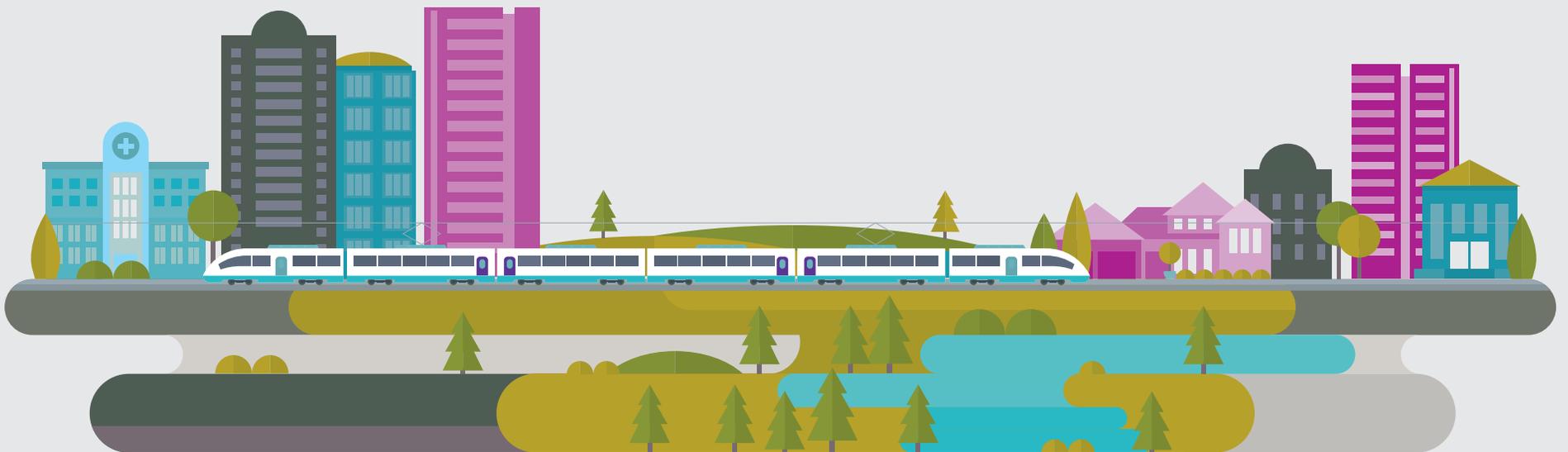


Preliminary Business Case for High Speed Rail on the Toronto to Windsor Corridor

Prepared for the Special Advisor
for High Speed Rail

Through the Ontario Ministry of Transportation

November 2016



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N.B. Un sommaire français de la publication ci-haut mentionnée est disponible en ligne - [Analyse de rentabilité préliminaire du train à grande vitesse dans le couloir Toronto-Windsor](#).

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November 2016

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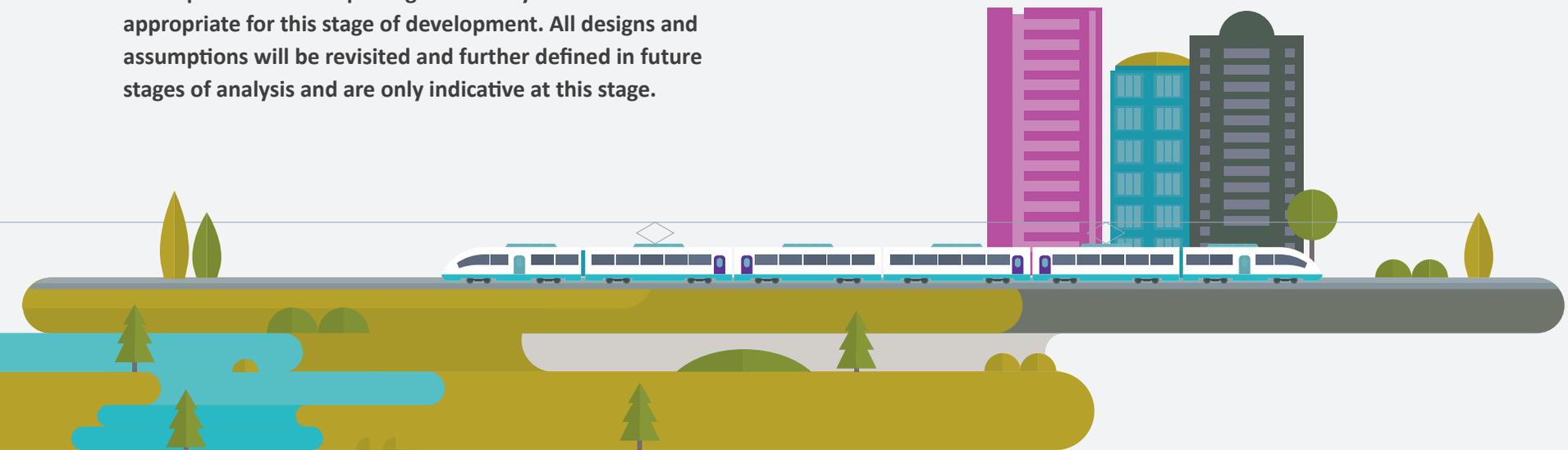
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This Preliminary Business Case report provides an assessment of the case for a High Speed Rail (HSR) line between Toronto and Windsor. The work has been undertaken to build upon previous HSR studies and support the Government and the Special Advisor for High Speed Rail's report on HSR. The analysis detailed within this business case will also inform the next stage of design for HSR as part of the Environmental Assessment (EA) process. This work has been completed with a number of assumptions to develop design and analysis tools that are appropriate for this stage of development. All designs and assumptions will be revisited and further defined in future stages of analysis and are only indicative at this stage.



Executive Summary

The 2014 Minister of Transportation's mandate included advancing the environmental assessment of High Speed Rail (HSR) along the Toronto to Windsor transport corridor that would provide services between Toronto, Pearson International Airport, Kitchener-Waterloo, London and Windsor. The commitment to advance the Environmental Assessment process has been reaffirmed in 2015 and 2016 Budgets as part of the Moving Ontario Forward plan. On October 30, 2015, the Honourable David Collenette, was appointed as Special Advisor to assist the province in bringing HSR to the corridor. The 2016 Minister's mandate letter outlined the development of the overall HSR project, including a time line to deliver the Environmental Assessment:

“Continuing to support the Special Advisor on High Speed Rail in the development of his report back on the economic development opportunities, financing models and feasibility for delivering high speed rail in Southwestern Ontario, in fall 2016. You will also issue the Request for Proposal for the Environmental Assessment related to this project in 2017.”

The preliminary business case for HSR is a key input to begin the Environmental Assessment (EA) process for HSR. To do so, this business case was framed to:

- Develop and define two HSR scenarios for the Toronto to Windsor Corridor as directed by the Special Advisor; and
- Analyze the scenarios using a preliminary business case framework to inform future phases of work.

This report summarizes the development of the HSR scenarios as well as their evaluation using the four chapter business case framework. This study builds upon previous studies for HSR in Canada with a focus on the Toronto to Windsor Corridor. These past studies assessed potential corridors, including a connection from Windsor to Quebec City¹ (Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor), as well as a direct connection between Toronto and London² (Toronto-Kitchener-London Ontario HSR Pre-Feasibility Study).

¹ Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor, EcoTrain, 2011

² Toronto-Kitchener-London Ontario HSR Pre-Feasibility Study, First Class Partnerships 2014

High Speed Rail Background

In general, “High Speed Rail” refers to a rail service that is able to achieve significantly faster speeds than conventional rail³ – including those currently operated in the Province of Ontario.

The International Union of Railways (UIC) has developed a definition of HSR:

... high speed is a combination of a lot of elements which constitute a whole “system”: infrastructure (new lines designed for speeds above 250 km/h and in some cases, upgraded existing lines for speeds up to 200 or even 220 km/h), rolling stock (special designed train sets), operating conditions and equipment, etc.⁴

HSR has been pursued in numerous countries across Europe and Asia as a means to provide improved mobility and trigger economic development. In the North American context, HSR has been explored as a potential transport investment in Canada and the USA. In general, the key factors that distinguish HSR from conventional rail in Europe and Asia include:

- Dedicated passenger lines with limited or no shared use with freight or conventional rail;
- Development of an HSR network as part of an existing rail network with built up demand;
- Use of city centre stations that offer strong integration with other regional, commuter, and metro/rapid transit networks;
- Use of standardized infrastructure throughout the network; and
- Use of electrified operations.

HSR projects have been initiated to achieve varying policy goals around the world. Benefits of high speed rail projects go far beyond the ‘high-speed’ headline and include:

- Increasing the capacity of existing passenger rail networks;
- Increasing economic competitiveness of regions by providing rapid and reliable connections between major employment and economic centres; and
- Provision of more sustainable transportation options.

Corridor Context

The Toronto to Windsor corridor is home to over 7 million people, making it Ontario’s most populous transport corridor. Economic activity along the corridor provides over 3.4 million jobs and consists of knowledge-based economies, manufacturing, hospitality/tourism, and agriculture. Additionally, the corridor connects 8 major Canadian universities and several colleges and trade schools.

A number of travel options are available along the corridor, including:

- Auto: travellers can use the provincial highway network, including the 401, which connects the major cities along the corridor;
- Rail: travellers may use GO Rail (peak direction service from Kitchener-Waterloo to Toronto), and VIA Rail;
- Bus: travellers may use GO Bus (frequent departures with connections in the Greater Toronto and Hamilton Area (GTHA) for short distance, and private operators for corridor travel; and
- Air: travellers may fly between Toronto and Windsor and Toronto and London.

³ Conventional Rail services typically operate on infrastructure that is speed constrained (less than 160 km/h) and do not employ a number of the technologies that enable High Speed Rail to reach speeds in excess of 200 km/h

⁴ Source: <http://www.uic.org/highspeed>

The corridor's primary means of travel is the automobile, which serves over 92% of all trips. Bus services serve 5% of trips and are offered predominantly by Greyhound, with some services provided by GO Bus in the GTHA. Rail services (provided by GO and VIA Rail) account for 1.9% of all trips. Flights are offered for longer distance inter-corridor travel, but only serve 0.1% of all demand. Key mobility challenges and opportunities for the corridor are outlined in Figure 1.

FIGURE 1: TORONTO TO WINDSOR CHALLENGES AND OPPORTUNITIES FOR MOBILITY



Challenges

Congested Auto Network

- Congestion is a critical issue that slows auto travel along the corridor- even with congestion, automobile has the highest mode share
- Automobile dependent corridors have increased pollutant and greenhouse gas (GHG) emissions and increased risk of transport accidents, injuries, or fatalities

Rail Service Issues

- Rail services are typically used for commuter trips; however, available track and track quality impacts frequency and travel times, which limits use of rail
- Travel times and frequencies between Kitchener-Waterloo and Toronto, and London and Toronto may limit demand

Air Travel - Future Capacity Constraints & Customer Costs

- Air travel is costly and still requires secondary modes to access urban cores; additionally, Pearson Airport seeks to expand its role as an even larger international hub and needs approaches to manage congestion

Bus Network

- Buses serve long distance trips with lower fares
- Bus services have limited capacity per vehicle, and do not consistently offer competitive travel times



Opportunities

Expand Rail Network

- Build upon existing rail network by offering speed and frequency improvements
- At a corridor level, this opportunity would allow for more frequent and reliable services between key demand centres and reduce travel times and position rail as a true competitor to the automobile

Align Transport Investment to Support Growth and Economic Development

- Align transport investment to support growth plans and potential economic development in urban areas along the corridor
- This would include the development of economic knowledge hubs in the GTHA and Kitchener-Waterloo, and a multi-modal transport hub at Pearson Airport

Relieve Congestion and Optimize the Network

- Utilize transport investment to relieve congestion and optimize the existing transport network
- This investment should consider its ability to provide an alternative to the automobile, which can alleviate congestion on the highway network

HSR Vision

A vision and accompanying set of goals and objectives were developed to guide the design and evaluation of HSR in the corridor in order to respond to the challenges and opportunities along the corridor.

FIGURE 2: VISION, GOALS, AND OBJECTIVES FOR HSR

Vision:

To transform mobility in Southwestern Ontario in order to connect communities, integrate centres of innovation, and foster regional and economic growth and development



Transform Mobility Choice in Southwestern Ontario

The Toronto-Windsor corridor will provide efficient and sustainable mobility in Southwestern Ontario



Provides new/ improved mobility choices for travellers along the corridor



Provides good value for money and optimal utilization of infrastructure



Improves overall transport efficiency and resilience throughout the region



Limits negative environmental impacts of travel on the corridor



Catalyze Economic Development

The Toronto-Windsor corridor will connect innovation hubs and centres of knowledge and industry to enable municipal and regional economic growth and development



Connects centres of employment and business



Connects knowledge centres throughout corridor



Triggers wider economic benefits



Manages interactions between freight and passenger travel to promote economic development



Supports Regional Integration & Development

The Toronto-Windsor corridor will support regional integration and development at a municipal, regional and corridor level



Connects major population, cultural and activity centres



Minimizes impact on natural and social environments



Integrates with urban form and transport networks



Supports development around stations

Representative HSR Scenarios

Two representative scenarios were developed to assess how HSR may perform in the Toronto-Windsor corridor:

- **Scenario A:** HSR designed for a top speed of 300km/h throughout the corridor that is developed with the highest level of infrastructure investment; and
- **Scenario B:** HSR designed to leverage existing corridors where possible in order to provide an HSR service with a top speed of 250 km/h.

These scenarios are summarized in Figures 3 and 4. Costs for each scenario have been estimated based on capital costs (cost to procure the overall infrastructure and vehicles), operating costs (including maintenance of infrastructure and staffing/labour for an HSR operating body), and renewal costs (costs to replace infrastructure at the end of its service life). Costs were estimated following international best practice, including uplifts to account for environmental mitigation, design fees, and a 66% contingency factor.⁵

Scenario A assumed a 300 km/h electric vehicle, while Scenario B considered a 250 km/h

electric vehicle that for the purpose of this study is assumed to employ tilting technology.

Each scenario was assumed to be delivered in a phased and consistent manner:

	Scenario A	Scenario B
Phase 1 (Toronto to London)	Service between Toronto/London with direct access to Pearson International Airport	Service between Toronto/London with indirect access to Pearson International Airport
Phase 2 (London to Windsor)	Expanded alignment with a new station at Windsor	Expanded alignment with new stations at Chatham and Windsor

Phase 2 operations are assumed to start in 2031 for analysis purposes only.

Evolution of Rail Service on the Corridor

Both HSR scenarios have been scoped to optimize the use of existing infrastructure plans and investments along the corridor. This includes alignment with Metrolinx's (the regional transport agency for the GTHA) GO Regional Express Rail (GO RER) program. GO RER is a major provincial initiative that was publicly committed to in the 2015 and 2016 provincial

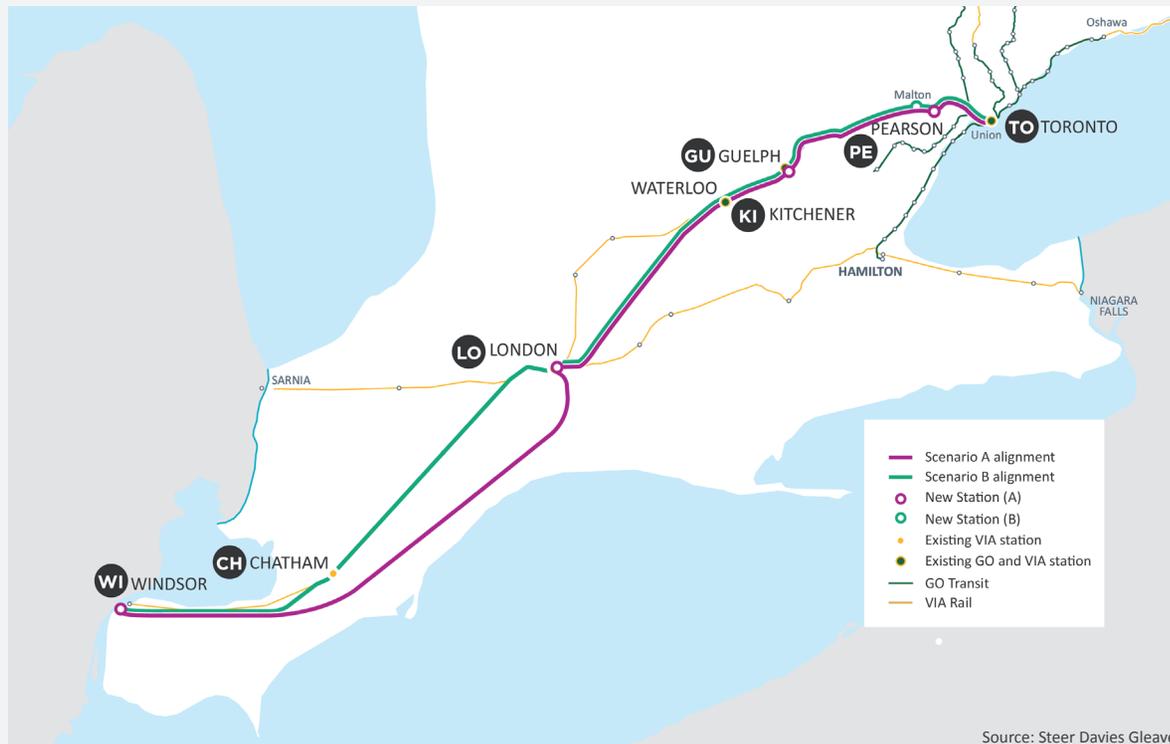
budgets. It will bring all-day bi-directional service to a majority of GO Transit stations by partially electrifying the current GO Transit network. The Toronto to Kitchener-Waterloo Corridor will see an improved two way all day electrified service as part of this ambitious plan.

The HSR corridor includes Toronto, Pearson International Airport, and Kitchener-Waterloo – all of which are currently served by Metrolinx services and will be served as part of the GO RER network.

HSR services have been scoped to leverage on planned improvements for GO RER and to also inter-operate with GO RER. All HSR costs along the Toronto to Kitchener-Waterloo corridor are assumed to be incremental to upgrades required for GO RER. Furthermore, an operating timetable has been developed to ensure the two services can inter-operate safely and effectively on shared infrastructure at a high level. Future studies should aim to further integrate and optimize these two services with respect to ridership, benefits, and costs.

⁵ American Association of Cost Engineering (AACE) guidelines: https://www.nsf.gov/about/contracting/rfq/s/support_ant/docs/facility_manuals/palmer_mcm_and_southpole/costestimatingssystemaace-208a.pdf

FIGURE 3: HSR ALIGNMENT AND STATIONS



Scenario A	Station Description
TO	Union Station
PE	New underground station
GU	New underground station
KI	Expansion of planned GO/VIA Rail Station
LO	Relocation of existing station
WI	New Station

Scenario B	Station Description
TO	Union Station
PE	Renovation & expansion of Malton Station
GU	Renovation of existing station
KI	Expansion of planned GO/VIA Rail station
LO	Renovation & expansion of existing station
CH	Renovation & expansion of existing station
WI	New station

Scenario A

300 km/h

Maximum Speed



Electric traction



Dedicated HSR right of way

Scenario B

250 km/h

Maximum Speed



Electric traction



Dedicated HSR right of way

FIGURE 4: HSR ALIGNMENT AND RUNTIMES

Scenario A	 Travel time on segment (min)	 Distance (km)	Description
TO ▶ PE	14	22.8	Use of existing rail alignment along the Union Station Rail Corridor (USRC) and Kitchener Line until Humber River. Tunnel from Humber River to Pearson Airport to allow for underground rail access
PE ▶ GU	18	53.9	Tunnel through to western Brampton, return to existing Kitchener Line until Rockwood, access Guelph in greenfield alignment with tunnel into Guelph under College Ave alongside the University of Guelph
GU ▶ KI	9	21.8	Use of Greenfield alignment and Guelph subdivision to access downtown station in Kitchener Waterloo
KI ▶ LO	25	87.1	Guelph subdivision to western limits of Kitchener, greenfield alignment alongside hydro corridor to allow high speed travel to eastern limits of London, trench alongside CN Dundas line into London
LO ▶ WI	49	190.7	CN Talbot line exiting London, onto former Canadian Southern Line to the west and through a greenfield curve to new track along the CP Windsor line at Tilbury with a connection to downtown Windsor
Total	115	376.3	

Scenario B	 Travel time on segment (min)	 Distance (km)	Description
TO ▶ PE	16	27.8	Use of existing rail alignment along the URSC and Kitchener Line leading to Malton Station Shared operations along alignment
PE ▶ GU	23	49.9	Use of upgraded Kitchener Line right of way
GU ▶ KI	9	18.1	Use of upgraded Kitchener Line right of way
KI ▶ LO	25	88.3	Guelph subdivision to western limits of Kitchener, green field alignment alongside hydro corridor to allow high speed travel to eastern limits of London, new tracks alongside CN Dundas line into London
LO ▶ CH	29	105.6	Development adjacent to existing CN line with connection in Chatham
CH ▶ WI	22	75.6	Cross over to a new track along the CP Windsor line with a connection to downtown Windsor
Total	124	365.3	

HSR Business Case Summary

A preliminary business case includes four chapters that address the potential for HSR based on multiple considerations. The HSR scenario business case analysis was driven by the cost of delivering HSR and changes in ridership along the corridor, and their resulting benefits and revenues. The ridership estimates for each scenario are:

- **Scenario A:** 11.6 million riders per year, resulting in a 12% HSR corridor mode share; and
- **Scenario B:** 10.6 million riders per year, resulting in a 11% HSR corridor mode share.



Strategic Case

Assesses the alignment of the alternatives with the project's vision/goals as well as policies and plans



Economic Case

Assesses the economic, social, and environmental impacts of the proposed alternatives, including a cost benefit analysis



Financial Case

Examines lifecycle costs and revenues of the project to understand its broader financial implications



Deliverability & Operations Case

Assesses issues and risks associated with project delivery and operations

Strategic Case: Scenario A



Transform Mobility Choice in Southwestern Ontario

The Toronto-Windsor corridor will provide efficient and sustainable mobility in Southwestern Ontario



Objective: Develop a transport service that provides new/improved mobility choices for travellers on the corridor
Performance: 115 minute corridor travel time yielding 11.6 million riders/year



Objective: Develop a transport service that provides good value for money and optimum utilization of infrastructure
Performance: Similar ridership to Scenario B but low value for money because its costs are 270% times greater than Scenario B



Objective: Develop a transport service that improves overall transport efficiency and resilience throughout Southwestern Ontario
Performance: 12% HSR mode share



Objective: Develop a transport service that limits negative environmental impacts of travel in the corridor
Performance: 7.9 million tonnes CO₂ reductions over lifecycle



Catalyze Economic Development

The Toronto-Windsor corridor will connect innovation hubs and centres of knowledge and industry to enable municipal and regional economic growth and development



Objective: Provide a transport service that connects centres of employment and business
Performance: Serves 1,160,000 jobs that typically benefit from HSR



Objective: Provide a transport service that connects knowledge centres throughout a corridor
Performance: Major centres (academic and industrial) are linked across the corridor



Objective: Provide a transport service that triggers wider economic benefits
Performance: Travel time improvements strengthen economic integration and expand each major centre's commute shed



Objective: Provide a transport service that manages interactions between freight and passenger travel, to promote economic development
Performance: Tunnel allows for improved segregation



Supports Regional Integration & Development

The Toronto-Windsor corridor will support regional integration and development at a municipal, regional and corridor level



Objective: Provide a transport service that connects major population, cultural and activity centres
Performance: Serves a population of 13 million people in 2041



Objective: Provide a transport service that minimizes impact on natural and social environments
Performance: HSR alignment interacts with natural areas and will require further mitigation strategies in future studies



Objective: Provide a transport service that is integrated with urban form and transport networks
Performance: HSR stations (except at London and Guelph) are integrated with each centre's downtown core with opportunities for transit network connections



Objective: Provide a transport service that supports urban development
Performance: Provides strong development potential around Pearson International Airport and downtown cores of Toronto, Guelph, Kitchener-Waterloo, and Windsor

Strategic Case: Scenario B



Transform Mobility Choice in Southwestern Ontario

The Toronto-Windsor corridor will provide efficient and sustainable mobility in Southwestern Ontario



Objective: Develop a transport service that provides new/improved mobility choices for travellers on the corridor
Performance: 124 minute corridor travel time yielding 10.6 million riders/year



Objective: Develop a transport service that provides good value for money and optimum utilization of infrastructure
Performance: Similar ridership to Scenario A with higher value for money because costs are 37% times that of Scenario A



Objective: Develop a transport service that improves overall transport efficiency and resilience throughout Southwestern Ontario
Performance: 11% HSR mode share



Objective: Develop a transport service that limits negative environmental impacts of travel in the corridor
Performance: 7.8 million tonnes CO₂ reductions over lifecycle



Catalyze Economic Development

The Toronto-Windsor corridor will connect innovation hubs and centres of knowledge and industry to enable municipal and regional economic growth and development



Objective: Provide a transport service that connects centres of employment and business
Performance: Serves 1,162,000 jobs that typically benefit from HSR



Objective: Provide a transport service that connects knowledge centres throughout a corridor
Performance: Major centres (academic and industrial) are linked across the corridor



Objective: Provide a transport service that triggers wider economic benefits
Performance: Travel time improvements strengthen economic integration and expand each major centre's commute shed



Objective: Provide a transport service that manages interactions between freight and passenger travel, to promote economic development
Performance: Separate alignments assuming freight rail rationalization



Supports Regional Integration & Development

The Toronto-Windsor corridor will support regional integration and development at a municipal, regional and corridor level



Objective: Provide a transport service that connects major population, cultural and activity centres
Performance: Serves a population of 13 million people in 2041



Objective: Provide a transport service that minimizes impact on natural and social environments
Performance: HSR alignment interacts with natural areas and will require further mitigation strategies in future studies



Objective: Provide a transport service that is integrated with urban form and transport networks
Performance: HSR stations are integrated with each centre's downtown core with opportunities for transit network connection



Objective: Provide a transport service that supports urban development
Performance: Provides strong development potential around Malton station and in downtown cores of all cities served

Economic Case

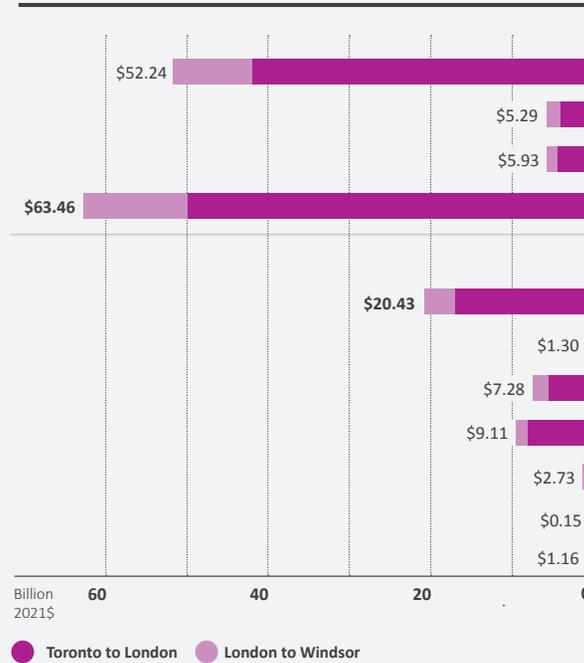
Economic appraisal was conducted over the construction period and a 60 year operating period. Key highlights from this appraisal include:

- Scenario B’s economic performance is higher than Scenario A and can likely be improved through further value engineering and optimization;
- Phase 1 for scenario B has a benefit cost ratio of 1.02 and a net present value of \$0.41 Billion – indicating overall strong benefit to the economy and good value for money; and
- Phase 2 has lower economic benefits but significant costs compared to Phase 1.

Notes:

The total capital costs include a significant contingency (66%). Cost methodology is detailed in Chapter 3

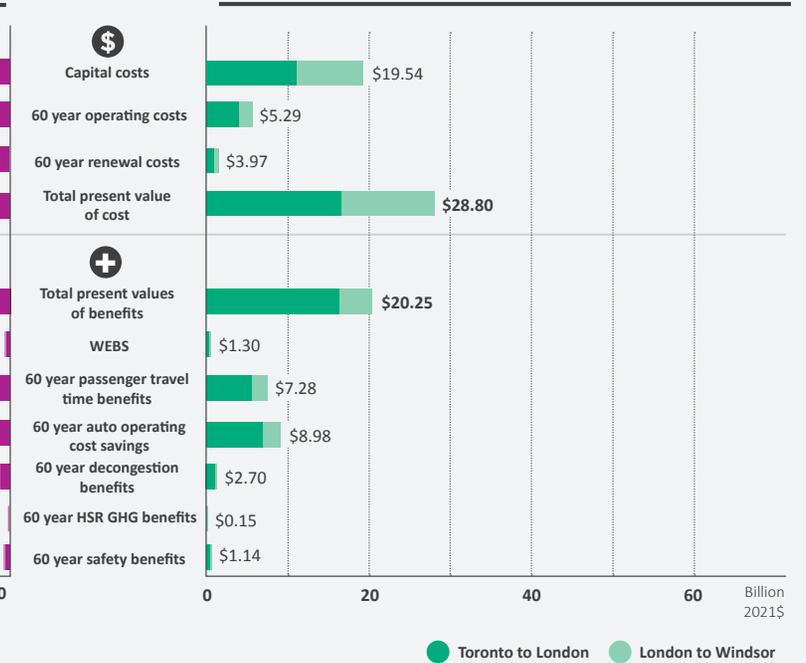
A Economic Appraisal



A Performance

	TO	LO	Total Project
Benefit cost ratio	0.36	0.17	0.32
Net present value (Bn 2021\$)	-\$31.92	-\$11.13	-\$43.03
Expanded BCR (included WEBS)	0.38	0.19	0.34
Expanded NPV (Bn 2021\$ included WEBS)	-\$30.77	-\$10.98	-\$41.73

B Economic Appraisal



B Performance

	TO	LO	Total Project
Benefit cost ratio	1.02	0.24	0.70
Net present value (Bn 2021\$)	\$0.41	-\$9.05	-\$8.55
Expanded BCR (included WEBS)	1.09	0.26	0.75
Expanded NPV (Bn 2021\$ included WEBS)	\$1.56	-\$8.90	-\$7.25

Financial Case

Financial appraisal was conducted over the initial construction period and a 60 year operating period. Key highlights from the financial analysis include:

- Total operating revenues exceed total operating costs. 2041 is the first year where revenue meets operating costs, with revenue exceeding operating costs for the remainder of the operating period;
- Neither scenario can cover the full costs of developing HSR; and
- Phase 2 (London to Windsor) incurs significant costs with only marginal increases in revenue in both scenarios.



Notes:

The total capital costs include a significant contingency (66%). Cost methodology is detailed in Chapter 3

BCR: benefit cost ratio (revenue / costs)*

NPV: Net Present Value (revenue- costs, billion \$2021)

*BCR is a simple division of total revenues by total costs, and illustrates the extent to which HSR revenues cover capital and operating costs. For example, a BCR of 0.44 means that revenues cover 44% of total costs. This is a distinct measure from the Economic BCR (see previous page).

Deliverability and Operations Case

The analysis of Scenarios A and B suggests they are both broadly deliverable and that all key risks are manageable. The key risks identified in this study include construction, operation risks, and ridership/revenue risks and would be considered normal infrastructure and operating risk of a railway environment.

Construction risks may impact the deliverability of the alignment and stations, which will increase capital costs and the time to deliver the program. Risks include:

- Development of HSR along an active railway, including the congested Union Station Rail Corridor (USRC) and Union Station;
- Development of HSR in environmentally sensitive areas, including the Niagara Escarpment;
- Land procurement;
- Development of new river crossings, which carry environmental risks; and
- Development of HSR adjacent to CP Windsor Yard.

The specific costs of addressing these risks have not been estimated in this study although allowances have been included. Costs have

been escalated to account for environmental mitigation and have also included a 66% risk contingency factor. Operating risks include those that may impact the ability of the HSR system to meet its travel time or risks that will raise operating/capital costs to mitigate potential operating conflicts:

- Coordinated operation between HSR and GO RER along the USRC and through to Kitchener-Waterloo;
- Potential congestion issues at Union Station due to significant demand for platform access; and
- Potential operation constraints near the CP Windsor yard.

Ridership and revenue risks include risks that will lead to lower ridership or revenue than estimated. Key risks include:

- Inability to meet travel times due to operational issues;
- Changes in economic and population growth that impact demand patterns; and
- New transport trends or technologies that diminish demand for HSR.

At this stage of the study, these risks are deemed manageable. Future stages

of the study should explore these risks with further analysis and also outline key considerations for HSR delivery, including:

- Governance and organizational structure;
- Integration with local built environment;
- Procurement process;
- Ridership and revenue yield planning;
- Monitoring and evaluation framework; and
- Environmental mitigation planning.

Business Case Summary

Toronto to Windsor Corridor

Case	A Scenario A	B Scenario B	
 <p>Strategic Case</p>	<ul style="list-style-type: none"> Scenario A broadly achieves the strategic vision for HSR It offers improved travel times compared to existing services: 115 minute end to end travel time and 11.6 million passengers/year by 2041 Reduces GHG emissions from transport: 7.9 million tonnes CO2 It connects employment centres and communities: serves a population of 11.16 million people and 1.15 million jobs that typically benefit from HSR 	<ul style="list-style-type: none"> Scenario B broadly achieves the vision for HSR It offers improved travel times compared to existing services: 124 minute end to end travel time with 10.6 million passengers/year by 2041 Reduces GHG emissions from transport: 7.8 Million tonnes CO2 It connects employment centres and communities: serves a population of 11.1 million people and 1.16 million jobs that typically benefit from HSR 	<p>Both scenarios achieve strong performance; however, Scenario B is the preferred strategic scenario given its lower cost and comparable benefit to Scenario A</p>
 <p>Economic Case</p>	<ul style="list-style-type: none"> Low BCR (0.32) and negative NPV (-\$43.0 billion 2021\$) Toronto to London segment also has poor performance – low BCR (0.36) and NPV (-\$31.9 billion 2021\$) Unlikely that the scenario can be further optimized to improve financial performance 	<ul style="list-style-type: none"> Moderate BCR (0.70) and a low negative NPV (-\$8.55 billion 2021\$) Toronto to London segment also has improved performance – higher BCR (1.02) and NPV (\$0.4 billion 2021\$) Both the scenario as a whole and the Toronto to London segment are likely to see improved BCRs with further optimization and scenario improvement 	<p>Scenario B achieves higher performance than A and can likely be optimized further</p>
 <p>Financial Case</p>	<ul style="list-style-type: none"> Revenue can cover operating costs for the entire alignment with the Toronto to London segment's revenue exceeding operating costs Low BCR (0.17) and NPV (-\$66.5 billion 2021\$) Unlikely that further optimization will reduce costs or revenue enough to improve financial case 	<ul style="list-style-type: none"> Revenue can cover operating costs for the entire alignment with the Toronto to London segment's revenue exceeding operating costs Low BCR (0.32) and NPV (-\$27.5 billion 2021\$) Future optimization may improve financial performance 	<p>Both scenarios can cover life cycle operating costs with revenue – Scenario B requires lower investment overall</p>
 <p>Deliverability & Operations Case</p>	<ul style="list-style-type: none"> Considered 'deliverable' from a preliminary constructability perspective – further study and analysis of alignment is required; in particular tunnel deliverability requires further review to determine overall feasibility for construction and operations Must be planned with respect to GO RER operations to ensure construction and operations do not limit GO RER services Construction near operating railways will require risk mitigation 	<ul style="list-style-type: none"> Considered 'deliverable' from a preliminary perspective – further analysis of alignment required. Proposed infrastructure is deemed lower risk than A due to lack of tunnelling Must be planned with respect to GO RER operations to ensure construction and operations do not limit service. Can leverage investment in GO RER and alignment with GO RER construction to improve deliverability Construction near operating railway will require risk mitigation 	<p>Both options are broadly deliverable with risks that can be readily mitigated</p>

Emergent Conclusions

While both scenarios perform well against the strategic objectives and are considered deliverable (pending further engineering analysis), their economic and financial performance indicates that Scenario B is the recommend option. Further design and optimization work on scenario B is required to maximize benefits and minimize costs of HSR delivery and operation and this is expected to further improve the business case for this option.

The key conclusions from this analysis are:

- It is expected that further refinement to Scenario A will not deliver significant cost savings or increased benefits;
- Scenario A's higher costs allow speeds of up to 300 km/h, however these speeds do not deliver a significant increase in benefits without fundamental changes to the underlying assumptions used in this analysis;
- Scenario B's use of existing rail infrastructure combined with improved speeds of up to 250 km/hr within the corridor attracts significant ridership, and will provide a catalyst for improved regional connectivity and economic growth regeneration;
- Scenario B's costs and benefits deliver stronger

economic performance, in particular between Toronto and London, which has a base Benefit Cost Ratio (BCR) of 1.02 and an expanded BCR of 1.09 while providing a travel time and speed comparable to gobal HSR examples;

- While revenue does not cover total capital cost and renewal costs with contingency, revenue exceeds operating costs from 2041 until the end of the appraisal period in 2084;
- As a result, total revenue generated over the project life cycle exceeds the total life cycle operating costs of the HSR system; and
- Further refinements to Scenario B, including cost optimization and improved service planning to deliver increased benefits are expected to improve the economic and financial case.



Recommendations

This analysis noted that Scenario B has positive performance and high potential. However, the scenario requires further investigation, design, and analysis as part of the environmental assessment process. The key characteristics of the design to be included in future studies are:

- An above ground HSR corridor that uses existing infrastructure where possible to drive down costs;
 - Ability to serve long distance business/leisure trips as well as commuter trips, particularly between Toronto, Pearson, Guelph, and Kitchener-Waterloo;
 - Use of running speed of up to 250 km/h
 - Central/downtown stations that are directly connected to rapid transit and local transport networks ; and
 - Direct service to all demand centres in the Minister’s mandate (Toronto, Kitchener-Waterloo, London, and Windsor), as well as Guelph and Chatham.
- Cost Refinement: further analysis and engineering works to revise costs and determine new estimates for the scenario. As the alignment is further designed it is expected that cost accuracy will increase, which will clarify the expected range of costs for HSR;
 - Benefits Refinement: further analysis, including more in-depth modelling will allow for a more accurate picture of potential benefits;
 - Identifying a Pearson International Airport direct connection solution in coordination with the GTAA. This may increase direct HSR benefits by \$250 million and generate up to 1 million new passengers a year – direct access requires further study to confirm alignment for connecting to the airport along with cost allocation; and
 - Strategy/Deliverability Planning: future analysis should clarify potential options and models for delivering HSR – including overall rail strategy for the corridor, potential delivery/operation models, and potential roles for the government in implementing the service. As these considerations will impact overall cost/benefit realization and rail business planning, different models should be explored in early stages of future work programmes.

A number of high level assumptions were made in this study that are commensurate with the preliminary status of the project. Future stages of review should prioritize four areas of analysis:



1

Introduction

Background

This Preliminary Business Case report provides an assessment of the case for a High Speed Rail (HSR) line between Toronto and Windsor. The work has been undertaken to build upon previous HSR studies and support the Government and the Special Advisor for High Speed Rail's report on HSR. The analysis within this business case will also inform the detailed design for HSR as part of the Environmental Assessment (EA) Process. This work has been completed with numerous assumptions to develop design and analysis tools that are appropriate for this stage of development. All designs and assumptions will be revisited and further defined in future stages of analysis and are only indicative at this stage.

The province of Ontario is undergoing rapid growth and development. Between the present and 2041 a population growth of 31% is expected. An ambitious transportation infrastructure investment plan has been initiated by the Government of Ontario to support this growth and development.

Advancing the environmental assessment for HSR was included in the Minister of Transportation's mandate letter from the Premier in 2014. This letter indicated a focus on:

“Advancing environmental assessments for high speed rail — building on the GTHA's forthcoming Regional Express Rail network — which will link Toronto, Lester B. Pearson International Airport, and Waterloo Region, as well as London and Windsor”

The commitment to advance the EA process has been reaffirmed in both the 2015 and 2016 Budgets as part of the Moving Ontario Forward plan. Further to this commitment, on October 30, 2015, the Honourable David Collenette, was appointed as Special Advisor to assist the province in bringing HSR to the corridor.

The 2016 Minister's mandate letter outlined the development of the overall HSR project, including a time line to deliver the Environmental Assessment:

“Continuing to support the Special Advisor on High Speed Rail in the development of his report back on the economic development opportunities, financing models and feasibility for delivering high speed rail in Southwestern Ontario, in fall 2016. You will also issue the Request for Proposal for the Environmental Assessment related to this project in 2017.”

Bringing HSR to the Windsor, London, Kitchener-Waterloo, and Toronto corridor is part of the largest infrastructure investment in Ontario's history – more than \$137 billion over 10 years. HSR has been proposed to play a crucial role in fulfilling the potential of this investment by:

1. Expanding travel options and mode choice by providing high speed, reliable and safe passenger rail service that can:
 - Increase mode choice for interregional passenger travel;
 - Improve travel time reliability;
 - Increase connectivity with regional and local transit systems to enable seamless travel; and
 - Support efforts to reduce Greenhouse Gas Emissions (GHG) associated with longer distance interregional travel.
2. Supporting knowledge-based and other economic development opportunities in southwestern Ontario and the regions surrounding the corridor:
 - Introduce new transportation technologies to the corridor (e.g. vehicles, infrastructure for energy supply and communications, etc.) which will promote economic development within and surrounding the corridor;

- Reduce travel times and expand employment and economic agglomeration opportunities by linking cities and populations into integrated regions; and
- Consider opportunities to develop and/or protect linkages to potential future HSR networks and other rail networks as appropriate in neighbouring provinces and states, thus linking Southwestern Ontario to other strategic economic hubs.

These high level goals frame the government's perspective on the potential benefits of HSR along the Toronto to Windsor Corridor.

What is High Speed Rail?

In general, "High Speed Rail" refers to a rail service that is able to achieve significantly faster speeds than more conventional rail services⁷ due to higher technical specifications for horizontal and vertical alignment of the track, operating systems such as signalling, and rolling stock.

As noted in Figure 1.1, HSR has been pursued in numerous countries across Europe and Asia as a means to provide improved mobility and trigger economic development.

⁷ Conventional Rail services typically operate on infrastructure that is speed constrained (less than 160 km/h) and do not employ a number of the technologies that enable High Speed Rail to reach speeds in excess of 200 km/h

The International Union of Railways (UIC) has developed a definition of HSR:

*"... high speed is a combination of a lot of elements which constitute a whole "system": infrastructure (new lines designed for speeds above 250 km/h and in some cases, upgraded existing lines for speeds up to 200 or even 220 km/h), rolling stock (special designed train sets), operating conditions and equipment, etc."*⁸

In the North American context, HSR has been explored as a potential transport project in Canada and the USA. In general, the key factors that distinguish HSR from conventional rail in Europe and Asia include:

- Dedicated passenger lines with limited or no shared use with freight;
- Development of an HSR network that overlaps existing rail networks with established demand;
- Use of city centre stations that offer strong integration with other regional, commuter, and metro/rapid transit networks;
- Use of standardized infrastructure throughout the HSR system; and
- Use of electric traction to power rolling stock.

⁸ Source: <http://www.uic.org/highspeed>

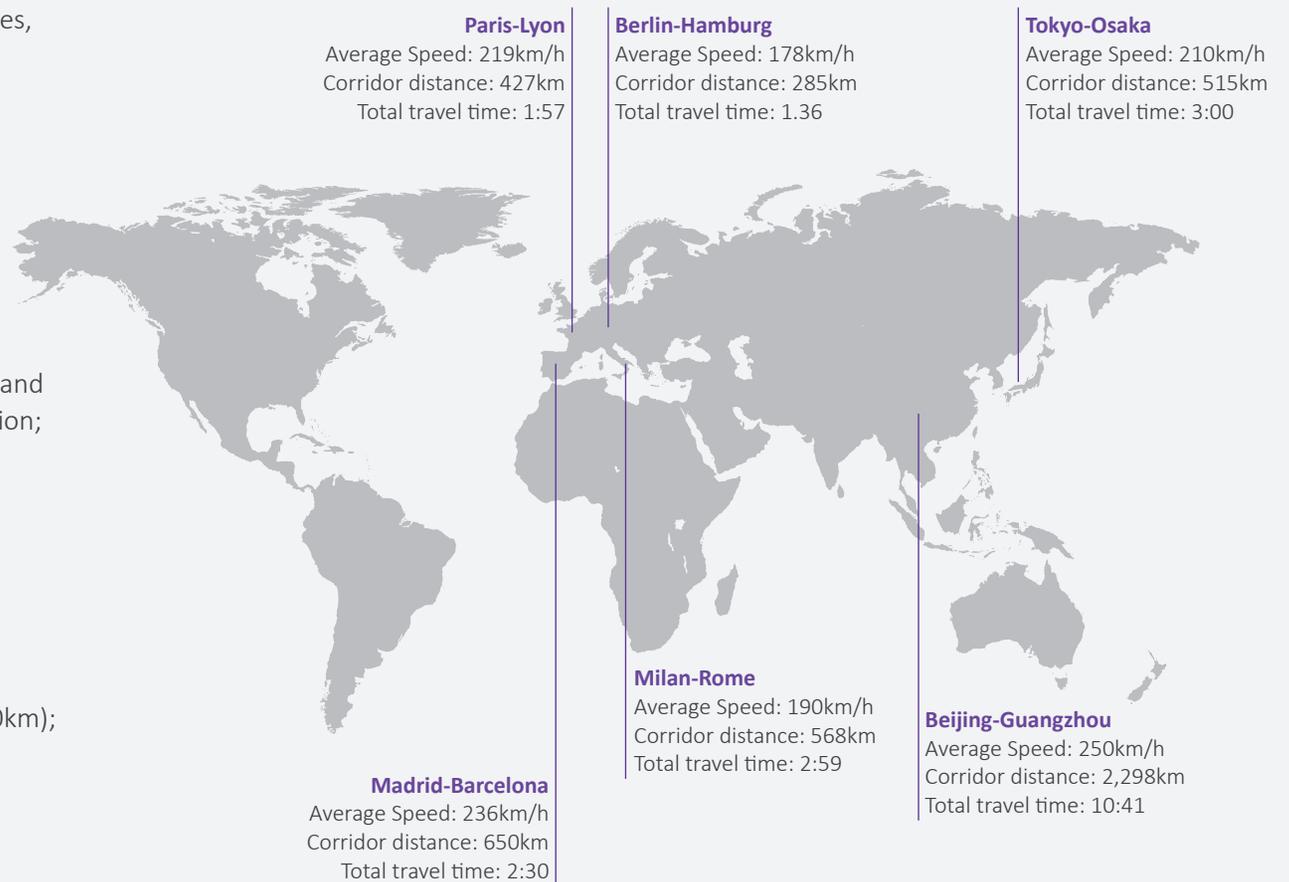
A high speed system is generally made up of the following physical components:

- Civil infrastructure including earth work, bridges, tunnels, grade separations and associated reconfigurations of existing infrastructure to make room for the new alignment;
- Stations that are integrated with local transport networks;
- Facilities to manage and operate the system and vehicles;
- Track;
- Systems including signalling, communications and associated electromagnetic spectrum acquisition;
- Traction power; and
- Vehicles.

Typically HSR systems offer standards that cannot collectively be achieved by conventional rail systems, notably:

- Journey times competitive with air travel and other modes over medium distances (200-500km);
- Frequent and regular service in peak and off peak periods;
- High levels of punctuality and reliability; and
- High quality passenger experience – including specific design considerations to improve ticketing and time spent in station and on vehicles.

FIGURE 1.1: GLOBAL EXAMPLES OF HSR SYSTEMS



Preliminary Business Case Purpose

This study's purpose is to:

- Develop and define two HSR scenarios for the Toronto to Windsor Corridor; and
- Analyze the scenarios using a preliminary business case framework

To achieve these results, a preliminary business case analysis includes:

- A review of previous work completed on HSR service in the corridor;
- A high level review of the corridor to identify potential alignments;
- Preliminary designs and associated cost, ridership, revenue, and benefits estimates for HSR options;
- A summary of the strategic case for HSR with respect to its alignment with government policy, as well as challenges and opportunities along the corridor;
- The economic and financial case for each scenario;
- Key transport, social, and environmental impacts of delivering a new HSR system; and
- Key procurement and implementation considerations for each scenarios

To meet these requirements, this document outlines the development and evaluation process for two representative HSR scenarios:

- **Scenario A**: HSR designed for a top speed of 300km/h throughout the corridor that is developed with the highest level of infrastructure investment
- **Scenario B**: HSR designed to leverage existing corridors where possible in order to provide an HSR service with a top speed of up to 250 km/h

These two scenarios were selected to:

- Explore the range of typical speeds associated with HSR, as discussed in Figure 1.1.;
- Understand the level of investment required to deliver different speeds for HSR; and
- Explore the potential difference in benefits achieved by different speeds along the corridor.

The outputs of this study will support future HSR analysis, including the environmental assessment in the Minister's mandate, by:

- Clarifying key issues for planning, developing, implementing, and operating HSR along the corridor; and

- Setting out costs and benefits of HSR at a high level – all costs and benefits will require further study as the design process for HSR progresses.



JR Central N700 HSR Train, Japan

BUSINESS CASE FORMAT

This preliminary business case has been prepared using a four chapter business case structure. This approach to Business Case Analysis (BCA) allows a ‘holistic’ review of potential projects and their benefits, costs, and deliverability considerations. The four chapters included in this business case format are outlined in Figure 1.2.

This business case is considered a preliminary business case – it is developed to understand the potential costs, benefits, and strategic fit of the HSR project and is built upon many working assumptions. As further development continues on the project, the level of detail for analysis will increase and key assumptions for the study will be tested and refined. An overview of project development stages is included in Figure 1.3.

FIGURE 1.2: FOUR CHAPTER BUSINESS CASE FRAMEWORK

- 

Strategic Case (section 4)
Assesses the alignment of the alternatives with the project’s vision/ goals as well as policies and plans
- 

Economic Case (section 5)
Assesses the economic, social, and environmental impacts of the proposed alternatives, including a cost benefit analysis
- 

Financial Case (section 6)
Examines lifecycle costs and revenues of the project to understand its broader financial implications
- 

Deliverability & Operations Case (section 7)
Assesses issues and risks associated with project delivery and operations

FIGURE 1.3: STAGES OF PROJECT DEVELOPMENT

			
Consider	Design	Act	Operate
<ul style="list-style-type: none"> • Pre-feasibility • Feasibility • Preliminary business case • Public consultation 	<ul style="list-style-type: none"> • Environmental Assessment/Transit Project Assessment Process • Detailed design • Public consultation 	<ul style="list-style-type: none"> • Procurement and delivery/construction • Determine concession method • Design governance structure 	<ul style="list-style-type: none"> • Operate service • Maintain and renew • Review and learn

PREVIOUS HSR STUDIES

This study builds upon previous studies, including:

- Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor, EcoTrain, 2011
- Toronto-Kitchener-London Ontario HSR Pre-Feasibility Study, First Class Partnerships, 2014

These studies assessed potential corridors, including a connection from Windsor to Quebec City (Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor completed by EcoTrain), as well as a direct connection between Toronto and London (Toronto-Kitchener-London Ontario HSR Pre-Feasibility Study completed by FCP). Where possible, this study has built upon the proposed solutions to provide continuity between the studies.

Document Overview

This document contains the preliminary business case for both scenarios, as well as additional content to describe the strategic development of HSR. It is composed of the following sections:

- Section 2: Corridor Context
- Section 3: Vision for High Speed Rail
- Section 4: High Speed Rail Scenario Scoping and Engineering
- Section 5: Strategic Case
- Section 6: Economic Case
- Section 7: Financial Case
- Section 8: Deliverability and Operations Case
- Section 9: Business Case Summary

2

High Speed Rail: Context and Vision

Overview

This section of the business case provides background information to support the development of vision, goals, objectives, and HSR scenarios. This section is composed of:

- A review of key policies for corridor stakeholders;
- An overview of travel on the Toronto to Windsor Corridor;
- A review of existing and future railway conditions;
- A summary of key corridor challenges and opportunities; and
- The development of a strategic vision for HSR.

Toronto to Windsor Corridor Overview

This business case is focused on the potential for HSR in Southwestern Ontario between Toronto and Windsor, as shown in Figure 2.1. As noted in the Minister’s mandate, the key centres for consideration in this study are:

- **TO** Toronto
- **PE** Pearson International Airport
- **KI** Kitchener-Waterloo
- **LO** London
- **WI** Windsor

In addition to the municipalities included in the Minister’s mandate, Guelph and Chatham have also been included in the review and development of HSR scenarios due to their direct proximity to the alignments used in this study. As of 2011, the corridor was home to over 7 million people, making it Ontario’s most populous transport corridor. Economic activity along the corridor provides over 3.4 million jobs and consists of knowledge based economies, manufacturing, hospitality/tourism, and agriculture.

Additionally, the corridor connects 8 major Canadian universities, and several colleges and trade schools. The population and employment patterns along the corridor lead to different trip types or travel markets:

- **Commuting** – travellers who live in one city but work in another;
- **Leisure** – travel for personal activities or tourism;
- **Business Travel** – travel for business meetings; and
- **Inter-modal Connections** – travelling from one city to another to connect to a different transport service, most notably at Pearson International Airport.

FIGURE 2.1: SOUTHWESTERN ONTARIO HSR STUDY AREA



Source: Steer Davies Gleave

	GTHA	GU	KI	LO	CH	WI
Population (people)	5,600,000	140,000	510,000	480,000	108,000	320,000
Employment (jobs)	2,780,700	248,200	74,800	231,800	52,625	138,100

Corridor Review

This sub section outlines a review of key strategic needs and opportunities along the corridor. This review assessed institutions and stakeholders along the corridor as well as their key plans/policies that either relate to HSR or are impacted by HSR. This review included the Ministry of Transportation and stakeholders.

TRANSPORTATION POLICY STAKEHOLDERS

The transportation stakeholders for consideration in the HSR business case are noted in Table 2.1. These stakeholders are ones that:

- Provide or regulate interregional and provincial transport of passengers or goods; or
- Own or operate service along the corridor

As discussed in the review, the HSR project is well positioned within the general policy framework within the corridor. Additionally, HSR can play a key role in addressing urgent transport issues, such as freight and optimization of airport use.

TABLE 2.1: KEY CORRIDOR ORGANIZATIONS, INSTITUTIONS, AND COMMUNITIES

	Relationship to HSR on Corridor	Key Synergies and Considerations for HSR
Proponent Policies	<p>Province of Ontario</p> <p>The Province of Ontario has numerous policies and Acts which may impact and/or guide HSR development. Examples include: 2015 Ontario Budget, Growth Plan for The Greater Golden Horseshoe, Greenbelt Plan, Niagara Escarpment Plan, Duty to Consult, Environmental Assessment process, and the 2015 Climate Change Strategy.</p>	<p>HSR is a means to improve overall sustainability of transport on Ontario’s most congested and economically critical corridor. Additionally, HSR can support the economic integration of multiple communities, while also managing growth.</p>
Stakeholder Policies	<p>Metrolinx</p> <p>Metrolinx is the provincial agency in charge of transportation planning in the GTHA region. It operates GO Transit, the regional transportation provider in the GTHA, with significant railway holdings and investments in and around the HSR corridor, and also owns/operates UPE, a rail shuttle between Union and Pearson Airport.</p>	<p>HSR is aligned with Metrolinx’s Regional Express Rail program, which seeks to transform mobility in the GTHA and Kitchener-Waterloo. HSR must consider GO RER development to identify synergies for infrastructure investment and development as well as optimizing service for the GTHA/Kitchener-Waterloo rail market.</p>
	<p>Canadian National Railway (CN) Canadian Pacific Railway (CP)</p> <p>Freight railway operators; significant railway holdings along proposed HSR route – currently freight and passenger rail share several segments.</p>	<p>HSR investment is an opportunity to improve the management of both freight and passenger rail – including the development of dedicated tracks and management of schedules/timetables.</p>
	<p>Transport Canada / Government of Canada</p> <p>Key national ministry in charge of transportation issues. Previous partners in HSR assessments along the Quebec-Windsor Corridor. Sets railway operation standards.</p>	<p>HSR development is in line with general direction to improve sustainability of transport. HSR must be developed in relation to federal standards and management frameworks for rail operations and safety.</p>
	<p>VIA Rail</p> <p>National inter-city railway provider, operating service to cities along the HSR corridor – currently planning High Frequency Rail/ dedicated track improvements.</p>	<p>HSR and VIA Rail may inter-operate on certain segments of the Toronto – Windsor corridor (e.g. Union Station). As the HSR project advances, the relationship between VIA Rail and HSR will be further developed and clarified.</p>
	<p>Greater Toronto Airports Authority</p> <p>GTAA operates Pearson Airport and has drafted white papers and plans that indicate how HSR may benefit the airport. Additionally, HSR services typically compete with short haul air services.</p>	<p>HSR directly serves Pearson Airport, which is in line with the airport’s vision to become a transport hub. Additionally, HSR can provide improved land connections for multiple communities in the corridor, alleviating runway demand for short haul flights.</p>

MUNICIPAL STAKEHOLDERS

HSR is a transformative investment that has the potential to support municipal development initiatives. Additionally, a functional HSR system is reliant on local connections – including connections to local transit.

This subsection includes a high level review of municipal policies to understand the connection between HSR and municipal policy (Table 2.2). This review was conducted based on published plans and policies and did not involve direct consultation with the municipal stakeholders. The municipalities included in this review are included in the Minister’s mandate along with two additional municipalities: Guelph and Chatham, which have been included based on their proximity to potential HSR alignments.

TABLE 2.2: MUNICIPAL POLICY REVIEW

City	Key Considerations	Synergies with HSR
Toronto	<ul style="list-style-type: none"> • Create a "City of Connections" where mixed-use and inter-regional transit spurs economic development. • Enforce downtown as the major area of development for both employment and residential uses. • Strategically position Toronto to attract a well-educated, highly skilled labour force. 	<ul style="list-style-type: none"> • New connections between downtown core and broader Ontario economy. • Potential to support multi-modal transport network development. • Aids in positioning Toronto as a knowledge centre.
Mississauga (Pearson International Airport)	<ul style="list-style-type: none"> • Develop a transit oriented city where transit is a viable mode to make connections between Mississauga, surrounding cities, and the rest of the region. • Cultivate creative and innovative businesses, where a strong and global business future is valued. 	<ul style="list-style-type: none"> • Allows for the airport to serve as an anchor for access to the city.
Guelph	<ul style="list-style-type: none"> • Concentrate development in downtown area, with mixed-uses and higher density office buildings. • Give transit "first priority." • Develop area around the University into a mixed-use corridor. • Support inter-regional connections, recently completed GO/VIA Rail station redesign, and routed bus routes through new station. 	<ul style="list-style-type: none"> • HSR stations may support development intensification. • HSR is in line with inter-regional connection policies.
Kitchener-Waterloo	<ul style="list-style-type: none"> • Make the region a prime location for innovation and entrepreneurship with post-secondary institutions taking a leading role. • Attract international businesses, with a focus on knowledge intensive industries. • Develop an 'innovation hub' at Kitchener's soon-to-be rebuilt train and ION Light Rail Transit (LRT) station, located downtown. 	<ul style="list-style-type: none"> • Make the region a prime location for innovation and entrepreneurship with post-secondary institutions taking a leading role.
London	<ul style="list-style-type: none"> • Attract top quality labour and foster a more knowledge intensive labour market, with a focus on regional finance, insurance, and health care markets. • Guide all development towards an intensified transit area served by two Bus Rapid Transit (BRT) lines. • Ensure that a HSR station is located Downtown, and in close proximity to the BRT network. 	<ul style="list-style-type: none"> • Expands London's commute shed to attract high skilled labour. • Supports densification and development adjacent to HSR stations. • HSR may be integrated with the BRT network.
Chatham	<ul style="list-style-type: none"> • A notable centre of agriculture and manufacturing, the official plan assumes there will be modest growth in the future. 	<ul style="list-style-type: none"> • Foster economic growth and development and position as a commutable community.
Windsor	<ul style="list-style-type: none"> • Urban development centred on Windsor's downtown, with high density employment development guided there. • Secondary commercial centres are also identified on the periphery of the city. 	<ul style="list-style-type: none"> • Supports urban redevelopment and economic/regional connections.

INDIGENOUS COMMUNITIES

The corridor will directly pass through areas within and adjacent to Indigenous communities (shown in Figure 2.2), including:

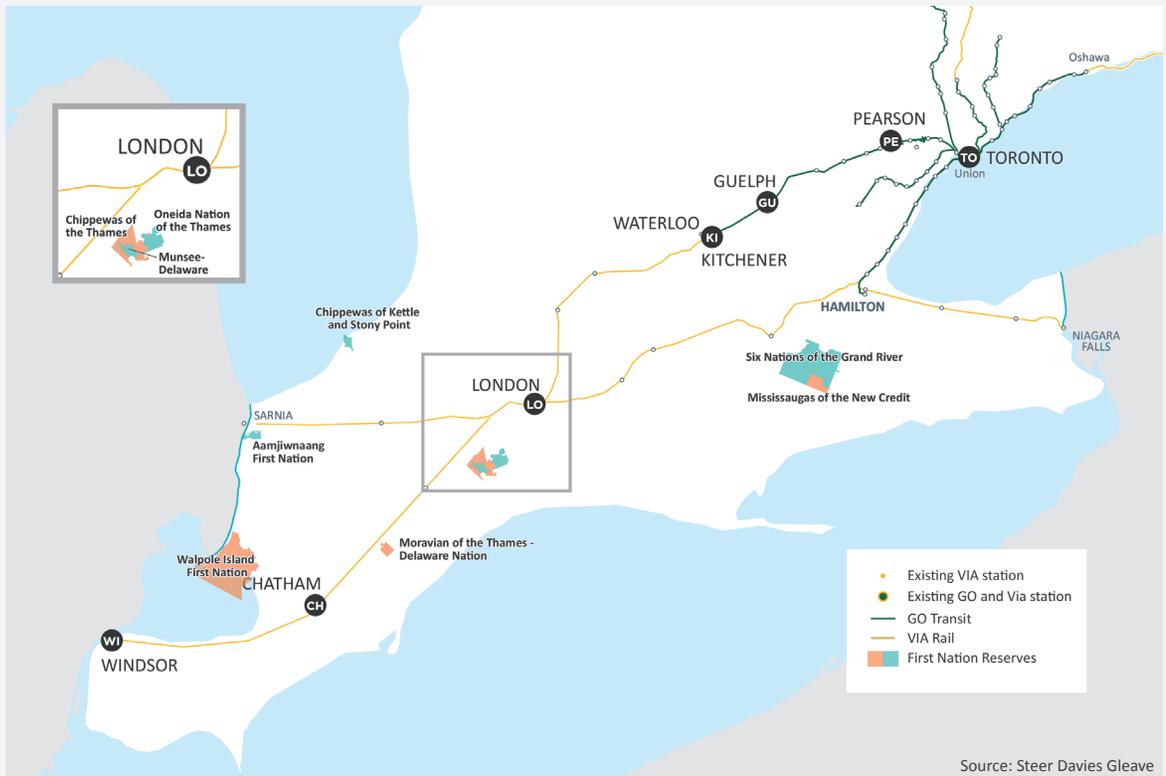
- Aamjiwnaang First Nation
- Walpole Island First Nation
- Chippewas of Kettle and Stony Point First Nation
- Chippewas of the Thames First Nation
- Moravian of the Thames / Delaware Nation
- Munsee-Delaware Nation
- Oneida Nation of the Thames
- Caldwell First Nation
- Mississaugas of the New Credit First Nation
- Six Nations of the Grand River First Nation

Given the preliminary nature of this business case, potential impacts on Indigenous communities have not been determined.

At least 10 First Nations have reserves and/or traditional territories Southwestern Ontario. Many have active land claims throughout southern Ontario, and to beds of the Great Lakes and rivers in the area.

Potential considerations include construction, development, and maintenance in traditional territories and operations through traditional territories. Engagement with indigenous communities in future work will clarify these potential considerations.

FIGURE 2.2: INDIGENOUS COMMUNITIES



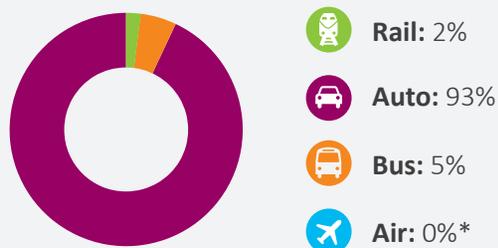
Corridor Transport Network and Services

The Toronto-Windsor corridor is a multi-modal transport corridor that includes multiple facilities for passenger transport and goods movement. The modes and facilities in the corridor include:

- Highways (passenger and freight traffic);
- Inter-city bus services;
- Railroads (passenger and freight movement); and
- Airports.

An overview of mode split along the corridor is outlined in Figure 2.3, and an overview of corridor travel is provided in Table 2.3.

FIGURE 2.3: CURRENT CORRIDOR MODE SPLIT



Source: 2011 TSRC Data, Statistics Canada
*Air has a mode share of less than 1%

TABLE 2.3: CORRIDOR TRAVEL SEGMENT REVIEW⁹

Segment	Typical Markets	Available Modes & Travel time	Description
TO ► PE	Commuter, intermodal, business	00:25 00:23	<ul style="list-style-type: none"> • Local roads/regional road network connecting to highway 427 • UPE rail service connecting Union Station, Bloor Station, Weston station, and Pearson Airport • Local Transit- including bus connections from local operators and GO buses
TO ► GU	Commuter, Leisure, Business	01:09 01:07 01:39 01:30	<ul style="list-style-type: none"> • Local roads/regional road network connecting to highway 401 or highway 7 • Rail services provided by GO Rail (peak direction only) and VIA Rail to Toronto
TO ► KI	Commuter, Leisure, Business	01:35 01:14 02:03 01:50	<ul style="list-style-type: none"> • Local roads/regional road network connecting to highway 401 • Rail services provided by GO Rail (peak direction only) and VIA Rail
TO ► LO	Leisure, Business, Intermodal	02:10 02:00 00:42 02:20	<ul style="list-style-type: none"> • Local roads/regional road network connecting to highway 401 • VIA Rail provides 7 trains per day to London – via Kitchener Waterloo and via a southern approach through Burlington
TO ► WI	Business, Leisure	04:14 03:41 01:00 05:05	<ul style="list-style-type: none"> • Local roads/regional road network connecting to 401 • VIA Rail provides 4 trains per day to Windsor
GU ► KI	Commuter, intermodal, business, leisure	00:26 01:30 00:24 00:45	<ul style="list-style-type: none"> • Local roads/regional road network connecting to highway 401 or highway 7 • Rail services provided by GO Rail (peak direction only) and VIA Rail
KI ► LO	Commuter, Leisure, Business	01:45 01:50 00:46	<ul style="list-style-type: none"> • Local roads/regional road network connecting to highway 401 or highway 7 • Rail services provided by VIA Rail
CH ► WI	Commuter, intermodal, business	00:43 01:25 00:54	<ul style="list-style-type: none"> • Local roads/regional road network connecting to Highway 401 • Rail services provided by VIA Rail • Some bus services provided by private operators

⁹ Auto travel time source: Google Maps – all times indicate drive times from city centre to city centre using most direct route
Rail travel time source: VIA Rail, GO Transit; Bus travel time : Greyhound/GO Transit; Air travel times: Google Flights as of 2016



PASSENGER AND FREIGHT RAIL

Railroads provide both passenger and freight service throughout the corridor. Passenger rail is provided by three operators:

- GO Transit: weekday peak direction passenger rail between Toronto, Guelph, and Kitchener-Waterloo;
- Union Pearson Express (UPE): daily 15 minute two way service between Toronto Union Station and Pearson International Airport; and
- VIA Rail: daily passenger rail service Toronto – Brantford – London – Windsor and Toronto – Kitchener – London – Sarnia (no service operated as Toronto – Kitchener – London – Windsor).

Travel times, fares, and frequencies for each rail travel option are shown in Table 2.4. For VIA Rail, fares vary depending on how far in advance they are booked and class of travel. The table shows fares for a journey booked one month in advance where low fares are economy and high fares are business class. While corridor travel times for VIA Rail are highly competitive with automobile travel, the reduced service frequency and cost of travel may suppress ridership. GO Transit's travel speed and frequency may also suppress rail demand along the corridor.

Future Conditions - Regional Express Rail

In April 2015, the Premier announced that the province will move forward with the GO Regional Express Rail (GO RER) initiative. GO RER is a plan to provide faster and more frequent GO rail service on the GO Transit Rail network with electrification on core segments of the network, including the Union-Pearson Express (UPE).

The project has been identified as a provincial priority for the GTHA under the government's Moving Ontario Forward plan for investment in transit, transportation and other priority infrastructure projects across the Province. GO RER will be delivered over 10 years, more than doubling peak service and quadrupling off-peak service compared to today. Weekly trips across the entire GO Transit rail network are expected to grow from approximately 1,500 to nearly 6,000 over 10 years.

Planned Service Levels on the Kitchener corridor include:

- Electrified service at about 15-minute frequencies between Union Station and Bramalea, including UPE;
- Peak-period, peak-direction service on weekdays every 30-minutes between Kitchener and Union Station and every 15-minutes between Mount Pleasant and Union Station; and

- Express service to Union Station for communities between Bramalea and Kitchener

The HSR corridor includes Toronto, Pearson International Airport, and Kitchener-Waterloo – all of which are currently served by Metrolinx services. In 2016, a commitment was made to extend electrified GO RER two way all day service to Kitchener-Waterloo. This investment will greatly increase mobility along the corridor and will connect a number of communities between Toronto and Kitchener-Waterloo.

TABLE 2.4: EXISTING CORRIDOR PASSENGER RAIL TRAVEL OPTIONS

Rail Trip	Operator	Travel Time (hh:mm)	Trains per Day	Low One Way Fare (\$)	High One Way Fare (\$)
PE ▶ TO	UPE	00:25	15 minute service (78 per direction)	9.00	12.00
TO ▶ GU	GO	01:39	2	13.70	13.70
TO ▶ GU	VIA Rail	01:09	2	22.60	22.60
TO ▶ KI	GO	02:03	8 ¹¹	15.28	17.20
TO ▶ KI	VIA Rail	01:35	2	27.12	27.12
TO ▶ LO	VIA Rail	02:10	7	44.00	78.00
TO ▶ CH	VIA Rail	03:20	4	51.00	90.00
TO ▶ WI	VIA Rail	04:14	4	57.00	112.50
GU ▶ KI	GO	00:24	2	7.95	7.95
GU ▶ KI	VIA Rail	00:26	2	20.00	20.00
LO ▶ CH	VIA Rail	01:02	4	26.00	63.00
LO ▶ WI	VIA Rail	01:58	4	38.00	79.50
CH ▶ WI	VIA Rail	00:43	4	23.00	46.00

Source: GO Transit, VIA Rail

¹¹ Off peak GO Bus services between Kitchener and Bramalea are provided to allow passengers to access the two way all day GO Rail service from Bramalea to Union

HIGHWAY NETWORK

The highway network along the corridor is focused on Ontario’s primary highway – the 401. This highway is used for most travel along the corridor, and experiences congestion within the GTHA during the peak period. As the major transport link on the corridor for goods and passenger travel, the highway network is well connected to all major demand centres along the corridor through connections to regional and arterial roads.

Congestion drastically impacts travel times for passengers and freight, especially for destinations between Toronto and the Kitchener-Waterloo. Along this corridor segment travel times are up to 55%-62% higher during peak period congestion, which has impacts for both passenger travel and goods movement. In particular, Highway 401 is one of the busiest routes in Toronto, carrying over 400,000 vehicles per day.¹²

¹² Source: Ministry of Transportation, Southern Highways Program, 2012-2016

INTERCITY BUS/COACH TRAVEL

Passenger bus service is provided by private bus operators across the corridor, and by GO Transit within the GTHA and to neighbouring communities including Kitchener-Waterloo. These bus services also serve smaller urban centres along the corridor. Bus travel options are shown in Table 2.5.

Fares vary depending on how far in advance they are booked, and on how they are booked. All fares discussed in this business case assume a fare booked one month in advance, where low fares are a mixture of web only/advance fares and high fares are the standard fare.

Additional bus services that connect between communities and urban centres outside of the corridor to cities along the corridor. In the future, these bus services could play a key role as connecting services to the HSR line.

TABLE 2.5: CORRIDOR BUS TRAVEL OPTIONS¹³

Bus Trip	Travel Time (hh:mm)	Buses Per Day	Low One Way Fare (\$)	High One Way Fare (\$)
TO ► GU	01:30 02:45	14	10.10	22.50
TO ► KI	01:50	19	12.65	23.00
TO ► LO	02:20	11	25.00	36.00
TO ► CH	04:10	1	30.00	54.00
TO ► WI	05:05	4	30.30	57.10
GU ► KI	00:45	6	5.50	11.70
KI ► LO	01:50	1	12.65	25.50
LO ► CH	01:25	1	12.65	24.30
LO ► WI	02:20	4	18.00	36.00
CH ► WI	01:25	1	11.25	22.75

¹³ Source: Greyhound Canada, GO Transit

AIR TRAVEL

Southwestern Ontario is served by seven airports, providing direct flights to international, domestic, and U.S. destinations. Five of these airports are located within the corridor – all of which offer connectivity to other cities in Canada, as well as some serving international destinations:

- Toronto Pearson International Airport
- Billy Bishop Toronto City Airport
- Region of Waterloo International
- London International
- Windsor International

Table 2.6 summarizes flight cost, frequency, and travel time. While air travel is the quickest means to traverse the corridor, only select origin/destination pairs are served and costs are significantly higher than rail. In addition, airport travel times are airport to airport and do not reflect:

- Access times to airports; and
- Time spent in passenger check in and security.

Toronto Pearson International Airport

Pearson is a key demand centre located along the proposed corridor. HSR integration with the airport is a potential means to:

- Manage demand for short haul flights – which frees up runway capacity for long haul flights; and
- Offer improved ground access for travellers from west of the airport.

In 2015, the GTAA published “Toronto Pearson: Growth, Connectivity, Capacity – the future of a regional asset” – a high level review of regional cooperation on air traffic.

TABLE 2.6: CORRIDOR PASSENGER AIR TRAVEL OPTIONS¹⁴

Flight	Travel Time (hh:mm)	Flights per Day	Low One Way Fare (\$)	High One Way Fare (\$)
Pearson-London Intl	00:42	10	260	324
Pearson-Windsor	01:08	6	130	242
Billy Bishop-Windsor	01:00	4	100	239
London-Pearson	00:46	9	250	281

¹⁴ Source: Google Flights

Key issues include:

- Air demand will grow to 65 million passengers per year by mid-2030s;
- By 2043 it is suggested that there will be a demand/capacity gap of 24 million passengers in Southwestern Ontario; and
- Ground transportation does not provide enough choice for travellers- by 2043 a 25-35% increase in driving times will occur.

While potential Smart Track and Eglinton Crosstown extensions have been proposed to improve access to the airport, the report identifies a need for new ground transport facilities to enable efficient and timely connections for travellers.

“As a rule, best-in-class city regions invest in combinations of high speed rail, rail and bus rapid transit connections to their airports.”¹⁵

¹⁵ Source: Greater Toronto Airports Authority. Toronto Pearson: Growth Connectivity, Capacity, the future of a regional asset. Toronto, ON, 2015.

Key Insights from Corridor Review

The corridor travel and stakeholder/policy review was synthesized into an overarching set of challenges and opportunities related to development and transport along the Toronto to Windsor Corridor – these are noted in Figure 2.5.

FIGURE 2.5: CORE CHALLENGES & OPPORTUNITIES



Challenges

Congested Auto Network

- Congestion is a critical issue that slows auto travel along the corridor- even with congestion, automobile has the highest mode share
- Automobile dependent corridors have increased pollutant and greenhouse gas (GHG) emissions and increased risk of transport accidents, injuries, or fatalities

Rail Service Issues

- Rail services are typically used for commute trips; however, available track and track quality impacts frequency and travel times, which limits use of rail
- Travel times and frequencies between Kitchener-Waterloo and Toronto, and London and Toronto may limit demand

Air Travel - Future Capacity Constraints & Customer Costs

- Air travel is costly and still requires secondary modes to access urban cores; additionally, Pearson Airport seeks to become an even larger international hub and needs approaches to manage congestion

Bus Network

- Buses serve long distance trips with lower fares
- Bus services have limited capacity per vehicle, and do not consistently offer competitive travel times



Opportunities

Expand Rail Network

- Build upon existing rail network by offering speed and frequency improvements
- At a corridor level, this opportunity would allow for more frequent and reliable services between key demand centres and reduce travel times and position rail as a true competitor to the automobile

Align Transport Investment to Support Growth and Economic Development

- Align transport investment to support growth plans and potential economic development in urban areas along the corridor
- This would include the development of economic knowledge hubs in the GTHA and Kitchener-Waterloo, and a multimodal transport hub at Pearson Airport

Relieve Congestion and Optimize the Network

- Utilize transport investment to relieve congestion and optimize the existing transport network
- This investment should consider its ability to provide an alternative to the automobile, which can alleviate congestion on the highway network

HOW IS HSR ALIGNED WITH CORRIDOR CHALLENGES/OPPORTUNITIES

HSR projects have been initiated to achieve varying policy goals around the world. Benefits of HSR projects go far beyond the ‘high speed’ headline and include:

- Increasing the capacity, speed, and reliability of existing passenger rail networks through provision of new infrastructure;
- Increasing economic competitiveness of regions by providing rapid and reliable connections between major employment and economic centres; and
- Provision of more sustainable transportation options.

These potential benefits are directly aligned with the challenges/opportunities along the corridor, as discussed in Table 2.7.

TABLE 2.7 HSR ALIGNMENT WITH CHALLENGES AND OPPORTUNITIES

HSR Benefit	How does it address challenges/opportunities?
Increasing the capacity, and reliability of existing passenger rail networks through provision of new rail.	<ul style="list-style-type: none"> • The existing rail network is constrained due to limited infrastructure and shared right of way with freight. HSR is an opportunity to invest in infrastructure to improve overall reliability and capacity of travel.
Increasing economic competitiveness of regions by providing rapid and reliable connections between major employment and economic centres.	<ul style="list-style-type: none"> • Improved travel speed and direct urban core access positions HSR as a mode of choice for business travellers. • HSR connections can allow new ‘commuter’ markets to be created. These markets are created when cities that may have a travel time of 2-3 hours apart by rail or auto are now within 40-60 minutes by HSR. This allows HSR to expand the commute shed of cities.
Provision of more sustainable transportation options.	<ul style="list-style-type: none"> • Use of clean or renewable source of energy for electric operations; and • Offering competitive price/travel time compared to other more pollution intensive modes.

Vision and Strategy for Corridor Mobility

SETTING A VISION FOR TRANSFORMED MOBILITY

The previous subsections have defined the nature of the challenges and opportunities on the Toronto to Windsor corridor. This subsection combines these challenges with input from the Provincial Government mandate and Ministry, to develop a problem statement and vision for the corridor. The problem statement and vision are the strategic foundation for pursuing solutions that can improve the corridor's mobility.

PROBLEM AND HSR VISION STATEMENTS

Drawing on the preceding HSR and corridor analysis, the following problem and HSR vision statements have been defined.

Problem Statement

“Southwestern Ontario is undergoing rapid growth and economic development, which must be supported by an efficient transportation network that connects centres of innovation with high speed and reliable mobility options. The existing transportation infrastructure on the corridor cannot adequately support the projected growth and objectives for economic development.”

Vision Statement, Goals, and Objectives

An HSR vision statement, goals, and objectives were developed in response to the above problem statement. The vision statement is:

To transform mobility in Southwestern Ontario in order to connect communities, integrate centres of innovation, and foster regional and economic growth and development

A set of goals and objectives, outlined in Figure 2.6, have been set out to measure progress towards the vision. Goals are broad value propositions that define ‘how’ to achieve the vision, while specific objectives state ‘what’ needs to be done to realize the goals. Clear strategic objectives provide a framework for assessing the veracity of options to deliver desired outcomes.

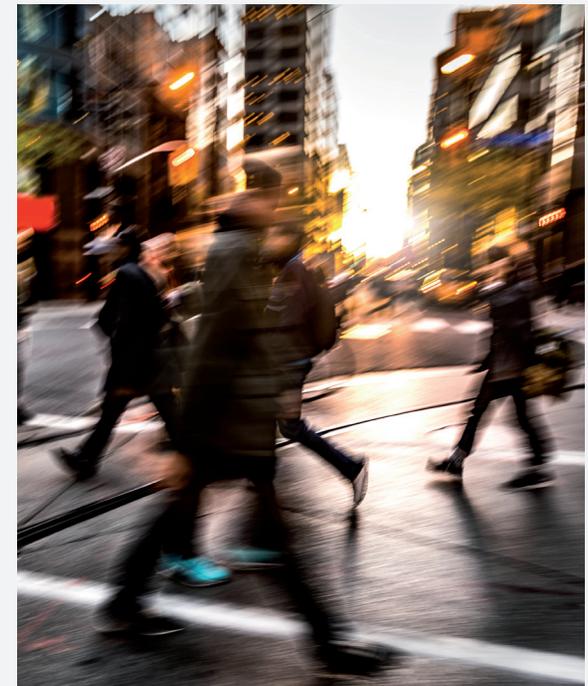


FIGURE 2.6: HSR VISION STATEMENT, GOALS, AND OBJECTIVES

Vision:

To transform mobility in Southwestern Ontario in order to connect communities, integrate centres of innovation, and foster regional and economic growth and development

 <p>Transform Mobility Choice in Southwestern Ontario</p> <p>The Toronto-Windsor corridor will provide efficient and sustainable mobility in Southwestern Ontario</p>	 <p>Provides new/improved mobility choices for travellers along the corridor</p>	 <p>Provides good value for money and optimal utilization of infrastructure</p>	 <p>Improves overall transport efficiency and resilience throughout the region</p>	 <p>Limits negative environmental impacts of travel on the corridor</p>
 <p>Catalyze Economic Development</p> <p>The Toronto-Windsor corridor will connect innovation hubs and centres of knowledge and industry to enable municipal and regional economic growth and development</p>	 <p>Connects centres of employment and business</p>	 <p>Connects knowledge centres throughout corridor</p>	 <p>Triggers wider economic benefits</p>	 <p>Manages interactions between freight and passenger travel to promote economic development</p>
 <p>Supports Regional Integration & Development</p> <p>The Toronto-Windsor corridor will support regional integration and development at a municipal, regional and corridor level</p>	 <p>Connects major population, cultural and activity centres</p>	 <p>Minimizes impact on natural and social environments</p>	 <p>Integrates with urban form and transport networks</p>	 <p>Supports development around stations</p>

DEVELOPING STRATEGIC GOALS

Three core goals were identified for HSR: transport, economic development, and regional development.

Transforms mobility choice in Southwestern Ontario

The policy and stakeholder review noted an immense opportunity to expand the role of passenger rail in the corridor. The current dominance of the auto mode along the corridor can be attributed to a lack of high frequency and low travel time competitive options.

Current rail services serve “niche” markets, whereas a HSR service may have the potential to expand into multiple markets due to improvements in travel time, frequency, and passenger amenity. For example, a new HSR service may create new travel markets for commuters between these cities. Finally, an HSR service may be transformative and capture the current auto market through improved service and competitive travel times.

Catalyze economic development

HSR would be a transformative investment in transport infrastructure for Ontario, which in turn could trigger economic growth and development. Therefore, economic development is a key consideration for HSR services.

In the case of the Toronto-Windsor corridor, economic development has been discussed as a key priority at a municipal and regional level, with key issues being:

- Improved linkages between knowledge hubs within each urban core; and
- Developing faster travel between economic centres, which enables agglomeration benefits.

Given the transformative nature of HSR, there is potential to leverage improved travel speeds, quality of service, and frequency of service, in order to foster stronger economic integration between cities throughout Ontario. This investment could be positioned as a key driver of increased economic integration.

In order to meet any wider economic development objectives, other supportive and aligned policy initiatives and investments may be required, including alignment of land use plans/policies near stations, and alignment of HSR development with economic planning.

Support regional integration and development

HSR is also aligned with goals for regional development. HSR investments can support regeneration of urban centres and development/intensification. Additionally, they can provide social and environmental benefits in line with regional and municipal policy, including:

- Creating a safer transport network; and
- Reducing environmental impact of transport.

In order to fully realize these benefits, an HSR system must be supported by additional policies and programs to ensure local transport networks are integrated with HSR stations. Further, HSR stations should be aligned with local development policies, plans, and goals to fully realize potential development benefits.

3

High Speed Rail Scenarios

Overview

This section outlines the scenarios that were considered to realize the vision for HSR along the corridor. To do so it scopes both scenarios with respect to:

- Alignment, station, and service plans;
- Phasing and delivery assumptions;
- Cost estimates; and
- Ridership and Revenue Forecasts.

Scenario Design

OVERVIEW

This study was scoped to analyze two representative scenarios for HSR service between Toronto to Windsor.

The scenarios are intended to be “representative” and provide a high level indication of the potential for HSR on the Toronto-Windsor corridor future studies will include further detailed design and analysis for an HSR alignment.

These scenarios have considered:

- Alignment—an indicative right of way that can support the HSR service, including geometric considerations of right of way,

high level assumptions for operating and maintenance centres, and capital costs for all alignment infrastructure;

- Stations – an indicative station location and type is proposed for each key demand centre, including capital and operating cost assumptions; and
- Service plan – an indicative service plan outlining fleet, timetable, and operating assumptions along with operating costs.

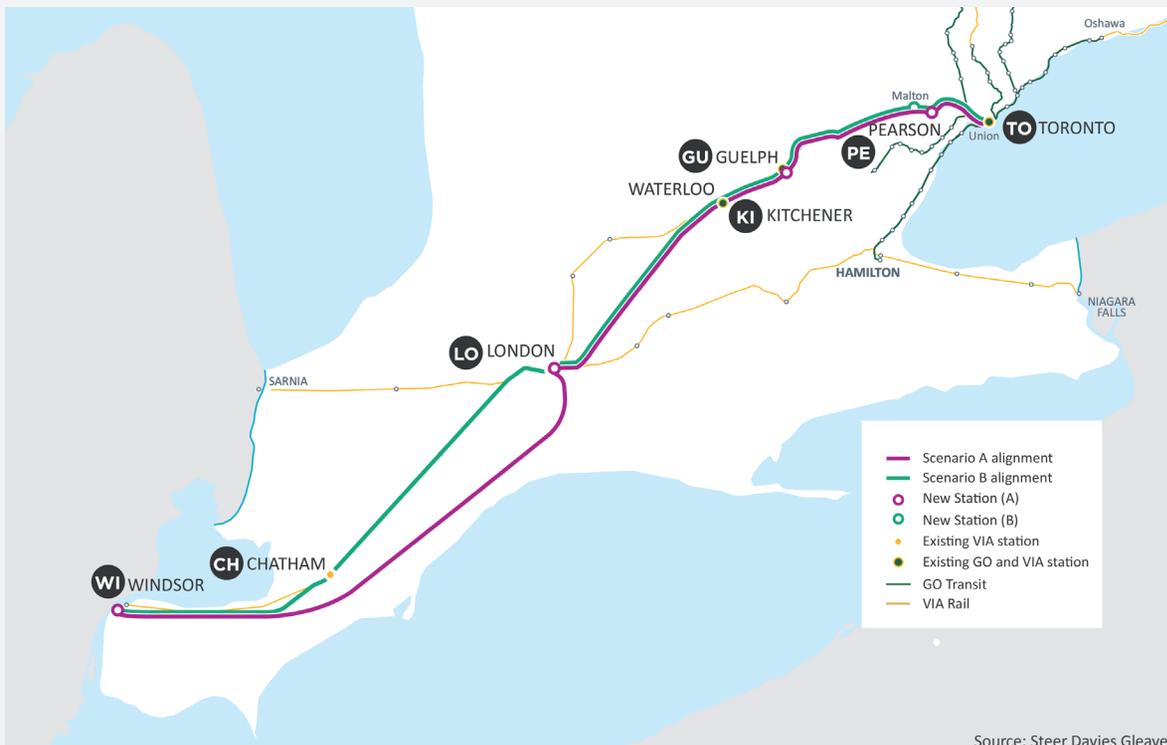
The two HSR scenarios have been developed to frame the boundary of what HSR is and what the Business Case could be based on differing maximum speeds, as follows:

- **Scenario A:** HSR designed for 300km/h along the corridor
- **Scenario B:** HSR designed 250km/h electrified alignment with increased use of existing right of way/corridors

These two scenarios are detailed in Figure 3.1 and Figure 3.2.

These runtimes are representative of the estimated minimum travel time that manages interaction with other services, such as GO RER. However it should be noted that detailed train simulation and modelling is required to validate this representative service plan.

FIGURE 3.1: HSR SCENARIO ALIGNMENTS



Scenario A

300
km/h

Maximum
Speed



Electric
traction



Dedicated HSR
right of way

Scenario B

250
km/h

Maximum
Speed



Electric traction



Dedicated HSR
right of way

Scenario A

Station Description

TO

Union Station

PE

New underground station

GU

New underground station

KI

Expansion of planned
GO/VIA Rail Station

LO

Relocation of existing station

WI

New Station

Scenario B

Station Description

TO

Union Station

PE

Renovation & expansion of
Malton station

GU

Renovation of existing station

KI

Expansion of planned
GO/VIA Rail station

LO

Renovation & expansion
of existing station

CH

Renovation & expansion
of existing station

WI

New station

FIGURE 3.1: HSR RUN TIMES AND ALIGNMENT DESCRIPTION

Scenario A	 Travel time on segment (min)	 Distance (km)	Description
TO ▶ PE	14	22.8	Use of existing rail alignment along the Union Station Rail Corridor (USRC) and Kitchener Line until Humber River. Tunnel from Humber River to Pearson Airport to allow for underground rail access
PE ▶ GU	18	53.9	Tunnel through to western Brampton, return to existing Kitchener Line until Rockwood, access Guelph in greenfield alignment with tunnel into Guelph under College Ave alongside the University of Guelph
GU ▶ KI	9	21.8	Use of Greenfield alignment and Guelph subdivision to access downtown station in Kitchener Waterloo
KI ▶ LO	25	87.1	Guelph subdivision to western limits of Kitchener, greenfield alignment alongside hydro corridor to allow high speed travel to eastern limits of London, trench alongside CN Dundas line into London
LO ▶ WI	49	190.7	CN Talbot line exiting London, onto former Canadian Southern Line to the west and through a greenfield curve to new track along the CP Windsor line at Tilbury with a connection to downtown Windsor
Total	115	376.3	

Scenario B	 Travel time on segment (min)	 Distance (km)	Description
TO ▶ PE	16	27.8	Use of existing rail alignment along the URSC and Kitchener Line leading to Malton Station Shared operations along alignment
PE ▶ GU	23	49.9	Use of upgraded Kitchener Line right of way
GU ▶ KI	9	18.1	Use of upgraded Kitchener Line right of way
KI ▶ LO	25	88.3	Guelph subdivision to western limits of Kitchener, green field alignment alongside hydro corridor to allow high speed travel to eastern limits of London, new tracks alongside CN Dundas line into London
LO ▶ CH	29	105.6	Development adjacent to existing CN line with connection in Chatham
CH ▶ WI	22	75.6	Cross over to a new track along the CP Windsor line with a connection to downtown Windsor
Total	124	365.3	

ALIGNMENT

Scenario A utilizes tunnels in Toronto and Guelph, along with a new build alignment to achieve speeds of 300 km/h, as discussed in Figure 3.2 and has minimal corridor sharing with GO RER or other rail services.

Scenario B's alignment is shared with GO RER. This allows for the planned investment in rail infrastructure under GO RER to be leveraged for the development of HSR. GO RER to Kitchener-Waterloo will build upon the existing GO rail network, as well as GO RER Scenario 5 to create a full build electrified GO RER corridor.

GO RER Scenario 5 is a 10 year optimized plan that includes frequent service on most inner corridors in the GO network along with significant electrification.¹⁶ This study was developed based on Scenario 5 assumptions and an assumed full build to Kitchener-Waterloo. As HSR and GO RER continue to evolve, these assumptions must be revisited.

The proposed Scenario B alignment has been assumed to be delivered in concert with GO RER to minimize costs and construction impacts. Table 3.1 provides an outline of the assumed evolution of infrastructure along the corridor for GO RER and Scenario B.

TABLE 3.1: TORONTO TO KITCHENER-WATERLOO CORRIDOR EVOLUTION

	Kitchener to Acton	Acton to Georgetown	Georgetown to Brampton	Brampton to Malton	Malton to Weston	Weston to Toronto	Union Station Rail Corridor
GO RER Scenario 5 Improvements	Single line retained	Single line retained Georgetown layover reconfigured	Fourth track added, from east of the Credit River, on the south side of Mt. Pleasant through to just west of Brampton	A fourth track added east of Brampton through to east of Bramalea	New CN freight bypass provided, GO RER limited to two tracks	Fourth track added on north side between west of Malton through to USRC	The arrangement within the USRC will need to consider the context of the wider GO RER, HSR and VIA Rail service requirements
GO RER Kitchener-Waterloo Full Build Improvements	The alignment would be double tracked, with a new station at Breslau	The alignment would be double tracked, the station at Georgetown would be reconfigured	The existing track alignment would be retained, with a third track added through Brampton	The existing track alignment would be retained through to the CN freight bypass	As Scenario 5	As Scenario 5	The arrangement within the USRC will need to consider the context of the wider GO RER, HSR and VIA Rail service requirements
HSR Improvements for Scenario B	HSR related track and grade separations to be provided in tandem with GO RER works to provide an alignment that can maintain higher operating speeds	Two new tracks would be added from east of the Niagara Escarpment to Georgetown, creating a four track alignment with two slow and two fast lines. HSR trains would pass GO RER service between west of Georgetown and Brampton station.	A new four track alignment (created by adding one or two new tracks as appropriate) would continue from the Acton to Georgetown section to just west of Brampton station to provide tracks for HSR to pass RER services.	The alignment would transition from the three tracks east of Brampton to a four track alignment. East of Bramalea, track alignments would be reconfigured using flyunders to provide two slow tracks on the north side of the corridor and two fast tracks on the south side.	A grade separated crossing of the fast lines would be provided to enable UPE services to cross over from the slow lines.	As Scenario 5	The arrangement within the USRC will need to consider the context of the wider GO RER, HSR and VIA Rail service requirements

CUMULATIVE ENHANCEMENTS

¹⁶ GO RER Initial Business Case: http://www.metrolinx.com/en/regionalplanning/projectevaluation/benefitscases/GO_RER_Initial_Business_Case_EN.pdf

The HSR improvements specified in the table make up the capital costs for HSR included in this study between Toronto and Kitchener-Waterloo. In addition, incremental infrastructure upgrades for HSR electrification, including signals, switches, and bridge works is assumed to be included in the scope of Scenario B.

The remainder of the corridor from London to Windsor for Scenarios A and B is largely new build along existing corridors, as discussed in Figure 3.2.

STATION DEVELOPMENT

All stations used in this study assume level boarding—which is not presently the case at most GO Transit stations, with the exception of those platforms specifically used for UPE—and a set of amenities similar to existing rail services. Specific customer service facilities have not been considered in this initial study.

Both HSR scenarios share the alignment with stations that are used by GO RER. In this analysis HSR is assumed to be given operational priority such that it can move through these stations with minimal decrease in speed. Changes to stations include modification of platform and track layout at Bramalea, Malton, Georgetown, and Mount Pleasant stations to allow for HSR passing opportunities, inter-operation, and speed maintenance.

Cost allowance has been provided for notional upgrades to Union Station in order to accommodate increased rail demand. A specific Union Station solution must be a key focus of future studies.

SERVICE PLAN AND FLEET

The same indicative service plan has been used in both scenarios. This service plan assumes that HSR trains can carry 600 passengers and will operate for 18 hours of the day. Operations have been broken into two plans:

- Peak (busiest two hours in AM/PM)—Three HSR trains per hour in both directions (two trains terminate at London, one train terminates at Windsor); and
- Off Peak—two trains per hour in both east and westbound directions (One train terminates at London, one train terminates at Windsor).

Preliminary runtime and schedule development indicate that these service plans can be delivered with the proposed infrastructure.

This study assumed that HSR would make use of a dedicated fleet of eight car electric multiple unit (EMU) trains that are compliant with the maximum operating speeds stipulated for each scenario. These trains could be similar in design to the Acela train used on Amtrak’s northeast corridor in the United States, which

are based on European high-speed trains. Trains were assumed to make use of tilting technologies to allow for higher speed along curves while maximizing passenger comfort by reducing lateral force on passengers. Fleet and associated station infrastructure are assumed to be fully accessible. Specific accessibility issues will be specified and addressed in future stages of design.

Further studies will need to confirm fleet assumptions based on overall safety guidelines and regulations, including crash worthiness, based on corridor design and service interactions with other passenger and freight services.



CRH HSR Train, China 2016

Phasing and Delivery

OVERVIEW

Each scenario was assumed to be delivered in a phased and consistent manner:

	Scenario A	Scenario B
Phase 1 (Toronto to London)	Service to Toronto/London with direct access to Pearson International Airport	Service to Toronto/London with indirect access to Pearson International Airport
Phase 2 (London to Windsor)	Expanded alignment with a new station at Windsor	Expanded alignment with new stations in Chatham and Windsor

Phase 2 is assumed to be operational by 2031 for analysis purposes only based on available modelling and evaluation tools.

These phases were applied to both scenarios in order to scope costs, model demand/benefits, and understand deliverability issues. Within these phases are multiple key considerations:

- Interaction with GO RER;
- Shared use of USRC and Union Station; and

- Integration with Pearson International Airport.

INTERACTION WITH GO REGIONAL EXPRESS RAIL

Both HSR scenarios will share the rail corridor with GO RER as they head west towards Kitchener-Waterloo. HSR infrastructure has been scoped to allow HSR service to inter-operate with GO RER while achieving peak speed. Phase 1 infrastructure from Toronto to London includes significant overlap with planned GO RER infrastructure as discussed in Table 3.1

Costing and development has been undertaken to:

- Optimize HSR infrastructure to capitalize on planned GO RER upgrades where possible to minimize HSR costs;
- Invest strategically in new passing loops (lengths of track to allow for HSR to pass GO RER) and system upgrades that minimize capital costs but maximize the operating speeds of both HSR and GO RER; and
- Develop functional timetables that rationalize rail services along the corridor.

Working timetables have been developed to ensure GO RER and HSR can inter-operate at the speeds proposed for this study. Both concepts were scoped to use three HSR trains per hour in the peak period and two trains

per hour off peak. The assumed GO RER service frequency is one train per hour. Future analysis should be conducted to optimize the frequency, costs, and benefits of GO RER and HSR beyond the work completed for this study.

SHARED USE OF THE UNION STATION RAIL CORRIDOR

HSR will need to share the USRC and Union Station with other rail services, including GO RER. This study has developed a working timetable to manage train flows to/from Union at a high or preliminary level. Further analysis to manage and optimize this corridor should be included in future HSR and GO RER project development.

INTEGRATION WITH PEARSON INTERNATIONAL AIRPORT

Integration with Pearson is a key design opportunity to maximize ridership and allow HSR to connect travelers the airport, while also offering commuter and recreational travel to Mississauga. Scenario A assumes direct connection to the airport through a dedicated tunnel. Scenario B provides indirect access by serving Malton station, with provision of a dedicated connector service to Pearson International Airport.

Currently, the GTAA is developing a plan for an expanded terminal, including the provision

of a transit hub. Future HSR studies should address potential integration measures as both the HSR and GTAA projects progress. This analysis should consider how costs of direct access would be allocated along with potential benefits to the airport:

- Reduced need for parking facilities;
- Improved airport amenity; and
- Relieved runway congestion from short haul flights.

Cost Estimates

BACKGROUND

Capital, operating, and renewal costs have been estimated for the two reference scenarios. Costs at this stage of development are subject to uncertainty, because:

- Designs are conceptual and at a very low level of development;
- Alignments have been developed using desktop analysis;
- No ground condition investigations have been conducted;
- Minimal infrastructure performance information is available; and
- Funding and financing options, as well as the cost of finance, are unknown.

These limitations are common to most preliminary business cases. All costs are shown in a dollar base from 2021, the year when construction would begin. Costs estimates are inflated using an inflation rate of 3%, which represents a 1% increase in costs in real terms, along with 2% nominal inflation from a 2015 base estimate year to 2021\$.

Note: this document shows costs for HSR in three ways:

- Section 3.2 – cost of procuring and operating the system as though it was procured entirely in 2021;
- Economic Case – total economic present value (2021\$) of the costs based on when they are incurred in real terms; and
- Financial Case – total financial present value (2021\$) of the costs based on when they are incurred in nominal terms.

Real values, used in the economic case, reflect the increase in the value of goods and services in terms of purchasing power from the base year. Nominal values, used in the financial case, reflect the expected cost of a good or service in the year of expenditure. These values include both the general inflation rate as well as the increase for the good/service in real terms.

Figure 3.2 provides a further overview of the costs used in this analysis.

FIGURE 3.2: COST COMPARISON

The business case uses three types of costs:

- 
Total capital costs with contingency which are an estimate of the cost of the HSR system if the entire system was procured today.
- 
Economic costs which are used to understand the economic value of the HSR system to society in Section 5.
- 
Financial costs which are used to understand the financial cash flow impacts of the HSR system in Section 6.

Total capital costs with contingency

Escalated direct costs to account for costs associated with project development, environmental mitigation, and risk/contingency (capital cost approach shown in figure 3.4).



Economic costs (real terms) –Section 5

HSR requires capital, renewal, and operating costs to be paid throughout the project lifecycle. Economic costs reflect the real price of these costs based on the year they are incurred and a social discount rate.

The social discount rate reflects a general ‘time preference’ for money – money today is seen as more valuable than money in the future so over time costs and benefits are discounted.



Financial costs (nominal terms) – Section 6

HSR requires capital, renewal, and operating costs to be paid throughout the project lifecycle. Financial costs reflect the actual price in the year they are required.

Because the purchasing power of money declines over time, cost estimates need to be adjusted throughout the lifecycle to reflect the increase in money required to procure them compared to if they were procured in the base year.

Notes:

Inflation reflects the general increase in prices for goods and services overtime.

Real inflation reflects the increase in prices for goods and services above the general increase in prices – for example, HSR fleet may increase in price faster than other goods and services.

Nominal values, used in the financial case, reflect the expected cost of a good or service in the year of expenditure base on both general and real inflation.

Real values, used in the economic case, reflect the value of the good or service based on real inflation without general inflation.

OVERALL ASSUMPTIONS

Costs included in this study are estimated to be incremental to GO RER Scenario 5 and GO RER service to Kitchener-Waterloo, which will provide two way all day electrified train service. GO RER costs include electrification, construction of additional tracks, and improvements to the operational capabilities of the rail network. Additionally, the costs of freight rationalization are not included in the cost estimates; however, it is assumed a freight rationalization solution will be in place as a key precondition for HSR services.

Construction is assumed to follow two phases:

- 2021-2024 – Phase 1 from Toronto to London (including synchronizing design and construction efforts with GO RER);
- 2025-2030 – Phase 2 from London to Windsor (target date for analysis purposes only).

CAPITAL COSTS

The methodology for the estimate is based on a bottom-up quantification of items, both existing and new, with unit rates applied to generate a direct cost estimate. Costs were estimated based on system components:

- Railway Alignment and Systems, including;
 - Railway Traffic Control Systems;
 - Railway Power Systems;
 - Railway Plant;
 - Civil Works;
 - Enabling Works;
- Stations and Buildings; and
- Fleet Costs.

Capital costs have been estimated following international best practice for a study at this stage of design with uplifts based on a ‘Class 4’ estimate using American Association of Cost Engineering (AACE) guidelines along with the United Kingdom Treasury Board Green Book, which calls for a 66% contingency given the detail of design used in this preliminary business case.¹⁷

Excluding the train fleet, the construction costs have had mark-ups applied to the direct construction cost to allow for a range of additional costs elements. These are based on simple % uplifts as shown in Figure 3.3. Such “soft costs” have been added as a percentage mark-up of the direct construction cost. The

total cost is the sum of the direct costs plus soft costs. All direct cost elements have the same mark-ups applied. Mark-ups are compounded at the construction total and point estimate.

These costs include the following assumptions:

- Capital costs for Scenario A are based on the Toronto to Windsor corridor that requires a new set of infrastructure to achieve 300 km/h; and
- Capital costs for Scenario B include a largely new corridor from Kitchener-Waterloo to London, an upgrade/expanded corridor from London to Windsor, and a corridor that is estimated based on the increment infrastructure requirements for HSR above those for GO RER as noted in the incremental costs above GO RER specified in Table 3.1 from Toronto to Kitchener-Waterloo.

Direct and total capital costs for Scenarios A and B are shown in Table 3.2. The largest component of the large differential between A and B is the tunnel costs in A, which provide direct access to Pearson International Airport, and enable the line to by-pass the constraints of the existing alignment through Guelph.

17 AACE American Association of Cost Engineering (AACE) guidelines: https://www.nsf.gov/about/contracting/rfq/s/support_ant/docs/facility_manuals/palmer_mcm_and_southpole/costestimatingssystemaace-208a.pdf

FIGURE 3.3: CAPITAL COST UPLIFTS

(1) Estimate Direct Capital Costs

- Based on assumed quantities to deliver the alignment



(2) Estimate uplifted capital costs

- Composed of the following uplifts to account for cost of constructing the alignment:
- 25% preliminaries
- 16.3% overhead and profit
- 0.5% training and spares



(3) Estimate total construction cost

- Composed of the following uplifts for cost associated with finalizing design and mitigating environmental issues :
- 12% design
- 12% project development
- 2% environmental mitigation



(4) Estimate total overall costs with contingency

- Calculated by adding a 66% uplift for risk/contingency

How are total capital costs estimated?

The cost estimation process begins with **(1) direct capital costs**, which reflects the quantities of materials required to deliver HSR. These costs are then uplifted to take into account preliminary work, overhead/profit, and associated training to deliver the project, resulting in **uplifted capital costs (2)**. These costs are then further uplifted to include works associated with detailed design, project development, and environmental mitigation to calculate a **total construction cost (3)**.

Finally, a risk/contingency factor is applied that accounts for an increase of 66% of the **total construction cost (3)** to calculate **total capital cost with contingency (4)**.

TABLE 3.2A: HSR CAPITAL COSTS (MILLION \$2021) SCENARIO A

A	Direct Costs			Total Capital Costs with Contingency		
	Phase 1	Phase 2	Total corridor	Phase 1	Phase 2	Total corridor
 Total Capital Costs	\$15,090	\$4,370	\$19,460	\$43,580	\$12,970	\$56,550
 Railway Systems	\$4,470	\$3,290	\$7,760	\$13,250	\$9,790	\$23,040
 Tunnels	\$8,480	\$0	\$8,480	\$25,170	\$0	\$25,170
 Stations	\$370	\$120	\$490	\$1,110	\$330	\$1,440
 Electrification	\$1,160	\$810	\$1,970	\$3,450	\$2,400	\$5,850
 Depot and Maintenance	\$0	\$0	\$150	\$0	\$0	\$450
 Fleet	\$600	\$0	\$600	\$600	\$0	\$600
 Cost per km (excluding fleet)	\$78	\$22	\$50	\$232	\$66	\$149

TABLE 3.2B: HSR CAPITAL COSTS (MILLION \$2021) SCENARIO B

B	Direct Costs			Total Capital Costs with Contingency		
	Phase 1	Phase 2	Total corridor	Phase 1	Phase 2	Total corridor
 Total Capital Costs	\$4,110	\$3,390	\$7,500	\$10,870	\$10,070	\$20,940
 Railway Systems	\$2,430	\$2,490	\$4,920	\$7,200	\$7,390	\$14,590
 Tunnels	\$0	\$0	\$0	\$0	\$0	\$0
 Stations	\$370	\$120	\$490	\$1,090	\$370	\$1,460
 Electrification	\$640	\$630	\$1,270	\$1,910	\$1,860	\$3,770
 Depot and Maintenance	\$0	\$0	\$150	\$0	\$0	\$450
 Fleet	\$670	\$0	\$670	\$670	\$0	\$670
 Cost per km (excluding fleet)	\$19	\$18	\$19	\$55	\$53	\$55

Illustrative Cost Comparison

HSR costs are included in a 2021 base year with a higher level of contingency compared to other infrastructure projects, including GO RER. This conservative cost estimate was employed commensurate with the level of design used for the study. The total capital cost for Scenario B expressed in \$2014 with an equivalent contingency is estimated to be: \$15.4 billion. The cost for phase 1 (Toronto to London) would be \$8.0 Billion and the cost for phase 2 (London to Windsor) would be \$7.4 Billion.

RENEWAL COSTS

Renewal costs have been estimated over a 60-year life of the project as is shown in Table 3.3. Renewal costs followed the same cost estimation process as capital costs, and only include components that will need replacement or heavy overhauls over the first 60 years of operations, these items include:

- Fleet;
- Tunnels (Scenario A);
- Signals and controls;
- Station equipment (including escalators/elevators);
- Track components (switches, and rails);
- Fleet maintenance equipment; and
- Electrification system components.

The same cost uplifts as capital costs (noted in Figure 3.3) were used, with the exception of contingency, which used 25% instead of 66%. A lower rate was used due to lower risk associated with replacement over the lifecycle of a project.

TABLE 3.3: HSR 60 YEAR RENEWAL COSTS

Element	A (Million 2021\$)	B (Million 2021\$)
Renewals	\$11,100	\$7,400

OPERATING COSTS

Operating costs have been identified for the high speed rail scenarios using an operating cost model developed based upon a standalone HSR organisation responsible for operating all the HSR services and maintaining the line.

The model does not include any track access charges for using the GO Transit infrastructure, nor does it include the cost of non HSR services using the dedicated HSR infrastructure. HSR stations are presumed to be independent and be used solely by the HSR services with the exception of Union, Guelph, and Kitchener-Waterloo.

The model is based upon a lean independent operating organization, responsible for the operation and maintenance of the service, rolling stock, stations and infrastructure. The model includes contingencies and overheads that are factored based on the operating cost type.

The estimated operating costs are shown in Table 3.4.

There are cost elements that are not included due to the level of development of the project, such as the acquisition of electromagnetic spectrum rights for signals and controls. Although these would be small costs, they

can aggregate to relatively significant costs during development, which will again require review as the project is developed.

Operating costs for Scenario B are equivalent to A given similar operating requirements, despite speed differences.

TABLE 3.4: HSR OPERATING COSTS

Element	A (Million 2021\$)	B (Million 2021\$)
Annual	\$220	\$220

Ridership and Revenue Forecasting

OVERVIEW

The ridership forecasting is based on establishing the Business-As-Usual (BAU) demand in the current (2014) and future years (2025, 2031, and 2041). The BAU uses established modelling techniques to forecast the demand that would switch from each of the existing modes (auto, rail, bus and air) to the new HSR service. Demand growth has been estimated using elasticities to population and GDP growth. Population data was supplied by MTO, while GDP forecasts were obtained from the Conference Board of Canada. Review of growth forecasts indicated substantial demand growth between 2014-2031 and 2041, of 55% and 91% from 2014 levels respectively, an annual rate of around 2.5%.

The propensity to switch to HSR is dependent on the differences between HSR and existing mode for:

- Travel time (including waiting and transfer time);
- Financial travel cost (including fares and parking costs); and
- Access and egress time from final destination and station.

Travelers are likely to switch to HSR when the overall cost of an HSR trip (a composite of travel time and fare) is competitive to the mode the user chose in the BAU. Access and egress times were not changed between the BAU case and the HSR scenarios.

The fares on HSR were set based on an assumed 20% increase applied to current GO and VIA Rail fares. This increment was then standardized into a fare by distance formula. The resultant fares employed are shown in Table 3.5.

Travel costs were consistent between Scenario A and B. All fares were set as cash fares – the basic fare paid by customers for an HSR ticket. The average fare (yield) received by the operator, which varies based on the products and ticket types offered by an operator, has not been considered in this analysis.

TABLE 3.5: ASSUMED ONE-WAY HSR FARES

Range of Fares (\$)	One Way Trips
15-20	Toronto to/from Pearson
	Pearson to/from Guelph
20-25	Guelph to/from Kitchener-Waterloo
	Pearson to/from Kitchener-Waterloo
	Toronto to/from Guelph
25-30	Toronto to/from Kitchener-Waterloo
	Guelph to/from London
	Kitchener to/from London
	London to/from Chatham
	Chatham to/from Windsor
40-45	Pearson to/from London
	London to/from Windsor
50-55	Toronto to/from London
	Guelph to/from Chatham
	Kitchener-Waterloo to/from Chatham
60-65	Toronto to/from Chatham
	Guelph to/from Windsor
65-70	Kitchener-Waterloo to/from Chatham
	Pearson to/from Windsor
85-90	Toronto to/from Windsor
	Toronto to/from Windsor

IN SCOPE DEMAND

Current in scope corridor demand¹⁸ is approximately 51 million trips per annum, increasing to 78 and 96 million by 2031 and 2041 respectively. The distribution of in scope demand by mode and urban centre for 2041 is shown in Table 3.6.

HSR DEMAND FORECAST

Using the forecasting model, the resulting HSR demand in 2041 is summarized in Table 3.7.

Scenario A and B achieve different levels of ridership for two reasons:

- **Scenario A** achieves higher demand to and from Pearson International Airport due to direct access; whereas
- **Scenario B** has increased demand at a number of stations due to direct connections to Chatham- however, it has lower overall demand than Scenario A because it does not serve Pearson International Airport directly.

This difference in airport demand is represented in the difference in demand originating in Toronto between scenarios – the majority of this difference is demand from Union Station to Pearson International Airport.

If Scenario B were to directly serve Pearson International Airport, preliminary forecasts suggest demand may increase by up to 1 million passengers per year with the majority of this increase being trips between Toronto and Pearson International Airport.

Actual HSR demand may vary based on variations in the assumptions used in the model, including:

- Travel time;
- Fares;
- Economic and population growth; and
- Available services and changes in travel cost.

TABLE 3.6: IN SCOPE BUSINESS AS USUAL DEMAND IN 2041 (TRIPS/YEAR)

Station	 Car	 Air	 Rail	 Bus	Total
WI	3,390,300	7,600	104,700	88,200	3,590,800
CH	2,074,000	-	24,200	47,100	2,145,300
LO	8,812,900	14,500	131,700	667,900	9,627,000
KI	22,135,100	-	245,100	573,000	22,953,200
GU	14,554,300	-	-	434,600	14,988,900
PE	24,599,900	12,600	575,500	1,038,900	26,226,900
TO	15,021,300	9,500	467,000	423,100	15,920,900
Total	90,587,800	44,200	1,548,200	3,272,800	95,453,000

¹⁸ In Scope Demand includes trips between the cities along the corridor with HSR stations that are likely to make use of HSR based on their origin. Trips within a city, which has an HSR station, that originate far from an HSR station are deemed out of scope

TABLE 3.7: HSR DEMAND BY STATION OF ORIGIN AND TRAVELLER TYPE IN 2041 (TRIPS/YEAR)

	2041 HSR Ridership Scenario A	2041 HSR Ridership Scenario B
WI	291,000	347,800
CH	-	155,800
LO	1,217,600	1,379,400
KI	1,644,000	1,690,500
GU	1,241,400	1,301,700
PE	3,233,200	2,006,500
TO	4,035,100	3,739,900
Total	11,662,300	10,621,700
Business	1,622,700	1,384,300
Commuting	3,106,000	3,452,900
Leisure	6,933,600	5,784,500

REVENUE FORECASTING

The annual revenue for HSR is a simple arithmetic summing across all the origin destination pairs of the product of the fare for each trip and the associated forecast annual demand.

The 2041 HSR revenue forecast (in \$2015) is as follows:

- **Scenario A** \$278m/year
- **Scenario B** \$273m/year

The revenue for the scenarios varies due to the combination of trips and trip types. Because Scenario B also serves Chatham, it collects additional revenue from longer distance trips.

4

Strategic Case

Overview

Section 4 outlines the strategic case for HSR in the Toronto- Windsor transport corridor. The strategic case determines how a set of potential solutions are aligned with corridor challenges and opportunities and broader policy goals using the vision, goals, and objectives set out in Section 2.

Transforms Mobility in Southwestern Ontario

This sub-section discusses how each scenario contributes to transforming mobility in Southwestern Ontario.

DEVELOP A TRANSPORT SERVICE THAT PROVIDES NEW/IMPROVED MOBILITY CHOICES FOR TRAVELLERS ALONG THE CORRIDOR

Travel times for each scenario have been set out for comparison against existing transport services. Table 4.1 outlines corridor travel times.

Scenario Comparison

Scenario A has a corridor travel time of 115 minutes, which decreases travel time along the corridor by 139 minutes compared to the current VIA Rail service. Scenario B is 9 minutes slower than Scenario A end-to-end, due to slower operating speeds through Guelph and the extra stop at Chatham. Both scenarios offer significant travel time savings for trips across the corridor.

Travel times from Toronto to Kitchener-Waterloo are 41 minutes for Scenario A and 48 minutes for Scenario B. This offers a vast improvement to mobility choices and places Kitchener-Waterloo in the commute shed for Toronto, effectively establishing a rapid connection between both economic hubs.

This finding suggests:

- There is minimal travel time difference between the 300 km/h and 250km/h service for the Toronto to Kitchener-Waterloo Segment;
- Travel time in this corridor is based on geometry of track and shorter distance between stations, which impose speed restrictions; and
- Therefore, track improvements in both scenarios are the key determinant of travel time improvements.

Overall both scenarios achieve a similar level of ridership with key variations being related to direct access to Pearson International Airport (Scenario A) and inclusion of Chatham (Scenario B) as discussed in Section 3.

TABLE 4.1: COMPARATIVE STATION TO STATION TRAVEL TIMES FOR HSR AND OTHER MODES¹⁹

Segment	Travel time (minutes)							
	A	B	UPE	GO	GO RER	VIA Rail	Air	Auto
TO ▶ PE	14	16	25					23
TO ▶ GU	32	39		99		69		67
TO ▶ KI	41	48		123	72	95		74
TO ▶ LO	66	73				130	42	120
TO ▶ CH		102				200		172
TO ▶ WI	115	124				254	68	221
GU ▶ KI	9	9		24		26		7
KI ▶ LO	25	25				105		46
LO ▶ WI	49	51				118		101
Resulting HSR Ridership (2041)	11,662,300	10,621,700						

¹⁹ Auto times are fastest journey time based on Google Maps travel times. GO Transit (rail/bus)/VIA Rail/Bus (greyhound) travel times are based on their respective timetables as of 2016. GO RER travel times based on Steer Davies Gleave runtime model, which is used for all HSR and GO RER runtimes. These runtimes are subject to Metrolinx analysis and coordination of service plans along the Kitchener-Waterloo corridor

DEVELOP A TRANSPORT SERVICE THAT PROVIDES GOOD VALUE FOR MONEY AND OPTIMAL UTILIZATION OF INFRASTRUCTURE

The value for money analysis in the strategic case compared the overall ridership for each scenario and the capital costs required to deliver the scenario (Table 4.2). This analysis is intended to determine the overall cost effectiveness of the two scenarios relative to each other.

As noted in table 4.2:

- Both scenarios achieve a similar level of ridership, with Scenario B’s ridership equalling of 91% Scenario A; and
- Scenario A’s costs are 270% those of Scenario B.

This review suggest that both scenarios are capable of delivering a similar degree of strategic benefits – in this case ridership; however, the cost of delivering A greatly exceeds B. The increased investment in Scenario A to deliver HSR service (270%) does not deliver a commensurate increase in benefits (9%).

TABLE 4.2: VALUE FOR MONEY ANALYSIS

Factor	A	B
Total Uplifted Capital Costs (million 2021\$)	\$56,550	\$20,940
2041 Annual Ridership (Million)	11.6	10.6

DEVELOP A TRANSPORT SERVICE THAT IMPROVES OVERALL TRANSPORT EFFICIENCY AND RESILIENCE THROUGHOUT SOUTHWESTERN ONTARIO

This objective is focused on understanding how efficient each scenario is. A high level assessment was conducted to determine modal share and change in vehicle kilometres travelled (shown in Table 4.3.) Currently, in the BAU case, it is expected that the automobile will be the dominant passenger mode with 95% of demand in 2041.

TABLE 4.3: TORONTO-WINDSOR 2041 MODE SPLIT

	BAU	A	B
Car	95%	85%	86%
Rail (incl. GO RER)	2%	2%	2%
Air*	0%	0%	0%
Bus	3%	1%	1%
HSR	-	12%	11%
Annual Change in automobile vehicle KM travelled (km, million)		-570	-570
Annual Change in Peak Auto vehicle KM travelled (km, million)		-250	-250

*The mode share for air is 0.04%- all of which is abstracted to HSR in both scenarios, allowing short haul runway space at Pearson International Airport to be reallocated. Note that mode share is different from 2011 TSRC mode share presented in Section 2.

DEVELOP A TRANSPORT SERVICE THAT LIMITS THE NEGATIVE ENVIRONMENTAL IMPACTS OF TRANSPORT

This objective is assessed by determining HSR’s impact on emissions along the corridor. In 2012, Ontario emitted 167 million tonnes of CO₂, of which 34% was from transport.²⁰ Because HSR has the potential to reduce automobile travel along the Toronto-Windsor corridor, it can contribute to a reduction of greenhouse gases in the transport sector.

Changes in CO₂ emissions were calculated based on both new emissions from HSR and reductions in emissions due to mode shift from automobile to HSR. HSR emissions were derived from emission rates for the existing power generation in Ontario and may decrease overtime. Emissions are assumed to be equivalent for each operating year; however, auto emission reductions vary as demand ramps up between opening and 2041.

The modelling process calculated 2031 and 2041 changes in vehicle kilometers travelled (VKT), which were used to calculate emission changes with a value of 0.22kg/km for automobile emissions, as per MTO guidance. Changes in auto travel distances are an output of the forecasting process, and are based on highway travel distances only.

Greenhouse gas estimates do not include changes in emissions due to air travel and bus departures, as a comparable schedule to current demand is assumed for future years. As a result, these emissions are conservative, and the observed emission reductions may be higher due to changes in flight and bus operating patterns.

Scenario Comparison

Both Scenarios A and B have similar emission impacts. Overall, the annual reductions in emissions for both scenarios represent a small portion of overall Ontario emissions (0.07%), based on a comparison of 2012 GHG emissions and 2041 emission reductions. However, both scenarios have a reduction factor (CO₂ reductions/HSR emissions) of over 20, which suggests that for every tonne of CO₂ that an HSR system creates due to electricity requirements, it removes over 20 tonnes from the auto network due to changes in travel demand.

TABLE 4.4: CO₂ EMISSION REDUCTIONS

CO ₂	A	B
2041 Annual Auto Reductions (tonnes)	111,290	111,928
60 year Net Reductions (tonnes)	7,868,500	7,809,000
Reduction Factor (CO ₂ reductions/ HSR Emissions)	21	21

²⁰ Source: Ontario’s Climate Change Update, 2014.

Catalyze Economic Development

PROVIDE A TRANSPORT SERVICE THAT CONNECTS CENTRES OF EMPLOYMENT AND BUSINESS, AND PROVIDE A TRANSPORT SERVICE THAT TRIGGERS WIDER ECONOMIC BENEFITS

A key rationale for pursuing HSR is its potential to trigger wider economic benefits by integrating employment centres and cities along the corridor. The Strategic Case provides a high level overview of the strategic tools HSR offers to provide economic benefits while Section 5, the Economics Case, provides an overview of the monetized economic benefits of HSR.

HSR's ability to connect employment centres triggers wider economic benefits through agglomeration, which is the process of increasing the productivity of an economy by reducing travel time between communities by providing reliable and rapid transport options.

For example, productivity benefits occur when an HSR service increases the total number of jobs or employment centres that are connected by rapid and reliable transport services within a given travel time to an employment hub (example: 45 minutes). This allows for:

- An increase in interaction and collaboration between firms or other institutions that are located across multiple cities; and

- An improved overall labour catchment for knowledge based industries, which can encourage business growth and new investment.

Research suggests that growing and healthy centres tend to benefit more from the HSR than declining areas and benefits are typically experienced when travel times are reduced to 30-90 minutes, depending on the region. Given the rate of growth in south western Ontario, WEBs are a key consideration for analysis.

Agglomeration at a strategic level is in two ways:

- Total employment along the new HSR corridor; and
- Changes in accessibility/commuted for major urban centres.

Total Employment along HSR Corridor

Total employment in the CMAs served by HSR along the corridor was estimated based on 2011 census data. The total employment catchment was calculated for each of the scenarios, and is shown in Table 4.5. The 2041 results are independent of the HSR system and are used to illustrate the number of jobs in each city by 2041. This is a representation of the total labour that can be reached via HSR. Table 4.5 also shows the total employment in 'HSR supported industries'. These are industries that

are likely to see a benefit from the improved connectivity that HSR can create, including:

- Information and cultural industries;
- Finance and insurance;
- Real estate; and
- Professional, scientific, and technical services.

These industries have been seen to benefit from HSR based on international experience monitoring the benefits of HSR, along with the benefits of improved rapid transport more generally. Industries that are candidates to be supported by HSR typically:

- Support or contribute to a knowledge or service based economy;
- Rely upon well-educated or higher skilled labour; and
- Are likely to have multiple offices or clients within the catchment served by HSR.

TABLE 4.5: CORRIDOR EMPLOYMENT CATCHMENT²¹

	Total Employment		Total HSR Supported Industries	
	2011	2041	2011	2041
TO	3,234,100	4,480,300	713,600	1,012,000
GU	110,000	157,600	11,900	17,600
KI	268,700	392,700	42,700	64,700
LO	229,100	307,400	35,700	48,200
CH	52,600	43,400	3,700	3,100
WI	171,400	169,600	16,100	15,900
A	4,013,300	5,507,600	819,900	1,158,500
B	4,065,900	5,551,000	823,600	1,161,600

²¹ 2011 employment figures & 2041 employment projections provided by MTO, produced by Hemson Consulting.

Change in Commute Shed

The Toronto, London, and Windsor commute sheds are used as units of analysis to demonstrate how HSR can change commuter travel along the corridor. The commute shed includes both GO Transit and local transit for cities along the corridor that will be served by an HSR station. The commute sheds for the corridor are shown in Figure 4.1 (Toronto as Origin), Figure 4.2 (London as Origin), and Figure 4.3 (Windsor as Origin).

These figures show the total area that can be reached within a given transit travel time from each proposed HSR station before and after HSR is implemented. They highlight the extent to which each 'commute shed' (the total area reachable from a station) grows with HSR.

Both HSR scenarios improve key potential economic connections by expanding the commute shed for each urban centre served

by the rail line. In particular, under both scenarios, the Kitchener-Waterloo to Toronto commute is reduced to less than 50 minutes.

Scenario Comparison

The total employment catchment area is larger for Scenario B due to the inclusion of Chatham. However, when the analysis focuses on industries likely to benefit from HSR, the two scenarios are nearly equivalent, with Scenario B having a catchment area that is 1.3% larger than Scenario A.

Commute shed changes are similar for both scenarios, with Scenario A having a slightly larger commute shed due to its faster travel time.

FIGURE 4.1: EXISTING TORONTO COMMUTE SHED ON LOCAL TRANSIT AND/OR GO TRANSIT AND FUTURE COMMUTE SHED ON HSR

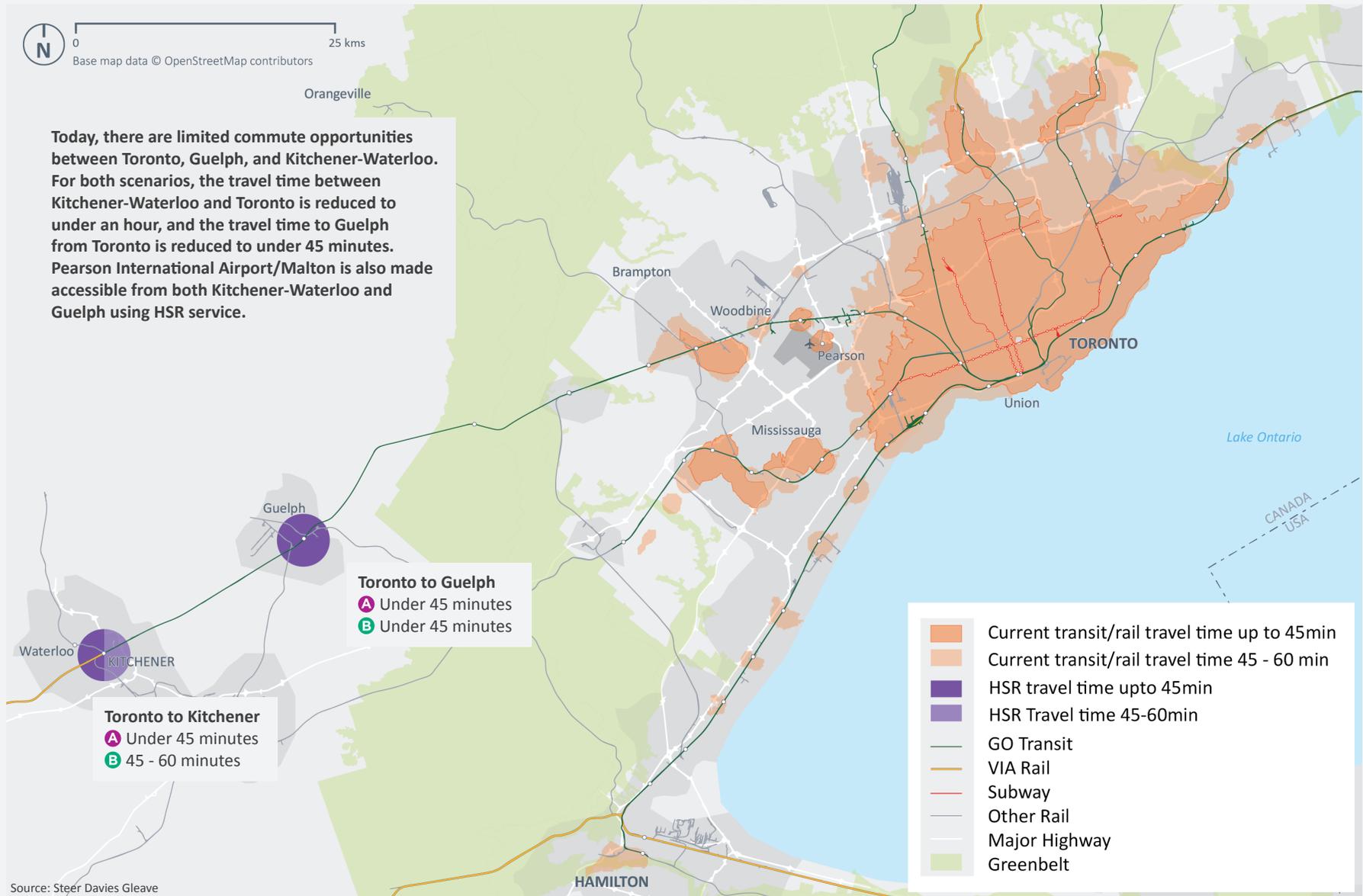
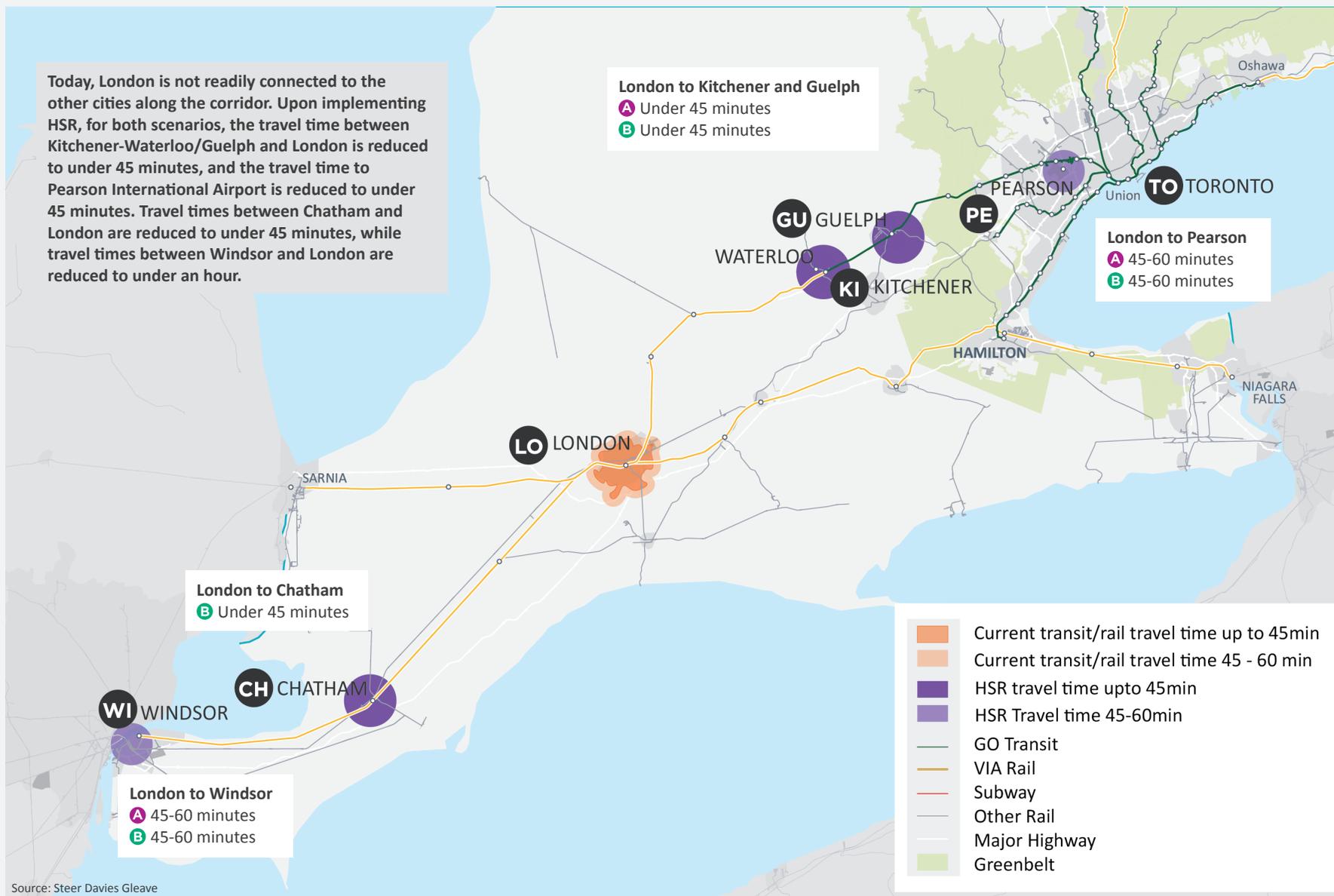
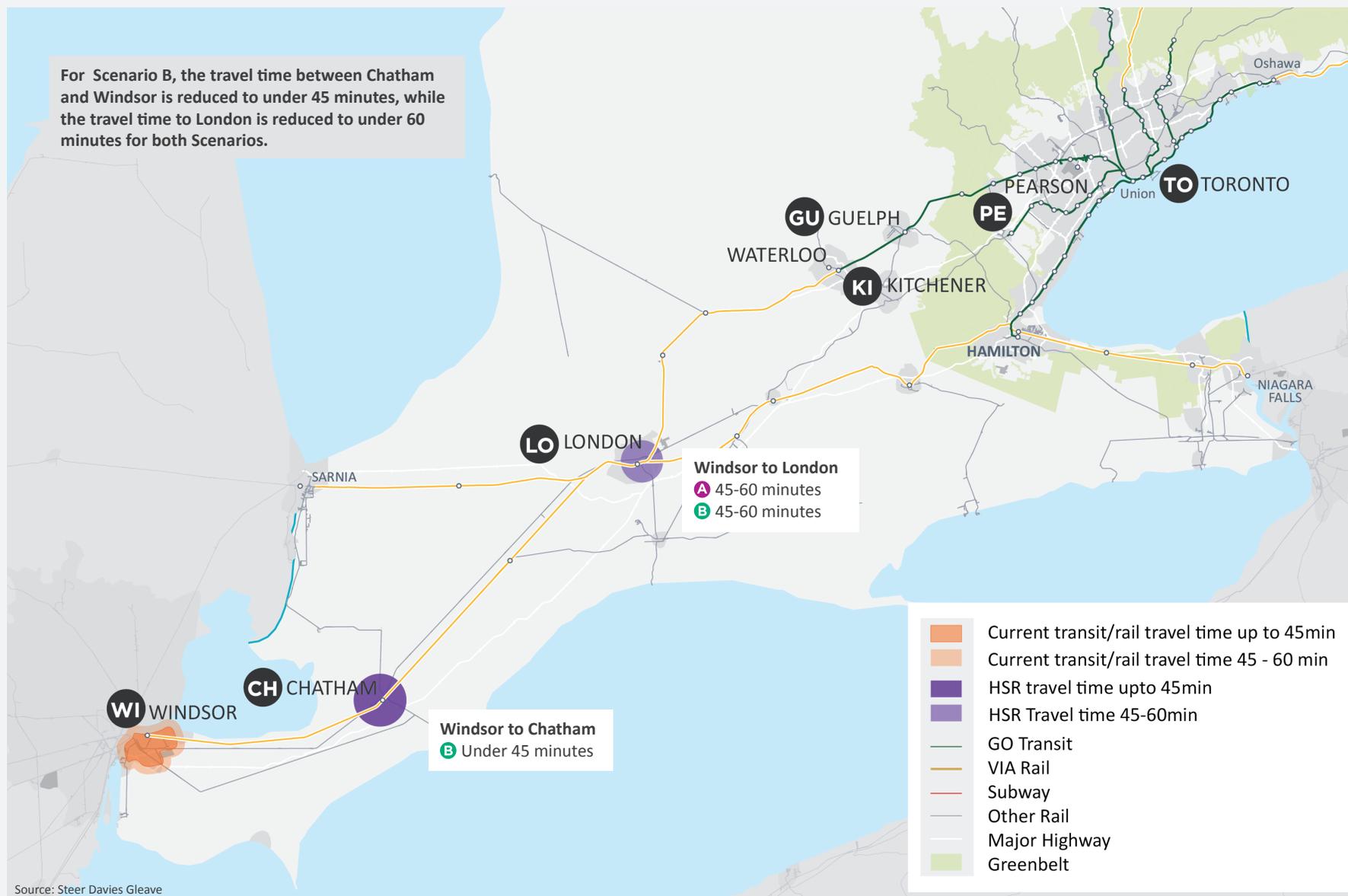


FIGURE 4.2: EXISTING LONDON COMMUTE SHED ON LOCAL TRANSIT AND/OR GO TRANSIT AND FUTURE COMMUTE SHED ON HSR



Source: Steer Davies Gleave

FIGURE 4.3: EXISTING WINDSOR COMMUTE SHED ON LOCAL TRANSIT AND/OR GO TRANSIT AND FUTURE COMMUTE SHED ON HSR



PROVIDE A TRANSPORT SERVICE THAT CONNECTS KNOWLEDGE CENTRES THROUGHOUT CORRIDOR

HSR has the potential to improve linkages between knowledge centres in Southwestern Ontario. Knowledge centres broadly include:

- Universities;
- Colleges; and
- Technical industry centres (example: research and development intensive industry cores).

Both HSR scenarios connect the same major universities and technical centres across Southwestern Ontario, with Scenario B also serving Chatham. Knowledge centres have been identified based on their ability to be accessed via transit, walking, or taxi from an HSR station. These centres are noted in Table 4.6.

Both scenarios provide reduced travel times and a dedicated/reliable rail service connecting all major travel hubs along the corridor.

In particular, the dense knowledge innovation hubs in Toronto and Kitchener-Waterloo become closely linked, having improved travel/access times: 44 minutes for Scenario A and 48 minutes for Scenario B. These improved travel times provide a rapid link between the heart of both Toronto and Kitchener-Waterloo’s knowledge centres.

TABLE 4.6: EXAMPLE OF KNOWLEDGE CENTRES ALONG CORRIDOR

Urban Centre	Knowledge Centres
Toronto	University of Toronto York University Ryerson University OCAD University Discovery District/Health Care Financial District Humber College Centennial College George Brown College Seneca College
Pearson International Airport	Adjacent business campuses/ corporate park
Guelph	University of Guelph Ontario Agricultural College Ontario Veterinary College
Kitchener-Waterloo	Wilfrid Laurier University, University of Waterloo Waterloo start-up/high tech hub Conestoga College
London	Western University Fanshawe College London Health Sciences Centre London Technological Hub
Chatham	St. Clair College University of Guelph Ridgeway
Windsor	University of Windsor St.Clair College College Boreal

PROVIDE A TRANSPORT SERVICE THAT MANAGES INTERACTIONS BETWEEN FREIGHT AND PASSENGER TRAVEL TO PROMOTE ECONOMIC DEVELOPMENT

Both goods movement and passenger movement facilitate economic development. Currently, rail corridors are shared for freight and passenger movements, which limit the potential of passenger rail to connect economic centres without impacting goods movement. Scenario A and B provide representative alignments that seek to minimize interactions with freight, in order to allow passenger rail to operate at higher frequencies and speeds without impact to goods movement in Southwestern Ontario.

Key Segregation Issues

Scenario B is dependent on a freight rationalization program due to its use of existing shared rail²² corridors through the GTHA. Scenario A avoids the usage of the existing rail network via a tunnel that begins at the Humber River and tunnels under Pearson International Airport/Brampton, thus this scenario removes any interactions with mixed use rail corridors within the GTHA.

Both of the above solutions carry

²² Rail Rationalization is an ongoing program to segregate passenger and freight rail operations in order to improve reliability, capacity, and speed.

unique costs and risks:

- **Scenario A** the tunnel is the highest cost component of the alignment – however it allows for Scenario A to be completely segregated from freight and passenger rail; and
- **Scenario B** freight rationalization is required for the scenario to be successfully implemented. Current cost estimates do not include the cost of any freight rationalization projects.

Support Regional Integration and Development

PROVIDE A TRANSPORT SERVICE THAT CONNECTS MAJOR POPULATION, CULTURAL, AND ACTIVITY CENTRES

HSR has the potential to provide a rapid and reliable connection between urban cores across Southwestern Ontario.

Population catchment for each scenario was estimated based on the 2011 census data and 2041 population forecasts (shown in Table 4.7, and provided by MTO, produced by Hemson Consulting).

Scenario Comparison

Because Scenario B directly serves Chatham-Kent, it has a higher overall population catchment. Despite its slower speed, Scenario B has a comparable ridership due to serving the additional demand centre in Chatham.

TABLE 4.7: HSR POPULATION CATCHMENT

	A	B
Population Catchment (2011)	6,995,000	7,099,400
Population Catchment (2041)	13,400,000	13,500,000

PROVIDE A TRANSPORT SERVICE THAT MINIMIZES IMPACT ON NATURAL ENVIRONMENTS

A number of important environmental features are found in the study corridor. Both the Niagara Escarpment and the Greenbelt are protected by provincial land use plans, restricting development and supporting appropriate uses to facilitate supportive recreational and agricultural activities. This review highlights the key considerations for environmental review. No direct environmental assessment of impacts has been conducted at this stage.

Niagara Escarpment

A UNESCO recognized World Biosphere reserve, the Niagara Escarpment is a topological feature running 275 km from the Niagara River to the Bruce Peninsula. It is a source of a number of Ontario's rivers and an important recreational area.

The Niagara Escarpment falls under the jurisdiction of the Niagara Escarpment Commission (NEC), an agency of the Ministry of Natural Resources (MNR). The Niagara Escarpment Plan (NEP) is an environmental land use plan that outlines development criteria and permitted uses for the escarpment. A new escarpment crossing would have a direct impact on the Escarpment Natural Area. According to Part 1.3 of the NEP, transportation and utility facilities are only permitted in Escarpment Natural Area if they are deemed to be essential. An application to amend the Niagara Escarpment Plan is required for the proposed work.

For both scenarios, a crossing over the escarpment will be required. The crossing of the Niagara Escarpment takes place in the area of Acton and Limehouse, following the existing Guelph subdivision with some improvements to curves for increased speed. The vertical design is expected to remain as close as possible to the

existing line, so as to maintain functionality with any running rights obligations; however, there would be consideration given to changing the vertical alignment for environmental reasons.

Greenbelt

The greenbelt surrounds the urban areas of the Greater Golden Horseshoe and is a crucial component of the Greater Golden Horseshoe Growth Plan. The Greenbelt confines urbanization to certain areas of the GGH, protecting an important agricultural land base. In addition, the Greenbelt includes a variety of ecologically sensitive areas and complements the Niagara Escarpment Plan.

National and Provincial Parks

No parks are located directly on the corridor; however, Point Pelee National Park is located south of Leamington, and 12 provincial parks can be found on the shores of Lake Erie or Huron in Southwestern Ontario.

Agricultural Areas

Southwestern Ontario represents Ontario's most important agricultural region, with approximately half of all the province's farms (Ministry of Agriculture, Southwestern Ontario at a Glance, 2011). The GGH Growth

Plan, the Greenbelt plan and official plans of cities along the corridor have restricted development into agricultural areas.

HSR Land Requirements

This analysis includes construction on lands currently unused for transport, including natural parks or agricultural land. The land requirements for greenfield development are:

- **Scenario A** : 130.6 km
- **Scenario B** : 67.7 km

The lengths of impact vary based on earthworks required along the alignment segment. A conservative assumption of 26m width results in the following overall land impacts:

- **Scenario A** : 3,395,600 m²
- **Scenario B** : 1,760,200 m²

Given the nature of the corridor, impacts on agricultural lands are assumed to be minimized through provision of infrastructure to be determined in consultation with affected communities in future stages of the study.

Table 4.8 sets a summary of the forecasted impacts on forests and protected areas for each scenario. Impacts are outlined in linear distance of impact, with the total area of impact varying based on construction and operation requirements, which should be determined in a future study. Both scenarios have minor impacts on forested areas, with Scenario A impacting 8.5 km and Scenario B impacting 9.9 km.

Water Bodies

The study area is rich in water bodies: it is surrounded by three great lakes (Ontario, Erie, and Huron), and has major rivers, many of which are protected by conservation authorities, including:

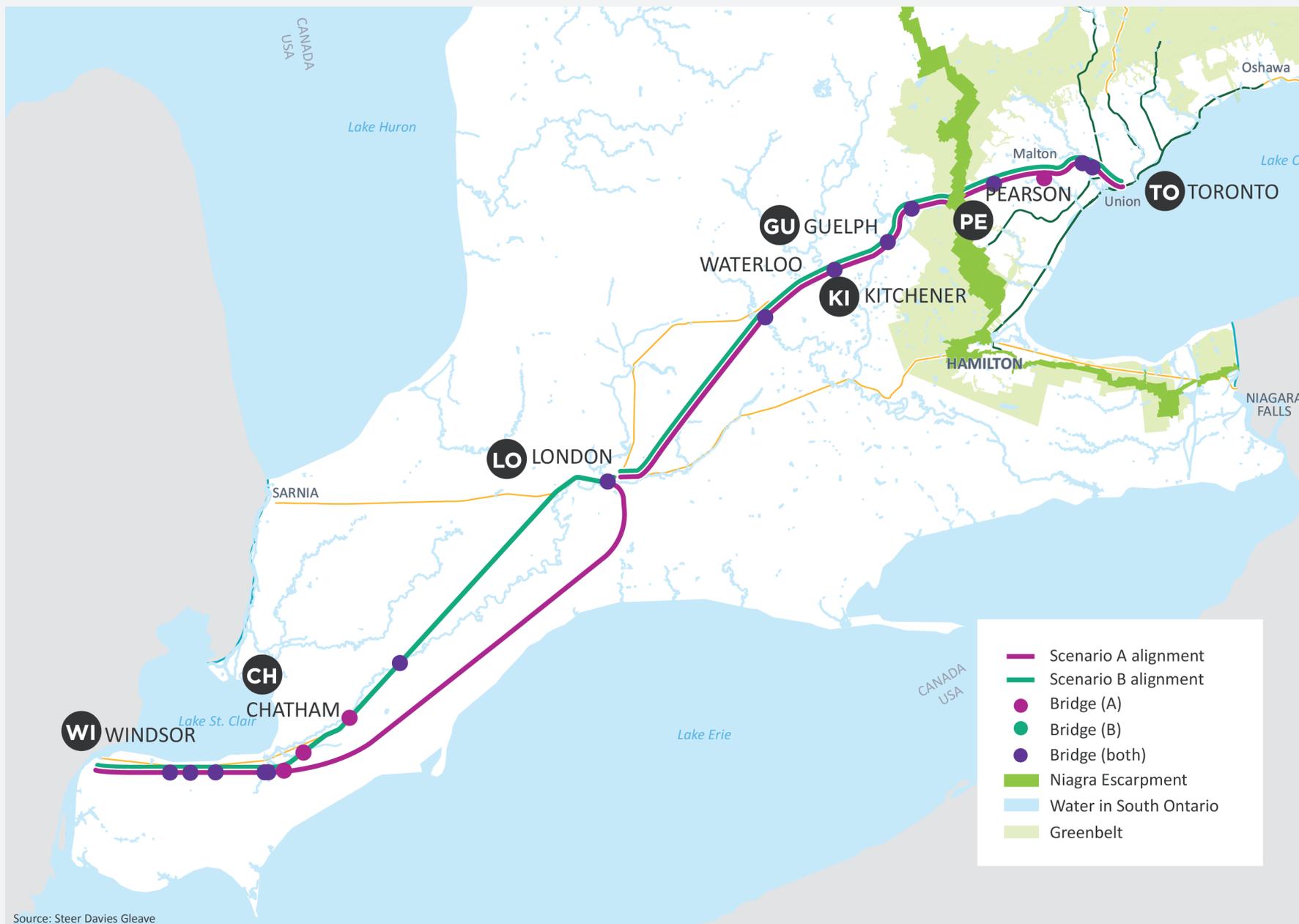
- Thames River (Upper & Lower Thames River Conservation Authorities);
- Grand River (Grand River Conservation Authority); and
- St. Clair River (Saint Clair Conservation Authority)

The alignments will cross multiple bodies of water including rivers and creeks, with costs of crossings included in scenario cost estimates. The major crossings for both scenarios are outlined in Figure 4.4.

TABLE 4.8: FOREST AND PARK IMPACTS

	A		B	
	Forested Area (Linear meters)	Park Area (Linear meters)	Forested Area (Linear meters)	Park Area (Linear meters)
TO ▶ PE	0	0	0	0
PE ▶ GU	1,990	140	2,570	0
GU ▶ KI	1,450	0	470	0
KI ▶ LO	4,260	0	4,260	0
LO ▶ WI	850	0	2,600	0
Total	8,550	140	9,900	0

FIGURE 4.4: IMPACT ON BODIES OF WATER



Source: Steer Davies Gleave

PROVIDE A TRANSPORT SERVICE THAT IS INTEGRATED WITH HUMAN ENVIRONMENTS AND TRANSPORT NETWORKS

Each scenario was assessed based on its ability to integrate with urban form and transport networks.

Transport Integration

Both scenarios serve a similar set of stations, leading to comparable transport network integration.

Urban Fabric, Cultural, and Noise Impacts

In terms of urban impacts, the Toronto to Kitchener-Waterloo segment of each scenario is expected to carry a similar degree of impacts. Both scenarios will make use of planned GO RER expansion, with additional construction beyond the footprint of GO RER occurring largely outside of urban areas. The key variation between Scenario A and B is the use of tunnelling under Pearson and Brampton in Scenario A. In general, this use of tunnelling mitigates some noise impacts compared to Scenario B, due to underground construction and operations. However, further studies will be required to determine impact on potential archaeological sites, as well as foundations of heritage buildings due to tunnelling.

Both scenarios follow a similar alignment

from Kitchener-Waterloo to Windsor, with the only variation being a different London-Windsor route used by Scenario B to allow direct service to Chatham.

A key urban impact for further consideration in each urban centre along the corridor is noise. The assumed HSR rolling stock in both scenarios runs quieter; however, due to increased service levels, there will also be an increase in frequency. Further studies will quantify noise changes due to the implementation of HSR.

Impact on Indigenous Communities

Given the preliminary nature of this business case, potential impacts on indigenous communities have not been determined.

At least 10 First Nations have reserves, land claims, and/or traditional territories that could potentially be impacted by HSR development through Southwestern Ontario. Many of these nations have active land claims throughout Southwestern Ontario, and to beds of the Great Lakes and rivers in the area.

In general, impacts over the lifecycle of the scenarios include:

- Alignment construction, development, and maintenance in traditional territories; and
- Operations through traditional territories.

Engagement with First Nations communities will clarify potential impacts due to construction and operations.

PROVIDE A TRANSPORT SERVICE THAT SUPPORTS URBAN DEVELOPMENT

Overview

This objective is oriented around HSR's ability to support development goals and agendas for the municipalities along the corridor. As this is a high level and preliminary business case, this objective is assessed based on how each station may impact development potential in its adjacent area. The review is presented in Figure 4.5.

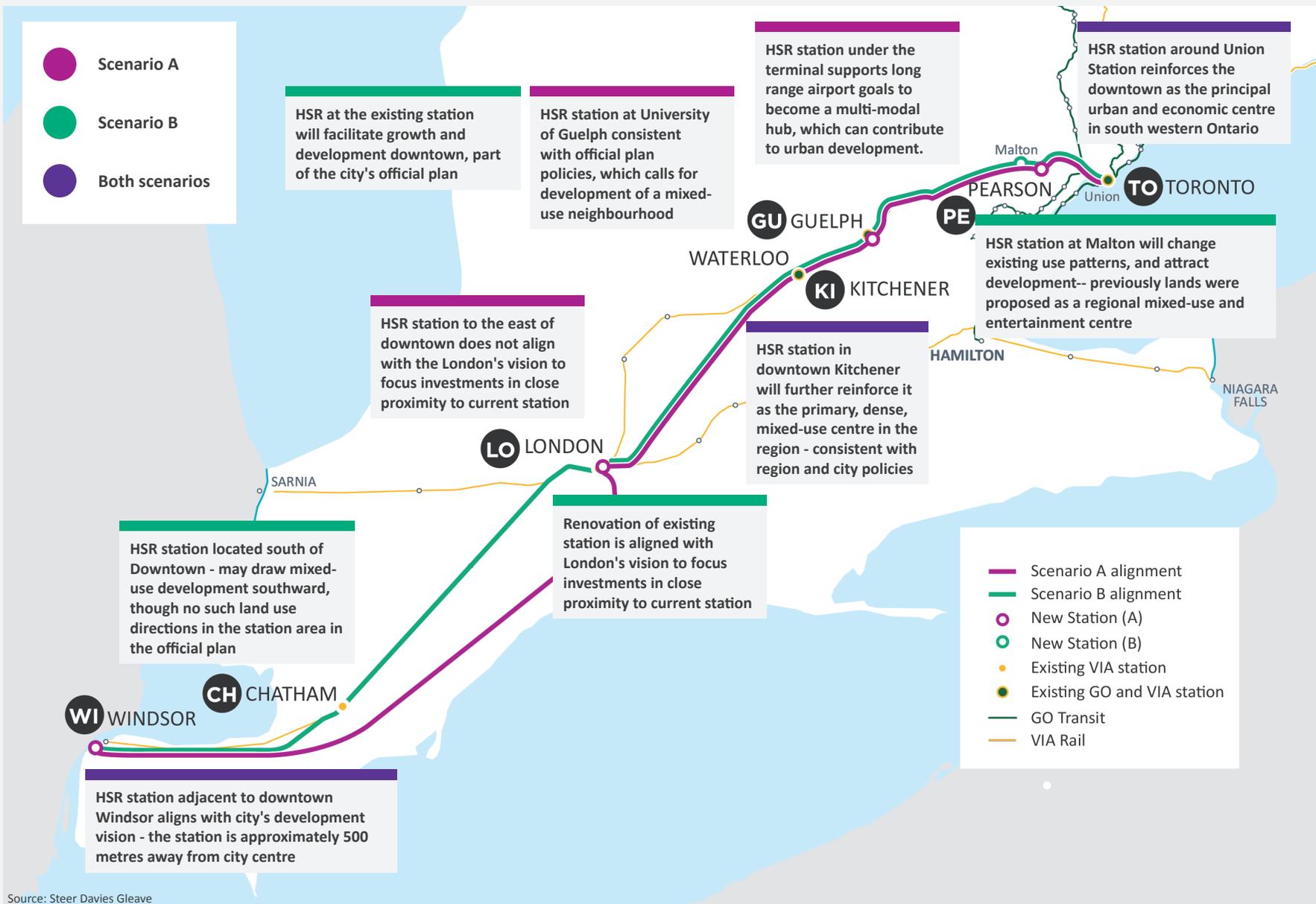
Scenario Comparison

The two scenarios provide a similar level of impact at:

- Toronto;
- Kitchener-Waterloo;
- London; and
- Windsor.

In general, the design decision to integrate the stations within existing core areas allows for a set of stations that are in line with development plans. Further studies will need to identify specific requirements and plans to leverage the development opportunities that accompany the development of an HSR service.

FIGURE 4.5: HSR ALIGNMENT WITH DEVELOPMENT



Source: Steer Davies Gleave

Differences only occur at Pearson International Airport and Guelph. The Pearson International Airport station for Scenario A directly links to the development of the airport as a multi-modal hub, which in turn supports development of lands directly adjacent to the airport for commercial and mixed uses. In Scenario B, the Malton Station may serve as a catalyst for new development in the immediately adjacent area, but is unlikely to have the same impact as a major multi-modal hub. However, as discussed in Section 3, direct access to the airport for Scenario B may be addressed in future studies as an additional service expansion.

The two scenarios also vary in Guelph. Within the city the Scenario A station broadly supports urban development policies; however, it is removed from the core. Scenario B provides an improved downtown station that may support downtown development.

Strategic Case Summary

The strategic case sets out scenario performance against a set of objectives and goals to determine how well aligned each scenario is with the vision for the corridor.

This process draws conclusions on how each scenario performs against the objectives, as well as how the two scenarios compare to each other.

From the preceding analysis, it is determined that both scenarios deliver an acceptable level of performance under the strategic case and therefore can achieve the overall vision for transformed mobility along the corridor. In general, both scenarios have the potential to realize the vision by:

- Delivering a service with improved travel time, reliability, and frequency that triggers significant mode shift;
- Improving regional integration between social and economic centres; and
- Providing an improved transport service with manageable impacts on human settlements and the natural environment along the corridor.

The key significant differences in performance are:

- Scenario A has a higher overall cost without a commensurate increase in ridership and is therefore more expensive per rider
- Scenario B's costs are lower because it leverages planned investment in GO RER;
- Scenario B has a larger catchment for population and employment by serving Chatham; and
- Scenario B is able to leverage investment in GO RER along the Kitchener-Waterloo corridor, realizing HSR cost savings compared to Scenario A.

This review concludes that:

- In strategic terms, there is minimal merit in pursuing a Scenario A 300 km/h scenario over Scenario B 250 km/h s due to minimal travel time differences and overall strategic benefits from the costs of higher speed; and
- The addition of Chatham, which lies along both alignments but is only included in Scenario B, adds moderate strategic value to the project.

A summary of each objective and comparison of performance is provided in Table 4.9.

TABLE 4.9: STRATEGIC CASE SUMMARY

Strategic Case: Scenario A



Transform Mobility Choice in Southwestern Ontario

The Toronto-Windsor corridor will provide efficient and sustainable mobility in Southwestern Ontario



Objective: Develop a transport service that provides new/improved mobility choices for travellers on the corridor
Performance: 115 minute corridor travel time yielding 11.6 million riders/year



Objective: Develop a transport service that provides good value for money and optimum utilization of infrastructure
Performance: Similar ridership to Scenario B but low value for money because its costs are 270% times greater than Scenario B



Objective: Develop a transport service that improves overall transport efficiency and resilience throughout Southwestern Ontario
Performance: 12% HSR mode share



Objective: Develop a transport service that limits negative environmental impacts of travel in the corridor
Performance: 7.9 million tonnes CO₂ reductions over lifecycle



Catalyze Economic Development

The Toronto-Windsor corridor will connect innovation hubs and centres of knowledge and industry to enable municipal and regional economic growth and development



Objective: Provide a transport service that connects centres of employment and business
Performance: Serves 1,160,000 jobs that typically benefit from HSR



Objective: Provide a transport service that connects knowledge centres throughout a corridor
Performance: Major centres (academic and industrial) are linked across the corridor



Objective: Provide a transport service that triggers wider economic benefits
Performance: Travel time improvements strengthen economic integration and expand each major centre's commute shed



Objective: Provide a transport service that manages interactions between freight and passenger travel, to promote economic development
Performance: Tunnel allows for improved segregation



Supports Regional Integration & Development

The Toronto-Windsor corridor will support regional integration and development at a municipal, regional and corridor level



Objective: Provide a transport service that connects major population, cultural and activity centres
Performance: Serves a population of 13 million people in 2041



Objective: Provide a transport service that minimizes impact on natural and social environments
Performance: HSR alignment interacts with natural areas and will require further mitigation strategies in future studies



Objective: Provide a transport service that is integrated with urban form and transport networks
Performance: HSR stations (except at London and Guelph) are integrated with each centre's downtown core with opportunities for transit network connections



Objective: Provide a transport service that supports urban development
Performance: Provides strong development potential around Pearson International Airport, and downtown cores of Toronto, Guelph, Kitchener-Waterloo, and Windsor.

TABLE 4.9: STRATEGIC CASE SUMMARY

Strategic Case: Scenario B



Transform Mobility Choice in Southwestern Ontario

The Toronto-Windsor corridor will provide efficient and sustainable mobility in Southwestern Ontario



Objective: Develop a transport service that provides new/improved mobility choices for travellers on the corridor
Performance: 124 minute corridor travel time yielding 10.6 million riders/year



Objective: Develop a transport service that provides good value for money and optimum utilization of infrastructure
Performance: Similar ridership to Scenario A with higher value for money because costs are 37% times that of Scenario A



Objective: Develop a transport service that improves overall transport efficiency and resilience throughout Southwestern Ontario
Performance: 11% HSR mode share



Objective: Develop a transport service that limits negative environmental impacts of travel in the corridor
Performance: 7.8 million tonnes CO₂ reductions over lifecycle



Catalyze Economic Development

The Toronto-Windsor corridor will connect innovation hubs and centres of knowledge and industry to enable municipal and regional economic growth and development



Objective: Provide a transport service that connects centres of employment and business
Performance: Serves 1,162,000 jobs that typically benefit from HSR



Objective: Provide a transport service that connects knowledge centres throughout a corridor
Performance: Major centres (academic and industrial) are linked across the corridor



Objective: Provide a transport service that triggers wider economic benefits
Performance: Travel time improvements strengthen economic integration and expand each major centre's commute shed



Objective: Provide a transport service that manages interactions between freight and passenger travel, to promote economic development
Performance: Separate alignments assuming rail rationalization



Supports Regional Integration & Development

The Toronto-Windsor corridor will support regional integration and development at a municipal, regional and corridor level



Objective: Provide a transport service that connects major population, cultural and activity centres
Performance: Serves a population of 13 million people in 2041



Objective: Provide a transport service that minimizes impact on natural and social environments
Performance: HSR alignment interacts with natural areas and will require further mitigation strategies in future studies



Objective: Provide a transport service that is integrated with urban form and transport networks
Performance: HSR stations are integrated with each centre's downtown core with opportunities for transit network connection



Objective: Provide a transport service that supports urban development
Performance: Provides strong development potential around Malton station and in downtown cores of all cities served.

5

Economic Case

Overview

BACKGROUND

The economic case defines the benefits and costs to society of each HSR scenario. This case draws heavily upon analytic modelling to provide estimates for costs and benefits. Some key benefits and costs cannot be quantified directly, and have instead been discussed qualitatively.

Approach

This economic appraisal includes both project costs and benefits to users and non-users. All costs and benefits estimated for this business case were developed using a set of assumptions consistent with MTO guidance. This ensures consistency and comparability between business cases. The base inputs and assumptions to the analysis are outlined in Table 5.1 – including a summary of the discounting and inflation approach used in the project.

Economic Appraisal

ANALYSIS OVERVIEW

Economic appraisal (cost-benefit analysis) was conducted based on the benefits and costs discussed outlined in Table 5.2. Conventional analysis includes all factors commonly included in MTO economic analysis:

- Benefits: time savings, vehicle operating cost saving, road safety savings, and GHG emissions.
- Costs: capital, operating, and life cycle costs

An expanded analysis has been conducted which also included the wider economic benefits (WEBs) related to HSR.

All analysis is presented in real terms in 2021\$ and assumes real inflation of 1%, and an economic discount rate of 3.5%.²³

²³ Real values, used in the economic case, reflect the increase in the value of goods and services in terms of purchasing power from the base year. Nominal values, used in the financial case, reflect the expected cost of a good or service in the year of expenditure. These values include both the general inflation rate as well as the increase for the good/service in real terms.

TABLE 5.1: ECONOMIC CASE INPUTS AND ASSUMPTIONS

Input	Details	Sources	Consideration	2015-2021	2021-2031	2031-2091
Analysis approach	All benefits/costs are expressed in real terms in 2021\$ Appraisal includes 10 years of construction in two phases (2021-2024, and 2024-2030) and 60 years of operation (2025-2084)		Capital Costs	3% (1% real + 2% nominal) per year	1% real per year (real inflation)	No additional compounded real inflation past 2031 – all costs have a factor of 110.5% applied
Economic Discount Rate	Year 0-30: 2.5% Year 30-60: 2.0%	Ministry of Finance	Operating/Renewal Costs	3% (1% real + 2% nominal) per year	1% real per year (real inflation)	No additional compounded real inflation past 2031 – all costs have a factor of 110.5% applied
Inflation Rate	2%	Ministry of Finance				
Real Inflation	1%/year until 2031					
Evaluation Period	60 Years	MTO Guidance				
Value of Time (VOT) (2015\$)	\$16.13/hour	Transport Canada, Greater Golden Horseshoe Model	Benefits	2% (nominal) per year	No Adjustment	No Adjustment
VOT Growth Rate	0% p.a.	Based on historical Ontario income growth	Discounting	N/A – all costs and benefits incurred after 2021	2021-2051: 2.5%	2051-2084: 2.0% per year
Auto occupancy	1.2	MTO				
Forecast Years	2031, 2041					
Interpolation	Demand growth interpolated between 2031 and 2041, growth extrapolated between 2041 and 2051. All benefits and demand assumed static 2051-2090					
GHG Value (2015\$)	\$0.01/km	Greater Golden Horseshoe Model, Transport Canada, and Environment Canada				
Auto operating cost savings (2015\$)	\$0.63/km	CAA 2011 driving costs				
Decongestion Benefit (2015\$)	\$0.30/km	Metrolinx Tier 3 Guidance				
Safety Improvements (accident mitigation) (2015\$)	\$0.08/km	Canadian Motor Vehicle Traffic Collision Statistics				

TABLE 5.2: FACTORS INCLUDED IN ECONOMIC CASE

Appraisal Category	Key Consideration	Methods and Description
Project Costs	Capital	Discount/inflate cost estimates over 60 year life cycle to show costs in real terms – which vary compared to those in Section 3 (base year costs) and Section 6 (costs in real terms)
	Renewal	
	Operating Costs	
User Benefits	Travel time savings	Estimated from demand model- travel time savings monetized at \$16.13/hour
	Auto user cost savings due to mode shift to HSR	Automobile vehicle km travelled (VKT) reductions calculated in model and monetized at \$0.63/km based on cost saved by users who now use the HSR project and forego auto operating expense
External Benefits	Reliability	Given the preliminary nature of this business case and unknown future reliability with GO RER, specific reliability benefits/improvements have not been calculated. However, it is expected that both HSR scenarios will deliver rail reliability benefits, which may be estimated in future work.
	Decongestion	Calculated by applying a rate of \$0.30/km for every peak period VKT reduction – based on decreased economic impact of congestion.
	Safety	Safety impacts are based on a monetization of auto accident reductions using a rate of \$0.08/km for every kilometer reduction of automobile travel removed due to shift to HSR.
	Emissions	Monetizes the benefits of greenhouse gas reductions at a value of \$0.01/km of automobile km reduction. A rate of \$0.05/kg of CO2 from HSR operations was applied. The value of GHG emission benefits was grown at 1% per year
	Environmental Impact Mitigation	Cost estimation process includes allowance for a 5% uplift on construction costs for environmental impact mitigation
	Goods Movement Impacts	<p>Goods Movement impacts have been addressed in two ways:</p> <ul style="list-style-type: none"> • Removing demand on links between key urban centres along the corridor; and • Assumption of HSR services operating highly segregated from freight. <p>Given the high level nature of this study, specific goods movement impacts have not been quantified.</p>
	Social Impacts	Future studies should seek to monetize and consider impacts to human environments and cultural heritage as discussed in the Strategic Case. At this time, no estimate is provided given the preliminary nature of the business case.
Wider Economic Benefits	Agglomeration Benefits	Calculated using international best practice for estimating agglomeration benefits due to reduction in cost/time of travel leading to higher effective density.

USER BENEFITS

User benefits represent the benefits to users of the new HSR system. These benefits reflect:

- Reductions in travel time; and
- Reductions in direct cost of travel for automobile users who switch to HSR.

Reliability benefits may also be included as user benefits, but have not been monetized given the preliminary nature of this study.

EXTERNAL BENEFITS

External benefits reflect the value to society that is realized due to changes within the transport network. These external benefits include:

- Decongestion benefits – benefits received by travellers who do not use HSR, but benefit from improved travel times due to users switching from auto to HSR in the peak period;
- Safety benefits – decreased costs to society due to fewer traffic accidents on the highway network; and
- Emissions – decreased costs to society due to reduced transport emissions.

WIDER ECONOMIC BENEFITS

Traditional benefit cost analysis (BCA) takes into account the improvement in welfare because of an investment in transportation infrastructure. Primarily, this takes the form of reductions in the cost and time for transportation (travel time savings). WEBs are included in an expanded BCA. WEBs are usually categorized into several components, each addressing a series of potential benefits identified in the regional economics literature:

- Agglomeration;
- Imperfect competition; and
- Labour supply Improvements.

Research suggests that the primary benefits related to HSR are associated with agglomeration based on the relationship between density of economic activity and productivity. The Toronto to Windsor HSR will reduce travel times in the corridor, which in turn decreases generalized costs of travel. This allows urban areas within the corridor to become effectively closer (shorter travel time), which increases the effective density of employment and economic activity in the region. WEBs due to agglomeration were calculated based on changes in generalized cost of travel and are shown by industry in Table 5.3. For reference, these industries include:

- Manufacturing – light and heavy manufacturing;
- Construction – residential, commercial, and industrial construction;
- Consumer Services – sales, retail, tourism, transport; and
- Producer Services – insurance, finance, research and development, and knowledge based industries.

TABLE 5.3: WEB OUTPUTS

	Value
NPV 60 Year (Million 2021\$)	\$1,300
Manufacturing (Million 2021\$)	\$260
Construction (Million 2021\$)	\$80
Consumer Services (Million 2021\$)	\$100
Producer Services (Million 2021\$)	\$860

A detailed review of WEBs analysis outputs suggests that:

- Producer services generate a majority of the benefits given the density of producer services between Kitchener-Waterloo, Guelph, and Toronto;
- Toronto accounts for the larger portion of benefits due to its largest employment market along with its immediate connection to other large urban areas along the corridor; and
- WEBs realized by London and Kitchener-Waterloo grows the most over the 60 year evaluation period due to their estimated rates of population and employment growth.



ECONOMIC APPRAISAL SUMMARY

For both scenarios, the economic analysis considered:

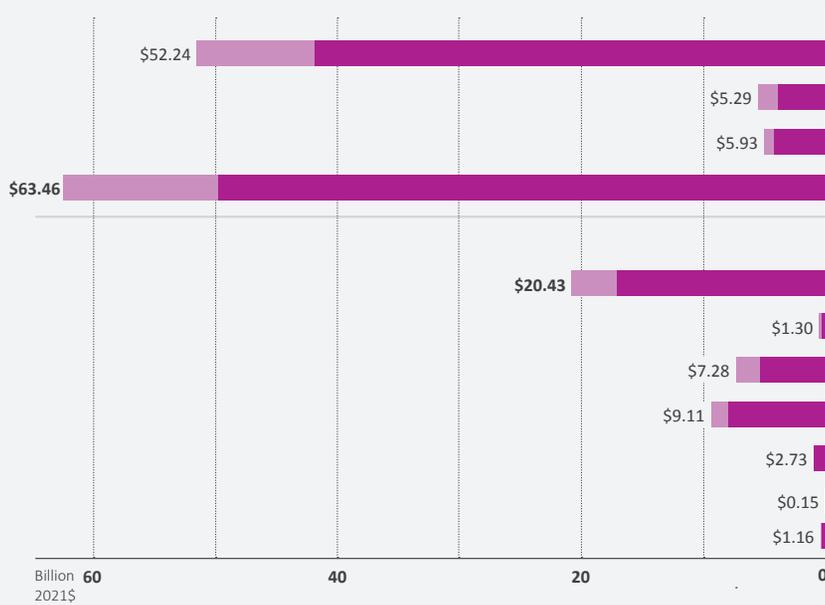
- Benefit Cost Ratio (BCR) (total benefits/total costs); and
- Net Present Value (NPV) (benefits – costs).

The economic case summary of costs, benefits, BCR, and NPV is provided in Figure 5.1.

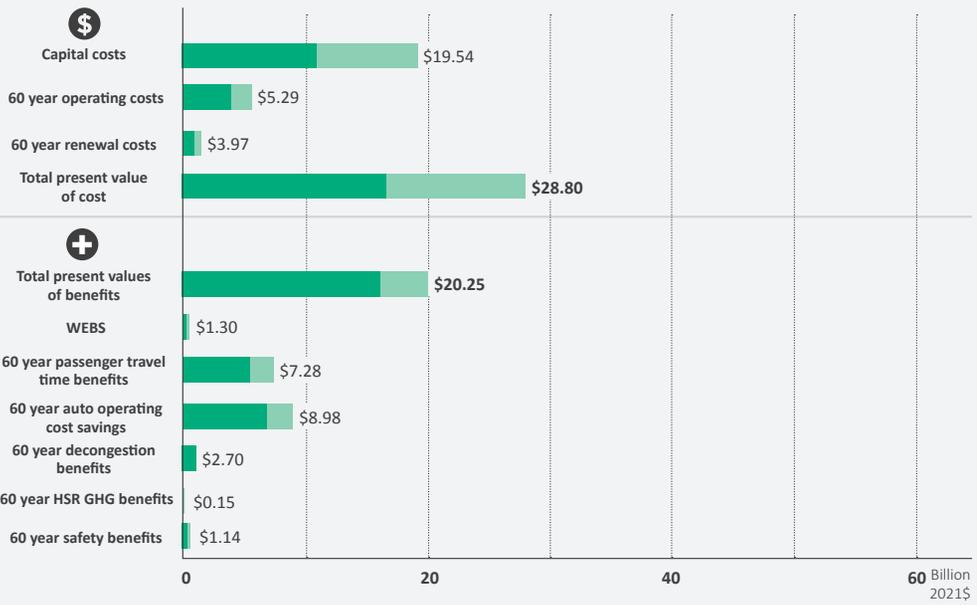
As discussed in Section 3, total capital costs have a 66% contingency applied to them. Future business cases should revisit the BCR and NPV of HSR as cost and benefit estimates are refined.

FIGURE 5.1: ECONOMIC CASE SUMMARY

A Economic Appraisal



Economic Appraisal **B**



A Performance

	TO ▶ LO	LO ▶ WI	Total Project
Benefit cost ratio	0.36	0.17	0.32
Net present value (Bn 2021\$)	-\$31.92	-\$11.13	-\$43.03
Expanded BCR (included WEBS)	0.38	0.19	0.34
Expanded NPV (Bn 2021\$ included WEBS)	-\$30.77	-\$10.98	-\$41.73

Performance **B**

	TO ▶ LO	LO ▶ WI	Total Project
Benefit cost ratio	1.02	0.24	0.70
Net present value (Bn 2021\$)	\$0.41	-\$9.05	-\$8.55
Expanded BCR (included WEBS)	1.09	0.26	0.75
Expanded NPV (Bn 2021\$ included WEBS)	\$1.56	-\$8.90	-\$7.25

SENSITIVITY TESTS

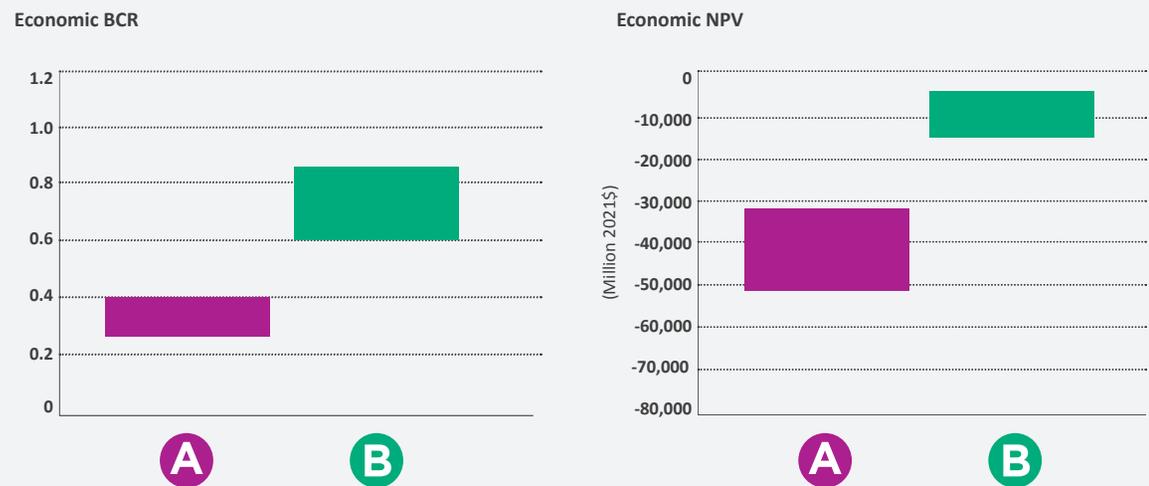
A set of economic appraisal sensitivity tests were conducted that vary the overall costs and benefits by +/-10% based on risk/uncertainty in realizing the estimated costs and benefits. An additional test was conducted that reduces the contingency applied to total capital costs by 20%, indicating the realization of an overall lower cost than what is budgeted for in the contingency estimate in Section 3.

These 'high end' BCRs are 0.39 for Scenario A and 0.81 for of Scenario B. For Phase 1 (Toronto to London), the high end BCRs are 0.46 (Scenario A) and 1.17 (Scenario B), noting a moderate improvement over the core scenario.

The sensitivity test is shown in Figure 5.2. The key conclusions from this analysis are:

- Without significant change to costs and benefits, neither scenario is likely to achieve a BCR greater than 1 or a positive NPV for the entire corridor.
- The overall BCR performance varies between 0.58 (if benefits are lower and costs are higher) and 0.81 (with lower cost contingency) highlighting the important of realizing benefits and managing costs;
- The NPV performance for Scenario A has a wider range of results due to its higher costs overall its BCR and NPV do not show significant improvement even with higher benefit realization; and

FIGURE 5.2: ECONOMIC CASE SENSITIVITY TESTS FOR FULL CORRIDOR (PHASE 1 AND 2 COMBINED)



ANALYSIS SUMMARY

Scenarios

In economic terms, the higher performing scenario is Scenario B, which has a conventional²⁴ BCR of 0.70 and a conventional NPV of -\$8.55 billion over the project lifecycle.

The BCA indicates a limited economic case for Scenario A, with a large negative conventional NPV of \$43 billion and a low conventional BCR of 0.32. Given the low BCR for Scenario A, and the heavy cost of tunnelling, it is unlikely that significant improvements to the NPV and BCR for Scenario A can be achieved through optimization.

Phasing

Scenario B's Phase 1 is the only HSR project to demonstrate economic value for money, with a conventional BCR of 1.02 and a conventional NPV of \$0.4 billion. This is because the first phase of the project realizes over 85% of the economic benefit, but only incurs 61% of the costs. This would suggest that while phase 2 has strategic merits (see strategic case); it does not generate commensurate benefits to cover the project costs, which causes the overall BCR to drop to 0.70 for the whole alignment.

Wider Economic Benefits

When WEBs are included in the analysis they do not increase the BCRs for the entire corridor over 1. Scenario A's BCR increases to 0.34 and Scenario B increases to 0.75. However, WEBs strengthen the case for Scenario B's Phase 1 corridor from Toronto to London by raising the BCR to 1.09 from 1.02.

Economic Benefits of Pearson International Airport Access

Scenario A and B both have different approaches to connecting HSR to Pearson International Airport:

- Scenario A – direct access via a tunnel; or
- Scenario B – indirect access via Malton Station

An analysis of Scenario A indicated that direct access to Pearson International Airport was benefit neutral compared to indirect access at Malton. While direct access increases overall ridership, this ridership is largely from Toronto Union Station. Direct access leads to a loss of some ridership from Guelph and Kitchener-Waterloo that would commute to a Malton station, but not to a Pearson International Airport Station. These commuter trips realize larger user and

external benefits per trip because they are a longer distance than trips between Toronto Union and Pearson International Airport.

A model test using direct access assumptions for Scenario B generated an estimated increase in benefits by \$250 million. Direct access increases demand by 1 million trips per year, which may carry additional economic benefits for the airport due to decreased demand for runway capacity for short haul flights.

Further review of direct access at Pearson International Airport should be considered in future studies, along with additional economic benefits to the airport, including:

- Savings in parking/facilities cost;
- Benefits of increased amenity; and
- Economic benefit of relieved runway congestion.

24 Conventional Benefit Cost Ratios and Net Present Values do not include Wider Economic Benefits – they are instead included in an expanded BCR or NPV

Recommendations

Further refinement of cost and ridership modelling may allow for an improved BCR for Scenario B, which may exceed a value of 1. General improvements to investigate include:

- Optimized infrastructure plan to lower costs – as option development continues, changes to the alignment may be identified to lower total capital costs – including use of a bimodal (diesel/electric train) that could lower costs for the Phase 2 alignment by foregoing electrification;
- Refined costs – current costs include conservative estimates to account for contingency. As project development continues, estimates will become more accurate and may reduce the level of contingency required;
- Refined modelling approach – additional modelling can refine ridership and benefits. Future modelling may also consider trips that use HSR as a connecting mode, or trips from other CMAs that may connect to HSR; and
- Market Generation – Phase 2's economic performance could be improved by developing it once market conditions allow a greater level of ridership and therefore benefits.



6

Financial Case

Overview

The Financial Case assesses the financial implications of each HSR scenario. It provides a financial Cost Benefit Analysis (CBA), as per MTO guidelines, of all project costs and revenue for each scenario, in nominal terms. This analysis covers the construction period (2021-2025) along with a 60 year operating window.

The output costs of the Financial Case vary compared to the base costs (Section 3) and Economic Case costs (Section 5) because they are in nominal terms.²⁵

Financial Appraisal

OVERVIEW

A financial appraisal was conducted for the two HSR scenarios, using inflation and discount rates as noted in Table 6.1. This analysis was conducted as a base review of the financial requirements to deliver the two HSR systems in nominal terms. This analysis does not constitute a fiscal impact assessment and further financial analysis will be required as the study advances. The analysis does not include depreciation or financial transaction

²⁵ Real values, used in the economic case, reflect the increase in the value of goods and services in terms of purchasing power from the base year. Nominal values, used in the financial case, reflect the expected cost of a good or service in the year of expenditure. These values include both the general inflation rate as well as the increase for the good/service in real terms.

and debt costs. Project development costs have been included in cost escalation as noted in Section 3.5 under capital costs.

TABLE 6.1: FINANCIAL ANALYSIS AND DISCOUNTING METHODS

Consideration	2021-2031	2031-2084
Capital Costs	3% (1% real + 2% nominal) per year	2% (nominal) per year
Operating costs	3% (1% real + 2% nominal) per year	2% (nominal) per year
Renewal Costs	3% (1% real + 2% nominal) per year	2% (nominal) per year
Revenue	2% (nominal) per year	
Financial Discount Rate	0%	2.5% per year

FINANCIAL ANALYSIS

The Financial Appraisal used for this business case included:

- Costs – including total capital costs (infrastructure, fleet, operations/maintenance centre) discussed in section 3; and
- Revenue – total lifecycle revenue from passenger fares.

The results of the financial analysis are shown in Figure 6.1. Costs include:

- Total capital costs with contingency – incurred during construction of Phase 1 (2021-2025) and Phase 2 (2025-2030);
- Operating costs – incurred to provide the system starting in 2025 with an increase in 2031 as Phase 2 comes online;
- Renewal costs – incurred to replace elements of the HSR system after they exceed their lifecycle or can no longer be maintained; and
- Revenue – generated by ridership, with a general growth over the first 20 years of ridership and revenue meeting operating costs by 2041, with costs exceeded for the remainder of the lifecycle.

FIGURE 6.1: FINANCIAL CASE SUMMARY



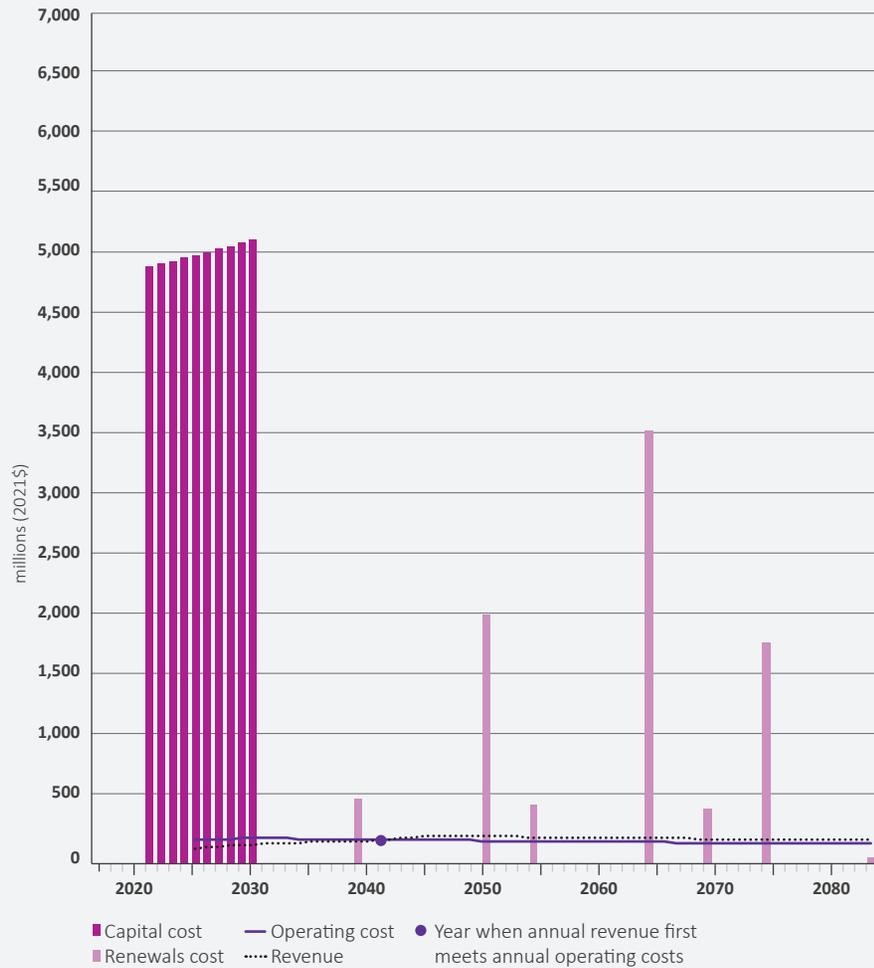
BCR: benefit cost ratio (revenue divided by costs)*

NPV: Net present value (revenue minus costs billion \$2021)

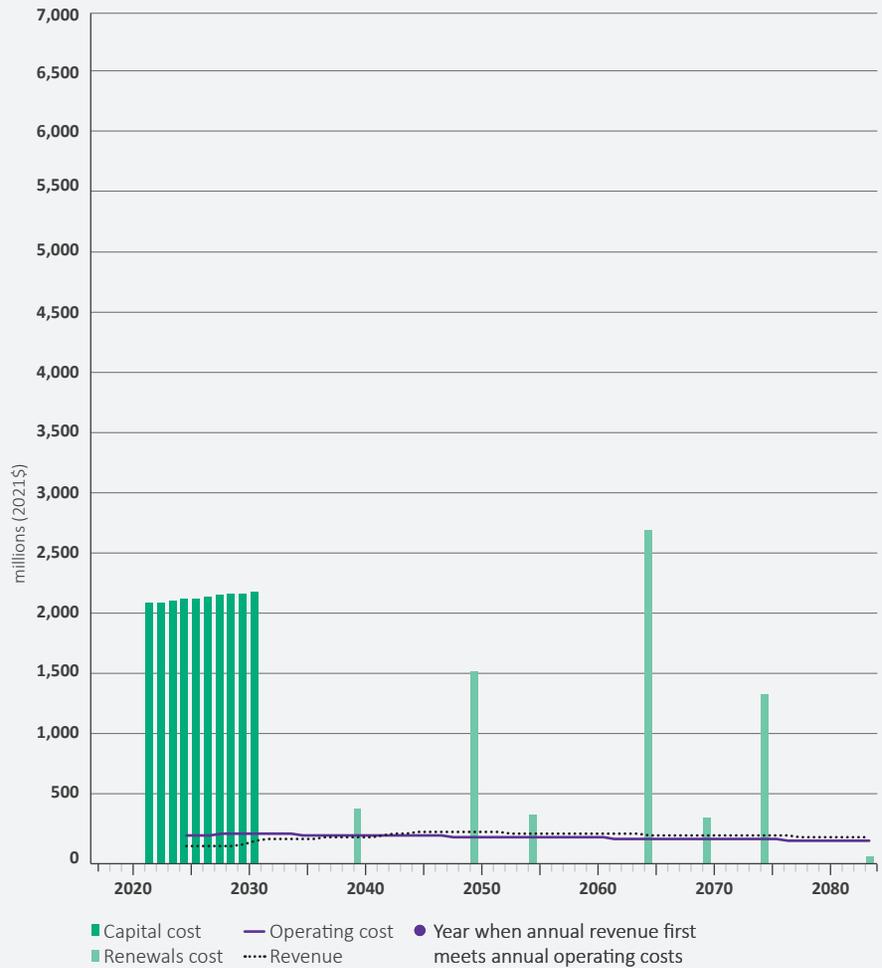
*BCR is a simple division of total revenues by total costs, and illustrates the extent to which HSR revenues cover capital and operating costs. For example, a BCR of 0.44 means that revenues cover 44% of total costs. This is a distinct measure from the Economic BCR (see previous page).

FIGURE 6.2: FINANCIAL APPRAISAL CASH FLOW ANALYSIS

A Scenario A



B Scenario B



CASH FLOW

Figure 6.2 outlines the cash flow for the two Scenarios based on the costs described above.

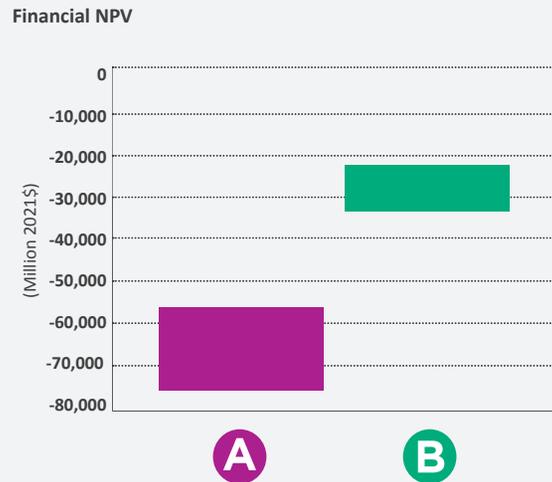
Figure 6.2 demonstrates that the annual revenue for both scenarios exceeds operating costs starting in 2041 until the end of the appraisal period.

SENSITIVITY TESTS

Financial sensitivity tests were conducted that vary the overall costs and revenue by +/-10% based on risk/uncertainties. An additional test was conducted that reduced the contingency applied to capital costs by 25%, indicating the realization of an overall lower cost than what is budgeted for in the contingency estimate in Section 3.

The sensitivity test is shown in Figure 6.3. Similar to the economic case, neither of the full build Scenarios is expected to achieve a positive NPV under the range of sensitivity tests. However, the overall scale of investment may vary based on uncertainty in costs, as noted by the lowest NPVs for both scenarios: -\$60 billion (2021) for Scenario A and -\$29 billion (2021) for Scenario B. The highest financial NPVs are -\$55 billion (Scenario A) and -\$22 billion (Scenario B). The sensitivity tests suggest that, even if costs are significantly lower, financial investment will be required for the majority of all project costs.

FIGURE 6.3: FINANCIAL CASE SENSITIVITY TESTS FOR FULL CORRIDOR (PHASE 1 AND 2 COMBINED)



FINANCIAL CASE SUMMARY

Scenarios

As noted in the analysis, both scenarios have a negative financial NPV and a financial BCR lower than 1. These results suggest that neither HSR scenario can be delivered without direct investment into the project – both have a negative NPV and BCRs below 1:

- **Scenario A** : NPV of-\$66.5 billion (2021) and BCR of 0.17; and
- **Scenario B** : NPV of-\$27.5 billion (2021) and BCR of 0.32.

Phasing

Phase 1 and Phase 2 both have low financial performance. However, Phase 1's performance is higher for both scenarios, including a BCR of nearly 0.5 for Scenario B. This indicates that the Phase can cover 50% of its total costs.

Conclusions

Further optimization of costs and refinement of cost modelling may lead to cost reductions, which could improve the financial case for the scenarios – however, it is not anticipated that the scenarios can cover full lifecycle costs.

Of particular note is that operating revenue over the 60 year evaluation period exceeds operating costs. By 2041, it is anticipated

that both scenarios will cover and exceed all operating costs and no longer require an annual operating subsidy. Over the lifecycle of the project, both scenarios will also generate revenue equivalent to that of the initial subsidy required for operations.

This suggests that capital and renewal costs cannot be accounted for with operating revenue. One exception is for the Scenario B Toronto- London segment, where revenue covers all operating and renewal costs. For both Scenarios A and B, the London-Windsor segment is unable to generate enough revenue to cover operating costs.

Both scenarios are unable to cover the sum of total capital, operating, and renewal costs, which is similar to HSR performance in other jurisdictions.



For example- in Japan, a new Shinkansen high speed line can be warranted if:

- Economic BCR >1
 - Revenue > Operating Costs
 - Alignment with strategic local and national objectives is demonstrated
- In these instances, the government may fund or take on debt to cover the capital costs required to deliver the service.

7

Deliverability and Operations Case

Overview

The deliverability and operations case provides a high level qualitative analysis of key issues that may impact the deliverability and operations of both HSR scenarios as well as a discussion of approaches that may be used or considered in pursuing HSR. Because this study has been conducted at a high or preliminary level. The deliverability case has been framed around identifying potential issues that warrant further review and analysis in future project stages. In addition it provides background material for project delivery to support future studies and research into different methods of procuring, delivering, and operating HSR in Ontario.

Challenges and Risks

BACKGROUND

Because this study has been conducted at a high level, the risks discussed in this case are commensurately at a high level and will all require further analysis to clarify the range of expected impacts.

The physical elements of each scenario were designed to be 'representative' of what an HSR service along the corridor may include. All designs were completed at a high level without specific studies and analysis of factors that

may impact physical deliverability – including geological conditions along the corridor.

Additionally, the operations plan developed for the HSR scenarios was created based on assumptions on cost of labour and materials, which were also assembled at a high level. Therefore, the risks presented within this section are intended to discuss the types of risks and challenges that may be encountered while developing an HSR system based on the assumed physical parameters and operations plan. Further analysis is required in future studies to both quantify and prioritize risks as well as to identify the cost of mitigation.

A set of key risks has been identified:

- Construction risks (Figure 7.1 and Table 7.1);
- Operating risks(Figure 7.2and Table 7.2);
- General Risks;
- Climate and Resilience Considerations; and
- Changing Technology.

TABLE 7.1: CONSTRUCTION RISKS

A Construction Risks	Segment	Construction Risks B
<ul style="list-style-type: none"> All required upgrades would be developed alongside operating railway until the use of the Pearson Tunnel. Portal construction at Islington Ave will have staging challenges for maintaining rail traffic during the construction period. Tunnel runs from Islington to Pearson – further analysis required to assess feasibility and constructability issues of tunnelling at this location. 	<p style="text-align: center;">TO ▶ PE</p>	<ul style="list-style-type: none"> All required upgrades would be developed along operating railway.
<ul style="list-style-type: none"> The tunnel under Pearson requires emergency exit buildings. Emergency exit structure onto GTAA lands that may not be very far removed from airport runways would have to be ensured. Tunnel construction will need careful staging and planning as it is conducted near a live runway for the airport. There is a need to stage works to maintain GO RER service in Brampton during construction, including portal from airport tunnel. On the west side of Georgetown, the Guelph subdivision crosses into territory that is both Greenbelt and Niagara Escarpment designated land until the edges of the town of Acton. This portion of the alignment must consider environmental impacts and risks to protected natural areas. The Rockwood-Guelph tunnel requires greenfield development. Surveying is required to determine feasibility of bored tunnels at this location. 	<p style="text-align: center;">PE ▶ GU</p>	<ul style="list-style-type: none"> Need to stage works to maintain GO RER service in Brampton during construction. Requires construction and operations within the Greenbelt and Niagara Escarpment – suitable environmental mitigation must be developed. Crosses Speed River, requiring a new bridge. Mitigation efforts will need to be undertaken
<ul style="list-style-type: none"> Greenfield tunnel portal carries low expected risk. New Grand River bridge crossing, which may be a complex construction. Through Kitchener, additional track can be laid first and subsequently the existing track upgraded to minimize impacts to service speed from construction, but temporary slow orders will be required for contractor safety during construction. 	<p style="text-align: center;">GU ▶ KI</p>	<ul style="list-style-type: none"> New Grand River bridge crossing, which may be a complex construction. Additional track can be laid first and subsequently the existing track upgraded to minimize impacts to service speed from construction, but temporary slow orders will be required for contractor safety during construction.
<ul style="list-style-type: none"> The majority of this alignment is built in a hydro corridor, within which topography is generally favourable. There are some risks from occasional requirements of a berm formation, a large cut segment, or the rare retention structure, but the hydro corridor generally is gently sloped with the odd exception scattered along the 67 km length. Key delivery risks include mitigating impact on Hydro infrastructure. Property issues are a large risk as the property limits and the terms of the easement for the hydro corridor are not yet known. Through London, the parts alongside the CN main line will be a risk to manage during construction. Disruptions to CN traffic would be costly. 	<p style="text-align: center;">KI ▶ LO</p>	<ul style="list-style-type: none"> The majority of this alignment is built in a hydro corridor, within which topography is generally favourable. There are some risks from occasional requirements of a berm formation, a large cut segment, or the rare retention structure, but the hydro corridor generally is gently sloped with the odd exception scattered along the 67 km length. Key delivery risks include mitigating impact on Hydro infrastructure. Property issues are a large risk as the property limits and the terms of the easement for the hydro corridor are not yet known. Through London, the parts alongside the CN main line will be a risk to manage during construction. Disruptions to CN traffic would be costly.
<ul style="list-style-type: none"> Managing construction within the city of Windsor is the key deliverability challenge. Construction must manage impacts on CP Windsor Yard and railway. Large number of grade separations along Windsor sub may require staging strategies depending on combined traffic impacts (road and rail) from concurrent construction at various road/rail crossings. Disruptions to CP rail traffic would be costly. 	<p style="text-align: center;">LO ▶ WI</p>	<ul style="list-style-type: none"> Managing construction within the city of Windsor is the key deliverability challenge. Construction must manage impacts on CP Windsor Yard and railway. Large number of grade separations along Windsor sub may require staging strategies depending on combined traffic impacts (road and rail) from concurrent construction at various road/rail crossings. Disruptions to CP rail traffic would be costly.

FIGURE 7.1: CONSTRUCTION RISKS

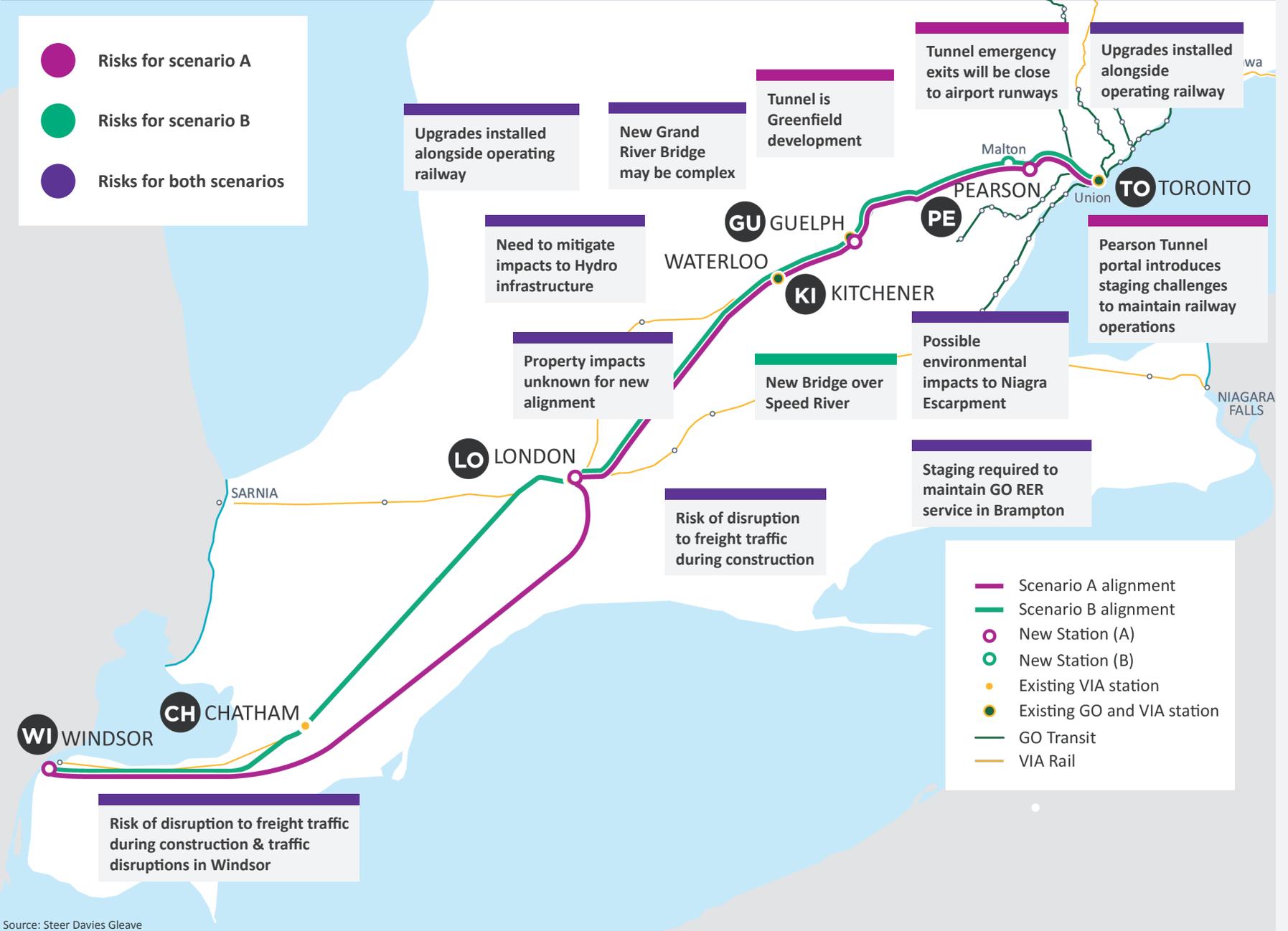


TABLE 7.2: OPERATION RISKS

A Operation Risks

Segment

Operation Risks **B**

- Union Station to Islington Ave uses the same alignment as GO RER for operations.
- This segment is speed constrained by vertical alignment and blended operations should not be disruptive. In addition, this segment of the corridor is congested and so would be sensitive to even minor delays from one service and domino effects could occur. A service priority agreement, if possible, could mitigate such risks. Operating risks from freight rail traffic are not anticipated.



- HSR and GO RER would share alignment on the Weston sub. This segment is speed constrained by vertical alignment as well as the Pearson connecting station. Therefore, blended operations should not be disruptive.
- However, this segment of the corridor is congested and so would be sensitive to even minor delays from one service and domino effects could occur. A service priority agreement, if possible, could mitigate such risks. Operating risks from freight rail traffic are expected to be very low with the rail rationalization in place but not non-existent as some local freight traffic is still serving Etobicoke along the Weston sub.

- HSR and GO RER service along the corridor may overlap in the Mount Pleasant area. This would be an issue to resolve in the detailed design phase. Otherwise, HSR service is segregated in other areas. Freight traffic will not impact HSR operations.



- HSR and GO RER service along the corridor may overlap in the Mount Pleasant area, with limited freight impacts to GO RER, leading to possible impacts to HSR. This would be an issue to resolve in the detailed design phase. In particular, Brampton station is sensitive to these impacts, requiring strict schedule adherence. Otherwise, HSR service is segregated in other areas.
- GO RER and HSR share tracks from Acton to Guelph.

- Shared tracks with GO RER. Within Kitchener, there is a small amount of freight traffic crossing the corridor. Impacts should be minimized because junction is close to station (readily implementable operational solution).



- Shared tracks with GO RER. Within Kitchener, there is a small amount of freight traffic crossing the corridor. Impacts should be minimized because junction is close to station (readily implementable operational solution).

- Scenario A operates in trench along the segment which mitigates operational risk



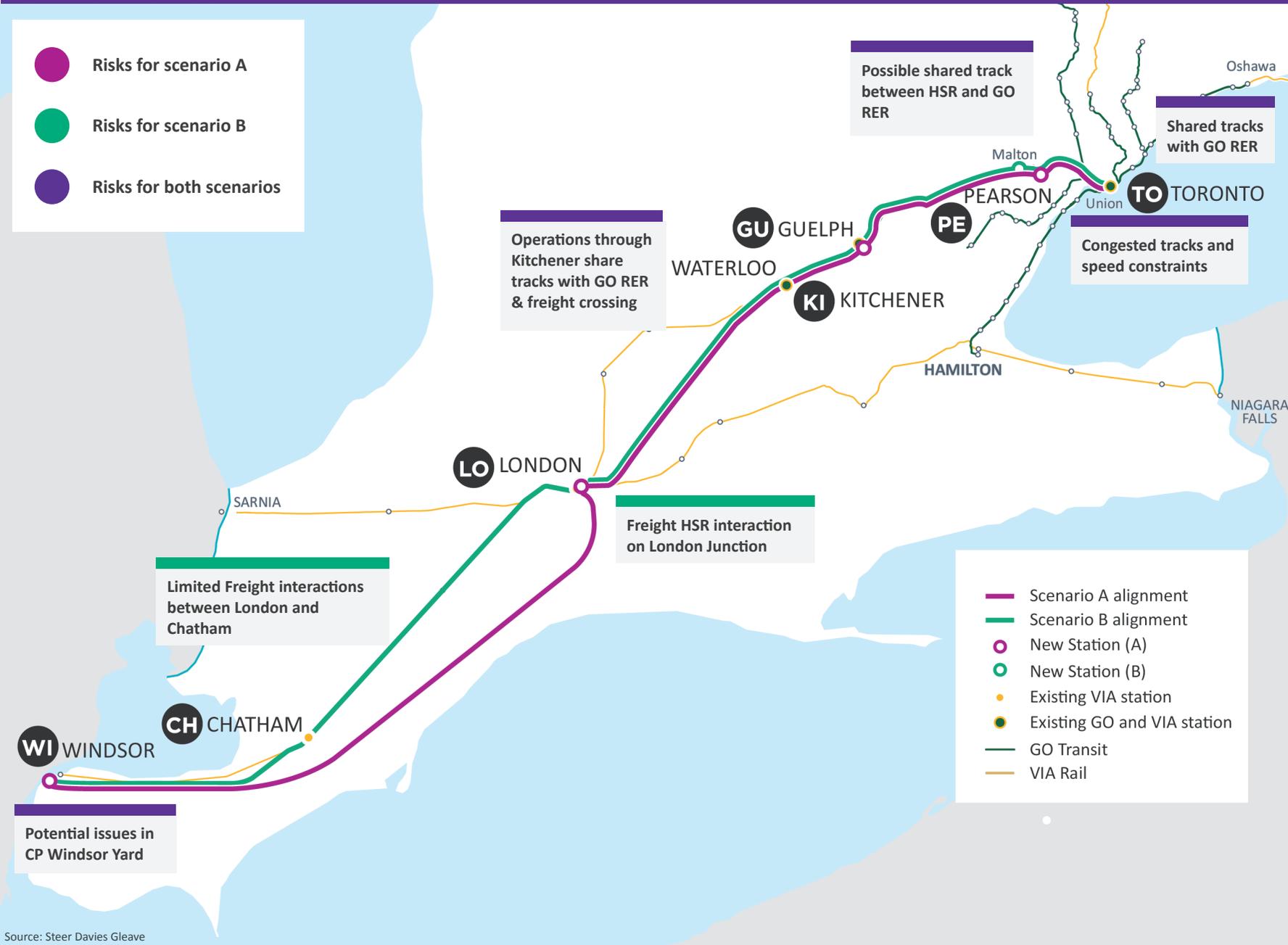
- Operations risks should not be an issue apart from an operating agreement with respect to London Junction in Scenario B (does not affect Scenario A), to accommodate a low volume of freight traffic crossing the HSR tracks –close to London station. This would be a low risk for operations, as diverging route interlocking movements approaching the station would be common and expected as a terminus for half the service, and the freight trains in question would be short compared to CN main line traffic.

- Potential issues in CP Windsor yard; detailed design issue. No operating risks anticipated along Windsor subdivision as traffic will be fully segregated.



- CN Chatham subdivision maintains some freight running rights, but traffic is very light (service still present, nonetheless), so single-track upgraded subdivision is low-risk and if issues arise they can be addressed in detailed design. Potential issues in CP Windsor yard; detailed design issue. No operating risks anticipated along Windsor subdivision as traffic will be fully segregated.

FIGURE 7.2: OPERATION RISKS



Source: Steer Davies Gleave

GENERALIZED RISKS FOR HSR

Age of Existing Corridors

The existing corridors of the Ontario railway network go back over a century, with most laid before the 20th century. While these rail corridors have been able to sustain today's freight needs and lower speed passenger rail, higher speeds such as 200-250 km/h have never been operated on these corridors.

Such higher speeds require a higher class of track with more demanding tolerances that must be maintained for safe and comfortable operations. The stricter tolerances require a reliable, well-engineered bearing soil beneath and supporting the track structure.

Achievement of the stricter bearing soil requirement could require excavating unsuitable soils beneath the existing railway that may not have a significant impact on existing freight or passenger operations at lower speeds, but may have impact on higher classes of track through an inability to sustain the required tolerances.

The quality of the ballast also impacts the track stability and water control properties that prevent influence from organic matter causing any shifting of the track structure. There are areas that are experiencing overgrowth through the ballast, which is considered

contaminated by the organic material, compromising drainage and track stability.

Existing bridges along the corridor may not be designed for higher speeds. As the speed of operations influences the vibrations and other forces exerted on the bridge structure, existing structures can require upgrades or replacements to accommodate higher speed operations.

Operations During Construction

Staging of construction for existing corridor upgrades would be required to maintain existing operations. This applies to both passenger and freight, where freight is the more demanding service, with a higher cost associated with service disruptions and tighter windows for scheduled service suspensions if along either of the CN or CP main lines.

In addition, HSR requires over 90 grade separations with intersecting roadways currently crossing the rail corridor at grade. Such grade separations can impact traffic flow, especially in urban areas. Implementing measures to maintain temporary arrangements for traffic crossing during construction is a common practice, but in some urban areas may be very difficult. Grade separation projects must also address subsurface utilities such as hydro, water, wastewater, fibre-optic and gas, and may have their own property and environmental mitigation requirements.

Passenger handling facilities at existing stations must also be staged in a manner that keeps the station operational during construction. Temporary platforms nearby may be an option where necessary. Alternate service planning and staging will be a necessity to maintain service levels and ensure safety of all types of rail service (passenger and freight).

Safety of the general public and construction crews must be ensured for all corridor works undertaken.

Tunnelling Construction

The tunnels identified for Scenario A have been specified on assumptions without the benefit of geotechnical information, which can affect both design and construction methods. The soil conditions have many impacts on the tunnel, as well as the surrounding areas. Tunnelling work could potentially cause settlement of nearby structures due to soil displacement. If soil conditions are poor, there are possible risks of liquefaction that would require an engineering solution. Risks of water intrusion must be mitigated where crossing a river.

Tunnels require emergency exit structures at regular intervals as part of their fire and life safety regime. Such structures must be able to pair the tunnel alignment with safe locations on the surface that people can

gather in an evacuation situation. A tunnel across a large airport property introduces particular challenges for locating such structures within the design requirements as well as regulatory, safety and security requirements.

Tunnels also require different construction types at different depths, which are typically determined by the tunnel's diameter. Tunnels that are extremely shallow cannot be built by a tunnel boring machine.

Track Geometry

Speeds associated with HSR will, in some locations, require changes and improvements to the existing corridor geometry, or in some instances, an entirely new corridor. Such property would need to be acquired for the project, whether for permanent purposes or as an easement during construction. For some of the necessary properties, notably in the Niagara Escarpment and Greenbelt areas, environmental mitigation measures may be required to accommodate the geometry for HSR. Vertical geometry requirements for HSR may also incur a variety of earthwork solutions, especially for rail-to-rail grade separations. The extent of these factors is only understood at a low level of detail due to the high level of design being undertaken without survey data.

The speeds achievable will be determined by Transport Canada's rating of a vehicle's allowable imbalance through curves, which in this Preliminary Business Case used assumptions based on Federal Railroad Administration publications from the United States; Transport Canada's position is unknown.

CLIMATE CHANGE AND RESILIENCE CONSIDERATIONS

A review and evaluation of climate change risks and resilience measures related to HSR service should be identified and assessed during the completion of future planning studies. Subsequent assessments could include a consideration of climate risks such as extreme hot and cold weather, heavy rain, high winds and storms to the infrastructure and assets associated with the railway including tracks, overhead line equipment, rolling stock, stations and earthworks. The Ministry of Environment and Climate Change is consulting with stakeholders to inform the design of a cap and trade program, which will take effect in 2017. Subsequent model development and forecasting for HSR should consider including sensitivity analysis of potential impacts to ridership demand in response to future fuel price scenarios under Ontario's Cap and Trade Program.



CHANGING TECHNOLOGY

Transport technology undergoes continuous evolution. As stages of the HSR study proceed, technical analysis should consider:

- Changes to intercity technology
- Driverless vehicles

Intercity Technology

This study assumed that the HSR solution would use ‘conventional’ HSR technology. As the study has progressed, technical discourse on two technologies has advanced:

- Hydrogen fuel cell rolling stock – which may reduce the price of electrification without compromising emission targets
- Hyper loop – which is an ‘unknown’ technology for rapid intercity travel

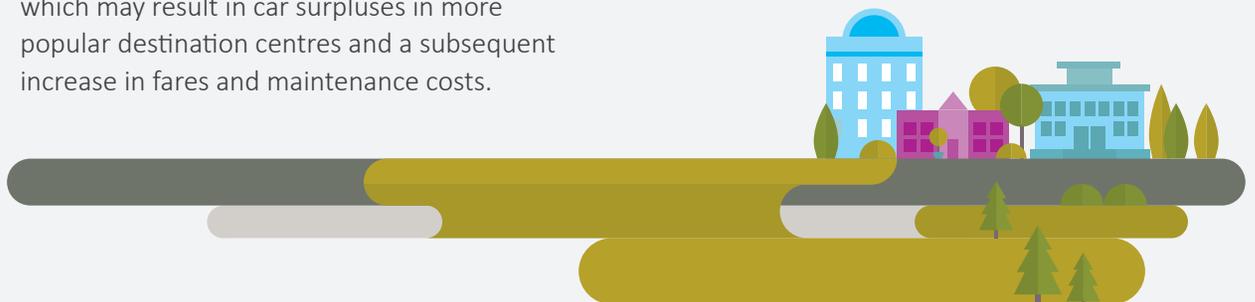
As the study progresses, these technologies should be reviewed to identify their potential role in delivery of HSR.

Driverless Vehicles

Driverless cars have the potential to alter commuting, work and leisure habits, challenge traditional car ownership and alter land use in urban spaces. They will also have significant potential benefits on current infrastructure use (decreased congestion), decreased emissions and improved road safety. Significant private

and public investment into the effects and implementation of driverless technology is on-going but there is no system that has yet achieved wide public adoption. Over long distances passengers will face a choice between a private, slower mode of road-based transport and a faster means of less private transport.

As driverless systems are implemented and adoption increases as the market adjusts it will become clear as to how driverless technology has affected the transportation mix. There should be a complementary effect between long-distance point to point transportation systems and driverless technology for the ‘last mile problem’ that all point to point systems suffer from. The benefit for the transportation system will be increased connectivity to the termini, reduced land impact at the termini (fewer parking spaces), potentially enabled by integrated ticketing between car and rail services. For driverless cars mass transportation systems are likely to be more efficient than long distance car journeys, which may result in car surpluses in more popular destination centres and a subsequent increase in fares and maintenance costs.



Deliverability and Operations Case Conclusions

EMERGENT FINDINGS

The deliverability review did not identify serious construction or operational risks that are a 'fatal flaw' to the project; however, at this stage some risks require mitigation:

- GO RER/HSR integration and interoperability;
- Environmental Impact on Niagara Escarpment;
- Management of rail operations near Windsor CP Yard; and
- Demand and revenue forecasts should be periodically updated based on up to date economic, demographic, and behavioural data.

NEXT STEPS

HSR represents a substantial investment. In order to effectively deliver a transformative investment like HSR it is critical to identify at an early stage the potential key stakeholders involved in the delivery process and define roles and responsibilities. This process should allocate risks to those that are better placed to handle them. The key activities can be classified as follows and many can be concurrent, dependent on the approach taken:

- Stakeholder engagement
- Determine a suitable oversight and governance framework;
- Develop a design that is sufficient for environmental clearance, permitting and land acquisition;
- Conduct an environmental assessment;
- Understand land acquisition requirements;
- Set out detailed design and procurement process;
- Plan the pattern of service and define the service offer (including fare structure and levels);
- Plan the regulatory and legal framework that HSR operates under;
- Build the infrastructure and procure vehicles;
- Source and organize staff to run the service (including driving vehicles, collecting revenue);
- Maintain and clean vehicles and maintain the infrastructure;
- Operate a successful and efficient business, meeting the needs of sponsors, passengers and wider stakeholders;
- Plan, define and operate network feeder services to access the infrastructure; and
- Collect revenues and retain ridership/revenue risk.

While not an exhaustive list, as technical work proceeds on the development of the HSR project, a thorough review of institutional delivery mechanisms should explore timelines and risks associated with these items.

Business Case Summary

Key Findings

OVERVIEW

The four chapter business case for the representative HSR scenarios is summarized in Table 8.1. The overall findings from this business case exercise are:

- The full build (Phase 1 and 2) requires a high level of investment and has a BCR below 1 and negative net present value in economic terms for both Scenarios;
- Phase 1 has a BCR over 1 and a positive net present value for Scenario B; and
- The overall costs to deliver a 300km/h HSR service do not deliver significant improvement over a 250 km/h service – therefore Scenario B is recommended for further consideration.

The following sub sections include scenario specific analysis along with recommendations for phasing and future study/analysis.

SCENARIO A

Scenario A was developed as the ‘high end’ of a performance envelope. It was designed to provide the highest possible speeds using 300 km/h rolling stock. As a result, it includes significant cost items – including a tunnel under Pearson International Airport and a

tunnel under Guelph. Consequently, this scenario’s costs are over twice that of Scenario B. Scenario A ridership and benefits are not found to exceed that of Scenario B, despite this investment. The scenario broadly meets the strategic goals for the study; however, its performance is not significantly higher than Scenario B, despite much higher costs.

Scenario A’s economic performance was poorer than B’s: a low BCR (0.32) and low NPV (-\$43 billion 2021\$). Financial performance was also poor with a low BCR (0.2) and NPV (-\$67 billion in 2021 dollars). By 2041, the annual revenue matches/exceeds the annual operating costs, and overtime the scenario will generate enough revenue such that total revenue exceeds total operating costs for the lifecycle of the scenario.

SCENARIO B

Scenario B was developed to leverage existing infrastructure where possible to improve overall performance at the expense of speed. It was determined that Scenario B was able to achieve similar performance to Scenario A, with a much lower overall cost.

Consequently, Scenario B’s economic performance improves over Scenario A: a BCR of 0.70 and NPV of -\$8.55 billion 2021\$. While these results show improvement compared to

Scenario A, it indicates that design optimization should be pursued to improve the economic outlook for the scenario given that costs exceed benefits. Scenario B's financial performance indicates that the Scenario can only cover its operating costs, with investment required for capital and renewal costs. By 2041, the annual revenue matches/exceeds the annual operating costs, and overtime the scenario will generate enough revenue such that total revenue exceeds total operating costs for the lifecycle of the scenario. Scenario B's BCR is 0.32 and its NPV is -\$27.5 billion in 2021 dollars.

PHASING ANALYSIS

Phase 1 generally has higher performance than Phase 2 due to proportionally higher ridership.

Scenario A's performance along this alignment is low (economic BCR: 0.32 and a BCR of 0.34 including WEBs) due to the high tunnelling costs.

Scenario B's Toronto to London segment has the strongest economic performance of all scenarios/segments. This includes a higher BCR (1.02) and NPV (\$0.4 billion in 2021 dollars) performance. When WEBs are included, the BCR of this Phase rises to 1.09 and the NPV rises to \$1.56 billion (2021). This indicated an overall positive economic performance for Phase 1.

The financial performance for Phase 1 is higher than for Phase 2 in terms of BCR. Scenario A phase 1 has a BCR of 0.19 and Phase 2 has a BCR of 0.10. Scenario B Phase 1 has a BCR of 0.44 with Phase 2 having a BCR of 0.14.

Financial NPV for Phase 2 is larger than Phase 1 for Scenario A. Phase 1 has a NPV of -\$50.4 billion (2021) while Phase 2 has a NPV of -\$16 billion (2021). Financial NPV is nearly equivalent for both Phases for Scenario B at -\$14.0 billion (2021) for Phase 1 and -\$13.5 billion (2021) for Phase 2. This occurs because Phase 1 has 60% of the overall costs.

Overall, Phase 1 offers strong economic benefits for Scenario B but will still require significant investment.

KEY CONSIDERATIONS

Scenario B is able to achieve a positive NPV and BCR greater than 1 for the Toronto to London segment. Based on these considerations, Scenario B is recommended as the basis for further HSR development.

The costs used in this analysis are conservative, and include a significant contingency of 66% on total capital costs (excluding vehicles). If they were to decrease with further design refinement without compromising benefits, then the overall economic and financial value of the project would improve.

Future studies should first return to the design and update costs to identify any further cost savings including:

- Review of proposed rail costs, electrification costs, and grade separations ; and
- Further synergies with GO RER to limit new build costs for HSR.

Additionally, Scenario B should also be optimized to achieve greater benefits, including:

- Identification of improved integration opportunities for HSR and local transit/communities to incentivize ridership; and
- Further review to continue to optimize runtimes and potential benefits.

The inclusion of two stations that were outside the original mandate- Chatham and Guelph-generated demand and benefits, with minor increase in costs compared to providing rail service that runs through or around these areas. Future studies should consider the inclusion of these stations and identify service plan variations (example: half of all trains through run, the other train serves the station) that further optimizes benefits and reduces costs.

TABLE 8.1: BUSINESS CASE SUMMARY

Case	 Scenario A	 Scenario B	
 <p>Strategic Case</p>	<ul style="list-style-type: none"> Scenario A broadly achieves the strategic vision for HSR It offers improved travel times compared to existing services: 115 minute end to end travel time and 11.6 million passengers/year by 2041 Reduces GHG emissions from transport: 7.9 million tonnes CO2 It connects employment centres and communities: serves a population of 11,14 million people and 1.15 million jobs that typically benefit from HSR 	<ul style="list-style-type: none"> Scenario B broadly achieves the vision for HSR It offers improves travel times compared to existing services: 124 minute end to end travel time with 10.6 million passengers/year by 2041 Reduces GHG emissions from transport: 7.8 Million tonnes CO2 It connects employment centres and communities: serves a population of 11.1 million people and 1.16 million jobs that typically benefit from HSR 	<p>Both scenarios achieve strong performance; however, Scenario B is the preferred strategic scenario given its lower cost and comparable benefit to Scenario A</p>
 <p>Economic Case</p>	<ul style="list-style-type: none"> Low BCR (0.32) and negative NPV (-\$43.0 billion 2021\$) Toronto to London segment also has poor performance – low BCR (0.36) and NPV (-\$31.9 billion 2021\$) Unlikely that the scenario can be further improved to improve financial performance 	<ul style="list-style-type: none"> Moderate BCR (0.70) and a low negative NPV (-\$8.55 billion 2021\$) Toronto to London segment also has improved performance – higher BCR (1.02) and NPV (\$0.4 billion 2021\$) Both the scenario as a whole and the Toronto to London segment are likely to see improved BCRs with further optimization and scenario improvement 	<p>Scenario B achieves higher performance than A and can likely be optimized further</p>
 <p>Financial Case</p>	<ul style="list-style-type: none"> Revenue can cover operating costs for the entire alignment with the Toronto to London segment’s revenue exceeding operating costs Low BCR (0.17) and NPV (-\$66.5 billion 2021\$) Unlikely that further optimization will reduce costs or revenue enough to improve financial case 	<ul style="list-style-type: none"> Revenue can cover operating costs for the entire alignment with the Toronto to London segment’s revenue exceeding operating costs Low BCR (0.32) and NPV (-\$27.5 billion 2021\$) Future optimization may improve financial performance 	<p>Both scenarios can cover life cycle operating costs with revenue – Scenario B requires lower investment overall</p>
 <p>Deliverability & operations Case</p>	<ul style="list-style-type: none"> Considered ‘deliverable’ from a preliminary constructability perspective – further study and analysis of alignment is required; in particular tunnel deliverability requires further review to determine overall feasibility for construction and operations Must be planned with respect to GO RER operations to ensure construction and operations do not limit GO RER services Construction near operating railways will require risk mitigation 	<ul style="list-style-type: none"> Considered ‘deliverable’ from a preliminary perspective – further study and analysis of alignment required. Proposed infrastructure is deemed lower risk than A due to lack of tunnelling Must be planned with respect to GO RER operations to ensure construction and operations do not limit service. Can leverage investment in GO RER and alignment with GO RER construction to improve deliverability Construction near operating railway will require risk mitigation 	<p>Both options are broadly deliverable with risks that can be readily mitigated</p>

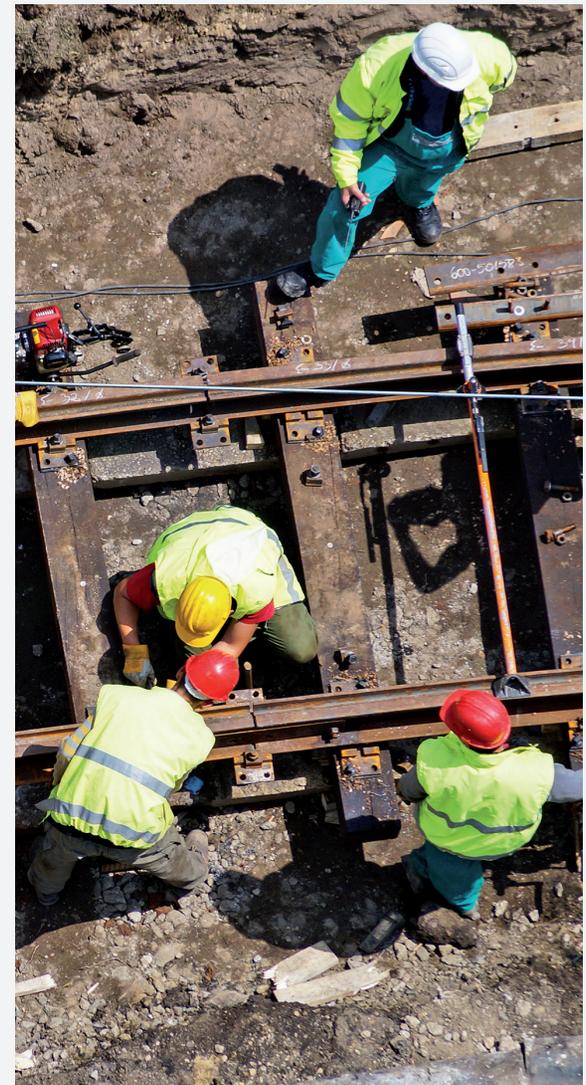
Scenario Phasing and Delivery

The Scenario review and business case analysis suggests that phasing may provide potential to realize benefits of HSR in a staged manner. As discussed in the economic case, the highest economic performance is obtained by Scenario B from Toronto to London (Phase 1). Staging should consider:

- Cost of developing system in one procurement window vs. cost of deferring procurement for Phase 2 (London-Windsor) until a future year;
- Improved linkages between London and Kitchener-Waterloo to the surrounding cities – in particular St. Mary's, Stratford, and Windsor; and
- The use of bimodal rolling stock to lower the cost of constructing the London-Windsor segment – bimodal trains would remove the need for electrification on this segment.

Staging could be pursued to deliver improved HSR. The first phase would yield the majority of initial HSR benefits and could be used to develop an expanded rail market. The current challenge with the London-Windsor segment is its low ridership and high costs. The development of HSR on a higher potential

segment first may further improve the ridership of the London-Windsor segment and therefore improve its economic and financial performance. As the rail market develops, HSR could be extended to operate Phase 2 including Windsor and Chatham.



Next Steps

The preliminary business case findings indicate that HSR in the Toronto to Windsor corridor warrants further investigation, design and analysis. Based on the business case findings, key characteristics to be included in future studies should include:

- An above ground HSR corridor that uses existing infrastructure where possible to drive down costs;
- The ability to serve long distance business/leisure trips as well as commute trips, particularly between Toronto, Pearson International Airport, Guelph, and Kitchener-Waterloo;
- The use of running speed of at least 250 km/h with speed calibrated to maximize demand
- Central/downtown stations that are directly connected to rapid transit networks ; and
- Direct service to all cities in the Minister's mandate as well as Guelph and Chatham.

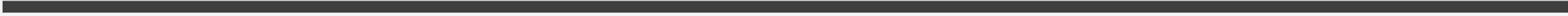
Future stages of review should prioritize a five analyses:

- Cost Refinement: further analysis and engineering works to revise costs and determine new estimates for the

scenario. As the alignment is further designed it is expected that cost accuracy will increase, which will clarify the expected range of costs for HSR;

- Benefits Refinement—further analysis, including more in-depth modelling will allow for a more accurate picture of potential benefits;
- Identifying a Pearson International Airport Direct Connection Solution—which may increase direct HSR benefits by \$250 million and generate up to 1 million new passengers a year – direct access requires further study to confirm alignment for connecting to the airport along with cost allocation;
- Strategy/Deliverability Planning—future analysis should clarify potential options and models for delivering HSR – including overall rail strategy for the corridor, potential delivery/operation models, and potential roles for the government in implementing the service. As these considerations will impact overall cost/benefit realization and rail business planning, different models should be explored in early stages of future work programmes; and
- Rail Strategy—future analysis should examine opportunities/challenges for providing

HSR in the corridor along with existing and planned passenger and freight services. Analysis should consider other planned projects as well as methods to align service delivery to best serve the corridor.



Glossary

Acronym	Definition	Description
AACE	American Association of Cost Engineering	Organization working to further knowledge of cost engineering
BAU	Business As Usual	The transit service offer that would be in place if there were no intervention/project
BCR	Benefit Cost Ratio	A measure of the value for money of a project. Total benefits divided by total costs
BRT	Bus Rapid Transit	A mass transit system offering improved journey times compared to traditional bus
CBA	Cost Benefit Analysis	Weighing up the costs and benefits of a project to determine its value for money
CMA	Census Metropolitan Area	An area consisting of one or more neighbouring municipalities with populations of at least 100,000.
CN	Canadian National Railway	National Freight operator (Federally regulated)
CP	Canadian Pacific Railway	National Freight operator (Federally regulated)
EA	Environmental Assessment	An assessment of the impacts a project or project on the environment
EMU	Electric Multiple Unit	A train that is composed of multiple self-propelled carriages that use electricity for motive power
GDP	Gross Domestic Product	The total value of goods and services produced within a given period
GGH	Greater Golden Horseshoe	An area containing 9 CMAs – Toronto, Oshawa, Hamilton, St-Catherines-Niagara, Peterborough, Guelph, Barrie, Kitchener-Cambridge-Waterloo, Brantford
GHG	Green House Gas	Gases emitted as a result of burning fuels
GTAA	Greater Toronto Airport Authority	Operator of Toronto Pearson International Airport
GTHA	Greater Toronto and Hamilton Area	Area consisting of Halton Region, City of Toronto, Peel Region, York Region and Durham Region, City of Hamilton
GO RER	Regional Express Rail	A transformative investment in the Greater Toronto and Hamilton Area's rail network, including expansions to Kitchener Waterloo. This project involves electrified two way all day service.

Acronym	Definition	Description
HSR	High Speed Rail	A rail system that is able to achieve considerably faster speeds than conventional rail
ION		Rapid transit project under construction in Kitchener-Waterloo
LRT	Light Rapid Transit	Urban public transit system, typically tramway, offering improved journey times
MNR	Ministry of Natural Resources	Ministry working to protect Ontario's biodiversity
MTO	Ontario Ministry of Transportation	Ministry responsible for management, planning, delivery, legislation, and oversight of Ontario's transportation network.
NEC	Niagara Escarpment Commission	Forming part of the Ministry of Natural Resources, this organisation works to protect and preserve the Niagara Escarpment
NEP	Niagara Escarpment Plan	Environmental land use plan outlining development criteria and permitted uses for the escarpment
NPV	Net Present Value	Benefits of the project minus the costs of the project
SC	Strategic Case	A written document assessing how a set of potential solutions are aligned with challenges, opportunities and broader policy goals
TPAP	Transit Project Assessment Process	A transit project specific assessment process that includes consultation, assessment of positive and negative impacts, an assessment of measures to mitigate negative impacts, and documentation of proposed projects.
TSRC	Travel Survey of Residents of Canada	A quarterly survey measuring domestic travel in Canada
UNESCO	United Nations Educational, Scientific and Cultural Organization	An organization aiming to build connections between nations focusing on education, protecting heritage and freedom of expression
UPE	Union Pearson Express	Daily 15 minute two way service between Toronto Union Station and Pearson International Airport
USRC	Union Station Rail Corridor	The immediate rail corridor connected to Union Rail Station
VKT	Vehicle Kilometres Travelled	A measure used to quantify changes in emissions, decongestion and safety benefits as a result of the project
VOT	Value of Time	A monetized value assigned to time i.e. the value in dollars of a minute/hour of a travellers time
WEBs	Wider Economic Benefits	The wider benefits to the economy from an increase in accessibility provided by a transport investment – these are typically quantified due to their impact on agglomeration.

