

## 4.3 Implementation

Implementation aspects discussed in this section are construction methods, duration of major construction activities, project costs, construction staging and effects, and commissioning.

### 4.3.1 Construction Methods

A variety of construction methods were considered as part of this study. The following is a discussion of the various types of construction to be employed along the Transit Project for both the subway running structure and at stations.

As illustrated in Exhibit 4-19, the following construction methods are anticipated as part of the Transit Project.

#### 4.3.1.1 Tunnelling

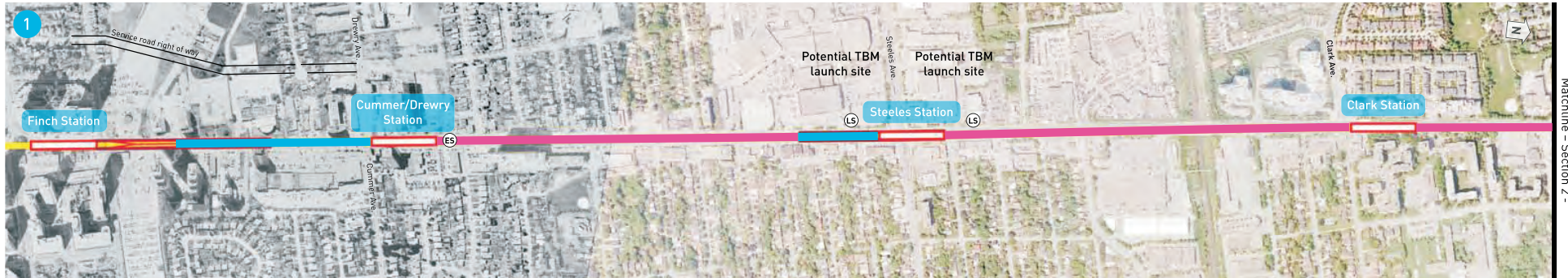
Tunnelling uses a large machine, usually built for the specific project, to excavate a tunnel and handle the excavated material, as well as place the initial tunnel lining, in a continuous, highly automated process. The front end of the machine consists of a circular cutting face that excavates the soil and pulls it into its round shell. The amount of material excavated using a Tunnel Boring Machine (TBM) is less than half that required for cut-and-cover construction. Tunnelling also minimizes disruption to traffic and buildings. A twin-bored tunnelling method is proposed for the entire running structure from Finch Station to the Richmond Hill Centre Station, with the exception of the section between the existing Finch Station tail tracks and Cummer/Drewry Station and the approaches to the East Don River bridge. Earth Pressure Balance (EPB) tunnelling methodology maintains a constant pressure along the cutting face through the use of a continuous injection of a slurry mixture. EPB reduces construction related settlement above the tunnel and minimizes the amount of ground water that enters into the construction area.

##### 4.3.1.1.1 Tunnel Boring Machine Launch and Removal

The tunnel boring machine requires both a launch site and a removal site. The machine with its trailing gear for conveyor belts and line assembly may occupy a length of about 70 m, and it requires an initial open cut excavation for it to be mobilized. Once tunnelling commences, the contractor will occupy the launch site for soil removal and tunnel liner insertion until the tunnel section is complete.

During this Transit Project Assessment Process, preliminary discussions were held with the affected local landowners about possible TBM launch and removal sites. For the purposes of determining the potential environmental effects of the Transit Project, the following approach was assumed:

While significant lengths of the subway extension will be tunnelled, the construction of subway stations and special track work structure is done using the cut and cover method.



- Legend**
- Subway station
  - Cut and cover
  - Tunnelling
  - Bridge construction
  - Tail tracks
  - LS Launch shaft
  - ES Exit shaft

1. Richmond Hill Centre Station and surrounding area would provide sufficient space for the southbound launch of the TBM and as well as storage of tunnel liners and other tunnelling materials and equipment;
2. Likewise, existing surface parking in the southwest quadrant of the Yonge Street / Steeles Avenue intersection could also provide sufficient space for the southbound launch of the TBM and storage of tunnel liners; and other tunnelling materials and equipment;
3. Cut-and-cover section at each end of the proposed East Don River Bridge. This area would be used as an extraction area to remove the TBM machines.
4. Cummer / Drewry Station could be used to remove the TBM.

Detailed research, analysis and design are required to confirm the tunnelling sequence as well as locations for storage of tunnel liners and other tunnelling materials and equipment. This work will be conducted during the detailed design phase of the Transit Project.

#### *4.3.1.1.2 Tunnel Boring Machine Operations and Maintenance*

The TBM is typically operated on two shifts per day advancing at a rate of approximately 15 m a day. Regular maintenance of the TBM will be required. Depending on the type of soil encountered, maintenance may vary across different depths and stages of construction. Stations and EEB's can serve as maintenance shafts, however the final operations and maintenance sequence will be determined during design and construction planning.

#### *4.3.1.1.3 Installation of Tunnel Liners and Grouting*

The machine has equipment to assemble and place a tunnel liner ring immediately behind its shell tailpiece as it advances. In soft ground, the machine advances by means of thrusting jacks reacting against the tunnel lining just placed. This structure is assembled immediately after the TBM shield advances and it is placed tightly against the excavated soil surface. Any resulting annular space between the soil surface and the tunnel liner is then backfilled with grout.

#### *4.3.1.1.4 Building Underpinning*

Building underpinning is used when structural reinforcement may be required for tunnel sections under or adjacent to a specific building. Depending on the depth/type of the foundation and the depth of the tunnel, building underpinning may be required for several properties. In this process, temporary support or reinforcement is provided by the use of drilled or jacked supporting piles so as to protect existing structure. To control ground settlement and distortion, ground freezing and grouting are usually the preferred soil improvement methods. Buildings that will require underpinning will be determined during design.

### **4.3.1.2 Cut-and-Cover Construction**

Tunnelling is an effective means of creating an underground linear facility, which has a uniform cross section. The geotechnical parameters that allow tunnelling also require

separation between tunnels and nearby structures, including other tunnels. This separation is usually the equivalent of at least 1 tunnel diameter (approximately 6 m). For some portions of the subway line, excavation by a TBM is not practical or economical. This includes:

- Stations – The large spans (station platform widths), relatively short lengths and complicated spatial arrangements normally preclude economical tunnelling.
- Cross-overs – Similar to the three track structure, the cross-overs for Finch Station, Steeles Station and Richmond Hill Centre Station have special structural configurations and require the placement of special track work.

In these instances cut-and-cover is the preferred method of construction. In addition, where the alignment can be close to the surface and access from the surface during construction results in negligible adverse environmental effects, cut-and-cover can be more economical than tunnelling.

The ground surface is opened (cut) a sufficient depth to construct the subway tunnel structure and ancillary facilities. The sides of the excavation are usually supported by vertical temporary walls to minimize the volume of material excavated and to protect adjacent facilities and buildings. The walls require cross-bracing or tiebacks for support. Once the construction excavation is complete, the contractor builds the structure from the bottom to the top of the structure. Once the structure construction is complete, the remaining excavation is backfilled and the surface is reinstated.

The cut-and-cover method results in larger quantities of excavated material and is suitable for shallow cuts (no more than 20 m depth). It also requires few special procedures and can be constructed in an expedited manner.

Recognizing that cut-and-cover can be more disruptive than tunnelling, the environmental effects and mitigation measures were assessed as part of the Transit Project Assessment Process.

The following sections provide an overview of this construction methodology.

#### 4.3.1.2.1 *Within Road Rights of Way*

When the excavation occurs within a road or street, existing utilities are often encountered and these must be maintained by temporary support or by relocation. When vehicular traffic must be maintained, temporary decking is placed over the cut using the side walls for support. The top down procedure may be used to minimize the length of time that the surface areas are disturbed.

#### 4.3.1.2.2 *Maintaining Services – Utilities*

In an urban setting all residents and businesses are serviced by a wide range of utilities. To avoid effects to these services, cut-and-cover requires special consideration for the maintenance of utilities. To facilitate cut-and-cover construction, utilities can be relocated. This is often completed in advance of the subway construction. Alternatively, the utility can be temporarily suspended through the construction site. The most appropriate method for the utilities that may be affected will be determined during the detailed design phase.

### 4.3.2 Anticipated Duration of Major Construction Activities

The anticipated duration of a project of this scope will be approximately 8 years, including the following overlapping activities:

- Design and Engineering (48 months overall duration);
- Construction (66 months overall duration); and
- Testing and commissioning (12 months duration).

The Transit Project could be in service by 2017 assuming a Spring 2009 full funding commitment to proceed with the implementation of the Transit Project.

### 4.3.3 Project Costs

Based on the station concepts and subway alignment, an order of magnitude project cost has been estimated in 2008 dollars and is provided in Exhibit 4-20.

**Exhibit 4-20: Major Project Costs**

Major Project Elements		Cost M \$
Stations and Area Facilities		\$655
Finch improvements	\$10	
Cummer / Drewry	\$70	
Steeles	\$195	
Clark	\$70	
Royal Orchard	\$65	
Langstaff / Longbridge	\$85	
Richmond Hill Centre	\$160	
Tunnels, special structures and operating systems		\$600
Subway trains		\$240
Storage and maintenance facilities for subway trains		\$110
Engineering and other costs		\$670
Property		\$125
<b>Project Cost Estimate, 2008 dollars</b>		<b>\$2.4 billion</b>

The above capital cost estimates of the Transit Project includes the implementation of an ATO/ATC signalling system, platform edge doors in stations and a per vehicle allowance for the storage and maintenance of subway trains, assuming that trains are stored at an existing TTC subway yard (Davisville or Wilson Yard). In the event that the SRYNS determines that a satellite or full yard is required on the Yonge line to support the Transit Project vehicle fleet (or for expanded service on the Yonge-University-Spadina Line), the current cost allowance will be adjusted accordingly.

As noted in more detail in Section 5.4.6, preliminary projections of future Yonge Subway ridership to 2031 undertaken by the TTC/City of Toronto, indicate that approximately 20% of the growth in Yonge Subway ridership south of Bloor to 2031 is attributable to the Yonge extension, 10% is attributable to the Transit City initiative and the remaining 70% is due to population /employment growth in the 905/416 area, improvements in transit service and other transit network expansions planned for the future. The above factors may be utilized to negotiate an attribution of the costs to expand Yonge-Bloor Station to the Transit Project.

#### **4.3.4 Construction Staging and Effects**

As discussed in the previous section, the preferred construction and staging procedures will affect transportation modes, mobility and infrastructure. It will be necessary to develop and implement appropriate decking for cut-and-cover construction as well as adequate staging to ensure that interruptions to vehicular and pedestrian travel are addressed. Traffic management plans will be developed during the detailed design phase that provide for adequate movement of vehicles and pedestrians through the construction periods. Due to lowered capacity of intersections along Yonge Street and likely higher traffic volumes on adjacent streets, signal timing strategies during design and coordination between transit providers are necessary. These traffic management plans will be developed in consultation with municipal staff, transit operators and other stakeholders as required. Additional details are provided in Section 4.3.4.1.

Construction approaches include:

- Utilizing techniques based on recommendations from the Geotechnical investigation;
- The use of Tunnel Boring Machine(s) (TBM) in order to minimize surface impacts, impacts on adjacent buildings, and eliminate ground water inflows without the requirement for external dewatering procedures during tunnelling;
- Only the stations and special track structures will be built using cut-and-cover methods, the rest of the subway will be tunnelled since twin tunnels will have no surface effect except at launch and removal locations; and
- Minimizing effects on traffic circulation through the use of decking at cut-and-cover sections under existing roadways, complemented by a traffic management plan.

##### **4.3.4.1 Traffic Management During Construction**

The Traffic Management Plan will detail vehicular and pedestrian traffic arrangements during the construction of the Transit Project. The analysis of traffic operations in the Traffic Management Plan will generally follow the Traffic Impact Study Guidelines prepared by the City of Toronto and York Region. The complexity of the Traffic Management Plan will also be related to the extent of the construction contract and the nature of the existing traffic congestion issues in the construction zone. The Traffic Management Plan will be developed during detailed design.

The general guidelines and principles that will be followed for traffic management during construction of the Transit Project include, but are not limited to:

- *Traffic Lanes*

Where possible, the existing number of traffic lanes will be preserved at an individual construction site. Reduction in the number of lanes will only be permitted after an evaluation of trade-offs at approved locations for long term construction activities.

As a general guideline, where the road surface must be excavated, the minimum number of lanes of traffic, as noted in Exhibit 4-21, should be provided at all times.

**Exhibit 4-21: Minimum Number of Lanes to be Maintained**

Existing Lanes	Minimum Number of Lanes to be Maintained
1 lane in each direction	1 lane with appropriate controls
2 lanes in each direction	1 lane in each direction
2 lanes in each direction 1 centre left turn (continuous)	1 lane in each direction 1 left turn at signalized intersection
3 lanes in each direction	2 lanes in peak direction 1 lane in off peak direction
3 lanes in each direction 1 centre left turn lane (continuous)	2 lanes in peak direction 1 lane in off peak direction 1 left turn signalized intersection

- *Alternative Traffic Options*

Where partial lane closures must occur, an analysis of traffic operations in the area of the construction, including appropriate upstream and downstream intersections, should occur to assess queue lengths, delays and general levels of service.

- *Road Closures*

Where full closure of the road must occur, a suitable road detour will be designated, with the approval of the appropriate road authorities. Temporary closings of arterial roads may occur from 7:00 p.m. to 5:00 a.m. and on weekends. In major commercial areas (i.e. Centerpoint Mall), later start times for road closures (i.e. 9:30 p.m.) will be considered during detailed design.

- *Turn Lanes*

Where lane closures are required at signalized intersections and a left turn lane is presently provided, provisions for left turning vehicles will be provided. If not possible due to construction, approval for the left turn restriction must be given by the appropriate road authority. If a left turn restriction is allowed, then a suitable detour route for left turns will be designated.

Right turn lanes may be closed and need not be accommodated in the traffic diversion, unless traffic volumes dictate their permanent need. This will be coordinated by the Proponent with the road authority.

- *Signing*

For all areas of construction, suitable advance signing shall be provided. Where lane restrictions will be present for long periods of time, advance signing shall also include appropriate alternate routes to encourage motorists to avoid the construction area.

- *Traffic Signal Adjustments/Timing:*

Where elements of the traffic signal infrastructure must be adjusted to accommodate traffic diversions, or excavations, the physical relocation will be designed for submittal to the appropriate road authority.

Where lane closures at a traffic signal must occur, there may be a need to adjust the traffic signal timing.

- *Transit Operations and HOV Lanes:*

Bus bays shall be provided during construction, if possible. The provision of bus bays and stops during construction will be coordinated between the Proponent and the transit operator.

HOV lanes will not be provided during construction.

- *Pedestrians*

A minimum 1.2 m pedestrian sidewalk shall be provided if a sidewalk currently exists. Where a sidewalk must be closed for temporary construction work, alternative pedestrian routes with appropriate signage will be provided.

- *Private Access*

Access shall be maintained to all driveways throughout the construction period, unless suitable arrangements have been made with the property owner and the appropriate road authority to provide an alternative access or temporary closure.

All elements of a traffic management concept must be approved by the affected road authorities, in consultation with the Police and Fire Departments and Ambulance Services, prior to the award of a construction contract.

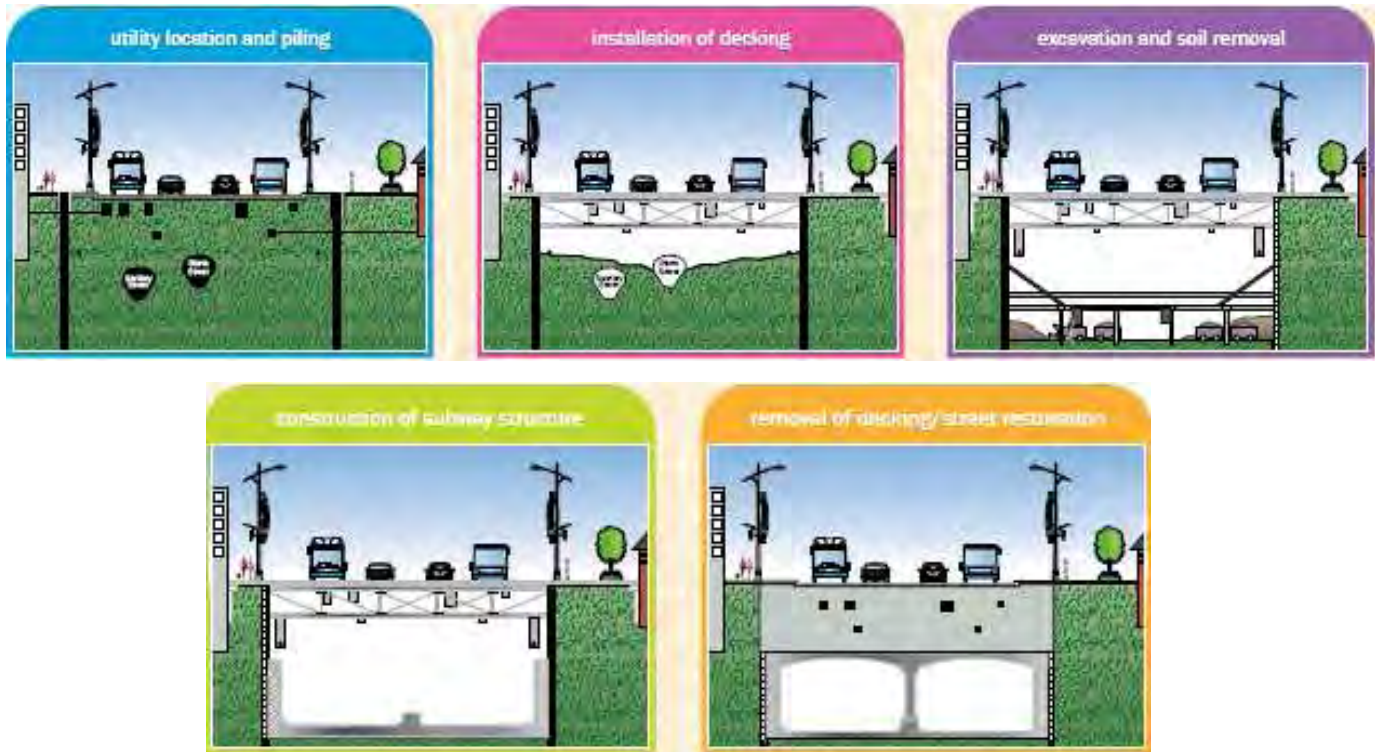
Prior to the start of construction, the Proponent will organize information sessions, as required, with the local community and business groups to explain the construction activities and restrictions, as well as to establish lines of communication.

Construction and proposed staging procedures will have temporary and/or permanent effects. For each subway station, a specific construction and staging plan will be developed during detailed design and will be implemented during construction based on traffic management principles that have proven successful on other similar subway construction projects including the Spadina subway project which is currently being

implemented based on such principles. An example of the traffic management principles to be developed and applied to the Transit Project are outlined above.

Exhibit 4-22 identifies the anticipated staging associated with the subway station and special trackwork sections utilizing the cut-and-cover construction method. The need for decking over the construction site will be determined on a site-by-site basis during detailed design.

**Exhibit 4-22: Typical Station Staging**



Construction staging will be required at the following areas:

- All subway stations;
- East Don River Bridge;
- Special trackwork locations;
- Tunnel boring launch and extraction locations; and
- Steeles Avenue Bus Terminal.

The preliminary staging requirements for the various sites are discussed below.

#### **4.3.4.2 Cummer / Drewry Station**

In order to construct the Cummer / Drewry Station, including the reconstruction of the existing tail tracks north of Finch Station and the completion of the triple track structure, localized lane closures and lane diversions will be required. Temporary decking will be required to maintain an appropriate number of traffic lanes through the construction area.

In order to define the construction staging requirements, additional traffic analysis will be completed during detailed design to confirm the temporary lane configuration along Yonge Street and Cummer / Drewry.

The City of Toronto and TTC will also review the possible implementation of the Service Road south of Drewry Avenue to provide additional road capacity in the vicinity of the subway station construction area.

#### **4.3.4.3 Steeles Station (TBM Launch site, Station, Crossover and Bus Terminal)**

In order to construct the Steeles Station and Bus Terminal, as well as the track crossover and accommodate the TBM launch site, construction staging and Traffic Management Plan will be developed during detailed design. Construction at the site will directly impact roads under the jurisdiction of York Region and City of Toronto. Impacts to roads under the jurisdiction of the City of Vaughan and Town of Markham will also be determined during detailed design. The final configuration of the roadway cross sections along Steeles Avenue and Yonge Street in the vicinity of the subway station will be confirmed during detailed design.

#### **4.3.4.4 Clark Station**

In order to construct the Clark Station, localized lane closures and lane diversions will be required. Temporary decking will be required to maintain an appropriate number of traffic lanes through the construction area. In order to define the construction staging requirements, additional traffic analysis will be completed during detailed design to confirm the lane configuration along Yonge Street. The opportunity may exist to reduce the existing number of lanes from the current condition during construction based on the overall traffic management principles developed for the project.

#### **4.3.4.5 East Don River Construction Staging**

In order to construct the East Don River Bridge crossing, the existing Yonge Street roadway will be diverted to the west side of Yonge Street to provide sufficient area to construct the bridge and the approaches. The preliminary staging of the East Don River Bridge are discussed in detail in Appendix C, East Don River Crossing Report.

#### **4.3.4.6 Royal Orchard Station**

The construction staging requirements for the Royal Orchard Station will be directly impacted by the traffic staging requirements for the north approach to the East Don River Bridge construction. The preliminary traffic staging for bridge construction is to shift Yonge Street in a 4-lane configuration to the west side of the right-of-way. Temporary decking will be required at the station construction area to maintain an appropriate number of traffic lanes through the construction area. Special consideration will be given during detailed design of the traffic staging as a result of the heritage properties on the west side of Yonge Street at this location.

#### **4.3.4.7 Langstaff / Longbridge Station**

In order to construct the Langstaff / Longbridge Station, localized lane closures and lane diversions will be required. Temporary decking will be required to maintain an

appropriate number of traffic lanes through the construction area. In order to define the construction staging requirements, additional traffic analysis will be completed during detailed design to confirm the lane configuration along Yonge Street. Any lane diversions will be to the west side of Yonge Street as a result of the Holy Cross Cemetery on the east side of Yonge Street at this location.

Currently Yonge Street transitions from 2 lanes to 3 lanes per direction approximately 100 metres north of the Longbridge / Yonge Street intersection. This widening is a result of the configuration for the Yonge Street / 407 interchange. Temporary conditions during construction will require coordination with 407/MTO to ensure the interchange operates to the satisfaction of all parties.

#### **4.3.4.8 Richmond Hill Centre Station**

In order to construct the Richmond Hill Centre Station, the existing buildings located over the station box must be demolished and the existing bus terminal temporarily relocated. Once these facilities have been cleared, construction of the station can be completed. The completion of the station construction under High Tech Road will require construction staging to maintain an appropriate number of traffic lanes on High Tech Road and minimize impacts to the existing bridge over the CN right-of-way.

#### **4.3.5 Commissioning**

Upon completion of the subway construction (running structure and stations) the subway operator will commence commissioning of the systems which will have impacts and mitigation as noted in Section 5.4, Operations and Maintenance Impacts.