ENTUITIVE

Entuitive | Uncompromising Performance

2400-2440 Dundas Street West, Toronto

RAIL SAFETY REPORT

FOR

FORA DEVELOPMENTS

June 7, 2024

EN Project No. EN024-00000

Issue and Revision Record

REVISION 01

ROLE	NAME	SIGNATURE	DATE
Prepared By	Jamie Kennedy		06/7/2024
Reviewed By	Ashley Mustafa, P. Eng.		06/7/2024
Approved By	Jonathan Hendricks, P. Eng.		06/7/2024

TABLE OF CONTENTS

1 INTRODUCTION

Entuitive Corporation ("Entuitive") has been retained by Fora Developments (the 'Owner' or 'Applicant') to provide a Rail Safety Report for the property at 2400-2440 Dundas Street West, in support of the Zoning By-Law Amendment application (re-submission) to permit a multi-tower, mixed-use development.

The purpose of this report is to review the site-specific risks as they relate to the nearby rail corridor and summarize the proposed mitigation measures to address these risks.

This report is limited to safety aspects related to the development's proximity to rail activity. Detailed analyses of external factors that affect quality-of-life/comfort, such as noise and vibration, are assessed independently of this report. Additionally, the proposed mitigation measures apply to the development lands and don't extend to the safety of individuals or property beyond it or within the rail corridor.

2 THE PROJECT

2.1 Site Details

The site, pictured in Figure 1 below, is an irregularly shaped lot bound by Dundas Street West to the west, the Metrolinx Weston Subdivision rail corridor to the east, an existing 3-storey commercial building to the north and a recently completed residential development to the south.

Figure 1: Site Location and Focus Area

The site is flat and at grade with the rail corridor. Currently the site is occupied by a retail grocery store at the south end of the property and an existing commercial building at the north end of the property. The majority of the site is used for surface parking to serve the existing uses.

Notably, Bloor GO Station is located next to the site, within the rail corridor right-of-way. Metrolinx operates daily passenger service on the Kitchener and Milton GO Transit lines. VIA Rail and UP Express trains also operate through the corridor as well. Standard station infrastructure including platforms, elevators, tunnels, and pick-up and drop off facilities, are all observed within the station boundary.

At the southeast corner of the property, a Metrolinx-controlled easement is used for passenger pick-up and drop off (PPUDO), which provides access to the GO Station.

The Site is situated in a highly dense urban area, and is in close proximity to higher order transit, making the application of the standard rail safety measures that include a 30-metre horizontal setback from the rail corridor and a 2.5-metre-high earthen berm impractical. Additionally, the dimensional constraints of the site physically limit the ability to implement the standard measures and achieve the density targets needed to support the project, as the site is within a Major Transit Station Area.

Considering the above, alternative mitigation measures are needed to meet the City of Toronto's and Metrolinx's rail safety requirements. Figure 2 below shows the context of the site in relation to the rail corridor and highlights the Metrolinx easement area.

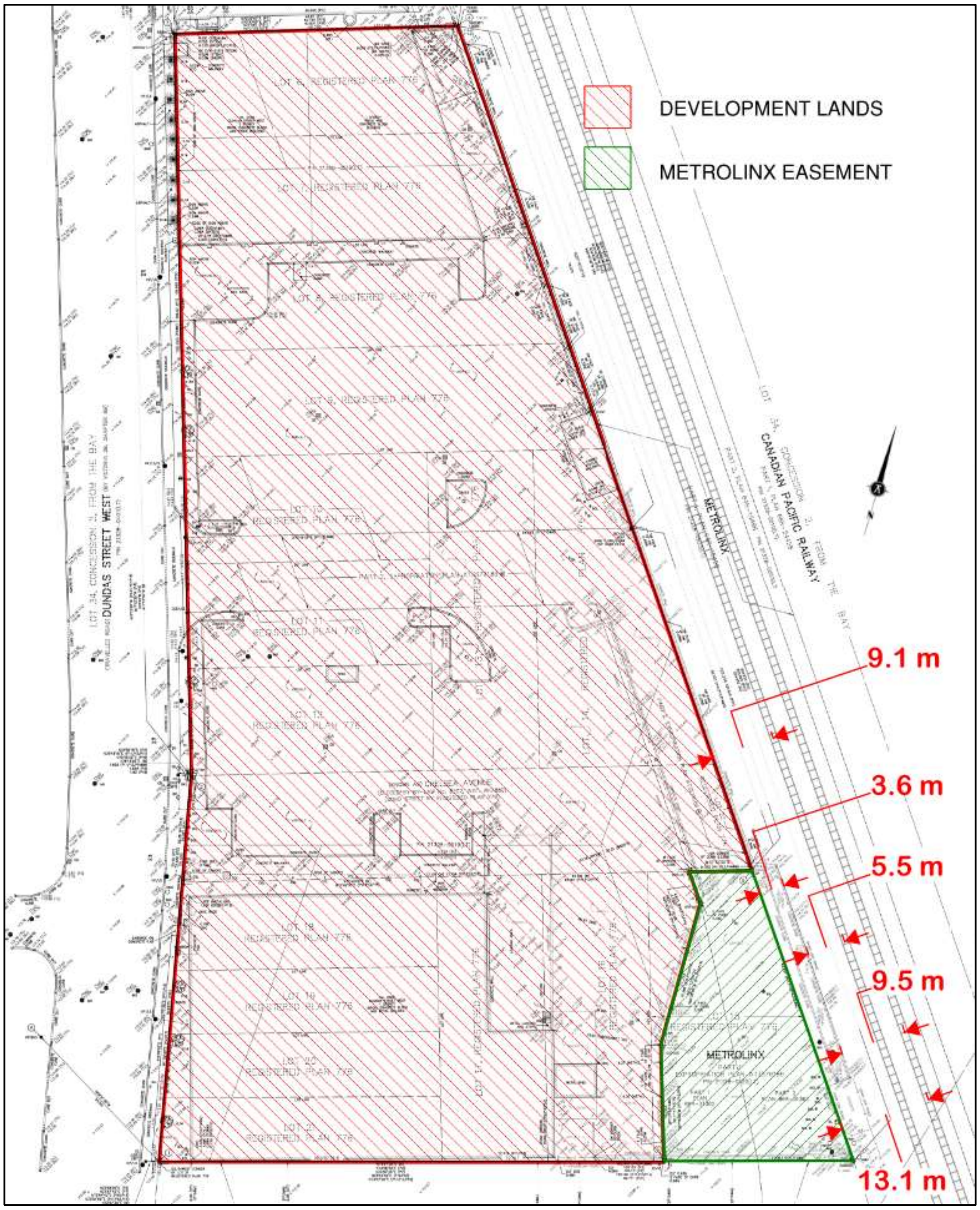

Figure 2: Concept plan related to rail corridor.

*Note: The track centreline distances above are based on satellite imagery and are approximate (±0.5m). At the time of writing a formal request was made to the rail authority for the track layout and expansion plans and will be updated as new information is received.

In the current condition, the closest active track is approximately 9m from the Applicant's property line. A chain link fence is observed approximately 3.6 from the property line, on Metrolinx's land, which extends alongside an existing walkway and the PPUDO. An existing generating station (or similar) is located on Metrolinx lands, immediately adjacent to the PPUDO, enclosed by a chain-link fence.

The existing interim passenger pick-up and drop-off area, the existing noise wall, and the existing chain link fence within Metrolinx's property line is shown in Figure 3 and Figure 4 below.

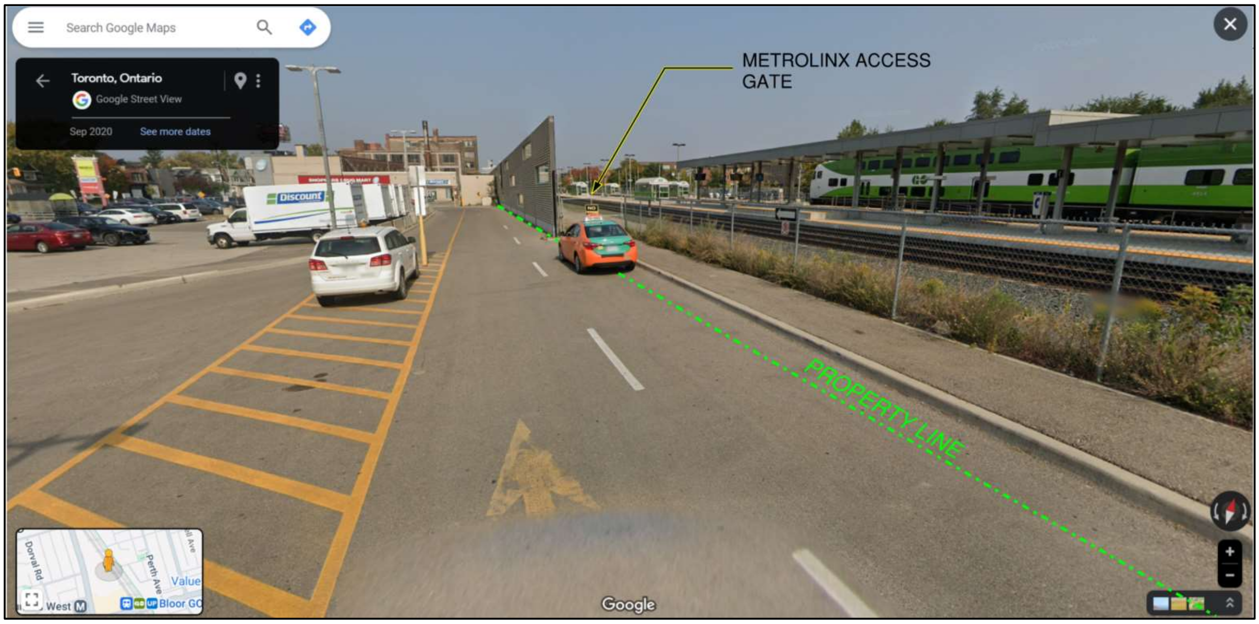

Figure 3: Rail Corridor Property Line (looking northeast)

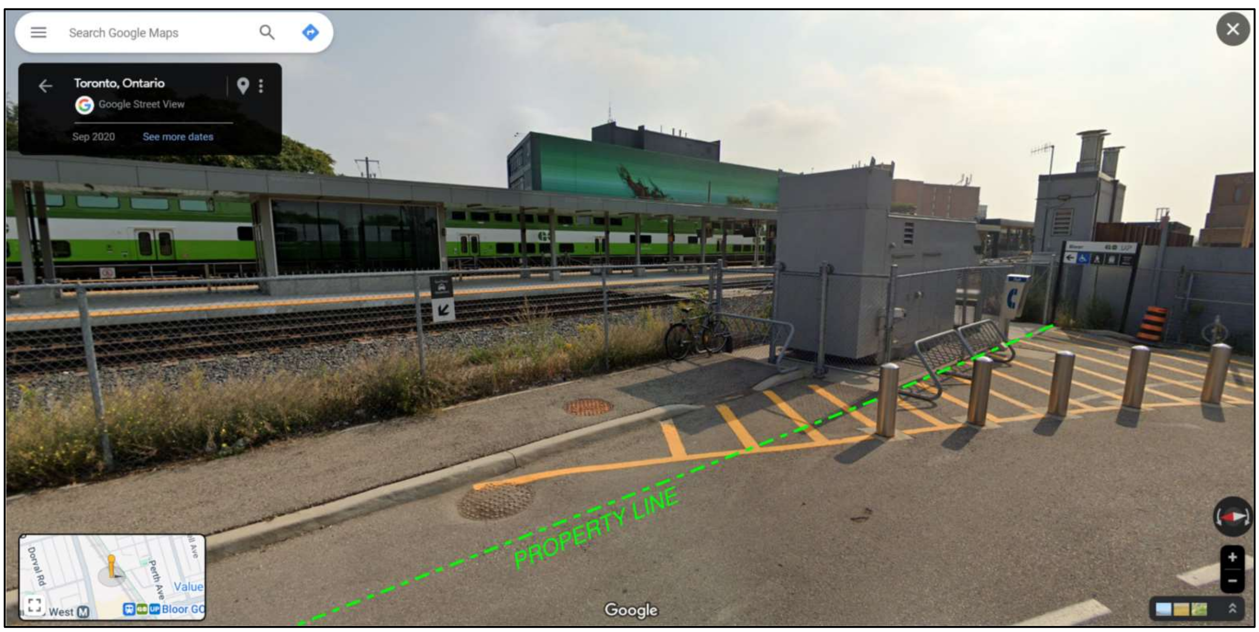

Figure 4: Rail Corridor Property Line (looking southwest)

In the completed development condition, the PPUDO area will be relocated further south to the neighboring property. Metrolinx will maintain a surface easement over subject property for access to the GO Station PPUDO.

2.2 Rail Corridor Details

The Weston Subdivision rail corridor, closest to the property, contains four principal main line tracks, and associated station infrastructure, including two (2) 300-metre-long platforms with sheltered canopies. Notably, one of the four tracks is part of the Lower Galt Subdivision rail corridor. The tracks are straight in alignment and run in a north-west direction serving Bloor GO Station.

Table 1: Rail Information for 2400-2440 Dundas Street West

Rail Corridor	Weston Subdivision	Lower Galt Subdivision
Classification	Principal Main Line	Principal Main Line
Track Mileage at Site	4.10	3.90
No. of Tracks	Three (3) tracks	One (1) track
Rail Traffic Typology	Passenger (Active) Freight (Operating Rights Only)	Passenger (Active) Freight (Operating Rights Only)
Speed	Max. Passenger: 80 mph Max. freight: 25 mph	Max. Passenger: 50mph Max. Freight: 50mph
Alignment	Straight in the immediate vicinity	Straight in the immediate vicinity
Elevation	The site is at approximately the same grade as the rail corridor (±0.4m)	

The aerial photo in Figure 5 below depicts the current GO Station facilities and notable rail infrastructure that has the potential to be impacted by the proposed development. This includes:

- The passenger pick-up and drop off area, located at the southeast corner of the property.
- The Metrolinx-owned noise wall extending along the western extent of the rail corridor
- The Metrolinx maintenance access gate at the south end of the noise wall

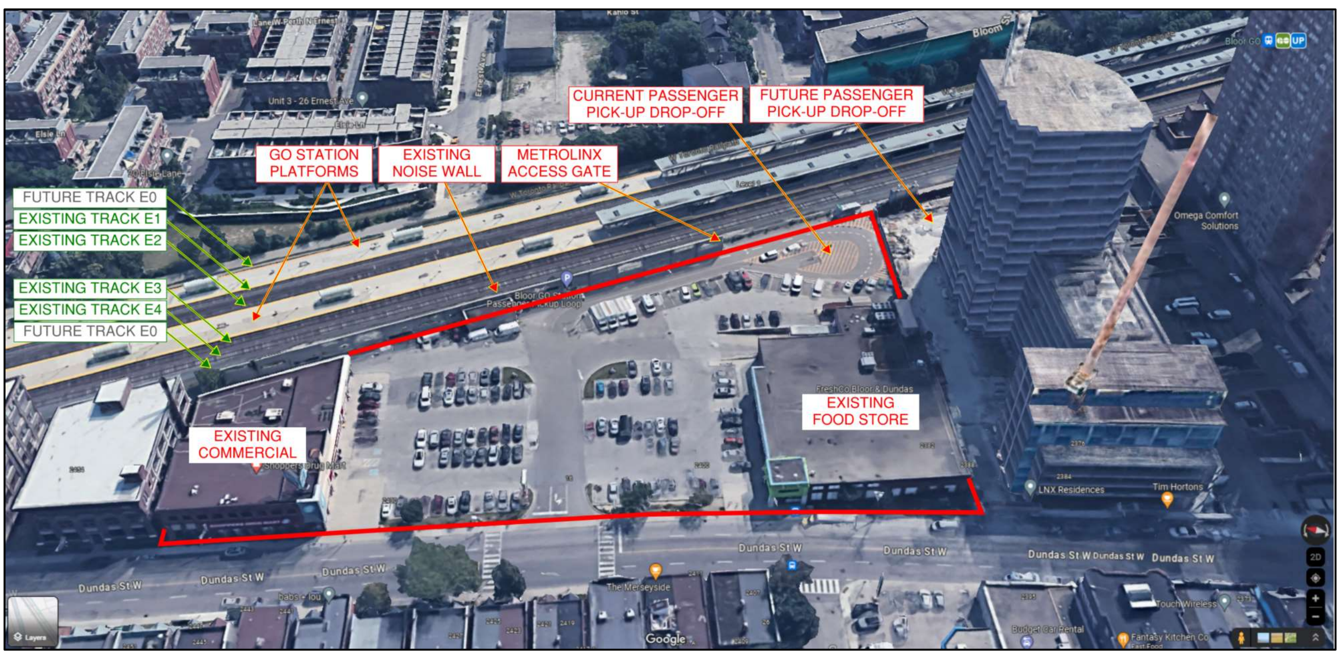

Figure 5: Aerial Image of Site and Notable Rail and GO Station Infrastructure

The western track, closest to the site, is part of the Metrolinx-owned Lower Galt Subdivision. The track was previously owned by Canadian Pacific Railway (CP), who sold the line to Metrolinx but retained freight operating rights in the sale. Today Metrolinx operates daily passenger traffic on the Milton GO Transit on this track.

The three tracks further from the site are part of the Metrolinx-owned Weston Subdivision. The track was previously owned by Canadian National Railway (CN), who also sold the line to Metrolinx, and also retained freight operating rights in the sale. Today, Metrolinx operates daily passenger services on the Kitchener GO Transit line and the Union Pearson Express (UPX). VIA Rail also operates daily passenger service within the corridor but does not serve the adjacent Metrolinx station, while freight traffic for both CN and CP is unscheduled and operates on an as-needed basis

A pedestrian bridge to the north of the site spans the rail corridor and offers grade-separated access for members of the public to safely traverse the corridor. The GO Station, signal bridge, and signal bungalow are highlighted in Figure 6 below.

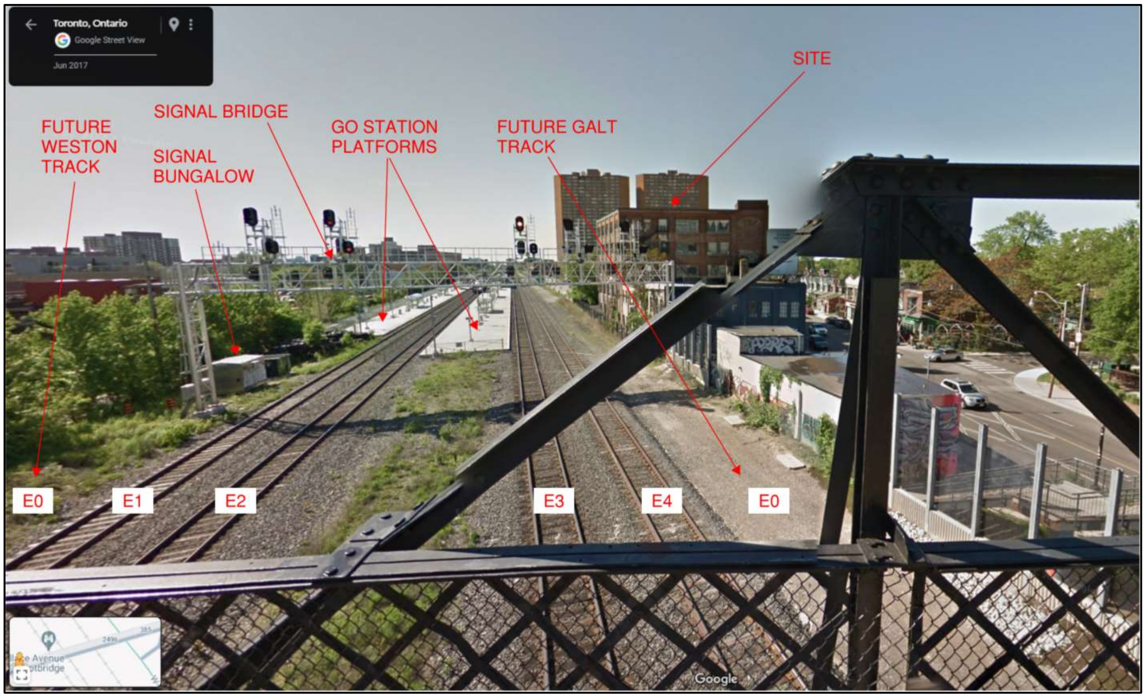

Figure 6: Existing Rail Corridor Infrastructure (looking south from pedestrian bridge)

2.3 Future Expansion[1]

As part of the Bloor GO Station Improvement Plans, Metrolinx is building a new track on the Kitchener GO line, next to the West Toronto Rail Path, on the east side of the corridor. Part of this work will include construction of a new entrance to Bloor GO Station, a new community park at Ernest Avenue, and a realignment of the Rail Path, on behalf of the City of Toronto.

Additionally, a new track is proposed on the Milton Line, next to the subject property, on the west side of the corridor. At the time of writing, timing and delivery of this additional track is not publicly available. A request to Metrolinx was submitted prior to the submission of this document and will be updated if new information is received.

The Metrolinx Track Diagram highlights the additional tracks that will be added to the corridor to the Weston and Galt Subdivisions once the rail corridor expansion is complete. The track diagram is included in Appendix A – Rail Corridor Details. It is assumed that the existing track speeds would be maintained in the future on both the Galt and Weston railways.

[1] Bloor GO Station Improvement. Metrolinx. 2024.

Additional details related to the expansion of the rail corridor and GO Station are highlighted in Figure 7 below.

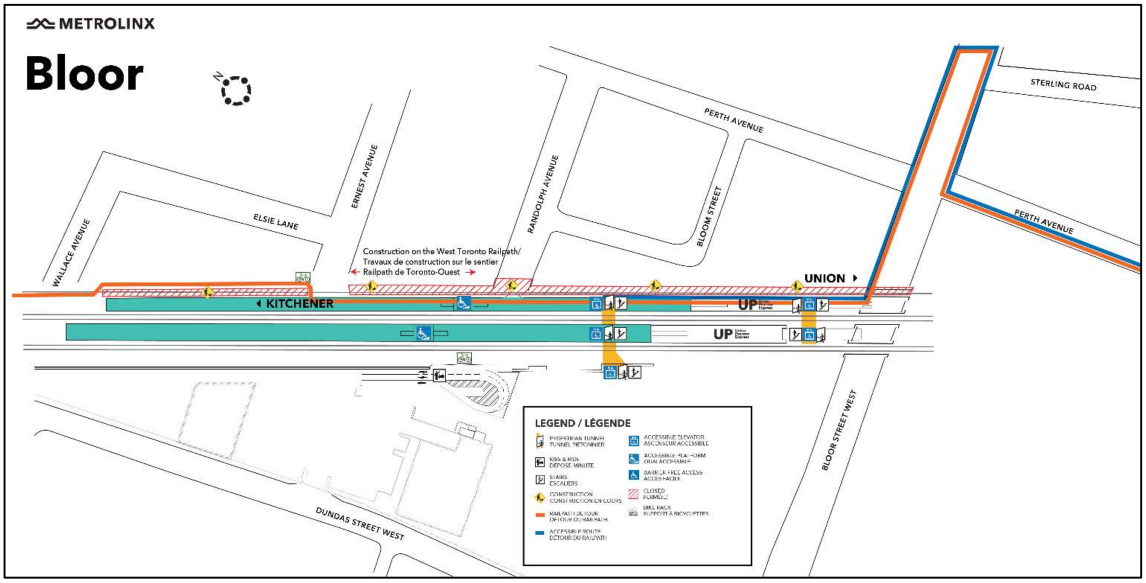

Figure 7: Bloor GO Station Expansion Plans

A summary of the future works affecting Bloor GO Station and the Weston Subdivision include:

- The fourth track will be installed from Lansdowne Avenue to Dupont Street to increase capacity on the Kitchener Line.
- A new pedestrian tunnel will connect Bloor GO Station with Randolph Avenue and a covered pedestrian pavilion will be added to access the station
- Realignment of the West Toronto Rail Path multi-use trail and the addition of plantings, gardens, and seating
- A new community park along the West Toronto Rail Path at Ernest Avenue
- Noise barrier and retaining wall installation

Changes to the existing Bloor Street West pedestrian bridge, which will include a taller fence on the west side of the bridge to increase safety.

Furthermore, an additional track is also anticipated along the west side of the rail corridor, to dual track the Galt Subdivision. However, at the time of writing, no details on the delivery or completion of the additional track were available.

Lastly, Metrolinx is also building a 270-metre underground pedestrian tunnel extension connecting Bloor GO/UP Station to Dundas West TTC Station.[2] While this connection is not anticipated to impact the proposed development, it will offer additional access to the GO Station in the future and reduce reliance on the connection to the GO Station through the subject site.

Most of the above changes to the GO Station are not anticipated to impact the development, and vice versa.

[2] Bloor Station (TTC Connection). Metrolinx. 2024. https://www.metrolinx.com/en/projects-and-programs/kitchener-line-go-expansion/what-were-building/bloor-station-ttc-connection

2.4 Safety Record of the Rail Corridor

Table 2 below summarizes the data published by the Transportation Safety Board (TSB) for accidents recorded in the adjacent rail corridor for the last 20 years (between 2004 and 2024) within 5 miles of the subject property.

Table 2: TSB data summary for rail incidents in proximity to subject site.

Period Start	2004	
Period End	2024	
Subdivision / Rail Corridor	Weston	Lower Galt
Total Number of Events	9	71
Total Number of Incidents	4	17
Total Number of Accidents	5	54
SUMMARY		
COLLISION INVOLVING TRACK UNIT	-	2
CROSSING	2	2
FIRE ON-BOARD R/S	-	2
MAIN-TRACK TRAIN DERAILMENT	-	1
MOVEMENT EXCEEDS LIMITS OF AUTHORITY	4	12
NON-MAIN-TRACK TRAIN COLLISION	-	3
NON-MAIN-TRACK TRAIN COLLISION (NO DERAILMENT, NO DAMAGE)	-	1
NON-MAIN-TRACK TRAIN DERAILMENT	1	29
NON-MAIN-TRACK TRAIN DERAILMENT (NO DAMAGE)	-	3
R/S COLL. WITH OBJECT	-	3
SIGNAL LESS RESTRICTIVE THAN REQUIRED	-	1
TRESPASSER	2	11

Noting the following details with respect to the TSB data above:

- No release of Dangerous Goods or Hazardous Materials was recorded in any of the Galt Subdivision accidents / incidents.
- The five (5) fatal injuries on the Galt Subdivision were all associated with trespassing related incidents and involved unauthorized rail corridor access.
- The two (2) fatal injuries on the Weston Subdivision were both associated with trespassing related incidents and involved unauthorized rail corridor access.
- The intersection where the 'Crossing' accidents occurred on the Weston Subdivision has been removed through a grade separation, eliminating the possibility of this risk for the future.
- The intersections where the 'Crossing' accidents occurred on the Galt Subdivision have both been removed through a grade separation, eliminating the possibility of this risk for the future
- The majority of incidents recorded on the Galt Subdivision occurred within the Lampton Yard, further northwest of the Subject Property on a CP-owned section of track.

The GO Expansion program has resulted in significant upgrades and improvements across the network, contributing to a safer overall operating environment. To deliver all-day, two-way service, Metrolinx has also removed numerous at-grade crossings through the corridor through grade separations, and increased security fencing to reduce trespassing.

3 PROPOSED DEVELOPMENT

The site is proposed as a multi-tower, mixed use residential, commercial, and retail development. The development is planned in two phases: Phase 1 and Phase 2. The North Block will be constructed as part of Phase 1, and the South Block will be constructed as part of Phase 2.

The site concept is illustrated in Figure 8 below.

Figure 8: Proposed Development Concepts

The existing food store will remain in place during Phase 1. Once Phase 1 is complete, the existing food store will move into the north block, to allow Phase 2 on the South Block to commence.

The Phasing Plan, shown in Figure 9 below illustrates the extent of each phase and highlights the future passenger pick-up/drop off loop is being relocated to the new development to the south.

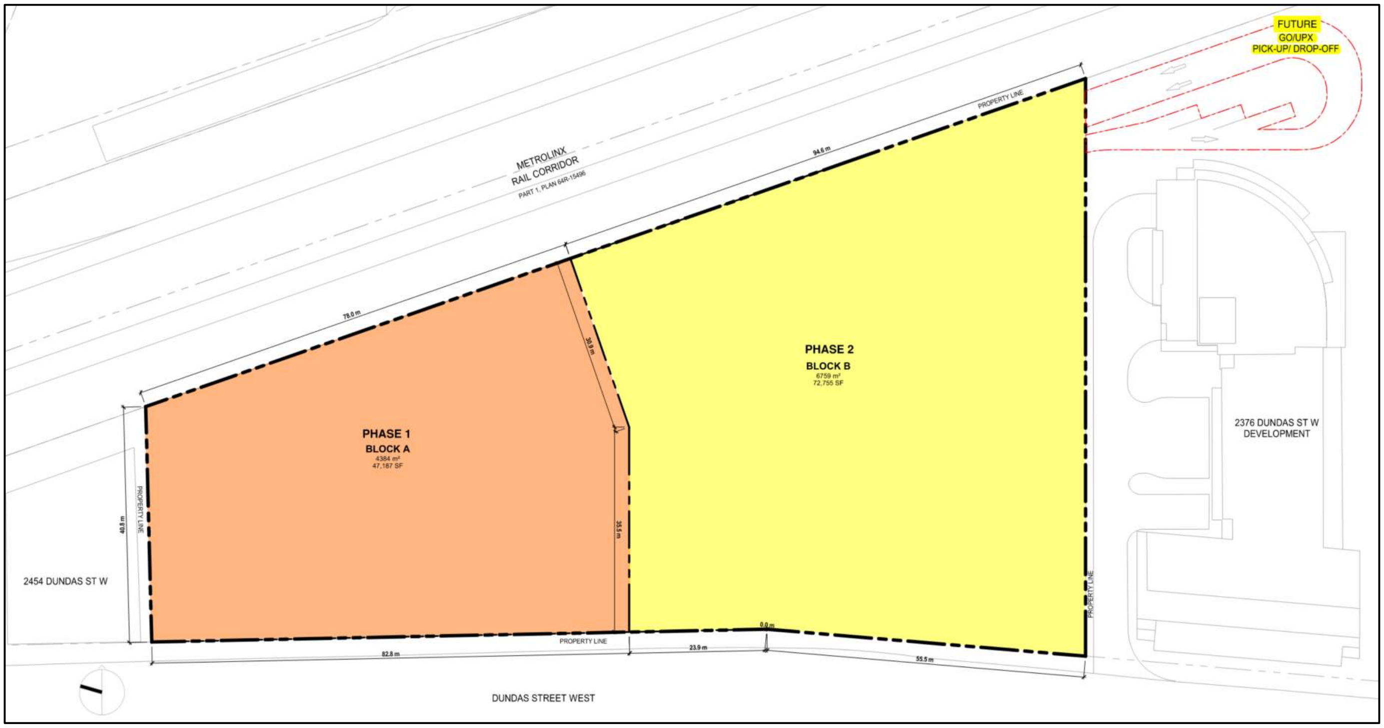

Figure 9: Phasing Plan

The updated Site Plan in **Error! Reference source not found.** below, responds to feedback received from the City of Toronto, who expressed the desire to include a park in the development plan, as opposed to the POPS (privately operated public space) which was previously contemplated. The primary land use objectives remain the same, which include permanently shifting the Metrolinx PPUDO south.

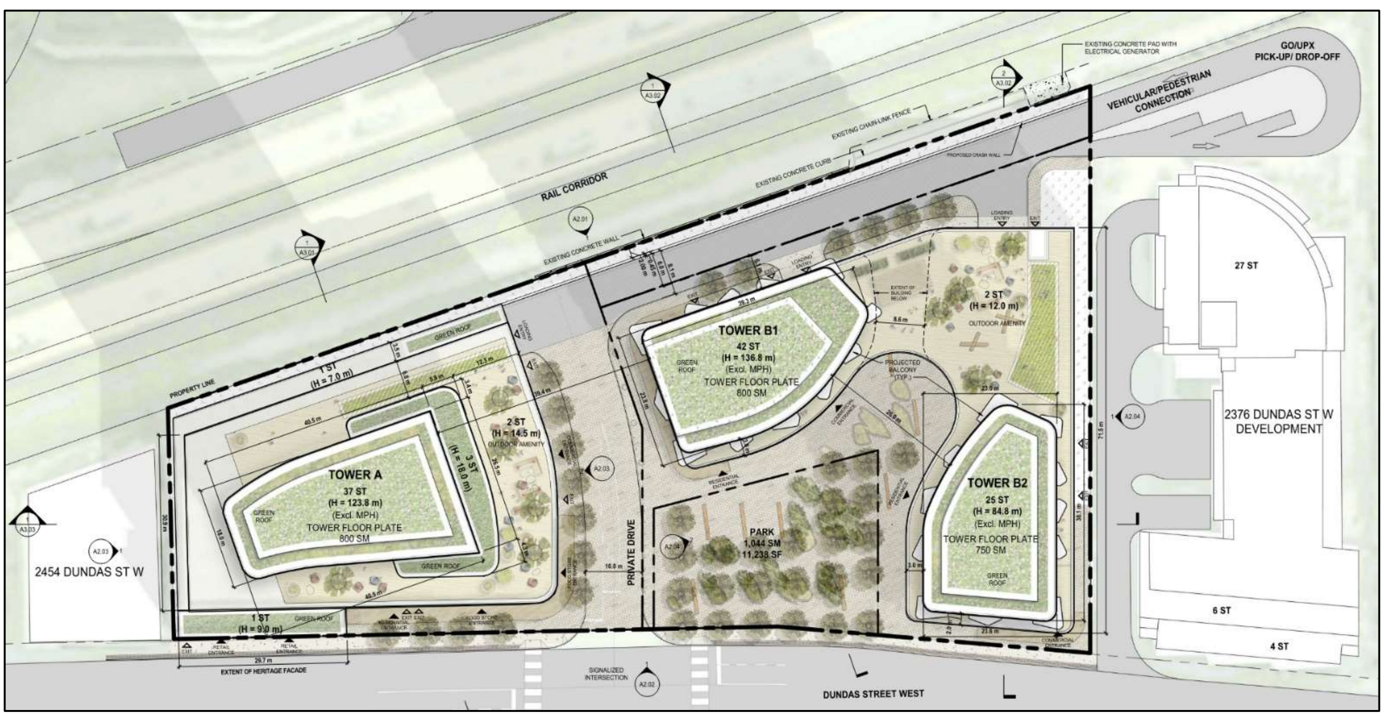

Figure 10: Updated Site Plan

The Lower Level and Ground Floor plans are shown in Figures 11-13 below. Notably, the below grade parking will be developed in two phases and will serve the entire development once complete, with the only access being provided from the North Block. The below-grade parking levels (Figure 11) will also leave the park space unencumbered, per City of Toronto requirements.

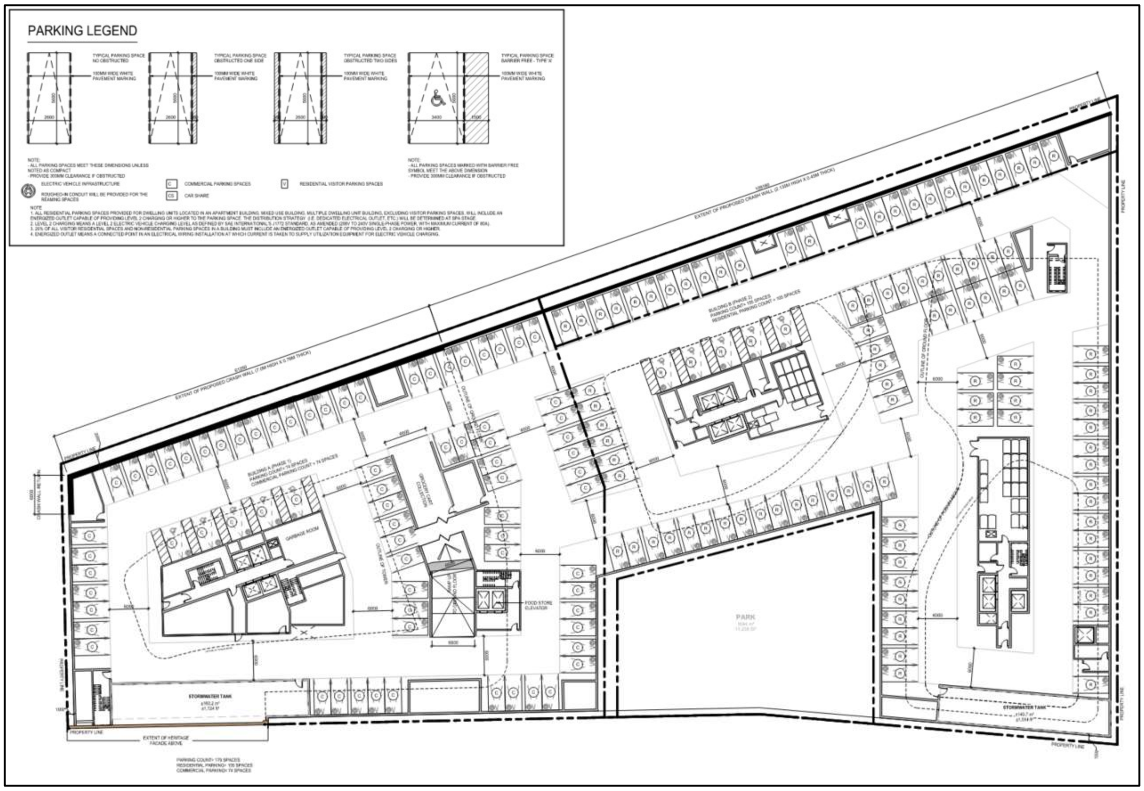

Figure 11: Extent of Lower Level / Below Grade Parking

The Ground Floor of the North Block, which will be constructed as part of Phase 1, is shown in Figure 12 below.

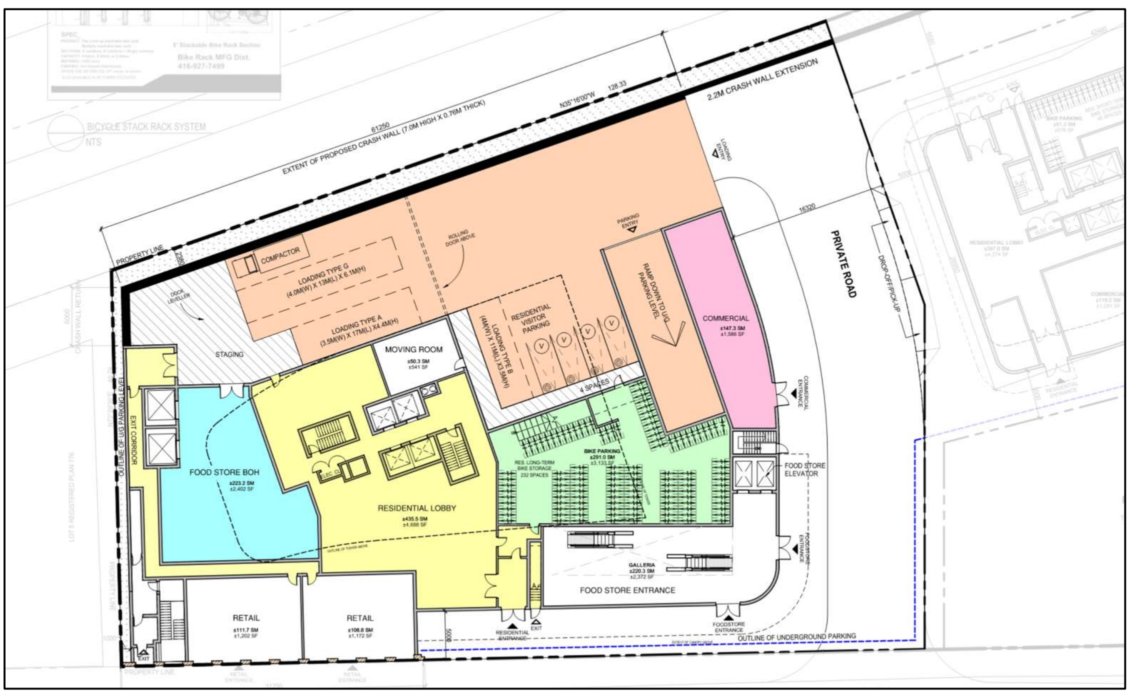

Figure 12: Proposed Ground Floor (North Block)

The ground floor of the North Block (Figure 12) is comprised of non-sensitive uses including a mix of low occupancy and unoccupied spaces such as loading, back-of-house, bicycle parking, and moving areas.

A small commercial space <1,500 sq. ft, two small retail spaces, the lobby and common areas for residents, and the entrance/lobby to the food store make up the occupiable spaces on the ground floor, though the majority of these uses are transitory and passive in nature, and not typically occupied for long periods throughout the day.

The entire second floor of the North Block will be dedicated for use as a retail grocery store and will replace the existing store at the site. The grocery store is considered a non-sensitive, transitory space. The areas where staff would be expected at regular intervals throughout the day are furthest from the rail corridor, closest to Dundas Street.

The Ground Floor of the South Block, which will be constructed as part of Phase 2, is shown in Figure 13 below. The ground floor of the South Block was designed with the same intention as the north block – to locate non-sensitive, low occupancy or unoccupied spaces within the areas closest to the rail corridor.

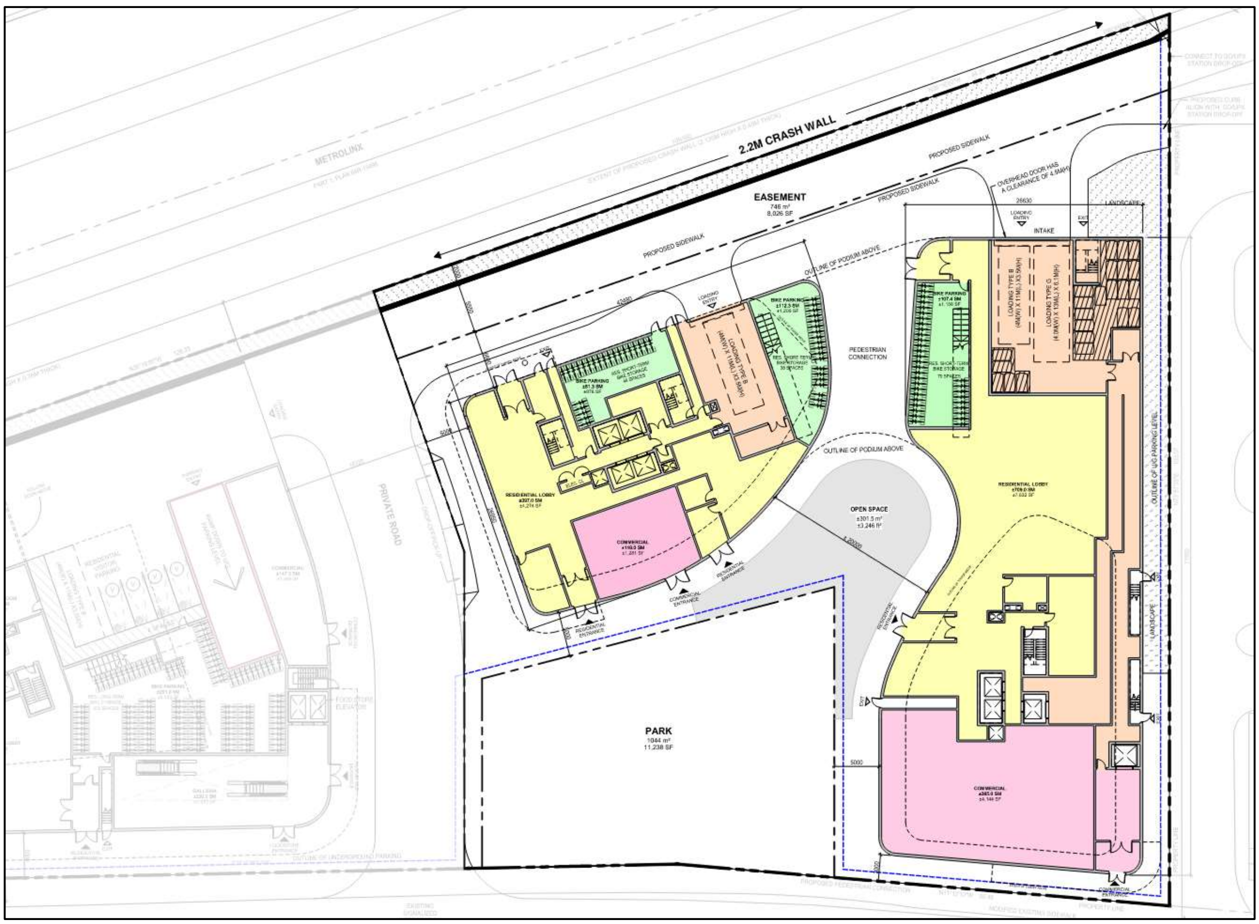

Figure 13: Proposed Ground Floor (South Block)

The largest commercial space (which is over 4,000 sq. ft) will be located furthest from the rail corridor, facing Dundas Street West, adjacent to the park.

The second floor of the South Block will be comprised of indoor amenity space and commercial office space. The inclusion of Commercial Use is driven by the City of Toronto, and their desire to maintain the Core Employment uses on the property as part of the rezoning process.

Please refer to the complete architectural set for the detailed floor plans.

4 GUIDELINES AND METHODOLOGY

This report has been prepared in accordance with the following guidelines and reference material:

- FCM/RAC Guidelines for New Development in Proximity to Rail Operations,
- City of Toronto Land Use Study for Development in Proximity to Rail Operations,
- Metrolinx Adjacent Development Guidelines,
- AECOM Crash Wall Design Guidelines.

4.1 FCM/RAC Guidelines

The FCM/RAC Proximity Guidelines began as an initiative between the Federation of Canadian Municipalities (FCM) and the Railway Association of Canada (RAC) to identify best practises and guidelines for new developments in proximity to railways, which present a unique set of risks and challenges.

The guidelines are intended to be used "to provide municipalities with the necessary tools to facilitate decision-making" and "address the variable nature in the delivery of mitigative measures for new developments in proximity to railway operations." (p.6).

Importantly, the guidelines also recognize, "when it comes to safety, all parties must be aware that there are inherent safety implications associated with new developments in proximity to a railway line, and that these implications can often be mitigated, but typically not eliminated. The goal is to establish a common, standardized process, whereby potential impacts to safety in the context of development applications in proximity to rail corridors can be assessed." (p.6)

New developments along the rail corridor should be designed and built to provide reasonable protection to the development against rail activities and accidents.

The FCM/RAC Guidelines set out requirements for:

- Life Safety: Impact from a derailed train, fire, smoke, projectiles and/or debris from an accident
- Comfort/Quality of Life: Noise, vibration, air quality

Standard Mitigation

The FCM/RAC Guidelines suggest that mitigation measures be provided as a "package" to address individual risks related to rail. The standard mitigation measures include:

- Minimum setbacks to sensitive/high occupancy use space, consistent with Table 3 below
- The application of a 2.5m-high earthen berm along the rail corridor property line
- An acoustic/noise barrier (height determined on a site-by-site basis)
- A minimum 1.83-metre-high chain link / security fence along the entire mutual property line

The FCM/RAC Guidelines recommend the setbacks shown in Table 3 below.

Table 3: FCM/RAC Recommended Setbacks.

Classification of Line	Setback	Berm Height	Berm Slope
Freight Rail Yard	300m		
Principal Main Line	30m	2.5m	≤ 2.5:1
Secondary Main Line	30m	2.0m	≤ 2.5:1
Principal Branch Line	15m	2.0m	≤ 2.5:1
Secondary Branch Line	15m	2.0m	≤ 2.5:1
Spur Line	15m	0	

Setback distances must be measured from the mutual property line to the building face to ensure that the entire railway right-of-way is protected for potential rail expansion in the future (Section 3.3).

Figure 14 below illustrates the preferred mitigation measures along a principal main line where the full setback and berm can be accommodated.

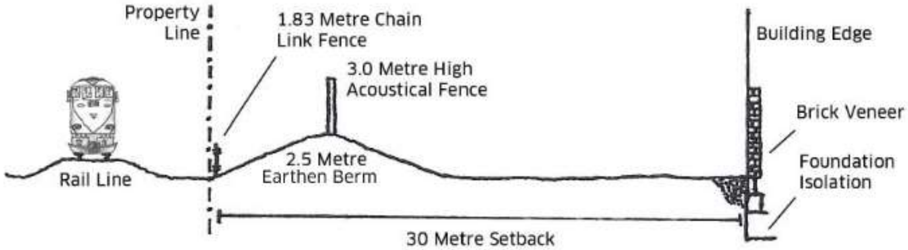

Figure 14: FCM/RAC Standard Mitigation Measures for New Development.

The FCM/RAC Guidelines (Section 3.3) indicate that, "appropriate uses within the setback area include public and private roads; parkland and other outdoor recreational space including backyards, swimming pools, and tennis courts; unenclosed gazebos; garages and other parking structures; and storage sheds."

In cases where a full setback can be provided, a berm may be constructed to protect the site. Setbacks and berms are typically provided together to achieve the maximum mitigation level.

Alternative Mitigation

If the space required for a full berm cannot be provided, an alternative mitigation measures may be required to address proximity issues.

The FCM/RAC Guidelines acknowledge that "challenges may be encountered in the case of conversions or infill projects on small or constrained sites" (Section 2.3). Under these conditions, the guidelines note that, "horizontal setback requirements may be substantially reduced with the construction of a crash wall" (Section 3.3). Where a crash wall is proposed, the setbacks to sensitive uses may be measures as a combination of horizontal and vertical measure, as long as the combined setback is consistent with the standard measure. This concept is illustrated in Figure 15 below.

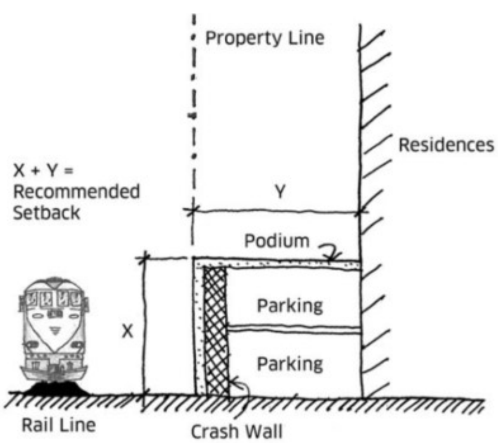

Figure 15: FCM/RAC Alternative Mitigation Measures for New Development

Importantly, the FCM/RAC Guidelines suggest that the risk-mitigating measures need not be disproportional to the development. The Third Principle for mitigation design is: *"All mitigation measures should be designed to the highest possible urban design standards. Design solutions, as developed through the Development Viability Assessment process, should not create an onerous, highly engineered condition that overwhelms the aesthetic quality of an environment."* (Section 3.1).

4.2 Metrolinx Adjacent Development Guidelines

The Adjacent Development Guidelines were developed by Metrolinx to communicate the implications of development near their GO Transit rail corridors, ensure safe and reliable rail operations, and minimize conflicts between future rail operations and new development.

The Adjacent Development Guidelines identify standard mitigation measures that are consistent with the recommendations within the FCM/RAC Guidelines but offer a tailored guide to navigating the Metrolinx approvals process.

Similar to the FCM/RAC Guidelines, the Metrolinx Adjacent Development Guidelines also include provisions for development sites that are not able to accommodate the standard mitigation measures. A few alternative scenarios are identified along with the recommended mitigation in Figure 16 below.

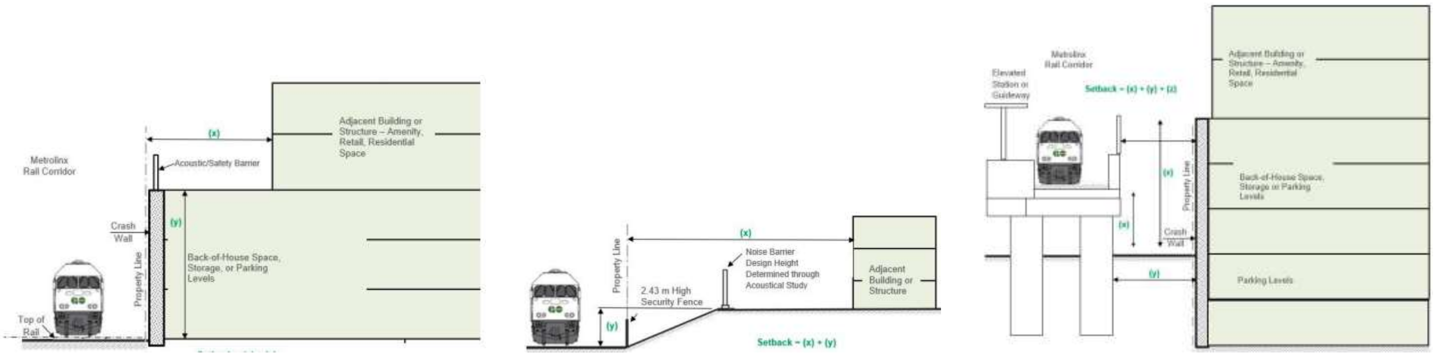

Figure 16: Alternative mitigation measures for spatially constrained sites

The current Metrolinx Adjacent Development Guidelines recommend the following building setbacks:

- Residential, commercial, institutional, industrial (high occupancy), Programmed Open Space: 30m
- Industrial (low occupancy): 15m
- Limited occupancy/passively used spaces (including parking garages, storage facilities, passive open space (including road rights-of-way and paths): No setback required (and are acceptable uses within the setback area of a development that includes sensitive uses)

In addition to the setbacks listed above, the Metrolinx Guidelines also require a 2.0-metre-high safety barrier for low occupancy, industrial uses to absorb the impacts of a possible train derailment. Where full setbacks are provided, this safety barrier is typically constructed as an earthen berm.

The Metrolinx Guidelines (Section 5.1.2.2) further state that:

- "A deflection or crash wall may be used as an alternative to an earthen berm for spatially constrained urban sites (as they generally occupy less space) and where a setback reduction would be beneficial.
- "Where barriers are integrated into the building face, they must be structurally separated from the building"
- "Openings through the barrier structure (e.g., windows, passageways) may be considered subject to confirmation that the barrier integrity will not be compromised"
- "Barrier returns are to be provided, with placement subject to site specific conditions, such that buildings with direct exposure to the Rail Corridor are suitably protected.to ensure that integrity is maintained in the event of a derailment."

In addition to the safety requirements noted above, as part of the development application, the

Landowner will also be required to enter into an Adjacent Development Agreement with Metrolinx; a standard agreement for new developments within 300 metres of railway facilities.

These guidelines provide an overview of relevant information to parties interested in undertaking development projects within Metrolinx's rail corridor zones-of-influence and identify key considerations from project initiation and design through to construction.

4.3 City of Toronto Land Use Study for Development in Proximity to Rail Operations

In 2019, the City of Toronto commissioned a land use study to provide recommendations specific to Toronto that staff can rely on when responding to development applications on lands adjacent to or in proximity of rail corridors and yards.

The City of Toronto has an important role to play in regulating land use and managing development proposed on sites in proximity to higher-risk activities, such as railways. The guidelines were prepared to assist the City in enacting land policies, guidelines, regulatory framework, and development approvals processes that support new developments that are compatible with their surroundings and apply appropriate mitigation measures to address safety, trespassing, and quality-of-life issues related to railway operations.

Development applications in proximity to rail are subject to a peer-review process conducted by a selected technical advisor for the City of Toronto and are anticipated as part of the development application.

4.4 AECOM Crash Wall Guidelines

Crash Wall Requirements

Crash walls are robust concrete structures designed to provide similar energy absorption capacities as the standard berm. The wall is to be designed to the standards established by AECOM (Development of Crash Wall Design Loads from Theoretical Impact and CW Guide Rev 2) looking at four (4) derailments scenarios:

(1) Freight train glancing blow (multiple car impact at deflection angle),
(2) Freight train direct impact (a single or pair of cars impacting the wall directly due to an accordion-type derailment),
(3) Passenger train glancing blow,
(4) Passenger train direct impact.

In addition to being designed for the derailment scenarios set out above, the crash wall shall have the following characteristics:

Crash Wall Thickness:

- 760mm if the wall is less than 7.6m from the centreline of the closest track.
- 450mm if the wall is greater than or equal to 7.6m from the centreline of the closest track.

Crash Wall Height:

- 3.6m from top of rail if the wall is less than 3.6m from the centreline of track.
- 2.135m from top of rail if the wall is greater than or equal to 3.6m and less than 7.6m from the centreline of track.
- 2.135m from top of grade if the wall is greater than or equal to 7.6m from the centreline of track.

The face of the crash wall shall be smooth and continuous and shall extend a minimum of 150mm beyond the face of the structure (such as a building column or bridge pier) parallel to the track.

Construction shall be solid and heavy. Separate precast blocks or stones are not acceptable.

5 ANALYSIS: ENERGY BALANCE METHOD

As per the AECOM Guidelines, an energy balance was performed to study the travelling length in case of derailment. There are four loading cases as shown below:

1. Freight Train Load Case #1: derailment of nine freight train cars.

> Freight Train Load Case 1 – Glancing Blow: nine cars weighing 143 tons (129 700 kg) each, impacting the wall at an angle, θ_G. The angle of impact will be a function of track curvature, and for tangent track may be taken as 3.5 degrees.

2. Freight Single Car Load Case #2: assuming only one car is derailed.

> Freight Train Load Case 2 – Single Car Impact: single car weighting 143 tons (129 700 kg) impacting the wall as it undergoes rotation about its center. The angle of rotation at impact is defined in [9]:
>
> $$\theta_f = \operatorname{asin}\left(\frac{d_{CL}}{8.5}\right) \qquad \text{(metric)}$$
>
> Where d_{CL} is in feet (m). Where d_{CL} is greater than 28 feet (8.5 m), this load case need not be considered.

This loading case assumes a single car will be rotating around its center and should the clear distance d_{CL} exceed 8.5m then there is no need to include this loading case as the train car will not make contact with the safety barrier in this derailment scenario.

3. Passenger Train Load Case #3: derailment of eight passenger cars.

> Passenger Train Load Case 3 – Glancing Blow: eight cars weighing 74 tons (67120 kg) each impacting the wall at an angle, θ_G. The angle of impact will be a function of track curvature, and for tangent track may be taken as 3.5 degrees.

4. Passenger Single Car Load Case #4: assuming only one car is derailed.

> Passenger Train Load Case 4 – Single Car Impact: single car weighing 74 tons (67120 kg) impacting the wall as it undergoes rotation about its center. The angle of rotation at impact is defined in [10]:
>
> $$\theta_f = \operatorname{asin}\left(\frac{d_{CL}}{13.0}\right) \qquad \text{(metric)}$$
>
> Where d_{CL} is in feet (m). Where d_{CL} is greater than 42’-6” (13 m), this load case need not be considered.

Similarly, this load case assumes a single car rotates around its center and should the clear distance d_{CL} exceed 13m then there is no need to include this loading case as the train car will not make contact with the safety barrier in this derailment scenario.

Changing the train weight due to different rail services is permissible as per the AECOM Guidelines.

> Where a track is designed for dedicated service by a particular train consist, variations to the design trains may be permitted by the Railway.

The speed of derailed equipment for glancing blow load cases can be calculated as shown:

$$v_G = \sqrt{v_0^2 + 2a\left(\frac{d_{CL} - 1.625}{sin\theta_G}\right)} \text{ [m/s]}$$

Where d_{CL} is the distance from the crash wall to the centerline of track in feet (m)
v_o is the track speed in ft/s (m/s)
a is the acceleration in ft/s^2 calculated as $-32(.25 + G)$
θ_G is the angle of impact defined in [4] or [5]
G is the grade in decimeal unit of the groundline in the direction of travel defined by the angle of impact relative to the centerline of track; calculated as $\frac{Groundline\ at\ wall - Base\ of\ rail}{d_{CL}/sin\theta_G}$.

The speed of derailed equipment for single car load cases can be calculated as shown:

$v_A = \frac{2.3\theta_f}{\sqrt{1-cos\theta_f}}$[m/s] for freight cars $v_A = \frac{2.9\theta_f}{\sqrt{1-cos\theta_f}}$ [m/s] for passenger cars

Where θ_f is the angle of impact, in radians, defined in [9] and [10].

The design force for the glancing blow load cases is:

$$F_G = \frac{\frac{1}{2}m(v_G sin\theta_G)^2}{32.17d_G} \quad [14]$$

$$F_G = \frac{\frac{1}{2}m(v_G sin\theta_G)^2}{d_G} \quad \text{(metric)} \quad [14M]$$

Where m is the mass of the derailed cars in lbm (kg)
v_g is the impact speed in ft/s (m/s), defined in [3]
θ_G is the angle of impact defined in [4] or [5]
d_g is the deformation of the consist in the direction of the applied force, and
$d_g = 10sin\theta_G$, in feet ($d_g = 3.048sin\theta_G$, in m)

The design force for the single car load cases is:

$$F_A = \frac{\frac{1}{2}m\left(v_A cos\theta_f\right)^2}{32.17d_A} \quad [15]$$

$$F_A = \frac{\frac{1}{2}m\left(v_A cos\theta_f\right)^2}{d_A} \quad \text{(metric)} \quad [15M]$$

Where m is the mass of the derailed cars in lbm (kg)
v_A is the impact speed in ft/s (m/s), defined in [7] or [8]
θ_F is the angle of impact defined in [9] or [10]
d_A is the deformation of the consist in the direction of the applied force, and
$d_A = 10sin\theta_G$, in feet ($d_A = 3.048sin\theta_G$, in m)

5.1 Results of the Energy Balance Method Evaluation of Derailment Scenarios

Due to the proximity of the site to the rail corridor, the proposed development will include a crash wall. The crash wall will be designed in accordance with the applicable guidelines and will be designed to account for the greatest potential impact on the closest rail track.

Table 4 below summarizes the derailment scenarios as set out in the AECOM Crash Wall Guidelines and includes the maximum distances from the centreline of track where a derailed train would come to rest. It should be noted that the derailment scenarios provide guidance on theoretical impact loads on a crash wall, and do not quantify the full range of possible derailments.

The energy balance analysis was completed using passenger trains operating at a maximum speed of 80mph and freight trains operating at a maximum speed of 25mph for the Weston Subdivision tracks and a maximum operating speed of 50mph for both freight and passenger trains on the Galt Subdivision tracks (which corresponds with the operating details included in Appendix A).

For this analysis, a derailment angle of 3.5° was used. These calculations were completed based on the assumption that the tracks are running straight and parallel to the site, as is the case with this development.

Additionally, as the site is at the same elevation as the tracks, a grade difference of 0m was used in the calculations. Additional details for the derailment calculations are provided in Appendix B.

Table 4: Train derailment distances based on Guideline derailment scenarios.

Scenario	Max. distance perpendicular to track where the train comes to rest
Freight Train Multi-Car Glancing Blow	<3.2m
Freight Train Single Car Direct Impact	<8.6m
Passenger Train Multi-Car Glancing Blow	<17.6m
Passenger Train Single Car Direct Impact	<13.1m

As Metrolinx is expanding the rail corridor, the crash wall design will consider the placement of the future Galt Subdivision track, closer to the property line.

The following impact forces for the Galt tracks were based on a future centreline 4 metres from the Metrolinx property line (6m from the face of the proposed crash wall). We also considered the impact forces from the closest Weston track, based on a centreline distance of 13.1m.

Table 5: Summary of impact forces on crash wall located 9.5m from nearest track.

Scenario	Impact Force	
	Galt Subdivision (Future Track)	Weston Subdivision (Existing Track)
Freight Train Multi-Car Glancing Blow	2000kN	0kN
Freight Train Single Car Direct Impact	1678kN	0kN
Passenger Train Multi-Car Glancing Blow	984kN	1304kN
Passenger Train Single Car Direct Impact	**3157kN**	0kN

Based on the analysis in Table 5 above, the Passenger Train – Single Car Direct Impact (Scenario 4) is the governing force for the crash wall, indicating an impact of 3157kN.

Additional details for the impact force calculations are provided in Appendix B.

6 EVALUATION: PROPOSED MITIGATION

The FCM/RAC Guidelines recommend a package of mitigation measures to address the risks associated with active railway operations. The following section summarizes the mitigation measures that are proposed for the new development to address safety concerns at the site.

6.1 Safety Barrier

A crash wall is proposed for the development to provide continuous derailment mitigation across the site. The design of the crash wall should be consistent with the AECOM design procedures for the four scenarios of derailment. Based on the maximum operating speeds in the adjacent corridors, Method 2 (the *Energy Balance Approach*) of the AECOM guidelines will apply. This method was analyzed in the previous section of this report and further details are included in Appendix B.

The crash wall will be built in 2 phases, consistent with the phasing plan described in the previous sections.

The proposed crash wall at 2400-2440 Dundas Street West will extend along the eastern extent of the property, as illustrated in Figure 17 below.

Figure 17: Proposed crash wall extent along property line

The crash wall for the North Block will be 7 metres high and integrated into the podium of the building. Where the building ends, the crash wall will extend to the southern extent of the site at a height of 2.135m, providing continuous derailment protection for both the North and South Block.

<u>Crash Wall Design Specifications</u>

In accordance with the AECOM Crash Wall Design Guidelines, the following criteria apply to the design of the integrated crash wall within the North Block:

- The proposed wall will be 7m above the adjacent ground level,
- The proposed wall will be built to a minimum thickness of 760mm,
- The applied impact load resulting from derailment will be measured 1.8m from the top-of-rail,
- The wall shall be designed to incorporate both horizontal and vertical continuity reinforcement to distribute the impact loads of a derailed train.

Further, the following criteria apply to the design of the cantilevered crash wall extending along the eastern extent of the site to protect the South Block:

- The proposed wall will be 2.135m above the adjacent ground level,
- The proposed wall will be built to a minimum thickness of 450mm,
- The applied impact load resulting from derailment will be measured 1.8m from the top-of-rail,
- The wall shall be designed to incorporate both horizontal and vertical continuity reinforcement to distribute the impact loads of a derailed train.

Crash Wall Location and Height Rationale

The provision of a 7-metre-high wall in the North Block was based on a number of different site-specific factors. As CN and CP Rail both have operating rights, the possibility of freight traffic remains for the foreseeable future. This includes the possibility of double-stacked freight cars moving past the site. The 7-metre-high wall is significantly greater than the recommendations of the national guidelines and offers superior protection to the occupants and building structure from the risks associated with the types of rail movements that travel on the adjacent tracks.

The additional height also helps to protect the structural columns supporting the development above and is consistent with similar types of crash wall designs applied at Metrolinx GO Stations across the GTA.

The extension of the crash wall along the eastern boundary of the property was based on a variety of factors including:

1. The desire to maintain a continuous crash wall along the entire property and tie the crash wall for the South Block into the crash wall for the North Block.
2. The desire to align (or as close as reasonably possible) the crash wall on the Subject Property with the recently built crash wall on the neighboring property to the south.
3. The benefit of improved protection to members of the public accessing the GO Station / PPUDO

Crash Wall Return

A 6-metre-long return is proposed for the northern end of the crash wall, furthest from Bloor GO Station. At the south end of the crash wall the crash wall will extend to the neighboring property line (or as close as reasonably possible). A similar condition is observed on the southern property, where the existing crash wall extends to the north and terminates without a return. The intention is for the two crash walls to come as close as practicably possible, in order to provide continuous protection through the entire station environment. Existing infrastructure and operational requirements may also impact the ability to achieve this outcome.

Both the return wall and extension are consistent with best practice across the GTA and reflect the overall intention of the guidelines – to offer additional protection for the side of the building that may be exposed to railway activities.

Crash Wall Openings

During the original development application, Metrolinx indicated that access to the maintenance gate, which is located within the rail corridor should be maintained in the completed development condition.

At the time of writing, options are being explored with the Project team and Metrolinx to understand the technical and operational requirements to accommodate the access gate without compromising the effectiveness of the crash wall.

Crash Wall Independence

The crash wall shall be independent of the building superstructure and is considered sacrificial in a derailment scenario. Where the crash wall is in line with the building basement line, the crash wall can be integrated and located on top of the building foundation wall. In such an arrangement the wall shall be designed to be dependent on the building foundation wall, but the foundation wall shall not be dependent on the crash wall. Should the crash wall be removed or destroyed the structural integrity of the foundation wall and the building superstructure shall not be compromised.

Such a foundation wall shall be designed locally for the capacity of the crash wall (i.e., in an extreme ULS condition, a hinge would form at the base of the wall and not in the building basement or superstructure).

Where the crash wall is outside of the building structure the structural elements supporting the building (columns and walls) should be sufficiently set back from the inside face of the crash wall to avoid contact between the wall deflected under impact loading and the elements supporting the building. Such a setback ensures that in the event of train impact the crash wall can be deflected without compromising the structural integrity of the building structure.

Corrosion Protection

As stipulated by the AREMA Guidelines under Section 2.6.4, exposed reinforcing bars, inserts, and plates intended for bonding with future extensions, shall be protected from corrosion. This is particularly relevant to this project as the crash wall is planned to be built in two phases. As such, any elements that could experience corrosion, are required to implement measures to prevent this from occurring.

6.2 Setbacks

In the case of 2400-2440 Dundas Street West, the application of a crash wall allows a). the reduction in the building setback and b). the setback to sensitive uses to be measured as a combination of horizontal and vertical measures.

The proposed setbacks for the North Block are illustrated in Figure 18 below.

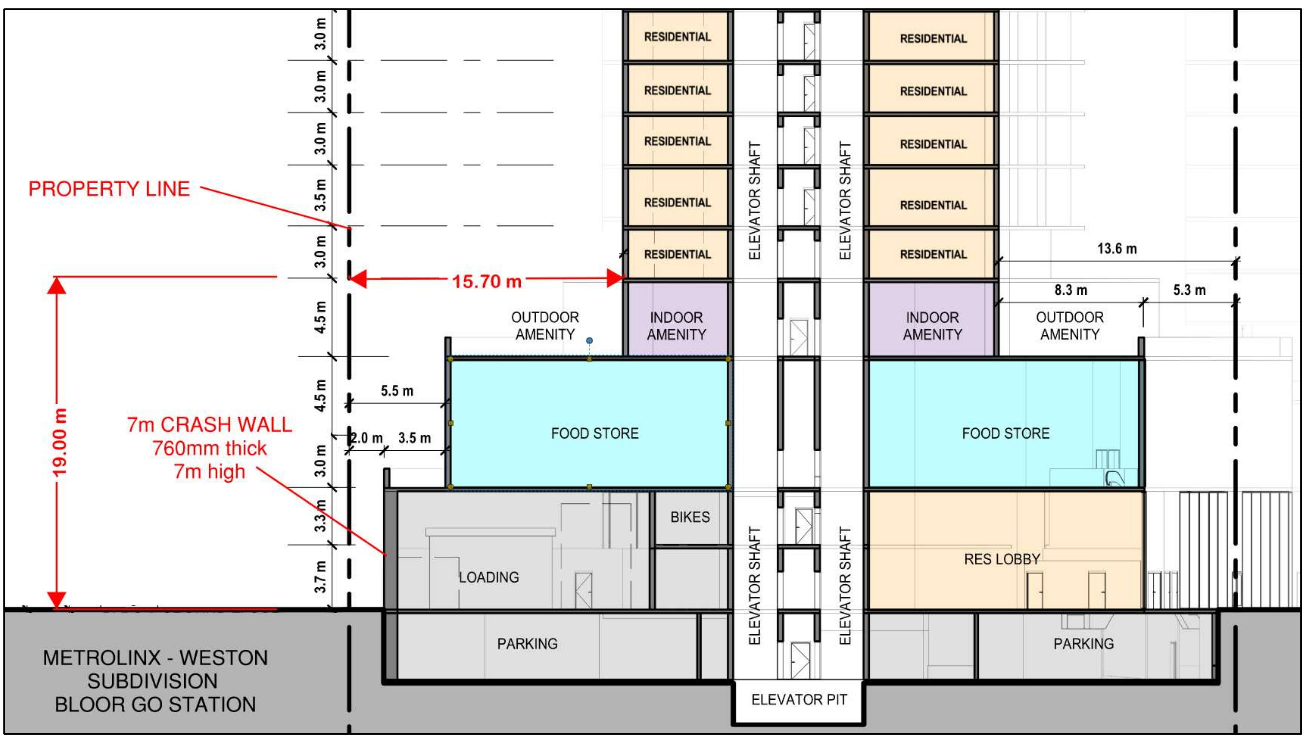

Figure 18: Sensitive Use Setback from rail corridor (North Block)

The residential units on the fourth floor and above achieve a minimum combined setback of approximately 35m (15.7m horizontal + 19m vertical), which exceeds the setback requirements for sensitive use.

As discussed above, non-sensitive uses such as loading, storage, back-of-house, common elements of the building are located on the ground floor, closest to the railway property line. The food store on the second floor will occupy the entire floor. Given the transient nature of the development, some encroachment within the setback area is considered to be acceptable and is consistent with podium-level retail development adjacent to Metrolinx rail corridors across the GTA.

While the small commercial space proposed on the Ground Floor of the North Block (shown in Figure 12 above) falls within the rail setback, it's physical size (<1500 sq. ft) restricts high occupancy uses, and is contemplated as small, subdivided artist spaces. While the commercial designation applies, the uses are not considered to be sensitive or high occupancy. Considering the enhanced safety barrier that is proposed for the North Block, the reduction in setback to this space is considered acceptable.

The setbacks for the South Block are illustrated in Figure 19 below.

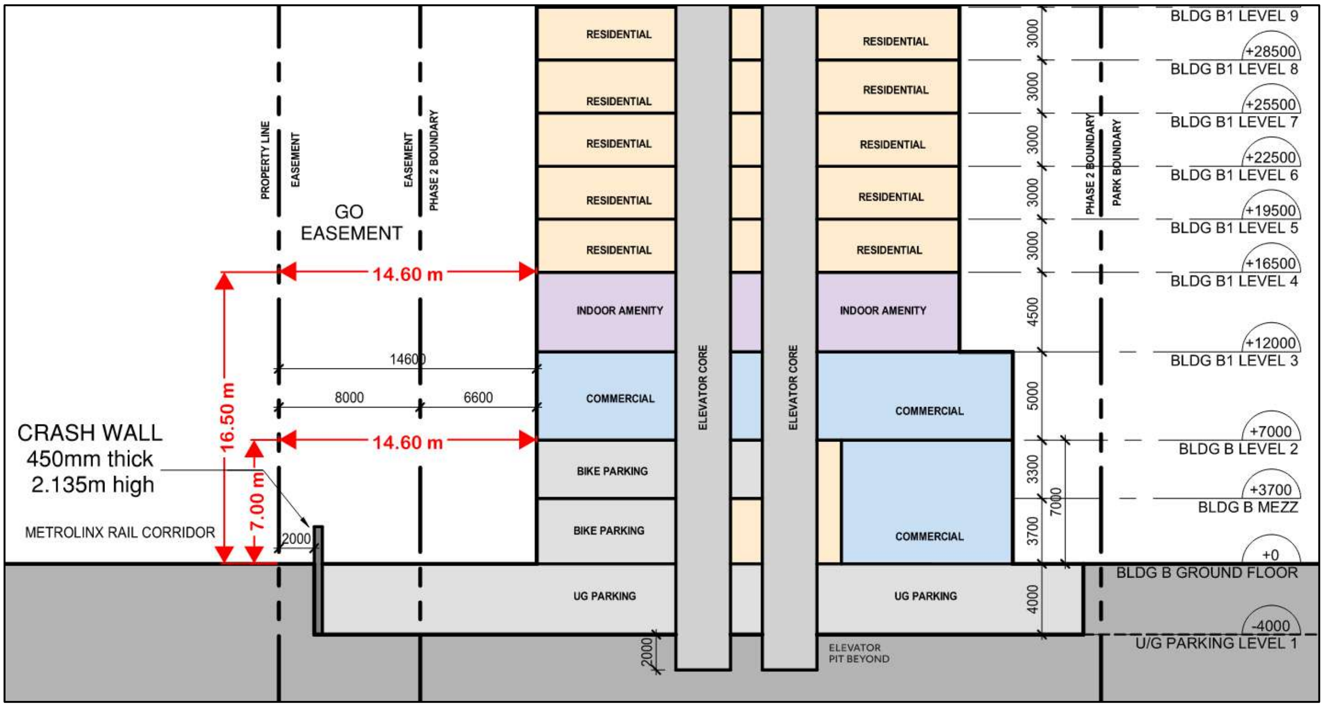

Figure 19: Sensitive use setback from rail corridor (South Block)

The residential units on the fourth floor and above achieve a minimum combined setback of approximately 35m (14.6m horizontal + 20,5m vertical), which also exceeds the setback requirements for sensitive use.

Due to the reduced horizontal setback between the building and the rail corridor property line, sensitive uses rely on a combination of vertical and horizontal setbacks to achieve the recommended separation distance from the railway.

The majority of uses proposed within the 25-metre setback area include unoccupied space for loading and servicing, common elements of the building such as corridors, lobbies, and back-of-house areas, amenity space (both interior and exterior), all of which are supported by the applicable guidelines.

The commercial space proposed on the second floor achieves a total combined setback of approximately 22m (14.6m horizontal + 7m vertical) which is less than the 25m recommended setback. Despite the modest reduction in the total setback that is proposed for commercial space, a number of site-specific factors contribute to a lower risk profile at the site, including:

- The application of a crash wall safety barrier,
- The existence of a newly built crash wall on the neighboring property to the south,
- The operating environment of a GO Station, resulting in the majority of trains stopping at the site,
- No building structure within the area immediately behind the crash wall.

Consistent with best practices, options to place passive, transient, and infrequently occupied spaces closest to the rail facing façade will be explored during the detailed design phase. This includes corridors, meeting rooms, kitchens and staff areas, and back-of-house areas where occupancy levels fluctuate throughout the day.

The full architectural drawing set should be reviewed in conjunction with this report and section.

Notably, the proposed setback is consistent with recently approved commercial development nearby. Including 150 Sterling Road and 77 Wade Avenue, which both proposed a combined setbacks to commercial use less than 20m, made allowable through the provision of a higher order safety barrier.

6.3 Trespassing

The FCM/RAC Guidelines assert that trespassing represents, 'by far, the greatest number of annual fatalities resulting from railway accidents." As such, adequate provisions to prevent the public from entering the rail corridor lands are recommended.

The crash wall that runs along the mutual property line and extends 2.135 metres above the adjacent ground satisfies the trespassing mitigation requirements for the affected rail authorities.

Importantly, the existing Metrolinx noise wall and existing chain link fencing in the corridor also acts as a mitigating factor to limit unauthorized access to rail corridor.

Lastly, the presence of Bloor GO Station immediately adjacent to the property will facilitate public access to station platforms within the rail corridor. While the new development can be designed to reduce trespassing risk, the reality is that members of the public will regularly be within the railway operating environment for the long-term future (i.e.. The lifecycle of Bloor Transit Hub).

6.4 Fire & Smoke

Given the height of the crash wall in the North Block and the total setback to sensitive occupancy exceeding the minimum recommended distances, there are no additional restrictions to the proposed development beyond Fire Code requirements associated with the construction materials or detailing for fire.

As the site is located along the southwestern boundary of the rail corridor, smoke and reduced air quality is unlikely to be a significant concern for future occupants at the property. Consistent with best practice, it is recommended to avoid placing air intake systems on the side of the development closest to the rail corridor, to avoid the potential ingress of smoke or diesel exhaust into the mechanical HVAC systems serving the units.

6.5 Graffiti Management

When crash walls are selected as the preferred mitigation measure for a new development, an anti-graffiti spray is typically applied to the rail-facing side of the barrier to discourage and manage graffiti. Per Metrolinx requirements, anti-graffiti mitigation measures will be explored by the design team during the detailed design phase of the project.

6.6 Debris

The combination of the crash wall extent and height provides sufficient mitigation for the risk of debris resulting from a derailment to reasonable levels.

6.7 Vandalism

It is important for any new rail-adjacent development to consider design measures that minimize the risk of vandalism to the railway. One of the most notable concerns involves objects being thrown onto passing trains, as this action can damage infrastructure, create unsafe operating conditions, or in the case of development near stations, affect passenger safety.

The proposed development at 2400-2440 Dundas Street West mitigates this risk using a series of step backs on the North Block in combination with balustrades and security screens on the outdoor amenity space facing the rail corridor on the upper levels. The screens will be consistent with the Metrolinx guidance, which prescribes a minimum 2.4-metre-high barrier to address this risk.

The residential balconies on both the North and South Block are setback a sufficient distance from the rail corridor property line to minimize this risk on the upper floors of the development.

6.8 Construction

Any construction considerations will be dealt with separately with the contractor's input. Additional permits such as Crane Swing Agreements and Flagging Permits may be required at the discretion of the Rail Authority.

6.9 Warning Clauses

Consistent with the Metrolinx Adjacent Development Guidelines, warning clauses may be required to ensure that future occupants of the development are aware of the risks associated with nearby rail facilities.

The Warning Clauses will be included as part of the Adjacent Development Agreement between the Landowner and Metrolinx.

7 CONCLUSION

This Rail Safety Report has been prepared in accordance with the FCM/RAC Guidelines, the Metrolinx Adjacent Development Guidelines, and the City of Toronto's Land Use Study: Development in Proximity to Rail Operations. It also considers AECOM Crash Wall Design Guidelines, which have been used to inform the safety barrier specifications.

This report recognizes the standard mitigation measures are not practical for this site, particularly given its proximity to higher-order transit.

The risk-mitigating measures include:

- A 7-metre-high, 760mm thick crash wall, integrated into the podium of the North Block.
- A 2.135-metre-high, 450mm thick crash wall, cantilevered and extending along the eastern `extent of the development
- A minimum 30-metre total setback to all residential, sensitive use space, achieved through a combination of horizontal and vertical measures
- Trespassing mitigation through the application of a crash wall along the mutual property line
- Non-sensitive, passive uses, low occupancy and unoccupied spaces intentionally designed/programmed within the areas of the development closest to the rail corridor
- Security barriers/balustrades on outdoor amenities for fall protection and to minimize vandalism to the adjacent rail corridor

Additional measures may be needed to mitigate noise and vibration; however these risks are assessed independently from this study.

The site-specific safety considerations relating to the development's proximity to the rail corridor have been reviewed and the measures proposed in this report are believed to reasonably mitigate the risks.

8 APPENDICES

Appendix A – Rail Information
Appendix B – Train Derailment Calculations
Appendix C – Risk Assessment Matrix
Appendix D – Additional GO Station Improvements

APPENDIX A – RAIL INFORMATION

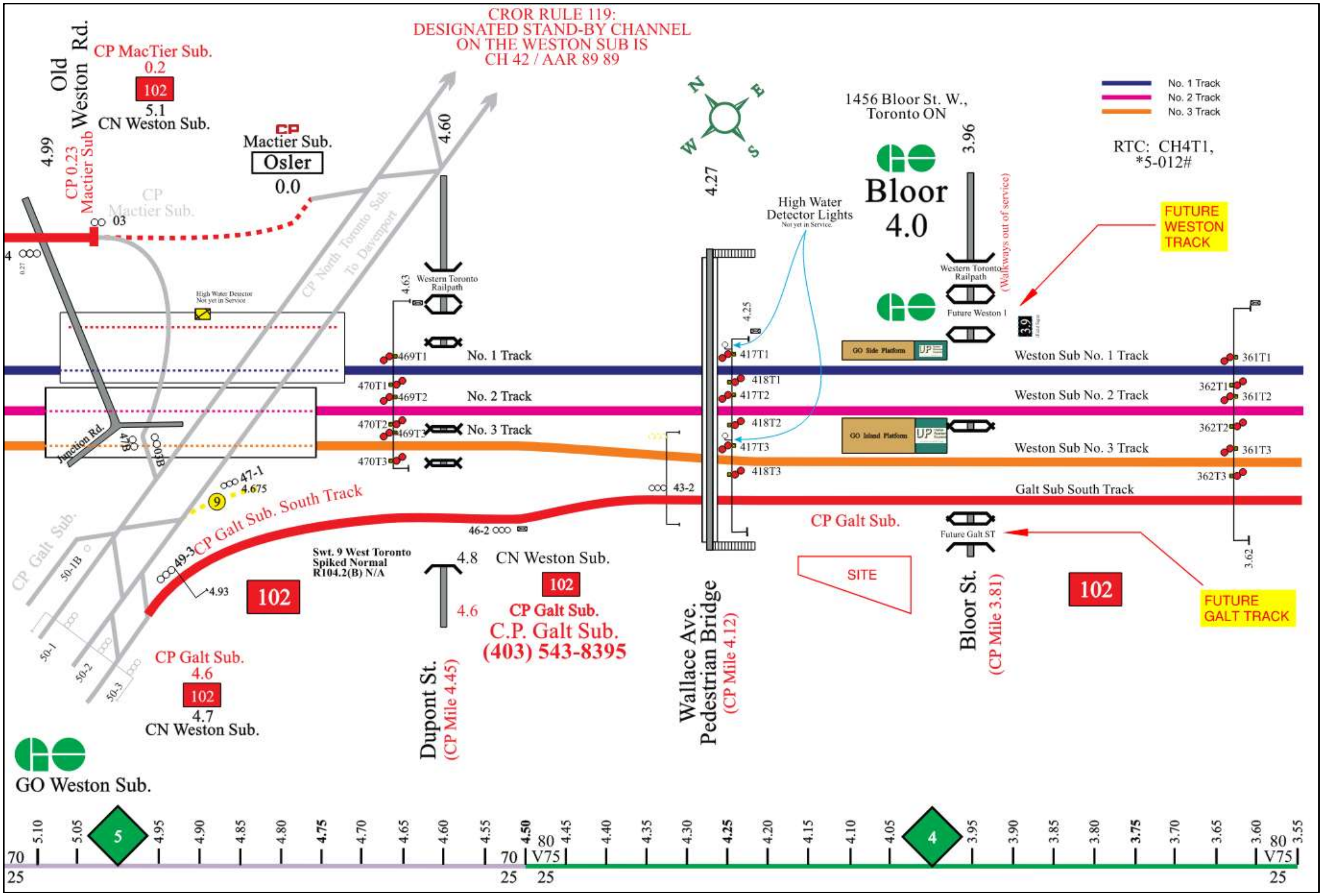

Figure A-1: Metrolinx Track Diagram

Figure A-2: Railway Association of Canada Track Information at Site Location

East Division Time Table No 12, Module 4.2 Galt Subdivision – Effective at 1200 March 23, 2018

GALT SUBDIVISION FOOTNOTES

0.0 RADIO

0.1 Zone Code (Z):
East of Guelph Jct. 3
West of Guelph Jct. 4

0.2 Engineering Service Reliability:
East of Guelph Jct. .... ✱31106# on CP 20
West of Guelph Jct. .... ✱41106# on CP 20

1.0 HOT BOX DETECTOR SYSTEM

1.1

WESTWARD			LOCATION		EASTWARD		
INSPECTION POINT	SET-OFF POINT	GOI SEC 5 ITEM 27.0	MILE (TRACK)	DTMF CODE	GOI SEC 5 ITEM 27.0	INSPECTION POINT	SET-OFF POINT
Before mile 9.3	Dixie	**	8.6 (1) 8.6 (2) 8.6 (3)	#008688 #008666 #008644	**	Before Keele Street mile 4.9	Keele Street
Before Signals 275-2 or 275-3	Milton north service track	**	24.9① (North) 24.9① (South)	#024966 #024944	**	Before Signals 220-2 or 220-3	Streetsville Jct.
Before Signal 449	Puslinch	**	42.6	#042655	**	Before Signal 402	Guelph Jct.
Before mile 67.6	Ayr	**	65.1	#065155	**	Before Signal 612	Galt Yard
Before Signal 857	Woodstock	**	83.4	#083455	**	Before Signal 798	Blandford
Before Signal 1031	Nissouri	**	98.8	#098855	**	Before Signal 948	Zorra

① HBD will also transmit movement length, and when a defect is detected will also transmit AEI car ID number with axle count.

2.0 EQUIPMENT RESTRICTIONS

2.1 **Crane and Auxiliary**
— 414216 to 414232: 30 MPH on bridges miles 2.62, 3.81, and 4.45.

3.0 DANGEROUS COMMODITIES

3.1 GOI Section 5, item 1.1 applies to all movements originating at Lambton and Quebec St.

3.2 Key trains and all movements handling one or more full carloads, containerloads, or trailerloads of SPECIAL dangerous commodities, unless a lower speed is otherwise prescribed, must not exceed:

Between Miles	MPH
1.9 and 9.55	25
9.55 and 34.3	35
53.5 and 59.9	35
106.9 and 111.0	35

Loaded cars (not applicable to residue cars) containing other dangerous goods, unless a lower speed is otherwise prescribed, must not exceed 35 MPH between mile 4.9 and mile 9.55.

4.0 SPEEDS

4.1

Westward	Freight Trains	Eastward
MPH	Mile (Track)	MPH
50	1.9 to 4.2	50
30	4.2 to 4.9	30
50	4.9 to 6.8	50
25	6.8 to 7.3 (No 1)	25
50	6.8 to 7.3 (No 2 & 3)	50
50	7.3 to 15.0	50
60	15.0 to 18.0	60
50	18.0 to 22.0	50
60	22.0 to 30.6	60
45	30.6 to 39.4	45
60	39.4 to 40.1	60
60	40.1 to 40.2 (North)	60
40	40.1 to 40.2 (South)	40
60	40.2 to 42.3	60
50	42.3 to 44.0	50
60	44.0 to 55.0	60
50	55.0 to 57.0	50
40	57.0 to 59.7	40
60	59.7 to 71.0	60
45	71.0 to 72.3	45
50	72.3 to 74.4	50
60	74.4 to 81.4	60
55	81.4 to 81.8	55
60	81.8 to 86.0	60
50	86.0 to 89.0	50
60	89.0 to 111.0	60
35	111.0 to 113.0	35
30	113.0 to 114.33	30
★25	114.33 to 114.6	

★ Until crossing is fully occupied.

Page 2/7

Figure A-3: Galt Subdivision Timetable

APPENDIX B – TRAIN DERAILMENT CALCULATIONS

DISTANCE FROM CENTRELINE OF TRACK

The train derailment distances for glancing blow load cases were calculated by applying the following equation and rearranging to solve for d_{CL}. The resulting values are summarized in the sections below.

$$v_G = \sqrt{v_0^2 + 2a\left(\frac{d_{CL} - 1.625}{sin\theta_G}\right)}\ [\mathrm{m/s}]$$

LOAD CASE 1 – GLANCING BLOW – MULTI-CAR FREIGHT		
Description	**Variable**	**Value**
Resistance	R	0.25
Grade	G	0
Groundline at wall		0
Base of rail		0
Angle of impact (degrees)	θ_G	3.5
Distance from the centreline of the track for train to come to rest (m)	d_{CL}	7.9
Track speed (mph)	v_o	50
Track speed (km/hr)	v_o	80.4672
Track speed (m/s)	v_o	22.35
Velocity of train at impact (m/s)	v_G	0
Velocity of train at impact (km/hr)		0
Velocity of train at impact (mph)		0
Impact force (kN)	F_G	0
Length to stop (m)	L	101.97
Length of the wall along which the impact force should act (m)	l_G	3.05

LOAD CASE 3: GLANCING BLOW – MULTI-CAR PASSENGER		
Description	**Variable**	**Value**
Resistance	R	0.25
Grade	G	0
Groundline at wall		0
Base of rail		0
Angle of impact (degrees)	θ_G	3.5
Distance from the centreline of the track for train to come to rest (m)	d_{CL}	7.9
Track speed (mph)	v_o	50
Track speed (km/hr)	v_o	80.4672
Track speed (m/s)	v_o	22.35
Velocity of train at impact (m/s)	v_G	0
Velocity of train at impact (km/hr)		0
Velocity of train at impact (mph)		0
Impact force (kN)	F_G	0
Length to stop (m)	L	101.97
Length of the wall along which the impact force should act (m)	l_G	3.05

IMPACT FORCES (GALT SUBDIVISION ONLY, ASSUMED FUTURE TRACK))

The design forces for glancing blow load cases were calculated using the equation below.

$$F_G = \frac{\frac{1}{2}m(v_G sin\theta_G)^2}{d_G} \quad \text{(metric)} \quad [14M]$$

The design forces for the single car load cases were calculated using the equation below.

$$F_A = \frac{\frac{1}{2}m\left(v_A cos\theta_f\right)^2}{32.17d_A} \quad [15]$$

All calculations were performed with a distance between the centreline of the closest track and the crash wall, d_{CL}, of 6m. The resulting values are summarized in the sections below.

LOAD CASE 1: GLANCING BLOW – MULTI-CAR FREIGHT

Description	Variable	Value
Resistance	R	0.25
Grade	G	0
Groundline at wall		0
Base of rail		0
Angle of impact (degrees)	θ_G	3.5
Distance from the centreline of the track for train to come to rest (m)	d_{CL}	6
Track speed (mph)	v_o	50
Track speed (km/hr)	v_o	80.4672
Track speed (m/s)	v_o	22.35
Velocity of train at impact (m/s)	v_G	12.2
Velocity of train at impact (km/hr)		43.8
Velocity of train at impact (mph)		27.2
Impact force (kN)	F_G	2000.36
Length to stop (m)	L	101.97
Length of the wall along which the impact force should act (m)	l_G	3.05

LOAD CASE 2: DIRECT IMPACT – SINGLE-CAR FREIGHT

Description	Variable	Value
Resistance	R	0.25
Distance from the centreline of the track for train to come to rest (m)	d_{CL}	6
Track speed (mph)		50
Track speed (km/hr)		80.4672
Angle of rotation at impact (radians)	θ_f	0.78
Impact speed (m/s)	v_A	3.34
Impact speed (km/hr)		12.01
Impact speed (mph)		7.47
Impact force (kN)	F_A	1678.64
Length of the wall along which the impact force should act	l	0.43

LOAD CASE 3: GLANCING BLOW – MULTI-CAR PASSENGER

Description	Variable	Value
Resistance	R	0.25
Grade	G	0
Groundline at wall		0
Base of rail		0
Angle of impact (degrees)	θ_G	3.5
Distance from the centreline of the track for train to come to rest (m)	d_{CL}	6
Track speed (mph)	v_o	50
Track speed (km/hr)	v_o	80.4672
Track speed (m/s)	v_o	22.35
Velocity of train at impact (m/s)	v_G	12.2
Velocity of train at impact (km/hr)		43.8
Velocity of train at impact (mph)		27.2
Impact force (kN)	F_G	984.08
Length to stop (m)	L	101.97
Length of the wall along which the impact force should act (m)	l_G	3.05

LOAD CASE 4: DIRECT IMPACT – SINGLE-CAR PASSENGER

Description	Variable	Value
Resistance	R	0.25
Distance from the centreline of the track for train to come to rest (m)	d_{CL}	6
Track speed (mph)		50
Track speed (km/hr)		80.4672
Angle of rotation at impact (radians)	θ_f	0.48
Impact speed (m/s)	v_A	4.14
Impact speed (km/hr)		14.91
Impact speed (mph)		9.26
Impact force (kN)	F_A	3157.75
Length of the wall along which the impact force should act	l	0.66

APPENDIX C – RISK ASSESSMENT MATRIX

RAIL SAFETY RISK ASSESSMENT

	Hazard	Without Mitigating Measures					With Proposed Mitigating Measures					Net change of Risk Classification	Comments
		Frequency	Severity	Residual Risk	Risk Classification		Frequency	Severity	Residual Risk	Risk Classification			
1	Derailment Freight - Flammable or Hazardous materials *Derailment of freight train transporting flammable/hazardous material*	2	3	6	Tolerable		2	2	4	Acceptable		-2	Provision of an independent crash wall and 30+ metre setback to sensitive uses reduces this risk
2	Derailment Freight - Inert Glancing Blow *Multicar derailment of freight train adjacent to site*	1	3	3	Acceptable		1	2	2	Acceptable		-1	Provision of an independent crash wall and 30+ metre setback to sensitive uses reduces this risk
3	Derailment Freight - Inert Direct Impact *Single freight car impact due to accordion style derailment*	1	3	3	Acceptable		1	2	2	Acceptable		-1	Provision of an independent crash wall and 30+ metre setback to sensitive uses reduces this risk
4	Derailment Passenger - Glancing Blow *Derailment of passenger train traveling towards the property at a 3.5°*	2	4	8	Tolerable		2	2	4	Acceptable		-4	Crash wall offers additional mitigation to limit ingress of a derailed passenger train into the site and is a sacrificial barrier that can be replaced if damaged/destroyed.
5	Derailment Passenger - Direct Impact *Single car rotational impact due to accordion style derailment*	2	4	8	Tolerable		2	2	4	Acceptable		-4	Crash wall offers additional mitigation to limit ingress of a derailed passenger train into the site and is a sacrificial barrier that can be replaced if damaged/destroyed.
6	Excess Speed - Freight *Derailment of freight train travelling at speed in excess of track design speed*	2	3	6	Tolerable		2	2	4	Acceptable		-2	Freight operations are limited, reducing the likelihood of this event. The crash wall safety barrier addresses this risk.
7	Excess Speed - Passenger *Derailment of passenger train travelling at speed in excess of track design speed*	2	4	8	Tolerable		2	3	6	Tolerable		-2	Crash wall offers additional mitigation to limit ingress of a derailed passenger train into the site and is a sacrificial barrier that can be replaced if damaged/destroyed.
8	Airborne Debris - Freight *Top level sea-can of a double stacked intermodal freight car is launched due to a derailment*	1	4	4	Acceptable		1	3	3	Acceptable		-1	7m+ crash wall is designed to address the presence of double-stacked freight cars and offers reasonable protection against airborne debris.
9	Ground borne Debris - Freight *As a result of derailment a sea-can or a part of the freight train become rolling or sliding debris along the ground*	2	3	6	Tolerable		2	2	4	Acceptable		-2	7m+ crash wall is designed specifically to address the presence of double-stacked freight cars and offers reasonable protection against airborne debris. Presence of GO Station also helps mitigates this risk, depending on which track incident originates on

10	Airborne Debris - Passenger *During a derailment, part of the passenger train become airborne projectiles*	1	3	3	Acceptable		1	2	2	Acceptable		-1	7m+ crash wall is designed specifically to address the risk airborne debris. Given the presence of the GO Station, the majority of trains will be slowing/stopping meaning the risk of derailment is reasonably low.
11	Ground borne Debris - Passenger *As a result of derailment, the train/part of the rolling stock travels along the ground towards the site*	1	3	3	Tolerable		1	2	2	Acceptable		-1	Presence of crash wall provides suitable mitigation against the risk of moving train parts at grade Given the presence of the GO Station, the majority of trains will be slowing/stopping meaning the risk of derailment is reasonably low.
12	Smoke/Exhaust *Ingestion of smoke or diesel exhaust into a building's HVAC systems*	3	3	9	Tolerable		3	2	6	Tolerable		-3	Restriction of low-level air intakes adjacent to the rail corridor reduces risk of ingestion of smoke or exhaust
13	Trespassing *Ingress of unauthorized personnel onto railway*	4	3	12	Intolerable		3	3	9	Tolerable		-3	Crash wall, noise wall, and chain link fence will extend the full length of the development site preventing trespassing opportunity from the site but the GO Station provides access to the corridor.
	Total Assessed Risk Score			79					52			-27	

RISK EVENT CLASSIFICATION

Frequency of Event	Class	Severity of Event: Negligible	Marginal	Serious	Critical	Catastrophic
		1	2	3	4	5
Improbable	1	1	2	3	4	5
Remote	2	2	4	6	8	10
Occasional	3	3	6	9	12	15
Probable	4	4	8	12	16	20
Frequent	5	5	10	15	20	25

RISK CATEGORY

Risk (Frequency Class x Severity Class)		Risk Assessment Category	Mitigation Measures Approach
Low	1 to 4	Acceptable	No further mitigation is required
Medium	6 to 9	Tolerable	Tolerable if ALARP* - mitigate to level that is reasonable
High	10 to 25	Intolerable	Risk shall be eliminated / reduced

*ALARP = As Low As Reasonably Practicable

DEFINITION OF FREQUENCY CRITERIA

Fraquency Rating	Description
1. Improbable	Extremely unlikely to occur
2. Remote	Unlikely to occur in rail lifecycle
3. Occasional	Likley to occur several times in rail lifecycle
4. Probable	Expected to occur
5. Frequent	Expected to occur continuous

DEFINITION OF SEVERITY CRITERIA

Severity Rating	Consequence to Person/Public	Consequence to Environment
1. Negligible	Non-reportable injury	None
2. Marginal	Single minor injury	Reversible minor environmental impact
3. Serious	Single permanent partial or temporary total disabling injury; multiple minor injury	Reversible moderate environmental impact
4. Critical	Single fatality; Single permanent total disability; Multiple permanent partial or temporary total disabling injury	Reversible significant environmental impact
5. Catastrophic	Multiple fatalities: Multiple permanent total disabling injuries	Irreversible significant environmental impact

APPENDIX D – ADDITIONAL GO STATION IMPROVEMENTS

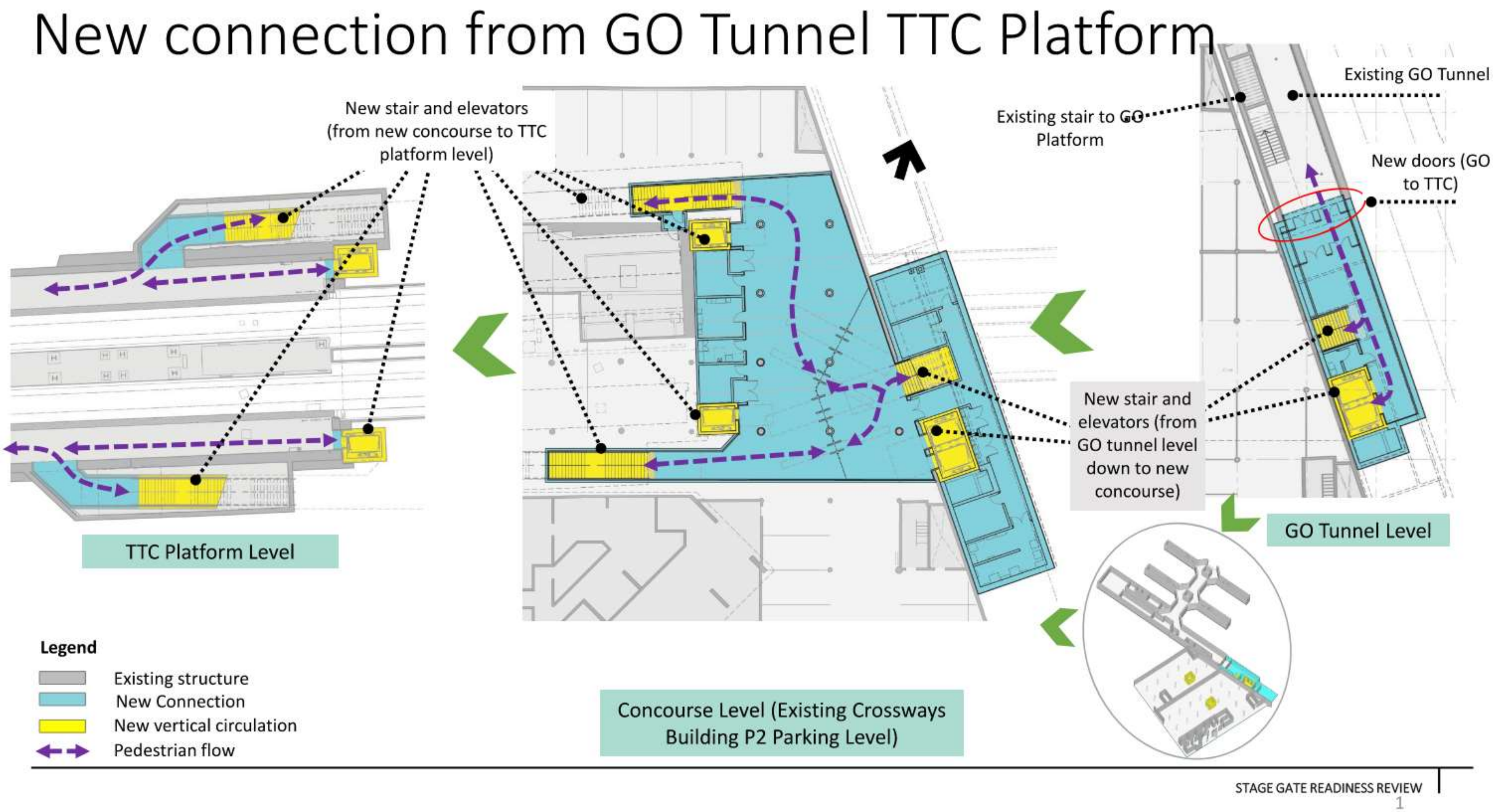

Figure D-1: Bloor GO Station Improvements

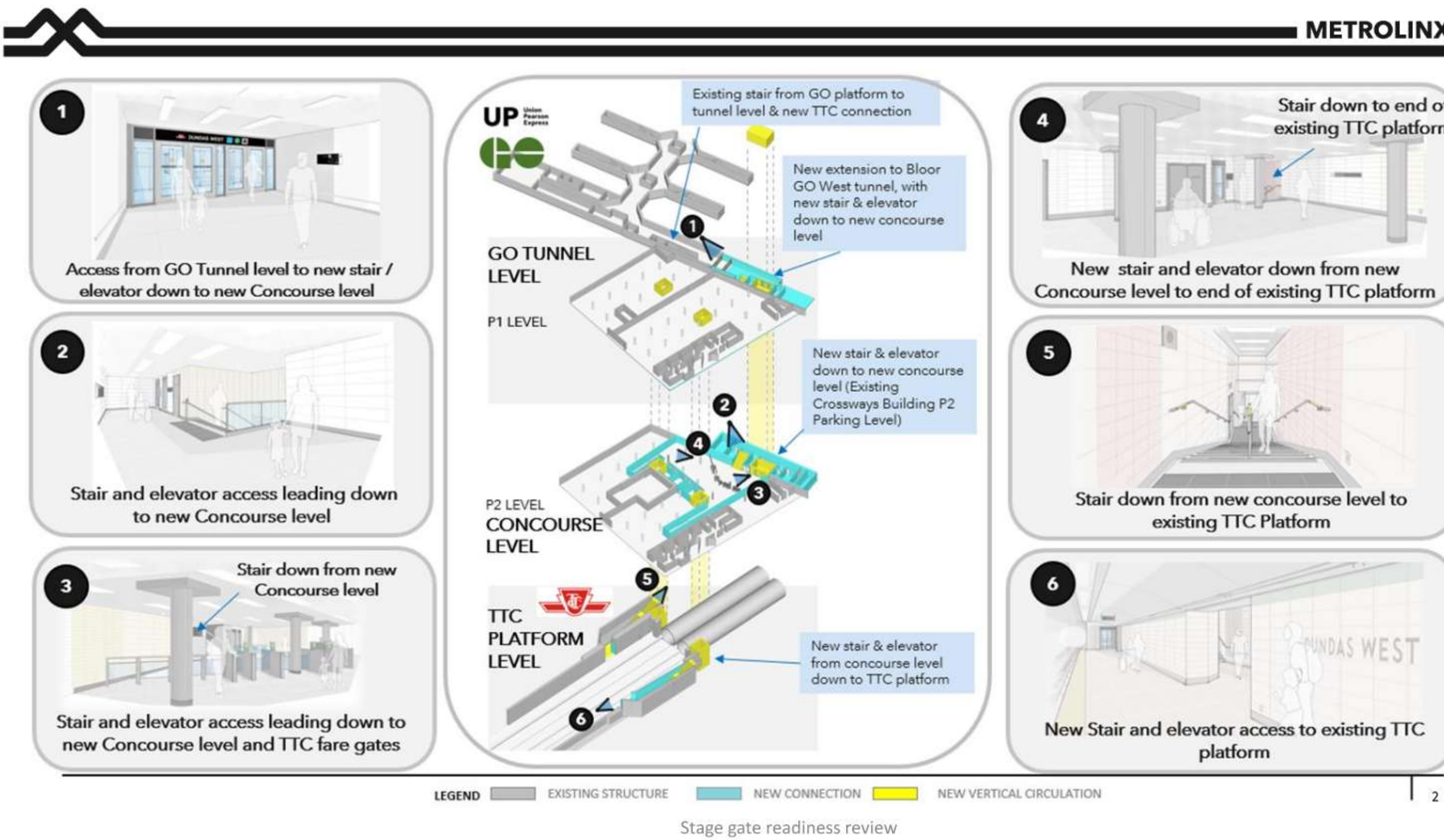

Figure D-2: Bloor GO Station Improvements