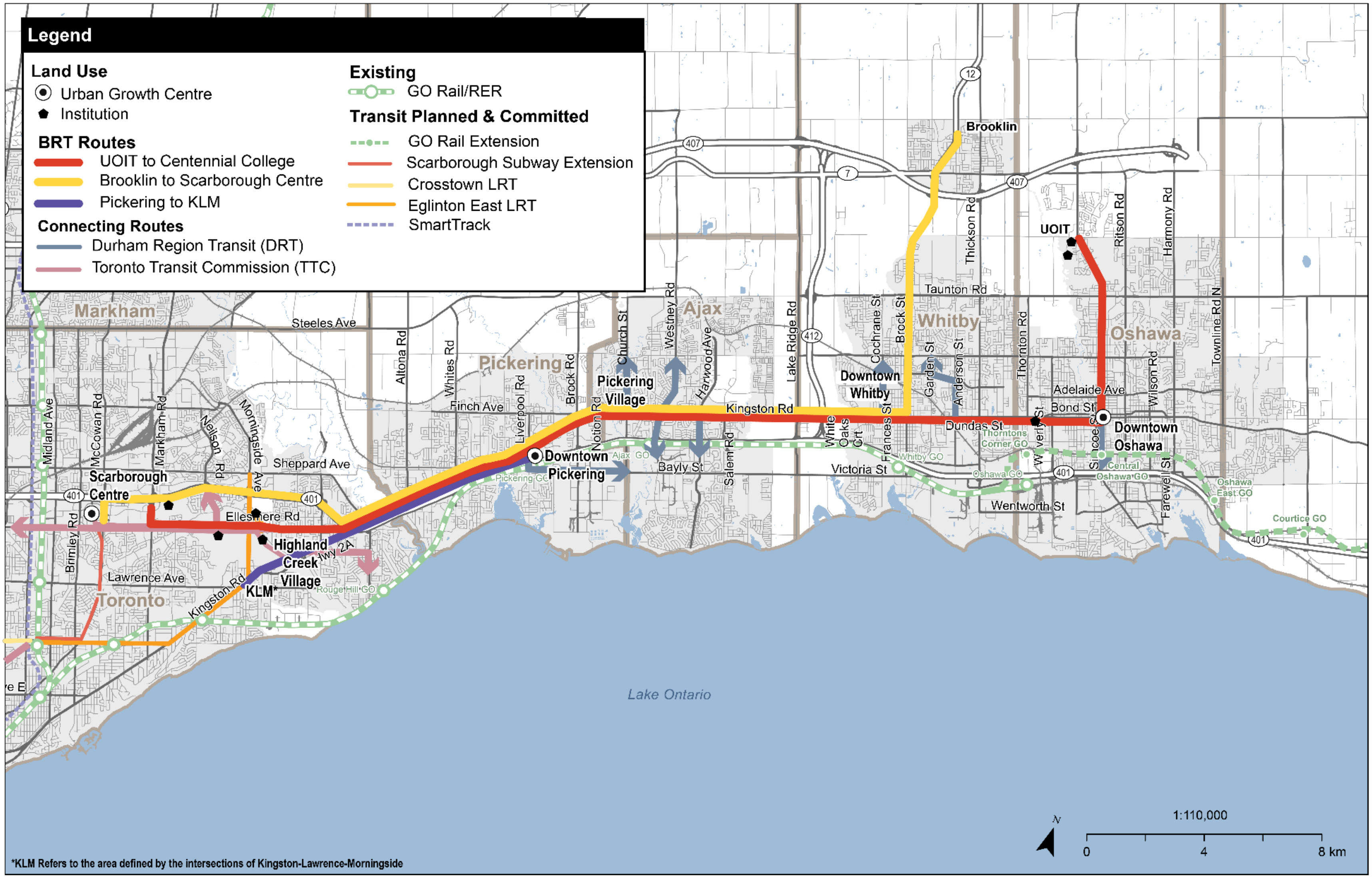


Exhibit 3.5: Two-Branch Service Concept

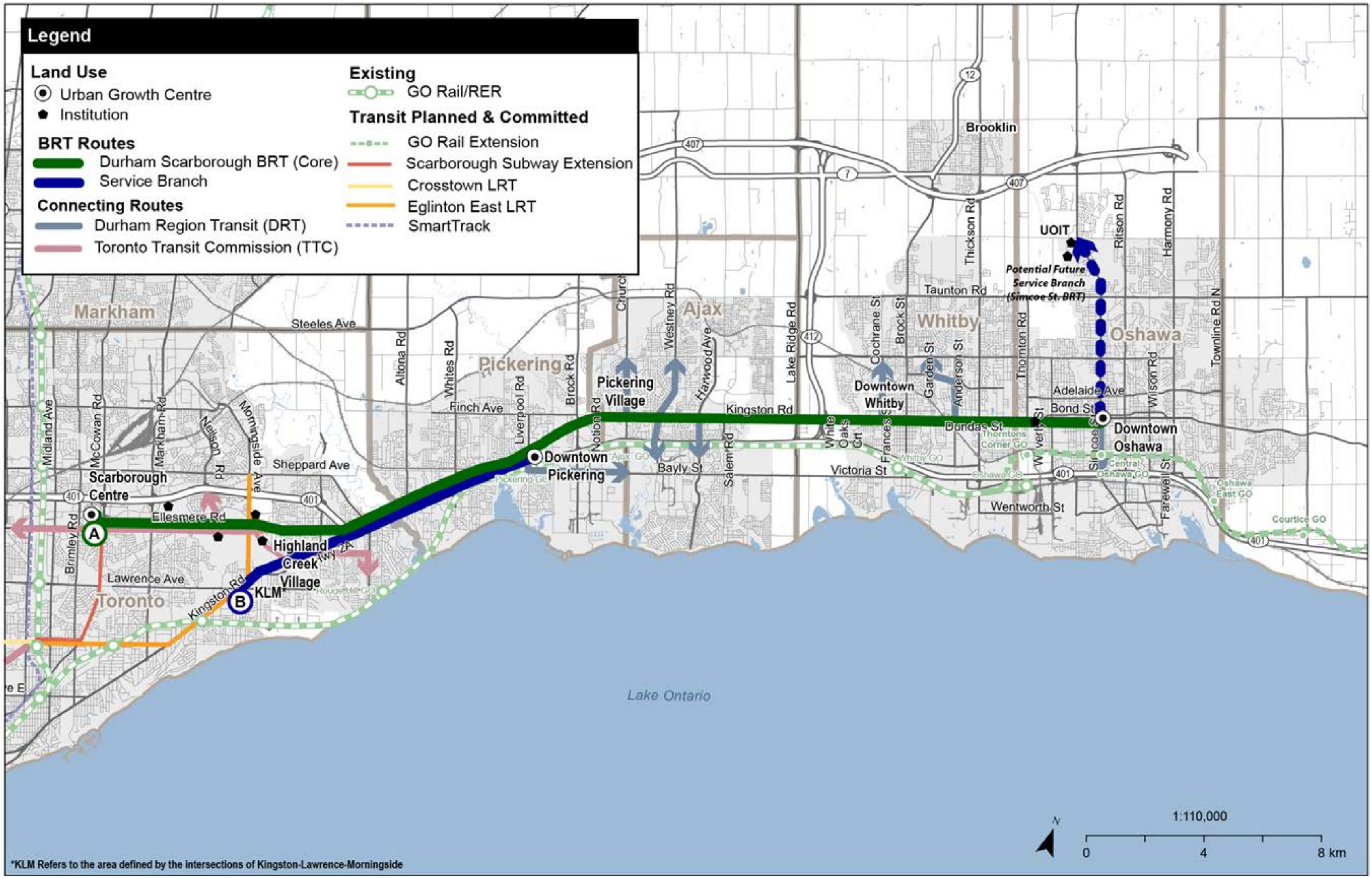
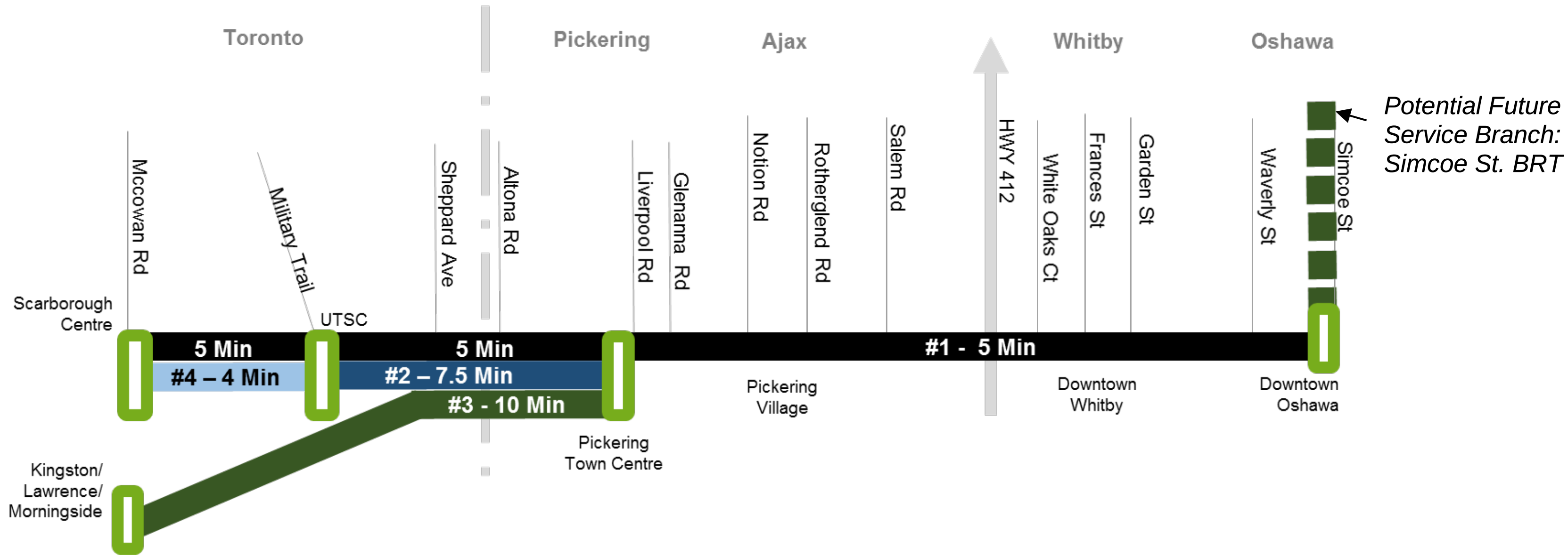


Exhibit 3.6: Recommended Service Strategy for the Two-Branch Service Concept



	SC to UTSC	UTSC to DTP	DTP to DTO	KLM to SC
Route	**Service Frequency (buses/hour)**			
#1 Scarborough Centre (SC) to Downtown Oshawa (DTO)	12	12	12	-
#2 UTSC to Downtown Pickering (DTP)	-	8	-	-
#3 Kingston/Lawrence/Morningside (KLM) to Downtown Pickering (DTP)	-	-	-	6
#4 Local services along Ellesmere Between Scarborough Centre (SC) and UTSC	15	-	-	-
Total buses/hour	27	20	12	6
	Passenger Demand & Capacity			
Capacity*	2430	1800	1080	540
Demand	2250	1750	875	420
Occupancy	93%	97%	81%	78%

*Capacity based on the use of Articulated Buses with a capacity of 90 passengers

3.3 BRT Right-of-Way Options

For BRT services to achieve high levels of speed and reliability, they should operate in exclusive lanes with transit priority. In constrained locations, priority infrastructure could include lanes that are shared with turning movements at intersections, HOV lanes, Business Access/Transit (BAT) lanes, and lanes that may be dedicated by time of day (for example, bus- only during peaks and retail parking off-peak).

Dedicated bus lanes for as much of the BRT corridor as possible are essential for maintaining rapid and reliable service between Downtown Oshawa and Scarborough Centre.

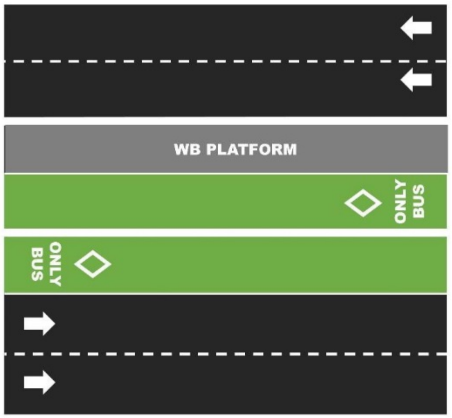
There are several recognized design best practices for the implementation of BRT.[6]

- Dual median lanes offer the most reliable and rapid service because they minimize conflicts with right turning general traffic. Dual median lanes typically have platforms on the right side, but centre platforms can also be used in cases where vehicles have doors on both sides. Dual median lanes can be converted to LRT in the future, should demand for the technology be realized. In urban areas with a high frequency of driveways, centre median lanes are also preferred to avoid conflicts with right turning vehicles.
- Curbside lanes use curbside platforms, much like conventional transit in mixed traffic. Curbside lanes can also have variable applications, ones which allow for other types of high occupancy vehicles (HOV lanes), time of day policies, or transit exclusive lanes that allow right turning vehicles. Curbside lanes can also be used where right-of-way width do not have enough space for two centre median lanes with buffer space and platforms. The preferable application for curbside lanes is in areas with a low concentration of driveways as there will be less conflict with right-turning vehicles.
- Queue jump lanes can be used at signalized intersections to allow buses to get to the front of a queue, and a special green signal for the queue jump lane can allow the bus priority through the intersection. Queue jump lanes are utilized in locations which may have constrained right-of ways or other physical constraints which may prevent the implementation of dedicated centre median or curbside bus lanes.

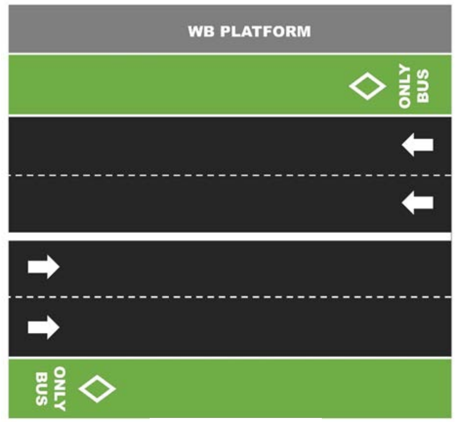
The conceptual illustration of each right-of-way type is provided in Exhibit 3.7.

[6] TCRP Bus Rapid Transit Implementation Guidelines ,2016

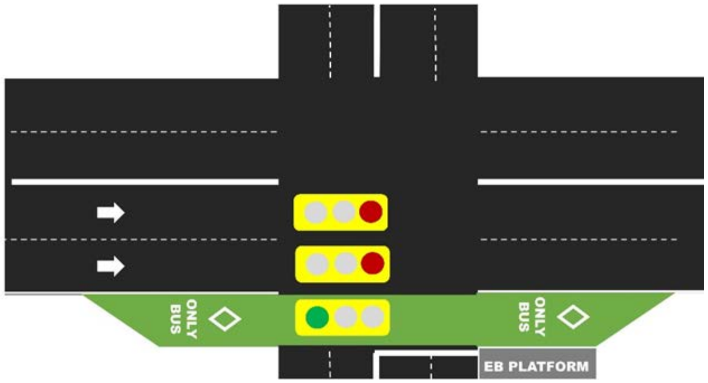
Exhibit 3.7: Right of Way Options



Centre Median



Curbside



Queue Jump

NOT TO SCALE

3.4 Stop Spacing and Stop Location

One of the characteristics of a rapid transit BRT is wider stop spacing than conventional transit bus routes in mixed traffic.

The existing PULSE service has 54 stops located, on average, every 550 m along the 30 km route between Downtown Oshawa and UTSC. Best practice examples for suburban BRT systems suggest an average stop spacing of between 700-800m.

Based on 2017 DRT boarding and alighting data on the PULSE service, there are a number of existing stops that have low ridership. As such, there are opportunities to modify the stop locations along the route and increase average spacing, which will lead to operating efficiencies and higher operating speeds while having minimal impact to the accessibility of the system. This is especially important to implementing any BRT construction phasing strategy, to ensure there are minimal ‘throw-away’ costs to existing investments along the corridor.

3.5 Taking a Lane versus Adding a Lane

A significant decision regarding the right-of-way typology for any on-street BRT system relates to the question of whether or not the existing right-of-way will be widened to host new transit lanes, thus maintaining the existing general purpose lane configuration, or whether the existing road width is maintained and general purpose lanes are converted into some form of bus priority lane. As a general principle, bus lanes should be provided without reducing the existing number of general purpose lanes as to avoid any significant impacts to traffic flow.[7]

However, in some cases, constructability issues and/or the sensitivity of adjacent land uses may prevent this, leading to a potential compromise. In such cases, a comprehensive evaluation, through the process of an environmental assessment, should be completed to determine an intervention that best serves the community. Urban and transit planning policies may also provide a vision for changes to a corridor which may support reducing traffic lanes and prioritizing transit lanes.

Urban design objectives can also guide the decision of whether or not to widen the roadway to make room for transit. If the objective is to prioritize a pedestrian-friendly urban realm in a certain area along the corridor, then widening the existing right-of-way can act counter to this objective since too wide of a right-of-way can sterilize the corridor by discouraging walking and cycling, unless adequate pedestrian and cycle provisions are provided.

Given that the urban form along the Durham-Scarborough corridor varies considerably, some areas are more pedestrian-oriented than others. The preservation of these pedestrian areas should be prioritized, while other parts of the corridor that do not have a pedestrian-friendly urban form are less likely to be affected by a wider right-of-way, due to the limitations posed by the existing conditions.

Since Highway 2 is designated as a high-capacity, vehicle moving corridor and an emergency detour route for the parallel Highway 401, the existing lane capacity should be maintained. Widening of the existing corridor was considered for the IBC in locations where Durham Region has not already widened the right-of-way to support centre median bus lanes, as part of their curbside construction.

3.6 Constrained Sections

There are a number of constrained sections, or ‘pinch points,’ along the corridor – Ellesmere Road (east of UTSC), Pickering Village, Downtown Whitby and Downtown Oshawa. To ensure reliability of BRT services in these sections, options for transit priority were considered. These areas are expected to undergo more detailed design and analysis in the PDBC to confirm the most appropriate infrastructure in these sections to ensure reliability of the BRT can be maintained throughout the entire corridor.

Alternative transit priority measures were considered for the constrained sections noted above, except Downtown Oshawa, to inform the rapid transit alternatives. A

[7] TCRP Bus Rapid Transit Implementation Guidelines, 2016

summary of this analysis is provided this section and the detailed evaluation is provided in Appendix B. It should be noted that this evaluation is not intended to rule out any options, but to identify which options are to be assumed for the purpose of developing capital and operating costs for the business case alternatives.

3.6.1 Ellesmere Road (east of UTSC)

In the City of Toronto, Ellesmere Road east of UTSC to the Toronto-Durham boundary is a stable residential area with single-family homes having direct frontage on Ellesmere Road.

Creating dedicated bus lanes by converting two of the four general purpose lanes was considered but would have operational conflicts with the frequent driveway accesses and with garbage collection operations.

Widening the corridor to provide dedicated bus lanes is not possible without significant disruption to the neighbourhood and existing land uses.

Transit priority with queue jump lanes was assumed for this IBC and will be confirmed in the PDBC.

3.6.2 Pickering Village

Pickering Village is a historic downtown area and the right-of-way does not allow for widening without significant disturbance to the existing building and parcel fabric. As there is currently no on-street parking along this segment, there is also a limited opportunity to convert existing road space to transit lanes.

Exhibit 3.8: Pickering Village (looking east)

Image: Google Earth

The following three alternatives were considered for the section of the corridor between Elizabeth Street and Rotherglen Road:

1. Dedicated Lanes – Adding either dedicated centre median or curbside lanes to the right-of-way, without reducing general traffic lanes. Curbside or median dedicated lanes will depend on which configuration is adopted for the rest of the corridor.
2. Queue Jump – Adding queue jump lanes at the intersection of Church Street and Kingston Road.
3. No change to existing configuration

The summary of the evaluation of the alternatives are shown in Exhibit 3.9. In summary, the queue jump alternative is carried forward in this study for the purpose of developing the business case alternatives. The queue jump alternative delivers transit travel time benefits with significantly fewer impacts to the surrounding community than the exclusive lane alternative. It should be noted that queue jump lanes were only considered at Church Street and the PDBC will consider either additional queue jump lanes at signals, extension of the centre-median lanes through this section, and/or the provision of HOV lanes.

It is noted that as a more detailed review of the design elements of the corridor develop, other treatments in this section could be considered.

Exhibit 3.9: Alternatives Evaluation for Pickering Village

	Exclusive Lanes	Queue Jump	No Change
Transit Travel Times	●	◐	○
Access	◐	●	●
Traffic Flow	◐	●	◐
Property Impacts	○	◐	●
Business Impacts	○	◐	●

3.6.3 Downtown Whitby

Downtown Whitby is a historic downtown area and the right-of-way does not allow for widening without significant disturbance to the existing building and parcel fabric. There is currently on-street parking along this segment valued by local businesses, but could be converted to transit lanes in the future.

The following three options were considered for the section of the corridor between Frances Street and Garden Street:

- Exclusive Lanes – Adding either dedicated centre median or curbside lanes to the right-of-way, with the removal of existing on-street parking. Curbside or median dedicated lanes will depend on which configuration is adopted for the rest of the corridor. With a curbside configuration, exclusivity for buses could be based on time of day, and be used for parking during off-peak periods.

- Queue Jump – Adding queue jump lanes at the intersection of Brock Street and Dundas Street. This would also require the removal of some on-street parking and reconfiguration of the existing dedicated WB right turn lane.
- No change to existing configuration.

Exhibit 3.10: Downtown Whitby (looking east)

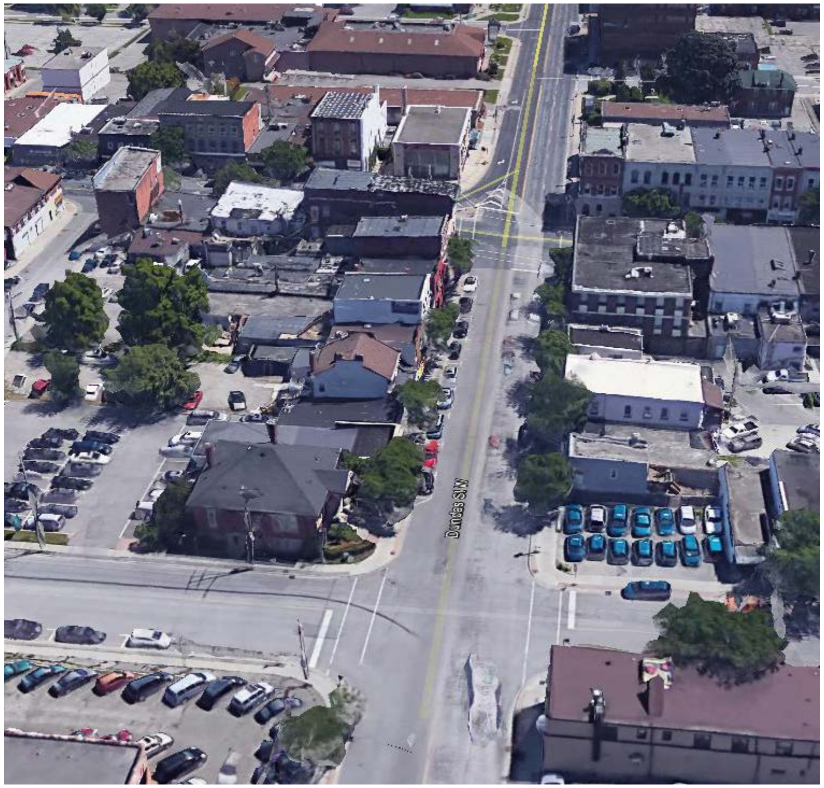


Image: Google Earth

The evaluation of the alternatives is shown in Exhibit 3.11. It should be noted that queue jump lanes were only considered at the Brock Street intersection and the PDBC will consider additional queue jump lanes in this section, BAT lanes, or other infrastructure treatments to ensure BRT reliability can be maintained through this area.

Exhibit 3.11: Alternatives Evaluation for Downtown Whitby

	Exclusive Lanes	Queue Jump	No Change
Travel Times	●	◐	○
Access	◐	●	●
Traffic Flow	◐	●	◐
Property Impacts	○	◐	●
Business Impacts	○	◐	◐
On-Street Parking	○	◐	●

For the purpose of defining business case alternatives, queue jump lanes were assumed in Downtown Whitby.

3.6.4 Downtown Oshawa

In Oshawa, King Street and Bond Street operate as a one-way pair through the downtown area.

Exhibit 3.12: Downtown Oshawa (looking east)

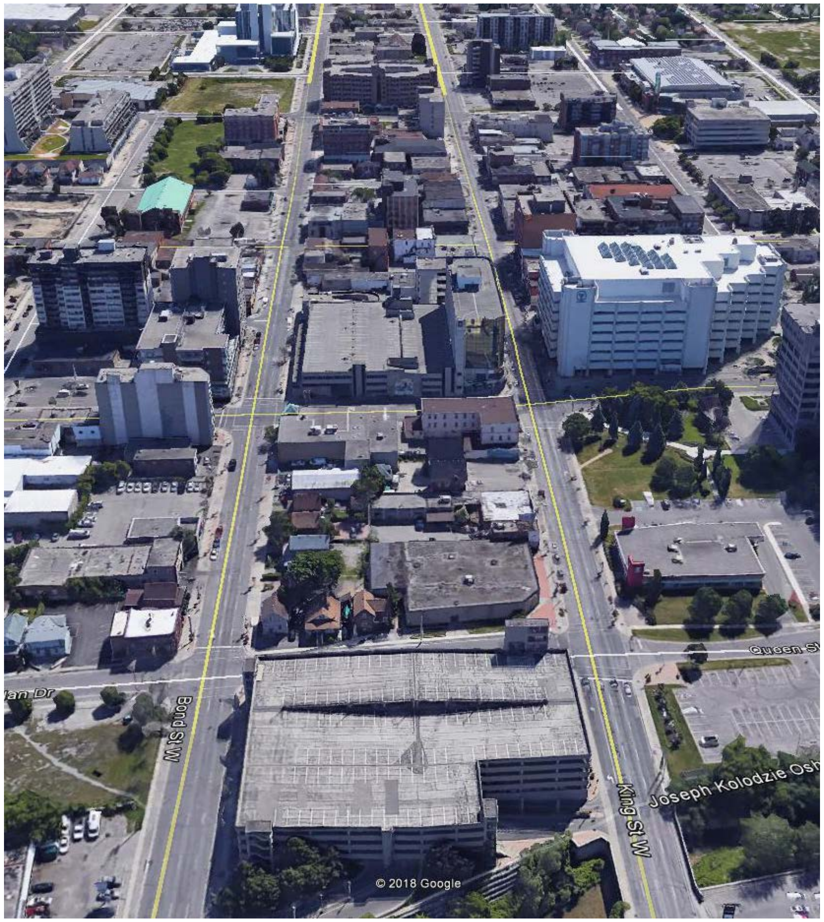


Image: Google Earth

The presence of the one way pair lends itself to a couplet design by converting one existing travel lane on each one way street into an exclusive bus lane. Using the one-way pair balances the traffic impacts and avoids the conflict of on-coming left turn lanes that would be present in a bi-directional concept. This concept was assumed in the development of the business case alternatives. BRT treatments in Downtown Oshawa will require further analysis and design in the PDBC.

4 BRT Alternatives

Three BRT alternatives were developed based on the evaluation of the key considerations from Section 3. These alternatives represent a range of capital infrastructure commitments and are evaluated against the 2041 Base Case which assumes existing PULSE service to UTSC and no new BRT infrastructure along the corridor.

4.1 Centre Median

The Centre Median alternative applies bus lanes in the centre median along the entire corridor, except for the constrained locations of Pickering Village, Downtown Whitby, Downtown Oshawa, and Ellesmere Road east of Military Trail. This alternative includes converting existing sections of curbside bus lanes to centre median bus lanes. This alternative is illustrated in Exhibit 4.1.

4.2 Curbside

The Curbside alternative applies bus lanes in the curbside creating continuity with the existing bus lanes and on-going curbside bus lane improvements.

The curbside bus lanes would be implemented across the entire corridor with the exception of Pickering Village, Downtown Whitby, Downtown Oshawa, and Ellesmere Road east of Military Trail. This alternative is illustrated in Exhibit 4.2.

4.3 Hybrid

The Hybrid alternative strategically applies elements from the Centre Median and Curbside alternatives while also identifying areas where transit priority with queue jump lanes would be sufficient. This approach is intended to optimize the value of investment by considering which right-of-way treatment is most suitable for the context for each section of the corridor.

The following elements form the Hybrid alternative:

- Between Scarborough Centre and UTSC, and through the Pickering sections of the corridor, centre median operations is selected as there is a higher frequency of transit service in these sections to accommodate the forecasted high ridership demand, particularly for travel westbound into Scarborough in the morning peak.
- Between UTSC and the Toronto-Durham boundary, where the right-of-way is constrained, transit priority with queue jump is applied.
- Through Ajax, centre median lanes are applied, improving on the curbside infrastructure that has already been completed.
- Through Downtown Whitby, transit priority with queue jump is assumed. This could be upgraded to curbside bus lanes if existing on-street parking is converted to transit lanes in the future. Curbside lanes in this section would provide flexibility to apply time-based bused lanes (i.e. parking during off-peak periods and bus lanes during peak periods).
- In Oshawa, the one-way couplet naturally lends itself well to curbside operations with adequate lanes and right-of-way to accommodate bus lanes and general purpose lanes.

This alternative is illustrated Exhibit 4.3.

Exhibit 4.1: Centre Median Alternative Infrastructure Concept

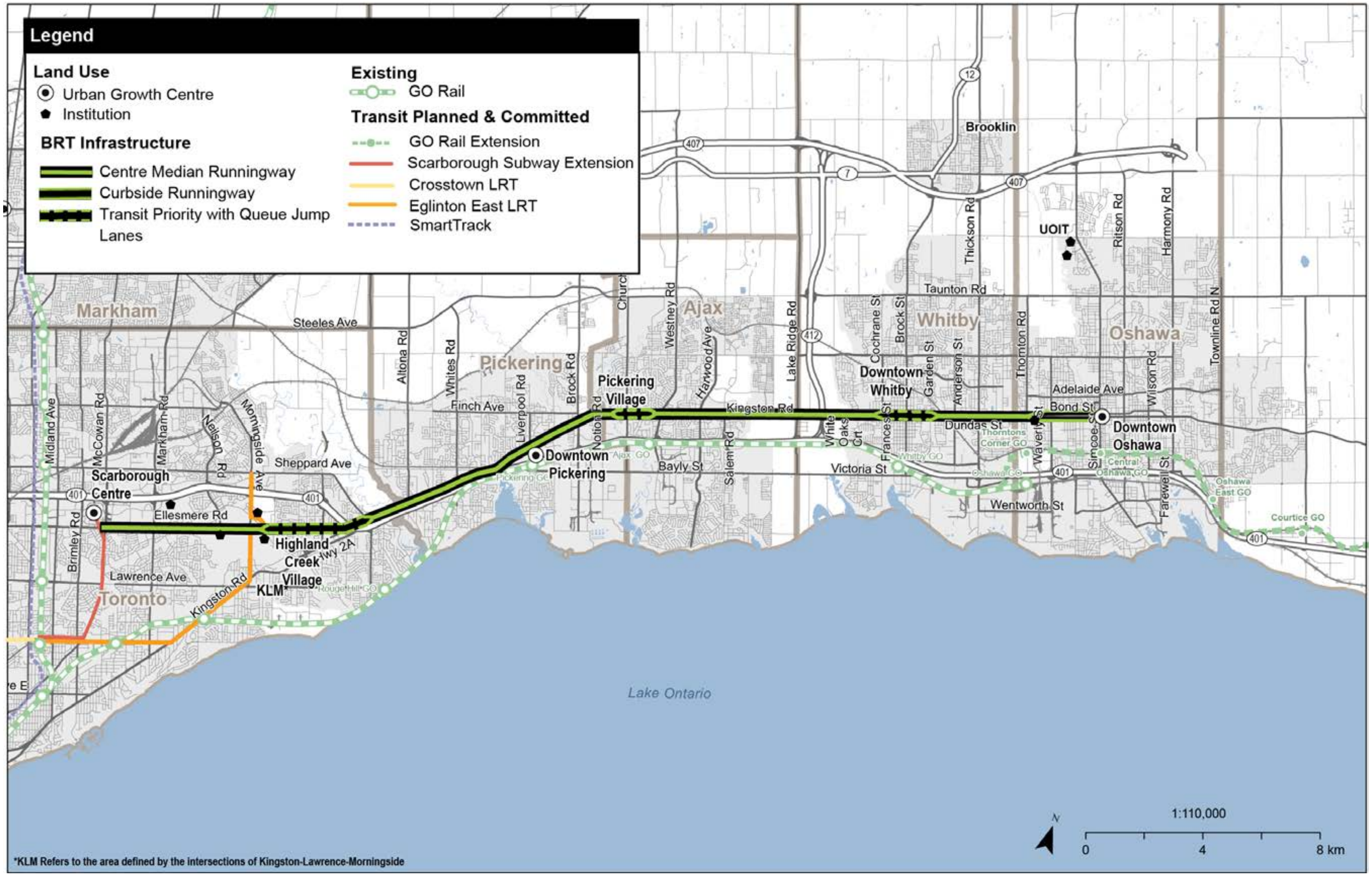
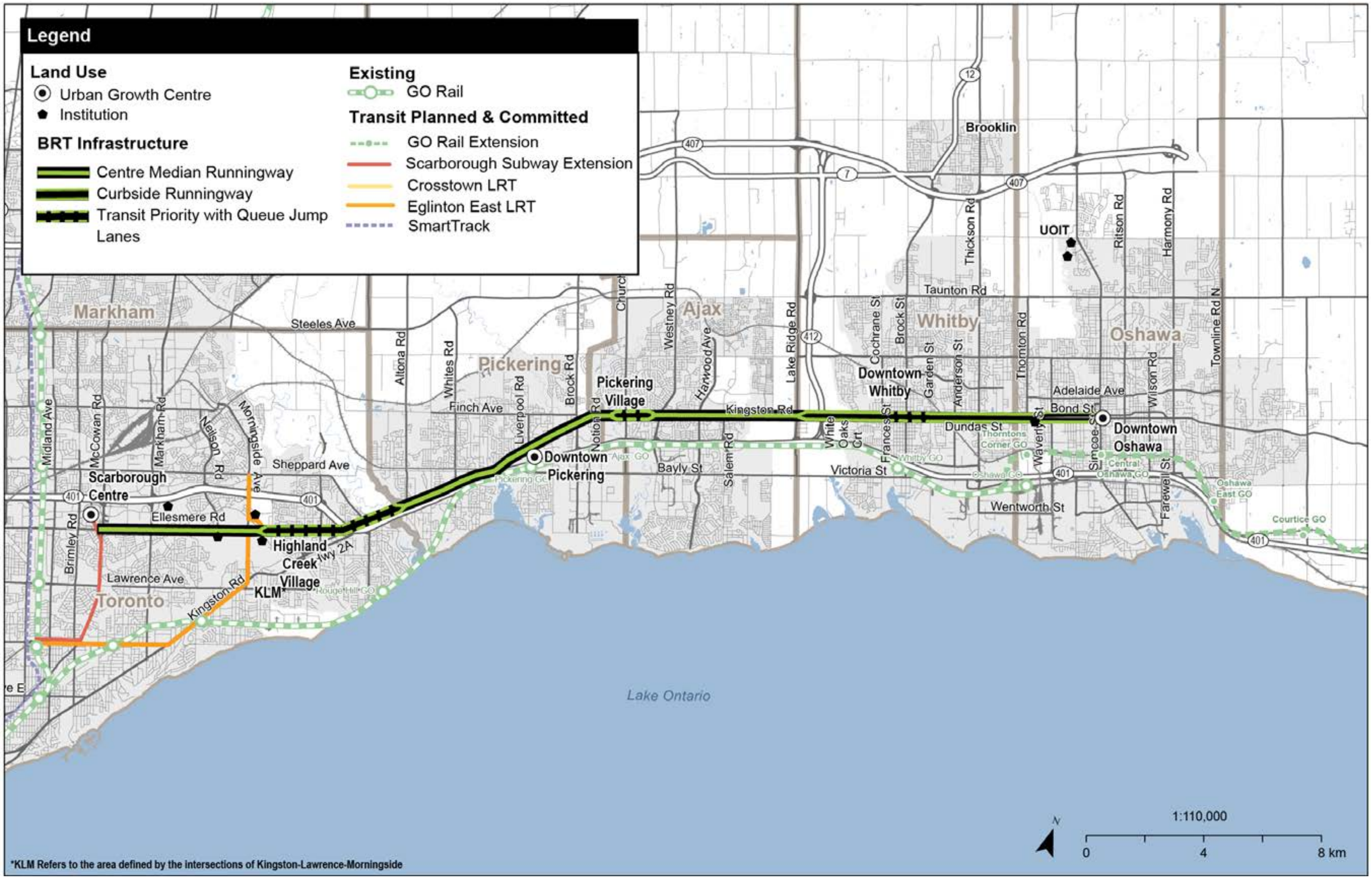


Exhibit 4.2: Curbside Alternative Infrastructure Concept

Exhibit 4.3: Hybrid Alternative Infrastructure Concept



5 Strategic Case

The strategic case evaluation framework for the IBC was adapted from the Draft 2041 RTP, Durham TMP and the City of Toronto's Rapid Transit Evaluation Framework. The approach assessed each rapid transit alternative in terms of the benefits that are delivered for people, places, and prosperity and resilience.

5.1 People

5.1.1 Ridership Forecasts and Travel Demand

Corridor ridership forecasts were obtained from the GGHM v4. Forecasts were derived for 2041 with the BRT corridor and for the base case which assumes no BRT on the corridor. Continued population and employment growth in Durham Region and Scarborough is expected to lead to increasing levels of travel demand in the study corridor. Given that there are limited opportunities to improve road capacity, this new demand will need to be accommodated by adequate transit services.

Exhibit 5.1 illustrates modelled peak direction (westbound) transit demand crossing major locations in 2011 and in 2041 for both the 2041 Base Case, and with BRT. All three locations show increases in transit demand between 2011 and 2041, with additional increases in demand in response to the introduction of BRT. In particular, corridor transit demand crossing the Durham-Toronto boundary and continuing westbound is forecast to increase substantially after the introduction of BRT. This is primarily due to the travel time savings for TTC and DRT services introduced by exclusive centre median bus lanes in the western section.

Exhibit 5.1: 2-hour AM Peak Transit Load at Screenline Locations

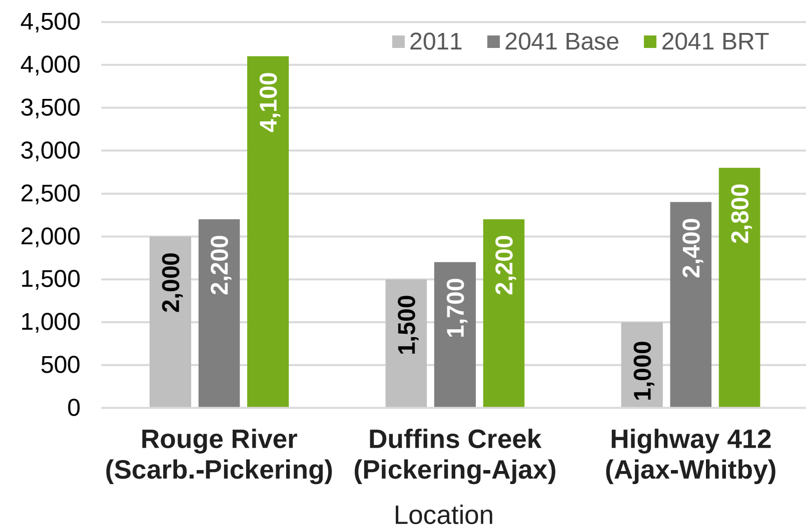
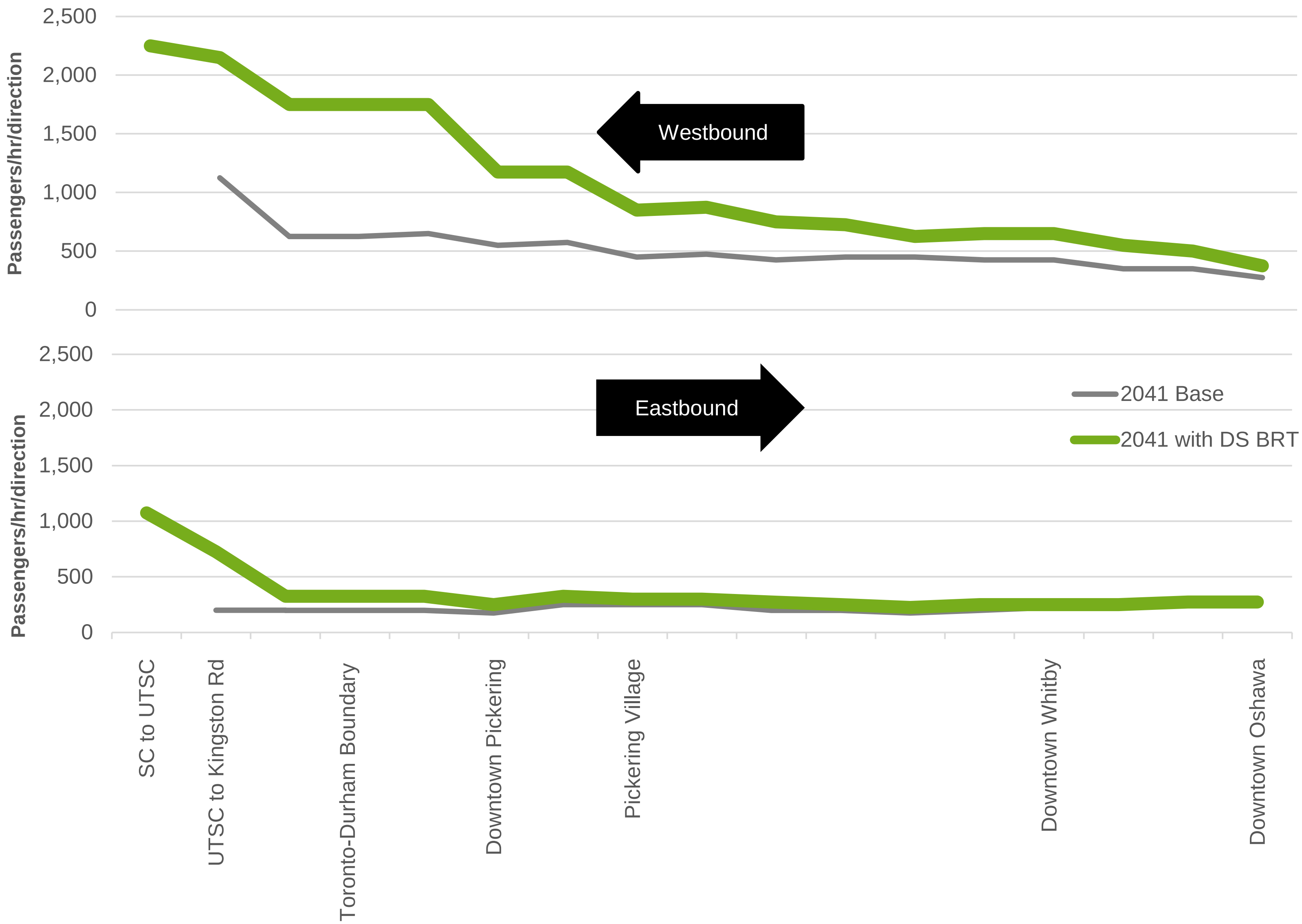


Exhibit 5.2 illustrates the eastbound and westbound ridership profiles of the corridor for the 2041 Base Case, and 2041 with BRT.

Exhibit 5.2: 2041 AM Peak Hour Transit Load Profile (Passengers/Hour/Direction)



The profiles show a substantial ridership benefit introduced by building and operating the BRT, with segment ridership increasing by as much as 180% at the western end of the corridor. While this benefit is most pronounced between Pickering and Scarborough, sections of Durham Region show at least a 20% growth in ridership between the BRT forecasts versus the base case. This increase in demand toward the west end of the corridor and especially into Scarborough is an important consideration for the development of a preferred service concept to support BRT infrastructure which is introduced in Section 3.2 and described in greater detail in Section 6.3.1.

Total ridership is categorized into two groups:

1. **Existing Riders** – Riders that would be on the system regardless of the investment (base case riders)
2. **New Riders** – Riders that are attracted to transit as a result of the investment.

The ridership for each alternative is shown in Exhibit 5.3.

Ridership forecasts were extracted from the 2031 and 2041 GGHM v4. The growth rate between 2031 and 2041 (7%) was assumed to be linear and applied to calculate growth in ridership, Vehicle Kilometres Travelled (VKTs) reduced, and Transit Travel Time savings from the start of operations in 2029 to when ridership was assumed to remain constant in 2047.

These ridership forecasts are pivotal in calculating several of the economic benefits that are presented in the Economic Case.

Exhibit 5.3: 2041 2 hour AM Peak Period Ridership

Year	Centre Median		Curbside		Hybrid	
	Existing	New	Existing	New	Existing	New
2031	5,700	1,300	-	-	-	-
2041	6,100	1,400	6,100	1,000	6,100	1,200

The Centre Median alternative has the highest ridership due to the benefits summarized in this section, and the economic case, which include a higher operating speed and improved reliability.

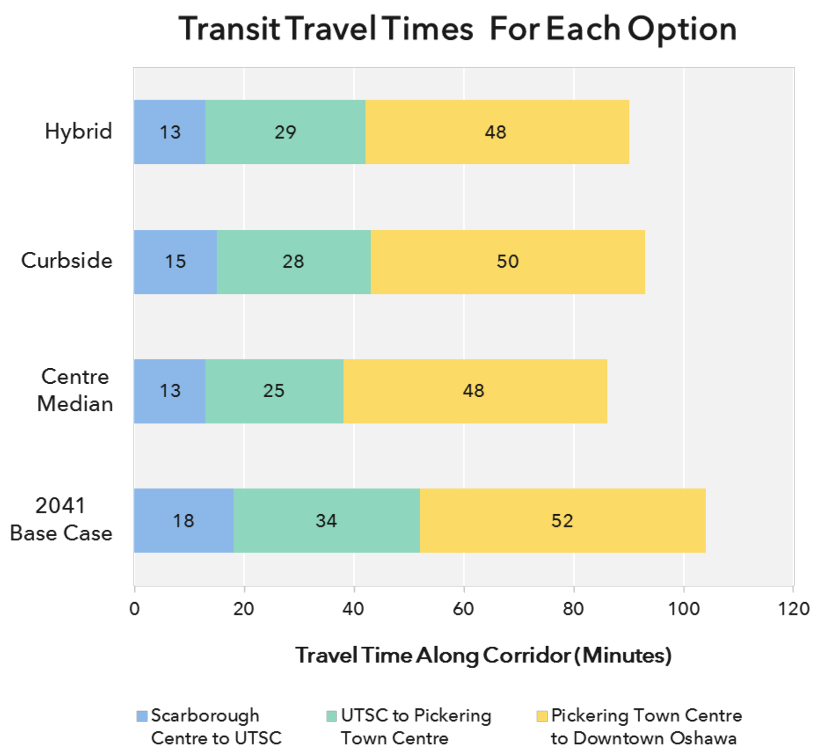
5.1.2 Transit User Experience

A rapid transit system should be designed to significantly improve the transit user experience compared to conventional transit. This is realized in the form of short wait times, schedule adherence (reliability), faster travel times and high quality amenities that make travel seamless and comfortable.

The operational efficiencies of rapid transit, such as travel times and reliability, are gained by separating buses from mixed traffic. As such, the degree to which these operational efficiencies are realized depends on the degree of separation throughout the corridor and whether or not buses are running in exclusive median lanes or curbside lanes. These efficiencies are quantifiable and can be accounted for by using metrics such as operating speed and schedule adherence.

Average operating speed was used to calculate the in-vehicle travel time between select destinations along the corridor for each of three business case alternatives and the base case are shown in Exhibit 5.4.

Exhibit 5.4: Transit Travel Times between Destinations for Each Alternative



While all three rapid transit alternatives deliver faster travel times compared to the 2041 base case, the centre median alternative has the fastest in vehicle travel time due to efficiencies gained by having centre-median bus operations for the majority of the corridor.

Savings between Pickering and Scarborough Centre are the most significant on the Centre Median and Hybrid alternatives, especially when considering the ridership demand through the western section of the corridor.

As mentioned, reliability is another operational efficiency of separating buses from mixed traffic. Reliability can be measured using schedule adherence statistics. While exclusive lanes provider improved reliability, these benefits are especially realized with a centre median configuration and less so with curbside operations.

Based on 2015 route performance statistics, TTC buses (Route 95) along the Ellesmere Road corridor experienced a delay of at least 3 minutes, 39% of the trips.

Without adequate schedule adherence calculations for the 2041 condition, 3 minutes was assumed to be the average delay experienced by passengers in 2041 in the base case condition. The average delay for each of the business case alternatives and the base case alternative are shown in Exhibit 5.5. Average delay for the centre median was assumed to be 0, since traffic congestion does not effect on-time performance for buses in a centre median running way. Since curbside operation can be affected by congestion and right turning vehicles, 1 minute average delay was assumed for the curbside alternative and 0.25 minutes assumed for the hybrid alternative.

Exhibit 5.5: On-time Performance (Average Delay) for the Business Case Alternatives

	Base Case	Centre Median	Curbside	Hybrid
Average Delay	3 min	0 min	1 min	0.25 min

The overall monetized value of this benefit is calculated as part of the economic case, but Centre Median and Hybrid alternatives provide the greatest benefits to reliability of transit service along the corridor.

In additional to these operating benefits, implementing rapid transit improves society's perception of transit and improves the view of transit as an efficient and convenient way to travel. Incremental improvements to BRT infrastructure along the corridor, and service improvements has resulted in a significant ridership increase over the last 5 years.

5.1.3 Mobility Choice

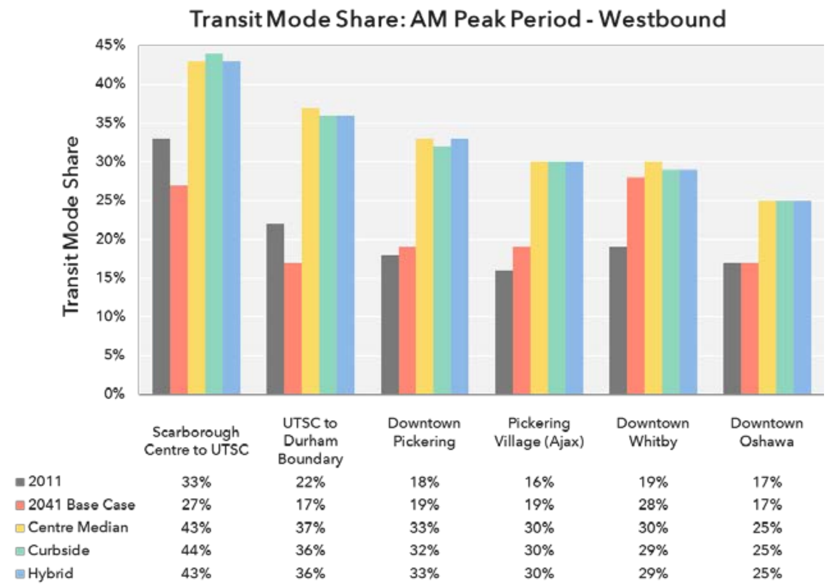
Rapid transit service is a key element to effectively encouraging reliance on automobiles and a shift toward transit use. Once rapid transit is in place to provide the backbone of a multi-modal system, other alternative modes, such as cycling, walking, car share and bike share can be supported to encourage even greater mobility choice.

In the context of the Durham-Scarborough BRT Corridor, the demand for travel will need to be satisfied through a high-capacity form of transit that is connected to the region's broader network and provide seamless mobility across the region.

A mode shift from auto-based travel to transit is the best indicator for improved mobility choice and can be used to determine the effectiveness that rapid transit has on facilitating this mode shift. Transit mode shares at six different areas along the BRT corridor were derived from the GGHM v4 and are presented in Exhibit 5.6.

Transit mode share for each of the three alternatives is significantly higher than 2011 and the 2041 Base Case. All three alternatives show significant, however the Centre Median alternative performs slightly better in 3 of 5 corridor segments. The largest change in mode share along the corridor occurs crossing the Toronto-Durham boundary, as well as in Downtown Pickering with an approximate 20% difference between the 2041 Base Case and BRT.

Exhibit 5.6: Transit Mode Shares (2 hour AM Peak Period – Westbound)



5.1.4 Social Inclusivity and Accessibility

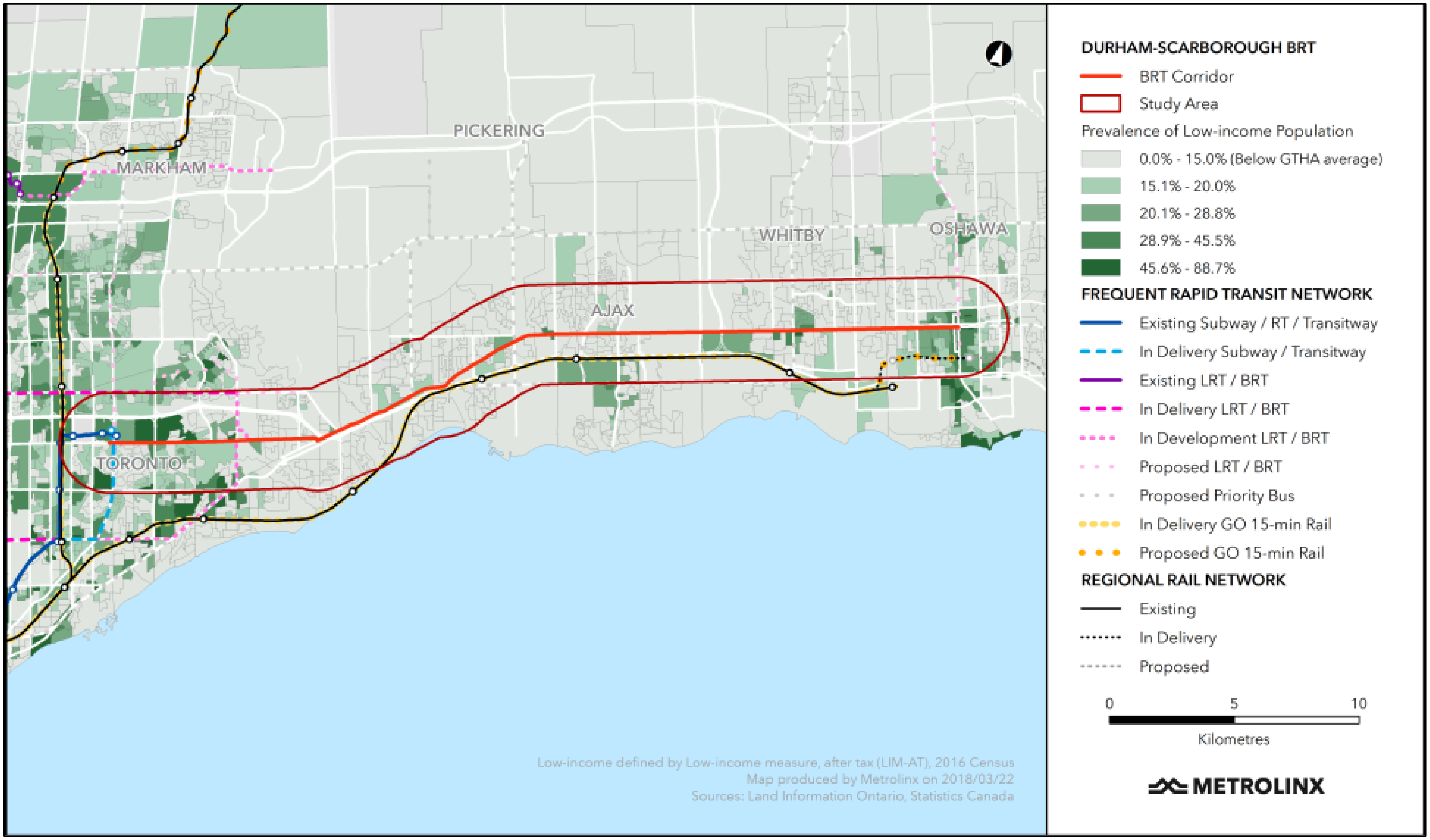
The quality of transit service varies considerably throughout the GTHA, yet the distribution of quality transit service does not necessarily align with those that need it the most. The 2041 RTP intends to improve this condition by creating more travel options that are more affordable for all residents and reducing vehicle ownership across the region.

Within the defined 2-km BRT corridor study area, all three alternatives would deliver rapid transit to approximately 645,000 residents and 229,000 jobs in 2041.

The corridor will also connect areas of social need as parts of the study area have a higher portion of low income[8] residents than the GTHA on average. On average across the GTHA, 15.1% of incomes are considered low income. In the Scarborough and Oshawa portions of the corridor, 19.8% and 18.7% of the population are considered low income, respectively. The prevalence of low income population along the study corridor is mapped in Exhibit 5.7.

[8] Statistics Canada, LIM-AT (Low-income measure after tax), 2015

Exhibit 5.7: Prevalence of Low Income Population in the Study Area



Source: Statistics Canada, LIM-AT (Low-income measure after tax), 2015

5.1.5 Evaluation Summary – People

Based on the evaluation of the strategic benefits to people, the centre median alternative provides the greatest benefits to the transit user but there are relatively equal benefits to each alternative for mobility choice and social inclusivity. This suggests significant strategic benefits to investing in BRT between Durham Region and the City of Toronto, maximizing specific project benefits through refinements of the alternative designs.

An evaluation summary of the People strategic case category is provided in Exhibit 5.8.

Exhibit 5.8: Strategic Case Evaluation Summary – People

	Centre Median	Curbside	Hybrid
Transit User Experience	✓✓✓	✓	✓✓
Mobility Choice	✓✓	✓✓	✓✓
Social Inclusivity & Accessibility	✓	✓	✓
People (Total)	✓✓✓✓✓✓	✓✓✓✓	✓✓✓✓✓

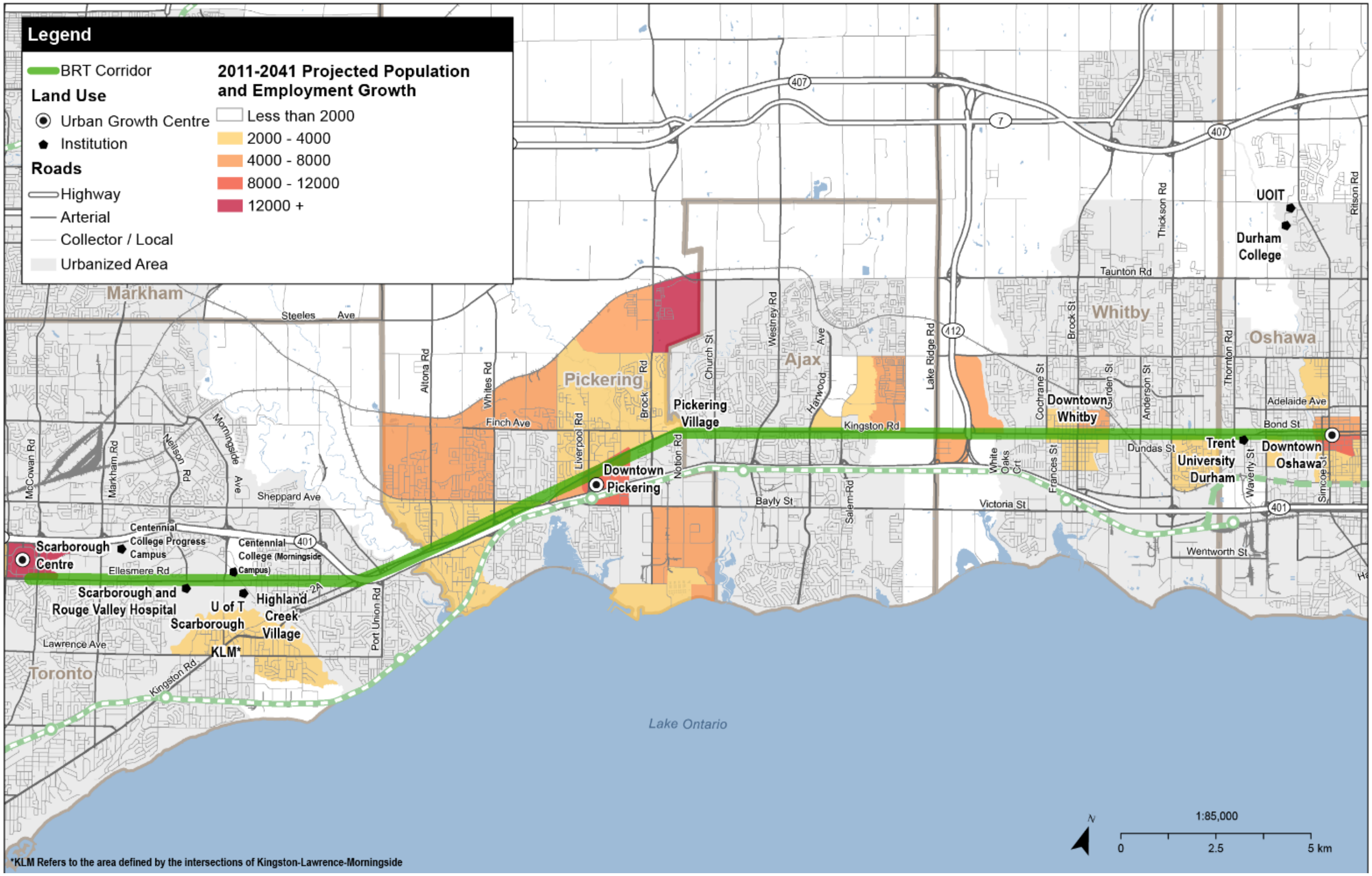
5.2 Places

5.2.1 Shaping Growth

Significant population and employment growth is expected in the corridor in the next 25 years. Based on these forecasts, the corridor is expected to host 215,000 more residents and 66,000 more jobs. This growth is well distributed throughout the BRT study area but is most significant in North Pickering and in the provincially designated UGC's along the BRT corridor, as identified in Exhibit 5.9.

Investment in rapid transit is often a catalyst for a more intensified form of development along the corridor that it serves. This has been exemplified in several systems across North America, where BRT was brought into a suburban context and transit oriented development followed. Most notably, this has occurred in Los Angeles (Orange Line BRT), Ottawa (Transitway BRT) and Eugene, Oregon (Emerald Express). In these cases, the total amount of Transit Oriented Development (TOD) investment was estimated to be in the range of $100 Million to $1 Billion. Given the high rate of growth forecasted along the rapid transit corridor, the existing low density urban form, and the supply of developable parcels, there is a potential for the value of TOD investment to be significant across the corridor.

Exhibit 5.9: Projected Change in Absolute Population and Employment in the BRT Study Area



The level of investment in rapid transit can play a part in the perception of the system from a developer's perspective. A fragmented system with only strategic transit priority improvements might be perceived as simply an enhanced bus route, whereas a fully separated, centre-median bus lane creates the perception of high-quality rapid transit route and a permanent infrastructure investment, which could then spur private development investment in TOD.

Of the three alternatives, the centre median and hybrid alternatives would create the greatest perception of transit infrastructure investment and permanence as it will be more visible within the corridor. This will attract a higher level of development than would otherwise occur in the base case condition.

5.2.2 Public Health and Environmental Quality

Per person-kilometre travelled, transit emits significantly less emissions than a private automobile, contributing to a reduction in greenhouse gas emissions and improved air quality. By encouraging a more compact transit oriented development, rapid transit can become a catalyst for creating more walkable communities, leading to an improved quality of life for residents.

The benefits of each of the alternatives are quantified in the economic case, but the Centre Median alternative offers the highest benefits to the emissions saved, compared to the Hybrid and Curbside alternatives.

Transit journeys are also significantly safer, in terms of collisions per person-kilometre travelled compared to journeys by personal automobiles. A higher transit mode share therefore translates into safety benefits which can be measured at a societal level and through a reduced demand for emergency and health services. These savings are also quantified in the economic case, but the Centre Median and Hybrid alternatives generate significant more safety savings than Curbside operation.

5.2.3 Community and Heritage

Since rapid transit can have a significant impact on built form and be a catalyst for new development in a corridor, it can pose a threat to the stability and heritage of the existing neighbourhood fabric.

There are several areas of the corridor that have heritage significance or a strong community identity which should be preserved as part of the BRT corridor.

Each alternative will have a different level of impact on the surrounding community and heritage features. By limiting expansion to areas of need and identifying opportunity to preserve the existing right-of-way, the Hybrid alternative provides less disruption to the surrounding built form, then the Centre Median and Curbside alternatives. These impacts will need to be further analyzed as part of the PDBC.

5.2.4 Evaluation Summary – Places

Based on the evaluation of the strategic benefits to places, the centre median alternative provides the greatest benefit in terms of shaping growth compared to the other two alternatives. When it comes to public health and environmental quality, all three alternatives deliver similar benefits. The Hybrid alternative delivers the greatest benefit when it comes to community and heritage. An evaluation summary of the Places strategic case category is provided in Exhibit 5.10

Exhibit 5.10: Strategic Case Evaluation Summary – Places

	Centre Median	Curbside	Hybrid
Shaping Growth	✓✓	✓	✓
Public Health & Environment	✓	✓	✓
Community & Heritage	-	-	✓
Places (Total)	✓✓✓	✓✓	✓✓✓

5.3 Prosperity and Resilience

5.3.1 Attracting sustainable development

Building rapid transit along a high growth corridor has the potential to attract types of developments that market a car-free lifestyle, which is enabled by the presence of higher order transit.

A transit system that is visibly recognized as fast and efficient has a greater potential to attract these types of developments than a lower priority transit system.

As acknowledged in Section 5.2.1 Shaping Growth, the Centre Median alternative commands greater recognition as a quality transit corridor compared to curbside operation, and especially compared to the 2041 base case alternative.

5.3.2 Affordability

Discussion regarding affordability will be the focus of the Financial Case chapter of this business case. All three alternatives have similar ranges of capital costs, with the Centre Median alternative higher than the Hybrid and Curbside alternatives.

5.3.3 Resilience to Advancements in New Mobility Technology

The impending arrival of connected and autonomous vehicle (CAV) technology that can offer ride-hailing services for a fraction of the cost of existing ride-hailing services is expected to shift the micro-economics of transportation choice.

With the relatively low cost and door-to-door service that these vehicles will offer, there is a risk that these services will replace traditional transit trips. As such, there are additional risks to investing in transit infrastructure projects. It will be important for transit agencies to leverage CAV technology to improve their own services, while also considering updates to their service strategy and role as a transportation provider.

Rapid transit will continue to be the backbone of a multi-modal transportation system in the future and just like today, providing BRT to optimize the efficient movement of people will be a priority.

5.3.4 Evaluation Summary – Prosperity and Resilience

Based on the evaluation of the strategic benefits of Prosperity and Resilience, the Centre Median alternative provides the greatest benefit in terms of attracting sustainable development. When it comes to affordability, the Hybrid and Curbside alternatives are the most affordable however the curbside alternative does not produce the same level of benefits as the other two alternatives. All three alternatives provide equal benefit in terms of resilience to advancements in new mobility. An evaluation summary of the Prosperity and Resilience strategic case category is provided in Exhibit 5.11.

Exhibit 5.11: Strategic Case Evaluation Summary – Prosperity and Resilience

	Centre Median	Curbside	Hybrid
Attracting Sustainable Development	✓✓	✓	✓
Affordability	-	✓	✓✓
Resilience to Advancements in New Mobility	✓✓✓	✓✓✓	✓✓✓
Prosperity and Resilience (Total)	✓✓✓✓✓	✓✓✓✓✓	✓✓✓✓✓✓

6 Financial Case

6.1 Fare Revenue

Fare revenue is directly related to growth in ridership and is used to measure the cost effectiveness of a system and to justify investment service improvements and infrastructure.

Incremental fare revenue is the amount of additional revenue of each alternative compared to the base case and is the product of new riders and the average transit fare. It does not account for lost fares due to fare integration. The Centre Median Alternative generates approximately $47 Million in incremental fare revenue over the project life span. The Curbside alternative generate $34 Million and the Hybrid alternative $41 M.

6.2 Capital Costs

6.2.1 Estimating Capital Costs

High-level capital costs were estimated for comparative purposes for this study, and are within an appropriate range to consider for an IBC. These capital costs will be further refined during the PDBC, and during TPAP preparation.

Capital costs for each of the rapid transit alternatives were determined by applying itemized capital cost inputs on a segment by segment basis.

The itemized capital costs were based on the costs from the Durham Region Highway 2 EA, costs from existing and ongoing improvements to the corridor, and the costs of other BRT systems in North America.

Costs are inclusive of all costs that would be associated with construction of the project and purchase of an articulated bus fleet, property acquisition, utilities relocation/replacement, stop platforms and terminal infrastructure including electric charging stations. These costs also account for road work that has already been completed in anticipation of rapid transit implementation, such as structure widening or property acquisitions.

Exhibit 6.1 provides a high level breakdown of the capital costs of the alternative in 2018 real dollars. A detailed list of itemized costs by segment can be found in Appendix C.

Exhibit 6.1: Estimated Capital Costs (Millions 2018$)

Cost Item	Centre Median	Curbside	Hybrid
Toronto Segment Cost	$82 M	$77 M	$66 M
Durham Segment Cost	$247 M	$206 M	$230 M
Total Segment Cost	$329 M	$283 M	$296 M
Contingency (50%)	$165 M	$142 M	$148 M
Project Management (10%)	$33 M	$28 M	$30 M
Engineering (15%)	$49 M	$42 M	$44 M
Total Infrastructure Cost	$576 M	$496 M	$518 M
Cost/km	$16 M	$14 M	$14 M
Fleet	$66 M	$71 M	$67 M
Total Capital Cost	**$642 M**	**$567 M**	**$585 M**

6.2.2 Construction Phasing

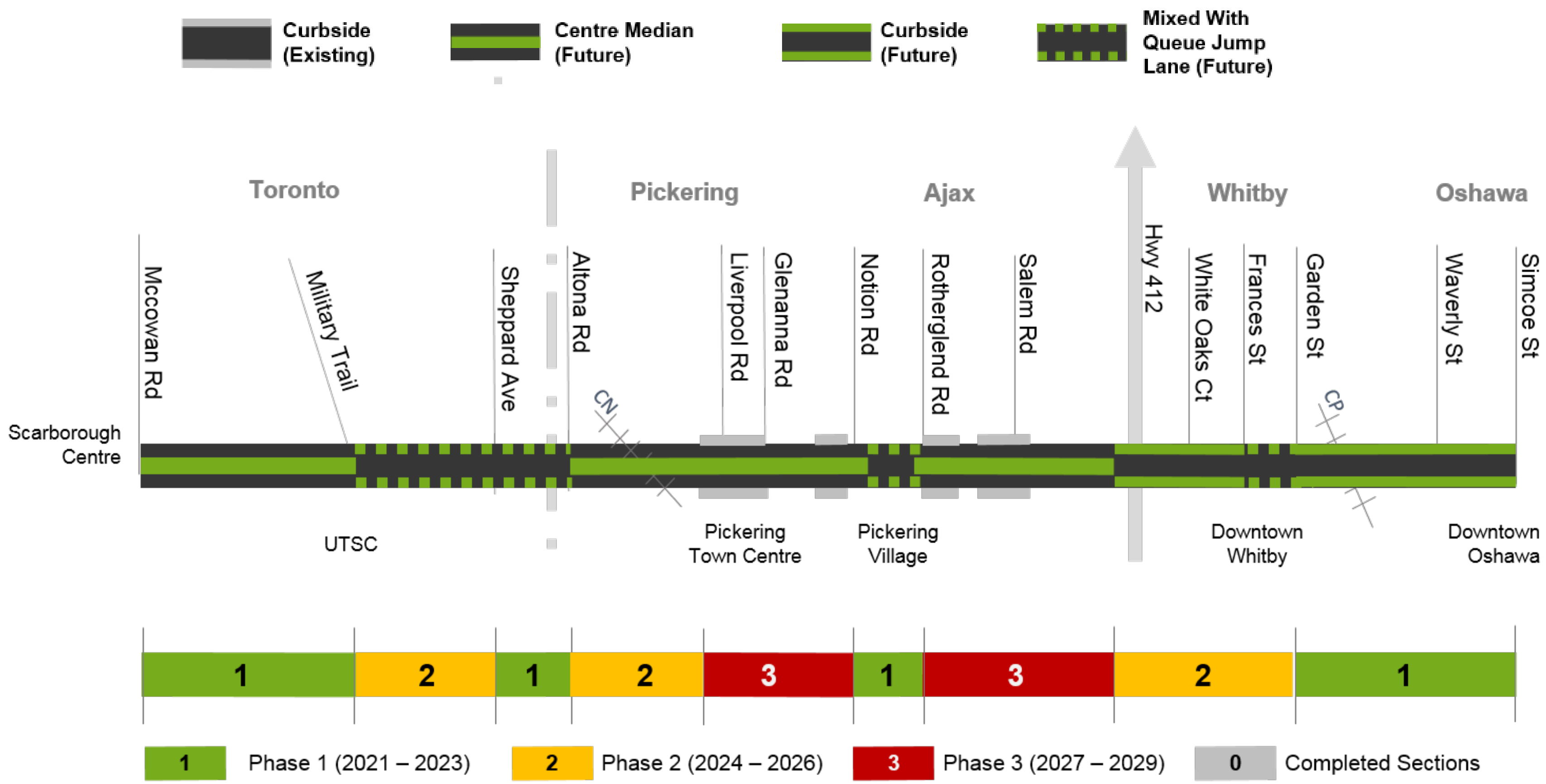
For the purpose of this IBC, construction phasing was developed to assist in the capital cost estimations, and to reflect the existing investment in the corridor, to minimize any potential throw-away costs of converting existing curbside infrastructure to Centre Median. The following guiding principles were developed to assist in construction phasing considerations:

- Approximately 10 years should pass between the opening of curbside lanes and commencing their replacement with centre median lanes.
- Areas with existing congestion should be prioritized.
- Filling the gaps between existing curbside operations should be prioritized.

A more detailed phasing approach will be considered as part of the PDBC and included in the assessment of procurement delivery approaches for the corridor.

Exhibit 6.2 illustrates the proposed phasing strategy. It was assumed that construction would begin in 2021, with completion in 2029. The forecasts for 2031 show high ridership demand by the time the BRT is operational in 2029.

Exhibit 6.2: Construction Phasing



6.3 Operating Costs

6.3.1 Service Concept

Total revenue hours were determined based on the Two-Branch service concept as described in Exhibit 3.6 and an assumed daily operating period (20 hours) which was separated into peak (6 hours) and off-peak (14 hours) operating periods, each with different service headways.

Headways were applied to match demand and increase over time using the 2031 and 2041 projections. Three eras of operations were introduced to reflect the change in demand over the lifecycle of the project.

1. 1-5 years (2026-2030)
2. 6-15 years (2031-2040)
3. 16 years and beyond (2041+)

The assumed service concept for this IBC, which includes off-peak and segment by segment headways for each period, is provided in Appendix D.

6.3.2 Revenue Hours

Operating costs were estimated by applying a cost per revenue hour of $102. This cost assumes the operation of electric buses, which have lower operating and maintenance costs than standard buses.

The annual revenue hours were calculated using the input parameters identified in Exhibit 6.3 and the service strategy which is detailed in Appendix D. The operating speeds for the three alternatives were calculated and a lower operating speed was allocated to the curbside alternative to account for a slightly slower operating speed as well as to account for delays due to right-turning traffic. This speed differential also accounts for the reliability differences from an operations perspective, contributing to differences in fleet size.

These calculations assisted in the determination of fleet requirements which were accounted for in the capital costs.

Exhibit 6.4 provides a summary of the annual operating and maintenance costs for each time period for each of the alternatives, including the base case, in 2018 real dollars.

The base case operating cost assumes service improvements to the existing PULSE service to match base-case demand and accounts for savings from possible rationalization and reallocation of some TTC service along the BRT corridor.

The incremental difference in base case operating costs and BRT operating costs works out to be approximately $4 million per year. Over the 30 year evaluation period of the project, the present value incremental operating cost equates to $75 Million for the Centre Median alternative, $97 Million for the Curbside alternative and $83 Million for the Hybrid alternative.

Exhibit 6.3: Operating Cost Input Variables

Input	Value	Unit
Input Variables		
Centre Median Operating Speed	25	km/h
Curbside Operating Speed	23	km/h
Hybrid Operating Speed	24	km/h
Terminal Time	0.1	portion
Spare Ratio	0.2	ratio
Cost/Revenue Hour	102	$

Exhibit 6.4: Revenue Hours and Operating Costs (Real Dollars)

Section and Period	Annual Rev. Hrs	Annual O+M
Base Case		
Year 1-5 Total	147,000	$15,000,000
Year 6-15 Total	176,000	$18,000,000
Year 16+ Total	206,000	$21,000,000
Centre Median		
Year 1-5 Total	186,636	$19,080,108
Year 6-15 Total	230,738	$23,588,728
Year 16+ Total	256,136	$26,185,208
Curbside		
Year 1-5 Total	196,778	$20,116,941
Year 6-15 Total	246,540	$25,204,193
Year 16+ Total	273,432	$27,953,407
Hybrid		
Year 1-5 Total	188,130	$19,232,842
Year 6-15 Total	237,892	$24,320,094
Year 16+ Total	263,290	$26,916,573

7 Economic Case

The economic case was intended to assess the economic benefits that could be realized by each of the rapid transit alternatives over a 30 year period from the start of operations. For each alternative, each of the economic benefits was monetized and compared to the total cost of the alternative to determine a benefit cost ratio.

7.1 Transportation User Impacts

7.1.1 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.

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. New riders incur half the monetary benefits of existing riders, which is a product of total hours saved and half the value of time.

The total accumulated value of this benefit is $376 M for the Centre Median alternative, and $367 M for the Curbside alternative and $374 M for the Hybrid alternative.

7.1.2 Reliability/Quality Benefits

Rapid transit provides more reliable service, resulting in more consistent schedule adherence which is highly valued by transit passengers and operations. A reliability ratio of 1.76, as suggested by Metrolinx, is applied to the value of time to account for the additional value that transit passengers place on reliability compared to travel time. The reliability benefit is based on the difference in average delay for each alternative, as identified in Exhibit 5.5. The reduction in average delay between the 2041 base case and each rapid transit alternative is then multiplied by the reliability ratio and the value of time.

The total accumulated value of this benefit is $183 M for the Centre Median alternative and $168 for the Hybrid alternative. This benefit is substantially more than the reliability benefits of curbside operations at $122 M.

7.1.3 Automobile Operating Cost Savings

Converting an automobile trip to a transit trip saves users on automobile operating costs from the mode switch, since transit costs significantly less than operating an automobile. Two different approaches can be applied to monetize this benefit.

1. Assumes that for every VKT reduced, drivers save the average cost of operating and owning an automobile for 1 km, which is $0.63 as stated by the Canadian Automobile Association (CAA).
2. Assumes that for every VKT reduced, drivers save the average cost of operating a vehicle for 1 km, which is $0.18 as stated by CAA.

For this IBC, a value of $0.63 was used which is standard across all Metrolinx IBCs for rapid transit projects.

The Centre Median and Hybrid alternatives resulted in larger automobile operating cost savings at $132 M and $115 M respectively. The curbside alternative generated $94 M automobile operating cost savings.

7.1.4 Safety Savings

The prevalence of fatal traffic collisions per kilometre travelled on transit is significantly less than per kilometre travelled by personal automobile. There is a significant benefit to society as a result of a mode shift from automobile to transit that was monetized in this business case. The benefit was monetized by applying a value of $0.08 for every VKT reduced.

The total accumulated value of this benefit $17 M for the Centre Median alternative, and $15 M for the Hybrid alternative. While these safety savings are similar between these two options, the Curbside alternative only generated $12 M in savings. This suggests a significant safety benefit between Centre Median and Curbside BRT operations. This will be an important consideration in the PDBC when refining the design to ensure that maximum safety benefits of any existing curbside infrastructure is maintained.

7.1.5 Congestion Reduction

Each trip that shifts from automobile to transit represents a reduction in congestion. This benefit was monetized by applying a value of $0.03 for every VKT reduced during the off peak period and $0.30 for every VKT reduced during the peak period.

The total accumulated value of this benefit is $13 M for the Centre Median alternative, $12 M for the Hybrid and $10 M for the Curbside.

7.2 Environmental Impacts

7.2.1 Emissions Savings

The emissions produced by a transit kilometre travelled is less than that of an automobile. A mode shift toward transit therefore results in a reduction in tailpipe emissions. This benefit was monetized by applying a value of $0.01 for every VKT reduced.

The total accumulated value of this benefit is $3 M for the Centre Median alternative, and $2 M for both the Hybrid and Curbside alternatives. While there is minimal differences in the quantifiable emission savings as a result of the mode shifts along the corridor, all three rapid transit alternatives generated significant transit mode shift in the corridor, as outlined in Section 5.1.1. This is an important strategic benefit to the Durham-Scarborough corridor.

7.3 Benefit Cost Ratio

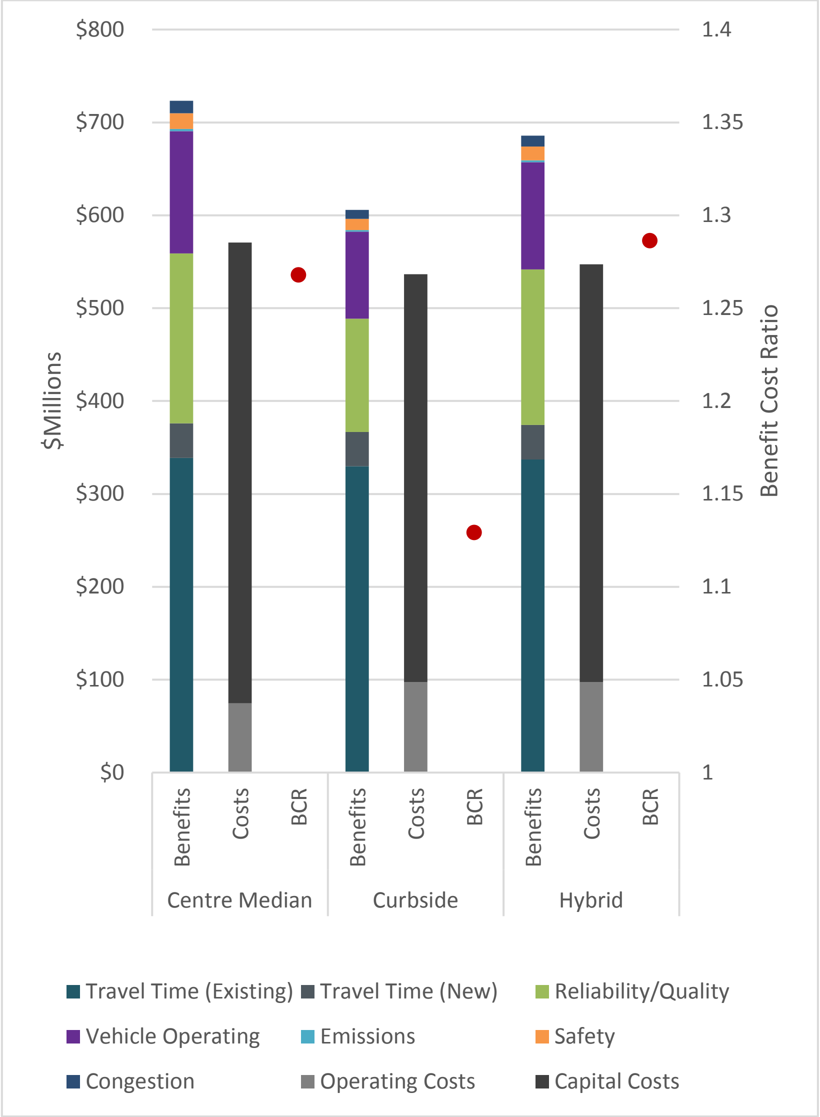
A benefit to cost ratio (BCR) was calculated to assess the relative economic benefits of each rapid transit alternative compared to the 2041 base case. All of the economic benefits that were identified in this section contribute to the total benefits, while the present value lifecycle capital and operating costs contribute to the costs. The summary of the total benefits, total costs, and resulting BCR is provided in Exhibit 7.1.

Based on the results from the economic case, the Hybrid alternative achieved the greatest benefit per dollar invested with a BCR of 1.29. This is reflected in the lower capital costs of the Hybrid alternative as it leverages opportunities to provide optimal right-of-way solutions in each section of the corridor. Given the similarity between the Centre Median and Hybrid alternatives, it is recommended that both of these options proceed to PDBC for further refinement.

Exhibit 7.1: Summary of Benefits and Costs (PV $Millions) (Table)

	Centre Median	Curbside	Hybrid
Transportation and Environmental Benefits (Millions PV$)			
Travel Time (Existing)	$339	$330	$337
Travel Time (New)	$37	$37	$37
Reliability/Quality	$183	$122	$168
Vehicle Operating	$132	$94	$115
Safety	$17	$12	$15
Congestion	$13	$10	$12
Emissions Reduction	$3	$2	$2
Total Benefits	**$723**	**$606**	**$686**
Costs ($PV)			
Operating Costs	$75	$97	$84
Capital Costs	$496	$439	$449
Total Costs	**$571**	**$536**	**$533**
Benefit Cost Ratio			
Net Present Value ($ Millions)	**$153**	**$69**	**$153**
BCR	**1.27**	**1.13**	**1.29**

Exhibit 7.2: Summary of Benefits and Costs (PV $Millions) (Chart)



8 Deliverability and Operations Case

There are several constraints identified in this IBC that may impact the deliverability and operations of the Durham-Scarborough BRT. Further analysis and the identification of mitigation measures for these constraints will be completed as part of the PDBC. Project delivery and risk management will also be considered as part of the deliverability and operational case of the PDBC.

The constraints identified are grouped into the following categories:

- Railway crossings;
- Crossing of natural features;
- Minimizing throw-away costs (rebuilding recent improvements); and
- Consideration of Highway 2 corridor ownership.

8.1 Railway Crossings

There are two railway crossings along the corridor, both of which overpass Highway 2 in Durham Region. Widening of the right-of-way under both these bridges was assumed for this IBC.

Pickering CN Rail Crossing

The Pickering CN Rail crossing, depicted in Exhibit 8.1, was identified for widening as part of Durham Region's Highway 2 EA Amendment in 2014 to accommodate continuous dedicated bus lanes through Pickering. The original 2011 Highway 2 EA did not include this section of Highway 2 in its scope. Widening this section requires significant capital investment and may result in disruption to the operations of the rail corridor for a period of time.

For the purpose of this IBC, the cost of widening of this bridge to allow for a 6-lane roadway cross section is assumed to accommodate all the rapid transit alternatives.

Exhibit 8.1: CN Rail Crossing of Highway 2 in Pickering

Imagery: Google, Map data: Google

Whitby CP Rail Crossing

Similar to the CN Rail crossing in Pickering, widening of the CP Rail structure in Whitby, shown in Exhibit 8.2, would be required to accommodate a 6-lane roadway which would include two BRT lanes.

Significant capital investment would be required accommodate roadway widening under this structure, which may disrupt CP's rail operations for a period of time.

Exhibit 8.2: CP Rail Crossing of Highway 2 in Whitby

Imagery: Google, Map data: Google

8.2 Crossing Natural Features

There are some significant natural features along the Durham-Scarborough corridor. Widening through these areas may pose significant challenges for environmental mitigation and ultimately the deliverability of any right-of-way widening. These natural features identified include:

- East Highland Creek;
- Rouge River Valley;
- Duffins Creek;
- Lynde Creek; and
- Oshawa Creek.

8.3 Minimizing Throw-Away Costs (Rebuilding Recent Improvements)

Building rapid transit represents a significant milestone for a community. In planning, and more significantly, during construction, the value of rapid transit investments often undergo public scrutiny as the disruption and the benefits that the project delivers in the long term can sometimes be difficult to understand.

Durham Region has made significant investments in the corridor to support curbside bus lanes, with a vision for centre median BRT in the future, Road widening in for curbside operation has been completed for conversion to centre median BRT. This suggests that there may not be significant throw-away costs to repurpose these lanes, and there are opportunities to re-purpose the associated stop infrastructure across the DRT network.

Minimizing any throw-away costs will be critical to ensure value-for-money of any infrastructure delivered, and for continued public and stakeholder support of the project.

8.4 Consideration of Highway 2 Corridor Ownership

Highway 2 in Durham Region is multi-jurisdictional, with segments owned by Durham Region, Town of Whitby, and City of Oshawa. Coordination between these jurisdictions is required as the design progresses. Further consideration should be given to ownership of the corridor as the study progresses.

9 Summary of Business Case Evaluation Results

Investing in rapid transit generate significant benefits to growing transit ridership in the region, providing quality transit services to access destinations across Durham Region and the City of Toronto and providing wider economic benefits to the GTHA.

A summary of the core findings from each of the four cases are presented in Exhibit 9.1. The evaluation of the rapid transit alternatives shows there are significant benefit to building and operating a BRT corridor connecting Durham Region and the City of Toronto.

The Hybrid alternative strategically applies elements from the Centre Median and Curbside alternatives where these treatments are most suitable, including transit priority measures in constrained locations. This approach optimizes the value of investment by considering what right-of-way treatment is most suited for the context of each corridor segment. Hybrid and Centre Median are the best performing alternatives, with the Hybrid alternative having a higher benefit-cost ratio (BCR) and lower capital cost. It reflects that curbside operations is preferred over centre median operations in the Oshawa section of the corridor where there is a one-way road couplet operation, and centre median operations is preferred in the east section where traffic and property access needs are higher.

It is recommended that the Hybrid alternative be carried through to the Preliminary Design Business Case.

Exhibit 9.1: Four Chapter Summary Results

	Centre	Curbside	Hybrid
Strategic Case			
People	✓✓✓✓✓✓	✓✓✓✓	✓✓✓✓✓
Places	✓✓✓	✓✓	✓✓
Prosperity and Resilience	✓✓✓✓✓	✓✓✓✓✓	✓✓✓✓✓✓
Additional 2041 2-hr AM Peak Corridor Ridership	1,400	1,000	1,200
Financial Case			
Operating Costs ($PV Millions)	$75	$97	$84
Capital Costs ($PV Millions)	$496	$439	$449
Total Costs ($PV Millions)	$571	$536	$533
Economic Case			
Total Economic Benefits ($PV Millions)	$723	$606	$686
Operating Costs ($PV Millions)	$75	$97	$84
Capital Costs ($PV Millions)	$496	$439	$450
Total Costs($PV Millions)	$571	$536	$533
Benefit Cost Ratio	**1.27**	**1.13**	**1.29**
Deliverability and Operations Case			
Deliverability and Operations	✓	✓✓	✓✓✓

10 Next Steps

The findings and recommendations from this IBC will be published on the Metrolinx website in spring 2018. The PDBC will begin in 2018 with a focus on refining the Hybrid alternative, service concepts and updating the project costs. It is assumed the PDBC will bring the project to an appropriate level of design to support a full funding decision. The work will continue in conjunction with ongoing service and infrastructure improvements underway by DRT and Durham Region. The PDBC will also include a detailed analysis of the identified constrained segments of the corridor, and the appropriate BRT treatments for these sections. A final recommendation on these segments will be provided in this phase of work.

The PDBC will also:

1. Provide opportunities for public and municipal engagement and consultation;
2. Identify property acquisition requirements;
3. Refine the preferred BRT service plan, including costs to existing operators;
4. Undertake detailed traffic analysis, and micro-simulation of BRT operations;
5. Undertake a project risk assessment; and
6. Develop a preferred project procurement and delivery approach

11 Sensitivity Tests

11.1 Fare Integration

Fare integration will eliminate the double fare for cross-boundary bus trips that involve a transfer to a bus in the adjacent municipality. A starting point for understanding the magnitude of the underserved cross-boundary transit market is the current cross-boundary bus transit trip market and the subset of these trips that pay a double fare.

At present, it is estimated that there are approximately 190 a.m. peak hour westbound local transit trips crossing the Durham-Toronto border on the Highway 2 corridor, of which approximately 60% are DRT PULSE and 40% on GO Bus. Among the DRT cross-boundary trips, UTSC (90 alightings) and Meadowvale Road (24 alightings) are the main alighting locations. Data was not available on the number of DRT passengers transferring to TTC (and paying a double fare). However, the transfer rate is considered low by TTC and UTSC is felt to be the final destination for those alighting at this location.

For discussion purposes, a 10% transfer rate between TTC and DRT PULSE might be indicative, reflecting half of the DRT system-wide transfer rate of approximately 20% and the impact of a double fare penalty. In this case, the number of existing cross-boundary transit riders paying a double fare and potentially impacted by fare integration would be small (<20 in the a.m. peak hour).

The majority of cross-boundary transit trips would continue to pay a single fare as the current cross-boundary transit directly serves the key destinations (e.g. UTSC) and thus would largely be unaffected in price terms by a fare integration policy.

The above situation makes it challenging to determine the ridership impacts with fare integration as this market is essentially induced demand and a new transit market that does not currently exist. As such, a traditional fare elasticity approach to estimate the ridership change due to a fare increase does not work effectively with such a small base demand. For instance, a -0.3 fare elasticity (as appropriate for the GTHA) applied to a double-fare to single-fare cross-boundary trip market (i.e. $6 to $3 fare or 50% reduction) would increase peak hour trips by 3, or 15% with an assumed 2011 westbound-cross-boundary bus transit demand of 20 trips.

To estimate the impacts of fare integration in 2041, cross-boundary BRT trips are estimated using the GGHM v4 and assuming the Durham-Scarborough BRT is in place and there is no fare integration. In the westbound direction, Durham-to- Scarborough cross- boundary transit demand in the a.m. peak hour is projected to increase from approximately 190 passengers today to 500 in 2041, reflecting an increase of 160%.

Pivoting from this forecast, a higher transfer rate of 25% is assumed for non-subway-oriented travel (up from an estimated 10% rate in 2011) to reflect a more mature and non-double-fare penalized transfer rate. Cross- boundary trips to Scarborough Centre that transfer to a subway are assumed to incur a double fare as an equitable price for the trip distance.

This results in approximately 575 cross-boundary transit trips with fare integration in 2041 for the a.m. peak westbound direction. This reflects a 15% increase compared to 500 cross-boundary trips without fare integration. Combined two-way, the total cross-boundary bus transit ridership increases from 800 to 920 a.m. peak hour trips without and with fare integration in 2041. On an annual basis, fare integration is estimated to increase two-way cross-boundary local transit ridership in 2041 from 1.88 to 2.16 million, an increase of 281,700 riders.

If transfers to the subway did not incur a double fare, an approximate increase of 75 cross-boundary riders could be assumed in the peak hour.

11.2 Service Integration

With an open door policy in effect, there is an opportunity to rationalize existing services in the Durham-Scarborough corridor, most notably on Ellesmere Road between UTSC and Scarborough Centre. There are four existing TTC routes that operate in this section of the corridor. GO Transit also operates regular service between Scarborough Centre and Oshawa Bus Terminal along Highway 2.

These routes can either be rationalized through truncation / service level adjustments, and may realize the operating benefits of using the BRT infrastructure.

An analysis on the potential operating savings as a result of these efficiencies was conducted.The resulting operating benefits were approximately $7 million annually.

11.3 Eglinton East LRT

The GGHM v4 scenarios for the Durham-Scarborough BRT assumed a network of In Delivery projects, representing committed and fully- funded transit improvements to be in place for the 2041 Base Case.

These In Delivery projects include GO Rail 15-minute, two-way, all-day service on the Lakeshore East corridor to Oshawa , GO Rail extension to Bowmanville, Eglinton Crosstown LRT, Sheppard East LRT and the Scarborough Subway Extension.

The Eglinton East LRT (EELRT) is not presently considered to be In Delivery by Metrolinx1, although planning is underway by the City of Toronto. This LRT facility would extend east on Eglinton Avenue from Kennedy Station (with connections to the Bloor- Danforth / Scarborough Subway and Eglinton Crosstown LRT), to Kingston Road and extending north east to Morningside Avenue / UTSC. An extension to Malvern is also being proposed as part of the study.

To understand the impact of the EELRT on the Durham-Scarborough BRT corridor, a sensitivity test was conducted which included the EELRT as an In Delivery project.

The analysis determined that there would be a 9.4% overall increase in ridership on the Durham-Scarborough BRT but that ridership along Ellesmere Road between Scarborough Centre and UTSC would decrease. This suggests some ridership would be transferring to the EELRT to access other destinations within the City of Toronto.

11.4 Value of Time Growth

A sensitivity test was undertaken on the benefit cost ratios with the value of time (VOT) growth set at 0%. The benefit cost ratios are updated in Exhibit 11.1.

Exhibit 11.1: Sensitivity on Benefit Cost Ratio with 0% VOT Growth

Alternative	BCR
Centre Median	1.08
Curbside	0.95
Hybrid	1.09

The BCR is sensitive to changes to the assumption for growth in value of time. Note that even with a 0% VOT growth rate, the BCR for the Hybrid alternative is still greater than 1.0.

Appendix A

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Corridor Context

Planning Context

The BRT Corridor has undergone significant study over the past decade, with numerous corridor-related studies and investments made in recent years.

The Big Move identified the corridor as a Top 15 Priority Project for implementation, and as progress has been made on the list of priority projects the Durham- Scarborough corridor was considered a ‘Next Wave’ project. The 2041 RTP confirmed the Durham-Scarborough BRT as a priority In-Development project, with advanced stages of planning with funding in place for planning and design.

A summary of the studies and initiatives to provide an overall planning context for the study is presented in this section. Further information on these studies and initiatives is provided under separate cover in the *Durham-Scarborough BRT Background Review Report*.

Previous Durham-Scarborough BRT Studies

The need and justification for rapid transit between Durham and Scarborough has been made in several past studies, including recommendations on technology, right- of-way (curbside versus median lanes) and service concepts, as described below.

Durham-Scarborough Bus Rapid Transit Benefits Case (2010)

This Metrolinx led study was undertaken to assess the benefits of higher-order rapid transit service along Highway 2 in Durham Region and Ellesmere Road in Toronto. The study applied the Benefits Case/Multiple Account Framework used by Metrolinx at the time, which has since been superseded by the current IBC framework and more recent planning developments.

Three BRT options from Simcoe Street in Oshawa to Scarborough Centre were assessed for the 2031 horizon:

- Full BRT with centre alignment and significant transit priority;
- BRT with centre alignment and partial transit priority within Durham and Toronto;
- BRT with centre alignment and partial transit priority in Durham and mixed-traffic operation in Toronto.

It was concluded that all BRT options in the Highway 2-Ellesmere Road corridor would generate significant transportation, environmental and socio-economic benefits, with the Full BRT with centre alignment providing the greatest benefit, but highest cost, with a benefit-cost ratio of 1.2 and capital cost of $498 million ($2009).

At the time of the study, the PULSE service was not in place and thus the base case did not include a transit connection from Durham to Scarborough. The BRT options were therefore providing a completely new service.

Durham Long Term Transit Strategy (2010)

The Durham Long Term Transit Strategy (LTTS) developed a long-term (2031) regional transit strategy, with a focus on higher-order transit.

Highway 2 was identified as the Region's highest priority rapid transit corridor. It was assumed rapid transit on Highway 2 would connect into Toronto, ultimately to Scarborough Centre with a major transit hub located at Sheppard Avenue/ Kingston Road to support transfers to other TTC routes. No detailed analysis or costing was undertaken for the transit network within the City of Toronto.

The preferred option from the LTTS included an LRT focus with Highway 2 widened from four to six lanes with the two median lanes dedicated to LRT. A proof-of- concept functional plan of the corridor was prepared, and the cost to develop the LRT corridor, from the Toronto/Durham boundary to Courtice Road was estimated to be $1 billion.

Preliminary Guidelines for the use of Curbside Lanes and Centre Median Transit Lanes (2011) *and* Application of Preliminary Guidelines (2011)

The purpose of these Durham Region studies was to develop preliminary guidelines for the selection of an appropriate design configuration (curbside lanes or centre median lanes) for on-road rapid transit along Durham Region arterial roads.

Centre median BRT was found to be the preferred option due to greater benefits from service reliability, transit travel time savings, and potential transit mode share increases. However, the centre median option resulted in higher delays to general traffic than the curbside option, where delays remained the same as existing conditions.

Similarly, left turn and pedestrian delays were higher at signalized intersections with the centre median option due to the added protected left-turn phase. The centre median option also required left turn restrictions at unsignalized cross streets, necessitating an allowance for U-turn manoeuvers.

Class Environmental Assessment Highway 2 Transit Priority Measures (2012) *and* Addendum (2014)

To progress Phase 1 of the rapid transit corridor, this EA study examined alternatives for widening Highway 2 in key transit priority opportunity areas.

Two sections of Highway 2 were excluded from the EA study area because of environmental, schedule, and financial constraints, at the CN Rail crossing in Pickering and, at Pickering Village in Ajax. The 2014 Addendum addressed the widening of the Highway 2 segment at the CN Rail crossing, as well as modifications on three of the arterial roads that cross the Highway 2 corridor.

Widening the subject segments of Highway 2 was selected as the preferred design solution, with the additional two lanes being dedicated for transit in curb lanes. Although dedicated transit lanes in the median was not selected as the recommended alternative at the time, it was identified that this option had the maximum potential person capacity along with the fastest and most reliable transit service. The study noted that that this option should be revisited in future Highway 2 transit studies.

Rapid Transit Evaluation Framework (2014)

As part of the City's Five Year Official Plan Review, the City of Toronto undertook a review of the transportation components of the Official Plan, referred to as Feeling Congested? In follow up work by the City, TTC and Metrolinx, a coordinated transit plan was presented that illustrated an integrated transit network in Toronto, with relevant projects to the study including:

- SmartTrack – electrified regional rail from Union Station to Markham. There is possibility of an extension of the BRT west of Scarborough Centre;
- Eglinton East LRT –Connections with the Durham- Scarborough BRT at UTSC;
- Scarborough Subway – extension of Bloor-Danforth subway to Scarborough Centre and a connection to the Durham Scarborough BRT; The plan recognizes the Durham-Scarborough BRT, extending eastbound from Scarborough Centre on Ellesmere Road to Kingston Road and continuing to Durham Region.

Draft Durham Transportation Master Plan (2017)

The Durham Transportation Master Plan (TMP) provides a multi-modal plan that defines the infrastructure, policies and programs to meet projected transportation needs to the year 2031. The Plan identifies the Durham-Scarborough BRT as an integral part of the Region's 2031 Higher-Order Transit Network, operating in dedicated transit lanes on Highway 2 from Simcoe Street in Oshawa to the Durham/Toronto boundary with an assumed connection to Scarborough Centre.

The TMP also includes the implementation of BRT on Simcoe Street from the Central Oshawa GO Station just south of Highway 2 (King Street) to Highway 407 and serving Downtown Oshawa and UOIT. A High-Frequency Network is also recommended that includes frequent service with transit priority on north-south arterial roads that would connect and feed the Durham-Scarborough BRT at Thornton Road, Brock Street, Westney Road, Brock Road (with high-occupancy vehicle lanes), and Whites Road (with HOV).

The section of Highway 2 east of the BRT corridor between Simcoe Street and Highway 418 is protected for future rapid transit, with a planned high-frequency bus route from the Highway 2 BRT at Simcoe Street to the future Bowmanville GO Station.

Other Studies and Projects

Other recent and on-going planning studies by Metrolinx, City of Toronto and Durham Region include major rapid transit and transit infrastructure initiatives that will need to be integrated with the Durham-Scarborough BRT to ensure that design considerations maximize the transit network user and operational benefits.

Eglinton East LRT (on-going)

The City of Toronto is currently undertaking planning and design studies to advance the implementation of the Eglinton East LRT, between Kennedy Subway Station and UTSC.

The project builds on the approved 2009 Scarborough-Malvern LRT Transit Project Assessment.

University of Toronto Scarborough Campus Master Plan (2011, and ongoing study)

The UTSC Master Plan provides a vision of Scarborough Campus to the year 2030. This includes accommodating an expanded campus to the north (near Ellesmere Road) that will increase enrollment from 10,200 students in 2010 to over 15,000 students by 2030.

The UTSC Master Plan indicates an existing 35% transit mode split for all trips to campus with a high potential for growth with planned and proposed transit improvements.

The Plan supports early implementation of a BRT route from Durham Region to Scarborough Centre and the 2011 recommendation was for the BRT to operate in mixed traffic on Ellesmere Road in the vicinity of the campus to minimize pedestrian crossing distance and provide better connectivity between North and South Campuses.

The study is currently on-going to determine how best to integrate new rapid transit facilities (Eglinton East LRT, Durham-Scarborough BRT) to serve the campus in light of more recent planning activities.

Highland Creek Village Study Area (2014)

This City of Toronto study developed a vision to guide future growth and development of this historic village as a mixed-use, community-focused and pedestrian-friendly destination. Highland Creek Village represents a major activity centre within the Durham-Scarborough corridor.

Highland Creek Village Transportation Master Plan (on-going)

This study was initiated in 2012 by the City of Toronto to develop alternative solutions for various transportation issues within the Highland Creek Village study area, given the complex street system and circulation challenges that presently exist.

The preferred alternative simplifies the routing of Kingston Road through the Village as continuous alignment in both directions and also allows for all movements at the Highway 2A and Military Trail intersection. This redesign would facilitate operations of a Durham-Scarborough BRT branch operating through Highland Creek Village.

Scarborough Centre Transportation Master Plan (on-going)

This study is developing a master plan that will provide a framework for an integrated and connected multimodal transportation network at Scarborough Centre.

As part of the Scarborough Subway extension of the Bloor-Danforth Subway to Scarborough Centre, the bus terminal at Scarborough Centre is being planned to accommodate TTC, DRT and GO Transit services.

GO Regional Express Rail Program

The GO Regional Express Rail (RER) program is a major element in Metrolinx's 15-Year Plan to implement The Big Move Regional Transportation Plan (2008), and the 2041 RTP. The program includes two major projects relevant to the Durham- Scarborough corridor, providing a parallel service through much of the corridor, but oriented to long- distance regional travel and Downtown Toronto destinations:

- Lakeshore East 15-minute GO service – frequent, two-way, all-day electrified regional rail service from Union Station to Central Oshawa Station
- Lakeshore East GO Rail Extension to Bowmanville Station – extension of the current GO Rail service from Oshawa to Bowmanville.

Existing Transit Routes

DRT Route 900 PULSE

The DRT 900 PULSE route currently operates along the Highway 2 corridor between Downtown Oshawa and UTSC via Ellesmere Road.

The 900 PULSE is the highest ridership route in the DRT network, hosting 2.4 million riders in 2015, which represents 20% of the system's ridership. This translates into a peak hour ridership of approximately 500-700 boardings in the peak hour in the peak direction. In peak load sections, in 2015, PULSE buses were experiencing loads exceeding capacity. DRT has since increased service frequency during peak periods to accommodate demand. Today, PULSE operates 20 hours of the day (18 hours on weekends) and 7 days per week with headways of 7-8 minutes during peak periods (8 buses per hour per direction), 10 minutes mid-day, and 15-60 minutes during off-peak periods. Currently 10% of the route operates in exclusive curbside bus lanes.

Of the 2.4 million riders on 900 PULSE in 2015, 12% transferred from another DRT service, 7% transferred using Presto (meaning either from another DRT service or GO Transit) and just 0.1% transferred from GO transit using a co-fare. Post-secondary students using the U-Pass accounted for 15% of riders (U-Pass is available to Durham College, UOIT, and Trent University (Oshawa) students). The main Durham College and UOIT campuses are located 7 km from the nearest PULSE station, indicating a large portion of the U-Pass users on PULSE likely also transferred from another DRT Route, most likely Route 401 Simcoe which provides service between Downtown Oshawa and both campuses, and is the second most heavily used route in the DRT system.

PULSE buses currently operate at a scheduled average speed of 28 km/h and requires 65 minutes to travel from downtown Oshawa to UTSC. This is achieved with a

550 m average station spacing and curbside bus lanes at select locations, currently representing 1.5 km of the 30-km route, with an additional 2 km of curbside bus lanes currently under construction.

The average vehicle load along the route is relatively consistent across the corridor with the average load the peak periods ranging from 10 to 25 passengers (excluding the terminals). In both the a.m. and p.m. peak periods, the highest passenger loads occur toward the east end of the corridor, with higher loads eastbound in the a.m. peak and westbound in the p.m. peak. This suggests that there is a high demand for transit to and from Oshawa. There are also high passenger loads around Pickering Town Centre and Pickering Village.

The east and west route terminals are the stations with the highest boardings along the route which suggests that both locations are high trip generation areas and there is a demand for transfers to other routes outside the corridor.

GO Bus Routes 92 and 92A

GO Transit operates the Route 92/A-Oshawa/Yorkdale bus that provides express service between Yorkdale Bus Terminal (Finch Bus Terminal for route 92A) and Oshawa Bus Terminal, including station stops at Scarborough Centre, Pickering Town Centre, Downtown Ajax, and Downtown Whitby. The route uses Highway 401 for most of its routing in the City of Toronto, then switches to Highway 2 at the Kingston Road interchange for the remainder of the route as it travels through Durham Region. Route 92A provides peak period express service along the same route between Finch Bus Terminal and Ajax, skipping station stops at Yorkdale and York Mills bus terminals.

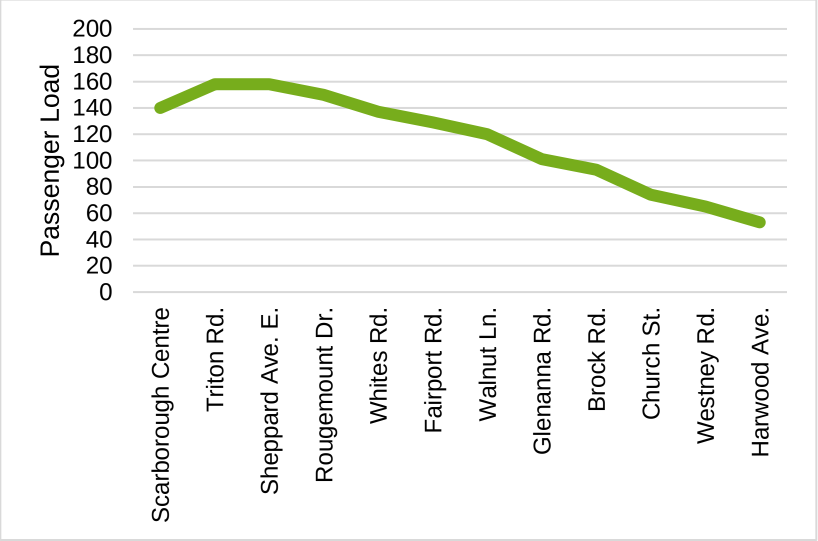
Along the stretch that Route 92 shares with 900 PULSE, Route 92 has 10 stops (in one direction), 8 of which are shared with 900 PULSE stops. The route operates 7 days/week, with up to 10-minute headways in peak periods in areas with 92A service and 30-minute to 1- hour headways during off-peak periods.

The route experiences high operating speeds due to limited stop service along the corridor and the usage of Highway 401 west of Kingston Road. Currently, during the a.m. peak period, the scheduled travel time between the Downtown Oshawa Bus Terminal and the Scarborough Centre Bus Terminal is 65 minutes and operates at an average speed of 33 km/h, generally with high schedule adherence.

The peak load section of the portion of the service along the BRT corridor is between Sheppard Avenue and

Scarborough, which carries 160 passengers in the westbound direction the AM the peak hour. The combined peak load profile of both routes through the BRT corridor is illustrated in Exhibit A.1.

Exhibit A.1: Route 92 and 92A GO Bus Westbound in the BRT Corridor – AM peak Hour Ridership Load Profile



Source: GO Transit 2017 data

TTC Routes 95, 38 and 133

The three TTC routes in the study corridor are described above below. Overall, a.m. peak hour passenger load in the westbound and eastbound directions are graphed in Exhibit 2 and 3 respectively.

The load profile show that ridership increases significantly starting at Military Trail/UTSC with a peak corridor passenger load of 870 passengers/hr at McCowan Avenue

TTC Route 95 York Mills

TTC Route 95 provides local and express service between York Mills subway station and the eastern terminus of Ellesmere road via Scarborough Centre and UTSC.

Route 95 service interlines with the BRT Corridor between Scarborough Centre and the intersection of Ellesmere Road and Kingston Road. Along this 8 km section, Route 95 has 18 stops in each direction, equating a station spacing of 440 metres.

In the morning peak period along the BRT corridor section, Route 95 operates approximately 15 buses per hour (8-9 local trips and 6-7 express trips) and has a peak load at McCowan Road of 370 passengers/h in the westbound direction.

TTC Route 38 Highland Creek

TTC Route 38A provides service between Scarborough Centre and Rouge Hill GO station via Ellesmere Road and Military Trail with connections to UTSC. The Route 38B service short-turns at UTSC to provide extra service to satisfy high passenger demand between Scarborough centre and UTSC.

Route 38 interlines with the BRT Corridor between Scarborough Centre and Military Trail. Along this 5.3 km section, Route 38 has 9 stops in each direction, equating a station spacing of 590 metres.

In the morning peak period along the BRT corridor section, Route 38 operates 10 buses per hour; 5 that go all the way to Rouge Hill Go Station and 5 that stop at UTSC. The route has a peak load at McCowan Road of 210 passengers/hr in the westbound direction.

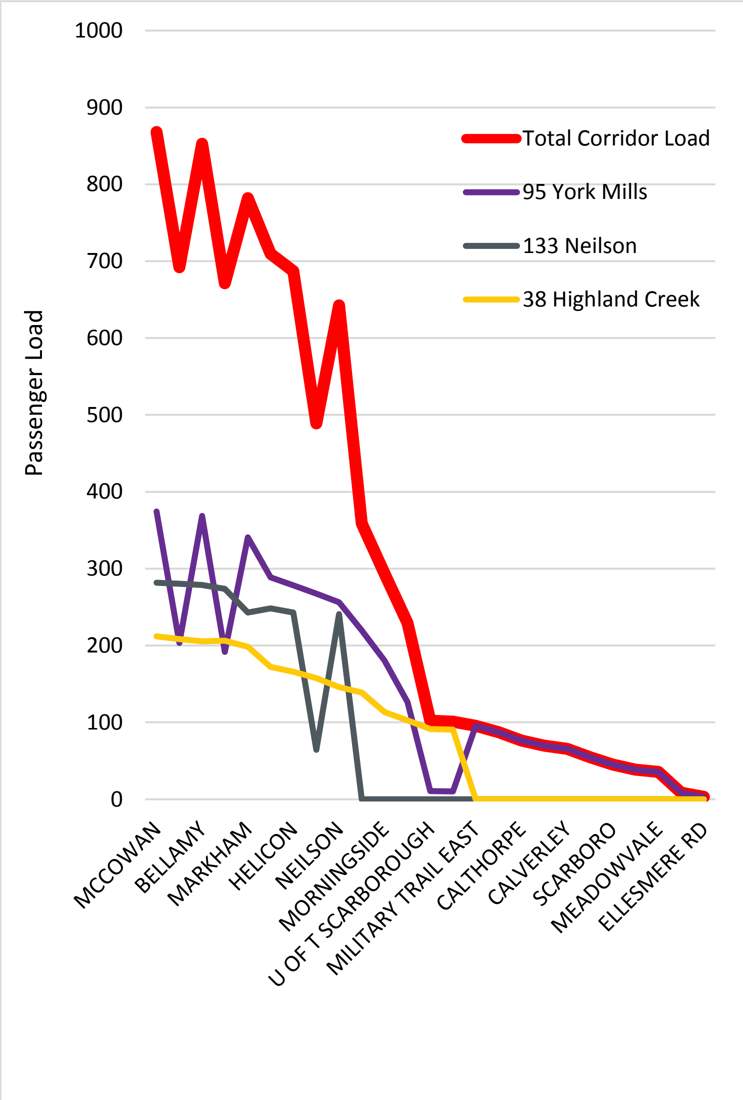
TTC Route 133 Neilson

TTC Route 133 provides service from Scarborough Centre along Ellesmere Road then north along Neilson Road.

Route 133 interlines with the BRT Corridor between Scarborough Centre and Neilson Road. Along this 4 km section, Route 133 has 6 stops in each direction, equating a station spacing of 670 metres.

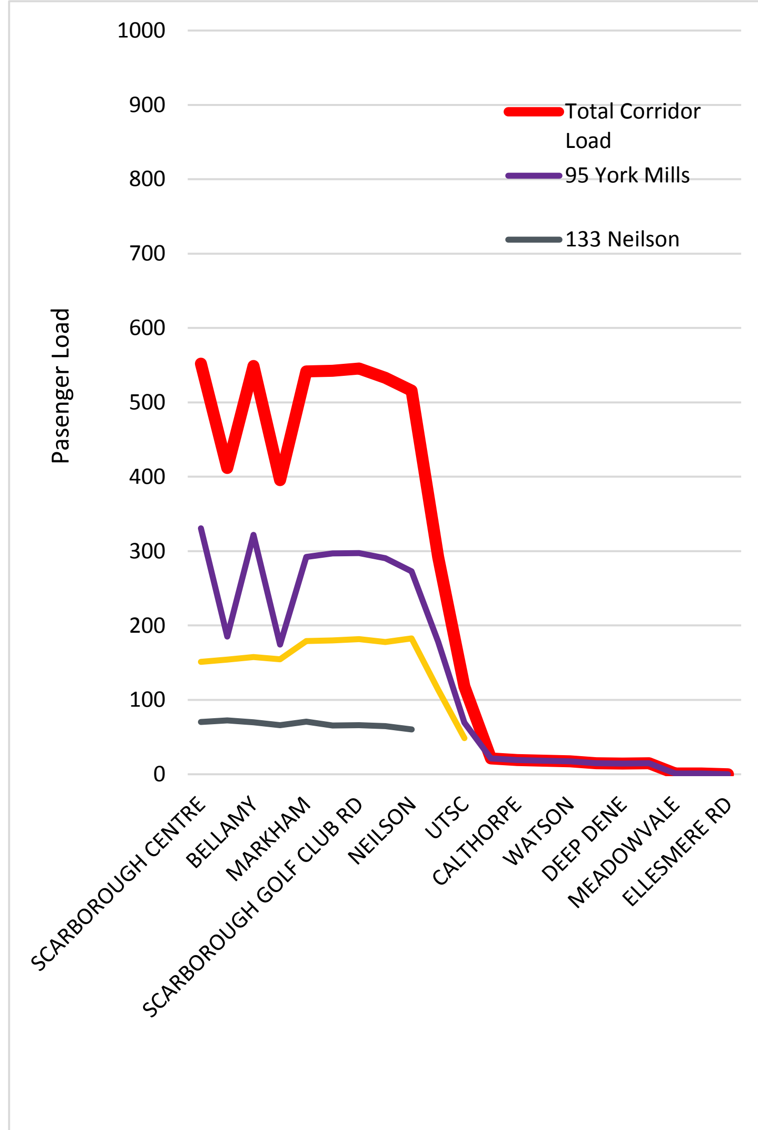
In the morning peak period along the BRT Corridor section, Route 133 operates 5-6 buses per hour and has a peak load at McCowan Avenue of 280 passengers/h in the westbound direction.

Exhibit A.2: TTC Routes Westbound in the BRT Corridor- AM Peak Hour Passenger Load



TTC boarding and alighting counts between 2013 and 2016

Exhibit A.3: TTC Routes Eastbound in the BRT Corridor – AM Peak Hour Passenger Load



Appendix B

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City of Toronto Route Options

Criteria	1. Ellesmere to Kingston Road (Transit Priority Measures)	2. Military Trail to Old Kingston Road Transit Priority Measures	3. Military Trail to Highway 2A (transit priority measures)
People			
People and Jobs	A high concentration of low-medium density housing. Approx. 9,000 residents within 500 m (2016) ◐	A high concentration of low density housing, some commercial retail, and some industrial employment. Approx. 6,000 residents within 500 m (2016). ●	A high concentration low density housing and some commercial retail. Approx. 3,000 residents within 500 m (2016). No opportunity for stations along stretch of Highway 2A. ○
New riders attracted	Few new riders – low growth but service improvements could occur with transit priority measures in place ◐	New riders from new development (Highland Creek) and routing of service along Old Kingston Road and existing service improvements with transit priority improvements ●	New riders from new development (Highland Creek). Difficult to obtain maximum benefit from transit infrastructure due to the limited amount of service on this section ◐
Transit travel time	11 minutes ◐	12 minutes. ○	10 minutes. Reliant on new intersection at Highway 2A and Military Trail. ●
Traffic flow	Low traffic on Ellesmere, east of Military Trail and currently 4 lanes in each direction. ●	Military Trail is a low speed, low traffic residential street but currently is only one lane in each direction. Old Kingston Road is also one lane in each direction ○	Military Trail is a low speed, low traffic residential street but currently is only one lane in each direction. ◐

Least Preferred ○ → Most Preferred ●

Criteria	1. Ellesmere to Kingston Road (Transit Priority Measures)	2. Military Trail to Old Kingston Road Transit Priority Measures	3. Military Trail to Highway 2A (transit priority measures)
Places			
Potential properties impacted	Impacts to driveway access, and potential properties affected depending on level of improvements. ◐	Limited availability for widening without severe impacts to property ○	Limited availability for widening without severe impacts to property ○
City Building and Revitalization Potential	No or very little opportunity for TOD. Ellesmere Road is a higher order transit corridor ◐	Opportunity for some TOD in Highland Creek Village with service directly through the village. ●	Opportunity for TOD in Highland Creek Village with service adjacent the village.
Prosperity and Resilience			
Implementability	Mature residential neighbourhood along Ellesmere – potentially some resistance to higher frequency of buses but currently has PULSE service. Ellesmere Road is a higher order transit corridor ●	Military Trail is a low speed residential street and high frequency bus traffic would be controversial. Operations along Old Kingston Road could also be controversial as it is a residential street. ○	Military Trail is a low speed residential street and high frequency bus traffic would be controversial. ◐
Capital cost	Shortest Route. Capital costs only for transit priority upgrades and potential property. ◐	Longer route than Ellesmere and a tight right-of-way could lead to requirements for property at station locations. ◐	New access to Highway 2A from Military Trail required and new signal to allow left turns onto Highway 2A westbound ramp from Kingston Road. ○

Pickering Village Option Evaluation

Criteria	1. Exclusive Lanes	2. Queue Jump Lanes/Priority	3. No Change
People			
Impact on transit times	2:47 (M:SS) 13 Seconds faster than Mixed Traffic during peak congestion. ●	2:53 (M:SS) 7 Seconds faster than mixed traffic during peak congestion. ◐	3:00 (M:SS) **Impacts to transit times will be significant due to traffic congestion** ○
Ease of pedestrian access	Centre platform creates more access challenges for people with disabilities. ◐	Rapid transit and local buses can share a stop adjacent the sidewalk ●	Rapid transit and local buses can share a stop adjacent the sidewalk ●
Traffic flow	Taking a lane would result in significant traffic delays. Restrictions to traffic operations would be required through this section Additional left turn signal time would be required to allow U-turns? ◐	Taking a lane would result in significant traffic delays Restrictions to traffic operations would likely be required through this section. A separate signal would be required to allow buses to jump ahead of queue. ◐	Maintaining existing lane configuration is would not impact traffic flow. ●

Criteria	1. Exclusive Lanes	2. Queue Jump Lanes/Priority	3. No Change
Places			
Potential properties impacted	Property takes and building demolition would be required on the south side of the Church/Kingston Road intersection, depending on size of platforms and integration with existing sidewalk. ◐	Property takes and building demolition would be required on the south side of the Church/Kingston Road intersection, depending on size of platforms and integration with existing sidewalk, but fewer than the exclusive lane option. ◐	No property impacts. ●
Prosperity and Resilience			
Impact on existing businesses	There will be significant impacts to businesses during construction. Access to businesses may also change as a result of construction. ◐	There will be some impacts to businesses during construction Access to businesses may also change as a result of construction. ◐	No expected impacts during or after construction. ●
Impact on street parking	No existing street parking	No existing street parking	No existing street parking

Downtown Whitby Option Evaluation

Criteria	1. Exclusive Lanes	2. Queue Jump Lanes/Priority	3. No Change
People			
Impact on transit times	4:39 (M:SS) 17 Seconds faster than mixed traffic during peak congestion. Exclusive lanes result in travel time savings. ●	4:48 (M:SS) 8 Seconds faster than mixed traffic during peak congestion. ◐	4:56 (M:SS) **Impact to transit times would be significant due to traffic congestion.** ○
Ease of pedestrian access	Centre platform creates more access challenges for people with disabilities. ◐	Rapid transit and local buses can share a stop adjacent the sidewalk. ●	Rapid transit and local buses can share a stop adjacent the sidewalk. ●
Traffic flow	Taking a lane would result in significant traffic delay. Changes to traffic configuration in this area would occur. ◐	Taking a lane would result in significant traffic delay A separate signal would be required to allow buses to jump ahead of queue. Changes to traffic configuration are likely. ◐	Maintaining existing lane configuration is would not impact traffic flow. ●

Criteria	1. Exclusive Lanes	2. Queue Jump Lanes	3. No Change
Places			
Potential properties impacted	Property and building demolition required to allow for 2 traffic lanes plus queue jump lanes. Les impact if current number of lanes is maintained. ○	Property and building demolition required to allow for 2 traffic lanes plus queue jump lanes. Less impact than Exclusive Lanes and less impact if existing number of lanes is maintained. ◐	No property impacts. ●
Prosperity and Resilience			
Impact on existing businesses	Impacts to businesses during construction. Impacts from removal of street parking. Impacts to access and driveways. Access to business may change ○	Impacts to businesses during construction. Impacts from removal of street parking. Impacts to access and driveways, but less so than impacts from exclusive lanes ◐	No impacts. ●
Impact on street parking	Removal of some or all (30 spaces) street parking on Dundas Street during off-peak period. ○	Removal of some or all (30 spaces) street parking on Dundas Street during off-peak period. More potential to maintain spaces than with exclusive lanes. ◐	Potential impact to street parking in off-peak ●

Appendix C

This document is formatted for double-sided printing.

DURHAM - SCARBOROUGH BRT - APPENDIX C - CAPITAL COSTS BY ALTERNATIVE

ID#	Segment Name	Centre Median	Curbside	Hybrid	Phase
1	McCowan Road from Entrance to STC to Ellesmere Road	$ 4,556,250	$ 4,443,750	$ 3,950,000	1
2	Ellesmere Road from McCowan to Military Trail	$ 55,235,125	$ 51,672,375	$ 55,235,125	1
3	Military Trail from Ellesmere to Old Kingston Road	Assuming the Ellesmere Routing, so no cost for these segments			
4	Military Trail from Old Kingston Road to HWY 2A				
5	HWY 2A Eastbound from Military Trail to Port Union Road				
6	Kingston Road from Port Union Road to HWY 2A wb Entrance				
7	Hwy 2a Westbound from Entrance to Military Trail				
3b	Ellesmere Road from Military Trail to Kingston Road	$ 2,000,000	$ 2,000,000	$ 2,000,000	2
4b	Kingston Road from Ellesmere Road to Sheppard Avenue	$ 2,000,000	$ 2,000,000	$ 2,000,000	2
8	Kingston Road from Sheppard Avenue to Altona Road	$ 18,288,313	$ 17,006,688	$ 2,750,000	1
9	Kingston Road from Altona Road to Merritton Road	$ 32,856,250	$ 29,800,000	$ 32,856,250	2
10	Kingston Road from Merritton Road to 300 m west of Liverpool Road	$ 32,679,063	$ 29,760,313	$ 32,679,063	2
11	Kingston Road from 300 m west of Liverpool Road to Glenanna Road (Downtown Pickering)	$ 5,029,400	$ 3,160,200	$ 5,029,400	3
12	Kingston Road from Glenanna Road to Denvar Road	$ 12,956,875	$ 11,830,625	$ 12,956,875	3
13	Kingston Road from Denvar Road to Notion Road	$ 6,830,600	$ 3,760,800	$ 6,830,600	3
14	Kingston Road from Notion Road to Rotherglen Road	$ 5,396,000	$ 5,396,000	$ 5,396,000	1
15	Kingston Road from Rotherglen Road to Ritchie Ave	$ 5,531,650	$ 3,072,200	$ 5,531,650	3
16	Kingston Road from Ritchie Ave to 400 m west of Harwood	$ 4,208,500	$ 3,434,000	$ 4,208,500	3
17	Kingston Road from 400 m west of Harwood to Salem Road	$ 7,632,750	$ 2,099,500	$ 7,632,750	3
18	Kingston Road from Salem Road to Audley Road	$ 14,552,500	$ 11,313,750	$ 14,552,500	3
19	Kingston Road from Audley Road to White Oaks Court	$ 29,100,875	$ 16,865,125	$ 16,865,125	2
20	Dundas Street West from White Oaks Court to Frances Street	$ 14,610,125	$ 11,890,375	$ 11,890,375	2
21	Dundas Street from Frances Street to Garden Street	$ 5,834,750	$ 5,834,750	$ 5,834,750	2
22	Dundas Street from Garden Street to Anderson Street	$ 23,819,875	$ 23,135,125	$ 23,135,125	1
23	Dundas Street from Anderson Street to Waverly Street	$ 28,776,063	$ 27,306,438	$ 27,306,438	1
24	King Street from Waverly Street to Simcoe Street	$ 6,323,500	$ 6,323,500	$ 6,323,500	1
25	Simcoe Street from King Street to Bond Street	$ 2,869,938	$ 2,869,938	$ 2,869,938	1
26	Bond Street from Simcoe Street to Waverly Street	$ 8,283,563	$ 8,283,563	$ 8,283,563	1
Total CAPEX		**$ 329,371,963**	**$ 283,259,013**	**$ 296,117,525**	
Contingency (50%)		$ 164,685,981	$ 141,629,506	$ 148,058,763	
Project Management (10%)		$ 32,937,196	$ 28,325,901	$ 29,611,753	
Engineering (15%)		$ 49,405,794	$ 42,488,852	$ 44,417,629	
Total CAPEX Including Congingency, PM, ENG		**$ 576,400,934**	**$ 495,703,272**	**$ 518,205,669**	
Construction Cost/Km		$ 16,011,137	$ 13,769,535	$ 14,394,602	
Fleet Cost		$ 66,000,000	$ 71,000,000	$ 67,000,000	
Total CAPEX + Fleet Cost		**$ 642,400,934**	**$ 566,703,272**	**$ 585,205,669**	

Phasing

	Centre Median	Curbside	Hybrid	Length of Phase
Phase 1 Cost (2021-2023)	$ 268,710,094	$ 256,265,406	$ 236,686,953	3
Phase 2 Cost (2024-2026)	$ 208,391,859	$ 171,763,484	$ 182,219,734	3
Phase 3 Cost (2027-2029)	$ 99,298,981	$ 67,674,381	$ 99,298,981	3
Total (Should Equal Row 36)	$ 576,400,934.38	$ 495,703,271.88	$ 518,205,668.75	

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Appendix D

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DURHAM - SCARBOROUGH BRT - APPENDIX D - OPERATING COSTS BY ALTERNATIVE

Centre Median Scenario OPEX					
Section and Period	Wkdy Rev Hrs	Sat. Rev Hrs	Sun/Stat Rev Hrs	Annual Rev. Hrs	Annual O+M
Year 1-5: Route 1	436	400	360	152,044	$ 15,543,710
Year 1-5: Route 2	18	-	-	4,482	$ 458,202
Year 1-5: Route 3	86	80	72	30,110	$ 3,078,195
Year 1-5 Total	540	480	432	186,636	**19,080,108**
Year 6-15: Route 1	520	520	468	186,004	$ 19,015,497
Year 6-15: Route 2	24	-	-	5,976	$ 610,936
Year 6-15: Route 4	112	100	90	38,758	$ 3,962,295
Year 6-15 Total	656	620	558	230,738	**23,588,728**
Year 16+: Route 1	598	520	468	205,426	$ 21,001,041
Year 16+: Route 2	48	-	-	11,952	$ 1,221,873
Year 16+: Route 4	112	100	90	38,758	$ 3,962,295
Year 16+ Total	758	620	558	256,136	**26,185,208**
Curbside and Hybrid Scenario Fleet O+M Costs					
Section and Period	Wkdy Rev Hrs	Sat. Rev Hrs	Sun/Stat Rev Hrs	Annual Rev. Hrs	Annual O+M
Year 1-5: Route 1	462	420	378	160,692	$ 16,427,810
Year 1-5: Route 2	24	-	-	5,976	$ 610,936
Year 1-5: Route 4	86	80	72	30,110	$ 3,078,195
Year 1-5 Total	572	500	450	196,778	**20,116,941**
Year 6-15: Route 1	560	560	504	200,312	$ 20,478,228
Year 6-15: Route 2	30	-	-	7,470	$ 763,670
Year 6-15: Route 4	112	100	90	38,758	$ 3,962,295
Year 6-15 Total	702	660	594	246,540	**25,204,193**
Year 16+: Route 1	644	560	504	221,228	$ 22,616,505
Year 16+: Route 2	54	-	-	13,446	$ 1,374,607
Year 16+: Route 4	112	100	90	38,758	$ 3,962,295
Year 16+ Total	810	660	594	273,432	**27,953,407**
Curbside and Hybrid Scenario Fleet O+M Costs					
Section and Period	Wkdy Rev Hrs	Sat. Rev Hrs	Sun/Stat Rev Hrs	Annual Rev. Hrs	Annual O+M
Year 1-5: Route 1	442	400	360	153,538	$ 15,696,444
Year 1-5: Route 2	18	-	-	4,482	$ 458,202
Year 1-5: Route 4	86	80	72	30,110	$ 3,078,195
Year 1-5 Total	546	480	432	188,130	**19,232,842**
Year 6-15: Route 1	540	540	486	193,158	$ 19,746,863
Year 6-15: Route 2	24	-	-	5,976	$ 610,936
Year 6-15: Route 4	112	100	90	38,758	$ 3,962,295
Year 6-15 Total	676	640	576	237,892	**24,320,094**
Year 16+: Route 1	618	540	486	212,580	$ 21,732,406
Year 16+: Route 2	48	-	-	11,952	$ 1,221,873
Year 16+: Route 4	112	100	90	38,758	$ 3,962,295
Year 16+ Total	778	640	576	263,290	**26,916,573**