Dundas BRT Initial Business Case

September 2020

METROLINX

Dundas BRT Initial Business Case

Draft Report

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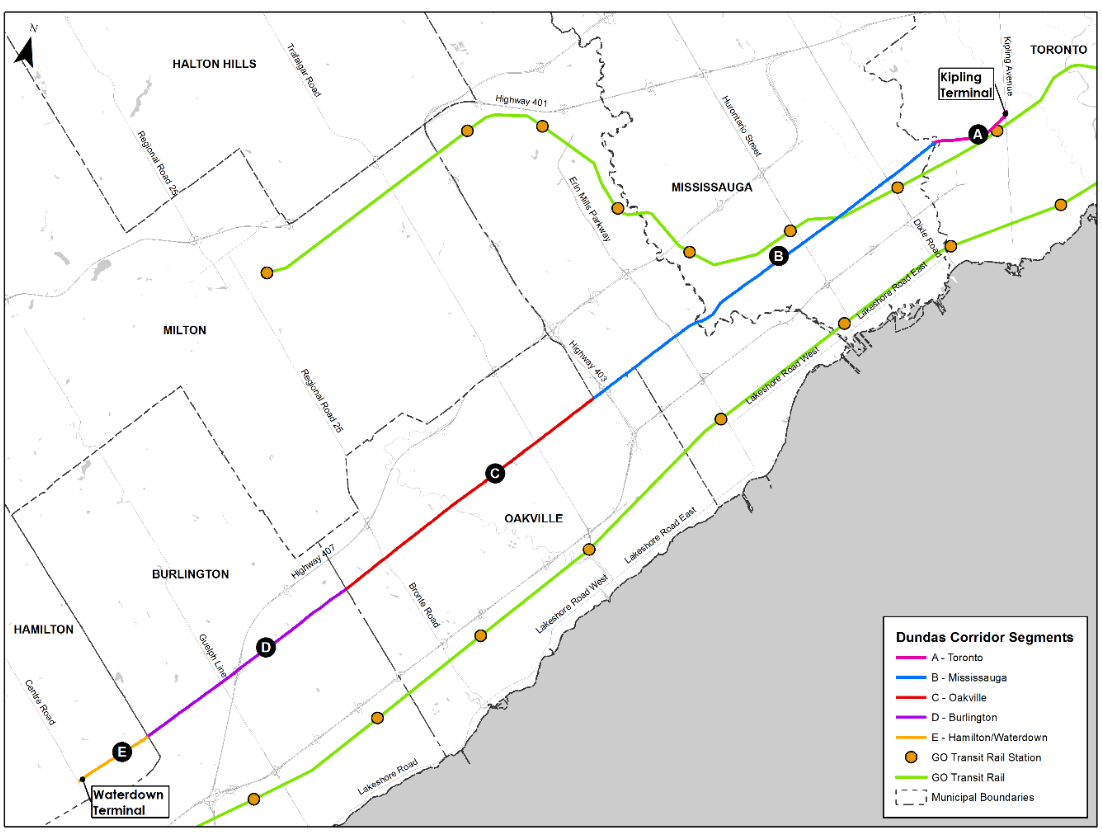
Executive Summary

Scope

The scope of this Initial Business Case (IBC) will be to evaluate the options for a Bus Rapid Transit (BRT) corridor along a 40-km section of Dundas Street between Kipling Subway station in the City of Toronto and the village of Waterdown in the City of Hamilton, herein referred to as the Dundas Corridor. Approximately 20-km of BRT infrastructure is proposed between Kipling Station and through the City of Mississauga with an integrated service plan for the entire corridor. This corridor spans 5 municipalities (Toronto, Mississauga, Oakville, Burlington and Hamilton) and has limited cross-boundary travel alternatives to the automobile, which leads to high auto usage and congestion. The corridor is forecasted to see significant growth and development, making it one of the key areas of the GTHA for living and working.

By 2041, 6% (284,000) of all employment in the GTHA and 8% (808,000) of the Region's total population will be living on the Corridor. The corridor will also contain 9% of all population growth and 6% of employment growth across the GTHA. Without improved transport alternatives, the overall livability and economic development potential of the corridor, including future developments, will be constrained. The Dundas BRT project, presented in Figure 1.1 by segment is a proposal for an integrated and holistic bus-based transit system along the corridor. It was identified in the 2008 Big Move RTP (in the 15-year time horizon) and is currently a priority in-development project under the 2041 Regional Transportation Plan (RTP). The Dundas BRT will address existing and future challenges in the transit network and ultimately support community integration and improve the quality of life of those living and working along the corridor.

Figure 1.1: Dundas Corridor Segmentation

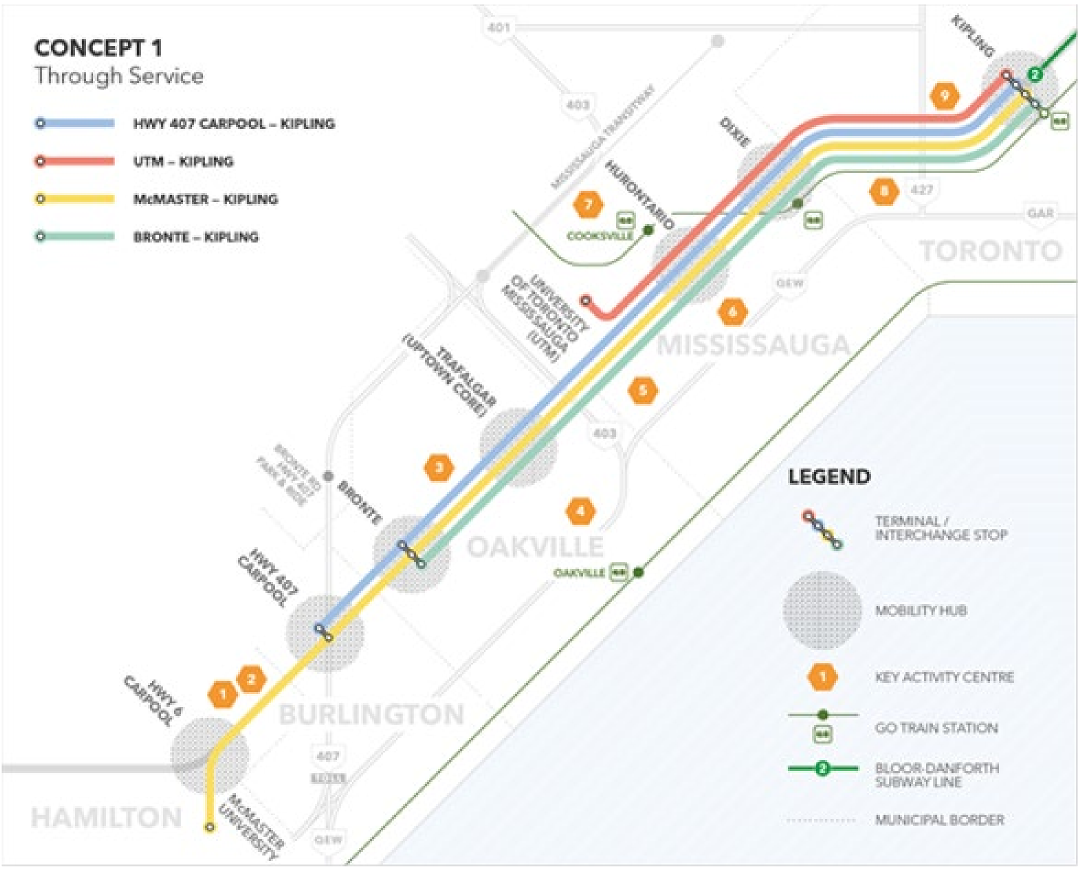


Metrolinx has identified three service options that could serve the corridor, using BRT infrastructure in the Mississauga segment and HOV/Bus lanes in the Oakville and Burlington segments.

- **Option 1 – Through Running Service** – a set of east-west running BRT services along the corridor to Kipling Station, with multiple starting points. This option is intended to test the value of corridor focused direct cross corridor service, presented in Figure 1.2 below;

Figure 1.2: Option 1 Through Service

Service Map



Peak Buses Per Hour by Line:

- Yellow (McMaster to Kipling) – 3 buses per hour
- Blue (407 to Kipling) – 3 buses per hour
- Green (Bronte to Kipling) – 12 buses per hour
- Red (University of Toronto at Mississauga to Kipling) - 12 buses per hour

Peak buses by segment:

- Hamilton to Burlington – 3 buses per hour
- Burlington to Oakville – 6 buses per hour
- Oakville to Mississauga – 18 buses per hour
- Mississauga to Toronto – 30 buses per hour

- **Option 2 – Segmented Service** – a set of east-west running BRT services that typically originate north or south of the corridor, with only some services terminating at Kipling Station. This option is intended to test the value of service between key transfer points and destinations that are north or south of the corridor, presented in Figure 1.3 below; and

Figure 1.3: Option 2 Segmented Service

Service Map

Peak Buses Per Hour by Line:

- Yellow (McMaster to 407 Carpool) – 7 buses per hour
- Blue (407 Carpool to Sheridan College) – 20 buses per hour
- Green (Sheridan College to Renforth via Mississauga Transitway) – 20 buses per hour
- Red (University of Toronto at Mississauga to Kipling) - 48 buses per hour

- **Option 3 – Overlapping Service** – a combination of Options 1 and 2, with some services running the entire length of the corridor and other services connecting the corridor to locations north or south of Dundas. This option is intended to test the value of an integrated BRT network spanning Hamilton to Toronto, presented in Figure 1.4 below.

Figure 1.4: Option 3 Overlapping Service

Service Map

Peak Buses Per Hour by Line:

- Yellow (McMaster to Kipling) – 7 buses per hour
- Blue (407 to Oakville GO) – 15 buses per hour
- Teal (Bronte to Renforth via Mississauga Transit Way) – 10 buses per hour
- Green (Sheridan College to Kipling) – 10 buses per hour
- Red (University of Toronto at Mississauga to Kipling) - 30 buses per hour

Peak buses by segment:

- Hamilton to Burlington – 7 buses per hour
- Burlington to Oakville – 32 buses per hour
- Oakville to Mississauga
    - Renforth 10 buses per hour / Dundas 17 buses per hour
- Mississauga to Toronto – 37 buses per hour

These service plans were developed to:

- Accommodate potential demand along the corridor; and
- Demonstrate the trade-offs and benefits of different approaches to delivering BRT

This Initial Business Case (IBC) evaluates the performance of all three options compared to a Business as Usual scenario as the basis for an investment decision. The investment options are evaluated across four key categories, which are strategic, economic, financial and deliverability and operations cases.

Findings

Strategic Case

The strategic case identifies the desired strategic outcomes of the investment in relation to the 2041 Regional Transportation (RTP) goals, outlines the criteria for each of the outcomes, and evaluates the three concepts through indices that are relevant to each specific criterion.

- Dundas BRT is likely to realize significant strategic benefits by addressing the study problem statement and providing direct improved transit connectivity across the corridor;
- Across most benefits, Option 3 (Overlapping Service) has the highest potential because it provides an expanded frequent rapid transit network across the Western GTHA and provided a blend of direct services and connecting services to major destinations off corridor; and
- Option 1 (Through Service) has greater benefits related to reducing automobile travel because it offers the highest frequency service across the corridor.

Economic Case

This economic case has been prepared as part of this IBC to present and assess the potential costs and benefits associated with delivering the proposed investment via a range of service design scenarios and vehicle technology options within the required investment timeframe.

The economic case will enable decision makers, project planners and wider stakeholders to understand how the preferred option will deliver value to the region that exceeds the costs that are required to deliver it. It provides robust estimates of the costs and benefits that will be generated by implementing the Dundas BRT and demonstrates the value that will be added to passengers and users of the Dundas Corridor.

- All Dundas BRT options are forecast to deliver overall benefits that exceed the total costs/investment required to implement them for both low and high benefits scenarios;
- Option 1has the highest BCR (2.3) and NPV ($2.5 billion);
- Option 3 has a lower BCR than Option 1 due to its significantly higher operating costs. There is an opportunity to further optimize all options at the Preliminary Design Business Case (PDBC) stage where one option is brought forward for further rationalization of operating costs and benefits to further improve BCRs and value for money.

Financial Case

The financial case sets out the potential financial impacts (i.e. lifecycle revenues and costs) associated with delivering the proposed investment. While both the Financial Case and Economic Case assess the costs of an investment, the Financial Case does not consider society-wide benefits of an investment. Instead, it is concerned with the financial resources required to implement the investment, the potential revenues to be generated from the investment, and the net cash flow impact for the agency responsible for the investment in nominal (inflation adjusted) terms.

- All service options will require financial subsidies from the public entity sponsor to be financially viable. It is important to note that most public transit projects typically require financial subsidies from governments to be delivered, operated, and maintain as planned;
- In terms of lifecycle operating subsidy requirement, Option 1 is projected to require the least amount of investment. This is attributed to its comparably low fleet requirement.
- The level of investment to deliver Option 3 is approximately 30% greater than the level of investment required to deliver Option 1. This difference should be reviewed in future stages of project development and compared against different levels of strategic and economic performance between the options; and
- Option 1 is projected to recover a higher share of operating and maintenance costs from revenues in comparison to other BRT options.

Evidently, all service options under consideration for the Dundas BRT will require significant financial investment to deliver and operate. Further analysis will be required as part of future project development to refine and scope the service options in greater detail, get the right size for the fleet requirements, and model fleet performance in order to generate more indicative financial projections for the Dundas BRT.

Deliverability and Operations Case

Given the early stage of analysis and similar components across all options, this evaluation is not focused on comparative delivery between Options 1-3, but instead focuses on key delivery considerations for a BRT service on the corridor. This analysis is intended to support Metrolinx in further developing the project design, delivery, and procurement plan for a BRT service (pending business case performance) across the project lifecycle.

- Clarify the governance structure of the project as well as roles, responsibilities and decision-making authority. If a public entity is being considered to take on any part of the project, they should equally be engaged to better understand their capacity and willingness to take on responsibility;
- Further investigation into Metrolinx' risk tolerance for different aspects of the project. This will assist with a decision on procurement method;
- Continued definition of the most effective service pattern for the operations of the BRT which help inform the optimal approach to service delivery. Additionally, confirm how the project is likely to be phased or expanded;
- Engagement of the five municipalities to gauge their amenability and cooperation with the project in terms of the suggested typical master municipal agreement topics with the goal of unearthing any key issues that may impact risk certainty;
- Public and stakeholder engagement along the project corridor to gauge support for the project and to reveal any key issues that need mitigation;

- Further project definition into civil engineering design, property impact, urban design and special technologies. This will allow for better understanding of potential cost to construct, reveal hidden risks that may be costly or highlight areas where early works may help to de-risk the project;
- Continued refinement of ridership forecasting, narrowing the size of fleet required and further defining the baseline requirements for the alignment and station characteristics. This will allow for better understanding of the operations and maintenance requirements including size and site location of an OMF, operating and capital costs; and
- High-level market research into the private sector's level of interest and ability to respond to a call for procurement – including construction, fleet and operations.

Summary

Table 1.1 summarizes the findings for each of the three options analysed in this business case.

Table 1.1: Summary of Dundas BRT Findings

		Option 1 Through Service	Option 2 Segmented Service	Option 3 Overlapping Service
Strategic Case				
Transportation	Increase transit ridership and decrease traffic congestion along the corridor	31,100 net new daily riders 555,000 hours of decongestion benefits per year	33,000 net new daily riders 345,000 hours of decongestion benefits per year	37,600 net new daily riders 500,000 hours of decongestion benefits per year
	Create an adaptable transportation network	113 services in the peak, capability to expand capacity east to west	166 services in the peak, capability to expand to sites off corridor, but no through service	157 services in the peak, capability to expand capacity east to west and off corridor
Quality of Life	Connects people from where there are to where they want to go	660,000 people live in a 2km catchment	990,000 people live in a 2km catchment	1,000,000 people live in a 2km catchment
	Reduced auto accidents resulting in death/injury	900 fewer accidents over project lifecycle	600 fewer accidents over project lifecycle	800 fewer accidents over project lifecycle
Economic Prosperity	Reduce commute times leading to increased productivity	13.9 minute reduction in average trip time	13.4 minute reduction in average trip time	14.0 minute reduction in average trip time
	Unlock economic and regional development on the Dundas Corridor	230,000 jobs within a 2km catchment	455,000 jobs within a 2km catchment	465,000 jobs within a 2km catchment
Environ-mental Benefits	Decrease GHG Emissions	Diesel – 600,000 tonne lifecycle reduction	Diesel – 100,000 tonne lifecycle reduction	Diesel – 210,000 tonne lifecycle reduction
Overall Pros		Best performance in terms of auto impacts	Reasonable balance of catchment and ridership impacts, allied with auto impacts	Greatest catchment of population and jobs served, resulting in greatest impact on transit ridership
Overall Cons		Lowest catchments and transit ridership impacts	Poorest environmental benefits	Poorer performance in terms of auto impacts
Overall Strategic Benefit		Best impact on auto use, with respectable impact on transit use and catchment	Strong balanced mix of impacts across transit and auto	Strong benefits in increasing transit use and serving the widest catchment, while providing auto benefits

	Option 1 Through Service	Option 2 Segmented Service	Option 3 Overlapping Service
Economic Case ($2019 PV)			
Total Benefit (B)	$4,039 M	$3,316 M	$4,039 M
User Impacts	$3,970 M	$3,270 M	$3,950 M
External Impacts	$80 M	$50 M	$90 M
Total Cost (C)	$1,980 M	$3,170 M	$2,690 M
Capital Cost	$850 M	$930 M	$920 M
Operating and Maintenance Cost	$1,130 M	$2,240 M	$1,770 M
Fare Revenue Adjustment (A)	$468 M	$503 M	$608 M
Net Present Value ((A+B)-C)	$2,525 M	$647 M	$1,955 M
Benefit-Cost Ratio ((A+B)/C)	2.3	1.2	1.7
Financial Case (Undiscounted $2019) over 64 Year Appraisal			
Total Revenues	$477 M	$512 M	$620 M
Total Project Costs	$2,407 M	$3,592 M	$3,108 M
Total Capital Costs	$950 M	$1,039 M	$1,024 M
Total Operating and Maintenance Costs	$1,457 M	$2,553 M	$2,084 M
Net Present Value/Net Investment	-$1,930 M	-$3,080 M	-$2,488 M
Operating Surplus or Subsidy	-$980 M	-$2,041 M	-$1,464 M
Operating Cost Recovery Ratio	0.33	0.20	0.30

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Introduction

Introduction

The proposal outlined in this Initial Business Case (IBC) is to deliver a Bus Rapid Transit (BRT) system along a 40-km section of Dundas Street between Kipling GO station in the City of Toronto and the village of Waterdown in the City of Hamilton, herein referred to as the Dundas Corridor. The Dundas Corridor serves five municipalities in the Greater Toronto & Hamilton Area (GTHA), one of the fastest growing city-regions in North America.

Purpose of this Report

This report has been completed to the requirements of an IBC based on Metrolinx's Business Case Manual Volume 2: Guidance[1]. The IBC is intended to:

- Confirm a problem and/or opportunity and identify a potential set of investments that could respond to them;
- Provide high-level scoping on a range of varying investments to be compared through a four-case analysis; and
- Develop insights and recommendations for future work.

An IBC is not used for:

- Detailed design;
- Delivery planning; or
- Procurement Decisions.

This document is important as it provides an evidence-based assessment of the case for investment in Dundas BRT. This business case provides evidence to decision-makers, stakeholders, and the public as a crucial part of transparent and evidence-based decision-making. This document is a key part of project planning, delivery, management and performance monitoring.

Dundas BRT Initial Business Case Background

The Dundas BRT included in this Initial Business Case combines two projects identified as priority in-development projects within the 2041 Regional Transportation plan (RTP):

- BRT from Kipling Station to Brant Street; and
- Priority Bus from Brant Street to Waterdown.

The Dundas Connects Master Plan (Dundas Connects), endorsed in 2018 by the City of Mississauga, and supported by Metrolinx, identified BRT between Kipling Station and Winston Churchill in the City of Mississauga. This IBC includes the infrastructure recommendations from this study in order to understand the costs and benefits for an integrated BRT and priority bus corridor in the Western GTHA.

[1] Metrolinx, Business Case Guidance, 2018

Document Structure

This IBC is structured around Metrolinx's Business Case structure as outlined in its Business Case Guidance. The structure of the IBC is as follows:

- **Section 1: Introduction** – provides an overview of the Business Case and a high-level summary of the project, its objectives and the intended benefits that will be realized through investment;
- **Section 2: Case for Change** – sets out the problem statement (why the intervention is required and in what context it is required), along with a set of goals and objectives that Dundas BRT will seek to meet to address the problem;
- **Section 3: Investment Options** – sets out the options for investment on the Dundas Corridor based on different BRT and priority bus service styles;
- **Section 4: Strategic Case** – sets out the strategic goals and objectives that Dundas BRT will achieve by determining the value of addressing the problem;
- **Section 5: Economic Case** – sets out the overall value to society of Dundas BRT by assessing the economic costs and benefits of the proposal to individuals and society. This section of the report appraises each option's costs and benefits to identify the option which represents the best value for money;
- **Section 6: Financial Case** – sets out the financial implications of delivery and establishes how much the project will cost in financial terms. This section of the IBC focuses on the specific capital, operating and revenue impacts of the scheme and the risks associated with delivery;
- **Section 7: Deliverability and Operations Case** – sets out the risks and requirements that must be considered in delivery and operation of the scheme, including the overall viability of the project, and the specific delivery and procurement strategy of the IBC; and
- **Section 8: Business Case Summary** – this section provides a summarized view of the core findings from each chapter.

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The Case for Change

Introduction

This section of the IBC presents the overarching case for change and rationale for investment in new bus rapid transit (BRT) along the Dundas Corridor. The section also articulates the problems which will be addressed and opportunities that will be unlocked through the implementation of the Dundas BRT project.

The Need for Regional Transportation Investment: Managing Growth and Congestion

The GTHA is one of the fastest growing city-regions in North America and is a nationally significant centre for business, culture and education. The GTHA is home to a diverse and growing population, a dynamic and thriving economy and has emerged as a desirable place to live, work, study and invest. The GTHA is the economic engine of Ontario and its role in securing economic growth in the province is set to continue. The population of the GTHA is forecast to grow from 7.2m people in 2018 to 10.1m by 2041, reflecting net growth of almost three million additional residents; employment in the GTHA is forecast to rise to 4.8m by 2041[2].

The 2041 Regional Transportation Plan (RTP) provides the blueprint for developing an integrated regional transportation system that serves the needs of businesses, residents, and institutions across the region:

> The GTHA will have a sustainable transportation system that is aligned with land use and supports healthy and complete communities. The system will provide safe, convenient and reliable connections; and support a high quality of life, a prosperous and competitive economy, and a protected environment.

The RTP includes a range of new services, infrastructure projects, and policies to keep the GTHA moving as it undergoes significant growth in the coming decades. The implementation of BRT as a transit solution forms a key part of the proposed Frequent Rapid Transit Network (FRTN) across the GTHA, outlined as a priority within the RTP which aims to provide high-quality transit to more people.

Existing Transit in the GTHA

The GTHA is currently served by a network of regional and local transit services including:

- GO Transit commuter rail and bus network which connects cities and towns across the GTHA;
- The Toronto Transit Commission (TTC) operates its integrated subway, streetcar and bus network across the City of Toronto; and

[2] Metrolinx, 2041 Regional Transportation Plan

A series of other local transit options in municipalities surrounding the City of Toronto, which includes bus services operated by Brampton Transit (including BRT), Burlington Transit, Durham Region Transit, Hamilton Transit, Mississauga Transit (including BRT), Oakville Transit, and York Region Transit (including BRT).

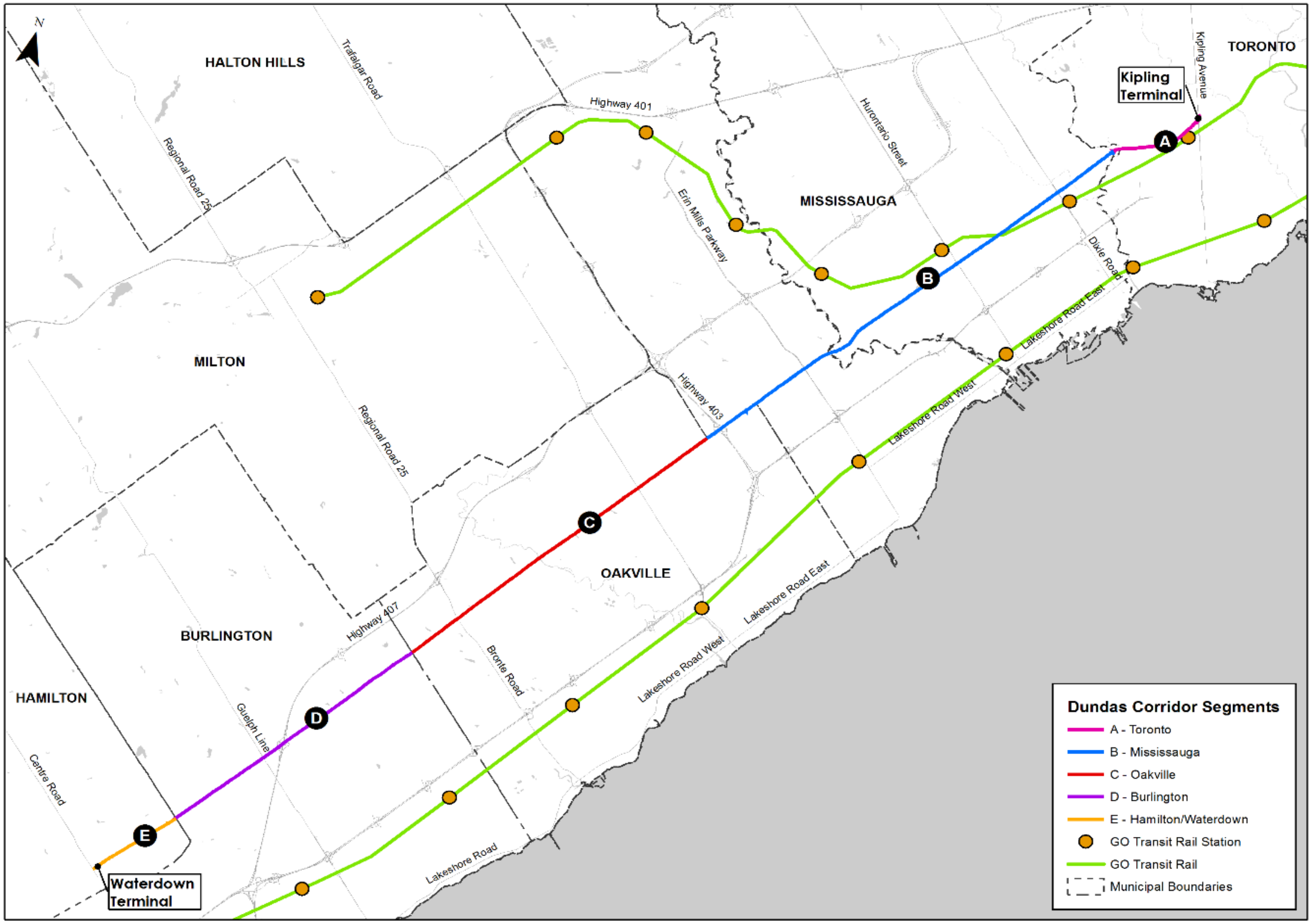
Higher-order transit services that connect destinations outside of central Toronto to one another are limited, leading to instances of congestion of key arterial routes on the road network. GTHA's key transit corridors – including the Dundas Corridor – are fundamental to realizing economic growth - and to ensure that the GTHA remains a globally competitive region in which to live and work. There are opportunities to increase transit service connections between places within the GTHA through the introduction of higher order transit services, including the Dundas Corridor, taking into account forecast population and employment growth across the GTHA.

This IBC focuses on the Dundas Corridor investment that is required to realize this vision and the four key outcomes identified within it:

- Safe Reliable and Convenient Connections;
- High Quality of Life;
- Prosperous Economy; and
- Protected Environment.

The Dundas Corridor comprises an approximately 40-km transport corridor that connects Toronto, Mississauga, Oakville, Burlington, and Hamilton. A map of the Dundas Corridor, which has been segmented by municipality for the purpose of this IBC, is presented in Figure 2.1.

Figure 2.1: Dundas Corridor Segmentation



Problem Statement: Liveability and Development on Dundas are Constrained by the Transportation Network

The problem statement defines the central issues that this IBC seeks to resolve through investment in the transportation network:

The Dundas corridor has limited cross-boundary travel alternatives to the automobile, which leads to high auto usage and congestion. The corridor is forecasted to see significant growth and development, making it one of the key areas of the GTHA for living and working. By 2041, the corridor will contain 9% of all population growth and 6% of employment growth across the GTHA. Without improved transport alternatives, the overall livability and economic development potential of the corridor, including future developments, will be constrained.

This problem is driven by two key issues as discussed in Table 2.1.

Table 2.1: Key Problem Drivers

Issue	Overview
Uncompetitive against auto travel and fragmented transit services along the corridor	The existing transit network does not allow for efficient movement across the corridor as there is no integrated transit service provided along the full length of the corridor. Multiple transfers, detours and double fares are often required for inter municipal journeys, which makes transit a less viable option than driving. Existing transit travel times are not competitive against auto travel. Service headways on many routes, especially in the western part of the corridor, are often greater than 15 minutes, even during peak periods, making transit an unattractive option for choice travellers. Transit trips also often require more pre-planning than auto travel (i.e. access time to transit stops, aligning travel plans to transit timetables), reducing the individual attractiveness of transit compared to personal auto travel.
Rapid population and employment growth lead to higher travel demand	Plans for development along the corridor call for a more compact urban form. Today, many trips originating on the corridor are to employment centres off corridor. In the future, plans call for more people to live and work in denser communities along the corridor. Significant increases in population and employment are likely to lead to more automobile trips in the corridor and worsening congestion. Without alternative travel options, the planned growth may be inhibited by the worsening congestion and associated increases in travel time which negatively impact economic productivity.

Issue 1 – Uncompetitive and fragmented transit services along the corridor

Issue 1 explores how travellers make use of the existing road and transit network and outlines key gaps in the future or planned network that contribute to the problem statement.

The Dundas corridor is a multimodal transport corridor that includes multiple facilities for passenger transport:

- **Highways** north and south of Dundas Street are available for automobiles, GO Buses, and freight traffic (Hwy 403, Hwy 407 and QEW);
- **Regional GO Transit** services (bus and rail) provide access to all municipalities along the corridor, and are predominately located outside the study area; and
- **Local bus services** Toronto Transit Commission (TTC), MiWay, Oakville Transit, Burlington Transit, and Hamilton Street Railway (HSR) connect with higher order transit services (GO Transit or TTC subway system) or circulate locally within the municipal boundaries of the service provider. The corridor's only express bus route (101 Dundas Express), which spans from Winston Churchill Blvd to Kipling Ave, is operated by MiWay.

The 40km Dundas road network is managed by multiple jurisdictions. Table 2.2 presents an overview of Dundas Street's main characteristics by segments. The eastern part of the corridor from Bronte Road, in Oakville, to Kipling Station in Toronto is three lanes per direction except for the two segments between Cawthra Road and Clayhill Road, and between Credit Woodlands Court and Winston Churchill Boulevard in Mississauga. In both sub segments, there are two lanes per direction and a median lane allowing turns. A mix of commercial activities surrounds the eastern part of the corridor from Mavis Road, in Mississauga, to Etobicoke while the western part is mainly residential. The western part of the corridor from Bronte Road to the Village of Waterdown (14km) in Hamilton has two lanes per direction.

Presently, public transit does not provide a continuous east-west service along the Dundas Corridor, which impacts connectivity and accessibility for residents and workers. The following agencies operate along the corridor:

- **Toronto Transit Commission** – provides five routes along Dundas Street west of Kipling Station;
- **MiWay** – operates 25 routes that make use of or intersect with the Dundas Corridor;
- **Oakville** – operates six routes that make use of or intersect with the Dundas Corridor;
- **Burlington** – operates 10 routes that make use of or intersect with the Dundas Corridor;
- **Hamilton** – operates one route in the Village of Waterdown that provides local circulation and makes use of the Dundas Corridor; and
- **GO Transit** – operates the regional Milton train-bus route that make use of Dixie Rd-Mavis Rd segment within the Dundas Corridor, and provides regional rail services close to the eastern end of the Dundas Corridor via the Milton Line. Stations at Kipling GO in Toronto, Dixie GO and Cooksville GO in Mississauga stop close to the Dundas Corridor (<500m). On the Lakeshore West Line, stations run parallel to the Dundas Corridor along the entire Corridor (approximately 3.5km from the Corridor).

Despite the presence of multiple service agencies along the corridor, services are fragmented and do not provide seamless connectivity between key activity areas along the Corridor. This fragmented service provision decreases the attractiveness of public transit as the preferred mode of travel for users of the Corridor. This fragmentation also extends to fare integration on the corridor, where the 905 agencies offer fare integration, but transfer to GO and TTC incurs an additional fare.

Table 2.2: Dundas Street Characteristics

Segment	Road segment	Length	Number of lanes per direction	Major intersections and interchanges	Typical intersection spacing	Intersection type - Signalized	Intersection type - Not signalized	Main Land Use - North	Main Land Use - South
A - Toronto	Kipling Ave/Hwy 427	2.4 km	3	Kipling Ave Shaver Ave Hwy 427	0.4 km	6	0	Commercial	Commercial
B - Mississauga	Hwy 427/ Cawthra Rd	5.2 km	3	Dixie Rd Stanfield Rd Blundell Rd Tomken Rd Haines Rd	0.18 km	16	0	Commercial	Commercial
	Cawthra Rd/ Clayhill Rd	3.5 km	2 (+central turning lane)	Cliff Rd Camila Rd Hurontario Rd Confederation Pkwy	0.23 km	6	1	Mix use	Mix use
	Clayhill Rd/ Credit Woodlands Ct	2.7 km	3	Mavis Rd Erindale Station Rd	0.36 km	5	0	Commercial	Commercial
	Credit Woodlands Ct/ Winston Churchill Blvd	4.2 km	2 (+central turning lane)	Mississauga Rd Erin Mills Pkwy Woodchester Dr	0.18 km	7	1	Residential	Residential
C - Oakville	Winston Churchill Blvd/ Ernest Appelbe Blvd	5.4 km	3	Winston Park Dr *(south of Mississauga's Ridgeway Dr)* Hyde Park Gate *(south of Mississauga's Vega Blvd)* Hwy 403 Trafalgar Rd	0.3 km	14	0	Residential	Residential
	Ernest	2.5 km	2	Ernest Appelbe Blvd	0.7 km	3	0	Residential	Residential

Segment	Road segment	Length	Number of lanes per direction	Major intersections and interchanges	Typical intersection spacing	Intersection type - Signalized	Intersection type - Not signalized	Main Land Use - North	Main Land Use - South
	Appelbe Blvd/ Gladeside Ave			Sixth Lane Harman Gate Towne Blvd					
	Gladeside Ave/ Bronte Rd	4.7 km	3	Neyagawa Blvd Third Line Hospital Gate Postmaster Dr Bronte Rd	0.4 km	9	2	Residential	Residential
	Bronte Rd/ Tremaine Rd	1.7 km	2	Zenon Rd Tremaine Rd	0.7 km	3	0	Residential	Residential
D - Burlington	Tremaine Rd/ Kerns Rd	9.8 km	2	Appleby Lane Millcroft Park Dr Weslock Common Rotary Way Walkers Line Hwy 407 Northampton Blvd Guelph Line Brant St./ Cedar Springs Rd	0.4 km	9	3	Residential	Residential
E - Hamilton	Kerns Rd/ Waterdown Rd	2.8 km	2	Burke St Waterdown Rd	0.45 km	4	4	Residential	Residential

Future Network

Table 2.3 provides an overview of the road-widening projects and transit network improvements along the Dundas Corridor. The recent widening of Dundas Street in Oakville near the new Oakville Trafalgar Memorial Hospital has installed road infrastructure useful for a priority bus service, including concrete curb-side bus bays. Planned road and transit projects will complement past efforts and create new opportunities for improved transit services along the Dundas Corridor. One of the key projects is to complete the widening of Dundas Street from four lanes to six lanes between Kerns Road east of the Village of Waterdown to Bronte Road in Oakville (construction is planned to commence between 2019 and 2022 for individual projects). Once complete, the Dundas corridor will be 6 lanes for the most part (32 km), with five lanes on two stretches in Mississauga.

There are also two major transit projects fully funded along the Dundas Corridor Study:

- Hurontario LRT: and
- Inter-regional bus terminal at Kipling Station.

Other planned corridor projects are noted in Table 2.3.

Existing Corridor Travel Patterns

Nearly 1 million trips occur along the Dundas Corridor each day. To better understand this, travel on the Dundas Corridor (defined as a 2km buffer on either side) has been divided into three geographic markets, with detailed travel demand from the 2011[3] Transportation Tomorrow Survey (TTS) data analysed:

- **Internal** – trips with an origin and destination within the same municipality;
- **Inter-municipal** – trips that start and end in two different cities along the corridor;
- **Trips to/from Downtown Toronto** (PD1) – trips with an origin or destination along the Dundas Corridor and an origin or destination in Downtown Toronto; and
- **Trips to/from the rest of the GTHA** – trips with an origin or destination along the Dundas corridor an origin or destination in the GTHA outside the corridor and downtown Toronto.

A summary of travel demand originating and terminating on corridor, to downtown Toronto (PD1), and the rest of the GTHA is provided in Table 2.4. This shows that more than half of travel demand from the corridor is heading towards the rest of the GTHA.

[3] The 2016 data was not yet available at the time of this analysis

Table 2.3: Relevant network and transit improvements along the Dundas Corridor

	Funded and/or committed	Key Insight for this IBC
A – Toronto	**Road Network** • Normalization of the interchange at Dundas Street, Bloor Street, and Kipling Avenue located east of Kipling Station (2020) **Transit Network** • Construction of an inter-regional bus terminal at Kipling Station. More detail regarding this project is provided in the transit study review section of this report.	• Normalization of the interchange will turn this intersection from a car-centric, freeway-style interchange into a "complete streets" environment that supports all road users. • These two projects will provide easier access to Kipling Station for all users including future improved transit services along the Dundas corridor. • It will assist in fostering new land development around Kipling Station.
B – Mississauga	**Road Network** • There are no committed capital road projects in the short- to medium- term, although Dundas Connects proposes roadway widening and reconfiguration to accommodate segregated ROW for BRT and cycling infrastructure. **Transit Network** • Increased transit services of MiWay Route 101 on Dundas Street to a service every 6-10 minutes during the peak period (2020). Similar additional service improvements are planned on three major routes feeding the corridor (Route 110 – University Express and 103 – Hurontario Express). • Hurontario LRT expected to be operational in 2024. Route 103 (express) will be removed, but Route 19 (local) will remain at reduced frequencies.	• Planned service improvement will provide better east-west transit services and faster north-south connections in Mississauga. • MiWay service improvements are consistent with the Dundas Connects recommendations on the implementation of BRT services along Dundas Street with dedicated curbside lanes from Laird/Vega to Mississauga Road, a reversible lane from Mississauga Road to The Credit Woodlands and median bus-only lanes from The Credit Woodlands into the City of Toronto and the delivery of the Hurontario LRT.
C - Oakville	**Road Network** • Dundas Street widening from Tremaine Road to Bronte Road (2020) **Transit Network** • Dundas Street is identified in the Halton Region's Mobility Management Study as a Transit Priority Corridor. The function of the corridor will be further developed in the Region's on-going Defining Major Transit Requirements study.	• Widening of Dundas Street from 4 to 6 lanes on that segment, with the curb lanes becoming HOV lanes.

	Funded and/or committed	Key Insight for this IBC
D - Burlington	**Road Network** • Dundas Street widening from Appleby Line to Tremaine Road (2020) • Dundas Street widening from Guelph Line to North Hampton Boulevard (2021) • Dundas Street Widening from North Hampton Boulevard to Appleby Line (2019) • Dundas Street widening from Bronte Creek Bridge between Appleby Line and Tremaine Road (2019) • Dundas Street widening from Guelph Line to Halton/Hamilton Boundary, including improvements at Brant Street (2022) **Transit Network** • *See Oakville Transit Network Improvements	• Widening of Dundas Street from 4 to 6 lanes on that segment. Additional lanes are planned to be used for rapid transit services.
E - Hamilton	**Road Network** • Full interchange (by MTO) at Hwy 5 and Hwy 6 intersection just west of Waterdown • Widening of Dundas Street to 6 lanes between Avonsyde Boulevard and Hamilton boundary (at Kerns Road) (2021) • Parkside Drive improvements and new east-west arterial road north of Parkside Drive that links to Highway 6 (2020). **Transit Network** • No significant and specific transit improvements committed along the corridor	• The Parkside Drive improvements will directly impact Dundas Street as it is intended to divert some traffic from Dundas Street to help relieve existing capacity issues.
Dundas Corridor	**Transit Network** • Increase GO Train services on the Lakeshore West line located south of the Dundas Street Corridor to every 15 minutes.	• While not directly affecting inter-municipality travel demand along Dundas Street, this service improvement may affect trips with an origin in the corridor and a destination downtown Toronto. Greater integration of local bus services intersecting Dundas Street with the Lakeshore West Go Rail line is foreseen.

Source: Halton Region Capital Implementation Plan on Dundas Street (2018 to 2031) and Metrolinx 2041 RTP.

A small proportion (4%) of all travel demand originating on the corridor is to downtown Toronto (PD1). Nearly half of all the travel demand on the corridor originates in Mississauga, while Toronto has a comparable level to Oakville and Burlington, and Hamilton has the lowest proportion (reflecting the small share of the route length and more rural nature of this section).

Table 2.4: Summary of corridor travel demand

Trip origin segment	Trip destination				
	Corridor	Downtown Toronto (PD1)	GTHA	Total	Share
A – Toronto	59,500	11,500	105,700	176,700	20%
B – Mississauga	181,100	15,100	218,300	414,500	46%
C – Oakville	63,200	7,200	71,600	142,000	16%
D – Burlington	51,300	2,900	67,600	121,900	14%
E – Hamilton	20,300	600	19,700	40,600	5%
Total	375,400	37,500	482,900	895,800	100%
	42%	4%	54%	100%	

Source: 2011 TTS data (only trips within a 2-km buffer of Dundas Street are considered "on the corridor"). Totals may not sum due to rounding

Table 2.5 disaggregates the summary to include trip type: home-to-work (commuting), home-to-school (travel to school from home), home-to-other (recreational travel), and other-to-other (travel without an origin or destination at home) trips. This analysis indicates that:

- Home-to-work trips consist of only 15% of travel *within* the corridor. The majority of trips are for recreational or education purposes – as employment grows on the corridor this pattern may change;
- Trips to the City of Toronto's Planning District 1 (PD1) – which covers the core downtown area of Toronto – and the rest of the GTHA have a larger share for home-to-work trips; and
- The largest market share (44% overall) is for home-to-other trips – which include trips to access public services, shops, personal activities or recreational activities.

Table 2.5: Travel demand between the Corridor and the rest of the GTHA and Toronto

Trip Purpose	Trip origin segment	Trips to Corridor		Trips to PD1		Trips to rest of GTHA		Total trips	
		Trips	%	Trips	%	Trips	%	Trips	%
Home-to-Work Trips (Home-Based Work - HBW)	A – Toronto	8,800	2%	5,800	16%	35,900	7%	50,500	6%
	B – Mississauga	31,100	8%	8,600	23%	76,600	16%	116,300	13%
	C – Oakville	8,900	2%	5,700	15%	22,700	5%	37,300	4%
	D – Burlington	7,000	2%	2,300	6%	23,000	5%	32,200	4%
	E – Hamilton	2,200	1%	400	1%	7,100	1%	9,700	1%
	Total HBW	**57,900**	**15%**	**22,800**	**61%**	**165,300**	**34%**	**246,000**	**27%**
Home-to-School Trips (Home-Based School - HBS)	A – Toronto	4,000	1%	1,100	3%	5,600	1%	10,600	1%
	B – Mississauga	31,000	8%	1,600	4%	24,600	5%	57,200	6%
	C – Oakville	10,200	3%	400	1%	6,400	1%	17,100	2%
	D – Burlington	6,900	2%	100	0%	4,400	1%	11,400	1%
	E – Hamilton	3,400	1%	0	0%	1,500	0%	5,000	1%
	Total HBS	**55,500**	**15%**	**3,200**	**9%**	**42,500**	**9%**	**101,300**	**11%**
Home-to-Other Trips (Home-Based Other - HBO)	A – Toronto	29,900	8%	2,400	6%	43,100	9%	75,500	8%
	B – Mississauga	90,800	24%	2,600	7%	84,100	17%	177,500	20%
	C – Oakville	34,300	9%	500	1%	31,100	6%	65,800	7%
	D – Burlington	30,600	8%	300	1%	29,800	6%	60,700	7%
	E – Hamilton	10,800	3%	100	0%	8,100	2%	19,000	2%
	Total HBO	**196,400**	**52%**	**5,900**	**16%**	**196,200**	**41%**	**398,500**	**44%**

Trip Purpose	Trip origin segment	Trips to Corridor		Trips to PD1		Trips to rest of GTHA		Total trips	
		Trips	%	Trips	%	Trips	%	Trips	%
Other-to-Other Trips (Non-Home Based - NHB)	A – Toronto	16,800	4%	2,200	6%	21,000	4%	40,100	4%
	B – Mississauga	28,100	7%	2,300	6%	33,000	7%	63,400	7%
	C – Oakville	9,800	3%	600	2%	11,400	2%	21,900	2%
	D – Burlington	6,900	2%	300	1%	10,400	2%	17,600	2%
	E – Hamilton	4,000	1%	100	0%	3,000	1%	7,000	1%
	Total NHB	**65,600**	**17%**	**5,500**	**15%**	**78,900**	**16%**	**150,000**	**17%**
All Trips (for all purposes)	A – Toronto	59,500	16%	11,500	31%	105,700	22%	176,700	20%
	B – Mississauga	181,100	48%	15,100	40%	218,300	45%	414,500	46%
	C – Oakville	63,200	17%	7,200	19%	71,600	15%	142,100	16%
	D – Burlington	51,300	14%	2,900	8%	67,600	14%	121,900	14%
	E – Hamilton	20,300	5%	600	2%	19,700	4%	40,600	5%
	Grand total	375,400	100%	37,500	100%	482,900	100%	895,800	100%

Source: 2011 TTS data (only trips within a 2-km buffer of Dundas Street are considered “on the corridor”). Totals may not sum due to rounding.

Mode split for trips within the corridor is shown in Table 2.6. In this table "auto" includes car drivers, car passengers, taxis and motorbikes; "active" includes walking and cycling trips. This data illustrates that auto is the dominant mode of travel on the corridor, carrying 84% of trips, while transit carries only 6% of trips. This is similar to the 87% auto mode split and 7% transit mode split for trips within the planning districts along the corridor. A key impact of the lack of competitiveness of transit services along the corridor is that there is a high dependency on automobile use on the Dundas Corridor. This causes congestion on parts of the Corridor, particularly in areas which are surrounded by commercial and retail-land uses. This leads to travel time delays, which will likely worsen as the corridor continues to develop.

Table 2.6: Daily travel demand and mode split by municipal origin and destination on the Dundas Corridor

Origin			**Destination**			**Total**
	A – Toronto	**B – Mississauga**	**C – Oakville**	**D – Burlington**	**E - Hamilton**	
A – Toronto	45,700 Auto: 87% Transit: 5% Active: 9%	11,900 Auto: 93% Transit: 7% Active: 0%	985 Auto: 98% Transit: 2% Active: 0%	505 Auto: 97% Transit: 0% Active: 3%	39 Auto: 100% Transit: 0% Active: 0%	59,200 Auto: 88% Transit: 5% Active: 7%
B – Mississauga	12,000 Auto: 92% Transit: 7% Active: 1%	158,000 Auto: 78% Transit: 10% Active: 12%	8,980 Auto: 96% Transit: 3% Active: 1%	1,840 Auto: 98% Transit: 2% Active: 0%	216 Auto: 100% Transit: 0% Active: 0%	181,000 Auto: 80% Transit: 9% Active: 11%
C – Oakville	1,100 Auto: 98% Transit: 2% Active: 0%	9,310 Auto: 96% Transit: 3% Active: 1%	49,500 Auto: 83% Transit: 2% Active: 14%	3,030 Auto: 100% Transit: 0% Active: 0%	211 Auto: 100% Transit: 0% Active: 0%	63,200 Auto: 86% Transit: 2% Active: 11%
D – Burlington	489 Auto: 97% Transit: 0% Active: 3%	1,870 Auto: 100% Transit: 0% Active: 0%	2,910 Auto: 100% Transit: 0% Active: 0%	43,400 Auto: 86% Transit: 5% Active: 9%	2,710 Auto: 100% Transit: 0% Active: 0%	51,300 Auto: 88% Transit: 4% Active: 8%
E – Hamilton	39 Auto: 100% Transit: 0% Active: 0%	220 Auto: 100% Transit: 0% Active: 0%	199 Auto: 100% Transit: 0% Active: 0%	2,540 Auto: 100% Transit: 0% Active: 0%	17,300 Auto: 85% Transit: 7% Active: 8%	20,300 Auto: 87% Transit: 6% Active: 7%
Total	59,400 Auto: 88% Transit: 5% Active: 7%	181,000 Auto: 81% Transit: 9% Active: 11%	62,600 Auto: 86% Transit: 2% Active: 12%	51,300 Auto: 88% Transit: 4% Active: 8%	20,500 Auto: 87% Transit: 6% Active: 6%	375,000 Auto: 84% Transit: 6% Active: 10%

Source: 2011 TTS data (Includes only trips within a 2-km buffer of Dundas Street)

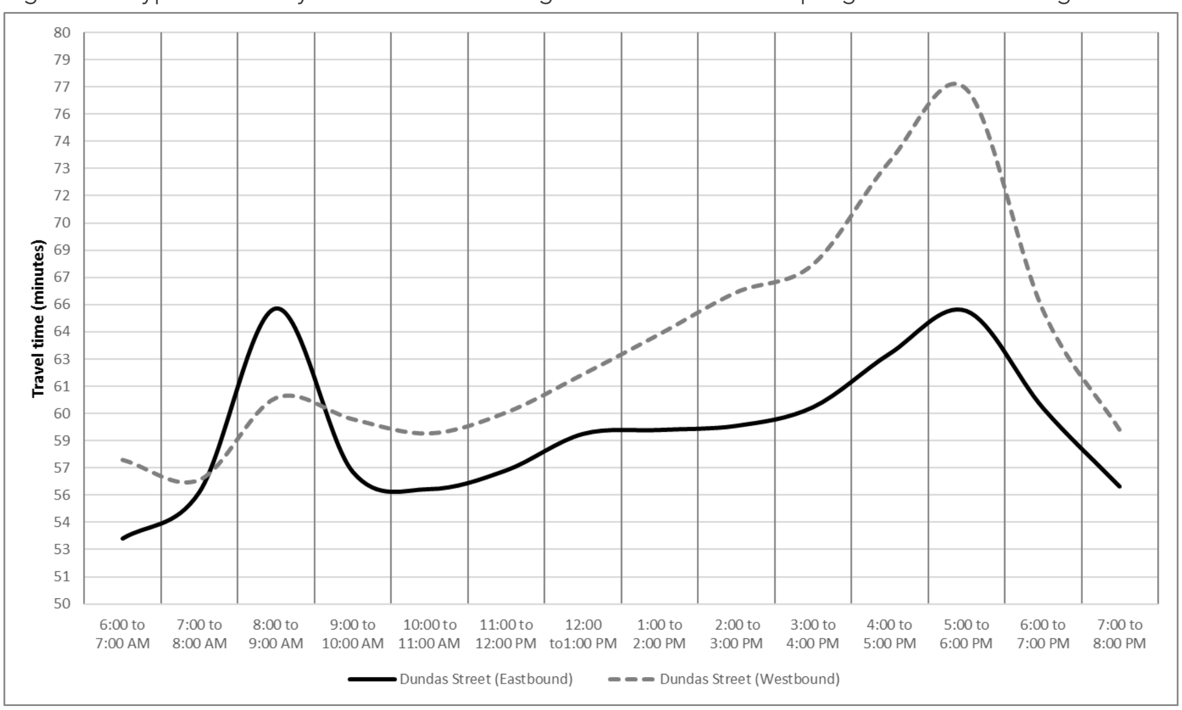
Auto Dependence of Dundas will Lead to Increased Congestion

This analysis suggests inability of present transit services along the corridor to fulfill the travel demand for many trip types:

- East-west connections along the corridor (trips within segments along the corridor) make up over 375,000 daily trips (over 40% of corridor demand);
- These trips cannot be completed by transit without multiple transfers and typically require the use of multiple service providers; moreover, transfers between transit operators may require extended waiting periods (depending on the level of coordination); and
- As a result, transit is likely to be less competitive than the automobile for many trips.

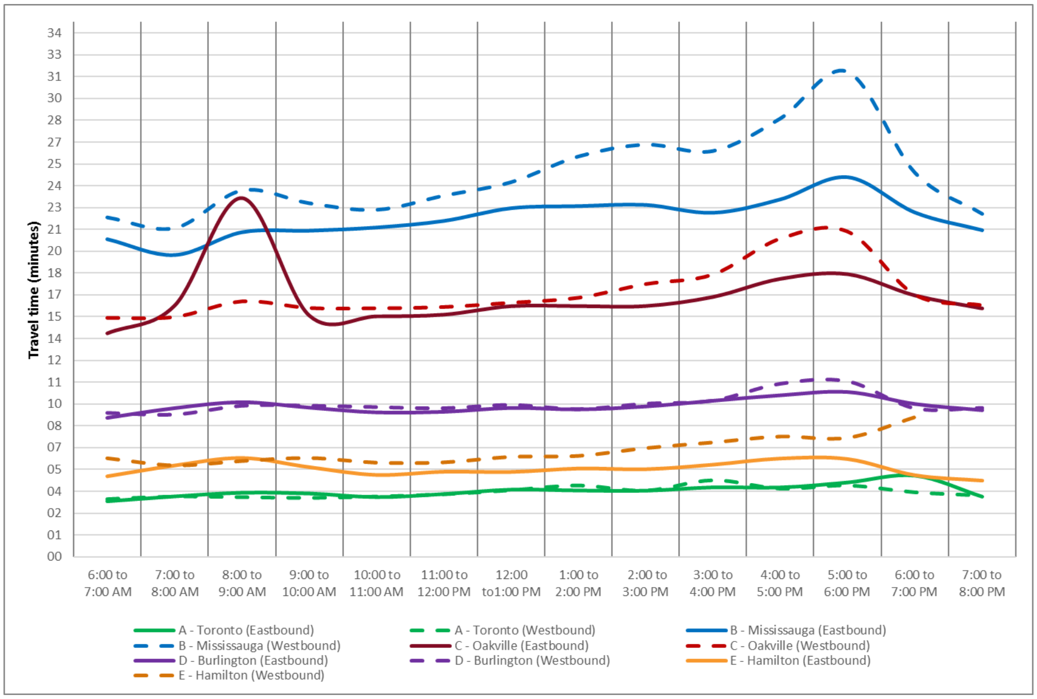
This level of auto dependence has a significant impact on corridor travel times and travel time reliability for both buses and automobiles. Travel times along the Corridor are significantly impacted by peak period congestion, as illustrated in Figure 2.2. Congestion in peak periods increases auto travel times by up to 25% in the east-bound direction and 33% in the west-bound direction. Figure 2.3 illustrates travel time by time of day for each municipal segment while Figure 2.4 presents the associated average speed by segments. Figure 2.5 outlines five key areas where congestion is an issue.

Figure 2.2: Typical weekday auto travel time along Dundas Street from Kipling Station to the village of Waterdown



Source: Steer, Google travel time monitoring between November 18th and December 5th, 2017

Figure 2.3: Typical weekday average auto travel time along Dundas Street by time of day and segment



Source: Steer, Google travel time monitoring between November 18th and December 5th, 2017

Figure 2.4: Typical weekday average auto speed along Dundas Street by time of day and segment

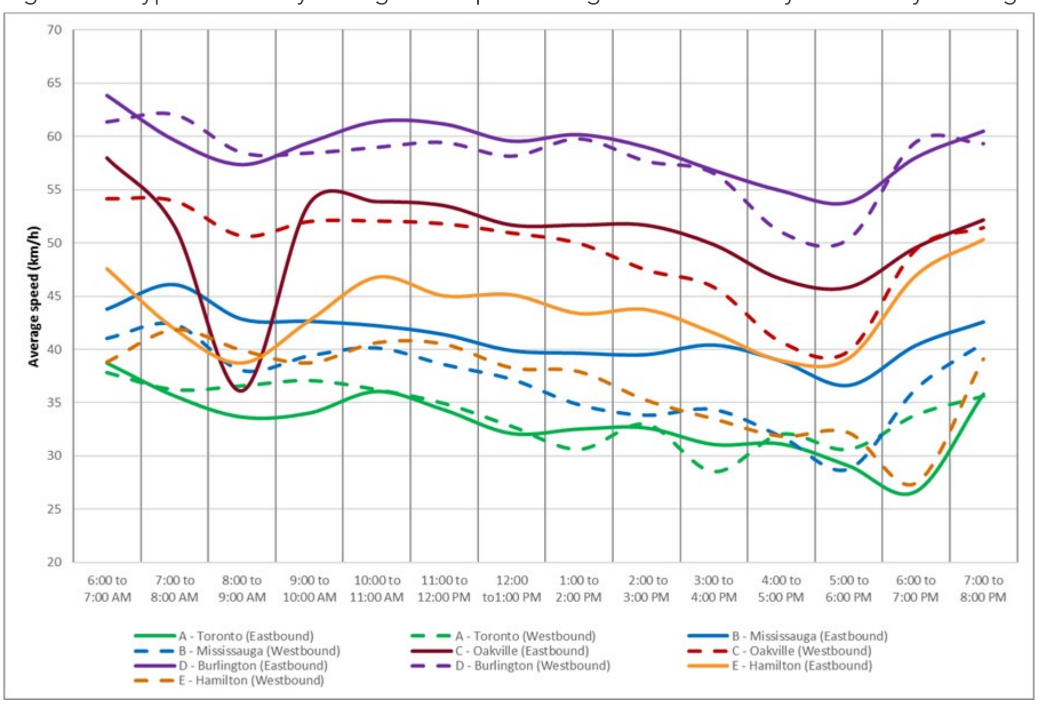
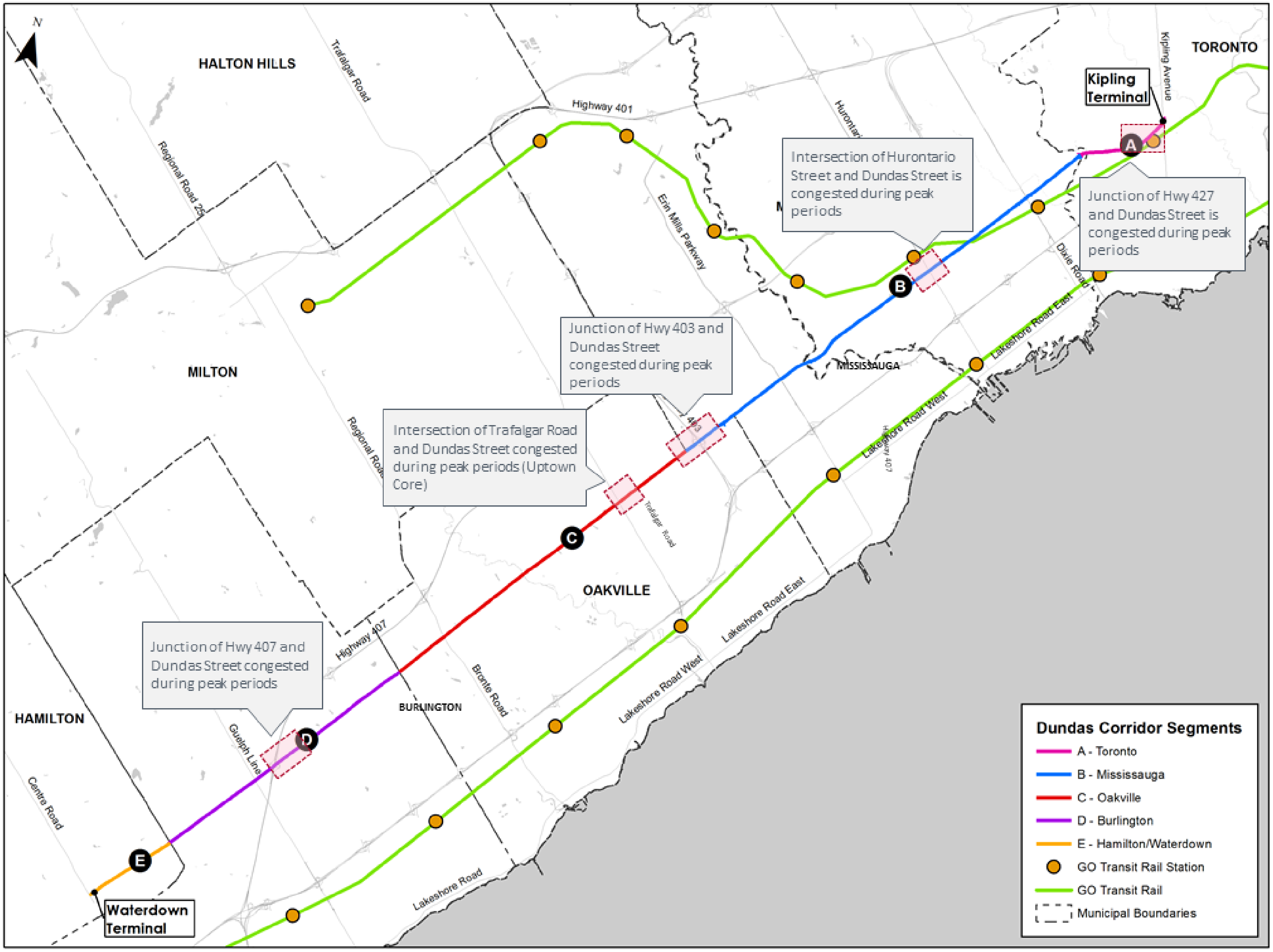


Figure 2.5: Main congested area along the Dundas Corridor Study during peak periods



Issue 2 – Rapid Population and Employment Growth Leads to Higher Travel Demand

Overview

Issue 2 describes the level of population and employment growth expected on the corridor and its anticipated impact on travel times, congestion, and transport demand on the corridor.

Forecast Population Growth

The Dundas Corridor plays a key role in the movement of people within the GTHA area. Population and employment data show that the catchment area[4] surrounding the Dundas Corridor accommodates approximately 558,000 people and 215,000 jobs[5]. An overview of forecasted population and employment growth along the Dundas Corridor is provided in Table 2.7.

The Corridor will play a key role in supporting future residential and employment growth in the GTHA. Forecasts in the Growth Plan indicate that 9% of the GTHA's total growth population and 5% of total employment growth between 2011 and 2041 will occur on the Corridor. By 2041, 6% (284,000) of all employment in the GTHA will be located on the Corridor, and 8% (808,000) of the Region's total population will be living on the Corridor.

Table 2.7: Forecast change in population and employment within 2km of Dundas Corridor

City	Population on Corridor (2011)	Future population on Corridor (2041)	Growth on Corridor	% of total growth on corridor	% of total growth in City	% of GTHA population on Corridor in 2041
Population						
Toronto	103,000	149,000	+46,000	+18%	+5%	1%
Mississauga	262,000	368,000	+106,000	+42%	+48%	4%
Oakville	100,000	166,000	+66,000	+26%	+71%	2%
Burlington	74,000	87,000	+13,000	+5%	+25%	1%
Hamilton (Waterdown)	19,000	38,000	+19,000	+8%	+8%	0%
Corridor	558,000	808,000	+250,000		+16%	8%
GTHA Wide	558,000	808,000	+250,000		+9%	

[4] The catchment area is defined as a 2km buffer north and south of Dundas Street along the Dundas Corridor
[5] Analysis of Metrolinx 2041 Market Forecast

City	Population on Corridor (2011)	Future population on Corridor (2041)	Growth on Corridor	% of total growth on corridor	% of total growth in City	% of GTHA population on Corridor in 2041
Employment						
Toronto	66,000	76,000	+10,000	+14%	+2%	2%
Mississauga	87,000	116,000	+29,000	+42%	+25%	2%
Oakville	31,000	53,000	+22,000	+32%	+49%	1%
Burlington	25,000	30,000	+5,000	+7%	+26%	1%
Hamilton (Waterdown)	6,000	9,000	+3,000	+4%	+3%	0%
Corridor	215,000	284,000	+69,000		+10%	6%
GTHA Wide	215,000	284,000	+69,000		+5%	

Source: Analysis of Metrolinx 2041 Market Forecast, figures may not sum due to rounding

The Impact of Growth on Travel Demand and Congestion

Ensuring the Dundas Corridor can accommodate growth is key for future residential and employment growth in the GTHA. The Corridor will accommodate six percent and eight percent of GTHA's population and employment respectively, illustrating the need to explore and consider new mobility options to provide alternatives to automobile use along the corridor. The key insights outlined from the review of population and employment growth patterns along the Dundas Corridor are summarized inTable 2.8.

Table 2.8: Key population and employment insights

Segment	Highlights
A - Toronto	• Population and employment growth is steady and expected to continue in areas around Kipling Station • 5% of total population growth and 2% of total employment growth in Toronto is expected to occur on the Corridor
B – Mississauga	• Employment growth on the Corridor will be significant and expected to occur in areas within and around the Dixie Employment Lands Area (expected to grow 61% by 2041). • 48% of total population growth and 25% of total employment growth in Mississauga will occur on the Dundas Corridor
C - Oakville	• Population growth is planned for areas north of the Dundas Corridor which is currently underdeveloped • Demand for housing will be significant in North Oakville (north of the Dundas Corridor) • Employment growth along the Dundas Corridor will be modest in comparison to population growth • 71% of Oakville's total population growth and 49% of total employment growth will occur within the Dundas Corridor
D – Burlington	• City-wide population growth is lower (approximately 10%) compared to other segments on the Dundas Corridor. • Employment will be expected to grow by approximately 60% (primarily east of the 407)
E – Hamilton/ Waterdown	• Large share of population growth in Hamilton is expected to occur in Flamborough, Waterdown. • Employment growth is forecasted to be lower than population growth, highlighting the need for mobility alternatives connecting Waterdown to other employment centres. • Residential development will likely remain low to medium density • The population on the Corridor is expected double (97%) by the year 2041; employment is expected to increase by 39% from 2011.

Future Transportation Demand

Without improvements to the transit service on this corridor to accommodate expected demand, the speed of travel on the corridor is expected to materially decrease in the future. This is illustrated by reviewing AM Peak period demand for transit and auto along the corridor in 2041 in Table 2.9, which has been estimated using the Greater Golden Horseshoe Model V4.

Table 2.9: 2041 BAU AM Peak Period (2-hr) Demand by Auto and Transit on the Dundas Corridor

	Destination					
Origin - Auto	**A - Toronto**	**B - Mississauga**	**C - Oakville**	**D - Burlington**	**E - Hamilton**	**Total**
A - Toronto	5,200	1,800	60	0	0	7,060
B - Mississauga	3,200	25,800	1,400	160	40	30,600
C - Oakville	400	4,200	10,200	800	160	15,760
D - Burlington	100	600	1,000	5,000	600	7,300
E - Hamilton	20	180	160	1,000	2,200	3,560
Total	8,920	32,580	12,820	6,960	3,000	64,280
Origin - Transit	**A - Toronto**	**B - Mississauga**	**C - Oakville**	**D - Burlington**	**E - Hamilton**	**Total**
A - Toronto	7,200	800	10	0	0	8,010
B - Mississauga	1,300	3,100	30	0	0	4,430
C - Oakville	10	200	300	100	0	610
D - Burlington	0	10	40	100	0	150
E - Hamilton	0	0	10	80	10	100
Total	8,510	4,110	390	280	10	13,300
Origin - Auto Mode Split	**A - Toronto**	**B - Mississauga**	**C - Oakville**	**D - Burlington**	**E - Hamilton**	**Total**
A - Toronto	42%	69%	86%	-	-	47%
B - Mississauga	71%	89%	98%	100%	100%	87%
C - Oakville	98%	95%	97%	89%	100%	96%
D - Burlington	100%	98%	96%	98%	100%	98%
E - Hamilton	100%	100%	94%	93%	100%	97%
Total	51%	89%	97%	96%	100%	83%

This analysis notes the following:

- Transit mode split is the highest in Toronto, where in the BAU many trips make use of the existing bus network that provides direct connectivity between MiWay to the TTC Subway and buses; and
- Automobile is the dominant mode for all other parts of the corridor and for the corridor as a whole, with an 83% mode split (comparable with the 2011 all-day mode split derived from the TTS data analysis).

Based on this analysis, future forecasts suggest that the absence of an interconnected transit system will lead to further congestion and auto dependence, which in turn can impact livability and development potential on the corridor.

The level of growth expected on the Corridor demonstrates the need to explore and consider new mobility options to provide alternatives to automobile use along the corridor and to provide a high-quality and efficient east-west transit service that serves the needs of the Corridor and its users. The transportation network has a key role to play to ensure that this growth can be accommodated by ensuring supply meets levels of demand and that it facilitates, not inhibits, growth.

What Happens if this Problem is Not Addressed?

Given that the Corridor is forecast to experience significant growth and development in the coming years, its role as a key regional transit corridor is set to grow. By 2041, the 2km catchment area of the Dundas Corridor will account for 9% of all population growth in the GTHA, as well 6% of employment growth. Without the provision of a connected transit service, the overall livability and economic development potential of the Corridor will be constrained.

If the problem (transportation network constraints' impact on corridor's liveability and development) is not addressed, there are several risks associated with taking no action as noted in Table 2.10 including:

Table 2.10: Impact of Not Addressing this Problem

Outcome	Impact
Transportation	If this problem is not addressed, the transport network will have decreased resilience and flexibility, which means: • Travel times will be less reliable • Travellers will have less choice • The network will have minimal flexibility to meet growing demand
Quality of Life	An auto dependent transport network will impact quality of life: • Increased risk of car accidents • Increased congestion, which means more time spent travelling to reach recreational destinations, cultural activities, educational facilities, or social services • Lower likelihood of active transportation use • Less effective use of urban spaces (e.g. more parking and auto lanes, and less attractive urban realm to encourage more sustainable transit-oriented developments)
Economic Development	An auto dependent transport network will adversely impact economic development: • Increased congestion means slower commute times, which can result in lost productivity • If neighbourhoods and future employment hubs are not accessible, then there is potential for supressed economic and urban development of the corridor
Environment	An auto dependent transport network will adversely impact the environment: • Congestion and heavy auto use will lead to increased GHG emissions • Heavy auto use will also lead to increased Criteria Air Contaminants (CACs), which directly impact human health and environmental integrity

Due to the above risks, there is a clear impetus to respond and ensure that growth along the Dundas Corridor is well-managed.

The Opportunity: Develop a Connected Transit Service

Table 2.11 summarizes the key challenges and opportunities of the transportation network based on the problem statement and its two key issues.

Table 2.11: Core Challenges and Opportunities of the Transport Network on Dundas Street

Challenges	Opportunities
Congested Auto Network • Congestion in peak periods slows down auto travel significantly. Despite the congestion issues, automobile has the highest mode share on the Corridor, at 84% (2011). • Automobile dependant corridors such as Dundas have high pollutant and greenhouse gas (GHG) emissions. **Missing East-West Transit Link** • Absence of east-west transit services along the full length of the Dundas corridor limit the inter-municipal travel by transit. Currently, multiple transfers are required, contributing to automobile trips dominating inter-municipal travel. • Limited transit services along Dundas Street in the Village of Waterdown and Burlington may discourage transit usage for internal trips along the western part of corridor. Currently, transit services in these municipalities are structured north-south around regional GO Transit services and not east-west. **Weak Transit Usage for Home-Based Work and Home-Based Other trips** • Personal business (market/shop, bank, grocery store, daycare and other amenities) and entertainment trips drive the overall travel demand along the Dundas corridor (up to 52%). Work trips (15%) and school trips (15%) represent a lower share of the travel demand. • Nonetheless, home-to-school trips represent 40% of the transit travel demand, indicating that	**Travel Demand** • The existing transit network and travel demand suggests potential for rapid transit improvements in the eastern part of the corridor from Mississauga to Kipling Station. In Mississauga, Dundas Street is the third busiest transit corridor; buses operate at 10-minute headways in the peak period. **Inter-municipal Transit Expansion** • East-west transit service expansion on Dundas Street would allow for more frequent and reliable services between key existing and planned centres and reduce travel times. This would improve transit's role as an alternative to automobile trips along the corridor to alleviating congestion. • Internal trips are the dominant market. They represent 84% of the daily travel demand along the corridor. Low inter-municipal travel demand suggests that there is an opportunity to phase the development of an improved transit services along the corridor by municipalities. **Align Transport Investment to Support Growth** • Connect designated mobility hubs and transit nodes. Improved transit services along the corridor have the potential to support growth plans, local businesses and the development of mobility hubs. • Align transit investment to support growth plans and the development of "anchor" mobility hubs to foster transit usage in this automobile dependent corridor. **Align Transit Expansion with Road Network Investment** • The completion of the widening of Dundas Street in

Challenges	Opportunities
students are the main transit users along the corridor.	Halton region will provide sufficient space to operate a bus rapid transit services with dedicated lanes throughout the corridor. • Street widening and related improvements should contribute towards the creation of walkable and bikeable complete streets that are well-integrated with the public realm and conducive for transit-supportive developments.

The problem statement can be addressed through careful strategic investment in the transit system along the corridor provided that it:

- Provides an integrated mobility solution along the corridor in line with plans and policies for the region and the municipalities on the corridor;
- Demonstrates positive value for money and a clear return on investment;
- Delivers tangible benefits to users who live and work along the Dundas Corridor; and
- Is flexible and can adapt to the increasing demand for travel as growth in the GTHA takes place.

Based on this assessment, the following vision statement has been developed to guide investment development in this IBC: “Develop a transit investment package that provides travellers with attractive alternatives to the automobile to support the development of a livable and prosperous corridor”.

This investment presents a series of opportunities to develop a connected transit service that will support economic and population growth, improve inter-municipal transit, address demand for travel along the corridor and contribute to the growth and transit ambitions of the GTHA. The opportunity realized by addressing the problem is a connected corridor that provides travellers with attractive alternatives to the automobile to support the development of a livable and prosperous corridor.

In this way, investment in a connected transit service will unlock a series of opportunities of strategic value to a range of stakeholders, including transit users, workers and residents. The key opportunities that the scheme will unlock are presented as follows:

1. **Addressing demand for transit services** – the fragmented nature of the existing transit network and current levels of travel demand along the Dundas Corridor presents a clear rationale for investment in light of forecast growth in demand along the Corridor;
2. **Improving inter-municipal east-west connectivity** – a continuous east-west transit service between municipalities along the Dundas Corridor will allow for more frequent and reliable services between existing and planned centres. This would reduce travel times and encourage modal shift to sustainable public transit as a viable and attractive alternative to automobile trips along the corridor, thus alleviating congestion;
3. **Aligning transit expansion with existing infrastructure investment** – Dundas BRT would complement a series of existing and planned improvements along the Dundas Corridor, such as the widening of Dundas Street from four lanes to six between Kerns Road east of

the Village of Waterdown to Bronte Road in Oakville. Once complete, the Dundas Corridor will be 6 lanes for the most part (32 km), with five lanes on two stretches in Mississauga. The completion of the widening of Dundas Street in Halton region will provide enough space to operate a BRT services with dedicated lanes throughout most of the Corridor; and

4. **Utilizing rapid transit to enable economic growth in the GTHA** – by enhancing connectivity along the Dundas Corridor, Dundas BRT will connect communities and act as an enabler to transit-oriented development that will stimulate economic growth. The Dundas Corridor is a centre of high current and future travel demand which connects various centres of economic activity. Delivery of the project will encourage sustainable, integrated development and offer greater choice of transit options.

The Solution: Community Integration with BRT

Overview

This IBC proposes the implementation of a BRT and priority bus corridor along Dundas Street (the Dundas BRT) to solve the problem identified in previous sections.

The Dundas BRT project, a proposal for an integrated and holistic bus-based transit system along the corridor between Kipling subway station and Waterdown, was identified in the 2008 Big Move RTP (in the 15-year time horizon) and is currently a priority in-development project under the 2041 Regional Transportation Plan (RTP). The Dundas BRT project would serve five municipalities (Toronto, Mississauga, Oakville, Burlington and Hamilton) and their respective transit agencies. In addition, GO Transit serves the western GTHA through the Lakeshore West and Milton rail lines and various bus routes.

The Dundas BRT will address existing and future challenges in the transit network and ultimately support community integration and improve the quality of life of those living and working along the corridor. The Dundas BRT scheme will meet the need for change in four key ways, as follows:

1. **Providing faster, more reliable public transit** – Dundas BRT will provide faster, more reliable public transit and increase the quality of services for those living and working along the Corridor;
5. **Encouraging more sustainable transit** – Dundas BRT will encourage travel behavioural change and patterns in travel by increasing the proportion of local journeys undertaken by public transit, thus reducing congestion and dependency on personal automobile use;
6. **Improve connectivity** – Dundas BRT will provide additional levels of connectivity to areas currently underserved by continuous east-west transit connections, particularly for those without personal vehicles; and
7. **Integrate land use & transportation to support economic growth** – Dundas BRT will facilitate transit-oriented development (TOD) around the Dundas Corridor to accommodate projected growth in population and employment and support the case for physical regeneration and development along the corridor.

These outcomes will lead to positive impacts including improved accessibility, a more efficient transit system and will generate wider economic impacts such as productivity growth.

Why BRT?

The analysis by Dundas Connects and this IBC indicates that the expected growth and demand is best met through BRT and priority bus initiatives. BRT offers the most competitive solution to deliver high-quality, high-frequency services along the Dundas Corridor for a number of reasons.

- **Cost efficiency** – BRT offers competitive cost savings relative to other transit infrastructure, such as light rail systems. BRT does not require significant capital investment in new infrastructure (i.e. for tracks and overhead wires). BRT systems historically represent a fraction of the capital cost of LRT and metro systems, especially if they are placed at grade;
- **Passenger capacity** – BRT can be operated closer to its theoretical capacity as its fixed infrastructure is less expensive, and its services are more configurable to be within acceptable ranges of anticipated demand as compared to other higher-order transit;
- **Flexibility in service provision** – BRT can provide flexibility in routing and levels of service provided in a way that other systems are not able to do. This is because, in effect, BRT can run on existing roads, meaning that it is a highly configurable system;
- **High-speed, high-frequency** – BRT has a comparative advantage in the levels of speed that can be reached if dedicated right-of-way (ROW) is implemented; and
- **Reliability** – the use of a segregated right of way for the vast majority of the Dundas BRT will deliver high levels of reliability, in both journey times and headway.

Examples of global BRT systems are illustrated in Table 2.12.

Table 2.12: Global BRT Systems and Lines

BRT Name	Geographical Location	Date Opened	Annual Demand	How the line was delivered?	Corridor Length
Orange Line	San Fernando Valley, Los Angeles, North America	October 2005. Expanded in 2012 from Canoga north to Chatsworth.	9.5m (26,200 daily)	BRT operated by the LA County Metro. Initial BRT cost USD $324 million ($23 million per mile). Funded through following measures: • Federal funding (RSTP) - $17.5m • Federal funding (S 5309) - $1.9m • State TCRP (Transit Congestion Relief Program) - $145.5m • State STOP - $0.4m • Proposition C - $127.3m • City of L.A - $1.8m	29km

BRT Name	Geographical Location	Date Opened	Annual Demand	How the line was delivered?	Corridor Length
South East Busway	Brisbane, Australia	Opened in 2000. Second section between Woolloongabba and Eight Mile Plains opened 2001. Extension to Rochedale completed in 2014.	35m	TransLink Transit Authority, as part of Department of Transport and Main Roads (Queensland Government). AUS $400m for original scheme. Extension to Rochedale (opened 2014) funded by Queensland Government and formed part of Federal Government's Gateway Upgrade South project.	Original section between Queen Street and Eight Mile Plains is 16km.
Stockholm BHLS (Blåbussli-nje)	Stockholm, Sweden	1998	17.1m (2011 data)	AB Storstockholms Lokaltrafik (SL) is the public transport authority owned by the Stockholm County Council. SL's Board of Directors consists of politicians elected by the County Council Assembly and employee representatives. Assumed that the Stockholm BHLS was funded by SL.	40km
Nantes Busway (Line 4)	Nantes, France	November 2006. Possible extension from Porte de Vertou to the village Vertou beyond the N844 ringroad.	7.5m	Operated by Semitan. Main stakeholder is Nantes Metropole. Costs for initial project: • EUROS 50m for infrastructure • EUROS 9.2m for rolling stock • EUROS 3.6m operating cost per vehicle per km From 2018, 22 E-Buses with larger capacity were introduced to the Line 4 fleet. Cost of project was EUROS 43.2m (infrastructure and vehicles). Funded through: • State through Caisse des Dépôts (Éco Cité Nantes Saint-Nazaire program) • Other funding, especially from Europe, is planned to supplement part of the sum. Busway may be converted to a tramway in the future – currently saturated during peak times and need to improve capacity.	7km

BRT Alignment with Plans and Policies

Dundas BRT represents a high degree of fit with existing policies and plans that are in place to shape growth and transport service and infrastructure delivery.

Provincial Priorities

The Growth Plan for the Greater Golden Horseshoe, published by the Ministry of Municipal Affairs and Housing Ontario in 2019, sets out the foundations for growth in the Greater Golden Horseshoe (GGH) area, the economic engine of southern Ontario. The area is home to approximately 25% of the province's economic output[6] and is expected to grow significantly in the coming years. The plan aims to effectively manage growth through supporting the achievement of complete, diverse communities that are active and healthy; making efficient use of land and infrastructure for employment, housing and culture, support transit viability, and contribute towards a sustainable, low-carbon environment.

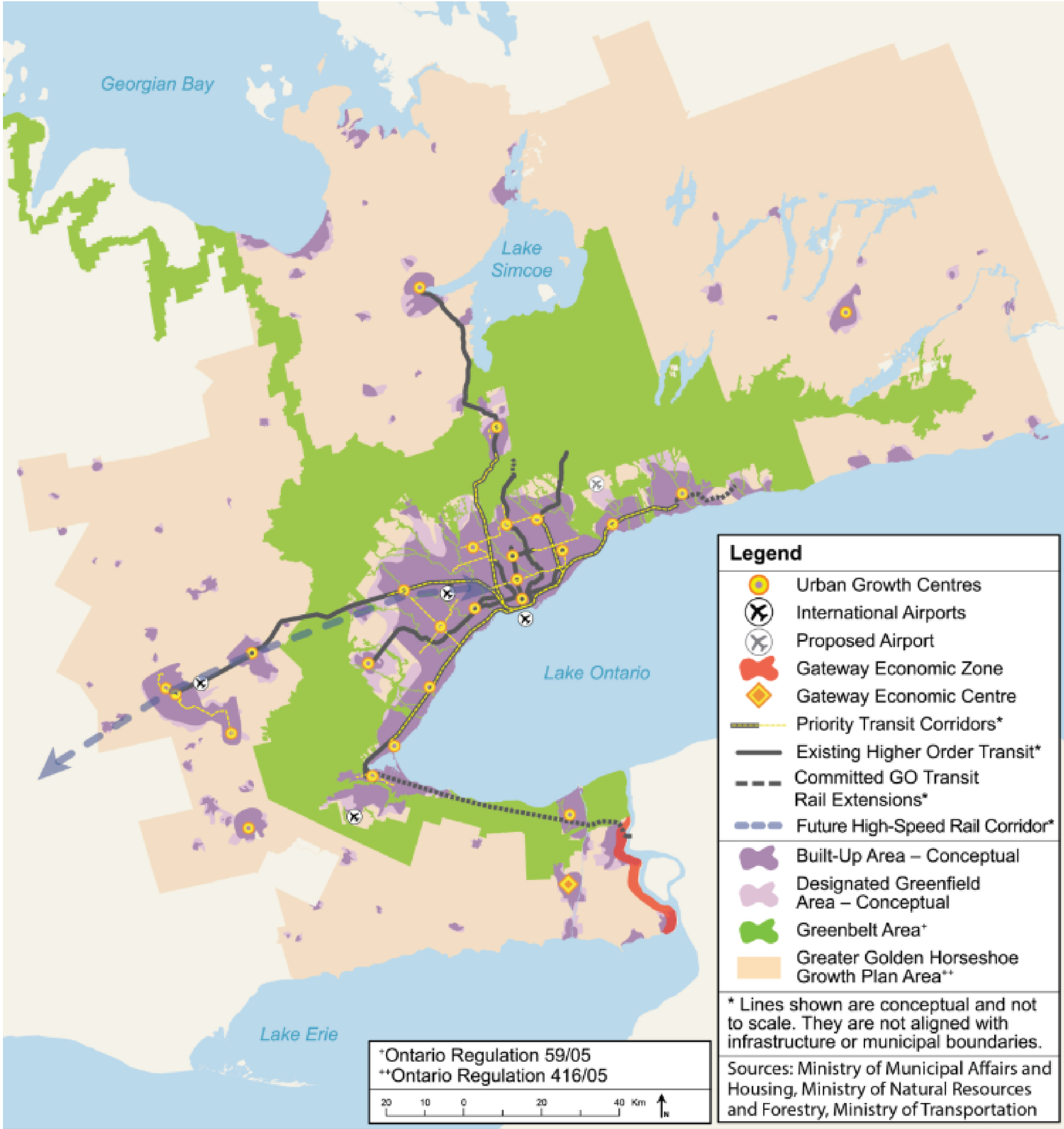
The Growth Plan sets out of a vision for an integrated transport network that allows 'people choices for easy travel both within and between urban centres throughout the region'. It aims to create a fast, convenient and affordable public transit system and promote active transportation to ensure that automobiles are only one of a variety of effective choices for transportation.

The Growth Plan also identifies a series of Priority Transit Corridors, outlined in Figure 2.6 that will support growth in the GGH and which aims to align transit with growth by directing growth to major transit station areas and other strategic growth areas such as urban growth centres. The delivery of Dundas BRT directly aligns with the objectives of the GGH Growth Plan, particularly through aligning transit with growth and supporting the creation of an integrated transport network that focuses on fast, convenient and affordable public transit.

Dundas BRT also fits with the Ontario Ministry of Municipal Affairs and Housing Greenbelt Plan, 2019, which encourages the development of transit-supportive communities as a necessary long-term approach towards developing low-carbon communities within the GGH area. The Dundas Corridor has almost negligible interaction with any Greenbelt policy areas, as almost the entirety of the Corridor is situated in existing Settlement Areas outside the Greenbelt. The Dundas Corridor transit development facilitates the achievement of complete communities by supporting the development of a BRT, a service that has the potential to integrate the economic opportunities while increasing overall transit mode share in local communities.

[6] Ontario Ministry for Municipal Affairs and Housing, Growth Plan for the Greater Golden Horseshoe, 2017

Figure 2.6: Priority transit corridors in the GTHA



Source: Ontario Ministry for Municipal Affairs and Housing, Growth Plan for the Greater Golden Horseshoe, 2019

Regional Priorities

The vision for transportation in the GTHA is outlined in the 2041 Regional Transportation Plan (RTP), published in 2018. The RTP aims to create a sustainable transport system that is aligned with land use and supports healthy and complete communities. The vision is to provide a system that provides 'safe, convenient and reliable connections; and supports a high quality of life, a prosperous and competitive economy, and a protected environment'.

The proposed project fits with these strategic priorities as follows:

- **Safe, reliable & convenient connections** – Dundas BRT will provide enhanced travel choice for passengers and users of the Dundas Corridor by providing a safe and reliable transit solution that provides convenient connections along the Corridor;
- **High quality of life** – By improving connectivity and connecting communities along the Corridor, Dundas BRT will contribute to supporting a high quality of life and increased liveability along the Corridor. It will improve east-west connectivity which will increase accessibility to employment for a large population and will contribute to sustainable development by encouraging mode shift away from private automobile use;
- **Prosperous economy** – Dundas BRT will enable economic growth and development along the Corridor by promoting transit-oriented development and accommodating employment and population growth along the Corridor. Specific development impacts are more likely to occur under conditions in which BRT vehicles operate on exclusive rights-of-way (ROWs) and where supportive policies complement strong development markets; and
- **Protected environment** – Dundas BRT will provide a safe and sustainable transport service along the Dundas Corridor which will decrease the environmental impact on the corridor by supporting a healthier and more sustainable transport mode choice. The implementation of the system on the corridor will increase east-west public transit connections, thus reducing dependency on private automobile vehicles. This will support the development of a protected and sustainable environment with a focus on clean growth.

Municipal Priorities

The Dundas Corridor serves five municipalities and one region in the GTHA. Dundas BRT has the potential to support municipal development and growth initiatives and delivery of the Dundas BRT corridor must fit with municipal priorities for transit and economic development. The key considerations of each municipality which will be served by Dundas BRT are presented alongside the synergies with the Dundas BRT project in Table 2.13.

Table 2.13: Municipal policy review and synergy with a Dundas BRT[7]

Jurisdiction	Policy Considerations	Synergies with Dundas BRT
Burlington	• Ensure land use and transportation decisions are integrated and support walking, biking and transit • Rethink streets to create complete streets that are connected, safe, efficient and comfortable • Invest in walking, biking and transit instead of new road capacity to reduce traffic and auto-dependency	• Transit-oriented development that promotes integrated, transit-oriented development • Increased connectivity through efficient use of public transit that promotes complete streets and reduces car dependency
Hamilton	• Create a sustainable and balanced transportation system • Promote health and safe communities • Deliver economic prosperity and growth	• Supports sustainable movement of people across the municipality and inter-municipally • Encourages mode shift to sustainable and efficient transit • Encourages transit-oriented development • Improved transit service on Dundas Street supports the level of residential growth anticipated for Flamborough; integrating the new population to employment opportunities in the eastern segments of the corridor
Mississauga	• Create safe, inclusive conditions for travel • Develop an integrated and connected network that encourages movement • Create healthier places that are sustainable and resilient	• Supports sustainable movement of people and increase connectivity along key arterial corridor in Mississauga • Supports sustainable transport which is resilient to change and is highly adaptable to future demand • Dundas BRT has a direct role in supporting Mississauga's priorities for transit outlined in the City's Strategic Plan by moving Mississauga towards developing into a transit-oriented city as a whole
Oakville	• Encourage environmental sustainability • Deliver economic and financial sustainability by focusing development on growth areas by promoting public transit and active transportation and decreasing automobile use • Deliver community and cultural sustainability by promoting public transit, cycling and walking	• Supports sustainable movement of people across the municipality and inter-municipally • Supports sustainable transport/movement of people by dissuading automotive vehicular uses • Dundas Corridor will strengthen the feasibility for higher order transit to service future new residential and commercial developments in North Dundas.
Toronto	• Improve quality of life for Torontonians through, among others: • Safe, affordable and accessible transportation choices through an inclusive and equitable city-wide transportation network, safer	• Transit-oriented development that promotes integrated, transit-oriented development • Support inter-municipal connectivity to stimulate economic growth and development • Improvements to transport on the corridor

[7] Sources: City of Burlington Transportation Plan; City of Hamilton, City in Motion (Transportation Master Plan); City of Mississauga, Mississauga Moves (Transportation Master Plan); Town of Oakville, Switching Gears (Transportation Master Plan); City of Toronto, Corporate Strategic Plan; Toronto Transit Commission, Five Year Service Plan; Region of Halton, Transportation Master Plan

Jurisdiction	Policy Considerations	Synergies with Dundas BRT
	streets, and greener transport options • Investment that improves safety, health, social and economic wellbeing and inclusion, including investment and delivery in safe and sustainable infrastructure • Preparation to tackle climate change, including infrastructure that is built and maintained to reduce greenhouse gas emissions • Prioritize surface transit by exploring bus transit lanes and implementing transit queue jump lanes and transit signal priority so that users can reach their destinations faster and more reliably	are a means to support potential employment (commercial) and residential growth in Etobicoke Centre. This aligns with the City of Toronto's long-term objective of anchoring growth outside of the downtown core
Region of Halton	• Provide a safe, convenient, accessible, affordable and efficient transportation system • Minimize the impact on the environment and promote energy efficiency	• Support the development of an inter-municipal and inter-regional transit corridor that meets the Higher Order Transit designation of Halton's Transportation Master Plan • Facilitate the achievement of regional transportation goals in Halton, through supporting healthy and safe travel • Provide greater choice for the travel needs of residents

The review of existing policy priorities at the provincial, regional and municipal level has shown a high degree of strategic fit with the projects objectives and the policy priorities of stakeholders. There are synergies and commonalities between the project's objectives and desired outcomes, explained further in the Strategic Case, and the policy priorities of stakeholders. This investment is complementary to existing transit objectives as expressed in municipal transport planning documentation and in the RTP for the GTHA.

BRT and Land Use Development

Bus Rapid Transit (BRT) investments have been seen to leverage transit-oriented development (TOD) by providing high-capacity, high-performance characteristics like Light Rail Transit (LRT) systems. They have assisted in guiding growth along their corridors in a more compact, mixed-use urban form which encourages sustainability but also has a notable impact upon land use values due to increased accessibility to transport, employment, goods, and services. The introduction of BRT also has an impact upon the size and typology of new development along the corridors.

Positive property development effects have been observed in cases where BRT has been part of an integrated transit and land-use strategy, and additionally where significant investments have been made to create a sense of performance of the system and to improve its environmental and aesthetic quality. Research has identified that specific development impacts are more likely to occur under conditions in which the BRT vehicles operate on exclusive right-of-ways (ROWs) and where supportive policies complement strong development markets. For example, newer and more compact and mixed-use developments have been earmarked take place in Vaughan Metropolitan Centre, Vaughan's Bathurst and Centre Area, Richmond Hill Centre and Markham Centre, which are all connected by York Region's Viva BRT along Highway 7. Other North American BRT case studies include Los Angeles' Orange Line BRT and Cleveland's HealthLine BRT which strongly illustrate the case for BRT as a tool for urban development along the corridor.

This sub-section explores examples of where BRT systems have incentivized transit-oriented development (TOD) and/or impacted the value of land and property adjacent to the BRT system. A common definition of TOD is outlined below, followed by a list of key characteristics of BRT systems that aid in supporting this specific type of land use.

Transit-oriented development / community (TOD/TOC): Concentrating higher-density, mixed-use, pedestrian friendly development within walking distance of frequent transit stops and stations, in combination with measures to discourage unnecessary driving. Ultimately, TOCs are walking and cycling-friendly communities that are focused around frequent transit.

Enabling factors of BRT-induced TOD include:

- Good pedestrian access between TODs and BRT stations – sidewalks, over bridges, dedicated pedestrian crossings at intersections.
- High capacity transit vehicles (articulated buses)
- Support interchanges between transit and cyclist modes (e.g. cycle lockers at key stations, designated cycle paths adjacent to stations). Given that the vast majority of urban growth is projected for smaller and intermediate-sized cities across the world, a bus-based form of TOD interlaced with high-quality infrastructure for pedestrians and cyclists can place many global cities on sustainable pathways[8].
- Well-located BRT stations – located along desired routes, good location on sightlines, iconic, interchanges with other modes (e.g. rail transit), local amenities.
- Well-located BRT corridor – located in areas nearby large development parcels which are on good-quality land that are prime for high density development and/or rezoning (e.g. Cleveland's new masterplan for midtown is centred on development intensification along BRT routes). Furthermore, majority of successful TOD investments are located near routes that either pass through or terminate at the cities' downtowns.
- High-quality design of BRT stations – (i.e. well-lit, safe, and secure stations with efficient ticketing system).
- The review of case studies has determined BRT systems have the potential to influence land development, but the conditions are very context dependent.

[8] Cervero and Dai (2014), *BRT TOD: Leveraging transit oriented development with bus rapid transit investments*, Transport Policy 36, Issue 127-138

Case Study 1: Orange Line, San Fernando Valley, Los Angeles, North America

In 2017 a major development was proposed near North Hollywood Metro Station by Metro / Trammell Crow Company. The area was initially identified as a redevelopment project in 1979 and since then LA Metro has acquired much of the land in the station area. This project was also encouraged due to its proximity to the Metro Red Line northern terminus. The project currently comprises the following elements:

- 1,625 residential units
- 150,000 sq ft of retail
- 400,000 sq ft of office
- 1,000 transit spaces
- Renovated bus facility
- Public plaza

The Orange Line Transit Neighbourhood Plans project launched in 2012 to put forward areas for rezoning industrial land along the Orange Line corridor, enabling developers to build higher office towers and multi-family apartment buildings at six stops/stations. Whilst specific development projects were not included in those Neighbourhood Plans, the following development projects have evolved along the Orange Line corridor:

- Warner Center:
  - Major overhaul of old Promenade mall site for 1,400 residential units and 2 hotels to the 34-acre site. 1-acre public square. Sits adjacent to the Orange Line corridor.
  - Another development of 12 storeys will provide 274 residential units.
  - 24-acre complex will transform the Warner Centre Corporate Park – 24-storey hotel, 15-storey office buildings, 1,000 residential units.
- Canoga:
  - 7-storey 271-unit residential building adjacent to station.

Case Study 2: 99 B-Line, Vancouver, British Columbia, Canada

The 99 B-Line is an express bus line in Vancouver that runs along the Broadway Corridor between the University of British Columbia (UBC) and SkyTrain Broadway-Commercial station, which is North America's busiest bus corridor. From 2008 to 2013 several major planning policy initiatives were pursued and implemented along the corridor. For example, 1,600 additional residential units have been approved and developed along the corridor as well as several new commercial developments[9].

This may also be because of the SkyTrain Canada Line opening in 2009 and not purely due to the 99 B-Line. It may also be more likely that urban planners and developers are seeking sites identified in future policy and strategic land use planning from relevant municipalities (City of Vancouver in the case of the 99 B-Line) and becoming reactant to this, rather than the presence of existing transportation corridors. Updated growth estimates suggest that by

[9] KPMG (2013), *The UBC-Broadway Corridor – Unlocking the Economic Potential*, February 2013

2041, approximately 150,000 more people, jobs and students could be added to the Broadway Corridor. Demand currently exceeds capacity on the B-Line, with plans to provide a higher order transit system to meet demand. The SkyTrain Millennium Line will be extended from VCC-Clark to UBC's Point Grey campus to Arbutus Street in the future, likely to bring forward further residential and commercial development. This also reiterates the point that developers are focusing efforts on the B-Line corridor given policy recommendations for addition of SkyTrain in the future, rather than the existing B-Line itself.

Case Study 3: Quito, Ecuador

The Trolebus arrival in 1995 has made the Quitumbe terminal area more desirable; prices have increased accordingly, with the unintended effect that it is no longer viable to build affordable housing in the area[10] Before and after comparisons between intervention and control areas across the city following BRT introduction shows that for:

- Apartment buildings - prices increased 3% for Corredor Norte, 5% for Trole, and decreased 2.5% for Ecovia (which is considered the extension of the historic centre that now houses important financial and economic activities – not residential).
- Single family houses - prices along the Corredor Norte increased 9.4%.

Case Study 4 Clos-Toreau, Nantes, France

Clos-Toreau urban project was pursued because of the Nantes busway Line 4 connecting Clos-Toreau with downtown Nantes in only 10 minutes. The project supported the following development outcomes along its route:

- New public facilities; leisure centre, nursery, community hall, health centre, municipal offices, superstore expansion
- Residential and office space
- Improvements to public squares

There is limited information available on the land value impacts associated with the Clos-Toreau project Nevertheless this project demonstrates how a BRT system can enable and encourage transit-oriented development.

BRT Strategic Framework

Figure 2.7 presents the strategic framework for Dundas BRT. This framework illustrates the logic for pursuing a BRT on the Dundas corridor based on the problem statement, vision, and potential benefits that can be realized across the four key outcome areas (transportation, quality of life, economic development, and environment). This framework is used throughout the remainder of the IBC to scope and evaluate options.

[10] Rodriguez et al. (2015), *Land development impacts of BRT in a sample of stops in Quito and Bogotá*, Transport Policy

Figure 2.7: BRT Strategic Framework

Problem Statement

The Dundas corridor has limited cross boundary travel alternatives to the automobile, which leads to high auto usage and congestion. The corridor is a forecasted to see significant growth and development, making it a key sector of the GTHA for living and working. By 2041, the corridor will contain 9% of all population growth and 6% of employment growth across the GTHA. Without improved transport alternatives, the overall livability and economic development potential of the corridor, including future developments, will be constrained.

Vision

Develop a transit investment package that provides travellers with attractive alternatives to the automobile to support the development of a livable and prosperous corridor.

Outcomes

Outcomes represent the value a transportation investment can realize for the region.

Transportation
- Increasing ridership and decreasing congestion
- Adaptable capacity for a growing corridor

Quality of Life
- Connecting people to the places they want to go on corridor
- Reducing auto accidents resulting in injury or death

Economic Prosperity
- Faster commutes for increased prosperity
- Connecting urban development and mobility hubs across the corridor

Environment
- Decreased Greenhouse Gas emissions for a more sustainable corridor

Outputs

The direct measurable results from delivering the investment

- **Change in Ridership**
- **Change in Auto Vehicle Kilometres Travelled**
- **Change in Revenue**

Actions

The core changes to the transportation network

- **Provide interconnected corridor transit service**
- **Provide faster transit service on dedicated right of ways**
- **Provide high frequency transit**

Inputs

Resources required to deliver the investment

- **Capital Costs**
- **Operating Costs**
- **Enabling Policies**
- **Labour**

3

Investment Options

Introduction

This Chapter describes a set of three BRT alternatives for the Dundas Corridor, which will be analyzed in the four evaluation chapters of this IBC. This section includes option development methodology and option descriptions.

BRT options have been scoped based on the requirements of an IBC. This means:

- Options have been scoped to a level of detail to support decision makers in identifying whether further analysis and future business cases for Dundas BRT are warranted based on performance in the Strategic, Economic, Financial, and Deliverability and Operations cases;
- Options have been scoped as reference options to test different approaches to deliver BRT – each option is considered to be mutually exclusive and intended to understand the range of costs, benefits, and delivery issues associated with the delivery of BRT on the corridor; and
- Options have been designed and costed based on many working assumptions, which should be refined in future stages of analysis.

Option Development Process

Overview

This IBC used a four-step option development process to generate options:

- Step 1 – Review previous studies, plans, and proposals for rapid transit on the Dundas Corridor;
- Step 2 – Identify high potential employment and population centres to serve;
- Step 3 – High level service planning; and
- Step 4 – Option refinement.

Step 1 – Review previous studies, plans and proposals

The following studies were identified to inform the development of BRT options:

- Metrolinx Dundas Street Rapid Transit Benefits Case Analysis (2010);
- Kipling Bus Terminal Study (2015); and
- Dundas Connects Study (2016-2018).

Metrolinx Dundas Street Rapid Transit Benefits Case Analysis (2010)

A Metrolinx Benefits Case Analysis for Dundas Street rapid transit (RT) was completed in 2010. The project involved the provision of a higher order rapid transit service along Dundas Street from Burlington (Highway 407) to Kipling Station in the City of Toronto, linking Etobicoke and Mississauga city centres. The study compared 4 options over a 30-year period (2009-2038):

- **Option 1 – BRT Light**[11]: Highway 407 to Kipling
- **Option 2 – Full BRT**: Hurontario to Kipling
  – BRT Light: Highway 407 to Hurontario
- **Option 3 – LRT**: Hurontario to Kipling
  – BRT Light: Highway 407 to Hurontario
- **Option 4 – Full BRT**: Highway 407 to Kipling

[11] BRT Light was defined as a scaled-down BRT service without exclusive right-of-way, but with off-vehicle fare payment and signal priority at key intersections

The analysis noted that all the options decrease automobile travel on the corridor and increase transit ridership, while also realizing economic benefits. Table 3.1: Multiple Account Evaluation Summary – Dundas Street rapid transit project BCA (2010) summarizes the results of the Multiple Account Evaluation (MAE) of this business case. The evaluation found that:

- Option 1, 2, and 4 have similar benefit cost ratios (BCRs) that range from 1.6-1.7, indicating overall return on investment;
- Option 1 (BRT Light) has the lowest costs and benefits;
- Option 2 (BRT Light and BRT) has higher costs than Option 1, with benefits increasing at a similar rate as costs (spending more to realize a greater benefit, but the same BCR); and
- Option 3 (LRT) has the highest costs but benefits do not increase at a level equal to the increase in costs (hence a lower BCR of 0.9).

The MAE conclusions provided four key insights for the Dundas Corridor Study:

- There is a case for the implementation of a BRT type system (options 1, 2 and 4) on the full length of the corridor because the BCR for each BRT option is comparable;
- the Dundas Corridor Study should consider both full BRT and BRT Light;
- Transit demand varies across the corridor - west of Cooksville (in Mississauga), the forecast level of demand does not require a higher capacity rapid transit service, but service integration should be pursued; and
- BRT provides operational flexibility to implement rapid transit in various stages according to funding availability, demand, land use, and economic changes.

Table 3.1: Multiple Account Evaluation Summary – Dundas Street rapid transit project BCA (2010)

Impacts	Option 1 (BRT Light)	Option 2 (BRT and BRT Light)	Option 3 (LRT and BRT Light)	Option 4 (Full BRT)
	Transportation User Account			
Transportation User Benefits (PV $m)	373	432	499	772
	Financial Account			
Costs (PV $m)	222	273	554	466
Benefit-Cost Ratio (BCR)	1.7	1.6	0.9	1.7
	Environmental Account			
GHG Emissions (PV $m)	2.8	3.3	3.9	5.2
	Economic Development Account			
Employment impact during construction				
Employment (person-years)	974	1812	4271	3819
GDP ($m)	79.4	157.6	471.4	332.1
Income ($)	35.6	70.6	166.4	148.8

Impacts	Option 1 (BRT Light)	Option 2 (BRT and BRT Light)	Option 3 (LRT and BRT Light)	Option 4 (Full BRT)
Long-term impacts (2041)				
Employment (person-years)	42	100	55	144
GDP ($m)	3.6	8.7	4.8	12.5
Income ($)	1.6	3.9	2.2	5.6
	Social Community Account			
Land Use Shaping	✓	✓✓	✓✓	✓✓✓
Road Network	✓✓	✓✓✓	✓✓✓	✓
Construction implications	✓	✓✓	✓✓	✓✓✓

Kipling Bus Terminal Feasibility Study (2015)

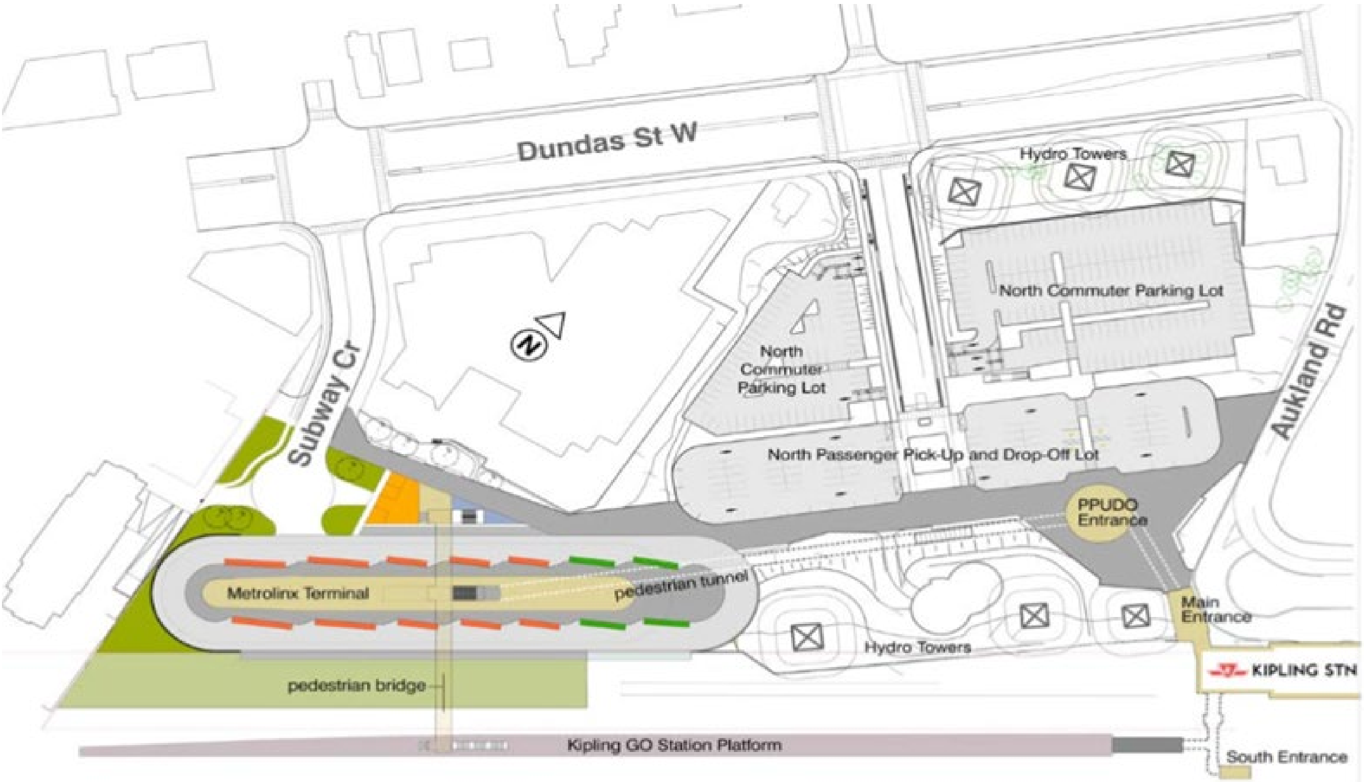
Kipling Station currently serves as the western terminus station for Line 2 on the TTC subway and is located on GO Transit's Milton Line in Toronto. MiWay bus routes from the west currently terminate at Islington station, which is located 1.4 km east of Kipling Station. There was an opportunity to relocate this bus terminal to a new integrated facility south of Dundas Street at Kipling Station and create a new inter-regional bus terminal.

The study focused on the new bus terminal layout and related changes to roads, sidewalks, parking lots, and landscaping; improved pedestrian and cycling access while assessing its impacts. Two layout options were evaluated. In the preferred option, the existing TTC bus terminal at Kipling Station will not be changed as the TTC will continue operating it, and the MiWay bus terminal will be located west of the TTC terminal and has a direct entrance to Dundas Street.

Based on the evaluation, the study recommended the preliminary design for a new inter-regional bus terminal to accommodate MiWay and GO Transit buses and improvements to the station area, including accessibility upgrades to Kipling GO station and enhanced pedestrian and cycling connections to transit services. As Kipling Station is located directly south of Dundas Street West, the study envisioned Dundas Street bus rapid transit fully integrated into the design of the Kipling Mobility Hub.

The construction of the new MiWay and GO bus terminal is already underway at Kipling Station, and all MiWay buses currently operating out of Islington Station (which is not universally accessible) will be moved to the new Kipling terminal when the construction is done. The bus terminal is being constructed at the bottom of Subway Crescent. A new signalized intersection and site entrance at Acorn Avenue would have short-term parking on either side, providing a direct, central route for vehicles, cyclists and pedestrians. Figure 4.1 presents the preferred layout option. The new bus terminal will count 14 bus bays; 10 for MiWay and 4 for GO Transit services. This project is currently under construction and is expected to reach substantial completion by late 2020.

Figure 3.1: Preferred option for the new regional bus terminal at Kipling Station



Source: Metrolinx, Kipling bus terminal feasibility study and preliminary design

Dundas Connects

Dundas Connects reviewed potential BRT alignments within the City of Mississauga. This Business Case noted:

- **Strategic Case:** the project is expected to generate positive economic impacts on livability in the vicinity of the corridor as the public realm improvement will make streets more attractive to transit users and pedestrians, thus helping foster greater community interaction. Meets revitalization plans and growth objectives of Mississauga;
- **Financial Case:** The total project cost is $593 million. The operating cost recovery ratio is 64%. The BRT option generates financial losses of $496 million on an NPV over 60-year time horizon. Hence, the project is not deemed profitable on a strictly financial basis;
- **Economic Case:** This project generates more benefits than costs with a BCR of 1.5 and an NPV of $296 million (2017 $); and
- **Delivery Case:** Project technically deliverable. Impact of fare integration is to be considered.

The specific options from Dundas Connects are discussed further in this chapter as they have been selected for use as the Mississauga segment of the Dundas BRT corridor.

Step 2 – Identify high potential employment and population centres to service

Step 2 identified a set of key areas for consideration in Dundas BRT options based on:

- Future population and employment forecasts (discussed in Chapter 2);
- Planning and policies that set out areas for investment and growth (discussed in Chapter 2);
- Priority areas identified in previous studies; and
- Existing service patterns and corridor design.

This analysis identified a range of activity centres and 'transfer nodes' for consideration in option development. Activity centres are geographic areas along the corridor that are expected to generate significant demand for home, work, and recreation trips. Transfer nodes are places on the corridor that are a logical location to transfer between services based on planned and existing bus, LRT, and GO Rail services.

Step 3 – High Level Service Planning and Step 4 – Option Refinement

Based on the outputs from steps 1 and 2 and initial transportation demand modelling using the Golden Greater Horseshoe Model v4 (GGHMv4), a set of high-level service plans were developed:

- **Option 1 – Through Running Service** – a set of east-west running BRT services along the corridor to Kipling Station, with multiple starting points. This option is intended to test the value of corridor focused direct cross corridor service;
- **Option 2 – Segmented Service** – a set of east-west running BRT services that typically originate north or south of the corridor, with only some services terminating at Kipling Station. This option is intended to test the value of service between key transfer points and destinations that are north or south of the corridor; and
- **Option 3 – Overlapping Service** – a combination of Options 1 and 2, with some services running the entire length of the corridor and other services connecting the corridor to locations north or south of Dundas. This option is intended to test the value of an integrated BRT network spanning Hamilton to Toronto.

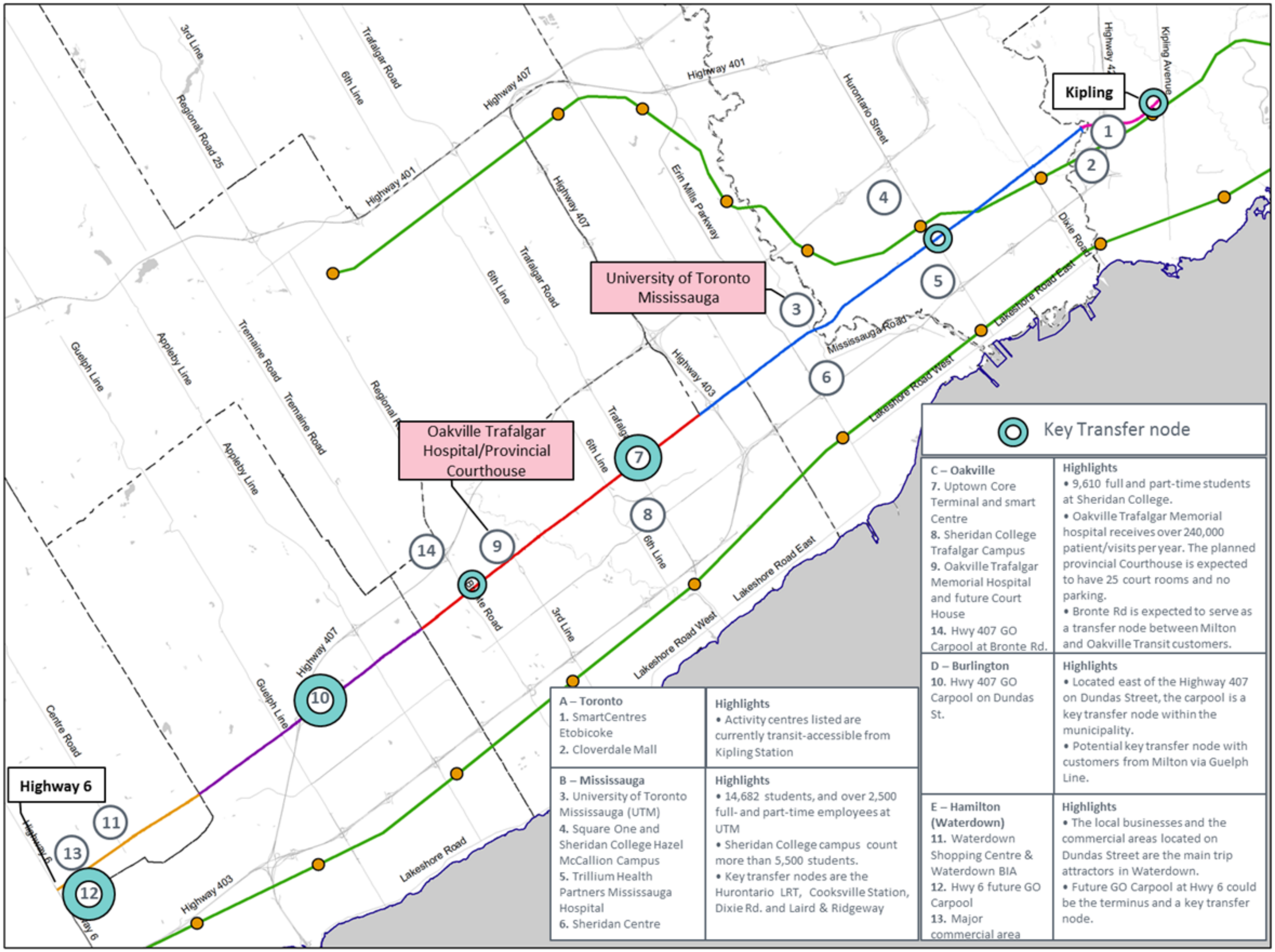
These service plans were developed to:

- Accommodate potential demand along the corridor; and
- Demonstrate the trade-offs and benefits of different approaches to delivering BRT.

Initial service plans were reviewed in a technical design workshop prior to the development of final options for review, which are discussed in subsequent sections.

At this time, an operating model for the options has not been established. This IBC does not assume which operators will provide the service. This topic will be addressed in future studies and business cases.

Figure 3.2: Activity Centres and Transfer Nodes on the Dundas Corridor



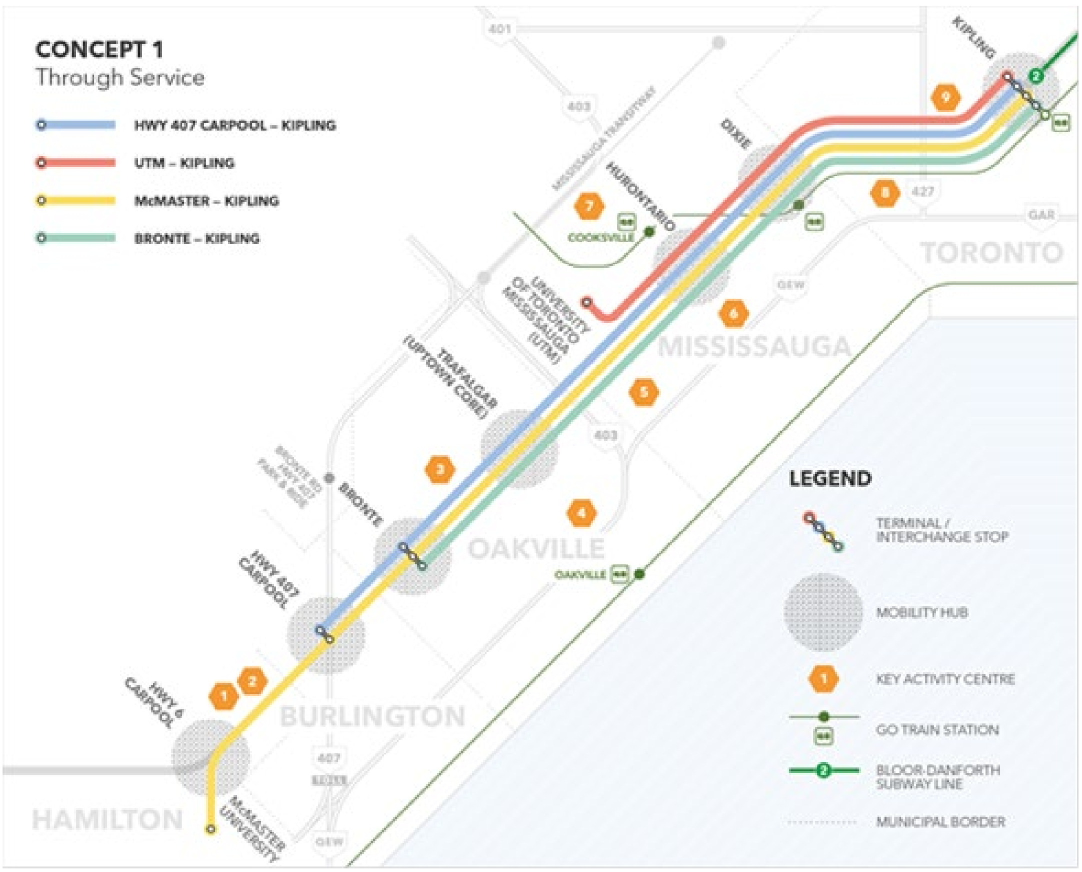
Option Overview

An overview of each option is provided in Tables 3.2 to 3.4, including:

- Proposed service plan/map; and
- Summary of how the option acts on the actions in Chapter 2 to realize benefits (which are assessed in Chapters 4-7).

Table 3.2: Option 1 (Through Service) Overview

Service Map



Action (from Strategic Framework)	How does this option deliver the action?
Provide interconnected corridor transit service	• Delivers multiple routes running across the Dundas Corridor east to west • One route runs the entire corridor, while other routes start at key activity centres east of Hamilton

Provide faster transit service on dedicated right of ways	• Faster travel times can be realized by:
	  ◦ The use of HOV/Bus Lanes in Halton and Hamilton
	  ◦ The use of a BRT corridor in Mississauga

Provide high frequency transit	**Peak Buses Per Hour by Line:** • Yellow (McMaster to Kipling) – 3 buses per hour • Blue (407 to Kipling) – 3 buses per hour • Green (Bronte to Kipling) – 12 buses per hour • Red (University of Toronto at Mississauga to Kipling) - 12 buses per hour **Peak buses by segment:** • Hamilton to Burlington – 3 buses per hour • Burlington to Oakville – 6 buses per hour • Oakville to Mississauga – 18 buses per hour • Mississauga to Toronto – 30 buses per hour

Table 3.3: Option 2 (Segmented Service) Overview

Service Map

Action (from Strategic Framework)	How does this option deliver the action?
Provide interconnected corridor transit service	• Delivers multiple routes connecting key centres along the corridor, with only some cross-boundary service (spanning two segments, but not corridor wide)
Provide faster transit service on dedicated right of ways	• Faster travel times can be realized by: ◦ The use of HOV/Bus Lanes in Halton and Hamilton ◦ The use of a BRT corridor in Mississauga
Provide high frequency transit	**Peak Buses Per Hour by Line:** • Yellow (McMaster to 407 Carpool) – 7 buses per hour • Blue (407 Carpool to Sheridan College) – 20 buses per hour • Green (Sheridan College to Renforth via Mississauga Transitway) – 20 buses per hour • Red (University of Toronto at Mississauga to Kipling) - 48 buses per hour

Table 3.4: Option 3 (Overlapping Service) Overview

Service Map

Action (from Strategic Framework)	How does this option deliver the action?
Provide interconnected corridor transit service	• Delivers multiple routes connecting key centres along the corridor, with dedicated cross-boundary bus service spanning multiple segments of the corridor, including direct service from Hamilton to Toronto
Provide faster transit service on dedicated right of ways	• Faster travel times can be realized by: ◦ The use of HOV/Bus Lanes in Halton and Hamilton ◦ The use of a BRT corridor in Mississauga

Provide high frequency transit	**Peak Buses Per Hour by Line:**
	• Yellow (McMaster to Kipling) – 7 buses per hour
	• Blue (407 to Oakville GO) – 15 buses per hour
	• Teal (Bronte to Renforth via Mississauga Transit Way) – 10 buses per hour
	• Green (Sheridan College to Kipling) – 10 buses per hour
	• Red (University of Toronto at Mississauga to Kipling) - 30 buses per hour
	Peak buses by segment:
	• Hamilton to Burlington – 7 buses per hour
	• Burlington to Oakville – 32 buses per hour
	• Oakville to Mississauga
	  ◦ Renforth 10 buses per hour
	  ◦ Dundas 17 buses per hour
	• Mississauga to Toronto – 37 buses per hour

Detailed Option Scoping: Costing and Ridership Forecasting

Overview

As discussed previously, three options were developed for this IBC. Option scoping included:

- **Capital costs** – drawn from other studies (notably Dundas Connects) and best available evidence for other cost elements (such as a new operations and maintenance centre);
- **Operating costs** – developed based on the level of service provided in each option to meet demand; and
- **Ridership forecasting and service planning** – ridership forecasting was conducted iteratively with service planning – an initial version of each option was tested and then optimized based on resulting demand.

Costs

Each BRT option includes four capital cost categories and an operating and maintenance cost estimate, as discussed in Table 3.5, with further details provided in subsequent sub sections.

Table 3.5: Infrastructure for BRT investment

	What is included?	What is consistent between options?	What varies between options?
Alignment (Right of Way / Road Works)	• Road works to implement HOV and/or BRT Lanes • Signals	• Mississauga Dundas Connects BRT alignment • HOV road works across the rest of the corridor	• No variations between options

	What is included?	What is consistent between options?	What varies between options?
Stops/Stations	• Bus stops • Stop area amenities • Station integration	• The same standard of stop and station is assumed across all options	• The number of stops based on branches
Operation and Maintenance Centre	• Bus staging and maintenance facilities	• The same facility is assumed for all options	
Fleet	• Diesel fleet required to meet service plans	• Assumed vehicle (40-foot)	• Number of vehicles required
Operating and Maintenance Costs	• Day to day operations and maintenance	• Input assumptions for costs	• Level of service and overall costs

Alignment

The alignment considered in this project includes two types of alignments:

- **Dundas Connects** – assumed to be in scope as part of each BRT option as the Mississauga segment of the corridor; and
- **Business as Usual** – planned upgrades to Dundas St. in Halton, Burlington, and Hamilton – assumed to be part of the business as usual scenario, with no impact on option costs.

Dundas Connects Alignment

All options in this IBC share a common alignment for the Mississauga portion of the corridor drawn from the business case for Dundas Connects (corridor's BRT concept and right-of-way characteristics shown in Figure 3.3 and Figure 3.4 respectively). The recommended BRT service uses dedicated transit lanes on the entire alignment along the Dundas Street corridor, with the following configuration:

- A median-running guideway from Etobicoke Creek to the Credit Woodlands (Figure 3.5);
- A reversible lane through Erindale Park from The Credit Woodlands to Mississauga Road (Figure 3.6); and
- Curbside transit lanes from Mississauga Road to Ridgeway Drive (Figure 3.7).

Figure 3.3: Dundas Street BRT Concept: alignment, stops, and running way types

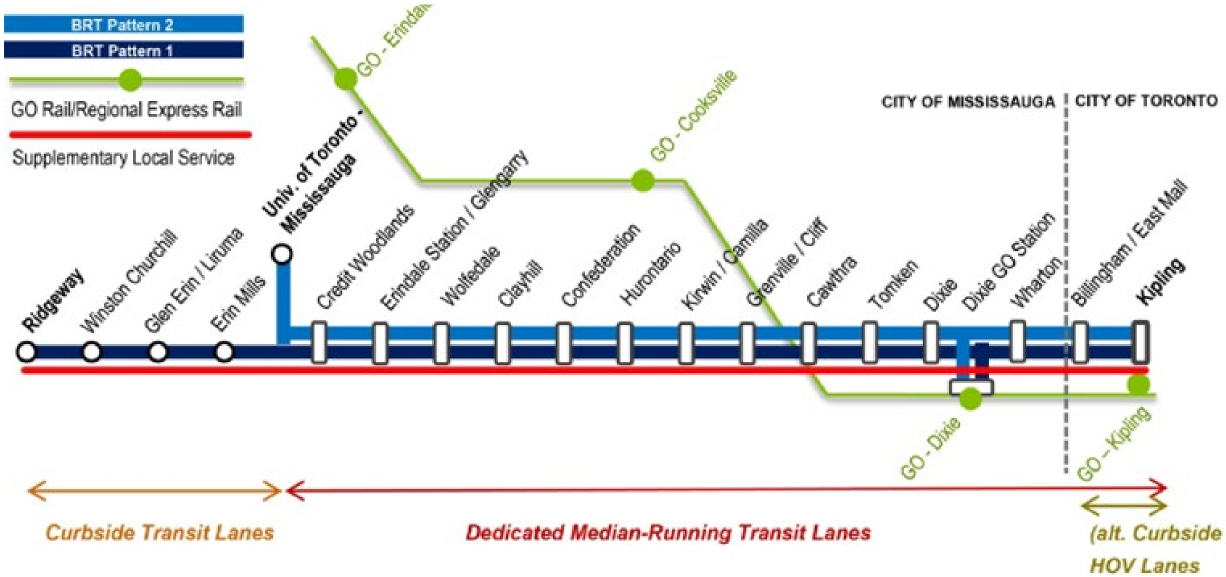


Figure 3.4: Right-of-way characteristics along Mississauga's portion of Dundas Corridor

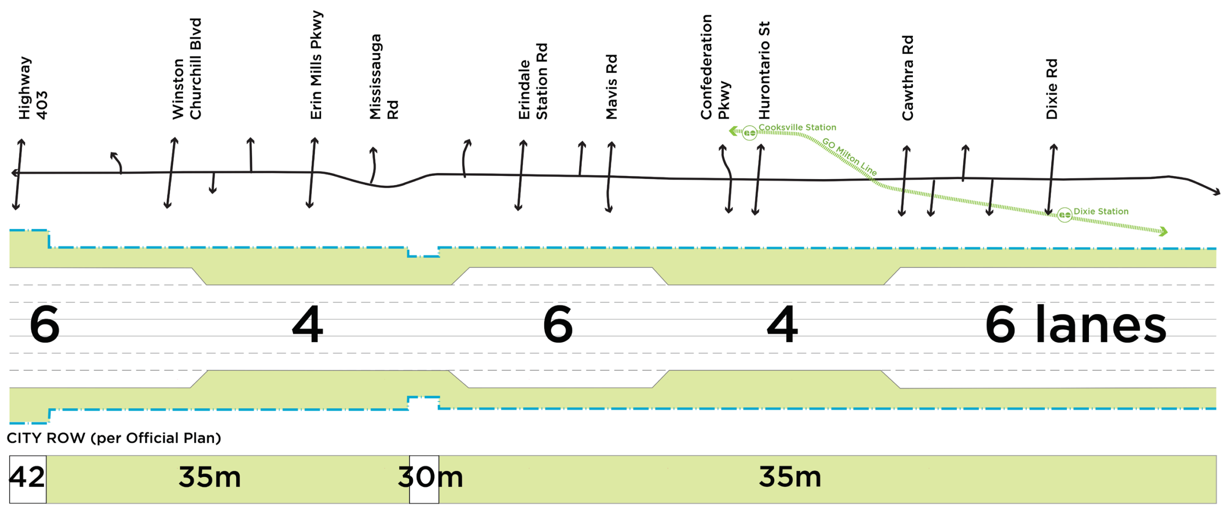


Figure 3.5: Median BRT configuration

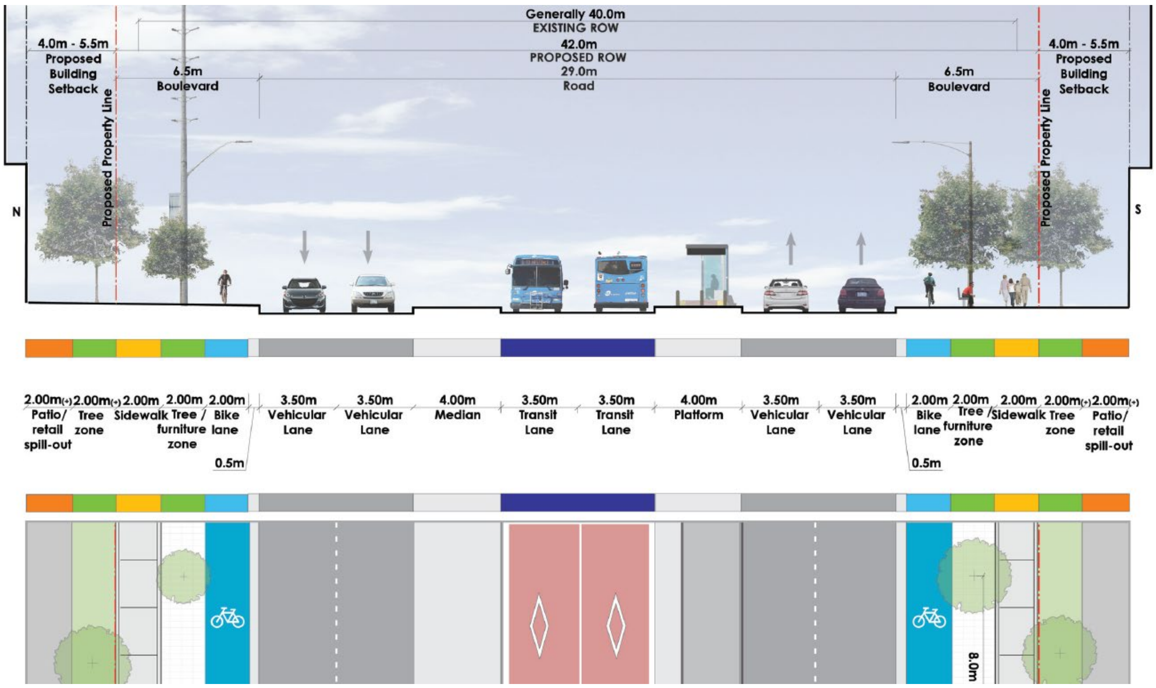


Figure 3.6: Reversible BRT configuration

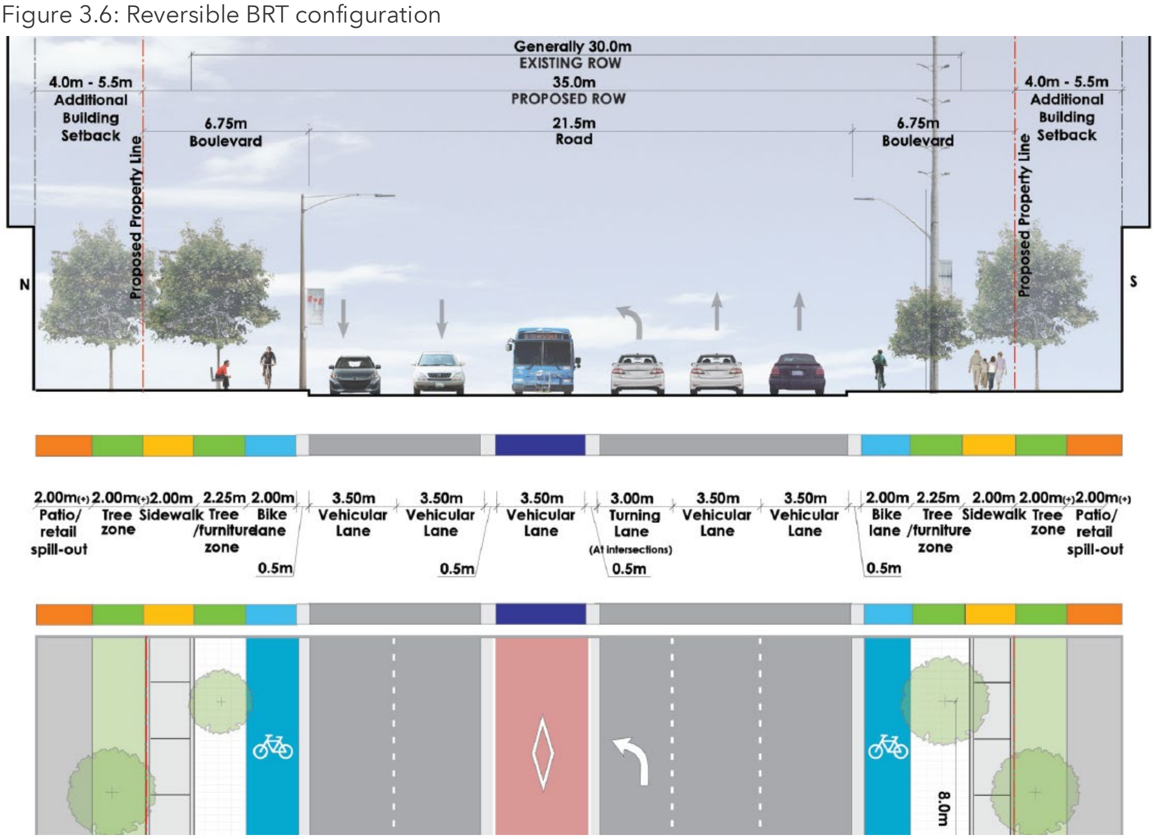
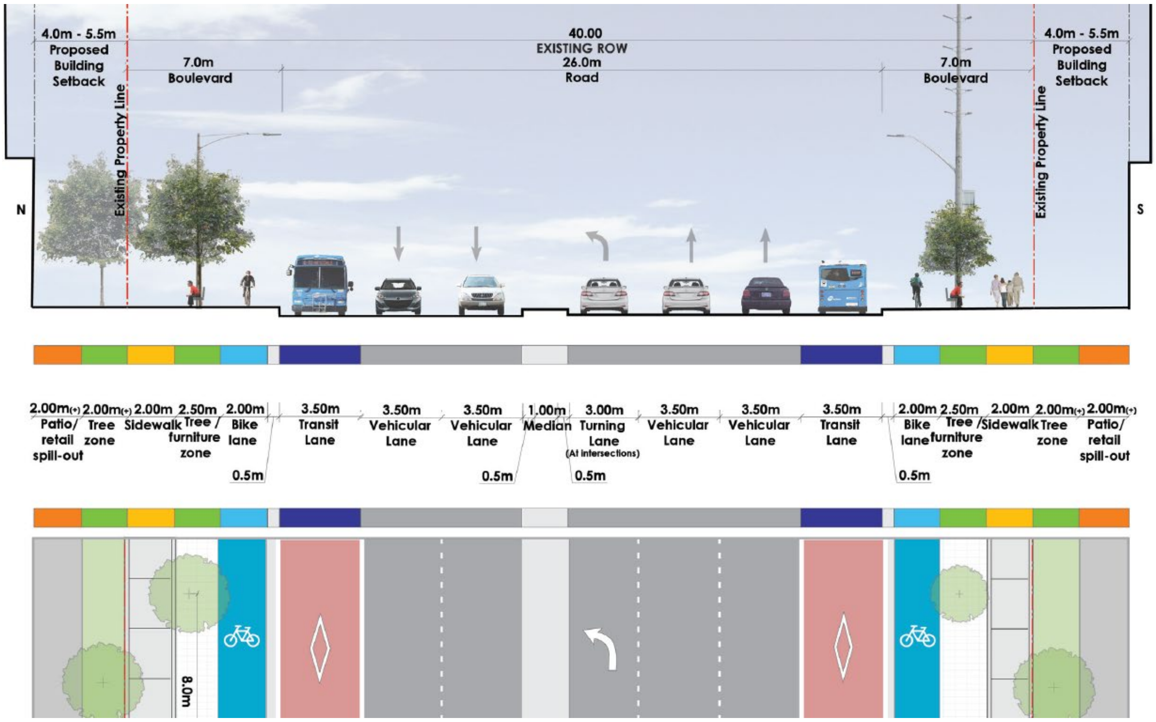


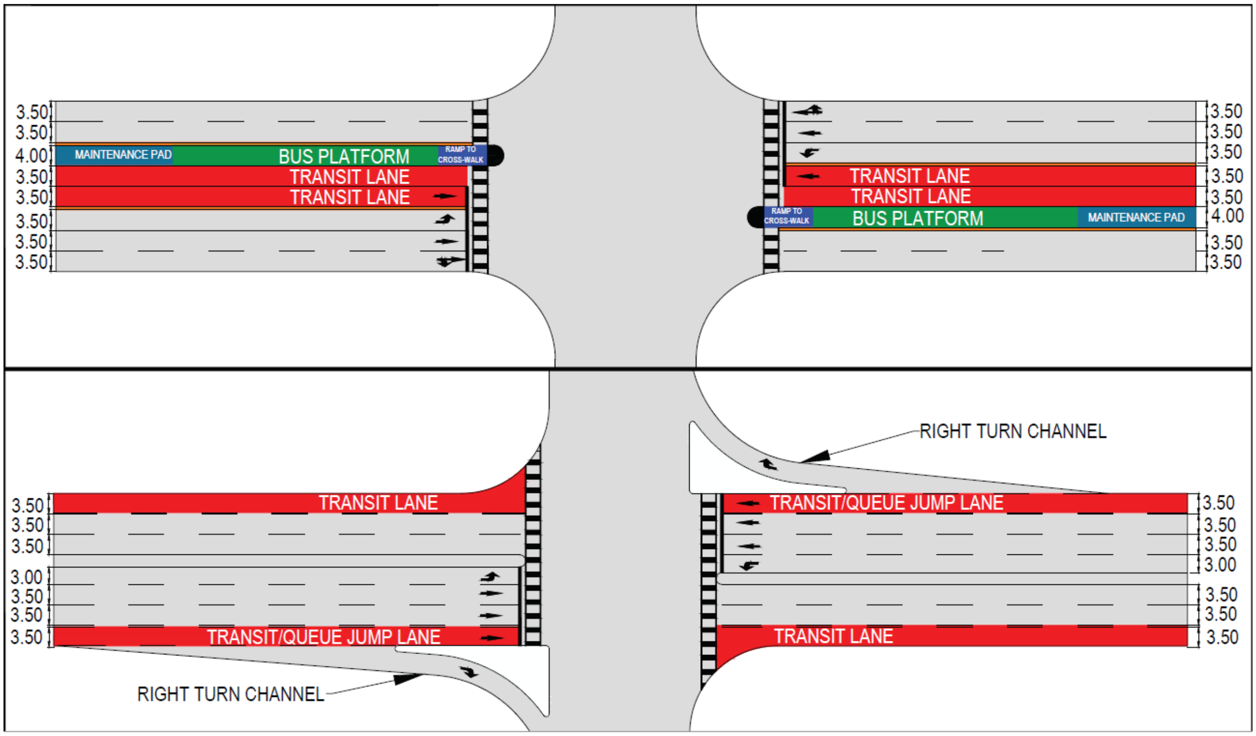
Figure 3.7: Curbside BRT configuration



Key design elements of the corridor include:

- 21 km of route with 21 stops;
- Average spacing: 1 stop/ km;
- Three terminals, 2 at the west end and 1 at the east end;
- Dundas Street remains with 4 through-traffic lanes (two eastbound and two westbound) except west of Winston Churchill Blvd (4 lanes currently); and
- Turning lanes provided at key intersections (refer to Figure 3.8) to accommodate left turns and U-turns.

Figure 3.8: BRT intersection layout proposed by Dundas Connects



Halton to Hamilton

As discussed in Chapter 2, Dundas Street will be expanded significantly throughout Halton Region in the next five years. These expansions include the development of shared HOV and bus lanes, which are considered sufficient for improved BRT service on these segments of the corridor. By 2022 the road network will include the following changes:

- **Oakville** – widening from Tremaine Road to Bronte Road to 6 lanes, with one HOV/bus lane in each direction; and
- **Burlington** – widening from Appleby Line to Halton/Hamilton boundary to 6 lanes, with one HOV/bus lane in each direction.

Because these projects are fully funded and in delivery these are not included in the capital costs for the Dundas BRT options.

Stations

The spacing of stops on Dundas BRT was mainly based on Dundas Connects' consideration to balance travel time savings for through passengers against coverage needs for places of significant trip generators, and to protect essential connection to buses running along cross-streets. On that basis, a stop every kilometre was assumed west of Mississauga. In total, an additional 29 stops were assumed, plus an eastbound stop for Ridgeway (where Dundas Connects only allows a westbound stop given the service loop via Ridgeway and Laird).

Operations and Maintenance Centre

A new operating and maintenance centre for buses is assumed to be built along the corridor. This centre will be used for bus staging and servicing. As the operating model for the service has not been defined, this element of the BRT project will require further review at future stages of the project lifecycle once an operating model is established.

Fleet Capital Costs and Operating and Maintenance Costs

Fleet estimates were set out to match the service plans defined in Tables 3.2 to 3.4. Each option requires the following new 40-foot buses:

- Option 1 (Through Service) – 115 buses
- Option 2 (Segmented Service) – 176 buses
- Option 3 (Overlapping Service) – 166 buses

Fleet costs include diesel vehicle estimates based on current costs of procurement. These are broadly consistent with recent fleet procurement exercises undertaken by TTC and Metrolinx.

Operating costs were estimated based on an all-day service plan for each option. This estimation process developed costs based on:

- Vehicle hours and vehicle kilometres travelled to determine staffing, wear and tear, and fuel; and
- Providing enough capacity to meet demand into the future (2041).

Costs were estimated in 2019 Canadian Dollars based on historic bus operating costs in the region.

Fleet sizing and operating costs estimation focused on providing a conservative estimate for the capital and operating requirements to deliver the service plans identified in Tables 3.2 to 3.4:

- Service levels were set to accommodate projected peak ridership from modelling results;
- Demand for off peak periods were factored from peak results: midday and evening at 50% of peak; Late evening at 50% of evening;
- Length for each segment (depending on branch structure), combined with modelled speeds were used to determine transit trip times for each option; speeds were not adjusted for different operating periods;
- Recovery times were minimum 10% of trip time to determine cycle times;
- Cycle times were set to accommodate blending of branches where possible, but not strictly – some service designs are not conducive to consistent blends;
- Cycle times and headways drive fleet requirements for each branch, which are summed for each option;
- Required vehicle hours were calculated from number of vehicles and operating period length, by period, and summed for each option;
- Weekends were based on weekday off-peak service designs, and 18 hours for Saturdays and 15 hours for Sundays/holidays (see parameters);
- Vehicle-kms (VKT) were calculated from the number of vehicle-hours times the average of EB and WB speeds, by period, and summed for each option; and
- Energy costs were calculated for diesel based on the VKT and costs factors based on GTHA agency reported energy costs.

Cost Estimates

The capital and operating costs estimate for each option is included in Table 3.6.

Table 3.6: Capital and Operating Costs by Option

Cost Items ($2019 Million)	Option 1 (Through Service)	Option 2 (Segmented Service)	Option 3 (Overlapping Service)
Capital Costs			
West Terminus	*$5*	*$5*	*$5*
Ridgeway Dr. to east of Winston Churchill Blvd	*$8*	*$8*	*$8*
East of Winston Churchill Blvd to Fifth Line Ave	*$15*	*$15*	*$15*
Fifth Line Ave to east of Sir Johns Homestead	*$6*	*$6*	*$6*
East of Sir Johns Homestead to The Credit Woodlands	*$36*	*$36*	*$36*
The Credit Woodlands to Clayhill Rd	*$77*	*$77*	*$77*
Clayhill Rd to west of Cawthra Rd	*$123*	*$123*	*$123*
West of Cawthra Rd to Etobicoke Creek	*$162*	*$162*	*$162*
Etobicoke Creek to The East Mall	*$42*	*$42*	*$42*
The East Mall to Acorn Ave	*$28*	*$28*	*$28*
Mississauga to Toronto Total	$502	$502	$502
Halton to Hamilton	No incremental costs from BAU		
Stations	$59	$59	$59
Fleet	$66	$101	$95
Operations and Maintenance Centre	$200	$200	$200
Operating Costs per Year	$65	$117	$95

Note that these costs represent current (2019) costs, which include the total cost to deliver the investment if done in 2019. Since investments are considered over a longer term, based on time required to deliver and an operating window, these costs vary from the discounted values in the Economic Case (real terms), and the Financial Case (nominal terms). Further context on the three types of cost treatments is included in Metrolinx's Business Case Guidance Volume 2.

Forecasting

Overview

The GGHMv4 model (which covers the entire GTHA) was used to forecast demand by option for use in this IBC. The following analysis is used in the Strategic, Economic, and Financial cases to evaluate the case for the Dundas BRT. The model forecasts daily weekday demand, but the analysis below is focused on peak demand only (as this drives capacity and fleet considerations). Such forecasts and associated benefits have been factored to annual levels for overall IBC analysis.

Core assumptions used in the forecasting include:

- Delivery of the 2041 RTP committed projects;
- 2041 market land use forecasts, compliant with the Growth Plan; and
- Transit fare levels and integration consistent with current policies.

AM Peak Ridership

Forecasts for the Dundas BRT options during the 2041 AM peak (6:45–8:45AM) are shown in Tables 3.7 to 3.8 including ridership on the Dundas corridor, and ridership on off-corridor branches.

Table 3.7: Option 1 (Through Service) AM Peak Period Ridership (2 hour volumes)

Line	Dundas	Off Dundas	Total	Peak Load
McMaster-Kipling	1,900	300	2,200	890
407CPool-Kipling	2,200	-	2,200	870
Bronte-Kipling	1,600	1,000	2,600	1,870
UTM-Kipling	1,000	100	1,100	900
Total East Bound	6,700	1,400	8,100	
Kipling-McMaster	2,000	400	2,400	2,270
Kipling-407CPool	1,200	-	1,200	400
Kipling-Bronte	900	-	900	410
Kipling-UTM	600	-	600	440
Total West Bound	4,700	400	5,100	
Total	11,400	1,800	13,200	

Table 3.8: Option 2 (Segmented Service) AM Peak Period Ridership (2 hour volumes)

Line	Dundas	Off Dundas	Total	Peak Load
McMaster-407CPool	500	200	700	630
407CPool-Sheridan	2,100	100	2,200	2,300
Sheridan-Renforth	1,400	1,400	2,800	2,370
UTM-Kipling	3,000	100	3,100	2,440
Total East Bound	7,000	1,800	8,800	
407CPool-McMaster	1,500	500	2,000	3,170
Sheridan-407CPool	1,000	100	1,100	770
Renforth-Sheridan	500	900	1,400	1,120
Kipling-UTM	1,700	-	1,700	1,190
Total West Bound	4,700	1,500	6,200	
Total	11,700	3,300	15,000	

Table 3.9: Option 3 (Overlapping Service) AM Peak Period Ridership (2 hour volumes)

Line	Dundas	Off Dundas	Total	Peak Load
McMaster-Kipling	3,100	300	3,400	1,370
407CPool-Oakville	1,100	500	1,600	1,820
Bronte-Renforth	300	1,700	2,000	1,500
UTM-Kipling	1,100	100	1,200	920
Sheridan-Kipling	1,600	200	1,800	1,060
Total EB	7,200	2,800	10,000	
Kipling-McMaster	3,100	500	3,600	3,320
Oakville-407CPool	300	300	600	480
Renforth-Bronte	100	400	500	290

Line	Dundas	Off Dundas	Total	Peak Load
Kipling-UTM	700	100	800	580
Kipling-Sheridan	1,100	200	1,300	950
Total WB	5,300	1,500	6,800	
Total	12,500	4,300	16,800	

Peak Ridership Profiles

Figure 3.9 and Figure 3.10 illustrate the total transit volume for all transit lines on the Dundas corridor from McMaster University to Kipling Station. The volumes displayed are for the AM peak period (2-hrs) in the eastbound (inbound) and westbound (outbound) directions.

Figure 3.9: AM Peak Period Ridership (2 hour volumes) on Dundas Corridor (Eastbound)

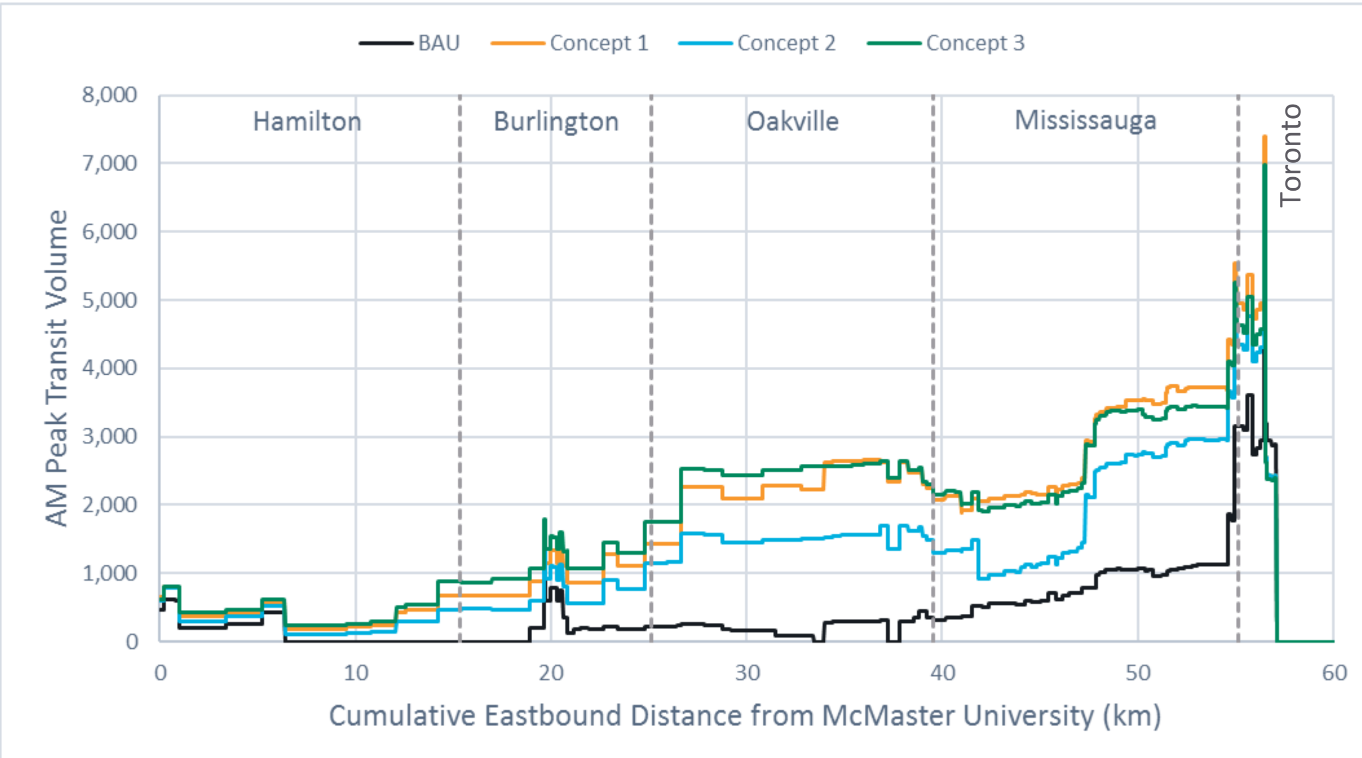
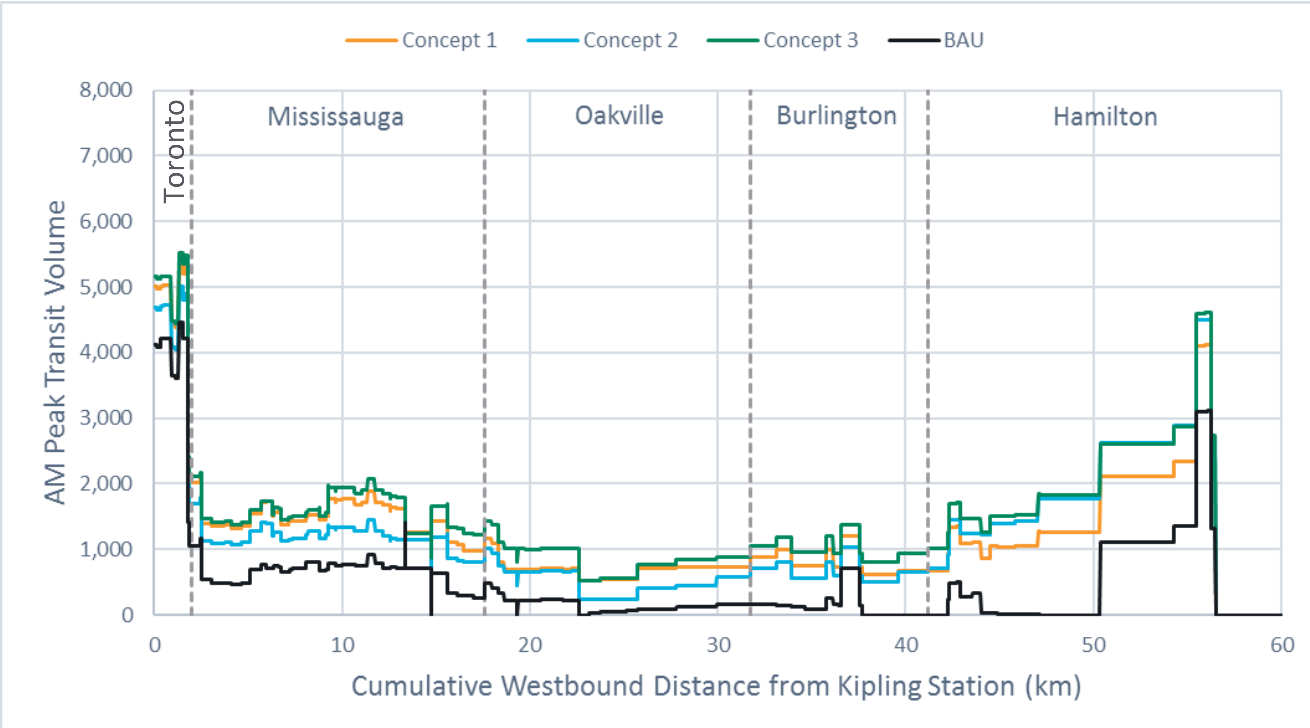


Figure 3.10: AM Peak Period Ridership (2 hour volumes) on Dundas Corridor (Westbound)



The charts compare volumes for the three options against the BAU for ridership on the Dundas corridor only. Generally, the increase in eastbound demand is minimal in Hamilton and low in Burlington. However, the volume increases in Oakville and is sustained through Mississauga before finally dropping off at Kipling Station. The dip in volume within Mississauga occurs between Erin Mills Parkway and Hurontario Street, where there are multiple other local bus routes within the alignment, as well as the University of Toronto Mississauga campus (UTM) and the Hurontario LRT.

The westbound volume increase is lower than for the eastbound direction, but remains steady to Hamilton where it picks up through Waterdown on the approach to McMaster University. This indicates that the BRT service is serving a strong demand for direct transit from Waterdown to downtown Hamilton. With major attractions along and at both ends of the route, the modelled results indicate that the BRT would service demand travelling in both directions during the peaks.

The volume profile for option 3 (Overlapping Service) is similar to option 1 (Through Service) even though the total boardings for option 3 are about 28% higher than option 1. This difference can be attributed to the branch line on option 3 to Renforth station. Option 2 (Segmented Service) shows greater total boardings than option 1 (again, due to the off-corridor branch lines) but has lower corridor volumes eastbound through Oakville and Mississauga. This is a likely result of the transfer penalties applied in the model; due to its segmented nature, transit users of option 2 may make up to three transfers to get to the end of the line, whereas direct services exist in both option 1 and 3.

4

Strategic Case

Introduction

The Strategic Case is the foundation of this IBC. It articulates how the proposed investment will support and achieve the regional and local development objectives for transportation and urban development.

Urban and regional development policies in the GTHA have been organized into four broad policy themes to communicate the strategic benefits of investment in BRT along the Dundas Corridor. These strategic benefits are defined as:

- **Transportation Benefits** – increasing efficiency, effectiveness, and resilience of the transportation system;
- **Quality of Life Benefits** – making it easier for people to access the region with safe and convenient services;
- **Economic Prosperity Benefits** – fostering economic development by reducing commute times, connecting businesses, and supporting investment; and
- **Environmental Benefits** – supporting sustainability by reducing the environmental impact of travel.

These strategic benefits have been identified through policy and quantitative analysis (notably use of the GGHMv4 forecasts set out in the previous Chapter). They build on technical work already undertaken to date to assess the case for BRT implementation along the Dundas Corridor.

Table 4.1 sets out the core strategic benefits of the Dundas BRT.

Table 4.1: Seven Core Strategic Benefits of Dundas BRT

Policy Theme		Benefit	Description of benefit	Key Performance Indicators
Transportation	1	Increase transit ridership and decrease traffic congestion along the corridor	Dundas BRT will improve transit travel times along the Dundas Corridor, promoting increased ridership and reduced congestion in the corridor as some auto demand transfers to the BRT.	Transit ridership Traffic decongestion
	2	Create an adaptable transportation network	Dundas BRT will increase capacity along the Dundas Corridor by adding new services. Once it is implemented, it will provide an entirely new and direct connection along the Corridor that will accommodate population and employment growth in the catchment area.	Ability to serve anticipated demand
Quality of Life	3	Connects people from where there are to where they want to go	Dundas BRT will provide new, integrated transit services that will open up accessibility to employment opportunities facilitated by public transit.	Population within 2km of service Points of interest within 2km of service
	4	Reduced auto accidents resulting in death or injury	Dundas BRT will improve safety along the Dundas Corridor by reducing the level of road traffic accidents through a reduction of car usage along the Corridor	Reduction in accidents
Economic Prosperity	5	Reduce commute times leading to increased productivity	Dundas BRT will improve travel times along the Dundas Corridor and provide a new, reliable service that connects communities along the Corridor. This will reduce commute times along the Corridor and improve access to jobs within the Dundas Corridor.	Average change in commute times
	6	Unlock economic and regional development on the Dundas Corridor	Dundas BRT will help catalyze economic and urban development along the corridor through increased connectivity.	Jobs and economic hubs within 2 km of corridor
Environmental Benefits	7	Decrease GHG Emissions	Dundas BRT will reduce the environmental impact caused by current car use by promoting modal shift away from automobile to public transit.	Change in GHG emissions

Transportation Benefits

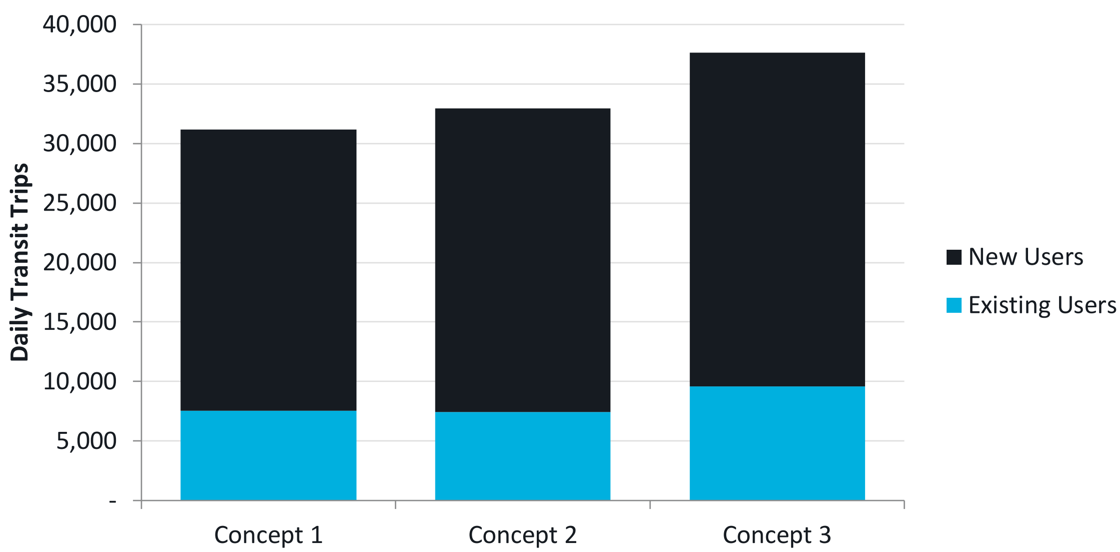
Dundas BRT will deliver significant transportation benefits to users of the Dundas Corridor. The key transportation benefits which will be realized are set out below.

Benefit 1: Increase Transit Ridership and Decrease Traffic Congestion Along the Corridor

Dundas BRT has the potential to raise transit demand by 35,000 trips per day, leading to decreased traffic and improved travel along the length of the corridor.

Figure 4.1 illustrates how each Dundas BRT option will significantly increase transit ridership along the corridor by providing an integrated transit service spanning the corridor.

Figure 4.1: Net Daily Transit Ridership (Trips) with Dundas BRT



These ridership gains will also lead to decongestion along the corridor, including removing 23,000 to 28,000 auto trips daily. These new transit boardings result in the following decongestion travel time savings for drivers[12]:

- Option 1 (Through Service) – 555 thousand hours per year
- Option 2 (Segmented Service) – 345 thousand hours per year
- Option 3 (Overlapping Service) – 500 thousand hours per year

How is the Benefit Realized?

Dundas BRT can encourage transit ridership and decongestion by improving travel times and frequencies (as per the service assumptions used in demand modelling) with high reliability along the Dundas Corridor.

[12] Based on 0.01 hours per vehicle kilometre travelled removed for every new transit trip

Comparative Performance

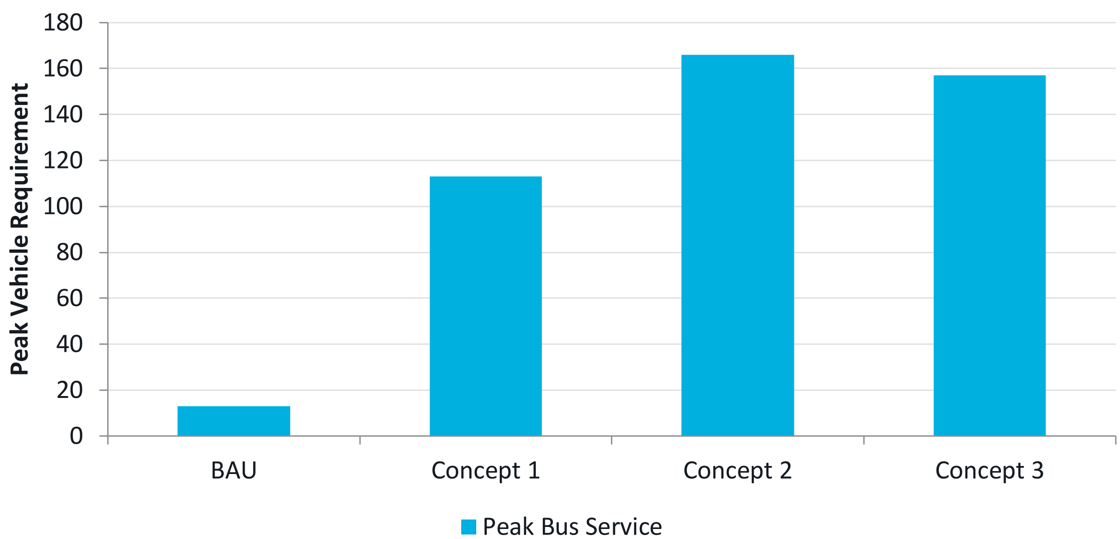
Option 3 (Overlapping Service) offers the greatest net new ridership (28,100/day) and total ridership (37,600/day) on the Dundas BRT service because it provides more direct connections than Option 2 (Segmented Service) and more off corridor connectivity than Option 1 (Through Service). Option 1's ridership is lower than Option 3 but has a greater decongestion benefit because much of this ridership travels longer distance.

Benefit 2: Create an Adaptable Transportation Network

Investment in Dundas BRT will provide much needed through transit capacity that can be scaled and grown over time to meet demand resulting from new urban development.

Dundas BRT will increase capacity along the Dundas Corridor by adding new services. The 2041 peak vehicle requirement under the BAU and BRT options is shown in Figure 4.2. Once implemented, Dundas BRT will provide direct connections along the Corridor that will accommodate population and employment growth in the catchment area. This will provide transit capacity upon completion and into the future.

Figure 4.2: Peak Vehicle Requirement on the Dundas Corridor



How is this Benefit Realized?

BRT is a flexible transit technology that allows adaptable capacity to meet emergent needs with minor changes to the base infrastructure build out, this means:

- Early in the project lifecycle, fewer buses could be deployed to reduce operating costs and match capacity with demand; and
- As demand increases more buses can be added to scale capacity with demand on the same right of way deployed earlier in the lifecycle.

Comparative Performance

All options perform to a similar standard on this benefit due to their scalability. However, Option 3 (Overlapping Service) provides greater coverage with branching corridors (to UTM, downtown Mississauga, Oakville GO etc) which allows capacity to be scaled more readily across the western GTHA. In addition, it connects directly to GO Rail, which will support ridership development on both services. For these reasons, Option 3 gives the highest increase in transit ridership (37,600/day).

Quality of Life Benefits

Dundas BRT will maintain and enhance quality of life across the Dundas Corridor, which is forecast to grow significantly in the coming years. As the population grows so too will transportation demand. Without new regional transportation options, increased congestion will affect the local quality of life. Providing high-quality connections through the BRT will provide a high quality of life for the population by realizing the following benefits.

Benefit 3: Increase Rapid Transit Access to More People

Dundas BRT can serve up to 1 million people living along the Dundas corridor and parallel corridors, allowing them to travel within their community or connect to destinations in neighboring cities.

Dundas BRT will realize benefits for employees and employers located along and surrounding the Dundas Corridor, as well as in the wider economic geography by providing universal access to public transport and increasing east-west connectivity.

The total population in 2041 that will live within 2km of the Dundas BRT system (by option) is shown in Figure 4.3.

Figure 4.3 : Population Living Within 2km of the Dundas BRT System (2041)

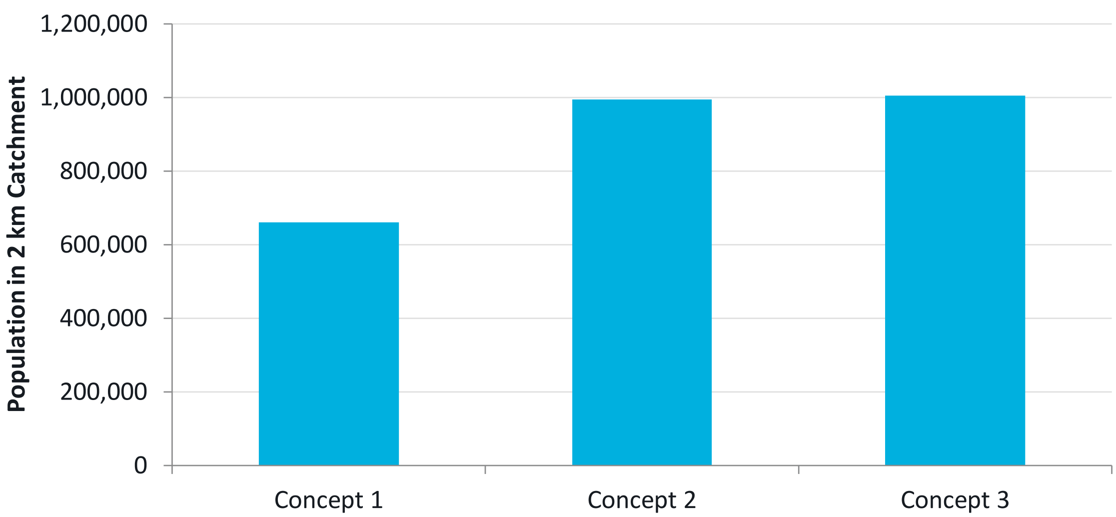


Figure 4.3 illustrates how 660 thousand to over 1 million people will live within a 2km catchment (active transportation and transit access catchment) by 2041. Dundas BRT will provide the population with a new fast and reliable service that connects them to:

- Retail and recreational activities along the corridor – including connectivity between cities and neighbourhoods currently not connected by transit;
- Cultural, educational, and social services on corridor; and
- Higher order transit services - including the TTC subway (all options) and GO Rail (Option 3 (Overlapping Service) only) which will offer two-way all-day service as per the GO Expansion program.

How is this Benefit Realized?

By and large, pedestrian and cycling infrastructure is essential to effectively integrate BRT systems with adjacent developments and realize connectivity benefits. Examples of pedestrian and cycling interventions include:

- Pedestrian access, wider pedestrianization around stations / stops;
- Pedestrian paths;
- Bike paths;
- Bike lockers at major stops; and
- Bike facilities on buses.

In addition, developing Dundas BRT timetables to synchronize with other services will ensure the population living in the catchment can connect to the service.

Comparative Performance

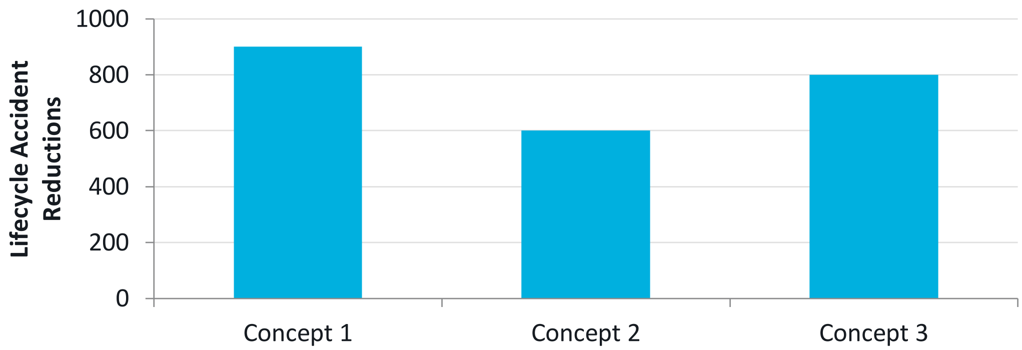
Options 2 and 3 have the highest performance in terms of catchment size (around 1 million population); however, Option 3 has higher performance on overall connectivity due to the combination of through and connecting routes that give travellers the greatest choice.

Benefit 4: Reduced Auto Collisions Resulting in Death or Injury

Dundas BRT has the potential to reduce auto demand on the corridor, leading to lower collision risk and a potential lifecycle decrease of over 800 accidents causing death or injury over the project lifecycle.

BRT represents a highly secure and safe public transit solution which will reduce the dependency on car use. The system will deliver safety benefits from fewer road collisions that result in injuries and deaths due to fewer vehicle kilometres driven on the road network, as shown in Figure 4.4.

Figure 4.4: BRT Reduction in Car Collisions Resulting in Injury or Death Over the Project Lifecycle



As noted in Figure 4.4, Dundas BRT is expected to significantly reduce accidents over the project lifecycle based on average accidents per automobile vehicle kilometre travelled.

How is the Benefit Realized?

This benefit is realized with similar considerations as Benefit 1 – ensuring that the service is integrated between operators, provides robust connections to other transit services and thence major regional destinations, is reliable and well marketed, and offers a competitive travel time to other modes as per the service assumptions included in the demand forecast.

Comparative Performance

Option 1 (Through Service) has the highest performance. Option 2 (Segmented Service) has slightly lower performance because it does not attract as many long-distance auto trips to transit as Option 1 because it has reduced through frequencies along the core east-west corridor.

Economic Prosperity Benefits

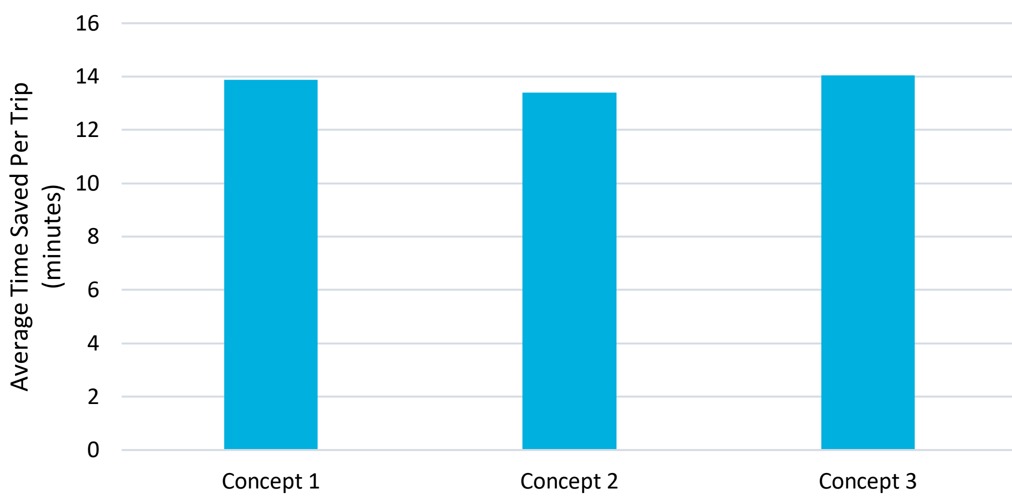
Dundas BRT will deliver economic benefits for the Dundas Corridor and wider GTHA area by enabling economic growth through increasing connectivity. This will have tangible economic benefits, summarised as follows:

Benefit 5: Reduced Commute Times Supporting Economic Productivity

Dundas BRT has the potential to reduce transit commute times by up to 14 minutes per trip, supporting productivity across the corridor and region.

Travel time savings will be generated as a result of the Dundas BRT project through higher speeds that can be accommodated through BRT. This will result in a more efficient transit service that reduces travel times along the corridor. This will result in improved mobility and job access for individual users of the system, which will support economic growth along the corridor. Figure 4.5 illustrates average transit travel time savings for each option based on changes in in-vehicle and waiting time[13].

Figure 4.5: Average Transit Travel Time Savings per Trip



How is the Benefit Realized?

This benefit is realized through BRT's dedicated right-of-way and signaling priority at traffic intersections, which improve transit service reliability and decrease transit travel times. Additional factors that help to realize the benefits across the options are service integration and robust local and regional transit connections as per the service assumptions included in the demand forecast.

Comparative Performance

All options provide a similar range of performance (13.4 – 14.0 minutes), with Option 3 (Overlapping Service) (marginally) providing the highest level of time savings.

[13] Note – these averages do not include weightings used in the economic case or transportation demand models that reflect perception of time. They can be considered as 'clock time' or measurable time.

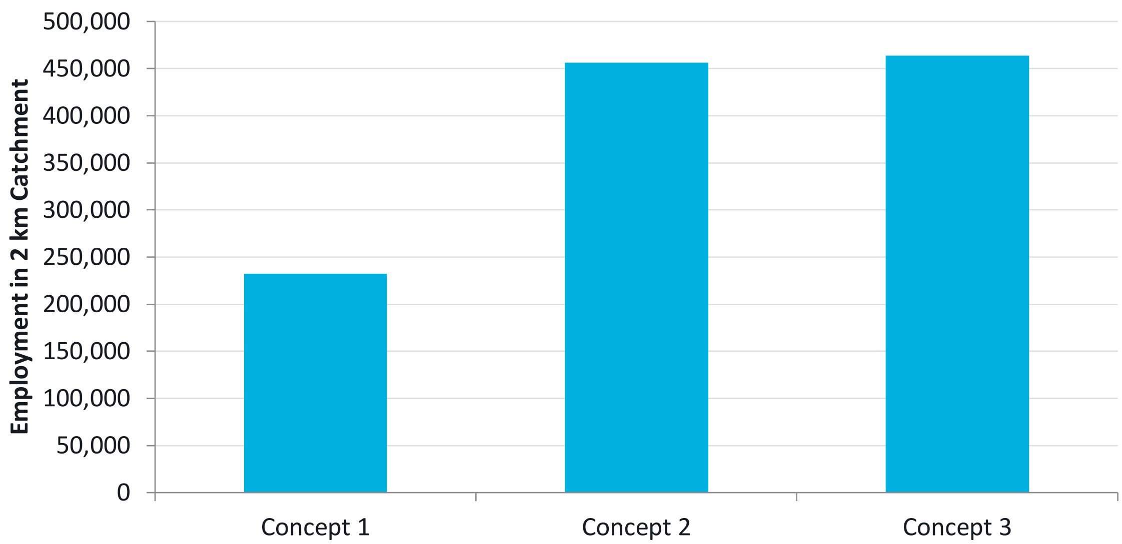
Benefit 6: Unlock Economic and Regional Development on the Dundas Corridor

Dundas BRT can connect major employment sites serving up to 460,000 employees along the corridor, which in turn unlocks increased urban and economic development potential.

Dundas BRT will increase transit service along the Dundas Corridor, thus connecting the existing economic centres along the Corridor. This will support access to labour for employers by allowing them to tap into a larger pool of potential employees.

This will support economic growth and intensification of employment and residential uses along the corridor, thereby contributing to a more vibrant, walkable and attractive place to live and work. The total number of jobs served by each BRT option within a 2 km catchment is shown in Figure 4.6, which illustrates how the BRT can connect the corridor and foster economic development.

Figure 4.6: Employment within a 2 km Catchment of Dundas BRT (2041)



How is this Benefit Realized?

This benefit is realized similar to Benefit 3 – ensuring adequate transit and active travel connections to the corridor will augment the connectivity benefits of Dundas BRT. In addition, economic development benefits can occur when transit significantly decreases travel time and connects key employment centres or areas slated for urban development.

In other jurisdictions, high quality rapid transit investments have been seen to leverage transit-oriented development (TOD) by providing high-capacity, high-performance service. They have assisted in guiding growth along their corridors in a more compact, mixed-use urban form which encourages sustainability but also has a notable impact upon land use values due to increased accessibility to transportation, employment, goods, and services. The introduction of improved transit also has an impact upon the size and typology of new development along the corridors. Evidence of these effects is being seen along Eglinton Avenue in Toronto, with the Eglinton LRT under construction, and on Hurontario Street in Mississauga in anticipation of the LRT project.

Positive property development effects have been observed in cases where BRT has been part of an integrated transit and land-use strategy, and additionally where significant investments have been made to create a sense of performance of the system and to improve its environmental and aesthetic quality. Research has identified that specific development impacts are more likely to occur under conditions in which the BRT vehicles operate on exclusive rights-of-way and where supportive policies complement strong development markets. The VIVA system in York Region is a strong GTHA example of this, planned in conjunction with TOD supportive land use policies.

It is anticipated that, if the ridership and travel time benefits associated with this project can be realized, Dundas BRT will support development along the corridor.

Comparative Performance

Options 2 and 3 have the highest performance in terms of catchment size – compared to Option 1 (Through Service) they directly connect to major employment centres in Mississauga (along the Mississauga Transitway) and Oakville (along Trafalgar); however, Option 3 (Overlapping Service) has higher performance on overall connectivity because it offers both through and connecting services, while Option 2 (Segmented Service) still required transfers for many routes.

Protected Environment Benefits

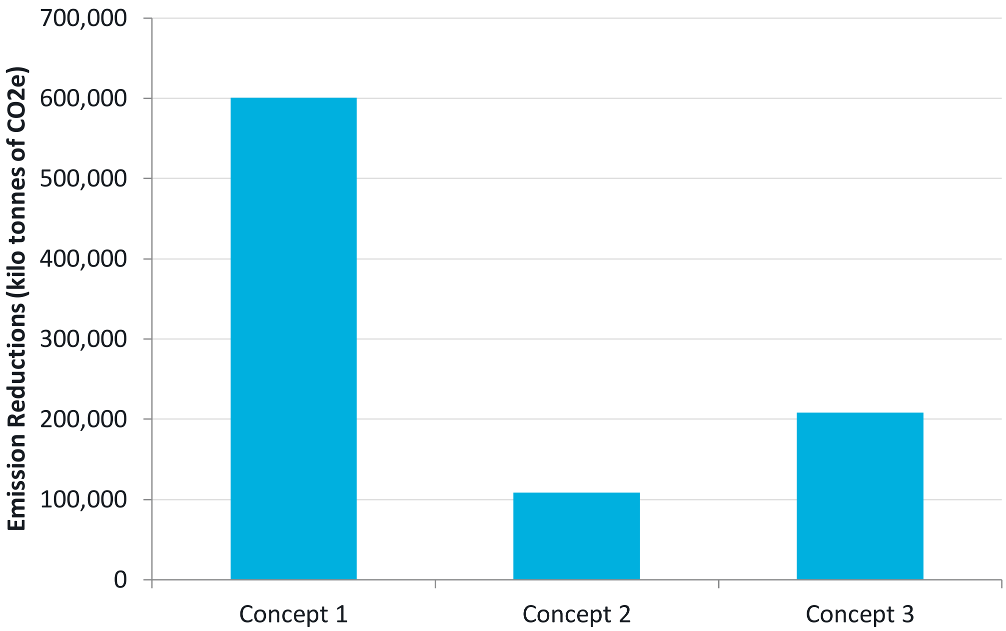
The GTHA transportation network is a major source of greenhouse gas (GHG) emissions and is a key contributor to the region’s carbon footprint. Dundas BRT will contribute to a more sustainable environment through reduced auto emissions.

Benefit 7: Decrease the Environmental Impact of Transportation Along the Dundas Corridor

Dundas BRT has the potential to decrease GHG Emissions on the corridor by up to 600 kilo tonnes, which supports GTHA policies to mitigate climate change caused by transportation.

Dundas BRT will deliver positive environmental benefits by reducing transportation emissions along the corridor – including GHGs that contribute to climate change when drivers choose transit instead of their car. However, the operation of an expanded bus fleet will also increase GHG emissions, in particular when a diesel fleet is used. Figure 4.7 illustrates the net emission reductions for the diesel variants of each option.

Figure 4.7: Decreased Greenhouse Gas Emissions from Dundas BRT



How is this Benefit Realized?

This benefit is realized by:

- Providing a service that attracts drivers to transit and reduces automobile vehicle kilometres travelled; and
- Minimizing transit emissions.

By reducing vehicle travel times, volumes of greenhouse gases emissions (primarily carbon dioxide) from automobiles will be reduced.

Comparative Performance

Option 1 (Through Service) provides the greatest GHG reductions because, similar to other benefits based on automobile vehicle kilometres travelled reductions, it attracts longer distance trips to transit.

Strategic Case Conclusions

Table 4.2 summarizes the Strategic Case analysis by the seven core benefits. This analysis notes a robust strategic case for each of the Dundas BRT options and suggests the following key conclusions:

- Dundas BRT is likely to realize significant strategic benefits by addressing the study problem statement and providing direct improved transit connectivity across the corridor;
- Across most benefits, Option 3 (Overlapping Service) has the highest potential because it provides an expanded frequent rapid transit network across the Western GTHA and provided a blend of direct services and connecting services to major destinations off corridor; and
- Option 1 (Through Service) has greater benefits related to reducing automobile travel because it offers the highest frequency service across the corridor.

Based on these conclusions, the following considerations are proposed for future work:

- Consider Option 1 (Through Service) as an early stage Dundas BRT project, which can be expanded into Option 3;
- Optimize Option 3 to retain high frequency end to end service (as provided in Option 1) to realize the same automobile vehicle kilometre reduction benefits as Option 1.

Table 4.2: Dundas BRT Strategic Case Conclusions

		Benefit	Option 1 (Through Service)	Option 2 (Segmented Service)	Option 3 (Overlapping Service)	Conclusion
Transpor-tation	1	Increase transit ridership and decrease traffic congestion along the corridor	31,100 net new daily riders 555,000 hours of decongestion benefits per year	33,000 net new daily riders 345,000 hours of decongestion benefits per year	37,600 net new daily riders 500,000 hours of decongestion benefits per year	Option 3 has highest overall performance
	2	Create an adaptable transportation network	113 services in the peak, capability to expand capacity east to west	166 services in the peak, capability to expand to sites off corridor, but no through service	157 services in the peak, capability to expand capacity east to west and off corridor	Option 3 has highest performance to expand to meet changing needs overtime
Quality of Life	3	Connects people from where there are to where they want to go	660,000 people live in a 2km catchment	990,000 people live in a 2km catchment	1,000,000 people live in a 2km catchment	Option 3 has highest performance due to wide coverage and combined through and connecting service
	4	Reduced auto accidents resulting in death or injury	900 fewer accidents over project lifecycle	600 fewer accidents over project lifecycle	800 fewer accidents over project lifecycle	Option 1 has highest performance because of higher automobile vehicle kilometres travelled reductions
Economic Prosperity	5	Reduce commute times leading to increased productivity	13.9 minute reduction in average trip time	13.4 minute reduction in average trip time	14.0 minute reduction in average trip time	Option 3 has (marginally) highest overall performance
	6	Unlock economic and regional development on the Dundas Corridor	230,000 jobs within a 2km catchment	455,000 jobs within a 2km catchment	465,000 jobs within a 2km catchment	Option 3 has highest performance due to wide coverage and combined through and connecting service

	Benefit	**Option 1 (Through Service)**	**Option 2 (Segmented Service)**	**Option 3 (Overlapping Service)**	**Conclusion**
Environ-mental Benefits 7	Decrease GHG Emissions	Diesel – 600,000 tonne lifecycle reduction	Diesel – 100,000 tonne lifecycle reduction	Diesel – 210,000 tonne lifecycle reduction	Option 1 has highest performance because of higher automobile vehicle kilometres travelled reductions
Overall Pros	Brief summary of pros	Best performance in terms of auto impacts	Reasonable balance of catchment and ridership impacts, allied with auto impacts	Greatest catchment of population and jobs served, resulting in greatest impact on transit ridership	Option 3 is the best performing option overall but would benefit from further refinement to optimise and balance transit and auto impacts. All options will need careful development of service delivery governance and procurement model to ensure benefits are realised.
Overall Cons	Brief summary of cons	Lowest catchments and transit ridership impacts	Poorest environmental benefits	Poorer performance in terms of auto impacts	
Overall Strategic Benefit	Statement on recommendations based on strategic performance	Best impact on auto use, with respectable impact on transit use and catchment.	Strong balanced mix of impacts across transit and auto	Provides strong benefits in increasing transit use and serving the widest catchment, while providing auto benefits too.	
Key Strategic Risks and Dependencies	Statement on level of risk to strategic benefits realization	Medium risk around service delivery governance and procurement.	Medium risk around service delivery governance and procurement.	Medium risk around service delivery governance and procurement.	

5

Economic Case

Introduction

This economic case has been prepared as part of this IBC to present and assess the potential costs and benefits associated with delivering the proposed investment via a range of service design scenarios and vehicle technology options within the required investment timeframe.

The economic case will enable decision makers, project planners and wider stakeholders to understand how the preferred option will deliver value to the region that exceeds the costs that are required to deliver it. It provides robust estimates of the costs and benefits that will be generated by implementing the Dundas BRT and demonstrates the value that will be added to passengers and users of the Dundas Corridor.

The assumptions used in the Economic Case are defined in Table 5.1 as drawn from Metrolinx's Business Case Guidance Volume 2.

Table 5.1: Assumptions Used in Economic Case

Factor	Assumption
Economic Discount Rate	3.5%
Analysis Period	60 years after operations commence Assumed Construction From 2022-2024 Operations from 2025-2084
Value of Time (2019$)	$18.06 (no value of time growth is assumed in this analysis)
Cost Escalation	1% per year until 2031
Decongestion and Auto User Benefits	Peak: 0.01 hours saved per reduction in auto vkt Off-peak: 0.0125 hours saved per reduction in auto vkt
Unperceived automobile operating cost savings (2019$)	$0.09 per reduction in auto vkt
Safety Benefits (2019$)	$0.095 per reduction in auto vkt
GHG Reductions (2019$)	$0.01 per reduction in auto vkt

Options Analysed in Economic Case

As previously set out, three service options have been developed for delivering a BRT service on the Dundas Corridor. The costs and benefits associated with the following options were therefore assessed as part of the economic case for the Dundas BRT:

- Option 1 – Through Service
- Option 2 – Segmented Service
- Option 3 – Overlapping Service

Cost-benefit analysis has been undertaken for each option and presented and discussed in detail in subsequent sections.

Economic Costs to Deliver Dundas BRT Options

The costs or required investment for each option under consideration for the Dundas BRT are presented and described in detail in this section. The costs are broken down into two categories:

- **Capital and Renewal Costs**: This comprises one-time fixed costs incurred to build the required infrastructure (i.e. stops, roadway enhancements, maintenance depots, and bus fleet) to deliver the service as well as costs incurred to replace the bus fleet every 12 years as they reach the end of their useful life.
- **Operating and Maintenance Costs**: This comprises on-going costs required to operate the service and provide daily maintenance including labour costs, fuel/energy costs, vehicle maintenance costs, facilities (stops, stations, and depots) maintenance costs, and administration costs.

Economic Cost Summary

The projected costs associated with each service option (over 64 year appraisal period) are summarized in Table 5.2.

Table 5.2: Estimated lifecycle costs per service option for the proposed Dundas BRT investment

Economic Costs ($2019 PV)	**Option 1 - Through Service**	**Option 2 - Segmented Service**	**Option 3 - Overlapping Service**
Capital Costs(A)	$850 M	$930 M	$920 M
Infrastructure	$690 M	$690 M	$690 M
Fleet (including Renewal)	$160 M	$240 M	$230 M
Operating Cost (B)	$1,130 M	$2,240 M	$1,770 M
Operating and Maintenance Costs	$1,490 M	$2,600 M	$2,130 M
Fleet Impacts (Savings)	$-360 M	$-360 M	$-360 M
Total Cost (A+B)	$1,980 M	$3,170 M	$2,690 M

The following observations can be drawn from this analysis:

- Infrastructure costs are projected to be the same for all three set of service options, with the Dundas Connects proportion of capital cost accounting for around 66%, the rest being the BRT stops on the western section and the operations and maintenance centre. Given that, the Dundas Connects capital cost accounts for some 13-19% of the total project cost;
- Option 1 (Through Service) is estimated to have the least investment requirement (i.e. fleet purchase and renewal, operating and maintenance, and fleet size) in comparison to Options 2 and 3. This is expected as the package of bus routes in Option 1 are operated at significantly lower service frequencies along the Dundas corridor. This results in lower service time, fleet requirement, fleet purchase and renewal costs, and operating and maintenance costs;
- In contrast, Option 2 (Segmented Service) is estimated to incur the highest investment requirement of all three set of options as it includes a package of bus routes operated on different sections of the corridor at much higher daily service frequencies. Option 2 also include a service extension along the existing Mississauga Transitway as key component, which drives up the service frequency requirements and the aggregate costs required to deliver the service;
- While the investment required to deliver Option 3 (Overlapping Service) is lower in comparison to Option 2, it is still estimated to be higher than Option 1. Option 3 is essentially a hybrid option, an optimal compromise between Options 1 and 2 as most sections of the service are delivered under slightly lower service frequency and performance regimes and, by extension, lower costs than in Options 2.

Economic Benefits

The benefits assessed as part of the economic case for the Dundas BRT are categorized as follows:

- **User Impacts:** This refers to impacts experienced by travellers who will benefit from using the Dundas BRT, as well as travellers in the transportation network who will benefit from other travellers shifting from other modes to the Dundas BRT. User impacts are realized in the form of lower travel costs and shorter commute times. User impacts are further broken down as follows:
    - **Transit User Impacts:** This refers to the reduction in the generalized travel costs and time that will accrue to new and existing transit users on the corridor owing to the proposed Dundas BRT investment.
    - **Auto User Impacts:** This refers to the travel time and operating cost reduction that will be experienced by auto travellers that remain on the network because of the decongestion (i.e. travellers shifted off the auto network) spurred by the proposed Dundas BRT investment.
- **External Impacts:** This refers to impacts generated by the proposed Dundas BRT investment, which will collectively reduce the aggregate social cost or negative societal impacts of the transportation system. The external impacts of the proposed Dundas BRT investment are envisaged to include improved road safety, greenhouse gas emissions reduction, and improved local air quality.

Emissions impacts include the detriment associated with increased diesel bus operation as well as the benefit of reduced automobile use on the corridor. Transit user benefits are presented in a range within this IBC to account both for the uncertainty regarding the impacts and benefits of introducing a new through corridor rapid transit service in a corridor that currently has limited through service, as well as the technical challenge of comparing such a material change in transit service in a robust way:

- **Low –** user benefits are derived by comparing BAU local bus times to each option's rapid bus travel times (reflecting overall lower improvements compared to the BAU)[14]; and
- **High –** consistent with Metrolinx's economic appraisal guidance, user benefits are derived by comparing BAU rapid bus times (some of which are significantly higher than local bus times) to each option's rapid bus times (reflecting significant improvements from the BAU).

The use of Low and High is for benefits only; system ridership and fare revenue is the same in each.

[14] The GGHMv4 model has five transit modes in its transit choice set: local bus, rapid bus, premium bus, subway and GO Rail. For Dundas BRT, local bus and rapid bus are the key modes of interest. In the Dundas corridor, the BAU network is primarily local bus; Dundas BRT is treated as a rapid bus.

Economic Benefits Summary

The projected benefits associated with each service option are summarized in Table 5.3.

Table 5.3: Dundas BRT Investment Options Benefits

Impact Area	**Impact Type**	**Option 1 Through Service**	**Option 2 Segmented Service**	**Option 3 Overlapping Service**
Transit Users	Travel Time Benefits	$2,567 M	$2,188 M	$2,586 M
	Crowding & Reliability	$2,066 M	$1,740 M	$1,836 M
Automobile Users	Congestion Reduction	$237 M	$146 M	$282 M
	Auto Operating Costs	$170 M	$104 M	$202 M
Health & Safety	Accident Reduction	$59 M	$36 M	$70 M
Environment	Greenhouse Gas reductions	$19 M	$12 M	$22 M
Total Benefits		$4,039 M	$3,316 M	$4,039 M

The following key observations can be drawn from the benefits analysis:

- Of the three set of service options assessed, Option 3 is estimated to realize the highest amount of user benefits and the broader society valued at over $4 billion as it offers the most direct transit connectivity for transit passengers without compromising end to end service coverage along the corridor.
- In contrast, Options 1 and 2 are estimated to generate lower amount of benefits for travellers and broader society. This is expected as Option 1 provides the lowest level of transit access and overall service quality to transit riders, which include lower service coverage, lower service frequency, higher service transfers for end to end trips, and longer journey times. Consequently, this limits the number of auto users likely to switch to the Dundas BRT, which in turn limits the level of auto user (decongestion) benefits and other external benefits that can be realized as a result.

Economic Case Summary

The results of the benefit to cost assessment of the three service options over 64 year appraisal are presented and summarized in Table 5.3.

Table 5.4: Economic Case Summary

Impact Type ($2019 PV)	Option 1 - Through Service	Option 2 - Segmented Service	Option 3 - Overlapping Service
Total Benefit (B)	$4,039 M	$3,316 M	$4,039 M
User Impacts	$3,970 M	$3,270 M	$3,950 M
External Impacts	$80 M	$50 M	$90 M
Total Cost (C)	$1,980 M	$3,170 M	$2,690 M
Capital Cost	$850 M	$930 M	$920 M
Operating and Maintenance Cost	$1,130 M	$2,240 M	$1,770 M
Fare Revenue Adjustment (A)	$468 M	$503 M	$608 M
Net Present Value ((A+B)-C)	$2,525 M	$647 M	$1,955 M
Benefit-Cost Ratio ((A+B)/C)	2.3	1.2	1.7

The following key findings can be drawn from the economic analysis:

- All Dundas BRT options are forecast to deliver overall benefits that exceed the total costs/investment required to implement them for both low and high benefits scenarios;
- Option 1has the highest BCR (2.3) and NPV ($2.5 billion);
- Option 3 has a lower BCR than Option 1 due to its significantly higher operating costs. There is an opportunity to further optimize all options at the Preliminary Design Business Case (PDBC) stage where one option is brought forward for further rationalization of operating costs and benefits to further improve BCRs and value for money;

Overall, the three service options all deliver strong value for money to the GTHA and significant benefits to travellers.

6

Financial Case

Introduction

The financial case sets out the potential financial impacts (i.e. lifecycle revenues and costs) associated with delivering the proposed investment. It focuses on:

- How much will it cost to build, operate, and maintain the investment?
- How will the investment impact network revenues?
- How will the investment be funded?
- What is the net financial impact of the investment?

While both the Financial Case and Economic Case assess the costs of an investment, the Financial Case does not consider society-wide benefits of an investment. Instead, it is concerned with the financial resources required to implement the investment, the potential revenues to be generated from the investment, and the net cash flow impact for the agency responsible for the investment in nominal (inflation adjusted) terms.

This financial case will support ongoing and future financial planning activities undertaken by project planners and decision makers by providing preliminary estimates of the lifecycle costs and subsidies required to deliver the Dundas BRT investment during the required investment period.

Options Analysed in the Financial Case

Similar to the Economic Case, the three service options under consideration for the Dundas BRT investment were appraised through a financial lens. The costs and revenues associated with the following options were therefore assessed as part of the Financial Case for the Dundas BRT:

- Option 1 – Through Service
- Option 2 – Segmented Service
- Option 3 – Overlapping Service

Fare Revenue Impacts

Within the IBC, only fare revenue impacts have been considered at this time. The fare revenue is calculated by applying an average fare to the number of incremental transit trips using Dundas BRT (in the AM peak period, then expanding to all day and annualising). The average fare is based on the average fare of the transit agencies on the corridor, excluding Toronto (given the current restrictions on pick up and drop off by non-TTC operators). No account has been taken of trips that transfer to TTC and pay an additional fare. On that basis, the fare revenue may be an underestimate; conversely, ongoing efforts to achieve improved fare integration would likely counter that.

Summary of Revenue Impacts and Key Observations

The projected revenue associated with implementing each service option on the Dundas Corridor over 60 years of operation is summarized below in Table 6.1.

Table 6.1: Revenue Impacts in Financial Terms

Item (Undiscounted $2019)	Option 1 - Through Service	Option 2 - Segmented Service	Option 3 - Overlapping Service
Fare Revenue	$477 M	$512 M	$620 M
2041 Incremental Annual Ridership	9.8 million riders	10.5 million riders	12.7 million riders

The following key observations are noted from this analysis:

- Of the three set of service options assessed, Option 3 is estimated to generate the highest amount of fare and aggregate revenues ($620 million) as it is projected to attract the highest level of incremental annual passenger ridership (2041 ridership – 12.7 million) in comparison to Options 1 and 2; and
- Option 1 is estimated to generate the least amount of fare and aggregate revenues ($477 million) as it is projected to attract the least level of incremental annual passenger ridership (2041 ridership – 9.8 million).

Financial Costs

The following costs were analyzed as part of the Financial Case to project the costs impacts of each service option:

- **Capital and Renewal Costs**: This comprises one-time fixed costs incurred to build the supporting infrastructure (i.e. stops, roadway enhancements, maintenance depots, and bus fleet);) required to deliver the service; costs incurred to replace the bus fleet every 12 years as they reach the end of their useful life; and the interest costs incurred as a result of borrowing to finance all capital and renewal costs, which for the purpose of the Financial Case is assumed to be 5.78% of all capital and renewals costs incurred in a given year.
- **Operating and Maintenance Costs**: This comprises on-going costs required to operate the service and provide daily maintenance including labour costs, fuel/energy costs, vehicle maintenance costs, facilities (stops, stations, and depots) maintenance costs, and administration costs.

Financial Cost Summary

The projected costs associated with implementing each service option over 64 year appraisal are summarized in Table 6.2.

Table 6.2: Capital, Operating and Maintenance Costs in Financial Terms

Item (Undiscounted $2019)	Option 1 - Through Service	Option 2 - Segmented Service	Option 3 - Overlapping Service
Total Capital Costs	$950 M	$1,039 M	$1,024 M
Infrastructure Cost	$790 M	$794 M	$793 M
Fleet (Including Renewal) Cost	$160 M	$245 M	$231 M
Total Operating and Maintenance Costs	$1,457 M	$2,553 M	$2,084 M
Total Project Costs	**$2,407 M**	**$3,592 M**	**$3,108 M**

The costs items and key observations are similar to those used and presented in the Economic Case except a provision for interest/financing costs in the Financial Case, which is provided in Table 6.2.

Financial Case Summary

The net financial impacts of three service options are presented and summarized in Table 6.3.

Table 6.3: Financial Case Summary

Financial Case Metric (Undiscounted $2019) over 64 Year Appraisal	Option 1 - Through Service	Option 2 - Segmented Service	Option 3 - Overlapping Service
Total Revenues	$477 M	$512 M	$620 M
Total Project Costs	$2,407 M	$3,592 M	$3,108 M
Total Capital Costs	$950 M	$1,039 M	$1,024 M
Total Operating and Maintenance Costs	$1,457 M	$2,553 M	$2,084 M
Net Present Value/Net Investment	-$1,930 M	-$3,080 M	-$2,488 M
Operating Surplus or Subsidy	-$980 M	-$2,041 M	-$1,464 M
Operating Cost Recovery Ratio	0.33	0.20	0.30

The following key observations can be drawn from the analysis in Table 6.3:

- All service options will require financial subsidies from the public entity sponsor to be financially viable. It is important to note that most public transit projects typically require financial subsidies from governments to be delivered, operated, and maintain as planned;
- In terms of lifecycle operating subsidy requirement, Option 1 is projected to require the least amount of investment. This is attributed to its comparably low fleet requirement.
- The level of investment to deliver Option 3 is approximately 30% greater than the level of investment required to deliver Option 1. This difference should be reviewed in future stages of project development and compared against different levels of strategic and economic performance between the options; and
- Option 1 is projected to recover a higher share of operating and maintenance costs from revenues in comparison to other BRT options.

Evidently, all service options under consideration for the Dundas BRT will require significant financial investment to deliver and operate. Further analysis will be required as part of future project development to refine and scope the service options in greater detail, get the right size for the fleet requirements, and model fleet performance in order to generate more indicative financial projections for the Dundas BRT.

7

Deliverability and Operations Case

Introduction

This section of the IBC describes the proposed approach for delivering the Dundas BRT. It sets out the division of roles and responsibilities for the project and identifies key project challenges, risks and possible mitigation measures.

It should be noted that at the IBC level, the Deliverability and Operations Case is a high-level overview of deliverability and operations commensurate with the level of detail available at this point in time and without consulting specialist experts in each area. Further study will be required as the project progresses, and more details become known.

Review Structure

This review follows the core requirements as defined by Metrolinx's Business Case Guidance Volume 2. Given the early stage of analysis and similar components across all options, this evaluation is not focused on comparative delivery between Options 1-3, but instead focuses on key delivery considerations for a BRT service on the corridor. This analysis is intended to support Metrolinx in further developing the project design, delivery, and procurement plan for a BRT service (pending business case performance) across the project lifecycle.

Key Assumptions

For the purposes of this report, several key assumptions have been made. These include:

- A BRT fleet to support additional buses for existing operators, of new low-floor vehicles that are driver operated with conventional diesel vehicle technology;
- Signal priority at intersections in Toronto and Mississauga to provide signal priority for buses by extending or curtailing traffic signal phases to facilitate and prioritize BRT movement. This requires specialized traffic signalling priority equipment that detects buses and integrates with traffic signal controllers to assign priority to buses;
- Enhanced BRT bus stops with shelters, railings, windscreens, wayfinding, ticket vending, security phone and cameras, and lighting;
- BRT capacity of approximately 3,000-6,000 passengers per hour per direction (pphpd) using low headways typical of rapid transit and varying depending on service configurations; and
- The BRT will be designed to be converted to LRT where appropriate (notably the centre running Dundas Connects section) if and when demand warrants it.

Service and Fare Integration

Two key themes central to Dundas BRT are service and fare integration. These are woven into the discussion that follows around how the project is delivered; both in terms of the initial capital spend required to deliver the infrastructure, systems and fleet, and then the subsequent operations.

Dundas BRT services could be delivered through network and service expansion of the existing transit agencies on the corridor to an agreed configuration and service standard that delivers a holistic BRT service along the entire corridor. Conversely, a unique party operator could be utilized to operate Dundas BRT, with fare policies integrated with the existing agencies, and contracted service standards to provide a distinct service (akin to York Region VIVA). Development of Dundas BRT will need to consider these alternatives in light of the capacity and ability to expand service, and the merits of a distinct service offer set apart from existing services.

State of Fare and Service Integration

Fare integration between the 905 agencies already exists and, subject to agreement to expand this to Dundas BRT services, could simply be continued. This includes honouring fares and tickets, and in some instances also honouring products/passes. Fare integration with TTC remains a barrier, but the analysis presented in this IBC has maintained this barrier as a working assumption, which suggests ridership is conservative in this business case of the existing fare structure. In addition, there is a degree of service integration where operators cross boundaries to provide direct trips to key transfer points (GO Rail or TTC Subway stations) or provide service along high demand corridors. Future service planning for Dundas BRT should consider further enhanced service integration as an opportunity to connect more passengers to the BRT system.

Capital Delivery

Delivery Strategy

Given the regional nature of this project, it is assumed that provincial funding will be required, along with Metrolinx oversight. As such, the project is subject to Metrolinx' typical governance and approvals process which includes the review and approval by the Metrolinx Senior Management Team, Investment Panel and Board. Investment decisions must also be approved by the Ontario Treasury Board.

Although this is a Metrolinx IBC, cooperation and agreement will be required with the host municipalities to advance the project, including future planning, management, delivery and operation of the system, and for ownership and maintenance of certain project components (notably the right of way). Collaborative planning works will also take into account the process the host municipalities may have to undertake towards obtaining approval for federal and provincial funding for some of the project components under the Investing in Canada Infrastructure Plan (ICIP).

Major Capital Components

Most BRT systems are made up of the same typical components, along with some unique infrastructure to match the needs of its host. Major components for a BRT are outlined in Table 7.1. For Dundas BRT, these components are related primarily to the segment in Mississauga (Dundas Connects), where a centre running segregated BRT right of way is proposed; for the remainder of the route, the BRT infrastructure will primarily make use of the existing right-of-way for the HOV lanes.

Table 7.1: Civil Infrastructure

BRT Alignment	Fleet
• Roadway and curbs • Signage • Public art • Fencing • Systems (communications, lighting) • Landscaping • Substations (if required) • Intersection interface • Road geometry and pavement design • Drainage and utilities • Retaining walls • Bridges/tunnels • Ground improvements • Property acquisition	• 40-foot assumed • Fuel type • Mechanical philosophy (replaceable parts vs. rebuild) • Seating, capacity and configuration • Multipurpose space for wheeled devices • Accessibility features (kneeling vehicle, ramps, hand holds, perches, visual/audio cues) • Bicycle storage • Advertising • Public Address • Fare collection • Security features (cameras, etc.) • Livery • Climate control • Window type • Lighting and ventilation • Flooring and seat materials • Driver's area
BRT Stations/Stops	**Operations and Maintenance Facility (OMF)**
• Platform, platform access (ramps), • Shelter/windscreens and railings • Seating, • Fare vending and fare gate infrastructure • Wayfinding and signage • Security cameras, lighting, speakers, emergency phones, variable messaging • Advertising space • Systems and equipment cabinets • Refuse and recycling • Landscaping • Public art • Vertical circulation or other infrastructure connections to transit interchange points or key designations	• Security • Control Room • Data centre/IT • Staff/operators/mechanic facilities • Administration, scheduling, union and management offices • Reception and driver sign-on • Heavy and light maintenance bays • Cleaning, washing and fuelling/charging bays • Refuse, recycling, fluids • Stores and asset management • Vehicle storage • Expansion • Landscaping • Parking • Sustainability design certification requirements • Special maintenance tools, equipment and vehicles • Paint booth and body shop

Systems, Signalling and Equipment

- Control Room
- Vehicle location system
- SCADA (Supervisory Control and Data Acquisition) – systems monitoring including power
- Traffic signal controller upgrades
- Traffic signals
- Overhead power or charging (if required)
- Radio
- Telecommunications/data systems
- Master clock
- WiFi
- Ticketing
- CCTV/Emergency phones not located at stations/stops

Constructability

Depending on available cross section, existing traffic volumes, and types of signalling technology used, constructing an in-street BRT can range from complex to straight forward. However, it generally tends towards being similar to any type of major road construction project. In the case of an at-grade, centre median running BRT, the centre portion will often be constructed last, with the roadway on either side of the alignment, as well as 'behind the curb' streetscape, being reconstructed first. If traffic lanes are being removed or reduced with the introduction of the BRT or during the construction phase, it is important to have robust communications with the public about what to expect. Traffic congestion will likely be at its worst during construction and will gradually ease as construction completes with the new lane configuration in place. The BRT alignment may also close many side street and property access traffic movements that were permitted previously. Provision should be made to alert the public to these major changes.

A possible construction sequence (excluding any desired relocation of utilities under the BRT alignment), with specific application to Dundas Connects through Mississauga and Toronto, is as follows:

- Remove centre medians or other above grade infrastructure in the centre of the right of way, if space is required for traffic diversions;
- In one direction, divert or constrain traffic away from the outside curb lane to allow space for construction crews to rebuild from existing curb to property line (or acquired property line). This may include a new buffer between the property line and the sidewalk or active transport facilities and a boulevard between the new curb and the sidewalk for street furniture and landscape. This could include street lighting, traffic signal cabinets, fire hydrants, benches, trees, etc. Intersections may have to be rebuilt with new geometry and traffic signal positioning. Property accesses may be temporarily shut or diverted during construction. Once the curb is in place and safe provisions are made for traffic signals and sightlines, traffic is restored;
- Repeat on the other side of the road; and
- Close the BRT alignment to traffic and begin construction of the stations and roadway possibly using a more robust road surface such as concrete. Traffic lanes on either side of the alignment can

be shut to facilitate construction, or the BRT alignment and stops could be constructed in halves with construction crews using the other half of the alignment as staging.

Phasing

The proposed Dundas BRT corridor is 40km long (with around 20km of new infrastructure through Mississauga and Toronto to provide a segregated right-of-way), a significant length for a new rapid transit system. Phasing of a system of that length may be a useful tool – the following considerations should be reviewed during further design and development of the preferred IBC option.

Staging

The length of the system lends itself to a phased approach to project delivery, however if the benefits case indicates that the project is sensitive to requiring its entire length to capture the benefits that offset its cost, this may not be the case. Given buses already serve the corridor, it is possible that precursors to full BRT could be implemented ahead of full conversion to a rapid transit system. This might be an especially feasible option towards the less populated end of the system in Halton.

Scale of the System and Expandability

Preliminary ridership forecasts can give an initial sense of demand on the system over a period of time. This will allow the project to scale the system's capacity to match ridership. Often, demand grows over time or initial ridership projections can under-predict the attractiveness of a new system which highlights the need for the ability to expand the system in a cost-effective way. Overbuilding a system is also not ideal as it could be costly for little benefit in return. Further, unused infrastructure must still be maintained or may not be fit for future purpose when it is eventually needed. Taking expandability into account and creating initial design solutions that accommodate future expansion is ideal.

Operations and Maintenance Facilities

The positioning of the main or initial OMF is critical to understand, along with positioning of secondary operations and maintenance facilities, as well as driver sign-on/road release options and security staging. The ability to effectively respond to incidents on the system is of key importance, as well as having an efficient start, end and ramp up/down periods for service throughout the day. A main facility that is skewed towards one end of a 40km line might yield undesirable, non-revenue based operational costs if fleet vehicles must travel extended distances into and out of service. If a location near the centre of the system cannot be found, secondary facilities may be required. If a phased approach to the system is used, then this must also be accounted for. Critically, if operation of the BRT is centred around existing transit agencies expanding service on the Dundas corridor in an integrated way, then use of existing facilities, expanded as appropriate, would be the likely approach.

Transit Connections

Depending on how the BRT service pattern is developed and evolves over time, a phased approach to transit connections may be required. As seen through the different service options, there are potentially different transfer points or facilities required for passengers to move from one BRT route to another. Ideally, transfers can be made by a passenger alighting from one service and then boarding another service to continue their journey without having to change platforms. However, if other routing options exist, especially ones that come from off the BRT corridor, passengers may need to change platforms once arriving at the BRT to continue their journey in either the east or west direction. Strategic thinking about how passengers will change from one platform from another and potential volumes of pedestrians will be important to consider when making infrastructure provisions for the transit connection.

Technology

It is also worth noting that a phased approach to technology is also important to consider in this stage of planning. If there are any aspirations to convert the BRT corridor to LRT or other higher-order non-bus based rapid transit, general geometric requirements should be considered to understand if there are specific risks that should be noted and possibly mitigated if cost neutral to do so.

Community Benefits

In 2014, Metrolinx approved a Community Benefits Framework and have since utilized community benefit procurement requirements on Finch West LRT and Eglinton Crosstown LRT projects to enhance training and job opportunities, as well as apprenticeships. The framework also calls for opportunities for the use of local suppliers.

The two LRT projects are both complex and large-scale rapid transit projects. The Dundas BRT may be slightly different in terms of scale of construction as the roadway/alignment will be largely in place prior to the project being implemented. However, there will likely still be significant roadworks to improve intersection geometry and alignment features, construct stations and operations facilities, as well as install specialised equipment such as traffic signal priority.

Community benefits may still be an applicable framework in this context however the results may be less impactful compared to larger scale projects. Community Benefits Assessment may be required as part of the ICIP application.

Environmental Assessment Requirements

Metrolinx adopts the streamlined approach provided by the accelerated environmental assessment program (TPAP – Transit Project Assessment Process) for large transit projects, as granted by the *Environmental Assessment Act*. However, some individual sections of the route have also been improved in advance of the full BRT project using a Municipal Class EA, for instance the 6-lane widening through Halton Region. How the project is advanced and phased may dictate the type of environmental assessment that could be pursued in terms of time efficiency and cost. The Mississauga portion covered in Dundas Connects will require an EA/TPAP for further delivery; the Toronto portion may also require this, depending on the final configuration of that section.

Construction Impacts

As noted in the constructability section above, BRT construction is often not more impactful that typical road works projects. However, some key construction impact issues that need to be considered include:

- Except for major intersections, all other access across the BRT alignment will typically be closed. This can often raise access issues for some select properties. Nevertheless, the use of intuitive geometric design, signage and a strong communications plan will often be enough to ensure that motorists find their way to their destination and will begin to plan their approach their destinations on the second trip;
- Width of the available right of way, property acquisition and setbacks will likely need to be taken into account at pinch points – often at major intersections where there is station infrastructure as well as numerous turning bays for traffic;

- Traffic Management during construction, including robust communications and emergency access plans. If traffic lanes are being removed in favour of BRT, congestion may be noticeable. Additionally, changes to intersection signal timing and geometry may require adjustments by motorists. Speed reductions through construction zones may also increase congestion;
- Areas sensitive to noise and vibration (hospitals, universities, theatres, etc.) may need special mitigations;
- Properties without alternative access points during construction or properties with particular access concerns such as school pick up/drop off or shopping centre access during holiday seasons will need to be factored into construction scheduling and access mitigations. Early engagement with stakeholders can help reveal special access requests that need to be factored into scheduling;
- Emergency vehicles access across the construction sites, near key medical centres and in areas where there is high likelihood for congestion will need to be planned for;
- Pedestrian and cyclist access across the site can be challenging, but not insurmountable. Use of effective signage, detouring and keeping accessibility front of mind in terms of drop offs, ramps and debris can help alleviate issues. In areas of high pedestrian volumes, such as transit exchanges, additional care may be needed in developing access plans; and
- Construction through intersections may be required. Where possible, these works can be timed to occur during weekends, overnight or during holidays to expedite construction and minimize disruption, however this is likely to cost more.

As the Dundas BRT is in its initial planning stages without confirmed funding or a construction timeline, it is not possible to confirm the full set of adjacent, parallel or other such works in the immediate vicinity that may have significant impact on this project. Two key Metrolinx projects are being built in the corridor, namely the Hurontario LRT by 2024 and the Kipling Station upgrade; however, these would be unlikely to coincide with Dundas BRT construction.

Operations and Maintenance

O&M Key Roles and Responsibilities

There are several different options for how the operations and maintenance of the Dundas BRT could be procured. Depending on which procurement type is selected, responsibilities for the operations and maintenance of the BRT will be allocated, likely based on risk exposure. Theoption to utilise the existing transit agencies on the corridor to provide the required service will be critical, essentially providing an integrated network along the corridor through a shared planning, funding and operating agreement.

In any event, the Project Owner (i.e. Metrolinx and/or other government body or agency) will likely want to retain key responsibilities based on their mandate or other areas that may greatly impact cost or schedule. This could include master municipal agreements, certain permitting, environmental assessments, property acquisition, BRT service definition, performance requirements and fleet and maintenance requirements. The Project Owner may want to transfer all operations and maintenance; design and construction; fleet procurement; permitting; traffic management during construction, and power consumption to the O&M provider(s), among others. Some examples of responsibilities that may be more uncertain until later in the project definition with regard to retained responsibility include safety and security, coordination with other transit services and operators (if operated by a third party), public communications, fare collection, and the design of stations.

The Project Owner will also need to appoint resources to key roles for any retained responsibilities, as well as liaison roles for contractor O&M roles. Performance assessment of the O&M contract will be very important for the Project Owner to undertake. While the procurement type will influence the number of liaison, oversight and management roles required, typical key roles will still be required regardless and will need prescriptive definition.

Service and Maintenance Plans

The maintainer will develop a maintenance plan for the fleet and the system overall based on the system size and number of fleet as well as projections for expansion. The maintenance plan will detail the preventative and heavy maintenance requirements for all aspects of the system, often influenced by manufacturer recommendations and past experience. From this, the maintainer will be able to create a detailed schedule for all asset maintenance. This allows the maintainer to understand the amount of space and staff required to maintain the system, how many tools or pieces of special maintenance equipment will be required. Maintaining a modern Enterprise Asset Management System (EAMS) will allow the maintainer to more efficiently record maintenance and repairs history as well as more effectively maintain a sensible spares ratio for parts.

For fleet, there will be daily checks and requirements such as external washing, interior cleaning, fluid top up and fueling, with more in-depth checks and cleaning/maintenance requirements completed weekly and monthly with odometer-based preventative and heavy maintenance intervals.

Stations will have daily requirements such as cleaning, refuse and recycling, ticket vending maintenance, and other general upkeep. Maintenance of Way, as well as signals and power will also have routine maintenance intervals.

Additionally, the owner of the system may need to define the approach they plan to use for the BRT and would like the maintainer to follow. This is often based on cost of fleet renewals and cost to maintain. Some systems put more emphasis on preventative maintenance as opposed to heavy overhauls if fleet will be replaced on certain intervals. Similarly, different emphasis may be placed on new component purchasing/parts swapping vs. parts rebuilding.

Project Lifecycle Considerations

There are several important project lifecycle considerations to take into account for operations and maintenance of a BRT. Namely, the transition from construction to testing, commissioning to operations, operations hand over and decommissioning. While these are expanded upon below, a key principle is to encourage O&M planners, designers, and contractors to approach their work cognisant of the whole project lifecycle; this will encourage solutions with better efficiencies over the long term. O&M contractors who have past experience with BRTs, system handover and other major milestones may be sufficiently informed to key lessons learned that the Project Owner could benefit from.

Depending on the procurement method, be it traditional design bid build or P3, there may be differences in how the operations and maintenance team are integrated into the construction team. Ideally, these two groups work together to ensure a smooth transition and that testing and commissioning reveals any issues that should be addressed prior to revenue service commencement. Often there is a Construction Period Joint Committee of some form between the project owner and the construction contractor. These committees often oversee several other sub-committees such as safety and security and communications. Following substantial completion, the Operations Period Joint Committee between the Project Owner and the O&M contractor could take over all sub-committees from the Construction Joint Committee to ensure seamless transition.

If the Project Owner contracts operations and maintenance of the system, it will be important to have developed robust handover procedures should the contract be terminated or go to a new bidder. These should cover a reasonable handover period, training of new staff, clear ownership of equipment and tools, general provisions for staff retention, well-kept maintenance manuals, reporting and records, etc.

While decommissioning may be far into the future, some provisions for how it would be dealt with would be ideal to develop. This is especially the case if there is any notion of potentially transitioning the BRT corridor into a higher order transit technology.

Project Dependencies

BRT projects can be quite similar to other roadworks projects. Even so, there may be dependencies that should be considered. These may include:

- Significant upcoming utility works or other major construction projects along the corridor
- Fleet procurement and manufacturer's ability to deliver;
- Availability of any special infrastructure, tools or technologies for instance for innovative electric bus charging;
- Ability to secure any required property, including a satisfactory location for the OMF; and
- Ability to come to agreement with host municipalities regarding roles and responsibilities, permitting, operations, special events or construction, etc.

Required Changes in Regulation or Legislation

Several BRT and bus priority systems and projects already exist in Ontario and in the GTHA. Therefore, it is not envisaged that the Dundas BRT would require any special changes to regulation at the provincial level. At the municipal level, a master agreement may be required between Metrolinx and the different municipal government to clarify the roles of each regarding the project. This could include areas such as:

- Control and maintenance of traffic signals and intersections;
- Third party utilities under the BRT;
- Land contributions and property acquisitions;
- Contributions to any project agreements or evaluation of bids;
- City permits;
- Public Art;
- Urban realm elements such as landscaping and wayfinding/signage;
- Construction and project communications;
- Construction and traffic management;
- Adjacent development;
- Security and communications;
- Future plans;
- Advertising on stops;
- Dispute resolution;
- System security and emergency response;
- Interaction with other transit operators and transit exchanges;
- Fare collection; and
- Snow removal.

Achieving agreement with several different stakeholders may be a lengthy process and is worth beginning early to gain mutual understanding. Additionally, agreements with other transit operators in the area where that the BRT may interface with will be important in order to confirm access to facilities, operations within facilities, maintenance, security, contributions to funding, etc. Of particular note, within the City Limits of Toronto and as per 2006, c. 11, Sched. A, s. 56 (2) of the City of Toronto Act, the City must agree to approve operation of a transit service[15].

Human Resources/Staffing

The total number of staff required will be based on the phasing of the project, number of fleet required based on service option, the procurement method, and third party service contracts, among others. Additionally, unionized roles occasionally have certain position restrictions that must be accounted for especially as related to distinct skill areas. Function areas that will need to be considered include:

- Management, Business Administration and Procurement
  - Management
  - Administration
  - Trainers
  - Communications
  - HR / Staffing / Labour Relations
  - Procurement and Contracts
- Operations
  - Operations Supervisors
  - Drivers/Operators
  - Control Centre & SCADA
- Maintenance
  - Stores and EAMS
  - Fleet mechanics and custodians
  - Maintenance of way (Power/Signals/General)
    - Electricians and signal technicians
    - Alignment maintainers/ general labourers
  - Systems
- Facilities
  - Station Custodians
  - Facilities Custodians
  - Landscaping/ Grounds
  - General Electricians/Mechanics
  - Non-revenue Vehicles
- Safety and Security

[15] https://www.ontario.ca/laws/statute/06c11#BK68

Procurement Plan

Role of Infrastructure Ontario

Infrastructure Ontario has acted in a procurement advisory role to Metrolinx on several major rapid transit projects, including the York Viva Bus Rapid Transit in the GHTA. It seems reasonable that if the Project Owner were to utilize a P3 procurement method, that the Dundas BRT project would also likely benefit from Infrastructure Ontario acting as procurement advisor given their lengthy experience with delivery of large rapid transit projects in Ontario.

Assessment of Industry

Compared to other forms of rapid transit, BRT construction is relatively straight forward to design and construct, especially if it is at grade with fleet using tried and tested power supply.

However, specialised transit design is still essential for any type of rapid transit. Elements that may call for specialised BRT design expertise include BRT stations and transit interchanges, traffic intersection interface, signal design, fleet power supply requirements and the design of the operations and maintenance facility.

At this stage of the project, with no confirmed construction horizon, it may be difficult to assess capacity within the market. Nevertheless, without the need for specialised construction methodology, it is likely that local contractors could be able to carry out this assignment. Major transit projects in the region that will be complete or nearing completion before the BRT is under procurement, include the following:

- York Viva Bus Rapid Transit open in 2020;
- Eglington Crosstown should be open in 2022;
- Hurontario LRT should be open in 2024; and
- Finch West LRT complete in 2023.

Feasible Procurement Options

There are several procurement options available to the Project Owner for the Dundas BRT. The two likely categories for consideration are traditional design bid build (DBB) or public private partnership (P3). The selection may be reflective of numerous points of consideration in terms of:

- Cost certainty;
- Level of risk to be passed on to the private sector vs. retained risk;
- Level of prescriptiveness and involvement in decision making pertaining to construction methodology and impacts; design, materials and aesthetics; operations and maintenance; and
- Consideration for any unique aspects to the project that could benefit from industry innovation that is not easily found in the region.

P3

Generally, P3 models provide a lower cost point for major projects by transferring risk to the private sector in areas where they are better suited than the owner to effectively carry out a task. They can potentially keep cost low by using integrated project teams of experts in each area and by using cost effective, innovative techniques and lessons learned from projects elsewhere, especially where fewer prescriptive restrictions are applied to construction methodology or design.

Additionally, within the P3 model, there are several options for how much risk is transferred to the private sector and could include any of the following project elements either separately or bundled:

- D - Design of the system and stations
- B - Building (construction) of the system
- F - Financing
- O - Operations
- M - Maintenance
- V - Vehicles (Fleet) procurement
- R - Rehabilitation of the system at agreed upon interval

Typical examples of bundling include a full DBFOMVR contract let to one consortia working as an integrated team. Other examples are DBF contracts let separately to an O&M contract, separate to a fleet procurement contract. In the case of separate contracts, the owner usually must somehow facilitate between the groups to ensure sufficient levels of integration, which can be occasionally favourable. For instance, if a large fleet is needed to be procured for several different projects, it may be possible for the owner to obtain a better price by ordering all the fleet together, separate from the main P3 contract for a specific project.

DBB

Using a traditional DBB model, the Project Owner feels they are more effectively positioned to take on the risk or are very familiar with the project type being proposed, having built and operated a similar project. Even using the DBB method, contractors must still be retained, however the project owner usually remains highly involved in the prescriptiveness of the project.

Dundas BRT is unique in that it will be operated on roads owned by different municipalities, some of which have completed upgrade work already on the corridor. It may be worth exploring if municipalities plan to carry out any infrastructure work on the corridor and to potentially find cost sharing solutions that require only one construction period but may be achieving the goals of several different projects. For instance, major utility upgrades or road rehabilitation projects.

BRT service can be provided by enhanced service integration between MSPs, with each providing a portion of the overall service configuration, culminating in an integrated BRT service on the corridor. With existing fare integration between the 905 operators (but not with TTC at present), an integrated BRT service on most of the corridor would result. This can be considered in more detail in the next stage of project development.

Future Proofing Long Term Contracts

Ensuring the system is future proofed over the long term can require strategic thinking early on. For an at grade BRT without extensive station infrastructure, this can be manageable. Some elements of the system that may require future proofing considerations include:

- Size and expandability of the OMF;
- Length and amount of station infrastructure;
- Size of pedestrian facilities such as platform widths, space to wait to cross the road, cross walk widths;
- Power supply considerations, if applicable;
- Ability to extend the alignment without greatly impacting adjacent property. If setbacks are required as property redevelops, this could be put into place early on; and
- Fleet purchasing options which would allow additional orders to be made a set price for a window of time.

Evaluation of Procurement Options

At this early stage of project development, procurement options have not been evaluated. More definition into the project characteristics will aide in determining which procurement option may best fit the project and the owner. Consideration for the points above regarding risk tolerance for different project elements and responsibilities should be given as the project progresses.

Soft Start BRT Implementation

The preceding discussion has set out, at a generic level, the various delivery and operations considerations for implementation of the complete Dundas BRT project. The phasing section highlighted the length of the project and the ability to introduce elements in a phased manner, culminating in the overall full roll out. In practice, the characteristics of the project and its core elements mean that a soft start could be implemented relatively quickly, assuming the governance and regulatory aspects are resolved. In summary:

- The core infrastructure element is the median segregated right of way proposed in Mississauga, emanating from the Dundas Connects study. This will take 5-7+ years to come to fruition (given the need to gain TPAP approval to procure and construct);
- The widening of Dundas St to 6 lanes, providing the HOV lanes for the BRT is in progress, with construction completed throughout expected by 2022; and
- In practice, soft start operations using available infrastructure could commence in 1-2 years, the timescale required for resolution of the governance and regulatory aspects, funding commitment and acquisition of the requisite fleet. As additional infrastructure becomes available (new sections of HOV lanes in Halton for example), the BRT routes would migrate over, and service levels ramped up as demand grows. Such an approach would realise early benefits, help shape new land use development and lock-in the HOV lane designation before auto traffic grows substantially (without which Halton may be pressured to remove such designation).

More consideration would need to be given to how other elements are phased in (such as BRT stops, transit priority etc.), but such a soft start has merit.

Delivery & Operations Case Conclusions

The Dundas BRT project is being proposed along a 40km route in the GTHA, spanning five municipalities. This initial deliverability and operations case highlights the following points for further consideration as the project develops in order to reduce the level of project risk:

- Clarify the governance structure of the project as well as roles, responsibilities and decision-making authority. If a public entity is being considered to take on any part of the project, they should equally be engaged to better understand their capacity and willingness to take on responsibility;
- Further investigation into Metrolinx' risk tolerance for different aspects of the project. This will assist with a decision on procurement method;
- Continued definition of the most effective service pattern for the operations of the BRT which help inform the optimal approach to service delivery. Additionally, confirm how the project is likely to be phased or expanded;
- Engagement of the five municipalities to gauge their amenability and cooperation with the project in terms of the suggested typical master municipal agreement topics with the goal of unearthing any key issues that may impact risk certainty;
- Public and stakeholder engagement along the project corridor to gauge support for the project and to reveal any key issues that need mitigation;
- Further project definition into civil engineering design, property impact, urban design and special technologies. This will allow for better understanding of potential cost to construct, reveal hidden risks that may be costly or highlight areas where early works may help to de-risk the project;
- Continued refinement of ridership forecasting, narrowing the size of fleet required and further defining the baseline requirements for the alignment and station characteristics. This will allow for better understanding of the operations and maintenance requirements including size and site location of an OMF, operating and capital costs; and
- High-level market research into the private sector's level of interest and ability to respond to a call for procurement – including construction, fleet and operations.

8

Business Case Summary

Business Case Summary

The key findings from each of the four cases are presented below in Table 8.1. Based on the analysis conducted in each of the chapters, All the Options perform well and show a robust case for investment, demonstrating the benefits of service integration on the Dundas corridor to support BRT infrastructure investment.

Recommendations for Future Stages of Work

The development of a PDBC for Dundas BRT should consider the following key issues in greater detail:

- Operating model, including how to deliver in a coordinated model by the transit agencies along the corridor with support from Metrolinx; and
- Phasing – including consideration for delivering a joined-up end to end service similar to Option 1 (Through Service) in the immediate future and gradually scaling the service to Option 3 as resources are available and dependencies are delivered (example: road widening in Halton region).
- Consideration to the provision of electric buses and fleet in the future project lifecycle development.

Table 8.1: Dundas BRT IBC Summary

Case	Option 1 (Through Service)	Option 2 (Segmented Service)	Option 3 (Overlapping Service)
Strategic	Strongest reduction in auto trips and congestion, accidents, and emissions because it offers the highest east to west through running service	Strong strategic performance, but lower performance than other options	Strongest performance against the majority of benefits due to a comprehensive network of BRT services that connect the Dundas Corridor to the Western GTHA
Economic	BCR: 2.3 NPV: $2,525	BCR: 1.2 NPV: $647	BCR: 1.7 NPV: $1,955
Financial	Total Cost $2,407 Capital Cost $950 Total Revenues $477	Total Cost $3,592 Capital Cost $1,039 Total Revenues $512	Total Cost $3,108 Capital Cost $1,024 Total Revenues $620
Deliverability and Operations Case	All options are deemed deliverable pending a detailed deliverability and design review as the project definition is developed. Priority should be given to refining the Dundas Connects infrastructure and gaining TPAP approval to support benefits realisation in Mississauga and Toronto. Where possible, phasing should be considered to deliver improved east-west and connecting services early and/or as Halton roadworks are completed.		