Ontario Line Preliminary Design Business Case

December 2020

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Disclaimer on COVID-19

Readers should note that the analytic models used in this business case draw on multiple datasets collected and refined prior to the spread of COVID-19. As a result, they do not model the impact or potential long-term outcomes of the current global pandemic. There is currently insufficient data or information available to allow the models employed in this business case to reasonably analyze the impact of the COVID-19 outbreak on this project or for the models to be used to comment on the expected changes in the forecasts described in this business case. Metrolinx is currently exploring the potential long-term impacts of COVID-19, however the specific impacts of COVID-19 on Ontario Line have not been forecast. As of the date of distribution of this business case, the COVID-19 pandemic has had a material impact on the movement of people and goods, including travel patterns and behaviours. Readers of this business case should consider its findings in this context.

Executive Summary

Business Case Scope

This document is the Preliminary Design Business Case (PDBC) for the Ontario Line – a project that was announced in the 2019 Ontario budget as part of the Province's "New Subway Plan for the Greater Toronto Area". This PDBC has been developed in follow up to the Initial Business Case (IBC) presented to the Metrolinx Board in September 2019. Based on Board direction, the Ontario Line has been advanced to the preliminary design process.

This PDBC compares two operating options using an optimized Ontario Line Alignment in order to:

- present an updated Ontario Line alignment and corresponding service plans that were developed through the preliminary design process; and
- review the benefits and costs of the Ontario Line of the revised Ontario Line and compare them to IBC performance.

Ontario Line Options

Figure E-1 illustrates the current alignment for the Ontario Line, alongside the July 2019 alignment included in the IBC. The preliminary design process focussed on improving the Ontario Line alignment through further design, planning, and forecasting, and on developing a line that can:

- alleviate crowding and congestion on Line 1 and other elements of Toronto's transportation network to improve traveller experience;
- support new urban development and Transit Oriented Communities (TOC) and connect more Torontonians to places of work and recreation with fast, reliable, and frequent rapid transit;
- increase the overall connectivity and resilience of Greater Toronto and Hamilton Area's (GTHA) transportation network to prepare it for population and employment growth beyond 2041; and
- enable a high quality of life, economic prosperity, and sustainable environment for the City of Toronto and the GTHA.

Two operating concepts (defined in Table E-1), both using the alignment in Figure E-1, have been developed for the PDBC to explore the impacts to project benefits and costs of varying service patterns and train sizes. The findings of this PDBC will be used to inform future stages of service planning.

Figure E-1: Ontario Line PDBC Alignment Compared to IBC Alignment

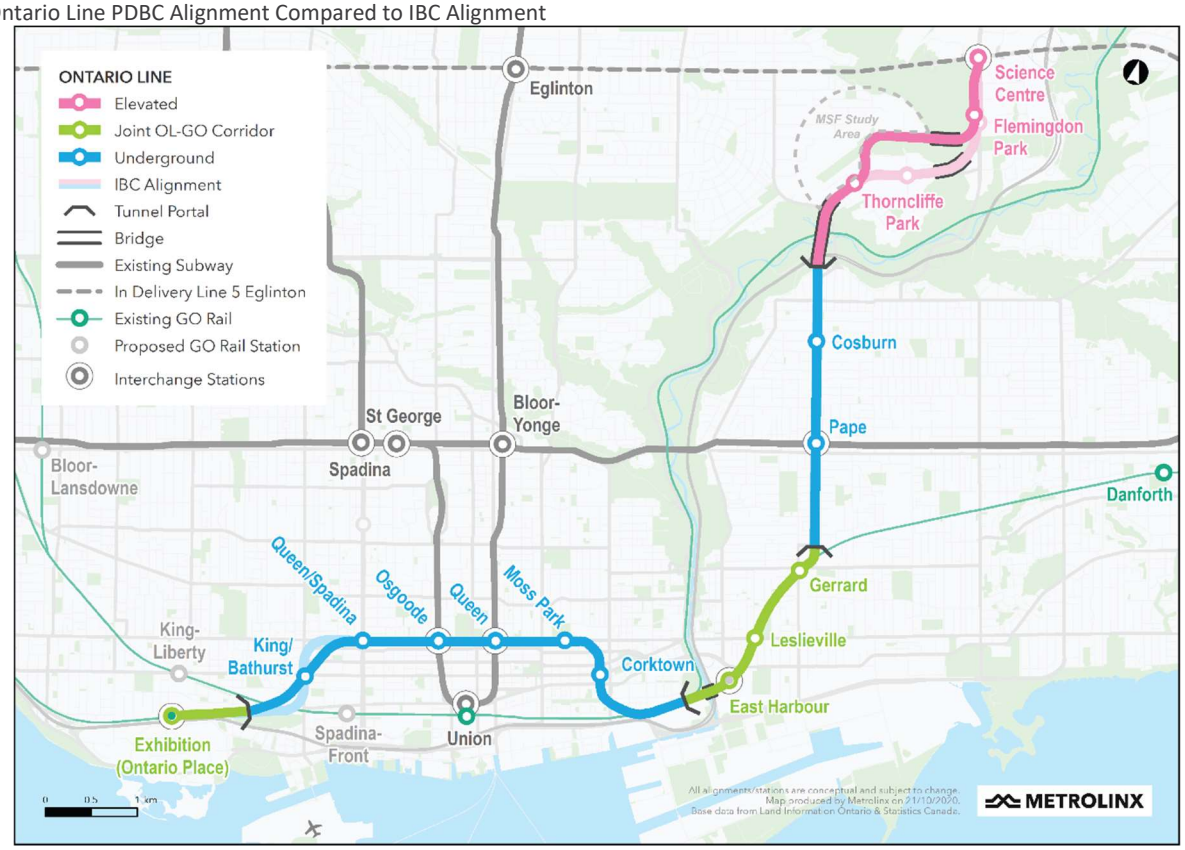

Table E-1: Ontario Line Options and Assumptions Included in Preliminary Design Business Case

Analysis Scope	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
Train Size	• 100m (five car) trains • 750 passenger per train capacity	• 80m (four car) trains • 600 passenger per train capacity
Frequency	• 40 trains per hour (TPH) in peak • 12-24 TPH off-peak	• 34 TPH (2030-2041), 40 TPH (2041 on) in peak • 12-24 TPH in off-peak
Rationale for Inclusion	• Demonstrates how the IBC operating concept performs on the optimized alignment	• Explores how the benefits and costs of the Ontario Line can be further optimized with a refined operating concept
Alignment and Stations	• 15 stations, each with a 100m platform along an optimized alignment (including track underground and on shared corridors and elevated structures) with approximately 26 to 30 minute runtime between Ontario Science Centre and Exhibition • Interchanges with local and rapid transit network at Science Centre, Pape, Osgoode, and Queen stations • Cross platform interchange with GO rail services at East Harbour between the Ontario Line and the Stouffville and Lakeshore East lines. Interchange with Lakeshore West express services at Exhibition Station	
Land Use	• 2041 market land use projection updated since the IBC to reflect new census data and land use forecasts.	
Fares	• Use of TTC Fares for Ontario Line (the assumed TTC and GO Transit Discounted Double Fare from the IBC was not included)	
Transit Network	• Updated GO Expansion On-Corridor Plan • Updated rapid transit network assumptions	

Business Case Analysis

Table E-2 summarizes the performance of the Ontario Line detailed in this PDBC compared to the IBC.

Table E-2: Business Case Summary

Strategic Case	IBC Performance	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept	Rationale for Change
1. Improved access to transit	• 389,000 trips per day	• 388,000 trips per day on the Ontario Line	• 374,000 trips per day on the Ontario Line	**Comparable performance** (Changes to input land use compared to IBC)
2. Increased access to economic activity	• +53,000 jobs accessible within 45 minutes by transit • +66,000 jobs accessible to lower-income Torontonians within 45 minutes by transit	• +47,000 jobs accessible within 45 minutes by transit • +57,000 jobs accessible to lower-income Torontonians within 45 minutes by transit		**Comparable performance** (Changes to input land use compared to IBC)
3. Support a synergistic relationship between transit and city building	• Transit Oriented Communities (TOC) could result in +20,000 new trips	• TOC could result in +55,000 new trips if delivered alongside the Ontario Line	• TOC could result in +52,000 new trips if delivered alongside the Ontario Line	**Improved performance** (Refined TOC forecasts)
4. Improved travel time and reliability	• 355 thousand minutes saved in peak hour	• 390 thousand minutes saved in peak hour		**Improved performance** (improved run times)
5. Improved comfort and safety	Significant crowding reduction during the busiest hour of the day • **Line 1:** -14% crowding • **Bloor-Yonge Station:** -17% crowding • **Eglinton Station:** -15% crowding • **Union Station:** -13% crowding	Significant crowding reduction during the busiest hour of the day • **Line 1:** -6,000 trips (-15% crowding) • **Bloor-Yonge Station:** -14,000 trips (-22% crowding) • **Eglinton Station:** -5,000 trips (-16% crowding) • **Union Station:** -14,000 trips (-14% crowding)	Significant crowding reduction during the busiest hour of the day • **Line 1:** -5,000 trips (-12% crowding) • **Bloor-Yonge Station:** -10,000 trips (-15% crowding) • **Eglinton Station:** -5,000 trips (-16% crowding) • **Union Station:** -14,000 trips (-14% crowding)	**Comparable Performance**
6. A more resilient and integrated transport network	• +39,000 transfers between Ontario Line and Rapid Transit and GO rail in peak hour	• +62,000 new trips on transit per day • +50,000 transfers between Ontario Line and the Frequent Rapid Transit Network	• +60,000 new trips on transit per day • +50,000 transfers between Ontario Line and the Frequent Rapid Transit Network	**Improved performance** (improved run times)
7. Moving people with less energy and reduced emissions	• -1 million tonnes of GHG emissions per year	• - 7.2 million litres of automobile fuel consumed per year • -14,000 tonnes of GHG emissions per year		Since the publication of the IBC, the GHG estimate in the published IBC was identified to be erroneous and has since been corrected and updated.
8. Improve Quality of life and public health	• Note – indicator refined for PDBC to focus on health impacts not captured in IBC	• -28,000 car trips a day resulting in -1,200 collisions causing death or injury over the project lifecycle		**Current version of benefit not included in IBC**
9. Unlocking jobs and economic development	• New benefit in PDBC	• +4,700 jobs per year supported between 2020-2030		**New benefit not included in the IBC**

Economic Case	IBC Performance (million 2019$)	PDBC Alignment with IBC Operating Concept (million 2020$)	PDBC Alignment with Refined Operating Concept (million 2020$)	Rationale for Change
Total Economic Benefits (million $)	$9,200	$10,230 to $11,310	$9,900 to $10,960	**Improved performance** Optimized run times, interchanges, and consideration of additional user benefits
Total Costs (million $)	$10,400 to $12,000	$9,910 to $10,550	$9,610 to $10,260	**Improved performance** Detailed design that allows greater certainty on costs and risks
Expected NPV (million $)	-$2,800 to -$1,200	$540	$500	**Improved performance** Improved benefits with costs that have decreased relative to IBC high-end estimates.
Expected BCR	0.76 to 0.88	1.05	1.05	
Financial Case				
Capital Costs (million $)	$9,500 to $11,400*	$8,600	$8,420	**Improved performance and change in assumptions** Detailed design that allows greater certainty on costs and risks. Terminal value of land was not included in the IBC.
Operations and Maintenance Costs (million $)	$1,900	$1,570	$1,410	**Improved performance** Improved 'bottom up' operating cost model
Revenue Impact (million $)	$1,800	$ 2,430	$ 2,360	**Change in assumptions** Fares no longer have a discounted double fare
Net Financial Impact (million $)	-$9,600 to $11,500	-$7,740	-$7,470	**Improved performance** Refined costing has resulted in a net financial impact lower than the IBC
Revenue Operating Cost Ratio	0.95	1.6	1.7	**Improved performance** Increases in revenue and decreases in operating costs relative to IBC
Deliverability and Operations Case				
Procurement Approach	**IBC reviewed a range of P3 delivery models.**	Metrolinx and Infrastructure Ontario will use a multipackage P3 model to deliver the Ontario Line while mitigating key risks and maximizing value for money and operational flexibility.		Metrolinx and Infrastructure Ontario developed a procurement model based on market sounding and further technical analysis and planning.

*If accounting for terminal value of land (Present Value = $1,016 million), as was done in the PDBC, the IBC capital costs would be $8,480 to $10,380 million

Change due to methodology update

Improved performance compared to the IBC

Comparable performance to IBC

Benefit not included in IBC

Business Case Conclusions

This PDBC for the Ontario Line presents a revised alignment and two operating concepts that have been developed based on detailed planning, design, and engineering and critical lessons learned from the Ontario Line IBC and previous subway planning studies. The result of this planning and development work is an optimized subway that is forecast to:

- serve up to **374,000 to 388,000 trips each day and** move up to **5,000 to 6,000 travellers off Line 1 during the busiest hour of the day**, freeing up capacity for other travellers;
- make travel times faster and more predictable – the Ontario Line will **save travellers seven minutes per trip on average** and also make the Toronto transportation network more integrated and resilient to disruption;
- support urban development and improved access - **the Ontario Line connects underserved communities and areas planned for further development** by leveraging rail corridors and making use of new tunnels and structures; and
- generate at least **$9.9 to $11.3 billion in economic benefit** for the City of Toronto and the GTHA as a whole, with an expected BCR of 1.05– **meaning for every dollar spent the region will benefit by up to $1.05**.

The following overall conclusions are drawn from the PDBC and IBC comparison:

- overall Ontario Line performance in the Strategic and Economic cases has improved since the IBC – the application of benefits management throughout the planning process has augmented key benefits (such as travel time savings);
- benefits were augmented by improving end to end travel times and optimizing stations for ease of access, egress, and integration with urban form – these changes resulted in quicker trips and reduced crowding across the network;
- costs were minimized and key risks were mitigated throughout the preliminary design and key technical stakeholders engagement process – across the Economic Case and Financial the PDBC costs are either close or below the ‘low end’ estimate presented in the IBC;
- while the PDBC makes use of revised land use forecasts that are in general more conservative than IBC forecasts (which would typically result in lower ridership and benefits) and does not include GO-TTC fare integration, the improved runtimes included in both options generate a comparable level of ridership compared to the IBC;
- the Financial Case notes overall improvements to the financial efficiency of the project – both capital costs and operating costs have been optimized which has resulted this results in a project with a more manageable net financial impact and greater revenue to operating cost ratio; and
- the PDBC development and preliminary design process has generated a more cost-effective Ontario Line with increased benefits, as is evidenced by the higher range of BCRs in the PDBC (1.05 compared to 0.76 to 0.88) and higher total benefits.

Next Steps

The next steps for the Ontario Line following this PDBC include:

- harnessing lessons learned during the development of this PDBC to develop a refined reference concept design and concept of operations;
- advancing to procurement milestones – the request for qualifications (RFQ) for Civils North and Rolling Stock Systems Operations and Maintenance (RSSOM) were released in June 2020 and request for proposals (RFP) are planned for release in Fall 2020; and
- developing the Full Business Case to advance the project towards final approvals and confirm costs, benefits, and key technical and design choices.

1 Introduction

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Introduction and Preliminary Design Business Case Objectives

The Ontario Line is one of four priority subway projects under development in the **Greater Toronto Area (GTA).** The line will run from Ontario Science Centre, at Don Mills Road and Eglinton Avenue E, south to Pape Station on Line 2 and then connect to the downtown core at both Queen and Osgoode Stations, before continuing west to Exhibition/Ontario Place. This project is the largest single subway expansion in Toronto's history and will provide much-needed expanded subway service to Toronto to make it faster and easier for hundreds of thousands of people to get where they need to be each day.

This document is the Preliminary Design Business Case (PDBC) for the Ontario Line. The PDBC has the following objectives:

- advancing the recommended option from the Initial Business Case (IBC) to a higher level of design and development (typically 10-30%+);
- refining and optimizing the IBC option based on lessons learned during the IBC development process; confirming, testing, and challenging assumptions made in the IBC;
- documenting the benefits, costs, trade-offs, and risks of the project to advance it to the next stage of delivery readiness; and
- supporting required approvals to continue to advance procurement and construction.

Background

The Greater Toronto and Hamilton Area (GTHA) is one of North America's fastest growing regions, projected to grow by over 40% between 2016 and 2041[1]. While population and employment growth continue across the region, key activities, in particular office growth, continue to be concentrated in Toronto's downtown core and periphery. This growth will further the need for increased transit capacity and access to downtown from across the region. Metrolinx is now investing more than $20 billion in the GO Expansion program to expand the rail system[2], with faster and more frequent trains and the capacity to carry three times as many passengers by 2041. GO rail will continue to serve primarily longer-distance trips and the improvements specified in GO Expansion are being developed in existing corridors with all trains running to or from Union Station. However, the GO rail system does not serve all parts of Toronto, nor does it serve many shorter distance trips. Other parts of the network are in need of investment. Crowding on the existing subway network, in particular on Line 1 Yonge and specifically at Bloor-Yonge Station, constrains transit ridership growth into downtown from north and northeast Toronto. This constraint directly affects the ability to accommodate future growth in the region. Previous studies have found that improvements and optimizations to the existing system designed to provide additional transit capacity would not, on their own, be enough to address capacity issues during peak periods. As the city's population continues to grow, new transit infrastructure is required to relieve congestion in downtown Toronto.

[1] Statistics Canada 2016 Census; Growth Plan for the Greater Golden Horseshoe, 2017
[2] http://www.metrolinx.com/en/greaterregion/projects/go-expansion.aspx

Based on this need for new capacity and connections, Metrolinx and Infrastructure Ontario have developed the Ontario Line project in order to rapidly deliver a new subway line in Toronto that can reduce crowding on existing lines, expand network coverage and resilience, and maximize wider ranging social, economic, and environmental benefits to both the city and the region.

Ontario Line Background – Initial Business Case

The Ontario Line IBC was released on July 25, 2019. The IBC compared the Relief Line South and a new "Ontario Line" alignment with a Business as Usual (BAU) scenario. The Relief Line South Alignment was 7.5 km of underground rapid transit from Pape to Osgoode with eight stations (including four interchanges). The Ontario Line Alignment included in the IBC had fifteen stations (six interchanges with GO and other rapid transit) and provided 15.5 km of new rapid transit including the use of underground segments, shared rail corridors, and elevated structures. This analysis noted the following key conclusions:

- both the Relief Line South and the IBC Ontario Line offer significant improvements compared to a Business As Usual scenario, generating $3.4 billion (Relief Line) and $7.4 billion (IBC Ontario Line) worth of economic benefits respectively;
- the IBC Ontario Line's use a range of alignment types – including shared rail corridors- allows for a larger build out of rapid transit for lower cost per km with quicker construction timelines compared to a fully underground alignment;
- as a result, the IBC Ontario Line was able to cover a larger geography, provide more stations and expanded network integration, and generate greater benefits for travellers (expanded access to recreational and economic opportunities, including for lower-income Torontonians);
- the IBC Ontario Line was found to generate nearly twice the economic benefits ($3.4 billion for the Relief Line South compared to $7.4 billion for the IBC Ontario Line) and significantly higher strategic benefits than the Relief Line South for a proportionally smaller cost increase.

Based on this analysis, the IBC noted the Ontario Line presents stronger business case performance than the Relief Line south. In September 2019, the Ontario Line IBC went to Metrolinx's Board of Directors. The IBC was endorsed by the Board with direction to advance the Ontario Line to the preliminary design stage.

Ontario Line Preliminary Design

After the September 2019 board meeting, Metrolinx and Infrastructure Ontario began the preliminary design process for the Ontario Line in order to optimize the project, confirm its expected costs and benefits, respond to community feedback and develop a delivery plan. This PDBC is among the next steps following the IBC. A key element of this process was stakeholder and public engagement, including five open houses were held in early 2020 across Toronto at the following locations:

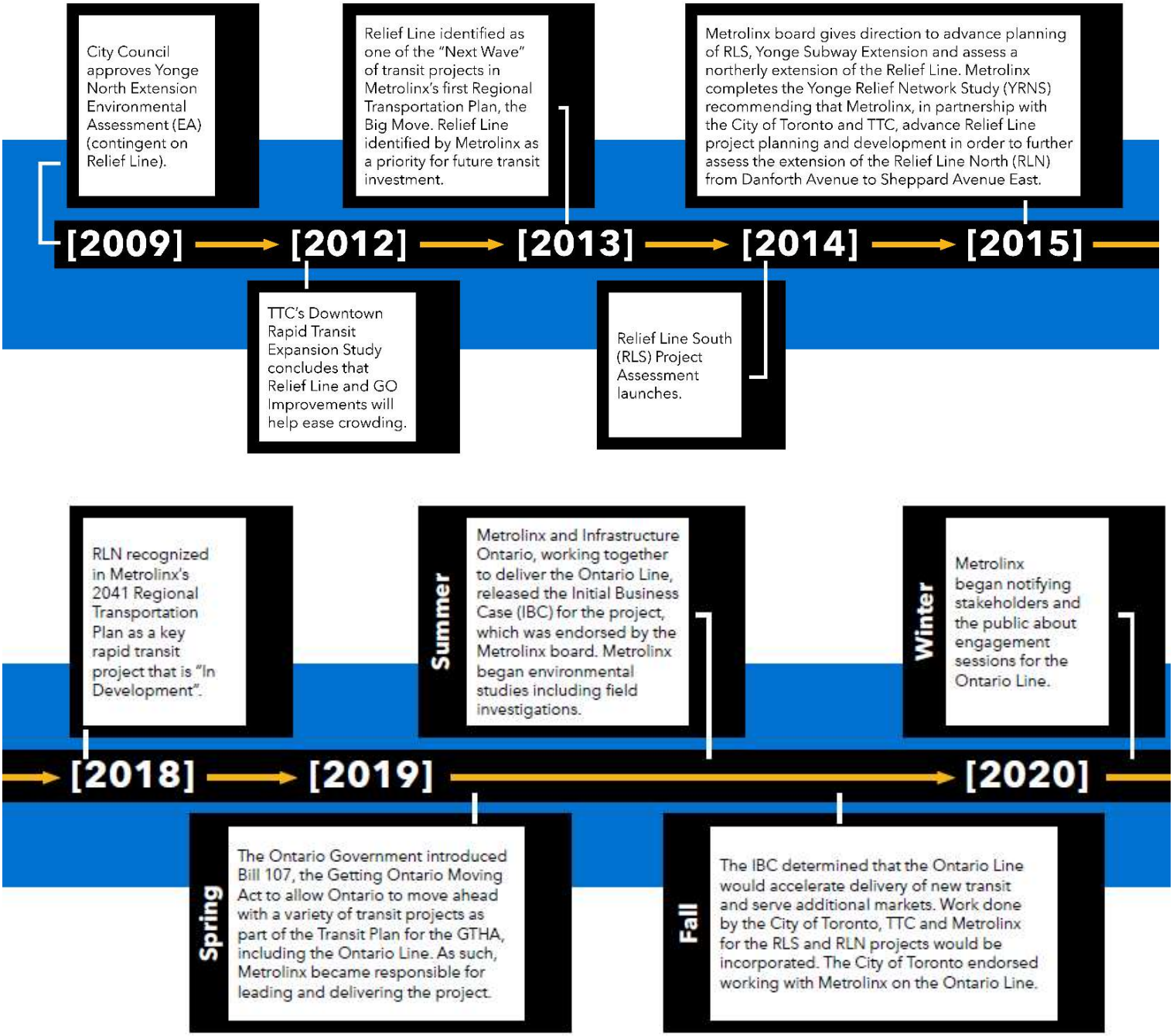
- Ontario Science Centre (January 23, 2020)
- Exhibition Place (January 29, 2020)
- Ryerson University (January 27, 2020)
- Metropolitan Community Church of Toronto (January 28, 2020)
- East York Open House (February 5, 2020)

The open houses involved an overview of the project planning and an opportunity for comments. Alongside this public engagement Metrolinx launched the following activities:

- refining design engineering to maximize benefits and address risks;
- developing the PDBC (this report);
- seeking environmental approvals through a TPAP; and
- preparing the procurement and delivery process.

The evolution of the Ontario Line is summarized in Figure 1-1.

Figure 1-1: Ontario Line Evolution



Business Case Overview

Business Case analyses are mandated by Metrolinx for all capital projects. As projects develop in scope and construction, business cases are completed to define the rationale and requirements for delivering said investment. As shown in Figure 1-2, the PDBC is the second of four business cases completed in an investment's lifecycle. The PDBC reviews the recommended option of the IBC and refines and optimizes it. This PDBC includes the following remaining chapters as specified by Metrolinx Business Case Manual Volume 2[3]:

- **Chapter 2 – The Case for Change** – defines the problem the Ontario Line aims to solve and identifies the broader value to the region of solving it.
- **Chapter 3 – Ontario Line Project Scope** – defines the current scope of the Ontario Line and how it has evolved from the IBC.
- **Chapter 4 - Strategic Case** – defines the range of benefits to travellers, Toronto, and the broader region that the Ontario Line will realize.
- **Chapter 5 - Economic Case** – assesses the socio-economic benefits and costs of the Ontario Line and evaluates its overall value for money in economic terms.
- **Chapter 6 - Financial Case** – establishes the financial impact of the Ontario Line including capital, operating, and revenue impacts.
- **Chapter 7 – Deliverability and Operations Case** – defines the proposed approaches to procure, delivery, manage, and operate the Ontario Line, including any key risks that must be mitigated.
- **Chapter 8** – **Conclusion –** provides a summary of the business case, including a comparison of IBC and PDBC performance, and recommended next steps.

[3] Business Case Manual Volume 2: Guidance (April 2019)
http://www.metrolinx.com/en/regionalplanning/projectevaluation/benefitscases/Metrolinx-Business-Case-Guidance-Volume-2.pdf

Figure 1-2: Metrolinx Business Case Lifecycle

2

Case for Change

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Introduction

The Case for Change defines the overarching rationale for pursuing the Ontario Line project by articulating a key problem that transportation investment can address and exploring why the Ontario Line is a suitable solution. It includes the following sections:

- **Problem Statement** – a summary of the key problem the Ontario Line aims to address.
- **Identifying the Solution** – a summary of why the Ontario Line is a suitable solution to this problem.
- **Value Proposition** – a summary of the key benefits the region can realize by addressing this problem.

Problem Statement

This section defines the regional problem that this PDBC responds to. The problem statement defines a challenge currently facing the GTHA and City of Toronto and forecasts what its impact will be if it is not addressed.

As described in the 2041 Regional Transportation Plan (the RTP)[4] The GTHA is experiencing unprecedented growth, which calls for corresponding expansion of its transportation network. Expanding the transit system is essential to connect people to schools, jobs and their communities. By 2041, the population in the GTHA is expected to reach more than 10 million people, representing a 41% increase from present day. At the core of the GTHA, the City of Toronto is the region's largest centre of economic activity and home to around 2.9 million residents and 1.3 million jobs. By 2041, 40% of all jobs in the GTHA are estimated to be located in the City of Toronto, making it the largest employment centre in the region and retaining its position as the engine of regional economic growth. With this growth, transit and road traffic congestion levels are expected to worsen and commute times to become longer, which will lead to negative impacts to Ontario's quality of life, environment, and economy if left unaddressed.

The effects of the region's accelerated growth are visible through its increasingly dense built form, the significant levels of tall and mid-rise buildings that are under construction, and constraining levels of congestion and crowding on the transportation network. Line 1 Yonge-University, the primary north-south spine of Toronto's rapid transit system, which serves both local and regional trips, is currently operating near capacity at peak times and the City's road network faces similar patterns of congestion. Without effective intervention, congestion on both the road and transit network is expected to worsen and commute times will become longer. To effectively accommodate the levels of projected growth, increasing the transit network's capacity into downtown Toronto, other major employment areas and neighbourhoods throughout the City, is critical to unlocking the GTHA's potential as a leading international metropolitan region and maintaining the GTHA's appeal to people, workers and the business community. Under such pressure, a quick and efficient delivery of an expansion of the rapid transit network is critical.

[4] The 2041 Regional Transportation Plan for the Greater Toronto and Hamilton Area (The RTP) is the blueprint for creating an integrated, multi-modal regional transportation system that will serve the needs of residents, businesses, and institutions.

This problem is underpinned by three critical issues that impact travellers and impede regional growth:

- **Issue 1 – Crowding and capacity –** the existing transportation network will not be able to provide reliable, fast, and frequent mobility that meets future population growth.
- **Issue 2 – Coverage and network resilience –** the existing transportation network provides limited direct access to the downtown core, which reduces network reliability and resilience – a minor disruption on Line 1 can mean significant delays throughout Toronto.
- **Issue 3 – Community growth and development –** the existing transportation network does not provide rapid transit connections to much of downtown Toronto, including key eastern and western growth areas and underserved lower income communities.

Issue 1: Crowding and Capacity Constraints Limit Growth

The GTHA is Rapidly Growing and 20% of this Growth Will be Concentrated in Toronto

Population and employment growth in the City of Toronto drives the need for investment in the GTHA's public transit network. Figure 2-1 and Figure 2-2 illustrate future population and employment in Toronto. Combined, these figures note that:

- downtown Toronto is forecast to have the highest population density and jobs in the GTHA; and
- other areas with high population and employment density are forecast to be along major corridors including the Yonge Street corridor, where significant growth and higher density developments are planned in northern Toronto and into southern York Region.

By 2041, the population of Toronto is forecast to be over 3.4 million (34% of the GTHA's 10.1 million total) and total employment is estimated to be over 1.8 million (40% of the GTHA's 4.8 million total). Toronto's population growth alone should be 22% compared to 2016, which will place increased strain on a subway, bus, streetcar, and road network that was designed for a smaller population. In addition, Toronto is expected to receive 20% of the GTHA's forecasted growth, which will result in a more compact and higher density downtown core than today, for which reliable and higher capacity transportation options will be required.

Without Investment, Line 1 Alone Must Support Growth in North Toronto, South York Region, and Downtown Toronto

Today, the 38.8 km long Line 1 plays a crucial role in Toronto and the broader GTHA's transportation network. In 2018, it averaged nearly 800,000 passengers per day – which exceeds the total demand of some peer rapid transit networks, such as the 211 km Bay Area Rapid Transit (BART) system in the San Francisco Bay Area that carried 411,000 passengers per day on average in 2019. Line 1 is the only rapid transit line that directly serves the financial district from north of Union Station, and also directly serves major development centres – such as Yonge and Eglinton and North York Centre – in the City of Toronto. Future growth in York Region and in North Toronto is forecast to rely on Line 1, with many users accessing the subway line through its existing terminus at Finch Station.

Figure 2-1: 2041 Population Density in Toronto

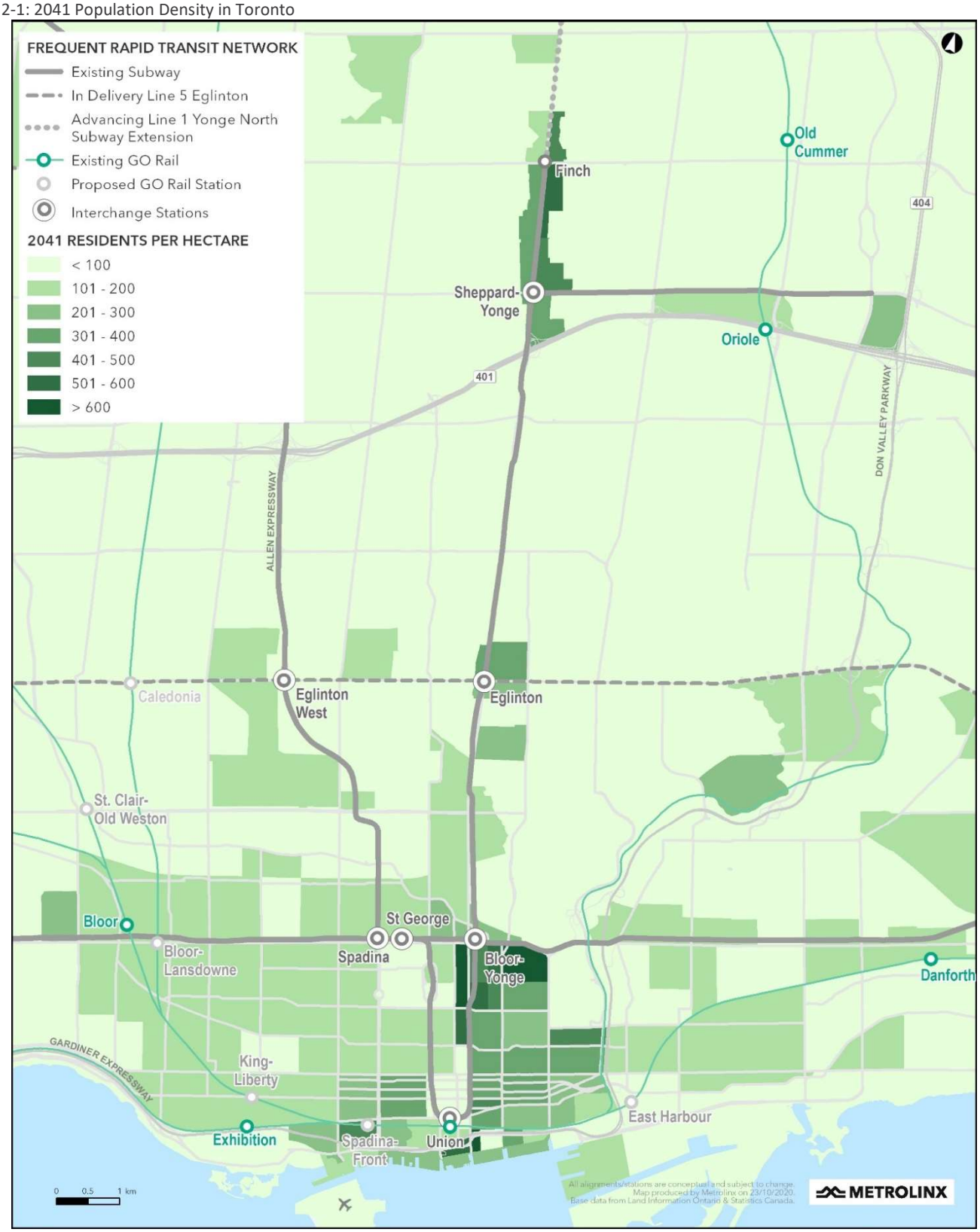
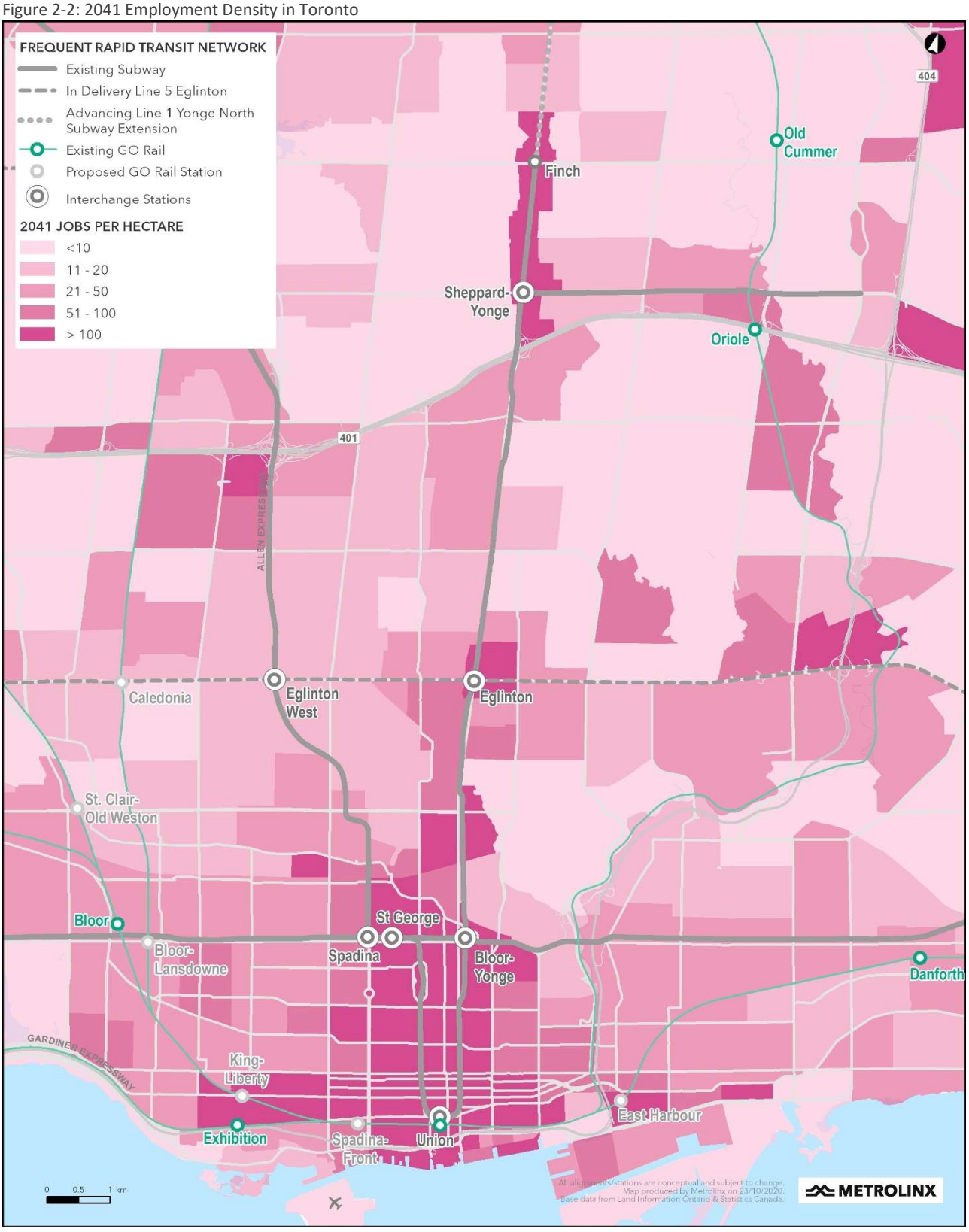


Figure 2-2: 2041 Employment Density in Toronto



The planned Yonge North Subway Extension will extend Line 1 to the Toronto boundary and beyond into York Region with a terminus at Richmond Hill Centre. The project will bring rapid transit closer to transit users, making their overall journey times shorter, and support regional residential and employment growth objectives as it improves connectivity between Toronto and York Region. This extension is anticipated to attract even more transit users to Line 1, including new transit riders, with preliminary analysis noting that increased demand will occur on Line 1 north of downtown Toronto, with some demand continuing on to downtown where Line 1 is most congested.

Today's population and employment levels have made crowding on Line 1 a significant issue. Current demand levels negatively impact user experience, lead to congested platforms and trains, and make travel times less reliable. Today Line 1 is operating at capacity at peak times and will be unable to serve the demand associated with the forecasted growth along the Yonge Street corridor without relief - as shown in Figure 2-3. As both the Toronto and York Region segments of the Yonge Corridor develop alongside downtown Toronto and other parts of the City, Line 1 will see increased demand as the sole rapid transit line to provide access to the core from north of Union Station. While investment has been made in new signaling technology and fleet to augment Line 1's capacity, this investment will be insufficient to accommodate future demand.

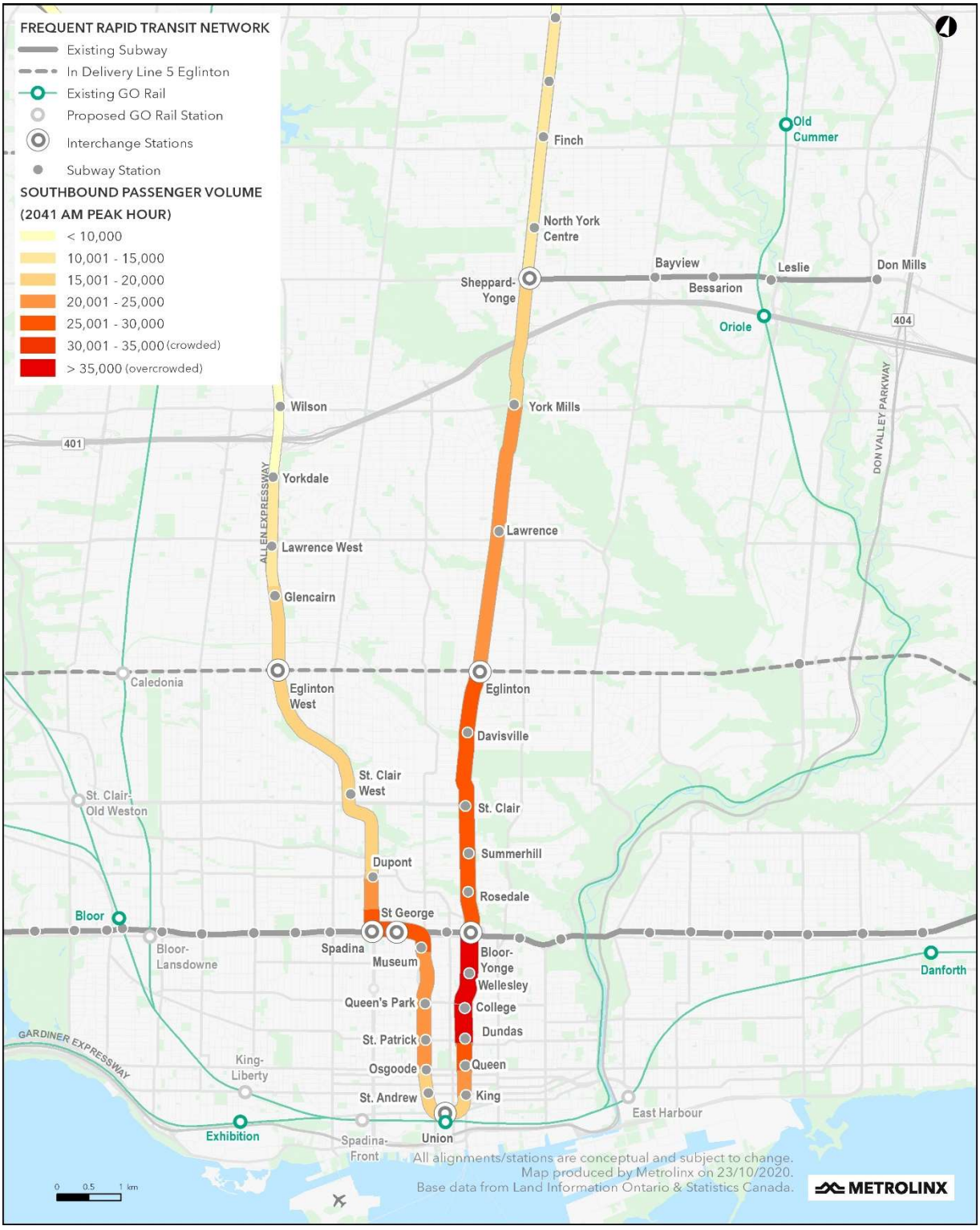
Impacts of Issue 1

Issue 1 emphasizes that for regional growth plans to succeed new travel choices are required. With over 1.2 million more people anticipated to live in Toronto and York Region by 2041, both the City of Toronto and the broader GTHA require expanded mobility choices to keep the region moving in the future. If this issue is not addressed, the following negative impacts are anticipated:

- A congested subway network may discourage transit use and lead to more trips by automobile, which causes congestion on Toronto's road network. In addition, crowding impacts also increase travel times for those without the option to use a private automobile, forcing people to make unnecessary trade-offs between cost and time sacrifices.
- The Yonge North Subway Extension, which will extend Line 1 north to Richmond Hill and support regional growth goals, which in turn will generate increased ridership on the subway. Without relief to Line 1, these customers may experience increased crowding – in particular if they are travelling south to downtown Toronto.

Line 1 is overcrowded and cannot, alone, support continued growth in the downtown core and broader region. If both the subway network and road network are congested, the region will not provide sufficient mobility to both accommodate population growth and support a high quality of life, prosperous economy, and sustainable environment.

Figure 2-3: Line 1 Peak Hour Passenger Volumes in 2041[5]



[5] Stations shown on the YNSE are for illustrative purposes and are currently undergoing planning and design.

Issue 2: Coverage and Network Resilience

Without Investment the Rapid Transit Network will Not Resilient Enough to Serve Regional Growth

Downtown Toronto[6] is Canada's largest employment centre and is home to a range of cultural and recreational amenities. Combined, commute and recreational trips to/from downtown Toronto are forecast to exceed 2.5 million trips per day[7] in 2041, of which roughly 50% will be made on transit. In the same year, downtown Toronto is anticipated to have nearly five hundred thousand office jobs, 40% of all jobs in the region. Moving over 1.25 million trips a day by transit requires a resilient and effective network. By 2041, downtown Toronto will be served by:

- **TTC Line 1** – which connects directly to Line 2 (including the Scarborough Subway Extension), Line 5 (Eglinton Crosstown), key east-west running surface routes, and GO rail and GO Bus at Union Station.
- **GO rail** – including two-way all-day fifteen-minute frequency or better service on the Lakeshore East, Stouffville, Barrie, Kitchener, and Lakeshore West lines, which links Toronto and the broader GTHA as well as providing connectivity between Toronto stations.

While the GO rail network and Line 1 provide frequent and fast service to the downtown core, they do not provide a complete network:

- Line 1 funnels demand through a small number of stations on two parallel corridors (Yonge Street and University Avenue) converging on Union Station – this 'u-shape' provides limited coverage of the downtown area, as the two sides of Line 1 are typically only 600 m apart (east to west), while downtown spans over 4 km east to west. This means that significant parts of downtown Toronto are not served by subway services.
- GO rail connects travellers directly to the Financial District and Union Station via the east-west running Union Station Rail Corridor. Additional downtown stations are proposed to extend network coverage; however even with these stations, the stop spacing of regional rail systems does not provide direct connectivity to many key activity and employment centres.
- Line 2 provides east-west service, but most trips that start on Line 2 and end in the downtown core transfer to Line 1, which puts increased burden on Line 1 to provide access to the core.

Limited Access to Downtown Toronto Means Increased Dependency on Line 1 and GO rail and Decreased Resilience

Due to the constrained nature of the network (only one access pathway from north of downtown via Line 1, only one east-west connection on GO rail) incidents on either GO rail or Line 1 can have serious follow-on impacts for the entire transportation network.

[6] Downtown Toronto Is defined in Toronto's Official Plan as an area running between Bathurst and the Don Valley (West to East) and the waterfront to Dupont and the Rosedale Valley (https://www.toronto.ca/wp-content/uploads/2017/11/9082-cp-official-plan-Map-06_OP_Downtown_AODA.pdf)
[7] Drawn from the Greater Golden Horseshoe Model V4, includes all trips that begin or end in Downtown Toronto

In 2019, the TTC recorded more than 120 instances of subway delays of greater than 30 minutes on the subway network, with 48 instances exceeding 60 minutes[8]. In total, more than 750 hours of delays across the subway network occurred in 2019. Currently, even small disruptions on the network can significantly impact travel times for those commuting in and out of the downtown area. Insufficient coverage on the network creates "pinch-points" on existing lines and can lead to system clogging and reduced resilience, particularly at peak hours of travel. Due to the cascading effect across the network, it can take significant time to recover to normal operations and delays often spill over onto other modes such as buses, which increases journey times and result in lost productivity.

Impact of Issue 2

While Line 1 and the GO rail network provide fast, frequent, and direct connections to Union Station and the University Avenue and Yonge Street Corridor, they do not provide wider coverage throughout Toronto and can become pinch-points for accessing the downtown core if they are delayed. As discussed in issue 1, as the region grows, these services will also become more congested and potentially have greater incidences of unplanned delays. Combined, these delays will impact both quality of life and economic productivity and may make managing forecast growth more challenging.

The downtown core has limited rapid transit service - it is only served by Line 1 and GO rail. This means even small disruptions can significantly impact travel times. Without additional rapid transit access to the core – including connections between existing subways and rail lines - the network will not be resilient enough to support regional growth nor will it provide complete coverage across Canada's largest employment centre.

Issue 3: Community Growth and Development

Downtown Toronto Will Continue to See Rapid Growth in the East and West – Two Areas Not Served by Rapid Transit

After decades of growth along University Avenue, Bay Street, Yonge Street and other north-south corridors, downtown Toronto has undergone significant growth along east-west corridors in recent years. This land use pattern is expected to continue into the future as official plans call for increased development along with east and west sides of downtown Toronto. These areas are experiencing significant levels of growth as guided in land-use patterns and policies included in the City of Toronto's In-force Downtown Plan (TOcore), which presents 25-year vision that sets the direction for the city centre as the cultural, civic, retail and economic heart of Toronto and as a great place to live. Figure 2-4 illustrates this growth by highlighting the location of tall buildings throughout the city.

[8] Figures based on analysis of TTC Subway & SRT Train Service Delay Data on Lines 1, 2, 3 and 4, January-December 2019

Figure 2-4: Map of existing buildings over three storeys, City of Toronto

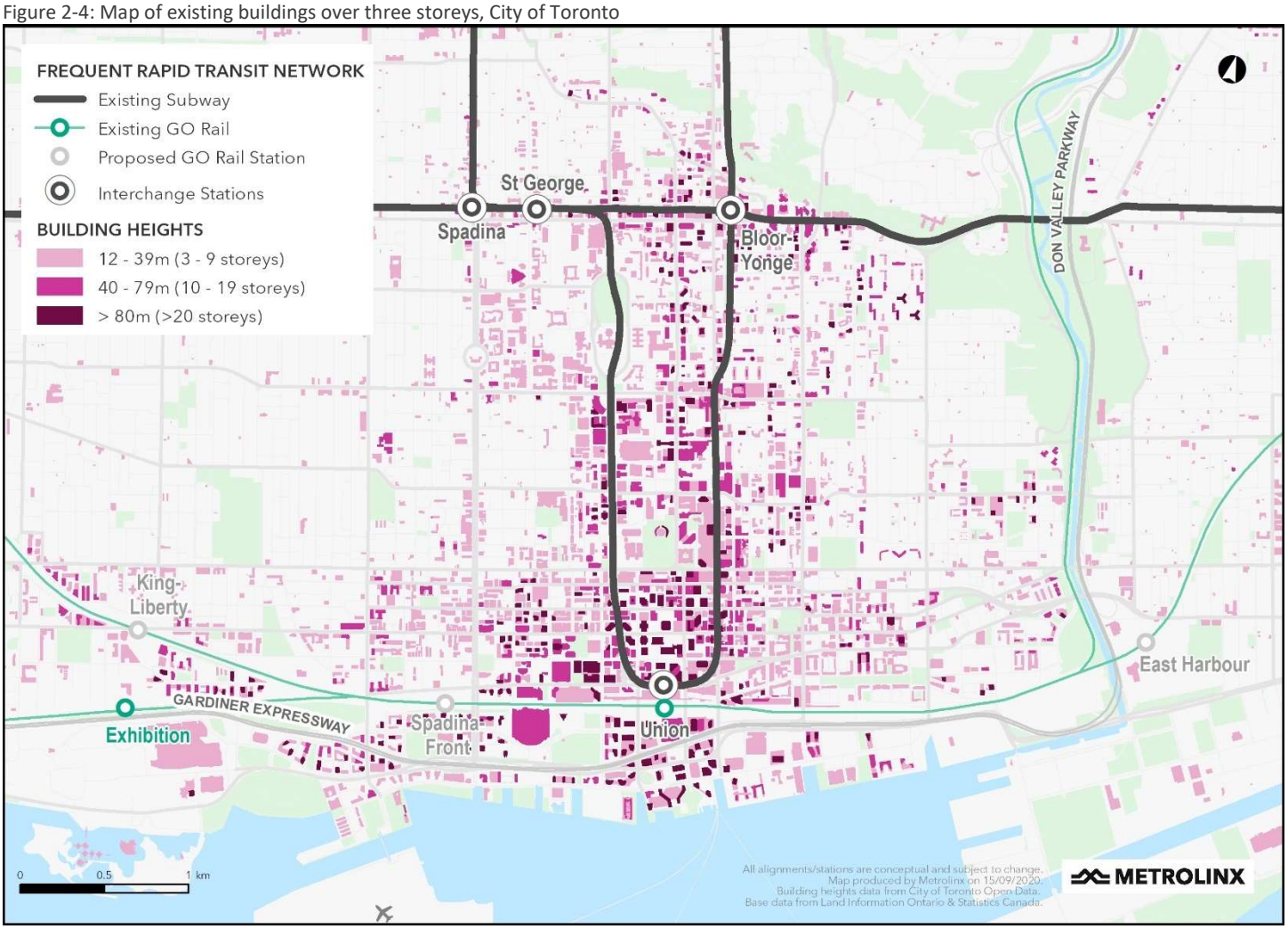


Figure 2-4 notes that higher density land uses and taller buildings have been developed throughout the eastern and western parts of downtown Toronto which are currently not served by subways/rapid transit and only have limited coverage by the proposed new GO rail stations. The existing rapid transit network provides key north-west connectivity converging on Union Station, but trips that continue beyond this area eastward or westward rely on transfers to other, less rapid modes to traverse the downtown area. The lack of optimal connectivity between eastern and western downtown and the core has resulted in road congestion and crowded surface transit, which in the long run may impede continued development of this part of the city. This lack of connectivity also impacts development potential and limits opportunities for Transit Oriented Communities (TOCs). TOCs will place more housing and jobs near or at transit stations along the routes of the province's four priority subway projects. The TOC approach provides real opportunities to build vibrant, higher density, mixed-use communities that are connected to transit stations. This will increase transit ridership and reduce traffic congestion. However, a robust high-quality transit service is required for TOCs to occur.

Today's Rapid Transit Does Not Provide Direct Connectivity for Lower Income Communities

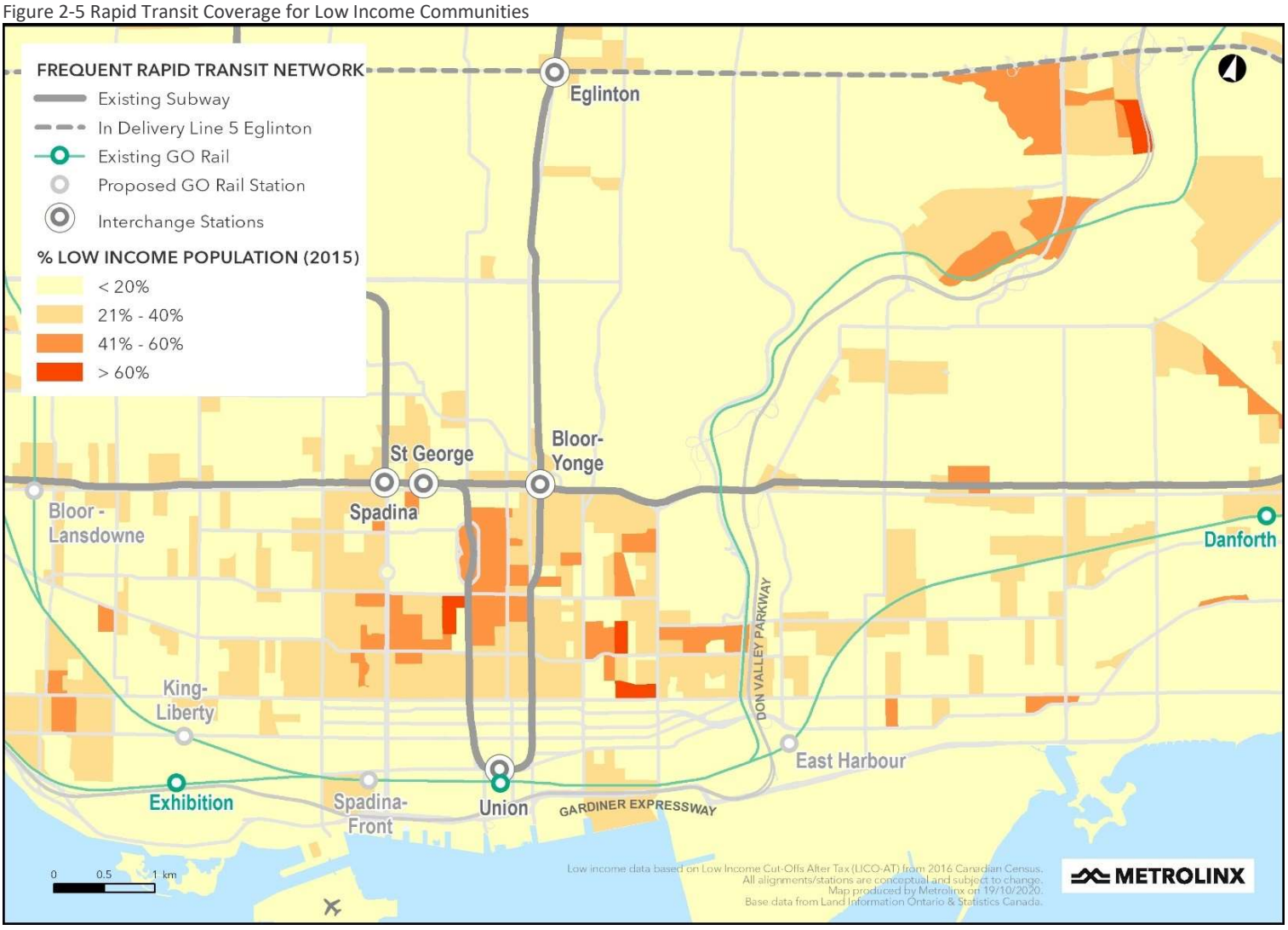
The existing rapid transit network currently underserves priority communities in and adjacent to downtown Toronto. Lower income communities and priority neighbourhoods are not directly served by Line 1 or Line 2, which limits opportunities for these communities to connect to jobs and cultural, social service, and recreational destinations.

This creates two key impacts:

- these communities are reliant on surface transit, which may result in longer travel times when compared to wealthier communities with access to rapid transit; and
- these communities may become car dependent, which may add additional financial burden.

Figure 2-5 illustrates the distribution of low-income communities. This figure notes that communities to the east and west of downtown Toronto have limited access to rapid transit, as do lower income communities near the in-delivery Science Centre Station on Eglinton Crosstown (Line 5).

Figure 2-5 Rapid Transit Coverage for Low Income Communities



Impact of Issue 3

Toronto's Downtown Plan highlights downtown as the focal point for residential and non-residential development activity in the City and its policies seek to create complete communities by connecting land use with a transportation system that forms a well-connected and integrated network that improves mobility and accessibility, while reducing dependency on the private automobile. The current lack of rapid transit connections to these areas is anticipated to generate the following negative impacts:

- A lack of rapid transit beyond the Financial District impedes the Downtown Plan vision as key areas slated for development, in particular the east and west, will be reliant on an already congested road and transit network.
- Key priority areas that are underserved by rapid transit will continue to be underserved in the future, which will limit the economic activities available to these communities and also impede social equity.

The existing rapid transit network underserves priority communities and does not provide direct east-west connections where significant and rapid growth is occurring. This incomplete network does not meet the aspirations, goals, and plans for the City of Toronto and the broader GTHA.

Identifying the Solution

This section identifies the opportunities of responding to the Problem Statement and assesses the potential solutions to deliver it.

Quality public transport underpins the liveability and competitiveness of the GTHA, driving economic prosperity by enabling efficient interaction between workers, businesses, residents and visitors. Rapid transit investment has the potential to expand travel choices within the City of Toronto in order to add capacity, coverage and connectivity and support the continuation of the high quality of life and economic competitiveness enjoyed by the City.

The Ontario Line IBC proposed that a new subway connection that makes use of rail corridors, tunnels, and elevated structures could:

- reduce crowding on Line 1 and other transportation services, while providing new capacity to meet growing transportation demand;
- create a more resilient network with multiple intermodal connections/interchanges and expanded coverage; and
- provide rapid transit connectivity for some of Toronto's most rapidly growing areas and currently underserved communities.

The Ontario Line has been planned and designed to respond to this problem statement and the three critical issues that drive it to ensure Toronto has access to a network that meets the needs of future growth. The rationale for advancing the Ontario Line as a solution to this problem is further expanded upon in Table 2-1, while the scope of the project is defined in Chapter 3 and its benefits are assessed in more detail in chapters 4-7.

Table 2-1: Assessment of the Opportunities the Ontario Line can Create

Opportunity	How does the Ontario Line create these opportunities?
Add fast, frequent, and competitive service that serves new travellers and reduces crowding on other lines and routes	Daily demand into the downtown core and across the city requires a level of capacity that can only be delivered by subways and railways – the Ontario Line can move thousands of people in each direction each hour.
	By directly linking to Pape Station, the Ontario Line can draw demand off Line 1, which in turn frees up capacity on this line to accommodate future growth and improves the experience of existing customers across the network.
Create a more resilient and integrated network	The Ontario Line will connect directly to GO rail, Line 1, Line 2, Line 5 (Eglinton Crosstown), and multiple bus and streetcar routes, which enables broader coverage and creates a more resilient network.
	New connections mean that customers have expanded choice when the entire network is functional, but also when individual lines have planned maintenance disruptions and unplanned disruptions.
Leverages existing corridors to connect more communities underserved by rapid transit and foster TOCs	The Ontario Line corridor makes use of tunnels, rail corridors, and structures to traverse Toronto's geography to connect communities, including low income and marginalized communities which are underserved by rapid transit today.
	The Ontario Line connects major development sites and areas that have undergone rapid growth without rapid transit on the shoulders and to the east and west of downtown.
	The TOC approach provides real opportunities to build vibrant, higher density, mixed-use communities that are connected to transit stations. The TOC approach will help integrate transit and community development into the Ontario Line development, TOC will make commuting easier and faster – bringing more jobs and more housing closer to transit.

Why Use Subway to Solve the Problem?

Toronto is served by a range of transportation options, from the existing rapid transit lines (subways), to an expansive streetcar and bus network and regional rail via GO Transit. Other modes, such as BRT and LRT, play a critical role in the GTHA transportation network and are being invested in through other projects and programs – however, they are not optimal solutions to provide more capacity needed to address the problems outlined in this chapter, as assessed in Table 2-2. Higher capacity, higher speed transit solutions offer the best opportunity to meet the future needs of the City of Toronto's residents and workers, particularly for trips that rely on rapid connectivity.

Table 2-2: Assessment of alternative modes to address the problem

Alternative Mode	Assessment
Highway and Road Network	The existing highway network provides six lanes into the core on the Don Valley Parkway and six lanes on the Gardiner Expressway. Already constrained by congestion, these highways do not have capacity for further growth and cannot be realistically expanded further due to the impacts this would have on the surrounding urban development and sensitive environmental areas that this would adversely impact. In addition, highway/road network expansion without appropriate investment in rapid transit will further increase the number of vehicles on the road, leading to more congestion in the future.
Streetcar	The City of Toronto has an extensive streetcar network which mainly provides east-west connectivity on key transportation corridors such as along King, Queen, Dundas, and College, as well as north-south connectivity such as along Spadina Avenue and Bathurst Street. However, while the streetcar network provides coverage, it cannot provide speed and capacity that forecast growth requires as streetcar performance is heavily influenced by the road network (size of vehicles are limited to block size, speed is limited by traffic signals, capacity is limited by roadway geometry and traffic signals). Streetcars will not be a complete solution to the problem but will play a crucial role in connecting people to new rapid transit.
Bus	Buses are a flexible mode but like streetcars their capacity is constrained by the road network in the downtown core. While the City of Toronto has an expansive network of bus routes and services, these services operate in mixed-traffic environments, which limits their speed potential and are subject to wider network congestion. Buses will not be a complete solution to the problem but will play an important role in connecting people to new rapid transit.
GO rail	GO rail connects the GTHA to downtown Toronto. A transformational investment program (GO Expansion) will provide two-way, all-day service across the network. However, GO rail services do not provide wider coverage across east-west Downton Toronto as the existing right of way converges on Union Station. Connecting the rapid transit and GO rail network in Toronto will lead to a more resilient network – however, GO rail alone is not a solution to the problem statement.

Strategic Value Proposition

This section summarizes the benefits of addressing the problem in high-level strategic terms, which are then evaluated in future chapters.

Addressing the problems outlined above through strategic investment in transportation presents the opportunity to provide benefits for the City of Toronto and the broader region through the realization of regional policy objectives. The 2041 Regional Transportation Plan (RTP) for the GTHA is the blueprint for creating an integrated, multi-modal regional transportation system that will serve the needs of residents, businesses, and institutions. The infrastructure, services, and policies in the plan will keep GTHA and its people moving as the region grows and evolves.

The RTP sets out a vision for transportation in the GTHA:

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

The IBC for the Ontario Line reviewed the ability of the project to address the role the Relief Line played in the 2041 Frequent Rapid Transit Network (FRTN). This IBC noted the Ontario Line could realize greater benefits than the Relief Line while addressing the same core problem (relieving Line 1).

Strategic Benefits

Regional policies, including the 2041 RTP, have been used to generate a strategic benefits framework for the Ontario Line based on three strategic benefit categories. These benefits, outlined below, comprise the high-level outcomes that Ontario Line seeks to realize for the region and are assessed in more detail in Chapter 4 (Strategic Case). These outcomes are:

- **Strong Connections –** expanding transit coverage to more communities in order to increase access to key destinations and economic opportunities.
- **Complete Travel Experiences –** improving travel time, comfort, and reliability for riders on currently congested routes, such as Line 1, and for new riders who shift to rapid transit.
- **Sustainable and Healthy Communities –** moving more people more quickly using less energy and reducing the negative impacts of the transportation network by shifting trips to more sustainable modes and reducing traffic congestion.

Table 2-3: Overview of PDBC Outcome Area and Strategic Benefits

Outcome Area	Strategic Benefits	Description
Strong Connections	1. Improve access to transit	The Ontario Line allows more people to access public transit
	2. Increase access to economic opportunities	The Ontario Line increases labour market opportunities by providing direct rapid transit connections to places of work
	3. Support a synergistic relationship between transit and city-building	The Ontario Line enables transit-oriented communities, which in turn increase its ridership
Complete Travel Experiences	4. Improve travel time and reliability	The Ontario Line reduces travel time by providing fast, frequent, and reliable service
	5. Improve comfort and safety	The Ontario Line provides a comfortable and safe service while reducing crowding on other lines
	6. A more resilient and integrated transportation network	The Ontario Line enables ridership growth by limiting network disruptions and maximizing connectivity
Sustainable and Healthy Communities	7. Move people with less energy and pollution	The Ontario Line shifts demand from emission and energy intensive modes to more sustainable public transit
	8. Improve quality of life and public health	The Ontario Line enhances reduces the risk of automobile collisions and supports active travel
	9. Unlock jobs and economic development	The Ontario Line is a direct investment in Toronto and will generate new jobs and support economic growth

Benefits Map

The remainder of this PDBC assesses how the Ontario Line achieves the benefits outlined in Table 2-3 (Strategic and Economic Cases), the costs of the project (Economic and Financial Case), and what is required to successfully deliver the project (Financial and Deliverability and Operations Case). The PDBC makes use of a logic chain approach to project evaluation to illustrate what is included in the investment program and how delivering the Ontario Line will generate the proposed benefits. Figure 2-6 explores the logical linkages between: inputs (the resources required to deliver the project), actions (the key elements of the project to be delivered), outputs (the performance spec of each element of the project), and outcomes (the Strategic Case and Economic Case benefits of the project). This figure illustrates how each output supports an intermediate outcome – expanding transit access, improving quality of service, and attracting travellers from automobile to transit (which is enabled by access and quality of services). In term these intermediate outcomes enable the overall strategic and economic benefits of the project. Table 2-4 illustrates how these factors are considered in each of the PDBC evaluation chapters.

Figure 2-6: Ontario Line Benefits Map

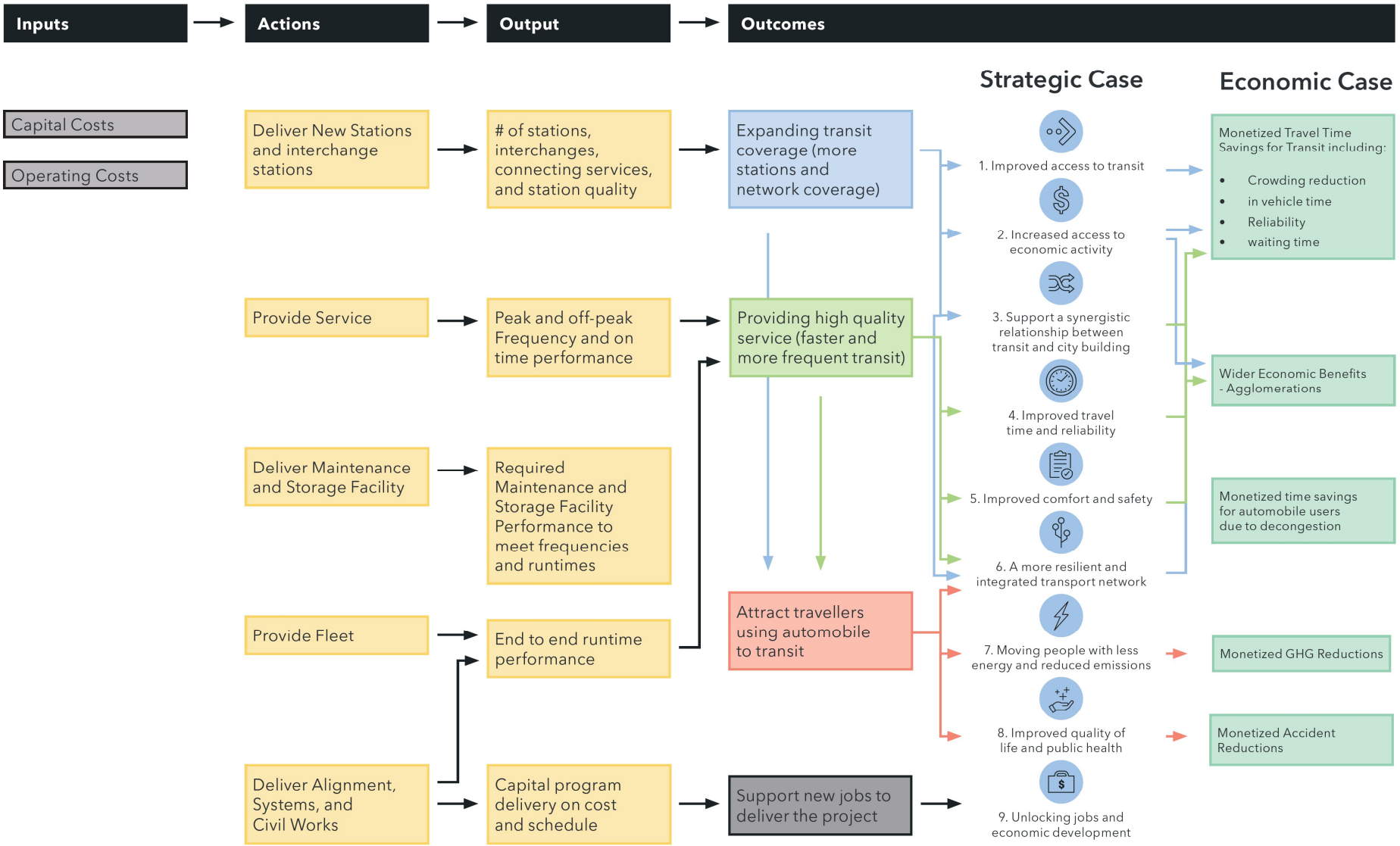


Table 2-4: PDBC Benefits Framework and PDBC Map

	INPUTS	ACTIONS	OUTPUTS	OUTCOMES
Core Question	What level and type of investment is required to deliver the Ontario Line?	What is included in the Ontario Line project?	What level of performance should the Ontario Line achieve?	What are the benefits of the Ontario line?
What is Included?	• Expenditure (capital and operational) • Organizational capacity required to deliver and operate	• Infrastructure development and construction • Service changes • Operations and maintenance	• Change in travel times • Service frequencies • Service performance	• Key performance indicators for strong connections, complete travel experiences and sustainable and healthy communities
Measures	• Cost and cost efficiencies • Job creation • Stakeholder participation and coordination	• On-time delivery • Design and construction that meets environmental, safety and accessibility requirements	• Target travel times, service frequencies, reliability, and on time performance	• Measuring proposed benefits using a benefits realization framework
Role in Business Case				
Chapter 3 – Investment Options	• Defines costs and input requirements	• Defines project scope and components	• Defines target run-times, frequencies, connections delivered	• Specify model assumptions based on the scope used to estimate benefits
Chapter 4 – Strategic Case	• Summarizes how project costs and inputs realizes benefits	• Summarizes how project scope realizes benefits	• Outlines how target run-times, frequencies and connections delivered realize benefits	• Outlines the outcomes to be realized by the project
Chapter 5 – Economic Case	• Capital, O&M, and renewal costs (real)	• Discussed as relevant as part of the economic narrative	• Uses travel times, frequencies, and other service factors to forecast ridership changes/benefits	• Monetizes key benefits and outcomes in economic terms
Chapter 6 – Financial Case	• Capital, O&M, and renewal costs (nominal)	• Discussed as relevant as part of the financial narrative	• Uses revenue and cost efficiencies in financial case assessment	• Cost per outcome metrics are used as relevant in the financial narrative
Chapter 7 – Deliverability and Operations Case	• Outlines staffing requirements to deliver the line	• Outlines project delivery plan, procurement plan, and regulatory/ environmental requirements	• Outlines operations plan and key financial risks during operation	• Outlines key risks that may impact benefits realizations

3

Ontario Line Project Scope

METROLINX

Introduction

This chapter provides an overview of the Ontario Line scope as of July/August 2020. This chapter includes the following sections:

- **Ontario Line Reference Concept Design Overview –** a high level description of the Ontario Line project, including elements that are fixed as of this PDBC, elements to be refined at the Full Business Case (FBC) stage, and performance objectives for the project.
- **Ontario Line Program Development Process –** a summary of the process used to develop the Ontario Line.
- **Ontario Line Detailed Scope –** a review of the scope for each segment of the line and a high-level description of the proposed operating concept for the line.
- **Options Evaluated Assumptions –** a summary of the options developed for evaluation in this PDBC and the assumptions used to evaluate them.

Ontario Line Reference Concept Design Overview

This section introduces the Ontario Line project and provides an overview of the Reference Concept Design assumed in this PDBC and how it has evolved since the IBC.

Introduction to the Ontario Line

The Ontario Line was announced by the Province of Ontario in 2019 and is one of the four priority subway projects Metrolinx is developing for the Greater Toronto Area (GTA). Since the publication of the IBC, Metrolinx has undertaken a comprehensive work program to advance planning for the delivery of this transportation investment. Metrolinx developed a Reference Concept Design (RCD) that illustrates how the Ontario Line can be delivered and the scope of benefits the region could realize. This RCD is used to:

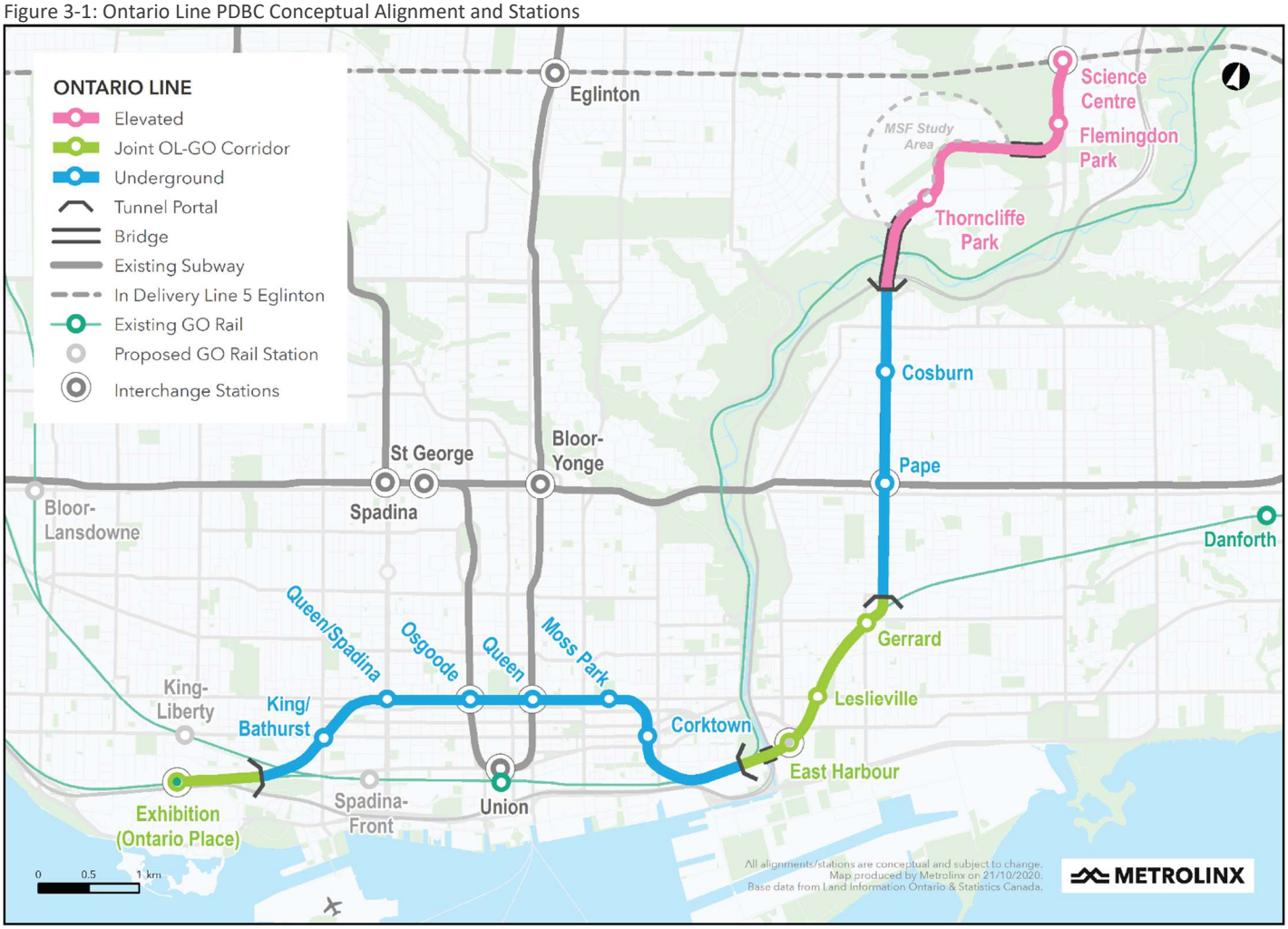
- Develop a comprehensive and deliverable scope for the project
- Determine a budget and construction schedule to be approved by Treasury Board
- Define benefits and how they are realized
- Identify key risks and ways to mitigate them

This RCD was developed based on extensive engineering, planning, and economic modelling/analysis to present a realistic and deliverable concept for the Ontario Line. This concept will evolve further during procurement and the development of the FBC. The RCD is not a final design of the project – it is a potential solution that demonstrates what is required to deliver the Ontario Line (costs, resources, delivery approach) and what its benefits will be. The Ontario Line design will continue to evolve between the PDBC and FBC stages and through procurement based on lessons identified in this PDBC, feedback, and designs and innovations provided by bidders (see Deliverability and Operations Case).

Ontario Line Scope Overview

The Ontario Line is one of the largest subway expansions in Toronto's history. It has been designed to ease congestion on existing transit lines throughout the city and bring transit to underserviced neighbourhoods. The RCD for the proposed Ontario Line comprises a new subway service from Exhibition/Ontario Place to the Ontario Science Centre via downtown Toronto to make it faster and easier for hundreds of thousands of people to get where they need to be each day. A map of the RCD Ontario Line conceptual alignment and station locations is provided in Figure 3-1.

Figure 3-1: Ontario Line PDBC Conceptual Alignment and Stations



Ontario Line Infrastructure Overview

The Ontario Line will be a modern rail rapid transit system that runs between Ontario Science Centre and Exhibition Place through downtown Toronto. It will have 15 stations, including interchange stations connecting to:

- GO Rail services at
    - Exhibition
    - East Harbour
- TTC Subway Network at
    - Line 1 at both Queen and Osgoode stations
    - Line 2 at Pape station
    - Line 5 Eglinton at Ontario Science Centre.

Stations will also connect with surface bus and streetcar routes. The Ontario Line will have a fully segregated right-of-way and will be fully automated. Stations will be fully accessible with elevators to all levels. Stations will be equipped with platform edge doors to support safe and efficient boarding, alighting, and overall operations at high frequencies.

Ontario Line Service Overview

The scheduled operating hours for the Ontario Line are planned to align with TTC subway operating hours. Service at interchange stations will be provided concurrently with the first or last scheduled service of TTC subway lines. With shorter, driverless trains, service frequencies will be higher than on existing TTC subways. The RCD assumes up to 40 trains per hour (TPH) at peak hours and up to 24 TPH in the off-peak. The Ontario Line will also have the flexibility to operate for extended hours during special events.

Journey times from end-to-end will be 26-30 minutes or less, with optimized dwell times to support ease of access. The Ontario Line will be able to move 24,000 to 30,000 passengers per hour per direction when operating at 40 TPH.

Ontario Line Reference Concept Scope

The PDBC design for Ontario Line is provided in Table 3-1.

Table 3-1: Ontario Line Key Project Components by Element

Project Element	Key Design Features	Performance Objectives
Stations	• Station design is optimized for integration with other modes and urban environments to ensure ease of access • The line will provide a connection to existing and planned surface routes, including daytime and nighttime streetcar and bus connections, and rapid transit and rail • Platform edge doors and 100 m stations • Transit Oriented Community opportunities are being considered as each station is designed	• 15 new stations (7 at-grade/elevated, 8 underground) • Connections to TTC Streetcars at 10 stations • 7 connections to the frequent rapid transit network: 3 GO lines (Lakeshore West, Lakeshore East and Stouffville) and 4 rapid transit lines (Line 1 at Queen and Osgoode, Line 2 at Pape, and Line 5 at Science Centre)
Service Plan	• The Ontario Line will provide high-frequency, rapid transit service in both the peak and off-peak period • Travel times to downtown Toronto will be significantly reduced	• Up to 40 TPH in the peak period • Between 12-24 TPH in off-peak • 26 to 30-minute end-to-end run-time

Alignment	• The Ontario Line will follow an alignment from Exhibition/Ontario Place to the Ontario Science Centre via downtown Toronto
	• Three bridges over the Don River
	• 1500 Volts DC overhead contact system
	• The line includes other key works (emergency exits, life protection, ventilation, noise and vibration mitigation
		• 15.6 km of revenue service (16.5km length including turnbacks)
		• Alignment length by type- approximately:
		  ○ 8.8 km underground track
		  ○ 3.7 km at-grade/joint rail corridor track
		  ○ 3.1 km elevated guideway track
		• 3 river bridges
		• 4 tunnel portals

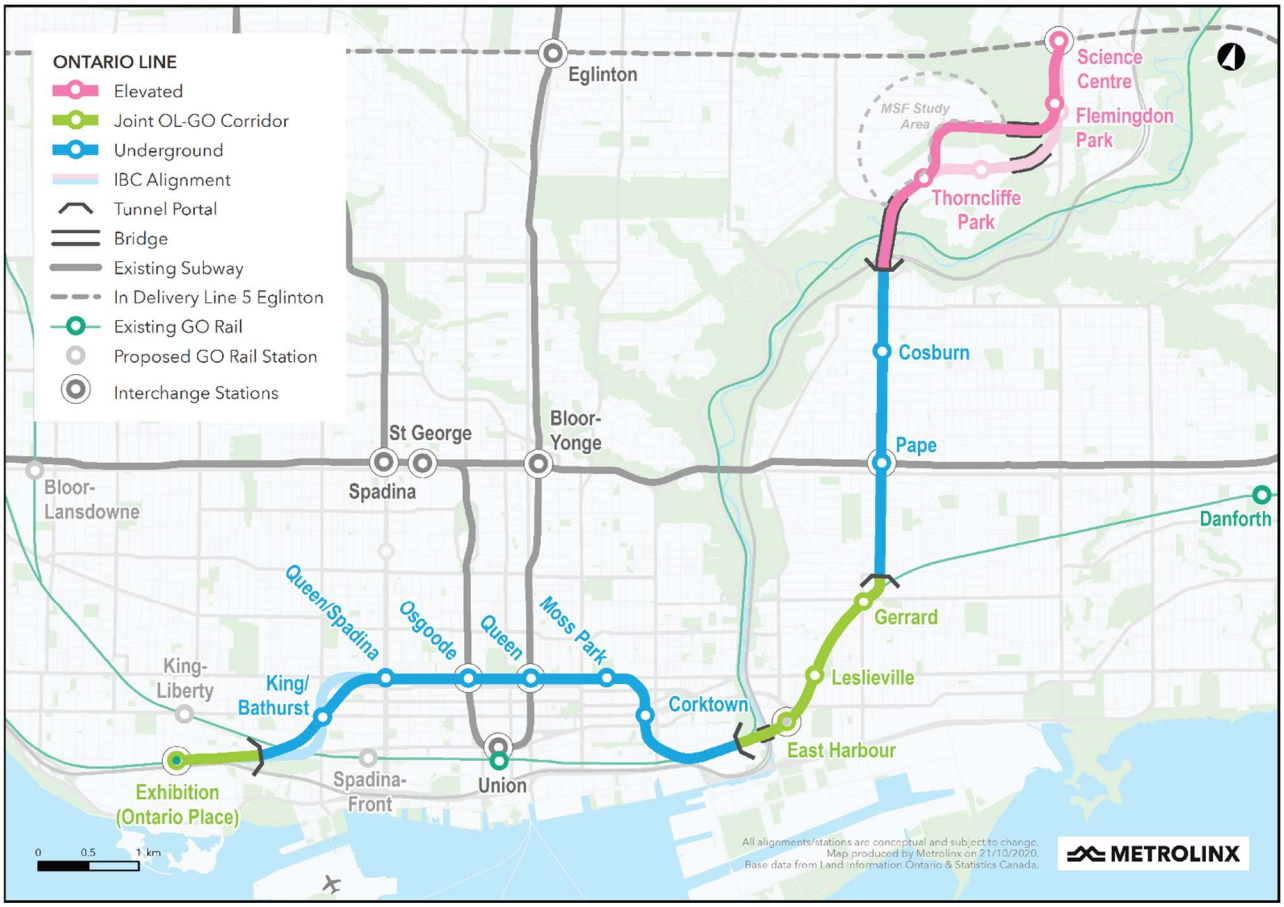
Fleet and Maintenance and Storage Facility	• The Ontario Line fleet is currently planned to consist of four- to five-car trains achieving maximum speeds of 80 km/h • Driverless and automated technology to maximize operating efficiency, flexibility, and travel time reliability • A dedicated maintenance and storage facility will be built in the Leaside/Thorncliffe Park industrial area	• Depot Capacity for 44 trains - either four-car (80m length) or five-car (100m length) with an opportunity to adapt fleet overtime based on customer demand and operational needs • Maximum train width of 3. metres • Maximum speed 80 km/h with acceleration to meet 26-30-minute Science Centre to Exhibition run times

Evolution of the Ontario Line Concept

Since the completion of the IBC, the Ontario Line RCD has evolved based on further design, planning, and analysis described in Table 3-3. The revised alignment is shown in Figure 3-2 and includes the following changes:

- Changes to the alignment in western downtown and northern segments
- Refined station planning

Figure 3-2:Evolution of the Ontario Line from the IBC to PDBC



Changes at Exhibition Station

The IBC base case assumed a cross-platform interchange between GO and Ontario Line trains at Exhibition Station. The updated PDBC design has both Ontario Line platforms on the north side of the GO tracks. Although it creates longer transfer times for passengers, this updated station design has the benefit of reduced capital and staging costs (previous design required underground tail tracks and four portals), lower construction risk and complexity, and it enables construction of an additional island platform for use by express GO trains. The new design protects for future changes to the line, including westward extension as well as a future cross platform interchange with GO trains.

Changes in Downtown West Alignment

The alignment between Exhibition Station and Queen/Spadina through King/Bathurst station has been changed to follow a shorter and more direct alignment, providing reduced travel times for passengers. This change in alignment results in lower capital costs because of a shorter track tunnel, reduced tunneling risks, and improved construction procedures. Utility impacts and the schedule and costs for utility relocations are also reduced. While the alignment runs diagonally across the street grid, property impacts are not significantly greater than the IBC alignment which was intended to run under public streets where possible.

Changes in Alignment through Thorncliffe Park and Flemingdon Park, around the Maintenance and Storage Facility

The IBC alignment through Thorncliffe Park included an elevated line along the entire length of Overlea Boulevard, with an elevated junction and connecting track north to the Maintenance and Storage Facility (MSF). The alignment has now been shifted northward to follow adjacent to the hydro corridor and connect directly with the MSF. Thorncliffe Park station is shifted west along Overlea Boulevard while Flemingdon Park station is shifted north and to the west side of Don Mills Road. While walking distances to stations are increased for passengers, there are potential offsetting benefits:

- impacts to cultural and educational facilities east of Beth Nealson Drive on Overlea Boulevard are reduced;
- construction costs and risks are reduced because the line is shorter with no need for a separate connecting track to the MSF;
- while the line is adjacent to the hydro-corridor, the resulting alignment may reduce the need to relocate or raise existing hydro towers;
- better use of existing publicly owned lands; and
- impacts to residential properties on the east side of Don Mills Road are reduced.

Metrolinx continues to explore alternative configurations for the MSF to identify an optimal design and location that is well integrated with the local area (including support for redevelopment), manages costs/risks, and supports project benefits.

Continued Evolution of the Ontario Line

Following the PDBC, Metrolinx will continue to advance the Ontario Line through procurement and further design. The RCD for the Ontario Line is anticipated to continue to evolve as further design work is completed. Table 3-2 outlines the scope of what is fixed within the PDBC and the elements to be clarified in the FBC.

Table 3-2: Status of Ontario Line Scope

Element	State of Scope in PDBC	Elements to be revisited in FBC
Stations	Location and conceptual design	More detailed design
Service Plan	Peak service of 34-40 TPH Off-peak service of 12-24 TPH	Optimizing service pattern with respect to benefits and cost efficiency
Alignment	Refined from IBC with significantly higher stages of design for the alignment, systems, and civil works (typically 30%+ design)	Final design of alignment, systems, and civil works
Fleet	Automated rolling stock (80-100m trains under consideration)	Size and configuration of initial and future rolling stock
MSF	General requirements	Location and design

Ontario Line Program Development Process

This section outlines the concept development process and approach for the Ontario Line used to develop the scope included in this PDBC.

Background and Concept Development Process

In spring 2019, a joint Metrolinx-Infrastructure Ontario (IO) team undertook an initial design process to identify a "representative" Ontario Line concept for the purposes of the IBC. The following guiding principles were used to undertake the initial concept development:

- consider alternative alignments, such as surface or elevated guideways, and construction methods to optimize delivery, improve the customer experience, and create better access to jobs and key destinations;
- reduce costs and delivery times and allow flexibility for implementation;
- use modern, automated driverless technology, and platform edge doors to increase safety and reliability and achieve travel time savings; and
- consider a dedicated MSF on industrial land.

Initial design criteria were established to support the development of options.

These formed the basis of design to confirm feasibility, specifying components such as maximum grades, clearances above and below existing features such as roads and building foundations, tunnel and elevated/at-grade guideway dimensions, minimum turning radii, vehicle speeds and capacity.

These criteria were developed in coordination with subject matter specialists drawing from standards for projects such as existing TTC subways, Metrolinx's other rapid transit projects, and reference projects such as the Vancouver SkyTrain and Canada Line, London DLR and Copenhagen's City Circle Line.

At the time, these criteria were understood to be indicative for the purposes of developing the IBC' representative alignment and subject to change as the project planning progressed. Several options were developed based on these criteria and designs were produced to confirm feasibility. The alternatives were evaluated, taking account of community impacts, capital and operating costs, constructability, and operability to identify the preferred concept

Reference Concept Design Development Approach and Process

Following the IBC planning and design process, an extension of the previous process was undertaken to build upon the IBC and optimize the project to improve its benefits while managing costs and delivery risk.

The design criteria used to develop the Ontario Line were reviewed based on results from a market sounding exercise and other technical exercises.

Other drivers for change came from updates to base assumptions and inputs such as: ridership estimates; property; stakeholders (including: City of Toronto, TTC, public and private sector developers) and public input; tunnelling methodology; contract delineation; updated base mapping; new geotechnical information (depth of bedrock and soil conditions); existing and proposed buildings; utilities; operational assumptions; and service integration. A number of new alternatives were identified. The options were evaluated against a broad range of criteria structured under the four cases from the Metrolinx Business Case framework. These alternatives were assessed against a base case, the IBC representative alignment. Any changes from the base case were subject to a comprehensive evaluation and presented at the Metrolinx Executive level for approval.

Preliminary Design: Advancing the Reference Concept Design

A range of preliminary design exercises were undertaken to refine the design of the Ontario Line across all project elements (example: alignment between two stations) with a consideration of:

- managing costs and risks to optimize the line for delivery;
- maximizing benefits; and
- downstream and whole of line impacts of design choices

These exercises are summarized in Table 3-3.

Table 3-3: Summary of Ontario Line planning studies and technical considerations

Technical Elements	Preliminary Design Processes and Outcomes
Station and platform configurations	• All-corridor station configurations – each station went through an architectural design process to confirm the location of entrances with emphasis on transfer quality, cost, integration with the community context, construction methods, schedule, and constructability. Changes were considered in the design refinements, as follows: ○ **Exhibition Station configurations** – alternative station configurations were considered against the IBC cross-platform configuration, including underground, split-level and north-side configurations. A north side at grade configuration was chosen. These configurations were also explored to determine the opportunities and constraints for a future integration with GO rail express trains. Key considerations included: impacts to proposed Liberty New Street, property requirements, and cost. The design was modified to future-proof design for a future express GO Transit platform. ○ **King Bathurst Station –**a "diagonal" alignment was selected to reduce route length and cost. Several possible configurations were considered, with the RCD solution avoiding impacts on large development sites and the historic Wheat Sheaf tavern, while enabling good interchange with street cars and supporting shorter travel times. ○ **Queen-Spadina Station configuration** – several station configurations and construction methods were considered, including off-street options constructed with cut and cover methods. Key decision drivers: construction cost, schedule, traffic impacts, heritage impacts and integration, and business impacts. No change has been made. ○ **Osgoode Station configuration** – an architectural review was undertaken of the base case design using updated design criteria and ridership forecasts to optimize the connection to Line 1 and ensure adequate access capacity within the station and to the surface. The station box was shifted west to better align with the existing Osgoode Station. ○ **Queen Station configuration** – alternative station configurations were developed to reduce transfer times between Ontario Line and Line 1; avoid costly and time-consuming relocation of major utilities along Queen Street (including the Enwave heating and cooling tunnels); and minimize community and business disruption during construction. The station has been shifted east to straddle Yonge Street and the existing Line 1 station. ○ **Moss Park Station configuration** – alternative station locations, configurations and construction methods were considered with a focus on compressing the construction schedule. Other considerations included: property requirements, overbuild and entrance integration, community and business impacts, impacts to Federally owned properties, and construction costs. Plans now are to build the station in a mined cavern under Queens Street with a single entrance within Moss Park. ○ **Corktown Station configuration and east tunnel launch options** – minor shifts to Corktown Station were identified to improve tunneling flexibility from the east, reduce community impacts, compress the schedule, reduce costs, and optimize station overbuild and entrance integration opportunities. The station was shifted east off Berkeley Street into the property to the east. This site is also to be used for tunneling launch and construction staging and laydown. ○ **East Harbour Station configuration and alignment** – alternative concepts were developed to address space constraints to the north of the Don Yard while still allowing wide enough platforms at East Harbour to permit overbuild. A minor shift in alignment was made to avoid impacts to properties and environmental features north of Don Yard, while providing space for the multi-use path. ○ **Leslieville Station**: various locations and configurations were reviewed. The station is situated mostly to the south of Queen Street East and spans over the existing rail bridge. This ensures that Jimmie Simpson Community Centre will be able to continue operating throughout construction with minimal impact.

Technical Elements	Preliminary Design Processes and Outcomes
	○ **Gerrard Station and tunnel portal configuration** – a number of alternative options were developed to address the challenging gradients and curvature between the at-grade section along the GO corridor and the tunneled section under Pape Avenue. Key considerations: community impacts, cost, travel time, station entrance access and community integration. A surface station has been maintained with the northbound platform shifted south to allow for a direct run under Pape, mitigating property acquisition requirements. ○ **Pape Station configuration** – several alternative configurations for the interchange at Pape Station were developed to improve the transfer quality between Line 2 and the Ontario Line, while mitigating risks of tunneling under Line 2 while it continues in operation. The assessment considered property requirements, constructability in relation to the existing station, community and business impacts, traffic impacts, overbuild opportunities, and cost. The station was shifted off the street to the east side of Pape. ○ **Cosburn Station configuration** – several alternative station configurations and construction methods were developed including in-street and off-street mined and cut-and-cover options. Key drivers included cost, schedule impact, community impacts, development overbuild, and alignment impacts. The station was shifted off the street to the west side of Pape. ○ **Science Centre Station configuration and Don Mills alignment** – alternative Science Centre Station configurations were explored to optimize the connection with Line 5 Eglinton and the bus terminal. Key considerations included: transfer time, Don Mills alignment, community impacts, cost and schedule. The station was shifted to the northeast corner of Don Mills and Eglinton. ○ **Thorncliffe Station -** the updated plans now have a significant change in the route that will reduce community impacts. Instead of proceeding along Overlea Boulevard after the station in Thorncliffe Park, tracks will run adjacent to the nearby hydro corridor, a little to the north, as the line moves toward Flemingdon Park. These options are undergoing further development and refinement.
Maintenance and Storage Facility	• **Maintenance and Storage Facility (MSF) site selection –** a number of alternative MSF locations were identified and evaluated to determine the preferred location. Key drivers of the decision: technical feasibility (large enough to accommodate opening day and future expansion), community impacts, business impacts job displacement, environmental constraints, distance to mainline (operational costs), and impacts to street network. The MSF site is under current review with an aim to deliver an optimized facility.
Alignments	• **West Segment** – alternative alignments were considered against the base case option between Queen-Spadina and Exhibition Station. Alternatives included a number of diagonal variations considering costs, station entrances, travel time savings, and tunneling construction flexibility. A 45-degree diagonal option was chosen. • **Downtown Segment** – alternative alignment and station locations were identified and assessed between Osgoode and Don Yard including options that combined stations and added additional stations. Key decision drivers included: tunneling approach and launch sites, cost, property requirements, development overbuild, population/employment catchments, service to vulnerable populations, schedule risks, and potential for development overbuild and entrance integration. No change has been made to the base case; however, modifications to the base case were recommended at Corktown station, as described above. • **East segment -** the Ontario Line tracks will run on either side of four (three existing and one new) GO train tracks. Significant design and engineering efforts have been made to ensure the six-track railway does not significantly impact bordering properties or other ongoing infrastructure projects. Using the existing rail corridor and streamlining Ontario Line construction work with planned GO Expansion means Ontario Line can keep mostly within an existing footprint and minimize impacts to surrounding neighbourhoods. • **North segment** – alternative alignments were developed between Millwood Road and Science Centre Station to explore opportunities to improve access to the MSF and reduce community impacts along Overlea Boulevard and Don Mills. Thorncliffe Station was shifted west, and alignment turned north to follow adjacent to the Hydro corridor to Don Mills.

Technical Elements	Preliminary Design Processes and Outcomes
Tunneling and Bridging	• **Downtown West launch sites** – alternative TBM launch and extraction sites were explored along the base case alignment with the goal to maximize tunneling flexibility, reduce costs, compress construction schedule, and minimize community impact. The launch site is now assumed to be west of Strachan Avenue in the Lakeshore West rail corridor. • **Strachan Ave bridge replacement alternatives** – a design exercise was undertaken to assess alternative approaches to the replacement of Strachan Ave bridge, which may be necessary depending on the final location of the Downtown West TBM launch site. The study considered various bridge types and construction methods, to minimize construction time. • **Ontario Line / Lakeshore East Joint Corridor bridges**– a design exercise was undertaken to understand the schedule and cost trade-offs of two scenarios for each existing GO bridge -- (1) replace bridge and build a new combined structure shared with Ontario Line trains and (2) build new separate Ontario Line bridges parallel to existing GO bridges. Considerations included: property requirements, community impacts, condition of bridge and timing of planned replacement (i.e. will the bridges have to be replaced in the near term or can they be rehabilitated into the long term), cost and schedule. The decision was made to retain the existing bridges and build new Ontario Line bridges parallel to the existing corridor. The only exception is at Eastern Avenue where the bridge is at the end of its useable life and needs to be replaced. • **Don Valley Crossing adjacent to Leaside bridge** – alternative alignment and bridge construction methods were explored adjacent to the Leaside bridge including the exploration of options to share the existing bridge structure similar to the Prince Edward Viaduct. Key considerations included: alignment geometry, structural modifications (for example: capacity of the Leaside Bridge to accommodate additional weight), community and traffic impacts, cost and schedule. No change was made.

Ontario Line Detailed Scope

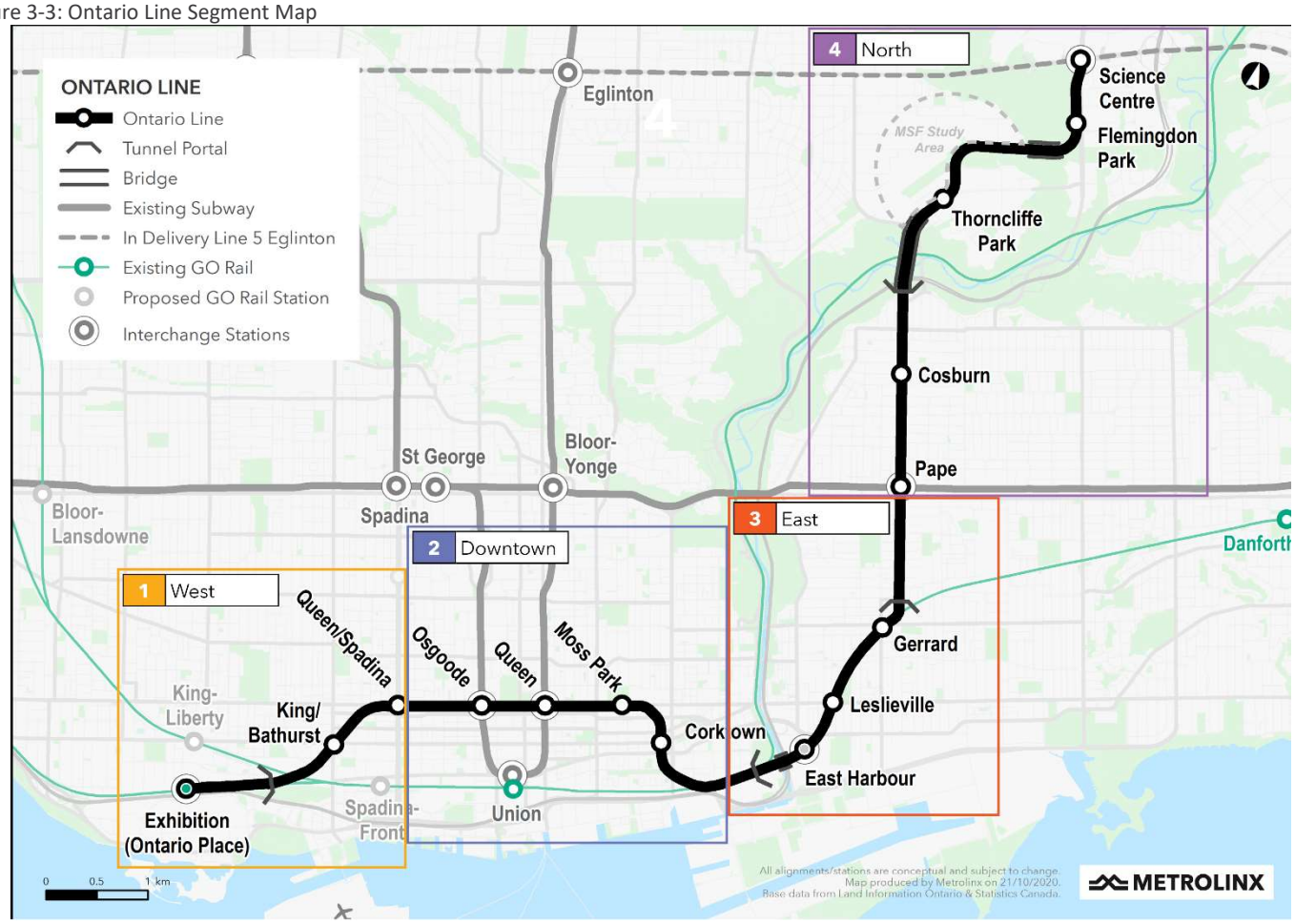
This section provides a detailed scope of the Ontario Line reference design concept including a segment by segment overview of the reference concept and a detailed description of the operating concept for the project.

The Ontario Line RCD scope has been broken into the following components, each with a separate section included in this chapter:

1. **West Segment: Exhibition to Queen-Spadina**
2. **Downtown Segment: Osgoode to the Don Yard**
3. **East Segment: East Harbour to Pape Station**
4. **North Segment: Pape Station to Science Centre**

Figure 3-3 illustrates these segments. An overview of Ontario Line operations is provided following the segment subsections.

Figure 3-3: Ontario Line Segment Map

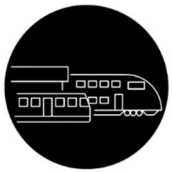


Rapid Transit Alignment Planning: Background

While each rapid transit project is unique and designed to meet local needs, all rapid transit system designers must address a similar set of choices and trade-offs. In particular, rapid transit projects must consider the type of alignment to develop in order to best meet the needs of travellers by providing expanded coverage and high-quality service, minimize impact on urban form, minimize costs, and manage key risks.

Each segment overview section in this PDBC discusses the specific choices made on each segment to provide expanded rapid transit coverage while minimizing costs and risks. At a high level, alignments and stations included in each segment could be tunnelled, elevated, or make use of another mode's corridor (shared corridor). Table 3-4 provides a general overview of these design choices, which can be used in conjunction with the segment sections to understand the Ontario Line design.

Table 3-4: Alignment Types Considered During Ontario Line Scope Development

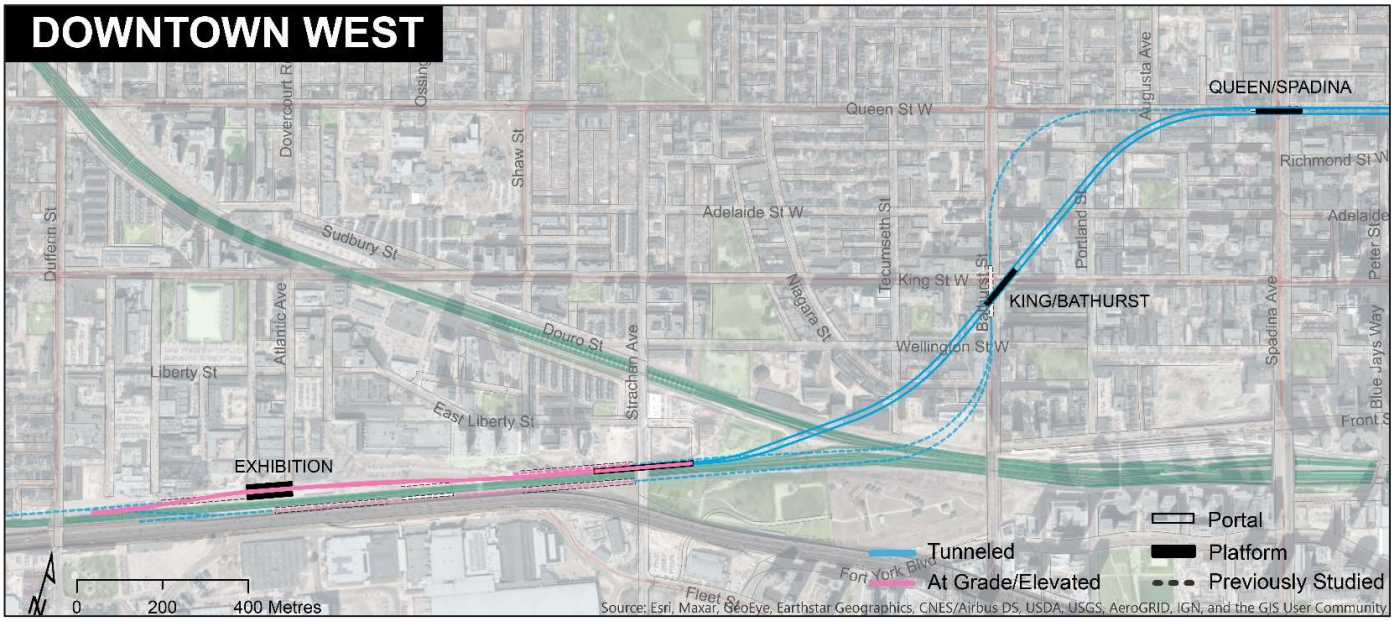
	Description	Technical Requirements	Pros	Cons
Shared Corridor 	• Delivering rapid transit alongside another transportation mode (example: existing shared corridor north of Kennedy Station used by Line 3 and Stouffville GO) • The Ontario Line leverages existing Metrolinx rail corridors to provide a more cost-efficient network coverage (building further faster) with reduced construction impacts and duration	• Available corridor space or a corridor that can be expanded for use by rapid transit • Noise, vibration, and visual impact mitigation • Ensuring seamless operations between rail modes by delineating corridor and adjacent land use	• Derives further value from existing corridors • Lower cost and shorter construction period compared to tunnels if a suitable corridor is available • Potentially short passenger access times and transfer times between modes • Urban form is already shaped by rail corridors in Toronto, which limits impact of operations and construction	• Mitigation may be required for noise or visual impacts to communities • May present challenges for transition points between shared corridors, structures, and tunnels and would require extra coordination among existing rail operations
Underground 	• Delivering rapid transit underground with tunneling, mining, or cut and cover • The Ontario Line will be in tunnels through downtown Toronto and along Pape Avenue, where other alignments are not feasible	• Tunneling at a sufficient depth to avoid utilities, foundations, and other underground structures • Tunnel ventilation, emergency exists, fire protection • Ensuring seamless and quick access/egress from stations and interchanges between modes • Can required a large number of vertical circulation elements (such as stairs, escalators, and elevators)	• Limited visual impact and noise • Limited interaction with other modes or uses • Can provide more direct routing	• Costly and complex to deliver • Typically, the longest construction time • Mitigation needed for vibration • Requires tunnel ventilation and emergency exits, which may negatively impact urban form • Depth of stations and associate vertical circulation can increase construction costs and risks and significantly increase access time (diminishing travel time savings)
Elevated 	• Delivering rapid transit on elevated structures that run above the street (Example: Line 1 through Rosedale, Line 2 through High Park, and Line 3) • The Ontario Line will run on elevated structures across the Don River, to Thorncliffe Park and most of the remaining alignment to Science Centre Station through Thorncliffe Park	• Existing corridor with sufficient space • Noise, vibration, and visual impact mitigation depending on adjacent land use	• Effective for navigating grade change • Lower cost and risk than tunneled rapid transit	• Requires mitigation for visual and noise impacts • If not designed optimally it can divide urban form

1. West Segment: Exhibition to Queen-Spadina

Segment Overview

This segment comprises approximately 2 kilometres of surface and underground track and stations, from the western end near Dufferin Street in the GO Rail Corridor to Peter Street and Queen Street. Figure 3-4 provides an overview of this segment. It includes two underground stations (King-Bathurst and Queen-Spadina) and one at-grade station (Exhibition). Tail tracks west of Dufferin Street provide space to reverse and store trains. These are aligned to allow future westward extension. The Exhibition terminus station provides interchange with GO Transit's Lakeshore West service and is at-grade. High transfer volumes are anticipated at this station, which will alleviate congestion at Union Station by providing an additional rapid transit route into the downtown and the heart of the Financial District when travelling from the west. It also serves Liberty Village, Exhibition Place and Ontario Place. Moving east, the tracks enter the tunnel near Strachan Avenue, with underground stations at King-Bathurst and Queen-Spadina. Both are likely to be built mostly using sequential excavation mining (SEM) techniques, limiting surface disruption and impacts. The journey time between Exhibition and Queen-Spadina (including dwell times at intermediate stations) is anticipated to be about four minutes.

Figure 3-4: West Segment Alignment Map



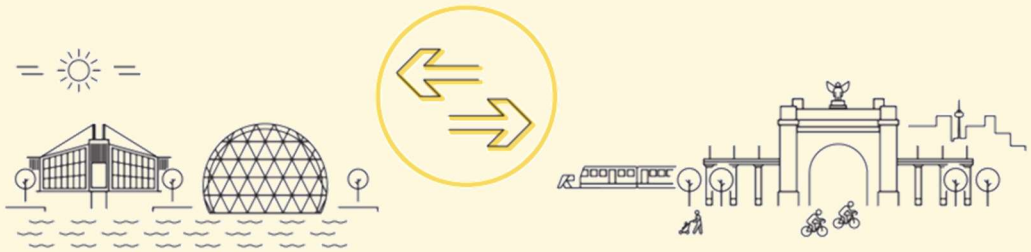
Stations

This segment of the Ontario Line includes three stations at Exhibition, King-Bathurst and Queen-Spadina. Table 3-5 provides an overview of the stations included in Segment 1, including the rationale for their inclusion and the connections that the stations will enable.

Table 3-5: Overview of West Segment Stations

Station	Rationale	Proposed Connections
Exhibition	Exhibition is the planned western terminus station which will provide an interchange with GO Transit's Lakeshore West service and TTC streetcar and bus routes. It will act as a key interchange station diverting passengers off the GO Transit network, providing relief to congestion at Union Station. This station serves the Liberty Village and neighbourhoods to the north and Exhibition Place and Ontario Place to the south. There is an opportunity for a last mile connection to Ontario Place.	• Lakeshore West GO • 509 Harbourfront and 511 Bathurst Streetcars • 29 Dufferin Bus • 63 Ossington Bus **Blue Night Network:** • 307 Bathurst, 329 Dufferin, and 363 Ossington Future (TBC): • Ontario Place last-mile connection
King/Bathurst	Major inline station connecting to both the King and Bathurst streetcar lines. This station serves the densely populated King West and Fashion District. It provides relief to the 504 King Streetcar service, the busiest in Toronto, by diverting passengers to the Ontario Line before downtown.	• 145 Downtown/Humber Bay Express • 504 King, 511 Bathurst, 508 Lakeshore **Blue Night Network:** • 307 Bathurst
Queen/Spadina	Major inline station connecting to both Queen and Spadina Streetcar services. Serves high density areas in Queen West, Chinatown, the Entertainment District, and a regional retail destination.	• 501 Queen and 510 Spadina **Blue Night Network:** • 301 Queen and 310 Spadina

As part of the Ontario Line implementation and development, potential transportation connections between Exhibition station (existing Lakeshore West GO Rail, TTC streetcar and future OL station) and the Ontario Place site will be explored. With the significant investment being made by the Provincial Government in the Ontario Line, the purpose of this study is to identify a range of 'last-mile' connection solutions for the terminus station at Exhibition Place that could potentially support future opportunities at the Ontario Place and Exhibition Place sites. To help support future stakeholder discussions and government decision-making, the study will analyze a range of last mile connection options.



Planning Considerations

The following planning considerations were identified for this segment of the Ontario Line:

- **Interchanges** - with existing GO Transit and TTC streetcar routes requires optimizing transfer quality through the placement and design of entrances and platforms;
- **Heritage** – entrance integration and protections during construction, avoiding impacts to existing buildings and opening up opportunities for entrance integration into future developments;
- **Green space** – minimizing impacts on public green space; and
- **Tunnelling strategy** – coordinating alignment and station design with tunnelling strategies to limit community impacts, reduce costs, and speed up construction.

Table 3-6 provides a detailed summary of the key design changes made on this segment since the IBC.

Table 3-6: Overview of West Segment Design Changes

Design Change	Description	Rationale
Exhibition Station and Eastbound/ Westbound tracks on north side of GO corridor	IBC assumed a cross-platform configuration on opening day. Ontario Line platforms are now all north of the existing GO platforms in a side platform configuration. The eastbound Ontario Line platform is shared with the westbound local GO platform. May require reconstruction or modification of Strachan bridge to make space for two Ontario Line tracks on the north side of the GO corridor.	• Cross-platform configuration required expensive end of line infrastructure including underground tail tracks, cross-over and four portals. • Surface side platform configuration reduces costs and risk, by avoiding tunnelling under an active GO corridor and construction of portals in a constrained location (between a GO corridor and the Gardiner Expressway). • Avoids impact to TTC Exhibition Streetcar Loop and potential impact to Gardiner Expressway foundations. • Design protects for future western extension and cross-platform interchange configuration.
Space proofing for future express island platform at Exhibition Station	Design modified to protect for potential future GO express centre platform at Exhibition – currently express trains travel in the two centre tracks and cannot stop at Exhibition.	• Increases the number of passengers who can transfer between Ontario Line and GO Rail.
Tunnel launch in Ordnance Park	IBC conceptualized tunnel boring machine (TBM) launch east of Exhibition Station on north and south sides of the tracks – with updated Exhibition Station design (north side), tunnels run side-by-side allowing for a combined portal and TBM launch. TBM launch site moved east of Strachan just south of the Kitchener-Milton-UP Express GO corridor within site of the future Ordnance Park.	• Reduce complexity and risk, shortening the length of TBM tunnel and allowing the tunnels to the west of the launch site to be constructed concurrently with tunnelling. • Launch location allows for efficient and cost-effective protection of potential western extensions and cross platform station. • After construction is finished, an opportunity to create a new park above the tunnel will be available, in keeping with existing plans for the site.
Diagonal alignment between Spadina and Strachan	IBC alignment followed Bathurst Street; updated alignment runs diagonally crossing Bathurst-King at a 45-degree angle.	• Reduces capital cost and requires a shorter tunnel. • Increased passenger benefits by reducing travel times. • Schedule improvement by reducing the number of major utility relocations. • Tunnelling risk reduction by improving launch conditions. • Reduced number of impacted properties with a shorter tunnel.

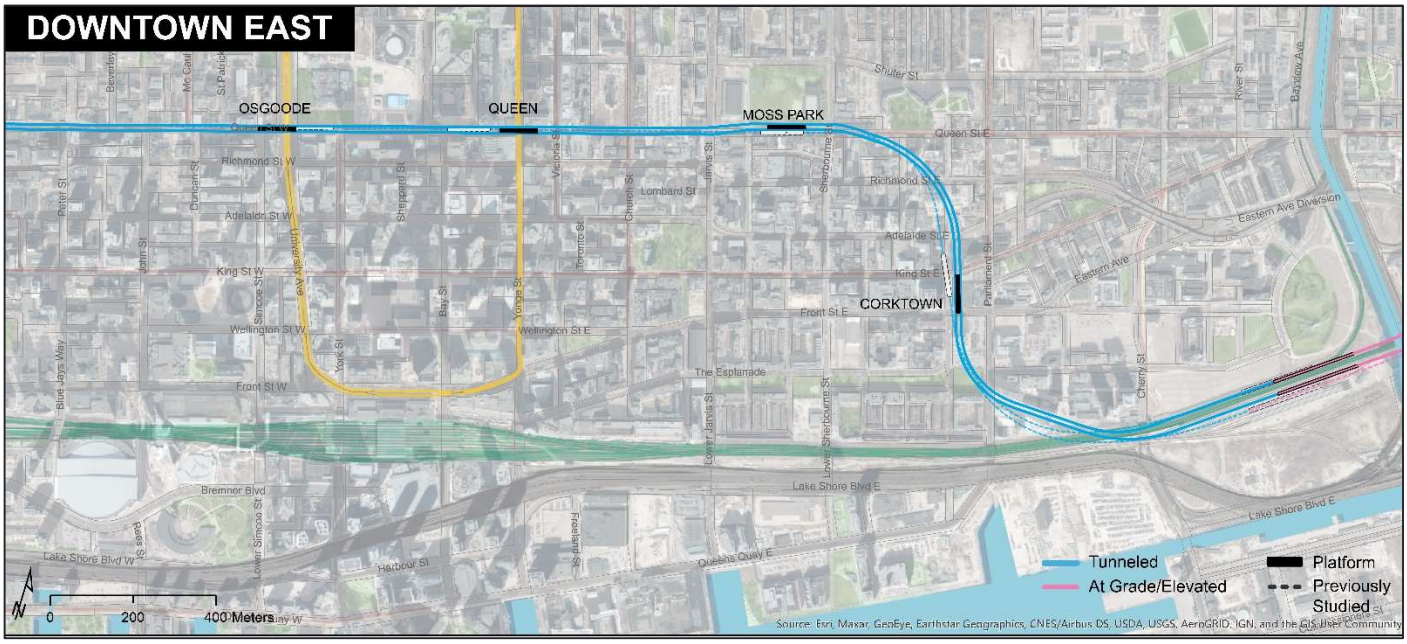
2. Downtown Segment: Osgoode to Don Yard

Segment Overview

This segment is approximately 5 kilometres in length, entirely underground, from Queen and Peter Street through downtown to the Don Yard at Cherry Street. It includes four underground stations, at Osgoode (University Avenue), Queen (Yonge Street), Moss Park and Corktown (King and Parliament). Figure 3-5 provides an overview of this segment. Most of Segment 2 is in a tunnel directly under Queen Street turning south under Berkeley Street. Osgoode, Queen and Moss Park are currently envisaged to be built mostly with SEM techniques, but there will be some surface disruption including temporary road closures to construct pedestrian concourses and interchange with Line 1.

Corktown station is envisaged to be a TBM launch site, and built in open cut, with some temporary road closures. Special care is being taken to protect archeological heritage at this site, which was the location of Ontario's first Parliament. South of Corktown station, the alignment turns east under Distillery Lane where the tracks split to position north and south of the GO corridor, rising up to the surface east of Cherry Street to two tunnel portals within the existing Don Yard GO Train storage facility to run at-grade toward the Don River. This section may be built using a combination of SEM and open-cut construction techniques. The eastbound journey time between Queen/Spadina and Corktown (including dwell times at intermediate stations) is planned to be about 6 minutes.

Figure 3-5: Downtown Segment Alignment Overview



Stations

This segment of the Ontario Line includes four stations at Osgoode, Queen, Moss Park and Corktown. Table 3-7 provides an overview of the stations included in Segment 2, including the rationale for their inclusion and the connections that the stations will enable.

Table 3-7: Overview of Downtown Segment Stations

Station	Rationale	Connections
Osgoode	Provides an interchange station with a direct connection to Line 1 Yonge-University. This is an existing, high ridership station serving the north-west quadrant of the Financial District as well as offices and medical institutions north on University Avenue, City Hall, and other government services.	• Line 1 Yonge-University • 501 Queen • 142 Downtown/Avenue Road Express • Blue Night Network:301 Queen
Queen	Provides a key interchange station with direct connections to Line 1 Yonge-University. An existing station with high ridership, serving the north-east quadrant of the Financial District, City Hall, Eaton Centre, St Michaels Hospital, Ryerson University and other major retail and entertainment destinations in the Downtown Yonge area.	• Line 1 Yonge-University • 501 Queen • 503 Kingston Road • 97 Yonge • Blue Night Network: 301 Queen and 320 Yonge
Moss Park	An inline station serving the Moss Park neighbourhood. Provides connections with the Queen streetcar and Sherbourne bus and a key north-south cycling route on Sherbourne Street. This station serves the area east of the downtown core, the St. James Campus of George Brown College, and many community and social services.	• 501 Queen • 503 Kingston Road • 75 Sherbourne • Blue Night Network:301 Queen
Corktown	An inline station serving the Corktown community, Distillery District and the St. James Campus of George Brown College. It offers a connection to the eastern leg of the King streetcar, and local bus services on Parliament Street. This station serves high levels of existing and planned residential development and provides relief to the busy 504 King Streetcar by diverting passengers to the Ontario Line.	• 503 Kingston Road • 504 King • 65 Parliament • Blue Night Network:304 King

Planning Considerations

The following planning considerations were identified for this segment of the Ontario Line:

- **Interchange** – opportunities to provide an interchange with the Ontario Line and existing Line 1 at Osgoode and Queen Stations to optimize passenger transfers between both subway lines should be prioritized;
- **Heritage** – locating and designing station entrances/exits while considering and respecting existing heritage features such as Osgoode Hall and limiting construction impacts;
- **Utilities** –disruptions to utilities under Queen Street should be avoided;
- **High vehicular, streetcar, bike and pedestrian** volumes – construction impacts should be limited while ensuring adequate capacity and connection on surface and sub-surface routes (PATH);
- **Key destinations** – site station locations which optimize connections to downtown employment and retail, entertainment and service destinations such as Eaton Centre, City Hall, Four Seasons Centre for the Performing Arts, and hospitals;
- **Green space** – temporary and permanent impacts to public greenspace should be limited; and
- **Tunnelling strategy** – alignment and station design should be coordinated with tunnelling strategies to limit community impacts, reduce costs, and speed up construction.

Table 3-8 summarizes the key design changes for the Ontario Line since the development of the IBC and the rationale for those changes.

Table 3-8: Overview of Downtown Segment Design Changes

Design Change	Description	Rationale
Station box at Ontario Line Osgoode Station shifted west under University Avenue	• IBC alignment sited the Osgoode Station box east of University Avenue • Station box has been shifted west between Simcoe Street and University Avenue to improve customer transfers between Line 1 and the Ontario Line	• Improves passenger experience by reducing the transfer time between Line 1 and Ontario Line • Better spacing of Ontario Line stations through this segment
Station box at Ontario Line Queen Station shifted east under Yonge Street	• IBC alignment sited the Queen Station box west of Yonge Street between Bay Street and the Eaton Centre entrance • Station box shifted east to be centred under Yonge Street with a new integrated entrance on the northeast corner of Yonge and Queen	• Capital cost and schedule risk reduction achieved by avoiding the need to relocate Enwave district heating infrastructure • Improves passenger experience by reducing transfer time between Line 1 and Ontario Line • Better spacing of Ontario Line stations through this segment
Change to downtown east alignment and Corktown Station sited off-street	• IBC alignment assumed an alignment that roughly followed the Berkeley Street right-of-way • Updated design shifts the Corktown Station box east off Berkeley Street into a block of properties bounded by Berkeley Street, Front Street East, Parliament Street and King Street East • Corktown Station will be constructed using open cut methods; the station excavation and work site will also be used to launch TBMs to the north and for staging of the mined tunnels south between Corktown and the Don Yard. South of Corktown Station, the alignment has been shifted to travel directly under Distillery Lane	• Capital cost reduction achieved with an open cut construction methodology at Corktown Station reducing station construction costs and avoiding building basements along Distillery Lane • Reduced community impact by shifting Corktown Station construction into an off-street work site which doubles as a work site for tunnel construction. • Tunnelling strategy and risk mitigation by providing suitably sized site for tunnelling to the north and south of Corktown Station • Allows for station entrance integration opportunities

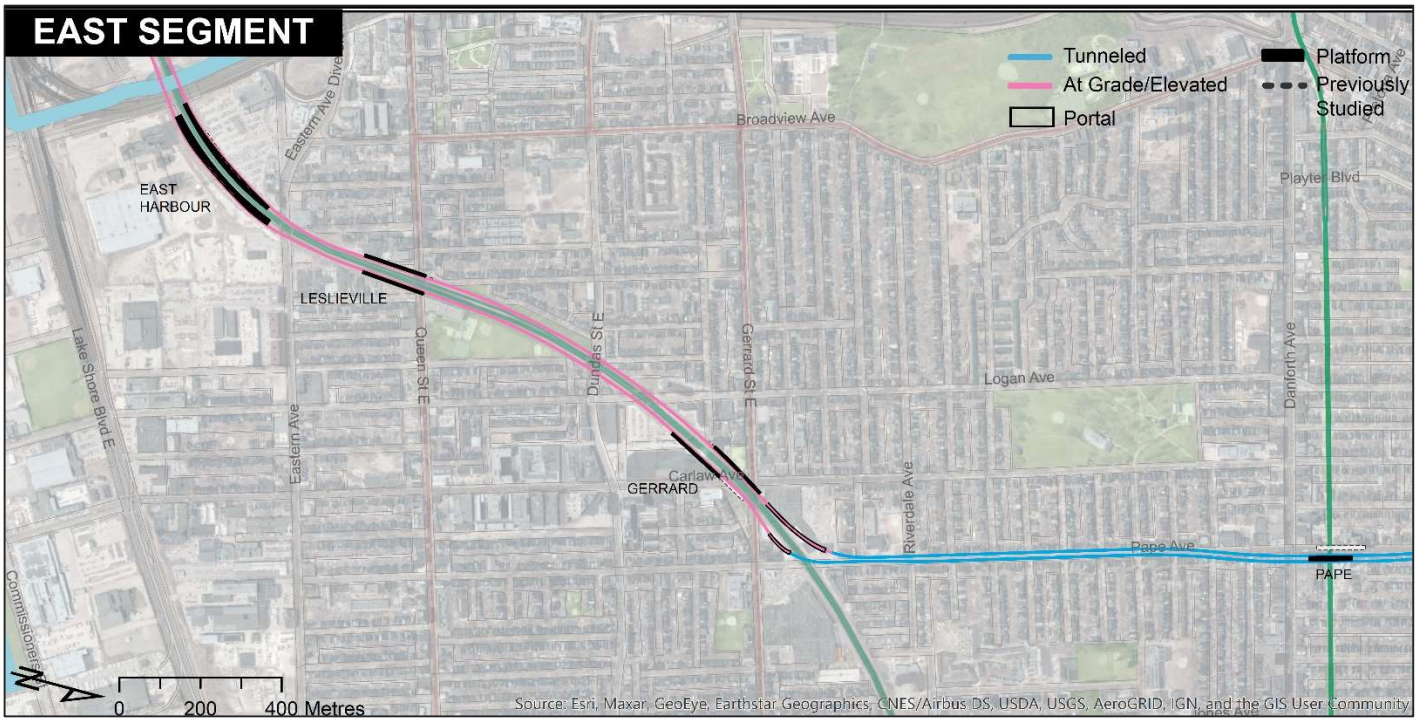
3. East Segment: East Harbour to Pape Station

Segment Overview

This segment of the Ontario Line runs between the Don Yard at Cherry Street and Pape Avenue. It follows the existing Lakeshore East GO Rail corridor and includes three stations: East Harbour (Broadview extension), Leslieville (Queen Street), and Gerrard (Carlaw Avenue). The stations are all at or just above ground level, alongside the GO tracks. Figure 3-6 provides an overview of this segment.

The Ontario Line tracks come to the surface within the GO Don Yard east of Cherry Street, running on either side of the existing GO tracks along the rail corridor to Gerrard Street at Carlaw Avenue, then diving under Pape Avenue in twin portals. There is one portal on either side of the GO rail corridor. Pairs of new bridges are required for the Ontario Line alongside the existing GO bridges, at the Don River, Eastern Avenue, Queen Street, Dundas Street, Logan Avenue, Carlaw Avenue, and Gerrard Street. The existing pedestrian crossing connecting Pape Avenue over the GO corridor will be replaced. The crossing of the Don River and Don Valley Parkway may deploy innovative techniques to speed up construction. It will incorporate improved crossings over the Lower Don for pedestrian and cycling access. On much of the corridor, there is sufficient space for the Ontario Line tracks. Adjacent properties may be required to accommodate the infrastructure. The journey time between Corktown and Gerrard (including dwell times at intermediate stations) will be about 5 minutes.

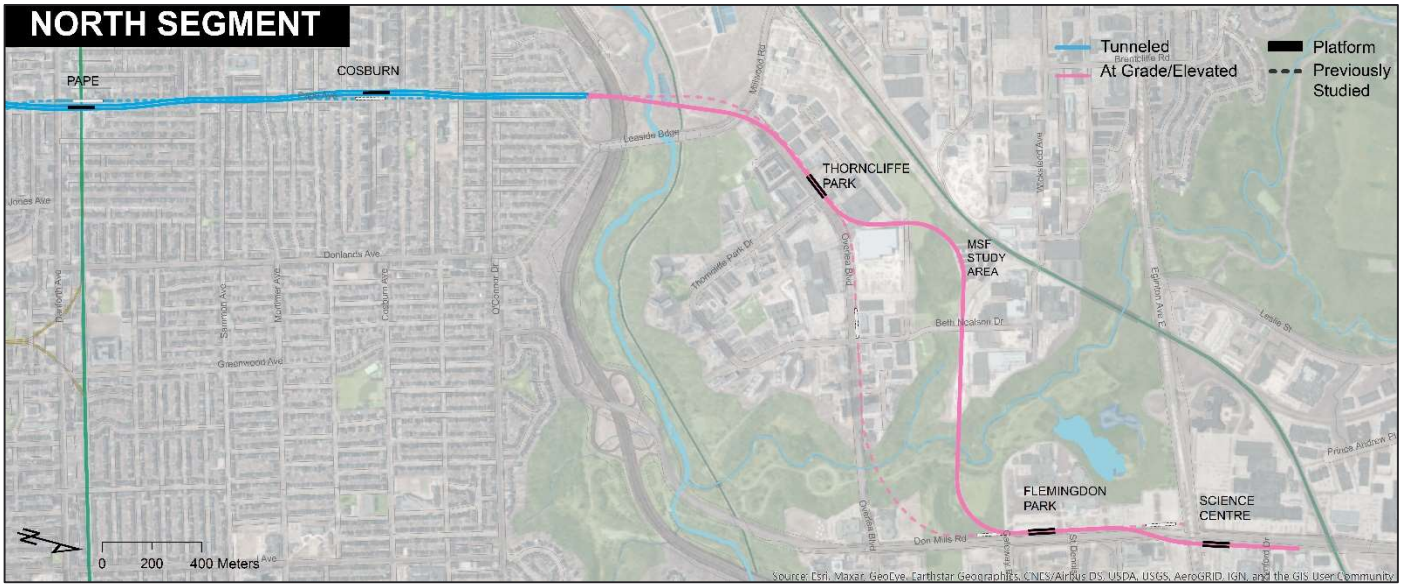
Figure 3-6: East Segment Alignment Overview



Segment Overview

This segment extends from Gerrard and Pape to Wynford Drive, just north of Don Mills Road and Eglinton. It includes five stations: underground stations at Pape (Danforth) and Cosburn; and elevated stations at Thorncliffe Park, Flemingdon Park, and Science Centre. Figure 3-7 provides an overview of this segment. From Gerrard to Minton Place, just north of O'Connor Drive, the line is in tunnel. North of Minton Place, the line is mostly elevated. It crosses the Don River and the Don Valley Parkway on a new bridge about 200m west of the Leaside Bridge (Millwood Road) and crosses the West Don River on a new bridge about 300m north of the Charles H. Hiscott Bridge (Overlea Boulevard) above E.T. Seton Park. Tail track may be provided for reversing and storing trains north of Science Centre station, aligned to protect for a possible northward future extension. The journey time between Gerrard and Science Centre (including dwell times at intermediate stations) is anticipated to be about 10 minutes.

Figure 3-7: North Segment Alignment Overview



Stations

This segment of the Ontario Line will include stations that will serve the areas of East Harbour, Riverside, Leslieville and Riverdale. Table 3-9 provides an overview of the stations included in Segment 3, including the rationale for their inclusion and the connections that the stations will enable. The East Harbour Station is being designed and constructed as part of an integrated development at East Harbour, maximizing the potential for TOC development at this station.

Table 3-9: Overview of East Segment Stations

Station	Rationale	Connections
East Harbour	The main function for this station is to provide an interchange between the Ontario Line, GO, and TTC streetcar services to the Port Lands. This station is located within the planned East Harbour development and is envisaged to be an integrated transit hub, serving major employment and retail land uses. The cross-platform interchange design allows for convenient transfers between GO and Ontario Line trains.	Future connections: • Lakeshore East and Stouffville GO • Broadview Streetcar extension
Leslieville	The station directly serves parts of the Leslieville and Riverside neighbourhoods. A relatively small and simple station minimizes impacts to Jimmie Simpson Recreation Centre and adjacent business premises. While the main entrances are on the south side of Queen Street, a second entrance to the westbound platform is provided for use by passengers transferring from westbound streetcars. This will be a busy interchange between the Ontario Line and streetcars serving the neighbourhoods along Queen Street East.	• 501 Queen • 503 Kingston Road • **Blue Night Network:** 301 Queen
Gerrard	This station will be a busy interchange with the streetcars serving the neighbourhoods along Gerrard Street East. It will provide a much faster route to downtown from these communities and also relieve congestion further west. It will directly serve parts of the Riverdale and Leslieville communities, as well as the dynamic mixed-use neighbourhood around Carlaw and Dundas. The northbound platform of Gerrard Station is located on the west side of Carlaw Avenue, convenient for transfers to the eastbound streetcars, while the southbound platform spans the Gerrard-Carlaw intersection and will have access from both sides of the intersection. A clear-span structure will minimize impacts at street level.	• 506 Carlton • 72 Pape

Planning Considerations

The following planning considerations were identified for this segment of the Ontario Line:

- **GO Transit connections** – East Harbour has been designed to optimize transfers to a future GO station to divert passengers from GO Transit and relieve Union Station congestion;
- **Connections to streetcar network** – surface transit connections have been considered and the Ontario Line has been designed to reduce transfer lengths wherever feasible; and
- **Community impacts** – this segment has been designed to limit temporary and permanent impacts to existing residential communities along the corridor.

Table 3-10 summarizes the key design changes for the Ontario Line since the development of the IBC and the rationale for those changes.

Table 3-10: Overview of East Segment Design Changes

Design Change	Description	Rationale
Northbound alignment revision and platform shift at Gerrard Station	Portals located west of Pape Avenue and north of Gerrard Street have been moved off the street. Northbound and southbound tunnels meet just north of the GO corridor. In addition, the northbound platform has been shifted slightly south to the west of Carlaw Avenue.	• Lower capital costs achieved via a shorter tunnelled section • Reduced community impact by avoiding tunnelling at shallow depths under existing homes • Reduced business impacts, as the northbound portal is confined to the west of Pape Avenue • Increased tunnelling flexibility and reduced risk achieved by combining the TBM launch/extraction site north of rail corridor and reducing the potential for negative impacts (track settlement) to the GO corridor.

East Segment Planning and Design – Shared Corridor

The Ontario Line IBC compared the proposed Relief Line alignment (underground along the entire line) to the Ontario Line alignment (strategic use of underground, tunnelled, and shared corridor sections) to explore how to generate increased benefits for travellers and Torontonians and make best use of available resources for rapid transit expansion. The development of the IBC Ontario Line concept drew many technical considerations from previous work on the Relief Line, including use of underground tunnels in portions of the corridor where at grade, shared corridor, or elevated structures would not be feasible. The Ontario Line alignment also considered opportunities to leverage other transportation assets, such as the GO rail corridor, that were previously not considered in Relief Line planning. The IBC analysis noted that the use of shared corridors on the East Segment (as well as on the West Segment) resulted in the following benefits:

- realize opportunities to provide a longer line (delivering more rapid transit to Toronto) by targeting tunnels where they are most needed and making use of more cost-effective alignments elsewhere (the IBC noted average capital cost per km for the Ontario Line were 25 to 30% lower than a fully tunnelled Relief Line South);
- accelerate construction by aligning Ontario Line delivery with GO Expansion delivery while reducing station construction impacts on businesses, utilities, and the transportation network (including bridges);
- integration with mixed use paths to expand traveller choice;
- improve station accessibility - deep stations on this segment were found to decrease ridership by up to 15% due to longer access times compared to located close to street level due to longer access/egress times); and
- provide multimodal integration between GO rail and Ontario Line.

Based on these considerations, the PDBC focused preliminary design efforts on optimizing the shared corridor and connecting stations (Gerrard, Leslieville, and East Harbour) to further augment benefits identified in the IBC and minimize costs and risks. This process included design of mitigation measures for noise, vibration, property, and visual impact of the shared corridor – including reducing the impact of the existing GO rail alignment and the future Ontario Line additions. The goal of this process it to result in minimal impact to the urban realm while improving how the existing rail corridor integrates with adjacent neighborhoods.

4. North Segment: Pape Station to Science Centre

Stations

This segment of the Ontario Line includes five stations: Pape, Cosburn, Thorncliffe Park, Flemingdon Park and Science Centre. Table 3-11 provides an overview of the stations included in Segment 4, including the rationale for their inclusion and the connections that the stations will enable.

Table 3-11: North Segment Stations

Station	Rationale	Connections
Pape	The main purpose of this station is to provide an interchange with Line 2, offering a faster route to downtown and providing congestion relief to Line 1 at Yonge, including relieving the busy Bloor-Yonge Station interchange. This station is expected to be built in open cut, along the east side of Pape Avenue north of Danforth Avenue, incorporating the site of the current bus station.	• Line 2 Bloor-Danforth • 72 Pape • 25 Don Mills • 81 Thorncliffe Park • 925 Don Mills Express • **Blue Night Network:** 300 Bloor-Danforth and 325 Don Mills
Cosburn	This station will serve Pape Village and local East York residents. It will also connect with local buses along Cosburn Avenue.	• 25 Don Mills • 81 Thorncliffe Park • 925 Don Mills Express • 87 Cosburn • **Blue Night Network:** 325 Don Mills and 322 Coxwell
Thorncliffe Park	This station is to be located on the north side of Overlea Boulevard near the western leg of Thorncliffe Park Drive to minimize visual and community impacts on Overlea Boulevard.	• 25 Don Mills • 100 Flemingdon Park • 925 Don Mills Express • 88 South Leaside • 81 Thorncliffe Park • **Blue Night Network**: 325 Don Mills
Flemingdon Park	This station is to be located on the west side of Don Mills Road, north of Gateway Boulevard, providing connections to the Flemingdon Park neighbourhood and Ontario Science Centre while minimizing impacts on Don Mills Road.	• 25 Don Mills • 100 Flemingdon Park • 925 Don Mills Express • 144 Downtown/Don Valley Express • **Blue Night Network:** 325 Don Mills
Science Centre	This station is to be located at the northeast corner of Eglinton Avenue East and Don Mills Road, maximizing connectivity with Line 5 Eglinton and its adjacent bus terminal. This approach minimizes the impact on existing buildings, provides development opportunities and protects for a possible future northward extension.	**Future connections:** • Line 5 Eglinton **Existing connections:** • 25 Don Mills • 100 Flemingdon Park • **Blue Night Network:** 325 Don Mills

Planning Considerations

The following planning considerations were identified for this segment of the Ontario Line:

- **Connections with the broader rapid transit network** – this segment will provide connections between the Ontario Line and Line 2 Bloor-Danforth at Pape Station and Line 5 Eglinton at Science Centre Station. At each of these stations, the Ontario Line will offer a faster route to downtown, diverting passengers and relieving congestion on Line 1 (Yonge side).
- **New connections with priority neighbourhoods** – the Ontario Line will provide new connections for communities within Thorncliffe Park and Flemingdon Park.

Table 3-12 summarizes the key design changes for the Ontario Line since the development of the IBC and the rationale for those changes.

Table 3-12: North Segment Design Changes

Design Change	Description	Rationale
Shift of Pape Station location	Pape Station has been shifted off-street to the east side of Pape Avenue, so that it can be constructed with mixed cut-and-cover and mined methods.	• Greater passenger benefits – shorter transfer time between Line 2 and Ontario Line. • Capital Cost reduction – open cut opportunities and minimized traffic disruptions and utility impacts. •
Shift of Cosburn Station	Cosburn Station has been shifted off-street to the west side of Pape Avenue and constructed with cut-and-cover method.	• Greater passenger benefits will be realized by constructing a shallower station which reduces passenger travel time to/from the street level. • Capital cost reduction achieved through open cut construction methods. • Schedule compression by adopting more efficient construction methods. •
Overlea Boulevard alignment	The alignment at this portion of the segment swings north immediately east of Thorncliffe Park Station and will run adjacent to the nearby hydro corridor.	• Reduced community impacts by avoiding impact to sensitive uses on the north side of Overlea Boulevard. • Risk reduction through a less challenging crossing of the Hydro One corridor. • Property impacts reduced along Don Mills Road. • Reduced capital and operating costs by shortening non-revenue track lengths and creating a better connection to the maintenance and storage facility from the mainline.

Ontario Line Operations

This section outlines the operating concept for the Ontario Line, including key operating assumptions and rolling stock characteristics.

Service Overview

The Ontario Line has been designed to deliver the following service:

- **Frequency -** operate a maximum peak service of 40 TPH (one train every 90 seconds) and off-peak service of 12 to 24 TPH.
- **Runtimes and speed –** end to end travel times of less than 26-30 minutes with a maximum speed of 80 km/h.
- **Station operations –** modern automation technology and use of platform edge doors to enable delivery of a highly reliable and frequent service not just in peak hours but midday, evenings and weekends.
- **Capacity and crowding -** passenger capacity assumptions for the Ontario Line are set out in Table 3-13, together with comparative figures for some other existing and planned comparator systems.

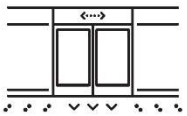
Table 3-13: Sample Characteristics of Rapid Transit Lines

	Train size (L x W) (m)	Passengers per square meter	Passengers per train	Passengers per direction per hour (pphpd)
Toronto Rocket	138 x 3.2	3.29 (design) 2.44 (observed)	1,458 (design) 1,100 (observed)	26,400 with 24 TPH 39,600 with 36 TPH
Vancouver Expo Line Vancouver Canada Line	68 x 2.65 41 x 3.0	2.95 2.78	532 342	19,152 with 36 TPH 10,260 with 30 TPH
Montreal Réseau Express Métropolitain	76.2 x 2.94 (peak train size)		600	15,600 at 26 TPH 24,000 at 40 TPH
Ontario Line [Assumed]	100 x 3.0 or 80 x3.0	Proposed loading standard*: 3-4 in peak 2.5 off-peak	750 (100 m train) 600 (80 m train)	24,000 to 30,000 with 40 TPH

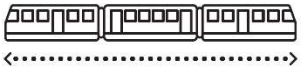
*Based on planning and analysis conducted by Metrolinx after the completion of the IBC. Note that standing densities are calculated for internal area, including gangways but excluding seats.

Rolling Stock

The Ontario Line has been conceived to make use of modern rapid transit technology, as implemented on more than 40 systems around the world including Vancouver, Copenhagen, and Paris. Similar technology is at the core of the Réseau Express Métropolitain system being delivered in Montreal.



Trains can stop precisely with platform screen doors that open and close in sync.



Trains could be about 100 metres in length, assuming a three metre car width.

Up to 40 trains an hour with 90 second intervals between trains.

Automatic trains to deliver required frequencies in a cost effective manner.

The proposed rolling stock for the Ontario Line is:

- planned to be fully automated with modern signalling systems like those used on transit in Vancouver, London, Paris, Shanghai and Singapore.
- expected to make use of advances in vehicle design and rail technology that will result in significantly less noise than those currently used on other lines on the subway system.

Compared with Toronto's existing subways, trains will be shorter than those used on Line 1 but will operate more frequently (up to 40 trains per hour). Shorter stations can be built at lower cost and with less disruption, while higher frequency provides the required capacity, with shorter wait times for passengers. Trains will have passenger seats and standing space similar to other Toronto subway lines and are expected to operate at broadly similar passenger densities.

The benefits of using modern technology for the rolling stock operating on the Ontario Line include:

- the use of designated waiting areas and precise stopping points for train doors allows for quicker, more efficient boarding times;
- doors on platforms increase safety and reduce the chances of debris and litter making its way on to the tracks; and
- more frequent service will allow more people to move quickly, safely and cost-effectively.

Vehicles will be fully compliant with the Accessibility for Ontarians with Disabilities Act (AODA), with level boarding from station platforms as at existing subway stations. Stations and tunnels are being designed to accommodate trains up to 100 meters long and 3 meters wide, however the initial trains are likely to be shorter and may be slightly narrower. Other than the provision of Platform Doors, the passenger experience will be very similar to existing Toronto subway trains. Provision of platform screen doors, and steep gradients especially at the tunnel portals, means that Ontario Line trains will need to have more powerful acceleration and more precise stopping than existing subway trains. Overhead electrification is planned, because it is now generally more reliable and less expensive than the third rail system used on subway Lines 1, 2, and 4. Details of rolling stock used on automated metros in other jurisdictions are provided in Table 3-14. The exact vehicle design for the Ontario Line will be determined by the successful proponent for the Rolling Stock, Systems, Operations and Maintenance (RSSOM) contract. Further information on procurement is contained in Chapter 7: Deliverability and Operations Case.

Table 3-14: Example Rolling Stock Reference Table

Supplier	Name	Location	Number of Cars	Train Length (m)	Train Width (m)	Seating Configuration	Number of Seats	Standing Capacity (pax/m²)	Total Capacity
Alstom	Metropolis	Montreal	4	76.2	2.94	Longitudinal	128	472 (4pax/m²)	600 (4pax/m²)
Hitachi	Driverless Metro	Lima	6	107	2.85	Longitudinal	168	734 (4pax/m²)	902 (4pax/m²)
Siemens	Inspiro	Nuremberg	4	75.9	2.9	Longitudinal	128	476 (4pax/m²)	604 (4pax/m²)
Hyundai-Rotem	Driverless Metro	Vancouver	4	82	3.0	Transverse	176	416 (4pax/m²)	592 (4pax/m²)

Customer Experience Vision

The Ontario Line will provide customers with a seamless, integrated end to end customer journey through:

- customer and community-centred design;
- optimized digital technologies, omni-channel experiences and offerings;
- real time, personalized end to end customer information and service notifications;
- integrated services and operations with partner transit agencies;
- integrated payments and transfers that leverage digital channels to create an “on the move” experience;
- Regional Customer Experience Standard and Service Standards and Customer-centric KPIs;
- harmonized wayfinding; and
- integrated first and last mile services and offerings.

The Ontario Line’s vision for customer experience fits with Metrolinx’s broader vision for transit in the Greater Golden Horseshoe Area (GGHA): to deliver a seamless, integrated end to end customer experience, supported and reinforced by appropriate architectural, interior, landscape and urban design solutions across the network.

Business Case Options Assumptions

This section defines the options and assumed business-as-usual (BAU) evaluated in this PDBC, along a summary of the key assumptions included in the evaluation and analysis of the Ontario Line.

Business as Usual Assumptions

The Ontario Line has been planned to integrate directly with the future transportation network and meet the needs of forecast changes in land use – including changes in population and employment. This future state of the region without the Ontario Line is referred to as the "Business as Usual" or BAU. It includes all transportation investment that are currently funded and committed (meaning resources have been allocated to fund delivery, or the project has reached the highest stage of approvals and project readiness). Table 3-15 defines the BAU assumptions used to develop and evaluate the Ontario Line.

Table 3-15: Business as Usual Used for the Ontario Line Preliminary Design Business Case

Assumption Category	Assumptions Made
Transportation Network	• Existing subway network (Line 1, Line 2, Line 4) • Eglinton Crosstown and Eglinton West Extension (to Renforth) • Finch LRT • Scarborough Subway Extension (removes TTC Line 3 / Scarborough Rapid Transit) • Yonge North Subway Extension • GO Expansion • New GO Stations (including select stations identified under the SmartTrack proposal) • Existing TTC surface transit network with minor changes to reflect population growth

Land Use	• 2041 Market Land Use, which reflects growth rates derived from population models and historic land use growth in the GTHA
	• Population
	  ○ **GTHA –** 10.1 million
	  ○ **Toronto** – 3.4 million
	• Employment
	  ○ **GTHA –** 4.8 million
	  ○ **Toronto –**1.8 million

Ontario Line Preliminary Design Business Case Options

PDBCs compare multiple variants of preferred option identified at the IBC stage across the four cases in order to:

- demonstrate that multiple variants were considered and analyzed;
- confirm that an optimal variant has been identified for further development; and
- identify key lessons learned to inform the continued development of the option through to the FBC stage.

As discussed in this chapter, a series of studies and planning exercises were conducted to develop the optimized Ontario Line alignment shown in Figure 3-1 (see Table 3-3) and the "Ontario Line Detailed Scope" section for further details on work conducted to develop this alignment).

This PDBC includes two operating variants (described in Table 3-16) that make use of this alignment, developed based on lessons learned since the completion of the IBC: the *IBC operating concept* and a *Refined Operating Concept*. These options were included in the PDBC to explore benefits and trade-offs of different train sizes and phased service delivery. The results of this exploration are outlined in the Strategic, Economic, Financial, and Deliverability and Operations Cases and will be used to inform future planning, design, and project development at the FBC stage.

The *IBC Operating Concept* uses 100 m trains with a frequency of 40 trains per hour during the peak period.

The *Refined Operating Concept* uses 80 m trains and a phased service plan, which begins with 34 trains per hour in the peak period and deploys additional service to respond to ridership growth over time. In this phasing plan, it is assumed that a 40 train per hour service level would be deployed by 2041, comparable to the *IBC Operating Concept* option.

The GGHMv4 transportation demand model and a range of cost estimation techniques were used to assess the benefits and costs of the Ontario Line alignment (shown in Figure 3-1) and the two operating concepts. The key inputs to these analytic processes are aligned with the scope discussed in Table 3-1 (including variation by option), and are communicated in Table 3-16.

Table 3-16: Ontario Line Scope Used for Modelling (Demand Forecasting and Costing)

Analysis Scope	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
Train Size	• 100 m (five car) trains • 750 passenger per train capacity	• 80 m (four car) trains • 600 passenger per train capacity
Frequency	• 40 trains per hour (TPH) in peak • 12-24 TPH off-peak	• 34 TPH (2030-2041), 40 TPH (2041 on) in peak • 12-24 TPH in off-peak
Rationale for Inclusion	• Demonstrates how the IBC operating concept performs on the optimized alignment	• Explores how the benefits and costs of the Ontario Line can be further optimized with a refined operating concept
Alignment and Stations	• 100 m platform 15 stations with an optimized alignment (including track underground and on shared corridors and elevated structures) with approximately 26 to 30-minute runtime between Ontario Science Centre and Exhibition • Interchanges with local and rapid transit network at Science Centre, Pape, Osgoode, and Queen stations • Cross platform interchange with GO rail services at East Harbour between the Ontario Line and the Stouffville and Lakeshore East lines and Lakeshore West express service direct interchange at Exhibition Station	
Land Use	• 2041 market land use projection, updated since the IBC to reflect new census data and land use forecasts.	
Fares	• Use of TTC Fares for Ontario Line (the assumed TTC and GO Transit Discounted Double Fare from the IBC was not included)	
Transit Network	• Updated GO Expansion On-Corridor Plan • Updated rapid transit network assumptions	

Ontario Line and Pandemics

Metrolinx is exploring a range of measures to provide transit in a safe and efficient manner during pandemic situations. These measures include:

- **Operational considerations** – including crowding management protocols, cleaning regimes, and use of cleaning agents and products in stations and on fleet to respond to pandemic situations
- **Design choices** – including designing fleet and stations to be adaptable to pandemic situations with air quality, filtration, and cleaning systems (Example UV lights to disinfect)

The Ontario Line will be designed and implemented throughout the 2020s. Requirements to respond to the pandemic will be considered over the coming years as the procurement and project delivery process advances alongside pandemic recovery. This will allow critical lessons learned from COVID-19 to be integrated into both the design of the Ontario Line and its concept of operations.

Project Interdependencies

The Ontario Line's performance will be heavily influenced by parallel infrastructure projects, land use development programs, and transportation policies. Table 3-16 reviews these project interdependencies at a high-level to inform future planning, delivery, and evaluation of the Ontario Line.

Table 3-17: Ontario Line Interdependencies

Interdependency	Description	Potential Outcome
Transit Oriented Communities	The TOC program is intended to support the development of complete communities by bringing jobs and homes closer to transit, augment the benefits of rapid transit, and provide additional financial resources to deliver new rapid transit infrastructure	TOC can increase the amount of population and jobs adjacent to or integrated into Ontario Line stations. The specific impacts of TOC are explored in the Strategic Case under Benefit 3.
GO Expansion	GO Expansion will transform the GO rail system into a regional rapid rail network with two-way, all-day service every fifteen minutes or less in core areas of the system.	Ontario Line will connect to the Lakeshore East, Lakeshore West, and Stouffville GO rail Lines. In addition, the Ontario Line will be built partly along existing GO rail corridors and parts of the infrastructure and stations may be delivered as initial works as part of the GO Expansion program.
Fare Integration	The IBC assumed fare integration through the 2018 GO/TTC Double Fare Discount Program. After the completion of the IBC, it was announced that this program would not be extended beyond March 2020. Metrolinx is currently reviewing a range of fare integration policies for the GTHA. The PDBC is being prepared assuming that fare integration between GO and TTC, including the Ontario Line, is not provided.	Fare integration will likely generate increased higher total ridership on both the Ontario Line and GO Rail services, along with increased transfers between these lines. In addition, fare integration will affect the type of fare enforcement and fare payment systems required for the Ontario Line.
Rapid Transit Delivery	The Ontario Line PDBC assumes that Yonge North Extension, Scarborough Subway Extension, and Eglinton Crosstown / Eglinton West Extension are all successfully delivered by 2041.	Each of these projects directly interchanges with the Ontario Line – a complete network is anticipated to provide greater benefits to the GTHA and also augment overall network efficiency. Yonge North Extension requires additional capacity on Line 1, which the Ontario Line is anticipated to provide by drawing demand off Line 1 in the peak period. The benefits of an integrated network are further discussed in the Strategic Case under Benefit 6.

4

Strategic Case

METROLINX

Introduction

The Strategic Case summarizes the performance of the options against the identified strategic objectives to indicate if the investment addresses the Problem Statement and the goals of the *2041 Regional Transportation Plan*. Criteria were developed and selected to evaluate each option's ability to meet the objectives and support the realization of the strategic outcomes. This chapter is structured around the three outcomes defined in the Problem Statement chapter, as follows:

Outcome 1

STRONG CONNECTIONS

Assessment of how the options would improve people's mobility and access to opportunities and destinations.

Outcome 2

COMPLETE TRAVEL EXPERIENCES

Review of how the options would allow people to travel faster, more comfortably, more conveniently and more reliably.

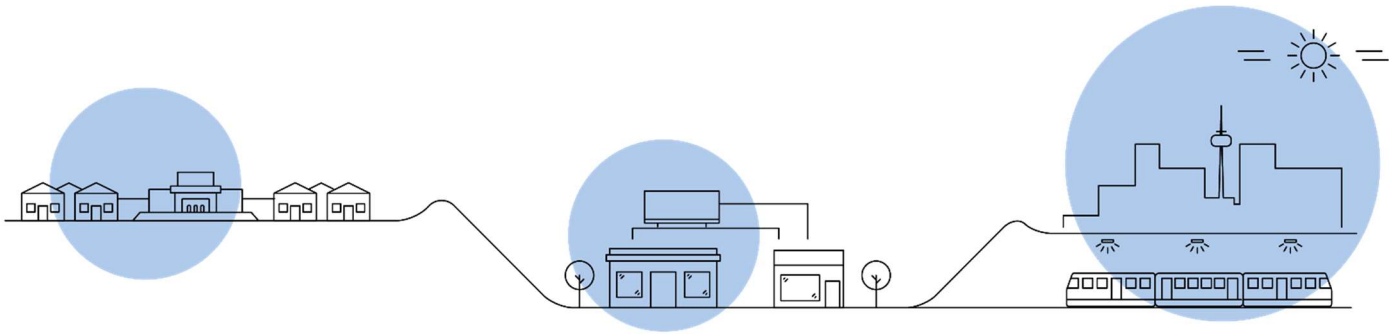
Outcome 3

SUSTAINABLE AND HEALTHY COMMUNITIES

Examination of how the options would support sustainable travel patterns and public health.

Outcome 1: STRONG CONNECTIONS

This outcome reflects the transportation network's ability to provide effective and strong connections that enable the people of Toronto and the GTHA to have a high quality of life, prosperous economy, and sustainable environment. Strong connections allow people to use transit for a variety of trip purposes, whether it is commuting to work, conducting business, visiting family and friends, or pursuing educational and recreational activities. Strong connections also support regional development by providing the needed transportation network capacity to accommodate the over 615,000 new Torontonians and 275,000 new jobs forecast to be in Toronto by 2041[9]. The Ontario Line will improve the connections between people and the places where they live, work and play in order to realize three key benefits:



1. Improved access to transit	2. Increased access to economic activity	3. Support a synergistic relationship between transit and city building
By 2041, up to 388,000 trips could be made on the Ontario Line each day and over 255,000 people could live within a 10-minute walk of an Ontario Line station.	On average, 47,000 additional Toronto jobs could be accessible within a 45-minute transit ride to city residents. Looking more specifically at lower-income residents and the access they currently experience, the increase would be even greater, with 57,000 additional jobs within a 45-minute transit ride.	The Ontario Line will improve rapid transit connectivity between residential, commercial, and employment centres and will also directly serve key locations planned for Transit Oriented Community development. When delivered alongside Transit Oriented Community projects, the Ontario Line could serve an additional 52,000 to 55,000 trips a day.

[9] Drawn from 2041 Market Land Use, which was used for all forecasts in this business case.

OUTCOME 1: STRONG CONNECTIONS

BENEFIT 1: Improve Access to Transit

By 2041, up to 388,000 trips a day could be made on the Ontario Line and more than 255,000 people will live within a 10-minute walk of the line.

Benefit Overview

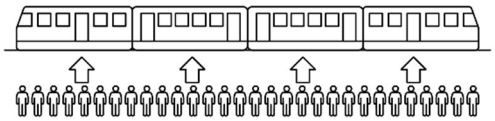
This benefit is focused on the extent to which the Ontario Line can generate transit ridership and serve the people of Toronto. This benefit was assessed using the Greater Golden Horseshoe Model Version 4 (GGHMv4[10]) to forecast the Ontario Line's ridership.

Benefit Analysis

The Ontario Line realizes this benefit by providing new rapid transit running from Exhibition/Ontario Place to the Ontario Science Centre via the downtown core, with fifteen stations located near population and employment centres. The Ontario Line serves dense older neighbourhoods including Moss Park and Leslieville, and newer developments at Corktown. The Ontario Line also serves dense residential areas west of University Avenue, including Chinatown, Alexandra Park, Liberty Village, and older, relatively dense neighbourhoods including Cosburn, Thorncliffe Park and Flemingdon Park. Current forecasts note that the Ontario Line could:

- serve 374,000 to 388,000 trips per day in 2041 (as shown in Figure 4-1 for the peak hour and all day in Figure 4-2);
- connect over 32,000 lower income residents to fast, frequent, and reliable rapid transit including Moss Park and Flemingdon Park if it were built today (population count based on 2016 numbers) (see Figure 4-3); and
- be accessible within a 10-minute walk[11] by more than 225,000 people (see Figure 4-4).

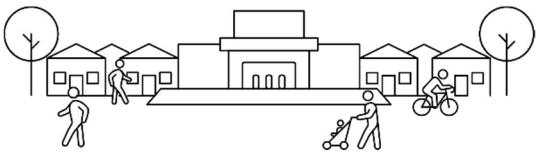
How many trips could be made on the Ontario Line each day?



374,000 to 388,000 trips a day

Projected number of daily boardings
Source: GGHm v4

How would the new line serve low-income residents?



+32,000 users

from low-income areas living within a walking distance of a station.

2016 low-income residents within 10-minute walkshed of options
Source: Statistics Canada, 2016 Census

[10] The GGHMv4 is a model used by Metrolinx and the Ontario Ministry of Transportation (MTO) to forecast future transportation demand. It is a four stage network model that forecasts the choices individual travellers will make including where to travel, what mode to use, and when to travel based on base line population and employment forecasts.

[11] All metrics related to walking distance access were calculated using an 800-metre walkshed around stations, based on an assumed 2041 street network, where an 800m walk is considered to take on average ten minutes. Where a catchment area is mentioned, the study area considered is an 800m radius buffer (as the crow flies distance) around stations.

Figure 4-1: Ontario Line Peak Hour Boardings

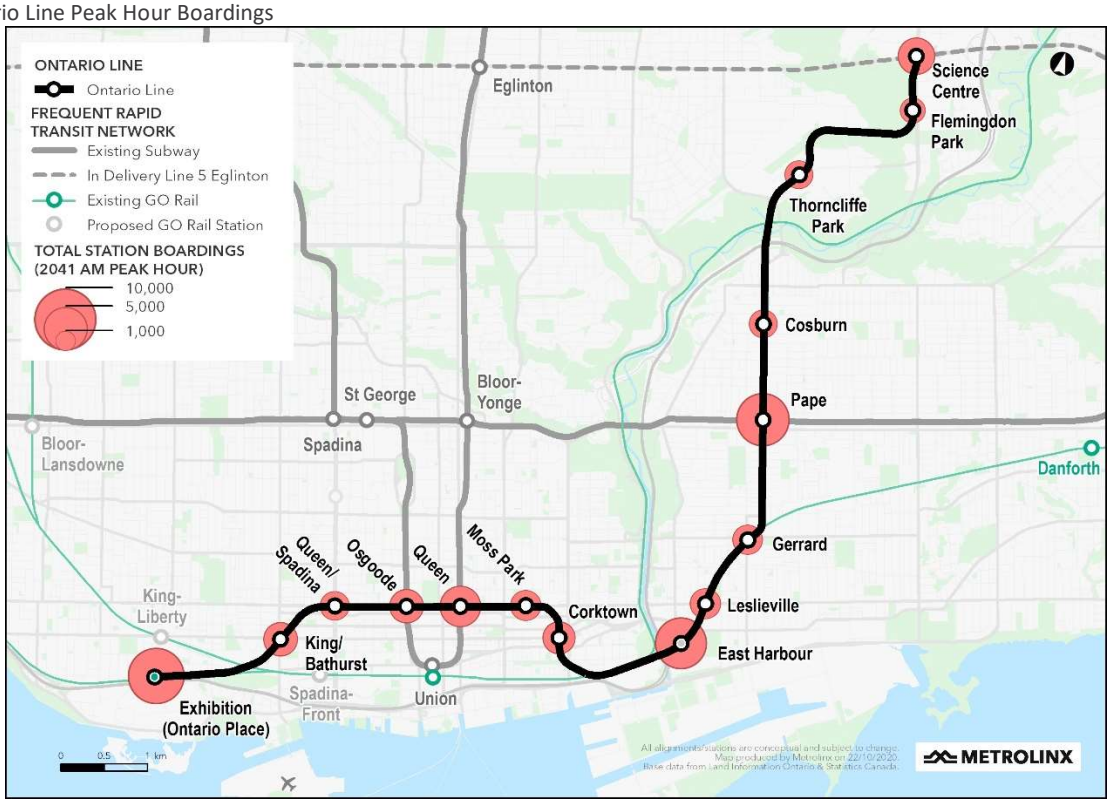


Figure 4-2: Ontario Line Daily Hour Boardings

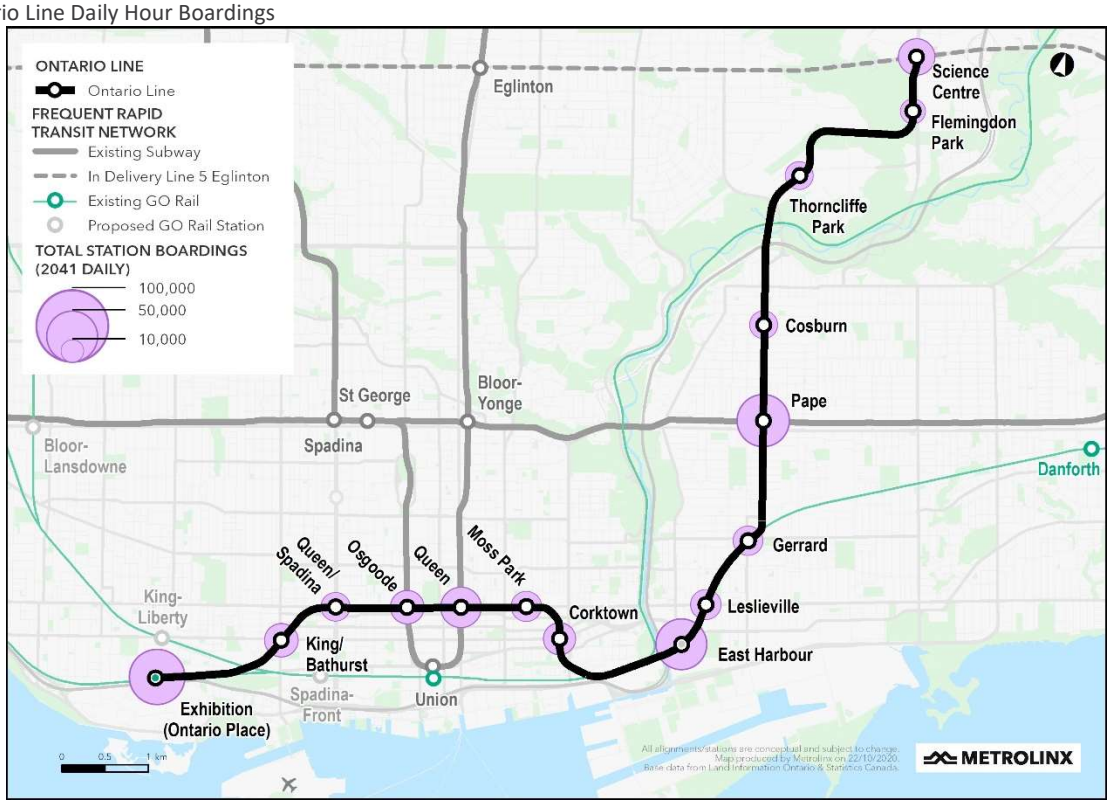


Figure 4-3: Lower Income Communities Served by Ontario Line

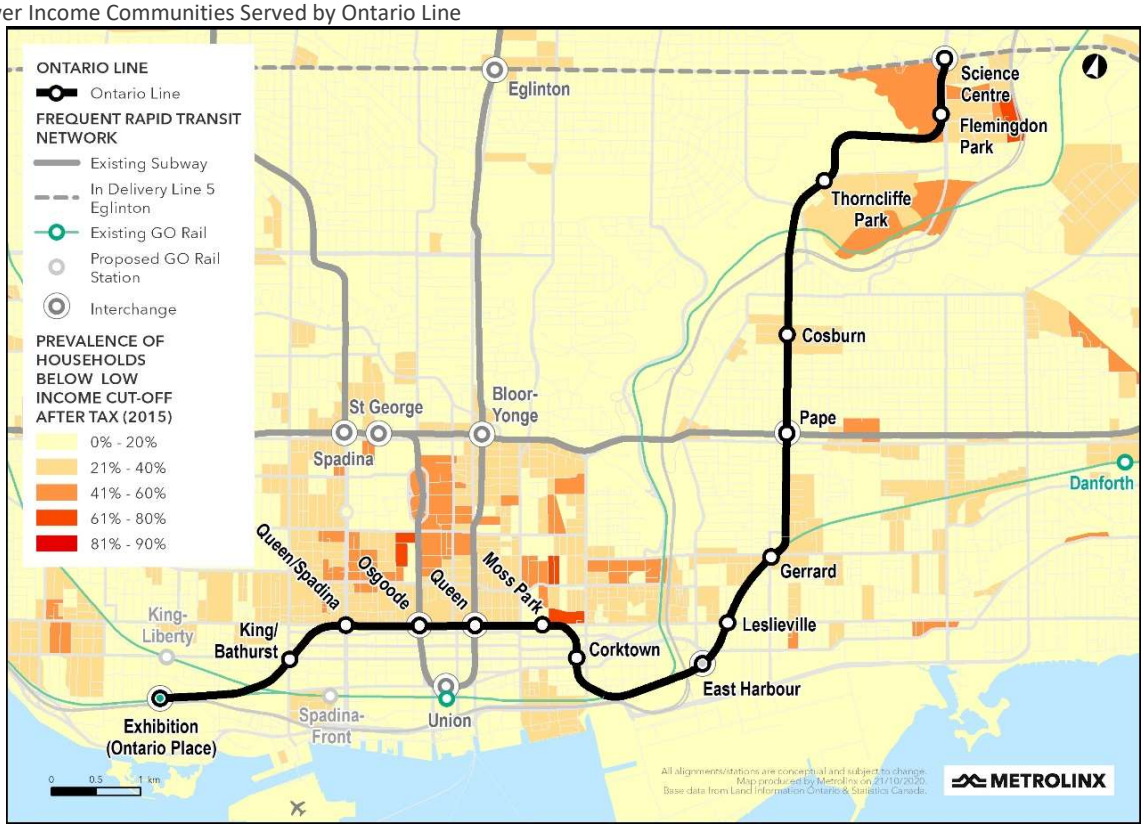
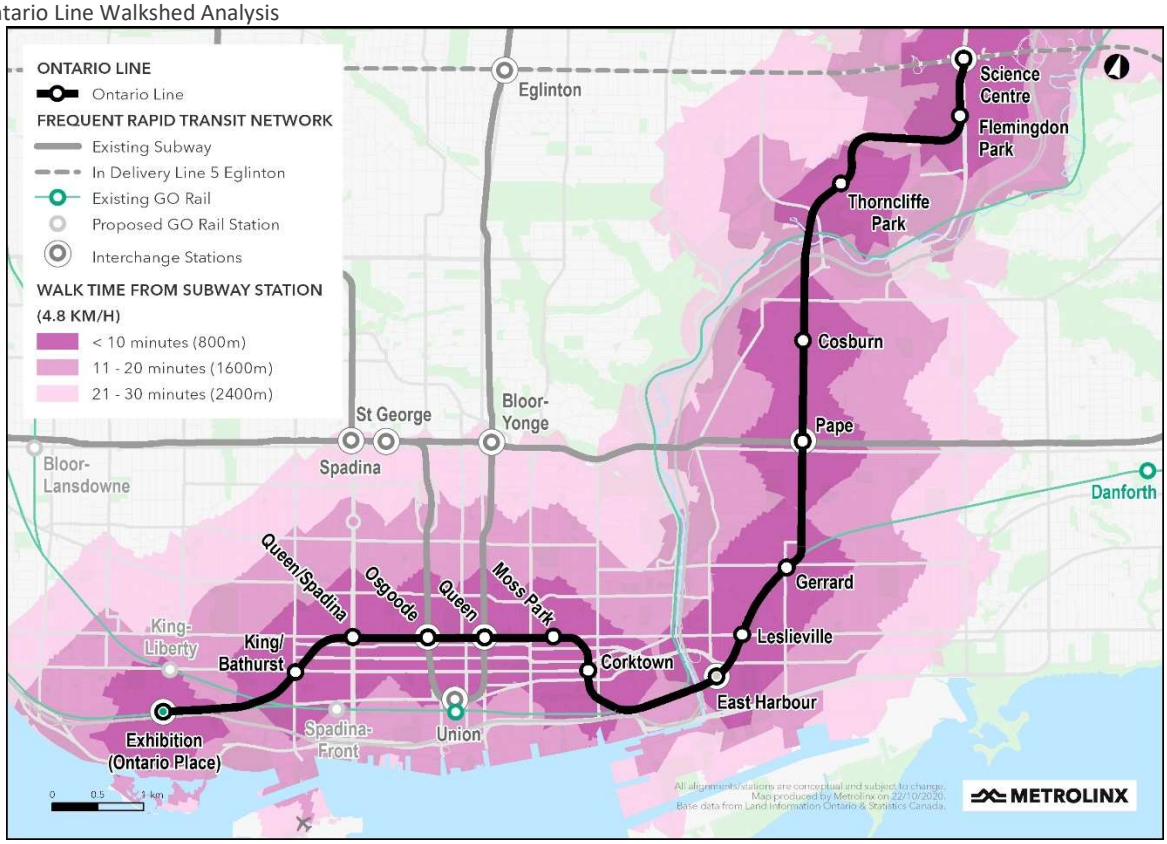


Figure 4-4: Ontario Line Walkshed Analysis



This analysis demonstrates that:

- the Ontario Line could enhance the accessibility to transit for those living, working and visiting the City of Toronto, by increasing access to new frequent, rapid transit connections to and from downtown Toronto, as well as a number of other major urban growth areas in the City of Toronto. Overall, transit accessibility to the downtown core and inner-city areas could be increased as a result of new connections to places previously underserved by transit.
- more residents could have access to transit within walking distance of their homes, which could make transit more attractive and enable the sustainable movement of people where cars would previously have been a more attractive mode.

Table 4-1 provides an overview of the how the Ontario Line supports Benefit 1: Improve Access to Transit.

Table 4-1: Benefit 1: Improve Access to Transit Summary

Criteria	**PDBC Alignment with IBC Operating Concept**	**PDBC Alignment with Refined Operating Concept**
How many people would gain walking distance access to rapid transit? *Projected 2041 residents within 800 m of the line	255,000 people within a 10-minute walk of the line	
How would the option impact the mobility of lower-income residents? * 2016 Census, Statistics Canada	32,000 lower-income residents within a 10-minute walk of the line if it were available today	
How many people are forecast to use the new transit line? *2041 GGHM v4 outputs	388,000 daily trips	374,000 daily trips

OUTCOME 1: STRONG CONNECTIONS

BENEFIT 2: Increase Access to Economic Opportunities

The Ontario Line increases access to economic opportunities by allowing Toronto residents to access, on average, an additional 47,000 jobs within a 45-minute trip on transit, with the number going up to 57,000 for low-income residents.

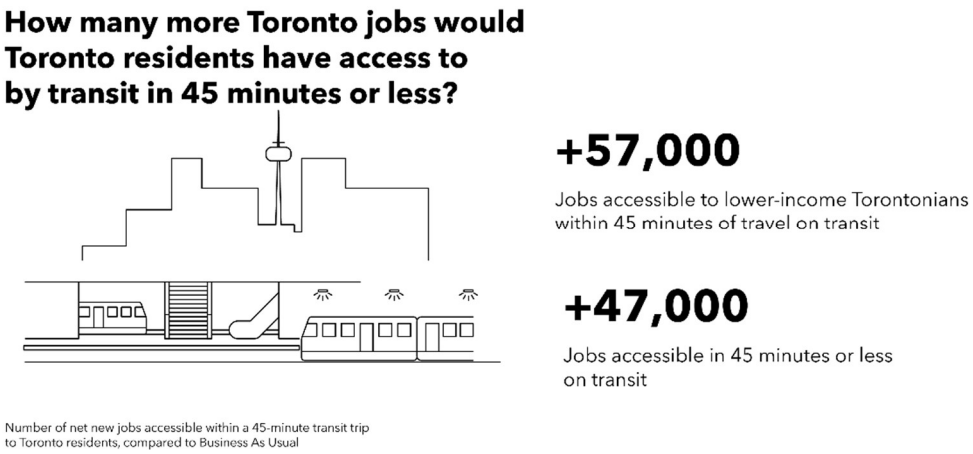
Benefit Overview

This benefit is focused on how the Ontario Line supports a thriving and prosperous economy by estimating the number of jobs that will be connected to rapid transit after the Ontario Line is delivered. This benefit is primarily estimated using the GGHMv4 model and long-range population and employment forecasts. Combined, these data sources illustrate the extent to which the Ontario Line could increase access to economic opportunities by analyzing the change in travel time from households to employment opportunities (jobs included in the land use forecast).

This benefit also considers labour market accessibility for lower income Torontonians who may be more likely than others to rely on transit to get to work or meet other daily needs.

Benefit Analysis

The Ontario Line offers a platform for economic development and agglomeration in the heart of Ontario's most significant economic centre. Faster and more reliable connections between major centres across the City of Toronto could drive sustainable regional growth and economic development by giving people more choice about where to call home or set up business.



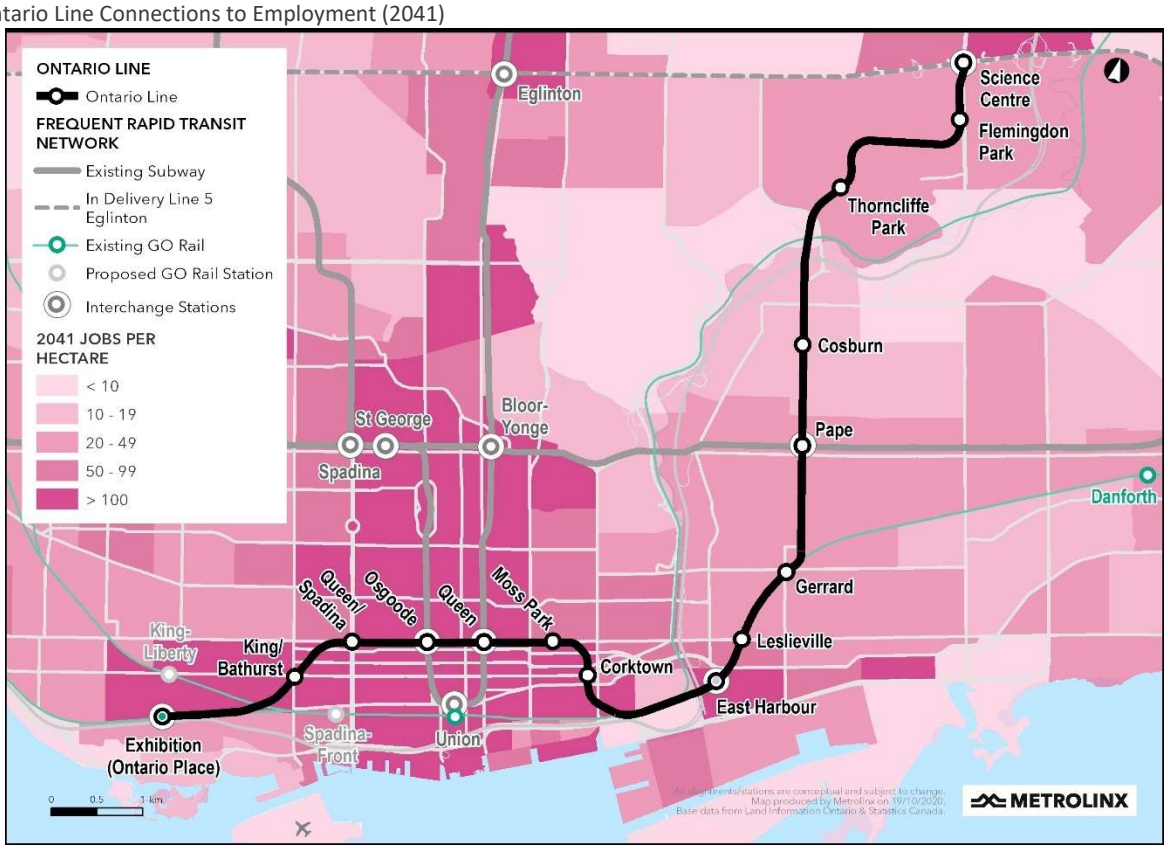
Number of net new jobs accessible within a 45-minute transit trip to Toronto residents, compared to Business As Usual

By providing high quality connections that get people to work faster and provide employers with a broad pool of talent, the Ontario Line could unlock job opportunities, create new jobs, and support economic development within the city. The Ontario Line has been planned to serve major employment centres in the Financial District, downtown Toronto more broadly, and planned employment hubs including East Harbour. As a result, the Ontario Line could support economic development by making an additional:

- 47,000 jobs in Toronto accessible to Torontonians on average, within a 45-minute transit ride by 2041; and
- 57,000 jobs accessible on average to lower-income Torontonians specifically, within a 45-minute transit ride.

In addition, by 2041, over 444,000 more jobs (compared to a future scenario without the Ontario Line) are forecast to be within a 10-minute walk of rapid transit (see Figure 4-5 and Figure 4-6).

Figure 4-5: Ontario Line Connections to Employment (2041)



This analysis shows that:

- the Ontario Line could connect employees to job opportunities in support of a more productive economy, by reducing travel times between homes and employment locations by growing the transit network and better serving more economic centres.
- the Ontario Line could benefit both the region's employer and employee bases, making it easier for people to access economic opportunities with competitive transit options, to catalyze economic development, by increasing the number of jobs accessible within 45 minutes and under by transit; and
- the Ontario Line could expand the number of job accessible to lower-income Torontonians.

How many jobs would be within a 10-minute walk of the new line in 2041?

440,000 jobs

Table 4-2 provides a summary of the Ontario Line's contributions to Benefit 2: Increase Access to Economic Opportunities.

Table 4-2: Benefit 2: Increase Access to Economic Opportunities Summary

Criteria	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
How could the option serve areas of planned employment growth? *GGHM v4 outputs*	444,000 projected jobs within a 10-minute walk of the line	
How many jobs could be accessible within a 45-minute transit commute for an average Toronto Resident? *GGHM v4 outputs*		+47,000
How many more jobs could be accessible within a 45-minute transit commute to the average lower-income Toronto resident? *GGHM v4 outputs and LICO, Statistics Canada, 2016* *This number assumes that the distribution (percentage and location) of low-income residents in Toronto remains unchanged since 2016*		+57,000

OUTCOME 1: STRONG CONNECTIONS

BENEFIT 3: Support a Synergistic Relationship between Transit and City-Building

The Ontario Line could improve rapid transit connectivity between residential, commercial, and employment centres and could also directly serve key locations planned for Transit Oriented Community development. This synergistic relationship is forecast to support an additional 50,000 to 52,000 trips a day on the Ontario Line.

Benefit Overview

This benefit focuses on how rapid transit can best connect to where people live and work today and where population and employment centres will be in the future. Transit infrastructure can be delivered to encourage Transit-Oriented Communities (TOC), which are higher-density, mixed-use developments that are connected, next to or within a short walk of transit stations and transit stops.

Metrolinx and Infrastructure Ontario pursue TOC to advance the following objectives of the provincial government:

- increase transit ridership and reduce traffic congestion;
- increase housing supply and jobs with access to transit;
- create complete communities based on current best planning practice; and
- catalyze positive value capture for the Province to maximize transit investment while reducing taxpayer burden.

In addition to TOC objectives, the Ontario Line has been developed to align with the Toronto planning context. Two major policies guide development in the City of Toronto: the provincial Growth Plan for the Greater Golden Horseshoe (the "Growth Plan"), and the City of Toronto Official Plan (the "Official Plan").

Benefit Analysis

The Ontario Line will improve rapid transit connectivity between residential, commercial, and employment centres and will also directly serve key locations where TOC development is possible, for example, the Ontario Line could:

- directly serve some of the key urban growth centres that are planned to accommodate the largest percentage of future growth, including downtown Toronto as well as other growth-focused areas (Figure 4-6 shows key higher-population density areas to be served by the line);
- directly serves built-out and rapidly growing areas on the eastern and western parts of downtown Toronto as shown in Figure 4-7;
- enhance connections for both low-density neighbourhoods and other higher-density neighborhoods (such as Flemingdon Park and Thorncliffe Park), which are underserved by transit;
- serve a number of communities which are generally mixed-use in nature and are expected become higher density in the future; and
- serve existing TOCs and others in development and planning that intersect with other transit connections, such as at the Ontario Science Centre Station that will directly connect with the Line 5 (Eglinton Crosstown LRT) station.

While the TOC program is under active development, the GGHMv4 was used to forecast how a representative successful TOC program would enhance the benefits of the Ontario Line. This analysis suggests that the Ontario Line could serve an additional 55,000 trips per day (14% increase in daily demand) if delivered alongside TOC.

Figure 4-6: Ontario Line Connectivity to Population Dense Areas

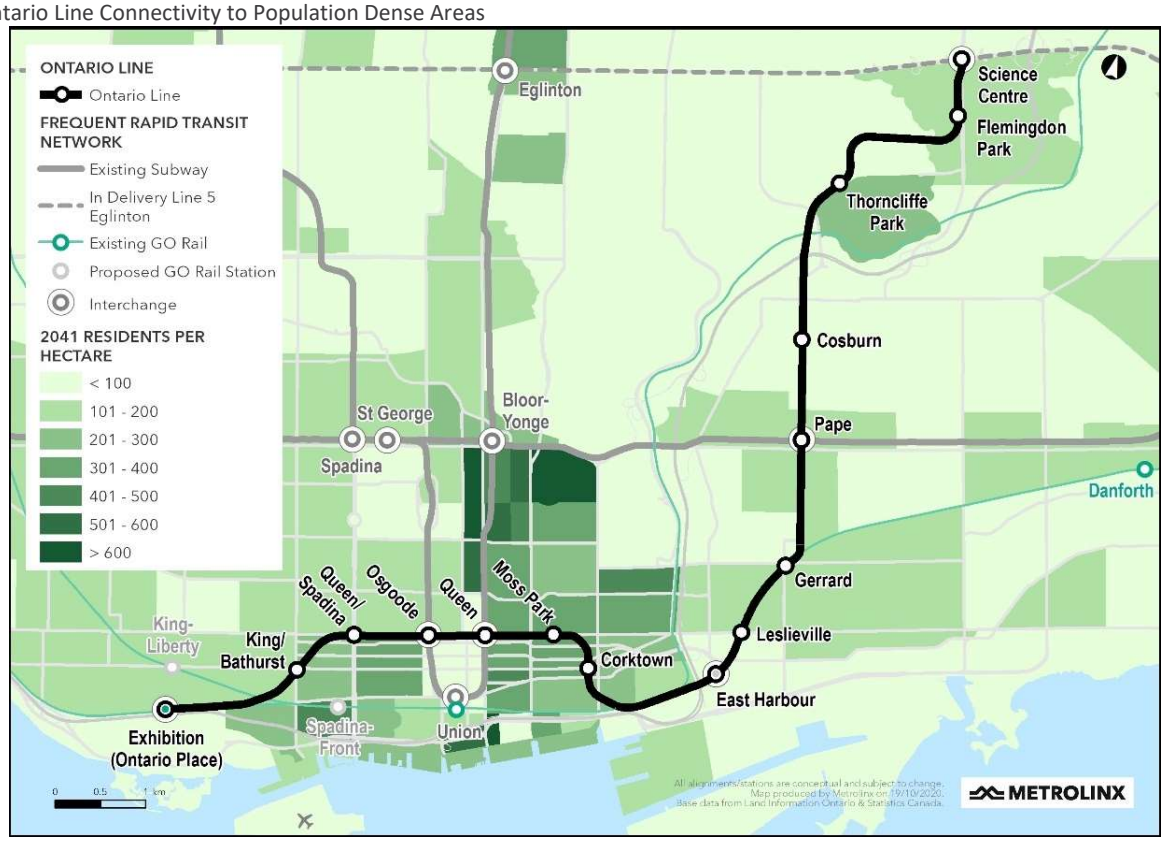
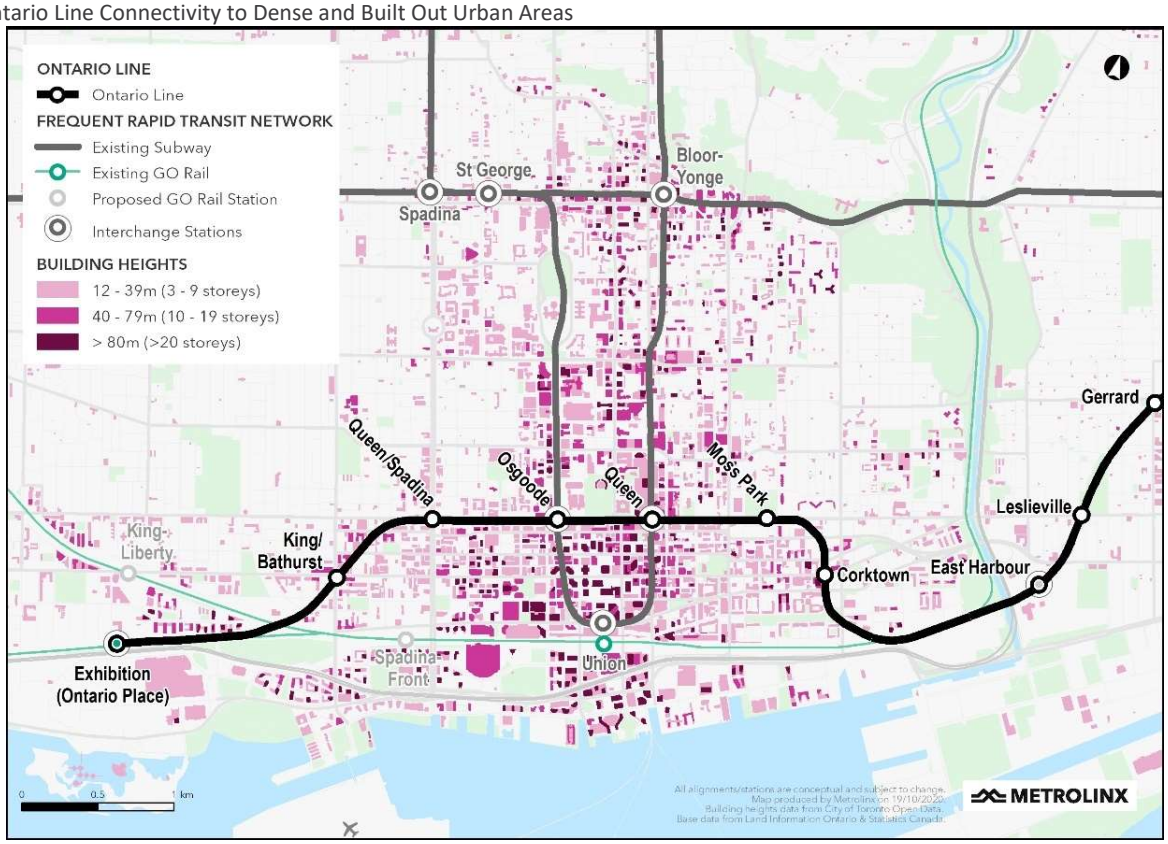


Figure 4-7: Ontario Line Connectivity to Dense and Built Out Urban Areas



This analysis notes that:

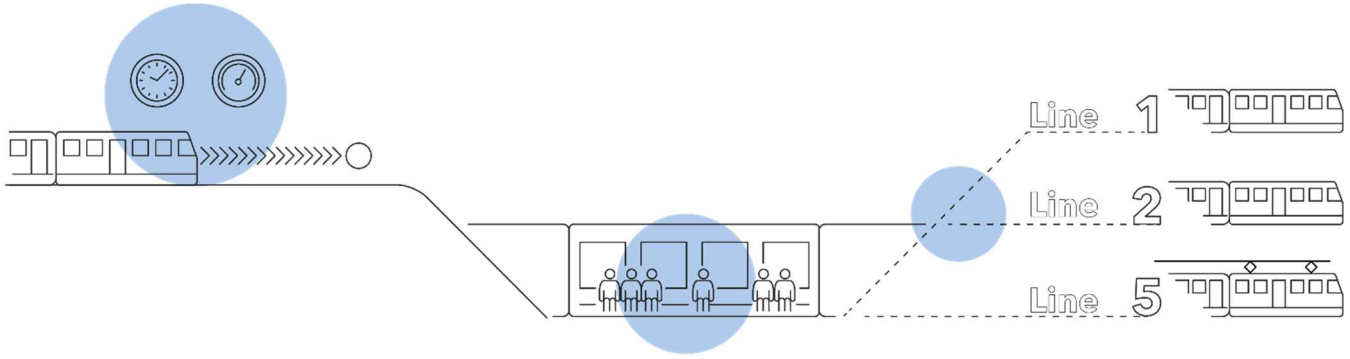
- the Ontario Line will be implemented to directly serve key urban growth centres and growth-focused employment areas, complementing and supporting the realization of growth plans for these sites, specifically in terms of housing the city's growing population and supporting commercial development opportunities to accommodate the city's business base;
- the introduction of new rapid transit may unlock new development in neighbourhoods that are underserved by transit, further increasing ridership and better connecting communities with transit; and
- the benefit of a synergistic delivery of TOC and the Ontario Line is increased access for travellers and result in greater use of the Ontario Line.

Table 4-3: Benefit 3: Support a Synergistic Relationship between Transit and City-Building Summary

Criteria	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
How would Transit-Oriented Communities (TOC) opportunities affect ridership of the line? * *Based on analysis of potential TOC opportunities	+ 55,000 daily trips beyond the forecast 388,000 trips in Benefit 1	+ 52,000 daily trips beyond the forecast 374,000 trips in Benefit 1
How does the option align with planned/future development?	The line serves the following urban growth areas: Financial District, Moss Park, proposed East Harbour, Lower Don Lands, Regent Park, Canary District, Exhibition/Ontario Place, Liberty Village, King/Portland and Don Mills/Eglinton	
Does the option improve the connectivity of Urban Growth Centres (UGC)?	Yes, the option directly serves the downtown Toronto UGC and increases options to access the Yonge-Eglinton UGC due to a connection with Eglinton Crosstown.	
Does the option support areas with land uses compatible with rapid transit as identified in City of Toronto's Official Plan?	Yes, stations are generally located in areas designated for mixed-use, regeneration, employment, and higher-density residential use.	

Outcome 2: COMPLETE TRAVEL EXPERIENCES

This outcome reflects the quality of travel experience that passengers have access to. A complete travel experience is a high-quality experience where customers do not have to worry about unreliable travel times, delays, low frequency and/or limited availability of service, or services not fully connecting them to their end destination. Complete travel experiences support a high quality of life by reducing the stress of travel, enable economic prosperity by providing predictable and reliable travel times for employers and employees alike, and create a more sustainable environment by making transit fast and reliable enough to compete with less sustainable travel modes. The addition of the Ontario Line will improve the speed, frequency and reliability of transit service in Toronto. The Ontario Line will realize three key benefits that reflect more complete travel experiences in Toronto and the broader GTHA:



4. Improved travel time and reliability

On average, customers are forecast to save seven minutes of travel time per trip, with some customers saving significantly more time. For example, a trip from Thorncliffe Park to Queen Station could save 15 minutes. Combined, every day this totals 2.7 million minutes across all travellers.

5. Improved comfort and safety

The Ontario Line is forecast to attract demand off other crowded lines, which in turn will increase comfort and safety across the entire Toronto network. Line 1 could be 12% to 15% less crowded, Bloor-Yonge Station could be 15 to 22% less crowded, and Union Station could be 14% less crowded.

This means that Line 1 - including the Yonge North Subway Extension - will have significantly reduced crowding and travellers will benefit from reduced congestion at Union Station.

6. A more resilient and integrated transportation network

The Ontario Line could connect to over 40 other transit lines/routes to build a more resilient network that can better respond to delays and disruptions, and also provide customers with expanded choice.

As part of an integrated network, the Ontario Line could attract 60,000 to 62,000 new transit trips a day and enable 50,000 more transfers between rapid transit lines each day.

OUTCOME 2: COMPLETE TRAVEL EXPERIENCES

BENEFIT 4: Improve Travel Time and Reliability

The Ontario Line could save travellers an average 7 minutes per trip, with some trips saving significantly more time. For example, a trip from Thorncliffe Park to downtown Toronto that is 40 minutes today could be 25 minutes with the Ontario line – a saving of 15 minutes. This means travellers would spend less time travelling and have more time to pursue other activities.

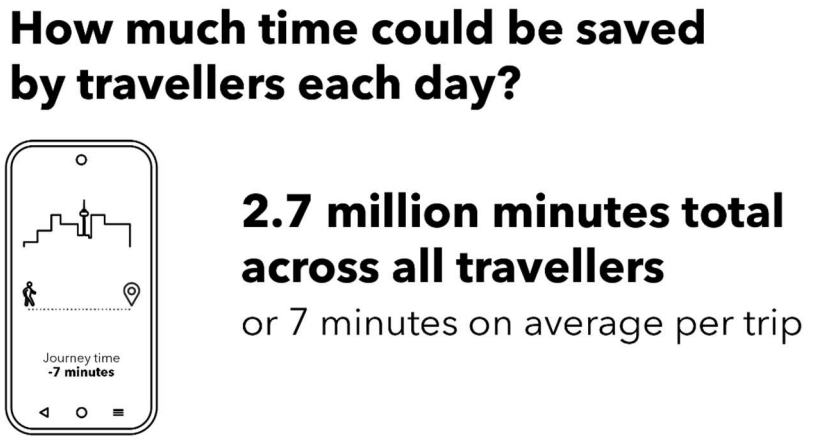
Benefit Overview

This benefit is focused on exploring how the Ontario Line saves travellers time compared to the BAU network. Moving people quicker and offering reliable travel is at the heart of the 2041 *Regional Transportation Plan*. The Ontario Line should reduce travel times for people travelling in Toronto by providing fast, frequent, and reliable rapid transit.

Benefit Analysis

Competitive travel times and reliable transit service are essential to accommodate the demands of a growing population and to ensure people are connected to where they need to go, when they need to go. Based on analysis of travel time comparisons between the Ontario Line and a BAU scenario the following savings are forecast:

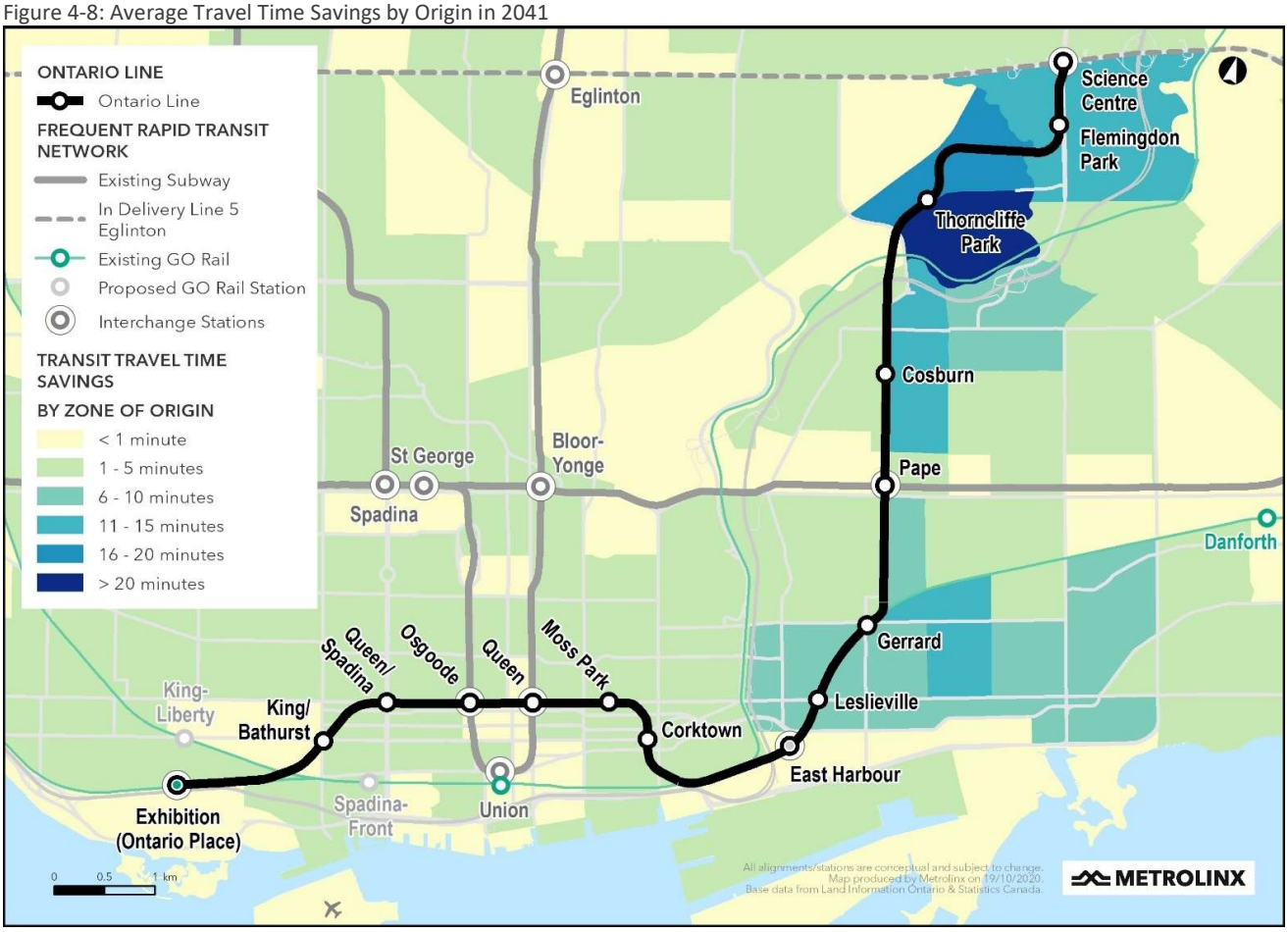
- the Ontario Line could save customers an average of **7** minutes of travel time every day (average travel time savings by origin are shown in Figure 4-8 in 2041); and
- the total time saved by all travellers every day could equal 2.4 million (refined operating concept) to 2.7 million (IBC operating concept) person minutes.



Total transit travel time savings, morning peak hour
Source: GGHm v4

Time savings will vary by a traveller's origin and destination – for example a traveller going from Pape Station to Queen Station would save 5 minutes (compared to using Line 2 and Line 1), while a traveller going from Thorncliffe to downtown could save 15 minutes compared to using the surface and subway network today. The use of automated vehicles and platform edge doors (which are intended to limit delays at station and keep the service to scheduled headways) are anticipated to provide a higher degree of reliability for customers using the Ontario Line.

Figure 4-8: Average Travel Time Savings by Origin in 2041



How would travel to Downtown Toronto be affected?

Example trip from Thorncliffe Park to King & Bay Intersection

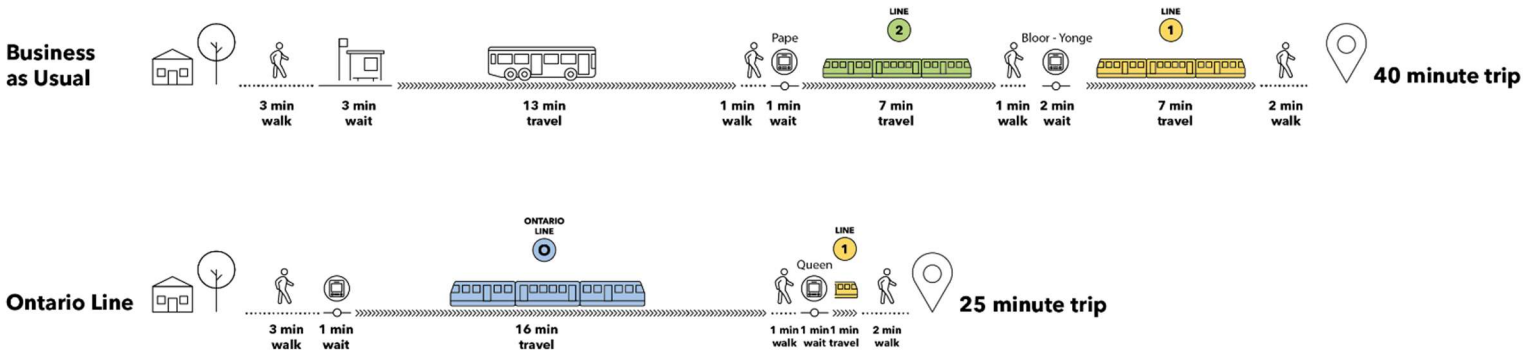


Table 4-4 summarizes the Ontario Line's contributions to Benefit 4: Improve Travel Time and Reliability.

Table 4-4: Benefit 4: Improve Travel Time and Reliability Summary

Criteria	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
What are the resulting total travel time savings in 2041? *Total travel time savings for all transit trips in Toronto (perceived time). GGHM v4 outputs.*	2.7 million minutes (daily) 390,000 minutes (busiest hour) 7 minutes per trip (average)	
Does the option offer sufficient capacity for ridership growth? * *Volume to capacity ratio at the line's busiest point in 2041. GGHM v4 outputs.*	Yes, Ontario Line trains are expected to operate at 67% of their maximum capacity in 2041 and allow for growth through to 2077.	Yes, Ontario Line trains are expected to operate at 73% of their maximum capacity in 2041 and allow for growth through to the 2060s, at which point the case for larger vehicles may be considered.

OUTCOME 2: COMPLETE TRAVEL EXPERIENCES

BENEFIT 5: Improve Comfort and Safety

The Ontario Line could alleviate pressure on the transportation network by reducing crowding on Line 1 by 12 to 15% at its busiest point, creating more comfortable and safe experiences for passengers.

Benefit Overview

Providing comfort and safety in the transit experience is of paramount importance to ensuring complete travel experiences for passengers and to ensure regular use of the transportation network. Transit crowding, for example, places pressure on operations and service reliability, as well as passenger comfort and safety for those travelling throughout the network. The Ontario Line offers a safe and comfortable option for travel across the City of Toronto by relieving crowding on existing lines and better integrating transit into the network of the future to allow for convenient and seamless travel. This benefit has been analyzed by assessing the change in crowding on the transportation network as a result of the introduction of the Ontario Line as well at select points in the transit network which are already constrained by crowding using the GGHMv4.

Benefit Analysis

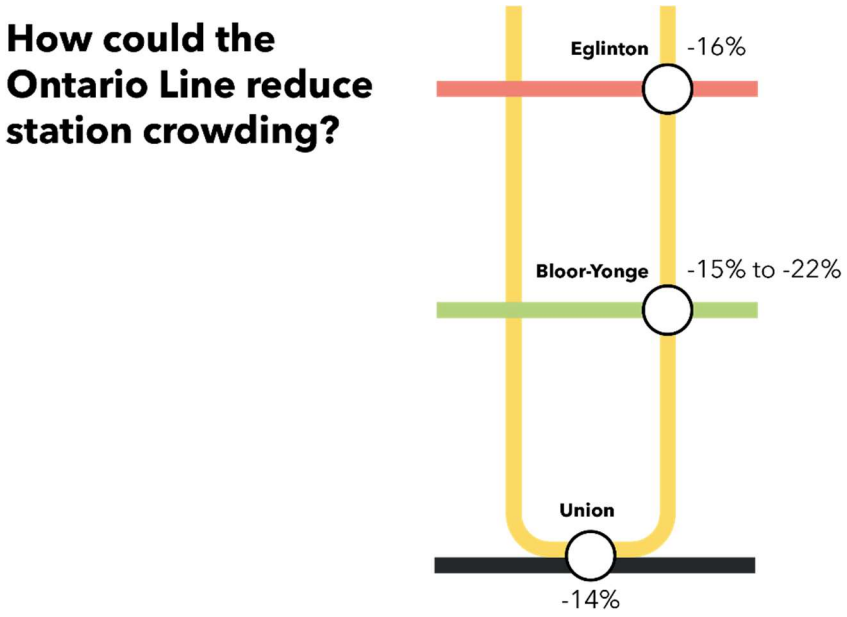
The Ontario Line could improve the overall comfort and safety of people travelling throughout the region by diverting demand from existing lines reducing crowding during the busiest hour of the day:

- Line 1 could be 12% to 15% less crowded at its busiest point (between Bloor Yonge and Wellesley);
- Bloor Yonge Station could be 15% to 22% less crowded;
- Eglington Station could be 16% less crowded; and
- Union Station could be 14% less crowded.

This analysis indicates that the Ontario Line could reduce crowding on constrained elements of the frequent rapid transit network. This means that:

- Line 1 could no longer be overcrowded in the peak period.
- customers on the Stouffville Line, Lakeshore East Line, and Lakeshore West Line could benefit from reduced crowding as they finish their trip and exit at Union Station.

Table 4-5 provides a summary of the Ontario Line's contributions to Benefit 5: Improve Comfort and Safety.



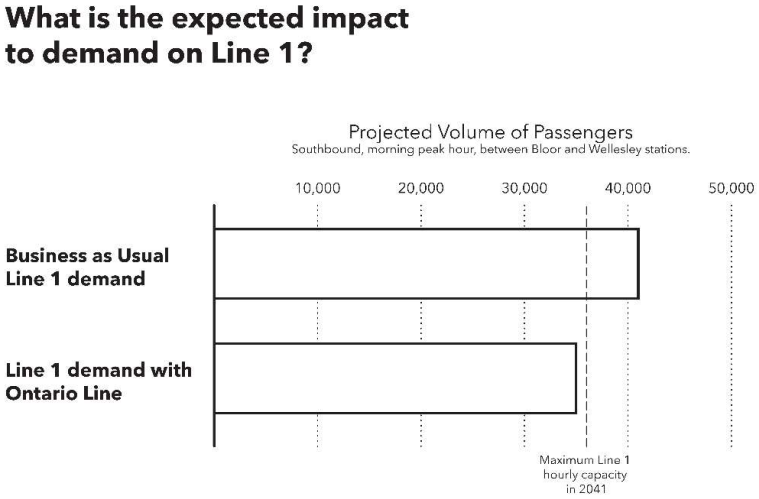


Table 4-5: Benefit 5: Improve Comfort and Safety Summary

Criteria	**PDBC Alignment with IBC Operating Concept**	**PDBC Alignment with Refined Operating Concept**
What relief does the Ontario Line offer Line 1? *Crowding at the busiest point*	-15% crowding at the most crowded point during the busiest (equal to 6,000 fewer trips *southbound between Bloor Yonge and Wellesley stations)*	-12% crowding at busiest point during the busiest hour (equal to 4,800 fewer trips)
What relief does the option provide to Line 2 Bloor-Danforth?	-21% crowding at busiest point during the busiest hour at the busiest point (equal to 6,000 fewer trips travelling westbound into Bloor Yonge Station)	-14% crowding at busiest point during the busiest hour (equal to 4,000 fewer trips travelling westbound into Bloor Yonge Station)
What relief does the option provide to Line 5 (Eglinton Crosstown LRT)?	-32% crowding at busiest point during the busiest hour (equal to 2,600 fewer trips travelling westbound to Eglinton Station)	-29% crowding at busiest point during the busiest hour (equal to 2,400 fewer trips travelling westbound to Eglinton Station)
What is the Ontario Line's impact on crowding at Union Station?	-14% crowding during the busiest hour	-14% crowding during the busiest hour
What is the Ontario Line's impact on crowding at Bloor-Yonge Station (Line 1 and Line 2)?	-22% crowding during the busiest hour (equal to 14,000 fewer trips)	-15% crowding during the busiest hour (equal to 10,000 fewer trips)
What is the Ontario Line's impact on crowding at Eglinton Station (Line 1)?	-16% crowding during the busiest hour (equal to 5,000 fewer trips)	-16% crowding during the busiest hour (equal to 5,000 fewer trips)

OUTCOME 2: COMPLETE TRAVEL EXPERIENCES

BENEFIT 6: A More Resilient and Integrated Transportation Network

The Ontario Line could attract 59,000 to 62,000 new transit trips a day by providing an integrated rapid transit solution for Toronto and the GTHA – including over 40 connections to other forms of transit. The Ontario Line will create a more resilient network that can respond to delays and disruptions, and also provides customers with expanded choice.

Benefit Overview

This benefit focuses on the extent to which the Ontario Line creates a more integrated and resilient network by exploring:

- the number of connections the Ontario Line makes to other rapid transit; and
- the number of bus and streetcar routes that the Ontario Line connects to; and
- the resulting increase in transit ridership.

These connections allow customers to access more of the city, creating new journey opportunities. In addition, the expanded network will increase choice should any element of the transit network become disrupted or delayed. Direct connections to the surface network will also help travellers to get as close as possible to their final destinations on transit.

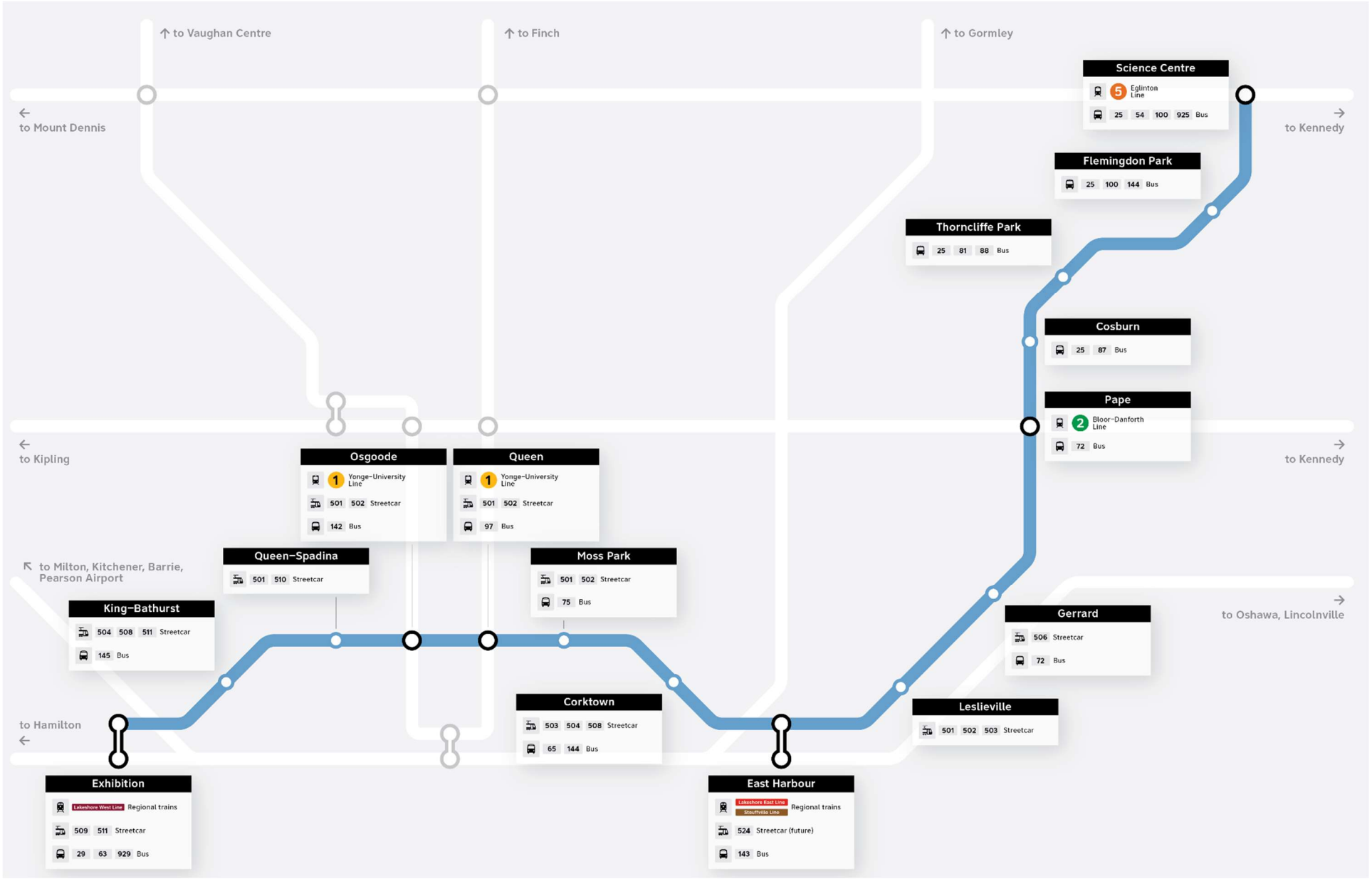
Benefit Analysis

The Ontario Line will create a more resilient and integrated transportation network for the GTHA by adding new connections, transfer points and inter-modal connections that enable resilience and integration of the existing network.

This more integrated network could enable over 60,000 more trips by transit in Toronto each day.

The Ontario Line will provide connections to surface routes, including streetcar connections, bus connections and night service routes (comprising bus and streetcar services). In addition, the line will provide connections with rapid transit and GO rail. The Ontario Line will have interchange stations that integrate with the following TTC lines: Line 1 (Yonge-University) at both Queen Station and Osgoode Station; Line 2 (Bloor-Danforth) at Pape Station; Line 5 (Eglinton Crosstown LRT) at Science Centre. The Ontario Line will have interchange stations that integrate with the following GO Transit lines: Lakeshore West at Exhibition Station and Lakeshore East/Stouffville at East Harbour Station. Figure 4-9 provides a summary of the connections provided by the Ontario Line.

Figure 4-9: Map of connections to the Ontario Line by type of transit connection[12]



[12] Indicated connections represent travel demand modelling assumptions and are subject to change as planning process advances

Combined these connections have the potential to transform mobility in Toronto by building the integrated and resilient network downtown Toronto needs to continue to grow and act as Canada's largest employment centre. These benefits are:

- **Expanded coverage –** the Ontario Line increases accessibility across Toronto as a whole by allowing customers to connect to Line 1, 2, and 5 on the TTC network and also connect to the GO rail network. This means that customers can use rapid transit to travel further than in the BAU – for example a trip from Leslieville to Exhibition, which was previously only served by a combination of surface network routes, can now be completed on a one-seat ride on the Ontario Line. A trip from the Bloor corridor to the Science Centre, which used to require the use of Line 2, Line 1, and a bus (or Line 5, once completed) now can be completed with only one transfer on Line 2 and the Ontario Line. Additionally, connections to GO rail services (Stouffville, Lakeshore East, and Lakeshore West) give Ontario Line travellers more entry points into the broader regional travel network. The Ontario Line can also be used by travellers from outside of Toronto to access more of the city, with transfers at Exhibition and East Harbour allowing customers to use the Ontario Line to access more of downtown Toronto and surrounding destinations, such as the Ontario Science Centre.
- **Resilience to disruption –** the Ontario Line reduces the impact of delays in the Toronto rapid transit network. For example, a peak period delay on Line 1 today limits access to the downtown core for transit users – including those who walk to Line 1, access it from the surface network or use Line 2 or the future Line 5 (Eglinton Crosstown – scheduled to open in 2022) to connect to it. The Ontario Line will be accessible by Line 5, Line 2, and a range of surface routes, which will allow customers to still use rapid transit to access the core, even if Line 1 is disrupted. In addition, the direct connection to GO rail services at Exhibition Station and East Harbour will allow customers to interchange between GO rail and the Ontario Line in the event that the Union Station Rail Corridor is disrupted, giving rail users a high-speed secondary route to the core. With the Ontario Line, this benefit includes unplanned and planned disruptions, giving customers reliable access to the core when segments of Line 1, Line 2, or the GO rail network are closed for planned or unplanned maintenance.

Combined, these benefits reflect that the Ontario Line adds a 'best first choice' for travellers who are currently underserved by rapid transit. These travellers can use the extensive TTC and GO rail network to access the Ontario Line and travel across Toronto. In addition, the Ontario Line also adds a strong 'second best choice' for many travellers who will continue to use Line 1 or the GO rail network after the Ontario Line is complete. In situations where these lines are unavailable, the Ontario Line can be used to complete trips in a timely and reliable manner.

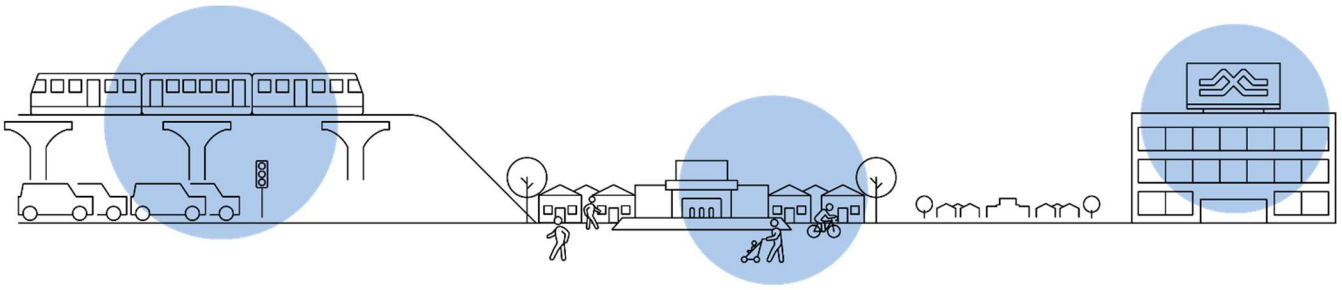
Table 4-6 provides a summary of how the Ontario Line realizes Benefit 6: a more resilient and integrated transportation network.

Table 4-6:Benefit 6: A more Resilient and Integrated Transportation Network Summary

Criteria	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
How does the expanded network support increased transit use? *GGHMv4 forecasts for 2041*	+62,000 transit trips a day	+60,000 transit trips a day
How well does the option connect with rapid transit?	Line 1	2 connections
	Line 2	1 connection
	Stouffville GO	1 connection
	Lakeshore East GO	1 connection
	Lakeshore West GO	1 connection
	Eglinton Crosstown (Line 5)	1 connection
How often do surface transit routes connect to the line during the morning peak hour? *Number of surface trips stopping within 100m of new stations during peak hour (routes that connect to more than one station are only counted once). GGHM v4 outputs.*	At least 445 surface route trip connections/hour	
How attractive are transfers with rapid transit? *Number of daily transfers between Ontario Line and rapid transit at Exhibition GO, Osgoode, Queen, proposed East Harbour GO, Pape, and Eglinton. GGHM v4 outputs for 2041.* This reflects how more people can use multiple services to complete their trip in a more convenient or comfortable way.	+50,000 total transfers between Ontario Line and other rapid transit (including GO rail)	

Outcome 3: SUSTAINABLE AND HEALTHY COMMUNITIES

This outcome focuses on how transportation enables communities to reduce energy use and climate change impacts while providing a high quality of life and continued economic prosperity. The Ontario Line will support the development of sustainable communities and travel patterns along the corridor by realizing three key benefits:



7. Moving people with less energy and reduced emissions The Ontario Line could reduce overall energy expended for transport by up to 7.2 million litres of automobile fuel every year. This is the same as nearly 120,000 fill ups at the pump per year. This reduction in automobile travel is estimated to amount to over 14,000 tonnes of greenhouse gas emission reductions per year.	**8. Improved quality of life and public health** The Ontario Line could improve local air quality and reduce collisions by up to 1,200 over the project life cycle by taking over 28,000 cars off the road each day and encouraging use of active travel to access transit. Travellers who switch to rapid transit from driving tend to walk more and realize health benefits from a more active lifestyle.	**9. Unlocking jobs and economic development** The Ontario Line is expected to support over 4,700 jobs per year between 2020 and 2030, with continued employment after 2030 for the operations and maintenance of the line.

OUTCOME 3: SUSTAINABLE AND HEALTHY COMMUNITIES

BENEFIT 7: Move People with Less Energy and Pollution

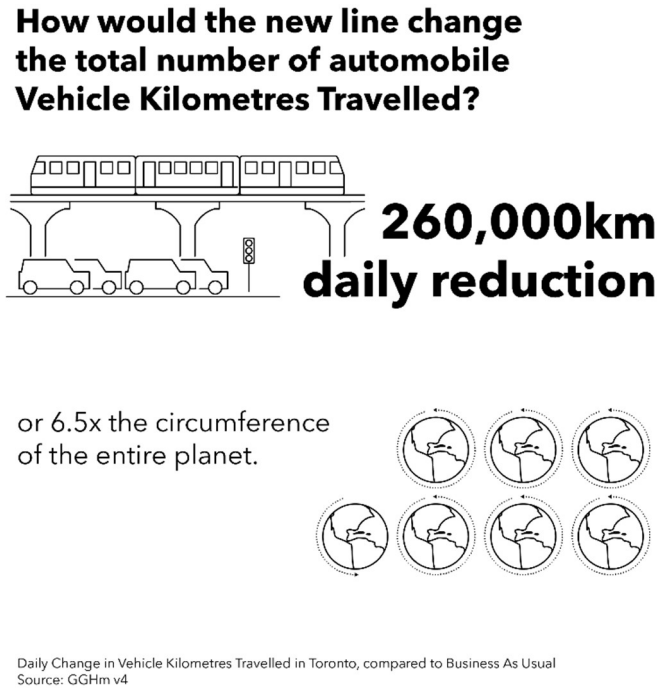
The Ontario Line could eliminate more than 14,000 tonnes of greenhouse gas emissions every year in the City of Toronto and reduce automobile fuel consumption by 7.2 million litres per year – a volume equal to nearly 120,000 fill ups at the pump.

Benefit Overview

This benefit focuses on the net reduction in energy and climate change impacts due to the delivery of the Ontario Line. In general, transit is a more efficient and sustainable transportation mode than automobiles because transit vehicles carry significantly more passengers despite requiring more energy to operate. This means the environmental impact of a passenger kilometer of travel on transit is much lower than a kilometer of travel on an automobile. This benefit is analyzed based on changes in demand for transit and automobile use derived from GGHMv4 forecasts.

Benefit Analysis

A key benefit of delivering the Ontario Line is that it will make transit more attractive and viable for people travelling across the City of Toronto, thereby encouraging modal shift away from auto trips to transit, which in turn could relieve congestion on the GTHA's road network and minimize energy consumption in the process. An assessment of the extent to which the Ontario Line could move people with less energy and pollution has been undertaken by estimating the amount of energy saved per year in the City of Toronto (as expressed as greenhouse gas, or GHG, emissions reductions) with the Ontario Line compared to if the project was not built. The benefit analysis shows that:



Daily Change in Vehicle Kilometres Travelled in Toronto, compared to Business As Usual
Source: GGHm v4

- the Ontario Line could reduce automobile vehicle kilometres travelled by nearly 266,000 km a day which will reduce the overall energy expended for transportation by up to **7.2 million litres of fuel** per year; and
- this change in automobile demand could result in GHG emissions savings of more than 14,000 tonnes per year.

Benefit Analysis Findings

This analysis indicates that: the Ontario Line will support domestic policy objectives for environmental sustainability and low-carbon economies by actively reducing the overall energy expended for transport in the City of Toronto. Table 4-7 summarizes the Ontario Line's contributions to Benefit 7: Move People with Less Energy and Emissions.

Table 4-7: Benefit7: Move People with Less Energy and Pollution Summary

Criteria	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
How could the option impact greenhouse gas emissions (GHGs)?	Reduction of 14,000 tonnes per year of GHG emissions	
How could the option reduce automobile and fuel use?	Reduction of 260,000 vehicle kilometres travelled by automobile a day Reduction of fuel usage by 7.2 million litres per year	

OUTCOME 3: SUSTAINABLE AND HEALTHY COMMUNITIES

BENEFIT 8: Improve Quality of Life and Public Health

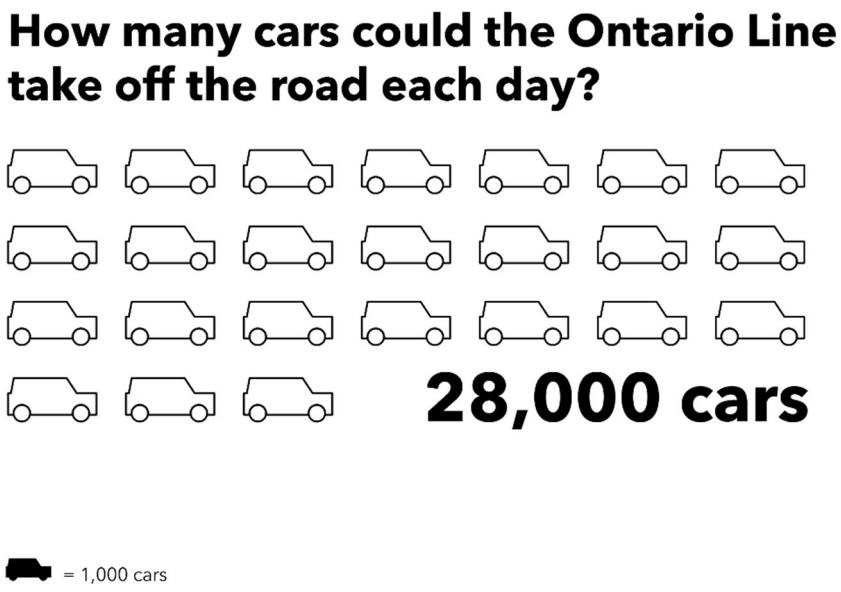
The Ontario Line could take 28,000 cars off the road every day, which could support goals to reduce automobile collisions and support increased physical activity and health for Torontonians who choose Ontario Line.

Benefit Overview

This benefit explores how transportation supports health and wellbeing – both by encouraging physical activity and by mitigating negative externalities of transportation, such as automobile collisions resulting in death or injury. This benefit is assessed by estimating the change in active travel and auto travel due to the delivery of the Ontario Line through the GGHMv4 model.

Benefit Analysis

The extent to which the Ontario Line will improve quality of life and public health has been assessed by estimating the change in traveller behaviour as a result of the introduction of the Ontario Line and the resulting impact on local air quality, active travel and collisions reductions.



The analysis shows that:

- the Ontario Line could reduce collisions on the GTHA road network by taking 28,000 cars off the road each day by 2041, which could result in over 1,200 fewer collisions resulting in death or injury over the project's lifecycle;
- the Ontario Line could encourage the use of active travel to access transit, with over 28,000 more people anticipated to use transit who otherwise would drive (out of 59,000 to 60,000 new transit trips total); and
- those who switch to the Ontario Line could walk **300 to 800 metres** more per trip on average than they would if they drove (this is equal to more than 2.6 million km per year) – this increased physical activity relative to driving will support both individual and overall public health.

Benefit Analysis Findings

This analysis indicates that:

- the Ontario Line will support policies for increasing active transportation and creating safer conditions for travelling in the City of Toronto, reducing the number of road traffic accidents by taking cars off the road.
- through encouraging shifts to more sustainable modes of transportation, the Ontario Line will support policies for improving local air quality, which will contribute to overall improvements to public health.
- the Ontario Line will encourage physical activity such as walking and cycling, which benefits individuals' physical health and wellbeing.
- active transportation yields economic, social and environmental benefits, such as increasing the amount of physical activity a person undertakes, reducing the number of road traffic accidents and improving air quality. The introduction of the Ontario Line will support active transportation, improve local airport quality and reduce the number of fatalities as a result of car accidents by encouraging mode shift to sustainable transit options.

Table 4-8 summarizes the Ontario Line's contributions to Benefit 8: Improve Quality of Life and Public Health.

Table 4-8: Benefit 8: Improve Quality of Life and Public Health Summary

Criteria	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
How does the option reduce automobile collisions causing death or injury?	- 28,000 fewer automobile trips per day in 2041 -1,200 collisions over the project lifecycle	
How do the options support the development of walkable communities?	Ontario Line also brings rapid transit to dense and/or intensifying auto dependent areas, thus encouraging active modes for access. On average travellers are expected to walk up to 300 to 800 metres more per trip when they use transit compared to an automobile (see Economic Case for monetized value of this benefit)	

OUTCOME 3: SUSTAINABLE AND HEALTHY COMMUNITIES

BENEFIT 9: Unlock Jobs and Economic Development

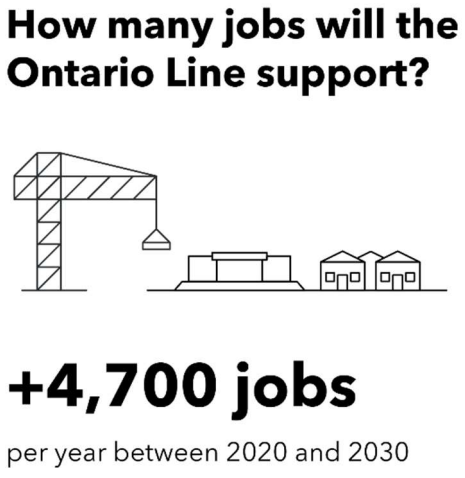
The Ontario Line could be a platform for economic development and growth within the City of Toronto by supporting **4,700 jobs each year between 2020 and 2030.**

Benefit Overview

This benefit focuses on the direct and indirect jobs generated by pursuing the Ontario Line. While Benefit 2 discusses how transit improvement can connect people to jobs and support an innovative and prosperous economy, this benefit explores how investment in transit can create quality jobs across the project lifecycle – including designing, building, and operating the line. Job creation is a key element of economic development policy, including diversifying the economy and creating opportunities in skilled labour and trades.

Benefit Analysis

The number of jobs the Ontario Line could support have been estimated based on the application of Input Output multipliers. This analysis shows that the Ontario Line could support an estimated 4,700 jobs per year, with additional employment after the line is delivered for the continued operations and maintenance of the project. Transportation projects have historically been strong job creators and generators of economic activity because they require a range of skills, job types, and varying experiences for their successfully deliver and operations.



This allows infrastructure projects to support skill and labour pool development in multiple sectors – including construction, technology, design, engineering, and manufacturing. Additionally, the use of P3 procurement models for major infrastructure projects can attract investment from out of province or internationally to develop plants and offices, both of which also create jobs.

Table 4-8 summarizes the Ontario Line's contributions to Benefit 9: Unlock Jobs and Economic Development.

Table 4-9: Benefit 9: Unlock Jobs and Economic Development

Criteria	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
How many jobs could the project support?	+4,700 supported jobs in the construction and supply-chain industries between 2020 and 2030 Continued employment after project delivery	

Strategic Case Summary

This section of the Strategic Case provides a summary of the nine key benefits of the Ontario Line, a framework to support benefits realization as the project advances to the FBC stage, and a review of how equitable these strategic benefits are.

The Ontario Line will transform how people travel across the City of Toronto by transit, allowing customers more choice to travel across the city quickly and reliably, improving their journey times and experience. The project will play an important contributing role to regional policy objectives, including the RTP 2041, by delivering strong connections, creating more complete travel experience, and supporting the creation of sustainable and healthy communities. The Ontario Line achieves this strategic performance and addresses the problem statement by:

- adding fast, frequent, and competitive service that serves new travellers and reduces crowding on other lines and routes;
- creating a more resilient and integrated transportation network in the GTHA; and
- leveraging existing corridors to connect more communities underserved by transit.

Option Performance Comparison

The Strategic Case assesses the overall contributions of the Ontario Line, and its two options, to key plans and public policy goals. This analysis notes that the options achieve a comparable level of performance across most benefits explored in this PDBC, with one key performance differences: current estimates suggest the refined operating concept option (80 m trains) has lower congestion relief in 2041 than the IBC operating concept option (100 m trains). This difference is due to fewer transfer to the Ontario Line at Ontario Science Centre Station (from Line 5 – Eglinton) and at Pape Station (From Line 2) because there is lower capacity with 80 m trains than with 100 m trains. Under the refined operating concept, more customers are forecast to continue to Line 1 to finish their trip.

This analysis identified the following considerations for future planning:

- explore opportunities for right sizing fleet and frequency to demand based on realized demand, customer response, and changing travel patterns throughout the lifecycle of the Ontario Line (this could include changing to a larger fleet when needed); and
- explore opportunities to encourage shifting discretionary travel in the peak period (example recreational trips) to the off-peak through other measures (such as off-peak fares incentives) if demand begins to reach short-term rolling stock capacity.

Table 4-10 summarizes the performance of the Ontario Line Strategic Case.

Table 4-10: Strategic Case Summary

		PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
Strong Connections	**Benefit 1 – Improved access to transit**	• 388,000 trips per day on the Ontario Line	• 374,000 trips per day on the Ontario Line
	Benefit 2 – Increased access to economic activity	• +47,000 jobs accessible within 45 minutes by rapid transit • +57,000 jobs accessible to lower-income Torontonians within 45 minutes by transit	
	Benefit 3 – Support a synergistic relationship between transit and city building	• Transit Oriented Communities could result in +55,000 new trips if delivered alongside the Ontario Line	• Transit Oriented Communities could result in +52,000 new trips if delivered alongside the Ontario Line
Complete Travel Experiences	**Benefit 4 – Improved travel time and reliability**	• 2.7 million minutes saved per day • 7 minutes saved per trip on average	
	Benefit 5 – Improved comfort and safety	Significant crowding reduction during the busiest hour of the day • **Line 1:** -6,000 trips (-15% crowding) • **Line 2:** -6,000 trips (-16% crowding) • **Bloor Yonge Station:** -14,000 trips (-22% crowding) • **Eglinton Station:** -5,000 trips (-16% crowding) at Eglinton Station • **Union Station:** -14,000 trips (-14% crowding)	Significant crowding reduction during the busiest hour of the day • **Line 1:** -5,000 trips (-12% crowding) • **Line 2:** -4,000 trips (-15% crowding) • **Bloor Yonge Station:** -10,000 trips (-15% crowding) • **Eglinton Station:** -5,000 trips (-16% crowding) at Eglinton Station • **Union Station:** -14,000 trips (-14% crowding)
	Benefit 6 – A more resilient and integrated transport network	• +62,000 new trips on transit per day • +50,000 transfers between Ontario Line and the Frequent Rapid Transit Network	• +60,000 new trips on transit per day • +50,000 transfers between Ontario Line and the Frequent Rapid Transit Network
Sustainable and Healthy Communities	**Benefit 7 – Moving people with less energy and reduced emissions**	• - 7.2 million litres of automobile fuel consumed per year • -14,000 tonnes of GHG emissions per year	
	Benefit 8 – Improve Quality of life and public health	• -28,000 car trips a day resulting in -1,200 collisions causing death or injury over the project lifecycle	
	Benefit 9 – Unlocking jobs and economic development	• +4,700 jobs per year supported in construction and supply train industries between 2020-2030	

Benefits Realization

There is a need to ensure that the investments made in transportation projects lead to clear, sustainable benefits for the region. The Strategic Benefits outlined in this Strategy Case will be realized through the delivery of a transformational investment to deliver a new rapid transit connection for the city of Toronto.

These benefits will be enabled through:

- **Project delivery** – direct investments in the project and the delivery of key project components, including investments in capital (fleet, track, stations, and wider construction investments such as bridges and tunnels) and operations (service planning, service and fare integration, stakeholder collaboration);
- **Operationalization** – operational aspects of the Ontario Line project, in effect from day one of the Ontario Line operation, including service plan implementation, safety measures, maintenance and marketing.
- **Enabling/supporting investments** – wider policy enablers, including the implementation of planned and in-delivery infrastructure investments such as Line 5 (Eglington Crosstown LRT) and GO Expansion, fare integration, and Transit-Oriented Communities.

Table 4-11 demonstrates how the Ontario Line's key components will support the realization of benefits for the region.

Equitable Distribution of Benefits

Equity refers to the fair and appropriate distribution of impacts (benefits and costs) and is an important factor in the planning of transit investments. The RCD of the Ontario Line has been developed to take account the needs of the GTHA population now and in the future and the strategic outcomes of the Ontario Line outlined above are aimed at delivering Strong Connections, Complete Travel Experiences and Sustainable and Healthy Communities. The University of Toronto[13] in 2019 assessed the socio-economic distribution of benefits of the Ontario Line based on an assessment of the Ontario Line alignment and its performance relative to the BAU[14]. The assessment concluded that:

- the benefits of the Ontario Line are forecasted to be fairly evenly spread across all levels of socioeconomic status in the GTHA, with concentrations specifically among low-income populations;
- in neighbourhoods most significantly benefiting from the Ontario Line investment (for example: those within 5km of the transit line), benefits are also concentrated among visible minorities and recent immigrants; and
- overall, the distribution of benefits was assessed to be equitable, in that they do concentrate among population groups more likely to depend on public transit for their daily mobility needs, especially lower-income populations. These benefits are largely dependent on the Ontario Line benefits extending beyond downtown including north of the Don Valley as well as to areas served east and west of the downtown that will benefit greatly by a new rapid transit connection in complement to existing surface transit options.

[13] Farber, Dr. S, Allen, J. University of Toronto. 2019. The Ontario Line: Socioeconomic distribution of travel time and accessibility benefits
[14] As defined in the IBC. With identical forecasted land-use patterns, but different travel demand and travel time projections, relative to this PDBC.

Table 4-11: Benefits Realization Framework for the Ontario Line

Strategic Benefit	Enablers required to realize benefit
1. Improve access to transit	• Deliver the 15 stations specified in Chapter 3 with an emphasis on local area integration and first/last mile connectivity • Maintain travel times, frequencies, and reliabilities used in forecasts
2. Increase access to economic opportunities	• Provide high frequency, high reliability transit services linking the key employment sites specified in Chapters 2-4 • Deliver stations to allow ease of access, egress, and connection to key employment centres – including consideration of first/last mile connections on transit or other types of mobility
3. Support a synergistic relationship between transit and city-building	• Including TOC requirements within planning and design of stations • Deliver stations to allow ease of access, egress, and connection to key employment centres – including consideration of first/last mile connections on transit or other types of mobility
4. Improve travel time and reliability	• Effective integration of Ontario Line with other modes in the City of Toronto, including rapid transit network and GO rail • Maintaining travel times, frequencies, and reliabilities used in forecasts
5. Improve comfort and safety	• Automated, driverless technology in trains and platform edge doors to ensure safety, comfort, and reliability • Maintaining travel times, frequencies, and reliabilities used in forecasts to attract demand from Line 1 • Ensuring all interchanges, and in particular the interchange at Pape between Line 1 and Line 2 is seamless and provides a comparable level of performance to the interchange included in GGHMv4 forecasting
6. Build an integrated transportation network	• Effective integration of Ontario Line with other modes in the City of Toronto, including rapid transit network and GO rail • Ensuring all interchanges, and in particular the interchange at Pape between Line 1 and Line 2 is seamless and provides a comparable level of performance to the interchange included in GGHMv4 forecasting
7. Move people with less energy	• Maintaining travel times, frequencies, and reliabilities used in forecasts to attract demand from automobile • Lighter and smaller trains with electric rail technology and automatic operation
8. Improve quality of life and public health	• Maintaining travel times, frequencies, and reliabilities used in forecasts to attract demand from automobile • Integration with active modes to encourage walking and cycling for first/last mile connections • Integration with surface network to reduce automobile access
9. Unlock jobs and economic development	• Consider job creation throughout the design and development process of Ontario Line • Consider inclusion of job creation and skill development policies during delivery and operations

5
Economic Case

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Introduction and Assumptions

The Economic Case is one of two chapters focused on the rationale for pursuing an investment (the other being the Strategic Case). While the Strategic Case evaluates options based on a project specific policy/plan-oriented evaluation framework, 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.

This analysis considers the magnitude of costs and benefits for a 60-year lifecycle (the evaluation period) as well as:

- Benefit Cost Ratio (BCR) – the net benefits divided by the net costs, which is used to indicate benefits that are realized per dollar spent
- Net Present Value (NPV) – the net benefits minus net costs, which is used to indicate total net benefits to the region

The Economic Case includes the following sections:

- **Assumptions –** a summary of the core economic analysis assumptions and approaches used in this PDBC
- **Cost Analysis –** estimated economic costs for the Ontario Line
- **Impacts Analysis –** estimated economic impacts for the Ontario Line
- **Economic Case Summary –** a summary of the economic benefit cost analysis for the Ontario Line, including the BCR and NPV
- **Sensitivity Tests –** additional economic analysis conducted on the Ontario Line to understand how changes in baseline assumptions could impact the project's overall economic performance

Assumptions

Assumptions set out in Table 5-1 are provided by the Metrolinx Business Case Guidance. The values presented in the economic case are the total lifecycle costs and benefits of the project in economic terms. Therefore, the costs shown are different from the Province's expected investment to construct the project and the project's budget. See the Financial Case for these specific financial costs.

Table 5-1: Economic Case Assumptions

Input	Impact Type
Analysis Approach	• All benefits/costs are expressed in real terms in 2020$ and Appraisal begins in 2020
Evaluation Period	• 70 years (Includes construction period and 60 years of operation)
Economic Discount Rate	• 3.5%
Value of Time (VoT) (2020$)	• $18.42/hour
VoT Growth Rate	• 0%
Ridership Growth Rate	• 1.3%, capped after 30 years from year of evaluation (2020-2049).
Auto Occupancy	• 1.077
Auto Operating Cost Savings (2018$)	• Marginal operating cost: $0.09/km and Total operating cost: $0.66 km
Safety Improvements (Accident Mitigation/Relief) (2018$)	• $0.10/km
GHG Emissions (2019$)	• $54.5/Tonne
Health Benefits (Active Travel) (2015$)	• $2.96/km walked and $1.48/km cycled
Operating Cost Growth Rate	• 1%

Modelling Assumptions

The GGHMv4 model is a key input into Economic Analysis and provides the following inputs:

- **Change in demand by mod**e – including mode shift from automobile to transit used to generate change in automobile vehicle kilometres travelled (VKT)
- **Change in perceived travel times**

The GGHMv4 considers changes in land use patterns and the transportation network to estimate peak ridership with a forecast horizon of 2041. Peak ridership is then scaled to represent a whole day and a whole year, with population and employment growth profiles used to then estimate demand and benefits across the lifecycle of the project. The following assumptions were applied when forecasting the impacts of the Ontario Line:

- Train Headway: 1.5 minutes per direction
- Total Capacity per Train: 750 people (100m train), 600 people (80m train)
- Line Capacity: 30,000 passengers per hour per direction (100m train), 24,000 passengers per hour per direction (80m train)
- Speeds varied: from 20km/hr to 60km/hr. Average speed of 36 km/hr.
- Stations: includes all 15 stations of varying depths from -35m to 12m.

Cost Analysis

The costs or 'required investment' to deliver the Ontario Line subway are divided into three categories, as discussed in Table 5-2.

Table 5-2: Cost Categories

Cost Category	Description	Key Assumptions
Capital Costs	Fixed one-time costs incurred during the implementation of the investment. The capital costs include the labour and materials required for construction; as well as contingency. Property acquisition costs are excluded from the economic analysis.	**Fleet** • Fleet assumptions vary between 80 m and 100 m variants • Surface Fleet Impact: Ontario Line subway is expected to lead to fewer buses and street cars on the TTC network. **Alignment and Tunneling** • Costs reflect various methods of tunneling along the alignment. Tunneling costs provide for construction of two twin tunnels along the corridor. • The south tunnel is constructed between Ordinance Park and Don Yard utilizing primarily tunnel boring machine (TBM) tunneling methodologies with shorter segments of sequential excavation method (SEM). • The north tunnel is constructed generally between Gerrard and Minton Place utilizing TBM tunneling methodologies.
Rehabilitation Costs	Complete major rehabilitations to restore infrastructure to ensure operational continuity throughout the project's lifecycle.	• Rehabilitation and refurbishment are assumed to continue for the 60-year operation period, and a terminal value, equal to the last 20 years of rehabilitation cost is assumed.
Operating and Maintenance Costs	Ongoing costs required to operate the service and provide day to day maintenance	• Includes operating labour, electric power, and maintenance for vehicles, station and the route. • **Bus and Streetcar Operating Impacts:** impacts to the bus and streetcar network generated by Ontario Line subway. In this case, savings as bus requirements are reduced, along with streetcar service hours. Reduction in bus operations are expected to return $26M (2020$) in savings. Reductions in streetcar operations are expected to return $4M (2020$) in savings.

A contingency of 1.5% was added to Rehab Costs and Operation and Maintenance Costs. Across the Capital Costs, Metrolinx has applied at standardized approach to account for uncertainty in project costing. This approach is applied to all projects with adjustment to recognize the nature of the project and where it stands in the design development process. Contingencies are included based on estimator's opinion of the confidence interval and base uncertainty associated with the base cost estimate for various scope elements. The contingency varies by scope element, however on average the project cost estimate is carrying 19.2% contingency. An uplift to individual cost items of 9 to 18% was applied to balance optimism bias, with a standard deviation of 9 to 15% accordingly. Optimism bias is the tendency of individuals to expect better than average outcomes.

The uplift varies based on level of design for the components of the project, which varies from 15% -30%, with the overall project generally considered at 30% design development. In the context of infrastructure projects, optimism bias can lead to underestimation of costs and project duration. Optimism bias was not applied to fleet given there are clear

market signals for fleet costs. The capital, operating, maintenance and rehabilitation costs for the entire lifecycle of Ontario Line subway investment are listed in Table 5-3. These costs are incremental to the BAU scenario and have been discounted based on the approach defined earlier in this chapter. The following items are excluded from the analysis:

- Property costs are excluded from the economic analysis, and as such, do not require rehabilitation
- Transit-Oriented Communities are not reflected outside the growth assumptions in the land use model in the costs or benefits. See the *Sensitivity Tests* section for more information.

Table 5-3: Ontario Line Costs[15]

Ontario Line Costs (million 2020$ PV)	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
Capital Costs	**$8,410 to $9,050**	**$8,260 to $8,910**
Infrastructure	$7,000 to $7,640	$7,000 to $7,640
Vehicles (Fleet)	$870 to $900M	$710 to $770M
Terminal Value	-$120 to -$130	-$120 to -$130
Bus and Streetcar Fleet	-$70	-$70
Rehabilitation	$690 to $760	$690 to $760
Operating Costs	**$1,500**	**$1,350**
Total Present Value of Costs	**$9,910 to $10,550**	**$9,610 to $10,260**

[15] Note – total low and high capital costs and total costs are developed based on a probability distribution of each constituent cost element. They do not equal the summation of all low and high costs included in the table. Cost estimates reflect a range representing low to high forecasts to account for optimism bias at the early stages of project design. The values presented are in economic terms. Therefore the costs shown are different from the Province's expected investment to construct the project and the project's budget.

Impact Analysis

Impact analysis assesses how the Ontario Line could benefit or dis-benefit travellers and the broader GTHA over the course of its lifecycle. Metrolinx Business Cases consider the impacts discussed in Table 5-4.

Table 5-4: Cost Categories

Cost Category	Description	Alignment with Strategic Benefits	Included in BCR and NPV?
User Impacts	Changes in generalized travel time for transit users and other travellers due to the delivery and operations of the Ontario Line	• Benefit 1: Improve Access to Transit • Benefit 4: Improve Travel Time and Reliability • Benefit 5: Improve Comfort and Safety • Benefit 6: A More Resilient and Integrated Transportation Network	Yes
External Impacts	Changes in the externalities of transportation (example: change in emissions) due to the delivery and operations of the Ontario Line	• Benefit 7: Move People with Less Energy and Pollution • Benefit 9: Improve Quality of Life and Public Health	Yes
Wider Economic Impacts	Changes to economic productivity in the GTHA due to the delivery and operations of the Ontario Line	• Benefit 2: Increase Access to Economic Opportunities • Benefit 3: Support a Synergistic Relationship between Transit and City-Building • Benefit 9: Unlock Jobs and Economic Development	No – Wider Economic Impact assessment is still under development in the GTHA

Subsequent subsections outline the analysis conducted for each impact category.

User Impacts

User Impacts are a key area of analysis for transport investments. They capture how the investment could improve the welfare of transport network users or travellers. The Ontario Line Subway investment could impact the following groups:

- **Existing Subway Passengers**: The investment could reduce the generalized cost of travel below the current cost of travel by expanding the subway network across Toronto. This investment could provide a direct benefit to existing users, specifically those on the subway network experiencing crowding, as well as bus and streetcar users who have new opportunities to shift their journeys to the subway and benefit from faster, more frequent, and more reliable service.
- **New Subway Passengers**: The investment could reduce the generalized cost of travel on transit. This could attract new users to transit that used to travel via other modes. These new users could receive a benefit equal to the difference in what they were willing to pay and the new generalized cost of travel on transit.
- **Automobile Users**: The investment could attract some auto users off of local roads; this could generate congestion reduction benefits (in addition to the benefits travellers receive when they switch to subway) when compared to the Business as Usual for the remaining auto users.

All user impacts included in this analysis, which is summarized in Table 5-5, are "net impacts" across the investment, that is, the a sum of benefits and disbenefits to all travellers.

Table 5-5: User Impacts of the Ontario Line

User Type	Impact Type (Million 2020$, PV)	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
Transit	Travel Time Benefits	$4,540 to $5,120	$4,530 to $5,110
	Vehicle Crowding Reduction	$1,120	$860
	Platform and Station Crowding Reduction	$170	$170
Automobile	Congestion Reduction	$1,540 to $1,730	$1,540 to $1,730
	Operating Cost Reduction	$110 to $120	$110 to $120
Resource Correction	Fare Revenue Adjustment[16]	$2,230 to $2,520	$2,170 to $2,450

The benefits related to the travel time impacts are expressed in a range. The range is generated by Monte Carlo Simulation, which is a computational method that uses repeated random sampling to understand how variation in different variables can affect a modeled or estimated outcome. In this instance, the benefits draw from a range of uncertainties for ridership inputs related to population and employment. This is in keeping with the Metrolinx Business Case Guidance (2019) to develop ranges based on low, most likely and high scenarios and probability curves that match the characteristics of the benefits.

External Impacts

The Ontario Line could also generate external (also known as 'societal') impacts based on well-being and environmental impacts that apply to travellers and the broader region. External impact categories are:

- **Health –** changes in the general well-being or health of travellers in the region
- **Safety –** reductions in collisions resulting in death or injury on the road network
- **Environmental** – greenhouse gas (GHG) emission reductions

External impacts are estimated based on mode change from the GGHMv4. If travelers move from a less efficient mode to the Ontario Line then there is an impact equivalent to the externalities per trip on the Ontario Line, minus the externalities on their previously used mode.

[16] The Fare Revenue Adjustment is included to fully account for user benefits that are under represented in the GGHMv4, which accounts for social costs of transport and private costs of transport when estimating user benefits. Because fares are a transfer and not a social cost, the GGHMv4 user benefit outputs underrepresent benefits and fare revenue is used to 'adjust' these benefits to represent their total value. For more information on the fare revenue adjustment, see Metrolinx Business Case Manual Volume 2: Guidance.

The following approach is used for each externality:

- **Collision Reduction** is calculated based on the change in automobile Vehicle Kilometres Travelled (VKT) multiplied by the pro-rated cost per km of automobile travel associated with collisions.
- **Health Benefits** from walking and cycling are calculated based on the average distance a new transit user will walk compared to if they used automobile (current transit users do not experience this benefit).
- **GHG reductions** are estimated in tonnes through GGHMV4.

Table 5-6 summarizes the Ontario Line's external impacts.

Table 5-6: External Impacts of the Ontario Line

Impact Type	Impact Type (Million 2020$, PV)	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
Health	Health Benefits from Active Travel	$470	$470
Safety	Collision Reduction	$30 to $40	$30
Environment	Greenhouse Gas Emission Reductions	$20	$20

Wider Economic Impacts

Traditional economic analysis for transportation projects focuses on how an investment could reduce travel times and negative externalities of the transportation system on the whole with assumed static land use (population and employment) and economic activity. Wider Economic Impacts (WEIs) have emerged internationally as an expansion to economic analysis that explores how a transportation investment can impact both the level of productivity (or economic activity in a region) as well as the distribution of population and employment.

WEIs are usually categorized into three categories, each addressing a series of potential benefits identified in regional economics literature and other Business Cases for transformational projects globally. These benefits are also explored in Metrolinx's Business Case Guidance Volume 2 and include:

- **Agglomeration benefits –** changes to regional productivity due to reduced travel time / increases accessibility between employment and industrial centres in the GTHA. Agglomeration benefits are expected to occur as firms become closer together in terms of time – this allows firms to benefit from increased exchange of ideas in face to face meetings or business transactions.
- **Labour Access benefits –** changes to travel time between places people live and places people work allows employees to have access to a wider array of employment opportunities (due to their expanded commute shed) and employers to have access to an expanded talent pool. Productivity tends to increase in the region when employer needs and desirable employment opportunities are better aligned through reduced travel times.
- **Imperfect Competition benefits –** changes to travel time can also increase economic output by reducing the cost of transport for local businesses (example: a subway reduced congestion, which in turn makes shipping companies more productive) as well as for consumers (example: a subway makes a shopping centre more attractive to shop at). In effect, transportation investment can lead to more competitive markets and support a more productive economy.

Metrolinx has developed tools to estimate agglomeration benefits. These tools measure the extent to which changes in travel time between economic centres can lead to increased productivity based on 'agglomeration elasticities' (a measurement of how travel time between employment centres influences productivity) and a 'decay parameter' (a measure of how agglomeration benefits dissipate over longer distances). These tools are still under development and have been included in this PDBC to illustrate the potential on the Ontario Line. However, as these estimates are still under development, they are not included in the BCR or NPV for the project.

When applied to the Ontario Line, these tools estimate $1.7 to $2.0 billion of potential lifecycle benefit due to agglomeration. This value is equal to 17.5 to 22% of user benefits (including resource correction), which is aligned with international experience with agglomeration on peer projects:

- **Crossrail (London, UK)** – agglomeration benefits were valued at 24% of user benefits
- **HS2 Phase 1 (UK)** – agglomeration benefits were valued at 44% of user benefits (note – this is an intercity project, compared to Ontario Line, which is an urban subway)
- **Melbourne East West Road and Rail Package (Australia) -** agglomeration benefits were valued at 22% of use benefits

Unlike user impacts and travel time savings that are directly realized by travellers using the subway, these agglomeration benefits are realized due to firms having improved access to one another, which in turn can support a more prosperous and innovative economy. These benefits are realized by reducing travel times between industrial and employment centres in Toronto. For a description of how the Ontario Line reduces travel times see Strategic Benefit 4: Improve Travel Times and Reliability and Figure 4-8 in the Strategic Case.

Economic Case Summary

This section summarizes the Ontario Line's costs and benefits and its overall performance through the Benefit Cost Ratio (BCR) and the Net Present Value (NPV) calculation. Table 5-7 summarizes the economic case for the Ontario Line and includes a range of BCRs and NPVs based on the low to high estimates for certain costs and benefits. The Expected BCR is the mean of the continuous distribution of benefit cost ratios obtained by varying the capital cost input.

Table 5-7: Economic Case Summary [17]

	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
Total Costs (Million 2020$, PV)	**$9,910 to $10,550**	**$9,610 to $10,260**
Capital and Renewal Costs	$8,410 to $9,050	$8,260 to $8,910
Operating Costs	**$1,500**	**$1,350**
Total Impacts	**$10,230 to $11,310**	**$9,900 to $10,960**
User Impacts	$7,480 to $8,260	$7,210 to $7,990
Fare Revenue Adjustment	$2,230 to $ 2,520	$2,170 to $2,450
External Impacts	$520 to $530	$520
Benefit-Cost Ratio (BCR)	**0.99 to 1.12**	**0.99 to 1.12**
Expected BCR	**1.05**	**1.05**
Net Present Value (Million 2020$, NPV)	**-$100 to $1,180**	**-$130 to $1,130**
Expected NPV (Million 2020$, NPV)	**$540**	**$500**

[17] Note – similar to the Costs in Table 5.3, the low and high end NPV and BCR are based on probability distributions and are not directly calculated from the minimum and maximum costs and benefits presented in this table

The preceding economic analysis suggests the following conclusions for the Ontario Line:

- the Ontario Line could generate $9.9 to $11.3 billion of economic benefit for travellers, the City of Toronto, and the GTHA over its lifecycle -these benefits are likely to exceed the costs of delivering the project, with an expected BCR of 1.05, which means for every dollar spent on the Ontario Line, the GTHA could receive up to $1.05 in benefit;
- overall Ontario Line performance has improved since the IBC – the application of benefits management throughout the planning process has augmented key benefits (such as travel time savings) and also managed costs and mitigated key risks as is evidenced by the higher range of BCRs in the PDBC (1.05 compared to 0.76 to 0.88); and
- while the Ontario Line has a robust and positive Economic Case there are additional opportunities to optimize economic performance during the development of the Full Business Case (the next business case in Metrolinx's lifecycle process), including optimizing service patterns and exploring additional ways to optimize infrastructure.

Option Performance Comparison

The Economic Case assesses the overall value for money of the Ontario Line and its options by monetizing benefits and estimating costs incurred during construction and over the first 60 years of operations. This analysis leads to the following findings:

- both options have a comparable economic case based on BCR and NPV performance; and
- the refined operating concept option has reduced fleet and operating costs due to the use of 80 m trains (compared to the use of 100 m trains in the IBC operating concept option) – this train choice also reduces benefits realized by travellers as trains will be more crowded (in particular, in future years beyond 2060), which in turn reduces traveller benefits – however the change in benefits and costs are roughly equal.

Combined, these findings note that Metrolinx has flexibility in selecting an operating pattern and fleet size as both the 80 m and 100 m options have a comparable economic case. Based on this, the following considerations are noted for future planning:

- consider developing warrants for modifying fleet size at appropriate points in the project lifecycle (example, during re-procurement of fleet or after the first 30-year operating concession) based on loading standards, costs, and traveller benefits to further optimize the economic case; and
- explore opportunities to optimize the off-peak service plan (including explicit off-peak economic analysis) to characterize and realize greater off-peak traveller benefits.

Sensitivity Tests

This section provides additional economic analysis based on variations to input model assumptions, economic parameters, and other changes to land use and the transportation network. Tests have been divided into three categories:

- **Test for an Optimistic Land Use –** varying the land use in the GGHMv4 to reflect a more optimistic – or higher built out- scenario for the GTHA
- **Test for Transit Oriented Communities (TOC)–** varying land use in the GGHMv4 to reflect the potential outcome of a successful TOC strategy
- **Test for Fare Integration –** implementing integrated GO Transit and TTC fares to test the impact on ridership and transfers between the two systems at East Harbour and Exhibition
- **Economic Parameter Sensitivity Tests -** variations to economic parameters to understand the potential performance of the Ontario Line under scenarios where underlying economic assumptions change

Test for an Optimistic (High) Land Use

Ridership estimates are based on changes expected in the land use patterns. Specifically, this test examines an optimistic land use scenario, whereby population and jobs around Ontario Line Subway stations is intensified. Forecasts were developed by using secondary plans and development pipeline information. The impact of a more optimistic land use scenario results in higher overall project benefits since there are more riders accessing the Ontario Line. Details are outlined in Table 5-8.

Table 5-8: Impacts of Benefits based on an optimistic (higher) land use

	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
Total Costs	$9,910 to $10,550	$9,610 to $10,260
Total Impacts	**$12,470 to $13,820**	**$11,850 to $13,150**
Benefit-Cost Ratio (BCR)	**1.21 to 1.36**	**1.18 to 1.34**
Expected BCR	**1.29**	**1.26**

Test for Transit Oriented Communities (TOC)

The provision of a new subway service being implemented will make living and working near Ontario Line Subway stations more attractive. Metrolinx will identify Transit Oriented Community (TOC) opportunities across the planned Ontario Line with the aim of catalyzing complete communities, capturing the uplift in land value, and driving ridership.

TOC aligns to the transit-supportive policies of the Growth Plan for the Greater Golden Horseshoe and Metrolinx's Regional Transportation Plan, which identify dense mixed-use environments around higher order transit as key measures to reduce traffic congestion, greenhouse gas emissions, and journey times. This test examines massing of individual sites around each Ontario Line station determined by a set of built form criteria derived from the City of Toronto Built Form Guidelines as well as policy/zoning when applicable, resulting in a net increase of population and/or employment for specific traffic analysis zones. Trip rates derived from the GGHMv4 were applied to estimate total travel time savings for these users. The impact of TOC was determined to be an additional 135,000 person minutes in savings in the peak hour.

Test for Fare Integration

The fare integration test scenario analyzes the ridership impact of implementing a fare structure that permits free transfers between GO and TTC users. The fare scenario test assumes a future state where customers move seamlessly between services and do not need to worry about the operator of the bus or train that gets them to where they need to go within the city; consistent with the vision of the Metrolinx 2041 Regional Transportation Plan (RTP). The impact of implementing fare integration resulted in an additional 11,000 users on the Ontario Line.

Economic Parameters Sensitivity Tests

The sensitivity tests were undertaken to account for on uncertainty in input variables that have a substantial impact on the business case. The values of key economic parameters were varied to determine how the options would perform under different circumstances to reflect these uncertainties. Table 5-9 outlines the results of this sensitivity analysis.

The tests noted the following conclusions:

- Operating Cost Growth Rate test of 0.5% and the ridership growth rate test of 2% had minimal impacts on the BCR;
- where the Economic Discount rate is tested at 2.5% over the investment lifecycle, the BCR increases substantially for the option from 0.99 to 1.12 (Expected Value or EV: 1.05), to 1.18 to 1.33 (EV: 1.26) which represents the highest performing test; and
- if the Operating Cost Growth Rate is higher than assumed in the assumptions and tested at 2%, the BCR decreases significantly for the option from 0.99 to 1.12 (EV: 1.05), to 0.93 to 1.05 (EV: 0.99), which represents the lowest performing test.

Table 5-9: Sensitivity Analysis

Parameter	MX Assumption*	Tested Value	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
Using Standard Metrolinx Assumptions			0.99 to 1.12 (EV: 1.05)	0.99 to 1.12 (EV: 1.05)
Value of Time Growth Rate A parameter used to escalate the Value of Time across the investment lifecycle. Value of Time is a factor used to monetize changes in generalized time to determine the overall welfare benefit to transport network users.	0.0%	0.7%	1.12 to 1.26 (EV: 1.19)	1.11 to 1.26 (EV: 1.19)
Economic Discount Rate The economic discount rate reflects society's time preference for money, that is, present consumption versus future consumption.	3.5%	2.5%	1.18 to 1.33 (EV 1.26)	1.18 to 1.33 (EV 1.26)
Ridership Growth Rate A parameter used to escalate ridership throughout the investment lifecycle.	1.3%	0%	0.96 to 1.09 (EV 1.02)	0.96 to 1.09 (EV 1.02)
		2%	1.01 to 1.14 (EV 1.07)	1.00 to 1.14 (EV 1.07)
Operating Cost Growth Rate A parameter used to escalate operating costs throughout the investment lifecycle.	1%	0%	1.04 to 1.17 (EV 1.10)	1.03 to 1.17 (EV 1.10)
		0.5%	1.01 to 1.14 (EV 1.08)	1.01 to 1.14 (EV 1.07)
		2%	0.93 to 1.05 (EV 0.99)	0.93 to 1.05 (EV 0.99)

* Expected Value (EV) is the expected BCR.

6

Financial Case

METROLINX

Introduction

The Financial Case assesses the overall financial impact of proposed investment options. While the Strategic Case and Economic Case outline how an investment achieves organizational goals and social value, the Financial Case is one of two cases (the other being the Deliverability and Operations Case) that focuses on the requirements to successfully deliver an investment. This includes a review of expenditures (capital, operating and maintenance) and total revenue (fares) gained, required over the lifecycle of the investment incremental to the base case scenario. The Financial Case is agnostic regarding procurement and delivery method, but cost estimates are prepared based on a traditional design-bid-build approach.

The Financial Case includes the following sections:

- **Assumptions –** a summary of the core financial analysis assumptions and approaches used in this PDBC.
- **Capital Costs –** estimated capital costs for the Ontario Line.
- **Operating and Maintenance Costs –** estimated operating and maintenance costs for the Ontario Line.
- **Revenue Impacts –** a summary of the expected revenue for the Ontario Line.
- **Funding Sources –** a summary of potential funding sources available to advance the Ontario Line.
- **Financial Case Summary –** a summary of the financial analysis for the Ontario Line, including NPV and Total Cost Recovery Ratio.

Assumptions

Table 6-1 sets out the assumptions used for the calculations of the Financial Case. All the estimations are accounted in 2020$ values.

Table 6-1: Financial Case Assumptions

Parameter	Value
Discount Rate	5.5% (nominal)
Inflation Rate	2%

Capital Costs

The capital cost of building and delivering the Ontario Line options is the largest component of overall project costs. Capital cost estimations include the following elements:

- **Infrastructure –** Components related to the new physical installations for the line to operate, such as stations, stops, bus terminals/entrances, track elements, facilities, and systems among others. This element also considers property acquisition allowances and professional design services[18].
- **Rehabilitation –** Required major rehabilitations to restore infrastructure to ensure operational continuity throughout the project's lifecycle.
- **Terminal Value –** This is the residual value of the assets at the end of the analysis period.
- **Bus and Streetcar Fleet –** This category considers impacts to required numbers of buses and streetcars after the delivery of the Ontario Line.

Table 6-2 presents the detailed capital costs for the Ontario Line, and Table 6-3 illustrates an undiscounted summary of these costs. As detailed in the Ontario Line Project Scope (Chapter 3), there has been substantial design work that allows for improvement in the cost estimates, providing more certainty in capital costs estimations, especially at station level. This refinement will continue in the Full Business Case.

[18] The price of land is not included in this allowance as purchased land is assumed to achieve price growth at the same rate as the discount rate, resulting in a net present value of zero. Price of land is included in the undiscounted expenditure Table 6-3.

Table 6-2: Capital Cost Summary in Financial Terms, Discounted (million $)

	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
Infrastructure	**$6,860**	**$6,860**
All Stations, Stops, Bus Terminals/Entrances	**$2,010**	**$2,010**
Exhibition Station and Early Works	$170	$170
East Harbour Station	$30	$30
Leslieville Station	$40	$40
Gerrard Station	$40	$40
Thorncliffe Park Station	$40	$40
Flemingdon Park Station and Bus Terminal	$40	$40
Science Centre Station	$80	$80
King-Bathurst Station	$180	$180
Queen-Spadina	$200	$200
Osgoode	$240	$240
Queen	$230	$230
Moss Park Station	$160	$160
Corktown Station	$150	$150
Pape Station and Bus Terminal	$220	$220
Cosburn Station	$100	$100
Joint Developments	$90	$90
Guideway and Track Elements	$1,540	$1,540
Support Facilities	$330	$330
Sitework and Special Conditions	$360	$360
Systems	$760	$760
Property Acquisition	$520	$520
Professional Services, HST	$1,360	$1,360
Vehicles (Subway Fleet)	**$800**	**$640**
Fleet renewal	**$110**	**$90**
Rehabilitation	**$1,130**	**$1,130**
Terminal Value	**-$220**	**-$220**
Bus and Streetcar Fleet	**-$80**	**-$80**
Total Capital Costs	**$8,600**	**$8,420**

Table 6-3: Costs in Financial Terms, Undiscounted (million $)

Line Item	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
Infrastructure	$10,460	$10,460
Vehicles (Subway Fleet) not including replacement	$1,100	$880
Fleet replacement	$1,760	$1,410
Rehabilitation	$14,380	$14,380
Terminal Value	-$8,980	-$8,980
Bus and Streetcar Fleet	-$590	-$590
Total Capital Costs	**$18,130**	**$17,560**

Operating and Maintenance Costs

The second most relevant cost category in the construction of the Ontario Line is the operation and maintenance costs. These costs cover all aspects of operating the Ontario Line, including staffing and power, in addition to vehicle, track and station maintenance.

There are also operating costs impacts due to changes in the bus and streetcar surface network because of the Ontario Line. Compared to the Business as Usual scenario, some routes could become shorter now that they are arriving to a different new terminus at an Ontario Line station; these rearrangements could also require fewer buses overall. Table 6-4 and Table 6-5 present the total operating and maintenance costs at discounted and undiscounted formats.

Table 6-4: Operating and Maintenance Costs in Financial Terms, Discounted (million $)

Line Item	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
Project Operating and Maintenance Costs	$2,280	$2,120
Bus and Streetcar Operating Impacts	$-710	$-710
Total Operating Costs	**$ 1,570**	**$1,410**

Table 6-5: Operating and Maintenance Costs in Financial Terms, Undiscounted (million $)

Line Item	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
Project Operating and Maintenance Costs	$19,770	$18,530
Bus and Streetcar Operating Impacts	-$5,520	-$5,520
Total Operating Costs	$14,250	$13,010

Revenue Impacts

Revenue impacts are quantified in Table 6-6 and have been derived from the transportation demand model used to estimate ridership. Revenue impacts include revenue resulting from changes in fare paid and number of trips taken.

Table 6-6: Revenue Impacts in Financial Terms (million $)

Line Item	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
Incremental Fare revenue	$2,430	$2,360

Funding Sources

When the priority transit projects were announced by the Province in 2019, the preliminary funding announcement for Ontario Line was $10.9 billion. A concept of operations is being developed to inform funding of the operating costs. A project funding and financing approach is currently being developed with all levels of government. The Ontario Line was nominated for federal funding under the Investing in Canada Infrastructure Program (ICIP) in July 2019. The Province continues to advocate for the federal government to commit to a funding contribution of at least 40% of the capital costs for the Ontario Line. In support of the nomination, the Ontario Line Initial Business Case was submitted to the federal government for review. Additional business case analysis, including this Preliminary Design Business Case, will also be provided.

An additional funding program under exploration is TOC. TOC development is designed to provide positive value capture for the Province to maximize transit investment while reducing taxpayer burden. The TOC Program offers opportunities to reduce the capital cost for high order transit by working with the private sector and leveraging third-party investment. A benefit of TOC includes offsetting the cost of station construction which would save taxpayers' money.

Financial Case Summary

Table 6-7 presents an overall summary of the financial impact of investing in the Ontario Line. This summary contains the total incremental revenue, capital costs, and operating and maintenance costs. The total financial performance of the Ontario Line is also reflected in the Net Present Value (NPV) and the Total Cost Recovery Ratio.

Table 6-7: Financial Case Summary

Financial Case Metric	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept
Total Revenue Impacts	$ 2,430	$ 2,360
Total Capital Costs	$ 8,600	$8,420
Total Operating and Maintenance Costs	$1,570	$1,410
Total Costs	**$10,170**	**$9,840**
Net Financial Impact	**-$7,740**	**-$7,470**
Revenue / Operating Cost Ratio	**1.6**	**1.7**

Option Performance Comparison

The Financial Case assesses the overall financial impact of the Ontario Line and the two operating options considered in this PDBC. This analysis leads to the following finding: the refined operating concept option uses smaller 80 m trains that carry lower capital and operating and maintenance costs, which reduces the overall cost of the project (compared to the use of 100 m trains in the IBC operating concept option). Metrolinx may consider the use of 80 m trains for the first 30-year operating period, and into the second 30-year operating period to reduce overall financial impact of the project.

7

Deliverability and Operations Case

METROLINX

Introduction

The Deliverability and Operations Case is an analysis of investment delivery, operations and maintenance, and service plans for Ontario Line, as well as any issues that should be considered during the continued development of the project. This includes delivering the project from original concept through to planning, design, environmental assessment, stakeholder engagement, procurement, construction and operations.

This chapter is divided into the following sections:

- **Procurement Plan –** an overview of the procurement plan now underway for the Ontario Line
- **Project Delivery –** an overview of the delivery model used for the Ontario Line
- **Operations and Maintenance Plan –** an overview of the proposed operations and maintenance plan for the Ontario Line
- **Deliverability and Operations Case Conclusions –** a summary of the case including a review of key risks and issues for future consideration

Procurement Plan

This section summarizes the procurement model being deployed for delivery of the Ontario Line. It includes an overview of the procurement model and structure of procurements that are underway.

Procurement Model Overview

Metrolinx and Infrastructure Ontario are delivering the Ontario Line through a Public-Private Partnership (P3) model. P3 procurement is used to:

- Transfer design, cost, and schedule risk to those who are best equipped to manage them;
- Mobilize GTHA, Canadian, and international experience, where appropriate, to optimize the design, delivery and operations for the Ontario Line;
- Position Metrolinx and Infrastructure Ontario to manage initial and subsequent procurements to adapt to future needs; and
- Achieve competitive pricing and leverage innovations.

The desired result from P3 procurement is a seamless Ontario Line delivery that is cost-effective, efficient and accountable. Historically, this approach to procurement has achieved cost certainty with fixed pricing; supported delivery by or before the target construction and procurement milestones; minimized the integration risk associated with multiple procurements; and unlocked the greatest innovation potential by way of design optimization.

There are five major principles that drive the P3 value proposition:

1. **Fixed Price, Performance-Based Contracts** – the P3 model seeks to protect the public from cost overruns and ensure that private partners execute on their contractual obligations with poor asset/service performance resulting in financial penalties to the private partners.
2. **Optimal Risk Allocation** – the P3 model allocates risk based on the premise that the party best able to effectively manage a given risk, should assume that risk.
3. **Integration of design, construction, and maintenance** – the P3 model can enhance asset performance and residual asset value, resulting in savings associated with increased levels of competition and other efficiencies afforded through the private sector.
4. **Private Financing** – The P3 model provides access to capital and financing, imposing the discipline of the market and an additional layer of oversight on the project.
5. **Innovation -** The P3 model promotes private sector design innovation. The technical specifications are performance based, focused on customer benefits and technical outcomes. By specifying outputs rather than inputs, the private sector has freedom to optimize its solution from a cost and deliverability perspective.

Ontario Line Procurement Model

Based on these principles, Metrolinx and Infrastructure Ontario have developed a multi package procurement approach that aims to manage risk, unlock innovation, and deliver the Ontario Line faster and at a better value to the people of Ontario than other procurement models. This model is described in Table 7-1.

Table 7-1: Ontario Line Procurement Model

Procurement Package	Description	Status
Rolling Stock, Systems, Operations, and Maintenance (RSSOM)	• A 30-year-term design-build-finance-operate-maintain contract for the Ontario Line. This includes all rail track and systems, key operating responsibilities for the Ontario Line, and providing fleet along with a maintenance and storage facility. This contractor will work collaboratively with the TTC and integrate fare equipment with the PRESTO system.	Request for Qualifications Issued June 2020, Request for Proposal planned for Fall 2020
Southern Civil, Stations, and Tunnels	• A design-build-finance contract for the southern segment of the Ontario Line, from Exhibition/Ontario Place to the Don Yard portal (west of the Don River). This includes seven stations, a six-km tunnel, and civil works.	
Northern Civil, Stations, and Tunnels	• Scope will be defined in the Requests for Qualification when it is issued. The anticipated scope includes seven stations, a three-kilometre tunnel, two portals and the associated approach structures, bridges and elevated guideways.	Request for Qualifications planned for Spring 2022
Early Works	• Ontario Line from the Don Yard to Gerrard Street will be delivered as part of the GO expansion project. Much of this, as well as some work at Exhibition, will be delivered as “Early Works”, using conventional design-bid-build contracting.	Pre-qualification beginning fall 2020

Trade-offs between Capital and Operations and Maintenance Costs

An inherent benefit of a DBFOM contract with RSSOM is that they can make trade-offs between capital and O&M phases to minimize project whole life costs. However, the decision to procure most civil works with DBF means Metrolinx needs to use other means to ensure consider whole life costs are minimized. Metrolinx is setting reliability, availability and maintainability targets. These will be reviewed throughout design development and integration. Handover procedures will be set out between the DBF contractors and Metrolinx and between Metrolinx and RSSOM. These will include the provision of operation and maintenance manuals, staff training, asset registers and as-built records. Contractors will be required to collaborate to integrate, test and commission their work, as well as achievement of safety and sustainability certifications.

Project Delivery

This section explains the Ontario Line project governance, key project components and assumptions, and other management/delivery arrangements necessary to deliver the project successfully.

This section of the Deliverability and Operations Case includes the following sub sections:

- **Project Sponsors and Governance Arrangements –** a summary of the governance used to deliver the Ontario Line
- **Major Project Components –** a review of the key components included in the Ontario Line
- **Constructability –** a review of key construction considerations for the Ontario Line
- **Environmental Assessment Requirements –** a summary of the legislated environmental assessment requirements for the Ontario Line
- **Project Dependencies –** a review of the key dependencies for successful project delivery

Project Sponsor and Governance Arrangements

Overall responsibility for the delivery of the Ontario Line is with Metrolinx and Infrastructure Ontario. Both organizations are working in close collaboration with TTC and the City of Toronto, who bring design, development and operation knowledge, as well as capabilities to the project in different stages of its lifecycle. The responsibilities for finalizing the design, construction, partially financing, operating and maintaining the project are expected to fall to the P3 partners in collaboration with the TTC, with Metrolinx and Infrastructure Ontario being accountable for the development of an acceptable project. This accountability structure is expanded upon in Table 7-2.

Table 7-2:Roles and Responsibilities for Delivery

	Role
Metrolinx and Infrastructure Ontario	The joint Metrolinx and Infrastructure Ontario Team is responsible for the project as a whole. Metrolinx is the designated delivery organization and is leading on planning, design, delivery and operations, while Infrastructure Ontario is responsible for procuring, funding, and administering the prime contracts and identifying and implementing TOC opportunities. Metrolinx will provide the early works and review and comment upon the works of the successful RSSOM proponent (RSSOM ProjectCo) and civil contractors during the process of designing, constructing, testing, commissioning, and overseeing safety and security certification of all infrastructure for the Ontario Line. Additionally, Metrolinx will review and comment upon the works of the RSSOM ProjectCo during the process of operating, maintaining and managing the Ontario Line. Metrolinx will own all Ontario Line assets such as tunnels, structures, systems, stations, and vehicles. As the Owner, they will manage and oversee the operations and maintenance contract for RSSOM as well as executing third-party agreements with key partners such as the City of Toronto, the TTC, and GO Transit. Metrolinx is developing a Concept of Operations, Concept of Maintenance and Concept of Safety and Security to delineate the responsibilities between all parties involved in the operation and maintenance of Ontario Line. These documents are the baselines for the development of the operations and maintenance contract within the RSSOM contract. Detailed operations agreements will be developed between the RSSOM ProjectCo, the TTC, GO Transit and other third parties.
TTC and the City of Toronto	The TTC and the City of Toronto are supporting the design and development of the project and will share responsibility with Metrolinx and the RSSOM ProjectCo for operating and maintaining the line once complete. The TTC will be responsible for day-to-day operations as they related to customer-facing activities such as fare enforcement and network transit control. Coordination with the City of Toronto will be necessary for acquiring permits and agreeing on operating and maintenance hours for the Ontario Line. TTC is the subway, streetcar, and bus transit service provider for Toronto. There are integrated interchange stations between the Ontario Line and the existing TTC subway network at Osgoode station, Queen station and Pape station and the TTC-operated Line 5 (Eglinton Crosstown LRT) at Science Centre station. In addition, there are streetcar and bus lines that intersect with and feed the Ontario Line.
Civil Contractors	Civil contractors are the design and construction contractors for the Ontario Line civils, stations and tunnels infrastructure. Civil contractors may also provide infrastructure for the TTC where their infrastructure is impacted by the design and construction of civil works. Civil contractors will prepare training documentation and operations and maintenance manuals for civil contractors' infrastructure, which will be reviewed by the RSSOM ProjectCo.
RSSOM	RSSOM ProjectCo will be engaged in a 30-year operating period and will be responsible for the delivery of all rolling stock, rail systems, track, and the maintenance and storage facility (MSF). The RSSOM ProjectCo is accountable for achieving system integration and safety and security certification and will develop the Ontario Line operating rules and procedures governing operations and maintenance of the Ontario Line. The RSSOM ProjectCo will be responsible for delivering the performance of the operations and services in terms of reliability and availability. This allows Metrolinx to bring in international expertise on the efficient and reliable operation of driverless, unattended transit systems to Toronto.
GO Transit	GO Transit, a division of Metrolinx, is the regional public transit service for the Greater Golden Horseshoe, with routes that provide a cross-platform interchange with the Ontario Line at Exhibition Station and East Harbour Station. During the operation and maintenance phase of the Ontario Line, GO Transit will share responsibility to operate these stations and to ensure customers can make use of interchanges.
PRESTO	PRESTO is the fare payment and collection system used for transit in the GTHA, including TTC and GO Transit services. The system will be used for the Ontario Line, and the RSSOM ProjectCo is responsible for providing, monitoring and maintaining fare collection devices at all stations.

Major Project Components

Major components for the Ontario Line system are listed in Table 7-3, including information about the alignment, fleet, stations, MSF, and Systems, Signaling, and Equipment. Note that some details are likely to change as the DBF contractors and RSSOM finalize their designs.

Table 7-3:Major Capital Components

Rapid Transit Alignment	Fleet
• Fully segregated right of way, lighting • Emergency access/egress, Emergency Exit Building (EEBs) • Fire life safety systems • Cross passages (depending on tunnel configuration) • Guideway Intrusion Detection System (GIDS) • Berthing at terminal stations • Staging of trains • Storage for disabled trains • Staging of maintenance vehicles • Crossovers and transition trackage between the main line and the MSF • Crossovers and tail track for reversing trains at terminals, north of Science Centre and west of Exhibition • Crossovers for maintenance use and during service disruptions, between Queen and Moss Park stations and between Pape and Cosburn stations	• GoA4 (Grade of Automation 4) driverless vehicle system • Accessibility for Ontarians with Disabilities Act (AODA) compliant vehicles • Level boarding from station platforms • Maximum 100 m train length, 3.0 m train width • Ultimate capacity of 750 passengers per vehicle or 30,000 passengers per hour per direction assuming 40 trains per hour • Capacity includes a minimum of 20% seating • Bidirectional operation • Open gangways allowing movement between cars • Onboard signalling, train control, and communications equipment • Pantograph 1500V dc power supply and delivery • Automated passenger counting systems
Stations	**Maintenance and Storage Facility MSF**
• Accessibility for Ontarians with Disabilities Act (AODA) compliant stations • Station ambassadors • PRESTO fare gates and Ticket Vending Machines (TVMs) • Weather-protected waiting areas and transfer routes between subway and GO Transit • CCTV monitoring • Wi-Fi and cell phone coverage, • Consistent platform architecture, lighting, branding, and signage • Signage, system information panels and other wayfinding features • Emergency evacuation and ventilation systems • Fire alarm and fire suppression systems • Platform Edge Doors • Elevators and escalators to all platforms • Public Address System • Passenger Assistance Intercoms • Emergency Alarm Stations • Emergency Uninterruptible Power systems	• Operations Control Centre (OCC) and Backup OCC • Local control facilities for signaling and train control system at terminal stations and stations adjacent to interlockings • Local control facilities for ventilation control at each underground station • Local control facilities for the traction power system at each traction power substation • Security Operations Office (SOO) may be located at a station • CCTV monitoring • Infrastructure and station maintenance vehicles • Offices for RSSOM managers, supervisors, administrators, and engineers • Service and store trains • Departure test track

Systems, Signalling and Equipment

- Systems monitoring
- Communications based train control system
- Signalling and train control system
- Communication systems provided onboard trains
- Wi-Fi network and cell phone coverage
- Traction power via an overhead contact system, power of 1500V DC
- Power supply sectioning
- Radio
- CCTV/emergency phones on corridor

Constructability

Building a subway in developed neighbourhoods across a large and busy city is a complex design and engineering undertaking. The Ontario Line construction process will have several levels of complexity based on the location and type of infrastructure to be built.

- **Bridges** – The Ontario Line will cross over the Don Valley three times. Bridges are being designed to mitigate environmental and visual impacts, with limited construction staging areas especially in sensitive environments. Bridge designs will balance these objectives against costs and complexity.
- **Stations** – Stations in downtown are inevitably complex, because they need to fit in densely built up areas while providing efficient and high capacity access between trains, other transit lines, and street level.
- **Tunnels** – Tunnels and associated portals are inevitably expensive, highly complex structures. Various approaches are being taken to mitigate risks and impacts.
- **Joint rail corridors** – the Ontario Line will share existing GO rail corridors. While this will reduce costs and impacts compared with construction on a separate alignment, construction will need to take account of the need to maintain GO services and also access on intersecting streets, several of which have streetcar services.
- **Elevated sections** – There is substantial experience building elevated transit guideways in urban areas, although experience in Ontario is limited. The work is considered of medium complexity, with proven methods to mitigate impacts both during construction and after completion.

Key construction considerations are outlined in Table 7-4.

Table 7-4: Key Construction Considerations

Impact	Key Construction Considerations
General	• Significant property needed for laydown and staging areas; large staging sites are required downtown required as space is limited at each station location • Staging and laydown areas need to be identified and are required along entire corridor, particularly at portals and at MSF • Integration of RSSOM / Civil ProjectCo works to be well coordinated, handovers and access to construction site well defined • There will be significant utility relocations • Access to properties to be maintained, but some areas will require closures, such as the Queen Station area • MSF and bridge construction will impact the Don Valley, but impacts are to be minimized • Areas sensitive to noise and vibration (hospitals, schools, neighbourhoods, etc.) may need special mitigations • Properties without alternative access points during construction or properties with particular access concerns such as Eaton Centre and areas around Exhibition and Liberty Village will need to be factored into construction scheduling and access mitigations. Early engagement with stakeholders can help reveal special access requests that need to be factored into scheduling • Emergency vehicles access across the construction sites will need to be planned for • Pedestrian and cyclist access across the above grade sites could be challenging, but not insurmountable. Use of effective signage, detouring and keeping accessibility front of mind in terms of drop offs, ramps and debris can help alleviate issues. In areas of high pedestrian volumes, such as transit exchanges, additional care may be needed in developing access plans • Construction through intersections and along roads will be required. Where possible, these works can be timed to occur during weekends, overnight, or during holidays to expedite construction and minimize disruption
Tunnels/Portals	• Significant laydown space needed for portals and tunnels including spoils handling • Large volume of trucks to remove spoils and materials, haulage routes to be coordinated • Staging of tunnels portals critical to getting access to the RSSOM ProjectCo within the tunnels to do their work
Elevated Guideways	• Staging of elevated guideway over existing roads will require weekend closures
Shared Rail Corridor	• Coordination of shutdowns for working impacting GO rail operations
Stations	• Interface with existing stations, coordination with TTC required to tie into existing stations and systems • Traffic lane closures will require approval for staging of stations, impacts to bus/streetcar operations and infrastructure to be minimized

Additional constructability considerations are included in subsections below.

Alignment Construction

The alignment has been modified since the IBC to reduce costs and impacts while reducing travel times and increasing passenger benefits. It includes sections in deep tunnel, ground level and on elevated structures. Tunnels are likely to be constructed mostly using Tunnel Boring Machines (TBMs) but might also be built with a Sequential Excavation Mining (SEM) and open-cut construction methods.

Bridge Construction

Elevated sections are built with columns typically spaced 20m to 50m apart, and beams on which the tracks are laid. Various construction methods may be used, with beams cast-in-place, precast, or precast in short segments that are joined together into beams using post-tensioning cables. The choice of construction method will be determined by the infrastructure contractor, taking account of costs, time required for construction, and impacts during construction.

Station Construction

Stations are designed to provide capacity for initial and projected future demand, while integrating with the surrounding environment including future development of Transit Oriented Communities. Station design principles consider safety, accessibility, access to other transportation and transit, ridership and passenger experience, as well as costs, impacts, and time required for construction. Whether it is above or below ground, constructing a station is a multi-step process. Station construction typically begins with acquiring and clearing property, and protecting or relocating utilities such as power lines, water lines, sewers, gas pipes, cable and telephone lines and storm drains. Streets may need to be diverted and, where stations are being built in open cut, temporary decking may be required to provide access for local traffic during construction. Underground stations may be built in open cut or SEM. This can be a lengthy process, especially where access is limited to one or two shafts with limited surface space for stockpiling materials. Surface and elevated stations can be built more quickly using conventional construction methods.

Utility Works

When conducting any construction, infrastructure that is already in the area should be considered. Construction can involve the removal, replacement, relocation and upgrading of utilities. This means third party utilities (for example: gas, hydro and telecommunications) and city infrastructure (for example: water, sanitary sewer and stormwater) may need to be relocated and, in some cases, upgraded to make room for the Ontario Line.

Future Proofing Through Design and Construction

Key elements of the Ontario Line are being designed to protect for future demand growth:

- length of stations and thus ultimate train size and capacity;
- size and expandability of the MSF, and, thus, ultimate fleet size;
- size of station facilities, including platform width, escalators and elevators;
- power supply for stations and train operations; and
- fleet procurement, with options to purchase additional trains within the RSSOM contract.

Environmental Assessment Requirements

This project is being planned in accordance with the Ontario Line Regulation (Reg. 341/20) under the Environmental Assessment Act (EAA) O Reg. 341/20 acknowledges that certain types of transit projects have more predictable environmental effects that are more readily managed, and that a more streamlined approach to the Environmental Assessment (EA) is appropriate for these projects. The Ontario Line Regulation is a proponent-driven, self-assessment process that provides a defined framework for the proponent to follow. The Ontario Line Regulation includes provisions for consultation with the public, agencies and Indigenous communities in addition to Environmental Conditions, Early Works, and Environmental Impact Assessment reporting requirements.

The Environmental Conditions Report summarizes the local environmental conditions within the Ontario Line Project‘s footprint and surrounding area through a combination of desktop review and field studies. As per the Ontario Line Regulation, the Environmental Conditions Report also provides a preliminary description of potential impacts that the project may have on the environment and a description of how these impacts have been studied in further detail in the Early Works and/or Environmental Impact Assessment Report (EIAR). In addition, potential mitigation measures are described, and a preliminary list of potential permits and approvals is documented. The Ontario Line Early Works are components of the Ontario Line Project that are proposed to proceed before the completion of the Ontario Line assessment process (O Reg. 341/20). Early Works are considered to be of strategic importance to enabling the timely implementation of the project. The environmental impacts and mitigation measures for Early Works were assessed ahead of the rest of the Ontario Line project components and will be available before the Ontario Line assessment process commences.

The EIAR builds on the preliminary impacts and mitigation measures proposed in the Environmental Conditions Report. Technical studies were undertaken between 2019 and 2020 to supplement the studies undertaken for the Environmental Conditions Report, and to support the preparation of the EIAR to determine the existing environmental conditions, assess the extent of the potential effects associated with the Project, and to identify appropriate mitigation measures. The environmental and socio-economic effects of the Ontario Line project have been avoided or reduced to the extent feasible through the design process or will be addressed through mitigation measures proposed in the EIAR.

Consultation for the Ontario Line project occurs in two main stages – pre-planning activities undertaken prior to the Notice of Commencement of the Environmental Impact Assessment (EIA) and regulated EIA consultation activities undertaken following the Notice of Commencement of the EIA. Pre-planning activities include consultation to help inform the eventual EIAR. They are being undertaken to help inform design decisions and identify possible environmental effects and required mitigation measures. Pre-planning consultation activities include obtaining input from government agencies, municipalities, elected officials, members of the public, and Indigenous communities. Information sessions were held in January and February of 2020 to provide the public with an overview of the project and to collect feedback that has been used to inform project planning. In addition, feedback is being collected digitally using Metrolinx's online engagement platform throughout the pre-planning process. The documentation of the impact assessment process along with a consultation record will be submitted to the Ministry of Environment, Conservation and Parks within 100 days of publishing the Notice of Commencement.

Project Dependencies

There are a number of dependencies that should be considered for the Ontario Line project. These may include:

- interaction with GO Expansion and electrification projects, including changes to express and local ser-vices stopping at cross-platform interchange stations, as well as delivering early works on the GO Rail corridors;
- Eglinton Crosstown LRT delivery for integration at Science Centre Station;
- East Harbour Station Transit-Oriented Community development and connectivity with GO rail;
- Exhibition Station connectivity with GO rail;
- agreement with the City of Toronto regarding items like permitting, lane closures, and other construction projects; and
- Dufferin bridge and Dufferin loop extension and continued streetcar service downtown.

Metrolinx is working to proactively manage these interdependencies and ensure seamless delivery of the Ontario Line.

Operations and Maintenance Plan

This section provides an overview of the current Operations and Maintenance Plan for the Ontario Line.

The operations and maintenance plan review included in this PDBC includes the following subsections:

- **Operations Plan Overview** – a high-level review of the current operations plan for the Ontario Line.
- **Operations and Maintenance Key Roles and Responsibilities** – a summary of the keys roles and responsibilities included in the operations and maintenance plan.
- **Service and Maintenance Plans –** a summary of the service plans and approach to maintenance for the Ontario Line.
- **Human Resource Implications –** a summary of the staffing model for operating and maintaining the line.

Operations Plan Overview

Service Plan

The Ontario Line will operate as an integral part of the Toronto subway network, with the same service hours. First and last train times will be aligned so passengers can complete their journeys. During peak periods, a frequency of up to 40 Trains Per Hour (TPH) can be provided. With lower operating costs of an automated system, it will be possible to operate a more frequent service at off peak times. With an automated system, it is also easier to adjust capacity to match ridership throughout the day, and the RSSOM contract will provide flexibility to increase or decrease frequencies as travel patterns change and for special events. Bus and streetcar services will function as feeder services to Ontario Line, and their services will be adjusted by the TTC as needed.

Station Operations

Stations will have comparable operations to existing rapid transit stations. They will make use of automated passenger counting systems, accessible wayfinding features, emergency evacuation/ventilation systems, fire alarm and fire suppression systems, elevators/escalators for easier access, and designated waiting areas. They will improve upon existing operations standards by introducing platform edge doors at all station platforms. Communications facilities will include: a public address system, passenger visual information systems, passenger assistance intercoms, CCTV, emergency alarm stations at each end of the platform, voice and data radio coverage, and cell phone and Wi-Fi coverage.

Fare Collection System

The fare collection is through fare gates at all stations using a smart card fare collection system, which will be integrated with the PRESTO fare management system. Interchange stations with the TTC subway and GO Transit will have an integrated fare paid zone. Fare collection devices will include ticket vending machines and smart card validators integrated into the fare gates at stations. Passengers can purchase smart cards from full-service vending machines. Passengers without smart carts can purchase a limited-use card from a ticket vending machine that will be valid for a single ride. Smart card readers will be used by fare inspectors (TTC field staff) for proof of payment validation along the Ontario Line.

Train Operations

The Ontario Line will meet the Grade of Operations Four (GoA4) standard as defined by the International Electrotechnical Commission (IEC). Trains will be automatically operated during normal operations and procedures, including door closing, obstacle detection and also in emergency situations. On-board staff will not be required for safe operation. There are now more than 100 GoA4 systems, safely carrying millions of passengers each day. The oldest urban GoA4 system in the world is Vancouver Skytrain, which began revenue service in December 1985, having been expanded several times to 80 km with three lines. The Link train at Toronto Pearson Airport is a GoA4 system that has been operating since 2006. The Ontario Line will use a Communications Based Train Control (CBTC) system and will be equipped with the following Automatic Train Control (ATC) functions:

- **Automatic train protection (ATP)** – to maintain fail-safe protection against collisions, excessive speed, and other hazardous conditions, through safe train separation assurance, train detection, rollback protection, overspeed protection and interlocking functions;
- **Automatic train operation (ATO)** – performs a number of functions such as speed regulation, programmed stopping, door control, performance level regulation, or other functions otherwise assigned to a train operator; and
- **Automatic train supervision (ATS)** – monitors train performance, adjusts the performance of individual trains to maintain schedules, and provides data to adjust service to minimize inconveniences otherwise caused by irregularities, including applying and removing work zones and temporary speed restrictions. It also provides the external interfaces from the CBTC system to other rail systems.

The Ontario Line CBTC system will be capable of operating up to 40 trains per hour and will likely have a range of advanced capabilities including fully bi-directional operation, automatic route setting, and moving block train separation. These will support efficient operation and also service recovery after minor and major disruptions. Final specifications will be developed by the RSSOM ProjectCo.

Operations and Maintenance Key Roles and Responsibilities

Table 7-5 outlines required responsibilities to operate the Ontario Line. The accountable party for each responsibility will be defined during the continued development of the Ontario Line. The major partners in this process are Metrolinx (including GO Transit and PRESTO), TTC, the City of Toronto, contractors (ProjectCos), and development companies (DevCos). Specific roles will be defined as the project advances to future stages.

Table 7-5:Operations and Maintenance Required Responsibilities

Functions	Required Responsibility (to be confirmed in future stages of planning)
Operations	Operations of Revenue Vehicles
	Staffing of Operations Control Centre (OCC)
	MSF Yard Operations
	Cleaning of stations and vehicles
	Station Operations (for example: opening and closing stations, platform management, dwell time management)
	Customer-facing Station Operations (for example: in-person customer enquiries, providing customer directions)
	Provide bus substitution services during planned and unplanned service disruptions. (coordinated with OL-OCC)
Safety and Security	Safety of Passengers (for example: fire and life safety)
	Security of Passengers (for example: passenger and security related emergencies)
	Security of Ontario Line Infrastructure (for example: access to guideway)
	Staffing of security operations office
Customer service	Provision of digital passenger information related to the Ontario Line, including broadcasting of announcements using the public address system and messaging using the passenger visual information system
	Provision of face-to-face passenger information related to the Ontario Line through customer-facing station staff
	Provision of passenger information from interchanging transit services, including the broadcasting of announcements using the Public Address System and messages using the IDS
	Media relations related to the Ontario Line, including TV/radio interviews
	Social media relations related to Ontario Line
	Administration of Project Website
	Customer enquiries, through email, customer service number or Passenger Assistance Intercom
	Collection of lost property from Ontario Line Infrastructure and vehicles
	Distribution of lost property to Passengers
Fares	Fare Enforcement
	Fare Collection Systems (ticket vending machines, fare gates) and Fare Collection (collect cash, distribute PRESTO cards)

Maintenance Plan

RSSOM ProjectCo will be responsible for maintenance of the Ontario Line system. The RSSOM ProjectCo's maintenance plan will detail the asset management requirements for all aspects of the system, often influenced by manufacturer recommendations and past experience. From this, they will be able to create a detailed schedule for all asset maintenance.

It is expected that the MSF will be the base location for all maintenance activities, in particular, for the fleet. With RSSOM ProjectCo providing both the fleet and the MSF, facilities can be optimized for the flee in accordance with the vehicle supplier recommendations. This also allows RSSOM ProjectCo to adjust the size of the facility to match staff size and spares storage needs.

RSSOM ProjectCo will use an Enterprise Asset Management System to record all maintenance and repair activities and manage spares. Metrolinx will have access to this system to ensure the maintenance services completed in accordance with the plan, to ensure reliable and safe service delivery during and beyond the RSSOM contract term. It is expected that RSSOM ProjectCo will have staff positioned at stations and roving attendants on trains so it can quickly respond to equipment failures. Protocols will be developed to coordinate maintenance activities on the joint Ontario Line-GO corridor.

Maintenance will be planned to minimize disruption to passengers, with most infrastructure maintenance conducted overnight. Maintenance shutdowns, if required, will normally be on weekends and will be coordinated with TTC and GO Transit to ensure alternative transit service is available.

Metrolinx will establish inspection and renewal regimes for assets such as escalators, elevators, pumps and fans that are procured and installed by Civil and Early Works contractors but handed over to RSSOM ProjectCo for maintenance. RSSOM ProjectCo will carry out regular cleaning and inspection of the passenger vehicle with preventative and heavy maintenance at appropriate intervals. RSSOM ProjectCo will also be responsible for keeping stations clean and ensuring equipment including escalators, elevators, lights, ventilation, passenger information and fare collection equipment are all working in accordance with requirements. Performance regimes will incentivize RSSOM ProjectCo to maintain to high standards.

The RSSOM contract will set out requirements for the asset condition upon hand back at the end of the contract to ensure the Ontario Line can continue to operate efficiently and reliably. Metrolinx will conduct periodic inspections to ensure assets are in the agreed condition and as recorded in the Enterprise Asset Management System.

Human Resources Implications

The operation and maintenance plan will require the roles/staff outlined by functional area in

Table 7-6. As the project evolves, a complete staffing plan will be developed to deliver the project's operation and maintenance plan.

Table 7-6: Human Resources Implications of the Ontario Line

Functional Area	Type of Roles for Staff
Management, Business Administration and Procurement	• Management and Administration • Communications • Trainers/HR / Staffing / Labour Relations • Procurement and Contracts • Financial and Commercial • Health, Safety, Security, Quality, and Environment
Operations	• Operations Supervisors • Control Centre and supervisory control and data acquisition • Operational Performance and Planning • Fare Enforcement and Customer Services
Maintenance	• Stores • Fleet maintenance technicians and cleaners • Guideway and Systems • Asset Engineering and Maintenance Planning/Infrastructure Access
Facilities	• Facilities Custodians/Cleaning • Landscaping • HVAC, Vertical Circulation

Deliverability and Operations Case Conclusions

This section of the Deliverability and Operations Case provides a timeline for delivering the Ontario Line and a summary of its key risks and risk mitigation plan based on the preceding section.

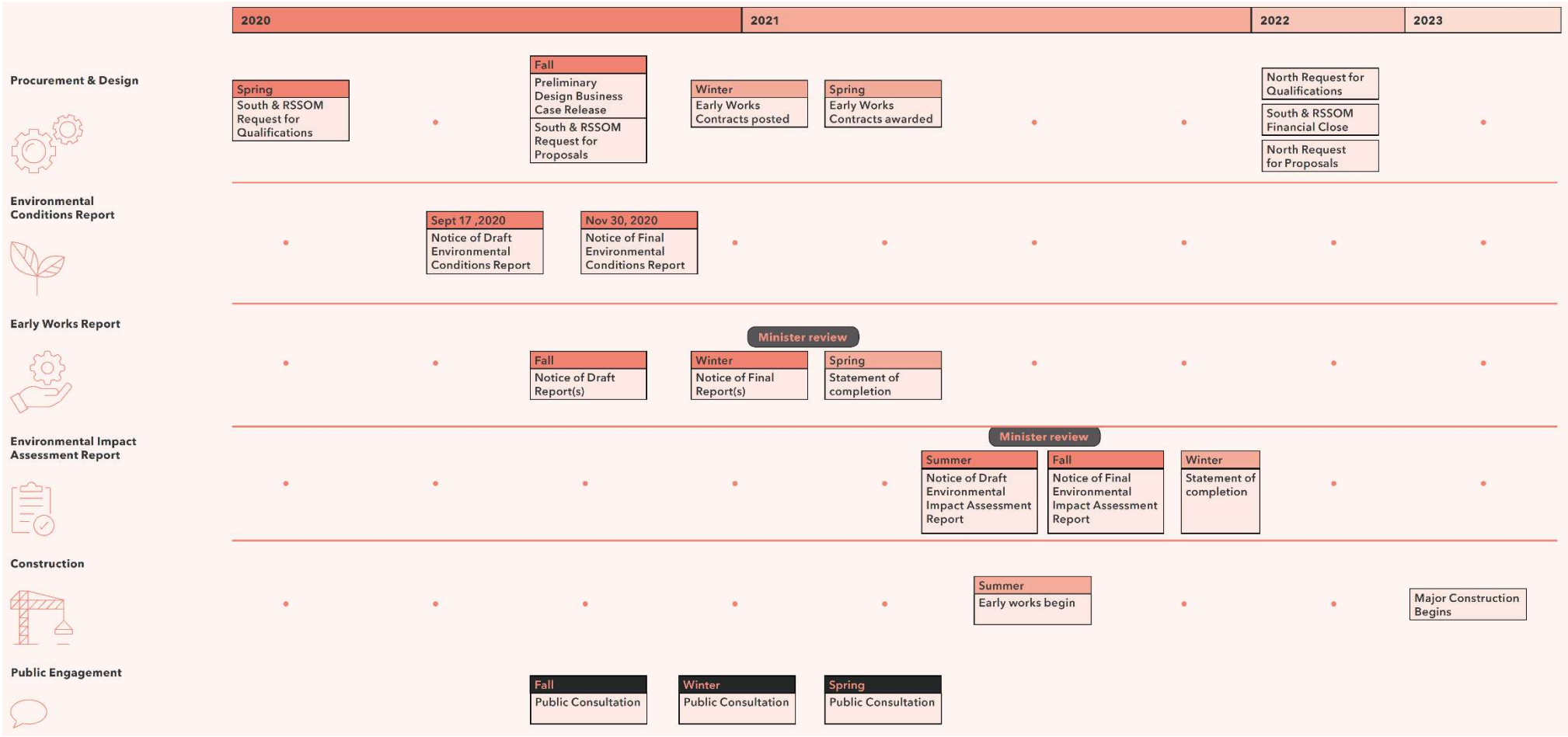
Timeline

The timeline for advancing the Ontario Line is shown in Figure 7-1, including time lines for procurement and design, environmental assessment, early works, construction, and public engagement.

Ontario Line Risk and Risk Management Plan

The preceding sections of the Deliverability and Operations Case outline the methods Metrolinx and Infrastructure Ontario will use to deliver, procure, operate, maintain, and manage the Ontario Line.

Figure 7-1: Ontario Line Delivery Timeline



A range of risks have been identified across these elements of the Ontario Line project, which are presented in Table 7-7.

Table 7-7: Ontario Line Delivery and Operations Risks

Risk Category	Risk Description	Risk Mitigation Approach
Procurement	Supply of skills may be constrained due to many other capital projects underway. This may result in escalating costs for labour and materials due to competing local demand for resources, equipment supply (such as trucks), sub-contractor availability, and some material.	Lead market engagement and create awareness.
Delivery/Construction	Delayed utilities relocations. This may happen due to additional work associated with non-identified customer connections; additional requirements not included in the design; and /or mis located utilities. Schedule impact - extend relocation time.	Establish agreements with utility operators. Close follow up on the progress during the bi-weekly meetings with utilities.
	Electric power network capacity may be inadequate to support temporary (construction) and/or permanent power needs. This may cause stop of works and additional cost during tunneling works.	Evaluate the current capacity, and plan forward. Work with electricity utilities to address requirements early. Design for location of substations and launch sites.
	Interdependencies of design. Interface and Integration between RSSOM and the various civil and station delivery organizations (North and South Civils, Station TOC DevCos, GO OnCorr, Metrolinx) Interface points between RSSOM and the various delivery organizations need to be aligned to mitigate risk of impacts on cost and schedule.	Increase communication amongst all parties: build understanding and find consensus. Prepare and analyze linear scheduling to include the interdependencies. Liquidated damages in each contract for each defined interface point. “Wrap” agreements as appropriate.
	Integration with other projects ongoing at the same time and space in the joint corridor. This may result in cost increase and schedule delay due to many interfaces.	Determine and agree on the schedule interfaces. Preform, monitor progress on the ongoing works
	Location or utilities different than documented in the SUE investigation and/or the utilities baseline design. This may have a cost and schedule impact.	Agree on the strategy for when this occurs (location identification different from SUE). Field investigation to be able to reduce the cost impact.
	Differing site conditions (DSC) compared to the GBR may result in cost and schedule impact, variations / change in quantities, claims.	Perform due diligence of the geotechnical investigations. Core sample drilling is underway along the entire corridor.
	Delays in acquiring Federal and Provincial property requirements. Note that Moss Park Armoury is a Federal site.	Identify key properties required from each level of government and conduct early engagement on property requirements. Establish an approval process.
Operations	Integration of railway systems including vehicles, power supply, signalling, and, platform doors. Fire and life safety systems that work together with railway systems, meet regulatory requirements and are acceptable to the emergency services. Developing an optimal service plan that manages uncertainty over operations, customer service strategy. Overcrowding when the system opens or in the future.	Railway systems and vehicles procured through a single RSSOM contract. RSSOM has responsibility for train, station, and tunnels safety. Early and continuing consultation with emergency services, with lessons learned from Eglinton Crosstown and other recent projects. Initial fleet is being procured to meet projected 2040 peak demand, with provision for additional fleet to be acquired. Stations are being built for 100m long trains, although 80m trains at 40 tph can carry expected demand to 2080. Station access (escalators, elevators, etc.) is being sized for projected 2080 demand. Develop a flexible approach to service delivery

8 Conclusion

METROLINX

Chapter Overview

This chapter provides a conclusion to the Preliminary Design Business Case (PDBC) for the Ontario Line. It includes the following sections:

- **Performance Summary –** a summary of the Ontario Line's performance across the four cases including a comparison to the Initial Business Case (IBC).
- **Next Steps –** a description of the next steps proposed for the Ontario Line based on the evaluation included in this PDBC.

Performance Summary

This PDBC evaluated a refined version of the Ontario Line project. Since the IBC was completed in July 2019, the Ontario Line project has undergone more detailed design, planning, and forecasting analysis to develop a refined concept minimizes costs and risks and maximizes benefits. During the design process, the scope, core benefits, and costs that were evaluated in the IBC have evolved.

The result of this planning and development work is an optimized and deliverable subway that:

- serve up to **374,000 to 388,000 trips each day**, making the Ontario Line one of the busiest rapid transit lines in North America;
- move up to **5,000 to 6,000 travellers off Line 1 during the busiest hour of the day**, freeing up capacity for other travellers;
- **make travel times faster and more predictable** – the Ontario Line could save customers seven minutes per trip on average and also make the Toronto transportation network more integrated and resilient to disruption;
- support urban development and improved access - **the Ontario Line connects underserved communities and areas planned for further development** by leveraging rail corridors and making use of new tunnels and structures; and
- generate at least **$9.9 to $11.3 billion in economic benefit** for the City of Toronto and the GTHA as a whole, with an expected BCR of 1.05– **meaning for every dollar spent the region will benefit by up to $1.05**.

Table 8-1 provides a summary of both the IBC and PDBC and identifies areas where performance has evolved. In this table the following colour coding is used to note rationale for difference in performance between IBC and PDBC:

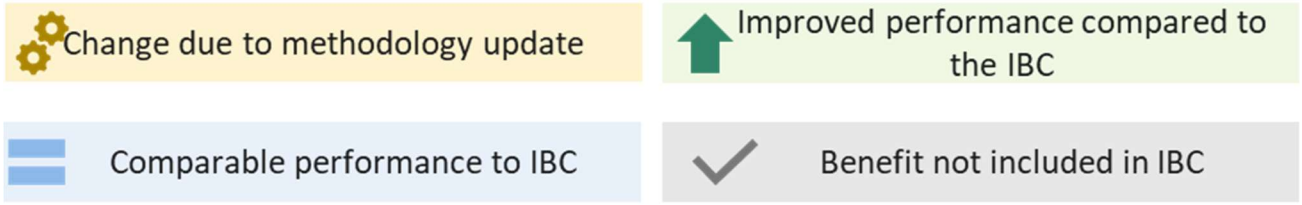


Table 8-1: Business Case Summary – IBC and PDBC Performance Comparison

Strategic Case	IBC Performance	PDBC Alignment with IBC Operating Concept	PDBC Alignment with Refined Operating Concept	Rationale for Change
1. Improved access to transit	• 389,000 trips per day	• 388,000 trips per day on the Ontario Line	• 374,000 trips per day on the Ontario Line	**Comparable performance** (Changes to input land use compared to IBC)
2. Increased access to economic activity	• +53,000 jobs accessible within 45 minutes by transit • +66,000 jobs accessible to lower-income Torontonians within 45 minutes by transit	• +47,000 jobs accessible within 45 minutes by transit • +57,000 jobs accessible to lower-income Torontonians within 45 minutes by transit		**Comparable performance** (Changes to input land use compared to IBC)
3. Support a synergistic relationship between transit and city building	• Transit Oriented Communities (TOC) could result in +20,000 new trips	• TOC could result in +55,000 new trips if delivered alongside the Ontario Line	• TOC could result in +52,000 new trips if delivered alongside the Ontario Line	**Improved performance** (Refined TOC forecasts)
4. Improved travel time and reliability	• 355 thousand minutes saved in peak hour	• 390 thousand minutes saved in peak hour		**Improved performance** (improved run times)
5. Improved comfort and safety	Significant crowding reduction during the busiest hour of the day • **Line 1:** -14% crowding • **Bloor-Yonge Station:** -17% crowding • **Eglinton Station:** -15% crowding • **Union Station:** -13% crowding	Significant crowding reduction during the busiest hour of the day • **Line 1:** -6,000 trips (-15% crowding) • **Bloor-Yonge Station:** -14,000 trips (-22% crowding) • **Eglinton Station:** -5,000 trips (-16% crowding) • **Union Station:** -14,000 trips (-14% crowding)	Significant crowding reduction during the busiest hour of the day • **Line 1:** -5,000 trips (-12% crowding) • **Bloor-Yonge Station:** -10,000 trips (-15% crowding) • **Eglinton Station:** -5,000 trips (-16% crowding) • **Union Station:** -14,000 trips (-14% crowding)	**Comparable Performance**
6. A more resilient and integrated transport network	• +39,000 transfers between Ontario Line and Rapid Transit and GO rail in peak hour	• +62,000 new trips on transit per day • +50,000 transfers between Ontario Line and the Frequent Rapid Transit Network	• +60,000 new trips on transit per day • +50,000 transfers between Ontario Line and the Frequent Rapid Transit Network	**Improved performance** (improved run times)
7. Moving people with less energy and reduced emissions	• -1 million tonnes of GHG emissions per year	• - 7.2 million litres of automobile fuel consumed per year • -14,000 tonnes of GHG emissions per year		Since the publication of the IBC, the GHG estimate in the published IBC was identified to be erroneous and has since been corrected and updated.
8. Improve Quality of life and public health	Note – indicator refined for PDBC to focus on health impacts not captured in IBC	• -28,000 car trips a day resulting in -1,200 collisions causing death or injury over the project lifecycle		**Current version of benefit not included in IBC**
9. Unlocking jobs and economic development	New benefit in PDBC	• +4,700 jobs per year supported between 2020-2030		**New benefit not included in the IBC**

Economic Case	IBC Performance **(million 2019$)**	PDBC Alignment with IBC Operating Concept **(million 2020$)**	PDBC Alignment with Refined Operating Concept **(million 2020$)**	**Rationale for Change**
Total Economic Benefits (million $)	$9,200	$10,230 to $11,310	$9,900 to $10,960	**Improved performance** Optimized run times, interchanges, and consideration of additional user benefits
Total Costs (million $)	$10,400 to $12,000	$9,910 to $10,550	$9,610 to $10,260	**Improved performance** Detailed design that allows greater certainty on costs and risks
Expected NPV (million $)	-$2,800 to -$1,200	$540	$500	**Improved performance** Improved benefits with costs that have decreased relative to IBC high-end estimates.
Expected BCR	0.76 to 0.88	1.05	1.05	
Financial Case				
Capital Costs (million $)	$9,500 to $11,400*	$8,600	$8,420	**Improved performance and change in assumptions** Detailed design that allows greater certainty on costs and risks. Terminal value of land was not included in the IBC.
Operations and Maintenance Costs (million $)	$1,900	$1,570	$1,410	**Improved performance** Improved 'bottom up' operating cost model
Revenue Impact (million $)	$1,800	$ 2,430	$ 2,360	**Change in assumptions** Fares no longer have a discounted double fare
Net Financial Impact (million $)	-$9,600 to $11,500	-$7,740	-$7,470	**Improved performance** Refined costing has resulted in a net financial impact lower than the IBC
Revenue Operating Cost Ratio	0.95	1.6	1.7	**Improved performance** Increases in revenue and decreases in operating costs relative to IBC
Deliverability and Operations Case				
Procurement Approach	**IBC reviewed a range of P3 delivery models.**	Metrolinx and Infrastructure Ontario will use a multipackage P3 model to deliver the Ontario Line while mitigating key risks and maximizing value for money and operational flexibility.		Metrolinx and Infrastructure Ontario developed a procurement model based on market sounding and further technical analysis and planning.

*If accounting for terminal value of land (Present Value = $1,016 million), as was done in the PDBC, the IBC capital costs would be $8,480 to $10,380 million

Option Performance Comparison

This PDBC compared two operating concepts using the same optimized PDBC alignment and station designs. These options included the IBC operating concept (40 TPH in the peak with 100 m trains) and a refined operating concept developed for the PDBC (34 TPH in the peak until 2041, 40 TPH in the peak beyond 2041 with 80 m trains). Both options were evaluated throughout the business case to identify key lessons and findings to inform next steps for Ontario Line project development. Across the PDBC the following findings and lessons were identified:

- both options can realize similar strategic and economic benefits across most indicators and have the same economic BCR (1.05), however, the refined operating concept has reduced crowding benefits (for travellers on the Ontario Line as well as those who use other rapid transit lines) as it uses smaller trains and attracts fewer trips off of Line 1 – these impacts are most pronounced later in the project lifecycle beyond 2060;
- adopting the refined service concept can also reduce operating and capital costs in support of a lower overall net financial impact; and
- there are a range of tools Metrolinx can consider alongside train size to optimize customer experience – including off-peak frequencies and incentives to encourage customers to shift from the peak to the off-peak.

Based on these findings, the following considerations are noted for further development in the FBC for the Ontario Line:

- optimize train size and peak and off-peak frequencies to respond to customer need, demand levels, and travel patterns;
- include explicit off-peak forecasting and benefits analysis in future stages of planning and business case analysis; and
- explore how fare integration, off-peak fares, and other travel incentives could help manage demand relative to capacity on the Ontario Line and across the subway network.

The following overall conclusions are drawn from the PDBC and IBC comparison:

- overall Ontario Line performance in the Strategic and Economic cases has improved since the IBC – the application of benefits management throughout the planning process has augmented key benefits (such as travel time savings);
- costs were minimized and key risks were mitigated throughout the preliminary design process – across the Economic Case and Financial the PDBC costs are either close or below the 'low end' estimate presented in the IBC;
- while the PDBC makes use of revised land use forecasts that are in general more conservative than IBC forecasts (which would typically result in lower ridership and benefits) and does not include GO-TTC fare integration, the improved runtimes included in both options generate a comparable level of ridership compared to the IBC (noting that with similar land use and fare assumptions used in the IBC, ridership in the PDBC would be expected to be higher);
- the Financial Case notes overall improvements to the financial efficiency of the project – both capital costs and operating costs have been optimized which has resulted this results in a project with a more manageable net financial impact and greater revenue to operating cost ratio; and
- the PDBC development and preliminary design process has generated a more cost-effective Ontario Line with increased benefits, as is evidenced by the higher range of BCRs in the PDBC (1.05 compared to 0.76 to 0.88) and higher total benefits ($9.9 to $11.3 billion in the PDBC compared to $9.2 billion in the IBC).

Next Steps

The following potential next steps have been identified for the Ontario Line:

- harnessing lessons learned during the development of this PDBC to develop a refined reference concept design and concept of operations;
- advancing to procurement milestones – the request for qualifications (RFQ) for Civils North and Rolling Stock Systems Operations and Maintenance (RSSOM) were released in June 2020 and request for proposals (RFP) are planned for release in Fall 2020; and
- developing the FBC to advance the project towards final approvals and confirm costs, benefits, and key technical and design choices.