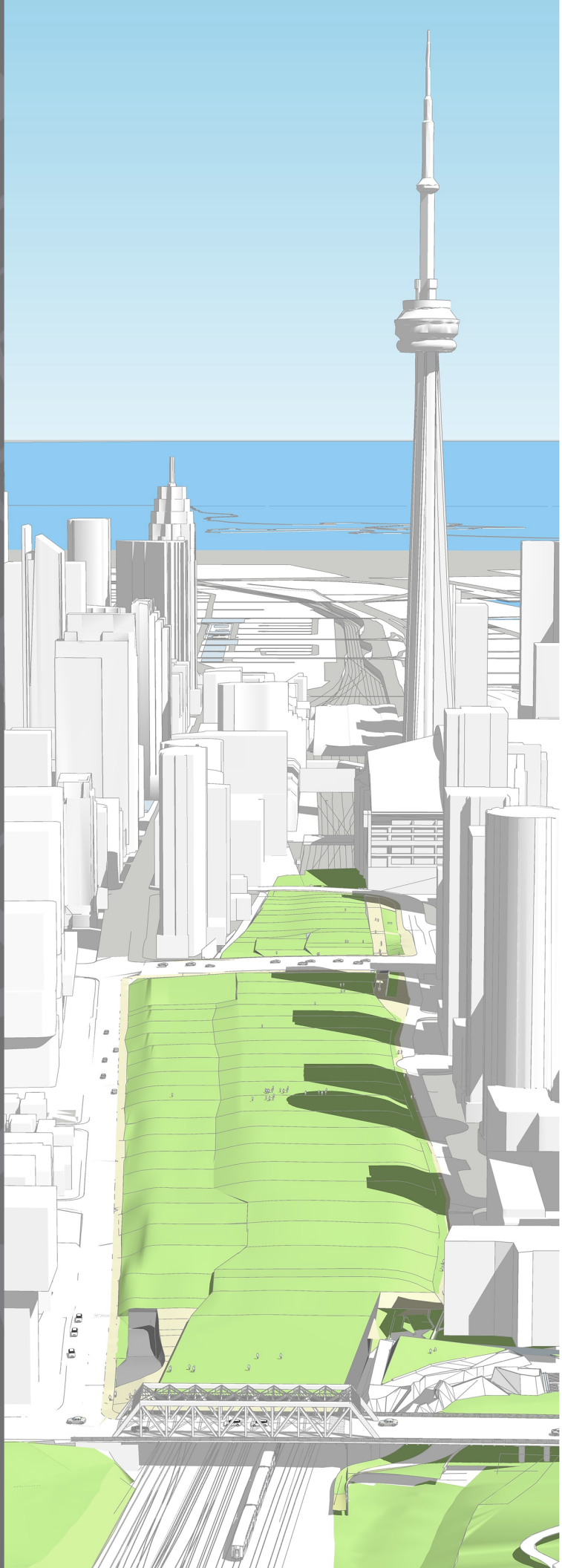

RAIL DECK PARK

Engineering & Costing Study

NOVEMBER 24, 2017

TORONTO

BUILD TORONTO

WSP

McMILLAN ASSOCIATES ARCHITECTS

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EXECUTIVE SUMMARY

Background

The proposal for Rail Deck Park (the project) comprises the construction of a decking structure over the rail corridor between Blue Jays Way and Bathurst Street in Downtown Toronto. The purpose of the project is to facilitate the development of approximately 8.15 hectares (20.14 acres) of new parkland with associated pedestrian / cycle connections. (Although not considered within the scope of this study, the Metrolinx-owned property at the southwest corner of Spadina Avenue and Front Street could be included at a later planning stage, and would increase the potential park area to 8.78 hectares or 21.7 acres.)

In 2017, an Engineering and Costing Study for Rail Deck Park (the study) was undertaken by Build Toronto and consultants WSP Canada Group Limited and McMillan Associates Architects, in consultation with the City of Toronto (the project team).

The purpose of the study was to produce a comprehensive reference design concept for the decking structure with a specific focus on the technical aspects of the site and surrounding areas including:

- Existing conditions including topography, landforms and physical features, geotechnical and hydrogeological conditions and Archaeological considerations;
- Rail corridor operations and capital works;
- Structural solutions;
- Utilities;
- Vibration and noise attenuation;
- Mechanical systems;
- Permits and approvals;
- Construction methodologies;
- Risk factors.

The study did not involve specific design or programming for the park itself. Instead it incorporated assumptions concerning potential future park design elements to inform the requirements for the decking structure.

Reference Design Concept

The reference design concept for Rail Deck Park was developed from the “bottom up” utilizing data that was collected from various sources. The design concept was informed by a tabletop review of

existing conditions that was undertaken at the onset of the study. The design concept addresses edge conditions of the new park development and considers connectivity, grade separations, pedestrian movements, and emerging potential park programming elements.

The design concept considers structural solutions that will be permissive of a range of park and ancillary uses.

The concept design is intended to be non-prescriptive in nature in order to allow for the maximum range of programmatic elements and future design activities. Consideration has been given to a range of possible solutions for all systems including foundations, structures, mechanical, and electrical systems. Conceptual layout plans including track level plans, street level framing plans, and street level grading plans have been prepared to illustrate the project conditions. The concept design includes track-level structures and a deck supporting frame.

Cross sections and 3-dimensional models have been developed through this study. A sample of these cross sections and models is provided in the Appendix to this document.

Construction in the Rail Corridor

The emerging capital plans and initiatives in the rail corridor were explored along with some of the technical considerations applicable to undertaking design and construction in and around the rail system. As planning for Rail Deck Park progresses, ongoing coordination with Metrolinx will be essential.

The existing rail infrastructure in the study area was assessed. The rail corridor is comprised of active rail lines along the entire corridor, and an adjacent storage yard between Bathurst Street and Spadina Avenue. There are four major rail lines from the west that access the Union Station Rail Corridor (USRC) including nine approach tracks plus seven yard tracks between Bathurst Overhead and Spadina Avenue that may be affected by construction of the decking structure.

Rail Deck Park will be located above the USRC and will need to be coordinated with capital works phased or underway in the rail corridor. Current rail planning considerations include future track works, signal systems upgrades, switch machine replacement, and electrical enabling works.

The design concept for Rail Deck Park complies with Metrolinx's recently published Performance Specifications for Structures Passing Over Electrified Corridors. (Vertical clearance can be obtained using different design options such as alternative track tie profiles and/or by raising the overhead structures.)

The design concept incorporates minimal new structural elements within the rail corridor due to limited space. Further study into the effect of electromagnetic fields will be required as planning for Rail Deck Park progresses.

A new GO station at Front Street West and Spadina Avenue is planned as a part of service expansion under the GO Regional Express Rail initiative. Preliminary designs for station circulation and track-level platform are incorporated into the design concept.

Rail corridor access and permits are critical considerations for the future construction of Rail Deck Park. Construction access routes, track and work blocks (including potential delay and cancellation of these blocks by Metrolinx), track protection and flagging, and construction safety are some of the key elements that will influence the development and the overall cost of the project.

Geotechnical & Hydrogeological Assessment

For the purposes of planning, and based on a tabletop review of existing conditions, key assumptions considered the composition and thickness of the soil and groundwater levels. Two foundations options were considered in the design concept, including driven steel H-piles and augured caissons.

It was determined that groundwater conditions will not affect the design of the deep foundation units and dewatering is not expected to impact the installation of driven piles. Groundwater may however impact the installation of caissons and will require further investigation.

Structural Design

The proposed structural system considered in the design concept is long span girders spanning north-south, with framing or cast-in-place concrete beams and columns in the east-west direction. Lateral stability will be provided by cast-in-place shear walls and by rigid frames and buttressing.

Maximum span lengths are approximately 60 metres. Preliminary girder systems considered in the design concept are structural steel trusses, steel box girders, precast concrete girders, and precast concrete segmental girders. The structural girder depths range from 1.5 metres to 4.5 metres depending on span and type.

Utilities & Mechanical Systems

The approach to servicing focuses on identifying options where services can be located rather than where they should be located, since the programming of the park has not been established.

Servicing analysis included storm drainage, watermains, sanitary sewers, Toronto Hydro, and telecommunications.

The depth of the secondary structural system will allow for major civic and mechanical systems to be incorporated within the decking structure.

This analysis does not demonstrate any major constraints for future design and integration of civil and mechanical systems once requirements, related to both above and below deck functions, are articulated.

Noise & Vibration

The design concept provides mitigation of train-related noise and vibration as the deck essentially provides a large and absorbent barrier.

Careful consideration of materials and design will be required to avoid amplification of train-related noise at openings. This can be mitigated through the use of sound absorptive materials below the deck without adversely impacting uses above the deck.

Below-Deck Safety Systems

The design concept gives consideration to general requirements for below-deck safety systems related to the decking structure include:

- Lighting system that is vandal-resistant;
- Emergency lighting to illuminate exits, corridor, principal routes and any typical congregation areas, with uninterruptable and back-up power supplies;
- Air quality / ventilation system that provides permanent and temporary (during construction) ventilation, and one that does not negatively impact the above-grade uses on or around the decking structure;
- Emergency evacuation of train passengers including an emergency procedure plan;
- Emergency egress and signage including warning and hazard signs;
- Emergency generator designed to meet back-up power requirements; and
- Fire protection including automatic fire detection, standpipe and hose systems, and portable fire extinguishers.

Topographic Integration

The topographic conditions along the perimeter of the project site were evaluated and took into consideration the grading of the decking structure relative to the existing grade along the edges of the site. The lowest vertical separation occurs in the area of the Spadina Pedestrian Underpass

and Capreol Court, to the south of the project site and west of Spadina Avenue, while the greatest vertical separation occurs in the area of the Northern Linear Park, to the east of Spadina Avenue.

Authorities Having Jurisdiction & Approvals

Rail Deck Park is subject to City of Toronto by-laws and/or requirements. Permits, licenses and approvals will be required from various agencies at the provincial and federal levels, including routine requirements and those related to construction in the rail corridor. Metrolinx, for example, as the transit authority, will undertake a technical review of the design and have responsibility for approval of a construction access agreement.

EA Requirements

Initial evaluation suggests that an Environmental Assessment (EA) should be undertaken and can be delivered through a streamlined process (e.g., the Schedule C Municipal Class EA process).

Construction Methodology

The Engineering and Costing Study considers the logical sequencing of construction steps as follows:

- **Early Works:** Work required across most or all of the Rail Deck Park site to relocate utilities, construct temporary facilities, establish access points, and staging areas and to erect barriers;
- **Foundations:** major below-ground structures in and around the Rail Yard, including hoarding, shoring, removal of fill, excavation, installation of caissons and other structures, and primary grade beams;
- **Primary Structures:** walls and columns parallel to tracks (in the east-west direction);
- **Secondary Structures:** long-span girders over the tracks (in the north-south direction);
- **Systems:** fit-up of major mechanical, electrical, irrigation, and drainage systems;
- **Decking:** dressing above the trusses plus securing the underside; and
- **Park:** installation of hard and soft landscaping, park program, and facilities.

Approach to Phasing

Construction “phasing” refers to the order in which the development and construction of the decking structure could be sequenced. It must be logically conceived while also viewed in the context of an overall vision for the project.

The proposed approach to phasing for the project includes a preferred Phase 1 option which starts west of Spadina Avenue and extends to the current location of the "Puente de Luez" pedestrian bridge.

Scope & Costs

The cost estimate was developed as a Class 4 Estimate, in accordance with guidelines provided by the Association for Advancement of Cost Engineering.

The total budget for complete development of Rail Deck Park is estimated to be in the range of $1.665 billion.

The estimate is based on an analysis of the reference design concept, which is advanced to between 1% and 5% design development.

The cost estimate reflects the scope of the design concept which has been quantified and estimated. The design concept will be substantially refined and elaborated through subsequent stages of design.

Cost Categories

The cost summary was developed for early works (Phase 0) and each of the four construction phases (Phases 1-4) for the decking structure and park development.

Hard costs generally include all elements related to early-works, foundations, primary and secondary structures, systems, decking and park development described above.

Cost associated with the early works should be considered provisional until further information concerning related capital works in the rail corridor are known. There is a higher degree of certainty associated with deck and park construction which are more applicable to quantity and unit price analysis.

Exclusions from the cost estimate include soft costs related to services that could reasonably be delivered by the City (e.g., legal costs), taxes and fees administered by the City, and escalation. Allowances and contingencies have been documented.

General Requirements

General requirements for track related work are cited as much higher than customary. It is assumed that these allowances will remain applicable to work related to the rail corridor, rail yard, and any work which is to be performed adjacent to or above the rail lines.

Work Restrictions

Approximately $304 million is allocated to work restrictions related to premiums for construction activities in, around or above the rail corridor and yard. These values are subject to refinement through advancement of the concept and development of constructability methodologies with Metrolinx, and are considered to be highly variable at this stage.

Contingencies & Allowances

Approximately $327 million is allocated to design and pricing, construction and other contingencies. Design contingencies are lower for deck and park construction, where the scope is clearer and the methodological uncertainty related to track work is reduced.

Potential for further certainty of scope and/or reduction of contingencies can be realized during subsequent design work and through engagement with Metrolinx. This will involve work to refine the assumptions of this study, determine design scope for early works with more certainty, and through coordination of track-level works associated with Rail Deck Park, North Bathurst Yard reconfiguration, and Spadina-Front GO Station construction.

1.0 BACKGROUND

The proposal for Rail Deck Park (the project) comprises the construction of a decking structure over the rail corridor between Blue Jays Way and Bathurst Street in Downtown Toronto. The purpose of the project is to facilitate the development of approximately 8.15 hectares (20.14 acres) of new parkland with associated pedestrian / cycle connections. (Although not considered within the scope of this study, the Metrolinx-owned property at the southwest corner of Spadina Avenue and Front Street could be included at a later planning stage, and would increase the potential park area to 8.78 hectares or 21.7 acres.)

In 2017, an Engineering and Costing Study for Rail Deck Park (the study) was undertaken by Build Toronto and consultants WSP Canada Group Limited and McMillan Associates Architects, in consultation with the City of Toronto (the project team). This report presents the findings from that study.

1.1 Purpose

The purpose of the study was to produce a comprehensive reference design concept for the decking structure with a specific focus on the technical aspects of the site and surrounding areas including:

- Existing conditions including topography, landforms and physical features, geotechnical and hydrogeological conditions and Archaeological considerations;
- Rail corridor operations and capital works;
- Structural solutions;
- Utilities;
- Vibration and noise attenuation;
- Mechanical systems;
- Permits and approvals;
- Construction methodologies; and
- Risk factors.

The study did not involve specific design or programming for the park itself. Instead it incorporated assumptions concerning potential future park design elements to inform the requirements for the decking structure.

1.2 Alignment with Other Initiatives

The study complements other programming and planning efforts of the City of Toronto for Rail Deck Park. This includes the comprehensive land use study undertaken by Urban Strategies Inc. for the proposed Official Plan Amendment for the rail corridor.

1.3 Project Team

The Project Team includes the City of Toronto, Build Toronto, and WSP Canada Group Limited (WSP) along with McMillan Associates Architects (MAA).

1.3.1 City of Toronto

The City of Toronto, involving various divisions, has the responsibility for determining the cost and constructability of a structure over the rail corridor between Blue Jays Way and Bathurst Street, to facilitate the development of new parkland and pedestrian / cycle connections for the City of Toronto. They engaged Build Toronto to work with them to undertake the analyses, and provide guidance and ongoing direction to Build Toronto for the assignment.

1.3.2 Build Toronto

Build Toronto‘s responsibility was to manage the assignment on behalf of the City and to report back on building Parkland over the rail corridor study area. This included retaining an experienced multi-disciplinary Consultant Team – led by WSP Canada Group Limited (WSP) with McMillan Associates Architects (MAA) – that specializes in major infrastructure development including landscape and urban design, structural engineering, architectural design, rail corridor work, project management and costing. Build Toronto is also responsible for overseeing the analyses and feasibility studies; reporting on progress and updating City staff on a regular basis; summarizing the results and providing overall guidance to and managing the Consultant on the assignment; managing presentations to the City; and overseeing the development of the final report.

1.3.3 WSP Canada Group Limited

WSP’s role and responsibility is to develop the engineering study methodology and process; provide technical expertise in the fields of project management, landscape and urban design, rail corridor development and operation, structural engineering, architectural design and costing; assess project complexity in terms of operational, design and construction constraints and considerations; and estimate capital and construction costs. The WSP | MAA team is staffed with highly qualified and experienced individuals.

2.0 STUDY METHODOLOGY

2.1 Study Area

The study area, as illustrated in **Figure 1,** spans the existing rail corridor between Bathurst Street to the west and Blue Jays Way to the east. The corridor is comprised of active rail lines along the entire corridor, and an adjacent storage yard between Bathurst Street and Spadina Avenue. The area spans the existing rail corridor between Bathurst Street to the west and Blue Jays Way to the east and consists of approximately 20.14 acres.

Figure 1: Rail Deck Park Study Area

2.2 Data Gathering

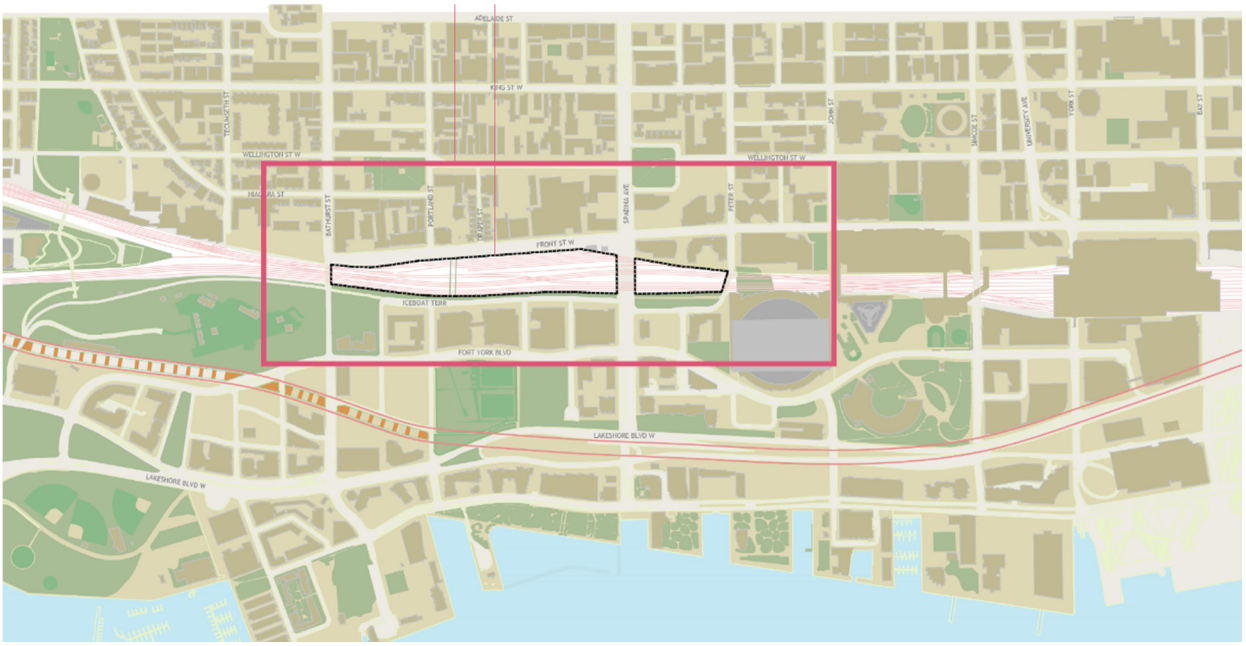
Data was collected from several sources at the City of Toronto, design and investigative work by the Consultant Team, and from the public domain. The data was organized in digital form as drawings and in report format. Data sources included the following:

- Property boundary data;
- Enterprise Stereoscopic Model (ESM) for topographic mapping ;
- Digital Map Owners Group (DMOG) Data for underground utilities;
- City Utility Mapping (CUMAP) data for the sewer or watermain network;
- Aerial photography & orthoimagery (including historical photos); and

- Studies in the public domain and as submitted to the City of Toronto related to:
  - Geotechnical and subsurface investigations;
  - Noise, wind and vibration; and
  - Stormwater management.

The approximate extent of data capture for existing drawings, maps, photos and technical reports is shown in **Figure 2**.

Figure 2: Extent of Rail Deck Park Data Capture

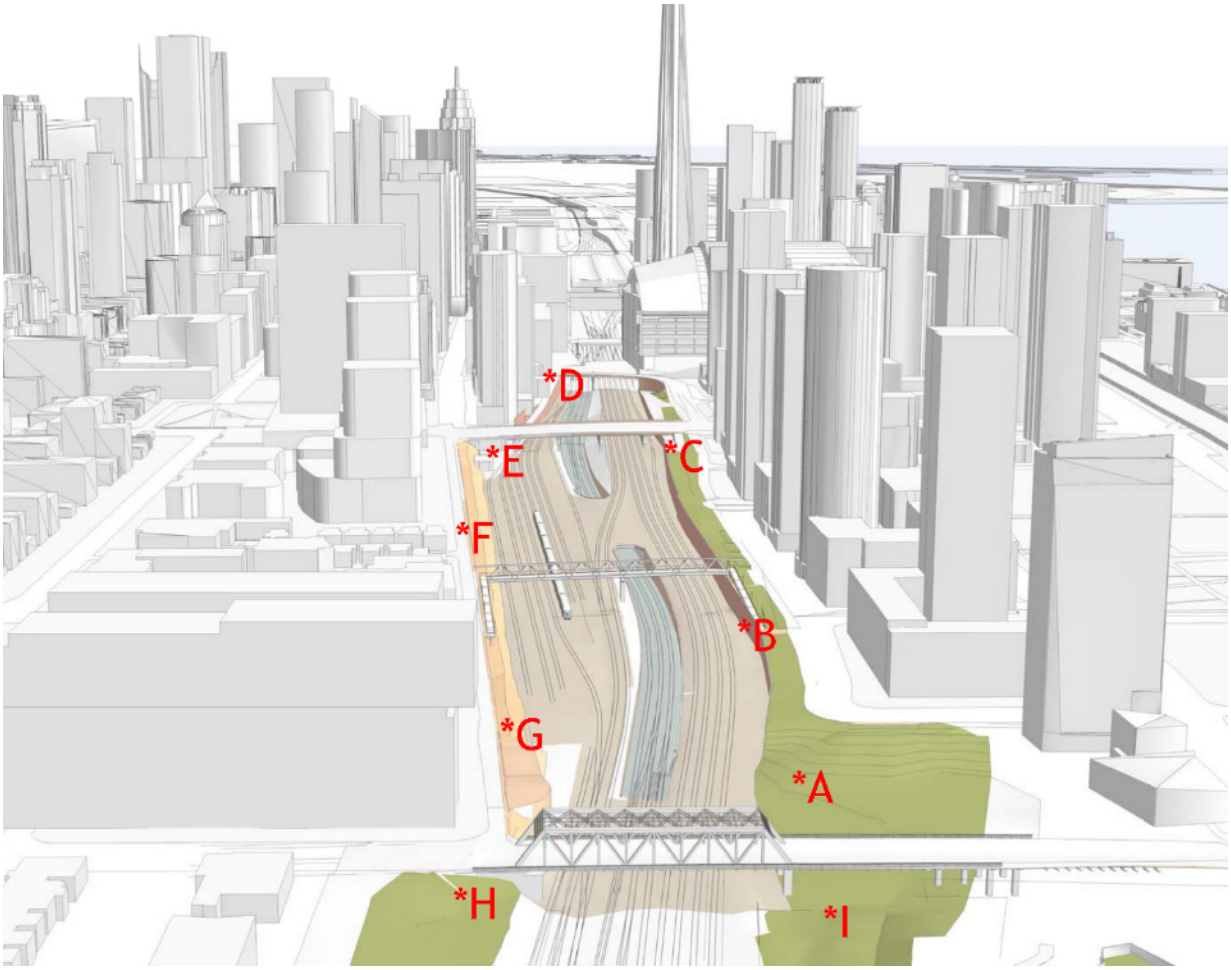


3.0 EXISTING CONDITIONS

3.1 Topography & Landforms

There are a variety of prominent landforms and edge conditions in and around the site. The conditions are shown and labeled in **Figure 3** and briefly described below.

Figure 3: Existing Topography & Landforms in the Vicinity of the Project Area



Major features include the following:

A. The Mouth of the Creek Park (future) and connection beneath Bathurst Street Bridge to Fort York are relatively low, with the existing grade at the elevation of the rail corridor itself.
B. A high retaining wall forms the south edge of the corridor at Iceboat Terrace, with several subterranean structures such as parking garages and common areas for

condominium complexes of Concord CityPlace. This wall is 8 to 10 metres high in places.

C. Northern Linear Park extends the length of the southern perimeter of the project area and includes a pedestrian connection beneath Spadina Avenue.
D. Metrolinx service access ramp from Blue Jays Way beneath the Spadina Avenue Bridge to the transformer yard and Go Train Yard. This access ramp is separated from the Rail Corridor by a retaining wall which varies in height from 2 to 8 metres, housing several basement and underground parking structures for the Apex and Matrix condominium buildings.
E. Metrolinx Transformer Yard, and the potential site of the planned Spadina-Front GO Station development.
F. Front Street between Bathurst and Spadina is 3 to 4 metres lower than Iceboat Terrace on the south, with a sloped embankment down to the GO Train Yard.
G. Metrolinx earthen ramp for service access down to the GO Train Yard off of Front Street.
H. Future connection to West Toronto Rail Path.
I. Embankment and future cycle and pedestrian path to and from Fort York beneath the Bathurst Street Bridge.

3.2 Geotechnical & Hydrogeological

A tabletop review of available reports containing geotechnical and hydrogeological information for the project area was completed as a part of this study and the information is summarized in this section. The approach taken to the geotechnical and hydrogeological data is to provide a generalized summary of the subsurface conditions that will affect the design and construction of Rail Deck Park.

This area has historically been very highly developed and large amounts of fill have been placed on top of the original shoreline.

The project area is located within the physiographic region known as the Lake Iroquois Plain. The subsurface conditions encountered in the project area consist of a relatively thin and possibly discontinuous layer of glacial till and inter-glacial deposits, referred to as Sunnybrook Tills.

The entire site is underlain by shale bedrock of the Georgian Bay Formation, with the bedrock surface lying at Elevation 72 to 74 at approximately 4 to 6 m below the track elevation.

The groundwater level within the rail corridor is assumed to be approximately 1 metre below grade. The actual level will be influenced by various factors, including the level of Lake Ontario; drainage and permanent dewatering around adjacent building and the railway facilities; and severe rainfall events.

3.3 Archaeological Considerations

As a component of the study a Stage 1 archaeological assessment was completed to provide an overview of archaeological potential within the study area. The objective of a Stage 1 background study is to evaluate in detail the property's archaeological potential, which will support recommendations for Stage 2 survey for all or parts of the property and to recommend appropriate strategies for Stage 2 survey (if required).

In support of the determination of archaeological potential, the Stage 1 will provide information about the property's geography, history, previous archaeological fieldwork and current land condition. The Stage 2 survey provides an overview of archaeological resources on the property and a determination of whether any of the resources may be artifacts and archaeological sites with cultural heritage value or interest.

3.3.1 Existing Site Conditions & Identified Archaeological Potential

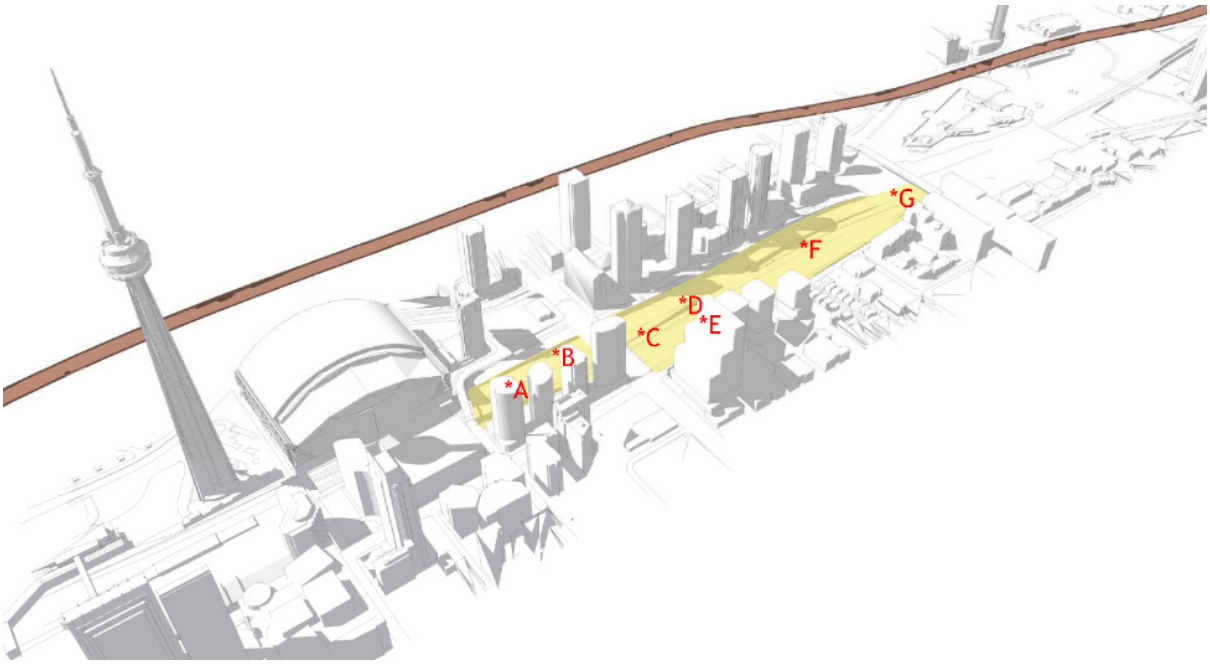
The location of the study area in close proximity to the original Lake Ontario shoreline, Old Fort York, and numerous early Euro-Canadian settlement features indicates that the property holds high potential for the recovery of archaeological resources. This potential is noted within the City of Toronto Archaeological Management Plan digital map (Last Updated April 19, 2017) and is further influenced by the many archaeological sites already registered within the Ontario Archaeological Sites Database (33 sites within a 1km radius). The majority of these sites relate to the early Euro-Canadian settlement of the Town of York and its growth and expansion as the City of Toronto.

Evaluating the presence of early contact period sites and structures relies heavily on the review and evaluation of early contact period mapping. Further site development information can then be gathered through the analysis of property development as observed in aerial and satellite imagery.

Following the review of historic mapping dating between 1788 and 1924, as well as various aerial photographs dating throughout the 20th century, the following primary structures/features have been identified within the study area and are indicated in **Figure 4**:

A. Approximate location of various train-shed structures (ca. 1884-1924)
B. Approximate location of full circle roundhouse and associated structures (ca. 1884-1924)
C. Approximate location of engine house (ca. 1857-1924)
D. Approximate location of half-circle roundhouse and associated structures (ca. 1857-1924)
E. Approximate location of engine house (ca. 1858)
F. Approximate location of engine house (ca. 1857-1858)
G. Approximate Location of Passenger Depot (ca. 1857-1858)

Figure 4: Archeological Features within Project Area



The review of early aerial imagery (ca. 1947) show that by this time substantial railway growth had occurred, with many new rail lines being added and older structures removed or replaced. The development of the railway is observed to continue throughout the second half of the 20th century, with the final result being the reduction of the waterfront rail yards and transition of the area into a recreational/residential zone.

Today the study area represents a fraction of the original rail yard area, and has been heavily modified and graded to support modern rail traffic. While the modern use and development of the study area for use with modern rail traffic has undoubtedly had some effect on the sub-surface archaeological deposits, the frequent documentation of deeply buried archaeological sites within the city of Toronto require that caution be taken to ensure that no deeply buried resources are present.

4.0 RAIL CORRIDOR CONSIDERATIONS

This section summarizes some of the emerging capital plans and initiatives in the section of the Union Station Rail Corridor (USRC) that falls within or otherwise impacts the project area, as well as some of the technical considerations applicable to design and construction in and around the rail corridor.

The information presented here reflects publicly available documents and the Consultant team's experience on related projects in the USRC.

As planning for Rail Deck Park proceeds in subsequent phases, input from, and agreement with, Metrolinx concerning related capital plans in the USRC will be essential.

4.1 Existing Rail Infrastructure & Services

There are four major rail lines from the west that access the Union Station Rail Corridor that may be affected by Rail Deck Park construction. The lines are the Kitchener, Barrie, Lakeshore West, and Milton lines.

Within the project area, there are nine approach tracks (within the main lines) plus seven yard tracks between Bathurst Overhead and Spadina Ave. Other rail infrastructure in the project area includes large overhead railway signal bridges, an overhead pedestrian bridge, a rail crossover tunnel, and the Spadina Avenue and Blue Jays Way overhead bridges.

By 2020, GO Train trips to Union Station are planned to increase from 1,500 to 2,200 per week. Upon electrification of the Metrolinx lines and additional track expansions by 2024, rail trips to Union Station along the GO rail network are expected to grow up to 6,000 trips per week which will make Union Station one of the busiest passenger rail networks in North America. VIA, Amtrak and freight train trips are additional to the above GO train trips.

The USRC is approximately 6.4 kilometres in length and is located between Strachan Avenue (Mile 1.59W – Kitchener Corridor, Mile 1.57 – Lakeshore West Corridor) and the Don River. The corridor holds 41 kilometres of track, with 256 switch machines. **Figure 5** details track schematics within the area of the proposed park including switches, signals, and a rail track fly-under.

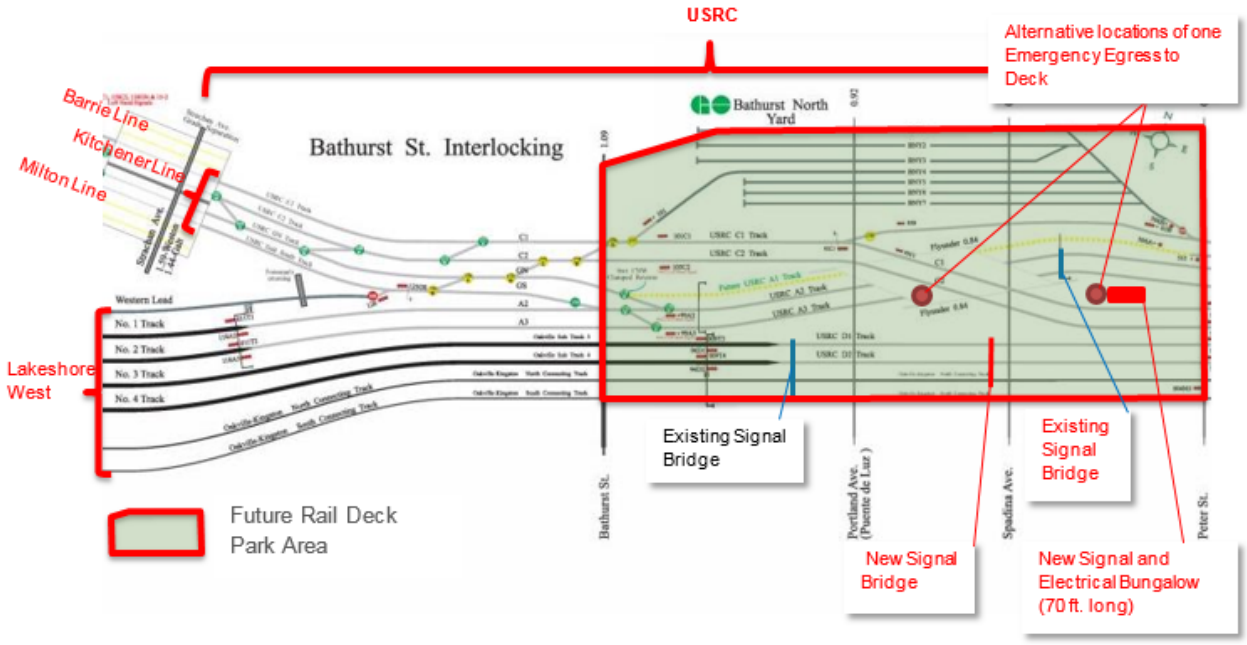
The Oakville-Kingston North connecting tracks, as well as the Oakville-Kingston South connecting tracks are operationally protected for CN freight. The GS track from Kitchener and the A2 track from Lakeshore West are merged as the A2 track located at Bathurst St. (Mile 1.09W).

A track fly-under bridge is located between Portland Avenue and Spadina Avenue where two tracks go above the bridge, and three below. Large track switches and leads are used to

expand these 10 tracks to 16 as they enter the Union Station Train Shed just east of Peter Street/Blue Jays Way Overpass (Mile 0.53W).

Construction coordination with Metrolinx will be essential to ensure all major train operations remain functional during operating hours to avoid disruption to train operations.

Figure 5: USRC Track Schematic: Strachan Avenue to Peter Street



4.1.1 Existing Rail Service

The **Kitchener Line** operates weekdays providing rush-hour train service between Toronto and Kitchener. Trains along this corridor are unidirectional and run eastward in the morning from Kitchener to Toronto, and westward in the afternoon. There are four mainline tracks coming from Northwest including the Kitchener, Milton and Barrie Corridors within the USRC.

The UP Express was opened for operation in June, 2015 and is connected to Toronto Pearson Airport Terminal 1 via a spur line off the Kitchener line. The UP Express opens for operation at 5:30 a.m. and departs from Union Station every 15 minutes. The last train departs at 1:00 a.m. Major work within the USRC should be planned between the times of 1:00 a.m. and 5:30 a.m., which is outside current UP Express train operational hours.

The **Barrie Line** is primarily single track and runs from Allandale Waterfront GO Station to Union Station. Similar to the Kitchener line, weekday rush-hour service is provided between Barrie and Toronto. As of December 2016, there are 19 trips per day that run between Aurora

GO Station and Union, and 6 from Allandale Waterfront GO to Union. There are 9 trips per day that run from Union Station. Metrolinx is planning to have 6 additional trips along this line to improve trip frequency. By Year 2020, weekday, midday, and evening hourly service will be added between Aurora GO and Union Station and a second track will be constructed on the Barrie line.

Two-way, all-day service is already provided along the **Lakeshore West Line** seven days a week from Aldershot GO station in Burlington to Union Station. As of 2014, the Lakeshore West line saw 17 million annual ridership with a total of 90 total trips per weekday. Two-way, all-day service was increased along the Lakeshore corridors in June 2013 from hourly to half hourly. Currently, a majority of passengers travel in the peak direction towards Union Station. In addition to GO-Transit operations, the corridor is utilized by freight lines, VIA Rail and Amtrak.

The **Milton Line** operates weekdays providing rush-hour train service between Toronto and Milton. Trains along this corridor are unidirectional and run eastward in the morning from Milton to Toronto, and westward in the afternoon/evenings. The Milton line enters the USRC via track GS shown in **Figure 5**. Since 2015, four new peak rail trips were added, bringing the total number of trips each day to 20. The Regional Express Rail project is also planned to increase service and train trips.

4.2 Capital Works in the Rail Corridor

Future capital works in the rail corridor have been identified based on public documents and the Consultant's knowledge of future works planned by Metrolinx. Exact plans and requirements will be subject to confirmation by Metrolinx as the project advances.

Metrolinx's Regional Transportation Plan (RTP) anticipates a significant increase in demand for rail services over the next 15 to 25 years. In May 2015, the GO Regional Express Rail Initial Business Case Study was published. The study evaluated and forecasted the need for two-way all-day regional rail services along the seven Metrolinx rail corridors. The study also cited the need for the electrification of a majority of the rail network, and installing new train control systems to improve safety, train operations, and capacity.

Significant capital works have commenced within the USRC with the implementation of a Signalling and Train Control Improvement Program. As part of this program, the replacement of switch machines within the USRC is currently being completed. The main track switches within the area of the corridor between Bathurst Street and Blue Jays Way have been largely completed, while the North Bathurst Storage Yard switches are scheduled for replacement.

In addition, signaling and power cable enabling and relocations are currently taking place which will occupy locations where substructures would be located to support the Rail Deck Park superstructure.

In addition to the signal improvements, various track construction works are planned within the project area such as track crossovers and track shifts at Bathurst Yard. These track configurations are still in a preliminary stage of planning and will need to be addressed in successive design stages for Rail Deck Park.

Two new features that will need to be addressed in future design work for Rail Deck Park include: (i) Signal/Power Bungalows (70 ft. long) east of Spadina Avenue between the tracks; and (ii) a Signal Bridge west of Spadina Avenue over five main tracks that will be constructed as a part of current signal improvements (these features are shown in **Figure 5**).

4.2.1 Signalling Systems Upgrades

Metrolinx is currently in the process of replacing and modernizing the existing signal system in the USRC via its Signalling and Train Control Improvement Program.

The corridor contains approximately 228 signals that will be replaced in order to reduce signal disruptions, increase recovery time, and combine operations into one control centre. These works are underway presently with substantial completion in 2021.

Given the clearance zones and equipment required for the installation of signals, if these works are underway during the commencement of works for the Rail Deck Park, coordination will be required with Metrolinx and the Contractor.

Care should also be taken to ensure the sightlines and visibility of all signals remain intact during and after construction to ensure safe train operations. Proper design and layout of train signals is essential for proper train spacing, speeds, and sightlines to optimize train movement capacity.

Given that the rail environment will transition from open to an enclosed trainway, the structural layout of Rail Deck Park will need to be reviewed to ensure signal sightlines meet the train operational requirements.

4.2.2 Switch Machine Replacement

The USRC contains 183 switch machines which are used to move trains from one set of railway tracks to another. In conjunction with the signalling systems upgrades, these switch machines will be replaced and modernized to allow for greater train speeds in and out of Union Station.

Substantial completion of this project is scheduled for December 2017 so these works should have no impact on the project.

4.2.3 Corridor Electrification

Metrolinx plans to implement electrification over a large portion of their rail system, including the USRC. The current proposal is a 25kVac system that will deliver power to trains via an

Overhead Catenary System (OCS), together with power collection by a pantograph mounted on the roof of the vehicles. Metrolinx currently plans to use a mix of four different catenary structures which include portal structures, portal structures with side cantilevers, multi-span structures, and poles with single cantilevers.

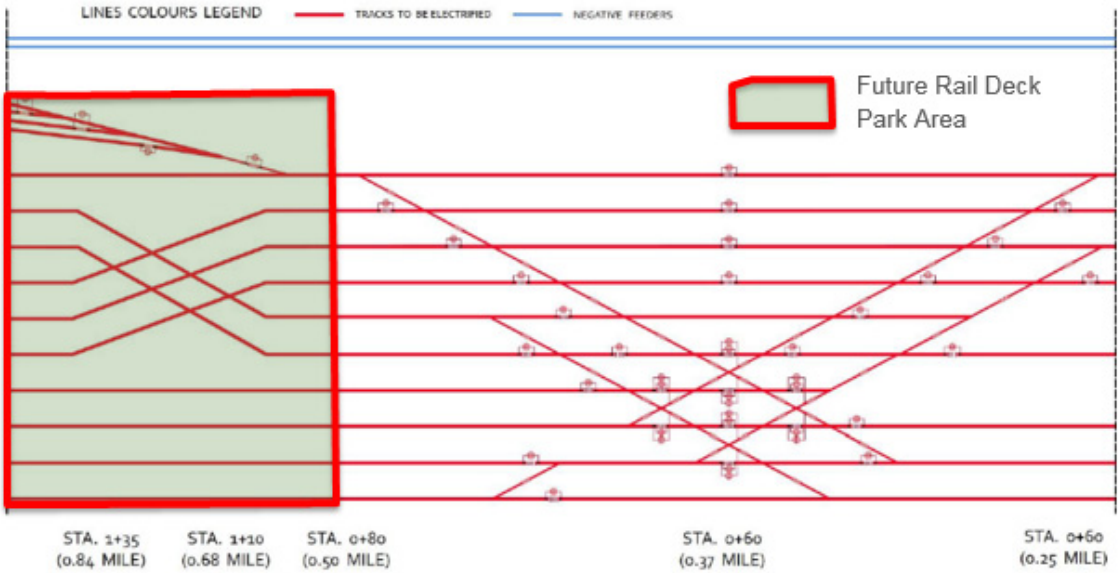
The OCS required within the USRC may consist of catenary structures placed along the tracks that will be electrified. There are a significant number crossovers and tracks within the project site, as illustrated in **Figure 6**. As a result, there are numerous challenges with installing OCS equipment and poles that will be reviewed as the detailed design of the works begins.

A crucial consideration for the electrification of the USRC is the size of the structures required to support the loads of dead-end cross-over wires. The catenary structures will likely need to be more substantial than typical portal structures because of the corridor width and number of tracks to service.

Future design for Rail Deck Park should investigate building in and incorporating an alternative or supplementary support structure to support the OCS through this section of the rail corridor. Optimal solutions can be developed based on reviewing OCS arrangements at other underground structures, tunnels, stations and precedent projects.

The design of the support columns for the Rail Deck Park superstructure must take into consideration the layout of the catenary structures to be installed along the USRC once electrification works commences.

Figure 6: Future Electrification of Tracks within the USRC



4.2.4 Track Clearances

Electrification performance specifications have been reviewed for the purpose of addressing minimum vertical and horizontal Metrolinx clearance requirements for the future RER in this Engineering and Costing Study. These specifications are articulated in the Metrolinx document "Performance Specifications for Structures Passing Over Electrified Corridors."

Transport Canada's minimal railway vertical clearance for non-electrified tracks is 6.706 metres. This value is increased to a minimum of 7.584 metres for electrified rail corridors to account for space needed for the OCS conductors and electrical clearances to enable safe train operations.

This minimum vertical clearance is measured from the top of high rail (TOR) and carried to a point 3.5 metres laterally from the centreline of the outermost track. Any deviation from these clearance specifications will require approval by Metrolinx.

In addition to vertical clearances for future electrification, coordination with Metrolinx on future track changes and improvements should be incorporated into future design work for Rail Deck Park in terms of providing required horizontal clearances for tracks adjacent to the proposed future structures in the rail corridor. Other horizontal clearances from track centerlines for structures such as poles require a minimum of 2.9 metres horizontal clearance on tangent tracks, and increased to account for rail curvature and track elevation.

The reference design concepts developed as a part of this study identify and maintain these horizontal and vertical clearances.

Prior to detailed design, a field survey is required to determine existing track lateral and vertical clearances conflicts. Areas of potential clearance conflict should be identified from the survey data to allow design and construction methods to be developed, enabling evaluation of alternative solutions to obtain minimum clearance requirements.

In its current configuration, several existing overhead structures within the USRC may have to be adjusted in order to meet the new Metrolinx vertical clearance requirements, including the Peter Street/Blue Jays Way bridge, Spadina Avenue bridge, overhead signal bridges (at mile markers 0.94 and 1.06) and Bathurst Street bridge. Solutions to address these clearance challenges could inform and be incorporated into the design for Rail Deck Park.

4.2.5 Electromagnetic Fields

The introduction of a 25kVac overhead catenary wires and auto-transformer feeder wires may result in the production of an electromagnetic field, which will have to be considered in future design work for Rail Deck Park.

Care will have to be taken to protect any equipment which could be affected by the electromagnetic field.

Additionally, any steel structure, architectural treatments, or metallic structures crossing over the track will require provisions for the bonding and grounding of these elements.

Section 3.3 of the Performance Specifications for Electric Traction Enabling Works (MX-ELECT TRACK EW-SPEC-2016-REV0) notes the requirements of structural grounding in detail, which be confirmed as an applicable Metrolinx Electrification Document.

4.3 North Bathurst Storage Yard

The North Bathurst Storage Yard is located immediately south of Front Street between Bathurst Street and Spadina Avenue. It is a layover yard that can store up to seven GO Train "consists" (i.e., a 340-metre long assembly of twelve passenger cars and one engine) from the Barrie, Kitchener, and Milton GO lines on weekdays between rush hours. At other times, these trains are stored at layover yards at the other end of these lines.

The demand for storage space has steadily increased with the increase of GO Train service. In 2007, GO Transit started work on renovations to upgrade and increase capacity at the yard. These works were completed in 2010. With increased GO train service, the functions of seven tracks comprising the yard may be re-profiled for different operational purposes, including the location of a potential new GO Station at the corner of Spadina Avenue and Front Street West. Metrolinx is currently giving consideration to relocation of much of this storage capacity to the Wilson Yard.

4.4 Planned Spadina-Front GO Station

As part of the Big Move Regional Transportation Plan, Metrolinx is advancing the implementation of Regional Express Rail (GO RER) to transform its GO Transit service to a two-way, all-day regional transportation system.

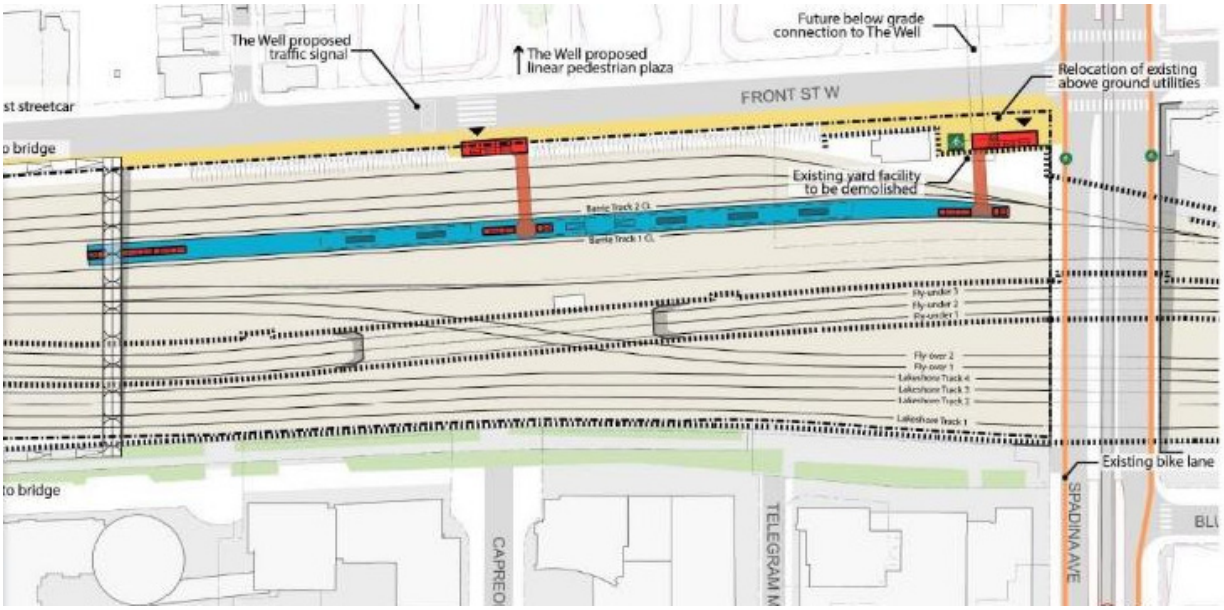
GO RER plans for the Barrie corridor include over 30 miles of new track, layover facilities, rail-to-rail and rail-to-road grade separations, new station construction and station improvements.

Together with the City's SmartTrack proposal, these initiatives will introduce 12 new stations to existing GO Transit corridors.

This work includes Concept Plans for a new Spadina-Front GO station at the corner of Front Street West and Spadina Avenue, as approved by Toronto City Council on November 8, 2016 and Metrolinx Board of Directors on December 8, 2016 (**Figure 7**).

Relevant early considerations identified by Metrolinx for Spadina-Front GO station planning, which have informed this study include: (i) the station plan would require the removal of two or three train storage tracks in the Bathurst Yard, pending further analysis is to determine operational impact and potential alternative storage locations; and (ii) there is an opportunity for integrated development on site and/or integration with City's rail deck park proposal.

Figure 7: Proposed Spadina-Front GO Station Concept Plan



5.0 REFERENCE DESIGN CONCEPT

5.1 General Approach

For the purposes of advancing the Project and analyzing the probable cost of construction, a reference design concept has been produced and is described herein and in the Appendices.

Generally, this work is technical in nature and approaches the Project from the "bottom up," where considerations include geotechnical, structural, rail, utilities, site servicing, constructability, phasing and construction costs. The concepts developed also address edge conditions and consider connectivity, grade separations, pedestrian movements, and emerging potential Rail Deck Park programmatic elements as they relate to, and inform, potential technical solutions.

The design concept is intended to be reasonably comprehensive, considering a very broad scope. Notwithstanding this, the design concept is purposely intended to be non-prescriptive in nature and maximally permissive of a range of programmatic elements and future design activities. In this regard, consideration has been given to a range of possible solutions for all systems, e.g.: foundations, structure, mechanical, electrical, decking, etc. The drawings and reports have been consolidated into a single compendium comprising plans, sections and 3-dimensional models which represent the design concept very broadly to a level of suitable accuracy.

The following figures illustrate the reference design concept, indicating the track-level structures and the deck support framing, respectively. These figures are reproduced at higher resolution in **Appendix C**, with additional annotations.

Figure 8 shows the primary structures running east-west in the Corridor and Bathurst Yard. (Note: Foreground buildings removed.)

Figure 8: Rail Deck Park Track-level Primary Support Structure

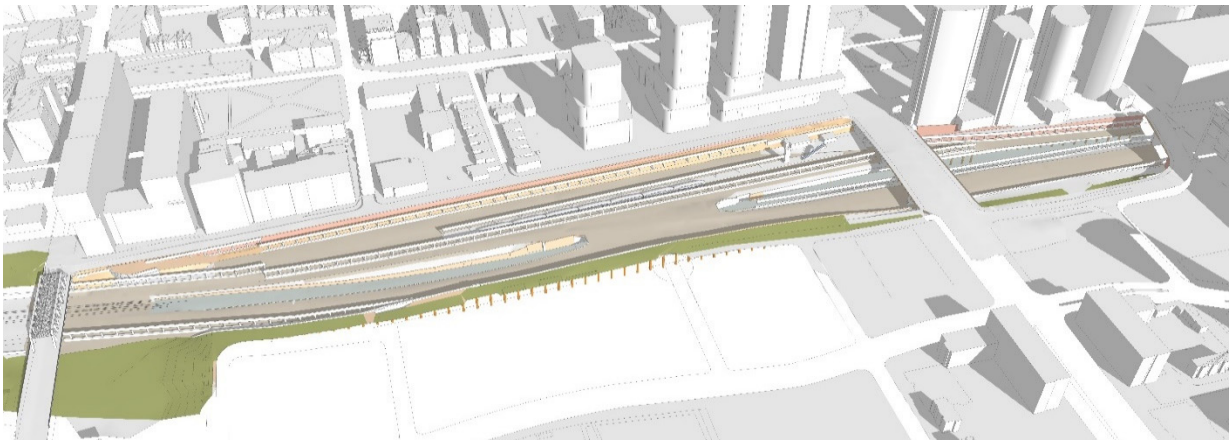
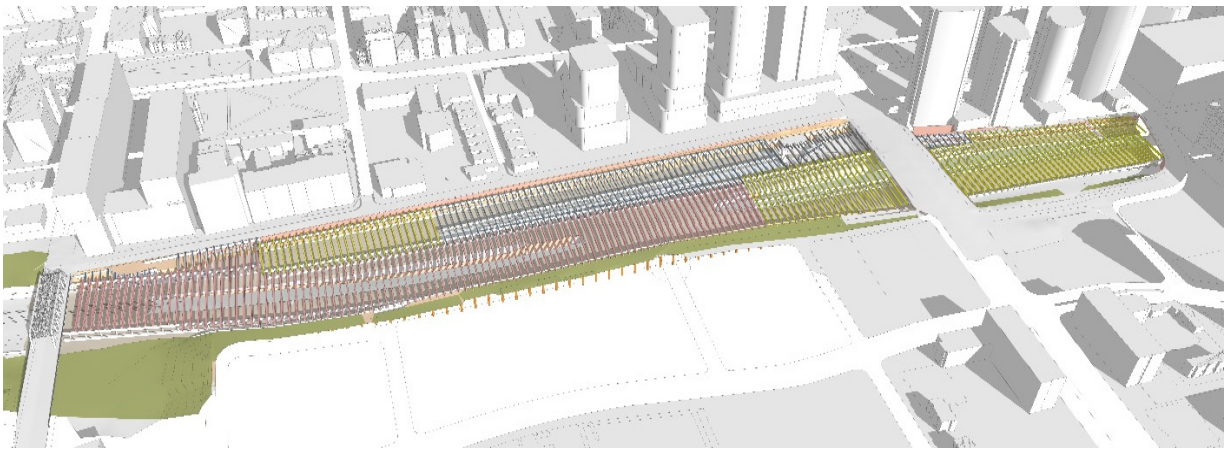


Figure 9 shows three span depths comprising the secondary support structure spanning north-south over the Corridor and Bathurst Yard. Spans are colour-coded by length.

Figure 9: Rail Deck Park Secondary Structure



5.2 Presentation of Design Concept

The Design Concept developed as a part of this Engineering and Costing Study is presented through a set of plans and drawings included in the Appendices to this report. These include:

- Conceptual Layout Plans;
- Analytical Area Summary Plans;
- Cross-Sections; and
- 3-Dimensional Models.

5.2.1 Conceptual Layout Plans

The conditions are represented in a number of illustrative plans in **Appendix A**, including:

- **Track Level Plan**: illustrating the tracks, rail horizontal clearances, general physical features and possible locations of primary structures at or below track level, including:
  - Caissons;
  - Shear walls and grade beams;
  - Columns and associated crash-wall protection;
  - Primary structural beams running generally east-west; and
  - Potential platform location(s) for a future GO RER Spadina Station in the existing North Bathurst Yard.

- **Street Level Framing Plan**: illustrating a generic structural layout spanning between the primary structures described above. Span lengths are generally colour coded as:
  - Modest Spans in blue, spanning up to 20 m;

  - Intermediate Spans in green, spanning from 20 m to 40 m; and
  - Long Spans in red, with spans from 40 m to 60 m or greater.

- **Street Level Grading Plan**: illustrating approximate grades on the Rail Deck Park and existing grades immediately adjacent to the proposed park.

5.2.2 Analytical Area Summary Plans

The project area comprises a variety of area types which collectively contribute to the Rail Deck Park concept. These are:

- Properties (boundaries);
- Construction over rail;
- Renovation of edge conditions for integration with Rail Deck Park; and
- Modification to, and integration of, current parks into the Rail Deck Park.

These area types are also summarized and quantified in **Appendix A**.

5.2.3 Cross Sections

A number of cross-sections through the site have been prepared based on the data collected, and indicating rail clearances and approximate structural depths. Given the variety of existing conditions on all four sides of each major section of the Rail Deck Park site, more than a dozen sectional studies have been prepared in reasonable detail.

Sections are labelled alpha-numerically; indicating their east-to-west position 0 through 850 metres on the site with Bathurst Street set as zero. East-west structures along the primary structural lines are labelled A through Z starting at the north curb of Front Street to the south curb of Ice Boat Terrace. Sections are also labelled to indicate the direction of the view.

Sections are included in **Appendix B**.

5.2.4 3-Dimensional Model(s)

In conjunction with analytical plans and sections of physical features, a three-dimensional model has been produced of the site itself in some detail and the broader context more generally for illustrative purposes.

The model is a reasonably accurate depiction of the existing topography and surrounding roads, bridges and buildings. The model includes elements of the reference concept design for Rail Deck Park, as described on the plans in **Appendix A**.

Excerpts from this model are included as **Appendix C**, including several views of construction sequencing.

5.3 Major Considerations for the Design Concept

The following analysis of the concept is generally organized by discipline, with site-specific locations referenced where appropriate. These analyses generally apply to all project segments; see **Section 7.0** for discussion of proposed segments and stages for Rail Deck Park.

The reference design concept is scrutinized from the bottom-up and, in addition the rail corridor considerations described in the preceding sections, addresses the following:

- Geotechnical;
- Structural;
- Civil & Mechanical Systems;
- Topographical Integration;
- Noise & Vibrations;
- Lighting & Air Quality; and
- Authorities Having Jurisdiction & Approvals.

5.4 Foundations

The preliminary framing plan for the Rail Deck Park involves the deck supported on girders spanning north-south at 4 m o/c. The girders rest on cap beams or shear walls that run in an east-west orientation along the north and south edges of the rail corridor, and interspersed between some of the tracks.

In view of the anticipated high reactions from the girders, up to 14,000 kN, it is recommended that all loads be carried on deep foundation units bearing on or socketed into the shale bedrock.

It is recognized that the selection of one deep foundation type over the other may depend partly on space constraints, i.e. if the foundation can physically fit in the available space. The current track configuration in the rail corridor provides multiple linear areas with sufficient area to accommodate larger foundation types.

For the purposes of initial plan development, it is recommended that two foundation options be considered:

- Driven steel H-piles (interlocking steel sections which are driven into the ground); and/or
- Augered caissons (drilled cylindrical shafts which are infilled with engineered reinforced concrete).

As the design for Rail Deck Park advances, other pile options could be considered. For example, micro-piles may prove to be a viable option in locations where there are space constraints governing the available work zone.

5.4.1 Foundation Types

Steel H-piles should be driven to seat on the bedrock surface. For piles driven in this fashion, the geotechnical SLS condition will not govern and the ULS resistance is essentially the structural resistance of pile, allowing for below-grade installation. Typical values of factored ULS resistance that could be used in preliminary design are as follows:

Pile Section	**Factored ULS Resistance** (kN)
HP 310 X 110	2,000
HP 310 X 152	2,750
HP 360 X 132	2,400
HP 360 X 174	3,200

Where high lateral resistance is required in the north-south direction, consideration should be given to using battered piles to provide the resistance. In the east-west direction, lateral forces could be resisted either by battered piles or by constructing a shear wall along the foundation line.

Augered caissons (drilled piles) can be considered to provide the necessary support. Caissons must be carried down to sound bedrock and can be designed by one of the following approaches:

- End bearing and founded a short distance into sound bedrock; or
- Skin friction in a deep socket in the sound bedrock.

For end bearing on sound bedrock, a preliminary factored ULS resistance of 10,000 kPa can be assumed.

The maximum caisson diameter that is likely to be required for vertical resistance is 1.5 m. As a preliminary estimate, a 1.5 m diameter caisson loaded to 10,000 kPa can be expected to settle approximately 40 mm. As the design develops, SLS values must be determined that will limit settlement to acceptable magnitudes. These settlements will essentially be immediate, meaning that there are no long-term, time dependent settlements.

For a caisson to be designed for end bearing on bedrock, the base must be completely cleaned prior to placing concrete. This is typically achieved using a cleaning bucket after the caisson has been advanced to the required depth. It is recommended that the constructability and quality control issues associated with this method be thoroughly discussed in the detailed design phase.

To carry the maximum load of 14,000 kN in adhesion in a rock socket, a 1.5 m diameter socket penetrating 7 m into sound shale is required. Cleaning the base of the socket is not important if no end bearing component is considered in the resistance calculation.

The caisson socket must be dewatered and the sides of the socket must be roughened prior to placing concrete.

5.4.2 Hydrogeological Considerations

The groundwater conditions will not affect the design values for deep foundation units.

Dewatering is not expected to impact the installation of driven piles but dewatering may be necessary to permit the construction of the pile caps.

The presence of groundwater will impact the installation of caissons and a liner must be used to support the sides and exclude the groundwater to permit placement of concrete in the dry. If pile caps are required on the caissons, dewatering may be necessary to permit construction in the dry.

5.5 Structural Design

This section describes potential structural solutions. The plans in **Appendix A**, sections in **Appendix B**, and the three-dimensional model in **Appendix C** graphically delineate the conceptual structural logic, systems, and member depths described below.

The potential solutions described here will generally support the range of above-deck loads and uses anticipated for Rail Deck Park.

5.5.1 Spans & Structural Systems

The design concept for Rail Deck Park incorporates minimal new structural occupation within the USRC owing to existing space limitations and anticipated future track works, as well as to ensure accessibility for track and utility maintenance.

The proposed structure for Rail Deck Park is long span girders spanning North-South with secondary framing or cast-in-place concrete deck running in the East-West direction.

Three main supporting lines, consisting of cast-in-place concrete beams and columns, are proposed in the East-West direction: one at the North side of the rail corridor, one at the South side of the rail corridor and one line of support in between. Columns and grade beams will be supported by deep foundations to bedrock as described in the preceding section.

Lateral stability will be provided by cast-in-place concrete shear walls in the East-West direction, and by rigid frames and buttressing in the North-South direction.

Expansion joints will be required to deal with temperature and shrinkage movements. The exact location and number of joints will depend on a variety of issues including the phasing plan. Expansion joints should be anticipated approximately every 60 m along the length of the decking structure.

In design and selection of structural members every effort will be made to maximize the degree of repetition despite the fact that the supporting lines are not parallel. This will improve the cost efficiency, construction schedule, and quality control for the project.

Maximum span lengths are approximately 60 m. Preliminary girder systems being considered are:

- Structural Steel Trusses,
- Steel Box Girders,
- Precast Concrete Girders, and/or
- Precast Concrete Segmental Girders.

Two of these options, Structural Steel Trusses and Precast Concrete Girders (segmental or not), have been developed in further detail and sample cross sections are provided in **Appendix B**.

The structure depth has been chosen based on what is the most efficient for the spans, loading and geometric considerations. Cross sections chosen allow for soil/planters for planting to be within the structure depth, between the members as spaced. This approach offers a balance between flexibility of planting locations, while minimizing the grade change between the decking structure and the surrounding road and sidewalk elevations.

Two levels of soil overburden were studied: 1500 mm planting depth; and 500 mm planting depth. Superimposed dead loads and live loads are explained in more detail in the following section.

Main girder depths do not change with the varying soil overburden levels and variety of live and dead loads considered, but the steel truss member weights and concrete pre-stressing; and/or reinforcement will be tuned to maximize efficiency for the specific loading at each location.

A summary of structural depths is provided below:

	Steel Truss with precast "tub"	**Pre-stressed / Post-tensioned Girders**
Up to 20m span:	1800 mm	1500 mm
20m – 40m span:	3200 mm	2500 mm
40m – 60m span:	4500 mm	3500 mm

**Refer to Appendix B figures for cross sections*

Integration of the rail deck with the planned Front-Spadina GO Station circulation system and platform may provide an opportunity for, or require, additional vertical supporting elements and foundations. This will minimize long spans and maximize clearance, but also allow the opportunity for vertical transportation to the platform and flexibility for additional load requirements for station entrances and other structures above grade.

5.5.2 Above-Deck Design Assumptions & Loads

As the design concept for Rail Deck Park advances, superimposed dead loads will be chosen to accommodate the required use of the space and make-up of the soft and hard landscape materials, roofing materials, etc. Allowances for suspended mechanical and electrical utilities and equipment will also be provided.

Rail Deck Park will include a variety of programs areas for access mainly by pedestrians and cyclists. Load allowance will consider limited vehicular access for service and maintenance vehicles, and emergency vehicles.

The loading considered will be as required by 2014 CSA S6 – Canadian Highway and Bridge Design Code. Design environmental loading for Toronto including temperature, snow, rain (water retention as applicable), wind, earthquake, vibrations, earth and hydrostatic pressures. Structure protection of piers and walls immediately adjacent to the rail lines will be provided as required by the various railway authorities using this corridor for rail impact loading. Consideration will be given to designing the primary structure to withstand the rail impact loading.

Any small building structures supported on top of the rail deck will be designed as per Ontario Building Code and National Building Code Structural Commentaries. Where the decking structure is anticipated to support building structures, allowances will be made to accommodate the base reactions in detailed design.

Additional construction load requirements and loads resulting from phasing/sequencing will be considered.

5.6 Utilities

The approach to utility servicing in this study has been to identify where services can be provided for Rail Deck Park, since detailed programming for the park use and exact locations of serving requirements have not yet been established. In the following sections, the locations of the existing utilities have been identified that could service Rail Deck Park.

Further analysis will be required once the park design and program have been established and the specific servicing requirements are known.

5.6.1 Stormwater Management

Stormwater for the project area is currently drained by the existing drainage system in the rail corridor.

The existing surrounding streets of Front Street, Bathurst Street, Spadina Avenue, and Ice Boat Terrace and Blue Jays Way are all at elevations substantially higher than the Railway Corridor,

and the sewers have not been designed to accommodate storm runoff from development over the rail corridor.

It is assumed that significant quantities of stormwater which presently drain at the track level will be captured and redirected through a stormwater management system integrated with the decking structure. It is assumed that this system will be connected to the street-level sewer system by different means and paths, with opportunity for stormwater detention and rainwater harvesting at the park level.

The design of the drainage system will be coordinated with Metrolinx to confirm the locations where the storm drainage from the Rail Deck Park can tie into the drainage system within the rail corridor.

As part of the Rail Deck Park design, stormwater management measures will be required to meet the City's Wet Weather Flow Management Guidelines which will reduce the overall impact on the existing drainage system in the rail corridor.

During detailed design, stormwater management measures for stormwater quantity and quality controls will need to be incorporated into the park design to reduce the peak runoff rate from the site, and to provide quality treatment of the storm runoff. Examples of water quantity controls that could be incorporated include surface storage using controlled flow catchbasins and below grade storage using either cistern or superpipes located between the structural members over the rail corridor.

Water balance measures should also need to be incorporated during the detailed design stage in order to promote the retention and reuse of stormwater. Examples of water balance measures could include bioswales, vegetated filter strips, enhanced grass swales, and absorbent topsoil layers, which will promote water balance through evapotranspiration and reuse. Stormwater can potentially be reused for irrigation and other non-potable uses.

5.6.2 Watermains

The existing watermains in the vicinity of the study area include a 300mm/400mm watermain along Front Street, from Bathurst Street to Spadina Avenue and a 300mm watermain on Blue Jays Way. These watermains will be adequate to provide the water connections to the proposed site.

The exact location and size of the required connections will depend on the proposed park design and program and will be determined during the detailed design stage of the project.

During the detailed design stage of the project, hydrant flow tests should be completed to confirm the capacity of the existing watermains. It should be noted that previous work by the Consultant Team adjacent to the project area indicates that the existing pressures in the

watermain ranged from 80 psi to 90 psi and that adequate fire flow was available for the high rise developments south of the rail corridor.

5.6.3 Sanitary Sewers

The existing sanitary sewers in the vicinity of the study area include a 375 mm combined sewer on Front Street, and an 850 x 1300 mm egg shaped brick combined sewer on Front Street. There are no sanitary sewers on Blue Jays Way east of Spadina Avenue. The closest sanitary sewer on the east side of Spadina Avenue is on Navy Wharf Court approximately half way between Blue Jays Way and Bremner Boulevard.

The exact location and size of the required connections will depend on the proposed park design and program and will be determined during the detailed design stage of the project.

5.6.4 Toronto Hydro

Toronto Hydro has ductbanks along Front Street between Bathurst Street and Spadina Avenue, and along Blue Jays Way east of Spadina Avenue that could be used to service the proposed site.

It will be necessary to coordinate with Toronto Hydro to confirm connection locations to provide electricity to the proposed site. The exact location and size of the required connections will depend on the proposed park design and program and will be determined during the detailed design stage of the project.

5.6.5 Telecommunications

Bell Canada have ductbanks along portions of Front Street between Bathurst Street and Spadina Avenue that could be used to service the proposed site.

It will be necessary to coordinate with Bell Canada and any other telecommunications provider to confirm exact connection locations and where connections can be provided to the proposed site. The exact location and size of the required connections will depend on the proposed park design and program and will be determined during the detailed design stage of the project.

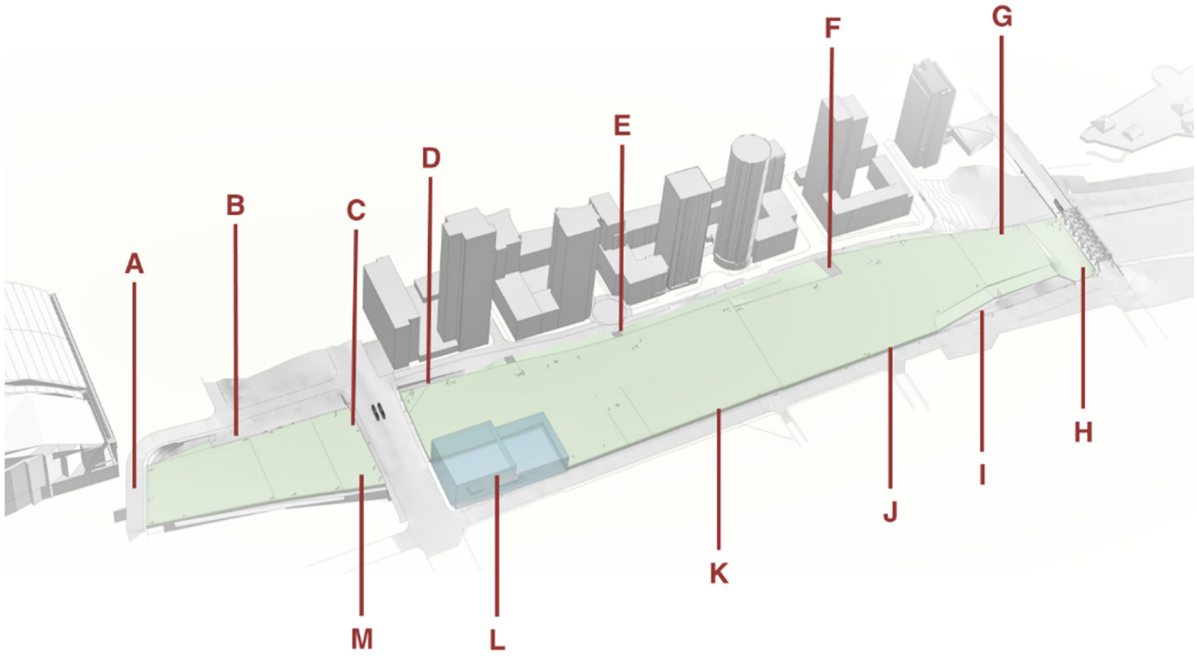
5.7 Topographic Integration

The grading of Rail Deck Park is dependent on the depth of structure, the clearance required by rail operations (as described in Section 4.2.4 Track Clearances) and by the design concept for the decking structure (e.g., structural and planting depths).

Appendix A contains a Street Level Grading Plan which indicates approximate grades of the Rail Deck Park finished surface relative to the existing grades along the perimeter of the project area (i.e., street-level grades).

An annotated oblique aerial view, looking from the northeast of project area is provided in **Figure 10**, and indicates the topographic relationship between street-level grade and the assumed finished grade achieved through the concept design for decking structure.

Figure 10: Topographic Relationship between Street-Level Grade and Decking Structure



A. Blue Jays Way is the highest point of Blue Jays Way has the potential to be relatively close to the Rail Deck Park grade at the east end.
B. Northern Linear Park and adjacent Blue Jays Way is separated from Rail Deck Park by 4 to 6 m.
C. The grade separation along those portions of Rail Deck Park adjoining the Spadina Avenue bridge are relatively modest.
D. If the existing Spadina Avenue bridge pedestrian underpass is preserved and/or improved, a relatively pronounced grade change from the walkway up to Rail Deck Park will exist.
E. Capreol Court is likely the highest existing elevation in the project area, and has the potential for an almost flat transition to the decking structure.
F. Dan Leckie Way is relatively close to the finished grade of decking structure. The horizontal distance along the south edge affords space for transitional ramps, stairs and embankments.
G. The elevation difference between the current design concept for Mouth of the Creek Park and the decking structure is significant and will have to be addressed as design advances for both projects.

H. A small but potentially workable footprint is available at Bathurst Street and Front Street to accommodate a ramp up to Rail Deck Park opposing the Metrolinx ramp down to the north Bathurst Yard, to connect with the anticipated extension of the West Toronto Rail Path in this area.
I. A notable grade change will be required to accommodate the service access ramp into the rail corridor
J. The grade relationship between Front Street and the finished edge of the decking structure at this location (Portland Street) is approximately 3 m to 4 m and will be addressed through a range of stairs and ramps. If a reasonable horizontal setback can be achieved and depending on the width of Front Street, this edge provides opportunities to achieve integration with surrounding grades, incorporate station access and enhance connectivity across the rail corridor.
K. The grade relationship between Front Street and the finished edge of the decking structure at this location (east of Draper Street) is approximately 3 m to 5 m. It provides the same opportunities described for location "J" above.
L. The anticipated requirement for station access and the potential of a building structure on this corner creates an opportunity to integrate Rail Deck Park access through and/or around the building.
M. As the Spadina Avenue bridge descends northbound, the likely grade difference between the sidewalk and the decking structure increases.

5.8 Noise & Vibration

The City of Toronto has by-laws which indicate the allowable limits for both noise and vibration during construction. These are Noise by-law 591-1 and Vibration by-law 514-2008. Clause C (3) of the Noise by-law notes that all construction activities shall occur between 7:00 a.m. to 11:00 p.m., however, rail and tunnel activities are exempt from this clause.

The MOEE/GO Transit Draft Protocol (1994), though not formally adopted, provides outlines for Noise and Vibration tolerances at existing uses for the development of transit-related projects. Noise levels during daytime and nighttime are not to exceed ambient sound level (combined with the sound level from existing rail service) or 55 and 50 dBA respectively. Ambient noise levels around rail corridors range from 55 to 70 dBA.

The introduction of the Rail Deck Park will provide mitigation of train related noise at many of the neighbouring uses, as the deck essentially provides a large noise barrier between the sources and the receptors. However, due to reflection beneath the deck, there is the possibility that train noise will be amplified at the openings. This can be mitigated through the use of sound absorptive materials below the deck.

The electrification of the USRC is expected to produce less noise compared to diesel engines and decrease noise levels. Based on Metrolinx's Noise & Vibration Impacts (December 2010) study, the new works are not expected to increase noise by over 3 dB, which is a change in

magnitude that is generally imperceptible. During construction, noise levels should be kept to a maximum of 115 dBa for a few seconds, and a maximum of 92 dBa for the remainder of the exposure.

Vibration velocities in the range of 0.14 to 0.2 mm/s range generate barely perceptible vibration in residences. The effects of vibrations tend to be localized as ground-borne vibration typically decay much faster over distance than sound. The zone of influence for vibrations are generally significantly smaller than sound. MOEE/GO Draft Protocol notes that the vibration velocity produced from GO Transit projects at point of reception should not exceed the higher of 0.14 mm/s at point of vibration assessment or the vibration levels from existing operations when they exceed 0.14 mm/s. It should be noted that these limits apply to existing residential dwellings or places where people ordinarily sleep or a commercial/industrial operation that is exceptionally sensitive to noise or vibration and not to Rail Deck Park itself. Neither the City of Toronto nor the Province of Ontario have vibration limits that apply to parks.

Mitigation efforts should be considered if vibration velocities rise by 25% or more. Based on the Noise & Vibration Impacts study, the zone of influence is expected to decrease in size with the implementation of electrification along the USRC. Although vibration levels will be lowered, any conduits, electrical metallic tubing, non-metallic ducts or tubing, and wires with their outer casings that will be mounted below the decking structure need to be rigidly secured in place by means of cleats, straps, or bushings.

5.9 Below-Deck Safety Systems

The specific below-deck safety system requirements for Rail Deck Park will be determined by the treatment of the structure – as either as an enclosed structure or an open access design.

If the Rail Deck Park is considered an enclosed structure, specific additional requirements from NFPA 130 of the US National Fire Protection Act will apply.

Current railway industry practice for enclosed railway structures requires specific design requirements regarding life safety coverage. These requirements are included in “NFPA 130, Standard for Fixed Guideway Transit and Passenger Rail Systems.”

The general requirements for an enclosed structure are summarized below. If Rail Deck Park is ultimately designed as an open access structure (i.e. similar to a parking structure) then these requirements should be re-evaluated.

5.9.1 General & Emergency Lighting Systems

Rail Deck Park will require additional lighting for rail maintenance and operational requirements. The general lighting system shall provide consistent illumination under the decking structure. The required length of traditional lighting based on speeds and the corresponding safe stopping distance will be determined through detailed design.

A minimum lighting level of 40 lux is to be provided for general purpose lighting. Similar requirements have been specified for Metrolinx projects such as the proposed Highway 401 Rail Tunnel on the Kitchener Corridor.

The lighting system should include luminaires that are specifically designed for use in underground rail tunnel systems, a prismatic glass refractor to control light output from LED light sources, and a die-cast aluminium front frame and body for durability. At a minimum, lamps of a dimmable LED type with lifetime exceeding 50,000 hours should be selected.

Emergency lighting is required to illuminate exits and corridors, principal routes providing access to exits, and everywhere employees normally congregate. All emergency lighting provided must operate automatically in the event that the regular power supply is interrupted. These systems must be designed so that during a period of evacuation, illumination levels of train-level walkways and walking surfaces shall not be less than 2.7 lx (0.25 ft.-candles), measured along the path of egress at the walking surface. Emergency lighting will require uninterruptable and back-up power supplies.

As part of the emergency lighting system luminaire's requirements will include: vandal-resistant, surface mounted LED battens, complete with clear diffusers; light fittings and lighting controls rated to IP65, or higher. Lighting must be installed at a height above the designated emergency walking surface to permit maintenance without the use of a ladder.

5.9.2 Air Quality & Ventilation Systems

During successive stages of design, a mechanical ventilation study will be required to establish effects of the Rail Deck Park over the rail corridor and the system requirements to mitigate these effects and ensure proper air quality.

In addition, a three dimensional (3D) Computational Fluid Dynamic (CFD) analysis will have to be completed to ensure proper ventilation placement in the event of a fire as per NFPA 130, Standard for Fixed Guideway Transit and Passenger Rail Systems.

A temporary ventilation system should be anticipated for use during construction, including but not limited to fans, dampers, controls, and related appurtenances. The temporary system will be accompanied by a detailed air quality analysis.

A permanent ventilation system will be required within the decking structure for regularly-scheduled operations, maintenance operations and emergency situations in the below-deck area.

It is expected that diesel trains will operate through the USRC for the foreseeable future. Therefore, a mechanical ventilation will be required in accordance with NFPA 130 for the enclosed structure (exceeding 305 metres in length). This system could entail large ventilation fans, or a series of 1.6 metre diameter jet fans along the enclosure.

Ventilation fans should be accommodated within horizontal and vertical clearances under the decking structure if required. In opening areas, ventilation requirements could be reduced. Options for exhaust system discharge must be carefully located and designed so as not to negatively impact above-grade uses in or around the Rail Deck Park.

5.9.3 Emergency Access & Egress

Emergency evacuation in this area of the rail corridor is currently a challenge given the width of the corridor, number of tracks and limited points of access and egress. Design of the decking structure should consider opportunities to increase the number and accessibility of emergency access and egress points.

If Rail Deck Park is ultimately considered an enclosed structure, it will be required to meet "The Standard for Fixed Guideway Transit and Passenger Rail Systems (NFPA 130)" for permanent emergency access points. This requires emergency be provided at 762 metre intervals. The length of the park is expected to be approximately 850 metres, meaning an additional access/egress route will be required. **Figure 5** shows possible alternative locations.

The design of the primary structures (parallel to the rail) and secondary structures (perpendicular to the rail) must incorporate appropriately spaced and separated egress routes from the track level up to grade.

The rail corridor under the Rail Deck Park will require a walk surface or other approved means for employee and passenger evacuation to enable a safe route along the rail corridor to the nearest egress point or other point of safety. For emergencies such as fire, ventilation systems may be required to address safety of egress pathways.

5.9.4 Other Emergency Systems

Items such as warning signs will be required at entrances to the rail corridor and on fences or barriers adjacent to the rail corridor, identifying the hazard. Directional signs and emergent lights will be required to be readily visible to passengers for emergency evacuation.

Various emergency plans should be established during construction. An Emergency Procedure Plan will be required to specifically address the various types of emergencies that might be experienced within the USRC during construction of the Rail Deck Park. A site-specific emergency plan must also be prepared prior to commencing work.

Following construction, an emergency plan as well as operational procedures for emergency situations will be required for train operations and employees performing maintenance under the decking structure.

In all situations, evacuation will take place only under the guidance and control of authorized train system employees or other authorized personnel as warranted under an emergency situation.

In the event of failure of the normal power supply within the Rail Deck Park, an emergency generator is required. Emergency lighting, protective signaling systems, emergency communication system, and the fire command center would need to be connected to the emergency generator system. The generator system should be included in the design for railway clearance requirements.

Automatic fire detection, standpipe and hose systems, portable fire extinguishers will also be required as per NFPA 130. The standpipe and hose systems are required for Toronto Fire Services to connect to in event of a fire in the rail corridor. For example, connections are required at 60 m intervals along the enclosed corridor. Other details are included in NFPA 130 which include access roads and specifics on required connections and distances.

In case of fire, all the passengers and employees need to be evacuated in accordance with an approved Safety Evacuation Plan.

6.0 AUTHORITIES HAVING JURISDICTION & APPROVALS

Project permits, licenses, and approvals will be procured as required from various agencies at the three different levels of government including municipal, provincial and federal.

The anticipated permits, licenses, and approval from each of these levels of government and other anticipated requirements are described in the following sections and will be further delineated in future stages of the work.

This section also provides advice concerning the potential for Environmental Assessment process.

In addition, various approvals and measures will need to be put in place to ensure safe and effective construction in the rail corridor.

6.1 General Municipal Approvals & Permits

The Rail Deck Park project is located in the City of Toronto, with by-laws and/or requirements in place to address social-environmental factors including noise, air quality, and road encroachment.

Since the project abuts numerous building garages, the City of Toronto building permit process (designated structure) may be applicable.

6.2 General Provincial Approvals & Permits

A number of permits, licenses and approvals are at the provincial level, including those to be obtained through the Toronto Region Conservation Authority (TRCA), Ministry of Natural Resources (MNR), Ministry of Energy and Climate Change (MOECC), and others. There are significant approval bodies that will influence the development and timelines of the project.

Metrolinx, as a transit authority has two aspects in their approval process – a technical review and a construction & access agreement – both of which will take a significant amount of time to finalize. Metrolinx requirements are discussed in further detail below.

6.3 Rail Corridor Access, Work, & Safety Requirements

Works affecting railway operations and major or minor track closures will require a Rail Corridor Access Permit. When working at a specific track location, adjacent tracks must also be taken out of service from train operation to protect workers.

Arranging of access will require approval from the Toronto Terminal Railway (TTR) which is responsible for the maintenance and operation of all passenger and freight trains including on and off track equipment and vehicles.

Construction access and route plans must be prepared for contractor access and deliveries. Access must be permanently controlled at entrance gates and will need to be maintained during construction for emergency vehicles. Public access and visibility will be restricted through proper controls such as gates and site barriers.

Construction track/work blocks affecting train operations will need to be developed based on detailed work plans and will require Metrolinx approval prior to track permit authorization being issued. Natural track block windows outside of train operation times for construction should be anticipated (e.g., night work outside of Union-Pearson Express hours).

Currently Metrolinx is to be notified of major planned works within the rail corridor more than one year in advance. A written detailed construction activity report including planned dates and duration with activities broken into hourly increments is to be submitted to Metrolinx 16 weeks in advance of any work blocks.

Metrolinx reserves the right to change previously approved track blocks due to unforeseen operational requirements without penalty. As such, provisions have been made in the estimate to account for such delays.

A site meeting with the contractor and Railway Flagman (Railway Protection Person) is required four weeks in advance to confirm any track protection requirements. Metrolinx reserves the right to make adjustments to the track block and Flagman schedule as required. The Railway Protection Person will provide proper track protection and assist, participate and / or conduct job briefing prior to work commencing. They will also have the contractor sign the job briefing form before employees or equipment are allowed to move or be positioned in the right of way. All parties involved in the work must obey the Railway Protection Person directives at all times. All parties involved in the work must always expect train, engine, car or tack unit movement on any track, at any time, in either direction. Costs of the Railway Protection Person will be covered by the contractor through agreement with the rail corridor owner.

The contractor will be required to be competent/approved and have experience working on similar rail corridor environment. The contractor will be required to comply with all Canadian Rail Operating Rules (CROR) flagging requirements.

Contractors must be experienced and approved and have work experience in similar rail corridors. Contractors' Safety Plan and Safety Record should be reviewed prior to being shortlisted on a bidders list.

To work safely within the rail corridor, all personnel must have protective equipment (PPE) and be trained in railway safety courses (i.e.: GO-Safe training), and be familiar with the rules and regulations of working in the rail corridor. All vehicles, equipment, and tools should be in good operating condition. All vehicles and equipment are to give the trains the right of way. Vehicles, equipment and personnel must be prepared and able to stop at all railway at-grade crossings,

and shall stop working when required to ensure safe train operations. If cranes are being used, crews shall ensure that the crane body, boom or load attached to the crane is parked parallel to the tracks to maintain adequate minimum clearances. Crane loads must be grounded while trains are passing to avoid any swinging motion.

Safety rules and regulatory compliance shall be monitored on-site and during work in the rail corridor. Non-compliance will be addressed immediately with applicable consequences.

6.4 Federal Approvals & Permits

Any federal approvals and/or permits required under the Railway Safety Act, the Transportation of Dangerous Goods Act, the Canadian Transportation Accident Investigation and Safety Board Act, the Canada Labour Code and/or the Canada Transportation Act will be confirmed in subsequent phases of the project.

Other responsibilities include those permits, licenses and approvals required with the utilities and authorizations where multiple levels of governments and regulatory agencies are involved.

6.5 Environmental Assessment

Initial evaluation suggests that the Rail Deck Park project can meet Ontario Environmental Assessment Act requirements through a streamlined process – i.e., through the Schedule C Municipal Class EA or a Regulation (e.g. Transit Projects Regulation).

Municipal Class EA Schedule 'C' projects involve the following components:

- Phase 1: Identify the problem or opportunity;
- Phase 2: Identify alternative planning-level solutions to address the problem or opportunity by taking into consideration the existing environment and establish the preferred solution taking into account public and review agency input;
- Phase 3: Examine alternative concepts for implementing the preferred solution, based upon the existing environment, public and review agency input, anticipated environmental effects and methods of minimizing negative effects and maximizing positive effects; and
- Phase 4: Document, in an Environmental Study Report a summary of the rationale, and the planning, design and consultation process of the project as established through the above phases, and make such documentation available for scrutiny by review agencies and the public.

Figure 11 identifies the permits, licenses, and approvals, at all levels of government and otherwise, that are anticipated for the project.

Figure 11: Municipal, Provincial, Federal, and Other Permits, Licenses and Approvals

Anticipated Permits / Licences / Approvals	Municipal	Provincial	Federal	Other
Municipal Consent	●			
PHM-125	●			
Road Closure Permit	●			
Noise By-Law Exemptions	●			
Municipal Road Occupancy Permit	●			
Tree Cutting Permit	●			
Encroachment Agreements	●			
Public Lands Act		●		
Ministry of Tourism, Culture and Sport (i.e. Archaeological Assessment)		●		
Ministry of Labour Notice of Project		●		
Record of Site Condition Regulation, Ontario Regulation 153/04		●		
Ontario Endangered Species Act 2007, Permit		●		
Certificate of Approval from MoE		●		
Environmental Protection Act		●		
Ontario Regulation 347 (Hazardous Wastes Through a Series of Listings and Tests)		●		
Approval by the MOECC Director for environmental plans as required per EA conditions of approval		●		
TRCA Permit (Ontario Regulation 158)				●
Letter of Intent				●
Permanent and Temporary Easement Agreements				●
Utility Crossing Approval (Hydro One; Rogers, TELUS, Bell Canada, Enbridge Gas, City of Toronto, Toronto Hydro)				●
Stormwater Management Approval				●
Metrolinx Technical Review				●
Metrolinx Construction Methodology Review				●
Metrolinx/City Construction Access Agreement				●

7.0 BUILDING RAIL DECK PARK

The following section describes the logic behind the implementation and construction of the Project.

7.1 Construction Steps

This refers to logical steps required, in sequence, to prepare, construct and complete a project or phase of a project. These steps are somewhat independent of phases and some steps of work must be performed each time for multiple phases. For example, extensive rail preparatory work will be required over the whole of the project area, especially for utilities, signals, electrical and other relocates necessary to allow for the construction and operation of Rail Deck Park.

This sequencing is fundamental to determining risk and costs, and has been applied to the breakdown of project costs in **Section 8**, and are illustrated in **Appendix C**.

Sequentially, the construction steps are generally as follows:

- **Early Works**: rail systems and utility work in and around the Rail Yard and Corridor;
- **Foundations**: major below-ground structures in and around the Rail Yard and Corridor;
- **Primary Structures**: walls and columns parallel to tracks (in the east-west direction);
- **Secondary Structures**: long-span trusses over the tracks (in the north-south direction);
- **Systems**: fit-up of major mechanical, electrical, irrigation and drainage systems;
- **Decking**: platform above the trusses plus securing the underside; and
- **Park**: installation of hard and soft landscaping, park program and facilities.

Each step above is described chronologically and in more detail below.

7.1.1 Early Works

This includes the preparatory work in and around the rail corridor and yard required to reroute utilities, relocate signals and electrical distribution, establish staging areas and generally prepare the Rail Deck Park project site and surrounds for heavy civil and structural works. It also includes some preparatory work for major tie-ins of stormwater systems and other site servicing work.

Site and subsurface investigations will be performed to locate utilities and services as well as to determine geotechnical, environmental, hydrogeological and archeological conditions, which will influence design solutions and construction methods.

With respect to rail systems, a comprehensive work program will be necessary during this step to ensure that all systems affected by Rail Deck Park are identified and, if necessary, relocated in a manner suitable for ongoing rail operations and maintenance beneath the completed Rail Deck Park.

Rail components and systems include but are not limited to:

- Signal in-ground relocations and utilities conduit backbones;
- Rail and other track materials (OTM) upgrades;
- Ballast placement (including new ballast and surfacing after ties and rail);
- Concrete tie upgrades (non-combustible);
- Turnouts (non-combustible); and
- Upgrade track area walk surfaces for employee and passenger egress.

The probable extent of the early works scope is over the entire site. Additional track-level will precede each phase of construction.

7.1.2 Foundations

The foundations portion of the work is performed from track level, and involves the establishment of deep foundations as described in Reference Design Concept section. The nature of this work necessitates access down to the track elevation from street level by heavy civil equipment such as augers and excavators. Allowances must also be made to accommodate removal of excavated soils. It is important to acknowledge that much or all of this work must be performed under rail procedures inasmuch as the work is in or around an active rail line.

At the completion of this stage of work, caissons and other foundation systems will be in place ready to receive primary structural systems, and the project will be substantially “out of the ground”.

7.1.3 Primary Structures

This is the stage of work where the first visible structural elements emerge above grade (track level). It involves work largely in the rail corridor and yard, and the work occurs at track level, including column, major beam and crash-wall construction; temporary work platforms and access ramps, and the readying of the primary structure for the placement of secondary structural elements.

While not as extensive as the foundations stage, there will be major structural works associated with the construction of reinforced concrete and steel structures parallel to the tracks. This work will require the clear delineation of construction islands (described below), and procedures for access and the application of work restrictions acceptable to the rail operator.

7.1.4 Secondary Structures

Once the primary structures are in place, the fabrication, assembly and installation of the secondary support structures for the Rail Deck Park is commenced. The secondary structures are comprised of medium to long span members in precast concrete or steel as described in

Reference Design Concept section. The secondary structures will be fabricated off-site and delivered in the maximum size suitable for transport by road. These structures will then be pre-assembled and prepared in staging areas adjacent to the Rail, and then positioned for installation.

Once fabricated, delivered and pre-assembled, installation of medium to long span members over an active Rail will be subject to work restrictions and will require rail shut-downs imposed by the rail operator.

7.1.5 Systems

This includes major mechanical and electrical systems required by the park itself and related to rail operations and maintenance, and to provide ultimate means of public and personnel evacuation and life safety systems.

Above the deck, distribution and tie-ins will be required for park electrical systems as well for drainage and irrigation. Below the deck, systems include mechanical exhaust for ventilation, electrical distribution for rail systems, and communications and emergency lighting required for egress.

The underside of the decking structure may present an opportunity for securement and distribution of electrification systems. It is anticipated that there will be an operations and maintenance separation between the decking structure above and the rail below to the greatest degree possible.

7.1.6 Decking

This phase involves completion of the "sandwich" which forms the entire assembly between Rail Deck Park above and the rail yard and corridor below. The decking above the structure includes topsoil and planting structures as well as provisions for hard landscaping, plazas and walkways which may take the form of precast concrete or steel decking.

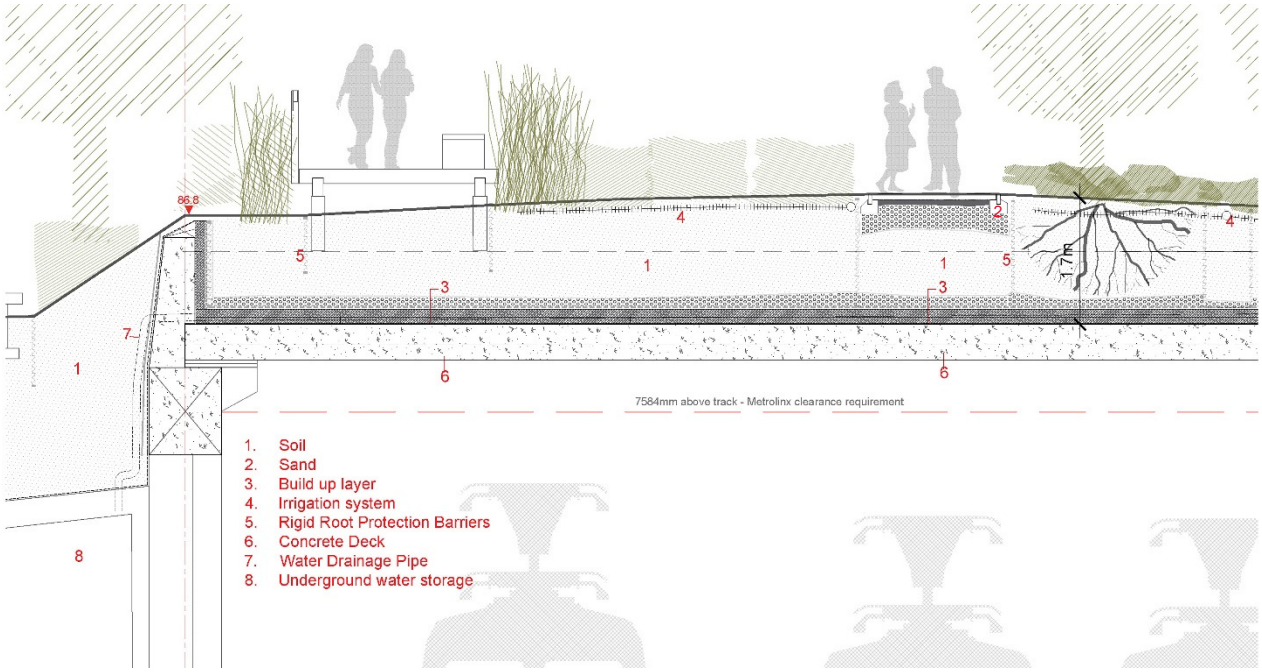
The assembly must also function as an acoustic and vibration separation as well as a life safety barrier.

7.1.7 Park Development

This comprises the installation of the park itself atop the deck as well as between the secondary structural members, and the activation of all remaining systems necessary for full and safe operation. Planting, paving, lighting and all other systems are connected to the distribution systems established as a part of the decking structure.

The overall construction of the structure, deck, systems and park are illustrated in **Figure 12** below, which is excerpted from **Appendix B** figure B-22.

Figure 12: Representative Technical Section through Completed Decking Structure



7.2 Construction Methodology

Construction access and sequencing is a primary challenge on this downtown Toronto site, surrounded by main arteries on three sides, and constructed over an active/operational rail corridor. Two preliminary methods of construction are described below.

The first approach would be to construct from above the rail corridor. This would include the erection of a temporary work platform supported by temporary steel trusses spanning to permanent lines of support. The work platform would be moveable along the length of the deck. As portions of deck are completed they can be used as temporary staging areas. Main girders or segments could be launched onto the temporary platform at street level.

The second approach would be to construct from below. This may include the use of mobile cranes, capable of moving along rail tracks, and erecting girders/trusses from below. Depending on the sequencing and timing of construction of the RER station, the area planned for the station could be used as a staging area allowing for site production/assembly of long span elements. The design team undertook to engage a construction manager to provide additional input on some possible construction techniques and methods.

7.2.1 Construction Islands

Construction islands are the areas of the site which will be utilized for must be defined, and a constructor must be clearly assigned and identified.

It is assumed that the early works and foundations stages will be performed entirely under Metrolinx work regulations.

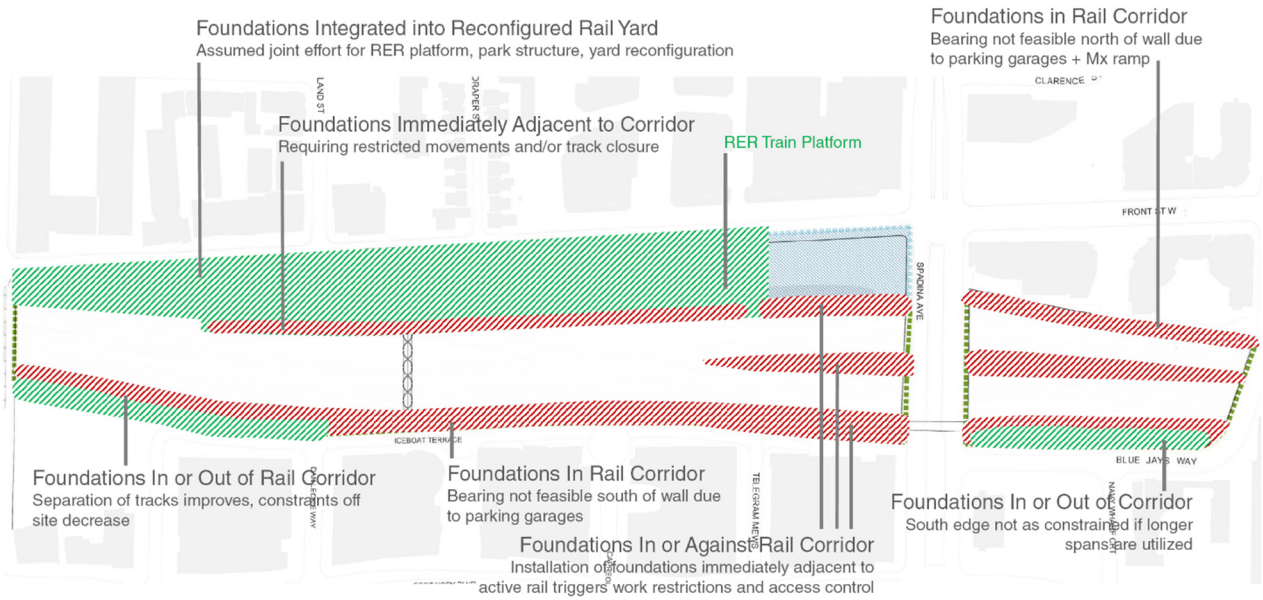
It is assumed that once the early works are completed, the deck construction stage will be possible under a dedicated constructor or constructors, with the following important provisions:

- **Construction Island Access**: the *access to* construction islands which have extensive frontage on streets is expected to relatively straightforward. The access to small, attenuated construction islands which are mostly surrounded by active rail corridor is expected to be much more challenging. This is particularly true on the areas flanking Spadina Avenue, as well as for the area at the north-east of the Rail Deck Park site between the rail and Metrolinx access ramp beneath the Spadina Avenue Bridge.
- **North Yard**: the expected reconfiguration of the North Bathurst Yard, while not yet entirely clear in scope, has the potential to provide significant construction islands which are unencumbered by rail operations and/or largely separated from active rail operations. This large area is depicted in **green** in **Figure 13**.
- **Restricted Track Movements**: notwithstanding ease vs. difficulty of *access* to construction islands, areas depicted in **red** in **Figure 13** will be subjected to rail operations restrictions at any stage of construction.
- **Foundations** + **Primary Structures**: separate and apart from accessibility and track restrictions, construction islands indicated in **red** in **Figure 13** are also relatively constrained for space at the track level. This will necessitate careful planning for shoring, excavation, and placement of foundations as well as for the construction of primary structural walls, beams and girders (parallel to the tracks).
- **Deck Construction ~ Secondary Structures**: a vertical separation (i.e.: a horizontal plane between tracks and a construction island overhead) of the tracks from the deck is not assumed. This will require work restrictions during the placement of secondary structure (perpendicular to tracks). Additionally, laydown and staging areas will be very limited prior to the construction of the first stages of the first phase.
- **Track Shutdowns**: it is conceivable that the installation of the secondary structure (north-south girders, trusses, beams) above any active rail line will require a track shutdown for each lift-over where structures are installed.
- **Park Construction**: it is expected that once the primary and secondary structures are in place, they will serve to protect the active rail lines from overhead construction activities.

The construction islands for work at track level are illustrated in **Appendix E** and **Figure 13**.

Foundation placement areas at track level are indicated in green where Metrolinx work restrictions are potentially limited (or negated by Metrolinx track relocates) and in red where Metrolinx work restrictions are likely extensive (adjacent to tracks, constrained areas).

Figure 13: Location of Construction Islands



7.2.2 Staging Areas

This refers to areas of land or temporary platforms which are established or built as lay-down areas to support the construction of stages or phases. This also refers to strategies in time and space for the sequential construction of the project. Phasing options account for construction staging logic.

Extensive areas for staging (in blue) required on and off site for laydown, mobilization and access for Phase One (red line) in **Figure 14**. **Figure 15** shows area of completed deck (in green) preserved for staging (red line) as well as extensive off site staging area (shown on Front St.).

Figure 14: Initial Staging Areas for Phase One

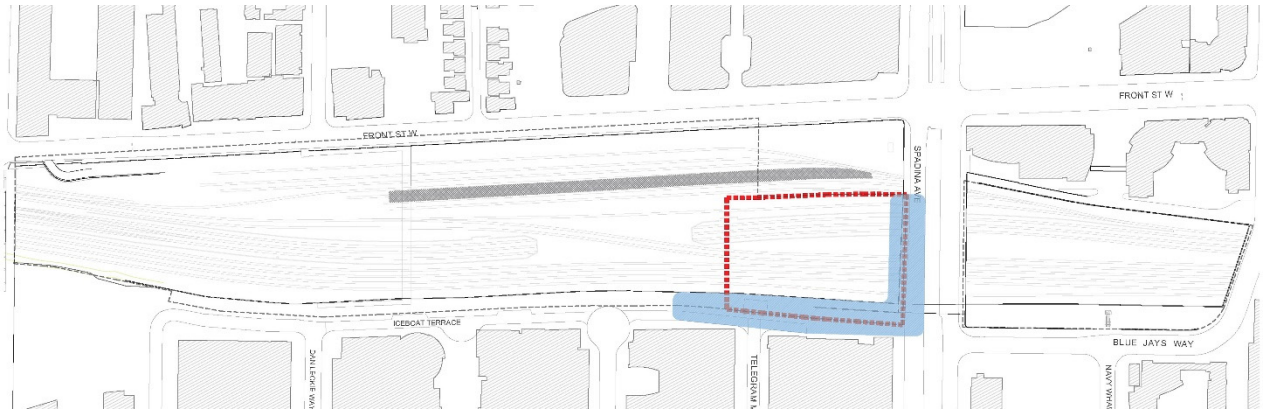
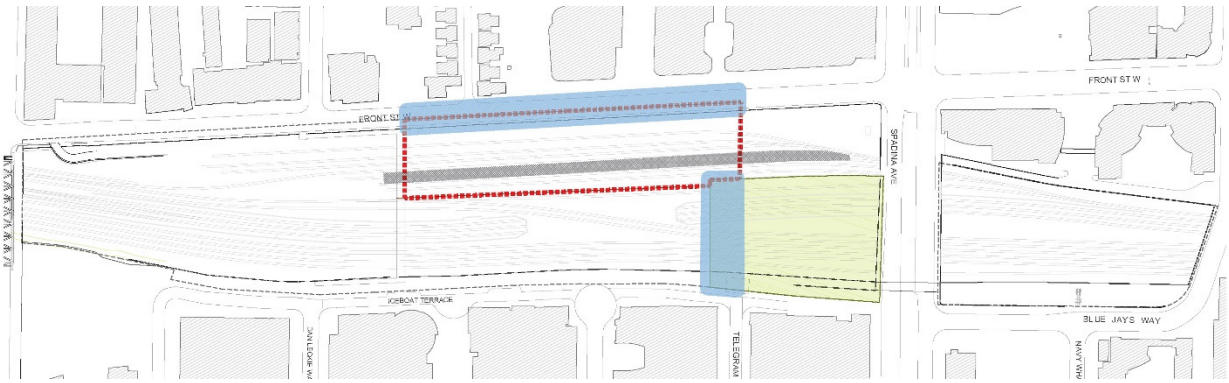


Figure 15: Subsequent Staging Areas for Phase One



7.3 Phasing

Construction “phasing” refers to the order in which the development and construction of the decking structure could be sequenced. Potential Phases are described below and in more detail in **Appendix E**. Any phasing approach chosen will include early works well beyond the footprint of the phase itself.

Phasing strategies can be driven by opportunities or constraints of other initiatives, programmatic priorities, and other factors. It must be logically conceived while also viewed in the context of an overall vision for the project.

The proposed approach to phasing for the project includes a preferred Phase One option which starts west of Spadina Avenue and extends to the current location of the "Puente de Luez" pedestrian bridge.

Although the **Figure 16** shows one option for the sequence of future phases of Rail Deck Park, this should be reviewed based on programming and design considerations for the park, as well as alignment with related capital works in the rail corridor.

The approach establishes the first phase across the entire north-south width of the rail corridor and yard, and establishes an area of long-span deck, intermediate-span deck and short-span deck all during the first phase.

Important to this approach is the ability to integrate the structural elements of the reconfigured North Bathurst Yard and potentially to establish a significant track-level construction island for the new RER platform, and primary structural work for the east-west Rail Deck Park foundations and supports. As with any phasing option, this would require significant early works to relocate services and utilities across much of the project area.

Figure 16: Proposed Phasing Approach

8.0 COST ESTIMATES

The cost estimate was developed as a Class 4 Estimate, in accordance with guidelines provided by the Association for Advancement of Cost Engineering.

The total budget for complete development of Rail Deck Park is estimated to be in the range of $1.665 billion (**Figure 17**). The estimate contained here in reflects October 2017 pricing levels and excludes any allowance for cost increases beyond this date (i.e., price escalation).

The estimate is based on an analysis of the reference design concept, which is advanced to between 1% and 5% design development.

The cost estimate reflects the scope of the design concept which has been quantified and estimated. The design concept will be substantially refined and elaborated through subsequent Project stages. Cost estimates should be read in the context of the list of exclusions, assumptions and estimate notes.

Figure 17: Cost Estimate Summary by Phase

	PHASE 0 & 1	PHASE 2	PHASE 3	PHASE 4	TOTAL
area (SM)	37,972	10,600	17,199	15,738	81,509
Early Works Packages	**155,000,000**	**7,000,000**	**9,000,000**	**9,000,000**	**180,000,000**
Deck Construction	255,000,000	73,000,000	99,000,000	103,000,000	530,000,000
Park Construction (On Top of Deck)	39,000,000	13,000,000	16,000,000	14,000,000	82,000,000
sub-total	**294,000,000**	**86,000,000**	**115,000,000**	**117,000,000**	**612,000,000**
General Requirements	42,000,000	12,000,000	16,000,000	17,000,000	87,000,000
Construction Management Fee	29,000,000	8,000,000	11,000,000	12,000,000	60,000,000
Work Restrictions	146,000,000	42,000,000	57,000,000	59,000,000	304,000,000
sub-total	**511,000,000**	**148,000,000**	**199,000,000**	**205,000,000**	**1,063,000,000**
Design and Pricing Contingency Construction (C/O) Contingency Other Allowances	156,000,000	44,000,000	63,000,000	64,000,000	327,000,000
HST - Excluded	0	0	0	0	0
Total Construction Cost (Excluding EW)	**667,000,000**	**192,000,000**	**262,000,000**	**269,000,000**	**1,390,000,000**
Total Construction Cost (Including EW)	**822,000,000**	**199,000,000**	**271,000,000**	**278,000,000**	**1,570,000,000**
Total Design Fees (Including Contingency)	**50,000,000**	**12,000,000**	**16,000,000**	**17,000,000**	**95,000,000**
Total Construction Costs + Design Fees	**872,000,000**	**211,000,000**	**287,000,000**	**295,000,000**	**1,665,000,000**
Cumulative Total (Excluding Escalation)	**872,000,000**	**1,083,000,000**	**1,370,000,000**	**1,665,000,000**	

8.1 Notes & Assumptions

The cost estimate has been developed based on a number of standard assumptions including that the work (including all sub-trades) will be procured on the basis of a competitive process and that bids will be received from a minimum of five general contractors.

Quantities and rates are provided in the estimate as a means of explaining the rationale for the estimate.

Quantities are based on best estimates and industry standards on behalf of the design team with respect to the materials, sizes and weights of structural members, depths and type of fill material, types of paving, etc. These quantities will be tested as the design work proceeds.

Rates are based on the past experience of the cost consulting team and feedback from some of the sub-trades following high level discussions. These rates should be revisited once more detailed design information becomes available and the project details and logistics are better delineated.

8.2 Cost Categories

The cost summary was developed for early works (Phase 0) and each of the four construction phases (Phases 1-4) for the decking structure and park development.

8.2.1 Hard Costs

Hard costs generally include all elements related to early-works, foundations, primary and secondary structures, systems, decking and park development described above.

Cost associated with the early works should be considered provisional until further information concerning related capital works in the rail corridor are known. There is a higher degree of certainty associated with deck and park construction which are more applicable to quantity and unit price analysis.

8.2.2 Construction Management Fee

This is an allowance for the fee that will be charged by a Contractor to either act as a General Contractor or as a Construction Manager depending on how the construction work is procured.

The fee range is normally 4% to 8% for a heavy civils project such as this. Currently the estimate includes 6% in this regard.

8.2.3 General Requirements

General Requirements is a provision for the contractor's site set-up and site supervision and is based on past experience.

General Requirements for track related work are cited as much higher than customary. It is assumed that these allowances will remain applicable to work related to the rail corridor, rail yard, and any work which is to be performed adjacent to or above the rail lines.

For the early works and deck construction, 15% is carried assuming that work constructing the primary structure at track level will attract rail related costs, while the work above this will be impacted to a lesser degree.

For park construction, 10% is carried which is in keeping with standard construction requirements.

8.2.4 Work Restrictions

This is an allowance to account for any restrictions that may be placed on the work by Metrolinx or other rail corridor authorities, including such items as night work, short shifts, hand excavation, use of specialty equipment, etc. The extent of these requirements are currently unknown.

For the deck construction 50% is carried while on the park construction 0% is carried.

Approximately $304 million is allocated to work restrictions related to premiums for construction activities in, around or above the rail corridor and yard.

These values are subject to refinement through advancement of the concept and development of constructability methodologies with Metrolinx, and are considered to be highly variable at this stage.

8.2.5 Contingencies & Allowances

Approximately $327 million is allocated to Design and Pricing, Construction and other contingencies. Design contingencies are lower for deck and park construction, where the scope is clearer and the methodological uncertainty related to track work is reduced.

Potential for further certainty of scope and/or reduction of contingencies can be realized during subsequent design work and through engagement with Metrolinx. This will involve work to refine the assumptions of this study, determine design scope for early works with more certainty, and through coordination of track-level works associated with Rail Deck Park, North Bathurst Yard reconfiguration, and Spadina-Front GO Station construction.

The Design and Pricing Contingency recognizes the amount and type of design information available for the project, and is an attempt to allow for potential increases in the estimated costs which normally occurs as the design detail is developed. This contingency is typically reduced as more detailed design information becomes available.

Construction (Change Order) Contingency is to account for the cost of changes to the work that will occur post-contract. For the early works and deck construction, this contingency is higher

given that much of the work will take place in and around the existing rail lines where many of the issues may not be fully identified until after the work commences on site. For the park construction, this contingency is lower given that the vast majority of the work will be carried out on top of the newly-constructed deck and therefore post-contract uncertainty is diminished.

8.3 Exclusions

Exclusions from the cost estimate include soft costs related to services that could reasonably be delivered by the City (e.g., legal costs), taxes and fees administered by the City, and escalation. Exclusions include the following:

- Soft Cost Exclusions
  - Project Management;
  - Consultant Fees (other than Design Consultant Fees which are included);
  - Planning Approvals;
  - Public Consultation & Information;
  - Legal and Accounting;
  - Permits & Fees;
  - Development Charges;
  - Property Taxes;
  - Municipal Connections and Hydro Charges;
  - Environmental Assessment process;
  - Cost of Financing;
  - Soft Cost Contingency (other than contingency for Design Consultant Fees which are included);
- Taxes (including HST Payable and HST Input Tax Credit)
- Project (Owner's) Contingency & Escalation
  - Work beyond park perimeter (Except as specifically identified in this estimate);
  - Fast-tracking of the work;
  - Upgrades or modifications to existing bridges (Spadina, Bathurst & Blue Jays Way);
  - Work related to mitigating electromagnetic field impacts – i.e., the interaction between the electric field produced by stationary charges (the bridge or park) and the magnetic field that is produced by moving charges (the trains);
  - Delays resulting from approvals/agreements with Metrolinx and/or cancellation(s) of work blocks;
  - Metrolinx documentation review fees; and
  - Remediation of the entire site if required (an allowance for local remediation only is included in the estimate).

9.0 PROJECT RISKS

Project Risks are listed below and are characterized by their type, consequence, probability and manageability.

Figure 18: Risk Matrix

risk matrix

F: Financial
S: Schedule
T: Technical
O: Operational
P: Public

LOW/EASY: ■
MEDIUM: ❍
HIGH/DIFFICULT: ●

	risk type F.S.T.O.P.	consequence	probability	manageability	mitigation
Rail Corridor Access Access, Safety, Service	FST	●	●	●	*Track blocks and track permits to carry out RDP works affecting train operations.* *Utilize natural track block windows outside of train operation times for RDP construction. (e.g. night work outside of UP Express hours)* *Ensure documented training for contractor and individuals working in the rail corridors. (e.g. Go-safe Training)*
Rail Corridor Coordination Service, Signal Sightlines, space for construction	FST	●	●	●	*Contractor daily work plan to ensure train operations are not affected unless planned and approved by operating railway in advance*
Rail Corridor Interference Space for foundations, excavation + spoils	FST	●	●	●	*Construction designs (i.e.. piers and deck) to incorporate required rail signal sightlines and visibility to ensure safe train operations* *RDP design to incorporate minimization of deck support structures adjacent to the tracks and in the rail corridor*
Rail Corridor Foundations & Soils Foundations, excavation + spoils	FST	●	●	●	*Soil Management Plans (SMP) to cover movement and management of soils during construction activities.*
Unknown Utilities Discovered during construction	FST	●	●	●	*Further detailed utilities surveys* *Data gathering in cooperation w/Mx*
Rail Utility Relocates undefined/unknown early works scope	FSTO	●	●	●	*Data gathering in cooperation w/Mx*
Archaeology found during investigations or construction	S	❍	■	❍	*Scope of field investigations to include archeological investigations*
Unknown Contaminated Soils .	FS	●	❍	❍	*All known contaminated soils will be identified with mitigation measures incorporated into the design. Treatment / Abatement measures will be*
Regulatory Compliance .	S	❍	■	❍	*Compliance to Transport Canada Railway Requirements, including Federal and Provincial Regulations as required. Address Regulatory Compliance issues immediately and consistently with consequences as required to ensure compliance and minimizing Safety Risks.*
Construction Windows Duration and impact on construction productivity - primarily related to work in rail corridor	SO	●	❍	❍	
Construction Staging Areas Ability to provide areas near site	TOP	❍	●	●	
Site Accessibility Public and Contractor access including traffic flow during construction	OP	❍	●	●	*The Construction Access and Routes Plan to be prepared for contractor and deliveries. Access to be permanently controlled at entrance gates .* *Maintain access for emergency vehicles. Restrict public access and visibility through proper controls (i.e. Gates and site barriers.)*

Risk Matrix (continued)

risk matrix

F: Financial
S: Schedule
T: Technical
O: Operational
P: Public

LOW/EASY: ■
MEDIUM: ◑
HIGH/DIFFICULT: ●

	risk type F.S.T.O.P.	consequence	probability	manageability	mitigation
Design Related to Metrolinx coordination & cooperation	FSP	●	●	◑	*Establish high level agreement for large construction islands and cooperation on track-level work.*
RER Station timing coordination & cooperation	STO	◑	◑	◑	
Noise and Vibration Impact on surrounding communities	T	◑	◑	■	*proximity of anticipated above-deck uses in RDP make this most consequential to park users. Surrounding buildign occupants should see a net improvement.*
Traffic Management Narrowed roadways during construction	OP	◑	●	●	*Construction Traffic management plans using OTM-Book7 for temporary lane closures, proper temporary signage and traffic signals to be prepared.*
Foundation Design Soil bearing capacity	FT	●	◑	◑	*Appropriately scoped geotechnical/hydrogeological investigations carried out in advance of the detail design.*
Clearance over Rail Confirmation of existing rail height to ensure minimum clearance requirements are met	TO	◑	●	◑	*Existing Lateral and Vertical Clearance conflicts to be defined by field survey. Determine minimum Metrolinx required lateral and vertical clearances and include allowance for future Electrification.*
Foundation Design Rock bearing capacity	FT	●	■	◑	*Appropriately scoped geotechnical/hydrogeological investigations carried out in advance of the detail design.*
Groundwater/dewatering Constructability issues	FST	◑	●	◑	*Appropriately scoped geotechnical/hydrogeological investigations carried out in advance of the detail design. Consideration in design to avoiding dewatering requirements, e.g. Raising pile caps, eliminating pile caps.*