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DUNDAS BUS RAPID TRANSIT BENEFITS CASE

June 2010

Dundas Rapid Transit

Benefits Case

Final Report

June 2010

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Executive Summary

In 2006 the Province of Ontario created the Greater Toronto Transportation Authority, renamed to Metrolinx in December 2007. The primary responsibilities of the new organisation are to provide leadership in the planning, financing and development of the Greater Toronto and Hamilton Area's (GTHA) multi-modal transportation network and to conform to the objectives and vision set out in the Province's *Greater Golden Horseshoe Growth Plan*.

Building on the Province's $11.5 billion *MoveOntario 2020* funding commitment for rapid transit expansion in the GTHA, Metrolinx developed the *Regional Transportation Plan* (RTP) to improve mobility throughout the GTHA Region. The final RTP, entitled *The Big Move*, was approved by the Metrolinx Board of Directors in November 2008.

As the rapid transit projects contemplated in *The Big Move* progress closer to implementation, a Benefits Case will be prepared for each project. The purpose of the Benefits Case is to undertake a comparative analysis of feasible options for a specific rapid transit project and present the results in such a way that it will assist decision makers to select a preferred option for implementation. The Benefits Cases help to identify the preferred project scope and inform project funding recommendations by the Metrolinx Board.

The Dundas Rapid Transit initiative is one of the projects contemplated in *MoveOntario 2020* and *The Big Move,* and was further identified in *The Big Move* as a Top 15 priority project. The project involves 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 (designated as Urban Growth Centres), proposed rapid transit at Hurontario, the University of Toronto at Mississauga campus and the Oakville Uptown Core at Trafalgar. The following four options have been identified for the Dundas project for comparison against the Base Case:

- **Base Case:** Business as usual
- **Option 1:** BRT Light[1]: Kipling to Highway 407
- **Option 2:** Full BRT[2]: Kipling to Hurontario,
  BRT Light: Hurontario to Highway 407

[1] BRT Light refers to **mixed traffic** operation of branded buses with ticket machines in bus stops for purchase and validation of tickets before boarding (similar to York VIVA)

[2] Full BRT refers to buses operating within an **exclusive right of way** of branded buses with ticket machines in bus stops for purchase and validation of tickets before boarding

- **Option 3**: LRT: Kipling to Hurontario,
  BRT Light: Hurontario to Highway 407
- **Option 4**: Full BRT: Kipling to Highway 407

A representation of each option is shown the figure below.

SUMMARY OF OPTIONS

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SUMMARY OF OPTIONS

	Option 1	Option 2	Option 3	Option 4
Type of Technology	BRT Light	BRT Light, BRT	BRT Light, LRT	Full BRT
Opening Year	2016	2016	2016	2016
Headway (min)* in 2021	3/5/10/15/20	2.5/7.5/10/15/20	5/7/10/15/20	1.9/3/6/8/15
Headway (min)* in 2031	3/5/7.5/12/20	2.22/6/7.5/12/20	5/6/7.5/12/20	1.7/3/5/7.5/15
BRT Vehs (2021)	41	40	25	57
LRT Vehs (2021)	-	-	10	-
BRT Vehs (2031)	44	45	27	63
LRT Vehs (2031)	-	-	10	-
Travel Time (end-to-end)	89 min	85 min	83 min	74 min
Capital Cost (2009$)	$225m	$291m	$648m	$505m

NOTE: * For the following sections: Kipling to Hurontario, Hurontario to Hwy 403, Hwy 403 to Trafalgar, Trafalgar to Bronte and Bronte to Hwy 407

The assessment of the options is done using a Multiple Account Evaluation (MAE) methodology. The MAE is a framework that provides a systematic identification and analysis of broader public policy implications and criteria of an option, not only costs and user benefits. The MAE framework is based on a number of evaluation "accounts" that together address the most significant project performance and policy considerations for a specific project:

- Transportation User Benefits
- Financial Impacts
- Environmental Impacts
- Economic Development Impacts
- Socio-Community Impacts

The assessment is done by comparing each option to the Base Case and identifying any incremental impacts, costs or benefits that are generated by each option. Note that project

scope, costs and service plans will need to be developed in more detail for funding and implementation. The analysis is done over a 30-year period (2009-2038). In order to compare the options on a "like-to-like" basis the monetized values are discounted to today's value. The values are discounted at a real discount rate of 5% and expressed in net present value in 2009 dollars.

The analysis of the Dundas BRT and LRT options reveals that the lowest cost option (Option 1, the BRT Light), with estimated capital and operating costs of $222 million in net present value terms, generates $373 million in benefits and has the joint highest (with Option 4) benefit-cost ratio of 1.7:1. By comparison, Option 2 has estimated capital and operating costs of $273m with an estimated $432 million in Transportation User Benefits. This results in a BCR of 1.6. Option 4 has estimated capital and operating costs of $466m with an estimated $772 million in Transportation User Benefits. This results in a BCR of 1.7 for Option 4. Option 3 has the highest estimated capital and operating costs of $554m but with an estimated $499 million in Transportation User Benefits results in a BCR of 0.9.

Option 4 has the highest travel time savings due to the faster journey times offered by the exclusive Full BRT lanes along the entire length of the route, highlighting the importance of the operating speed of the rapid transit system to the success of the project. Options 1, 2 and 3 all generate significantly fewer travel time savings than Option 4. However, Option 1 has the same BCR as Option 4 due to its much lower capital and operating costs.

An important cost consideration for this project is that the costs required for the Full BRT lanes between Highway 403 and 407 are relatively minor, as these additional lanes have already been built (or have committed funding) as part of Halton's widening proposals for Dundas Street; therefore improving the economic assessment of the project.

All of the options result in attracting people out of their cars and reducing automobile usage. Option 4, which has the largest effect, will result in a reduction of greenhouse gas emissions by approximately 10.4 tonnes annually by 2021. In net present value terms, this equates to $5.2 million for Option 4 compared to $2.8 million, $3.3 million and $3.9 million for Options 1, 2 and 3 respectively.

As expected the options with the highest capital costs generated the most significant economic development effects. Option 3, which has the highest capital cost will have the largest impact on employment, income and GDP during construction and is estimated to generate approximately 4,300 person-years of employment including direct and indirect impacts. By contrast, the lowest cost option (Option 1) produces the lowest overall economic development and employment benefits during construction as well as during the on-going operations with 900 person-years.

There is a wide range in how the various options support the GTHA land use and economic development objectives to revitalize the corridor by enhancing and supporting complementary planning and densification initiatives. Option 1 provides very small benefits as a result of the lack of travel time and reliability benefits from the project resulting in less than $100 million under

the high property value uplift estimate. Option 3 (LRT between Kipling and Hurontario) and Option 4 (Full BRT along the entire length of the corridor) on the other hand provide $422 million in property value uplift at the lower end of the scale and almost $1 billion in the higher end of the scale.

Overall, the results for Options 1, 2 and 4 indicate that an investment in rapid transit in the corridor will generate economic benefits and prove value for money and support the municipalities' (Toronto, Mississauga, Burlington and Oakville) objectives to revitalize, redevelop and reshape this corridor. Option 4 also provides the highest NPV, largest GHG emission reductions, highest economic development effects and land value uplift compared to Options 1, 2 and 3. The high costs for Option 3 show that the higher cost of LRT makes the case marginal and further optimisation might be required to improve its performance.

The table below summarizes the results from the MAE.

MULTIPLE ACCOUNT EVALUATION SUMMARY

Impact	Option 1	Option 2	Option 3	Option 4
Type of Technology	BRT Light	BRT Light, BRT	BRT Light, LRT	Full BRT
Transportation User Account				
Transportation User Benefits (PV $m)	$373	$432	$499	$772
Qualitative User Benefits	✓	✓✓	✓✓	✓✓✓
Financial Account				
Costs (PV $m)	$222	$273	$554	$466
Benefits Less Costs (PV $m)	$151	$159	($56)	$306
Benefit-Cost Ratio	1.7	1.6	0.9	1.7
Environmental Account				
GHG Emissions (PV $m)	2.8	3.3	3.9	5.2
Economic Development Account				
Economic Impacts During Construction				
Employment (person-years)	914	1812	4271	3819
GDP ($m)	79.4	157.6	471.4	332.1
Income ($m)	35.6	70.6	166.4	148.8
Long-term Economic Impacts (2031)				
Employment (jobs)	42	100	55	144
GDP ($m)	3.6	8.7	4.8	12.5
Income ($m)	1.6	3.9	2.2	5.6
Development Potential ($m)	47-99	292-610	422-837	472-989
Social Community Account				
Land Use Shaping	✓	✓✓	✓✓	✓✓✓
Road Network	✓✓	✓✓✓	✓✓✓	✓
Construction Implications	✓	✓✓	✓✓	✓✓✓

Part A Project Rationale

Introduction

Purpose of Report

In 2006 the Province of Ontario created the Greater Toronto Transportation Authority, renamed to Metrolinx in December 2007. The primary responsibility of the new organisation is to provide leadership in the planning, financing and development of the Greater Toronto and Hamilton Area's (GTHA) multi-modal transportation network and to conform to the objectives and vision set out in the *Places to Grow Act*, 2005.

Part of Metrolinx' mandate and one of its first deliverables was the development of the *Regional Transportation Plan* (RTP) known as The Big Move, a 25-year plan that presents the road map for the implementation of the Province's *MoveOntario 2020* vision of 52 new rapid transit projects in the GTHA by 2020.

As the rapid transit projects contemplated in The Big Move come closer to implementation, a Benefits Case will be prepared for each project. The Benefits Case will describe a range of feasible options for each project, be it different technology, capacity or length of alignment, and demonstrate the benefits and costs associated with each of the options.

The Dundas project is one of the projects contemplated in *MoveOntario 2020* and was identified as a Top 15 project in The Big Move. The project involves 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 (designated as Urban Growth Centres), proposed rapid transit at Hurontario, the UTM campus and the development node at Trafalgar. An initial phase of the project in Halton Region was funded through the provincial Quick Wins funding programme in March, 2008. This report is an evaluation of the implementation of rapid transit along the Dundas Street corridor, including both the initial phase and proposals for a larger project with additional phases.

Four different options were identified for this corridor and this document presents the comparison of these options against the Base Case[3] (which is defined as "business as usual"). The assessment of the options includes the relative strengths and weaknesses of each option on people, the economy and the environment compared to the cost of implementing the option. The objective of the assessment is to clearly outline the trade-offs among the criteria to enable decision makers to make an informed decision.

[3] Base Case assumes local bus network in place and no transit priority measures in place. Additional details on the Base Case can be found in Part B.

Report Structure

This report is structured as follows:

- **Part A - Project Rationale**: This section describes the policy context, the broader regional and project objectives, the characteristics of the corridor and the issues and opportunities to be addressed by the proposed project.
- **Part B – Project Options**: This section describes the options that are evaluated.
- **Part C – Project Assessment:** This section describes the evaluation methodology, the analysis and the summary results.

Project Rationale

Context and Need

The Dundas Street corridor forms one of the main east/west corridors in the Greater Toronto Hamilton Area linking Toronto, Mississauga, Oakville and Burlington. While *The Big Move* identified a corridor between Brant Street in Burlington in the west and Kipling in Toronto in the east, for the purposes of this analysis the western terminus is Highway 407 in Burlington. This terminus has been chosen because it is a more clearly defined 'anchor' and interchange with future transit routes. The section of Dundas between Brant Street and Highway 407 is still planned to have rapid transit service, and will be analyzed at a later date as part of the Brant Street rapid transit corridor identified by *The Big Move*.

The corridor is 37 km long with the potential to improve inter-regional transit. The project would provide improved connectivity:

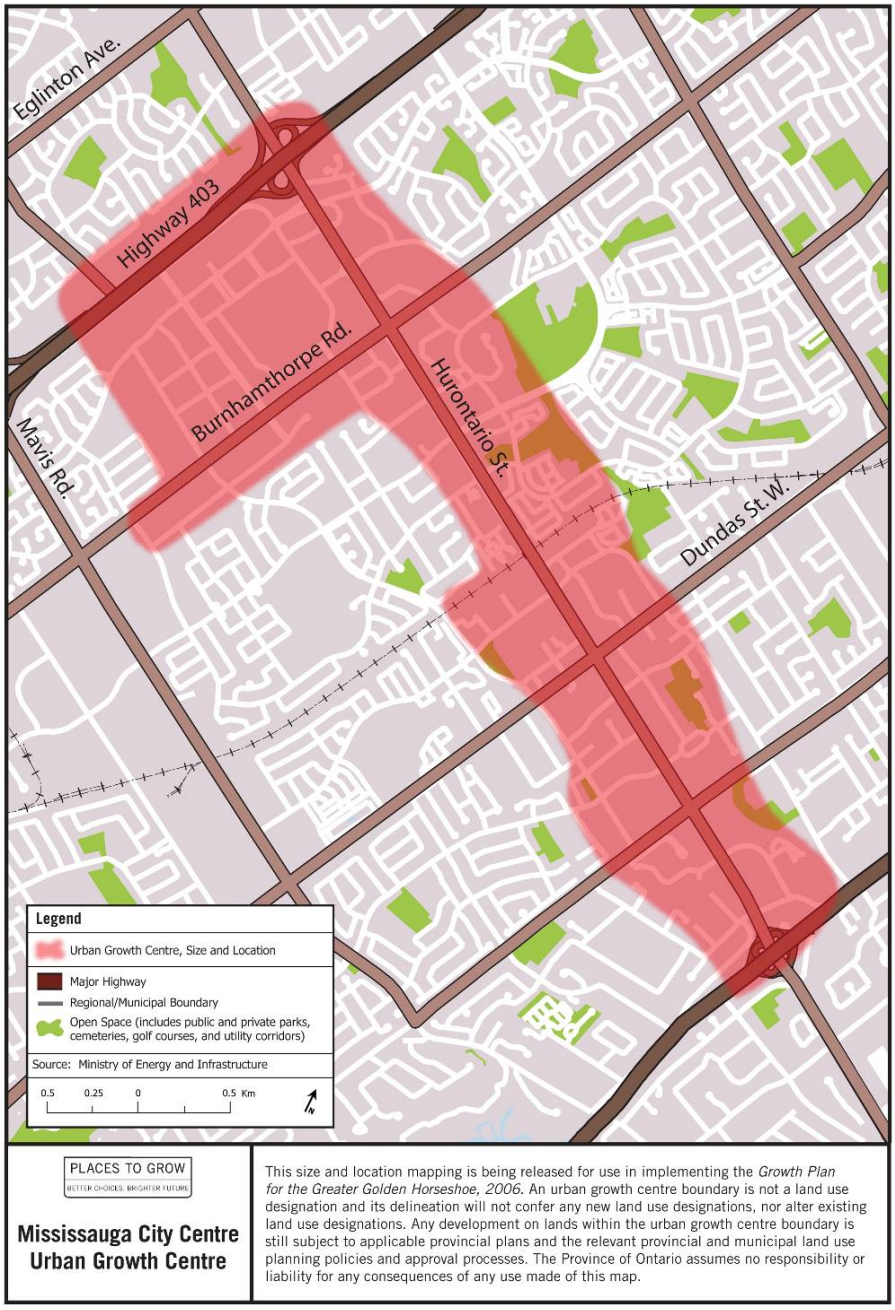
- Along Dundas Street between and within the City of Burlington and Town of Oakville in Halton serving current and future development;
- Within Mississauga, including the proposed Hurontario/Main Street corridor; and
- Improved access to the City of Toronto, including link to the subway and the Milton GO rail service.

In Halton, the Dundas corridor runs through the urban area to the 407 at which time the north side of the corridor becomes more of a rural area. In Mississauga, Dundas Street is the second busiest transit corridor where buses operate at 5 minute headways and carry approximately 18,000 riders daily. Also, within the Mississauga municipal boundary, Dundas Street has been identified as an urban corridor for intensification and passes through three employment areas. West of Kipling there is also a new community node planned at Dixie Road and Dundas Street and a 5.1 km High Occupancy Vehicle (HOV) lane has been in operation between Dixie Road and the Kipling Transit Terminal since 1992.

Furthermore the Dundas Corridor runs through Mississauga and Etobicoke (at Kipling) Urban Growth Centres, a number of existing or emerging downtown areas in the region identified by the *Growth Plan for the Greater Golden Horseshoe* as urban growth centres and the establishment of policies and minimum density targets to encourage their revitalization as vibrant, transit-oriented nodes. These Urban Growth Centres are shown in Figures 1 and 2.

This corridor will also help to meet both current and future transport demand in Mississauga as well as providing improved access into Toronto via Kipling. While existing development to date along portions of the western part of the Dundas Street corridor is modest, there are plans for significant expansion, as outlined below, stretching the entire length of the corridor. With present levels of congestion likely to worsen with development and limited public transit options, alternatives to the private car must be provided along the corridor and for travel further afield. Meeting existing transport demand in Mississauga and helping to facilitate development along the western parts of the corridor is a high priority.

FIGURE 1 MISSISSAUGA CITY CENTRE URBAN GROWTH CENTRE[4]



[4] SOURCE: 'Size and Location of Urban Growth Centres in the Greater Golden Horseshoe' (2008), Ministry of Public Infrastructure Renewal

FIGURE 2 ETOBICOKE CITY CENTRE URBAN GROWTH CENTRE[5]

[5] SOURCE: 'Size and Location of Urban Growth Centres in the Greater Golden Horseshoe' (2008), Ministry of Public Infrastructure Renewal

Dundas Corridor Land Development Plans

Projections and forecasts indicate that congestion will worsen in the coming years given the planned levels of development in the corridor. From the intersection of Dundas Street and Highway 407 east towards Mississauga there is room for considerable development to the north of Dundas Street. Current zoning provides for a mix of residential and commercial developments of both a low and high density nature as well as green spaces.

Dundas Street west of Kipling Station is identified as a surface priority segment by the City of Toronto's Official Plan while the eastern portion is listed as an Avenue. Kipling Station is within the Etobicoke Centre area in the City's Official Plan and the Etobicoke Centre Urban Growth Centre in the Province's *Places to Grow* plan.

Dundas through Mississauga is envisioned as a major transit corridor by the City of Mississauga's Official Plan. The Dundas Street corridor in Mississauga contains a wide variety of commercial, office and residential land uses with the residential districts including a varietyof dwelling types and densities ranging from detached dwellings to apartments. Dundas Street has been identified as an intensification corridor with potential for higher density mixed-use development consistent with planned transit service levels and Dundas Street bisects Mississauga's urban growth centre, which is planned to absorb a large percentage of future growth. Along with Hurontario Street, Dundas Street will become a priority location for intensification and compact development at a transit supportive density. The character of this corridor is proposed to be a minimum of 3 storeys with a pedestrian scale at the street edge and abutting land uses consisting of a mix of commercial, office and residential where appropriate.

The provision of high quality public transit integrated with the proposed development along the Dundas corridor will support the delivery of the policies set out by the 2004 Halton Regional Transportation Master Plan and to be developed as part of the Transportation Master Plan Update to 2031 in support of the Halton Region Official Plan Amendment 38.

North Oakville has plans for employment hubs along Highway 407 and high density development along Dundas Street to Trafalgar Road. In addition, some 20,000 new residential units with 50,000 residents are planned in North Oakville within the next 10 years. This planning is part of North Oakville's designation as an urban area with set employment and residential targets.

Immediately south of Dundas Street to the west of Trafalgar Road, Uptown Core is a designated growth area in Oakville's new Official Plan (*Liveable Oakville*) with medium and high density residential developments as well as open spaces. The majority of the development is slated to be 8-16 storeys while the remainder will be mostly low-rise construction. Overall there will be close to 10,000 residential units, approximately 100,000 square metres of retail space and over 50,000 square metres of office space. Ultimately, the development surrounding the intersection of Trafalgar Road and Dundas Street is envisioned to have high non-auto mode splits.

Within Oakville significant employment growth is forecast over the next 25 years. Forecasts suggest that some 46,000 jobs will be created within Oakville by 2034 with employment land playing a crucial role in providing space for this growth. The Employment Land Review conducted for Oakville in 2009 notes the importance of protecting land for use to provide for future job growth and highlights the areas between Dundas Street and Highway 407 in Oakville as an important supply of employment land. This includes the New Oakville Hospital at Third Line which is proposed to have 457 beds and almost 3,000 staff in 2014/15 and increasing to 602 beds and almost 3,500 staff in 2018/19. The Employment Land Review also emphasizes the importance of high density employment development, which is highly complementary to the provision of higher order transit along the Dundas Corridor.

On the western edge of Oakville, Palermo Village has also been designated as a growth area as well as an important transit hub. South of Dundas, Palermo has been designated a growth area in *Liveable Oakville* with a build out of 5,200 residents and 3,800 jobs while the area north of Dundas is envisaged as a dense, mixed urban use with 1000 people and around 7,000 square metres of retail and commercial.

Over the last 15 years, North Burlington has experienced significant growth adjacent to the corridor within 500 meters of Dundas Street. The Orchard, Millcroft, Brant Hills, Tyandaga and Headon communities are developed and Alton is over 50% built. This has included development on the south side of Dundas Street west of Burloak to Walkers Line and over 3,300 housing units approved since 2004 on the north side, west of Appleby Line. Additional development opportunities in the area will provide the opportunity for transit oriented development at appropriate densities west of Walker's Line. North Burlington will grow in population by another 10,000 to 15,000 people within the next 5-10 years.

On the eastern side of Burlington, adjacent to Bronte Creek, Burlington and Oakville are undertaking a secondary plan for approximately 60 ha of land to determine the future land uses for this area. Development of this land will potentially create a need for accessible enhanced transit services.

The community of Alton, on the western end of the corridor, has also established a Secondary Plan for development of the area bordered by Dundas Street in the south, Highway 407 in the north, Walkers Line in the west and Appleby Line in the east. Since 2004, subdivision approval has been granted for most of these lands. The approvals include a mix of high, medium and low-density residential development catering to just over 8,000 residents. Approximately 50 ha of employment land is forecast to yield employment close to 10,000. Additional zoning has also been provided for school and parks within the community as well as further high and medium density residential, commercial and mixed use employment development.

Finally the inter-regional transit node for the 407 Express Bus Service and Dundas BRT will be located at Dundas Street and the 407 with connections to local transit service and future Brant Street transit corridor and potential links to the New City Park development west of Brant Street.

Project Objectives

The Dundas corridor rapid transit project has a number of objectives that align with the overarching goals in *The Big Move*. The first of these common goals is giving people quality transit service on a corridor which currently does not provide continuous east-west services. The forthcoming transit-oriented development in the northern part of Halton Region and improved transit services will help to make this possible. The second is integration with regional services as Dundas rapid transit will offer better connectivity between Peel and Halton. The third common goal is to reduce congestion, which is facilitated through the increase of transit's competitiveness with driving while limiting road expansion. Lastly, an important consideration is the potential to guide more compact land use patterns in line with general transportation improvements in the area (road widening) rather than having to retroactively fit rapid transit within an existing corridor and the complications and difficulties this represents.

In addition to these common goals, the main objectives for higher-order transit in the Dundas corridor are outlined below:

- Continuous BRT service in the Dundas corridor, connecting Highway 407 in Burlington to Mississauga;
- Services two Urban Growth Centres in Toronto and Mississauga and other major growth areas in Halton (North Oakville and Burlington);
- Higher order GO Transit connections (rail and 407 bus services) throughout the corridor enhancing the regional transit network;
- Improves regional connectivity by linking Burlington, Oakville, Mississauga and the City of Toronto;
- Promotes active transportation linkages in the new growth areas, supporting walking and cycling to access the corridor service; and
- Supports the identification of Dundas Street East as an intensification corridor.

In two separate studies, Halton Region and the City of Mississauga are examining the planning concepts for the Dundas BRT focused on the infrastructure requirements and planning vision within their respective jurisdictions.

Project Overview

Context

The provision of higher order transit along the Dundas corridor from Kipling subway and GO Transit station in the east to Highway 407 in Burlington in the west along Dundas Street has been identified in MoveOntario 2020. Part of this work is based on the preliminary work that Halton Region had conducted as part of the Quick Wins submission to Metrolinx.

Halton Region has preliminarily identified the positive impacts rapid transit along the Dundas corridor would have on congestion, transit demand, community benefits and service quality. Amongst these is a forecast of significant time savings for users of improved public transit. Rapid transit service would also be integrated with various support corridors and the GO rail and bus services, which parallel the Dundas corridor, and will help to provide access from Mississauga to Halton and along the entire corridor.

The new rapid transit line will connect to Kipling as current Mississauga Transit services are relocated from Islington in the near future with the redevelopment of this terminal. Furthermore, Etobicoke Centre at Kipling and Dundas is also designated as an Urban Growth Centre and therefore improvement in transit provision to this hub is in line with the *Growth Plan for the Greater Golden Horseshoe*. It is important to note that the objective of this project is to improve connectivity along the Dundas corridor and as such it is not meant to replace or compete with regional facilities such as the GO Lakeshore rail corridor, which serves longer trips.

Transit Corridor Considerations

There are plans for significant development along the Dundas corridor. The transit improvements outlined here are aimed at supporting the focused development outlined earlier.

In Halton there are proposals to widen Dundas Street from four lanes to six lanes between Highway 403 to the Halton/City of Hamilton boundary (west of Brant). As part of the widening proposals for Dundas Street consideration has been given to the implementation of HOV lanes that would operate in the outside curb lanes during peak periods and ultimately implementation of BRT in reserved lanes. The region is in the process of undertaking the Dundas Street Bus Rapid Transit Corridor Feasibility and Implementation Study which will review these assumptions.

The widening of Dundas Street to 6 lanes is slated to begin with the section from Highway 403 to Oak Park Boulevard with construction to begin in 2009/2010. There are currently Class Environmental Assessments ongoing for the sections between Neyagawa Blvd to Oak Park Blvd and between Proudfoot Trail and Brant Street.

Construction is also ongoing on Dundas Street at Sixteen Mile Creek where the existing bridge is being replaced with two new three lane bridges as well as a widening of the street to 6 lanes with a centre-raised median.

In addition to those outlined above there are a significant number of improvements both committed and currently being studied along Dundas Street. These include:

- Grade Separation at the CN rail crossing between Appleby Line and Tremaine Road (start of construction 2012);
- Bronte Creek Bridge between Appleby Line and Tremaine Road (start of construction 2012);
- 4 to 6-lane widening from North Hampton to Appleby Line (start of construction 2012);
- Widening from 4 to 6 lanes from Tremaine Road to Bronte Road (start of construction 2015);
- Widening from 4 to 6 lanes (excluding CN Rail & Bronte Creek Bridges) from Appleby Line to Tremaine Road (start of construction 2017);
- 4 to 6-lane widening from Guelph Line to North Hampton (start of construction 2017);
- 4 to 6-lane widening from Guelph Line to Halton/Hamilton Boundary (start of construction 2020).
- 4 to 6 lane Widening from Bronte Road to Proudfoot Trail (start of construction 2012);
- 4 to 6 lane Widening from Neyagawa Boulevard to Oak Park Boulevard (start of construction 2013); and
- 4 to 6 lane Widening from Oak Park Boulevard to Highway 403 (start of construction 2011)

As part of Oakville's Uptown Core policies the provision of high quality public transit is seen as a vital component of promoting high density forms of sustainable development. The Town of Oakville is committed to encouraging the use of public transit and the intensification of the Uptown Core, both of which are supportive of the options outlined in Part B.

Burlington has opportunities to optimize the potential for new development on the remaining available land in the Dundas Street area and it is critical that land use options take full advantage of the availability of high quality public transit services.

Network Considerations

At present there is no continuous east-west transit service along the entire length of the corridor. There is an express bus service (201) and local bus service (1) along the eastern end of the corridor operated by Mississauga Transit while Oakville Transit route 5 serves Dundas Street from Bronte Rd to the Uptown Core Transit Terminal at Trafalgar Road. In Burlington the pattern is similar with bus services 11 and 15 serving short segments along Dundas Street and three other routes (6, 62 and 2) serving the same market, but not along Dundas Street.

In addition to the services noted above, Mississauga Transit Route 101 limited stop express service started running in Fall 2009. Route 101 provides service between the Uptown Transit Terminal in Oakville at Dundas Street and Trafalgar Road through to Islington Subway via the University of Toronto Mississauga (UTM). Note that Routes 101 and 201 will initially only operate during peak hours and therefore service outside these periods will be limited to Route 1/1C which provides off-peak combined frequency of 10 minutes on Dundas Street between Mississauga Road and the Islington Subway Station.

Currently, there are no competing GO services on Dundas St. itself, but there are a number of GO bus services which cross Dundas Street. However there are GO Bus services which operate to the north and south of the corridor as well as rail service on the Lakeshore West and Milton rail lines[6] (with the Milton GO line providing an alternative to trips between Hurontario and Kipling). GO Bus services operate along Highway 407 and QEW where GO Bus services 46 and 22 briefly cross the Dundas Street corridor at the Dundas and Highway 407 Park and Ride site.

The Big Move designates both Kipling and Mississauga City Centre as "anchor" mobility hubs. Cooksville, at the Cooksville GO station adjacent to the Dundas and Hurontario intersection, is also designated as an "anchor" mobility hub and is currently being planned by Mississauga and Metrolinx. Additionally, the corridor includes several locally-designated nodes. As proposed in the 2004 Halton Regional Transportation Master Plan the Dundas Street corridor will directly serve two proposed secondary regional transit nodes. Within the Plan the intersection of Highway 407 and Dundas Street in Burlington is noted as a secondary regional transit node and will be served by the proposed options outlined in Part B of this document. In addition, within the Uptown Core of Oakville the intersection of Dundas Street and Trafalgar Road is noted as a secondary regional transit node as part of the proposed Trafalgar Street BRT and again will be directly served by the options outlined in Part B of this report.

[6] Lakeshore is presently an all day service while Milton is peak period only. Metrolinx is currently undertaking a broader study of the potential costs and benefits of alternative technologies, including electrification and two-way all-day service, on all GO rail corridors. This study is expected to be complete by the end of 2010.

Part B Options

Project Options

The rapid transit options examined in this study are mainly bus-based options as the land use and density characteristics of the corridor make rail-based technologies expensive to implement and operate, particularly west of Hurontario.

Due to the very high cost of a subway relative to anticipated ridership, a western extension of the Bloor-Danforth subway from Kipling station was not proposed in *The Big Move* and has not been included in this evaluation. One option does consider light rail transit (LRT) between Kipling and Hurontario. For the purposes of this analysis, the LRT option assumes street running along Dundas St rather than using the CP Rail alignment between Kipling and Cooksville. The rationale for on-street running includes the limited capacity of the rail corridor, conflicts with other rail services, limited development potential along the rail corridor and the potentially remote location for stations.

A final issue is the challenging nature of the corridor between Kipling to Highway 427 where there is a limited right of way and extensive development (and consequent access issues) combined with an extended number of TTC and Mississauga Transit buses. Whatever option is carried forward for further design will require bus route reorganisation, including bus stop locations and review of the potential use of these.

The following four options have been identified for the project for comparison against the Base Case. A summary description of each option is provided below and shown in Figure 1.

- **Base Case:** Business as usual
- **Option 1:** BRT Light: Kipling to Highway 407
- **Option 2:** Full BRT: Kipling to Hurontario,
  BRT Light: Hurontario to Highway 407
- **Option 3**: LRT: Kipling to Hurontario,
  BRT Light: Hurontario to Highway 407
- **Option 4**: Full BRT: Kipling to Highway 407

All the options have a number of elements in common, including:

- Existing fare structure will remain in place pending any future inter-regional fare integration;

- Full BRT and LRT options will require additional lane capacity, assumed to replace HOV/transit lane proposals within existing road widening plans (up to a maximum of 6 lanes); and
- Replacement of existing limited stop express services, and retention of existing local services along the corridor (exact details of the bus implementation plan to complement rapid transit to be defined once project progresses to next level of design).

FIGURE 3 OPTIONS TESTED

Base Case

The base case will assume the following:

- Road capacity increased to 6 lanes within Halton (between Highway 403 and Trafalgar);
- No transit priority measures;

- Local buses remain in place (local bus network is based on Greater Golden Horseshoe Travel Forecasting Model network assumptions and assumes some growth in service);
- Routes 101 and 201 limited stop express services (peak hours only); and
- Local bus service between Highway 407 and Brant Street (15 minute headway).

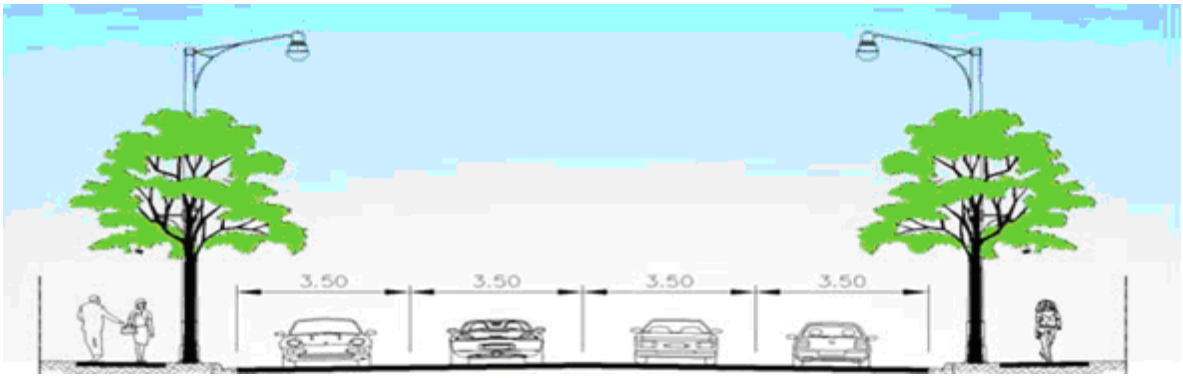
Note that an LRT service on Hurontario is also assumed in place in the Base Case. This makes Option 2 feasible by linking two LRT services and by having the service in the Base Case it means that all other options will be treated equally. However, it should be noted that the technology (BRT or LRT) for the Hurontario corridor is under evaluation in a separate Benefits Case report, and the preferred technology and funding for that project are not known at this time.

Option 1 – BRT Light

This option assumes the section between Kipling and Highway 407 as BRT Light. As envisioned, the BRT buses will be clearly branded to differentiate the BRT service from other local services. The buses will also be equipped with communications capabilities which will enable real-time scheduling information to be provided at BRT stops. The stations themselves will also be clearly defined and, in addition to real-time messaging, will also be equipped with automated ticket vending machines for purchase and validation of tickets before boarding. BRT buses will not provide tickets (fares) to be bought or sold on board, which will reduce the stop dwell times and improve the speed of the service.

Under this option, it is proposed that the existing road right-of-way be widened only at a limited number of key sections of the corridor where the BRT operation would derive the greatest benefit from a transit-only lane while elsewhere it will operate in mixed traffic. Therefore under this option it is anticipated that the roadway cross-section along the majority of the corridor will remain unchanged from today. This typical cross-section with the mixed traffic operation is illustrated in Figure 2.

FIGURE 4 BRT LIGHT CROSS-SECTION (ILLUSTRATIVE)



The BRT operations proposed under this option will also be enhanced with signal priority measures at key intersections along the corridor as necessary, particularly where the BRT operates in mixed traffic. With the increased exposure to mixed traffic operations under this option relative to the other options, there are more opportunities for BRT to benefit from the provision of signal priority, within mixed traffic sections and at the transition points to dedicated lanes.

Table 1 presents the assumed stop location (in common with all others).

TABLE 1 OPTION 1-4 STOPS[7]

	Station Locations (East to West)	
Kipling to Hurontario	1. Kipling 2. Shaver Av 3. Billingham 4. Neilson Dr 5. Wharton Way	6. Dixie Rd 7. Tomken 8. Cawthra Rd 9. Cliff Rd 10. Hurontario
Hurontario to Trafalgar	11. Confederation Pway 12. Mavis Rd 13. Erindale Station Road 14. The Credit Woodlands 15. Mississauga Rd (UTM) 16. Erin Mills Pway	17. Woodchester Dr 18. Winston Churchill Blvd 19. Ridgeway Dr 20. Ninth Line/Hwy 403 21. Eighth Line 22. Trafalgar Rd
Trafalgar to Highway 407	23. Sixth Line 24. Neyagawa Blvd 25. Third Line (Oakville Hos) 26. Postmaster Drive (east Palermo) 27. Bronte Road/Palermo 28. Tremaine Rd	29. Sutton Drive 30. Appleby Line 31. Millcroft Park Drive 32. Tim Dobbie Drive. 33. Walkers Line 34. Hwy 407

The physical location and configuration of each station will vary depending upon the specific characteristics and constraints at each location but are assumed to be located at the curb side.

The average speeds, travel times and headways for each section are provided in the following table. Note that the headways have been optimised based on ridership forecasts.

[7] Stop locations are consistent for all options and represent preliminary locations at this stage. Final number and locations subject to further detailed planning and design.

TABLE 2 OPTION 1 – AVERAGE SPEED, TRAVEL TIMES AND HEADWAYS

	Distance	Average Speed	Travel Time	2021 Headway	2031 Headway
Kipling to Hurontario *BRT Light*	9.2 km	25 kph	22 min	3 min	3 min
Hurontario to Hwy 403 *BRT Light*	10.4 km	25 kph	25 min	6 min	5 min
Hwy 403 to Trafalgar *BRT Light*	2.0 km	25 kph	5 min	10 min	7.5 min
Trafalgar to Bronte *BRT Light*	8.2 km	25 kph	20 min	15 min	12 min
Bronte to Hwy 407 *BRT Light*	7.3 km	25 kph	17 min	20 min	20 min
TOTAL ROUTE	**37.1 km**		**89 min**		

For the purposes of this assessment, it is assumed that articulated buses 18 metres in length are used and have a capacity of 90 passengers per vehicle. This is consistent with service planning guidelines elsewhere in the region and would provide a high level of service to the passengers.

This results in a total requirement of 41 BRT vehicles including spares and would provide a peak design load of 1800 passengers per hour per direction. In 2031, in line with ridership growth, the headways reduce slightly and results in a total requirement of 44 BRT vehicles including spares and would provide a peak design load of 2200 passengers per hour per direction. This is assumed to be sufficient to meet the anticipated peak hour demand along the corridor.

Option 2 – BRT to Hurontario

This option assumes the section between Kipling and Hurontario as Full BRT while the section between Hurontario and Highway 407 would be operated as BRT Light as described in Option 1.

The average speeds, travel times and headways for each section are provided in the following table.

TABLE 3 OPTION 2 – AVERAGE SPEED, TRAVEL TIMES AND HEADWAYS

	Distance	Average Speed	Travel Time	2021 Headway	2031 Headway
Kipling to Hurontario *BRT*	9.2 km	30 kph	18 min	2.5 min	2.2 min
Hurontario to Hwy 403 *BRT Light*	10.4 km	25 kph	25 min	7.5 min	6 min
Hwy 403 to Trafalgar *BRT Light*	2.0 km	25 kph	5 min	10 min	7.5 min
Trafalgar to Bronte *BRT Light*	8.2 km	25 kph	20 min	15 min	12 min
Bronte to Hwy 407 *BRT Light*	7.3 km	25 kph	17 min	20 min	20 min
TOTAL ROUTE	**37.1 km**		**85 min**		

For the purpose of this assessment, it is assumed that the BRT vehicles used under this option are the same 18-metre articulated buses as those proposed for Option 1. This results in a total requirement of 40 BRT vehicles for 2021 (including spares) and would provide a peak design load of 2200 passengers per hour per direction.

In 2031 there is a total requirement of 45 BRT vehicles including spares and would provide a peak design load of 2400 passengers per hour per direction. The one-way travel time under this option reduces travel time by approximately 4 minutes relative to Option 1.

Under the Full BRT section it is proposed that the existing road right-of-way be widened along much of the alignment such that the capacity for vehicular traffic is not affected by the addition of a median transit way. As such the cost of this option includes the construction of new curb lanes along the Full BRT length of the corridor, except on restricted right of way sections where conversion of lanes might be the case. Under this option it is anticipated that the roadway cross-section along the majority of the corridor between Kipling and Hurontario will be widened/coverted as illustrated in Figure 3.

FIGURE 5 FULL BRT CROSS-SECTION (ILLUSTRATIVE)[8]

The Full BRT section assumes the same general station locations as described for Option 1. The vehicle communications and station amenities described under Option 1 also apply to this option.

BRT operations will also be enhanced with signal priority measures at key intersections along the corridor as necessary. Specifically, intersections within sections of the alignment where BRT is proposed to operate in mixed traffic will include transit signal priorities in order to provide an advantage for transit to limit the impact of mixed traffic operations on BRT travel time and reliability.

The physical location and configuration of each station will vary depending upon the specific characteristics and constraints at each location. Within the exclusive median, BRT stations will be located on the far side of the intersections.

Option 3 – LRT to Hurontario

This option is the same as Option 2 except that the section between Kipling and Hurontario is LRT rather than BRT and integrating with the Hurontario LRT line. While the exact operational interaction between the two LRT lines needs to be defined (e.g. potentially this line could run to Square One), for the purposes of this analysis it has been assumed to terminate at Hurontario. Because this option is envisioned as an additional branch of the Hurontario LRT concept, the option would only be pursued if LRT is selected as the preferred technology for the Hurontario corridor.

The remaining sections between Hurontario and Highway 407 are the same as Options 1 and 2, including the proposed stops. Table 4 shows the characteristics of this option.

[8] Note this is presented for illustrative purposes only and cross sections to be defined in more detail as the project progresses to detailed design. Curb side running would be a potential alternative.

TABLE 4 OPTION 3 – AVERAGE SPEED, TRAVEL TIMES AND HEADWAYS

	Distance	Average Speed	Travel Time	2021 Headway	2031 Headway
Kipling to Hurontario *LRT*	9.2 km	35 kph	16 min	5 min	5 min
Hurontario to Hwy 403 *BRT Light*	10.4 km	25 kph	25 min	7 min	6 min
Hwy 403 to Trafalgar *BRT Light*	2.0 km	25 kph	5 min	10 min	7.5 min
Trafalgar to Bronte *BRT Light*	8.2 km	25 kph	20 min	15 min	12 min
Bronte to Hwy 407 *BRT Light*	7.3 km	25 kph	17 min	20 min	20 min
TOTAL ROUTE	**37.1 km**		**83 min**		

For the purpose of this assessment, it is assumed that the BRT vehicles which are operating are the same 18-metre articulated buses as those proposed for Option 1. The capacity of the 30 metre LRT vehicles proposed between Kipling to Hurontario have a capacity of 290 passengers per vehicle. This is consistent with service planning guidelines used in previous assessments commissioned by Metrolinx and would provide a high level of service to the passengers.

This results in a total requirement of 25 BRT and 10 LRT vehicles including spares for 2021 and would provide a peak design load of 3100 passengers per hour per direction. This increases to a total of 27 BRT and 10 LRT vehicles including spares in 2031 and would increase peak design load to 3300 passengers per hour per direction. The one-way travel time under this option increases relative to Option 1 by approximately 6 minutes.

Option 4 – Full BRT

This is the most 'transit intensive' option, with full BRT (as described in Option 2) assumed along the entire length of the corridor with buses operating within an exclusive right-of-way and with signal priority. The proposed stops will be the same as all other options. Table below summarizes the main operational characteristics of the option.

TABLE 5 OPTION 4 – AVERAGE SPEED, TRAVEL TIMES AND HEADWAYS

	Distance	Average Speed	Travel Time	2021 Headway	2031 Headway
Kipling to Hurontario *Full BRT*	9.2 km	30 kph	18 min	1.9 min	1.7 min
Hurontario to Hwy 403 *Full BRT*	10.4 km	30 kph	21 min	3 min	3 min
Hwy 403 to Trafalgar *Full BRT*	2.0 km	30 kph	4 min	6 min	5 min
Trafalgar to Bronte *Full BRT*	8.2 km	30 kph	16 min	8 min	7.5 min
Bronte to Hwy 407 *Full BRT*	7.3 km	30 kph	15 min	15 min	15 min
TOTAL ROUTE	**37.1 km**		**74 min**		

As per all other options it is assumed that articulated buses 18 metres in length are used and have a capacity of 90 passengers per vehicle. That operational plan results in a total requirement of 57 BRT vehicles including spares and would provide a peak design load of 2900 passengers per hour per direction.

This would increase to 63 BRT vehicles including spares in 2031 and would provide a peak design load of 3200 passengers per hour per direction. The one-way travel time under this option increases relative to Option 1 by approximately 15 minutes.

Note that for the purposes of this assessment it is assumed that existing road widening plans by Halton will be incorporated into the BRT design by using additional lane capacity between Highway 403 and Highway 407 as BRT busways.

Summary of Options

The table below summarizes the options to evaluate.

TABLE 6 SUMMARY OF OPTIONS

	Option 1	Option 2	Option 3	Option 4
Type of Technology	BRT Light	BRT Light, BRT	BRT Light, LRT	Full BRT
Opening Year	2016	2016	2016	2016
Headway (min)* in 2021	3/5/10/15/20	2.5/7.5/10/15/20	5/7/10/15/20	1.9/3/6/8/15
Headway (min)* in 2031	3/5/7.5/12/20	2.22/6/7.5/12/20	5/6/7.5/12/20	1.7/3/5/7.5/15
BRT Vehs (2021)	41	40	25	57
LRT Vehs (2021)	-	-	10	-
BRT Vehs (2031)	44	45	27	63
LRT Vehs (2031)	-	-	10	-
Travel Time (end-to-end)	89 min	85 min	83 min	74 min

NOTE: * For the following sections: Kipling to Hurontario, Hurontario to Hwy 403, Hwy 403 to Trafalgar, Trafalgar to Bronte and Bronte to Hwy 407

Part C Assessment

Evaluation Framework

The comparative analysis uses a Multiple Account Evaluation (MAE) methodology. The MAE is a framework that provides a systematic identification and analysis of broader implications and criteria of an option. It systematically compares the impacts on costs, users, environment, economy and community and shows the trade-offs among the often conflicting criteria.

The MAE framework includes a number of evaluation accounts that together address the most significant project performance and policy considerations for a specific project. The criteria and the accounts can be tailored for a project. The relevant accounts for the analysis of the Dundas Street rapid transit project are:

- Transportation User Benefits;
- Financial Impacts;
- Environmental Impacts;
- Economic Impacts; and
- Socio-Community Impacts.

It is important to note that the options defined in this report have only been developed to a level of technical detail sufficient to enable a comparative analysis for the purpose of selecting a preferred option. Project scope, costs and service plans need to be developed in more detail for funding and implementation.

The assessment is done by comparing each option to the Base Case and identifying any incremental costs or benefits that are generated by each option. Hence, the results should not be interpreted as "total" values, but as the incremental impact compared to the Base Case.

The analysis is done over a 30-year period (2009-2038). Where possible the impacts are monetized and quantified. In order to compare the options on a "like-to-like" basis and to reflect time value of money the monetized values are discounted to today's value at a real discount rate of 5%. These values, and other input variables used in this analysis are shown in Appendix A.

Transportation User Benefits

This account considers the incremental benefits to the transportation users as a result of the investment in the Dundas project. The monetized benefits are measured in travel time savings for both transit users and road users; automobile operating cost savings achieved by individuals as

their trip times or overall automobile usage declines; and reduction in accidents as a result of declining automobile usage.

In addition to the monetized benefits, there are qualitative user impacts which may include passenger comfort, accessibility and reliability. In most instances they are captured in the ridership and travel time savings, but in some instances they can be isolated and identified separately if significantly different among the options.

Travel Time Savings

Travel time savings are included for both transit and non-transit users. The improvement of transit services along Dundas St shows that the investment will generate significant time savings for existing transit users (those who currently use transit), new transit users and auto users. The value of time is estimated at an average of $13 per hour[9] and is expected to grow, in real terms, by 1.6% per year over the period.

Option 4 delivers the highest transit incremental benefits, followed by Options 2, 3 and 1 respectively. This is because the fast journey times offered by the Full BRT option deliver significant additional benefits to transit users, which in turn attracts more new users. Furthermore it also offers a direct service along the entire corridor. As a comparison Option 1 is significantly slower than Option 4 (by 15 minutes) while Options 2 and 3 are 12 and 9 minutes slower than Option 4 respectively. Option 3 travel time savings are reduced somewhat as result of the transfer required at Hurontario for east-west trips.

The present value of travel time savings for both transit and auto users over the evaluation period (2009-2038) is largest for Option 4, the Full BRT option, estimated at $386 million in present value terms and greater than the travel time savings generated by Options 1,2 and 3 which are $156 million, $172 million and $202 million respectively.

Automobile Operating Cost Savings

Automobile operating costs savings are derived from a reduction in auto kilometres as a result of the transit investment. The analysis shows that the Dundas project will result in reduced auto usage and that reduction is linked to the travel time of each option. It is estimated that the reduction in auto kilometres by 2021 ranges from 26 million vehicle kilometres for Option 1 to more than 52 million kilometres for Option 4.

Translating these savings into monetary terms, the present value of the automobile operating cost savings over the period are $197 million, $237 million, $269 million and $350 million for Options 1, 2, 3 and 4 respectively. The estimates for all options are shown in Table 7.

[9] See Appendix A for details.

Safety Benefits

The reduction in collisions is based on fewer vehicle kilometres driven. The monetary savings resulting from a reduction in collisions is calculated based on an assumed value of 7 cents per kilometre in reduced road travel (see Appendix A). The present value of safety benefits over the period ranges between $20 million for Option 1 to $36 million for Option 4. The estimates for all options are shown in Table 7.

Qualitative Transportation Benefits

The major differences between the options from a user's perspective are travel time, reliability, need for transfer and passenger comfort. Travel time and transfer requirements are largely captured in the travel time savings estimates. Therefore, from a user's perspective, the options are differentiated by the degree to which service and schedule reliability are achieved and by passenger comfort. The Full BRT lanes and LRT will enhance the reliability of options 2 and 3 (between Hurontario and Kipling) and for the entire corridor for option 4. Option 1 will provide the lowest level of reliability as a result of limited exclusivity.

All options will likely experience some variability in travel time depending on traffic congestion and cross-traffic at intersections. However in order to minimise travel times the operating assumptions must include signal priority at intersections along the corridor to achieve the forecast speeds.

Finally, an important consideration for any option is the need to maintain reliable and fast journey times and ensuring that these advantages are not 'eroded' as the project moves on to detailed design by reductions in BRT (or LRT) lanes or signal priority.

Summary

Table 7 summarizes the incremental transportation user benefits associated with the Dundas project.

TABLE 7 INCREMENTAL TRANSPORTATION USER BENEFITS

All Values in NPV $m in 2009 prices	Option 1	Option 2	Option 3	Option 4
Travel Time Savings	$156	$172	$202	$386
Automobile Cost Savings	$197	$237	$269	$350
Accident / Collision Reductions	$20	$23	$27	$36
Transportation User Benefits	**$373**	**$432**	**$499**	**$772**

Financial Account

This account includes the assessment of the direct incremental "cash" items, primarily costs and revenues from the owner's perspective, for each option over the assessment period. Costs include the incremental capital and operating costs incurred by each option compared to the Base Case. Incremental revenues may also include fare revenues, advertising, and proceeds from disposal of assets. Any savings resulting from the implementation of the options are also included in this account.

Ridership and Revenues

Annual ridership and fare revenues have been projected using the Greater Golden Horseshoe Travel Forecasting Model[10] and Figures 4 to 7 show peak hour passenger link flows by direction for the four options in 2021 and 2031.

As expected, in all options the passenger flows increase further east and closer to Kipling subway station as passengers access the subway and the TTC bus network. This is reinforced by the considerably higher eastbound flow (compared to westbound) reflecting high inbound commuting flows.

The figures show that Option 3 attracts the highest demand levels in the Kipling-Hurontario section in the eastbound direction. This is primarily because the journey times offered by Option 3 are significantly faster than the other options and provides the most convenient link to Hurontario LRT assumed under this scenario (exact operational arrangements to be confirmed). However while Option 4 (Full BRT) provides marginally lower flows in this section, for sections west of Hurontario it show the highest ridership as result of considerably faster travel times (compared to options 1 and 2) and offering a no-transfer service along the entire length of the corridor (compared to option 3).

[10] This model has been used for the development of *The Big Move* and ensures consistency with that work. The model is strategic in nature and the effect of small projects can be minimal. However the main purpose of the benefits case work is of a comparative nature and we consider the model adequate for this purpose.

Based on these ridership estimates, the analysis shows that in 2031 (from a system-wide perspective) Option 4 would generate incremental annual fare revenues of around $5.4m versus $2.7m, $1.7m and $3.1 for Options 1, 2 and 3 respectively. In net present value terms over the period of the analysis, incremental revenues are $10.9 million, $11.3 million, $28.8 million and $46.9 million for Options 1, 2, 3 and 4 respectively.

FIGURE 6 RIDERSHIP – 2021 EASTBOUND (AM PEAK HOUR)

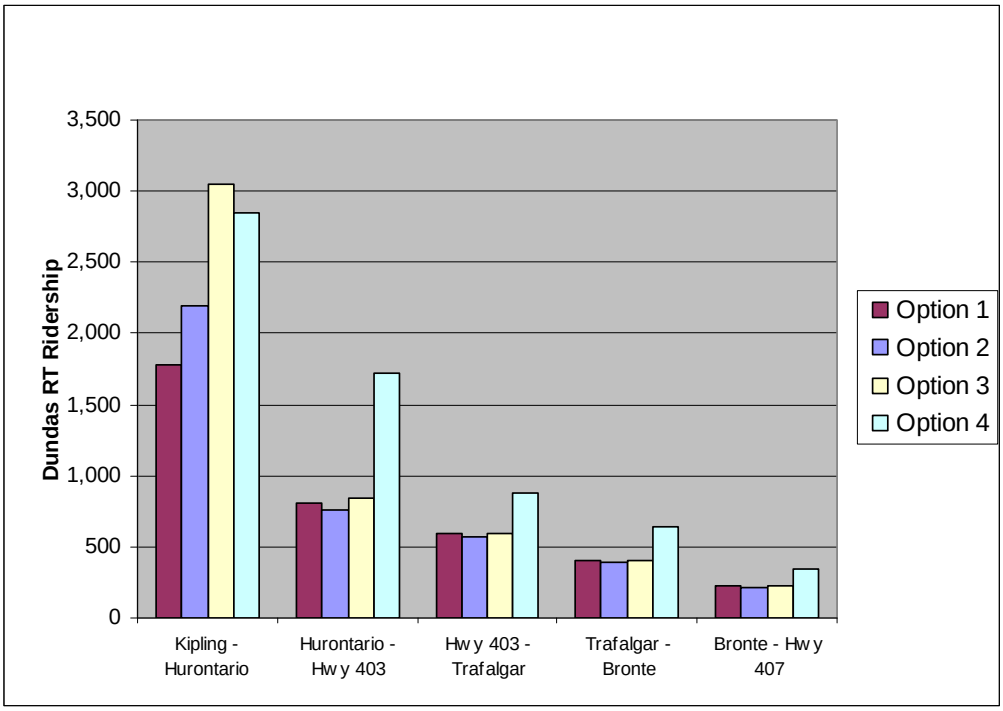


FIGURE 7 RIDERSHIP – 2031 EASTBOUND (AM PEAK HOUR)

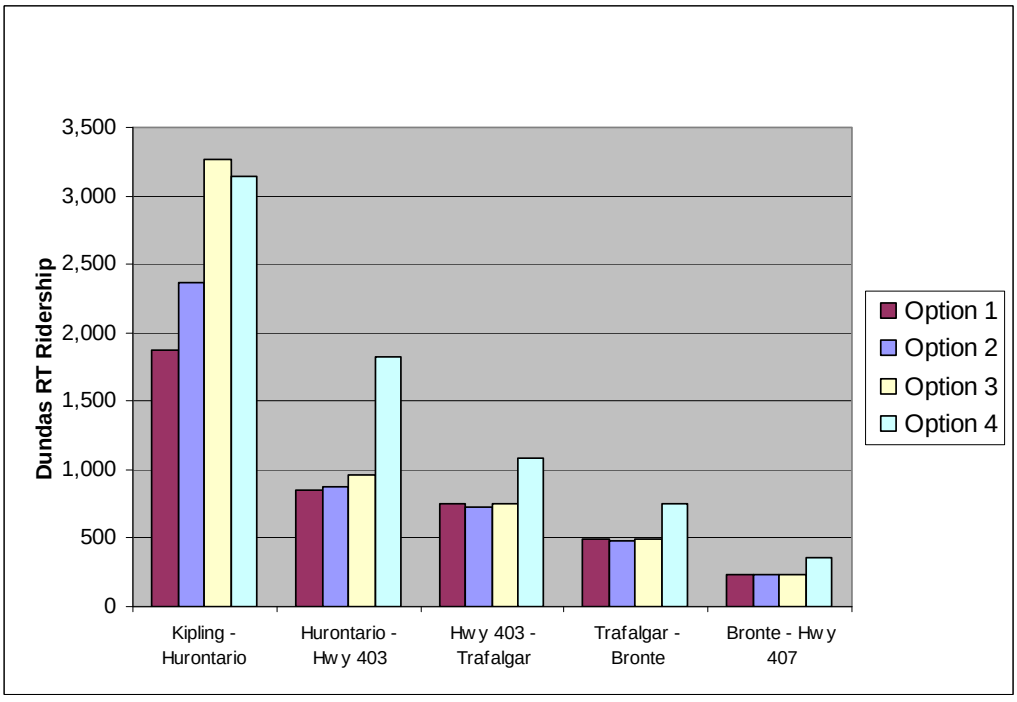


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FIGURE 8 RIDERSHIP – 2021 WESTBOUND (AM PEAK HOUR)

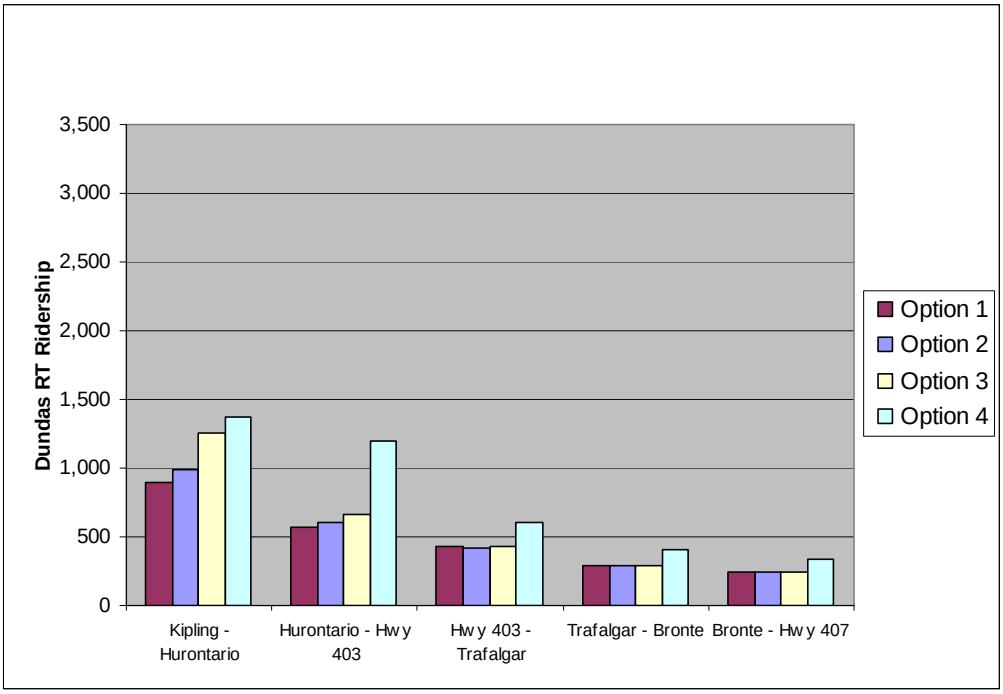
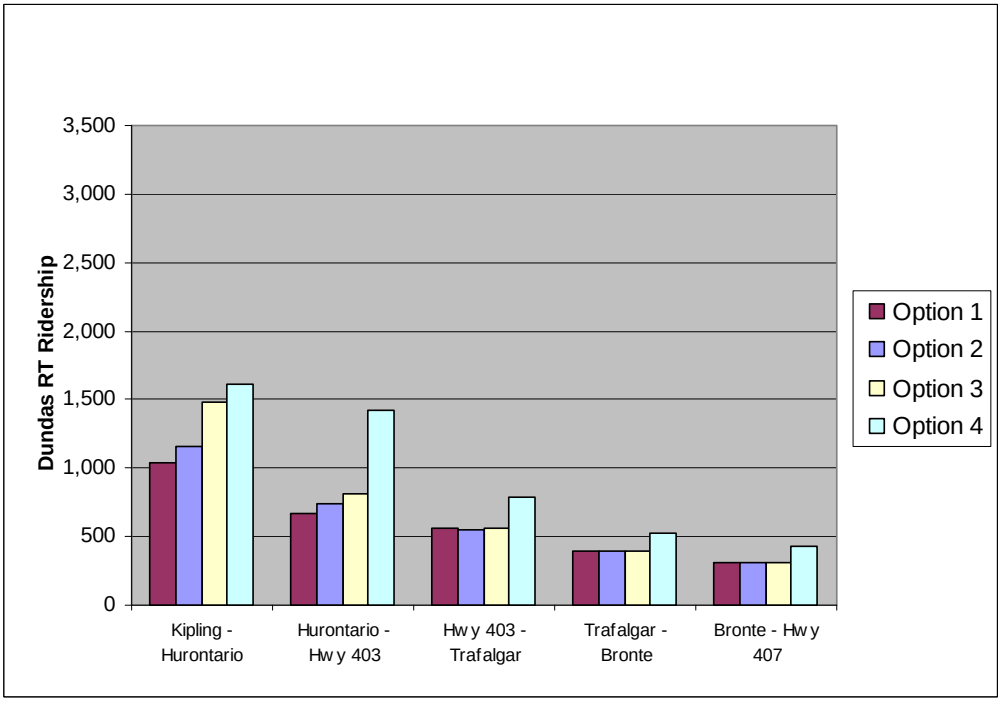


FIGURE 9 RIDERSHIP – 2031 WESTBOUND (AM PEAK HOUR)



Capital and Operating Costs

The capital costs include all costs associated with the construction and acquisition of the infrastructure, revenue collection, vehicles, and maintenance centre. The estimates also include design, management & administration, insurance, environmental permitting, property, and contingencies. An important consideration for this project is that the costs required for the Full BRT lanes between Highway 403 and 407 are relatively minor as these additional lanes have already been built (or have committed funding) as part of Halton's widening proposals for Dundas Street.

The construction period is assumed to be the same for all four options with start in 2012 and completion by 2015 for opening of service in 2016. Predictably, Option 3 has the highest capital cost of the four options with an estimated cost of $649 million in 2009 prices due to the LRT section. Option 4 is estimated to cost $505 million while the capital cost for Options 1 and 2 are $225 million and $291 million respectively (all costs excluding interest during construction).

For all options the vehicle costs have been distributed evenly over the years 2014-2015. It is assumed that all buses are to be replaced in all options in the period 2027-28 reflecting a 12 year bus lifecycle and property costs estimated based on right of way requirements and a generic property cost of $2.5m per hectare.

Bus maintenance costs are based on a $0.6m/bus unit rate provided by Mississauga Transit. Option 3 LRT maintenance costs are based on a unit rate per LRT vehicle ($2.7m/vehicle) as assumed that Option 3 would use expanded LRT facilities to be developed as part of the Hurontario LRT and would not incur the cost of developing a separate facility.

Table 8 shows the capital costs and operating costs for each option. All values are expressed in 2009 dollars.

TABLE 8 CAPITAL AND OPERATING COSTS ($ MILLION)

All Values in 2009 $m	Option 1	Option 2	Option 3	Option 4
Capital Costs	$225	$291	$648	$505
Bus operating cost savings (2021)	($0.91)	($0.91)	($0.91)	($0.91)
Rapid transit operating costs (2021)	$7.31	$6.58	$7.96	$9.99
Annual incremental operating costs (2021)	$6.40	$5.67	$7.05	$9.08

The incremental operating costs assume the operating patterns identified previously, including removal of express services 101 and 201 resulting in operational cost savings. The LRT operating costs are based on TTC operating estimates and are applied in other benefits cases while bus

costs are derived from Mississauga Transit ($110/hour for standard buses and $152/hour for BRT which includes all operating and maintenance costs).

This report does not deal with the specific issues and implications of the funding, implementation, operation and procurement of the project. Those are currently under review by Metrolinx with specific roles and responsibilities to be determined.

Summary

Table 9 shows the capital costs, operating costs and incremental fare revenues expressed in present value for the period 2009-2038.

TABLE 9 INCREMENTAL COSTS AND REVENUES

All Values in NPV $m	Option 1	Option 2	Option 3	Option 4
Capital Costs	154	208	478	369
Operating Costs	67	65	76	97
Total Incremental Costs	222	273	554	466
Incremental Fare Revenues	10.9	11.3	28.8	46.9

Comparing Benefits and Costs

Table 10 compares the results from the Transportation User Benefits and Financial accounts. As illustrated in the table all options apart from Option 3 generate benefits greater than costs and therefore result in benefit cost-ratios of more than 1. Option 3 is the highest cost option (as result of the relatively high LRT capital costs) and it generates the lowest benefit-cost ratio of 0.9. The BRT Light (option 1) is the least expensive option and generates a benefit cost-ratio of 1.7 demonstrating the project provides value for money. Options 2 and 4 generate similar benefit to cost ratios of 1.6 and 1.7 which are slightly higher than the corresponding value for Option 1.

TABLE 10 COMPARISON BENEFITS AND COSTS

All Values in NPV $m	Option 1	Option 2	Option 3	Option 4
Transportation User Benefits	373	432	499	772
Incremental Costs	222	273	554	466
Net Benefit (Cost)	151	159	(56)	306
Benefit-Cost Ratio	**1.7**	**1.6**	**0.9**	**1.7**

Environmental Impacts

This account examines the environmental impacts of the Dundas Rapid Transit options. The major environmental impact with respect to urban transit projects is the ability of the project to reduce greenhouse gas emissions from reduced automobile usage.

Greenhouse Gas Emissions

As mentioned in the Transportation User Benefits section, all four options lead to an annual decline in automobile usage. By 2021, it is estimated that the number of kilometres travelled by automobile will decline by over 26 million kilometres annually under Option 1. The annual reduction anticipated under Options 2, 3 and 4 are approximately 27 million, 36 million and 52 million kilometres respectively in 2021.

As shown in Table 11, this translates into an annual reduction of CO_2 emissions ranging through 5.3 tonnes for Option 1, 5.4 tonnes for option 2, 7.2 tonnes for Option 3 and 10.4 tonnes for Option 4. By the year 2031 these annual reductions are 6.3 tonnes for Option 1, 9.2 tonnes for Option 2, 8.6 tonnes for Option 3 and 8.9 tonnes for option 4.

The present value of the reduction in CO_2 emissions over the period 2009-2038, based on an average value of $0.01 per kilometre (see Appendix A), is estimated at $2.8 million for Option 1, $4.2 million for Option 2, $3.9 million for Option 3 and $6.6 million for Option 4. The value of a tonne of CO_2 is currently a subject of debate. These figures, regardless of the value assigned per tonne of CO_2, are still very useful for comparison purposes among the options.

TABLE 11 REDUCTION IN CO_2 EMISSIONS

	Option 1	Option 2	Option 3	Option 4
2021 Reduction in CO_2 tonnes	5.3	5.4	7.2	10.4
2031 Reduction in CO_2 tonnes	6.3	9.2	8.6	8.9
NPV Value ($ m)	2.8	3.3	3.9	5.2

Economic Development Impacts

This account measures the economic impacts for each scenario relative to the Base Case, including impacts from construction and economic impacts incurred from implementation of project options. These impacts are reported in terms of GDP. The change in jobs and the change in the associated labour income are stated in 2009 dollars. Results reflect how the implementation of the Dundas Rapid Transit Project will directly affect both households and businesses in the regional economy, and total provincial economic impacts that are derived by applying Ontario specific multipliers to derive indirect affect of employment, wages and GDP

generated by the direct impacts of construction and improvements to the transportation network.

This account also includes an assessment of the incremental impacts the options will have on land values and development in the corridor.

Temporary Economic Impacts During Construction

The implementation of the various options will generate both direct and indirect economic benefits that are temporary in nature and span the schedule of construction. As shown in Table 12, the construction is estimated to create between 588 and 2,749 person-years of employment and between 326 and 1,522 person-years of employment indirectly as a result of increased economic activity for suppliers. The impact on employment, wages and GDP is driven by the capital cost required to build each option. Option 3, which has the highest capital cost of the four options, also has the largest employment and income impacts.

TABLE 12 EMPLOYMENT AND INCOME IMPACTS DURING CONSTRUCTION

Option	Direct Impacts			Regional (Indirect) Impacts		
	Employment (person years)	Wages ($m)	GDP ($m)	Employment (person years)	Wages ($m)	GDP ($m)
Option 1	588	22.9	51	326	12.7	28
Option 2	1166	45.5	101	646	25.2	56
Option 3	2749	107.2	239	1522	59.3	132
Option 4	2459	95.8	214	1360	53.0	118

Long-term Economic Impacts

In the long-term there will be ongoing economic benefits as a result of the Dundas Rapid Transit Project. These benefits reflect both households' freed up vehicle operating expenditures and transportation cost savings to area businesses. The former effect is simply a redirected consumption demand by households away from purchases of gas, parking, automotive parts and services and into other consumer goods/services.

The latter reflects improved regional competitiveness for local businesses that now have lower costs of doing business, including access to a larger labour market and encountering less congestion on roadways because people are choosing to use the transit system instead of driving. The impact of the project will be different for each business.

Implementation of the Dundas Rapid Transit project will also generate social benefits that can be monetized, including valuing time savings and emission benefits. These have already been captured above under transportation user benefits.

As shown in Table 13, the Dundas Rapid Transit project is also expected to have an on-going and positive impact on jobs, wages and the GDP once it is in operation. The impacts for each option are driven by transit and auto travel time savings provided by each option. Option 4 has the greatest employment and income impact with an estimated 103 direct jobs and 41 indirect jobs created in 2031. The long term economic impacts of Option 1 are limited.

TABLE 13 EMPLOYMENT AND INCOME IMPACTS

Scenario	Direct Annual Impacts			Indirect Annual Impacts		
	Employm. (Jobs)	Wages ($m)	GDP ($m)	Employm. (Jobs)	Wages ($m)	GDP ($m)
2031						
Option 1	30	1.2	2.6	12	0.5	1.0
Option 2	72	2.8	6.8	28	1.1	1.9
Option 3	40	1.6	3.5	15	0.6	1.3
Option 4	103	4.0	8.9	41	1.6	3.6

Land Value Changes

There is evidence from a number of different jurisdictions around the world that investment in rapid transit can have a positive impact on property values in the general area of a new rapid transit line and particularly within close proximity to station areas. This evidence also suggests that the specific rapid transit technology is also a determining factor in the degree to which property values may be influenced. For example, a more permanent, rail-based, higher capacity technology such as LRT will typically capture a larger area of property within their area of influence than lower capacity bus-based transit facilities. As shown in Table 14 , the catchment area around at-grade LRT is typically 500 metres as compared to the slightly smaller catchment area around a BRT station estimated to be 400 metres.

As indicated in the table, the introduction of rapid transit will provide a modest lift in percentage terms to land values within the applicable area of station impact. Based upon the ranges shown, BRT has up to 2% property uplift for residential and commercial respectively while LRT 4% for both residential and commercial, in addition to the greater impact area as mentioned above.

Table 14 presents the estimated value uplift factors based on ranges of value uplift found in a number of research studies reviewed. The table shows the catchment area around a BRT station is estimated at 400 metres (compared to the slightly larger catchment area around a LRT station estimated at 500 metres) and this is consistent with value uplift assumptions applied for other rapid transit benefit cases undertaken in the region.

TABLE 14 PROPERTY VALUE UPLIFT FACTORS

Technology		**BRT**	**LRT**
Station Impact Area		**400m**	**500m**
Residential	Low	1%	2%
	High	2%	4%
Commercial	Low	2%	2%
	High	2%	4%

Based on the ranges of value uplift found in research studies reviewed for this analysis, land uses along the proposed Dundas rapid transit route and the current property value data obtained from the cities of Toronto, Mississauga and Burlington and the town of Oakvillle, the potential land/property value uplift is estimated for the four implementation options currently under consideration by multiplying the percentage of value uplift typical for each land use by the total assessment of lands within station areas in each land use category. The following summarizes the assessment for each of the options.

Option 1 – BRT Light

This options consists primarily of a BRT Light service, effectively operating in mixed traffic and therefore not perceived to impact land values significantly. Within the land area impacted by Option 1, the average uplift is between 0.1% and 0.2%. It is estimated that the potential average uplift in assessment value as a result of this Option could result in approximately $47 million to $96 million.

Option 2 – Full BRT to Hurontario

The alignment for this option is the same as Option 1 but with Full BERT operating between Kipling and Hurontario providing travel time and reliability benefits compared to Option 1. This results in a higher average uplift compared to Option 1 of between 0.7% and 1.5%, which translates into potential average uplift in assessment between $291 and $609 million.

Option 3 – LRT to Hurontario

This option assumes LRT between Kipling and Hurontario, the busiest and most development section of the route, with the rest of the route as BRT Light. This results in a higher average uplift compared to Option 2 of between 0.9% and 1.8% and potential average uplift in assessment between $422 and $837 million. The increase in estimated land value uplift is as a result of the larger impact of LRT (500 versus 400 metres) and the larger uplift factors assumed (see Table 14).

Option 4 – Full BRT

The Full BRT under Option 4 results in fastest corridor times and uplift is expected at all stations resulting in higher land value uplift as compared to options 1, 2 and 3. This results in average uplift of between 1.0% and 2.0% and potential average uplift in assessment between $472 and $989 million.

Summary

Table 15 summarizes the economic development impacts including direct and indirect impacts along with the land value uplift for each option.

TABLE 15 ECONOMIC DEVELOPMENT IMPACTS

	Option 1	Option 2	Option 3	Option 4
Total Impacts During Construction Period:				
Employment (Person-years)	914	1812	4271	3819
GDP ($m)	79.4	157.6	471.4	332.1
Income ($m)	35.6	70.6	166.4	148.8
Impacts in 2031:				
Employment (jobs)	42	100	55	144
GDP ($m)	3.6	8.7	4.8	12.5
Income ($m)	1.6	3.9	2.2	5.6
Land Value Increase				
Low Estimate ($m)	47	292	422	472
High Estimate($m)	99	610	837	989

Social Community Impacts

This account examines each option from the community perspective with specific consideration given to the ability of each option to enhance the quality of life within a local community. This may result from land use changes or developments that can occur in response to the introduction of a new rapid transit line, as well as the improvements brought about by the enhanced accessibility, both locally and regionally, offered by the new transit alternative. This account also considers the ability of each option to positively affect the overall health of the local community and its residents through reduced auto congestion on local streets as well as the ability of transit to support a more balanced lifestyle for local residents along with enhanced personal safety.

Land Use Shaping

Experience in other jurisdictions demonstrates that the combination of complementary local planning initiatives and the implementation of rapid transit can positively support and influence development, particularly around rapid transit stations, promoting more compact and mixed use communities.

The western section of the corridor is changing from a rural area mostly serviced by cars to a more urban and developed environment. However it is important to reinforce that it is not only the investment in rapid transit that will support transit oriented development and prevent urban

sprawl, it is the proposed zoning, corridor development frontage and urban design that also need to be considered in the context of the corridor. Therefore the municipalities along the corridor who can influence land use and transit planning need to work in partnership to support intensification of communities while reducing the dependence on the automobile. This is reinforced by the 'Places to Grow' plan which has identified two Urban Growth Centres in Mississauga and Etobicoke.

Although rapid bus transit generally has a lower impact on land values than other types of transit technologies, in combination with land planning policies and the permanence of Full BRT alignments, BRT can support and accelerate the development of more compact and complete communities in the two Urban Growth Centres and along the corridor.

For the purpose of this analysis, it is assumed that, consistent with the land value uplift estimates presented earlier in this report, all four transit options are capable of promoting land use changes to support the local planning initiatives and changes to the local zoning. However the investment associated with the more permanent Full BRT infrastructure is likely to result in the redevelopment of the corridor and therefore achieve the region's objective to develop more dense and less car-dependent urban environments.

Road Network

A number of road widening and intersection improvements will be required to accommodate the BRT lanes for options 2 and 4 and LRT for option 3. The introduction of rapid transit lanes will provide the corridor with the opportunity to create streetscapes which reduce the influence of the car e.g. banning left turns, reducing road widths, improving walking and cycling environments, etc. A further advantage of BRT lanes is that they create pedestrian refuges in the median improving the ability of pedestrians to cross the road, particularly for seniors. These improvements will be greatest for Option 4.

As proposed, the new rapid transit line will impact the local road network in two significant ways. Firstly, based on the average transit speeds proposed for the corridor a significant level of signal priority will be required to support the transit operation. Secondly, depending on the extent of signal priority required, there is the potential to negatively impact traffic at intersections where there are likely to be longer delays while priority is given to rapid transit. As Option 4 requires the highest level of segregation along the entire length of the corridor it will be the most affected. A final issue is the challenging nature of the corridor between Kipling to Highway 427 where there is a limited right of way and extensive development (and consequently access issues) combined with an extended number of TTC and Mississauga Transit buses. This issue affects Options 2, 3 and 4 but arguably the effect will be greatest for Option 3 (LRT) as the other two options, if necessary, could run mixed with traffic in pre-determined locations.

Construction

All four options will involve a certain degree of disruption to traffic, neighbouring commercial, retail and residential properties during construction, particularly between Kipling to Highway 407. While the specific construction impacts associated with the implementation of each option cannot be determined until the project is defined in more detail, it is assumed that Option 4 (Full BRT) will be the most disruptive as it requires the longest length of segregated lanes. Options 2 and 3 would be the next option in terms of construction impacts while Option 1 would have the least construction impacts.

Sensitivity Analysis

Discount Rate

Since the analysis is based on discounted cash flow and subject to changes as the discount rate changes, the robustness of the ranking of the options with respect to the benefit-cost ratio was tested under two alternative discount rates – 3% and 7%. As shown in Table 16, under all discount rate tests Option 4 shows the highest NPV while Options 1 and 4 show the highest BCR. The 3% test shows all options returning positive NPV and BCR whilst for the 7% test Options 1, 2 and 4 still produce a positive BCR and NPV.

TABLE 16 DISCOUNT RATE SENSITIVITY ANALYSIS

Discount Rate	3%		5%		7%	
Option	**NPV $m**	**BCR**	**NPV $m**	**BCR**	**NPV $m**	**BCR**
Option 1	269	2.0	373	1.7	78	1.4
Option 2	299	1.9	432	1.6	72	1.3
Option 3	61	1.1	(56)	0.9	(124)	0.7
Option 4	531	2.0	306	1.7	162	1.4

Summary of Results

The analysis of the Dundas BRT and LRT options reveals that the lowest cost option (Option 1, the BRT Light), with estimated capital and operating costs of $222 million in net present value terms, generates $373 million in benefits and has the highest benefit-cost ratio of 1.7:1. By comparison, Option 2 has estimated capital and operating costs of $273m with an estimated $432 million in Transportation User Benefits. This results in a BCR of 1.6. Option 4 has estimated capital and operating costs of $466m with an estimated $772 million in Transportation User Benefits. This

results in a BCR of 1.7 for Option 4. Option 3 has the highest estimated capital and operating costs of $554m but with an estimated $499 million in Transportation User Benefits results in a BCR of 0.9.

Option 4 has the highest travel time savings due to the faster journey times offered by the exclusive Full BRT lanes along the entire length of the route, highlighting the importance of the operating speed of the rapid transit system to the success of the project. Options 1, 2 and 3 all generate significantly fewer travel time savings than Option 4. However, Options 1 and 2 have a higher BCR than Option 4 due to their much lower capital and operating costs.

An important cost consideration for this project is that the costs required for the Full BRT lanes between Highway 403 and 407 are relatively minor, as these additional lanes have already been built (or have committed funding) as part of Halton's widening proposals for Dundas Street, therefore improving the economic assessment of the project.

All of the options result in attracting people out of their cars and reducing automobile usage. Option 4, which has the largest effect, will result in a reduction of greenhouse gas emissions by approximately 10.4 tonnes annually by 2021. In net present value terms, this equates to $5.2 million for Option 4 compared to $2.8 million, $3.3 million and $3.9 million for Options 1,2 and 3 respectively.

As expected the options with the highest capital costs generated the most significant economic development effects. Option 3, which has the highest capital cost will have the largest impact on employment, income and GDP during construction and is estimated to generate approximately 4,300 person-years of employment including direct and indirect impacts. By contrast, the lowest cost option (Option 1) produces the lowest overall economic development and employment benefits during construction as well as during the on-going operations with 900 person years.

There is a wide range in how the various options support the GTHA land use and economic development objectives to revitalize the corridor by enhancing and supporting complementary planning and densification initiatives. Option 1 provides very small benefits as a result of the lack of travel time and reliability benefits from the project resulting in less than $100 million under the high property value uplift estimate. Option 3 (LRT between Kipling and Hurontario) and Option 4 (Full BRT along the entire length of the corridor) on the other hand provide $422 million in property value uplift at the lower end of the scale and almost $1 billion in the higher end of the scale.

Overall, the results for Options 1, 2 and 4 indicate that an investment in rapid transit in the corridor will generate economic benefits and prove value for money and support the municipalities' (Toronto, Mississauga, Burlington and Oakville) objectives to revitalize, redevelop and reshape this corridor. Option 4 also provides the highest NPV, largest GHG emission reductions, highest economic development effects and land value uplift compared to Options 1, 2

and 3. The high costs for Option 3 show that the higher cost of LRT makes the case marginal and further optimisation might be required to improve its performance.

Table 17 below summarizes the results from the MAE.

TABLE 17 MAE SUMMARY

Impact	Option 1	Option 2	Option 3	Option 4
Transportation User Account				
Transportation User Benefits (PV $m)	$373	$432	$499	**$772**
Qualitative User Benefits	✓	✓✓	✓✓	✓✓✓
Financial Account				
Costs (PV $m)	$222	$273	$554	$466
Benefits Less Costs (PV $m)	$151	$159	($56)	$306
Benefit-Cost Ratio	1.7	1.6	0.9	1.7
Environmental Account				
GHG Emissions (PV $m)	2.8	3.3	3.9	5.2
Economic Development Account				
Economic Impacts During Construction				
Employment (person-years)	914	1812	4271	3819
GDP ($m)	79.4	157.6	471.4	332.1
Income ($m)	35.6	70.6	166.4	148.8
Long-term Economic Impacts (2031)				
Employment (jobs)	42	100	55	144
GDP ($m)	3.6	8.7	4.8	12.5
Income ($m)	1.6	3.9	2.2	5.6
Development Potential ($m)	47-99	292-610	422-837	472-989
Social Community Account				
Land Use Shaping	✓	✓✓	✓✓	✓✓✓
Road Network	✓✓✓	✓✓	✓	✓
Construction Impact	✓✓✓	✓✓	✓✓	✓

APPENDIX

A

INPUT VARIABLES AND ASSUMPTIONS

Factor	Value	Source
Discount Rate Sensitivity Analysis	5% (real terms) 3% and 7%	Province of Ontario
Value of Time Business Other Weighted Average	 $35.16 (2008$) $10.82 $13.02	Transport Canada, Greater Golden Horseshoe Model
Value of Time Growth	1.6% per annum	Based on GDP per capita increases, GDP/ Population estimates from www.greatertoronto.org
Average Accident Cost	$0.07 per km	Collision Statistics: 2004 Canadian Motor Vehicle Traffic Collision Statistics, TP3322. Vehicle Kilometers: Statistics Canada, Catalogue No. 53–223–XIE, "Canadian Vehicle Survey"
Greenhouse Gas Emissions 2006 2021 2031	 2.39 kg /l or 0.23 kg per km 2.35 kg /l or 0.21 kg per km 2.35 kg /l or 0.20 kg per km	Urban Transportation Emissions Calculator, Transport Canada, Greater Golden Horseshoe Model
Average Cost of CO_2	$0.01 per km $40/tonne (median cost)	Several literature sources, Transport and Environment Canada, Greater Golden Horseshoe Model and http://envirovaluation.org/index.php/2007/09/06/university_of_hamburg_forschungsstelle_n_1
Auto Operating Costs	In 2008$ + 2.0% p.a. increase 2007 - $0.50/km 2021 - $0.65/km 2031 - $0.79/km	Data in 2007 based on CAA calculation of average driving costs and includes operating and ownership costs (long-term costs). Increase based on Greater Golden Horseshoe Model
Annualisation Factors: Metro / LRT Road	Peak-daily/Daily-Annual 3 / 300 10 / 300	Greater Golden Horseshoe Model