## **APPENDIX 1**

## TRANSIT NETWORK ANALYSIS

The purpose of this appendix is to provide an update on the transit network analysis as it pertains to:

- i. SmartTrack
- ii. Scarborough Subway Extension
- iii. Relief Line

This appendix also sets out the preliminary findings for accessibility modelling and travel demand (ridership) modelling for the same projects. Finally, this appendix describes how the potential network elements will be further tested and refined leading to recommendations about priority transit improvements to be presented to Executive Committee in June and City Council July, 2016.

## 1. TRANSIT NETWORK PLANNING

In large cities around the world, the transit network is a critical piece of transportation infrastructure. As modern cities grow, transit becomes increasingly important as it provides a much more efficient means of providing mobility than an auto-based transportation network.

Transit networks are made up of many individual routes (or lines) that together offer opportunities to travel. With the addition of each new line, the travel opportunities on other lines in the network increase. As a result, the network improves as a system, changing the way people travel by providing more direct routes and faster travel times.

The effectiveness of a transit network can be measured in many ways. Two of the most objective ways to quantify a network's effectiveness are:

- 1. Accessibility: the opportunities for travel provided by the network
- 2. Travel Demand: the number of people who will choose to use the network

The complicated interrelations between different elements of the transit network and the people using the network makes transportation modelling an important part of evaluating and planning transit networks. Models allow "what-if?" scenarios to be tested to assess the impacts of different network configurations on ridership and accessibility.

As a result of the complexity of transit networks and the continually increasing demands for travel in a growing city like Toronto, the process of planning a transit network is iterative. As different parts of the city grow, the need to travel increases and evolves. As planning and engineering work progress on individual transit projects, service characteristics are refined and additional information is gathered which can then be incorporated into the network planning process.

Toronto's City Planning Division takes a broad network-based approach to planning Toronto's rapid transit system, considering both the TTC system and the broader GO Transit regional transit system. Further background to transit network planning can be found in the October 2015 report to Executive Committee on SmartTrack *EX9.1 SmartTrack Status Update*, *Appendix 6 Transit Network Analysis* 

(http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2015.EX9.1).

## 2. THE CITY OF TORONTO'S TRANSIT PLANNING PROCESS

Part of the "Feeling Congested?" initiative, the transportation component of the Official Plan review, is to develop a new rapid transit plan for the City. The resulting rapid transit plan will be part of Toronto's Official Plan, and will provide certainty regarding rapid transit priorities. The rapid transit plan will be subject to review every five years, as are all components of the Official Plan.

At the core of the transit network planning process is the Rapid Transit Evaluation Framework (RTEF), developed in 2013 by City Planning staff with extensive input from the public and stakeholders. The RTEF evaluates the contributions of individual projects to the overall transit network. Further details about "Feeling Congested?" were reported to Planning and Growth Management Committee in *PG35.2 "Feeling Congested?" Recommended Official Plan Amendment for Selected Transportation Policies: Official Plan Comprehensive Review* (http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2014.PG35.2).

Three principles and eight evaluation criteria are the foundation of the RTEF. These principles are:

- *Serving People* how well does the project meet the demand for travel in terms of helping passengers, drivers, goods and services get to where they need to go, and in terms of improving equity or fairness by bringing better transportation services to all parts of the city?
- *Strengthening Places-* how well does the project strengthen and connect neighbourhoods, balance the functions of serving as a travel corridor and a place-building agent, and protect and enhance the quality of the urban environment?
- *Supporting Prosperity* how affordable is the project to build, operate and maintain, how well does it support the city's economic development goals, improve its competitiveness and deliver the greatest ridership/travel volumes at the least cost?

Several of the RTEF criteria are based on measurements of travel demand and accessibility – the outputs from transportation models.

Details about the eight evaluation criteria that comprise the three principles were reported to Planning and Growth Committee in Section 2 of *PG29.6 Update on the "Feeling Congested?" Initiative – A Consultative Approach to Transportation Planning* (http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2013.PG29.6).

The "Feeling Congested?" draft comprehensive transit network in 2013 comprised 25 proposed new transit expansion projects that had been identified by the City, TTC and/or Metrolinx. These projects are shown on Figure 1. More information about each project is found in Attachment 1 of *PG34.12 "Feeling Congested?" – Update on Progress to Date* (http://app.toronto.ca/tmmis/viewAgendaltemHistory.do?item=2014.PG34.12).

A preliminary scoring matrix of the 25 rapid transit projects evaluated as part of the "Feeling Congested?" initiative was included in 2013.PG29.6 Update on the "Feeling Congested?" Initiative - A Consultative Approach to Transportation Planning (http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2013.PG29.6). This evaluation made use of the City's old travel demand model which has since been replaced by the

GTAModel V4.0, newly developed by the University of Toronto for the City.

The preliminary evaluation of projects will be updated based on updated results from transportation models and updated assumptions associated with all projects. The introduction of Regional Express Rail by the Province of Ontario, and the development of SmartTrack on two GO corridors represent the most significant updates to network assumptions. This updated evaluation will form the foundation of the rapid transit plan that will be included in Toronto's Official Plan.



Figure 1: Preliminary Rapid Transit Project Scoring Matrix (Spring 2013)

## 3. EARLY RESULTS FROM THE TRANSIT PLANNING PROCESS

#### **Accessibility Modelling**

The City is using the Connectivity Calculator, developed by Metrolinx in collaboration with Arup Canada Inc, to model transportation accessibility. Transportation accessibility combines mobility (travel time) and proximity (distance to destinations) to quantify the ability to access destinations. Specifically, the Connectivity Calculator calculates the opportunities to reach destinations in a given time, provided by possible transit networks.

Destinations (e.g. jobs) that are accessible from each origin (e.g. home) are added together to provide an average number of destinations that can be reached from each origin. This measure indicates the potential value of a possible transit network. The measure can be refined by considering detailed information about particular destinations (e.g. services offered, types of jobs, etc.) and population segments (e.g. age, education level, etc).

As a first step, City staff have used this model to evaluate the contributions to the network of SmartTrack, the Eglinton West LRT, the Relief Line, the Scarborough Subway Extension and the Scarborough Transit Network including the Eglinton East LRT. Current population and employment data has been used to calculate the number of jobs that would be accessible within 45 minutes if each project was operational today.

Key findings to date include:

- On average, each Toronto resident can currently access around 320 000 jobs
- The addition of currently approved and funded projects would increase the number of jobs that each Toronto resident can access by an average of 14%, and the number of jobs that each resident of a Neighbourhood Improvement Area (NIA) can access by an average of nearly 35%

## SmartTrack

- The addition of SmartTrack could increase the average number of jobs that each Toronto resident can access by up to 17 500, or 5%
- The addition of the Eglinton West LRT (as approved in 2009) would increase accessibility to jobs significantly more than the addition of either the Eglinton or Northern heavy rail corridor if provided at a frequency of 15 minutes
- The proposed SmartTrack stations that would provide the greatest increase in access to jobs are:
  - 1. Spadina
  - 2. Liberty Village
  - 3. Gerrard

## Scarborough Subway Extension

- The addition of the three- or four-stop Scarborough Subway Extension could increase the average number of jobs that each Toronto resident can access by an average of up to 3 500, or 1%
- The McCowan alignment increases the access to jobs the most of any three-stop extension options
  - Compared with the three-stop extension, the four-stop extension would provide access to more than 1000 additional jobs, or increase accessibility to jobs by approximately 45% compared to the three-stop extension
- For residents of NIAs in Scarborough, all three- and four-stop extension options significantly improve access to jobs
- The recommended Scarborough Transit Network (which includes the Eglinton East LRT) improves access to jobs for residents of Scarborough and residents of NIAs in Scarborough significantly more than any of the three- and four-stop extension options alone.

## Relief Line

- The addition of the Relief Line could increase the average number of jobs that each Toronto resident can access by an average of up to 12 500, or 3.5%
- Corridors B and D (connecting to Pape Station) increase accessibility to jobs significantly more than corridors A and C (connecting to Broadview Station)
  - Corridor D (Pape Station to downtown via King/Wellington) increases accessibility to jobs slightly more than Corridor B (Pape Station to downtown via Queen/Richmond)
- Inclusion of a station at Unilever reduces access to existing jobs (because it would increase travel time on the Relief Line between Line 2 and downtown) however it would more than double the number of people who could access jobs located at the Unilever site in the future
  - A Unilever Station on the Relief Line increases the number of people who can access future jobs at the Unilever site by more than 100 000, even if SmartTrack and an extension of the Braodview streetcar also serve the site

# **Travel Demand Modelling**

Over the past year, the City has been working with the University of Toronto to develop a new transit ridership model (GTAModel V4.0) to more accurately estimate future travel demand within the Greater Toronto and Hamilton Area (GTHA). This model uses inputs including population and employment projections to estimate how people will choose to use the transit network in the future.

The new model includes numerous advancements relative to the previous model that make it the best tool available within the GTHA to undertake this analysis. In summary, its greater functionality includes:

- 1. Calibration using the most recent comprehensive region-wide travel behaviour survey data available (i.e. the 2011 Transportation Tomorrow Survey);
- 2. Capability to simulate full day (24 hour) travel demand instead of just the busiest (AM peak) period, given that peak travel mode is often influenced by trips made at other times in the day;
- 3. Improved representation of counter-peak commuter flows;
- 4. Greater flexibility to model alternative fare structures; and
- 5. Introduction of capacity constraints on the transit network.

As a first step, Professor Eric Miller of the University's Transportation Research Institute is using this model to evaluate the network implications of SmartTrack. The final report on these findings will be presented to Executive Committee in May and City Council in July, 2016. Preliminary ridership reports are included in Attachments 1 to 3. Population and employment projections are key inputs to the travel demand model. Attachment 4 provides an overview of the projections that were developed for the current round of transit planning, and which are also being used to support the financial analysis for SmartTrack. Attachment 5 is an interim report on findings to date from the peer review of the City's new travel demand forecasting model and the ridership forecasts for the proposed SmartTrack initiative.

Key findings to date include:

# SmartTrack

- SmartTrack is capable of capturing significant ridership assuming a TTC fare and 5minute service, regardless of the growth scenario or the horizon year. For example, using the base case scenario which assumes heavy rail along Eglinton Avenue, ridership forecasts for 2031 indicate daily boardings ranging from about 283,000 to 321,000. Based on an initial assessment of replacing heavy rail with LRT along Eglinton Avenue, it is expected that the ridership range will be comparable.
- SmartTrack assists in providing congestion relief on the Yonge Subway at the critical point south of Bloor, especially with 5-minute service.

# Scarborough Subway Extension

- The four options modelled are capable of capturing significant ridership. Daily boardings ranges from 115,000 to 147,000 in 2031. Morning peak hour, peak point, peak direction ridership ranges from 13,700 to 17,700.
- The net new riders estimated for all four options range from 7000 to 8280 per day, indicating that all options provide a similar benefit to people in Scarborough from a ridership perspective.

- The options considered would increase ridership on the Yonge Subway south of Bloor by between 800 and 1200.
- The options are capable of capturing significant ridership. Daily boardings range from 115,000 to 147,000 in 2031. Morning peak hour, peak point, peak direction ridership ranges from 13,700 to 17,700.
- Assuming the McCowan3 option, the introduction of SmartTrack would reduce ridership on the subway extension to about 109,800 daily users and 12,600 peak hour, peak point, peak direction riders assuming 15-minute SmartTrack service in 2031. Assuming 5-minute SmartTrack service daily users would be about 88,200 and peak hour, peak direction, peak point ridership would be about 9,800 riders. In either case, the peak point ridership would be comparable or higher than that observed today near the terminal points of existing subway lines, with the exception of the Yonge line in the vicinity of Finch station.

## Relief Line

- The Relief Line is capable of capturing significant ridership ranging from 90,400 to 189,600 daily boardings in 2031, depending on the corridor and whether SmartTrack is included in the transit network
- Relief Line relieves congestion on the Yonge Subway at the critical point south of Bloor. The reduction is larger than that provided by 15-minute SmartTrack service (in the absence of the Relief Line), but less than the reduction provided by 5-minute SmartTrack service (in the absence of the Relief Line).
- The Relief Line appears to bring the projected 2031 Yonge peak hour, peak point ridership to approximately the capacity of the line. The ridership reduction associated with 5-minute SmartTrack service appears to bring the Yonge Subway peak point ridership below the capacity of the line. However, with 15-minute SmartTrack service the Yonge Subway peak point ridership remains above the capacity of the line.
- The combined effect of the Relief Line with SmartTrack at either 15- or 5-minute service reduces Yonge subway southbound volume below the capacity of the line in 2031. However, it appears that by 2041, only the combination of the Relief Line with 5-minute SmartTrack service will bring the projected Yonge peak hour, peak point ridership to approximately the capacity of the line.
- Considering the proposed extension of the Yonge Subway into York Region, it appears that neither the Relief Line nor the 15-minute SmartTrack options by themselves, or in combination with each other, bring the peak point ridership below the capacity of the line in 2031. By itself, the 5-minute SmartTrack service reduces the Yonge Subway ridership to about the capacity of the line. The combination of the Relief Line and 5-minute SmartTrack service together appear to further reduce ridership below capacity in 2031.

However, by 2041, it appears that no combination of the Relief Line and SmartTrack reduces ridership below the capacity of the line.

## **Possible Networks**

Preliminary modelling results, along with preliminary findings from the ongoing project assessments and the latest information provided by Metrolinx about regional network improvements have been used as a foundation for Figure 2 and Figure 3, which set out the possible development of Toronto's rapid transit network over the shorter and longer term.

Figure 2 shows the possible rapid transit network in 6 years. Since the planning horizon for this map is so short, the projects depicted are those which are already underway, including the Toronto-York Spadina Subway Extension, Eglinton Crosstown LRT and Finch West LRT.



Figure 2: Rapid Transit Being Built in the Next 6 Years

Since it takes several years to complete the planning, design and construction stages for major transit projects, a planning horizon needs to extend at least ten years to realistically include projects not already in the project assessment process. As such, Figure 3 uses a 15-year horizon to illustrate a possible transit network that includes the potentially highest priority projects not already underway.

This network is intended to be ambitious but feasible. It reflects emerging findings from the Relief Line Project Assessment, the proposed approach to Scarborough transit expansion, and planning for SmartTrack in terms of the benefits, strategic fit and constructability of various projects. Recognizing that funding for transit project construction is not unlimited, the benefits

of projects must be weighed against their cost and the time it takes to construct them in order to deliver the best network for the people of Toronto.

![](_page_9_Figure_2.jpeg)

Figure 3: Preliminary Recommended Rapid Transit to be Built Within the Next 15 Years

Several of the projects shown on these maps are in very early stages of planning. Although the best information available has been used, it is possible for the maps to change based on the findings of ongoing or future project assessments, or other studies. The iterative nature of the transit network planning process means that the recommended network emerging from the RTEF will continue to evolve as work progresses on each of the projects.

## **Further Refinement**

Staff will continue to refine the possible network in Figure 3 over the coming months, and will present an update report to Executive Committee in June and City Council in July.

Building on the findings from U of T modeling, staff will undertake further modelling work using GTAModel V4.0, and the Connectivity Calculator developed by Metrolinx in collaboration with Arup Canada Inc. This work will further assess the network impacts of transit lines illustrated in Figures 2 and 3, as well as other potential network additions such as the development of the "Missing Link" freight rail corridor and Scarborough Express Rail.

Appropriate sequencing of the range of projects being considered for the transit network will be better understood through this modelling work and will inform the phasing of the possible future transit networks.

It is anticipated that the June update report to City Council will include recommendations to proceed with next steps on a number of different projects. The next steps will vary depending upon the current state of each project.

## 4. INDIVIDUAL TRANSIT PLANNING PROJECTS

In advance of finalizing the rapid transit plan for inclusion in Toronto's Official Plan, the City Planning Division has been proceeding with work on individual transit planning projects which are assumed priorities. The three RTEF principles – Serving People, Strengthening Places, and Supporting Prosperity – guide the City Planning Division's current planning work on SmartTrack, the Scarborough Subway Extension and the Relief Line.

## SmartTrack

The principles and evaluation criteria were used as the basis for assessment of options in the feasibility review of a SmartTrack heavy rail corridor connecting Mount Dennis to the Mississauga Airport Corporate Centre. As a result of that analysis, staff recommend that Council endorse a westerly extension of the Eglinton Crosstown LRT along Eglinton Avenue West rather than a new heavy rail corridor. The results of the analysis were released in January 2016 and are contained in Appendix 3 to this report.

The segment of the Eglinton Crosstown LRT west of Mt. Dennis Station was approved in 2009 as part of the Eglinton Crosstown project. The proponency of this project was transferred to Metronlinx to enable Metrolinx to proceed to construction. As such, Metrolinx has already begun a review of the approved project to determine if there are opportunities to improve the design and operation of the westerly section. City Planning will be partners in this review and will report back to City Council as work proceeds.

The RTEF principles are also guiding the planning analysis for other aspects of the proposed SmartTrack network along the Kitchener and Stouffville GO corridors.

## Scarborough Transit Network

The RTEF principles were used to create the preliminary recommended Scarborough transit network presented in *EX11.5 Scarborough Transit Planning Update* (http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2016.EX11.5) (Figure 4). In creating this network, the principles were used to evaluate options for achieving transit priorities for Scarborough. Namely 1) to support the development of Scarborough Centre as a vibrant urban node and 2) to support the development of complete communities along the avenues and improve local accessibility. Previous work undertaken by the City Planning Division on the Scarborough Subway Extension Project Assessment informed the evaluation of options and creation of the recommended Scarborough transit network.

![](_page_11_Figure_1.jpeg)

Figure 4: 2026 Recommended Rapid Transit network for Scarborough (including high frequency bus corridors)

#### **Relief Line**

Evaluation criteria for use throughout the Relief Line Project Assessment were developed based on the RTEF principles (<u>http://reliefline.ca/the-project/project-materials#FinalCriteria</u>). These criteria have been used to evaluate potential station areas (<u>http://reliefline.ca/pages/psa-results</u>) and determine the recommended corridor - connecting Pape Station to downtown via Queen/Richmond via Queen & Broadview (Figure 5). The draft corridor evaluation will be finalized considering input from stakeholders and the public.

Potential alignments with potential station locations in this corridor have been developed. The evaluation criteria will be used to evaluate the potential alignments and identify a recommended alignment with station locations.

Appendix 1: Transit Network Analysis

![](_page_12_Figure_1.jpeg)

Figure 5 - Relief Line Preferred Corridor