

ATTACHMENT 2

EGLINTON EAST LRT: CONSTRUCTABILITY REVIEW AND ASSESSMENT OF INTERFACE OPTIONS AT KENNEDY STATION

Project Overview

The Eglinton East Light Rail Transit (EELRT) is a proposed 15 kilometre transit line in Scarborough from the terminus of the Eglinton Crosstown LRT (ECLRT) to Malvern Town Centre via the University of Toronto Scarborough Campus (UTSC), and a segment on Sheppard Avenue extending to the terminus of the provincial Scarborough Subway Extension (SSE) and the future planned provincial Sheppard Subway Extension at Sheppard Avenue and McCowan Road. The EELRT will provide a connection to other higher-order transit services, including the ECLRT, Guildwood and Kennedy GO stations and Line 2 (Bloor-Danforth). It will improve transit reliability for residents in eastern Scarborough and support the development of complete communities.

The SSE is a proposed 7.8 kilometre extension of Line 2 from Kennedy Station to Sheppard and McCowan via Scarborough Town Centre. The project is being delivered by Metrolinx as part of the Province's Subway Program. The Advance Tunnel contract was awarded to Strabag Inc. in May 2021 and excavation and construction is currently underway. Metrolinx's Request for Proposals (RFP) for the Stations, Rail, and Systems (SRS) contract is currently in market, with the major design phase of work expected to begin in fall 2022.

The Sheppard Subway Extension is also planned for delivery by the Province and will connect the existing terminus at Don Mills Station on Line 4 (Sheppard) to the terminus of the SSE at Sheppard and McCowan. The 2022 Ontario Budget¹ reaffirmed the Province's commitment to deliver the Sheppard Subway Extension by advancing planning work for the project. City staff continue to work with Metrolinx to plan for convenient integration of the Sheppard Subway Extension and the SSE with the EELRT to improve passenger connection at the future transit hub at Sheppard and McCowan.

¹ <https://budget.ontario.ca/2022/>

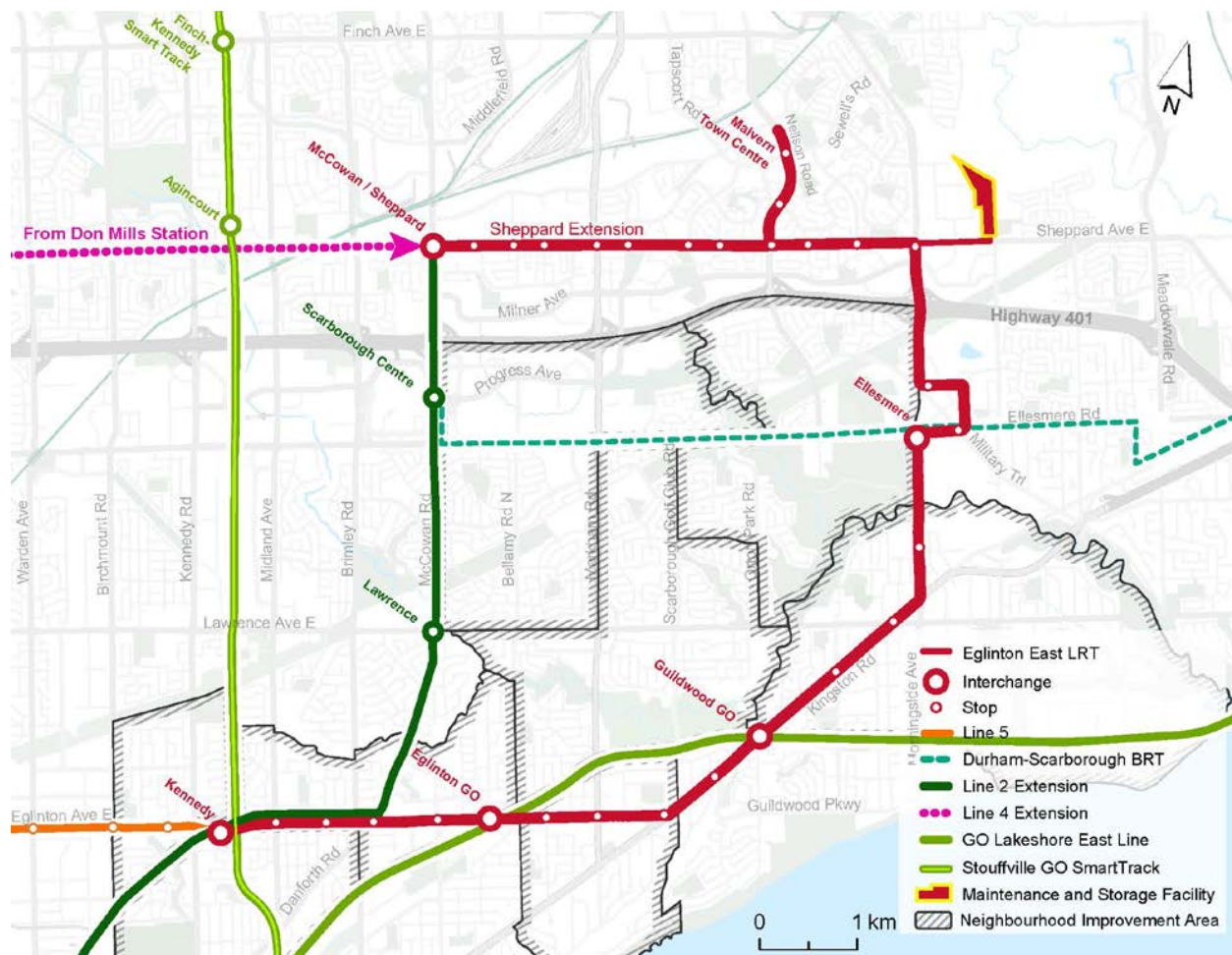


Figure 1. Transit expansion plans in Scarborough

Through-Service Constructability Assessment

In 2020, City Council approved the alignment of the EELRT as an extension of the Metrolinx-owned ECLRT by extending the ECLRT tracks underground at Kennedy Station, which would enable through-service at Kennedy. As part of the work underway to refine the project design to 10%, City staff undertook a constructability assessment of the EELRT through-service alignment. This assessment identified five significant SSE interface issues and challenges with delivering through-service at Kennedy Station due to constraints on Eglinton Avenue East from Kennedy Station to Bimbrok Road. These challenges are noted below.

In February 2022, City Council requested that Metrolinx and the City undertake a constructability exercise to resolve the alignment issues at Kennedy Station. City staff transmitted Council's request to Metrolinx and discussions with Metrolinx on this matter are underway.

- 1 LRT Portal over SSE Bored Tunnel
- 2 Eglinton Ave Bridge Abutment
- 3 SSE & EELRT Box Separation
- 4 EELRT Box and EEB
- 5 Traffic Management and Utility Conflicts

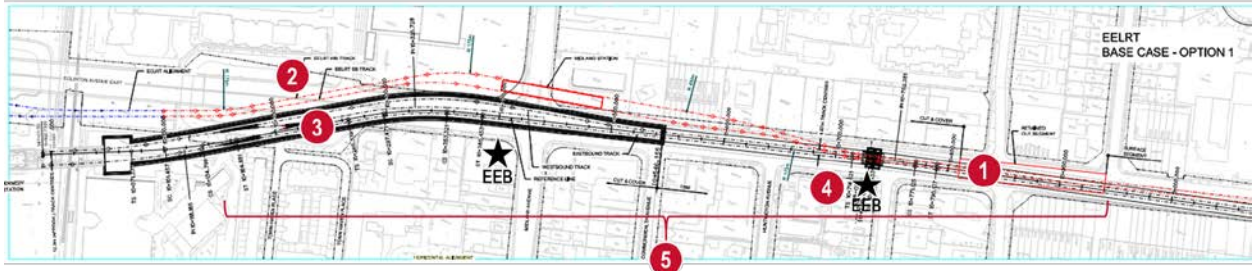


Figure 2. Issues identified through EELRT constructability review

1. EELRT tunnel impacts on SSE bored tunnel integrity

The key constructability challenge for the EELRT through-service concept is that the eastern end of the EELRT tunnel box would be resting directly on top of the SSE bored tunnel with less than 2 metres of vertical separation estimated between the two tunnels. This is a problem because the SSE bored tunnel has not been designed to support the load of the EELRT tunnel and the additional loads and construction disruption caused by the EELRT would negatively impact the integrity of the SSE tunnel. City and Metrolinx staff considered SSE design changes to incorporate structural protections to mitigate this issue, including realigning the SSE to establish greater distance from the EELRT tunnel or completing significant ground improvement and soil stabilization before advance tunnelling for the SSE begins. Metrolinx advised that the cost associated with such changes would be significant, as the Advance Tunnel contract has been awarded and construction is currently underway to prepare for excavation by the Tunnel Boring Machine. Additionally, changes to the tunnel design at this stage would significantly delay completion of the SSE. City staff have been unable to identify a viable solution to this major issue that would maintain the through-service concept.

2. Conflicts between the EELRT cut and cover box extending the EELRT tail tracks and Eglinton Avenue bridge abutment

The north wall of the EELRT tunnel box would likely conflict with the existing Eglinton Avenue bridge abutment footings. Further investigation of the existing footings together with the due diligence work undertaken by Metrolinx in the same area would be required to confirm the extent of the conflict and identify potential mitigations. Requirements for significant structural supports for the bridge abutment are anticipated.

3. Insufficient lateral separation between SSE and EELRT tunnel box structures at Kennedy

The EELRT interface with the EELRT tail tracks at and east of Kennedy Station is severely constrained by the location of the SSE tunnel extending from the Line 2 subway tunnel. Although Metrolinx included contractual obligations in the EELRT

Project Agreement to protect for the future EELRT, planning for the SSE did not include similar obligations.

In order to deliver the Council-approved through-service concept, the EELRT tunnel box would need to extend eastward from the existing ECLRT tail track tunnel at Kennedy Station and curve further north of the proposed SSE tunnel box. A minimum separation distance of 3 metres is required between the EELRT and SSE tunnel boxes according to TTC standards for clearance requirements between underground structures. Failure to meet the TTC clearance requirements would pose safety risks and add significant complexity for EELRT construction. Currently, proximity of the boxes is as little as 1.65 metres at its most constrained point and generally less than 3 metres. Meeting the TTC's minimum separation distance would require significant additional property taking along the north side of Eglinton Avenue. A potential solution would be to add requirements in Metrolinx's SRS contract for the design of SSE tunnel box walls to support future excavation of the EELRT box. Metrolinx advised that this additional requirement can be accommodated in the contract if the City can confirm the design requirement prior to the SRS contract award in fall 2022. This option would require the City to front-end the cost of reinforced tunnel box without a fully developed EELRT design.

4. EELRT tunnel box conflict with SSE emergency exit building

The EELRT tunnel box would be in direct conflict with the below grade portions of the SSE tunnel Emergency Exit Building (EEB-01). Modifications to the SSE design are required to avoid the need for the City to modify the EEB-01 after SSE construction is complete. Metrolinx informed City staff that the necessary changes can likely be made during the design development stage with the SRS ProjectCo beginning in fall 2022, provided that the EELRT alignment is confirmed and design advances on schedule.

5. Traffic management and utilities conflicts

Utility relocation for the SSE has not accounted for the future EELRT alignment. City staff are reviewing utility relocations planned by Metrolinx to confirm options to protect for the future EELRT alignment, avoid the need to undertake costly utility relocations shortly after SSE work is complete, and to minimize the resulting traffic disruption and community impacts. Metrolinx has advised that utility relocations are already underway as part of the early works and the Advanced Tunnel contract, therefore there is limited opportunity to coordinate utility relocations. Subject to City Council's approval of the recommendations in this report, City staff will work with Metrolinx to plan for all remaining utility relocations based on the updated EELRT alignment.

Additional Challenges

Given the in-progress status of SSE procurement and delivery, even minimal changes to the SSE design would result in a significant increase in cost, schedule, and community impacts. The construction of the Kennedy portions of the SSE are anticipated to extend to 2030. This implies that for the through-service concept, EELRT

construction in the vicinity of this area cannot begin until 2030 and will result in an opening day in the mid-2030s at the earliest. This also roughly translates to a 12-year period of continuous construction along the portion of Eglinton Avenue east of Kennedy Station.

Kennedy Station Distinct-Service Assessment

As part of the through-service constructability assessment process, City staff conducted analysis that identified a distinct-service concept as a viable alternative that mitigates the significant SSE tunnel interface challenges while providing significant benefits across the alignment. As part of these efforts, a focused technical exercise was undertaken to identify a preferred distinct-service alignment connection to Kennedy Station. A long list, comprising of elevated and at-grade (surface) options were considered and reviewed by City staff, in collaboration with the TTC, and with input from the Metrolinx SSE delivery team. Some of the design concepts reviewed and assessed in 2020 and presented in *EX19.5 Update on the City's Transit Expansion Projects - Fourth Quarter 2020* were re-assessed and refined in light of the updated project context and further technical constructability analysis. Through technical workshops, a long list of options was screened, refined, and evaluated to a short list of options and contingency options, and ultimately leading to the identification of one “representative” option for a surface (i.e. at-grade) alignment interface and elevated alignment interface at Kennedy Station for a more detailed comparative assessment.

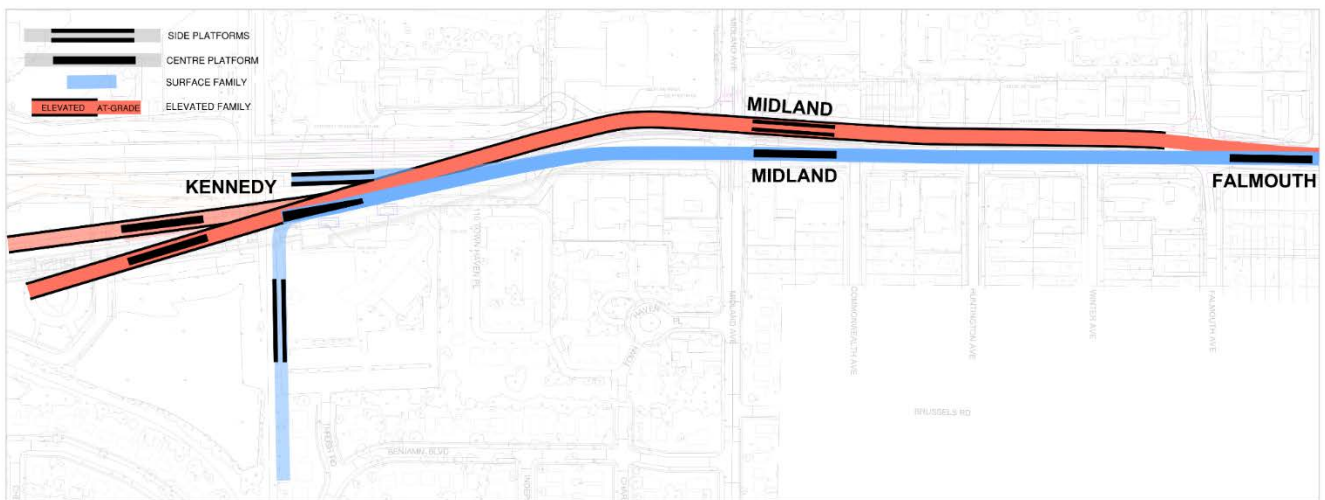


Figure 3. Alternatives for surface and elevated concept options for EELRT connection at Kennedy Station (Falmouth to Kennedy)

Table 1. Summary of alternatives identification process

Family	Option	Status	Justification
Elevated	Elevated Option 1 (EO1) – Platform Skewed over Kennedy Station	Representative alignment for elevated family	<ul style="list-style-type: none"> • Shorter transfer time than EO2 • Most space efficient at Kennedy
Elevated	EO2 –Platform North of and Parallel to Kennedy Station	Contingency*	<ul style="list-style-type: none"> • Increased interface risk with ECLRT tunnel connection and utility conflicts • Permanent reduction to bus terminal capacity
Surface	Surface Option 1 (SO1) – Side platforms south of new GO building	Superseded	<ul style="list-style-type: none"> • Superseded by SO6 (centre platform)
Surface	SO2 –Side platforms north of new GO building	Contingency*	<ul style="list-style-type: none"> • Feasible but requires significant modification to GO building, high interface risk • Higher risk construction adjacent to Eglinton overpass piers and abutment
Surface	SO3 – Parallel to GO tracks, side platforms, tail tracks	Not carried forward	<ul style="list-style-type: none"> • Requires demolition of arena – uncommitted project • Longest transfer times to Kennedy Station • Impact to residential properties for tail tracks
Surface	SO4 – Parallel to GO tracks, side platforms, third storage track	Not carried forward	<ul style="list-style-type: none"> • Requires demolition of arena – uncommitted project • Longest transfer times to Kennedy Station

Family	Option	Status	Justification
Surface	SO6 – Centre platform south of new GO building	Representative alignment for surface family	<ul style="list-style-type: none"> • Shortest transfer times among surface family • Centre platform preferred for customer experience, not possible for other options • Reduced interface with GO building compared to SO2

**Options in the contingency category are deemed to be feasible, but less desirable overall with the option to incorporate some of the desirable features of each design in the next phase.*

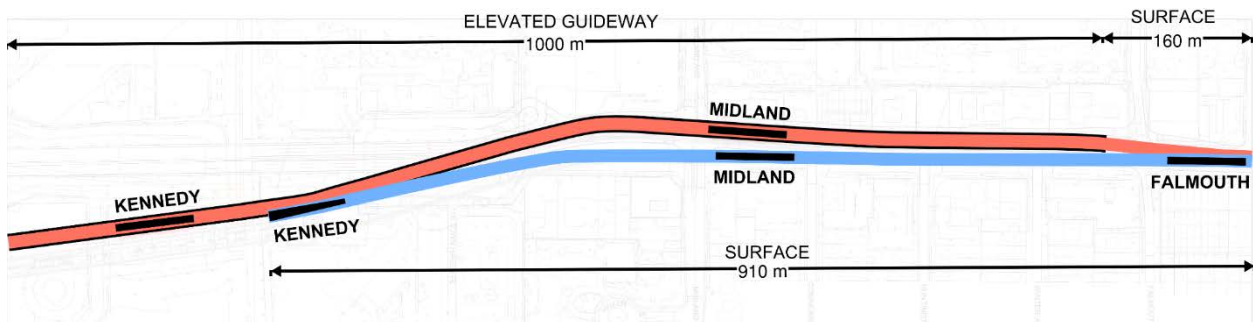


Figure 4. Representative Options for EELRT connection at Kennedy Station

Table 2. Representative Option Features (Kennedy Station to Falmouth)

Feature	Surface Option (SO6)	Elevated Option (EO1)
Corridor length	910 m	1160 m
Length of at-grade portion	910 m	160 m
Length of elevated guideway	NA	1000 m
Secure overnight storage capacity	NA	2 trains
Estimated Passenger Travel Time – Falmouth to/from Kennedy (average one-way)	204 seconds	180 seconds
Estimated Construction Duration	3-4 years (e.g. 2030 to 2033)	6-7 years (e.g. 2030 to 2036)
Eglinton right-of-way width	41 – 48 m	51 – 68 m
Weighted average transfer time to all modes and street	169 seconds	164 seconds

Representative Surface Kennedy Interface Concept

The representative surface concept illustrated below would run at-grade down the middle of Eglinton Avenue East until approximately 50 metres west of Midland Avenue. At this point, the guideway would pass through a new signalized intersection to the south of the right-of-way and the overpass bridge. The line would terminate at-grade with a centre platform immediately south of the new Kennedy GO building. A storage track would be provided in the median of Eglinton Avenue between Midland and Falmouth platforms.

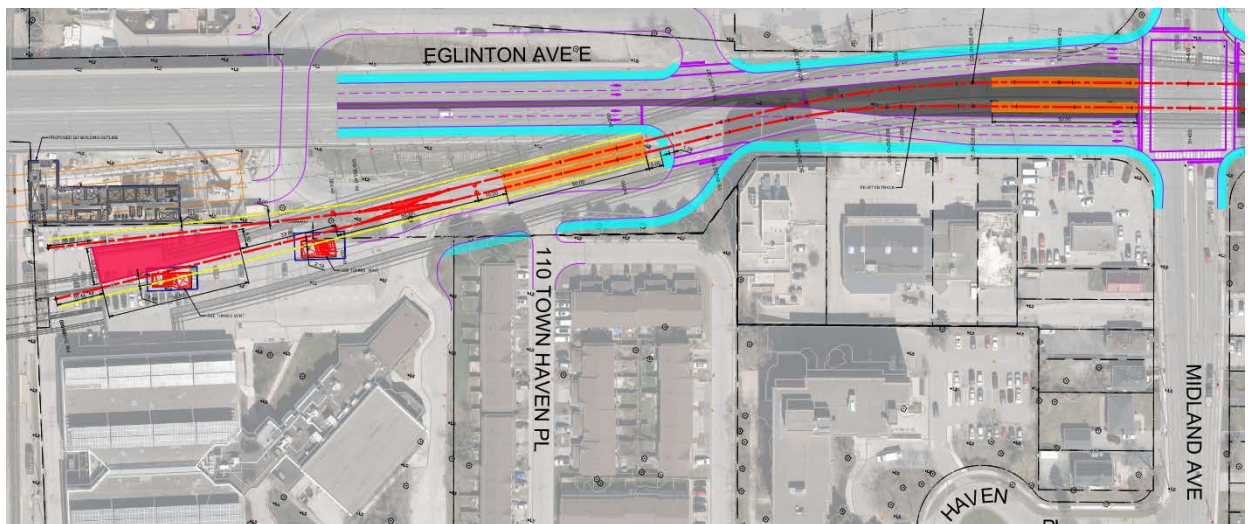


Figure 5. Representative at-grade option (SO6) from Kennedy Station to Midland Ave

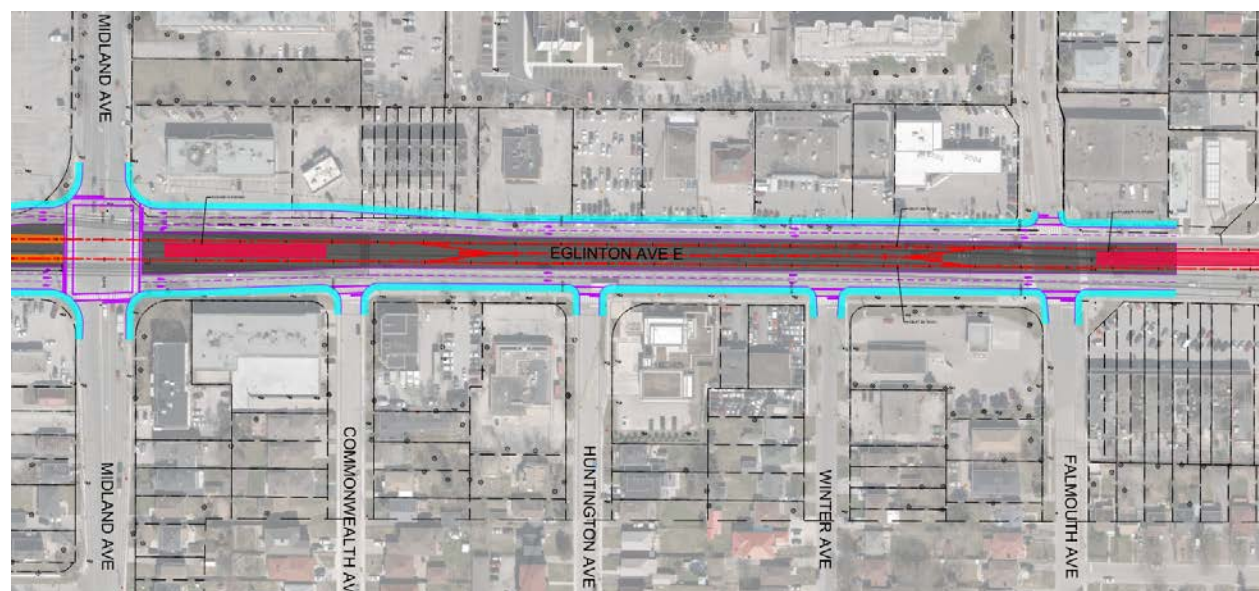
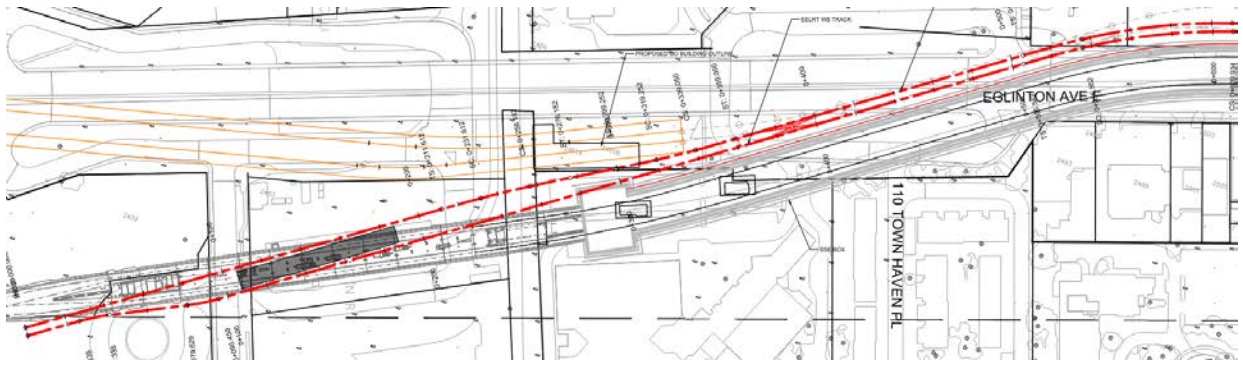


Figure 6. Representative at-grade option (SO6) from Midland Ave to Falmouth Ave

Representative Elevated Kennedy Interface Concept

In the representative elevated concept, the EELRT surface guideway would transition to an elevated structure of approximately 1 kilometre in length from just west of Falmouth Avenue to Kennedy Station. The grade change and curve eliminates the possibility of a station at Falmouth. Due to an exclusion zone above the SSE tunnel, the guideway must be shifted north, impacting an estimated 21 properties. The structure would rise to approximately 10-12 metres as it approaches Midland Avenue, where a station would be provided east of the intersection within the northeast corner property. West of Midland, the elevated guideway would begin to transition to the south side of Eglinton Avenue and cross the GO rail corridor. The terminal station would divide the existing Kennedy Station structure at a slight skew angle. This option would require the demolition and reconstruction of the above-grade portions of the SRT station. The guideway would extend approximately 100 metres further west to allow for end of line train storage. Eglinton Avenue would be realigned and shifted to the north to accommodate the elevated guideway in the median.



Kennedy Station Interface (EO1) Concept Plan

Scale –
Vertical and
Horizontal
10m
50m



Kennedy to Falmouth (EO1) Concept Profile



East of Kennedy to Falmouth (EO1) Concept Plan

Figure 7. Representative elevated option from Kennedy Station to East of Falmouth Avenue

The representative at-grade option and elevated option were evaluated according to the City’s Rapid Transit Evaluation Framework (RTEF) with an added lens of evaluation using a Metrolinx Business Case framework (e.g. Strategic, Economic, Financial, and Deliverability). In summary, the at-grade option was selected namely because it offers numerous benefits over the elevated option, including cost savings, a shorter construction duration (i.e. half that of the elevated option), avoidance of 21 property takings on Eglinton Avenue, minimal impact to Kennedy Station users during construction, opportunity to coordinate with SSE to limit rework and construction, and minimal visual impact adjacent to residential properties. With respect to costs, the at-grade interface at Kennedy Station could result in savings of up to \$650 million (2022\$) in property and construction related costs based on initial Class 5 level estimates

compared to the representative elevated option. In addition, the preliminary economic case assessment showed that the representative at-grade option at Kennedy Station could result in approximately \$230 million to \$280 million less in total economic (dis)benefit (in 2020\$ and 2022\$) over the representative elevated option over construction and lifecycle operations of the line. This is mainly due to greater construction period multi-modal travel time delays and GHG emissions associated with the elevated option.

Through a preliminary travel time simulation completed, the representative surface option was shown to have approximately 30 seconds longer transit user travel time for EELRT over the representative elevated option². This is primarily due to needing to travel through signalized intersections for the segment between Falmouth Avenue and Kennedy Station. The average transfer time at Kennedy to/from other services and the street was found to be effectively equal for both the representative surface option and elevated option. Economic (dis)benefits for this assessment are outlined in Table 3 and subject to further refinement through completion of an initial business case for a distinct-service concept.

Recognizing the marginally greater overall travel time (disbenefit) for the surface concept, City staff will continue to refine the at-grade Kennedy interface in the context of long term planning for the Kennedy Mobility Hub, Eglinton Avenue East and with the overall key objective of enhancing the transit customer experience. Refinement of the at-grade connection will also include work to confirm plans for a pocket track that is proposed between the Midland and Falmouth stops to provide train storage for operational flexibility. This is required as the representative at-grade option does not enable end of line storage for the EELRT trains.

² Travel time was evaluated using OpenTrack (rail operations simulation software), which considers the interplay between rail alignment (distance, curvature, gradient, speed restrictions) and vehicle characteristics (acceleration, deceleration, tractive effort curve, rolling resistance). For this analysis, nominal specifications from the Alstom Citadis Spirit LRV were used (which are typical for urban low floor LRVs). A 90% performance factor was used to account for potential driver performance variation. For the surface option, traffic delay was added based on the conceptual signal timing values, assumed no significant grade, coordination between the two signals (at Midland and at the terminal entry, both CL = 120s), and the anticipated average delays (excluding time spent at WB nearside Midland stop).

Table 3. Comparative Assessment of at-grade and elevated interface options at Kennedy Station

Criteria	At-grade Kennedy Station Interface	Elevated Kennedy Station Interface
Strategic	<ul style="list-style-type: none"> • Shortest construction duration • Opportunity to coordinate with SSE reinstatement design to limit rework and construction impacts • Avoids full property takings on Eglinton • Minimal impact to Kennedy Station users • Minimal visual impact • 51 parking spaces lost at arena • Minimal impact on future redevelopment opportunities 	<ul style="list-style-type: none"> • Longest construction period (double that of at-grade) • Fewer opportunities to coordinate with SSE to reduce impacts • Requires 21 property takings along Eglinton, displacing 8 businesses and 77 employees • 6+ year Kennedy Station reconstruction will impact bus passengers • Greater visual impact and structure adjacent to residential • 11 parking spaces lost at arena • 10-15% reduction in development potential south of overpass, 34% reduction in properties east of overpass
Economic	Approximately \$240 Million (dis)benefit*	Approximately \$470 – \$520 Million (dis)benefit*
Financial	<p>Construction: Estimated \$170 Million (includes \$30 Million property costs)</p> <p>Maintenance cost drivers: shorter route, no grade change, no elevated structure</p> <p>Operations cost drivers: Increased deadhead</p>	<p>Construction: Estimated \$820 Million (includes \$140 Million property costs)</p> <p>Maintenance cost drivers: longer route, grade change, elevated structure</p> <p>Operations cost drivers: Decreased deadhead</p>

Criteria	At-grade Kennedy Station Interface	Elevated Kennedy Station Interface
Deliverability	<ul style="list-style-type: none"> • Minor encroachment into 11 provincially owned properties, some flexibility to reduce/avoid • Critical path segment (terminus) can begin in 2026; reduced exposure to SSE delays • No impact to existing Kennedy Station operations • Requires shifting SSE vents, emergency exits; additional due diligence for guideway over tunnel 	<ul style="list-style-type: none"> • Significant land requirements from 11 provincially owned properties, no alternatives • Critical path segments cannot begin until after 2030; high exposure to SSE delays • Complex construction phasing in reconstruction of Kennedy Station while maintaining station operations • Avoids need to shift SSE vents and emergency exits; additional due diligence where elevated structure runs adjacent to tunnel
Operations	<ul style="list-style-type: none"> • Lack of secure end of line storage reduces operational flexibility during service disruptions • At-grade operation increases risks of conflicts with road users 	<ul style="list-style-type: none"> • Secure end of line storage provided via tail tracks improving operational resilience • Elevated operation reduces risk of conflicts with road users

*Economic (dis)benefits accounts for (1) passenger travel time savings for 60-year lifecycle of the project, (2) multi-modal travel time savings during the construction phase, and (3) greenhouse gas emissions associated with construction and operation of the line.