Re: EX16.1

Relief Line Subway

Initial Business Case

June 2016

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1. Executive Summary

Line 1 (Yonge) capacity challenges have been reaffirmed through several studies, including the Downtown Rapid Transit Expansion Study (DRTES) in 2012, and the Yonge Relief Network Study (2015). The Relief Line project is one of Toronto's priority transit expansion initiatives. The project is envisioned to be completed in phases, with the connection from downtown to Line 2 (Bloor-Danforth) as phase one. Per City Council direction, a Relief Line Project Assessment was initiated in 2014 to assess corridor and station options for the first phase. The next phases of the Relief Line assessment will consider northern and western extensions of the proposed line north to Sheppard Avenue East and west of University Avenue. Future extensions of the Relief Line were an important consideration in narrowing the longer list of potential corridor options for the first phase of the project. The recommended Pape-to-Downtown via Queen/Richmond corridor was approved in March 2016 by City Council (2016.EX13.3).

This initial business case examines options within the approved Pape-to-Downtown via Queen/Richmond corridor for the first phase of the Relief Line from a four case perspective: strategic, economic, financial, and deliverability. Two alignment options are assessed against the base case scenario (Option 1), which involves planned improvements to Line 1 to address capacity issues. The options are presented in Table 1 below.

Table 1: Relief Line Initial Business Case Options

Option 1 (Base)	Option 2	Option 3
Continue with planned improvements to Line 1 and surface transit network on Queen Street and King Street	Relief Line Subway from Pape Station on Line 2 to downtown via Queen Option 2a: Alignment follows the GO corridor from Gerrard Square to Queen	Relief Line Subway from Pape Station on Line 2 to downtown via Eastern then Queen

The preferred option as a result of this initial business case analysis is Option 3, the Relief Line subway from Pape to downtown via Eastern then Queen. A summary is provided below.

Summary of Findings:

The Strategic Case evaluated the performance of the options based on the City's *Feeling Congested?* evaluation framework with a focus on the ability of each option to meet project objectives of providing relief on Line 1 (Yonge), reducing crowding at Bloor-Yonge station and reducing congestion on surface transit routes, while meeting broader city-building objectives. Through this evaluation, it was determined that Option 3 would meet the project objectives while also serving a greater number of city-building objectives.

Both options are capable of providing relief to Line 1 (Yonge). The first phase of the Relief Line is anticipated to provide a net reduction of 3,400 to 5,900 riders on Line 1 (Yonge) south of Bloor during the AM peak period. The subsequent extension of the Relief Line north to Sheppard Avenue is projected to provide even greater relief, with a net reduction of 6,500 to 9,900 riders relative to the Base Case in 2041 (see Section 3). Although Option 2 performs better from the

perspective of providing relief to Line 1, Option 3 is projected to bring more net new riders to Toronto's transit network. The ability to attract new transit ridership is indicative of greater behavioural shifts in mobility choice, which supports Official Plan policy objectives of increasing public transit mode-share.

Option 3 also emerged as the preferred option as it provides greater potential for development and economic growth by opening up a significant amount of land for new jobs and affordable housing with station connections at the Unilever site and the West Don Lands. Another key consideration in the analysis was an option's ability to deliver on broader social equity goals. The analysis indicated that Option 3 would serve the greatest number of equity seeking households and provide improved transit connections for people to access the emerging employment hub planned for the Unilever site. Option 3 would also bridge existing barriers between neighbourhoods such as Corktown, serving a city-building objective of building healthy neighbourhoods. A summary of the Strategic Case evaluation is included in Table 2.

The results of the Strategic Case evaluation suggest that while Option 2 performs better in providing relief to Line 1, Option 3 performs better from the perspective of broader city-building objectives and the City's *Feeling Congested?* evaluation framework, particularly with respect to social equity, shaping the city, supporting growth, and healthy neighbourhoods. Option 3 would also attract greater net new riders, which suggests a shift in transit mode-share.

Table 2: Strategic Case Summary

	Option 2 Pape-Queen	**Option 3 Pape-Eastern-Queen**
Project Objectives		
Alleviate crowding on Line 1 south of Bloor		
Alleviate crowding at Bloor-Yonge Station		
Provide alternative route to downtown, and additional capacity into and from downtown		
Feeling Congested Criteria		
Choice		
Experience		
Social Equity		
Shaping the City		
Healthy Neighbourhoods		
Public Health and Environment		
Supports Growth		
Strategic Case Summary		

The **Financial Case** evaluated the options based on the estimated cost of the project. Capital cost estimates were developed based on less than 5% conceptual design. The capital cost of Option 3 is greater than Option 2 by approximately $500 million (YOE/Escalated$). The cost of Option 3

is higher due to the length of the alignment and an additional station. High-order magnitude operating and maintenance cost estimates were developed for illustrative purposes only (see section 4).

Table 3: Relief Line Capital Cost Expenditure – Class 5 Estimate ($ millions)

	Option 2 Pape-Queen	**Option 3 Pape-Eastern-Queen**
Constant $2016	$4,082	$4,417
Net Present Value $2016	$4,405	$4,766
YOE/Escalated$	**$6,284**	**$6,799**

Notes:

- Cost estimate prepared by the TTC.
- Costs do not include financing, lifecycle and operations/maintenance.
- Assumes line in service by 2031, with construction taking approximately 10 years (2021-2031)
- Escalation rate applied for YOE/Escalated$ is 4%
- Discount rate applied for Net Present Value calculation is 3.3%
- Cost estimates have been developed at less than 5% design and are a Class 5 cost estimate (per AACE guidelines).
- Costs assume traditional procurement approach.
- Costs assume that flood remediation of Eastern Avenue site is in place at time of construction.

The **Economic Case** evaluated the performance of the options by monetizing the benefits of implementing rapid transit in the corridor. The Economic Case analysis indicates that both options of the Relief Line project would result in user benefits such as travel time savings and crowding relief. Although Option 3 would provide approximately 10% more benefits than Option 2, the cost of Option 3 is also higher. The Economic Case analysis generated a Benefit-Cost Ratio (BCR) of 0.3 for both options. From the Economic Case perspective, both options perform equally.

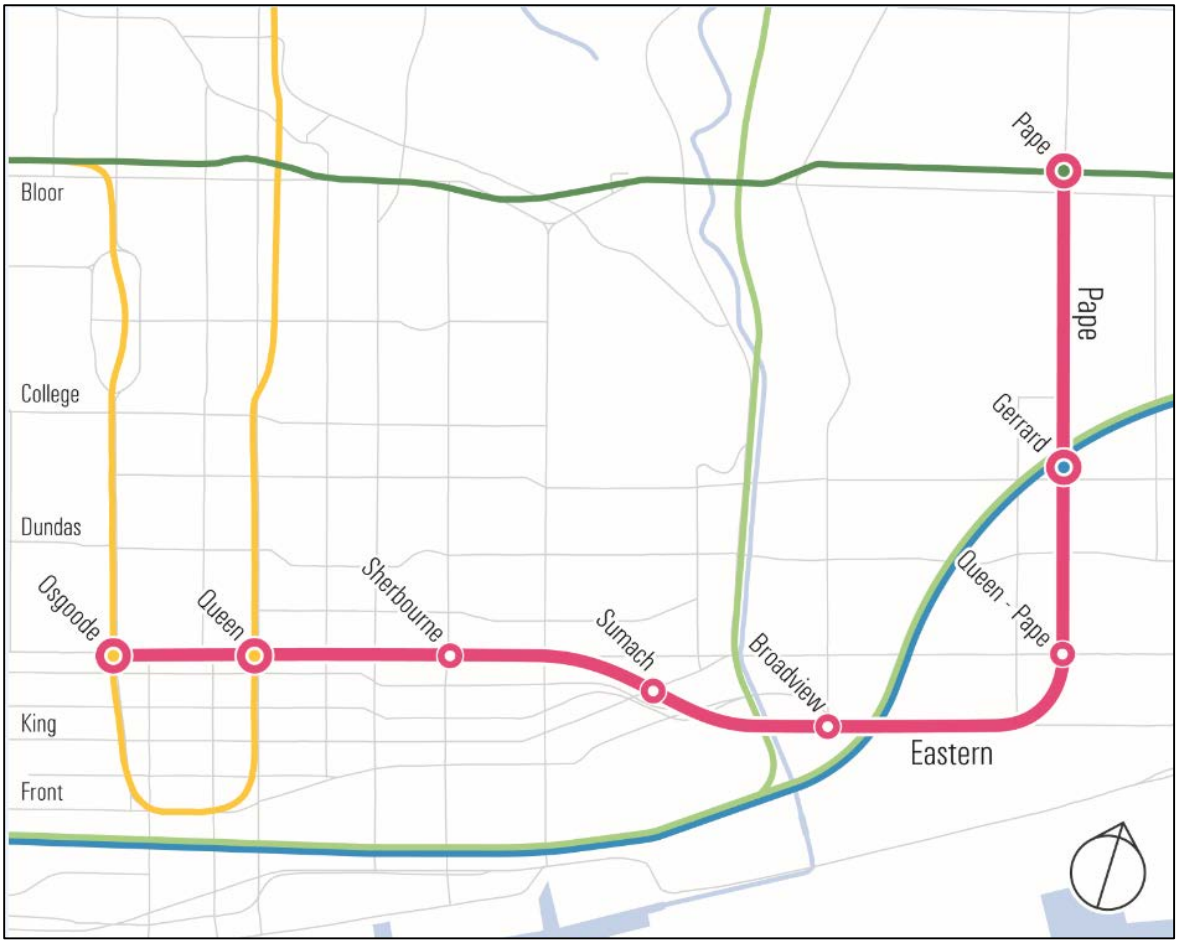
It is important to note that the benefits captured through this economic case analysis is more closely associated to regional projects and do not accurately capture local benefits of large infrastructure investments. The economic case should therefore be read in conjunction with the strategic case to provide a more comprehensive view of benefits. Further work to develop the economic case model to quantify benefits specific to local planning objectives will be undertaken in subsequent refinements of the initial business case for the Relief Line project.

The **Deliverability & Operations Case** assessed the performance of each option with respect to technical and engineering considerations, operations and service planning considerations, and project delivery and governance. There are a few challenges specific to Option 3, including additional property impacts due to an additional station and the longer alignment, vertical circulation requirements due to a deeper station at Queen and Pape, aging sewer infrastructure that would impact King/Sumach and Eastern/Broadview stations, and mitigation for flood protection south of Queen Street and east of the Don River. Both projects would require coordination with the Don & Central Waterfront Wet Weather Flow Tunnel Project. Although both options are technically feasible, Option 2 performs better from the Deliverability and Operations Case perspective.

Summary

Both options meet the objectives of the Relief Line project to provide relief to Line 1 (Yonge) south of Bloor, reduce congestion at Bloor-Yonge Station, and provide relief to the surface transit network. Both options performed similarly in the Financial and Economic Case analyses. Although Option 3 would cost more, due to a longer tunnel and an additional station, it would deliver additional benefits proportionate to the additional cost. On the whole, Option 3 presents greater strategic benefit related to broader city-building objectives, which are highlighted in the Strategic Case evaluation.

Figure 1: IBC Preferred Option - Option 3



2. Background and Context

Problem Statement:

Toronto's transit network plays a significant role in moving people around. Projected population and employment growth in Toronto's downtown is growing at four times the rate of the City of Toronto as a whole. Between 2011 and 2015, the residential population of downtown has grown by an estimated 40,000 to 45,000. Since 2009, Toronto's downtown has added an average of 12,500 jobs annually, accounting for two thirds of the City's total employment increase. In addition, the City's plans suggest significant growth in areas immediately adjacent to the downtown core in the Waterfront and shoulder areas east and west of the downtown.[1]

Figure 2: Projected Growth in Toronto's Downtown[2]

Downtown growth is projected to continue, adding additional pressures to Toronto's transit system. Capacity on Line 1 Yonge-University is a well-documented challenge for Toronto's transit system[3].

In the relatively short term, improvements such as signal upgrades (i.e. automated train operations / automated train control) to the subway are expected to provide a measure of relief to overcrowding on Line 1. However, by 2031, major improvement such as the Relief Line and the SmartTrack/GO RER will be required to achieve more significant relief. Beyond 2031, additional improvements including the extension of the Relief Line north to Sheppard Avenue will be required to relieve further growth in ridership in the Yonge corridor.

[1] DRTES, 2012
[2] See the TOcore: Planning Toronto's Downtown – Phase 1 – Summary Report and Phase 2 Directions Report.
[3] See the Downtown Rapid Transit Expansion Study and Metrolinx's Yonge Relief Network Study

The need for the Relief Line and its critical significance in the transit network cannot be overstated. Other important additions to the transit network, such as the extension of Line 1 (Yonge) north, will rely on the implementation of alternative routes into and out of the downtown core.

In addition, Bloor-Yonge Station has the highest passenger volume in the TTC subway system, and serves as a critical transit interchange between two of Toronto's busiest subway lines (Line 1 and Line 2). The Relief Line is envisioned to address these challenges to Toronto's transit network. Specifically, the objectives of the Relief Line project are to:

1. Alleviate congestion at the most congested point on Line 1 (Yonge) during the critical morning peak hour (i.e. immediately south of Bloor in the southbound direction).

2. Alleviate congestion through Bloor-Yonge subway station during the critical morning peak hour by reducing the volume of passengers transferring from westbound Line 2, to southbound Line 1.

3. Provide much needed redundancy within the rapid transit network serving the downtown core in the event of service interruptions on Line 1; and provide additional rapid transit capacity within downtown to relieve crowding on the surface transit network.

4. Deliver the City's planning objectives as set out in the Official Plan, using the Feeling Congested? evaluation framework.

Decision History on Options Development

In January 2009 (2009.EX28.1), City Council approved an Environmental Assessment Study for an extension of the Yonge Subway from Finch Avenue to Highway 7. Recognizing that such an extension would require improvement to existing crowding conditions that occur on the Yonge Subway at peak times, City Council also directed the following:

- Metrolinx be requested to prioritize the Relief Line within its 15-year plan, and in advance of the Yonge North Extension in order to accommodate capacity issues;
- The TTC be requested to commence the proper studies, including Environmental Assessments as required, to evaluate the merits of the rapid transit line; and
- The TTC be requested to proceed with the studies necessary to construct the Relief Line.

In 2012 Metrolinx identified the Relief Line as part of the "Next Wave" of projects in the Regional Transportation Plan.

Downtown Rapid Transit Expansion Study

In response to Council direction, TTC conducted a study to consider options to relieve congestion on Line 1 and Line 2, and crowding at Bloor-Yonge Station, and to provide additional transit capacity to accommodate growth in travel demand to/from downtown. In October 2012, the TTC Board considered the report, Downtown Rapid Transit Expansion Study (DRTES) Phase 1 Strategic Plan. The report concluded that the first phase of the Relief Line,

between downtown and Line 2 east of the Don River, could provide the greatest and most immediate benefit to relieving overcrowding on Line 1 (Yonge). The study also recommended future extensions of the Relief Line to the north and west.

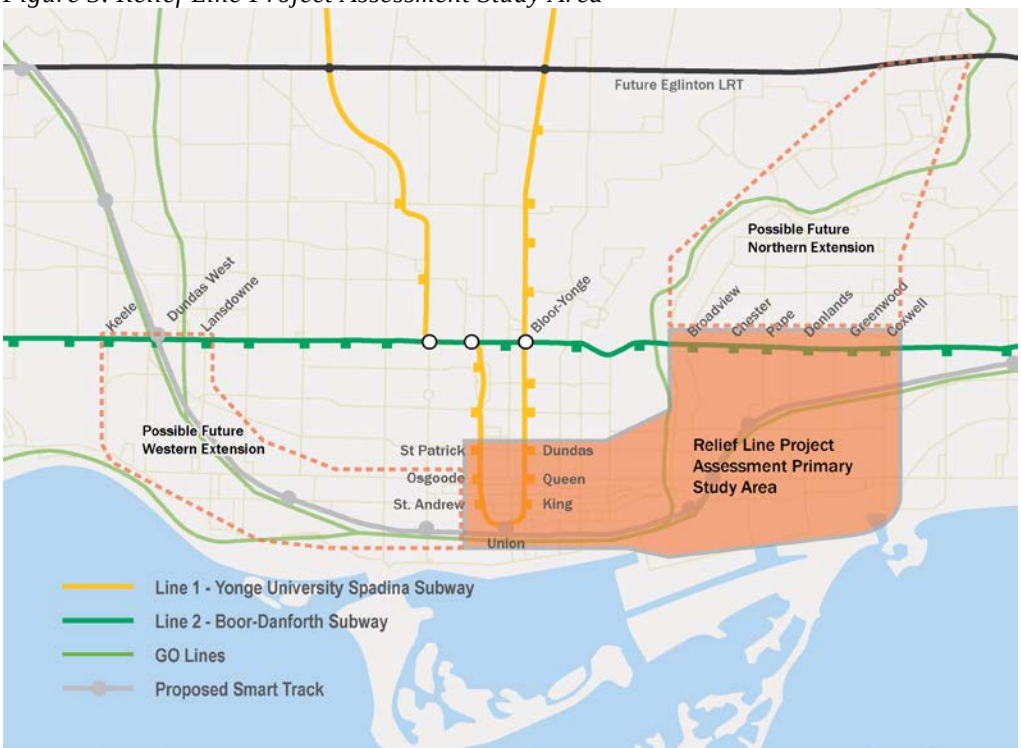
On October 24, 2012, the Commission adopted recommendations of the DRTES and forwarded the report to the February 28, 2013 Planning & Growth Management Committee for consideration (2013.PG22.5), where direction was given to the Chief Planner & Executive Director, City Planning to report on a process for establishing the criteria for selecting alignments and station locations for the first phase of the Relief Line, and subsequent measures to obtain approvals under the Environmental Assessment Act.

Relief Line Project Assessment: Phase 1

The Relief Line Project Assessment (RLPA) was initiated by City Council in December 2013 (2013.PG29.7). The Study Terms of Reference and Public Consultation Plan were approved in June 2014 for the City and TTC to proceed with the RLPA; see (2014.PG33.12). Appendix A (2014.PG33.12), and Appendix B (2014.PG33.12). The study area for the RLPA was identified as the eastern section of the proposed project connecting Line 2 to the downtown; the focus on the first phase is in accordance with the finding of the DRTES.

The long-term aspiration is a Relief Line that extends north to Sheppard Avenue East, and west of University Avenue. The downtown eastern section needs to be completed first in order for any future extensions north to provide crowding relief to the Bloor-Yonge station. Future phases of the Relief Line have been a key consideration in the City and TTC's evaluation of potential corridors for the first phase of the Relief Line.

Figure 3. Relief Line Project Assessment Study Area

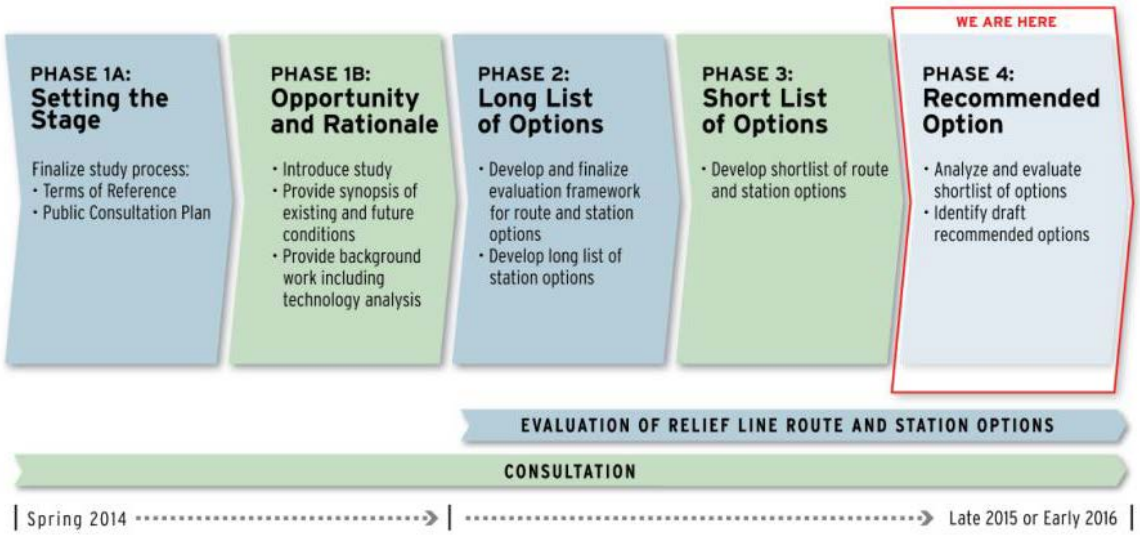


In Fall 2013, Metrolinx initiated the Yonge Relief Network Study to identify regional solutions to providing relief to the Yonge subway. The findings of the Yonge Relief Network Study were presented and approved by the Metrolinx Board in June 2015 (Report to June 25, 2015 Metrolinx Board: Yonge Relief Network Study (YRNS)). The Study made several recommendations that re-affirmed the need for a Relief Line, and continuation of planning and technical analysis to ensure that the project is ready when funding is available. The findings also indicated that the extension of the Relief Line north to Sheppard Avenue East will provide additional positive benefits. Figure 4 provides a conceptual image of the potential next phases of the Relief Line extending to Sheppard Avenue East (the connection between Pape Station and Sheppard Avenue East, including alignment and stations, will be addressed in a future study).

Figure 4: Conceptual image of Second Phase of Relief Line

Following City Council approval of the Terms of Reference and Public Consultation Plan for the RLPA, the study proceeded towards identification and evaluation of options to identified a preferred alignment and station locations for the first phase of Relief Line. Comprehensive planning and technical analysis has been undertaken since 2014 by the City and TTC as illustrated in Figure 5.

Figure 5. RLPA Study Process and Status



The RLPA examined six corridors, which were developed and assessed with subsequent extensions of the Relief Line in mind. The six corridor options included:

A: Broadview-Queen
B1: Pape-Queen via Queen
B2: Pape-Queen via Eastern
C: Broadview-King
D1: Pape-King via Queen then King
D2: Pape-King via Eastern

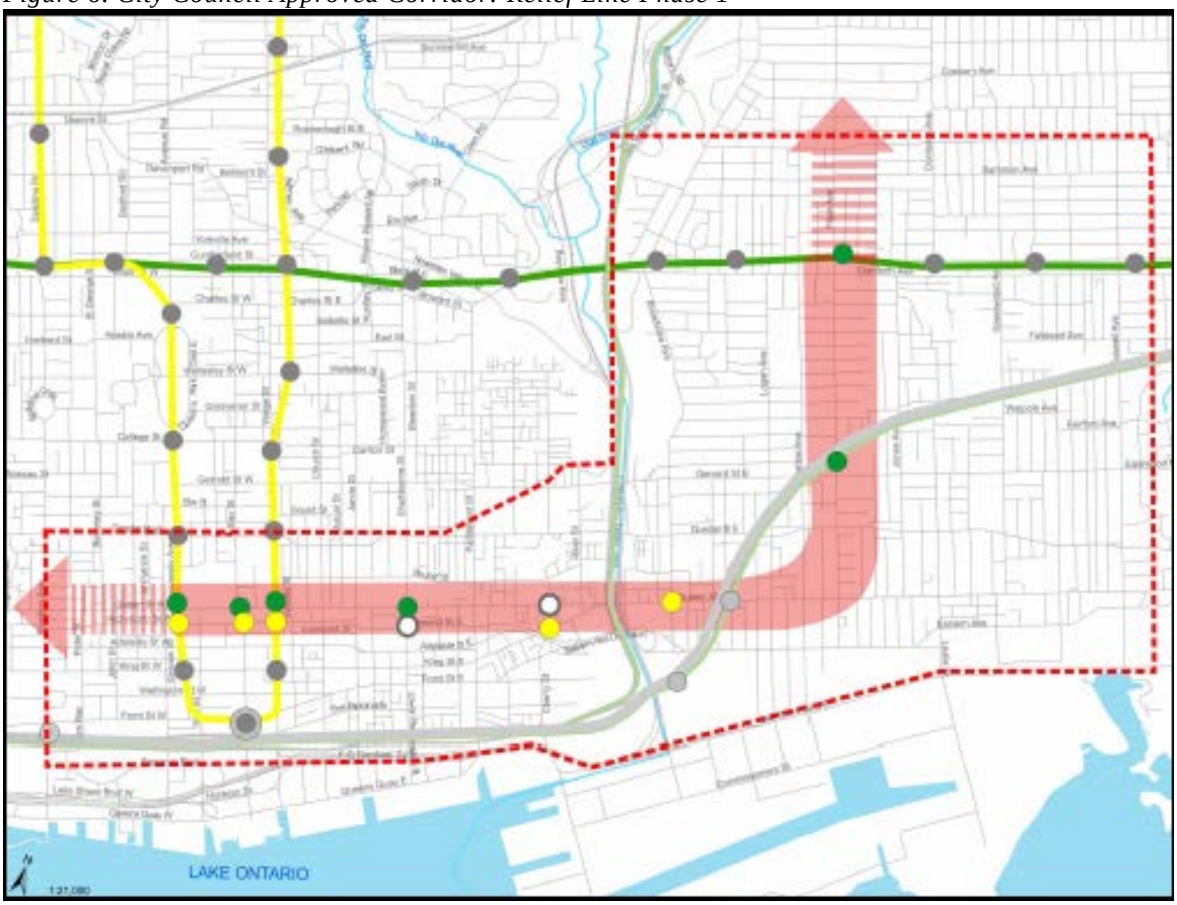
The Pape-to-Queen corridor (option B1) emerged as the preferred corridor due to several strategic city planning and deliverability considerations, including:

- Has the lowest estimated construction costs;
- Has fewer engineering and construction obstacles through downtown;
- Best distributes rapid transit service in the downtown area by avoiding concentration of pedestrian flows at Union Station and surrounding sidewalk and PATH networks, and provides a more centrally located east-west rapid transit service for the northern portions of downtown (i.e. between Queen and Bloor);
- Opens up significant amount of land for new development opportunities;
- Best supports social equity by being able to include a station at Queen and Sherbourne and provide direct access to support planned redevelopment of Moss Park to serve the local community and build capacity in the LGBT sport and recreation community; and
- Complements, rather than duplicates, other planned rapid transit investments, such as SmartTrack/GO RER to Union Station and priority transit on King Street.

In March 2016, City Council approved the recommended Pape to downtown via Queen/Richmond corridor as the preferred corridor for the Relief Line (2016.EX13.3). The

analysis supporting the recommendation for the Queen corridor can be found in Appendix 6: Relief Line Project Assessment of the March 2016 report.

Figure 6. City Council Approved Corridor: Relief Line Phase 1



Alignment options based on the corridor approved by City Council were developed and evaluated based on the *Feeling Congested?* criteria. An alignment on Queen rather than Richmond was preferred for several reasons:

- straighter path and faster travel times;
- allows direct transfer connection to the Yonge-University-Spadina Subway line;
- engineering feasibility;
- minimized property acquisition costs;
- utility impacts;
- improved access to Neighbourhood Improvement Areas; and
- areas of planned population growth, institutions, services and key destinations.

RLPA analysis shortlisted the alignment options within the approved Corridor to:

a) Pape to downtown via Queen
b) Pape to downtown via via GO corridor
c) Pape to downtown via via Eastern (i.e. near Unilever)

For the purposes of this business case, options (a) and (b) are considered identical in terms of station locations, travel times, and ridership. A summary evaluation and detailed evaluation of the alignment options is provided on the Relief Line project website.

Relief Line Phase 1: Short-listed Options

Three short-listed options have been developed for more detailed business case analysis for the first phase of the Relief Line project. Option 1, the Base Case scenario, assumes planned improvements to Line 1 (Yonge), including additional rolling stock, and Automated Train Operation/Automated Train Control. Options 2 and 3 are two alignment options within the City Council approved Corridor as described in more detail below.

Option 2 is the Pape to downtown via Queen alignment with an approximate length of 7 km and seven stations. Option 3 is the Pape to downtown via Eastern alignment with an approximate length of 7.5 km and eight stations. Option 3 differs from Option 2 as it extends further south to Eastern Avenue and includes a station at Broadview/Eastern.

Figure 7: Option 1 (Base Case)

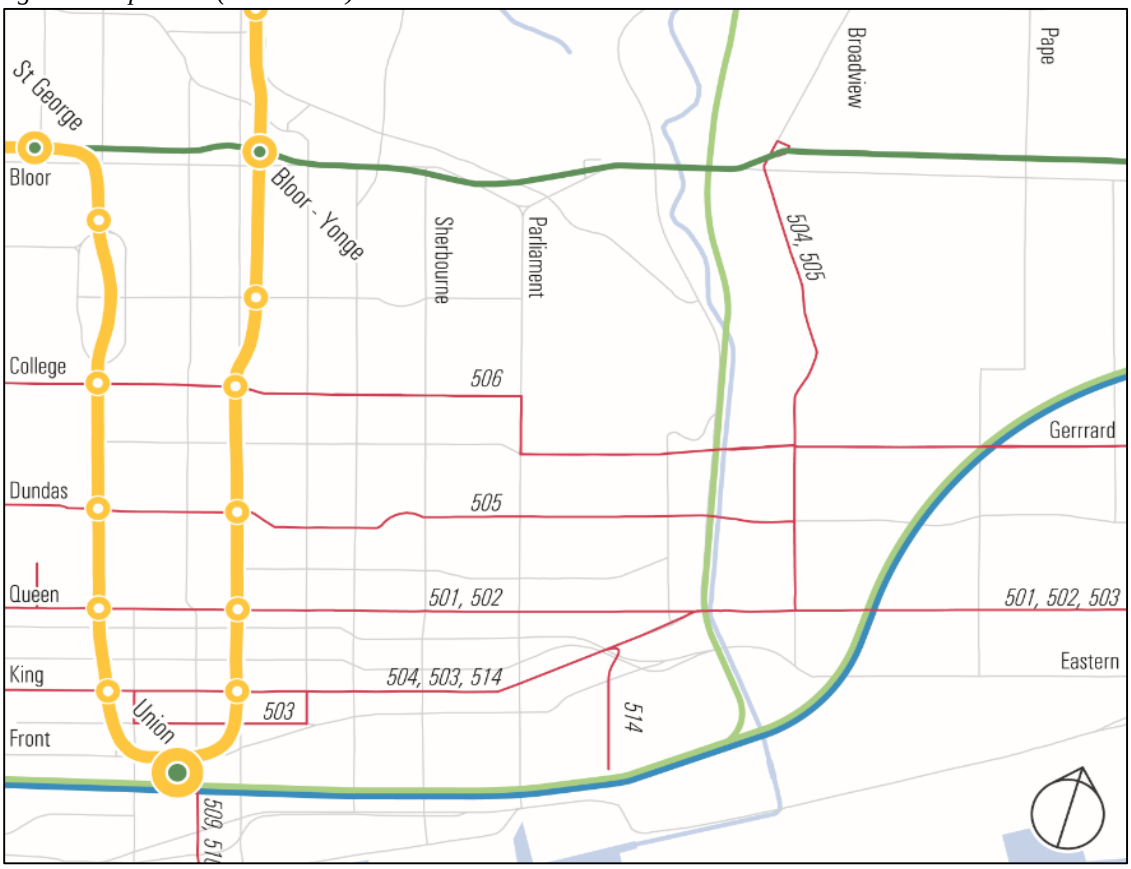


Figure 8: Option 2 Pape-to-Queen Alignment

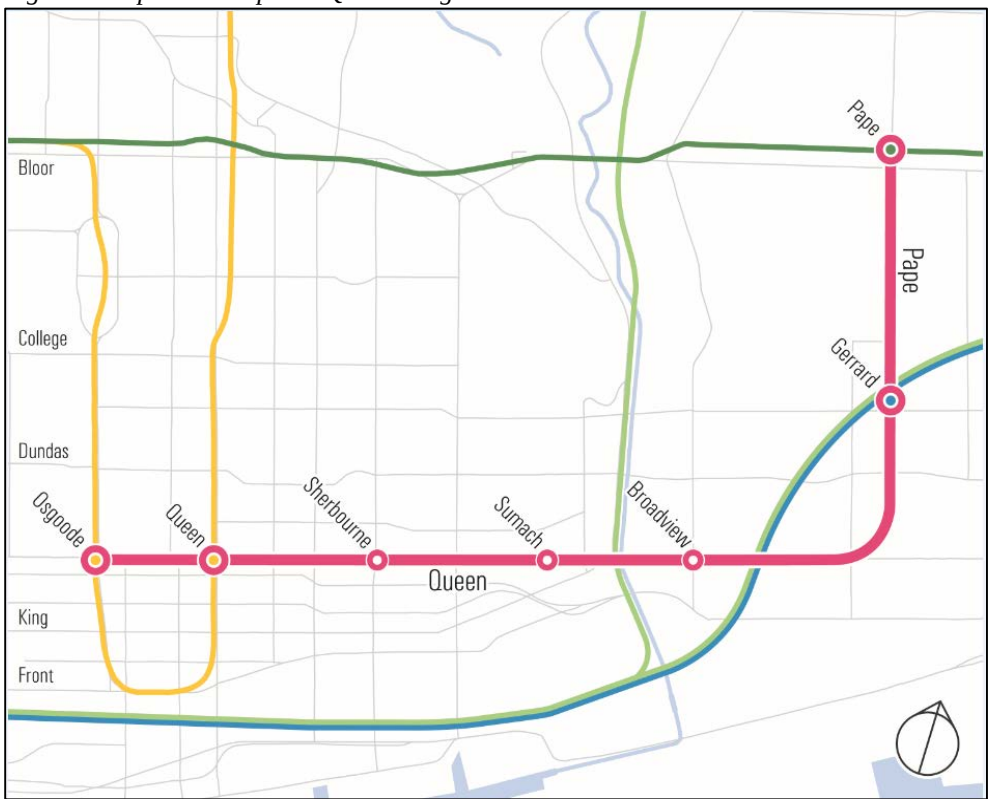


Figure 9: Option 3 Pape-Eastern-Queen Alignment

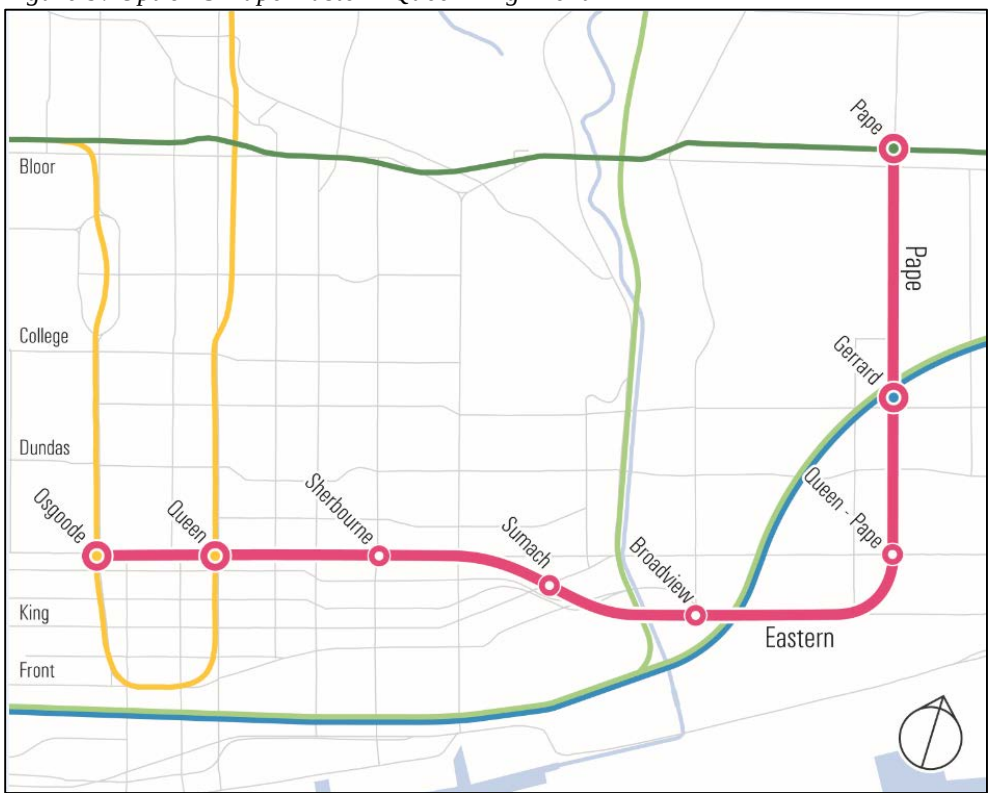


Table 4: Relief Line Initial Business Case Options

	Option 1 (Base Case)	Option 2	Option 3
Summary Description	Continue with planned improvements to Line 1 and surface transit network on Queen St and King St	Relief Line subway from Pape Station on Line 2 to downtown via Queen Option 2a: Alignment follows the GO corridor from Gerrard Square to Queen	Relief Line subway from Pape Station on the Line 2 to downtown via Eastern then Queen
Alignment	N/A	Pape Station on Line 2 to downtown via Queen Street	Pape Station on Line 2 to downtown via Eastern and Queen Street
Length of Alignment	N/A	7 km/ 6.25 km tunneled	7.5 km/6.7 km tunneled
Number of Stations	N/A	7 stations	8 stations
Station Locations	N/A	1. Pape Station *(Interchange with Line 2)* 2. Pape-Gerrard *(potential ST Interchange)* 3. Queen-Broadview 4. Queen-Sumach 5. Queen-Sherbourne 6. Queen-Yonge *(Interchange with Yonge line)* 7. Queen-University *(Interchange with University line)*	1. Pape Station *(Interchange with Line 2)* 2. Pape-Gerrard *(potential ST Interchange)* 3. Queen-Pape 4. Broadview-Eastern *(potential SmartTrack interchange at Unilever)* 5.Queen- Sumach 6. Queen-Sherbourne 7. Queen-Yonge *(Interchange with Yonge line)* 8. Queen-University *(Interchange with University line)*
Service Concept	Assumed future year service frequency on subways and on surface transit network (i.e. includes complete implementation of Automated Train Control)	2 minutes during peak hours 3 minutes during off-peak hours (comparable to Line 2 (Bloor-Danforth) in 2031)	2 minutes during peak hours 3 minutes during off-peak hours (comparable to Line 2 (Bloor-Danforth) in 2031)
Infrastructure Requirements *This may change as the service frequency is refined. It will be revisited in a future iteration of the Business Case.	Automatic Train Control Fleet- new rolling stock;	- 6.8km bored twin tunnels, tail tracks and crossovers - 7 stations (2 Terminal Stations (Open-cut), and 5 inline stations (Open-cut)) - 3 crossovers - 5 substations - 4 emergency exit buildings - 192 metres tail tracks at both terminal stations - 160 metre storage tracks at the northern terminal station - 2 connecting tracks to Line 2 - Rolling stock (7 4-car trains* plus 15% maintenance spares for total	- 7.5km bored twin tunnels, tail tracks and crossovers - 8 stations (2 terminal stations (open-cut), 6 inline stations (open-cut) - 3 crossovers - 6 substations - 3 emergency exit buildings - 192 metre tail tracks at both terminal stations - 160 metre storage tracks at northern terminal station - 2 connecting tracks to Line 2 - Rolling stock (9 4-car trains* plus 15% maintenance spares for total of 11 4-car trains)

	Option 1 (Base Case)	Option 2	Option 3
		of 9 4-car trains) - Greenwood Yard - Signalling systems	- Greenwood Yard - Signalling systems

Base Network Assumptions

The business case analysis is based on the following base network assumptions:

- Eglinton Crosstown LRT from Mt Dennis to Kennedy Station (currently under construction);
- Toronto-York- Spadina Subway Extension (currently under construction);
- Sheppard Avenue East LRT (funded);
- Scarborough Subway Extension (3 stop) (funded); and
- Connections to new subway stations from existing local bus and streetcar routes.

3. Strategic Case

The Strategic Case is an assessment of the options based on alignment with the project objectives and broader City building objectives. It captures considerations that are not easily monetized and are therefore not captured in the Financial or Economic cases. The city-building objectives included in this analysis were developed through extensive consultation as part of the *Feeling Congested?* Official Plan Review. The framework focuses on three principles—*Serving People, Strengthening Places, and Supporting Prosperity*. These three principles are further articulated as eight criteria outlined below:

Serving People

- **Choice** - Develop an integrated network that connects different modes to provide for more travel options
- **Experience** - Capacity to ease crowding / congestion; reduce travel times; make travel more reliable, safe and enjoyable
- **Social Equity** - Allow everyone good access to work, school and other activities

Strengthening Places

- **Shaping the City** - Develop an integrated network that supports growth
- **Healthy Neighbourhoods** - Changes in the transportation network should strengthen and enhance existing neighbourhoods; promote safe walking and cycling within and between neighbourhoods
- **Public Health & Environment** - Support and enhance natural areas; encourage people to reduce how far they drive; mitigate negative impacts

Supporting Prosperity

- **Affordability** - Improvements to the transportation system should be affordable to build, maintain and operate. The affordability criteria will be assessed through the Financial Case section of this business case.
- **Supports Growth** - Investment in public transportation should support economic development: allow workers to get to jobs more easily; allow goods to get to markets more efficiently

Through the RLPA, corridor and alignment options were assessed using evaluation criteria developed for the project based on the *Feeling Congested?* framework. For the purposes of the business case, a short list of *Feeling Congested?* criteria is reported. This short list of criteria is also reported for each of the other transit project business cases to allow for comparison between projects. The business case analysis evaluated each of the options against the project objectives and the criteria.

Performance of Options based on Project Objectives

The objectives of the Relief Line are to reduce the volume of passengers travelling on Line 1 (Yonge) south of Bloor; reduce the volume of passengers transferring within Bloor-Yonge Station; provide an alternative rapid transit route for transit users going into and out of downtown; and deliver the City's Official Plan objectives evaluated through the *Feeling Congested? evaluation framework.*

Options 2 and 3 are both capable of reducing demand on Line 1 at its peak point south of Bloor-Yonge Station. The capacity of Line 1 is expected to increase to 36,000 passengers per hour with the implementation of a new signalling system. In order to achieve this capacity improvement, a reduction in dwell[4] times is required at Bloor-Yonge station, which can be achieved by reducing the passenger transfers at Bloor-Yonge station. Option 2 performs better in reducing dwell times as it is projected to have a higher reduction in AM peak volumes on Line 1, a higher reduction in passengers transferring between Line 2 and Line 1, and a higher reduction in AM peak volumes on Line 2. As such, Option 2 has the greatest impact on reducing the volume of southbound passengers on Line 1. Both options are capable of reducing the number of transfers between the westbound Line 2 and southbound Line 1, with Option 2 predicted to have the greatest impact.

Preliminary results also indicate that the reductions in AM peak volumes east of Yonge Street on the 501 and 504 Streetcars are similar for both options. Option 3 also has the opportunity to connect directly with the 514 Cherry streetcar as well as an eastern Waterfront LRT.

Table 5 below shows the relief on the volumes of passengers travelling on Line 1 south of Bloor in 2031 for the two options. In addition, it presents the reduction in transfers from the westbound Line 2 (Bloor-Danforth line) to the southbound Line 1 (Yonge Line). Option 2 performs better in both measures in the 2031 horizon year.

Table 5: Relief to Line 1 (Yonge) in 2031

	Ridership on Line 1 (Yonge) South of Bloor		**Transfers from WB Bloor-Danforth to SB Line 1 (Yonge)**	
	Total volume (AM Peak Hour)	Net reduction (AM Peak Hour) **	Total volume (AM Peak Hour)	Net Reduction (AM Peak Hour) **
Base Case	40,100	n/a	10,300	n/a
Option 2	34,200	5,900	4,600	5,700
Option 3	36,700	3,400	7,300	3,000

* Forecasted boardings does not take into account the influence of SmartTrack
*Capacity on the Yonge Line South of Bloor is assumed to be 36,000 by 2031
** The assessment of anticipated relief will be revisited as details regarding the design of the preferred alternatives are refined, including assumptions concerning alignment geometrics, operating speeds and headways.
***The assumptions for ridership modelling and accessibility calculations do not reflect the influence of SmartTrack, nor the planned employment growth for the Unilever site which is anticipated to be approximately 21,000 by 2031 and 50,000 at full build out.

[4] Dwell time refers to the amount of time the train is in the station, allowing passengers to get off the train and others to board the train

In addition, Table 6 below presents the ridership estimates for Option 2 and Option 3 in 2031. In terms of total daily ridership, Option 2 performs slightly better than Option 3. In terms of total boardings and attracting new transit riders to the system on the Relief Line, Option 3 performs best.

Table 6: All-day ridership on Relief Line in 2031

	AM Peak Period Boardings	**All day Boardings**	**Net New Riders**
Option 2	58,500	177,100	10,800
Option 3	54,600	165,500	13,400

*The assumptions for ridership modelling and accessibility calculations do not reflect the influence of SmartTrack, nor the planned employment growth for the Unilever site which is anticipated to be approximately 21,000 by 2031 and 50,000 at full build out.

When the Relief Line is extended further north in the future, the relief it can provide to Line 1 increases substantially. 2041 ridership forecasts, assuming extension of the Relief Line north to Sheppard are based on a notional alignment that connects Pape Station to Don Mills Station. As seen in Table 7 below, when both Option 2 and 3 are extended to Sheppard Avenue East they are expected to provide significantly more relief to Line 1 when compared to the first phase of the Relief Line that connects only from Pape Station to downtown. Option 2 extended to Sheppard Avenue performs better than Option 3 in terms of easing crowding on Line 1.

Table 7: Relief to Line 1 (Yonge) in 2041 Assuming Northern Extension to Sheppard

	Ridership on Line 1 (Yonge) South of Bloor		**Transfers from WB Line 2 (Bloor-Danforth) to SB Line 1 (Yonge)**	
2041	Total volume (AM Peak Hour)	Net reduction relative to base without Relief Line	Total volume (AM Peak Hour)	Net Reduction relative to base without Relief Line
Base Case	42,600	n/a	10,400	n/a
Option 2 with northern extension to Sheppard Avenue**	32,700	9,900	5,100	5,300
Option 3 with northern extension to Sheppard Avenue**	36,100	6,500	8,400	2,000

*Capacity of Line 1 is assumed to be 36,000 per hour

**The assumptions for ridership modelling and accessibility calculations do not reflect the influence of SmartTrack, nor the planned employment growth for the Unilever site which is anticipated to be approximately 21,000 by 2031 and 50,000 at full build out.

Table 8 below presents the corresponding ridership estimates for 2041, assuming extension of the Relief Line to Sheppard Avenue East. In terms of total daily ridership, Option 2 performs better, while Option 3 attracts more net new transit users. When compared to the phase 1 of Relief Line, both options would provide significantly more total daily ridership and net new transit users.

Table 8: All-day ridership on Relief Line in 2041 Assuming Northern Extension to Sheppard

	AM Peak Period Boardings	All day Boardings	Net New Riders
Option 2 (with northern extension to Sheppard Avenue *)	103,600	314,200	26,500
Option 3 (with northern extension to Sheppard Avenue *)	98,300	304,400	30,400

*The assumptions for ridership modelling and accessibility calculations do not reflect the influence of SmartTrack, nor the planned employment growth for the Unilever site which is anticipated to be approximately 21,000 by 2031 and 50,000 at full build out.

Feeling Congested? Evaluation

Choice

A great transit network is an integrated one that connects different routes and modes to provide for more travel options. This can be measured by the number of transfer opportunities, accessibility to rapid transit options, and number of major connections to walking and cycling infrastructure. The Relief Line provides potential connections with other existing and planned major transit routes, including SmartTrack/GO RER at Pape and Gerrard and the Unilever site (Option 3). The Relief Line will also provide an additional benefit by relieving demand on the Queen streetcars (both Options 2 and 3) plus the King streetcars (Option 3).

The Relief Line facilitates transfers into and out of downtown, such as passengers transferring from the Queen streetcar to the subway at Broadview (Option 2) or at Pape-Queen (Option 3). The Relief Line will also provide a direct connection to the underground PATH network, four bus routes at Pape Station, and Toronto Bike Share locations at Queen Station and Osgoode Station (and potentially at additional stations as the Toronto Bike Share program expands).

Table 9 includes a summary of all measures used to evaluate the options in terms of the ability to increase choice.

Table 9: Choice Evaluation

Choice Criteria	Option 2 Pape-Queen	Option 3 Pape-Eastern-Queen
Transfer opportunities with other transit routes **(rapid transit in bold,** future connections in italics)	1. **Line 1 (at Queen Station)** 2. **Line 1 (at Osgoode Station)** 3. **Line 2 (at Pape Station)** 4. **SmartTrack/GO RER Station at Pape and Gerrard** 5. 506 Carlton Streetcar (at Gerrard Square) 6. 501 Queen Streetcar (at Broadview Station) 7. 502 Downtowner Streetcar (at Queen-Pape) 8. 504 King Streetcar (at Queen-Broadview) 9. 6 Bay (bus)	**1. Line 1 (at Queen Station)** **2. Line 1 (at Osgoode Station)** **3. Line 2 (at Pape Station)** **4. SmartTrack/GO RER Station at Pape and Gerrard** 5. 506 Carlton Streetcar (at Gerrard Square) 6. 501 Queen Streetcar (at Queen-Pape) 7. 502 Downtowner Streetcar (at Queen-Pape) 8. 504 King Streetcar (at King/Sumach) **9. SmartTrack/GO RER Station**

Choice Criteria	Option 2 Pape-Queen	Option 3 Pape-Eastern-Queen
	10. 72 Pape (bus) 11. 25 Don Mills (bus) 12. 81 Thorncliffe Park (bus) 13. *Broadview Streetcar Extension (at Queen/Broadview)* 14. *514 Cherry Streetcar (indirect connection 140m walk from Queen/Sumach)* **Total: 14** connections in total, Including **4** rapid transit connections, and **2** future transit connections	**(at Unilever)** 10. 6 Bay (bus) 11. 72 Pape (bus) 12. 25 Don Mills (bus) 13. 81 Thorncliffe Park (bus) 14. *Broadview Streetcar Extension (at Queen/Broadview)* 15. *514 Cherry Streetcar (at King/Sumach)* **Total: 15** connections in total, including **5** rapid transit connections, and **2** future transit connections
Average number of daily transfers across TTC system (Base case: 1.8 in 2031 and 2041))	1.8 (in 2031) 1.8 (in 2041)	1.8 (in 2031) 1.8 (in 2041)

***The assumptions for ridership modelling and accessibility calculations do not reflect the influence of SmartTrack, nor the planned employment growth for the Unilever site which is anticipated to be approximately 21,000 by 2031 and 50,000 at full build out.

Both options connect well with existing surface transit routes, and connect to a number of cycling routes. The stations for both options would be connected to a well-established pedestrian network.

Based on *Feeling Congested?* criteria for Choice, both options perform well. The introduction of Option 2 to the transit network is expected to slightly reduce the average number of transfers per trip across the entire TTC network.

Option 3 would be better connected to existing surface transit routes, including the 514 Cherry streetcar, resulting in the greatest modelled relief to AM inbound streetcar passenger volumes. In addition to the transit connections that Option 2 provides, Option 3 would also provide a connection to the SmartTrack/GO RER station at Unilever, and provide a more direct connection to the 514 Cherry streetcar route (at King/Sumach).

Both options perform similarly in terms of Choice.

Experience

An improved travel experience for the passengers has many elements, including the travel time between origins and destinations, the number of destinations a rider can access using the transit network and the ability to mitigate crowding on transit.

Table 10: Experience Evaluation

	Option 1 **Base Case**	**Option 2** **Pape-Queen**	**Option 3** **Pape-Eastern-Queen**
Transit Ridership Change	n/a	10,800 new transit riders (in 2031) 11,400 new transit riders (in 2041) without extension to Sheppard 26,500 new transit riders (in 2041) with extension north to Sheppard	13,400 new transit riders (in 2031) 15,400 new transit riders (in 2041) without extension to Sheppard 30,400 new transit riders (in 2041) with extension north to Sheppard
Travel time from Pape Station to Queen Station	16 min, 22 seconds	9 min, 10 seconds (includes dwell time at stations)	11 minutes, 40 seconds (includes dwell time at stations)
Change in Transit Travel Times between Pape Station and Queen Station (from base) in 2031	n/a	-44%	-29%
Congestion Relief on streetcars westbound in AM peak period (in 2031)	N/A	59% (Queen streetcar) 62 % (King streetcar)	69% (Queen streetcar) 74% (King streetcar)

***The assumptions for ridership modelling and accessibility calculations do not reflect the influence of SmartTrack, nor the planned employment growth for the Unilever site which is anticipated to be approximately 21,000 by 2031 and 50,000 at full build out.

Travel time on the line is shorter for Option 2 at 9 minutes and 10 seconds to travel from Pape Station to downtown. Option 3 has a travel time of 11 minutes and 40 seconds. Based on travel time, Option 2 performs better.

Option 2 offers the best travel time savings, as well as the greatest relief to Line 1 and at Bloor-Yonge Station. It also better serves a number of key destinations along Queen Street and further north. The absence of any sharp turns (the turn from Pape to Queen being achieved at a full speed 600m radius curve), which is attributed to it having a better travel time, results in a heightened passenger comfort compared to Option 3.

Option 3 offers smaller travel time savings for those passengers currently transferring from Line 2 to Line 1 at Bloor-Yonge station. This results in a relatively low modelled diversion potential for those passengers. This is a result of the longer tunnel length and an additional station. On the other hand, a station at Unilever attracts the greatest number of new riders to the transit system as a whole, as well as high daily ridership. A number of sharp curves along the alignment may result reduced passenger comfort.

Option 2 performs slightly better than Option 3 in terms of Experience.

Social Equity

Social equity is an important city-building objective when considering major transit investments. Some populations more heavily rely on public transit than others, with the incidence of the reliance on public transit greater in Neighbourhood Improvement Areas than other areas of the city. Social equity objectives include providing convenient, affordable and reliable transit options to those who need it, increasing access to jobs, and increasing the size and diversity of the labour-force available to existing or potential employers. The assessment of options in terms of social equity considered criteria such as access to jobs, access to labour, the number of equity-seeking individuals[5] within walking distance of a station, and consideration of Neighbourhood Improvement Area scores and population.

Option 2 provides five-minute walking access to two Neighbourhood Improvement Areas, Regent Park and the proposed redevelopment at Moss Park. With a potential station at Queen-Sumach, Option 2 provides slightly better benefits to Regent Park than Option 3, which includes a stop about 150 metres to the south.

Both options have a station at Queen/Sherbourne, which provides improved city-wide access to the planned sports and recreation complex at Moss Park.

Option 3 provides rapid transit service within a ten-minute walk to more vulnerable persons, estimated using Neighbourhood Equity Scores weighted by population. With an additional station, Option 3 serves more people in total, including social-equity seeking individuals.

By providing convenient, affordable and reliable transit options to those who need it, investment in the transit network enables better access to jobs for residents, and increases the size and diversity of the labour-force available to existing or potential employers.

[5] 'Equity-seeking groups' is a term**,** which covers groups who face barriers to equal access which are similar to those faced by the “employment equity designated groups”. Equity-seeking groups include groups whose members are treated differently because of their faith, immigrant status, sexual orientation, economic status, and level of education and/or literacy. For the RLPA, data for equity-seeking individuals was based on National Household Survey (2011) information for prevalence of Low-income Cut-off (LICO) households, female-led single parent families, recent immigrant (previous 5 years) individuals, and unemployment rate.

Table 11: Social Equity Evaluation

	Option 1 Base Case	Option 2 Pape-Queen	Option 3 Pape-Eastern-Queen
Change in number of number of equity-seeking individuals who are served by rapid transit*	n/a	+12,400	+14,400
Supporting equity[3] in mobility by gender, income, Family Status and Age Class**			Greatest absolute number
Increase in coverage of area served by transit	n/a	2.9 km^2	3.7 km^2
Average number of jobs within 60 min travel time for the average individual residing in Neighbourhood Improvement Areas	139,400	145,700***	144,000***
Change in the number of jobs accessible within 60 min for individuals living within NIAs	n/a	+6,300*** (+4.5%)	+4,600*** (+3.3%)
Average number of people accessible within 60 min travel time for individuals residing in Neighbourhood Improvement Areas	515,500	524,300	523,700
Change in the number of people accessible within 60 min for individuals living within NIAs	n/a	+8,800 (+1.7%)	+8,200 (+1.6%)

* This is conceptual number measurement based on Neighbourhood Equity Score, weighted by population
** For more detail, please refer to the results of the evaluation of alignment options from the technical analysis.
***The assumptions for ridership modelling and accessibility calculations do not reflect the influence of SmartTrack, nor the planned employment growth for the Unilever site which is anticipated to be approximately 21,000 by 2031 and 50,000 at full build out.

Option 2 includes a station at Sumach, less than 500 m from Regent Park; however, a station at King-Sumach in Option 3 offers imporved opportunity for supporting neighbourhood infrastructure as compared to the more constrained Queen-Sumach station area. The station at Queen-Broadview would not directly serve the planned future employment centre at the Unilever site, thus reducing its city-wide accessibility to equity seeking individuals.

Option 3 would serve more equity seeking individuals and households, as a result of having an additional station and improved access for more people in general. The proposed station at King-Sumach offers a key opportunity to consider additional social infrastructure and community space while bridging the West Don Lands and Regent Park neighbourhoods in Corktown. The station at Eastern-Broadview would improve city-wide transit accessibility for equity seeking populations to the planned employment node at the Unilever site. This option supports the more equity-seeking individuals in terms of gender, income, family status and age class.

For individuals residing in a Neighbourhood Improvement Area, the differences between Option 2 and 3 are insignificant with respect to the average number of people accessible within 60 minutes of transit travel time.

For Social Equity, Option 3 performs better than Option 2.

Shaping the City

Shaping the City is focused on ensuring that transit serves places where people live, both today and in the future.

Table 12: Shaping the City Evaluation

	Option 2 Pape-Queen	**Option 3 Pape-Eastern-Queen**
Existing population density	9200 people per km^2	8600 people per km^2
Projected Population Growth (additional residents)	26,700 people	27,500 people
Total future population	54,900	59,400
Service to residential growth areas		
Area of land designated for population growth	0.4 km^2	0.5 km^2
Proportion of land designated for population growth	14.4%	12.8%
Projected increase in population density (people per square kilometre)	9,300 people per km^2	7,500 people per km^2
Compatibility with City Planning Policies (i.e. ability to support the growth intentions of the Official Plan or relevant planning studies within the station area)	Queen Street East Heritage Conservation District limits potential for development and future population growth	Potential to serve the King-Parliament and West Don Lands and Regeneration areas Potential to serve Mixed use Areas and employment areas north and south of Eastern Ave.

Within a 500 metre walking distance of stations, Option 2 would serve more people today, but Option 3 would serve more future residents.

Across the TTC system, Option 2 provides slightly better access in terms of the average number of people accessible to any particular resident in Toronto within 60 minutes of transit travel time.

Across the TTC system, Option 2 provides slightly better access in terms of the average number of people accessible to any particular resident in Toronto within 60 minutes of transit travel time.

Table 13: Average population within 60 minutes of travel time by transit from any resident in the City of Toronto, today and in 2031

		Option 1 Base Case	**Option 2 Pape-Queen**	**Option 3 Pape-Eastern-Queen**
Today	Average number of people accessible within 60 min transit travel time for the average person	258,000	262,600	262,600
	Change in number of people within 60 minutes relative to base (%)	n/a	+3,900 (+1.4%)	+3,900 (+1.4%)
In 2031	Average number of people accessible within 60 min transit	385,400	395,500	394,400

		Option 1 Base Case	Option 2 Pape-Queen	Option 3 Pape-Eastern-Queen
	travel time for the average person			
	Change in number of people within 60 minutes relative to base (%)	n/a	+10,100 (+2.6%)	+9,000 (2.3%)

***The assumptions for ridership modelling and accessibility calculations do not reflect the influence of SmartTrack, nor the planned employment growth for the Unilever site which is anticipated to be approximately 21,000 by 2031 and 50,000 at full build out.

Investment in the transit network should be well coordinated with land use planning and economic development, and support growth. The Relief Line would support redevelopment opportunities at several of its stations including at Pape-Gerrard and Unilever, as well as on Queen Street, west of the Don Valley.

Option 3 addresses Shaping the City criteria better because it provides greater ability to serve more future residents, and it is more compatible with city building objectives in the Official Plan.

Healthy Neighbourhoods

Changes in the transportation network should strengthen and enhance existing neighbourhoods; promote safe walking and cycling within and between neighbourhoods.

The Relief Line will serve several existing neighbourhoods (defined as areas where 30% of the land within 500m is designated as stable residential).

Option 2 is anticipated to have a greater impact on heritage and is less effective in removing neighbourhoods that are bisected by a barrier (such as rail berms or viaduct ramps). A station at Gerrard/Pape would provide an improved pedestrian crossing of the rail corridor.

Option 3 is anticipated to have less impact to heritage buildings and Heritage Conservation Districts, with an opportunity to construct station areas that will improve neighbourhood connections (i.e. Gerrard/Pape, Broadview/Eastern and King/Sumach).

Table 14: Healthy Neighbourhoods Evaluation Summary

	Option 2 Pape-Queen	Option 3 Pape-Eastern-Queen
Proportion of land within walking distance (500m) of a station that is stable neighbourhoods	30%	30%
Impact on heritage	Potential for impact to Heritage Conservation Districts on Queen St East	Reduced potential for impact to Heritage Conservation Districts
Potential to remove neighbourhood barriers to promote walking and cycling	Significant opportunities for new neighbourhood connections at Gerrard/Pape	Significant opportunities for new neighbourhood connections at Gerrard/Pape, Broadview/Eastern and King/Sumach

Public Health & Environment

The assessment of options also considered the ability to support and enhance natural areas; encourage people to reduce how far they drive, mitigating negative impacts on the environment. The Relief Line is forecast to reduce automobile-kilometres travelled by 0.041% (Option 2) to 0.030% (Option 3) in the morning peak period. This amounts to a reduction of up to 63,400 vehicle-kilometres per day (Option 2).

Noise, dust emissions, vibration associated with construction of the subway is a consideration for potential impacts on sensitive receptors.

Table 15: Healthy Neighbourhoods & Environment Evaluation Summary

	Option 2 **Pape-Queen**	**Option 3** **Pape-Eastern-Queen**
Change in vehicle-kilometres travelled (from base)	-63,400 vehicle-km (-0.041% from base)	-47,000 vehicle-km (-0.030% from base)
Change in auto share	55% (insignificant difference)	55% (insignificant difference)
Significant Environmental challenges associated with the project	• No flora or fauna of concern at station areas • No stations are within any Environmentally Significant Area (ESA) • A majority of the alignment for both Options will be within bedrock and is not anticipated to have significant impact on groundwater or other water resources. The tunnel will be below the water table. • Construction impacts to natural areas or parks can be mitigated. Mitigation measures to be developed as part of detailed design. • More detailed analysis of environmental impacts may be investigated at the next stage of study	
Noise, dust emissions, vibration associated with construction.		Fewer sensitive receptors so slightly reduced impact from construction
Noise and vibration from operation		Fewer sensitive receptors so slightly reduced impact from operation

***The assumptions for ridership modelling and accessibility calculations do not reflect the influence of SmartTrack, nor the planned employment growth for the Unilever site which is anticipated to be approximately 21,000 by 2031 and 50,000 at full build out.

There are no significant impacts to public health and environment anticipated for Option 2. There may, however, be slightly greater noise and vibration impacts anticipated during construction and long term operations, mainly due the presence of a higher number of noise-sensitive receptors along the alignment; however, these impacts can be mitigated.

Similarly, there are no significant impacts to public health and environment anticipated for Option 3. There may, however, be greater noise and vibration impacts anticipated during construction; however, these impacts may potentially be mitigated.

With no significant differences between Options 2 and 3, both perform equally well.

Supports Growth

Investment in public transportation should support economic development by allowing workers to get to jobs more easily; and supporting employers from as wide of a labour market base as possible.

Both options improve the number of jobs accessible within 60 minutes of travel. The analysis considers *all* transit commuters across the TTC system. If implemented today Option 2 would perform slightly better than Option 3 (Table 16). In a future scenario (2031), Option 2 performs slightly better than Option 3 (Table 17).

Table 16: Access to jobs across TTC network (existing)

	Option 1 Base Case	**Option 2 Pape-Queen**	**Option 3 Pape-Eastern-Queen**
Access to Jobs (number of jobs accessible to the average person within 60 min transit travel)	88,600	91,100	90,600
Increase in jobs relative to base	n/a	+2,500 (+2.8%)	+2,000 (+2.3%)

***The assumptions for ridership modelling and accessibility calculations do not reflect the influence of SmartTrack, nor the planned employment growth for the Unilever site which is anticipated to be approximately 21,000 by 2031 and 50,000 at full build out.

Table 17: Future Access to jobs across TTC network (in 2031)

	Option 1 Base Case	**Option 2 Pape-Queen**	**Option 3 Pape-Eastern-Queen**
Access to Jobs (number of jobs accessible to the average person within 60 min transit travel)	111,900	115,200*	114,700*
Increase in jobs relative to base (%)	n/a	+3,300 (+2.9%)	+2,800 (+2.5%)

*The assumptions for ridership modelling and accessibility calculations do not reflect the influence of SmartTrack, nor the planned employment growth for the Unilever site which is anticipated to be approximately 21,000 by 2031 and 50,000 at full build out. This would increase the number of jobs accessible within 60 minutes for Option 3.

At a more local scale, Option 3 serves a greater area of land designated for jobs growth, greater number of jobs today and in the future (Table 18).

Table 18: Analysis of access to employment growth areas and projected employment growth

		Option 2 Pape-Queen	**Option 3 Pape-Eastern-Queen**
Service to employment growth areas	Area of land designated for employment growth	0.5 km^2	0.8 km^2
	Proportion of land designated for employment growth	19%	22%

		Option 2 Pape-Queen	Option 3 Pape-Eastern-Queen
Projected employment growth	Projected employment growth	9,700	22,300*
	Projected increase in employment density	3,400	6,100
Existing employment density	Existing Toronto employment	16,300	18,200
	Existing Toronto employment density	5,700	5,200
	Existing Toronto employment density	5,600	5,100

* This figure assumes that the number of jobs at Unilever will be approximately 21,000. The aspiration for this site is to accommodate approximately 50,000 jobs. This would increase the number of jobs accessible within 60 minutes for Option 3.

In summary, Option 2 is less effective in supporting growth as it provides only indirect service to the future employment growth planned for the Unilever lands. The proposed station at Queen-Broadview (compared to Eastern-Broadview) is not anticipated to support significant new employment in its immediate vicinity and may result in significant impact to the existing small-scale, mature retail environment during construction. Although Option 2 supports some development in the Queen-Broadview area, including Riverside Square development and existing higher density uses on Broadview south of Queen, the site is constrained in terms of the development that can be supported as a result of Queen Street East Heritage Conservation District. There is also limited ability to support growth at the West Don Lands.

Option 3, and its associated station locations, is best positioned to support businesses and improve city-wide access to employment opportunities as it provides more direct service to the Unilever lands with a station at Eastern/Broadview. This station would support future employment growth planned for the area while also leaving intact the established small-scale retail environment at Queen-Broadview. Option 3 supports development at the West Don Lands, Keating Channel Precinct, Distillery District, and Villiers Island/Port Lands. A station at King/Sumach offers opportunities to use the station to help reconnect the neighbourhood by overcoming the barrier presented by the GO Rail corridor.

Although Option 2 supports access to a slightly higher number of jobs across the system, overall, Option 3 addresses Supports Growth criteria better than Option 2.

Strategic Case Evaluation Conclusion

The Relief Line is an essential component of the future transit network in Toronto, providing relief to Line 1 (Yonge), Bloor-Yonge Station, and surface transit routes. Although both alignments perform similarly, a Relief Line alignment on Pape-Eastern-Queen (Option 3) serves a greater number of objectives within the Strategic Case, including:

- It opens up a significant amount of land for new jobs and affordable housing with station connections at the Unilever site and the West Don Lands.
- It best addresses social equity goals, such as by providing improved transit connections for people to access jobs centres, including downtown and the major new employment hub being planned for the Unilever site.
- It improves neighbourhood integrity by bridging existing barriers in communities such as Corktown and near Pape/Gerrard.
- It improves transit network connectivity with interchanges with the Queen and King streetcars and SmartTrack/GO RER.
- It attracts the most net new riders to the transit network.

Table 19: Relief Line Strategic Case Summary Evaluation

	Option 2 Pape-Queen	**Option 3 Pape-Eastern-Queen**
Project Objectives		
Alleviate crowding on Line 1 south of Bloor		
Alleviate crowding at Bloor-Yonge Station		
Provide alternative route to downtown, and additional capacity into and from downtown		
Feeling Congested Criteria		
Choice		
Experience		
Social Equity		
Shaping the City		
Healthy Neighbourhoods		
Public Health and Environment		
Supports Growth		
Strategic Case Summary		

4. Financial Case Evaluation

The Financial Case evaluation assesses the costs associated with each option. The cost estimates developed are based on less than 5 percent conceptual design, resulting in Class 5 cost estimates according to industry standards (See Appendix 2: Cost and Schedule Estimate Classification). Per industry guidelines, a project budget should be determined with a Class 3 cost estimate. The costs included in this initial business case should not be used for budgeting purposes.

Capital Cost Estimates

In order to develop capital cost estimates assumptions were also made regarding the potential construction start and in-service date for this project. These are noted in Table 20 below. The estimates are based on alignments and conceptual layouts provided by the project engineering consultant, HDR, Inc. Several assumptions were made in the development of these cost estimates, including:

- The construction of the stations, emergency exit buildings, crossovers and storage tracks are assumed to be cut and cover construction.
- For bored twin tunnels, each tunnel is assumed to be 5.85 metres in diameter and connecting tracks to the Line 2 line (Bloor Danforth) are also assumed to be bored.
- Tunnelling is assumed to be in bedrock, except under the Don River where compensation grouting will be required.
- There are no provisions for a maintenance and storage facility, as it is assumed that the subway trains for the Relief Line will be stored on the line and cycled to Greenwood Yard for servicing and maintenance, which is similar to the operation of line 4 (Sheppard Subway). Future extensions of the line will trigger the requirement for dedicated maintenance and storage facilities.
- Fleet and train size for each option has been calculated based on service levels of 3 minutes during peak periods and 4.5 minutes during off peak service, using average speeds provided by the modelling results. Based on projected demand at these service frequencies, it is assumed that 4 car trains will be used, which is similar to Line 4 (Sheppard Subway).

Table 20: Capital Cost Expenditure - Class 5 Estimate ($, millions)

	Option 2	**Option 3**
Constant $2016	$4,082	$4,417
Net Present Value $2016	$4,405	$4,766
YOE/Escalated $	$6,284	$6,799

Notes:

- Cost estimate prepared by the TTC.
- Costs do not include financing, lifecycle and operations/maintenance.
- Assumes line in service by 2031, with construction taking approximately 10 years (2021-2031)
- Escalation rate applied for YOE/Escalated$ is 4%
- Discount rate applied for Net Present Value calculation is 3.3%
- Cost estimates have been developed at less than 5% design and are a Class 5 cost estimate (per AACE guidelines).
- Costs assume traditional procurement approach.
- Costs assume that flood remediation of Eastern Avenue site is in place at time of construction.

Table 21: Capital Cost Expenditure- Breakdown (Constant 2016$, millions)

Cost Elements	Option 2	Option 3
Infrastructure (Structures, track, power, signalling, stations, utilities)	2,940	3,169
PM/Permits	760	819
Rolling Stock	122	149
Property Allowance	259	279
Total ($2016 Constant Dollars, millions)	**$4,082**	**$4,417**

Lifecycle Cost Estimates

In order to develop a lifecycle cost estimate for each project, assumptions were made regarding the potential construction start and in-service date for this project. The project is currently unfunded and does not have an approved project budget and schedule.

Assuming the Relief Line Phase 1 is required to be in-service by 2031, and the project takes ten years to construct (2021-2031), a high level construction schedule was created to assess the cash flow requirements over the construction period. Operating and maintenance costs (including recapitalization costs) were developed to determine the lifecycle costs for these options based on the traditional 60-year lifecycle assumed for public transit infrastructure (2031 to 2080). These costs are illustrative and based on the following assumptions:

- 3-minute weekday peak period service and 4-minute 30 seconds off-peak.
- Each option assumes 4-car trains.
- Bus and streetcar service changes have not been included.
- Escalation rate applied for Operating and Maintenance YOE/Escalated $ was 2%.
- Escalation rate applied for Recapitalization YOE/Escalated $ was 4%.

Table 22: Operating, Maintenance & Recapitalization Costs *(YOE/Escalated $, millions)*

	Option 2	Option 3
Operating & Maintenance	$5,731	$6,635
Recapitalization	$24,298	$31,028
Total	**$30,030**	**$37,663**

Table 23: Life Cycle Expenditure- (NPV $2016, millions)

	Option 2	Option 3
Capital Costs	$4,405	$4,766
Operating & Maintenance	$2,258	$2,614
Recapitalization	$2,449	$2,939
Total	**$9,113**	**$10,320**

The preliminary financial case evaluation indicates that Option 2 performs better than Option 3. The capital cost of Option 3 is greater than Option 2 by $500 million (YOE/Escalated $), which is primarily associated with the increased length of the Option 3 alignment and the additional station.

5. Economic Case Evaluation

The economic case evaluation determines how the benefits of each option measure against the costs. The economic evaluation quantifies and monetizes the costs and benefits of a proposed project. The services of a third party consultant were obtained to undertake the economic case assessment using the Metrolinx Business Case Methodology Guidance (see Appendix 3 for Economic Case Assumptions).

The economic benefit measures included in the analysis, are based on the Metrolinx business case guidance and include the following benefits:

- User Benefits: travel time savings, travel cost savings, crowding relief, etc.
- Producer Benefits (incremental fare revenue)
- External Benefits (i.e. Road decongestion, accident prevention, GHG emissions due to reductions in Vehicle Kilometres Travelled (VkT), etc).

It is important to note that the focus in the Metrolinx business case guidance is on travel time savings benefits and benefits associated with reduction in auto-use. As a result, there are several key benefits associated with local transit and city building objectives that are not monetized in this economic evaluation. Further work is required in the development of the business case tool to ensure the economic evaluation includes the monetization of the types of benefits expected from transit expansion projects which provide a more local service.

The economic case produces two key indicators: the Benefit-to-Cost Ratio (BCR) and the Net Present Value (NPV). A Benefit-Cost Ratio (BCR) is generated by comparing the economic benefits of the options over a 60-year project lifecycle. The BCR is determined by dividing the Present Value of the Benefits (PVB) by the Present Value of the Costs (PVC). A BCR that is greater than 1 indicates that benefits cover the costs of the project over the project's lifecycle. BCRs can be useful in assessing the value for money of options under study. The Net Present Value (NPV) of an option is the difference between benefits and costs (PVB-PVC), and offers insight into the present value of the various options under study.

The use of BCR and NPV is valuable in terms of assessing options against each other within a business case analysis. Caution however should be applied when comparing the BCRs of different projects presented in different business cases, as the base assumptions may be different. The results of the economic case evaluation for the first phase of Relief Line are summarized below.

Table 24: Summary of Economic Case ($2015, 000s)

Overall Indicators	Option 2 Pape-Queen	Option 3 Pape-Eastern-Queen
PV of Total Lifecycle Cost (PVC)	4,588,718	5,024,424
PV of Benefits (PVB)	1,336,093	1,493,706
Net Present Value (PVB-PVC)	-3,252,626	-3,530,718
Benefit to Cost Ratio (PVB/PVC)	0.3	0.3

The benefits of the Relief Line via Queen Street (Option 2) are mainly driven by travel time savings and crowding relief, with total benefits of approximately $1.3 billion. The Benefits of the Relief Line via Eastern Avenue (Option 3) are also mainly driven by travel time savings and crowding relief. Total benefits are approximately $1.5billion, which is approximately 10% greater than benefits of Option 2. However costs of Option 3 are also approximately 10% greater. As a result, both options perform equally.

Both options generate the same BCR of 0.3. Although the BCR for both options is less than 1.0, the benefits monetized through this process focus more on regional objectives (i.e. reduce auto use or generate travel time savings). Since the Relief Line is a local transit service intended to provide alternative routes on a heavily congested TTC transit network, in addition to serving key city building objectives, local economic benefits are not truly captured in this BCR. The City and TTC will continue to work with Metrolinx as the business case methodology is further developed to ensure economic evaluation of transit projects considers benefits associated with transit projects that are more local service oriented. The economic case should be read in conjunction with the Strategic Case to understand the full benefits of the Relief Line project.

6. Deliverability and Operations Case

The Deliverability and Operations Case considers key challenges to implementing a project. Implementation challenges have been highlighted for each option from a technical/engineering perspective, operational perspective, and governance perspective.

This is an initial business case intended to support the screening of options. As the project progresses and the preferred option is selected and further refined through more design and project risk assessment, the Deliverability and Operations Case will be further developed. The purpose of this section of the initial business case is to identify emerging deliverability and operational issues which may impact the selection of a particular option and identify next steps.

Engineering/Technical Considerations

An assessment of engineering and technical considerations were identified for each option with both options performing similarly from the engineering/technical perspective. More detailed engineering and technical considerations may arise as further work is completed.

Although geotechnical conditions are similar for both options, Option 3 forces the profile deeper than Option 2 where it crosses Queen Street. This will require the Queen/Pape Station to be deeper, resulting in increased vertical circulation requirements (stairs/escalators). It is anticipated that the majority of tunnelling will be through bedrock.

Initial utilities investigation has not identified significant differences between the two options. The Don & Central Waterfront Wet Weather Flow Tunnel project has potential to impact both Options and will require coordination. The aging sewer infrastructure at King/Sumach and Eastern/Broadview stations in Option 3 requires further assessment.

Option 3 south of Queen Street and east of the Don River will require significant mitigation for flood protection while Option 2 has no requirement for flood protection as the alignment is north of the flood plain. TRCA has initiated an environmental assessment for the required flood protection, so for the purposes of this business case, it is assumed to be in place.

Option 3 may involve raising road profiles based on the final elevation of the station at Broadview and Eastern which is dependent upon the TRCA flood protection requirements. Initial investigation indicates that neither option will impact the Gardiner Expressway project.

Property acquisitions are anticipated to be limited to station locations, emergency exit buildings and traction power substations. It is expected that Option 3 will require more property acquisitions because of the additional station. Option 3 will require an additional substation because of its added length however Option 2 will require an additional emergency exit building due to increased station spacing. Below grade easements for the tunnels will be required for both options.

Tunnelling requirements are similar for both Options. Costing for both Options is based on 5.85m diameter twin tunnels constructed using earth pressure balanced tunnelling boring

machines. Further analysis of tunnelling requirements will be undertaken during the design phase including the feasibility of a large diameter single bore tunnel. A large diameter bore tunnel may allow for station construction and special trackwork to be constructed within the tunnel structure which could potentially reduce surface impacts during construction and minimize requirements for underground easement.

Investigations to date have not revealed any potential contamination sites with the exception of the former Consumers Gas Company site south of Eastern Ave. Further assessment will be required to determine if any localized conditions exist for either option.

Operation and Service Planning Considerations

Both options will have prolonged impact to Pape Station bus routes north and south of Danforth Avenue for station, crossover box and launch shafts. Option 2 will have significant impact to streetcars at Queen-Broadview affecting the King and Queen Streetcars with additional impacts to the Queen streetcar at Queen-Sumach, Queen-Sherbourne and at downtown open cut sites. Option 3 may have impacts at King-Sumach to the King and Cherry streetcars depending on the construction method used as well as impacts on the Queen streetcar at Queen-Sherbourne and at downtown open cut sites.

Both Options will impact vehicular traffic on Pape Avenue north of Danforth and along Queen Street at multiple locations both of which are classified as major arterials. In addition Option 3 will impact traffic along the Eastern Avenue corridor. Both options will result in property access for a number of driveways along Pape Avenue to be blocked for prolonged periods. For both options, drive up access at all station locations will be restricted, but vehicle traffic can be moved to the laneway network at most locations.

Both options interchange with Line 1 at Queen and Osgoode stations and Line 2 at Pape station and it is anticipated that there will be no difference in cost or design of the interchange facilities at these locations. It is also anticipated that both options will interchange with SmartTrack at Pape-Gerrard station and Option 3 will interchange with SmartTrack at the Broadview-Eastern station.

From an operations and maintenance perspective, vehicle storage will be provided for both options on the line with vehicles being deadheaded to Greenwood Yard as required for servicing and maintenance. System maintenance costs will be higher for Option 3 than Option 2 since it is slightly longer, has one additional station and will require an additional substation.

Project Governance and Capital Project Delivery Considerations

There are a range of project governance and capital project delivery considerations that pertain to the Relief Line Phase 1 project. The project is currently an unfunded project, without clear roles and responsibilities delineated between the City and Province and the respective transit agencies, TTC and Metrolinx.

On June 1, 2016, the Province of Ontario announced $150 million to support the planning and design work for the route and station locations for the Relief Line project. Detailed work will be

conducted jointly by Metrolinx, the City and TTC, building on the work that has been undertaken to-date on the RLPA by the City and TTC. Detailed planning work on the Yonge North Subway Extension is concurrently being advanced. The timing of both projects will require coordination between Metrolinx, the City of Toronto, Regional Municipality of York, and its respective local transit agencies.

Following decisions on project governance and asset ownership, a detailed procurement options analysis and risk assessment will also be required. As the project does not have an approved schedule or budget, there will be a requirement to bring forward an updated budget and schedule once a Class 3 cost estimate is completed.

7. Conclusions and Next Steps

Summary

Table 25: Initial Business Case Summary

	Criteria	Option 2	Option 3
Strategic	Alleviate crowding on Line 1 south of Bloor		
	Alleviate crowding at Bloor-Yonge Station		
	Provide alternative route to downtown, and additional capacity into and from downtown		
	Choice		
	Experience		
	Social Equity		
	Shaping the City		
	Healthy Neighbourhoods		
	Public Health and Environment		
	Supports Growth		
	Strategic Case Summary		
Financial	Capital Cost (NPV, $2016, thousands)	$4,405,128	$4,766,470
	Operating and Maintenance (NPV, $2016, thousands)	$2,258,215	$2,614,282
	Recapitalization (NPV, $2016, thousands)	$2,449,164	$2,939,057
	Total	$9,112,507	$10,319,809
Economic	Total PV Benefits (PVB) ($2015, 000s)	1,336,093	1,493,706
	Total PV Costs (PVC)** ($2015, 000s)	4,588,718	5,024,424
	Net Present Value (PVB-PVC) ($2015, 000s)	-3,252,626	-3,530,718
	Benefit-Cost Ratio	0.3	0.3
Deliverability		Requires coordination with the Don & Central Waterfront Wet Weather Flow Tunnel Project; Additional emergency exit building due to increased station spacing.	Requires coordination with the Don & Central Waterfront Wet Weather Flow Tunnel Project; Significant mitigation for flood protection required; Slightly greater construction impacts; Greater property acquisitions due to additional station.

Next Steps

Continuing to advance work on the Relief Line Phase 1 project is crucial to addressing capacity challenges on the Yonge line. This initial business case recommends that Option 3 Pape-Eastern-Queen alignment be carried forward to refine the route and station locations through further design. The Province of Ontario's recent announcement to provide $150 million will support Metrolinx, the City and TTC in advancing planning and design on this project. Future phases of the Relief Line project planning will also include northern and western extensions of the project. In the immediate future, the City and TTC will work with the Province and Metrolinx to scope the next phases of the project planning work. This includes:

- refinements to station locations and preparation of station concept plans;
- development of the conceptual design for the preferred alignment;
- determining potential impacts and mitigation measures; and
- completing the Environmental Project Report (EPR); and
- launching the formal Transit Project Assessment Process (TPAP) and submitting the EPR for approval to the Ministry of Environment and Climate Change.

A Memorandum of Agreement (MOA) detailing the roles and responsibilities for the next phases of planning and design work for the Relief Line project, will be developed by the City, TTC, Metrolinx and the Province.

Appendix 1: Background Documents

January 27, 2009 EX28.1 Yonge Subway Extension – Environmental Assessment
http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2009.EX28.1

June 20, 2013 PG22.5 Downtown Rapid Transit Expansion Study Phase 1 Strategic Plan
http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2013.PG22.5

June 10, 2014 PG33.12 Relief Line Project Assessment: Finalized Terms of Reference and Public Consultation Plan
http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2014.PG33.12

June 25, 2015 Report to Metrolinx Board: Yonge Relief Network Study (YRNS)
http://www.metrolinx.com/en/docs/pdf/board_agenda/20150625/2015-06-25_Yonge_Relief_Network_Study.pdf

March 31, 2016 EX13.3 Developing Toronto's Transit Network Plan: Phase 1
http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2016.EX13.3

- Appendix 6: Relief Line Project Assessment
  http://www.toronto.ca/legdocs/mmis/2016/ex/bgrd/backgroundfile-90881.pdf

June 1, 2016 Province of Ontario Announcement
https://news.ontario.ca/mto/en/2016/06/ontario-supporting-next-steps-for-the-relief-subway-line.html

Appendix 2: Cost and Schedule Estimate Classification

Classification of Cost Estimates

Cost estimate classification systems are used throughout the estimating industry to categorize cost estimates based on the maturity level of project definition. As project development proceeds; estimate accuracy ranges narrow. This is due to the fact that as project design becomes further developed, more is known about the project and there is a corresponding reduction in risk and uncertainty in the cost estimate.

The Association for Advancement of Cost Engineering (AACE) provides the most generally accepted industry guidelines for cost estimate classification systems. Table 26 depicts AACE's Cost Estimate Classification system which provides general principles for using cost estimates to evaluate, approve and/or fund projects.[6] Table 26 illustrates typical ranges of accuracy. The +/- represents typical variation of actual costs from the cost estimate after application of contingency for given scope. A Class 5 cost estimate is based on the lowest degree of project definition, and a Class 1 cost estimate is based on a the highest maturity of project definition (full project definition). In addition to the degree of project definition, estimate accuracy is also driven by other systemic risks such as familiarity with the technology in the project; complexity; quality of reference cost estimating data; unique nature of the project, etc.

Table 26. AACE International Recommended Practice- Cost Estimate Classification Matrix (AACE 18R-97), 2016)

Estimate Class	Maturity of Project Definition *Expressed as % of complete definition*	End Usage *Typical purpose of estimate*	Methodology *Typical estimating method*	AACE Classification Expected Accuracy Range *Typical variation in low and high ranges*	MOTI BC Classification Expected Accuracy Range *Typical variation in low and high ranges [a]*
Class 5	0% to 2%	Concept Screening.	Parametric models; judgement or analogy	L: -20% to - 50% H: +30% to +100%	+/- 35%
Class 4	1% to 15%	Study or feasibility.	Parametric; Elemental factored	L: -15% to -30% H: +20% to +50%	
Class 3	10% to 40%	Budget authorization or control.	Semi-detailed unit costs	L: -10% to -20% H: +10% to +30%	+/- 20%
Class 2	30% to 75%	Control or bid/tender.	Detailed costing	L: -5% to -15% H: +5% to +20%	
Class 1	65% to 100%	Check estimate or bid/tender.	Detailed costing	L: -3% to -10% H: +3% to +15%	+/- 10%

Notes [a] Confidence interval 90% (i.e. expected accuracy 90 times out of 100)

[6] The Association for the Advancement of Cost Engineering (AACE), (2016) http://www.aacei.org/toc/toc_18R-97.pdf

The estimate level is important in terms of when it is appropriate to establish the project budget. The Ministry of Transportation and Infrastructure (MOTI), Government of British Columbia (MOTI BC Guidelines) has an established guideline that indicates at minimum 10 to 40% design should be complete (Class 3, AACE Estimate) in order for the estimate to become the basis for developing the project budget. This also is consistent with AACE Cost Classification Standards (AACE RP No.17R-97).

Further refinement of the cost estimates for the recommended scope of each project is required once further design has been completed, including undertaking project risk assessment processes.

Schedule Estimate Classification

The estimated project schedule also has an impact on estimated project cost. Assumptions based on historical project information were made with respect to the schedule for constructing each project in order to calculate the present value cost for each project.

AACE has published guidelines on recommended practice for the development of project schedules for the purpose of improving the understanding among stakeholders involved with preparing, evaluating and using project schedules for decision-making purposes. Table 27 outlines the AACE Schedule Classification Matrix, which uses the degree of project definition as the primary characteristic to define "Schedule Class". A Class 5 schedule is based on the lowest degree of project definition, and a Class 1 schedule is based on the highest maturity of project definition (full definition).

Table 27. AACE International Recommended Practice- Schedule Classification Matrix[7]

Schedule Class	Maturity of Project Definition *Expressed as % of complete definition [1]*	End Usage *Typical purpose of estimate*	Methodology *Scheduling Methods Used*
Class 5	0% to 2%	Concept Screening.	Top down planning using high level milestones and key project events.
Class 4	1% to 15%	Study or feasibility.	Top down planning using high level milestones and key project events.
Class 3	10% to 40%	Budget authorization or control.	"Package" top down planning using key events. Semi-detailed.
Class 2	30% to 70%	Control or bid/tender.	Bottom up planning. Detailed
Class 1	70% to 100%	Check estimate or bid/tender.	Bottom up planning. Detailed.

Note [1] AACE RP NO. 18R-97 provides the range in percentages for each class.

[7] AACE International Recommended Practice No. 27R-03, (2010), "Schedule Classification System". http://www.aacei.org/toc/toc_27R-03.pdf

Appendix 3: Economic Case Assumptions

Table 28: Economic Case Parameters and Assumed Values

Parameter	Value	Source / Comments
Discount Year	2015	Business Case Development Handbook (BCDH), Metrolinx
Discount Rate	3.50%	BCDH Tier 2 v0.2, pg44, section 10.3.4
Appraisal period (yrs)	60	BCDH Tier 2 v0.2, pg23, section 6.2.2
Auto operating cost savings ($/veh-km)	$0.63	Metrolinx recommended value
Auto operating cost savings annual growth (%)	0.7%	BCDH Tier 2 v0.2, pg47, section 10.5.1
Accident value ($/veh-km)	$0.07	BCDH Tier 2 v0.2, pg47, section 10.5.1
Accident value annual growth (%)	0.0%	BCDH Tier 2 v0.2, pg47, section 10.5.1
Greenhouse Gas ($/veh-km)	$0.010	BCDH Tier 2 v0.2, pg48, section 10.5.2
Greenhouse Gas annual growth (%)	0.0%	Assumed (Value not specified in BCDH)
Air Quality ($/veh-km)	$0.002	BCDH Tier 2 v0.3, pg42, table 10.1.5 (not specified in v0.2)
Air quality value annual growth (%)	0.0%	Assumed (Value not specified in BCDH)
Annualization factor	300	BCDH Tier 2 v0.2, pg44, section 10.3.3
Value of Time - Non-working (Commuting) $ per hour	$16.13	BCDH Tier 2 v0.2, pg46, section 10.4.2
Value of Time growth (pa)	1.600%	BCDH Tier 2 Draft 0.2, pg46, section 10.4.2
Costs Real or Nominal	Nominal	
Inflation	2.0%	BCDH Tier 2 v0.2, pg22, section 6.2.1

Appraisal Year	Buildup
1	35%
2	70%
3	100%
4	100%
5	100%
6	100%
7	100%
8	100%
9	100%
10	100%