Preliminary Design Business Case

Brampton LRT Extension Study

City of Brampton

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Executive Summary

Introduction

Extending the planned Hurontario LRT from the Brampton Gateway Terminal at Steeles Avenue to the Brampton GO station is a key transit priority and city-building project for the City of Brampton. The LRT extension will play an important role in the long-term rapid transit network in Brampton and is essential for supporting the sustainable growth and evolution of the Downtown Core and Central Area.

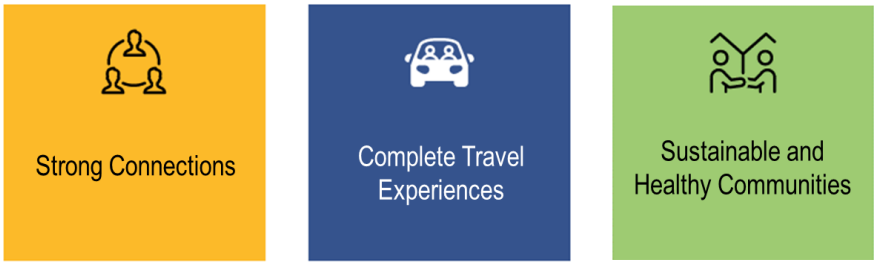
The Brampton LRT Extension study is intended to address the growth-related transportation needs specifically in Brampton by extending the Hurontario LRT along Brampton's Main Street from the Brampton Gateway Terminal to the Brampton GO Station. In addition, the extension is envisioned as a transformational city-building project helping to achieve broader objectives of the 2041 RTP of building economically strong, well connected, and sustainable communities.

Vision and Goals

The LRT extension will contribute to a safer and more integrated transportation system to serve the City of Brampton, encouraging civic sustainability, emphasizing transit use and other modes of transportation over traditional automobiles, and supporting the revitalization of Downtown Brampton into an aesthetically beautiful, place-making destination. The vision for the LRT extension reflects the transportation vision and actions set out in the Brampton 2040 Vision (2018).

The study has three main goals as follows:

- Create Strong Connections
- Build Complete Travel Experiences
- Support Sustainable and Healthy Communities.



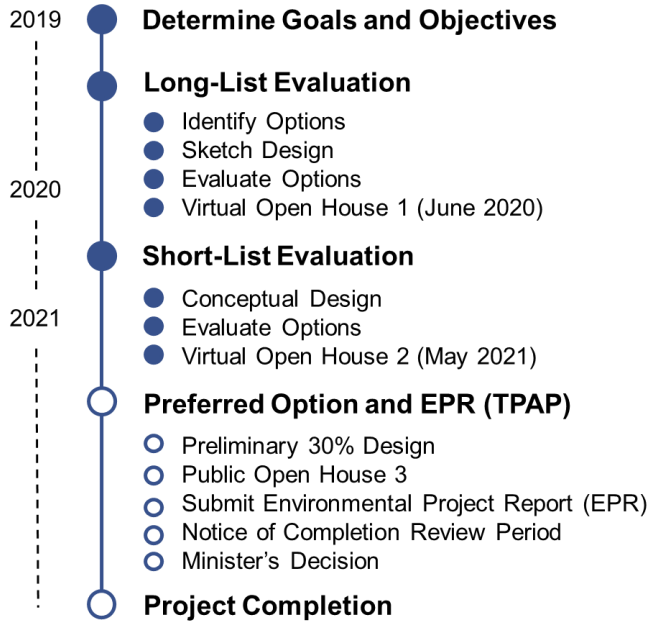
Project Background

In 2008, the publication of Metrolinx' "Big Move" 2041 Regional Transportation Plan (RTP) identified a strategic need for a rapid transit system along the corridor between downtown Brampton and Port Credit (the Hurontario corridor) due to forecasted significant population and employment growth. In 2018, the 2041 RTP was updated and reaffirmed the recommendation to extend the Hurontario LRT north from Steeles Avenue to Brampton GO.

Since the publication of the Big Move 2041 RTP and its latest update, the Hurontario-Main corridor has been a subject of studies that demonstrated the case for rapid transit, including Hurontario Main Street Corridor Master Plan (October 2010) and the Hurontario-Main LRT Environmental Project Report (June 2014). The Hurontario LRT Benefits Case Analysis (March 2016) presented a strong business case for this infrastructure, although with a reduced scope from Port Credit GO station in Mississauga through downtown Mississauga to Brampton's Gateway Terminal. This project was approved by the provincial government, and the construction began in early 2020.

Study Process

The evaluation of options is a multi-level process that has occurred over the course of the study. The Preliminary Design Business Case (PDBC) constitutes the final step in the evaluation of options before the initiation of the Transportation Project Assessment Process (TPAP). The flow chart below illustrates the study process.



Through this process, the long list of LRT options was evaluated and narrowed down to a short list. The short list was evaluated and has been presented at Virtual Open House 2 from April 22 through May 2021. Once a preferred LRT option is selected, the TPAP can be initiated and the Environmental Project Report developed.

Business Case Approach Overview

Business Case analyses are required by Metrolinx for all capital projects slated to obtain financial contributions from higher levels of government. They are completed to define the rationale and requirements for delivering the investment and forecast its performance in relation to the determined goals. This Preliminary Design Business Case (PDBC) will identify the best performing alternative for the extension of the Hurontario LRT. The approach is based on Metrolinx' Business Case framework that comprises four cases and introductory/background chapters as follows:

- **Problem Statement:** defines the need for the project and the case for change. It spells out the project justification and provides directions for the evaluation of investment options considered within the business case by specifying its strategic objectives. The project background dates back to 2008 when the Metrolinx' "Big Move" 2041 Regional Transportation Plan (RTP) identified a strategic need for a rapid transit system along the Hurontario Street between downtown Brampton and Port Credit (the Hurontario Corridor) to address the forecasted significant population and employment growth in the region. The LRT project would also support the "city building" objectives and support sustainable growth and offer competitive transportation service.

- **Investment Options:** introduces the investment alternatives to be evaluated and compared through the four cases that constitute the Business Case. The chapter briefly discusses how the options were developed and outlines the assumptions used in the travel demand and performance modeling. The short list of options evaluated in this business case includes four surface options and two options with underground segments. The options differ principally with respect to the LRT use of the road space along its route (LRT operations on dedicated lanes versus LRT operations on lanes shared with other traffic, and LRT operations underground) and some differences in alignment and station locations.

- **Strategic Case:** addresses how the project (with its investment options) will achieve strategic transportation objectives. The strategic objectives were defined around the strategic goals of the 2041 RTP – (A) Strong Connections, (B) Complete Travel Experiences, and (C) Sustainable and Healthy Communities – and represent the desired outcomes associated with each goal. The objectives center around improving access to transit and its performance, promoting a more sustainable transportation system, and supporting city-building objectives. The Strategic Case presents the performance of the short-listed options against the identified strategic objectives where the performance is measured with a set metrics that include quantitative and qualitative measures, as indicated in the following graphic.

Strategic Case Criteria:

Strong Connections

- Improve access to transit
- Increase access to economic opportunities
- Support city-building objectives

Complete Travel Experiences

- Improve travel time and level of service
- Improve comfort and safety
- Building an integrated transportation network

Sustainable and Healthy Communities

- Move people with less energy and pollution
- Improve quality of life and public health
- Reduce impacts to the natural and cultural environment

- **Economic Case:** evaluates the life-time economic costs, benefits and impacts of the proposed investment project to establish its economic benefits to society, net benefits, and the benefit-cost ratio. Project benefits and impacts were monetized to the greatest extent possible and compared with costs in a structured benefit-cost analysis framework, capturing the following:

Economic Case Criteria:

User Benefits

- Travel Time Savings
- Reliability Benefits
- Journey Quality Benefits
- Travel Time Impacts to Vehicles
- Vehicle Operating Cost Savings

External Benefits

- Decongestion Benefits
- Reduction in Road Accidents
- Reduction in Vehicle Emissions
- Health Benefits

Costs

- Capital Construction Costs
- Major Maintenance, Rehabilitation and Renewal Costs
- Annual Operations and Maintenance Costs

- **Financial Case:** establishes the costs to deliver the project, provides an overview of life-cycle costs and revenues related to the project and its overall financial performance. Costs taken into account include capital construction costs, financial costs, capital renewal costs, and incremental annual LRT operating costs. These are compared against expected incremental fare revenues due to new transit users to determine the overall fiscal impact of the project and operating ratios.

Financial Case Criteria:

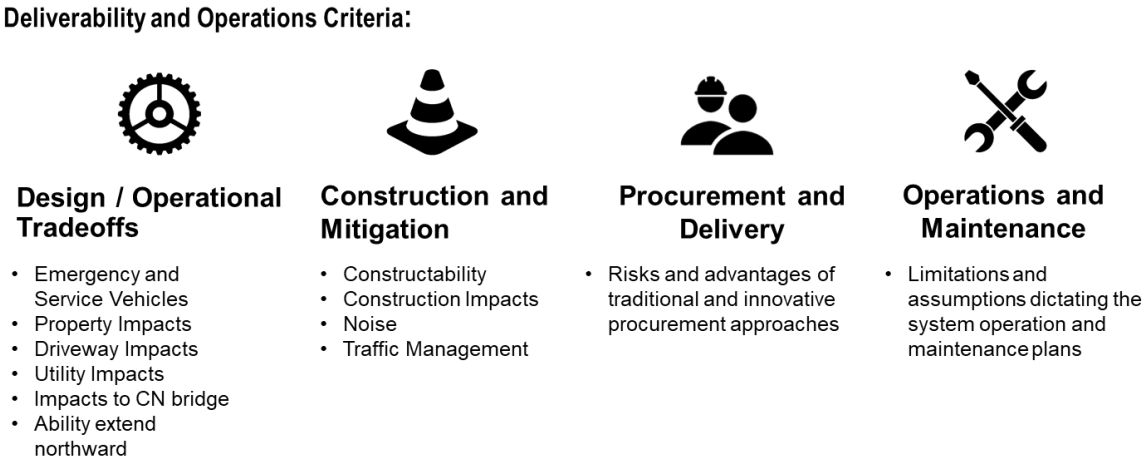
Costs

- Capital Construction Costs
- Financing Costs
- Major Maintenance and Renewal Costs
- Incremental Operations and Maintenance Costs

Revenues

- Additional LRT Revenues
- Additional GO Revenues

- **Deliverability and Operations Case:** provides a discussion on the feasibility and constructability of the project alternatives and considers risks. The discussion identifies known issues and constraints around each option that may facilitate or hinder project implementation and progress.



The framework is based on common business case concepts and principles including objective, evidence-based and transparent approach, consideration of comprehensive life-time benefits, costs, and impacts compared to a Business as Usual (BAU) or a no-build scenario, and using industry accepted guidance and assumptions for key parameter values such as the of travel time savings or discount rates. In Metrolinx' approach, business case analysis may be conducted multiple times as the project progresses through its development process, updated when new project-relevant data and information emerge.

As a PDBC, this business case conducts the analysis for a set of identified short-listed of options that incorporate certain design elements with potential impacts on their performance (conceptual design stage).

Problem Statement and Case for Change

Brampton's population is forecasted to increase by nearly 200,000 between 2016 and 2031 (or by 31.4 percent), and employment is forecasted to increase by nearly 82,000 (or by 40.3 percent). In the study corridor, population is expected to increase by over 20,000 (or 34.6 percent) and employment is expected to increase by over 8,000 (or 46 percent) [1].

The growth is expected to continue past 2031, although at a slower rate. Between 2031 and 2041, Brampton's population is expected to increase by 9.6 percent while employment is expected to increase by 14 percent. For the study corridor, the forecasted rates of growth are 12 percent for population and 17 percent for employment. If growing transportation needs are not adequately addressed, the significant increase in population and employment will exacerbate congestion, lengthen travel time and impact the quality of life for City of Brampton residents and commuters.

[1] Future population and employment forecasts provided by the City of Brampton (September 2019)

High capacity rapid transit offers an opportunity to address these needs by providing an attractive travel option with competitive journey times, reliability, and connections to other modes. The Hurontario-Main corridor is currently serviced by four bus services which operate during weekday peaks, off-peak periods and weekends, and provide connections to Brampton GO and other parts of the city. Based on the forecasted ridership, it is estimated that at the minimum by 2031 transit frequencies in Mississauga and Brampton will have to increase by 15 percent, and frequencies of corridor routes will have to increase by 40 percent. Given increasing congestion, it is also estimated that average journey times would increase by 5 percent across all routes[2].Therefore, introduction of rapid transit in the corridor is needed to increase transit capacity, offer attractive travel times and performance compared to existing transit and to auto travel in this growth corridor.

Further supporting the case for change, since the publication of the Big Move 2041 Regional Transportation Plan, other studies have been undertaken and have demonstrated the need for rapid transit along Main Street in downtown Brampton.

The Hurontario Main Street Corridor Master Plan (October 2010) introduced a project vision to provide an easy, reliable, frequent, comfortable and convenient light rail transit service throughout the corridor, with effective connections to other links in the inter-regional transit network, which could alleviate anticipated congestion on the corridor. The Hurontario-Main LRT Environmental Project Report (June 2014) built on the first master plan's visions and guiding principles, identifying an approach for a comprehensive 'urban style' LRT which would have competitive journey times, increase journey time reliability, minimize adverse impacts, make a positive contribution to the "beautiful street" component of the vision, and have affordable capital and operating costs. The Hurontario LRT Benefits Case Analysis (March 2016) re-instated the vision from the Hurontario-Main LRT Environmental Project Report (June 2014) and compared the vision to Metrolinx "The Big Move" objectives presenting a strong business case for this infrastructure.

The Brampton LRT Extension study plans to connect the Hurontario LRT along Main Street from the Brampton Gateway Terminal to the Brampton GO Station. The project will address the need for an appropriate, reliable, frequent, comfortable and convenient rapid transit service required to meet the forecasted demand. In doing so, the extension will improve the vibrancy of the Main Street corridor and ensure effective connections to other links in the inter-regional transit network. The proposed vision presented in the Brampton LRT Extension Study is consistent with Metrolinx 2041 RPT vision and goals for transportation in the region.

The impacts of the COVID-19 pandemic on transit ridership and travel patterns have been duly noted are recognized to be especially pronounced in the short term. However, the future population and employment to be served by the LRT extension is based on approved long-term growth forecasts. By 2041, the City continues to expect a need for this investment to meet the future needs of Brampton residents and businesses; therefore, the ongoing planning and design of the LRT is an important step to secure future funding.

[2] Hurontario LRT Benefits Case Analysis," March 2016; Prepared by Steer Davies Gleave for Metrolinx; para 3.18 and 3.19.

Findings from Public Engagement

The study has engaged the public at several occasions through the study. During the COVID-19 pandemic, following the advice of Ontario's Chief Medical Officer of Health, engagement activities have been hosted in a virtual format.

Following the Summer 2020 virtual Open House, which presented a long list of LRT options, the study team received hundreds of comments from the public regarding the future of the LRT extension. Frequently noted key messages from virtual Open House 1 are as follows:

From Thursday, April 22, 2021 to Thursday May 13, 2021, virtual Open House 2 was held online, to solicit public feedback on the short list, the findings of the Preliminary Design Business Case and the emerging preferred investment options. A summary of the public input from virtual Open House 2 can be found under separate cover.

Investment Options

The study area extends 3.6 km from the Brampton Gateway Terminal at Steeles Avenue East to the Brampton GO Station in Downtown Brampton. To enable the development and evaluation of LRT options, the study area was segmented based on existing and future context such as land use, number of lanes, existing and future right-of-way, and environmental features. The study area was divided into the three major segments (A,B and C), each with its distinct cross-sectional characteristics and constraints:

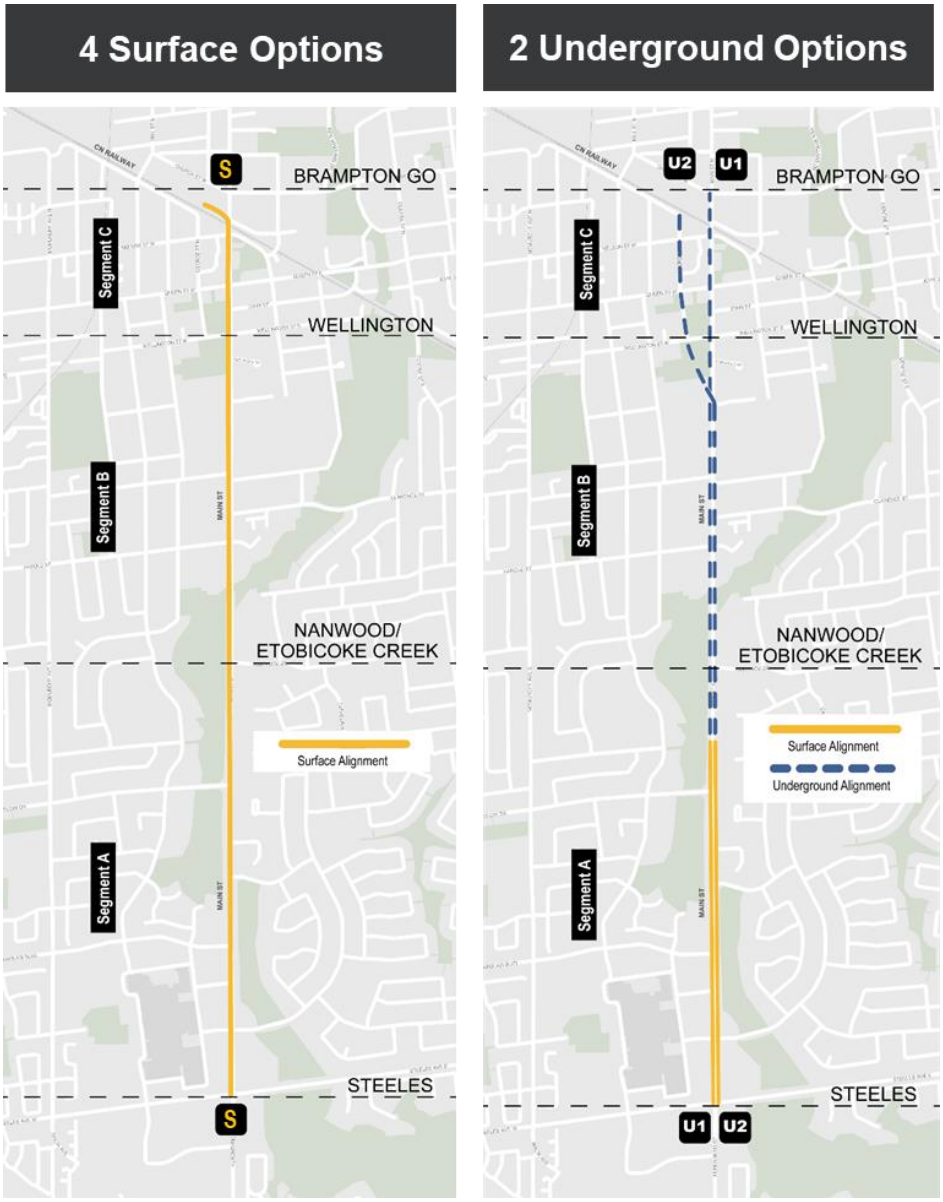
- **Segment A**, further divided into two segments:
  - A1: Steeles Gateway: from Steeles Avenue to Charolais Boulevard; and
  - A2: Main Street Greenway: from Charolais Boulevard to Nanwood Drive.
- **Segment B**, Main Street South: from Nanwood Drive to Wellington Street.
- **Segment C**, Downtown: from Wellington Street to Brampton GO Station.

A long list of twelve (12) options was developed and included:

- Six (6) Surface Options (surface LRT along Main Street);
- Four (4) Loop Options (surface LRT along Main Street with a one-way counterclockwise loop along Nelson Street, George Street, and Wellington Street); and
- Two (2) Underground Options (surface LRT along Main Street from Steeles Avenue to just south of Nan wood Drive and then underground from Nanwood Drive to the Brampton GO Station).

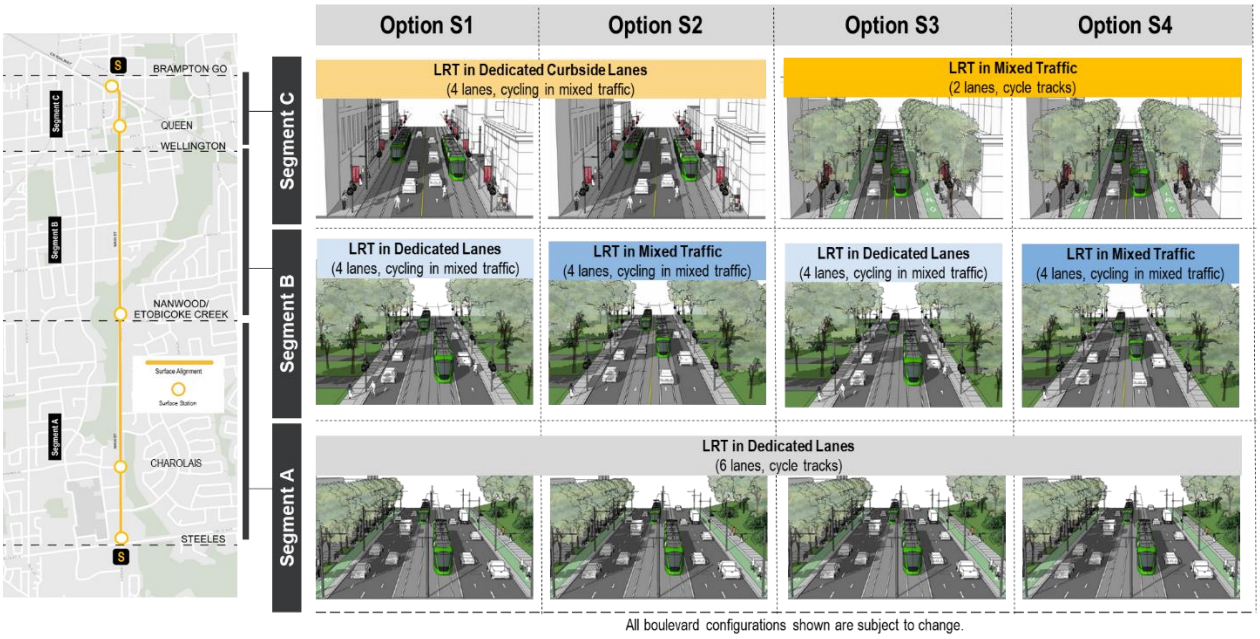
The long list of options was evaluated, presented to the public at virtual Open House 1 from June 22 to July 31, 2020 and narrowed down to a short list for further assessment. Loop options were not advanced due to technical feasibility pertaining to physical constraints and operational challenges in Downtown Brampton with respect to the proposed Hurontario LRT vehicle.

Based on the evaluation of the long list, a short list of six (6) options were carried forward. The short list is composed of four (4) surface options and two (2) underground options which were modelled to investigate impacts on transit and vehicular levels of service. Options generally differ with respect to the use of the road space (dedicated lanes versus lanes shared with other traffic), in alignment and station locations. Surface options are denoted by an “S” whereas underground options are denoted by a “U”.



Surface Options

Short List: Surface Options



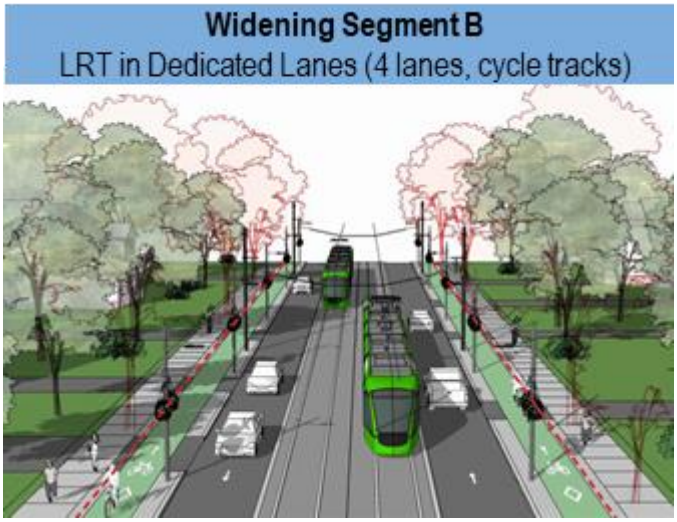
- **Option S1** This option consists of an above-ground dedicated LRT lanes in all segments of Main Street with the terminal station at the Brampton GO Station. This option reduces the travel lanes for automobiles to 2 lanes in Segments B and C. This alternative does not permit left turns along Segment B. No on-street parking is planned for Main Street. This option does not provide a continuous dedicated cycling route: cyclists can use dedicated cycle tracks in Segment A but must ride in mixed traffic conditions or on parallel routes in Segment B and C.

- **Option S2** This option consists of an above-ground dedicated LRT lanes in Main Street segments A and C and an LRT in mixed traffic within Segment B. The terminal station at the Brampton GO Station. This option is consistent with the 2014 TPAP recommendations. No on-street parking is planned for Main Street. This option does not provide a continuous dedicated cycling route: cyclists can use dedicated cycle tracks in Segment A but must ride in mixed traffic conditions or on parallel routes in Segment B and C.

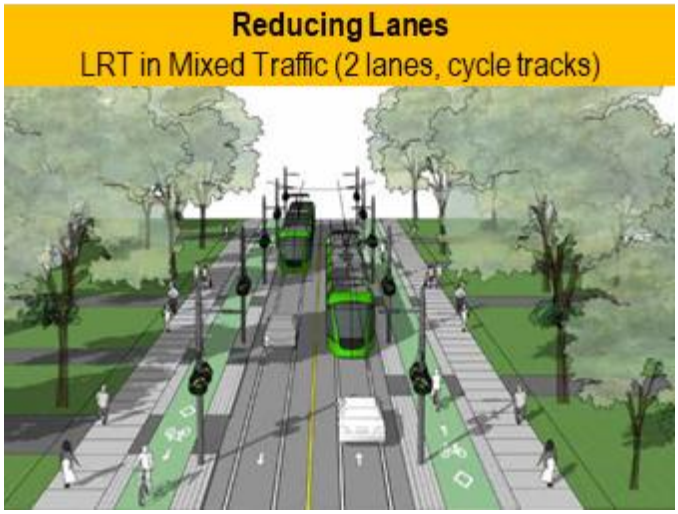
- **Option S3** This option alignment consists of a dedicated LRT lane in Segments A and B, and a shared LRT lane in Segment C. The terminal station is at the Brampton GO Station. This segment reflects the vision of Downtown Reimagined, which includes two lanes of shared mixed traffic and wide boulevards on either side in Segment C. No on-street parking is planned for Main Street. This option does not provide a continuous dedicated cycling route: cyclists can use dedicated cycle tracks in Segment A and C but must ride in mixed traffic conditions or on parallel routes in Segment B.

- **Option S4** This option alignment consists of a dedicated LRT lane in Segment A and a shared LRT lane in Segment B and C. The terminal station is at the Brampton GO Station. This segment reflects the vision of Downtown Reimagined, which includes two lanes of shared mixed traffic and wide boulevards on either side in Segment C. No on-street parking is planned for Main Street. This option does not provide a continuous dedicated cycling route: cyclists can use dedicated cycle tracks in Segment A and C but must ride in mixed traffic conditions or on parallel routes in Segment B.

Surface options presented challenges in accommodating dedicated cycling facilities between Nanwood Drive and Wellington Street due to the limited 20 m right-of-way available in that section of the study corridor. This lead to a subset of options being developed that would enable cycling and provide full cycling network connectivity between uptown and downtown Brampton. Variations in the Segment B cross-section were identified while retaining Segment A and C elements consistent with options S3 and S4. These additional options ultimately possessed critical flaws, major impacts and operational and safety concerns. Therefore, they were not evaluated in the PDBC. The investigation of cycling opportunities in Segment B is summarized and reasons for not including them in the PDBC are explained as follows:



- **Right-of-way (ROW) widening in Segment B to accommodate dedicated cycle tracks:** ROW widening posed significant impacts to the natural and cultural heritage environment as well as residential properties and their driveways. Widening would require an additional 6180 m² of property acquisition (as compared to no widening) which would result in increased project costs to the City. Furthermore, strong public and property owner interest has been expressed for the retention of the heritage character and mature tree canopy on Main Street south. An arborist survey was conducted on November 24, 2020 to quantify impacts of widening the ROW to 30m on existing trees. Trees expected to be removed, injured and retained were identified, including mature trees of significance (>100 cm Diameter at Breast Height). 148 trees would be removed (0 significant) while 111 would be injured (5 significant). A meandering multi-use trail was considered but was found to not minimize impacts to trees between the edge of the street and the future ROW line.



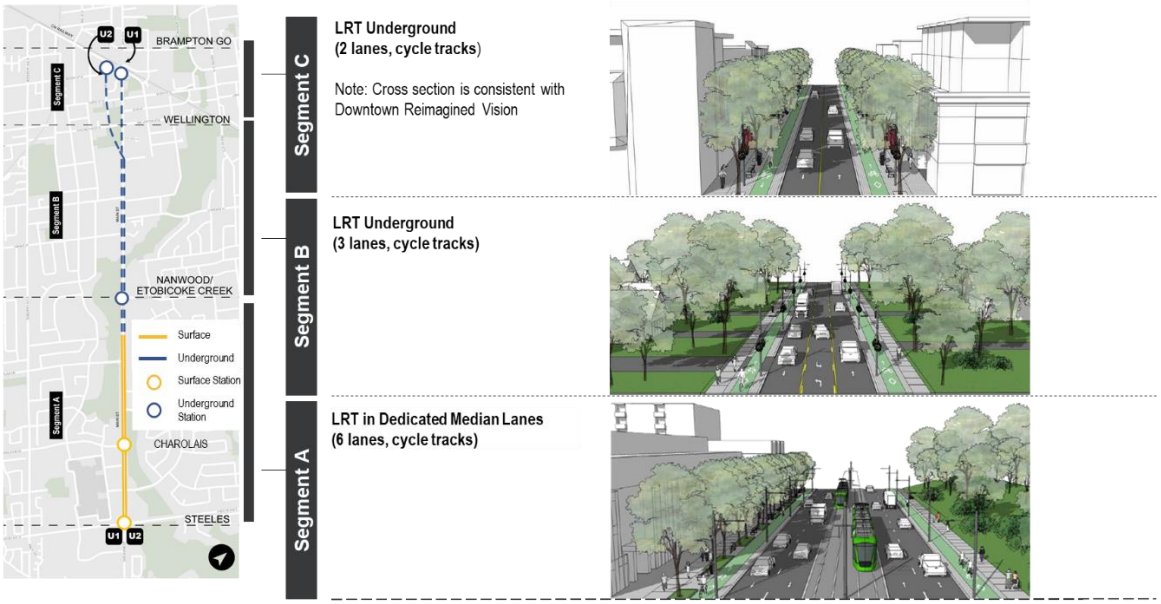
- **Reduction of lanes in Segment B to 2 / 3 shared LRT and general traffic lanes:** With a 2 or 3 lane section in Segment B, a significant increase in auto and transit travel time was observed, eroding the value of money proposition for such an option. Moreover, it would be unsafe to have vehicles turn left out of driveways across the opposing LRT lanes. The number of driveways (approximately 73) and length (~1 km) of this segment further increases risk of severe collisions (broadside and rear end). It would be extremely difficult to enforce turn restrictions as these are private, unsignalized driveways, making this option unfavorable from a traffic safety perspective. The mixed traffic/transit conditions would also be very poor for emergency/service vehicle operations (garbage removal, snow clearing) and would have additional negative impacts on transit/traffic unless shifted to off peak hours.

In light of the interrupted cycling network that characterizes surface options in Segment B, alternative or parallel cycling routes are under consideration to provide cycling connections to downtown Brampton. Potential cycling connections include routes along low traffic streets such as Elizabeth Street or along the existing Etobicoke Creek trail. Improvements to alternative or parallel cycling routes will be confirmed in the next stages of the study. In the absence of dedicated infrastructure, cycling in mixed traffic is to be protected in surface options through the use of sharrows and the provision of dedicated cycling facilities along alternate parallel routes.

This analysis is consistent with the Hurontario-Main LRT TPAP (2014) recommendations which do not include dedicated cycle facilities between Nanwood Drive and Wellington Street.

Underground Options

Short List: Underground Options 1 (Main St) & 2 (George St)



All boulevard configurations shown are subject to change.

- **Option U1** This option consists of a dedicated surface LRT in Segment A and underground portion running along Main Street in Segments B and C. Surface stations are provided at Steeles and Charolais while underground stations are provided at Nanwood and Brampton GO. For underground options, there is no station at Wellington/Queen. On the surface, the 3 traffic lanes will be provided along Segment B and the Downtown Reimagined vision of two lanes of shared mixed traffic with wide boulevards on either side will be provided in Segment C. No on-street parking is planned for Main Street. The terminus station is to be under Main Street. This option provides a continuous dedicated cycling route: cyclists can use dedicated cycle tracks in Segment A, B and C

- **Option U2** This option consists of a dedicated surface LRT in Segment A and an underground portion running along Main Street in Segment B before diverting onto George Street in Segment C. Surface stations are provided at Steeles and Charolais while underground stations are provided at Nanwood and Brampton GO. For underground options, there is no station at Wellington/Queen. On the surface, the 3 traffic lanes will be provided along Segment B and the Downtown Reimagined vision of two lanes of shared mixed traffic with wide boulevards on either side will be provided in Segment C. No on-street parking is planned for Main Street. The terminus station is located under George Street. This option provides a continuous dedicated cycling route: cyclists can use dedicated cycle tracks in Segment A, B and C

Station Locations

Station locations identified in the long list evaluation stage were reviewed and confirmed. The short list evaluation stage incorporated additional technical findings as well as public feedback received during virtual Open House 1 (held from June 22 to July 31, 2020) to inform the recommended station locations for surface and underground routes.

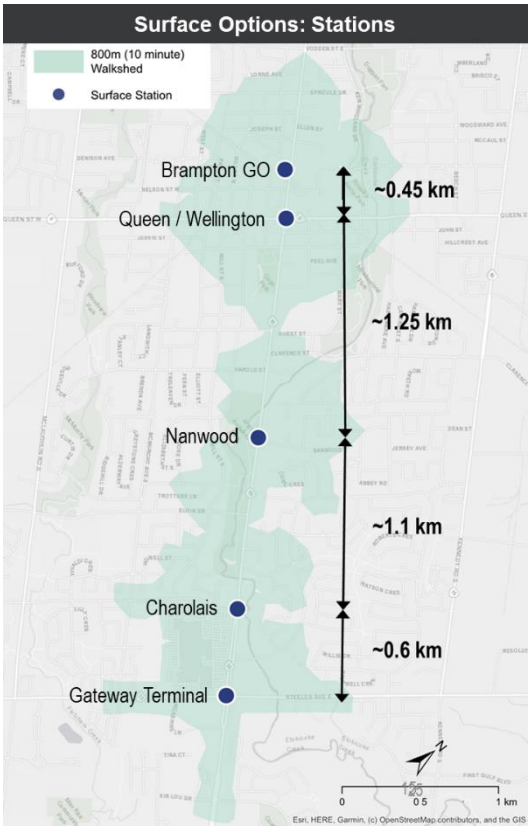
It should be noted that, although the Brampton Gateway Terminal Station is shown as part of the LRT Extension Study, it will be implemented as part of the Hurontario LRT project (Port Credit GO Station to Brampton Gateway Terminal). The exact location of the station (i.e. south of Steeles Avenue or north of Steeles Avenue) is subject to discussions with Metrolinx; however, for the purposes of this PDBC, it has been assumed to be located on the north side of Steeles Avenue.

Surface Stations / Stops

The proposed station locations for the surface options are shown below and are as follows:

- Brampton GO
  - Island Platform
- Downtown
  - Queen Street, Northbound Platform
  - Wellington Street, Southbound Platform
- Nanwood
  - Far-Side, Split Platform
- Charolais
  - Far-Side, Split Platform
- Gateway Terminal
  - North side of Steeles, Island Platform

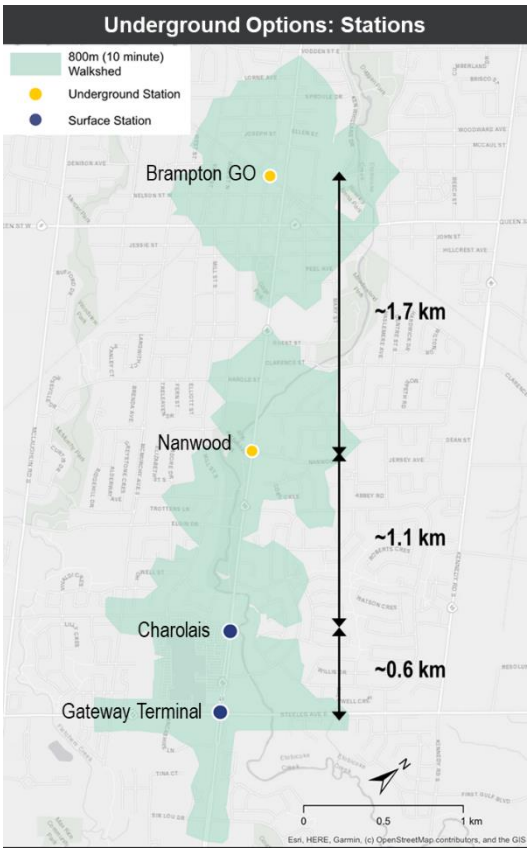
There was no change to the station locations relative to the base assumptions from the long list phase. Furthermore, the station locations are consistent with the 2014 Hurontario-Main TPAP recommendations.



Underground Stations / Stops

The proposed station locations for the underground options are shown below and are as follows:

- Brampton GO (underground)
- Nanwood (underground)
- Charolais (surface)
  - Far-Side, Split Platform
- Gateway Terminal (surface)
  - North side of Steeles, Island Platform



The underground station at Wellington Street was screened out during the short list phase. The implications on Metrolinx Preliminary Design Business Case strategic criteria such as ridership, future population, employment, low-income demographics served were reviewed.

Results indicated that the strategic benefits of maintaining the underground station were not deemed to outweigh implementation costs and impacts to Wellington Park, especially given the station's proximity to Brampton GO (within its 800m walkshed). Moreover, public support at virtual Open House 1 for an express service with fewer stops as well as general concerns related to project funding and availability further validated the removal of Wellington Station.

Summary of the Business Case Evaluation

The Preliminary Design Business Case (PDBC) for the Brampton LRT Extension study evaluated four surface and two underground LRT options to identify an emerging preferred option for each.

The following sections document the comparison of LRT options and present the overall conclusions drawn from the PDBC for each of the strategic, economic, financial and deliverability and operations case. One emerging preferred surface and one emerging preferred underground option has been identified.

Surface Options

D: LRT in Dedicated Lanes
S: LRT in Shared Lanes

Strategic Case

Comparison of how each option performs relative to the rest.

Worst | **Comparable** | **Best**

		Evaluation Criteria[3]	S1 (DDD)	S2 (DSD)	S3 (DDS)	S4 (DSS)
Strategic Case	Strong Connections	LRT Daily Ridership	30,900	27,700	29,500	26,300
		Ridership increase on HuLRT (Peak Period)	6,200	5,200	5,800	4,800
		2041 Population within 800 m of Stations	All options serve the same future population (28,500)			
		2041 Employment & low-income residents served	All options serve the same number of jobs and low-income residents (17,000 and 2,400)			
		Support areas with land uses compatible with rapid transit	Compatible (transit in dedicated lanes, cycling in mixed traffic in Segment C)	Least Compatible (transit in shared lanes, cycling in mixed traffic in Segment C)	Most Compatible (transit in mostly dedicated lanes, dedicated cycling in Segment C)	Less Compatible (transit in shared lanes, dedicated cycling in Segment C)
	Complete Travel Experiences	Transit Travel Time (PM Peak hour)	8 min	11 min	9 min	12 min
		Average Auto Travel Time in LRT Corridor per trip	6 min	6 min	7 min	6 min
		Total Transit Travel Time Savings	35,000 person-min	17,000 person-min	28,000 person-min	11,000 person-min
		Pedestrian and Bicycle Level of Service	Worse active transportation conditions		Better active transportation conditions	
		Transit and Vehicle Level of Service	Generally comparable between surface options.			
		Potential for Conflicts between LRT, Autos and AT	Low Conflict (LRT & auto) High Conflict (AT & auto)	High Conflict (LRT & auto) High Conflict (AT & auto)	Low Conflict (LRT & auto) Low Conflict (AT & auto)	High Conflict (LRT & auto) Low Conflict (AT & auto)
		Transfer times from LRT to nearby transit services (Bus and GO) and Downtown Brampton	All options have similar transfer times: 2 minutes to Brampton Transit Bus Terminal, 4 minutes to Brampton GO (EB) and 4 minutes to Queen / Main Street.			
	Sustainable Communities	Daily VKT Reduced in Study Corridor, PM Peak	1,500	400	1,300	300
		Additional Transit Trips, PM Peak (Diverted from Auto)	950	500	700	500
		Ability to Incorporate Downtown Reimagined Compatibility with Parks and Public Spaces Ability to provide a continuous cycling network	Less desirable public realm Gap in the cycling network connectivity in Segments B and C		More desirable public realm Gap in cycling network connectivity in Segment B	
		Impacts to Natural Environment, Cultural Heritage & Drainage	Similar impacts between surface options All options require similar ROW, Traction Power Substations at-grade and similar stormwater management considerations.			
Strategic Case Recommendation			**S3 best fulfils the objectives and supports the strategic case.**			

[3] This table presents the key differentiating elements between options. For a complete account of evaluation criteria and performance metrics, please see the full PDBC report.

Economic Case

D: LRT in Dedicated Lanes
S: LRT in Shared Lanes

Comparison of how each option performs relative to the rest.

Worst		Comparable		Best

	Evaluation Criteria	S1 (DDD)	S2 (DSD)	S3 (DDS)	S4 (DSS)
Economic Case	Total Economic Benefits ($ Million, 2019)	$529	$338	$446	$276
	Total Economic Costs ($ Million, 2019)	$375	$381	$379	$385
	Net Present Value ($ Million, 2019)	$155	-$43	$67	-$109
	Benefit-Cost Ratio (BCR)	1.41	0.89	1.18	0.72
	Economic Case Recommendation	**S1 and S3 best support the economic case.**			

Financial Case

D: LRT in Dedicated Lanes
S: LRT in Shared Lanes

Comparison of how each option performs relative to the rest.

Worst		Comparable		Best

	Evaluation Criteria	S1 (DDD)	S2 (DSD)	S3 (DDS)	S4 (DSS)
Financial Case	Capital Construction Costs ($ Million, 2019)	$348	$354	$353	$357
	Rehabilitation and Major Maintenance ($ Million, 2019)	$38	$39	$39	$39
	Operations and Maintenance Costs ($ Million, 2019)	$25	$25	$25	$25
	Total Incremental Revenues ($ Million, 2019)	$97	$76	$89	$67
	Net Financial Impact ($ Million, 2019)	-$315	-$342	-$327	-$354
	Financial Case Recommendation	**S1 and S3 best support the financial case.**			

D: LRT in Dedicated Lanes
S: LRT in Shared Lanes

Deliverability and Operations Case

Comparison of how each option performs relative to the rest.

Worst		Comparable		Best

		Evaluation Criteria	S1 (DDD)	S2 (DSD)	S3 (DDS)	S4 (DSS)
Deliverability and Operations	Procurement & Delivery	Procurement Strategies	Two potential procurement strategies are recommended for consideration: • **Option 1:** Proponent issues Design – Bid – Build (DBB) contract for construction of the extension. Proponent to reach agreement for HuLRT Project Co to operate and maintain the extension. Proponent could also use Design – Bid – Finance model in which a single contract is awarded for the design, construction, and full or partial financing of a facility • **Option 2:** Proponent to reach agreement for HuLRT Project Co to Design – Build – Finance – Operate – Maintain (DBFOM) the extension. Potential to remove finance from DBFOM contract if it can be financed publicly.			
	Design and Operational Trade-Offs and Issues	Emergency and Service Vehicle Operations	Impact to operations in Segment B (single traffic lane in each direction).	Limited impact to operations.	Impact to operations in: Segment B (single traffic lane in each direction) and Segment C (single mixed traffic/transit lane in each direction)	Impact to operations in Segment C (single mixed traffic/transit lane in each direction).
		Property Impacts	All options pose similar magnitude impacts to properties (~4,900 – 5,100 m^2 property required)			
		Driveway Impacts	Conversion of full moves access driveways to right-in-right-out (RIRO) for Segments A, B & C (77 driveways)	Conversion of full moves access driveways to right-in-right-out (RIRO) for: Segments A and C (19 driveways)	Conversion of full moves access driveways to right-in-right-out (RIRO) for: Segments A and B (73 driveways)	Conversion of full moves access driveways to right-in-right-out (RIRO) for Segment A (15 driveways)
		Utility Impacts	24 major utility conflicts have been identified			
		Impacts to CN bridge	Overhead Catenary System (OCS) mitigation required to provide vertical clearance under Main Street bridge. S1 may require widening to improve active transportation (i.e. add dedicated cycling infrastructure); whereas S3 and S4 do not.	Overhead Catenary System (OCS) mitigation required to provide vertical clearance under Main Street bridge. S2 may require widening to improve active transportation (i.e. add dedicated cycling infrastructure); whereas S3 and S4 do not.	Overhead Catenary System (OCS) mitigation required to provide vertical clearance under Main Street bridge.	Overhead Catenary System (OCS) mitigation required to provide vertical clearance under Main Street bridge.
		Ability to Extend Line in the Future	All options enable future extensions to the north.			
		Constructability	Surface construction is to be undertaken similarly to typical road widening construction for the length of the study area.			
		Schedule	Surface options are estimated to take up to 6 years from design to opening day.			
	O & M	Operations and Maintenance	• The LRT extension is to be designed as a fully compatible extension of the planned and under construction HuLRT, building on system assets such as Maintenance and Storage facilities and technology specifications. • The extension is to be facilitated such that the preliminary system operations plan documented in the 2014 Hurontario-Main LRT Environmental Project Report (EPR) applies to this project and that operator of the extension and overall line will achieve consistent operations and maintenance plans.			
		Deliverability and Operations Recommendation	**S2 and S4 best meet the deliverability and operations objectives as they minimize impacts to roadway and service operations and driveways.**			

Preliminary Design Business Case Findings

The performance of each option has been synthesized for each business case criterion in the table below.

	Evaluation Criteria	S1 (DDD)	S2 (DSD)	S3 (DDS)	S4 (DSS)
Surface Options	Strategic Case				
	Economic Case				
	Financial Case				
	Deliverability and Operations Case				
	PDBC Recommendation	✗ Do Not Carry Forward	✗ Do Not Carry Forward	✓ Carry Forward	✗ Do Not Carry Forward

With the considerations above, Option S3 is preferred as it best fulfils the objectives of the strategic case, generates the second highest economic case outputs and achieves financial case results that are better than most other surface options. Driveway access impacts are the greatest for S3, however, this trade-off is acceptable to minimize transit travel times along the corridor.

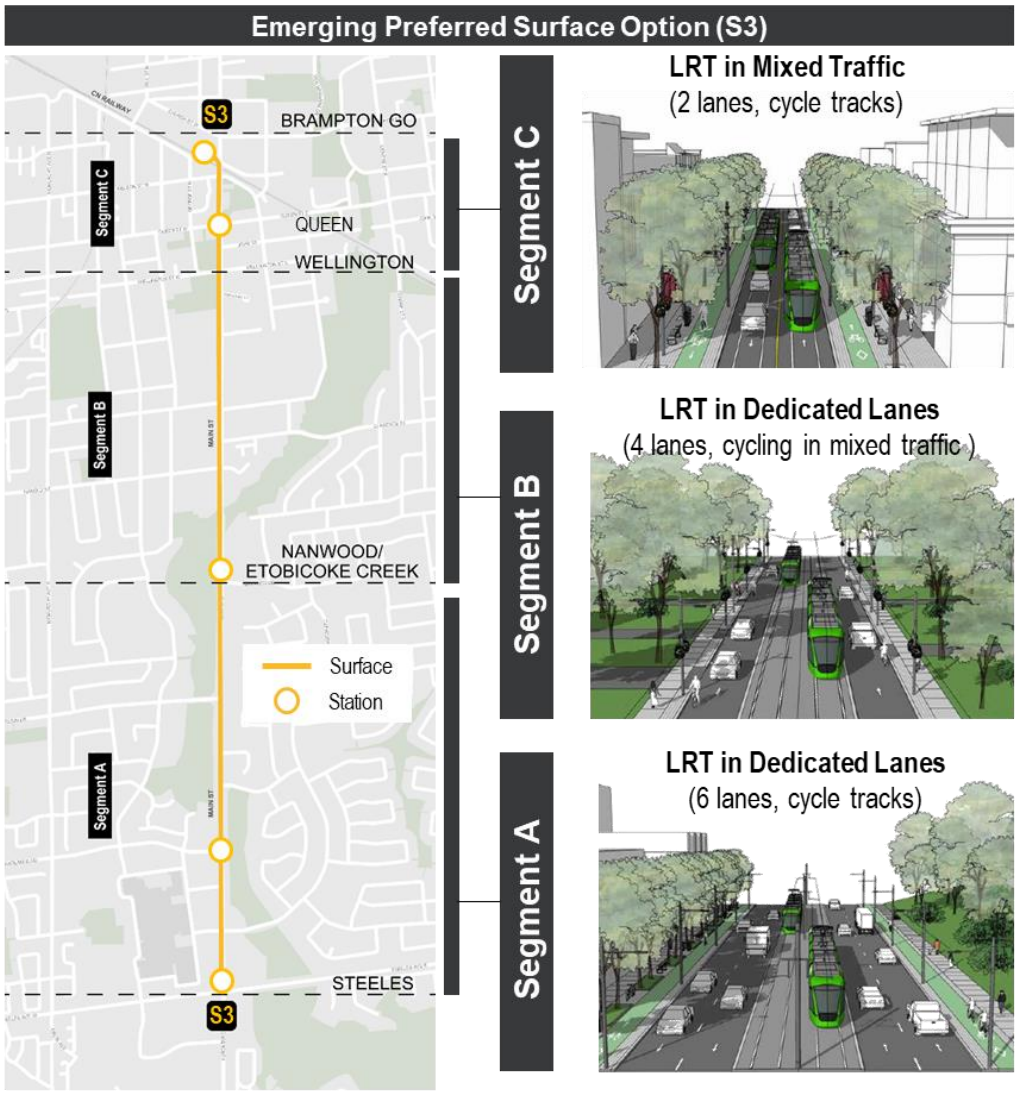
Option S3 provides the opportunity to revitalize Downtown Brampton into an aesthetically beautiful, place-making destination with wider sidewalks, streetscaping, and cycle tracks (consistent with Downtown Brampton Reimagined Vision) while minimizing overall transit travel time. Driveway accesses will be modified as a result of the dedicated LRT right-of-way, but this will ensure safe and efficient travel for all users of the street.

Therefore, Option S3 is the emerging preferred surface option**.**

Emerging Preferred Surface Option S3

The emerging preferred surface Option S3 is described as follows:

- The LRT will run in dedicated lanes between Steeles Avenue and Wellington Street and in shared lanes from Wellington Street to the Brampton GO Station. There will be 5 surface stops along the route at Brampton Gateway, Charolais, Nanwood, Queen / Wellington and Brampton GO.
- Option S3 allows for an enhanced streetscape in Segments A and C, including: cycle tracks, widened sidewalks, and a planting and furnishing zone. Cyclists must ride in mixed traffic in Segment B or use parallel routes.
- Driveways in Segment B will be modified to right-in, right out access.
- Overhead catenary systems and traction power substations (TPSS) will be located above ground in the study area.



All boulevard configurations shown are subject to change.

Strategic Case

U: Underground

Comparison of how each option performs relative to the rest.

Worst		Comparable		Best

		Evaluation Criteria	U1 (via Main St)	U2 (via George St)
Strategic Case	Strong Connections	LRT Daily Ridership	30,500	
		Ridership increase on Hurontario LRT (Peak Period)	6,100	
		2041 Population within 800 m of Stations	All options serve the same future population (28,000)	
		2041 Employment and Number of low-income residents served	All options serve the same number of jobs and low-income residents (15,000 and 2,200)	
		Support areas with land uses compatible with rapid transit	Compatible (higher order transit, AT improvements)	Compatible (higher order transit, AT improvements)
	Complete Travel Experiences	Transit Travel Time (PM Peak hour)	7 min	8 min
		Average Auto Travel Time in LRT Corridor, Minutes per Trip	6 min	6 min
		Total Transit Travel Time Savings compared to BAU	35,000 person-min	
		Pedestrian and Bicycle Level of Service	Improved active transportation conditions throughout study area	
		Transit and Vehicle Level of Service	Comparable transit and vehicle conditions	
		Potential for Conflicts between modes (LRT, Autos and AT)	Low Conflict between LRT, auto & AT	
		Transfer times from LRT to nearby transit services	Similar transfer times to nearby transit services: 3 minutes to Brampton Transit Bus Terminal, 4-5 minutes to Brampton GO Station	
		Transfer times from LRT to Downtown Brampton	4 min	6 min
	Sustainable Communities	Daily VKT Reduced in Study Corridor, Peak Period	1,200	
		Additional Transit Trips, PM Peak (Diverted from Auto)	700	
		Ability to Incorporate Downtown Reimagined	Ability to incorporate Downtown Reimagined in Segment C	
		Compatibility with Parks and Public Spaces	Similar relationship to parks and public spaces	
		Ability to provide a continuous cycling network	Ability to provide continuous and uninterrupted cycling facilities along the study corridor (reallocating road space for Segment B)	
		Impacts to the Natural Environment, Cultural Heritage & Drainage	Similar impacts on natural and cultural heritage resources and drainage	
		Strategic Case Recommendation	**U1 best fulfils the objectives and supports the strategic case.**	

Economic Case

U: Underground

Comparison of how each option performs relative to the rest.

Worst		Comparable		Best

	Evaluation Criteria	U1 (via Main St)	U2 (via George St)
Economic Case	Total Economic Benefits ($ Million, 2019)	$466	$472
	Total Economic Costs ($ Million, 2019)	$1,432	$1,465
	Net Present Value ($ Million, 2019)	-$965	-$992
	Benefit-Cost Ratio (BCR)	0.33	0.32
	Economic Case Recommendation	**U1 best supports the economic case as it has a marginally better value for money.**	

Financial Case

U: Underground

Comparison of how each option performs relative to the rest.

Worst		Comparable		Best

	Evaluation Criteria	U1 (via Main St)	U2 (via George St)
Financial Case	Capital Construction Costs[4] ($ Million, 2019)	$1,425	$1,425
	Rehabilitation and Major Maintenance ($ Million, 2019)	$140	$143
	Operations and Maintenance Costs ($ Million, 2019)	$25	$25
	Total Incremental Revenues ($ Million, 2019)	$86	$87
	Net Financial Impact ($ Million, 2019)	-$1,504	-$1,506
	Financial Case Recommendation	**U1 and U2 have a comparable financial case performance.**	

[4] Construction costs for underground options do not include streetscape or road configuration improvements at the surface as these were assumed to be undertaken as a separate City of Brampton initiative. Property acquisition are not included.

Deliverability and Operations Case

U: Underground

Comparison of how each option performs relative to the rest.

Worst		Comparable		Best

	Evaluation Criteria	U1 (via Main St)	U2 (via George St)
Deliverability and Operations	Procurement Strategies	Two potential procurement strategies are recommended for consideration, similar to surface options: • **Option 1:** Proponent issues Design – Bid – Build (DBB) contract for construction of the extension. Proponent to reach agreement for HuLRT Project Co to operate and maintain the extension. Proponent could also use Design – Bid – Finance model in which a single contract is awarded for the design, construction, and full or partial financing of a facility • **Option 2:** Proponent to reach agreement for HuLRT Project Co to Design – Build – Finance – Operate – Maintain (DBFOM) the extension. Potential to remove finance from DBFOM contract if it can be financed publicly.	
	Emergency and Service Vehicle Operations	Limited impact to emergency and service vehicles.	
	Property Impacts	~2,700 m^2 property required.	~5,300 m^2 property required.
	Driveway Impacts	All full moves access driveways in Segment A converted to right-in-right-out unless at signalized intersection (9 driveways along the surface portion)	
	Utility Impacts	• Segment B will have no impact on existing utilities. • Segment C will have limited impact on existing utilities.	• Segment B will have limited impact on existing utilities. • Proposed location of surface connection for Brampton GO station may have minor impacts on existing utilities.
	Ability to Extend Line in the Future	• Able to extend north in the future along Main Street.	• More difficult to extend north in the future from George Street. Potential conflict with building foundations.
	Constructability	• For underground sections, a combination of Sequential Excavation Method (mining) and Open Cut construction is anticipated. • TBM was ruled out during optioneering due to its high costs for such short length of the study area. • For surface sections (Segment A), construction is to be undertaken similarly to typical road widening construction for the length of the study area.	
	Schedule	Underground options are estimated to take between 7 and 8 years from design to opening day.	
	Operations and Maintenance	• The LRT extension is to be designed as a fully compatible extension of the planned and under construction HuLRT, building on system assets such as Maintenance and Storage facilities and technology specifications. • The extension is to be facilitated such that the preliminary system operations plan documented in the 2014 Hurontario-Main LRT Environmental Project Report (EPR) applies to this project and that operator of the extension and overall line will achieve consistent operations and maintenance plans.	
Deliverability and Operations Recommendation		**U1 better meets the design and operational objectives as it minimizes property and utility impacts and facilitates future extensions.**	

Preliminary Design Business Case Findings

The performance of each option has been synthesized for each business case criterion in the table below.

	Evaluation Criteria	U1 (via Main St)	U2 (via George St)
Underground Options	Strategic Case		
	Economic Case		
	Financial Case		
	Deliverability and Operations Case		
	PDBC Recommendation	✓ Carry Forward	✗ Do Not Carry Forward

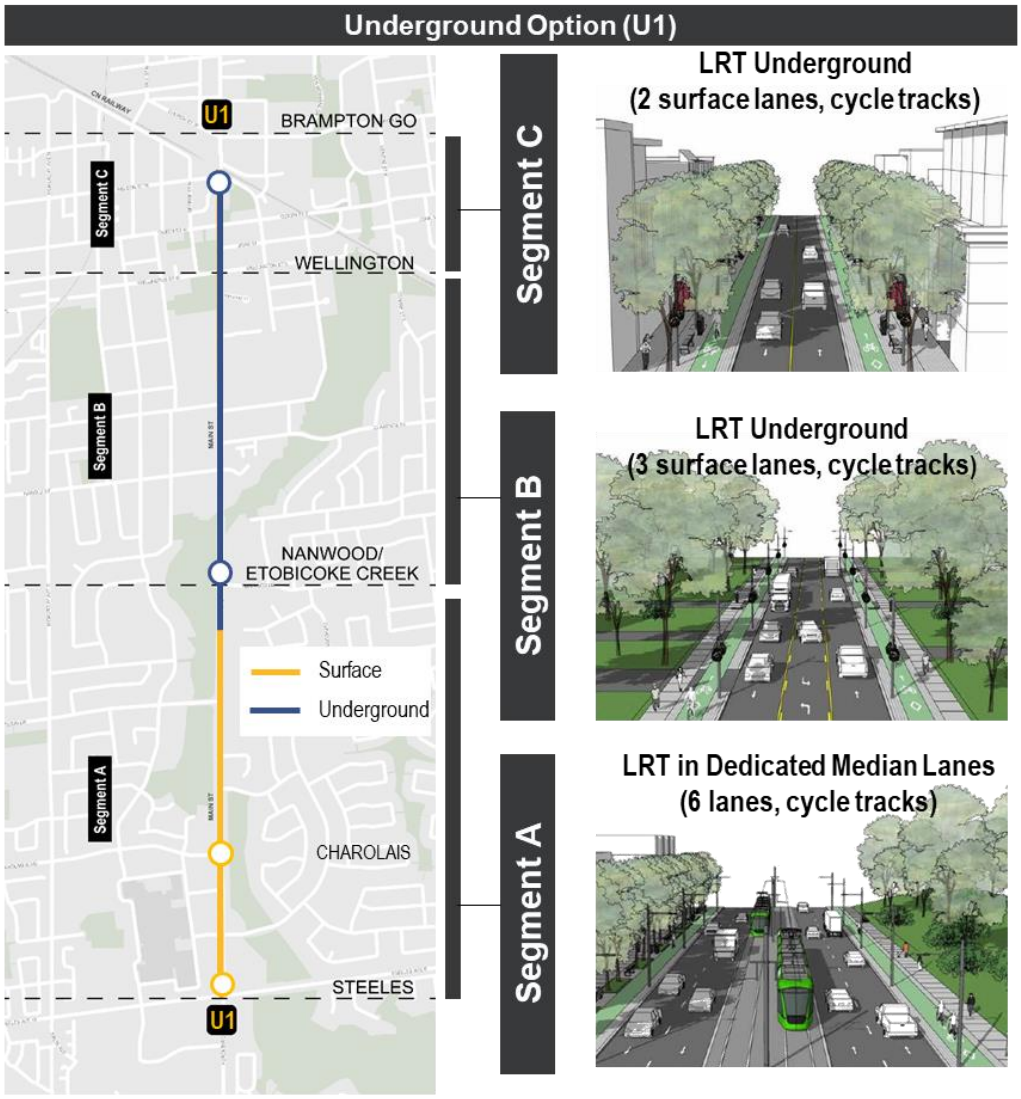
Overall, Option U1 (via Main Street) and U2 (via George Street) perform similarly from a strategic perspective with U1 have certain marginal benefits related to transfer and LRT travel time. However, Option U1 is more preferred than U2 as it is less costly, located closer to the heart of Downtown Brampton, requires less property takings and is more easily extended north in the future.

Therefore, Option U1 is the emerging preferred surface option.

Emerging Preferred Underground Option U1

The emerging preferred underground option U1 is described as follows:

- The LRT will run in dedicated lanes north of Steeles Avenue to Elgin Drive then run underground from just south of Nanwood Drive to the Brampton GO Station along Main Street. There would be 4 stops / stations along the line, with 2 at the surface (Brampton Gateway and Charolais) and 2 underground (Nanwood and Brampton GO).
- Option U1 allows for an enhanced streetscape in Segments A, B, and C, including: cycle tracks, widened sidewalks, and a planting and furnishing zone. Option U1 allows for a continuous cycling network along Main Street.
- No access modifications are required in Segment B. Traction Power Substations (TPSS) will be located underground within underground station.
- The portal and the two underground stations are located in the floodplain. Potential impacts to be mitigated.



All boulevard configurations shown are subject to change.

Comparison of Emerging Preferred Options

The emerging preferred surface and underground options S3 and U1 were compared and their key differences summarized as follows.

	Evaluation Criteria	Option S3 (DDS)	Option U1 (via Main Street)
Strategic Case	**Strong Connections**	• 9 minute transit travel time • Does not improve multi-modal level of service as much as option U1.	• 7 minute transit travel time • Improves multi-modal level of service more than option S3.
	Complete Travel Experiences	• Does not provide the same opportunity for improving pedestrian and cycling at the surface. Lack of dedicated cycling facilities in Segment B creates a discontinuous cycling network • More opportunity for conflicts between modes	• Improves pedestrian and cycling facilities/level of service at the surface. Continuous cycling network. • Less opportunity for conflicts between modes
	Sustainable and Healthy Communities	• Inability to close streets for civic events in Downtown. • Greater temporary and permanent impacts to natural and cultural environment (especially in Segment B).	• Provides opportunity to close streets for civic events in Downtown. • Fewer impacts to natural and cultural environment (especially in Segment B).
Economic Case	**Net Present Value**	$66.9 million	- $965 million
	Benefit-Cost-Ratio	1.18	0.33
Financial Case	**Capital Costs**	$353 million	$1.43 billion[5]
	Net Financial Impact	- $324 million	- $1.5 billion
Deliverability and Operations Case	**Impacts to Road Operations**	• More impact to emergency and service vehicle operations	• Fewer impact to emergency and service vehicle operations
	Impacts to Property	• More property impacts (up to 5,100 m^2 property required)	• Fewer property impacts (~2,700m^2 property required)
	Impacts to Driveways	• More driveway and access impacts/restrictions (73 driveways)	• Fewer driveway and access impacts/restrictions (9 driveways)
	Impacts to Utilities	• More utility impacts (24 major utility conflicts)	• Limited utility impacts
	Schedule	• Up to 6 years from design to opening day.	• 7 to 8 years from design to opening day.

Next steps will include refining the design and engineering to maximize benefits and mitigate outstanding risks for the emerging preferred options, selecting a preferred option and carrying it through the Transit Project Assessment Process (TPAP).

[5] Construction costs for underground options do not include streetscape or road configuration improvements at the surface. These were assumed to be undertaken as a separate City of Brampton initiative. Property acquisition are not included.

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1 Introduction

This introductory section provides a brief background of the project, the purpose and the process of the Business Case.

Extending the planned Hurontario LRT from the Brampton Gateway Terminal at Steeles Avenue to the Brampton GO station is a key transit priority and city-building project for the City of Brampton. The LRT extension will play an important role in the long-term rapid transit network in Brampton and is essential for supporting the sustainable growth and evolution of the Downtown Core and Central Area.

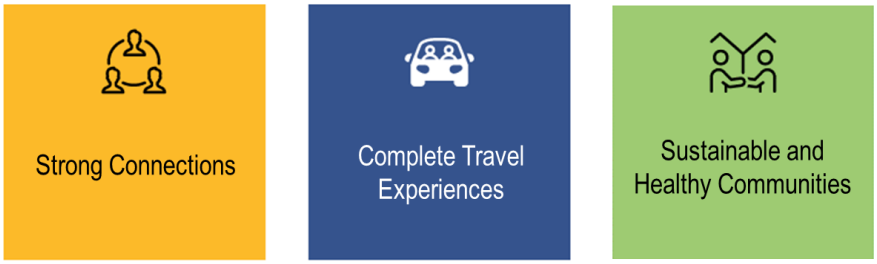
The Brampton LRT Extension study is intended to address the growth-related transportation needs specifically in Brampton by extending the Hurontario LRT along Brampton's Main Street from the Brampton Gateway Terminal to the Brampton GO Station. In addition, the extension is envisioned as a transformational city-building project helping to achieve broader objectives of the 2041 RTP of building economically strong, well connected, and sustainable.

1.1 Vision and Goals

The LRT extension will contribute to a safer and more integrated transportation system to serve the City of Brampton, encouraging civic sustainability, emphasizing transit use and other modes of transportation over traditional automobiles, and supporting the revitalization of Downtown Brampton into an aesthetically beautiful, place-making destination. The vision for the LRT extension reflects the transportation vision and actions set out in the Brampton 2040 Vision (2018).

The study has three main goals as follows:

- Create Strong Connections
- Build Complete Travel Experiences
- Support Sustainable and Healthy Communities.



1.2 Project Background

In 2008, the publication of Metrolinx' "Big Move" 2041 Regional Transportation Plan (RTP) identified a strategic need for a rapid transit system along the corridor between downtown Brampton and Port Credit (the Hurontario corridor) due to forecasted significant population and employment growth. In 2018, the 2041 RTP was updated and reaffirmed the recommendation to extend the Hurontario LRT north from Steeles Avenue to Brampton GO.

Since the publication of the Big Move 2041 RTP and its latest update, the Hurontario-Main corridor has been a subject of studies that demonstrated the case for rapid transit, including Hurontario Main Street Corridor Master Plan (October 2010) and the Hurontario-Main LRT Environmental Project Report (June 2014). The Hurontario LRT Benefits Case Analysis (March 2016) presented a strong business case for this infrastructure, although with a reduced scope from Port Credit GO station in Mississauga through downtown Mississauga to Brampton's Gateway Terminal. This project was approved by the provincial government, and the construction began in early 2020.

1.3 Study Process

The evaluation of options is a multi-level process that has occurred over the course of the study. The Preliminary Design Business Case (PDBC) constitutes the final step in the evaluation of options before the initiation of the Transportation Project Assessment Process (TPAP). The flow chart below illustrates the study process.

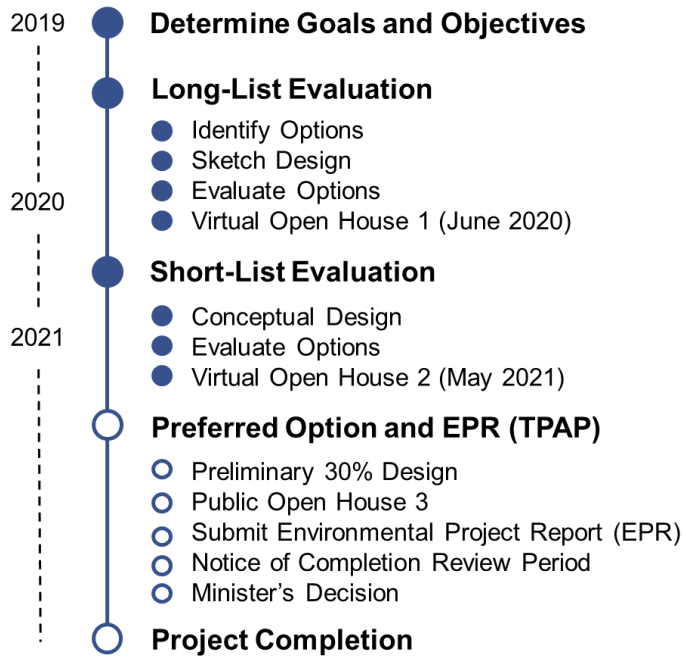


Figure 1-1: Study Process

Through this process, the long list of LRT options was evaluated and narrowed down to a short list. The short list was evaluated and has been presented at Virtual Open House 2 from April 22 through May 2021. Once a preferred LRT option is selected, the TPAP can be initiated and the Environmental Project Report developed.

1.4 Business Case Approach Overview

Business Case analyses are required by Metrolinx for all capital projects slated to obtain financial contributions from higher levels of government. They are completed to define the rationale and requirements for delivering the investment and forecast its performance in relation to the determined goals. This Preliminary Design Business Case (PDBC) will identify the best performing alternative for the extension of the Hurontario LRT. The approach is based on

Metrolinx' Business Case framework that comprises four cases and introductory/background chapters as follows:

- **Problem Statement:** defines the need for the project and the case for change. It spells out the project justification and provides directions for the evaluation of investment options considered within the business case by specifying its strategic objectives. The project background dates back to 2008 when the Metrolinx' "Big Move" 2041 Regional Transportation Plan (RTP) identified a strategic need for a rapid transit system along the Hurontario Street between downtown Brampton and Port Credit (the Hurontario Corridor) to address the forecasted significant population and employment growth in the region. The LRT project would also support the "city building" objectives and support sustainable growth and offer competitive transportation service.

- **Investment Options:** introduces the investment alternatives to be evaluated and compared through the four cases that constitute the Business Case. The chapter briefly discusses how the options were developed and outlines the assumptions used in the travel demand and performance modeling. The short list of options evaluated in this business case includes four surface options and two options with underground segments. The options differ principally with respect to the LRT use of the road space along its route (LRT operations on dedicated lanes versus LRT operations on lanes shared with other traffic, and LRT operations underground) and some differences in alignment and station locations.

- **Strategic Case:** addresses how the project (with its investment options) will achieve strategic transportation objectives. The strategic objectives were defined around the strategic goals of the 2041 RTP – (A) Strong Connections, (B) Complete Travel Experiences, and (C) Sustainable and Healthy Communities – and represent the desired outcomes associated with each goal. The objectives center around improving access to transit and its performance, promoting a more sustainable transportation system, and supporting city-building objectives. The Strategic Case presents the performance of the short-listed options against the identified strategic objectives where the performance is measured with a set metrics that include quantitative and qualitative measures, as indicated in **Figure 1-2**.

Figure 1-2: Strategic Case Criteria

- **Economic Case:** evaluates the life-time economic costs, benefits and impacts of the proposed investment project to establish its economic benefits to society, net benefits, and the benefit-cost ratio. Project benefits and impacts were monetized to the greatest extent possible and compared with costs in a structured benefit-cost analysis framework. The benefits and impacts evaluated are shown in **Figure 3-1**. These include user impacts such as travel time savings to transit users, travel time impacts to auto users remaining in the LRT corridor, improved transit reliability, and auto operating cost savings to auto users diverting to the new LRT. Costs taken into account include capital costs and incremental LRT operations and maintenance costs. In addition, the Economic Case discusses other benefits and impacts of the LRT which are difficult to quantify and capture in the net benefits and the benefit-cost ratio. These benefits and impacts include various wider economic and development benefits of transit infrastructure projects as well as short-term impacts due to construction itself.

Figure 1-3: Economic Case Criteria

- **Financial Case:** establishes the costs to deliver the project, provides an overview of life-cycle costs and revenues related to the project and its overall financial performance. Costs taken into account are shown in **Figure 1-4** include capital construction costs, financial costs, capital renewal costs, and incremental annual LRT operating costs. These are compared against expected incremental fare revenues due to new transit users to determine the overall fiscal impact of the project and operating ratios.

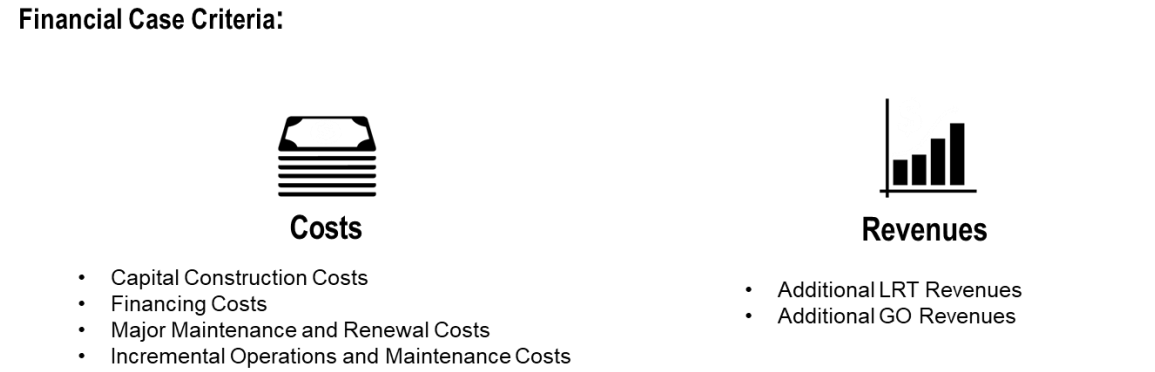


Figure 1-4: Financial Case Criteria

- **Deliverability and Operations Case:** provides a discussion on the feasibility and constructability of the project alternatives and considers risks. The discussion identifies known issues and constraints around each option that may facilitate or hinder project implementation and progress, as shown in **Figure 1-5.**

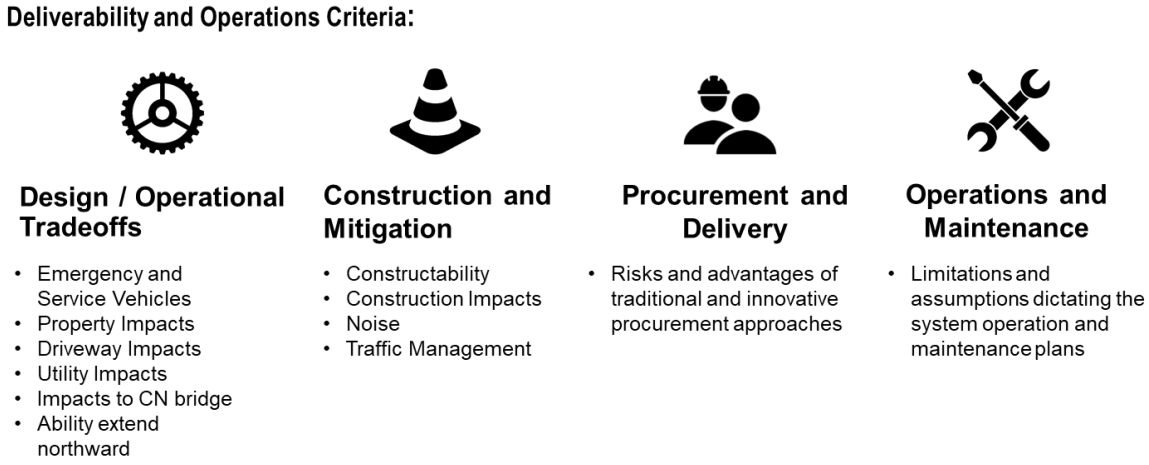


Figure 1-5: Deliverability and Operations Criteria

The framework is based on common business case concepts and principles including objective, evidence-based and transparent approach, consideration of comprehensive life-time benefits, costs, and impacts compared to a Business as Usual (BAU) or a no-build scenario, and using industry accepted guidance and assumptions for key parameter values such as the of travel time savings or discount rates. In Metrolinx' approach, business case analysis may be conducted multiple times as the project progresses through its development process, updated when new project-relevant data and information emerge.

As a PDBC, this business case conducts the analysis for a set of identified short-listed of options that incorporate certain design elements with potential impacts on their performance (conceptual design stage).

This business case report is organized around the framework outlined above with separate chapters dedicated to each of the four cases, problem statement and description of options considered. The appendices provide additional details as required.

2 Problem Statement and Case For Change

This chapter defines the need for the project and the case for change. It spells out the project justification and provides directions for the evaluation of investment options considered within the business case. The chapter is organized by outlining existing travel conditions and emerging trends in Brampton and Mississauga, detailing the project background and presenting the case for change, and describing the strategic project goals and objectives.

2.1 Existing Travel Conditions and Emerging Trends

As indicated in **Table 2-1**, the City of Brampton's population is forecasted to increase by nearly 200,000 between 2016 and 2031 (or by 31.4%), and employment is forecasted to increase by nearly 82,000 (or by 40.3%). In the study corridor, population is expected to increase by over 20,000 (or 34.6%) and employment is expected to increase by over 8,000 (or 46%The growth is expected to continue past 2031, although at a slower rate. Between 2031 and 2041, Brampton's population is expected to increase by 9.6% while employment is expected to increase by 14%. For the study corridor, the forecasted rates of growth are 12% for population and 17% for employment.

Table 2-1: Population and Employment Growth Forecasts in Brampton and Study Corridor

	2016	2031	2041	Change 2016-2031	Change 2031-2041
All Brampton					
Population	617,994	811,970	890,000	31.4%	9.6%
Employment	203,000	284,900	324,900	40.3%	14.0%
Study Corridor					
Population	64,000	80,770	90,470	34.6%	12.0%
Employment	17,500	26,280	30,740	46.0%	17.0%

Sources:
Existing population and employment: Brampton GeoHub, https://geohub.brampton.ca/pages/urban-form-population (accessed September 2020).
Study Corridor population and employment: 2016 Transportation Tomorrow Survey.
Future population and employment: City of Brampton (September 2019)

This growth is largely consistent with expected growth in the broader Hurontario corridor as described in Hurontario LRT Benefits Case Analysis 2016 report.[1]

With regard to transit, the Hurontario/Main corridor is currently serviced by four bus services which operate during weekday peaks, off-peak periods and weekends, and provide connections to Brampton GO and other parts of the city. Based on the forecasted ridership, it is estimated that at the minimum by 2031 transit frequencies in Mississauga and Brampton will have to increase by 15 percent, and frequencies of corridor routes will have to increase by 40 percent. Given

[1] Hurontario LRT Benefits Case Analysis," March 2016. Prepared by Steer for Metrolinx. Based on the report's Table 1.2, between 2006 and 2031, the population along the Hurontario corridor is forecasted to grow by 43 percent from 152,000 to 218,000. Employment in the region is forecasted to increase by 46 percent, from 76,000 to 111,000.

increasing congestion, it is also estimated that average journey times would increase by 5 percent across all routes.[2]

The impacts of the COVID-19 pandemic on transit ridership and travel patterns have been duly noted and are recognized to be especially pronounced in the short term. However, the future population and employment to be served by the LRT extension is based on approved long-term growth forecasts. By 2041, the City continues to expect a need for this investment to meet the future needs of Brampton residents and businesses; therefore, the ongoing planning and design of the LRT is an important step to secure future funding.

2.2 Case for Change

The implication of the significant increase in population and employment is an increase in travel demand and an increase in congestion if growing transportation needs are not adequately addressed. Therefore, introduction of rapid transit in the corridor is needed to increase transit capacity, offer attractive travel times and performance compared to existing transit and to auto travel in this growth corridor.

Further supporting the case for change, since the publication of the Big Move 2041 Regional Transportation Plan, other studies have been undertaken and have demonstrated the need for rapid transit along Main Street in downtown Brampton.

The Hurontario Main Street Corridor Master Plan (October 2010) introduced a project vision to provide an easy, reliable, frequent, comfortable and convenient light rail transit service throughout the corridor, with effective connections to other links in the inter-regional transit network, which could alleviate anticipated congestion on the corridor. The Hurontario-Main LRT Environmental Project Report (June 2014) built on the first master plan's visions and guiding principles, identifying an approach for a comprehensive 'urban style' LRT which would have competitive journey times, increase journey time reliability, minimize adverse impacts, make a positive contribution to the "beautiful street" component of the vision, and have affordable capital and operating costs.

The Hurontario LRT Benefits Case Analysis (March 2016) re-instated the vision from the Hurontario-Main LRT Environmental Project Report (June 2014) and compared the vision to Metrolinx "The Big Move" objectives presenting a strong business case for this infrastructure.

The Brampton LRT Extension study plans to connect the Hurontario LRT along Main Street from the Brampton Gateway Terminal to the Brampton GO Station. The project will address the need for an appropriate, reliable, frequent, comfortable and convenient rapid transit service required to meet the forecasted demand. In doing so, the extension will improve the vibrancy of the Main Street corridor and ensure effective connections to other links in the inter-regional transit network. The proposed vision presented in the Brampton LRT Extension Study is consistent with Metrolinx 2041 RPT vision and goals for transportation in the region.

[2] Hurontario LRT Benefits Case Analysis," March 2016; Prepared by Steer Davies Gleave for Metrolinx; para 3.18 and 3.19.

2.3 Findings from Public Engagement

The study has engaged the public at several occasions through the study. During the COVID-19 pandemic, following the advice of Ontario's Chief Medical Officer of Health, engagement activities have been hosted in a virtual format.

Following the Summer 2020 virtual Open House, which presented a long list of LRT options, the study team received hundreds of comments from the public regarding the future of the LRT extension. Frequently noted key messages from virtual Open House 1 are as follows:

From Thursday, April 22, 2021 to Thursday May 13, 2021, virtual Open House 2 was held online, to solicit public feedback on the short list, the findings of the Preliminary Design Business Case and the emerging preferred investment options. A summary of the public input from virtual Open House 2 can be found under separate cover.

3 Investment Options

This chapter introduces the options to be evaluated and compared through the four cases that constitute the Business Case. The chapter is arranged explaining how the options were developed, briefly outlining the long list of alternatives, identifying the key assumptions for those alternatives, and presenting the evaluation of alternatives used to develop the short list of cases to be carried through the Business Case with its four cases.

3.1 Options Development

The study area extends 3.6 km from the Brampton Gateway Terminal at Steeles Avenue East to the Brampton GO Station in Downtown Brampton.

To enable the development and evaluation of LRT options, the study area was segmented based on existing and future context such as land use, number of lanes, existing and future right-of-way, and environmental features. The study area was divided into the three major segments shown in **Figure 3-1**, each with its distinct cross-sectional characteristics and constraints:

- **Segment A**, further divided into two segments:
  - A1: Steeles Gateway: from Steeles Avenue to Charolais Boulevard; and
  - A2: Main Street Greenway: from Charolais Boulevard to Nanwood Drive.
- **Segment B**, Main Street South: from Nanwood Drive to Wellington Street.
- **Segment C**, Downtown: from Wellington Street to Brampton GO Station.

Figure 3-1: Study Area Segmentation (Existing and Planned OP ROW)

A long list of twelve (12) options was developed and included:

- Six (6) Surface Options (surface LRT along Main Street);
- Four (4) Loop Options (surface LRT along Main Street with a one-way counterclockwise loop along Nelson Street, George Street, and Wellington Street); and
- Two (2) Underground Options (surface LRT along Main Street from Steeles Avenue to just south of Nan wood Drive and then underground from Nanwood Drive to the Brampton GO Station).

The long list of options was evaluated, presented to the public at virtual Open House 1 from June 22 to July 31, 2020 and narrowed down to a short list for further assessment. Loop options were not advanced due to technical feasibility pertaining to physical constraints and operational challenges in Downtown Brampton with respect to the proposed Hurontario LRT vehicle.

3.1.1 Short List Options

Based on the evaluation of the long list, a short list of six (6) options were carried forward. The short list is composed of four (4) surface options and two (2) underground options which were modelled to investigate impacts on transit and vehicular levels of service. Options generally differ with respect to the use of the road space (dedicated lanes versus lanes shared with other traffic), in alignment and station locations. Surface options are denoted by an “S” whereas underground options are denoted by a “U”. The resulting short list of options is briefly described.

Surface Options

- **Option S1** This option consists of an above-ground dedicated LRT lanes in all segments of Main Street with the terminal station at the Brampton GO Station. This option reduces the travel lanes for automobiles to 2 lanes in Segments B and C. This alternative does not permit left turns along Segment B. No on-street parking is planned for Main Street. This option does not provide a continuous dedicated cycling route: cyclists can use dedicated cycle tracks in Segment A but must ride in mixed traffic conditions or on parallel routes in Segment B and C.

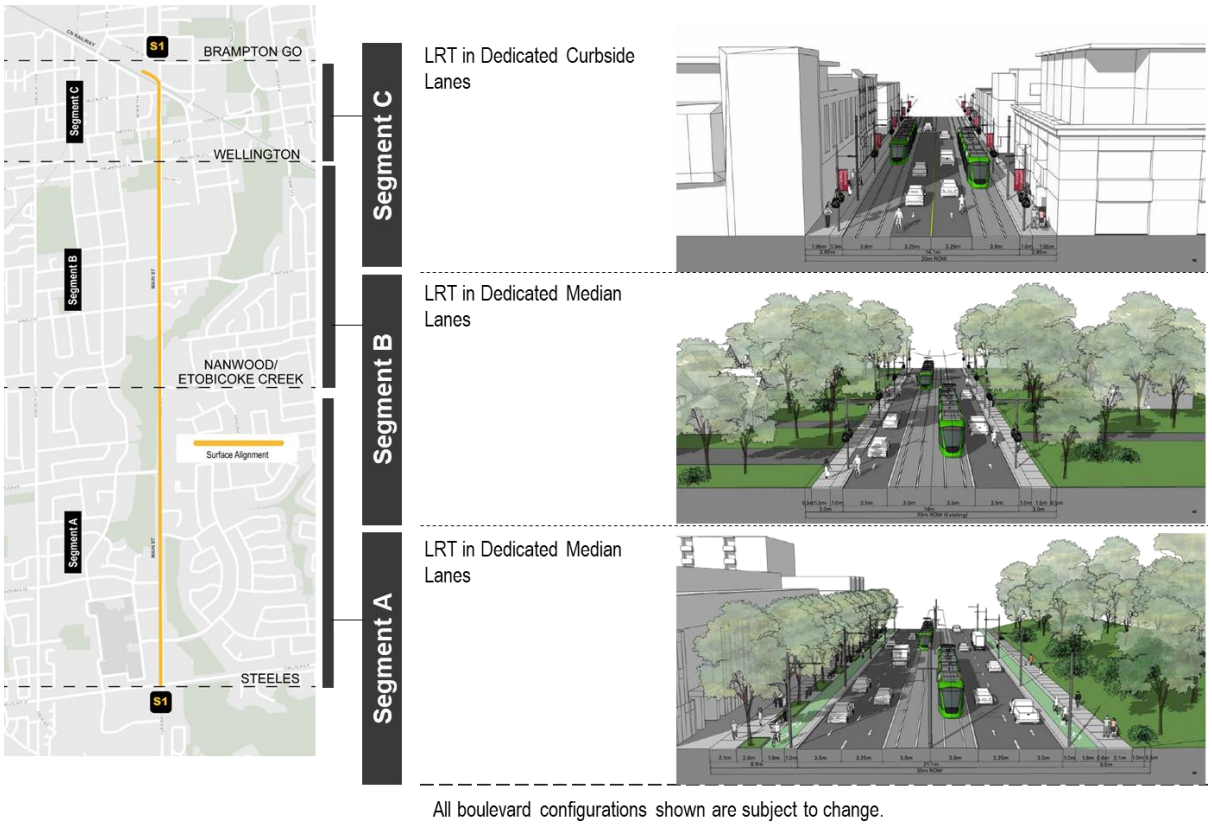


Figure 3-2: Option S1 (Dedicated, Dedicated, Dedicated)

- **Option S2** This option consists of an above-ground dedicated LRT lanes in Main Street segments A and C and an LRT in mixed traffic within Segment B. The terminal station at the Brampton GO Station. This option is consistent with the 2014 TPAP recommendations. No on-street parking is planned for Main Street. This option does not provide a continuous dedicated cycling route: cyclists can use dedicated cycle tracks in Segment A but must ride in mixed traffic conditions or on parallel routes in Segment B and C.

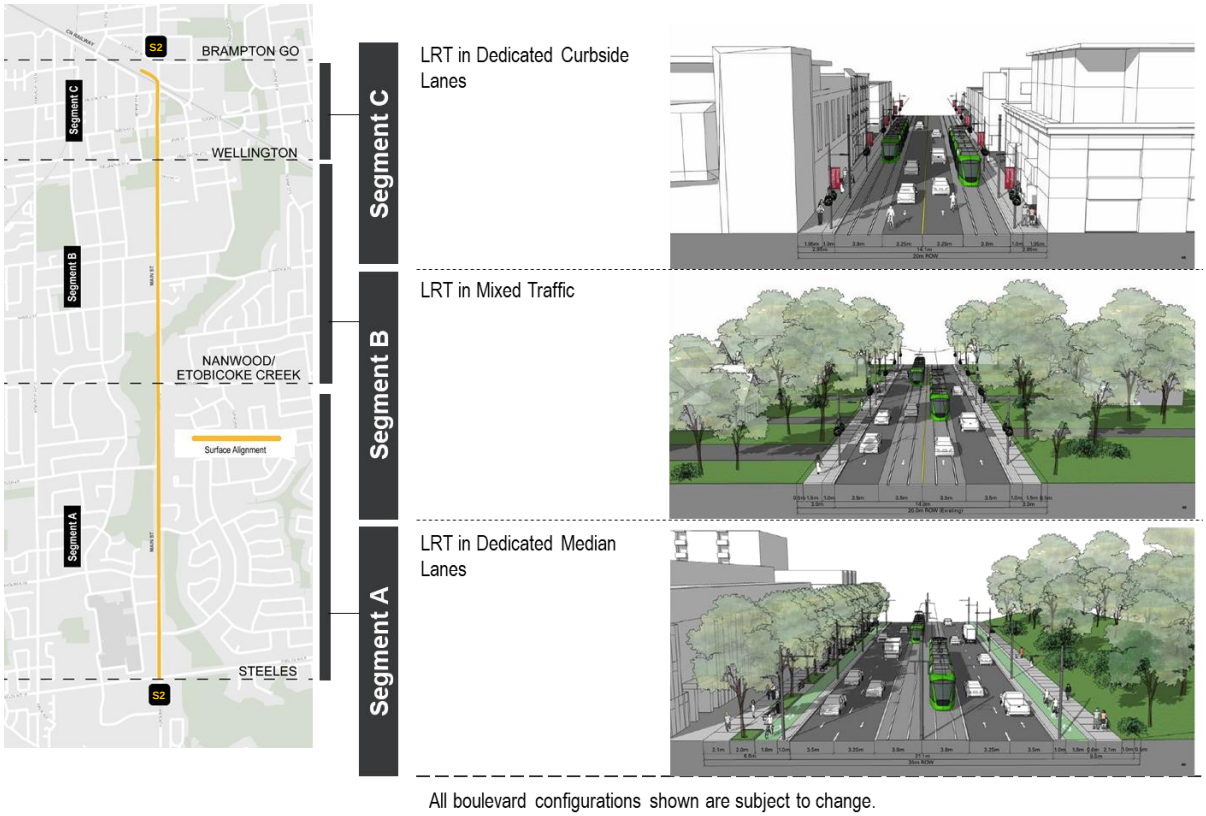


Figure 3-3: Option S2 (Dedicated, Shared, Dedicated)

- **Option S3** This option alignment consists of a dedicated LRT lane in Segments A and B, and a shared LRT lane in Segment C. The terminal station is at the Brampton GO Station. This segment reflects the vision of Downtown Reimagined, which includes two lanes of shared mixed traffic and wide boulevards on either side in Segment C. No on-street parking is planned for Main Street. This option does not provide a continuous dedicated cycling route: cyclists can use dedicated cycle tracks in Segment A and C but must ride in mixed traffic conditions or on parallel routes in Segment B.

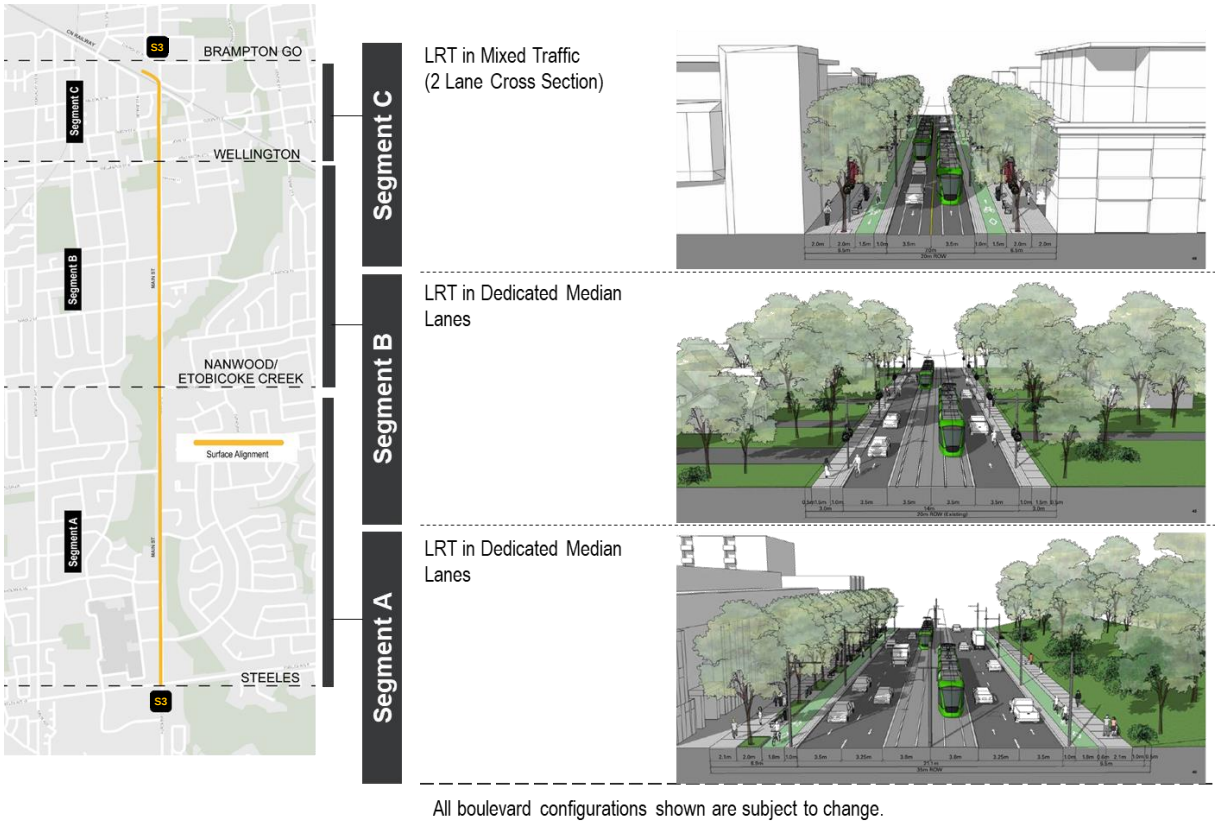


Figure 3-4: Option S3 (Dedicated, Dedicated, Shared)

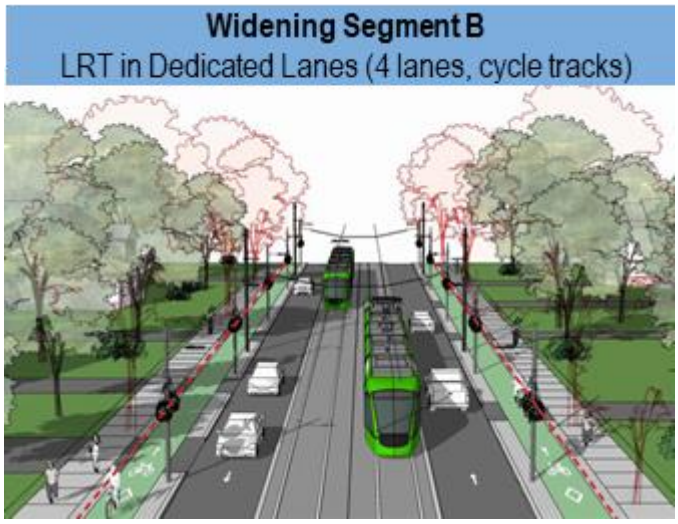
- **Option S4** This option alignment consists of a dedicated LRT lane in Segment A and a shared LRT lane in Segment B and C. The terminal station is at the Brampton GO Station. This segment reflects the vision of Downtown Reimagined, which includes two lanes of shared mixed traffic and wide boulevards on either side in Segment C. No on-street parking is planned for Main Street. This option does not provide a continuous dedicated cycling route: cyclists can use dedicated cycle tracks in Segment A and C but must ride in mixed traffic conditions or on parallel routes in Segment B.

Figure 3-5: Option S4 (Dedicated, Shared, Shared)

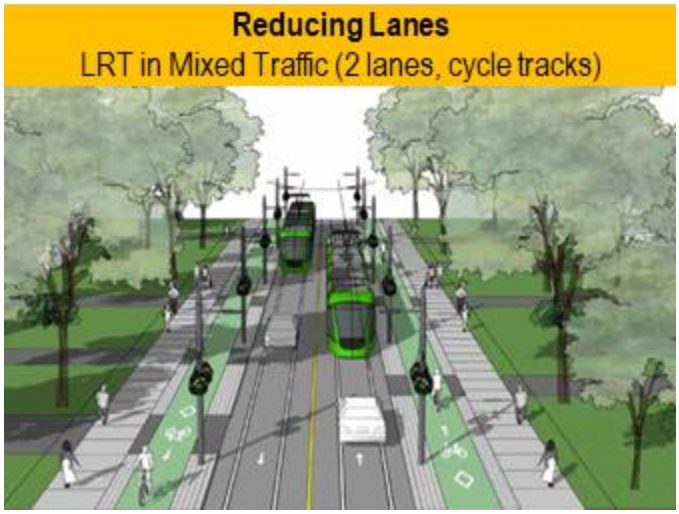
Transit mall options were not investigated as part of this study. Main Street is a major north-south thoroughfare and is the only street through Downtown Brampton that provides continuity and connectivity north of the CN rail tracks. Previous traffic analyses were completed as part of a separate studies to assess closure of Main Street but was not carried forward. Therefore, closing general purpose lanes was not considered for Main Street between Wellington Street and Brampton GO station. However, surface option S3 and S4 are designed such that they can be converted to a transit mall in the future.

Surface options presented challenges in accommodating dedicated cycling facilities between Nanwood Drive and Wellington Street due to the limited 20 m right-of-way available in that section of the study corridor. This lead to a subset of options being developed that would enable cycling and provide full cycling network connectivity between uptown and downtown Brampton. Variations in the Segment B cross-section were identified while retaining Segment A and C elements

consistent with options S3 and S4. These additional options ultimately possessed critical flaws, major impacts and operational and safety concerns. Therefore, they were not evaluated in the PDBC. The investigation of cycling opportunities in Segment B is summarized and reasons for not including them in the PDBC are explained as follows:



- **Right-of-way (ROW) widening in Segment B to accommodate dedicated cycle tracks:** ROW widening posed significant impacts to the natural and cultural heritage environment as well as residential properties and their driveways. Widening would require an additional 6180 m² of property acquisition (as compared to no widening) which would result in increased project costs to the City. Furthermore, strong public and property owner interest has been expressed for the retention of the heritage character and mature tree canopy on Main Street south. An arborist survey was conducted on November 24, 2020 to quantify impacts of widening the ROW to 30m on existing trees. Trees expected to be removed, injured and retained were identified, including mature trees of significance (>100 cm Diameter at Breast Height). 148 trees would require removal and 111 trees would be injured in the process, 5 of which are of significant value. A meandering multi-use trail was considered but was found to not minimize impacts to trees between the edge of the street and the future ROW line.



- **Reduction of lanes in Segment B to 2 / 3 shared LRT and general traffic lanes:** With a 2 or 3 lane section in Segment B, a significant increase in auto and transit travel time was observed, eroding the value of money proposition for such an option. Moreover, it would be unsafe to have vehicles turn left out of driveways across the opposing LRT lanes. The number of driveways (approximately 73) and length (~1 km) of this segment further increases risk of severe collisions (broadside and rear end). It would be extremely difficult to enforce turn restrictions as these are private, unsignalized driveways, making this option unfavorable from a traffic safety perspective. The mixed traffic/transit conditions would also be very poor for emergency/service vehicle operations (garbage removal, snow clearing) and would have additional negative impacts on transit/traffic unless shifted to off peak hours.

In light of the interrupted cycling network that characterizes surface options in Segment B, alternative or parallel cycling routes are under consideration to provide cycling connections to downtown Brampton. Potential cycling connections include routes along low traffic streets such as Elizabeth Street or along the existing Etobicoke Creek trail. Improvements to alternative or parallel cycling routes will be confirmed in the next stages of the study. In the absence of dedicated infrastructure, cycling in mixed traffic is to be protected in surface options through the use of sharrows and the provision of dedicated cycling facilities along alternate parallel routes. This analysis is consistent with the Hurontario-Main LRT TPAP (2014) recommendations which do not include dedicated cycle facilities between Nanwood Drive and Wellington Street.

The short list of surface options to be assessed in the PDBC are summarized in **Figure 3-6**.

Short List: Surface Options

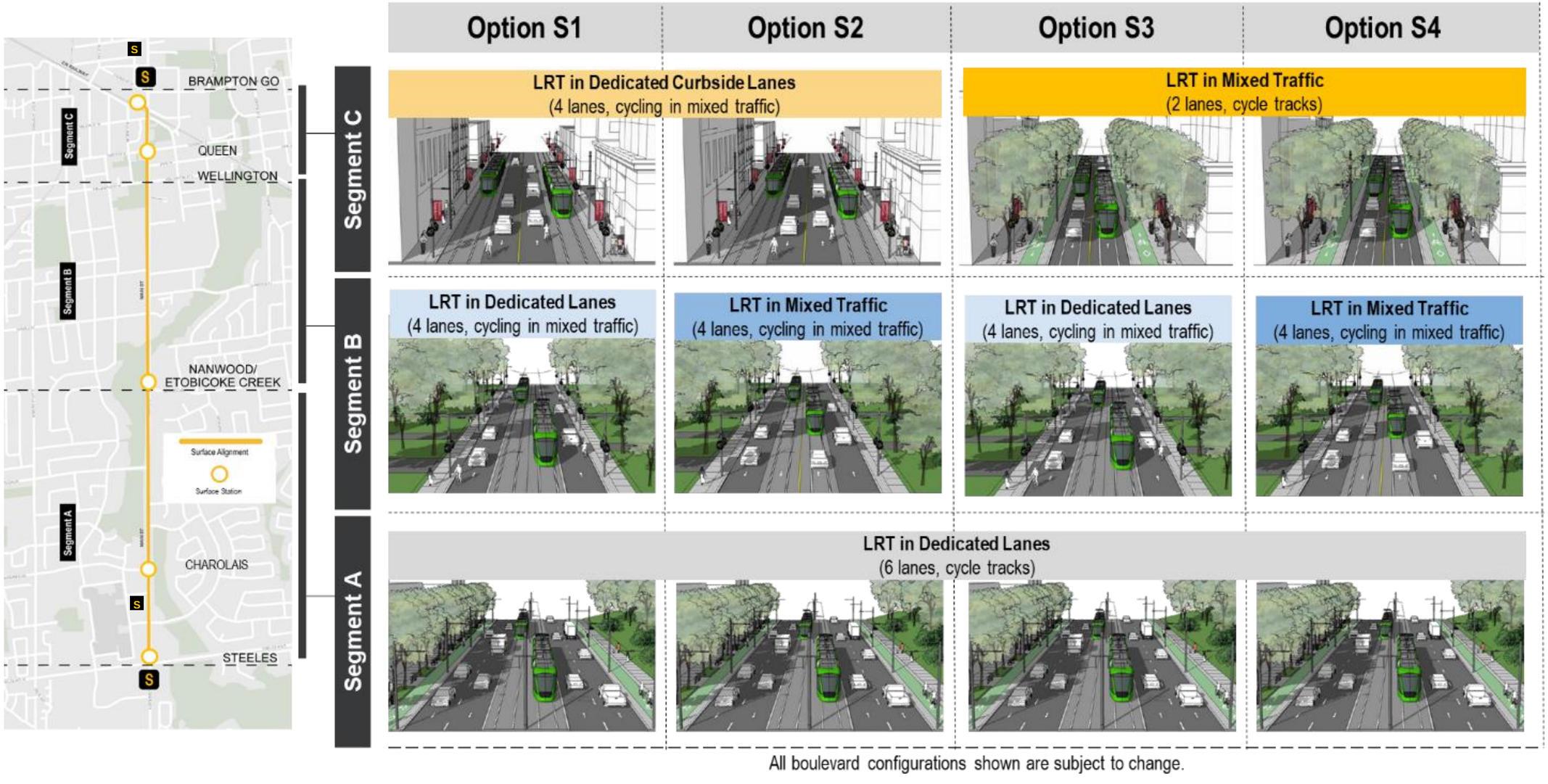


Figure 3-6: Summary of Short Listed Surface Options

Underground Options

- **Option U1** This option consists of a dedicated surface LRT in Segment A and underground portion running along Main Street in Segments B and C. Surface stations are provided at Steeles and Charolais while underground stations are provided at Nanwood and Brampton GO. For underground options, there is no station at Wellington/Queen. On the surface, the 3 traffic lanes will be provided along Segment B and the Downtown Reimagined vision of two lanes of shared mixed traffic with wide boulevards on either side will be provided in Segment C. No on-street parking is planned for Main Street. The terminus station is to be under Main Street. This option provides a continuous dedicated cycling route: cyclists can use dedicated cycle tracks in Segment A, B and C
- **Option U2** This option consists of a dedicated surface LRT in Segment A and an underground portion running along Main Street in Segment B before diverting onto George Street in Segment C. Surface stations are provided at Steeles and Charolais while underground stations are provided at Nanwood and Brampton GO. For underground options, there is no station at Wellington/Queen. On the surface, the 3 traffic lanes will be provided along Segment B and the Downtown Reimagined vision of two lanes of shared mixed traffic with wide boulevards on either side will be provided in Segment C. No on-street parking is planned for Main Street. The terminus station is located under George Street. This option provides a continuous dedicated cycling route: cyclists can use dedicated cycle tracks in Segment A, B and C.

Options U1 and U2 are presented in **Figure 3-7**.

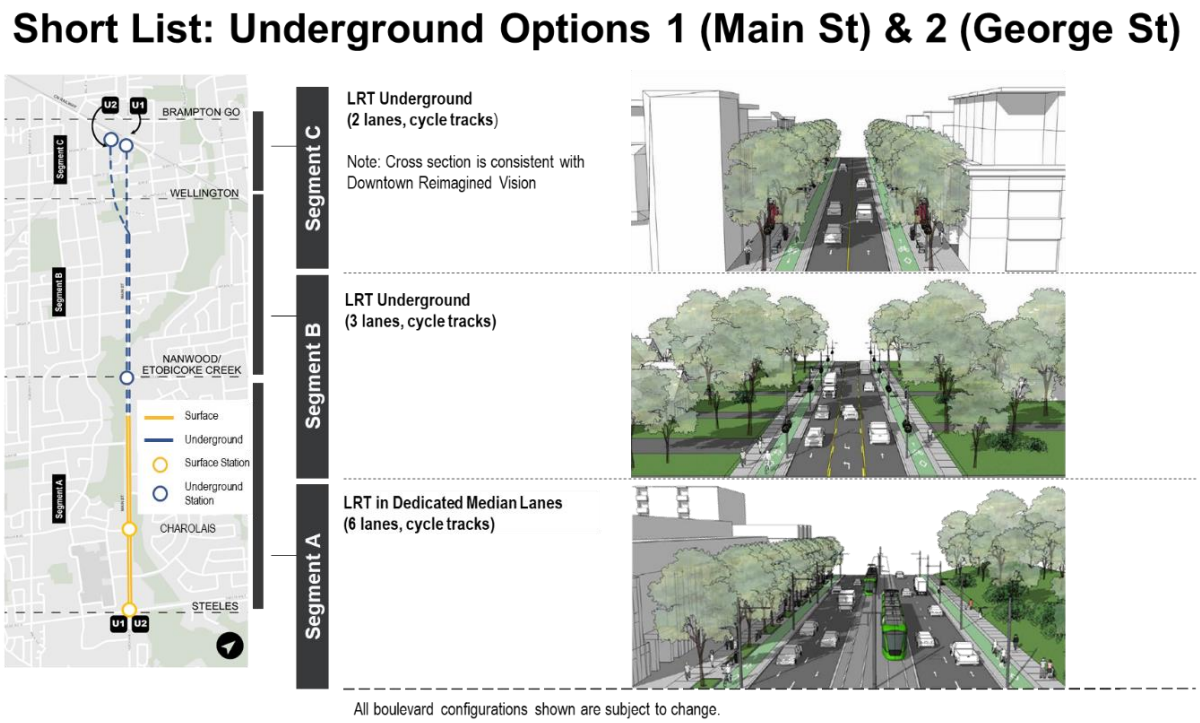


Figure 3-7:Options U1 & U2 (Dedicated, Underground, Underground)

3.1.2 Station Locations

Station locations identified in the long list evaluation stage were reviewed and confirmed. The short list evaluation stage incorporated additional technical findings as well as public feedback received during virtual Open House 1 (held virtually fromfrom June 22 to July 31, 2020) to inform the recommended station locations for surface and underground routes.

It should be noted that although the Brampton Gateway Terminal Station is shown as part of the LRT Extension Study, it will be implemented as part of the Hurontario LRT project (Port Credit GO Station to Brampton Gateway Terminal). The exact location of the station (i.e. south of Steeles Avenue or north of Steeles Avenue) is subject to discussions with Metrolinx; however, for the purposes of this PDBC, it has been assumed to be located on the north side of Steeles Avenue, pending further direction.

The station locations and evaluations were reviewed and confirmed by the City of Brampton.

3.1.2.1 Surface Stations / Stops

The proposed station locations for the surface options are shown in **Figure 3-8** and are as follows:

1. Brampton GO
   - Island Platform
2. Downtown
   - Queen Street, Northbound Platform
   - Wellington Street, Southbound Platform
3. Nanwood
   - Far-Side, Split Platform
4. Charolais
   - Far-Side, Split Platform
5. Gateway Terminal
   - North side of Steeles, Island Platform

There was no change to the station locations relative to the base assumptions from the long list phase. Furthermore, the station locations are consistent with the 2014 Hurontario-Main TPAP recommendations.

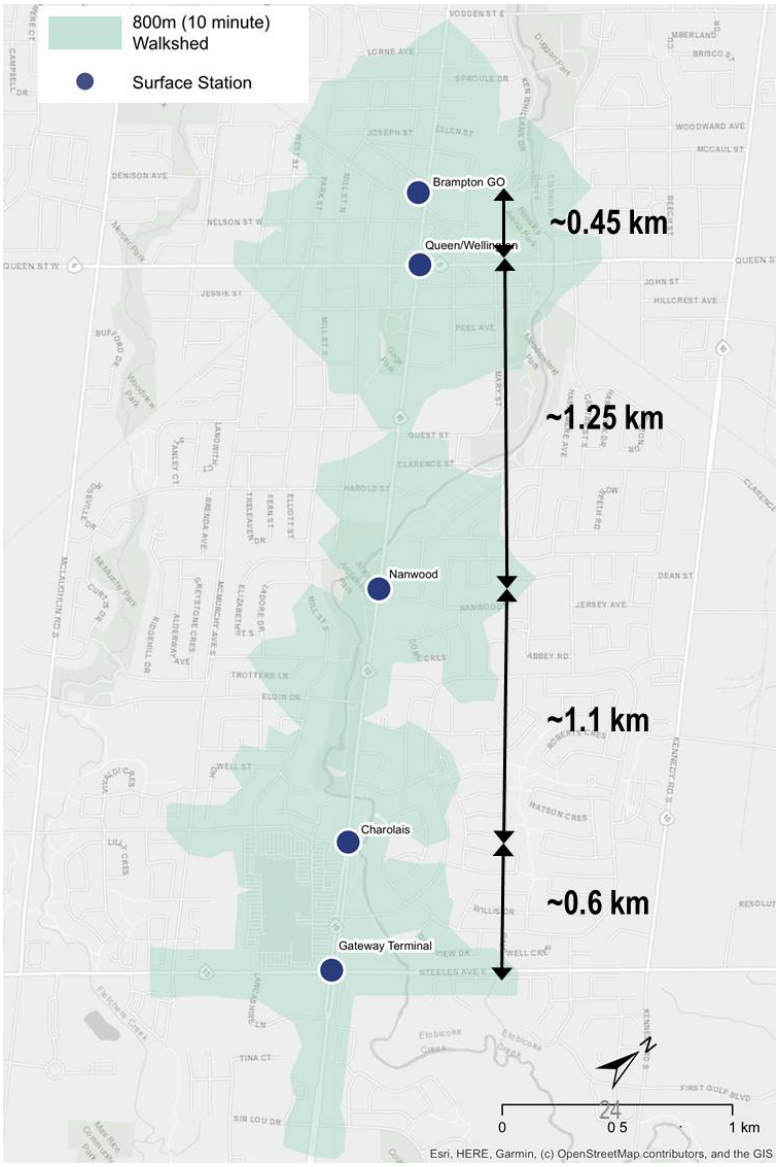


Figure 3-8: Surface Stations / Stops

3.1.2.2 Underground Stations

The proposed station locations for the underground options are shown in **Figure 3-9** and are as follows:

1. Brampton GO (underground)
2. Nanwood (underground)
3. Charolais (surface)
   - Far-Side, Split Platform
4. Gateway Terminal (surface)
   - North side of Steeles, Island Platform

The underground station at Wellington Street was screened out during the short list phase. The implications on Metrolinx Preliminary Design Business Case strategic criteria such as ridership, future population, employment, low-income demographics served were reviewed.

Results indicated that the strategic benefits of maintaining the underground station were not deemed to outweigh implementation costs and impacts to Wellington Park, especially given the station's proximity to Brampton GO (within its 800m walkshed). Moreover, public support at virtual Open House 1 for an express service with fewer stops as well as general concerns related to project funding and availability further validated the removal of Wellington Station.

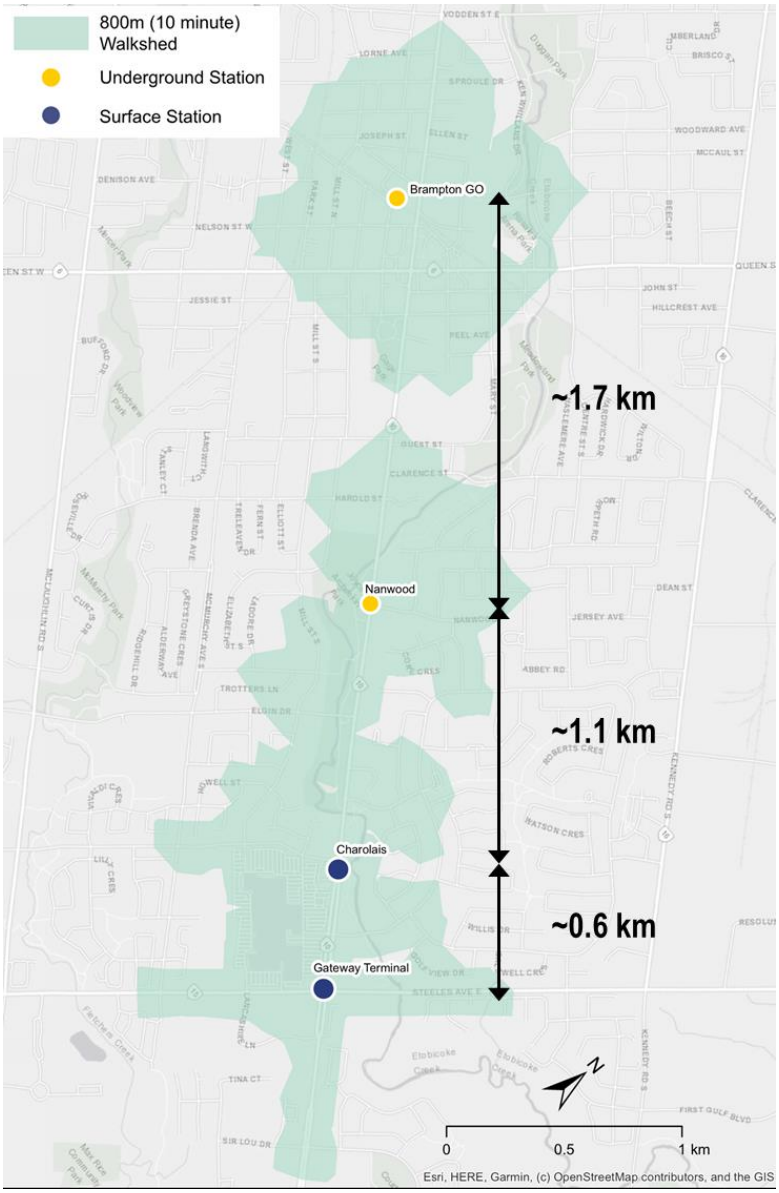


Figure 3-9: Underground Stations

4 Strategic Case

The Strategic Case summarizes the performance of the options against the identified strategic objectives to indicate if the investment addresses the issues identified in the Problem Statement. Performance measures were developed to evaluate each option's ability to meet the objectives and support the realization of the strategic goals/outcomes. The Investment Options were compared to the future Business- As-Usual Scenario, which includes bus service along Main Street (10-minute frequency assumed).

This chapter is structured around the three goals, or strategic outcomes, defined in the Problem Statement chapter as follows:

1. Strong Connections;
2. Complete Travel Experiences; and
3. Sustainable and Healthy Communities.

Each of the above sections outlines the results of the transportation modeling and evaluation of outcomes. The chapter ends with an overall summary and conclusions.

The *Transportation and Traffic Analysis Report for Short Listed Options*, dated December 12, 2020, provides the technical transportation inputs informing the Strategic Case.

4.1 Strategic Goals, Objectives and Performance Metrics

The strategic goals and objectives of the project are aligned with those of the Metrolinx 2041 RTP, presented in **Table 4-1.** Performance measures were developed to evaluate each option's ability to meet the objectives and support the realization of the strategic goals.

Table 4-1: Metrolinx RTP Goals, Objectives

Goals	Objectives	Performance Metrics
Strong Connections	Improve access to transit	a. 2041 Total daily boardings (ridership b. 2041 Ridership increase on Hurontario LRT (peak period) c. 2041 Ridership increase at Brampton GO (peak period) d. 2041 Incremental local bus boardings at Brampton GO (peak period) e. 2041 Population within 800 m of stations
	Increase access to economic opportunities	a. 2041 Employment within 800 m of stations b. 2016 Trips destined to 800 m of stations c. Number of low-income residents within 800 m of stations
	Support city-building objectives	a. Description of how the option aligns with planned development b. Description of how the option supports areas with land uses compatible with rapid transit as identified in the Official Plan c. Ability to incorporate Downtown Reimagined elements related to people-gathering place for civic events

Goals	Objectives	Performance Metrics
Complete Travel Experiences	Improve travel time and level of service	a. Auto travel time (PM peak hour) (Steeles to Church St) b. Transit travel time (PM peak period in vehicle travel time) (Steeles to Brampton GO) c. Travel transit travel time savings per trip, PM peak period d. Total transit travel time savings for all trips, PM Peak, person-minute e. Multimodal Level of Service
	Improve comfort and safety	a. Description of potential conflicts for drivers with LRT b. Description of potential conflicts for pedestrians & cyclists with LRT
	Building an integrated transportation network	a. Transfer distance and time between Brampton GO LRT platform and Brampton downtown bus terminal (centre of platform to centre of platform) b. Transfer distance and time between Brampton GO LRT platform and Brampton GO platform (centre of platform to centre of platform)
Sustainable and Healthy Communities	Move people with less energy and pollution	a. Total vehicle-kilometres travelled (VKT) along the study corridor (bounded by Kennedy and McLaughlin) during the PM peak hour b. Number of additional people who will use transit during the PM peak period compared to the base
	Improve quality of life and public health	a. Ability to achieve road to public realm ratio of 60/40 respectively b. Ability to provide adequate sidewalk width according to street character/context c. Ability to incorporate Downtown Reimagined Streetscape elements (for Segment C only) d. Compatibility with parks and public spaces e. Ability to provide a continuous cycling network
	Reduce impacts to the natural and cultural environment	a. Number/significance of natural heritage feature / area affected b. Number/significance of cultural heritage feature / area affected

Based on the above, the LRT extension should connect people to places that improve their lives, such as their residence, workplace, community services, parks and open spaces, and recreation. The LRT extension should also contribute to an easy, safe, accessible, affordable, and comfortable door-to-door travel experience that meets the diverse needs of travelers. Finally, the LRT extension should be an investment in transportation for present and future generations by supporting land use intensification, climate resiliency, and a low-carbon footprint while leveraging innovation.

The goals presented in **Table 4-1** are discussed in more detail below.

- **Strong Connections**

The LRT connection can provide strong connections by improving access to transit, thereby increasing access to economic opportunities, and support city-building objectives. Accessibility of transit can be improved by reducing barriers and promoting ease of using active transportation to get to and from LRT stops. Strong growth in population and employment in the study corridor offers an opportunity to increase connectivity of people to economic opportunities throughout the corridor and more broadly across Brampton. Additionally, investment in rail infrastructure will likely result in redevelopment along the corridor to create higher density developments which reduce car-dependency in the city's core.

- **Complete Travel Experiences**

Objectives to meet the goal of complete travel experiences are tied to improvements in the transit network through reduced travel times, improved comfort, safety and integration. A rapid transit system will improve travel times, as well as comfort, safety, service frequency, and reliability of travel compared to the existing bus services along the corridor.

The LRT extension will serve four mobility hubs, which are key nodes in the transit network where multiple modes and routes come together. The LRT will allow for interchanges with key regional services including GO Transit rail, local bus rapid transit, and bus services. Integration will also be achieved through improved wayfinding and information to simplify and encourage interchanges between various services.

- **Sustainable and Healthy Communities**

The LRT can reduce the population's dependence on automobiles, which will reduce the modal share of automobiles. Reduced automobile traffic will lower emissions, reducing pollution and increasing air quality. Bus services are also able to reduce frequency with the implementation of LRT along the corridor and could yield additional emission savings. The implementation of LRT will also encourage transit users to walk or bike to and from stations, improving health and wellness of users. For example, it is estimated that by 2031, the implementation of the Hurontario LRT will increase the transit mode share by 25 percentage points in the corridor to 49 percent. This compares to a mode share of just 14 percent across Mississauga and Brampton (see **Table 4-2**).

Table 4-2: Transit Mode Share, by Geographic Area, 2031 AM Peak

Scenario	Hurontario-Main LRT Corridor	Within Mississauga-Brampton
Do Minimum	24%	13.6%
With HLRT	49%	14%
Change	25%	0.4%

Source: "Hurontario LRT Benefits Case Analysis," March 2016. Prepared by Steer for Metrolinx. Table 4.4.

4.2 Strong Connections

4.2.1 Improve Access to Transit

The Brampton LRT Extension will improve access to transit through the provision of extended new rapid transit infrastructure compared to the No-Build, or Business as Usual (BAU), scenario. Continued population and employment growth in the City of Brampton and adjacent municipalities are expected to lead to increasing levels of travel demand in the study corridor. In the context of the Brampton LRT extension, the demand for travel will need to be satisfied through a high-capacity form of transit that is connected to the region's broader network and provide seamless mobility across the region. The Project would add approximately 3.5 km of high capacity rapid transit. The Project is projected to experience between nearly 26,300 and 30,900 daily boardings by 2041, depending on the option. Alternative S4 would result in the lowest daily ridership at 26,300 boardings per day, while S1, U1, and U2 will result in the highest daily ridership at over 30,500 boardings per day.

The project is also expected to increase boardings/alightings on Hurontario LRT and Brampton GO. These tend to be higher for the underground options than for surface options. Option U1 is expected to increase ridership on both Hurontario LRT and Brampton GO by 6,100 trips during peak period. From the surface options, Option S1 is expected to have the best performance by increasing ridership on Hurontario LRT by 6,200 peak period trips and on Brampton GO by 1,200 peak period trips.

The accessibility improvements are further supported by enhancements to the urban realm which reduces barriers of walking to and from LRT stops, as well as contributing to the broader ease of walking and cycling along the corridor. By 2041, the Project would provide walking distance access (measured as 800 meters) to rapid transit for 28,500 people and 28,000 people under surface and underground options, respectively.

Table 4-3 below provides a summary of the improved access to transit measures.

Table 4-3: Measures of Improved Access to Transit, by Option

	S1	S2	S3	S4	U1	U2
LRT Daily Ridership*	30,900	27,700	29,500	26,300	30,500	30,500
Ridership increase on Hurontario LRT (Peak Period)	6,200	5,200	5,800	4,800	6,100	6,100
Ridership increase at Brampton GO Rail Station (Peak Period)	1,200	1,000	1,100	800	1,400	1,400
Incremental local bus boardings at Brampton GO	1,300	1,000	1,100	800	1,500	1,500
2041 Population within 800 m of Stations	28,500	28,500	28,500	28,500	28,000	28,000

Source: EMME

* Daily northbound and southbound boardings for all stations from Brampton GO to Steeles Avenue.

4.2.2 Increase Access to Economic Opportunities

The Brampton LRT Extension would increase access to economic opportunities along the LRT corridor. This objective is measured in terms of 2041 employment within 800 meters of LRT stations and 2016 trips to destinations within 800 meters of stations. **Table 4-4** shows that surface options perform at a slightly higher level than underground options based on these measures due to their additional stations:

- 2041 employment within 800 meters of stations is estimated at 17,000 for surface options and 15,000 for underground options;
- 2016 trips with destinations located 800 meters of stations are estimated at 1,800 for surface options and 1,600 for underground options;
- low income population within 800 meters of stations is estimated at 2,400 for surface options and 2,200 for underground options.

Table 4-4: Economic Opportunities around LRT Stations

	S1	S2	S3	S4	U1	U2
2041 Employment[1] within 800 m of stations	17,000	17,000	17,000	17,000	15,000	15,000
2016 Trips destined[2] to 800 m of stations (Peak Hour)	1,800	1,800	1,800	1,800	1,600	1,600
Low income population[3] served	2,400	2,400	2,400	2,400	2,200	2,200

Source: [1]EMME, [2]Transportation Tomorrow Survey (2016), [3]Census Canada (2016)

4.2.3 Support City-Building Objectives

The objective of supporting city-building has three performance measures related to city development as listed in **Section 4.1.** Analysis of the options in relation to these performance measures led to the conclusions outlined below.

- Regarding the **alignment with planned development**, it is noted that all options serve the same key destinations and areas with planned high density of people and jobs. All options connect growth areas identified in Brampton's 2041 Vision (Uptown and Downtown) and link Urban Growth Centres identified in A Place to Grow such as Downtown Brampton and Mississauga City Centre.
    - Surface and underground options both have a stop / station at Nanwood Drive. The nearby Brampton Mall presents redevelopment potential, subject to the Brampton East Secondary Plan Special Policy Area (SPA1).
    - Underground options can provide underground connections to existing buildings and destinations. Option U1 has limited potential to integrate with adjacent development in downtown Brampton due to the station box in the centre of Main Street, with private properties to the west and contributing heritage City-owned buildings to the east; however, the connection to 8 Nelson (existing bus terminal) provides an opportunity for transit oriented development on that site. Opportunities to integrate Option U2 with the planned Centre for Innovation (CFI) were investigated but deemed unfeasible due

to schedule incompatibility, as per discussions with the City of Brampton. However, knockout panels from the station can be provided to protect for future connections from the station to the CFI as well as 8 Nelson (existing bus terminal). Therefore, both Option U1 and U2 exhibit similar alignment with planned development and intensification.

- Regarding **support for areas with land uses compatible with rapid transit** identified in the Official Plan (OP), options meet most OP policies similarly and move toward implementing the City of Brampton's Sustainable City Concept. The predominant land use designation for the Hurontario-Main Corridor according to Secondary Plan Area (SPA) 55 is "high and medium density residential dwellings". OP Policy 4.1.1 (minimum gross density) sets medium and high-density maximums of 50 to 200 units per hectare, which are best served by dedicated rapid transit and subway-type service according to MTO's transit-supportive guidelines. However:
    - Surface options address OP Policy 4.4.4 (Public Transit) differently. Options where LRTs operate in dedicated lanes best align with the Official Plan policies for the implementation of hierarchical high-frequency key north-south spines where transit priority is ensured via design and signal systems (OP Policy 4.4.4.2). Options with more exclusive / dedicated road space for LRT operations (S1, S3 and to a lesser extent, S2) have less potential for conflict and are better suited to supporting transit nodes and intensifying areas and to delivering fast, reliable, convenient, accessible and affordable service to key destinations. However, S1 fails to "ensure the provision of dedicated cycling lanes on arterial roads" and use "a series of walking, cycling and multi-use trails that connects Brampton's major destinations and links with other trails systems outside Brampton". (OP Policy 4.4.6.8)
- Regarding the **ability to incorporate Downtown Reimagined elements** related to people-gathering place for civic events, the surface options do not provide the opportunity to close down Queen and Main Street intersection for civic events as this would impact LRT operations. All underground options would allow the closure of Queen and Main Street. Options S3, S4, U1, and U2 incorporate Downtown Reimagined streetscape elements.

4.3 Complete Travel Experience

The extension of the rapid transit line will improve the speed, frequency and reliability of transit service in the study area. Combined, these will enhance the overall travel experiences for customers and make transit a more attractive travel mode.

4.3.1 Improve Travel Time and Level of Service

Moving people quicker, offering reliable travel and improving experience is a key component of the 2041 Regional Transportation Plan. LRT offers a potential for higher average speeds compared to the conventional transit. **Table 4-5 s**hows that all options are also estimated to improve travel times. Options S1, S3, U1 and U2 will generate substantial travel time savings along the LRT corridor of 5 to 7 minutes per trip compared to the No-Build / Business-as-Usual scenario. Other options such as S4 and S2 are estimated to generate smaller time savings,

between 2 and 3 minutes per trip. To account for the ridership along the extension, the total transit travel time savings were extracted and indicate that S1, U1 and U2 offer the greatest reductions overall.

Table 4-5: Travel Time Impacts of Brampton LRT Extension, by Option

	S1	S2	S3	S4	U1	U2
Alignment in Dedicated and Grade Separated Lanes, Percent of Total	100%	60%	80%	40%	100% with 50% Grade Separated	100% with 50% Grade Separated
Transit Travel Time (PM Peak hour, Build), Minutes	8	11	9	12	7	8
Average Auto Travel Time[3] in LRT Corridor, Minutes per Trip	6	6	7	6	6	6
Transit Travel Time Savings compared to BAU, Minutes per Trip	6	3	5	2	7	7
Total Transit Travel Time Savings compared to BAU PM peak period, Person-minute	35,000	17,000	28,000	11,000	35,000	35,000

Source: EMME

Auto travel times are consistent between options. At the same time, LRT can be expected to increase somewhat auto travel time in the LRT corridor due to dedicated LRT lanes which reduce the number of general driving lanes and thus road capacity. The increase in auto travel times would be larger for options which have dedicated LRT lanes over a larger portion of the alignment. Auto travel times in the LRT corridor under the Build scenarios are estimated between at 6 to 7 minutes per trip, as seem in **Table 4-5**. This compares to current travel time of about 7 minutes (based on Google Maps) and a 2041 BAU auto travel time of 5.6 minutes and thus implies a small to moderate impact.

Multimodal Level of Service

Table 4-6 summarizes the findings of the level of service analysis conducted to assess future conditions for pedestrians, cyclists, transit users and drivers as part of the *Transportation and Traffic Analysis Report for Short Listed Options*, dated December 12, 2020.

On an option-level, the following was observed:

- **Options U1 and U2 achieve the highest quality pedestrian and cycling environments across the study area.** As expected, underground options perform best as their surface impacts are minimal, and road space can be allocated to improve the pedestrians and cyclist facilities and implement the Downtown Reimagined vision. **Options S3 and S4 achieve the best Pedestrian and Bicycle Level of Service (PLOS and BLOS) results for surface options.**

[3] The similarities in auto travel times can be explained as a combination decreasing demand and similar available auto capacity. Rounding of travel times also makes results appear more similar.

- **In terms of transit level of service (TLOS), underground options outperform the rest.** As expected, Options U1 / U2 provide travel times most competitive with the auto-mode, particularly in downtown Brampton while providing transit travel time savings of up to 2 minutes compared to other options. **Among surface options, S4 performs better than others corridor-wide, has the lowest transit-auto ratio as well as highest transit headway adherence.** However, all options exhibit strong headway adherence and on-time performance. **Moreover, transit travel times are generally very comparable between the options according to the microsimulation (VISSIM).** Dedicated LRT operations do not perform as well as anticipated due to the need to transition from curb to median lanes which require delays at signals. Demand and signal timing differences are also contributing factors for fluctuations in transit metrics between options.
- **Surface options best accommodate transfers at Brampton GO, followed by Option U2.** Conversely, Option U1 is located closer to the heart of downtown Brampton (Queen Street / Main Street) than U2.
- **Regarding vehicle level of service (VLOS), options perform generally similarly and exceed the level of service targets set except at major intersections such as Steeles Avenue and Queen Street.** Total auto-travel times are comparable between options, ranging between 6 and 7 minutes. Volumes decrease along Main Street under LRT options with dedicated segments, indicating that drivers are changing to alternative routes

Overall, short-listed options perform comparably and generally well when reviewing across modes. However, Option S4 achieves better results for walking and cycling and yields marginal improvements to transit and vehicular LOS compared to other surface options. Underground options perform better than surface options and draw higher ridership, but these factors must be weighed against the increase in cost of implementation.

Table 4-6: Summary of Multi-modal level of service analysis

		S1 Dedicated, Dedicated, Dedicated	S2 Dedicated, Mixed, Dedicated	S3 Dedicated, Dedicated, Mixed	S4 Dedicated, Mixed, Mixed	U1 Dedicated, Underground (via Main St)	U2 Dedicated, Underground (via George St)
	Segment A						
PLOS	**int. PLOS**						
PLOS	# of intersections with LOS A-C	0 intersections					
PLOS	# of intersections with LOS D-E	4 intersections					
PLOS	# of intersections with LOS F	1 intersection					
PLOS	**seg. PLOS**	C					
BLOS	**int. BLOS**						
BLOS	# of intersections with LOS A-C	0 intersections					
BLOS	# of intersections with LOS D-E	4 intersections					
BLOS	# of intersections with LOS F	1 intersection					
BLOS	**seg. BLOS**	A					
TLOS	Transit-auto travel time ratio*	1.69	1.60	1.67	1.70	1.68	
TLOS	Stop level conditions	Rain protection					
VLOS	**int. VLOS**						
VLOS	# of intersections with LOS A-C	6	6	5	6	6	
VLOS	# of intersections with LOS D-E	0	0	1	0	0	
VLOS	# of intersections with LOS F	1	1	1	1	1	
VLOS	**seg. VLOS**	E	E	E	E	E	
	Segment B	**S1**	**S2**	**S3**	**S4**	**U1**	**U2**
PLOS	**int. PLOS**						
PLOS	# of intersections with LOS A-C	2	2	2	2	3	
PLOS	# of intersections with LOS D-E	1	1	1	1	0	
PLOS	# of intersections with LOS F	0	0	0	0	0	
PLOS	**seg. PLOS**	E	E	E	E	C	
BLOS	**int. BLOS**						
BLOS	# of intersections with LOS A-C	1	1	1	1	3	
BLOS	# of intersections with LOS D-E	2	2	2	2	0	
BLOS	# of intersections with LOS F	0	0	0	0	0	
BLOS	**seg. BLOS**	E	E	E	E	A	
TLOS	Transit-auto travel time ratio*	1.18	1.19	1.21	1.27	1.13	
TLOS	Stop level conditions	Rain protection				All-weather protection	
VLOS	**int. VLOS**						
VLOS	# of intersections with LOS A-C	9	9	9	9	9	
VLOS	# of intersections with LOS D-E	0	0	0	0	0	
VLOS	# of intersections with LOS F	0	0	0	0	0	
VLOS	**seg. VLOS**	A-C	A-C	A-C	A-C	A-C	
	Segment C	**S1**	**S2**	**S3**	**S4**	**U1**	**U2**
PLOS	**int. PLOS**						
PLOS	# of intersections with LOS A-C	3	3	3	3	3	
PLOS	# of intersections with LOS D-E	0	0	0	0	0	
PLOS	# of intersections with LOS F	0	0	0	0	0	
PLOS	**seg. PLOS**	C	C	B	B	B	
BLOS	**int. BLOS**						
BLOS	# of intersections with LOS A-C	1	1	2	2	2	
BLOS	# of intersections with LOS D-E	2	2	1	1	1	
BLOS	# of intersections with LOS F	0	0	0	0	0	
BLOS	**seg. BLOS**	E	E	A	A	A	
TLOS	Transit-auto travel time ratio*	1.84	1.83	1.28	1.30	0.47	
TLOS	Stop level conditions	Rain-protection				All-weather protection	
TLOS	Transfer time to bus terminal	2 min				4 min	3 min
TLOS	Transfer time from / to Brampton GO Rail	4 min				5 min	4 min
VLOS	**int. VLOS**						
VLOS	# of intersections with LOS A-C	4	4	3	4	3	
VLOS	# of intersections with LOS D-E	1	0	1	1	2	
VLOS	# of intersections with LOS F	1	2	2	1	1	
VLOS	**seg. VLOS**	D	A-C	E	D	A-C	
	Corridor-wide						
TLOS	**Coefficient of Variation of Headways+**	0.18	0.22	0.11	0.16	0.10	
TLOS	**LRT On-time Performance***	76%	78%	75%	74%	83%	

Transit-auto travel time ratio is computed based on traffic microsimulation results (VISSIM), as shown in the *Transportation and Traffic Analysis Report for Short Listed Options*, dated December 12, 2020.

+ Represents the standard deviation of headways divided by the mean headway. This indicates the regularity of transit vehicle arrivals with respect to the mean headway of each option. Therefore, this coefficient may not be necessarily comparable from scenario to scenario.

* A vehicle is “on-time” if it arrives between 4 – 8 minutes from the last departure. This represents a window of early arrival of 1 minute and a late arrival of 3 minutes from a headway of 5 minutes. On-time performance is expected to be better in real-life as Transit Signal Priority in Vissim uses distributions to grant priority (whereas for real-life, priority would just be granted).

Source: Transportation and Traffic Analysis Report for Short Listed Options (rev00, dated December 12, 2020)

4.3.2 Improve Comfort and Safety

To inform the comfort and safety objective, LRT options were evaluated in terms of their impact on road safety (due to potential interactions and conflicts between LRT vehicles and autos), potential conflicts with pedestrians and cyclists, and personal safety of riders. The analysis of the options in relation to these performance measures led to conclusions outlined below.

- **Regarding potential conflicts between LRT and autos**, it is noted that segments with a shared LRT lane have a relatively high potential for conflicts while segments with a dedicated LRT lane have a relatively smaller potential for conflicts. Segments with grade separated (underground) LRT have no conflict points. Taking these observations into account, the underground options would perform best while Option S4 (which has two segments with a shared LRT lane) and S2 would have most potential conflict points.
- **Regarding pedestrian and cyclist safety**, it is noted that the LRT alignment is not directly adjacent to pedestrian and cycle tracks. However, in options S1 and S2, the LRT runs in curbside lanes and has high potential for conflict with active transportation. Underground options are preferred as they not only reduce the potential for conflict between the LRT and other modes but they also provide the opportunity for dedicated space for pedestrians and cyclists to protect them from vehicles as well.
- **Regarding personal safety of riders,** all surface options have their alignment and stations above ground and thus low crime issue potential. For the underground segments of Options U1 and U2, the concern is higher and may require more attention to crime prevention features.

4.3.3 Build an Integrated Transportation Network

It is crucial to plan for an integrated transit network with a seamless and convenient customer experience. Transfers between transit lines help people to get as close as possible to their final destinations and also allow for operational efficiency. The Brampton LRT extension is designed to run as a part of the existing Hurontario corridor and extension of the Hurontario LRT currently under construction; thus no transfers are planned for Brampton Gateway station at Steeles Avenue. All options are equal in terms of transfer between the LRT station and the bus terminal at the Brampton Gateway Terminal. However, the Brampton GO Station and the Downtown Brampton Transit Bus Terminal are two key transfer locations for riders using the LRT extension which differ among options.

Transfer distances were measured from the center of platform to the center of platform for existing and proposed transit services and to the intersection at Queen and Main Street. The transfer time was also calculated and accounted for differences in horizontal, ascending and descending walking speeds**. Table 4-7** presents the findings of the review.

Table 4-7: Transfer time at future Brampton GO Station

Distance	S1 (DDD)	S2 (DSD)	S3 (DDS)	S4 (DSS)	Surface Transfers^	U1 (via Main)	U2 (via George)	Underground Transfers^
LRT to Brampton Transit Bus Terminal[1] (Via Main St)	2 min				3,200 to 4,100	3 min	3 min	4,800
LRT to Brampton GO Rail (NB LRT to EB GO)	4 min				200	5 min	4 min	300
LRT to Brampton GO Rail (NB LRT to WB GO)**	1 min				600 to 800	5 min	4 min	900
Brampton GO Rail to LRT (WB GO to SB LRT)	1 min				100	5 min	5 min	100
Brampton GO Rail to LRT (EB GO to SB LRT)**	2 min				800 to 1,100	5 min	4 min	1,300
LRT station to Downtown Brampton (Queen & Main St)	< 1 min				1,400 to 1,900	4 min	5 min	2,200

[1]The existing bus terminal at 8 Nelson Street was assumed, with the understanding that plans for its relocation are being considered.
** Peak transfers
^PM peak period (3 to 7 PM)

All surface options will have the same transfer times and perform well as they are at-grade and avoid vertical circulation. Between underground options, U2 has shorter transfer times as it provides more direct connections to the Brampton GO Rail Station and the Brampton Transit Bus Terminal.

Pedestrian walk time to the intersection of Queen and Main Street is identical for all surface options because they share the same station with a split platform at Queen / Wellington station . Moreover, though option U1 has a marginally higher transfer time to eastbound GO service, it is located closer to the heart of Downtown compared Option U2.

4.4 Sustainable and Healthy Communities

The addition of a new rapid transit service will support the development of sustainable communities and travel patterns along the corridor.

4.4.1 Move People with Less Energy and Pollution

Transit is one of the most efficient and sustainable ways of moving people, by reducing the space and cost of getting people to their destinations. That is why a key objective of the LRT extension project is to shift as many auto trips as possible to transit, to relieve road congestion and to minimize energy consumption in the process.

Table 4-8 below provides estimates of expected reduction in VKT in the broader transportation study area (defined as the area bounded by Kennedy, McLaughlin, Steeles, and Queen), in all of

Brampton (all non-highway links), as well as the number of LRT riders who diverted to transit from auto for their transportation needs. The table shows that the largest reduction in VKTs in the study corridor is expected under Option S3 and S1: 1,300 daily VKT and 1,500 daily VKT during peak period, respectively. Other options produce a much smaller VKT reduction in the study corridor in the amount of 300 to 400 daily VKT during peak period. Much larger reductions in VKT are expected across all of Brampton ranging from 700 to 2,700 daily VKT during PM peak period. The largest reductions are expected for underground options U1 and U2 at 2,600 daily PM peak VKT.

The PM peak number of new transit trips diverting from auto to transit is estimated at 500 to 950 for the surface options with S1 being at the high end of this range and S2 and S4 at the low end. Underground options create 700 additional transit trips under both options.

Table 4-8: LRT Daily Ridership per Alternative LRT Daily Ridership per Alternative

	S1	S2	S3	S4	U1	U2
Daily VKT Reduced in Study Corridor, Peak Period	1,500	400	1,300	300	1,200	1,200
Daily VKT Reduced in all Brampton, Peak Period	2,600	1,800	2,600	700	2,700	2,700
Additional Transit Trips, PM Peak (Diverted from Auto)	950	500	700	500	700	700

Source: EMME

4.4.2 Improve Quality of Life and Public Health

The objective of improving quality of life and public health has four performance measures listed in **Section 0**. In their essence, these measures describe the quality of public spaces, or their attractiveness, in particular from the point of view of non-motorized users. Analysis of the options in relation to these performance measures led to the conclusions outlined below.

- The **ability to achieve a road to public realm ratio of 60/40** is a specific approach to understanding the built form and the interaction between paved roadway and available public space. This ratio is a rule of thumb commonly used in urban design and can help gauge the relationship between the space allocated to different road users. Surface options satisfy this standard to different extents: all surface options achieve this split for Segment A, none for Segment B and Options S3 and S4 for Segment C. The underground options satisfy this metric for all segments.
- Regarding the **ability to provide adequate sidewalk width** according to street character/context, all options satisfy the requirement.
- Regarding the **ability to incorporate Downtown Reimagined Streetscape elements**, only options S3 and S4 and U1 and U2 can accommodate cycle tracks, furnishing zones and enhanced sidewalks / wider clearways.
- Regarding their **compatibility with parks and public spaces**, surface options cause more impacts to the quality of the public realm due construction as well as due to LRT infrastructure requirements at-grade such as traction power substations (TPSS), overheard catenaries and stop platforms. However, Options S3 and S4 allow for planting of trees in the boulevard space and may facilitate activities in public space such as patios for restaurants and cafes. They also have platforms that encroach less on existing public space such as Garden Square and

City Hall Plaza than other surface options. Underground options cause comparatively small disruptions as most construction activities take place underground. Upon completion, unsightly infrastructure such as catenaries and TPSS are hidden within station boxes and only headhouses are visible from the surface.

- Regarding their **ability to provide a continuous cycling network,** all surface options have difficulty accommodating dedicated cycle tracks in Segment B. However, unlike options S1 and S2, S3 and S4 also provide dedicated cycling facilities in Segment C. Opportunities for improved cycling connections along alternate or parallel routes should be reviewed for all surface options. On the other hand, underground options do not have gaps in their proposed cycling network as cycle tracks extend all the way from Brampton Gateway to Brampton GO station with minimal interruptions.

4.4.3 Reduce Impacts to the Natural and Cultural Environment

All options are proposed within the existing right-of-way to minimize impacts to the environment. Natural resources such as mature trees and overhead canopy contribute to the heritage character of Main Street South and are intended to be preserved under all options.

In terms of cultural heritage features, surface options may have greater impact than underground options due to required infrastructure at street level, namely traction power sub-stations (TPSS). Under surface options, TPSS have the potential to impact heritage-listed properties on Main Street south whereas TPSS for underground options are planned to be housed within station boxes. Nevertheless, measures to integrate TPSS into heritage buildings can be considered.

The Brampton LRT extension may also pose different risks to stormwater management, depending on the option. Surface options will have two surface crossings of Etobicoke Creek and its valleylands. The underground options entail one surface and one underground crossing of Etobicoke Creek and its valleylands as well as an underground portal south of Nanwood Drive.

Due to the study area's proximity to Etobicoke Creek, all options considered may pose impacts to the existing floodplain between Nanwood and Brampton GO, as seen in **Table 4-9**. All options traverse the Brampton East Secondary Plan Special Policy area (SPA1) and SPA3 in Downtown Brampton.

Table 4-9:Stormwater Management Considerations by station / stop

Station	S1	S2	S3	S4	U1	U2
Brampton Gateway	Located outside the floodplain					
Charolais	Located outside the floodplain					
Nanwood	Located within the existing high flood risk areas of downtown Brampton SPA.					
Wellington / Queen	Located within the existing high flood risk areas of downtown Brampton SPA.				n/a	
Brampton GO	Located within the floodplain. However, the TRCA and the City of Brampton, have undertaken Downtown Brampton Flood Protection Project Environmental Assessment (DBFP Project). By implementing flood protection measures, the City may have the opportunity to remove the SPA designation in part subject to provincial approvals. The stations head houses will be out of the flood zones if the measures are implemented.					

It must be noted that underground options may create greater impacts to stormwater management due to tunneling, underground stations and the underground portal. However, mitigation measures will be considered and will be established through discussions with the TRCA.

4.5 Strategic Case Summary and Conclusions

Table 4-10 below summarizes the strategic evaluation by objectives while **Table 4-11** provides a comprehensive overview of the strategic metrics and results.

Table 4-10: Summary of Strategic Evaluation

Goals	Objectives	Summary of Evaluation (Surface Options)	Summary of Evaluation (Underground Options)
Strong Connections	Improve access to transit	Similar future ridership estimates and increases on connecting transit routes (HuLRT and Brampton GO).	
		For surface options, S1 has the highest ridership and creates the largest increase in demand on connecting transit services.	U1 and U2 have similar future ridership
	Increase access to economic opportunities	All options perform similarly.	
	Support city-building objectives	All options serve areas of high density of people and jobs and meet most municipal policy directives.	
		Option S3 is more aligned with Official Plan guidance. Surface options do not allow for downtown closures for civic events.	Options U1 and U2 are more aligned with Official Plan guidance. Underground options offer redevelopment potential of the existing bus terminal at 8 Nelson Street.
Complete Travel Experiences	Improve travel time and level of service	Overall, the auto travel times and LRT travel times are very similar between surface options. Surface options provide similar experiences for transit users and drivers. S3 and S4 provide better pedestrian and cycling conditions.	Underground options have a slightly better travel time performance for both auto and LRT. Underground options improve conditions across all modes: pedestrians, cyclists, transit users and drivers.
	Improve comfort and safety	Surface options have the lowest potential for conflict between vehicles and LRTs where LRTs are mostly in dedicated lanes (S1, S3). Options providing enhanced active transportation facilities (S3, S4) have the lowest potential for conflict	Underground options have the least potential for conflict between modes.

Goals	Objectives	Summary of Evaluation (Surface Options)	Summary of Evaluation (Underground Options)
		between vehicles and active modes.	
	Building an integrated transportation network	Surface options have identical transfer times to transit nodes and key destination.	Underground options have generally similar transfer times to nearby transit services but U1 provides a better connection to Downtown Brampton
Sustainable and Healthy Communities	Move people with less energy and pollution	Option S3 creates the largest reduction in vehicle-kilometers travelled and divert slightly more auto trips to transit than other surface options.	Underground options perform similarly.
	Improve quality of life and public health	Surface options S3 and S4 outperform other surface options as they provide separated active transportation facilities, wider furnishing zones and encroach less on public space.	Underground options perform similarly: achieving appropriate road to public realm ratio, providing adequate sidewalk and streetscape, incorporating downtown reimagined elements and being compatible with parks and public space.
	Reduce impacts to the natural and cultural environment	Surface options have similar impacts to natural and cultural environments as they all are within the available right-of-way and have identical utility (TPSS) requirements. They also have similar flooding potential.	Underground options have similar impacts to the natural and cultural environments. They may pose more impacts to drainage than surface options due to the underground stations, tunnels and portals requirements.

Among surface alternatives, option S3, composed of the LRT in dedicated lanes between Steeles Avenue and Wellington Drive and in mixed traffic through to Brampton GO station, best fulfils the objectives and supports the realization of the strategic goals. Among underground alternatives, option U1 via Main Street is recommended from a strategic perspective.

Table 4-11: Summary of Strategic Case Performance Metrics

Evaluation Criteria, by Goal and Objective	S1 (DDD)	S2 (DSD)	S3 (DDS)	S4 (DSS)	U1 (via Main)	U2 (via George)
Strong Connections						
Improve Access to Transit						
LRT Daily Ridership	30,900	27,700	29,500	26,300	30,500	
Ridership increase on Hurontario LRT (Peak Period)	6,200	5,200	5,800	4,800	6,100	
Ridership increase at Brampton GO Rail Station (Peak Period)	1,200	1,000	1,100	800	1,400	
Incremental local bus boardings at Brampton GO (Peak Period)	1,300	1,000	1,100	800	1,500	
2041 Population within 800 m of Stations	28,500	28,500	28,500	28,500	28,000	
Increase Access to Economic Opportunities						
2041 Employment within 800 m of stations	17,000	17,000	17,000	17,000	15,000	
2016 Trips destined to 800 m of stations (peak our)	1,800	1,800	1,800	1,800	1,600	
Number of low-income residents served	2,400	2,400	2,400	2,400	2,200	
Support City-Building Objectives						
Alignment with planned development	Aligned, less opportunity to integrate with adjacent development.				Aligned, more opportunity to integrate with adjacent development (8 Nelson St)	
Support for areas with land uses compatible with rapid transit	Compatible (transit in dedicated lanes, no cycling in Segment C)	Least Compatible (transit in shared lanes, no cycling in Segment C)	Most Compatible (transit in mostly dedicated lanes, cycling in Segment C)	Less Compatible (transit in shared lanes, cycling in Segment C)	Most Compatible (higher order transit, AT improvements, redevelopment opportunities)	
Ability to Close Downtown for Civic Events	No	No	No	No	Yes	
Complete Travel Experience						
Improve Travel Time and Level of Service						
Transit Travel Time (PM Peak hour, Build), Minutes	8	11	9	12	7	8
Average Auto Travel Time in LRT Corridor, Minutes per Trip	6	6	7	6	6	
Transit Travel Time Savings compared to BAU, Minutes per Trip	6	3	5	2	7	
Total Transit Travel Time Savings compared to BAU PM peak period, Person-minute	35,000	17,000	28,000	11,000	35,000	
Pedestrian Level of Service	Worse PLOS than S3, S4, U1 and U2		Better PLOS than S1 and S2		Best overall PLOS	
Bicycle Level of Service	Worse PLOS than S3, S4, U1 and U2		Better BLOS than S1 and S2		Best overall BLOS	
Transit Level of Service	Generally comparable between surface options (varying by segment). S2 performs marginally better than the rest.				Comparable between underground options; Outperforms surface options.	
Vehicle Level of Service	Generally comparable between surface options (varying by segment).					

Evaluation Criteria, by Goal and Objective	S1 (DDD)	S2 (DSD)	S3 (DDS)	S4 (DSS)	U1 (via Main)	U2 (via George)
Improve Comfort and Safety						
Potential for Conflicts between LRT and Autos	Low Conflict	High Conflict	Low Conflict	High Conflict	Low / No Conflict	
Potential for Conflicts between LRT and PedsCyclists	High Conflict	High Conflict	Low Conflict	Low Conflict	Low / No Conflict	
Personal safety of rider	Similar crime issue potential between surface options				Similar crime issue potential between underground options	
Build and Integrated Transit Network						
Transfer times						
LRT to Brampton Transit Bus Terminal (Via Main St)	2 min				3 min	
LRT to Brampton GO Rail (NB LRT to EB GO)	4 min				5 min	4 min
LRT to Brampton GO Rail (NB LRT to WB GO)	1 min				5 min	4 min
Brampton GO Rail to LRT (WB GO to SB LRT)	1 min				5 min	
Brampton GO Rail to LRT (EB GO to SB LRT)	2 min				5 min	4 min
LRT station to Downtown Brampton (Queen & Main St)	< 1 min				4 min	6 min
Sustainable and Healthy Communities						
Move People with Less Energy and Pollution						
Daily VKT Reduced in Study Corridor, Peak Period	1,500	400	1,300	300	1,200	
Daily VKT Reduced in all Brampton, Peak Period	2,600	1,800	2,600	700	2,700	
Additional Transit Trips, PM Peak (Diverted from Auto)	950	500	700	500	700	
Improve Quality of Life						
Ability to Achieve Road to Public Realm Ratio of 60/40	Partly (Steeles to Nanwood)	Partly (Steeles to Nanwood)	Mostly (except from Nanwood to Wellington)	Mostly (except from Nanwood to Wellington)	Yes	
Ability to Provide Adequate Sidewalk & Streetscape	Yes	Yes	Yes	Yes	Yes	
Ability to Incorporate Downtown Reimagined	No	No	Yes	Yes	No	
Compatibility with Parks & Public Spaces	Least Compatible		Less Compatible		Most Compatible	
Ability to provide a continuous cycling network	Gap in the cycling network in Segments B and C		Gap in cycling network in Segment B		Ability to provide continuous and uninterrupted cycling facilities along the study corridor	
Reduce Impact to Natural and Cultural Environment						
Natural Environment	Similar impacts between surface options, more impact at surface level than underground options				Similar impacts between underground options	
Cultural Heritage	Similar impacts between surface options (TPSS), more impact at surface level than underground options				Similar impacts between underground options	
Drainage	Similar impacts to floodplain between surface options. Less impact than underground options.				Similar impacts to floodplain between underground options.	
Recommendation	**Among surface options, S3 best fulfils the strategic case.**				**Among underground options, U1 best fulfils the strategic case.**	

5 Economic Case

The Economic Case evaluates the value of the project based on the public benefits it generates over its life-cycle in relation to the costs of development, construction, and operation. Benefits and impacts are quantified and monetized to the extent possible and compared with costs in a structured benefit-cost analysis framework that leads to project performance metrics such as the net present value, internal rate of return, and benefit-cost ratio. Benefits and impacts which are difficult to quantify and capture in the calculation of net present value and benefit-cost ratio are addressed qualitatively.

Construction cost estimates used in this analysis are Class 5 cost estimates based on the short list designs of the PDBC options.

The Economic Impact Methodology can be found under **Appendix A**.

5.1 Introduction and Key Assumptions

The Economic Case provides estimates of the economic benefits that are expected to be generated by each of the alternatives over a 60-year period of operations (plus the construction period) and compares them to the anticipated costs. Costs include both the resources required to develop the Brampton LRT Extension project and the costs of maintaining the new infrastructure asset over time. Estimated benefits are based on the projected impacts of the project on both users and non-users of the facility, valued in monetary terms to the extent possible. The Economic Case determines if the expected benefits of this investment exceed the costs required to deliver it, and articulates the overall benefit to society of pursuing each investment option. The analysis considers the magnitude of costs and benefits as well as overall performance indicators, in particular:

- Net Present Value (NPV): project benefits minus project costs, which is used to indicate the overall net value of the project to society (magnitude of net benefits);
- Benefit-Cost Ratio (BCR): an indicator showing the value of benefits for each $1 of project costs (value of benefits in relation to project costs);
- Internal Rate of Return (IRR): discount factor needed for the annual costs and benefits of the project to have a NPV of $0 in a discounted cash flow analysis.

Table 5-1 below provides key assumptions for the analysis and parameter values that were used in the estimation of benefits and costs over the project analysis period. All of the assumptions were based on Metrolinx Business Case Guidance April 2019 edition. The same assumptions were used for all alternatives.

Table 5-1: Economic Case Key Analysis and Parameter Value Assumptions

Input	Unit	Value
Evaluation Period (LRT Operations)	Years	60
Discount Rate	% per Year	3.5%
Value of Time	$/hour per Person	$18.06

Input	Unit	Value
Value of Time Growth Rate	%	0%
Average Auto Occupancy	Number of People per Vehicle	1.08
Auto Operating Cost Savings due to Reduced VKT (Unperceived Auto Operating Costs Only)	$/km	$0.09
Decongestion Benefits due to Reduced VKT		
Peak Period	$/VKT	$0.01
Off-Peak	$/VKT	$0.00125
Road Safety Improvements; Reduction in Accidents due to Reduced VKT	$/VKT	$0.095 in Year 1; Decreasing 5.3% per year
Health Benefits from Increased Physical Activity due to Diversion from Auto Commuting to Transit (Increased Walking)	$/km walked	$3.92
Reduction in Emissions of Greenhouse Gas (GHG) due to Reduced VKT	$/VKT	$0.01
Local Air Quality Improvements due to Reduced VKT (Reduction in Emissions of CACs such as NOx, PMs)	$/VKT	$0.002
Extrapolation Factor, PM Peak to Daily - Transit	Number	3.2
Extrapolation Factor, PM Peak to Daily - Auto	Number	2.9

Note: All monetary values are in 2019 dollars.

5.2 Costs to Deliver the Investment

5.2.1 Capital Costs

Table 5-2 provides a summary of the capital cost of the project, by option.[4] Costs shown in the table represent a preliminary cost estimate of the likely magnitude of construction costs primarily related to guideways and track. Costs related to property acquisition, management, building permits, legal fees, utility relocation, and project risk contingency were not included in the estimates. Structure replacement and refurbishment costs were not included in the preliminary cost estimates. All options require structural work for the Etobicoke Creek south bridge; while only surface options may require some reinforcement of Etobicoke Creek north bridge.

For the purpose of this analysis, LRT vehicle costs were based on estimated needs for additional vehicles to maintain the planned headways on Hurontario LRT. The vehicle needs analysis indicated that for surface options three additional vehicles would be needed, and for the underground options one additional vehicle would be needed. The number of additional vehicles

[4] Project capital construction costs were estimated by Marshal & Murray quantity surveyors and development consultants in February 2021. Costs were presented in current dollars as of January 2021. For simplicity, given the timing of the analysis (the beginning of year 2021) they were assumed to represent 2020 dollars. For the purpose of the cost-benefit analysis, these costs were deflated to 2019 using an implicit price index from Statistics Canada (Table 36-10-0130-01, Gross fixed capital formation). Cost escalation was not included in these estimates.

needed was then multiplied by the cost per vehicle as implied by the vehicle costs of Hurontario LRT, adjusted from 2012 estimates to 2019 dollars using a consumer price index and an escalation factor of 1 percent annually over the years 2012-2019 .[5]. It was assumed that all vehicles would be replaced after 30 years at the same cost.

Rehabilitation and renewal costs that would be incurred after 15 years of operations were estimated as 60 percent of structures and indirect costs.[6]

Table 5-2: Project Capital Costs, Millions of 2019 Dollars

Cost Category	S1	S2	S3	S4	U1	U2
Guideways and Tracks	$31.1	$31.7	$31.4	$32.1	$247.2	$258.2
Platforms, Stations, Stops[7]	$17.2	$17.2	$17.2	$17.2	$430.7	$438.4
Siteworks	$98.3	$100.9	$100.3	$102.9	$89.5	$89.2
Systems	$33.2	$33.2	$33.2	$33.2	$33.6	$34.0
Allowances	$27.6	$28.1	$28.0	$28.5	$120.8	$123.6
Indirect Cost	$31.1	$31.7	$31.5	$32.1	$138.3	$141.5
Professional Services	$74.0	$75.3	$74.9	$76.3	$328.6	$336.3
HST - 1.76%	$5.5	$5.6	$5.6	$5.7	$24.4	$25.0
Contingency	$95.4	$97.1	$96.6	$98.4	$423.9	$433.9
LRT Vehicles	$27.5	$27.5	$27.5	$27.5	$9.2	$9.2
Total Construction Costs	**$440.9**	**$448.4**	**$446.3**	**$453.8**	**$1,846.0**	**$1,889.3**
Rehabilitation and Renewal	$143.1	$145.7	$145.0	$147.6	$636.0	$651.0

Construction is anticipated to start in 2026 and take 6 years for the surface options and 8 year for the underground options. The first year of LRT operations is then 2032 for the surface options and 2034 for the underground options.

For the purpose of this analysis, total construction costs, except for LRT vehicles, were equally distributed over the construction years. The LRT vehicles were assumed to be purchased three years before the end of the construction period, i.e. in year 4 for the surface options and in year 6 for the underground options.

Major maintenance and rehabilitation costs were distributed equally as annual renewal and rehabilitation costs over the years 16 to 60. LRT vehicles replacement was assumed to take place in year 30 with the cost equal to the original value.

5.2.2 Operations and Maintenance Costs

Incremental annual operations and maintenance (O&M) costs were extrapolated from the costs estimated for the Hurontario LRT (for the alignment length of 3.5 km as opposed to 20 km) and adjusted from 2012 to 2019 dollars using a consumer price index and an escalation factor of 1%

[5] Specific cost estimates based on Steer Davis Gleave “Hurontario Benefits Case Analysis”, March 2016.
[6] This assumption is similar to that used in Steer Davis Gleave “Hurontario Benefits Case Analysis”, March 2016.
[7] Capital costs do not include station relocation. The Brampton Gateway station will be maintained on the south side of Steeles Avenue, in line with the HuLRT project terminus station for the purposes of costing.

annually. The estimates were based on the costs to operate the LRT (staff costs, power costs, stop maintenance, etc.) as well as savings in the bus operating costs for buses which would no longer be needed.[8] This gave an estimate of $1.31 million annually.[9]

These costs were further adjusted to reflect higher O&M costs for underground stations than surface stations as follows. HDR's internal experience with other LRT projects in Canada indicated that the average annual O&M cost for a surface station amounts to about $228,000 and for an underground station to about $400,000. These costs include cleaning, utility charges, and management, and for underground stations also heating/ventilation and air conditioning, lighting, fire protection, intrusion detection systems, escalators and elevators, and fare gates operations.

Given that the surface options entail four stations, the total annual station O&M cost amounts then to 4*$228,000=$912,000. The underground options envision one surface station and two underground stations for the total annual station O&M cost of 1*$228,000+2*400,000=$1,028,000. The difference in station O&M costs amounts then to $116,000 (see the table below). This cost difference was added to the overall LRT O&M cost to give a cost of $ 1.43 million annually specific for the underground options. (For the surface options, the earlier established estimate of $1.31 million was used.)

Table 5-3: Station Costs for Surface and Underground Options

Number of Stations and Costs	Number of Stations		Cost Per Station
	Surface Options	Underground Options	
At Grade Stations	4	1	$228,000
Underground Stations	0	2	$400,000
Total Station O&M Cost, by Surface/Underground Options	$912,000	$1,028,000	
Incremental O&M Cost for Underground Options over Surface Options	**$116,000**		

5.2.3 Summary of Cost Estimates

Table 5-4 below provides a summary of life cycle project costs using a 3.5 percent discount rate, by option. The table shows that total costs for underground options are over $1.4 billion while the costs of the surface options are estimated at about $380 million (with the cost ranging from $375 million for Option S1 to $385 million for Option S4).

Table 5-4: Summary of Project Economic Costs, $ Millions, Present Value Discounted at 3.5%

Cost Category	S1	S2	S3	S4	U1	U2
Capital Construction	$318.2	$323.6	$322.1	$327.5	$1,290.0	$1,320.3
Major Maintenance, Rehabilitation and Renewal	$35.0	$35.5	$35.3	$35.9	$119.5	$122.2
Annual Operations and Maintenance	$21.7	$21.7	$21.7	$21.7	$22.0	$22.0
Total Economic Costs	**$374.9**	**$380.8**	**$379.1**	**$385.1**	**$1,431.6**	**$1,464.6**

[8] Specific cost estimates based on Steer Davis Gleave "Hurontario Benefits Case Analysis", March 2016.
[9] Cost escalation beyond 2019 was not included in the main estimate but tested in sensitivity analysis.

5.3 User Impacts

User benefits and impacts are a key motivation behind transportation investments such as the Brampton LRT Extension. They represent the welfare changes that the Brampton LRT is expected to generate to transportation network users. This includes current transit users in Brampton, auto users who will divert to transit/LRT, and auto users remaining in the LRT travel corridor and the broader network.

Specifically, user benefits are driven by ridership on the new transit and performance of the new transit compared to the existing transit (essentially travel speed). Brampton LRT Extension is also expected to increase ridership on Hurontario LRT (HuLRT) by offering a seamless connection to this service. The incremental users on HuLRT will also accrue travel time savings and other benefits related to HuLRT. In addition, Brampton LRT Extension is expected to help integrate and better coordinate transit services across Brampton generating travel time savings to all transit users.

Ridership on LRT Extension, LRT speed, transit bus speed, impacts on auto traffic remaining in the LRT corridor, HuLRT incremental ridership, and travel time savings to all Brampton transit passengers were estimated, by option, in EMME transportation model for model year 2041.

For the purpose of this BCA, ridership was assumed to grow over the years 2042-2049 at an average annual rate of growth of 1% (based on guidance from Metrolinx). After2049, ridership volumes were held constant. For years prior to 2041, ridership was decreased using a rate of growth consistent with land use scenarios for Brampton between years 2031 and 2041, specifically employment growth. This gave an average annual ridership growth rate of 1.59% for years between LRT opening and 2041.

Average speeds on LRT, existing transit bus, auto remaining in corridor, and travel time savings were assumed constant over the analysis period producing constant estimates of travel time impacts to LRT/HuLRT users, other transit, and auto remaining in the LRT corridor. The key input data assumptions used in the estimation of annual benefits and impacts are summarized in **Table 5-5** below. Parameters used for valuation of the impacts are as shown in **Table 5-1**.The detailed categories of user benefits are discussed following the table.

All benefits were estimated over a period of 60 years. Given the assumed start of construction in 2026, 6 years of construction for the surface options and 8 years for the underground options, the period of LRT operations used to estimate benefits and impacts is as follows:

- Surface options: 2032-2091; and
- Underground options: 2034-2093.

Table 5-5: Key Input Data Assumptions for Estimation of Benefits

Input	Unit	No Build	S1	S2	S3	S4	U1	U2
LRT Extension Daily Ridership, 2041	Boardings	NA	30,900	27,700	29,500	26,300	30,500	30,500
Growth in Transit Ridership, Average Annual	Percent							
Until 2041		1.59%	1.59%	1.59%	1.59%	1.59%	1.59%	1.59%
2041-2049		1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%
After 2049		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Average LRT Trip Length	km	NA	3.1	3.1	3.1	3.1	3.2	3.2
Average Trip Length of Auto Diverting to LRT	km	NA	18.1	18.1	18.1	18.1	17.9	18.0
Average Total Transit Travel Time in Brampton, all Transit	Min per Trip	65.9	65.5	65.7	65.6	65.8	65.5	65.5
In-vehicle Transit Time		31.2	31.0	31.1	31.0	31.1	31.0	31.0
Walk Time		29.1	28.9	29.0	28.9	29.0	28.9	28.9
Wait Time		5.7	5.7	5.7	5.7	5.7	5.7	5.7
Brampton Transit Demand	Trips, PM Peak	87,600	88,700	88,400	88,600	88,300	88,600	88,600
Travel Time Savings to all Transit in Brampton, Existing Users (Weighted)*	Person-Min, PM Peak	NA	54,750	28,032	44,238	17,958	52,998	52,998
Travel Time Savings to all Transit in Brampton, New Users (Weighted)*	Person-Min, PM Peak	NA	687	256	505	143	605	605
Source of LRT Ridership	Percent	NA						
From Bus Transit		NA	82.3%	84.6%	82.8%	85.4%	83.6%	83.6%
Diverting from Auto		NA	15.3%	9.6%	12.1%	10.4%	8.2%	9.8%
New Trips		NA	2.4%	5.8%	5.2%	4.2%	8.2%	6.6%
Average Auto Travel Time in Corridor	Min per Trip	5.6	6.7	6.1	6.7	6.2	6.2	6.7
Average Schedule Delay**	Min per Trip	0.78	0.37	0.41	0.43	0.40	0.30	0.25
Auto VKT Remaining in LRT Corridor	VKT, PM Peak Hour	NA	5,600	7,000	5,600	7,000	7,000	5,600
Journey Quality and Mode Perception Benefits	Min per Trip	NA	1.7	1.7	1.7	1.7	1.7	1.7

Source: HDR based on transportation modeling outputs.
Note: * Total travel time savings to transit users were calculated as a sum of in-vehicle travel time, walk time and wait time. A weighting factor of 2 was applied to walk time and a factor of 2.5 was applied to wait time.
** Source: Transportation and Traffic Analysis Report (Rev00, dated December 12, 2020)

5.3.1 Travel Time Savings to Transit Users

Travel time on LRT/HuLRT is expected to be faster than on the conventional bus and thus generate travel time savings to its users. In addition, Brampton LRT Extension is expected to help integrate and better coordinate transit services across Brampton generating travel time savings to all transit users.

Transit travel time benefits are accumulated by the existing transit users and new riders (diverted from auto and entirely new users/trips) over the project life span to determine the total transit travel time savings. The amount of time saved in hours is multiplied by the value of time of $18.06/h to obtain the monetary value of travel time benefits of the project. The existing riders obtain the full value of this benefit while the new riders incur this benefit at half the rate (based on the “rule of half”).

Transit travel time savings benefits were estimated from EMME transportation model outputs as the sum of two components: (1) the difference between No Build and Build average transit travel time multiplied by No Build transit demand (for existing transit users benefits), and (2) the difference between No Build and Build average transit travel time multiplied by the difference in Build versus No Build transit demand (for new transit users benefits). For each of these components, total travel time savings were calculated as a sum of in-vehicle travel time, walk time and wait time. A weighting factor of 2 was applied to walk time and a factor of 2.5 was applied to wait time. Table 5-5 shows the resulting estimates for 2041. These were extrapolated to years after and before 2041 using rates of growth shown in the table.

5.3.2 Reliability Benefits

The LRT is expected to provide a more reliable service, resulting in more consistent schedule adherence which is highly valued by transit passengers and operations. The reliability benefits were estimated in VISSIM based on the difference in average scheduled headway and the actual headways for the conventional bus and the LRT. If the actual headway is larger than the scheduled headway, the difference between the two is equivalent to schedule delay. Table 5-5 shows the estimated schedule delay in minutes per trip for each option and the No Build scenario. The difference in schedule between bus and LRT represents the reliability benefit.

This reliability measure was multiplied by the value of time and a reliability ratio of 1.76, as suggested by Metrolinx Guidelines, to account for the additional value that transit passengers place on reliability of travel time. This monetary value of reliability improvement was then multiplied by the number of LRT riders that would benefit. As in the case of travel time savings, the existing passengers accrued the full value of this benefit while new riders obtained this benefit at half the rate.

5.3.3 Journey Quality and Mode Perception Benefits

There has been growing recognition that travelers may prefer one mode over another for reasons that go beyond travel time and the amount of fare. These may include quality and amenity aspects

of stops/stations and vehicles, overall convenience and comfort, and other "softer" factors which may impact on the perceptions of travel and choice of mode.[10]

The emerging practice accounts for these benefits in the form of multipliers to the travel time of the relevant segment of the journey, or alternatively as a constant change to the generalized travel time (in minutes per journey). This evaluation uses the latter approach and adopts "mode specific constants" (or MSC) based on Australian business case guidance for public transport projects.[11] The benefits captured by MCSs are expressed in terms of a "bonus" travel time saved when travelling on LRT/rail as opposed to bus and vary by trip length. For example, for a 15-minute bus trip that would be replaced by LRT, they amount to 1,8 minutes per trip, and for a 10-minute bus trip that would be replaced by LRT, they amount to 1.1 minute per trip.

Given that the average No Build bus travel time in LRT corridor was estimated at 13.9 minutes, the journey quality and mode perception benefit was assumed to be equal approximately to the former estimate: 1.8*(13.9/15) = 1.7 minutes per trip as shown in Table 5-5.

5.3.4 Travel Time Impacts to Auto Users Remaining in the LRT Corridor

Construction of Brampton LRT will reduce the number of general driving lanes on Main Street for surface options as one lane in each direction will be taken for the LRT. This can be expected to negatively impact the average speed and travel times in the corridor. This impact is included in this economic case as a negative benefit, or the offset to other project benefits. The difference in auto travel time between No Build and Build scenario is multiplied by the number of vehicles affected to obtain total delay and then by the value of time ($18.06/h per person) and average vehicle occupancy (1.08 persons per vehicle) to obtain the monetary value of the delay.

Table 5-5 shows the estimated No Build and Build auto travel times in the LRT corridor. For the calculations of impacts, these travel times were adjusted to reflect the average auto trip length in the LRT corridor (assumed equal to the average LRT trip length).

5.3.5 Auto Operating Cost Savings to Users Diverting to Transit

Auto users who switch to LRT/transit for their travel needs will save on vehicle operating costs such as fuel and maintenance. These savings are largely already reflected in the LRT ridership and transit travel time savings.

There are also other vehicle operating costs which auto travelers consider as "sunk" with respect to an additional trip – such as insurance and depreciation – and do not take them into account when making travel decisions. However, in the long-run with a mode switch to transit, these costs may be reduced and realized as a benefit. These "unperceived" costs are assumed at $0.09 per km of travel diverted from auto to LRT based on the Metrolinx Business Case Guidance. The benefit to LRT users diverting from auto is then calculated as this unit cost multiplied by the number of LRT riders expected to be diverted from auto and average trip length. The average trip length of riders diverting from auto was assumed equal to the average length of the entire transit

[12] Classification based on: "Development of Tools for Assessing Wider Economic Benefits of Transportation", SHRP 2 Strategic Highway Research Program Capacity, Transportation Research Board, July 2013.
[12] Classification based on: "Development of Tools for Assessing Wider Economic Benefits of Transportation", SHRP 2 Strategic Highway Research Program Capacity, Transportation Research Board, July 2013.

trip (about 18 km which is longer than the average trip length on the Brampton LRT Extension itself) recognizing that the mode diversion will have an impact that extends beyond the LRT travel corridor.

5.3.6 User Benefits Estimates

Table 5-6 shows user benefit estimates for each LRT alternative. The table also shows the breakdown of transit benefits between the existing transit users and new transit users (encompassing users diverted from auto and entirely new travelers). Using the discount rate of 3.5 percent, Option S1 is expected to generate highest benefits valued at $415.6 million. This is followed by Option U2 with user benefits valued at $379.3 million and Option U1 with benefits valued at $374.8 million. Option S3 is another surface option with user benefits of more than $300 million.

Travel time savings to transit users represent the highest benefit for all options . Journey quality benefits represent the second highest benefit for all options. Travel time impacts to auto remaining in the corridor are negative as LRT operations create some disturbances in the operation of private automobiles, mostly by reducing the number of lanes.

Table 5-6: User Benefits over Analysis Period (60 Years), Millions of 2019 Dollars at 3.5% Discount

Impact Type	S1	S2	S3	S4	U1	U2
Travel Time Savings to Transit Users	$279.6	$142.9	$225.8	$91.5	$255.7	$255.7
Existing Transit Users	$277.9	$142.3	$224.5	$91.1	$254.3	$254.3
New Transit Users	$1.7	$0.6	$1.3	$0.4	$1.5	$1.5
Reliability Benefits to Transit Users	$32.2	$26.4	$26.3	$25.9	$35.5	$39.2
Existing Transit Users	$29.1	$24.2	$23.9	$23.8	$32.3	$35.7
New Transit Users	$3.1	$2.2	$2.5	$2.0	$3.2	$3.5
Journey Quality Benefits	$74.5	$67.6	$71.3	$64.5	$70.0	$70.0
Existing Transit Users	$67.2	$62.0	$64.6	$59.4	$63.8	$63.8
New Transit Users	$7.3	$5.6	$6.7	$5.1	$6.3	$6.3
Travel Time Impacts to Auto Remaining in LRT Corridor	-$8.4	-$5.3	-$8.4	-$5.4	-$5.1	-$8.1
Auto Vehicle Operating Cost Savings	$37.7	$21.2	$28.4	$21.8	$18.6	$22.5
Total User Benefits	**$415.6**	**$252.9**	**$343.4**	**$198.3**	**$374.8**	**$379.3**

5.4 Non-User and External Impacts

External impacts refer to broader socio-economic costs of transportation borne by the broader society which are not necessarily fully paid for by the transportation users. These include costs of road accidents (or road safety), environmental emissions (tailpipe greenhouse gases and criteria air contaminants), impacts on overall congestion and travel times experienced by other road users, and impacts on users' health due to the extent to which transportation choices affects their engagement in physical activity. Mode shifts from auto to transit will lead to a reduction in these costs as transit has lower social/external costs per trip profile.

External benefits are driven by LRT ridership diverted from auto as well as entirely new trips taking place on LRT. Key assumptions used in the estimation of LRT ridership, trips diverted from auto, and new trips are shown in **Table 5-5** while key valuation parameter assumptions are outlined in **Table 5-1**.

The detailed categories of external benefits are discussed below.

5.4.1 Decongestion Benefits and Travel Time Savings to Auto

The project will attract some travelers off the auto network and reduce auto VKT. The reduction in the volume of vehicles on the road will increase average speeds and reduce travel times to auto users remaining on the roads. Auto VKT diverted was estimated as the number of LRT travelers diverted from auto multiplied by the average auto trip length. This benefit was monetized by applying a value of $0.01 for every VKT reduced during the peak period and $0.00125 for every VKT reduced during the off-peak period.

5.4.2 Reduction in Road Accidents

Reduction in auto VKT will reduce the exposure to the risks of road collisions and thus the number of road accidents. Transit accidents may increase somewhat with increased ridership. However, overall road accidents involving transit vehicles are rare. There is thus a benefit to society from a mode shift from auto to transit. This benefit was monetized by applying a 2019 value of $0.095 for every auto VKT diverted This valuation parameter was reduced by 5.3 percent annually (as per Metrolinx Business Case Framework April 2019 guidance).

5.4.3 Reduction in Vehicle Emissions

Reduction in auto VKT will reduce tailpipe emissions (greenhouse gases and criteria air contaminants). Environmental emissions produced by transit are smaller than those produced by automobile. Therefore, diversion from auto to transit transportation is expected to generate benefits in terms of an overall reduction in emissions. These benefits were monetized by applying a value of $0.01 per VKT reduced for greenhouse gases (GHG), and a value of $0.002 for criteria air contaminants.

5.4.4 Health Benefits

Transit transportation encourages greater physical activity over a course of a day than travel by auto. At the minimum, each transit trip requires walking to the transit stop or station and then to the final destination while travel by auto is typically a door-to-door travel with minimal walking. Diversion from personal auto to transit for transportation needs is thus expected to generate health benefits from increased physical activity. This benefit was monetized by applying a value of $3.92 per km walked for each LRT rider diverted from auto or induced to travel (i.e. new traveler). For the purpose of this analysis, the average walk trip associated with each transit trip was assumed at 920 m. This includes a distance of 490 m from trip origin to transit stop or station and another 490 m from transit stop/station to final destination (based on subway access data from TTS Survey). It was assumed that about 12 percent of new users will be accessing the first stop or station by car, rather than walking reducing the total distance walked. It was also assumed that this benefit will fully materialize only in 5 years from project opening (as per Metrolinx Business Case Framework April 2019 guidance) with a uniform ramp-up over a period of 5 years.

5.4.5 External Benefits Estimates

Table 5-7 shows estimates of external benefits for each LRT alternative. The table demonstrates that over the analysis period, alternative S1 generates the largest total benefits at $113.7 million followed by alternative S3 with benefits valued at $102.7 million, and U2 at $93.2 million. Across all alternatives, the largest category of benefits is represented by health benefits followed by reduction in road accidents.

Table 5-7: External Benefits over Analysis Period (60 Years), Millions of 2019 Dollars at 3.5% Discount

Impact Type	S1	S2	S3	S4	U1	U2
Decongestion Benefits	$2.6	$1.5	$1.9	$1.5	$1.3	$1.5
Reduction in Road Accidents	$8.5	$4.8	$6.4	$4.9	$3.8	$4.6
Reduction in Vehicle Emissions	$5.0	$2.8	$3.8	$2.9	$2.5	$3.0
Health Benefits	$97.6	$75.9	$90.6	$68.3	$84.0	$84.0
Total External Benefits	**$113.7**	**$84.9**	**$102.7**	**$77.6**	**$91.6**	**$93.2**

5.5 Other Benefits and Impacts

In addition to the quantified benefits and impacts discussed in the previous sections, major transportation improvement projects such as Brampton LRT Extension may generate other benefits and impacts which are more difficult to quantify. These include:

- Increase in economic productivity due to improved transportation connections (referred to as “wider economic benefits”);
- Potential for development along the LRT corridor;
- Business activity and job creation from construction spending; and
- Construction-related disruptions to businesses, motorists, and pedestrians during the construction period.

The above benefits and impacts are discussed qualitatively below.

5.5.1 Wider Economic Benefits

Wider economic benefits, or wider impacts, of transportation infrastructure projects refer to impacts of these projects on broader business productivity.

These impacts reflect the observation that transportation infrastructure projects benefit not just the travelers and direct users of a facility in the form of travel time savings but have broader benefits on the broader economy. They represent factors, or creation of conditions, that enable businesses to gain efficiency by reorganizing their operations and/or gaining access to a better mix of inputs – physical and human – used in the production of their goods and services and gaining better access to new distribution markets. These effects are not usually captured in traditional cost-benefit analysis or economic impact analysis and go over and above those impacts.

There are at least three categories of wider economic benefits of a transportation project: (1) Reliability impacts, (2) Market access effects, and (3) Intermodal connectivity effects.[12]

Recent research indicates that public transit projects could also be the kind of transportation investments that create wider economic benefits. This takes place in particular through its labour market access effects leading to more clustered and higher density employment, promoting urban growth, and giving rise to agglomeration benefits, or productivity gains from higher concentration of businesses and people.

For example, Chatman and Nolan (2013) find significant links between transit service and employment density, or agglomeration, in US metropolitan areas, and from agglomeration to average wages and GDP per capita.[13] On balance, a 10% increase in bus and rail seat density (i.e. per 1000 population) is found to increase wages by 0.23% and GDP per capita by nearly 1%.

New LRT systems are well positioned to improve access of businesses located around the stations to labour force pools as such systems offer high capacity affordable transportation with competitive (or acceptable) travel times.

Knowles and Febrachi (2014) provide a comprehensive discussion and examples of wider economic impacts of LRT projects on cities and their economies, including improved access to labour market which is referred to by the authors as the extension of labour market catchment area.[14, 15] When commuting times and costs decline with the opening of a new transportation option, workers are prepared to make longer distance trips as these trips may be now within their subjective overall commuting time costs thresholds. Firms may be able to attract more skilled workers because of an effective expansion of the geographic labour market area. Some notable examples of the LRT projects impacts on labour market accessibility include Minneapolis in Minnesota, London Docklands, and Manchester where new LRT lines increased accessibility to employment centres and other activity sites. However, the authors also emphasize importance of other conditions (such as broader development/re-development and planning programs) and connections to other modes.

Expected impacts of the Brampton LRT extension project on labour force access to employment markets can be framed in terms of factors such as:

- Employment centres served and major employers in the vicinity of the proposed LRT;
- Connections to Hurontario LRT and GO station facilitated; and
- Impacts on average travel times by transit.

[12] Classification based on: “Development of Tools for Assessing Wider Economic Benefits of Transportation”, SHRP 2 Strategic Highway Research Program Capacity, Transportation Research Board, July 2013.
[13] Chatman, Daniel and Robert Nolan (2013), “Transit Service, Physical Agglomeration and Productivity in US Metropolitan Areas”, Urban Studies 2013, pages 1-21. The reported transit-wage rate elasticity amounts to 0.00234 and the reported transit-GDP elasticity amounts to 0.097.
[14] Knowles, Richard and Fiona Ferbrache, “An Investigation into the Economic Impacts on Cities of Investment in Light Rail Systems”, Report for UK Tram, June 2014.
[15] Other categories of impacts discussed by Knowles and Ferbrache (2014) include: stimulation of inward investment, unlocking of previously hard to reach sites for development, reorganization or rationalization of production, distribution and land use, and triggering of fresh growth.

The Brampton LRT extension corridor compasses the Downtown area (Wellington to Brampton GO) and the Uptown area (Shopper's World to Charolais) both of which are mixed use areas classified as Major Growth Areas. Surveys of Brampton employers indicate that currently there are over 520 businesses and over 6,200 jobs in the downtown area.[16] These businesses are well positioned to benefit from better travel times and connections that the LRT will facilitate. In other words, LRT will improve access to large existing employment market in downtown Brampton that also has future growth potential.

Brampton LRT will also improve access/generate more streamlined travel experience when connecting to the Brampton GO station and for travel to destinations served by the Hurontario LRT that is currently being developed. This will improve access to employment markets beyond Brampton in the GTA, including Toronto and Mississauga, but also access to Brampton itself. Under the Build scenario, 2040 ridership on GO that uses the Brampton GO station is estimated to increase between 2,560 to nearly 4,500 daily trips, and ridership on HLRT from or to Brampton is estimated to increase by 1,600 to 4,800 daily trips, depending on the option. Option S1 and U1/U2 represent the high end of these estimates while Option S4 represents the low end of the estimates.

5.5.2 LRT as a Catalyst for New Economic Development

Economic analyses of proposed new LRT systems often list new economic development along the LRT route as one of the important benefits. An LRT line may eliminate transportation obstacles and enhance accessibility of certain locations contributing to agglomeration economies and agglomeration benefits discussed earlier. LRT systems are more visible than buses and BRT systems and can help enhance a city's image and prestige as being an attractive and livable city, and be a key element in maintaining a strong city centre.[17]

As an example, an evaluation of the proposed Ottawa LRT found that a number of stakeholders interviewed felt that the absence of a rapid transit system, beyond the existing BRT system, negatively affects the perception of Ottawa. One stakeholder described the effect as diminishing the perception of Ottawa's sophistication that reduces its image as a truly global city.[18]

A recent example of a successful LRT and development around the LRT lines is in Minneapolis-St. Paul, Minnesota, which opened in 2014. The Metropolitan Council reports that developments around the LRT corridors (the Blue Line, the Green Line, and the Southwest Line) amounted to over $6.7 billion as of January 2017.[19]

In Canada, Calgary LRT is commonly considered as very successful in achieving high levels of ridership and leading to high-density transit-oriented development in the downtown core that includes office, commercial and residential uses.[20] However, a similar type of transit-oriented

[16] *Brampton Employers Survey Results*, January 2016 Edition. Compiled by Brampton Economic Development Office.
[17] Ferbrache, Fiona and Richard Knowles, "City Boosterism and Place-Making with Light Rail Transit: a Critical Review of Light Rail Impacts on City Image and Quality", Geoforum No. 80, pp 103-110, 2017.
[18] CPCS Transcom, "Ottawa Light Rail Transit (LRT) Economic Impact Study", Prepared for City of Ottawa, August 25, 2011.
[19] See https://metrocouncil.org/News-Events/Transportation/News-Articles/Nearly-$6-8-billion-in-new-development-reported-al.aspx (accessed September 2020).
[20] The value of the development has not been identified in published sources.

mixed use development along the route has been limited only to a few stations. Many of the stations are currently oriented to auto access through the provision of large park-and-ride lots and/or access through feeder busses.[21]

Successful development around LRT is not automatic or a universal feature of LRT systems. There have been examples where a LRT system largely failed to produce any sort of significant induced development or redevelopment along its route. Buffalo LRT is often cited as one such example.[22]

Literature notes that significant impacts and stimulated economic development only occur when a system is planned with policies and complementary land-use strategies in place, and that they are limited to rapidly growing regions with a healthy underlying demand for high density, mixed-use development.

The Brampton LRT extension corridor compasses the Downtown area (Wellington to Brampton GO) and the Uptown area (Shopper's World to Charolais) both of which are already mixed-use areas classified as Major Growth Areas and contain several sites with significant redevelopment potential. In addition, areas around the intersection of Main Street and Charolais and Main Street and Nanwood were also identified as potential significant redevelopment sites. All these areas have characteristics to benefit from the new LRT.

5.5.3 Economic Impacts of Construction Activities

Construction expenditures can create significant economic impacts in an economy in the form of business revenues, jobs, and related measures. Construction increases business activity in an economy: first to the project contractors who engage resources to develop and build the project, and then to suppliers of input materials, equipment, and services required by the project contractors. The first category of impacts is referred to as "direct impacts" and the second category is called "indirect impacts".

In addition, individuals who become employed as a result of the direct and indirect activities spend their wages on consumer goods and services generating further economic impacts in other sectors of the economy. These impacts are referred to as the "induced impacts". The total economic impact is the sum of the direct, indirect and induced effects.

The above impacts can be estimated on the basis of project cost estimates by broad category of expenditures (construction and development cost, purchase of equipment) and using input-output modeling approaches.

An input-output model captures and quantifies the flows of goods and services between the various industries in an economy. The indirect multipliers from such models provide an aggregate measure of the effect of an industry on all other industries in the economy that arise through supply-purchase relationships. The effects are measured in terms of the impact on business

[21] Higgins, Christopher D. and Mark R. Ferguson, "The North American Light Rail Experience: Insights for Hamilton", report prepared for City of Hamilton, April 2012.
[22] See Higgings and Ferguson (2012). However, it is noted that there have been recent reports of some positive development impacts of the Buffalo LRT (http://www.chch.com/buffalo-lrt/ (accessed September 2020).

revenues, employment requirements, or value added that would be generated for each dollar of revenue of the industry of interest. Direct multipliers provide measures of average employment, employment income, and GDP in the industry analyzed for each dollar of revenues in that industry. Induced multipliers provide similar measures in similar terms but for effects that would arise in the economy when direct and indirect employees re-spend their wages and salaries. These multipliers can be used to estimate the economy-wide effects of an initial expenditure such as expenditures on construction of an infrastructure project.

The actual impacts depend on where the funds are spent, or where the various goods and services needed for the construction would be purchased. This in turn depends on the location of the qualified contractors and suppliers and their ability to service large projects such as the Brampton LRT extension. Spending that takes place outside of the economy analyzed generates little impacts in that economy (although it may help improve the financial project performance if more competitive providers are found outside of the local economy).

At this time, it is not known where the various expenditures would be made and what amounts would be spent specifically in Brampton. Approximate impacts can be estimated based on certain reasoned assumptions that reflect the structure of Brampton's economy compared to a broader economy of the Greater Toronto Area.

Table 5-8 and **Table 5-9** provide order of magnitude impacts in all of Ontario and Brampton, respectively, for Option S1 and Option U1. These two options can be considered as representative of the range of impacts. Other LRT options can be expected to generate impacts of a similar magnitude and proportional to their costs**. Appendix A** provides the detail of the methodology used to derive these impacts.

Table 5-8 shows that in terms of jobs, during construction Option S1 is expected to generate 3,848 job-years across Ontario while Option U1 is expected to generate 17,630 job-years. **Table 5-9** shows that in Brampton, Option S1 is expected to generate 212 job-years while Option U1 is expected to generate 944 job-years. The relatively small impacts in Brampton reflect a relatively small share of Brampton in the GTA economy.

Table 5-8: Economic Impacts of Brampton LRT Construction in Ontario, Cumulative over Construction Years

Category of impacts	Output ($ M)	GDP ($ M)	Employment Income ($ M)	Employment (Job-years)
Option S1				
Direct	$416.7	$177.5	$128.0	1,969
Indirect	$242.6	$128.2	$79.2	1,178
Induced	$135.4	$80.0	$36.7	700
Total	**$794.7**	**$385.7**	**$243.9**	**3,848**
Option U1				
Direct	$1,875.6	$794.0	$583.7	8,970
Indirect	$1,131.5	$595.0	$367.1	5,452
Induced	$620.4	$366.9	$168.2	3,209
Total	**$3,627.4**	**$1,755.8**	**$1,119.0**	**17,630**

Note: Monetary Impacts are in 2020 dollars.

Table 5-9: Economic Impacts of Brampton LRT Construction in Brampton, Cumulative over Construction Years

Category of impacts	Output ($ M)	GDP ($ M)	Employment Income ($ M)	Employment (Job-years)
Option S1				
Direct	$11.3	$4.6	$3.2	46
Indirect	$25.5	$13.5	$8.3	124
Induced	$8.2	$4.8	$2.2	42
Total	**$45.0**	**$22.9**	**$13.8**	**212**
Option U1				
Direct	$41.4	$16.6	$12.5	182
Indirect	$118.8	$62.5	$38.6	573
Induced	$36.7	$21.7	$9.9	190
Total	**$196.9**	**$100.8**	**$61.0**	**944**

Note: Monetary Impacts are in 2020 dollars.

5.5.4 Construction Disruptions

Construction of major transportation projects, including an LRT, can be expected to cause some temporary disruptions in the vicinity of the project, including:

- Dust, noise, and vibrations due to working equipment.
- Roadway lane closures requiring detours of the regular traffic.
- Sidewalk closures requiring pedestrians to use alternate sidewalks or walk routes.
- Impeded access to stores and businesses located on the streets where construction takes place (impeded access to customers and deliveries).
- Interruptions in utility services in the corridor, e.g. power outages, water shut downs.

During construction, there will be significant use of heavy equipment for all aspects of the works. As such, the equipment will induce a certain level of vibration on neighbouring structures. As part of the overall construction effort the construction team will be required to undertake preconstruction surveys of neighbouring properties to assess existing building conditions.

Roadway lanes and sidewalk closures may cause inconvenience and travel delays to drivers and pedestrians while impeded access to stores and businesses may reduce the number of visits and thus business revenues.

These disruptions may particularly affect businesses that depend on customer visits to the physical business locations to generate revenue. Businesses which may be deemed to depend substantially on such visits include retail stores, personal care businesses, bars and restaurants. Non-retail businesses may not be as dependent on customers accessing their physical location to conduct business, and the impact on them can be expected to be much smaller. The specific extent of business losses will likely differ from project to project and depend strongly on local conditions and general economic conditions. Many municipalities undertake financial assistance

and mitigation programs to off-set some of the disruptions (e.g. through means such as signage to improve information, or supplementary parking to compensate for removal of on-street parking and improve access).

Many business communities around LRT projects express concerns regarding possible negative impacts. However, systematic studies of the impacts are lacking. In one published study, an Environmental Impact Statement study for Minneapolis-St. Paul LRT, construction-related loss of revenue to small businesses located along the LRT route was estimated at an average of 30% of pre-construction levels.[23] The largest impact was experienced by retail stores (with an average loss of revenue of 35%) and the smallest by restaurants (with an average loss of revenue of 20%). However, there was a large variation in losses within each group of businesses (with revenue losses ranging from a few percent to as much as 60-80%).

Another study examined the LRT project along Martin Luther King Jr. Way in Rainier Valley, and found that half of the businesses impacted had indicated revenue losses exceeding 50% of pre-construction values.[24]

Mitigation strategies can reduce the severity of negative impacts felt by businesses. These strategies can include providing financial assistance, such as “business interruption” payments to supplement lost revenues during construction, low interest loans or grants to encourage business investment, offering technical assistance or consulting services, conducting marketing efforts on behalf of businesses, and engaging in strong communication campaigns with the public.

5.6 Economic Case Summary Results

The Economic Case compares costs and benefits to determine the overall economic performance of an investment. All of the economic benefits that were identified in this section (i.e. user benefits and external benefits) contribute to total benefits, while the lifecycle capital and operating costs contribute to total costs. The summary of total benefits, total costs, and resulting net present value and benefit-cost ratio are presented in **Table 5-10.**

Table 5-10: Summary of Economic Case

Impact Type	S1	S2	S3	S4	U1	U2
User Benefits						
Travel Time Savings	$279.6	$142.9	$225.8	$91.5	$255.7	$255.7
Reliability Benefits	$32.2	$26.4	$26.3	$25.9	$35.5	$39.2
Journey Quality Benefits	$74.5	$67.6	$71.3	$64.5	$70.0	$70.0
Travel Time Impacts to Auto Remaining in LRT Corridor	-$8.4	-$5.3	-$8.4	-$5.4	-$5.1	-$8.1
Auto Operating Costs Savings	$37.7	$21.2	$28.4	$21.8	$18.6	$22.5
Total User Benefits	**$415.6**	**$252.9**	**$343.4**	**$198.3**	**$374.8**	**$379.3**

[23] Federal Transit Administration and Metropolitan Council, “Central Corridor Light Rail Transit Project: Supplemental Draft Environmental Impact Statement for Construction-Related Potential Impacts on Business Revenue”, December 2012; https://metrocouncil.org/Transportation/Projects/Current-Projects/Central-Corridor/Publications-And-Resources/Environmental/BusinessImpactsSEA/CC-ConstructionSDEIS.aspx (accessed November 2017).
[24] PolicyLink, “Business Impact Mitigations for Transit Projects,” November 2013.

Impact Type	S1	S2	S3	S4	U1	U2
External Benefits						
Decongestion Benefits	$2.6	$1.5	$1.9	$1.5	$1.3	$1.5
Reduction in Road Accidents	$8.5	$4.8	$6.4	$4.9	$3.8	$4.6
Reduction in Vehicle Emissions	$5.0	$2.8	$3.8	$2.9	$2.5	$3.0
Health Benefits	$97.6	$75.9	$90.6	$68.3	$84.0	$84.0
Total External Benefits	**$113.7**	**$84.9**	**$102.7**	**$77.6**	**$91.6**	**$93.2**
Grand Total Benefits	**$529.4**	**$337.8**	**$446.1**	**$275.9**	**$466.4**	**$472.4**
Project Costs						
Capital Construction Costs	$318.2	$323.6	$322.1	$327.5	$1,290.0	$1,320.3
Rehabilitation and Major Maintenance	$35.0	$35.5	$35.3	$35.9	$119.5	$122.2
Operations and Maintenance, O&M, Net Annual	$21.7	$21.7	$21.7	$21.7	$22.0	$22.0
Total Costs	**$374.9**	**$380.8**	**$379.1**	**$385.1**	**$1,431.6**	**$1,464.6**
Net Present Value (NPV)	$154.5	-$43.0	$66.9	-$109.1	-$965.2	-$992.1
Benefit-Cost Ratio	1.41	0.89	1.18	0.72	0.33	0.32
Recommendation	**S1 (followed by S3) is best suited to fulfil the economic case.**				**Both options are well-suited to fulfil the economic case**	

Note: Monetary values are in millions of 2019 dollars discounted at 3.5%

Table 5-10 demonstrates that over the analysis period option S1 generates the highest total benefits in the amount of $529.4 million, net present value of $154.5 million (discounted at 3.5 percent), and the highest benefit-cost ratio of 1.41. Option S3 is the second option with a positive net present value of $66.9 million on total benefits of $446.1 million, and the second-highest benefit-cost ratio of 1.18.It is notable that the underground options tend to generate higher total benefits on average than the surface options: $472.4 million under option U2 and $466.4million under option U1. However, with costs exceeding $1 billion, the net present value of these options is negative and the benefit-cost ratio is just 0.33 for option U1 and 0.32 for option U2.

In addition to the quantified benefits and impacts captured in **Table 5-10**, the project is expected to generate other benefits and impacts which are more difficult to quantify and reflect in metrics such as the net present value or the benefit-cost ratio. These include the following:

- Improved access to employment centres in downtown Brampton;
- Improved access to Brampton GO and HLRT with increased ridership on these transit lines;
- Potential for increased economic development along LRT; and
- Economic impacts (in the form of business output, job creation and related measures) from construction expenditures.

5.7 Sensitivity Analysis

The cost-benefit analysis outcomes presented in previous sections rely on a large number of assumptions and long-term projections, both of which are subject to considerable uncertainty.

The sensitivity analysis can be used to:

- Evaluate the impact of changes in individual critical variables to determine how much the final results would vary with reasonable departures from the “preferred” or most likely value for the variable; and
- Assess the robustness of the CBA and evaluate, in particular, whether the conclusions reached under the “preferred” set of input values are significantly altered by reasonable departures from those values.

The parameters and input data tested included the following:

- 2041 estimate of LRT ridership. 2041 ridership estimate is driving ridership level in each year over the analysis period. Higher ridership will tend to increase modeled benefits by increasing the magnitude of auto diversion and benefits that stem from it (auto operating costs savings, decongestion, reduction in road accidents, reduction in vehicle emissions, and health benefits). Lower ridership will have the opposite impacts. For this sensitivity analysis, an increase of 10% and a reduction of 10% in 2041 ridership were tested.
- Value of time growth. Currently, the CBA model assumes a 0% rate of growth in the value of time. This is a standard Metrolinx assumption. However, a growth rate of 0.75% is recommended for sensitivity testing. A growth rate in the value of time greater than 0% reflects expectations of future increases in real wage rates which would then lead to an increase in the valuation of travel time impacts and travel time savings benefits.
- Rate of growth in ridership after 2049. The default assumption is a cap of 0%. While this is a conservative assumption frequently adopted for long-term project evaluations, some moderate growth is also within the range of realistic outcomes, in particular for vibrant regions with growing population and employment. To get a sense of possible impacts, a rate of 1% of continued growth after 2049 was tested.
- Reduction in road accidents. Diversion of auto trips to transit is expected to reduce the number of road accidents and thus social accident costs. Metrolinx recommends a starting value of this cost saving in the amount of $0.095 per VKT diverted in 2019 with an annual reduction of 5.3% in each subsequent year. While this is a conservative assumption, continued trends in accident rates and increases in accident costs (for example due to increases in the real health care costs related to treatment of accident injuries, or valuation of income lost due accident injuries) are also within the range of realistic outcomes. To get a sense of possible impacts, a scenario was tested in which the social cost of accidents avoided remain at the constant level of $0.095 per VKT diverted over the entire analysis period.
- Ridership growth over 2041-2049. The rate of growth was reduce from 1% to 0.5% to assess the impact. Ridership has effect on all project benefits and thus a reduction in ridership can be expected to reduce project net present value and evaluation outcomes.

- Construction cost. An increase in costs with reduce project net present value and other project evaluation outcomes. Strong projects will show some level of performance robustness with respect to relatively small increases in costs which may result due to unexpected trends and cost escalation. To address this criterion, an increase in capital construction costs of 10% was tested.
- Operations and maintenance costs (net O&M). as in the case of capital costs, an increase in O&M costs will reduce project net present value and evaluation outcomes. An escalation factor of 1% annually was tested to assess impacts of possible real increase in the magnitude of operating costs.

Table 5-11 shows the results of this analysis for Option S3 and Option U1 (the two emerging preferred options). The first left column in the table indicates the parameter or input data tested and how this parameter/input data was changed. The other columns show the new estimates of benefits, net present value (NPV), and the BC ratio.

Table 5-11: Results of Sensitivity Analysis

Input Data or Parameter Tested	Option S3			Option U1		
	New Benefits	New NPV	New BC Ratio	New Benefits	New NPV	New BC Ratio
2041 Ridership Estimate: Increase by 10%	$468.9	$89.8	1.24	$487.9	-$943.6	0.34
Value of Time Growth: 0.75% Annually (Instead of 0%)	$539.2	$160.1	1.42	$578.0	-$853.5	0.40
Ridership Growth after 2049: 1% Annually (no Cap on Growth)	$488.0	$108.8	1.29	$515.6	-$916.0	0.36
Reduction in Road Accidents Benefits: No Reduction in Unit Value over Time	$469.6	$90.5	1.24	$482.2	-$949.3	0.34
Ridership Growth over 2041-2049: Reduction from 1% to 0.5%	$435.43	$56.30	1.15	$454.4	-$977.2	0.32
Construction Costs: Increase of 10%	$446.1	$36.7	1.09	$466.4	-$1,093.6	0.30
2041 Ridership Estimate: Reduction by 10%	$423.2	$44.1	1.12	$444.8	-$986.8	0.31
Net O&M Costs: Cost Escalation of 1% Annually over Analysis Period	$446.1	$58.2	1.15	$466.4	-$974.7	0.32

The results displayed in the table demonstrate that from the input data tests that reduce NPV and worsen project evaluation outcomes, increase in capital construction costs had the greatest impact. For option S3, the BC ratio declined to 1.09, and for option U1 it declined to 0.30. The impacts of O&M cost escalation, reduction in ridership growth, or initial estimate of ridership were relatively small.

From changes that increase NPV and improve project evaluation outcomes, growth in value of time had the greatest impact. For option S3, the BC ratio increased to 1.42, and for option U1 it increased to 0.40.

5.8 Economic Case Concluding Remarks

Of the surface options, S1 and S3 have a positive net present value and a BC ratio greater than 1 at the 3.5% discount rate. They both can be considered as suitable to fulfill the economic case. Sensitivity testing of Option S3 also revealed that it is relatively robust to changes in modeling assumptions and input data which tend to reduce project net present value and BC ratio. Upward deviations in capital construction costs can be considered the biggest risk to the performance of this option.

The underground options perform poorly from the perspective of the overall performance as represented by the project net present value and BC ratio because of substantially higher costs of these options. However, these options generate higher benefits than surface options S2, S3, and S4, in particular travel time savings and reliability benefits. Option U1 also has the smallest impact on travel times of autos remaining in the travel corridor, a dis-benefit of the LRT Extension project. It also has a higher net present value that option U2. Sensitivity testing of Option U1 revealed some changes in performance and possibly a higher NPV and BC ratio under some parameter and input data scenarios. However, none of the tests conducted generated a scenario resulting in a positive NPV and a BC ratio greater than 1.

6 Financial Case

The Financial Case assesses the overall financial impact of the proposed LRT options to the project sponsors and municipality where it will be located. It focuses on the requirements to successfully deliver an investment from the financial point of view. This includes a review of costs of the proposed project over its life cycle (capital construction, vehicles, capital renewal, operations and maintenance), revenues related to the project (fares and other revenues if relevant), and overall financial performance.

6.1 Key Assumptions

This Financial Case used the parameters and assumptions consistent with Metrolinx's Business Case Guidance (as of April 2019) as shown in **Table 6-1** below. All analysis is incremental to the base case of a No Build scenario in which the Brampton LRT extension is not built. The analysis was conducted in nominal dollars (or year of expenditure dollars) to present the overall net financial impact to project sponsors.[25]

Table 6-1: Financial Case Assumptions

Input	Unit	Value
Evaluation Periods	Years	60
Discount Rate	%	5.5%
Inflation Rate	%	2.0%
Annual Increase in Fares	%	2.0%
Capital and O&M Cost Escalation Growth		
Short Term (until 2031)	%	1%
Long term (after 2031)	%	0%

6.2 Capital Costs

Capital construction costs represent a Class 5 estimate of the likely magnitude of costs., all in terms of 2020 dollars. For the purpose of this analysis, LRT vehicle costs were based on estimated needs for additional vehicles to maintain the planned headways on Hurontario LRT. The vehicle needs analysis indicated that for surface options three additional vehicles would be needed, and for the underground options one additional vehicle would be needed. The number of additional vehicles needed was then multiplied by the cost per vehicle as implied by the vehicle costs of Hurontario LRT, adjusted from 2012 to 2019 dollars using a consumer price index, and escalated using an annual rate of 1%[26]. It was assumed that all vehicles would be replaced after 30 years of operations at the same cost.

For the purpose of this business case analysis, capital costs were assumed to be incurred in equal installments over the construction period of six years for surface options, between 2026

[25] In contrast, the benefit-cost analysis under the Economic Case is conducted in constant 2019 dollars that exclude inflation and cost escalation.
[26] Specific cost estimates based on Steer Davis Gleave "Hurontario Benefits Case Analysis", March 2016.

and 2031, and the construction period of eight years for underground options, between 2026 and 2033,except for the LRT vehicle costs which were assumed to take place in Year 3 before the end of the construction period. Each annual cost was then escalated and inflated to the year of expenditure based on the assumptions shown in **Table 6-1.**

Rehabilitation and renewal costs were estimated as 60 percent of structures and indirect costs that would be incurred over the analysis period after 15 years of operations.[27] In the analysis, these costs were distributed equally as annual renewal and rehabilitation costs over the years 16 to 60 and inflated based on the average annual inflation rate as shown in **Table 6-1**. In addition, LRT vehicles were assumed to be replaced in year 30 at the same cost as the original purchase but inflated to the year when this expenditure would take place.

Table 6-2 provides a summary of capital construction costs, capital renewal, and vehicle replacement costs. The sum of these three cost elements forms total capital life-cycle costs.

Table 6-2: Capital Costs, by Option, $ Millions

Item	S1	S2	S3	S4	U1	U2
Guideways and Trackworks	$40.9	$41.7	$41.3	$42.2	$335.1	$350.1
Platforms, Stations, and Stops[28]	$22.7	$22.7	$22.7	$22.7	$584.0	$594.4
Siteworks and Special Conditions	$129.3	$132.7	$131.9	$135.4	$121.3	$120.9
Systems	$43.7	$43.7	$43.7	$43.7	$45.5	$46.1
Allowances	$36.3	$37.0	$36.8	$37.4	$163.7	$167.6
Indirect Cost	$40.9	$41.7	$41.4	$42.2	$187.4	$191.9
Professional Services	$97.2	$99.0	$98.5	$100.3	$445.5	$456.0
HST - 1.76%	$7.2	$7.4	$7.3	$7.5	$33.1	$33.9
Design Development Contingency	$125.4	$127.7	$127.1	$129.	$574.7	$588.2
LRT Vehicles	$37.0	$37.0	$37.0	$34.9	$13.1	$13.1
Total Capital Construction Costs	**$580.6**	**$590.5**	**$587.7**	**$595.4**	**$2,503.5**	**$2,562.1**
Rehabilitation and Renewal	$390.9	$398.0	$396.0	$403.1	$1,917.1	$1,962.2
LRT Vehicles Replacement	$69.7	$69.7	$69.7	$69.7	$23.2	$23.2
Total Capital Life-Cycle Cost	**$1,041**	**$1,058**	**$1,053**	**$1,068**	**$4,444**	**$4,548**

Table 6-2 shows that the total capital costs to deliver the project vary between $1.04 billion for Option S1 to over $4.5 billion for Option U2. The surface options are substantially less costly with total costs below $1.1 billion. The major driver of capital costs are guideways, trackwork, and platforms and stations. Substantially higher costs for these items for the underground options are also driving up the contingency costs and future rehabilitation and renewal costs.

[27] This assumption is similar to that used in Steer Davis Gleave “Hurontario Benefits Case Analysis”, March 2016.
[28] Capital costs do not include station relocation, understanding that the Brampton Gateway station will be maintained on the south side of Steeles Avenue, in line with the HuLRT project terminus station.

6.3 Operations and Maintenance Costs

As outlined in the Economic Case section, incremental annual operations and maintenance (O&M) costs were extrapolated from the costs estimated for the Hurontario LRT (for the alignment length of 3.5 km as opposed to 20 km) and adjusted from 2012 to 2019 dollars using a consumer price index and an escalation factor of 1% annually. The estimates were based on the costs to operate the LRT (staff costs, power costs, stop maintenance, etc.) as well as savings in the bus operating costs for buses which would no longer be needed.[29] The costs estimated in this way amounted to $1.31 million annually in 2019 dollars. As discussed in the Economic Case section, these costs were further adjusted to reflect higher O&M costs for an underground station than a surface station. The difference in station O&M cost amounted to $116,000 additional cost for underground options. This figure was added to the previously calculated overall cost to obtain cost specific for the underground options.

For the Financial Case analysis, the O&M costs were then inflated and escalated using the inflation and escalation assumptions shown in **Table 6-1.**

6.4 Revenues

The Brampton LRT Extension project is expected to attract new users to transit which include travelers diverting from auto and entirely new travelers. These new trips will generate fare revenues that can be considered incremental to fare revenue from existing riders (i.e. riders diverting from the existing bus system). In addition, Brampton LRT is estimated to increase ridership on GO transit and Hurontario LRT which will also increase their utilization and revenue.

For the purpose of this analysis, incremental LRT fare revenues were estimated as the number of new trips multiplied by the average fare on Brampton transit. The adjustments due to fare integration with the other transit agencies in the Greater Toronto Area were not included. The average fare was based on published 2019 statistics for Brampton transit which produced a fare of $2.71 in 2019 dollars. Incremental fare revenues on GO transit were estimated as the incremental GO transit ridership multiplied by the GO co-fare which amounted to $0.80 at the time of this analysis. Both the LRT fare and GO co-fare were inflated to the respective analysis years using the average annual inflation rate shown in **Table 6-1**. The resulting estimates of fare revenues are shown in **Table 6-3**. In addition to incremental fare revenue (due to new ridership), the table shows total LRT fare revenue that includes revenue attributable to new and existing riders.

Table 6-3: Fare Revenues due to Brampton LRT Extension, Total over Analysis Period, $ Millions

[29] Specific cost estimates based on Steer Davis Gleave “Hurontario Benefits Case Analysis”, March 2016.

Item	S1	S2	S3	S4	U1	U2
Incremental LRT Fare Revenue	$728.0	$565.9	$675.5	$509.3	$693.6	$693.6
Incremental GO Fare Revenue	$150.6	$125.5	$138.0	$100.4	$170.4	$183.5
Total LRT Fare Revenue	$4,103.5	$3,678.6	$3,917.6	$3,492.7	$4,230.9	$4,230.9

Table 6-3 shows that Option S1 is estimated to generate the highest incremental LRT fare revenues at $728.0 million over the analysis period followed by Option S3 at $675.5 million and the underground options U1 and U2 at $693.6 million each. Option S4 is estimated to have lowest incremental fare revenues at $509.3 million. Incremental GO fare revenues are much smaller in magnitude. The highest estimate is for Option U2 at $183.571.9 million followed by Option U1 at $170.4 million. Option S4 is estimated to have lowest revenue of the six options considered at $100.4 million. Total LRT fare revenues are estimated at $4.01 billion for Option S1, followed by just below $4.2 billion for the underground options.

Non-fare revenues were not estimated as part of this analysis.

6.5 Financial Case Summary Results

A summary of the total financial impacts of the Brampton LRT extension project is presented in **Table 6-4** and **Table 6-5** for the discounted and undiscounted costs and revenue streams, respectively.

In discounted dollars terms, all options generate an overall negative net financial impact indicating that the project cannot finance itself based on generated revenue and requires a financial subsidy. The underground options require a subsidy of more than$1.5 billion over the analysis period, and the surface options require a subsidy of up to $354.5 million. Option S1 has the lowest net financial impact with a subsidy requirement of $314.9 million. However, all alternatives are expected to fully recover incremental operating costs from incremental revenues with the operating cost ratio ranging from 2.7 for Option S4 to 3.9 for Option S1 and 3.6 for option S3. Total cost recovery ratio ranges from about 0.06 for underground options to 0.23 for option S1.

Table 6-4: Summary of Financial Flow Statistics over Analysis Period, Discounted

Item	S1	S2	S3	S4	U1	U2
Capital Construction Costs	$348.4	$354.3	$352.7	$357.3	$1,425.2	$1,425.2
Major Maintenance and Renewal Costs	$38.2	$38.7	$38.6	$39.1	$140.2	$143.4
Incremental Operations and Maintenance Costs	$24.9	$24.9	$24.9	$24.9	$24.9	$24.9
Total Costs to Deliver Project	**$411.5**	**$418.0**	**$416.2**	**$421.4**	**$1,590.2**	**$1,593.5**
LRT Incremental Revenues	$80.0	$62.2	$74.3	$56.0	$69.1	$69.1
GO Incremental Revenues	$16.6	$13.8	$15.2	$11.0	$17.0	$18.3
Total Incremental Revenues	**$96.6**	**$76.0**	**$89.4**	**$67.0**	**$86.1**	**$87.4**
Net Financial Impact	**-$314.9**	**-$342.0**	**-$326.7**	**-$354.4**	**-$1,504.2**	**-$1,506.1**

Item	S1	S2	S3	S4	U1	U2
Operating Costs Recovery Ratio	**3.9**	**3.0**	**3.6**	**2.7**	**3.5**	**3.5**
Total Costs Recovery Ratio	**0.23**	**0.18**	**0.21**	**0.16**	**0.05**	**0.05**
Recommendation	**S1 and S3 are best suited to fulfil the financial case**				**Both options are well-suited to fulfil the financial case**	

In undiscounted dollars terms shown in **Table 6-5**, all options continue to have a negative net financial impact. Operating cost recovery ratio and total cost recovery ratio increase considerably.

Table 6-5: Summary of Financial Flow Statistics over Analysis Period, Undiscounted

Item	S1	S2	S3	S4	U1	U2
Capital Construction Costs	$580.6	$590.5	$587.7	$595.4	$2,503.5	$2,503.5
Major Maintenance and Renewal Costs	$473.8	$481.2	$479.1	$486.4	$1,940.3	$1,985.4
Incremental Operations and Maintenance Costs	$218.0	$218.0	$218.0	$218.0	$242.0	$242.0
Total Costs to Deliver Project	**$1,272.4**	**$1,289.6**	**$1,284.8**	**$1,299.9**	**$4,685.7**	**$4,730.9**
LRT Incremental Revenues	$728.0	$565.9	$675.5	$509.3	$693.6	$693.6
GO Incremental Revenues	$150.6	$125.5	$138.0	$100.4	$170.4	$183.5
Total Incremental Revenues	**$878.6**	**$691.4**	**$813.5**	**$609.7**	**$864.0**	**$877.1**
Net Financial Impact	**-$393.8**	**-$598.2**	**-$471.3**	**-$690.1**	**-$3,821.7**	**-$3,853.7**
Operating Costs Recovery Ratio	**4.0**	**3.2**	**3.7**	**2.8**	**3.6**	**3.6**
Total Costs Recovery Ratio	**0.69**	**0.54**	**0.63**	**0.47**	**0.18**	**0.19**

7 Deliverability and Operations Case

7.1 Introduction

The Deliverability and Operations Case analyzes the investment delivery, operations and maintenance, service plans and any other issues that may facilitate or prevent the realization of an option. This includes delivering the project from original concept through to planning, design, environmental assessment, stakeholder engagement, procurement, construction and operations.

The Deliverability and Operations Case is one of two cases (the other being the Financial Case) focused on requirements for delivering the investment.

The Deliverability and Operations Case will continue to evolve as the City of Brampton and project proponents advance the management of the project. The following outlines some key aspects of the project based on available information.

7.2 Design and Operational Trade-offs and Issues

The development of an LRT along Main Street has been in consideration since 2014 and builds on the Hurontario Main Street Corridor Master Plan published in 2010. Previous efforts on the project have involved public consultations and the completion of an environmental review/TPAP in 2014 as well as an Initial Business Case in 2016.

The current LRT Extension Study and Preliminary Design Business Case have been prepared with a conceptual (10-15%) level of design for each of the short-listed investment options.

7.2.1 Surface Options

Option S3 has the greatest impact on emergency and service vehicle operations in Segment B due to a single traffic lane in each direction and Segment C due to single mixed traffic/transit lane in each direction. Option S2 has the least impacts to emergency and service vehicle operations.

Option S1 has the greatest impact to driveways as all full moves access driveways in all segments must be converted to right-in-right-out unless at signalized intersection (77 driveways). Option S2 and S4 have impacts to 15 and 19 driveways, respectively with the majority of impacts being concentrated in Segment A. Option S3 impacts requires access restrictions at 73 driveways.

Options S1 and S2 require more property than S3 and S4 to accommodate dedicated left turn lanes in Segment C. Overall, all options have similar property requirements. All options require full taking for a surface TPSS in Segment B. TPSS locations in Segment A and C are on City owned lands.

The utility impact assessment was performed based the available information provided from various utility stakeholders, the Region of Peel's Design Specification and Procedure's Manual for Linear Infrastructure (Revised January 2015). Note that the vertical profile of Hydro conduits and duct bank, gas line, telecom utilities including the Rogers conduits, Bell Conduit and TELUS Conduits are not available as this time.

Utility conflicts were determined based on the location proximity of existing utilities infrastructure to the proposed track foundation and the utility free zone. While the conflict matrices list all the existing utilities within proximity of the proposed alignment, utility elevation data is required to confirm the actual conflicts.

Utility impacts are similar for all four surface options. **Table 7-1** below summarizes the critical conflicts identified based on available data.

Table 7-1: Summary of Critical Utility Conflicts

Utility Type	Location	Description	Impacted Options
Watermain – 400 mm	35 m south of the intersection of Steeles Avenue East and Hurontario Street	Watermain has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm watermain depth.	S1, S2, S3, S4
Watermain – 900 mm	17 m south of the intersection of Steeles Avenue East and Hurontario Street	Watermain has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm watermain depth.	S1, S2, S3, S4
Box culvert – 1200 mm x 1200mm	9.5 m north of the intersection of Main St and Bartley Bull Parkway	Box culvert has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm the elevation of the culvert from the surface.	S1, S2, S3, S4
Sanitary sewer – 900 mm	35 m south of Main St and Peel Village Parkway	Sanitary sewer has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm the sanitary sewer elevation.	S1, S2, S3, S4
Sanitary sewer – 900 mm	33 m south of Main St and Peel Village Parkway	Sanitary sewer has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm the sanitary sewer elevation.	S1, S2, S3, S4
Sanitary sewer – 1350 mm	26 m south of Main St and Peel Village Parkway	Sanitary sewer has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm the sanitary sewer elevation.	S1, S2, S3, S4

Utility Type	Location	Description	Impacted Options
Storm sewer – 750 mm	39 m north of Main St and Elgin Drive	Storm sewer has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm the storm sewer elevation.	S1, S2, S3, S4
Watermain – 400 mm	115 m north of the intersection of Main St and Elgin Drive.	Watermain has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm watermain depth.	S1, S2, S3, S4
Watermain – 400 mm	6.3 m – 7.1 m west of the centerline, between Main St and Nanwood Drive intersection to Main St and Wellington St W.	Watermain is located within the utility free zone.	S1, S2, S3, S4
Sanitary sewer – 525 mm	176 m north of Main St and Nanwood Drive.	Sanitary sewer has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm the sanitary sewer elevation.	S1, S2, S3, S4
Sanitary sewer – 1200 mm	198 m north of Main St and Nanwood Drive.	Sanitary sewer has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm the sanitary sewer elevation.	S1, S2, S3, S4
Storm sewer – 2250 mm	281 m north of Main St and Nanwood Drive; 6.1m east of the centerline	Storm sewer is located within the utility free zone.	S1, S2, S3, S4
Sanitary sewer – 910 mm	North of Main St and Etobicoke Drive; 5.3m east of the centerline	Sanitary sewer is located within the utility free zone.	S1, S2, S3, S4
Sanitary sewer – 1170 mm	South of Main St and Clarence Street; 0.0m – 5.3m east of the centerline	Sanitary sewer is located within the utility free zone.	S1, S2, S3, S4
Sanitary sewer – 825 mm	North of Main St and Clarence Street; 0.8m east of the centerline	Sanitary sewer is located within the utility free zone.	S1, S2, S3, S4
Sanitary sewer – 675 mm	31 m north of Main St and Glen Eagle Crescent; 2.4m west of the centerline	Sanitary sewer is located within the utility free zone.	S1, S2, S3, S4
Watermain – 600 mm	1.1 m south of Main St and Wellington St W	Watermain has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm the watermain elevation.	S1, S2, S3, S4

Utility Type	Location	Description	Impacted Options
Watermain – 600 mm	Crossing Main St at the intersection of Main St and Wellington St W.	Watermain has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm the watermain elevation.	S1, S2, S3, S4
Storm sewer – 3000 x 2000 mm	Crossing Main St at the intersection of Main St and Wellington St W.	Watermain has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm the storm sewer elevation.	S1, S2, S3, S4
Storm sewer – 600 mm	6.6 m south of Main St and John St	Storm sewer has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm the storm sewer elevation.	S1, S2, S3, S4
Watermain – 600 mm	2.5 m north of Main St and John St	Watermain has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm the watermain elevation.	S1, S2, S3, S4
Storm sewer – 600 mm	4.0 m north of Main St and Queen St	Storm sewer has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm the storm sewer elevation.	S1, S2, S3, S4
Watermain – 600 mm	4.2 m north of Main St and Nelson St	Watermain has been identified as a potential critical conflict within the LRT's utility free zone. More data is needed to confirm the storm sewer elevation.	S1, S2, S3, S4
Storm sewer – 1950 mm	2.7m west of the centerline; north of Main St and Nelson St	Storm sewer is located within the utility free zone.	S1, S2, S3, S4

All options are equal in terms of utility impacts, and their ability to be extended north in the future. All surface options encounter vertical clearance issues with the existing CN bridge above Main Street as well as the proposed 3rd track expansion. Mitigation measures have been considered for surface options to minimize the impact of overhead catenaries and messenger wires on railway operations.

Options S2 and S4 are more preferred from a design and operational trade-offs perspective as they minimize impacts.

Section 7.7 provides a summary of the key design and operational trade-offs and issues for each of the surface options.

7.2.2 Underground Options

For the underground options, three tunneling methods were considered: sequential excavation method (SEM), tunnel boring machine (TBM), and the cut and cover method.

TBMs are typically cost-effective for tunnel lengths greater than 2 kilometres. Ground support is installed concurrently with excavation and excavated material is transferred to a portal by a conveyor system or rail muck cars. However, the setup cost is high due to transport logistics from the factory and launch shaft requirements and can result in significant construction effort and schedule to complete. Given the underground portion of the Brampton LRT is only 1.6 kilometres long, it is too short to be cost effective.

Cut and cover construction involves open cut excavation between pre-installed walls to resist lateral ground movements. This method is widely used for the construction of tunnel portals and transit stations and can be used for stations with a maximum depth of about 20 metres. Cut and cover construction is most cost-effective for shallow excavations in wide streets which do not require significant utility relocations or other surface disruptions. However, cut and cover tunnels interfere with traffic, utilities, businesses and other urban activities when tunnel alignment is under city streets. While there is sufficient right of way south of Etobicoke Creek to effectively manage traffic during excavation, the right of way north of Etobicoke Creek would require the temporary closure of Main Street to facilitate the work.

SEM, widely used in Canada and worldwide, offers cost and schedule savings by utilizing inherent geological strength in the surrounding rock mass to stabilize the tunnel. SEM tunnels are less expensive for shorter tunnels due to the lower equipment mobilization and setup costs than TBM tunnels. In addition, from geotechnical data available from previous studies and drilling investigations, the bedrock under Main Street is well suited to SEM tunneling. Construction materials for SEM mining are readily available in Ontario, including the experienced labourers. Further boreholes and geophysical investigation are required to define subsurface conditions and ground risk. Therefore, SEM has been determined as the preferred option for underground tunneling.

Since SEM mining activities are primarily underground, accessed from the portal, which minimize any surface disruption relative to other methods. SEM tunneling activities also emit less noise and vibration relative to TBM or cut and cover construction due to the concentration of heavy equipment work underground. An accelerated schedule can also be achieved by providing multiple excavation faces during the SEM tunneling process. This can minimize any construction impacts while tunnels and station caverns are excavated simultaneously.

Option U1 requires less property acquisition than Option U2 as the Brampton GO Station is within the Main Street public right-of-way and the main entrance building is located on City owned lands. Option U1 is able to be extended further north in the future more easily than Option U2.

The utility impact assessment for the underground options began at the intersection of Main Street and Nanwood Drive and terminated at the proposed Brampton GO station for options U1 and U2. The assessment also included potential utility conflicts at open cut locations, such as Nanwood Drive and Brampton GO stations' surface connections.

Similar to the surface options utility assessment, further review is needed to confirm the elevation of all the utility infrastructure listed in the conflict matrices. The underground track segments from Nanwood Drive to Brampton GO have proposed to be located at a depth of approximately 20 meters below surface, and the track will be constructed with mining construction operation. Preliminary assumptions have been made that existing infrastructure within the Right-Of-Way are located between 1 – 5 meters below ground. Therefore, the construction operation will not be impacting the existing utilities.

At the underground station at Nanwood Drive and Brampton Go locations, the station buildings will be constructed using open cut method to make connection to the underground concourse. As such, the potential utility conflicts are only evaluated at the open cut construction locations. For Option U2 at the Brampton GO Station location, there are a few minor utilities which are in the proximity of the station location. Details of the utilities are outlined in the conflict matrix.

There are two historical channels located within the downtown Brampton area. One channel is located near the intersection Main Street and Wellington Street West and the second channel is located on Main Street between Nelson Street East and Queen Street East. As part the LRT construction, these two historical channels are to be removed to accommodate the future tracks. No tail tracks are required for underground storage at the terminus and a crossover is planned ahead of station platforms.

All options are equal in terms of emergency and service vehicle operations, and driveway impacts. They both require access restrictions (RIRO) to be implemented at 9 driveways along the surface portion in Segment A.

Option U1 is most preferred underground option from a design and operational trade-offs perspective as it minimizes property impacts and is most able to be extended further north in the future.

Section 7.7 provides a summary of the key design and operational trade-offs and issues for each of the underground options.

7.3 Construction Constraints and Mitigation

7.3.1 Surface Options

There are no material differences between options in terms of constructability for the surface options. Each option will entail:

- Permits and environmental approvals
- Removals
- Utility relocations (dry and wet utilities)

- Traction power substations (including civil works and testing) – 3 sites
- Stations and stop construction
- Roadworks
- Trackwork and guideway construction
- Overhead catenary system (OCS)
- Train control and signaling
- Commissioning and system testing acceptance

Construction in the surface section is similar to typical road widening construction. Construction staging will likely proceed as follows:

- Reconstruct the curb line on one side of the roadway and provide continuous traffic lanes on the other side of the roadway. The reconstruction will include rebuilding the curb lines, gutters, catch basins, etc. It should be noted that the reconstruction of the curb line may potentially occur simultaneously during utility relocations.
- Relocate underground utilities as required. This will include relocation of illumination poles and above ground utility poles, relocation of traffic signals and provision for temporary traffic signals where required.
- Reconstruct the other side of the roadway after the first side is completed. Traffic lanes in each direction will be maintained where feasible. A minimum of one lane in each direction will be provided at all times. Resurface the roadway after the roadway reconstruction.
- Construct new LRT facilities within the LRT right-of-way, including the track bed, track slab, tracks, LRT curbs, poles, platforms, etc.
- Construct streetscaping and urban design elements and provide active transportation improvements on both sides of the roadway if applicable.

The bridge construction methods will vary between bridges depending on the extent of modification and structure type.

Surface options are estimated to take up to 6 years from design to opening day.

Table 7-2: Surface Options Schedule

Phase	S1	S2	S3	S4
Design	Up to 2 years			
Permitting				
Utility Relocation				
Construction	~ 3 years			
Testing & Commissioning	~ 1 year			
Total Implementation Schedule	~ 6 years			

7.3.2 Underground Options

Figure 7-1 summarizes the construction method for the underground options along the study area.

Figure 7-1: Underground Options Construction

Underground options are estimated to take between 7 and 8 years from design to opening day, depending on the construction process selected. The construction method will be defined by the contractor; however, two potential scenarios were examined to show the range of schedules. Concurrent work provides the opportunity to expedite the project timelines by mining from both ends of the corridor, whereas subsequent work would consist of mining from one end to the other.

Table 7-3: Underground Options Schedule

Phase	U1 and U2 (Concurrent Work)	U1 and U2 (Subsequent Work)
Design	Up to 2 years	Up to 2 years
Permitting		
Utility Relocation		
Construction	~ 4 years	~ 5 years
Test & Commissioning	~ 1 year	~ 1 year
Total Implementation Schedule	~ 7 years	~ 8 years

Additional details related to constructability are provided for each segment in the following sections.

7.3.2.1 Segment A: Steeles to Nanwood

Segment A will follow the construction sequence as described in the surface options. Both options U1 and U2 are the same within Segment A.

7.3.2.2 Segment B: Nanwood to Wellington

Segment B includes the construction of the tunnel portal structure, Nanwood underground station, and the running tunnel between Nanwood and Wellington. Underground options will be constructed by SEM. Nanwood Station will be open cut partially within the Main Street right-of-way and partially within the Brampton Mall parking lot. Both Options U1 and U2 are the same within Segment B.

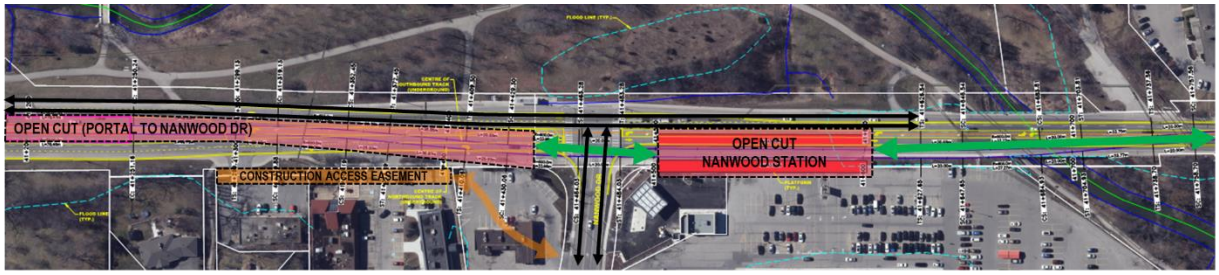
Mining will progress northwards towards the Brampton GO Station from the north end of Nanwood Station box and a small SEM operation will be required south under the Main/Nanwood intersection to the open cut section for the portal to minimize impacts to utilities within Nanwood Drive and maintain access during construction. The entire portal until the short SEM section under Nanwood Dr will be open cut. **Table XX** summarizes all the potential critical utility impacts of the open cut section leading into Nanwood Drive station. In addition to the critical conflicts listed on this table, there are also 24 existing utilities that may be impacted by the proposed open cut section. Further data is needed to confirm the vertical profiles of the existing utilities.

Table 7-4: Summary of Critical Utility Conflicts for Open Cut Section

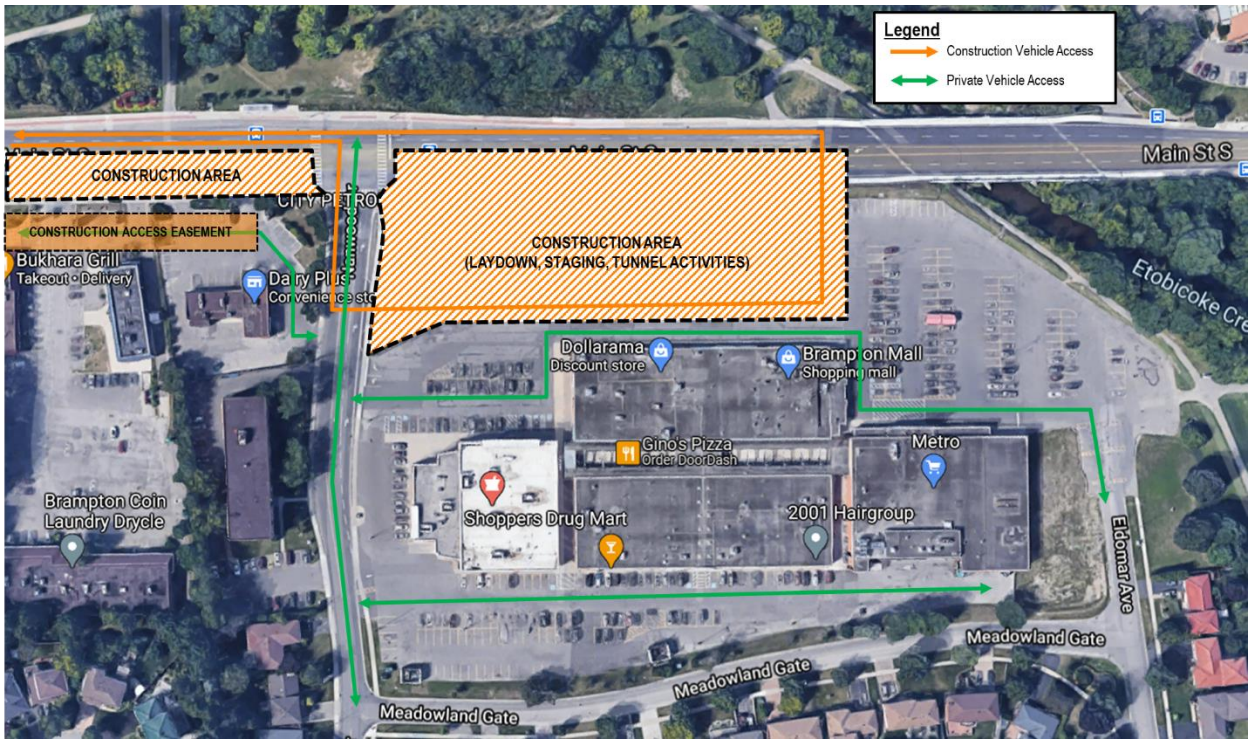
Utility Type	Location	Description	Impacted Options
Storm Sewer – 750 mm	39 m north of Main St and Elgin Drive	Storm sewer has been identified as a potential critical conflict in proximity to the open cut area. More data is needed to confirm storm sewer depth.	U1, U2
Watermain – 400 mm	115 m north of the intersection of Main and Elgin Drive	Watermain has been identified as a potential critical conflict in proximity to the open cut area. More data is needed to confirm watermain depth.	U1, U2
Watermain – 400 mm	210 m north of the intersection of Main and Elgin Drive; 7.7m west of Main St center line	Watermain has been identified as a potential critical conflict in proximity to the open cut area. More data is needed to confirm watermain depth.	U1, U2

Traffic will be diverted to the west side of Main St (at least one lane in each direction) for the duration of construction. Full access to Nanwood Drive will be maintained. All entrances to private property from Main St in the area between the portal and the Etobicoke Creek will be closed during construction. A construction access easement will be required to provide access to

properties south of Nanwood Drive through existing parking lots. Access to the Brampton Mall will be maintained through the access from Nanwood Drive. Areas of construction are shown in the image below.



A construction staging and laydown area will be required for tunneling activities such as tunnel muck handling and storage within the Brampton Mall parking lot. Construction vehicles will access the construction site via Main Street and Nanwood Drive. Private vehicle access to the Brampton Mall will be via Nanwood Drive only. A portion of the Brampton Mall surface parking lot will be required for construction staging and laydown as shown in the image below.



The running tunnels between Nanwood Drive and Wellington Street will be constructed via SEM within the Main Street ROW with minimal disruption to the surface, the Etobicoke Creek bridge, or utilities.

7.3.2.3 Segment C: Wellington to Brampton GO

The running tunnels continue north of Wellington to the Brampton GO. Option U1 stays within the Main Street ROW. Option U2 deviates off Main Street under Gauge Park to George Street. The alignment stays within the George Street ROW and straddles Brampton City Hall and City Hall's West Tower. Option U1 terminates within the Main Street ROW just south of the CN Rail with a mined cavern station. Option U2 terminates within the George Street ROW just south of the CN Rail with a mined cavern station. All options have been designed to protect for future CN/Metrolinx trackwork.

Option U1 and U2 will have access shafts from their respective station entrance buildings down to the mined cavern. Option U1 and U2 will require the demolition of 8 Nelson Street and a temporary relocation of the Downtown Brampton Bus Terminal for the duration of construction (unless already relocated). Both options can be constructed and will have minimal disruption to the surface other than construction access to 8 Nelson for station entrance building construction and shaft. Option U1 is preferred from a constructability and risk perspective as it minimizes proximity of the running tunnel to adjacent underground parking structures. Although not a significant risk, Option U2 has the potential to impact the foundations of City Hall, City Hall West Tower, the future Centre for Innovation (CFI) and any other below ground parking structures along George Street during mining of the running tunnel. Both options have limited impacts to utilities within this segment.

7.4 Procurement Options and Strategies

The investment options presented all represent an extension of Metrolinx and Infrastructure Ontario's in-delivery Hurontario LRT (Port Credit to Brampton Gateway Terminal). As such, there are several potential procurement options and strategies available each with advantages and disadvantages.

The Hurontario LRT is being procured using the Alternative Financing and Procurement (AFP) model. Specifically, through a Design, Build, Finance, Operate and Maintain (DBFOM) contract. The selected private sector consortium will be responsible for the design, construction, financing, maintenance and operations of the LRT over a 30-year term. Metrolinx establishes the scope and performance requirements for the project and retains ownership and control of the asset.

The proponents should evaluate the risks and viability of using an AFP model for the extension of the line as it may present unforeseen technical and operational issues that jeopardize the ultimate benefit of the project. A traditional procurement approach may be more suited to this situation as it provides more certainty to the proponent with respect to design, construction, operation and maintenance of the investment. Advantage and disadvantages of traditional versus alternative financing and procurement model is summarized in **Table 7-5.**

Table 7-5: Procurement Options

Procurement Option	Advantages	Disadvantages
Design – Bid – Build (DBB)	• Certainty with respect to design, construction, operation and maintenance of the investment. • Integrated line with Hurontario LRT to allow for sharing of maintenance and storage facility (MSF) and vehicle fleet. • Separate entity designs and builds the extension and the HuLRT Project Co could operate and maintain.	• Costs and timelines for project locked in too early before detailed design is completed. Potential for cost overruns in future. • Limited opportunity for innovation with integrated delivery (i.e. trade off in life cycle efficiency to achieve lower construction costs). • Under investment in maintenance. • Higher risk to asset owner (public entity).
Public Private Partnership (P3): • Design – Build (DB) • Design – Build – Finance – Operate – Maintain (DBFOM), or combination of the above	• Transfer of risk to private sector. • End to end responsibility incents integrated innovation from construction through to operation and maintenance. • Certainty for public entity regarding costs and timelines. • If same Project Co as HuLRT, same builder and operator for the entire line.	• Locked into same Project Co as Hurontario LRT. Potential to lose benefits of P3 approach. Subject to same performance criteria. • Risk in not reaching agreement with HuLRT Project Co for integrated line. • Separate P3 may lead to undesirable designs such as: nonintegrated or continuous line with separate Gateway Terminal Station and separate MSF.

Based on the advantages and disadvantages presented above, two options emerge as potential procurement strategies:

- **Option 1:** Proponent issues Design – Bid – Build (DBB) contract for construction of the extension. Proponent to reach agreement for HuLRT Project Co to operate and maintain the extension. Proponent could also use Design – Bid – Finance model in which a single contract is awarded for the design, construction, and full or partial financing of a facility.
- **Option 2:** Proponent to reach agreement for HuLRT Project Co to Design – Build – Finance – Operate – Maintain (DBFOM) the extension. Potential to remove finance from DBFOM contract if it can be financed publicly.

Any option that separates operation and maintenance for the extension from the HuLRT Project Co could have negative impacts on continuity of service such as the need for a separate maintenance and storage facility and should be avoided if possible unless clear agreements can be reached.

7.6 Operations and Maintenance Plans

For the purposes of this preliminary design business case (PDBC), it is assumed that the extension of the Hurontario LRT will be facilitated such that the preliminary system operations plan documented in the 2014 Hurontario-Main LRT Environmental Project Report (EPR) applies to this project and the operator of the extension and overall line will achieve consistent operations and maintenance plans. Key operational aspects of the line include:

- 22 km long (18 km from Port Credit to Brampton Gateway Terminal and 4 km from Brampton Gateway Terminal to the Brampton GO Station)
- 23 total stops (surface options) or 21 stops (underground options)
    - 19 stops (Port Credit to Brampton Gateway Terminal)
    - 4 stops (surface options) or 2 stops (underground options) Brampton Gateway Terminal to the Brampton GO Station
- Peak headway of 5 minutes operated with one light rail vehicle (LRV) or sets of two LRVs couples together. One LRV is approximately 50 m long, two coupled together are 100 m long.
- LRVs assumed to be the Alstom Citadis Spirit Light Rail Vehicle. The Citadis Spirit has a seated passenger capacity of 120 and maximum passenger capacity of 292.

7.8 Deliverability and Operations Summary

From a design and operational perspective, Options S2 and S4 are preferred as they minimize impacts to emergency vehicles, service operations and study area driveways.

Table 7-6: Design and Operational Trade-offs and Issue Measures (Surface Options)

Measure	Option S1	Option S2	Option S3	Option S4
	D-D-D	D-S-D	D-D-S	D-S-S
Emergency and Service Vehicle Operations (i.e. Fire, Paramedic, Garbage, Snow Removal, and Delivery Vehicles)	Impact to emergency and service vehicles in Segment B due to single traffic lane in each direction.	Limited impact to emergency and service vehicles.	Impact to emergency and service vehicles in Segment B due to single traffic lane in each direction and Segment C due to single mixed traffic/transit lane in each direction.	Impact to emergency and service vehicles in Segment C due to single mixed traffic/transit lane in each direction.
Property Impacts	~5,100 m^2 property required.	~5,200 m^2 property required.	~4,900 m^2 property required.	~5,000 m^2 property required.
Driveway Impacts	Conversion of full moves access driveways to right-in-right-out (RIRO) for: • Segments A, B & C (77 driveways)	Conversion of full moves access driveways to right-in-right-out (RIRO) for: • Segments A, C (19 driveways)	Conversion of full moves access driveways to right-in-right-out (RIRO) for: • Segments A, B (73 driveways)	Conversion of full moves access driveways to right-in-right-out (RIRO) for: • Segments A (15 driveways)
Utility Impacts	24 major utility conflicts have been identified	24 major utility conflicts have been identified	24 major utility conflicts have been identified	24 major utility conflicts have been identified
Impacts to CN bridge	Potential vertical clearance issues with CN bridge over Main Street. OCS mitigation proposed.	Potential vertical clearance issues with CN bridge over Main Street. OCS mitigation proposed.	Potential vertical clearance issues with CN bridge over Main Street. OCS mitigation proposed.	Potential vertical clearance issues with CN bridge over Main Street. OCS mitigation proposed.
Ability to provide northly extension All options equal.	Able to extend northerly in the future.	Able to extend northerly in the future.	Able to extend northerly in the future.	Able to extend northerly in the future.
Schedule	Surface options are estimated to take up to 6 years from design to opening day.			
Recommendation	**Options S2 and S4** are best suited to meet the design and operational objectives as they minimize impacts to emergency vehicles, service operations and study area driveways.			

Option U1 is most preferred underground option from a design and operational perspective as it minimizes property impacts and is most able to be extended further north in the future.

Table 7-7 below provides a summary of the key design and operational trade-offs and issues for each of the underground options.

Table 7-7: Design and Operational Trade-offs and Issue Measures (Underground Options)

Measure	Option U1	Option U2
Emergency and Service Vehicle Operations	Limited impact to emergency and service vehicles.	
Property Impacts	~2,700 m^2 property required.	~5,300 m^2 property required.
Driveway Impacts	All full moves access driveways in Segment A converted to right-in-right-out unless at signalized intersection (9 driveways along the surface portion).	
Utility Impacts	• Segment B will have no impact on existing utilities. • Segment C will have no impact on existing utilities.	• Segment B will have no impact on existing utilities. • Proposed location of surface connection for Brampton GO station may have minor impacts on existing utilities.
Ability to provide northly extension	Able to extend north in the future along Main Street.	More difficult to extend north in the future from George Street. Potential conflict with building foundations.
Schedule	Underground options are estimated to take between 7 and 8 years from design to opening day.	
Recommendation	**Option U1** is best suited to meet the design and operational objectives as it minimizes property impacts and is most able to be extended further north in the future.	

8 Summary of Business Case Evaluation

The Preliminary Design Business Case (PDBC) for the Brampton LRT Extension study evaluated four surface and two underground LRT options to identify an emerging preferred option for each.

This section documents the comparison of LRT options and present the overall conclusions drawn from the PDBC for each of the strategic, economic, financial and deliverability and operations case. One emerging preferred surface and one emerging preferred underground option has been identified.

8.1 Surface Options

8.1.1 Strategic Case

D: LRT in Dedicated Lanes
S: LRT in Shared Lanes

Table 8-1: Strategic Case Summary for Surface Options

Comparison of how each option performs relative to the rest.

Worst		Comparable		Best

		Evaluation Criteria[30]	S1 (DDD)	S2 (DSD)	S3 (DDS)	S4 (DSS)
Strategic Case	Strong Connections	LRT Daily Ridership	30,900	27,700	29,500	26,300
		Ridership increase on HuLRT (Peak Period)	6,200	5,200	5,800	4,800
		2041 Population within 800 m of Stations	All options serve the same future population (28,500)			
		2041 Employment & low-income residents served	All options serve the same number of jobs and low-income residents (17,000 and 2,400)			
		Support areas with land uses compatible with rapid transit	Compatible (transit in dedicated lanes, cycling in mixed traffic in Segment C)	Least Compatible (transit in shared lanes, cycling in mixed traffic in Segment C)	Most Compatible (transit in mostly dedicated lanes, dedicated cycling in Segment C)	Less Compatible (transit in shared lanes, dedicated cycling in Segment C)
	Complete Travel Experiences	Transit Travel Time (PM Peak hour)	8 min	11 min	9 min	12 min
		Average Auto Travel Time in LRT Corridor per trip	6 min	6 min	7 min	6 min
		Total Transit Travel Time Savings	35,000 person-min	17,000 person-min	28,000 person-min	11,000 person-min
		Pedestrian and Bicycle Level of Service	Worse active transportation conditions		Better active transportation conditions	
		Transit and Vehicle Level of Service	Generally comparable between surface options.			
		Potential for Conflicts between LRT, Autos and AT	Low Conflict (LRT & auto) High Conflict (AT & auto)	High Conflict (LRT & auto) High Conflict (AT & auto)	Low Conflict (LRT & auto) Low Conflict (AT & auto)	High Conflict (LRT & auto) Low Conflict (AT & auto)
		Transfer times from LRT to nearby transit services (Bus and GO) and Downtown Brampton	All options have similar transfer times: 2 minutes to Brampton Transit Bus Terminal, 4 minutes to Brampton GO (EB) and 4 minutes to Queen / Main Street.			
	Sustainable Communities	Daily VKT Reduced in Study Corridor, PM Peak	1,500	400	1,300	300
		Additional Transit Trips, PM Peak (Diverted from Auto)	950	500	700	500
		Ability to Incorporate Downtown Reimagined Compatibility with Parks and Public Spaces Ability to provide a continuous cycling network	Less desirable public realm Gap in the cycling network connectivity in Segments B and C		More desirable public realm Gap in cycling network connectivity in Segment B	
		Impacts to Natural Environment, Cultural Heritage & Drainage	Similar impacts between surface options All options require similar ROW, Traction Power Substations at-grade and similar stormwater management considerations.			
Strategic Case Recommendation			**S3 best fulfils the objectives and supports the strategic case.**			

[30] This table presents the key differentiating elements between options. For a complete account of evaluation criteria and performance metrics, please see the full PDBC report.

8.1.2 Economic Case

D: LRT in Dedicated Lanes
S: LRT in Shared Lanes

Comparison of how each option performs relative to the rest.

Worst		Comparable		Best

Table 8-2: Economic Case Evaluation Summary for Surface Options

	Evaluation Criteria	S1 (DDD)	S2 (DSD)	S3 (DDS)	S4 (DSS)
Economic Case	Total Economic Benefits ($ Million, 2019)	$529	$338	$446	$276
	Total Economic Costs ($ Million, 2019)	$375	$381	$379	$385
	Net Present Value ($ Million, 2019)	$155	-$43	$67	-$109
	Benefit-Cost Ratio (BCR)	1.41	0.89	1.18	0.72
	Economic Case Recommendation	**S1 and S3 best support the economic case.**			

8.1.3 Financial Case

D: LRT in Dedicated Lanes
S: LRT in Shared Lanes

Comparison of how each option performs relative to the rest.

Worst		Comparable		Best

Table 8-3 Financial Case Evaluation Summary for Surface Options

	Evaluation Criteria	S1 (DDD)	S2 (DSD)	S3 (DDS)	S4 (DSS)
Financial Case	Capital Construction Costs ($ Million, 2019)	$348	$354	$353	$357
	Rehabilitation and Major Maintenance ($ Million, 2019)	$38	$39	$39	$39
	Operations and Maintenance Costs ($ Million, 2019)	$25	$25	$25	$25
	Total Incremental Revenues ($ Million, 2019)	$97	$76	$89	$67
	Net Financial Impact ($ Million, 2019)	-$315	-$342	-$327	-$354
	Financial Case Recommendation	**S1 and S3 best support the financial case.**			

8.1.4 Deliverability and Operations Case

D: LRT in Dedicated Lanes
S: LRT in Shared Lanes

Table 8-4: Deliverability and Operations Case Evaluation Summary for Surface Options

Comparison of how each option performs relative to the rest.

Worst		Comparable		Best

		Evaluation Criteria	S1 (DDD)	S2 (DSD)	S3 (DDS)	S4 (DSS)
Deliverability and Operations	Procurement & Delivery	Procurement Strategies	Two potential procurement strategies are recommended for consideration: • **Option 1:** Proponent issues Design – Bid – Build (DBB) contract for construction of the extension. Proponent to reach agreement for HuLRT Project Co to operate and maintain the extension. Proponent could also use Design – Bid – Finance model in which a single contract is awarded for the design, construction, and full or partial financing of a facility • **Option 2:** Proponent to reach agreement for HuLRT Project Co to Design – Build – Finance – Operate – Maintain (DBFOM) the extension. Potential to remove finance from DBFOM contract if it can be financed publicly.			
	Design and Operational Trade-Offs and Issues	Emergency and Service Vehicle Operations	Impact to operations in Segment B (single traffic lane in each direction).	Limited impact to operations.	Impact to operations in: Segment B (single traffic lane in each direction) and Segment C (single mixed traffic/transit lane in each direction)	Impact to operations in Segment C (single mixed traffic/transit lane in each direction).
		Property Impacts	All options pose similar magnitude impacts to properties (~4,900 – 5,100 m^2 property required)			
		Driveway Impacts	Conversion of full moves access driveways to right-in-right-out (RIRO) for Segments A, B & C (77 driveways)	Conversion of full moves access driveways to right-in-right-out (RIRO) for: Segments A and C (19 driveways)	Conversion of full moves access driveways to right-in-right-out (RIRO) for: Segments A and B (73 driveways)	Conversion of full moves access driveways to right-in-right-out (RIRO) for Segment A (15 driveways)
		Utility Impacts	24 major utility conflicts have been identified			
		Impacts to CN bridge	Overhead Catenary System (OCS) mitigation required to provide vertical clearance under Main Street bridge. S1 may require widening to improve active transportation (i.e. add dedicated cycling infrastructure); whereas S3 and S4 do not.	Overhead Catenary System (OCS) mitigation required to provide vertical clearance under Main Street bridge. S2 may require widening to improve active transportation (i.e. add dedicated cycling infrastructure); whereas S3 and S4 do not.	Overhead Catenary System (OCS) mitigation required to provide vertical clearance under Main Street bridge.	Overhead Catenary System (OCS) mitigation required to provide vertical clearance under Main Street bridge.
		Ability to Extend Line in the Future	All options enable future extensions to the north.			
		Constructability	Surface construction is to be undertaken similarly to typical road widening construction for the length of the study area.			
		Schedule	Surface options are estimated to take up to 6 years from design to opening day.			
	O & M	Operations and Maintenance	The LRT extension is to be designed as a fully compatible extension of the planned and under construction HuLRT, building on system assets such as Maintenance and Storage facilities and technology specifications. The extension is to be facilitated such that the preliminary system operations plan documented in the 2014 Hurontario-Main LRT Environmental Project Report (EPR) applies to this project and that operator of the extension and overall line will achieve consistent operations and maintenance plans.			
		Deliverability and Operations Recommendation	**S2 and S4 best meet the deliverability and operations objectives as they minimize impacts to roadway and service operations and driveways.**			

8.1.5 Preliminary Design Business Case Findings

The performance of each option has been synthesized for each business case criterion in the table below.

Table 8-5: Evaluation Summary for Surface Options

	Evaluation Criteria	S1 (DDD)	S2 (DSD)	S3 (DDS)	S4 (DSS)
Surface Options	Strategic Case				
	Economic Case				
	Financial Case				
	Deliverability and Operations Case				
	PDBC Recommendation	✗ Do Not Carry Forward	✗ Do Not Carry Forward	✓ Carry Forward	✗ Do Not Carry Forward

With the considerations above, Option S3 is preferred as it best fulfils the objectives of the strategic case, generates the second highest economic case outputs and achieves financial case results that are better than most other surface options. Driveway access impacts are the greatest for S3, however, this trade-off is acceptable to minimize transit travel times along the corridor.

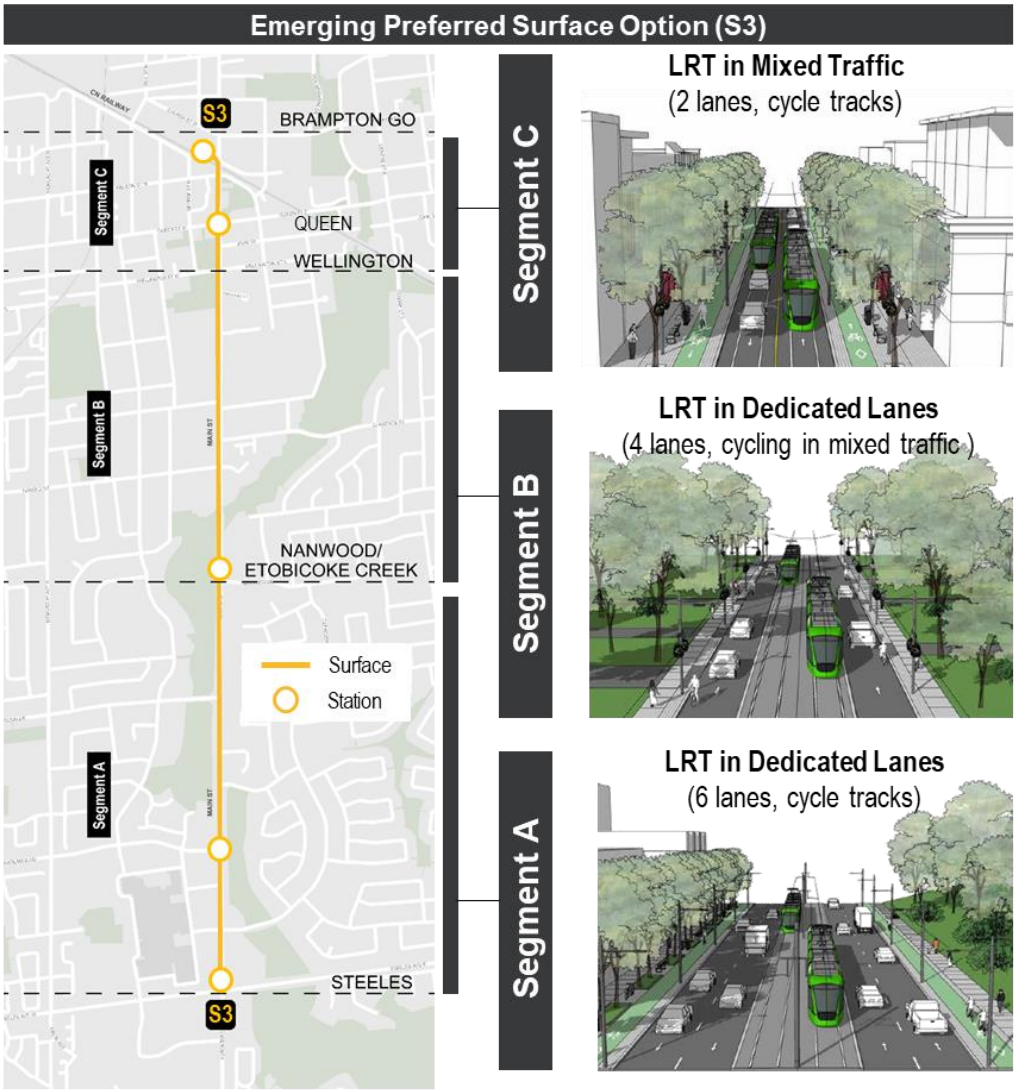
Option S3 provides the opportunity to revitalize Downtown Brampton into an aesthetically beautiful, place-making destination with wider sidewalks, streetscaping, and cycle tracks (consistent with Downtown Brampton Reimagined Vision) while minimizing overall transit travel time. Driveway accesses will be modified as a result of the dedicated LRT right-of-way, but this will ensure safe and efficient travel for all users of the street.

Therefore, Option S3 is the emerging preferred surface option.

8.1.6 Emerging Preferred Surface Option S3

The emerging preferred surface Option S3 is described as follows:

- The LRT will run in dedicated lanes between Steeles Avenue and Wellington Street and in shared lanes from Wellington Street to the Brampton GO Station. There will be 5 surface stops along the route at Brampton Gateway, Charolais, Nanwood, Queen / Wellington and Brampton GO.
- Option S3 allows for an enhanced streetscape in Segments A and C, including: cycle tracks, widened sidewalks, and a planting and furnishing zone. Cyclists must ride in mixed traffic in Segment B or use parallel routes.
- Driveways in Segment B will be modified to right-in, right out access.
- Overhead catenary systems and traction power substations (TPSS) will be located above ground in the study area.



All boulevard configurations shown are subject to change.

8.2 Underground Options

8.2.1 Strategic Case

U: Underground

Comparison of how each option performs relative to the rest.

Worst		Comparable		Best

Table 8-6: Strategic Case Summary for Underground Options

		Evaluation Criteria	U1 (via Main St)	U2 (via George St)
Strategic Case	Strong Connections	LRT Daily Ridership	30,500	
		Ridership increase on Hurontario LRT (Peak Period)	6,100	
		2041 Population within 800 m of Stations	All options serve the same future population (28,000)	
		2041 Employment and Number of low-income residents served	All options serve the same number of jobs and low-income residents (15,000 and 2,200)	
		Support areas with land uses compatible with rapid transit	Compatible (higher order transit, AT improvements)	Compatible (higher order transit, AT improvements)
	Complete Travel Experiences	Transit Travel Time (PM Peak hour)	7 min	8 min
		Average Auto Travel Time in LRT Corridor, Minutes per Trip	6 min	6 min
		Total Transit Travel Time Savings compared to BAU	35,000 person-min	
		Pedestrian and Bicycle Level of Service	Improved active transportation conditions throughout study area	
		Transit and Vehicle Level of Service	Comparable transit and vehicle conditions	
		Potential for Conflicts between modes (LRT, Autos and AT)	Low Conflict between LRT, auto & AT	
		Transfer times from LRT to nearby transit services	Similar transfer times to nearby transit services: 3 minutes to Brampton Transit Bus Terminal, 4-5 minutes to Brampton GO Station	
		Transfer times from LRT to Downtown Brampton	4 min	6 min
	Sustainable Communities	Daily VKT Reduced in Study Corridor, Peak Period	1,200	
		Additional Transit Trips, PM Peak (Diverted from Auto)	700	
		Ability to Incorporate Downtown Reimagined	Ability to incorporate Downtown Reimagined in Segment C	
		Compatibility with Parks and Public Spaces	Similar relationship to parks and public spaces	
		Ability to provide a continuous cycling network	Ability to provide continuous and uninterrupted cycling facilities along the study corridor (reallocating road space for Segment B)	
		Impacts to the Natural Environment, Cultural Heritage & Drainage	Similar impacts on natural and cultural heritage resources and drainage	
		Strategic Case Recommendation	**U1 best fulfils the objectives and supports the strategic case.**	

8.2.2 Economic Case

U: Underground

Comparison of how each option performs relative to the rest.

Worst		Comparable		Best

Table 8-7: Economic Case Summary for Underground Options

	Evaluation Criteria	U1 (via Main St)	U2 (via George St)
Economic Case	Total Economic Benefits ($ Million, 2019)	$466	$472
	Total Economic Costs ($ Million, 2019)	$1,432	$1,465
	Net Present Value ($ Million, 2019)	-$965	-$992
	Benefit-Cost Ratio (BCR)	0.33	0.32
	Economic Case Recommendation	**U1 best supports the economic case as it has a marginally better value for money.**	

8.2.3 Financial Case

U: Underground

Comparison of how each option performs relative to the rest.

Worst		Comparable		Best

Table 8-8: Financial Case Summary for Underground Options

	Evaluation Criteria	U1 (via Main St)	U2 (via George St)
Financial Case	Capital Construction Costs[31] ($ Million, 2019)	$1,425	$1,425
	Rehabilitation and Major Maintenance ($ Million, 2019)	$140	$143
	Operations and Maintenance Costs ($ Million, 2019)	$25	$25
	Total Incremental Revenues ($ Million, 2019)	$86	$87
	Net Financial Impact ($ Million, 2019)	-$1,504	-$1,506
	Financial Case Recommendation	**U1 and U2 have a comparable financial case performance.**	

[31] Construction costs for underground options do not include streetscape or road configuration improvements at the surface as these were assumed to be undertaken as a separate City of Brampton initiative. Property acquisition are not included.

8.2.4 Deliverability and Operations Case

U: Underground

Comparison of how each option performs relative to the rest.

Worst		Comparable		Best

Table 8-9: Deliverability and Operations Case Summary for Underground Options

	Evaluation Criteria	U1 (via Main St)	U2 (via George St)
Deliverability and Operations	Procurement Strategies	Two potential procurement strategies are recommended for consideration, similar to surface options: • **Option 1:** Proponent issues Design – Bid – Build (DBB) contract for construction of the extension. Proponent to reach agreement for HuLRT Project Co to operate and maintain the extension. Proponent could also use Design – Bid – Finance model in which a single contract is awarded for the design, construction, and full or partial financing of a facility • **Option 2:** Proponent to reach agreement for HuLRT Project Co to Design – Build – Finance – Operate – Maintain (DBFOM) the extension. Potential to remove finance from DBFOM contract if it can be financed publicly.	
	Emergency and Service Vehicle Operations	Limited impact to emergency and service vehicles.	
	Property Impacts	~2,700 m^2 property required.	~5,300 m^2 property required.
	Driveway Impacts	All full moves access driveways in Segment A converted to right-in-right-out unless at signalized intersection (9 driveways along the surface portion)	
	Utility Impacts	Segment B will have no impact on existing utilities. Segment C will have limited impact on existing utilities.	Segment B will have limited impact on existing utilities. Proposed location of surface connection for Brampton GO station may have minor impacts on existing utilities.
	Ability to Extend Line in the Future	Able to extend north in the future along Main Street.	More difficult to extend north in the future from George Street. Potential conflict with building foundations.
	Constructability	For underground sections, a combination of Sequential Excavation Method (mining) and Open Cut construction is anticipated. TBM was ruled out during optioneering due to its high costs for such short length of the study area. For surface sections (Segment A), construction is to be undertaken similarly to typical road widening construction for the length of the study area.	
	Schedule	Underground options are estimated to take between 7 and 8 years from design to opening day.	
	Operations and Maintenance	• The LRT extension is to be designed as a fully compatible extension of the planned and under construction HuLRT, building on system assets such as Maintenance and Storage facilities and technology specifications. • The extension is to be facilitated such that the preliminary system operations plan documented in the 2014 Hurontario-Main LRT Environmental Project Report (EPR) applies to this project and that operator of the extension and overall line will achieve consistent operations and maintenance plans.	
	Deliverability and Operations Recommendation	**U1 better meets the design and operational objectives as it minimizes property and utility impacts and facilitates future extensions.**	

8.2.5 Preliminary Design Business Case Findings

The performance of each option has been synthesized for each business case criterion in the table below.

Table 8-10: Evaluation Summary for Underground Options

	Evaluation Criteria	U1 (via Main St)	U2 (via George St)
Underground Options	Strategic Case		
	Economic Case		
	Financial Case		
	Deliverability and Operations Case		
	PDBC Recommendation	✔ Carry Forward	✘ Do Not Carry Forward

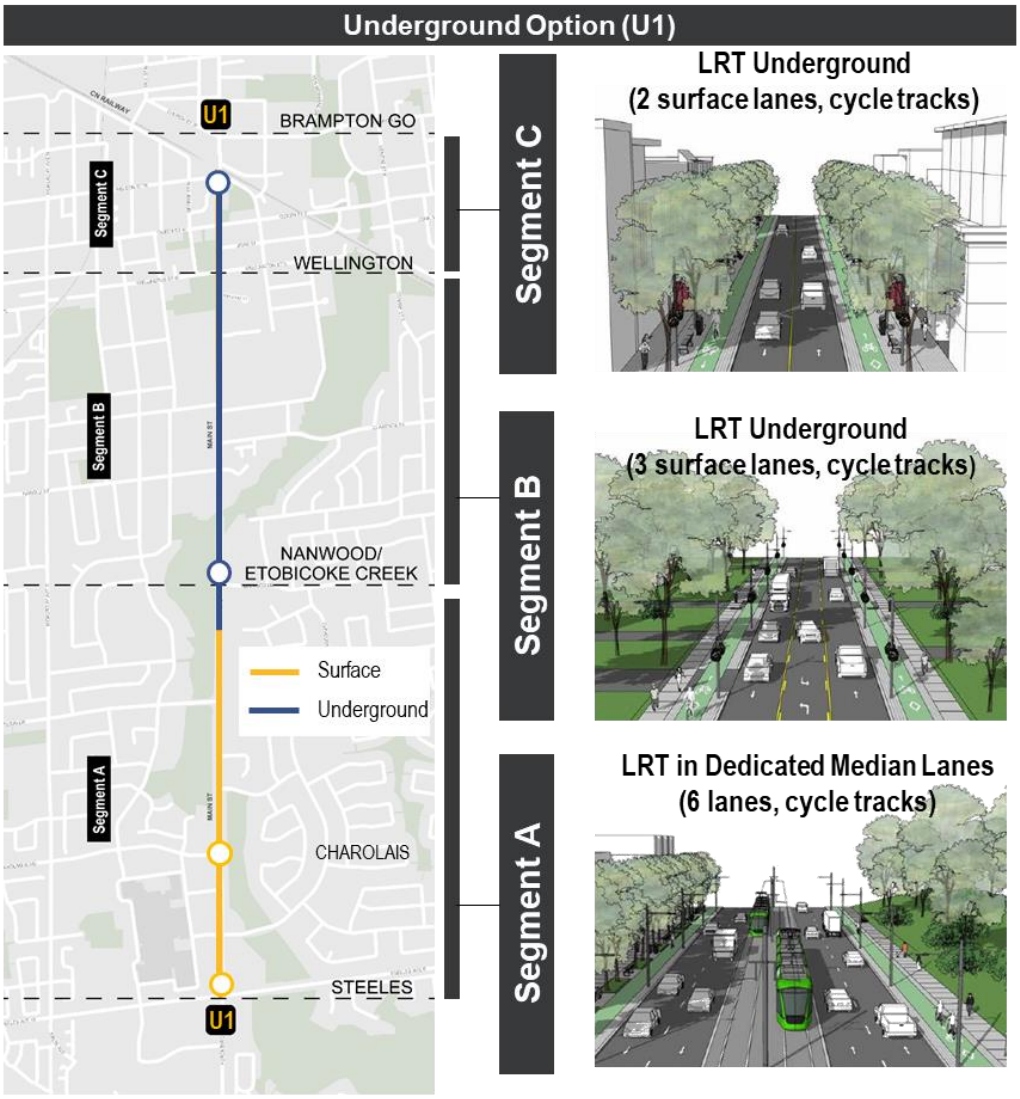
Overall, Option U1 (via Main Street) and U2 (via George Street) perform similarly from a strategic perspective with U1 have certain marginal benefits related to transfer and LRT travel time. However, Option U1 is more preferred than U2 as it is less costly, located closer to the heart of Downtown Brampton, requires less property takings and is more easily extended north in the future.

Therefore, Option U1 is the emerging preferred surface option.

8.2.6 Emerging Preferred Underground Option U1

The emerging preferred underground option U1 is described as follows:

- The LRT will run in dedicated lanes north of Steeles Avenue to Elgin Drive then run underground from just south of Nanwood Drive to the Brampton GO Station along Main Street. There would be 4 stops / stations along the line, with 2 at the surface (Brampton Gateway and Charolais) and 2 underground (Nanwood and Brampton GO).
- Option U1 allows for an enhanced streetscape in Segments A, B, and C, including: cycle tracks, widened sidewalks, and a planting and furnishing zone. Option U1 allows for a continuous cycling network along Main Street.
- No access modifications are required in Segment B. Traction Power Substations (TPSS) will be located underground within underground station.
- The portal and the two underground stations are located in the floodplain. Potential impacts to be mitigated.



All boulevard configurations shown are subject to change.

8.3 Comparison of Emerging Preferred Options

The emerging preferred surface and underground options S3 and U1 were compared and their key differences summarized as follows.

Table 8-11: Comparison of Emerging Preferred Options

	Evaluation Criteria	Option S3 (DDS)	Option U1 (via Main Street)
Strategic Case	**Strong Connections**	• 9 minute transit travel time • Does not improve multi-modal level of service as much as option U1.	• 7 minute transit travel time • Improves multi-modal level of service more than option S3.
	Complete Travel Experiences	• Does not provide the same opportunity for improving pedestrian and cycling at the surface. Lack of dedicated cycling facilities in Segment B creates a discontinuous cycling network • More opportunity for conflicts between modes	• Improves pedestrian and cycling facilities/level of service at the surface. Continuous cycling network. • Less opportunity for conflicts between modes
	Sustainable and Healthy Communities	• Inability to close streets for civic events in Downtown. • Greater temporary and permanent impacts to natural and cultural environment (especially in Segment B).	• Provides opportunity to close streets for civic events in Downtown. • Fewer impacts to natural and cultural environment (especially in Segment B).
Economic Case	**Net Present Value**	$66.9 million	- $965 million
	Benefit-Cost-Ratio	1.18	0.33
Financial Case	**Capital Costs**	$353 million	$1.43 billion[32]
	Net Financial Impact	- $324 million	- $1.5 billion
Deliverability and Operations Case	**Impacts to Road Operations**	• More impact to emergency and service vehicle operations	• Fewer impact to emergency and service vehicle operations
	Impacts to Property	• More property impacts (up to 5,100 m^2 property required)	• Fewer property impacts (~2,700m^2 property required)
	Impacts to Driveways	• More driveway and access impacts/restrictions (73 driveways)	• Fewer driveway and access impacts/restrictions (9 driveways)
	Impacts to Utilities	• More utility impacts (24 major utility conflicts)	• Limited utility impacts
	Schedule	• Up to 6 years from design to opening day.	• 7 to 8 years from design to opening day.

Next steps will include refining the design and engineering to maximize benefits and mitigate outstanding risks for the emerging preferred options, selecting a preferred option and carrying it through the Transit Project Assessment Process (TPAP).

[32] Construction costs for underground options do not include streetscape or road configuration improvements at the surface. These were assumed to be undertaken as a separate City of Brampton initiative. Property acquisition are not included.

Appendix A: Economic Impact Methodology

Appendix A: Economic Impact Methodology

This Appendix presents the methodology used to estimate the economic impacts of Brampton LRT construction and results obtained. The impacts were estimated for one surface option (Option S1) and one underground option (Option U1). These two options combined can be considered as representative of the range of outcomes.

Key Concepts in Economic Impact Analysis

Economic impact of an organization, activity, or project can be divided into two broad categories of impacts:

1) Jobs, income and related economic activity impacts stemming from the organization, activity, or project in question that are attributable either directly, or indirectly through supplier-purchasing relationships and re-spending of employee wages and salaries that were generated through direct and indirect activities; and,

2) Related economic development and other wider benefits and impacts throughout the economy such as additional facilitated economic activity, productivity improvements, quality of life improvements, etc.

The first category of impacts represents the traditional metrics evaluated in economic impact studies. They quantify the effects of the various rounds of expenditures and economic activities that are initiated throughout the economy as a result of an initial expenditure or business activity. In the case of the proposed LRT project economic activity is initiated first through the capital expenditures required to develop it (construction and purchase of equipment) and then operate it once it is completed. The stream of expenditures continues trough expenditures of the suppliers of goods and services as well as expenditures of employees re-spending their salaries.

The metrics of impacts are commonly referred to as “direct impacts,” “indirect impacts,” and “induced impacts” and can be defined as follows:

- Direct impacts are impacts attributable to the initial stream of expenditures that initiate further rounds of economic activity. These are the immediate economic outcomes occurring as the result of the activities related to the project evaluated. In the context of this study, direct impacts will include business revenues of construction companies engaged in the project, i.e. construction of the tracks and facilities, purchase of vehicles, signalling equipment, etc. Direct impacts also include employment, employment income, Gross Domestic Product (GDP), and government tax revenue that can be linked to this activity.

- Indirect impacts are the results of the spillover effects in the markets for intermediate goods and services. These purchases allow for production activities and employment at the firms that supply the direct goods and services to the project. These expenditures generate further rounds of economic activity down the production chain. As an example, in the context of this study, indirect effects stem from the expenditures of construction companies on construction materials, business services, rent of equipment, various supplies, etc. Indirect effects reflect

thus the supply chain demand and output, employment, etc. that are generated throughout this chain.

- Induced impacts result from the spending and re-spending of dollars earned by individuals who become employed as a result of the direct and indirect activities and impacts. Re-spending of employment wages and salaries on consumer goods and services results in further economic impacts in other sectors of the economy.

The total economic impact is the sum of the direct, indirect and induced effects.

The second broad category of effects captures various other effects on local economies where the organization or activities in question take place. Frequently, these impacts are very specific to the organization, and frequently they are difficult to quantify and convert into employment and business revenue terms. This category of impacts represents an empirical observation that impacts and benefits of an organization or investment project may go well beyond the jobs and business revenue attributable to them through direct, indirect, and induced impacts discussed above. The additional benefits and impacts may include broader social impacts in the regional economy, such as quality of life improvements of residents, broader productivity improvements in the local economy, synergies and spin-off opportunities for related businesses and research institutions (which then further generate direct, indirect, and induced impacts), enhanced profile of the area that may further result in increased tourist and business attraction.

The analysis in this section estimates quantitatively only the first category of effects. The economic impacts are thus estimated in terms of:

1. Direct impacts,
2. Indirect impacts,
3. Induced impacts, and
4. Total impacts.

Each of these impacts is estimated in terms of the standard measures of economic activity:

- Output, the total gross value of all business revenue. Output represents the total sum of all economic activity that has taken place in connection with capital expenditures required for the project and then operational expenditures. This is the broadest measure of economic activity.

- GDP, the “value added” to the economy. Since the GDP figure captures the difference between the value of output and the value of intermediate inputs, it represents the unduplicated total value of economic activity that has taken place. The GDP impacts represent the value-added to the economy as a result of the capital and operating expenditures.

- Employment, the number of incremental jobs created as a result of the capital expenditures and operating expenditures related to the Lake Erie Connector project.

- Salaries and Wages, the additional salaries and wages that would result from capital expenditures on the projects and its future operations.

- Government Tax Revenues, the total amount of tax revenues generated at all levels of government and includes estimates of personal income taxes, indirect taxes (e.g., sales tax), and corporate taxes.

Approach

The economic impacts of the project were estimated on the basis of the initial project cost estimates by broad category of expenditures (construction cost, purchase of equipment) and using input-output modeling approaches.

An input-output model captures and quantifies the flows of goods and services between the various industries in an economy. The indirect multipliers from such models provide an aggregate measure of the effect of an industry on all other industries in the economy that arise through supply-purchase relationships. The effects are measured in terms of the impact on business revenues, employment requirements, or value added that would be generated for each dollar of revenue of the industry of interest. Direct multipliers provide measures of average employment, employment income, and GDP in the industry analyzed for each dollar of revenues in that industry. Induced multipliers provide similar measures in similar terms but for effects that would arise in the economy when direct and indirect employees re-spend their wages and salaries. These multipliers can be used to estimate the economy-wide effects of an initial expenditure such as expenditures on construction of an infrastructure project.

Multipliers are available for different measures of economic activity, including output, employment, employment income, and GDP. For example, multiplying the direct revenue of an industry by the indirect output multiplier gives the value of indirect output across the entire economy that is attributable to that industry. Multiplying the same value of direct output by indirect employment multiplier gives the number of indirect jobs. Induced multipliers can be used in the same manner to obtain estimates of induced output, employment, employment income, and GDP. Direct multipliers, or ratios, are also sometimes used in the same way as indirect and induced multipliers to fill in missing statistics about the industry examined. For example, employment – if not known – can be estimated using the direct employment ratio which gives employment requirements for each million dollars of industry output/revenue.

Multipliers are available for a wide range of industries defined at various levels of NAICS classification for up to 6-digit NAICS codes. There may be no specific input-output industry for certain industries to be analyzed. In these situations, economists typically assign such industry to the closest best matching industry from the input-output model and use the corresponding sets of multipliers.

At this time, it is not known where the various project expenditures would be made and what amounts would be spent specifically in Brampton. Therefore, all impacts were first estimated at the provincial level (reflecting an assumption that they would take place somewhere in Ontario). Impacts in the City of Brampton were extrapolated from province-wide impacts based on

considerations where or in what proportion the various impacts are likely to take place.[1] The following considerations and general assumptions regarding where project-related expenditures are taking place were used to help refine the impacts to the level of the City of Brampton.

1. Direct effects in the City of Brampton would be stemming from expenditures on construction and equipment. Purchases of LRT vehicles would likely take place elsewhere in Ontario, and possibly outside of Ontario, and thus not generate any impacts in the City directly.

   In general, expenditures on construction are local expenditures taking place in the geographic area where the project is located. However, in large highly integrated multi-city regions such as the Greater Toronto Area (GTA), the City could award the construction contract to a Brampton company, or to another better qualified and more competitive GTA company, or to a joint venture that includes Brampton-based and other GTA-based companies. The second and third options may improve the cost-effectiveness and financial performance of the project but will generate limited economic impacts in Brampton itself. For the purpose of this evaluation, it was assumed that the percent of construction expenditures in Brampton will be equal to the share of Brampton construction employment in Toronto Census Metropolitan Area employment in this industry (estimated at about 2.6%).

   Equipment in general will be purchased from the most qualified supplier. Given the strong manufacturing base in the GTA, it is reasonable to assume that the required equipment can be purchased in the GTA. For the purpose of this evaluation, it was assumed that the percent of equipment expenditures in Brampton will be equal to the share of Brampton manufacturing employment in Toronto Census Metropolitan Area manufacturing employment (estimated at 10.5%).

2. Indirect impacts stemming from input purchases by suppliers of equipment required for the project are likely to benefit the City to some extent. These impacts were estimated as a proportion of the indirect impact across Ontario; the proportion was assumed equal to the share of the City manufacturing employment in the Toronto CMA manufacturing employment (estimated at 10.5%).

3. Induced impacts in the City will stem from direct and indirect employment in the City and benefit the City to the extent that expenditures from wages and salaries stay in the local economy. There are various ways to estimate the local impact of a stream of expenditures. One of the simple and practical methods is based on the economic base and location

[1] Statistics Canada maintains input-output models only at provincial levels. Some organizations attempt development of regional input-output models. Such models typically are also based on provincial input-output tables interpolated to the regional level based on more detailed regional data and information. However, the modeling results and multipliers from such analyses are generally not publicly readily accessible. Provincial-level impacts of a project can be seen as maximum realistic regional impacts of the project in question and thus provide a ceiling from which local impacts can be assessed ensuring at the same time that local impacts are not grossly overestimated.

quotient approach that entails calculation of basic and service employment.[2] The share of service employment in total employment is taken as a proxy of local demand satisfied from within the local economy and thus as a share of induced expenditures and generated induced impacts that stay locally (estimated at 70%).

Economic impacts of construction projects are typically estimated as cumulative effects of the entire project-related expenditures over the construction period. Average annual impacts can then be obtained by dividing this cumulative total by the number of years.

Data, Assumptions, and Results

The costs of Option S1 and Option U1 classified into key industrial categories are shown in the table below. Note that costs of LRT vehicles are excluded from this assessment as they would likely be purchased outside of Ontario.

Table 1: Capital Cost of Brampton LRT Extension, $ Millions (2019 Dollars)

Cost Category/ Project Element	Option S1	Option U1
Transportation Engineering Construction	$226.7	$1,100.1
Signaling and Communications Equipment	$33.9	$33.6
Engineering & Planning, Professional Services	$156.1	$678.8
Total	**$416.7**	**$1,812.4**

The above costs were matched to the corresponding input-output multipliers from the 2016 edition of Statistics Canada Interprovincial Input-Output model (the latest available set of multipliers at the time when analysis was conducted). To account for inflationary impacts between 2016 and the year of cost estimates, all employment multipliers are divided by the consumer price index for the period between 2016 and 2019.

Table 2 shows the estimated economic impacts in all of Ontario. For Option S14, total impacts include 3,848 job-years, $243.9 million in employment wages and salaries, $385.7 million GDP, and $794.7 million in business output. For Option U1, total impacts include 17,036 job-years, $1,081.2 million in employment wages and salaries, $1.7 billion GDP, and $3.5 billion in business output.

Table 2: Economic Impacts of Brampton LRT Extension across all of Ontario

Category of impacts	Output ($Millions)	GDP ($Millions)	Employment Income ($Millions)	Employment (Job-Years)
Option S1				
Direct	$416.7	$177.5	$128.0	1,969
Indirect	$242.6	$128.2	$79.2	1,178
Induced	$135.4	$80.0	$36.7	700

[2] Base employment is related to the basic sectors, or industries whose output is exported to other communities. In contrast, service employment is related to the service sector whose ultimate market is local, or whose output is consumed solely in the local economy.

Category of impacts	Output ($Millions)	GDP ($Millions)	Employment Income ($Millions)	Employment (Job-Years)
Total	**$794.7**	**$385.7**	**$243.9**	**3,848**
Option U1				
Direct	$1,812.4	$767.3	$564.0	8,667
Indirect	$1,093.2	$574.9	$354.7	5,267
Induced	$599.5	$354.5	$162.5	3,101
Total	**$3,505.1**	**$1,696.6**	**$1,081.2**	**17,036**

Note: Monetary effects are in 2020 dollars.

Using the considerations and general assumptions regarding local share of project expenditures or costs, Table 3 presents the expected economic impacts in the City of Brampton. For Option S1, total impacts include 221 job-years, $13.8 million in employment wages and salaries, $22.9 million GDP, and $45 million in business output. For Option U1 total impacts include 912 job-years, $58.6 million in employment wages and salaries, $97.4 million GDP, and $190.3 million in business output. The relatively small impacts in Brampton reflect a relatively small share of Brampton in the GTA economy.

Table 3: Economic Impacts of Brampton LRT Extension in Brampton

Category of impacts	Output ($Millions)	GDP ($Millions)	Employment Income ($Millions)	Employment (Job-Years)
Option S1				
Direct	$11.3	$4.6	$3.2	46
Indirect	$25.5	$13.5	$8.3	124
Induced	$8.2	$4.8	$2.2	42
Total	**$45.0**	**$22.9**	**$13.8**	**212**
Option U1				
Direct	$40.1	$16.1	$12.1	176
Indirect	$114.8	$60.4	$37.3	553
Induced	$35.4	$20.9	$9.6	183
Total	**$190.3**	**$97.4**	**$58.9**	**912**

Note: Monetary effects are in 2020 dollars.