

2. ANALYSIS OF ALIGNMENT ALTERNATIVES TO TIE INTO TTC'S PREFERRED ALIGNMENT

This section describes the analysis and evaluation of the alignment alternatives available to link York Region's preferred subway alignment across Highway 407 to the preferred alignment at Steeles Avenue identified by the TTC's EA study.

2.1 CONSIDERATIONS FOR DEVELOPMENT OF ALIGNMENT ALTERNATIVES

Key requirements that were identified for consideration in the development of VNSL alignment alternatives to tie into the TTC's preferred alignment at Steeles Ave. are discussed below.

1) Stations

A primary requirement of the VNSL alignment is that it must connect three stations along the extension:

- Vaughan Corporate Centre Station: This is the preferred northern terminus of the subway extension. It provides a connection to the core of the Vaughan Corporate Centre (VCC) and a linkage to the York Region Transit (YRT) local and BRT (Viva) bus services.
- Hwy 407 Station: This station provides a future connection to the MTO Transitway (subject of a future EA study), a GO Transit and YRT transit transfer facility and a park-and-ride facility.
- Steeles West Station: This station at the southern end of the VNSL is the link to the TTC network. The preferred concept is discussed and described in the TTC Spadina Subway Extension EA Report.

2) Triple Track

Since the Spadina Subway will extend to Highway 7, TTC requested the addition of a triple track arrangement in the vicinity of the Steeles West Station. The triple track structure allows trains to reverse direction at the station in order to operate different train headways north and south of the station. The triple track also provides storage opportunity in cases of emergency. The structure requires a tangent section of track and preferably, should be constructed using "cut and cover" construction methods. There is limited opportunity to accommodate a tangent section of triple track in the vicinity of the Steeles West station due to the proximity of building structures both north and south of Steeles Avenue. It is proposed to accommodate the Triple Track Structure between the existing York University Sports building south of Steeles Avenue and the future UPS expansion building on the north side. The triple track location and arrangement will be defined during the design phase.

3) Hydro Corridor

The alignment that follows a tangent north from the TTC's proposed Steeles West Station crosses diagonally under the Hydro Corridor which consists of two 500 kV and one 230 kV line. There is a V75 high-voltage Hydro Tower located approximately 100 meters north of the TTC's Triple Track Structure, which has a 14 metre deep foundation. North of the 75V corner tower, there are several other towers with shallower foundations fluctuating between 5 and 8 metres in depth according to the available information. Hydro One, in an August 30, 2006 letter, indicated that any impact to the Corridor should be avoided if possible.

4) UPS Facility

There is a large United Parcel Service (UPS) facility located at 2900 Steeles Ave W – the north-east quadrant of the Steeles Ave. and Jane St. intersection. UPS has submitted plans to expand their facility within the next few years. Since the VNSL subway is expected to be constructed after the new UPS facility is built, it will not be possible to use cut and cover subway construction methods under their future building expansion plans.

5) Black Creek and the Black Creek Flood Plain

All feasible alignments will require tunnelling under Black Creek. TRCA has stated that tunnelling may be feasible as long as proper construction methods and de-watering techniques are used. The cut-and-cover station should be located out of the fill regulation limit if possible, however, under extremely controlled conditions, TRCA may accept temporary excavation and backfill and reinstatement of small areas within the fill regulation limits, subject to their prior approval; nevertheless, TRCA does not support at grade construction of facilities within the flood plain; consequently at grade facilities such as park and ride/passenger pick-up/drop-off areas and bus terminals are to be located outside the estimated flood plain.

6) MTO 407 Transitway

The Ministry of Transportation (MTO) is in the early planning stages for the 407 Transitway. The Transitway Property Protection Study provided a conceptual alignment and identified recommended station locations. One of the main stations identified in this study is located in the same vicinity as the 407 VNSL subway station, and is intended to support coordinated inter-modal services. The VNSL alignment options developed in this study must assure the physical and operational integration of both facilities.

7) 407 ETR Right-of-Way

Due to both safety and legal concerns, the 407 Electronic Toll Road (ETR) opposes the construction of any subway infrastructure on the Highway 407 right-of-way (ROW). One of the concerns is the presence of ventilation shafts and/or emergency exits within the ROW. Should an emergency

require evacuation, this could result in people and emergency services having to be within the ROW, which presents a safety concern.

407 ETR is also concerned with the potential for subway construction activities disrupting the traffic safety and operation of the Highway 407 and Jane Street ramps. As a result, tunnelling activity is feasible but cut-and-cover construction is not acceptable within 407 ETR jurisdiction.

8) VCC Official Plan Easement

All alignment alternatives **must respect** the 23 metre easement set out in the City of Vaughan's Official Plan Amendment for the area north of Highway 407.

2.2 ALIGNMENT DESIGN CRITERIA

Fundamental design criteria (related to both track and station requirements) employed in the development of each alignment alternative are based on the Toronto Transit Commission's (TTC) Design Manual. A summary of the horizontal design criteria is presented in Table 2-1 below.

Table 2-1: Summary Of Subway Geometric Design Criteria

Horizontal Alignment		
➤ design unbalanced speed		80 Km/h
➤ superelevation		100 mm
➤ minimum spiral length		70 m
➤ absolute minimum horizontal curve radius (used only with TTC approval in special circumstances)		300 m
➤ desired minimum horizontal curve radius		600 m
➤ minimum length of circular curve		23 m
Vertical Alignment		
➤ maximum gradient of main-line track		± 3.5%
➤ minimum gradient of main-line track (for drainage purposes)		± 0.3%
➤ gradient through stations		± 0.3%
➤ minimum length of constant profile grade		150 m.
➤ tunnel diameter	inside	5.2 m
	outside	5.65 m
➤ minimum depth of cover:	top of box structure to grade	3.0 m
	top of station structure to grade	3.0 m
	top of tunnel to grade	1.5-2 tunnel dia.
		~ 8 m

2.3 DESCRIPTION OF ALIGNMENT ALTERNATIVES

2.3.1 Horizontal Alignment Options

Responding to the alignment constraints and requirements, and based on the TTC horizontal and vertical design criteria listed above, several alternatives were investigated from which four alignments were selected for further consideration. These are described below and shown in Figure 2-1.

Alignment 1

This alignment begins at the north end of the Triple Track Structure and supports the required design speed of 80km/h. The proposed Hwy 407 Station ends right at the Black Creek fill regulation area border. As a result it may require a slight temporary excavation and backfill within the fill regulation limits (i.e. the southeast corner of the station) with prior approval of TRCA. This alignment option has no affect on the Hwy 407 ramps but would require tunnelling under one 500kV Hydro Tower with a relatively shallow foundation.

Alignment 2

This alignment begins at the north end of the Triple Track Structure and again supports a design speed of 80km/h. The proposed Hwy 407 Station has no effect on Black Creek; however the station would have to be under two Hwy 407 ramps. To avoid any surface openings within 407 ETR jurisdiction, the emergency exit and ventilation shafts would be routed out of the 407 ROW through underground passageway and ducts respectively, feasible but costly. This option would also require diversions that would disrupt traffic on the ramps during construction. Tunnelling near or under a Hydro tower is also required.

Alignment 3

This alignment begins at the north end of the Triple Track Structure and supports a design speed of 80km/h. Approximately 50% of the proposed Hwy 407 Station is located within the Black Creek fill regulation area. This alternative also impacts the N-E Hwy 407 ramp and has potential impacts to Jane street southbound traffic during construction. Tunnelling near or under a Hydro Tower is required.

Alignment 4

This shortest alignment begins at the north end of the Triple Track Structure shown in the TTC EA and also supports a design speed of 80km/h. The proposed Hwy 407 Station has a substantial effect on Black Creek as

almost the entire station is inside the Creek's fill regulation area. Although this alternative has no impacts to the Hwy 407 ramps, it has a severe impact to Jane Street traffic during construction (as the proposed station crosses all lanes). Tunnelling near or under a Hydro tower is also required.

2.3.2 Vertical Alignment Options

The feasibility of vertical alignments (profiles) is governed by the relatively low maximum gradient for subway technology (3.5%), the maximum gradient at stations (0.3%) and the relatively short distance between the physical elements such as roads, railway lines and creeks that the alignment profile has to clear vertically. Both elevated and underground options were analyzed as well as combinations thereof. The analysis findings are summarized below.

2.3.2.1 Elevated Options

As shown on Figure 2-2, using the TTC EA's Steeles West Station track elevation as a starting point at the south end, a 3.5% grade to achieve the required clearance over CN Rail's Halton Subdivision tracks precludes insertion of a third track north of Steeles West Station for short-turning trains. Also, the rapidly rising tunnel would surface on privately-owned property south of the Hydro right-of-way. Proceeding north, the elevation required over CN tracks places the 407 Station more than 12m above grade in order to provide the required clearance over the N-W ramp on the north side of Hwy 407. After crossing the ramp, the profile grade to reach the desired elevation for an underground station at Hwy 7 would conflict with the existing Interchange Way grade and would require the Hwy 7 Station to be moved to the north side of the highway. Also, the turnback crossover would have to be moved to the less desirable location north of the station platform.

Generally, while feasible, the significant negative effects on property, Hydro One transmission lines and towers, Interchange Way and subway and station operations make this option unacceptable.

A combination of underground and elevated profile, also shown on Figure 2-2, accommodates the crossover and storage tracks but conflicts with the existing Jane Street grade after passing under CN Rail, precludes a station south of Hwy 407 and would have the same adverse impacts on Interchange Way and the Hwy 7 Station described above for the fully elevated option.

2.3.2.2 Underground Options

Given that the elevated options described above are not acceptable, the only possible vertical alignment is an entirely underground option which

provides the desirable minimum vertical clearances to foundations and Black Creek. These vertical constraints are applicable to, and affect all horizontal alignment alternatives in a similar manner. As such, they do not influence the alignment selection, but only dictate the profile of the preferred option. This profile is shown on Figure 2 - 3

2.4 ASSESSMENT OF ALIGNMENT ALTERNATIVES

The subway alignments identified above were assessed and a comparative evaluation carried out based on the criteria tabulated below.

Table 1: Evaluation Criteria

Factor	Sub-factors
Transportation Design	<ol style="list-style-type: none"> 1. Meets Horizontal alignment Design criteria 2. Meets Vertical alignment Design Criteria
Transportation Services	<ol style="list-style-type: none"> 1. Connection to future 407 Transitway 2. Service to the Vaughan Corporate Centre 3. Overall accessibility and station location 4. Travel time 5. Commuter parking opportunities 6. Possible extension of service beyond the Vaughan Corporate Centre 7. Integration with local bus service
Social Environment	<ol style="list-style-type: none"> 1. Effects on existing residents, businesses 2. Displacement of jobs/homes/businesses 3. Noise and vibration 4. Effects on the Beechwood Cemetery
Natural Environment	<ol style="list-style-type: none"> 1. Loss of/disruption to the natural environment 2. Restriction of access to conservation and recreation lands
Cost Considerations	<ol style="list-style-type: none"> 1. Length of alignment (measured from York Transit Terminal Station to VCC station) 2. Mitigation of effect on Hydro One facilities 3. Mitigation of effect on 407 facilities 4. Mitigation of effect on Black Creek 5. Mitigation of effect on existing roads/structures

2.4.1 Alternatives Evaluation

The alignment evaluation findings are presented in the table below.

Table 2.4.1: Alternatives Evaluation

Most Preferred ● ● ● ○ Least Preferred

	Alternative 1 – Preferred Alignment	Alternative 2	Alternative 3	Alternative 4
Transportation Design	Alignment complies with geometric and operational standards. ●	Alignment complies with geometric and operational standards. ●	Alignment complies with geometric and operational standards. ●	Alignment complies with geometric and operational standards. ●
Transportation Services	Allows physical and operational integration of 407 Subway Station with MTO Transitway Station. ●	Allows physical and operational integration of 407 Subway Station with MTO Transitway Station. ●	Allows physical and operational integration of 407 Subway Station with MTO Transitway Station. ●	Allows physical and operational integration of 407 Subway Station with MTO Transitway Station. ●
	Allows convenient passenger access to 407 subway station. ●	Passenger access to 407 subway station confined to south end. ○	Passenger access to 407 subway station constrained by proximity to Black Creek. ○	Passenger access to 407 subway station constrained by proximity to Black Creek ○
Social Environment	407 Station mostly on ORC property. ●	2/3 of the 407 Station on property under 407 ETR jurisdiction. ○	1/4 of the 407 Station on property under 407 ETR jurisdiction. ●	407 Station mostly on ORC property. ●
	Jane St. and Hwy 407 interchange ramp diversion avoided. ●	Two Hwy 407 interchange ramps affected during construction ○	One Hwy 407 interchange ramp affected during construction. ○	Hwy 407 interchange ramp diversion avoided. Requires diversion of Jane St. traffic during construction. ○
Natural Environment	Potential for a limited temporary excavation and backfill within the Black Creek fill regulation limits. (i.e. the southeast corner of the station). ●	Only minor impact to Black Creek due to access road construction. ●	50% of the Station within Black Creek fill regulation limits ○	Almost all of the Station within Black Creek fill regulation limits ○
Cost Considerations	Mitigation to permit tunneling under one 500KV Hydro tower will increase construction cost. ●	Mitigation to permit tunneling under one 500KV Hydro tower will increase construction cost. Costly ventilation shaft and emergency corridor to avoid any openings within 407 ETR easement. Major ramp diversions will further increase cost. ○	Mitigation to permit tunneling under one 500KV Hydro tower will increase construction cost. Temporary works to protect Black Creek and divert interchange ramp will add to 407 station construction cost. ○	Mitigation to permit tunneling under one 230 kV Hydro tower will increase construction cost. Major temporary works to protect Black Creek and divert Jane Street traffic will add to 407 station construction cost. ○

Note: Criteria for which all alternatives scored identically, have not been included in this table.

The selection of the preferred route focussed on determining the alternative that minimizes effects on major stakeholders such as TRCA, 407 ETR and Hydro One, while complying with TTC geometric and operational standards, and reducing traffic interference during construction. Note that all proposed Hwy 7 station locations provided connectivity to the Hwy 407/MTO Transitway.

Summary of Evaluation Results

Alignment 1 was selected as the preferred alternative for the following reasons:

- Effects on the 407 facilities and right-of-way are minimized due to deep tunnelling beneath the roadway and ramps;
- Both construction and operational effects on the Back Creek watercourse can be minimized and mitigated;
- Temporary disruption of traffic during construction is minimized as roadworks are confined to construction of a new signalized intersection and a right-in/right-out access to parking for the 407 Station;
- While tunnelling beneath one Hydro tower is unavoidable for all options, the tower foundation affected by Alternative 1 is the shallowest permitting the greatest cover over the subway tunnels;
- Complies with TTC geometric and operational standards, and presents minimum traffic interference during construction.