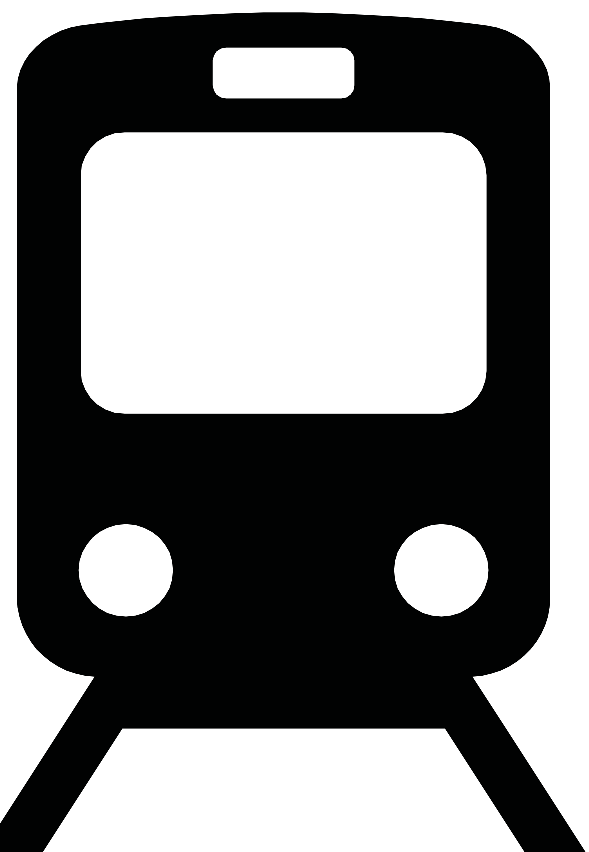
YONGE NORTH SUBWAY EXTENSION

ENVIRONMENTAL PROJECT REPORT ADDENDUM

Final Noise & Vibration Existing Conditions and Impact Assessment Report

April 14, 2022



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On behalf of Metrolinx IO:		
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Yonge North Subway Extension (YNSE) Environmental Project Report Addendum

Noise and Vibration Existing Conditions & Impact Assessment Report

FOR

CONTRACTING AUTHORITY METROLINX IO

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PART A – YNSE EPR ADDENDUM EXISTING CONDITIONS REPORT

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E.1 Executive Summary

Metrolinx and Infrastructure Ontario are undertaking an Addendum to the Environmental Project Report (EPR) for the Yonge North Subway Extension (YNSE). This study is following the requirements of the Transit Project Assessment Process (TPAP) under O. Reg. 231/08 and will address a change to the subway extension alignment, stations, and associated facilities.

Previous studies followed the TPAP for the YNSE. An EPR was completed by the Regional Municipality of York (York Region), York Region Rapid Transit Corporation, the City of Toronto and the Toronto Transit Commission in 2009 for the new subway extension. A further addendum to the EPR was prepared in 2014 to assess the potential environmental impacts associated with the identified Train Storage Facility (TSF) location that would accommodate up to 14 trains within the vicinity of the Richmond Hill Centre.

E.1.1 Study Purpose

As part of the YNSE EPR Addendum process, this Existing Conditions and Impact Assessment Report has been prepared to document the current existing conditions within the Study Area, to undertake an assessment of the potential impacts associated with the currently proposed YNSE Project, and to identify mitigation and monitoring measures, as appropriate.

The Noise and Vibration Existing Conditions and Impact Assessment Report is intended to:

1. Characterize existing noise and vibration conditions, including documentation of the dominant sources of noise and vibration.
2. Complete noise and vibration monitoring of dominant noise and vibration sources.
3. Calculate the existing sound and/or vibration levels at representative sensitive receptors, which include existing road and railway traffic.
4. Calculate future sound and vibration levels from the project's operations at representative sensitive receptors.
5. Calculate future sound and vibration levels from the project's construction at representative sensitive receptors.
6. Identify mitigation measures that may be required to meet the applicable noise and vibration requirements.
7. Identify monitoring requirements and commitments to future work.

The Existing Conditions Report (Part A) provides inputs into the Impact Assessment stage of the study (Part B). The measured and/or calculated existing sound levels can be used in establishing the ambient sound levels to compare and assess against the sound levels of new project elements, such as tunnel ventilation fans or operations of proposed subway vehicles.

E.1.2 Existing Conditions

The YNSE alignment runs primarily through developed areas. Typically, dominant existing noise sources include major roadways (such as Yonge Street and Steeles Avenue), railways (including both the CN Bala and York subdivisions), and Highway 407.

In order to identify receptors sensitive to noise and vibration, a review of existing land uses was carried out, which yielded that existing land uses include residential uses (with a mix of both high-rise and low-rise), commercial uses (such as offices, shopping centres, automotive dealerships), institutional uses (such as schools, places of worship, and cemeteries), and industrial uses. In general terms, this review of existing land uses was used to select the representative sensitive receptors to be used in the noise and vibration impact assessment. The noise and vibration baseline monitoring was completed at a selection of representative sensitive receptors. The monitoring indicated that the ambient sound levels along the corridor range from:

- 58 to 73 dBA $L_{eq,16hr}$ during the daytime period (7 a.m. to 11 p.m.); and
- 52 to 68 dBA $L_{eq,8hr}$ during the nighttime period (11 p.m. to 7 a.m.).

The quietest hourly equivalent sound levels range from:

- 41 dBA $L_{eq,1hr}$ to 70 dBA $L_{eq,1hr}$ during the daytime; and
- 37 dBA $L_{eq,1hr}$ to 64dBA $L_{eq,1hr}$ during the nighttime.

These sound levels are consistent with sound levels typically occurring in developed areas.

Vibration monitoring indicated levels well above the threshold of human perception (0.10 mm/s) near Finch Station. Otherwise, vibration levels at the monitored locations were well below human perception.

E.1.3 Summary of Potential Impacts, Mitigation Measures & Monitoring Activities

E.1.3.1 Key Findings

E.1.3.1.1 Construction Noise

- The noise impact assessment conservatively assumed that all construction equipment would operate in a small work area closest to each sensitive receptor instead of being spread throughout a given site.
- Without mitigation, construction sound levels are predicted to exceed construction noise criteria at many sensitive receptors along the alignment.
- To reduce potential impacts, appropriate mitigation measures (see Part B for details) could be implemented in addition to the development and implementation of a construction noise management plan before construction begins.

E.1.3.1.2 Construction Vibration

- The vibration impact assessment employed a conservative approach, where construction equipment was assumed to operate at the edge of a given construction site, closest to sensitive receptors.
- Without mitigation, there is the potential to exceed the vibration criteria at receptors located near the surface construction sites along the alignment.
- Tunneling using the tunnel boring machines is not expected to exceed the construction vibration criteria. Tunnelling support activities (such as the potential use of a temporary railway within the tunnels) have the potential to exceed the best-practice vibration criteria at some receptors located near the tunnels.

- The potential for exceedances will be reduced by implementing appropriate mitigation measures (see Part B for details) and through development and implementation of a plan to manage construction vibration before construction begins.

E.1.3.1.3 Operational Noise

- The operational noise of the subway is predicted to meet the existing pre-project sound levels. Therefore, no mitigation is needed.
- The subway vehicle passby noise is predicted to meet or be below the passby noise criteria at any sensitive receptor along the alignment. Therefore, no mitigation is needed.
- With proven mitigation measures such as noise barriers, the sound levels from all stationary sources (including stations, ventilation equipment, traction power substations, bus terminals/loops, and train storage facility) are predicted to meet or be lower than the applicable criteria at all assessed sensitive receptors along the alignment (see Part B for more details).

E.1.3.1.4 Operational Vibration

- Using proven and readily available mitigation measures, ground-borne vibration and ground-borne noise from subway operations are predicted to meet or be lower than the applicable criteria at all sensitive receptors along the alignment (see Potential Effects & Mitigation Measures for more details).
- As detailed design progresses, more detailed studies, including in-field testing, will be completed to define specific vibration control measures.

E.1.3.2 Operational Noise and Vibration Criteria

E.1.3.2.1 Subway Trains

- The noise and vibration criteria for the trains are provided by protocols provided by the Ministry of the Environment, Conservation and Parks (MECP).
- As there are no provincial requirements or standards for ground-borne noise, the criteria from the US Federal Transit Administration are used, similar to other recently completed transit projects. Noise and vibration mitigation will be investigated and implemented if a project is predicted to exceed any of the criteria.

E.1.3.2.1 Stationary Facilities

- The train storage facility (TSF) and facilities such as stations (which include ventilation equipment), traction power substations and bus terminals were assessed in accordance with the Ministry of Environment, Conservation and Parks, Environmental Noise Guideline - Stationary and Transportation Sources - Approval and Planning (NPC-300). Noise and vibration mitigation will be investigated and implemented if a project is predicted to exceed any of the criteria.

E.1.3.3 Potential Effects

E.1.3.3.1 Construction Noise and Vibration

- Without mitigation, there is potential for noise criteria and vibration criteria exceedances at some receptors near the surface construction sites along the alignment.

E.1.3.3.2 Operational Noise and Vibration

- Without mitigation, there is potential for stationary facilities noise criteria exceedances as well exceedances of the ground-borne noise and vibration criteria at many receptors along the alignment.
- There are no predicted exceedances of the air-borne noise criteria from train operations at receptors along the alignment.

E.1.3.4 Mitigation Measures and Monitoring Activities

The following is a summary of key mitigation measures – see **Table B 6-1** for the comprehensive list of mitigation measures and corresponding monitoring activities.

E.1.3.3.1 Construction Noise

- Use equipment that meets the Provincial criteria in NPC-115.
- Ensure equipment is kept in good working order and operate with effective muffling devices where required. Provide smooth surfaces for vehicles to travel throughout the construction zones to help reduce impulsive noises such as tailgate banging of dump trucks.
- Develop construction staging plans that reduce noise at nearby sensitive receptors. This can include:
    - maximizing the separating distance from stationary equipment (such as generators and compressors) to the extent feasible,
    - selecting truck staging areas that are as far away from sensitive receptors as feasible,
    - designing optimal truck routes that minimize on-site movement (especially reversing) and avoiding travel along the quieter residential streets.
- Schedule noisy activities during the daytime periods, where possible.
- Consider and erect temporary noise barriers or acoustic enclosures around noisy equipment such as concrete pumps, compressors, or generators and around long-term construction zones (such as the launch shaft), as required.
- Conduct real-time noise monitoring to identify sources of potential criteria exceedances and to implement additional mitigation measures to minimize the noise and vibration impacts, if required.
- Develop a communications protocol to provide notifications to the community on upcoming noisy activities, nighttime construction and their duration, and address complaints in a timely.

E.1.3.3.2 Construction Vibration

- Implement vibration isolation solutions such as resilient fasteners for the temporary tracks used by the temporary service locomotives during tunneling or use rubber-tired service vehicles, as required.
- Minimize the gaps between adjoining rail segments in the temporary tracks.
- Conduct regular inspection and maintenance of the temporary tracks, service trains and railway cars to minimize noise and vibration during tunneling operations.
- Schedule vibration intensive activities such as vibratory compaction during the daytime periods where possible.
- Complete pre-construction condition surveys and conduct monitoring in accordance with City of Toronto Bylaw 514-2008 as required.

- Maximize distance between equipment and sensitive receptors, where possible.
- Select construction/maintenance methods and equipment with the least vibration impacts, where possible.
- Operate construction equipment on lower vibration settings where available.
- Heavy equipment traveling over bumps or inconsistencies in the surface can generate higher vibration levels. Maintain smooth surfaces throughout construction zones to reduce vibration levels from such activities.

E.1.3.3.3 Operational Noise

- Deploy vehicle and track technology and related maintenance measures. These include regular wheel maintenance (to ensure smooth and round wheels) and rail grinding (which ensures smooth rails).
- For the stations, traction power supply substations and portal structure, implement the following mitigation:
    - All tunnel ventilation fan systems are to be provided with silencers, as required, to minimize noise and comply with the criteria outlined in MECP's noise guideline for stationary and transportation sources (NPC-300).
    - A 5.5m tall noise barrier at the Clark Station bus terminal, subject to further detailed design of the terminal.
- For the train storage facility, implement the following mitigation:
    - A 5.5m tall noise barrier along the western extent of the train storage facility, subject to further detailed design of the TSF.
    - Implement quiet special track work such as moveable point frogs.
- Select facility (stations, TPSS, and TSF) mechanical and electrical equipment to minimize sound levels and meet NPC-300 criteria.

E.1.3.3.4 Operational Vibration

- Implement mitigation measures such as floating slab track, ballast mats, resilient fasteners, and moveable point frogs, subject to further detailed design and studies, such as in-field measurements of the soils ability to transmit vibration.
- Implement regular vehicle and infrastructure maintenance such as rail grinding and wheel maintenance.

E.1.4 Permits/Approvals

An Environmental Activity Sector Registry or Environmental Compliance Approvals may be required for the traction power substations (TPSS) and the train storage yard (TSY). The required permits and approvals will be confirmed as part of detailed design.

A 1.0 Introduction

In 2009, the Regional Municipality of York, York Region Rapid Transit Corporation, the City of Toronto and the Toronto Transit Commission completed an Environmental Project Report (EPR) in accordance with the Transit Project Assessment Process (TPAP), to assess the potential environmental impacts of the proposed Yonge North Subway Extension (YNSE) Project. The study area was defined as Finch Avenue in the City of Toronto to Richmond Hill Centre Terminal at Highway 7 in the City of Richmond Hill, York Region. Notice to Proceed was given by the then Minister of Environment and Climate Change (now the Minister of Environment, Conservation & Parks [MECP]) and Statement of Completion was issued in April 2009.

In 2014, an EPR Addendum was carried out by the York Region Rapid Transit Corporation, in partnership with the Regional Municipality of York, Toronto Transit Commission (TTC), and the City of Toronto to assess the potential environmental impacts associated with the identified Train Storage Facility (TSF) location that would accommodate up to 14 trains within the vicinity of the Richmond Hill Centre. This EPR Addendum was completed in November 2014.

Subsequently in April 2019, the Government of Ontario announced a $28.5 billion expansion to Ontario's transit network. This rapid transit project plan includes four key initiatives including: the Ontario Line, the Scarborough Subway Extension, Eglinton Crosstown West Extension, and the YNSE **(Figure A 1-1**). The YNSE isan extension of TTC's Line 1 north from Finch Station to Richmond Hill.

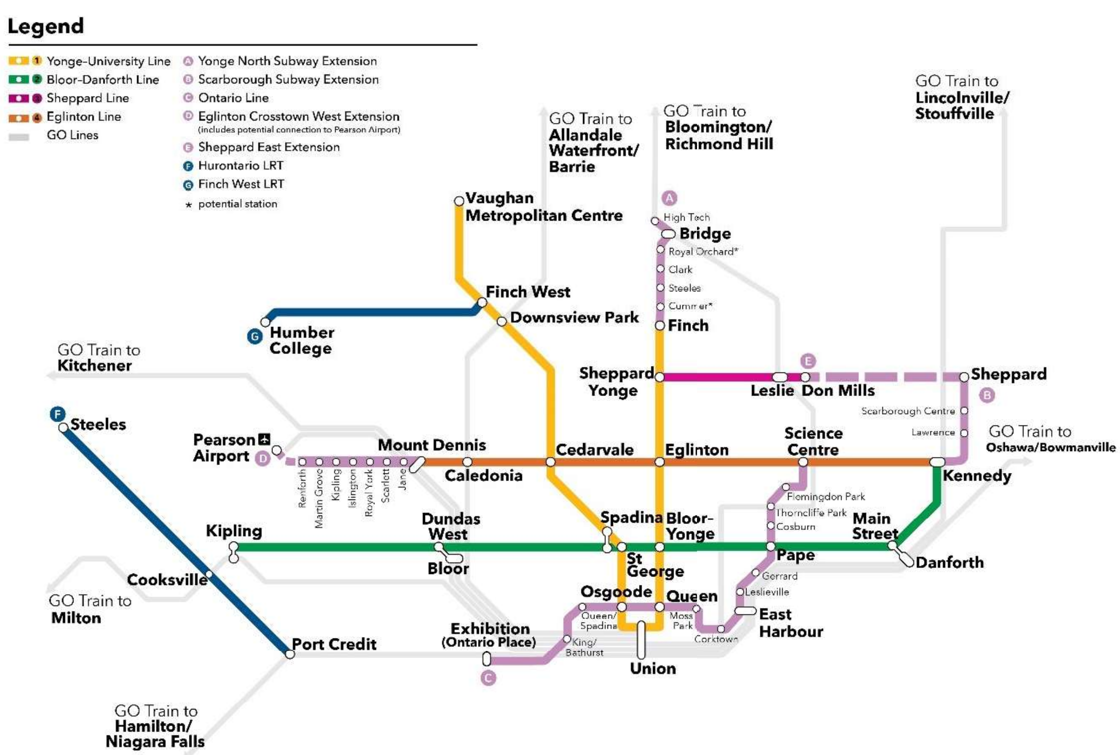


Figure A 1-1 Ontario's Rapid Transit Expansion Plan (Source: Infrastructure Ontario- 2019)

A 1.1 Initial Business Case

Metrolinx published the Yonge North Subway Extension Initial Business Case (IBC) and accompanying supplementary analysis on March 18, 2021. The IBC demonstrates how the Yonge North Subway Extension will significantly reduce travel times, grow the number of people who use public transit and serve the heart of major growth centres in Toronto and York Region. The scope and key objectives of the IBC were as follows:

- Document the details of the YNSE project, as contemplated at the time it was brought under the management of Metrolinx;
- Compare alternative alignments of the extension with a Business-As-Usual scenario;
- Investigate and evaluate options that might have additional transit benefits and/or reduced capital or operating costs; and
- Evaluate the performance of stations.

The Yonge North Subway Extension will bring higher-order rapid transit closer to a large number of residents and jobs in the intensification areas along the corridor, while providing a seamless connection between those areas. The business case introduces innovative design options in order deliver the most benefits possible within the funding envelope of $5.6 billion. The IBC generally provides recommendations for next steps in the Metrolinx Business Case process. The IBC notes:

- The Yonge North Subway Extension is one of four priority transit projects announced by the Government of Ontario, along with the Scarborough Subway Extension, the Ontario Line and the Eglinton Crosstown West Extension. The Ontario Line will provide relief to Line 1 by helping to spread demand across the transit network as it grows. The Yonge North Subway Extension will not come online until the Ontario Line goes into service.
- The extension will bring rapid transit closer to residents' destinations in the northern portions of Toronto and across York Region. The IBC highlights the need to prioritize access for bus passengers while focusing on walk-in access at each of the contemplated subway stations.
- Next steps will include refining the design of the selected alternative engineering to maximize benefits and address risks, developing a Preliminary Design Business Case, seeking required Environmental Assessment Act approvals and proceeding toward delivery.

A 1.2 Background

A 1.2.1 2009 EPR

The *Yonge Subway Extension - Finch Station to Richmond Hill Centre Transit Project Assessment- Environmental Project Report* (2009) included the assessment of approximately 6.8km of subway alignment via twin-bored tunnel, six (6) subway stations, associated track work, one (1) major bus terminal, one (1) bus loop, four (4) traction power substations, six (6) emergency exit buildings (EEBs) and one (1) bridge structure. **Figure A 1-2** provides a key map depicting the 2009 EPR scope (the red section of the proposed alignment is located in the City of Toronto; the blue section is located in York Region).

Figure A 1-2 Finch Station to Richmond Hill Centre – 2009 YNSE EPR Scope

A 1.2.2 2014 EPR Addendum

Subsequent to the 2009 EPR, an EPR Addendum was undertaken in 2014 to assess the potential environmental impacts associated with the following design changes:

- Extension of the subway alignment to approximately 1 km north of the previously approved Richmond Hill Centre Station;
- Extension of the subway alignment to approximately 1 km north of the previously approved Richmond Hill Centre Station;
- Two (2) Emergency Exit Buildings associated with the TSF.

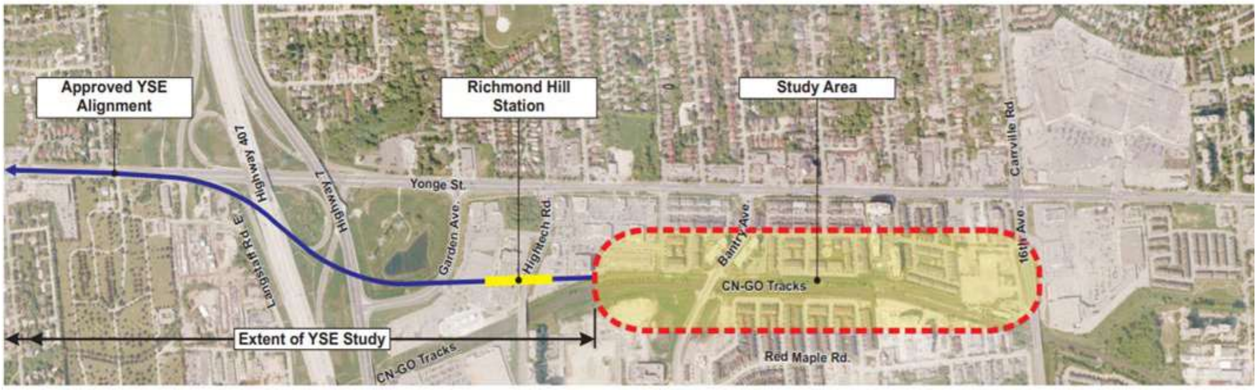


Figure A 1-3 Proposed Train Storage Facility Location – 2014 EPR Addendum

A 1.3 Study Purpose – Current EPR Addendum

Since the completion of the 2009 EPR and 2014 EPR Addendum, further changes to the proposed YNSE Project have been identified that will result in modifications to the plans presented in the previously approved 2009 EPR and 2014 EPR Addendum.

In accordance with *Section 15 of O. Reg. 231/08*, Metrolinx has determined that the changes to the Project (as described in Section 2 of the YNSE EPR Addendum document and within **Section A 2.0** below) are Significant and therefore necessitate completion of an EPR Addendum to: evaluate and document the updates to the Project description, update existing conditions, carry out associated environmental impact assessment studies, identify mitigation and monitoring requirements, and undertake public, stakeholder and Indigenous Nations consultation.

Furthermore, as per *Section 16 of O. Reg. 231/08*, since the construction of the Project has not commenced within 10 years of the issuance of the Statement of Completion (originally issued in 2009), Metrolinx is required to re-examine existing conditions as well as potential environmental impacts and mitigation measures documented in the previously approved EPR to ensure they are still valid and subsequently carryout additional environmental studies as appropriate.

A 1.4 Report Purpose

As mentioned in **Section A 1.3** the purpose of this Noise and Vibration Existing Conditions and Impact Assessment Report is two-fold:

- ***Part A –*** provides a detailed description and summary of Noise and Vibration existing conditions within the EPR Addendum Study Area (i.e., noise and vibration conditions before construction);
- ***Part B -*** provides a detailed description and summary of the potential Noise and Vibration impacts associated with the proposed YNSE project and associated mitigation and monitoring measures (i.e., noise and vibration conditions during and after construction.)

A 2.0 Update to the Project Description

A 2.1 Summary of Design Changes

This section provides a detailed description of the changes to the YNSE Project since completion of the 2009 EPR and 2014 EPR Addendum. **Table A 2-1** provides a high-level schematic depicting the 2009 EPR project components, 2014 EPR Addendum project components, and currently proposed YNSE project components for comparison purposes. In addition, detailed mapping of the project design elements iscontained in **Appendix A**.

Table A 2-1 Summary of YNSE Design Components, Changes & Rationale

Project Component	2009 EPR	2014 EPR Addendum	Current EPR Addendum	Rationale for Change
1. Proposed Subway Horizontal Alignment	Approximately 6.8 km underground subway alignment from the existing Finch Station to the proposed Richmond Hill Center Station (in the vicinity of Highway 7 and Yonge St. in the City of Richmond Hill). From Finch Station to just south of the Holy Cross Catholic Cemetery, the alignment follows Yonge St. underground. North of the Holy Cross Catholic Cemetery, the subway alignment swings slightly eastward, crossing the northwest corner of the Langstaff development lands. The alignment then turns northward under Highway 407/Highway 7. North of the Richmond Hill Centre Station, the alignment terminates at the end of subway tail tracks in the transit corridor on the west side of the CN Bala Richmond Hill GO Line.	Extension of the subway alignment by approximately 1 km from previous terminus at Richmond Hill Centre Station to 16th Ave. in the City of Richmond Hill.	The proposed YNSE subway alignment is approximately 9.5 km in total commencing at the existing Finch Station in the City of Toronto northerly to just beyond the limit of the proposed TSF (at Moonlight Lane) in the City of Richmond Hill. The proposed revenue portion of the alignment is approximately 8 km in length, while the remaining trackwork services the TSF. The proposed below grade portion of the subway alignment is approximately 6.5 km, beginning at Finch Station and extending to the proposed tunnel portal structure just south of Langstaff Road. Between Finch Station and Royal Orchard Blvd, the underground alignment is proposed to run under Yonge Street. It then curves to reach Bay Thorn Drive and continue to the east, before turning northwards where the alignment generally follows the existing CN Rail ROW until the proposed portal structure (just south of Langstaff Road) where the subway alignment emerges to at grade. The proposed at grade portion of the subway alignment is approximately 3 km in length beginning just south of Langstaff Road (from the proposed portal structure), with tracks located within and adjacent to the CN rail corridor ROW and terminating just beyond the limit of the proposed TSF (at Moonlight Lane) in the City of Richmond Hill. The at grade subway alignment generally follows the existing CN rail corridor ROW; however, the westernmost subway track is situated immediately outside the CN Rail ROW boundary for the majority of the at grade segment.	While the YNSE was previously envisioned to terminate just north of Highway 7, the area to the north was identified by Metrolinx as an area where refinement could enhance Project benefits and reduce capital costs. The proposed alignment that forms the basis for this EPR Addendum specifically addresses the challenges and opportunities of serving these areas and their future residents and employees.
2. Proposed Subway Vertical Profile	Below grade vertical profile design with a crossing above grade (bridge) over the East Don River. Proposed station and alignment depths were not presented within the 2009 EPR.	N/A	The subway alignment vertical profile was designed to reduce the depth of the stations along the route, except at the potential Royal Orchard Station, which is located approximately 500 m north of the deep East Don River Valley. The depth of the station platform at this location ranges from approximately 40 to 50 m below the existing ground surface, to account for tunneling south of the station below the East Don River.	The current YNSE vertical profile changes from below grade to at grade south of Langstaff Road, thereby eliminating the above grade (bridge) crossing over the Don River. The currently proposed profile reduces the depth of the stations along the route (except at Royal Orchard Station), while meeting applicable tunnel grade requirements (e.g., TTC Design Manual DM-0204-04).
3. Tunnels	Approximately 6.8 km underground tunneled alignment from the existing Finch Station to the proposed Richmond Hill Center Station in the vicinity of Highway 7 and Yonge St. in the City of Richmond Hill. For the purposes of determining the potential environmental effects of the Transit Project, the following approach was assumed within the 2009 EPR: • Richmond Hill Centre Station and surrounding area would provide sufficient space for the southbound launch of the TBM and as well as storage of tunnel liners and other	The underground Train Storage Facility assessed in the 2014 EPR Addendum would be located adjacent to the CN Rail corridor, beginning approximately 100m north of the Richmond Hill Centre Station. Cut and cover construction methodology was assumed for this work, during which the ground surface is opened (cut) a sufficient depth to construct the subway tunnel structure.	The proposed conceptual design involves the construction of tunnels for the underground alignment portion of the current YNSE alignment with the following key parameters: • Approximately 6 kms of twin 5.6 m internal diameter TBM tunnels • Twin tunnels run from Finch Transition Box Structure to proposed portal location • Reference YNSE Alignment assumes all tunneling undertaken using two (2) TBMs • Launched at the North Portal Launch Shaft, located immediately west of CN/GO rail tracks and south of Langstaff Road • Both TBM's are to be removed at the Finch Transition Box Structure where the extraction shaft is to be located	There is no change to the need for tunneling as part of the project. The currently proposed YNSE alignment still entails the construction of approximately 6 kms of tunnels; whereas the approximate length of tunnelling in the 2009 EPR was 6.8 km.

Project Component	2009 EPR	2014 EPR Addendum	Current EPR Addendum	Rationale for Change
	tunnelling materials and equipment; and • Existing surface parking in the southwest quadrant of the Yonge Street / Steeles Avenue intersection could also provide sufficient space for the southbound launch of the TBM and storage of tunnel liners; and other tunnelling materials and equipment. The 2009 EPR Identified the East Don River crossing as the TBM extracting shaft location (one at each end of the crossing). Cummer / Drewry Station was also identified as a potential location to remove the TBM in the 2009 EPR. The 2009 EPR assumed a twin-bored tunnelling method for the entire running structure from Finch Station to the Richmond Hill Centre Station, with the exception of the section between the existing Finch Station tail tracks and Cummer/Drewry Station and the approaches to the proposed East Don River bridge.			
4. Finch Station Modifications	N/A	N/A	Modifications to existing Finch Station as follows: • Upgrading existing tail track to support future revenue service; • Construction of the Finch Transition Box Structure, which is an underground structure that provides the transition between the existing Finch Station tail track structure and the new YNSE twin tunnels; • Upgrading operational and support systems (e.g., signal upgrades) within the existing tail track area; • Upgrade to the existing electrical and communication back-of-house room at the station; • Upgrade to the existing Hendon Avenue Traction Power Substation located approximately 130 m west of the station; and • An approximately 130 m long underground duct bank extending westerly along Hendon Avenue from the existing Finch Station.	Modifications to the existing Finch Station and nearby/associated facilities such as the existing Hendon Avenue Traction Power Substation are required to enable YNSE project implementation and future revenue service beyond Finch Station.
5. Stations	Total of six (6) below grade stations proposed.	No new or modified stations were proposed.	Total of Four (4) below grade stations and two (2) at grade stations are proposed, as follows: • Cummer Station (below grade) • Steeles Station (below grade) and bus terminal • Clark Station (below grade) and bus terminal • Royal Orchard Station (below grade) • Bridge Station and bus terminal (at grade) • High Tech Station (at grade)	Two stations, Bridge and High Tech Stations, are proposed at grade due to change in proposed subway alignment (i.e., at grade). The current station alignment maximizes the benefits of the subway extension while achieving the lowest cost for the acceptable Project scope. Of all considered alignments, the currently proposed route is the only one that provides the opportunity for one

Project Component	2009 EPR	2014 EPR Addendum	Current EPR Addendum	Rationale for Change
			Specific infrastructure associated with each proposed station is further detailed within the rows below.	Neighbourhood Station to be included in the Project scope while maintaining costs within the funding envelope.
	Cummer / Drewry Station: • Location: Yonge St. & Cummer / Drewry Ave., approximately 800 m north of Finch Station. • Station components: below grade station box, concourse, bicycle facilities, ventilation shaft, Bus loop located at Drewry Ave. Four (4) pedestrian entrances: ○ Main entrances located at the Northeast and southwest quadrants of the intersection of Cummer Ave. and Yonge St. ○ Southeast corner of Cummer Ave./ Drewry Ave. and Yonge St. ○ East side of Yonge St at the north end of the station box.		***Potential* Cummer Station (below grade)** Location: Slight shift to the southwest. The proposed station is an in-line underground station located at the intersection of Cummer/Drewry Avenue and Yonge Street and includes a bus loop on Drewry Ave. west of Yonge St. with associated bus operators' facilities. Station components include: • A below grade, two-level station box with one central platform at track level and a public concourse level above • Up to two (2) at-grade pedestrian entrances (locations to be determined as part of further design development) • Up to two (2) Fire Fighter's Access Shafts (FFA) • Secured bicycle storage	The proposed location shift is primarily to avoid utility conflicts. The reduced number of station entrances minimizes potential property impacts while maintaining access and circulation in a way that accommodates future ridership requirements.
	Steeles Ave. Station and bus terminal • Location: Yonge St and Steeles Ave, approx. 1.2 km north of Cummer/ Drewry Ave. • Station components: below grade station box, concourse, bicycle facilities, ventilation shaft. • five (5) pedestrian entrances: ○ Two (2) street entrances located north of the station box on each side of Yonge St. ○ Two (2) street entrances located south of the station box on each side of Yonge St. ○ One (1) entrance from median located on Steeles Ave. • Underground bus terminal below Steeles Ave West. • Passenger Pick-up and Drop-Off (PPUDO) • Below grade bus terminal with three (3) bus access ramps and a bus platform for 25 buses.		**Steeles Station (below grade) and bus terminal** Location: Yonge St. at the intersection with Steeles Ave, shifted south from 2009 EPR. Station components changes include: • Three (3) pedestrian entrances (locations to be determined as part of further design development): • One (1) FFA • Securedbicycle storage • At grade bus terminal at the southwest quadrant of Yonge St and Steeles Ave • Potential road modifications to accommodate curbside bus platforms located at the Yonge St. and Steeles Ave. intersection	The bus terminal at Steeles Station is proposed to be an at grade terminal to avoid conflicts with the existing York Durham Sanitary Sewer. The reduced number of station entrances minimizes potential property impacts while maintaining access and circulation in a way that accommodates future ridership requirements.

Project Component	2009 EPR	2014 EPR Addendum	Current EPR Addendum	Rationale for Change
	Clark Ave. Station • Location: Yonge St. and Clark Ave approximately 1 km north of Steeles Ave. • Station components: below grade station box, concourse, bicycle facilities, ventilation shaft. • Five (5) Pedestrian entrances: ○ One (1) main entrance southwest corner of Clark Ave. and Yonge St. ○ One (1) main entrance northeast corner of Clark Ave. and Yonge St. ○ One (1) north end of the station and on the west side of Yonge St. ○ One (1) entrance at the east side of Yonge St.	No new stations were proposed.	**Clark Station (below grade) and bus terminal** Location: No change, slight lateral expansion and shift southerly. Station components changes include: • Up to two (2) pedestrian entrances (locations to be determined as part of further design development) • Addition of bus facility with associated bus operator facilities	The reduced number of station entrances minimizes potential property impacts while maintaining access and circulation in a way that accommodates future ridership requirements. The addition of a bus terminal further enhances transit system integration and improves transfers between transit modes.
	Royal Orchard Station • Location: intersection of Yonge St. and Royal Orchard Blvd., approximately 800 m north of Centre St. • Station components: below grade station box, concourse, bicycle facilities, ventilation shaft. • two (2) pedestrian entrances: ○ one (1) main entrance northeast corner of Royal Orchard Blvd. and Yonge St. ○ one (1) entrance located southwest corner of Yonge St. and Thornhill Ave.		***Potential* Royal Orchard Station (below grade)** Location: Yonge Street, south of Royal Orchard Blvd. Station components changes include: • Up to two (2) pedestrian entrances (locations to be determined as part of further design development) • A deeper station box due to proximity to the East Don River Valley topographic depression. This change eliminates the need for the Don River above grade crossing. • Secured bicycle storage	Change to station location and depth as a result of changes in subway horizontal alignment and vertical profile. See rationale for alignment and profile change above.
	Langstaff / Longbridge Station • Location: between Longbridge Road and Langstaff Road, approximately 1km north of Royal Orchard Boulevard. • Station components: below grade station box, concourse, bicycle facilities, ventilation shaft. • PPUDO • Commuter parking • Two (2) pedestrian entrances: ○ One (1) on Hydro One property currently hosting a 230/500 kV transmission line south of Highway 407 and west of Yonge		**Bridge Station and bus terminal (at grade)** Location: west of the CN Rail Corridor and north of Highway 407 and Highway 7. Station components changes include: • Three (3) pedestrian entrances (locations to be determined as part of further design development) • Bus terminal • Passenger and service emergency exit • Secured bicycle storage	The change in station location is in response to changes in the subway horizontal alignment and vertical profile discussed above. The reduction in number of station entrances minimizes potential property impacts while maintaining access and circulation in a way that accommodates future ridership requirements.

Project Component	2009 EPR	2014 EPR Addendum	Current EPR Addendum	Rationale for Change
	Street. ○ One (1) located at the southeast corner of Yonge St. and Langstaff Road East			
	Richmond Hill Centre Station – Transit Hub • Location: east of Yonge St. traversing High Tech Road, west of the CN rail corridor and north of Highway 7, approximately 1 km north of Royal Orchard Boulevard. • Station components: below grade station box, concourse, bicycle facilities, ventilation shaft. • Two (2) pedestrian entrances: ○ One (1) located at northeast corner of the station box ○ One (1) located at the southeast corner of the station box • Bus terminal • PPUDO • Transit Hub		**High Tech Station (at grade)** Location: east of Yonge St. traversing High Tech Road, west of the CN rail corridor, and north of Highway 407 and Highway 7 and adjacent to Richmond Hill Centre Terminal. Station components changes include: • Two (2) pedestrian entrances (locations to be determined as part of further design development) • Secured bicycle storage • A revised PPUDO design to accommodate the revised station configuration	The change in station location is in response to changes in the subway horizontal alignment and vertical profile discussed above. Similar to the previously envisioned Richmond Hill Centre Station, the currently proposed High Tech Station will accommodate transfers to GO train and GO bus services, as well as local transit, and will improve subway access to the Richmond Hill Centre and Langstaff Gateway development areas.
6. Proposed Emergency Exit Buildings (EEBs)	Six (6) Emergency Exit Buildings (EEBs): 1. EEB 1: Private property on the east side of Yonge St. between Centre Ave. and Newton Drive; 2. EEB 2: Private property on the west side of Yonge St. between Doncaster Ave. and the CN rail corridor); 3. EEB 3: Within municipal right-of-way on the west side of Yonge St. opposite Arnold Ave.; 4. EEB 4: Within municipal right-of-way on the east side of Yonge St. between Centre St. and the proposed East Don River Bridge; 5. EEB 5: Private property on the east side of Yonge St. between Uplands Ave. and Kirk Drive; and 6. EEB 6: Within municipal right-of-way on the north side of Highway 7 west of Garden Ave.	Two (2) additional EEBs: 1. EEB 7: Located at the proposed TSF parking lot, east of Coburg Crescent. 2. EEB 8: Located west of the proposed alignment, south of Coburg Crescent.	Seven (7) EEBs (precise locations to be determined as part of further design development): 1. EEB-1: located approximately between the existing Finch Station and the potential Cummer Station 2. EEB-2: located approximately between the potential Cummer Station and the confirmed Steeles Station 3. EEB-3: located approximately between the confirmed Steeles Station and the confirmed Clark Station 4. EEB-4: located approximately between the confirmed Clark Station and the potential Royal Orchard Station 5. EEB-5: located approximately in the vicinity of the potential Royal Orchard Station 6. EEB-6: located approximately north of Royal Orchard Station in the vicinity of Bay Thorn Drive 7. EEB-7: located approximately north of the potential Royal Orchard Station and south of the portal structure	The TTC Design Manual requires EEBs to be located such that the distance from any underground location to an EEB is not greater than 381 m – i.e., the spacing between EEBs or between EEBs and the closest station platform or portal entrance must be 762 m or less. Applying this standard to the currently proposed design has identified the need for a total of seven (7) EEBs.
7. Traction Power Substations (TPSSs)	Traction Power is provided by a live third rail that provides electric power through a conductor placed alongside the rail. In order to give the voltage a boost at regular intervals	N/A	Seven (7) TPSSs at the following locations: • Three (3) TPSS in the approximate vicinity of Cummer, Steeles, and Clark Stations. • One (1) TPSS in the approximate vicinity of the potential Royal Orchard Station	The currently proposed subway alignment requires additional power compared to the alignment as presented in 2009 EPR due to its extended length (an approximate 6.8 km subway extension was assessed

Project Component	2009 EPR	2014 EPR Addendum	Current EPR Addendum	Rationale for Change
	along the subway alignment, electrical substations (i.e., Traction Power Substations [TPSSs]) are required. Traction power requirements dictate that TPSSs are not spaced more than 2.5 km from one another; however, a 2 km separation between TPSS is more typical. Four (4) TPSSs locations were included within the 2009 EPR in the vicinity of Steeles Station, Clark Station, Royal Orchard Station and Richmond Hill Centre Station.		• One (1) TPSS in the approximate vicinity of Bridge Station. • One (1) TPSS standalone building integrated with EEB-4 between the confirmed Clark Station and the potential Royal Orchard Station • One (1) TPSS at the Train Storage Facility (TSF), immediately south of 16th Ave.	in 2009 compared to the approximate 9.5 km extension currently proposed). This has resulted in the need for additional TPSS facilities. The current EPR Addendum assess a total of seven (7) TPSSs locations.
8. Proposed Portal Structure	N/A	N/A	The tunnel portal structure will be located south of Langstaff Road, west of the CN corridor ROW. This concrete structure serves as entrance/exit to and from the subway tunnel, where the alignment transitions between below and at grade.	This structure is required to allow for the below-grade to at-grade transition of the subway alignment.
9. Proposed Launch Shaft	For the purposes of determining the potential environmental effects of the Transit Project, the following approach was assumed within the 2009 EPR: • Richmond Hill Centre Station and surrounding area would provide sufficient space for the southbound launch of the TBM and as well as storage of tunnel liners and other tunnelling materials and equipment Existing surface parking in the southwest quadrant of the Yonge Street/Steeles Avenue intersection were also identified as providing sufficient space for the southbound launch of the TBM and storage of tunnel liners.	N/A	The current launch shaft location corresponds to a parcel of land west of the existing CN tracks and proposed portal structure, between Holy Cross Cemetery and Langstaff Road. A construction staging area/worksite will also be prepared for the assembly of the TBM at this location. The launch shaft structure is expected to be approximately 130 m in length.	The currently proposed location of the launch shaft reduces potential property impacts by using vacant industrial properties near the CN Rail ROW, south of Langstaff Rd. and has sufficient space to meet the functional needs of TBM operations.
10. Proposed Extraction Shaft	The 2009 EPR Identified the East Don River crossing as the TBM extraction shaft location (one at each end of the crossing). Cummer/ Drewry Station was also identified as a potential location to remove the TBM in the 2009 EPR.	N/A	The proposed extraction shaft for the TBM operations will be located within the boundaries of the Finch Transition Box Structure that will connect the existing Finch tail track with the new YNSE alignment running north.	A new extraction shaft location is required since an at grade crossing of the East Don River is no longer proposed. There is sufficient space at the Finch Transition Box Structure to permit the removal of the TBM.
11. Proposed Modifications to Bridges/ Structures/ Culverts	• East Don River crossing above-grade for both Subway and Roadway. Includes replacement of an existing culvert. • Proposed modifications to twin-box culvert located north of Highway 7 near Richmond Hill Centre Station.	N/A	• Design, construction, maintenance and removal of a temporary pedestrian bridge across the subway and CN rail corridors to replace the existing pedestrian bridge connecting Richmond Hill Centre (bus) Terminal and Langstaff GO Station. • Demolition of the pedestrian overpass bridge at Richmond Hill Centre will occur once bus operations are shifted to Bridge Station. • Crossing of East Down River is now below-grade, meaning a new structure at this location is no longer required.	To provide for continuous access across the rail corridor and subway alignment, the existing pedestrian bridge at Richmond Hill Centre Terminal is proposed to be replaced with a temporary pedestrian bridge. Temporary pedestrian bridge will be in place until Bridge Station is complete, with the Bridge Station providing access across the corridor.

Project Component	2009 EPR	2014 EPR Addendum	Current EPR Addendum	Rationale for Change
			• Langstaff Road East grade separation • Replacement of the existing culvert conveying German Mills Creek north of 16th Avenue. • A number of drainage culverts along the at grade portions of the alignment may be impacted (modified or replaced) to enable implementation of the Project. Any such culverts will be identified and addressed during future phases of design.	A new structure to carry the subway over the East Don River is no longer required now that the subway is below grade at this location. The existing culverts conveying German Mills Creek needs to be replaced to accommodate the tail tracks for the proposed TSF.
12. Proposed Train Storage Facility (TSF)	N/A	Underground Train Storage Facility (TSF): • Capacity: 14 trains; two (2) trains stored at Richmond Hill Centre Station and the remaining 12 trains stored at the TSF • Location: north of the Richmond Hill Centre Station • Maintenance building for staff access to the proposed TSF east of Coburg Crescent, and associated 25-30 space employee parking lot • A combined maintenance operators' facility and Electrical Service Building • A ventilation shaft • A drop shaft (a type of maintenance shaft)	At grade Train Storage Facility (TSF): • Capacity: 15 trains for overnight storage. • Location: in the vicinity of the CN corridor and 16th Ave., north of High Tech Station. • Transportation facility near Bantry Ave • Rail Cars & Shops Facility (RC&S) south of 16 Ave., including parking spaces for staff and visitors.	The current configuration for the proposed TSF was selected because it avoids reconstruction of overhead bridges (High Tech, Bantry, and 16th Avenue), promotes the consolidation of buildings to minimize impacts to City of Richmond Hill property, accommodates a future multi-use trail to be completed by the municipality, and because it meets functional TTC requirements. A drop shaft is no longer necessary now that the TSF is at grade.

A 2.2 EPR Addendum Study Area

The YNSE EPR Addendum Study Area generally encompasses the proposed project components (i.e., subway alignment, Stations, Train Storage Facility, launch and extraction shafts, and related ancillary components) and extends approximately 9 kms in length, commencing at the existing Finch Station along the existing Line 1 Yonge–University in the City of Toronto, and extends northerly through the City of Vaughan (to the west) and City of Markham (to the east), to Moonlight Lane (just north of the proposed TSF) in the City of Richmond Hill, York Region.

With reference to the more detailed project mapping found in **Appendix A**, the defined Study Area reflects the proposed location of the YNSE infrastructure components as well as a buffer zone that accounts for the area that may be potentially impacted by future project design refinements and/or modifications. Such design changes (if applicable) will be further defined and confirmed as part of the subsequent detailed design stage of the Project.

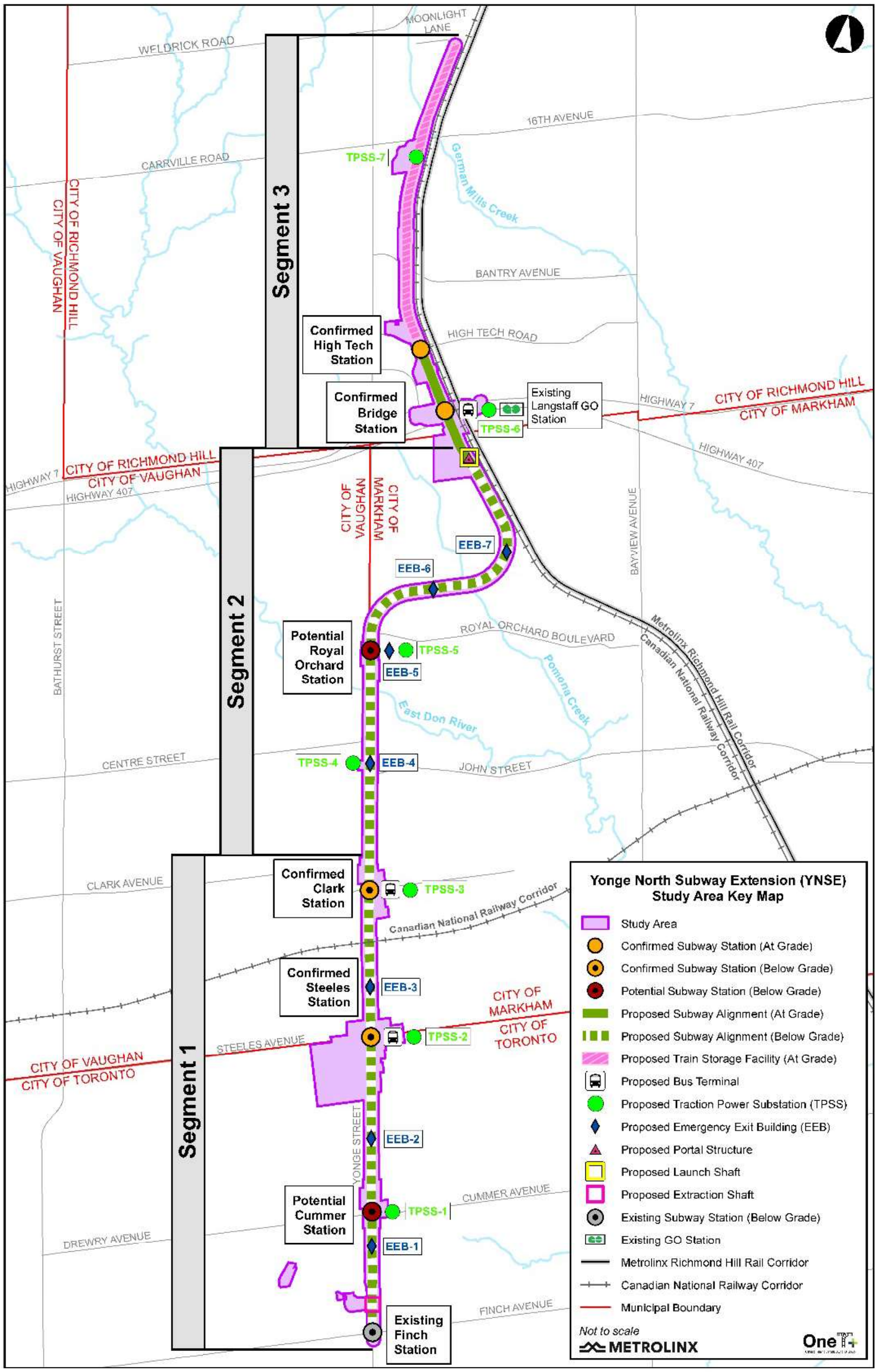


Figure A 2-1 YNSE EPR Addendum Study Area Key Plan Map

A 2.3 Study Area Segments

For reporting purposes and to better characterize the findings of the various environmental and technical studies, the EPR Addendum Study Area was further sub-divided into three (3) geographic segments (**Figure A 2-1**).

A 2.3.1 Segment 1 – Finch Station to Clark Station (Below Grade)

Segment 1 starts at the existing Finch Station and extends northward to the proposed Clark Station. It should be noted that this segment is inclusive of the proposed Clark Station and the proposed Cummer Station, Cummer Station Bus Loop, Steeles Station, and Steeles Station Bus Terminal. The entirety of this segment will be below grade. At Steeles Avenue, the Project Study Area crosses the boundary between the City of Toronto and York Region, for which Yonge Street serves as a boundary between the City of Vaughan to the west and the City of Markham to the east. Segment 2 – Clark Station to Portal/Launch Shaft (Below Grade)

A 2.3.2 Segment 2 – Clark Station to Portal/Launch Shaft (Below Grade)

Segment 2 starts immediately beyond the limits of the proposed Clark Station and extends northward to the proposed portal structure and launch shaft location, located south of Langstaff Road East within the City of Markham. This segment is inclusive of the entirety of the proposed portal and launch shaft footprint area, extending north to the proposed Bridge Station and west from the CN rail corridor towards Ruggles Avenue. It also includes the proposed Royal Orchard Station. This segment runs below grade until it reaches the tunnel portal, where it emerges to the surface. Segment 2 ends immediately north of Langstaff Road East, south of Highway 407 in the City of Richmond Hill within York Region.

A 2.3.3 Segment 3 – Portal/Launch Shaft to Moonlight Lane (At Grade)

Segment 3 starts immediately beyond the limits of the proposed portal and launch shaft location, near the proposed Bridge Station, and extends northward to Moonlight Lane which marks the northernmost Study Area limit. This segment, located within the City of Richmond Hill, includes the proposed High Tech Station and proposed TSF. The entirety of Segment 3 is planned to be at grade.

The purpose of **Part A** of this report is to provide a detailed description of the existing noise and vibration conditions within the Noise and Vibration Study Area, specifically:

1. Document the dominant existing sources of noise and vibration;
2. Complete noise and vibration monitoring of dominant noise and vibration sources;
3. Review existing and planned land uses to identify and select representative sensitive receptors for noise and vibration assessment. Representative sensitive receptors (also referred to as receptors or points of reception) are selections of residences or other sensitive receptors that represent the predictable worst-case noise and vibration impact of the proposed project element. Aside from residences, sensitive receptors can include institutional land uses such as schools, hospitals, places of worship, etc.
4. Calculate the existing sound and/or vibration levels at representative sensitive receptors based on existing traffic (roadway and railway volumes).

The Existing Conditions report provides critical inputs into the Impact Assessment stage of the study. The measured and/or calculated sound levels will be used in establishing the ambient sound levels to compare and assess against sounds levels of new project elements, such as tunnel ventilation fans or operations of proposed subway vehicles. For new transit projects, the applicable protocols target an absolute vibration level and vibration-induced sound level (i.e., vibration that is heard). As a result, the existing vibration levels do not affect the impact assessment directly. However, the existing vibration levels adjacent to current sources of vibration indicate the extent to which representative sensitive receptors experience vibration. The vibration levels measured also assist in providing some indication of vibration propagation characteristics of that area. The assessment method, criteria, and approach will be described further in Part B of this report.

The findings and existing conditions data have been organized into the three (3) Study Area segments accordingly for reporting purposes.

A 3.0 Methodology

The following section provides an overview of the methodology followed to collect and document Noise and Vibration existing conditions information within the Study Area.

Representative sensitive receptors are identified using publicly available data from official plans from municipalities and satellite aerial images. Field work surveys and official data from regulatory agencies (e.g., development applications) will complement this review. In general terms, the nature of the primary land uses, as further described in the YNSE Socio-Economic and Land Use Baseline Conditions/ Impact Assessment Report, will determine the representative sensitive receptors used in the noise and vibration impact assessment.

Ambient sources of noise and/or vibration are identified during field surveys and through desktop data collection of major railways and roadways within the Project Study Area. These are the major sources of noise and vibration that have the potential to dominate the ambient sound levels. Examples include Highway 407, Highway 7, and Yonge Street. Traffic data obtained directly from the various agencies and municipalities compliments the data collection process, and provides additional information to fill any data gaps.

Noise and vibration monitoring of existing conditions was completed between Finch Avenue and 16th Avenue to supplement the calculations. The last of these measurements were completed on August 13, 2021.

Railway, roadway, and highway traffic volumes will be used to calculate the existing condition sound levels. The existing conditions will inform the Construction and Operations noise and vibration modelling and will be used as a baseline to compare against projections of future conditions and complete the noise and vibration impact assessment.

Note that a glossary of terms has been included with the Impact Assessment report.

A 3.1 Review of Background Information and Guidelines

Data was collected from the following sources and considered as appropriate as part of documenting existing conditions within the Study Area:

1. Municipal Official Plans
2. Aerial photography
3. Surficial geology and topographic maps
4. Municipal bylaws

5. The Yonge Subway Extension - Finch Station to Richmond Hill Centre Transit Project Assessment-Environmental Project Report (2009)
6. Yonge Subway Extension - Finch Station to Richmond Hill Centre Transit Project Assessment- Environmental Project Report Addendum, Train Storage Facility EPR Addendum (2014*)*

Guideline and protocol documents reviewed include:

- Ministry of the Environment and Energy and Toronto Transit Commission, MOEE/TTC "Protocol for Noise and Vibration Assessment for the Proposed Yonge-Spadina Subway Loop" (June 1993)
- MOEE/GO Transit Draft Protocol for Noise and Vibration Assessment (Draft #9, 1995)
- Ministry of the Environment, Environmental Noise Guideline – Stationary and Transportation Sources (2013)
- Federal Transit Administration (FTA), U.S. Department of Transportation, "Transit Noise and Vibration Impact Assessment Manual" (September 2018)

A 3.2 Data Gap Analysis

A review of available background information (e.g., previously completed studies and/or reports) was undertaken to identify any data gaps, if relevant. This data gap analysis identified areas where data was non-existent from previous studies, and/or new data needed to be collected, and/or existing available data required review and updating or augmenting. The results of this data gap analysis were as follows:

1. Previous Noise and Vibration Impact Assessments (NVIAs) were completed more than 10 years ago. As a result, baseline conditions data is out of date. There have been numerous new residential developments within the Study Area since that time.
2. Baseline condition measurements were not completed for the entirety of the revised Reference Alignment.
3. Previous Noise and Vibration Impact Assessments lacked extensive baseline noise and vibration measurements, which are typically expected from more current NVIAs.

A 3.3 Desktop Data Collection

In addition to the information referenced in **Section A 3.1**, data requests were submitted to Metrolinx for review and approval. The data requests below were submitted by Metrolinx to CN, City of Toronto, City of Vaughan, City of Richmond Hill, City of Markham, Toronto Transit Commission, 407ETR, and Region of York:

1. Existing roadway and highway traffic data
2. Existing and future railway (CN, VIA Rail, and GO Transit) traffic data
3. Approved Development Applications
4. Proposed Subway Vehicle Noise Data

Desktop reviews were also completed to identify locations at which to deploy noise and vibration monitoring equipment.

A 3.4 Field Investigations

The following field investigations and site reconnaissance activities were undertaken to collect primary source data within the Study Area as part of the existing conditions phase:

1. Field surveys to identify baseline noise and vibration monitoring locations and determine permission to enter (PTE) requirements.
2. Field surveys to identify representative sensitive receptors.
3. Baseline noise and vibration monitoring.

A 3.5 Segment 1 – Finch Station to Clark Station

This section outlines the existing land uses (at a high-level) to assist in determining receptors

sensitive to noise and vibration, as well as potential sources of ambient noise and vibration along this segment of the YNSE alignment.

Primary Land Uses:

- High-rise and low-rise residential
- Commercial plazas
- Shopping centres
- Automotive dealerships
- Commercial offices

Ambient Sources of Noise and/or Vibration:

- Yonge Street
- Finch Avenue
- Cummer Avenue
- Steeles Avenue
- CN Rail York Subdivision
- Clark Avenue

A 3.6 Segment 2 – Clark Station to Portal/Launch Shaft

This section outlines the existing land uses (at a high-level) to assist in determining receptors sensitive to noise and vibration, as well as potential sources of ambient noise and vibration along this segment of the YNSE alignment.

Primary Land Uses:

- High-rise and low-rise residential
- Commercial plazas
- Golf course and country club
- Cemetery
- Industrial buildings

Ambient Sources of Noise and/or Vibration:

- Yonge Street
- Royal Orchard Boulevard
- Clark Avenue
- CN Bala Rail Subdivision (including freight, VIA Rail, and GO Richmond Hill trains)

A 3.7 Segment 3 – Portal/Launch Shaft to Moonlight Lane

This section outlines the existing land uses (at a high-level) to assist in determining receptors sensitive to noise and vibration, as well as potential sources of ambient noise and vibration along this segment of the YNSE alignment.

Primary Land Uses:

- High-rise and low-rise residential
- Industrial buildings
- Cemetery
- Commercial plazas
- Commercial office buildings
- Langstaff GO Station

Ambient Sources of Noise and/or Vibration:

- Highway 407
- Highway 7
- High Tech Road
- Bantry Avenue
- 16th Avenue
- CN Bala Rail Subdivision (including freight, VIA Rail, and GO Richmond Hill trains)

A 4.0 Noise and Vibration Measurements and Results

Figures 1 through 30 in **Appendix A** provide the proposed locations for noise and vibration monitoring along the entire alignment. **Table A 4-1** provides a brief description of the railway or roadway nearest the noise and vibration monitoring locations as well as the nearest intersection.

Table A 4-1 Noise and Vibration Monitoring Location Description

Noise and Vibration Monitoring Location	Study Area Segment	Nearest Roadway or Railway	Nearest Intersection or Roadway
N1	1	Yonge Street	Hendon Avenue/Yonge Street
N2	1	Yonge Street	Cummer Avenue/Drewry Avenue
N3	1	Drewry Avenue	Drewry Avenue/Yonge Street
N4	1	Yonge Street	Wedgewood Drive/Yonge Street
N5	1	Yonge Street	Newton Drive/Yonge Street
N6	1	Yonge Street	Abitibi Avenue/Yonge Street

Noise and Vibration Monitoring Location	Study Area Segment	Nearest Roadway or Railway	Nearest Intersection or Roadway
N7	1	Steeles Avenue West	Yonge Street/Steeles Avenue
N8	1	Yonge Street	Highland Park Boulevard/Yonge Street
N9	1	Clark Avenue	Yonge Street/Clark Avenue
N10	1	Yonge Street	Clark Avenue/Yonge Street
N11	2	Yonge Street	Arnold Avenue/Yonge Street
N12	2	Yonge Street	John Street/Yonge Street
N13	2	Yonge Street	Centre Street/Yonge Street
N14	2	Yonge Street	Bay Thorn Drive/Yonge Street
N15	2	CN Bala Rail Subdivision	Yonge Street
N16	3	CN Bala Rail Subdivision	Ruggles Avenue
N17	3	CN Bala Rail Subdivision	Cedar Avenue
N18	3	CN Bala Rail Subdivision / Highway 407	Langstaff Road East
N19	3	CN Bala Rail Subdivision	High Tech Road
N20	3	CN Bala Rail Subdivision	King William Crescent
N21	3	CN Bala Rail Subdivision	Coburg Crescent
N22	3	CN Bala Rail Subdivision	16th Avenue/Red Maple Road
V1	1	TTC Line 1 Yonge-University	Yonge Street/Finch Avenue
V2	1	York Rail Subdivision	Yonge Street
V3	2	CN Bala Rail Subdivision	Romfield Circuit
V4	3	CN Bala Rail Subdivision	Ruggles Avenue
V5	3	CN Bala Rail Subdivision	High Tech Road
V6	3	CN Bala Rail Subdivision	King William Crescent
V7	3	CN Bala Rail Subdivision	Coburg Crescent

A minimum of 2 hours of attended vibration measurements have been completed at each vibration monitoring location. A minimum of 72 hours of unattended noise measurements have been completed at each noise monitoring location, including at least one full weekend day and one full weekday.

The noise and vibration charts in **Appendix B** summarize the data collected during field investigations. Measurement data was discounted during inclement weather, which includes times when wind speeds exceeded 25 km/h or during periods of precipitation. Wind speeds in excess of this amount may generate induced noise across the microphone.

While not a significant concern during winter, windy periods can also result in a rustling of leaves or other foliage that can affect the noise measurements.

The sound levels shown in **Appendix B** provide the measured hourly sound level during the course of the measurement period. These measured sound levels will assist in accurately modelling future with-project and no-project sound levels. The hourly sound levels will also assist in establishing a baseline or guideline against which stationary noise sources are assessed.

Table A 4-2 summarizes the typical daytime and nighttime equivalent ($L_{eq,16hr}$ and $L_{eq,8hr}$, respectively) sound levels as well as the lowest hourly sound level during the daytime and nighttime periods. The sound levels measured are consistent with sound levels typically occurring in developed areas.

Table A 4-2 Summary of Measured Sound Levels

Receptor	Study Area Segment	Daytime Equivalent Sound Level (7 a.m. – 11 p.m.) $L_{eq, 16hr}$	Nighttime Equivalent Sound Level (11 p.m. – 7 a.m.) $L_{eq, 8hr}$	Quietest Hourly Sound Level	
				Daytime (dBA $L_{eq, 1hr}$)	Nighttime (dBA $L_{eq, 1hr}$)
N1	1	72	67	70	63
N2	1	72	64	70	63
N3	1	63	56	59	48
N4	1	72	67	70	63
N5	1	61	55	58	50
N6	1	73	68	69	64
N7	1	71	66	68	60
N8	1	58	52	51	46
N9	1	64	56	57	49
N10	1	67	60	60	55
N11	2	60	53	53	47
N12	2	63	56	54	47
N13	2	72	65	65	58
N14	2	60	52	52	44
N15	2	60	62	43	44
N16	3	61	60	51	43
N17	3	59	53	43	43
N18	3	65	63	56	50
N19	3	67	60	60	53
N20	3	59	60	44	37

Receptor	Study Area Segment	Daytime Equivalent Sound Level (7 a.m. – 11 p.m.) $L_{eq,\,16hr}$	Nighttime Equivalent Sound Level (11 p.m. – 7 a.m.) $L_{eq,\,8hr}$	Quietest Hourly Sound Level	
				Daytime (dBA $L_{eq,\,1hr}$)	Nighttime (dBA $L_{eq,\,1hr}$)
N21	3	62	62	41	37
N22	3	65	62	54	46

In general, the vibration data indicates that the existing vibration levels due to existing freight, passenger or commuter trains are well below the threshold of perception (0.10 mm/s RMS) at all surface rail locations. The vibration levels from existing TTC trains near Finch Station are well above the threshold of perception. This is expected given the shallow depth of the station box near the TTC subway station and the older track fixation and isolation methods used. **Table A 4-3** provides an overall summary of the measured vibration levels.

Table A 4-3 Summary of Measured Vibration Levels

Location	Study Area Segment	Location Description	Average Measured Vibration Level (mm/s RMS)	Vibration Level Range (mm/s RMS)
V1	1	Ground near TTC Finch Station	0.14	0.05 – 0.28
V2	1	Ground near CN York Rail Subdivision	0.03	0.02 – 0.04
V3	2	Ground near CN Bala Rail Subdivision in Holy Cross Cemetery	0.09	0.02 – 0.09
V4	3	Ground near CN Bala Rail Subdivision and Ruggles Avenue	0.03	0.02 – 0.05
V5	3	Ground near CN Bala Rail Subdivision and High Tech Road	0.03	0.02 – 0.07
V6	3	Ground near CN Bala Rail Subdivision and King William Crescent	0.04	0.03 – 0.06
V7	3	Ground near CN Bala Rail Subdivision and Coburg Crescent	0.03	0.02 – 0.03

Please refer to Part B Figure B 2-3 for an interpretation of ground-borne noise within the context of sound levels from various sound sources.

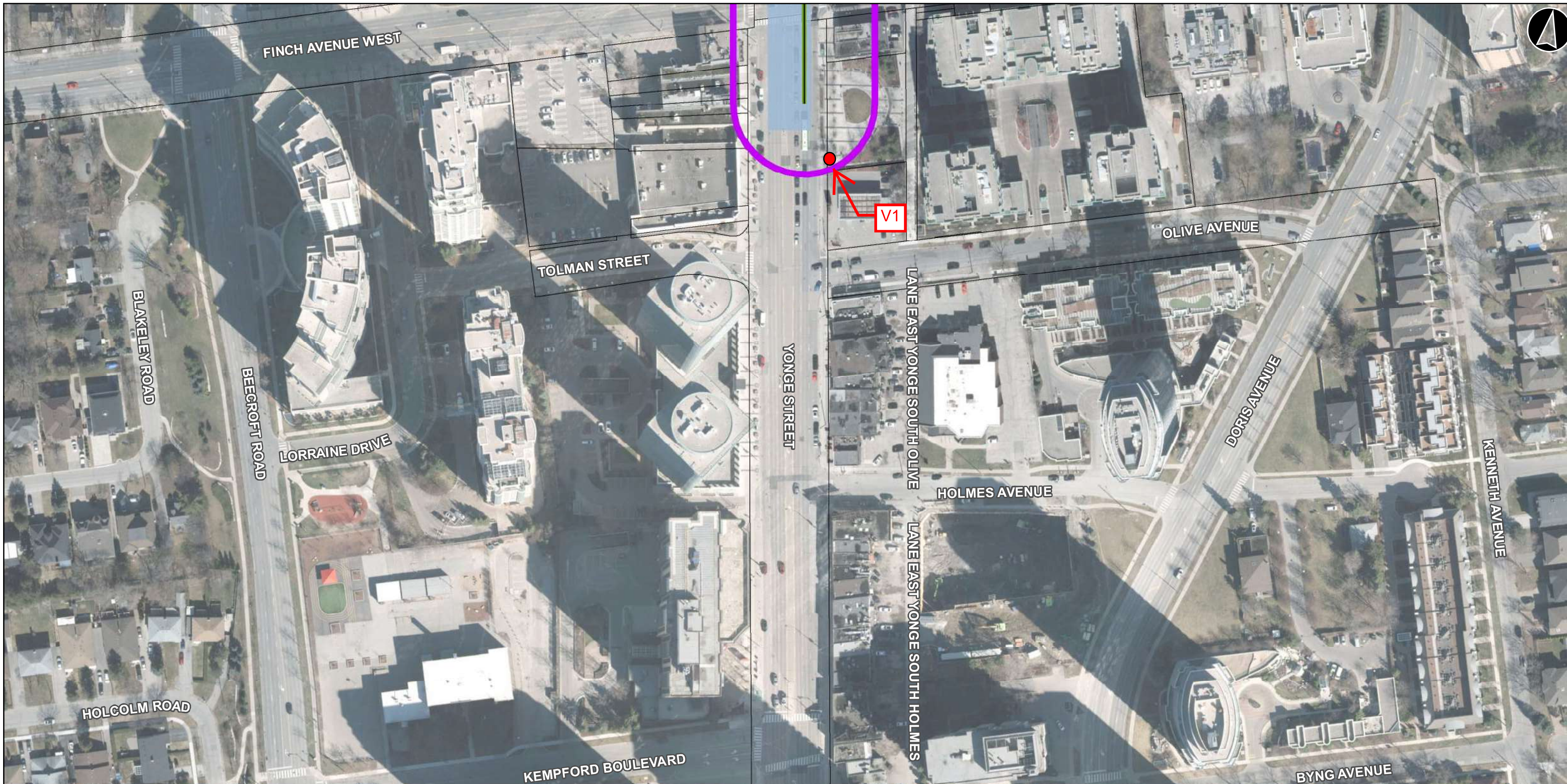
Table A 4-4 provides a detailed breakdown of the highest measured vibration levels at each location. Passby vibration level figures are also provided. The passby vibration level figures demonstrate the duration of a given vehicle passby and plots the magnitude of the vibration (mm/s) against time (seconds). For freight, passbys can last several minutes. For passenger or commuter trains, the passby lasts for less than a minute.

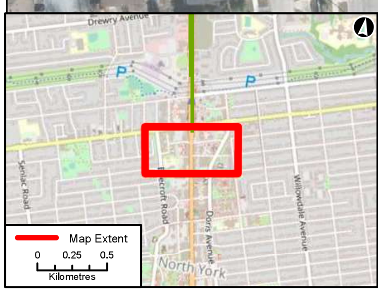
Table A 4-4 Summary of Highest Vibration Levels Measured

Measurement Location	Study Area Segment	Train Type	Maximum Vibration Level (mm/s, RMS)
V1	1	TTC Train 1	0.26
		TTC Train 2	0.20
		TTC Train 3	0.28
		TTC Train 4	0.23
		TTC Train 5	0.25
V2	1	Freight Train 1	0.02
		Freight Train 2	0.02
		Freight Train 3	0.04
		Freight Train 4	0.03
		Freight Train 5	0.04
V3	2	Freight Train 1	0.09
		Freight Train 2	0.09
		Freight Train 3	0.08
		Go Train 1	0.09
		Go Train 2	0.09
V4	3	Freight Train 1	0.04
		Freight Train 2	0.05
		GO Train 1	0.02
		GO Train 2	0.02
		GO Train 3	0.02
V5	3	Freight Train 1	0.07
		GO Train 1	0.02
		GO Train 2	0.03
		GO Train 3	0.02
		GO Train 4	0.02
V6	3	Freight Train 1	0.06
		GO Train 1	0.03
		GO Train 2	0.03
		GO Train 3	0.03

Measurement Location	Study Area Segment	Train Type	Maximum Vibration Level (mm/s, RMS)
		GO Train 4	0.03
V7	3	GO Train 1	0.03
		GO Train 2	0.03
		GO Train 3	0.03
		GO Train 4	0.02

APPENDIX A: NOISE AND VIBRATION MONITORING LOCATIONS





Legend

- Study Area
- Existing Finch Station
- Proposed Subway Alignment (Below Grade)
- Property Fabric
- Vibration Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

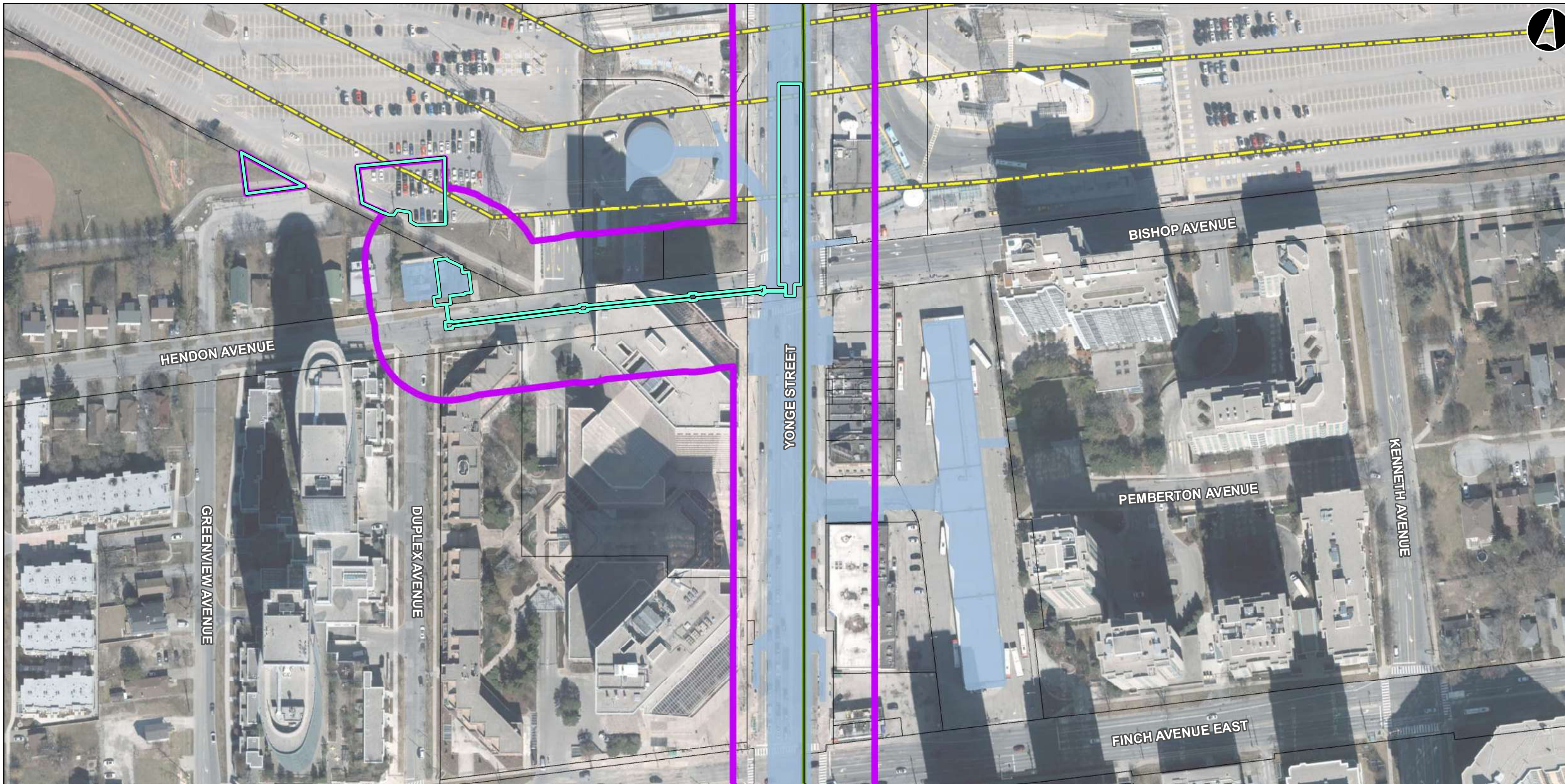
0 25 50
Metres
Datum: NAD27 MTM zone 10

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 1 - Figure 1

Jan, 2022 | 1:1,600
P 067400 | Rev 0

METROLINX
Infrastructure Ontario
One



Legend

- Study Area
- Existing Finch Station
- Proposed Finch Station Modifications
- Proposed Subway Alignment (Below Grade)
- Existing Hydro One Transmission
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50 Metres

Datum: NAD27 MTM zone 10

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 1 - Figure 2

Jan, 2022 | 1:1,600

P 067400 | Rev 0

METROLINX
Infrastructure Ontario
One

Legend

- Study Area
- Existing Finch Station
- Proposed Finch Station Modifications
- Proposed Transition Box Structure (Below Grade)
- Proposed Subway Alignment (Below Grade)
- Proposed Extraction Shaft
- Proposed TPSS Location
- Proposed EEB Location
- Existing Hydro One Transmission
- Property Fabric
- Noise Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

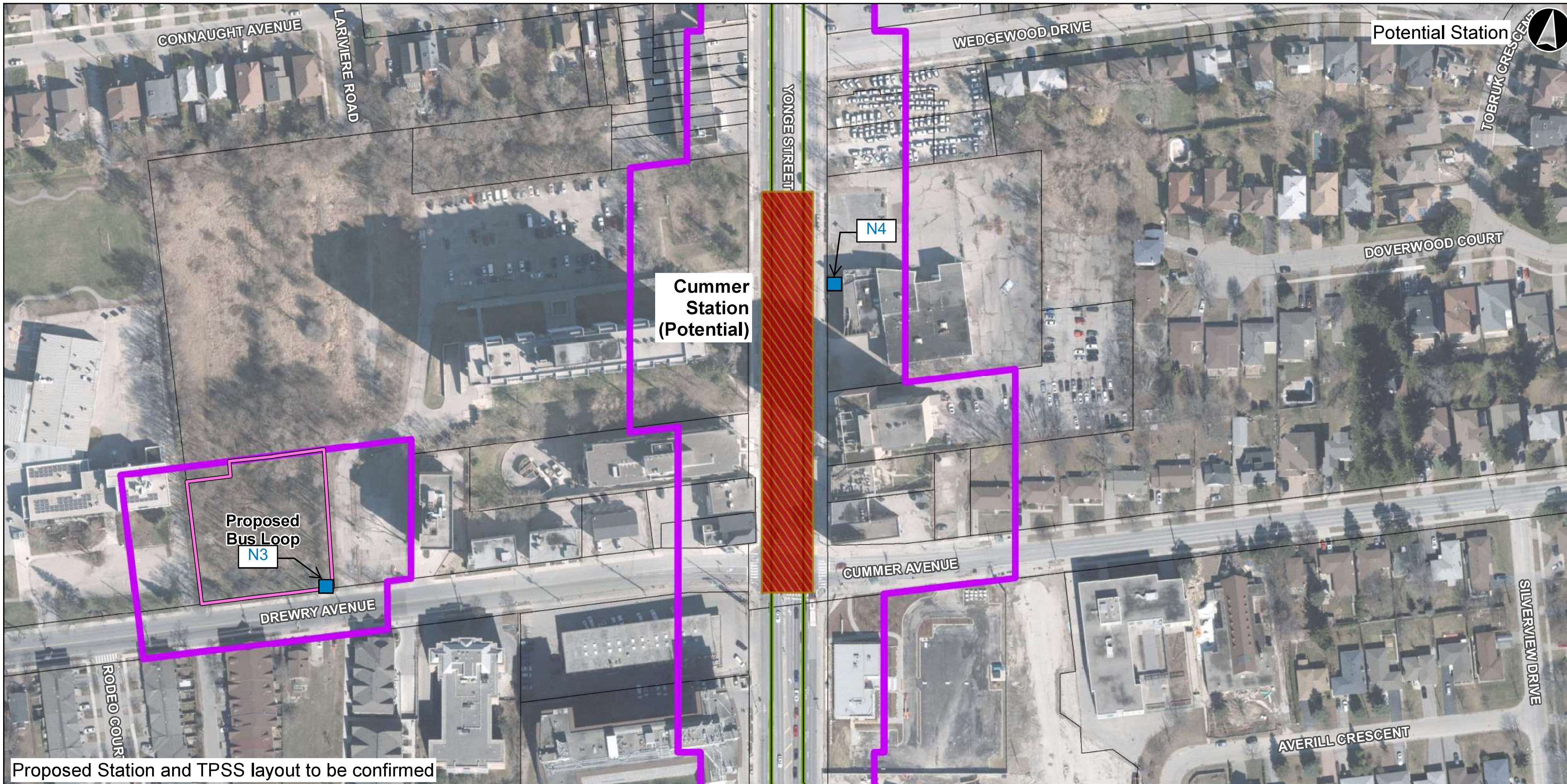
0 25 50 75
Metres
Datum: NAD27 MTM zone 10

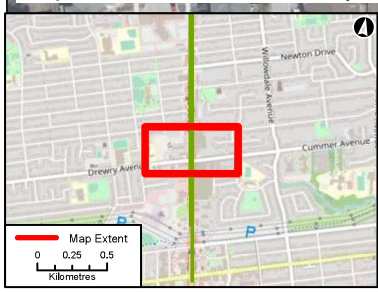
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 1 - Figure 3

Jan, 2022	1:1,900
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One





Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Potential Station Platform Area
- Proposed Bus Loop
- Property Fabric
- Noise Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

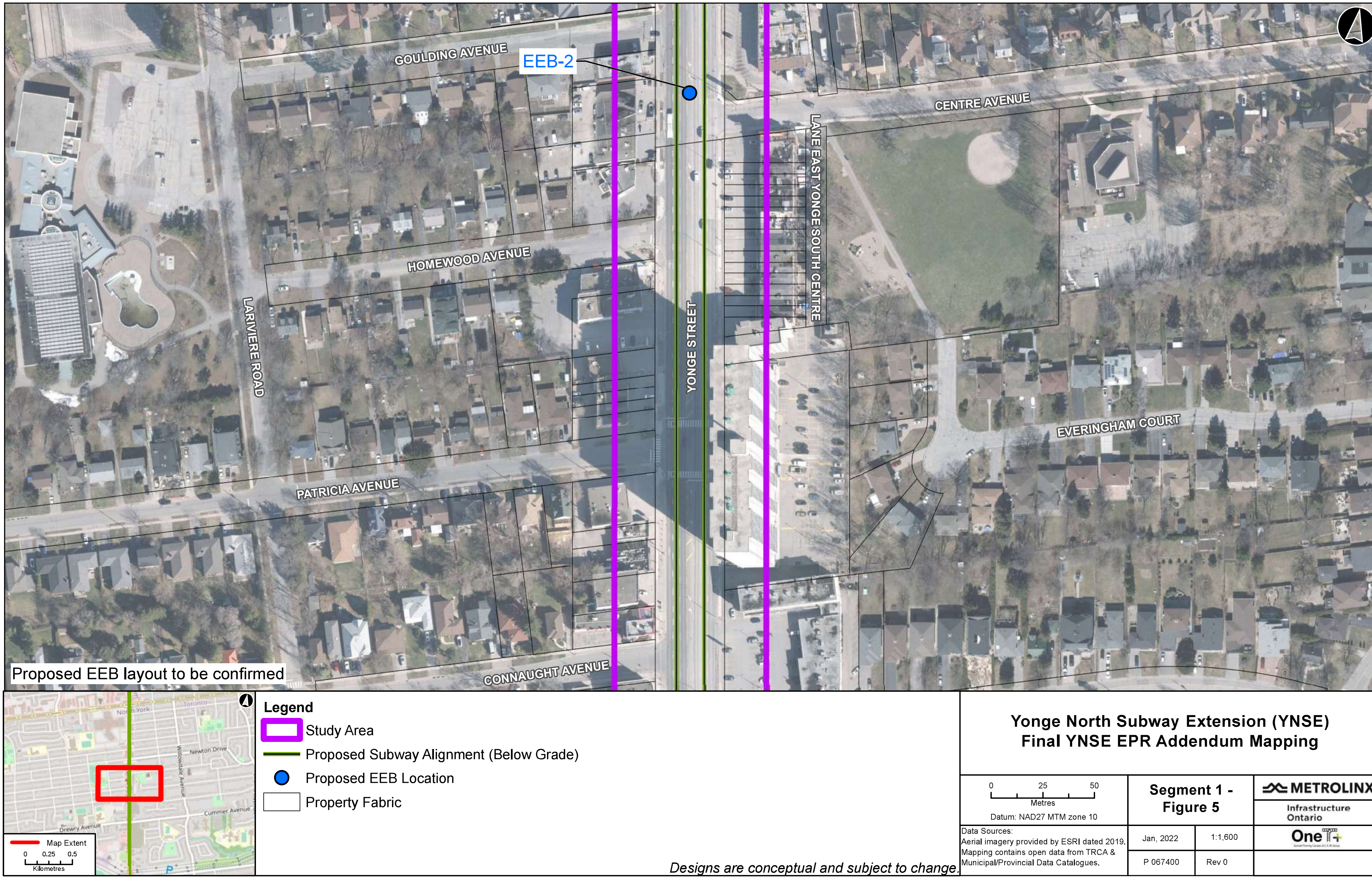
0 25 50
Metres
Datum: NAD27 MTM zone 10

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 1 - Figure 4

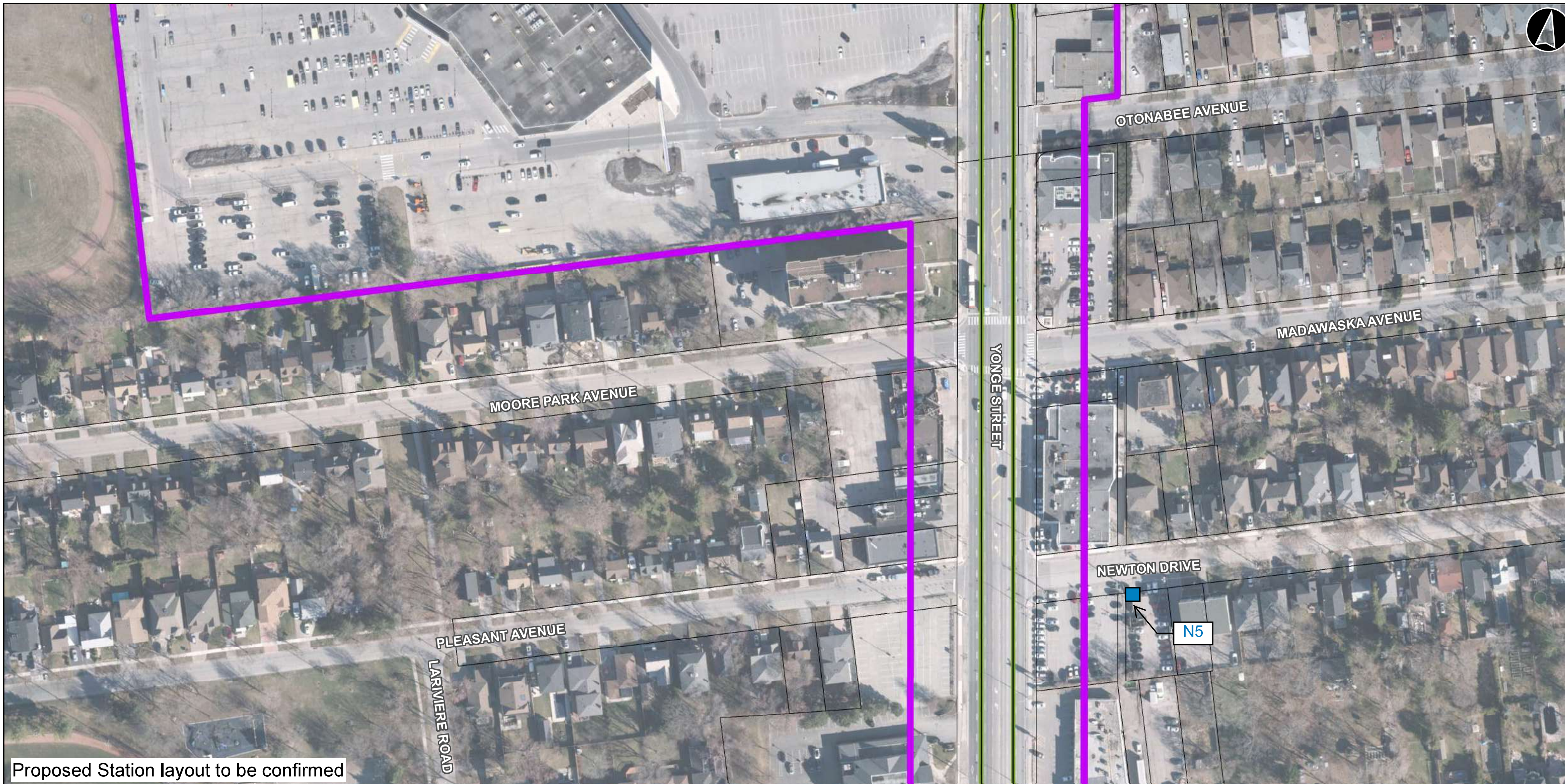
Jan, 2022	1:1,600
P 067400	Rev 0

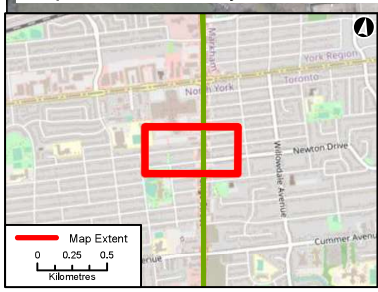
METROLINX
Infrastructure Ontario
One



Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50 Metres Datum: NAD27 MTM zone 10	**Segment 1 - Figure 5**		METROLINX Infrastructure Ontario
Data Sources: Aerial imagery provided by ESRI dated 2019. Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.	Jan, 2022	1:1,600	One T+
	P 067400	Rev 0	





Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Property Fabric
- Noise Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

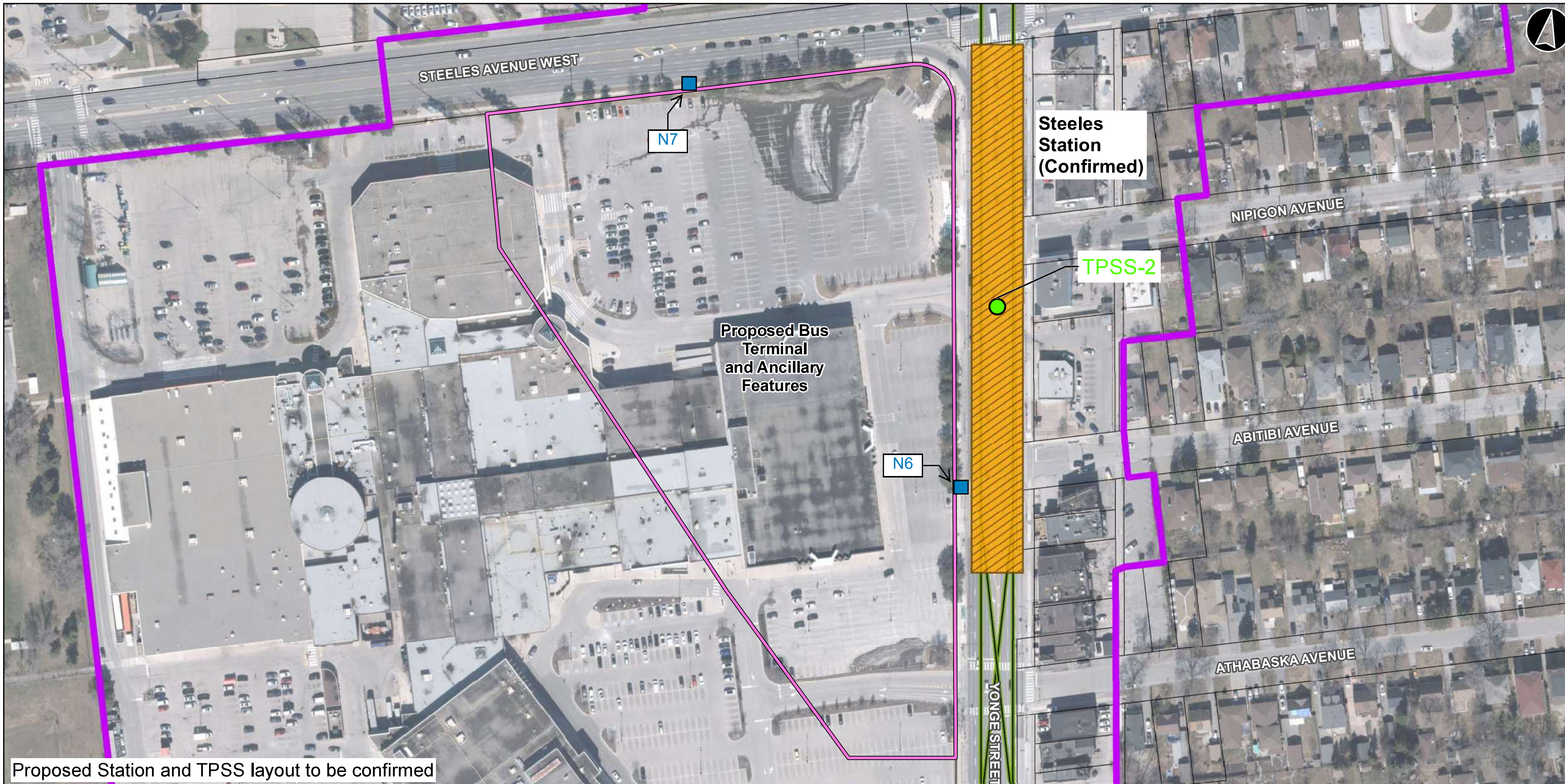
0 25 50
Metres
Datum: NAD27 MTM zone 10

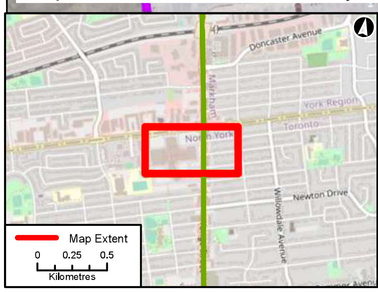
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 1 - Figure 6

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One





Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Confirmed Station Platform Area
- Proposed Bus Terminal and Ancillary Features
- Proposed TPSS Location
- Property Fabric
- Noise Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

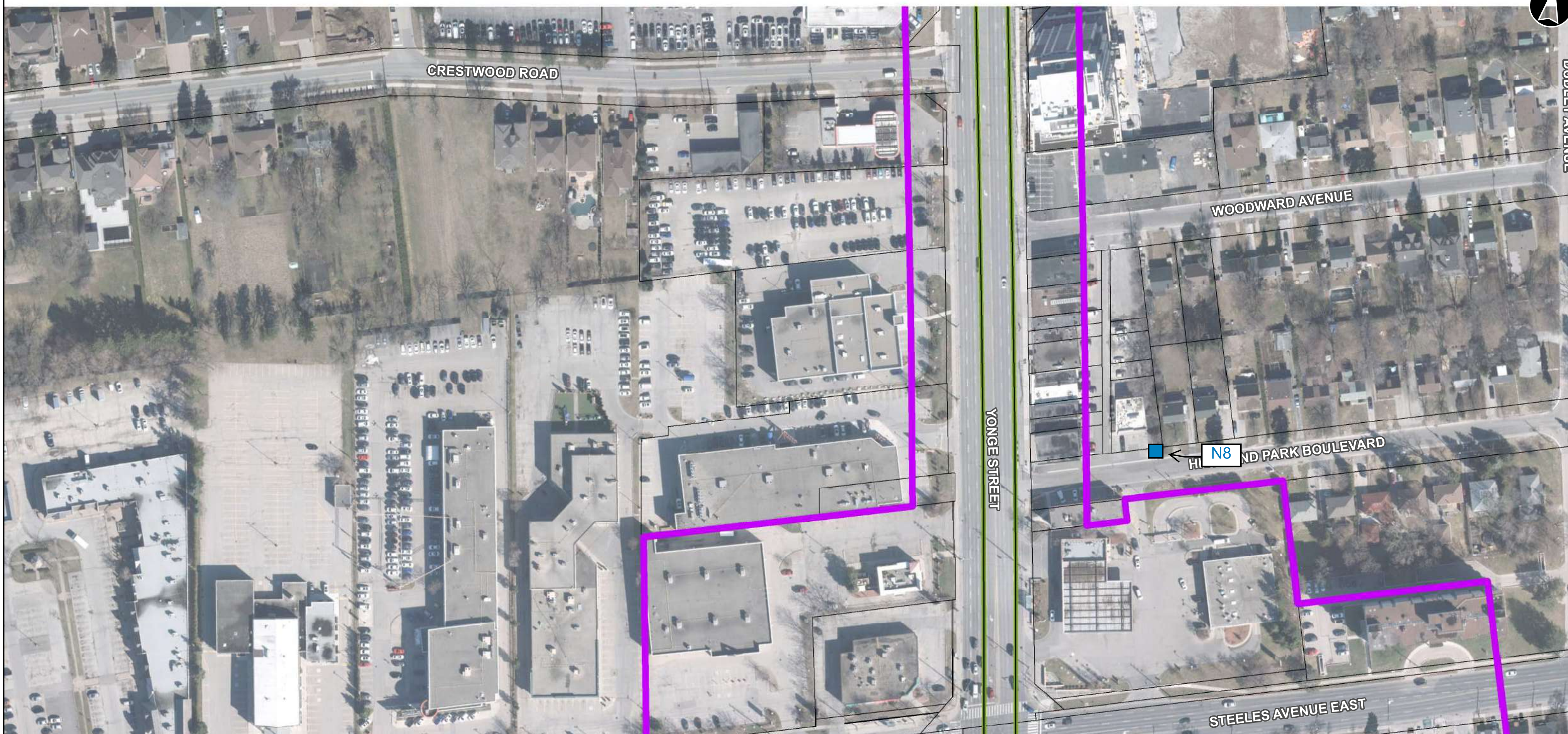
0 25 50
Metres
Datum: NAD27 MTM zone 10

Segment 1 - Figure 7

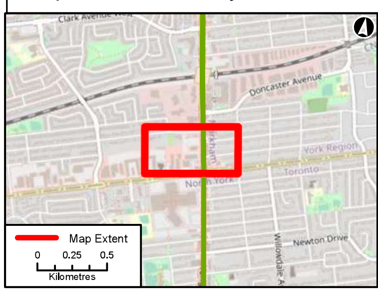
METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0



Proposed Station layout to be confirmed



Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Property Fabric
- Noise Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

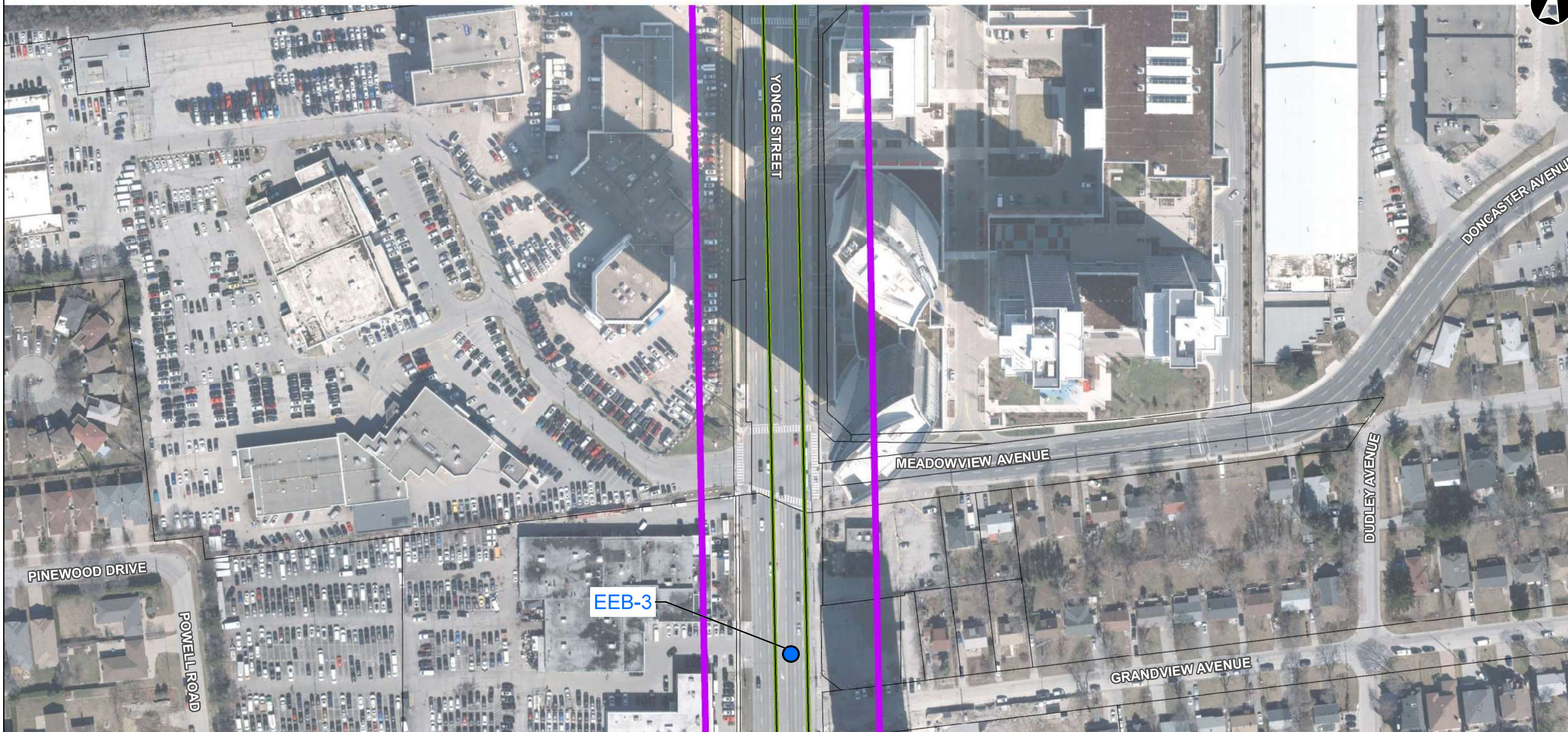
0 25 50
Metres
Datum: NAD27 MTM zone 10

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

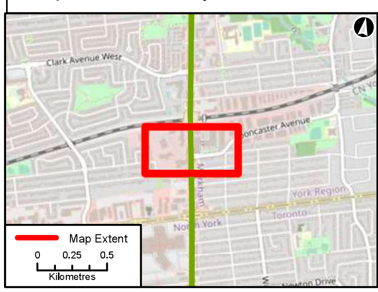
Segment 1 - Figure 8

Jan, 2022	1:1,600	
P 067400	Rev 0	

METROLINX
Infrastructure Ontario
One



Proposed EEB layout to be confirmed



Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Proposed EEB Location
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50 Metres

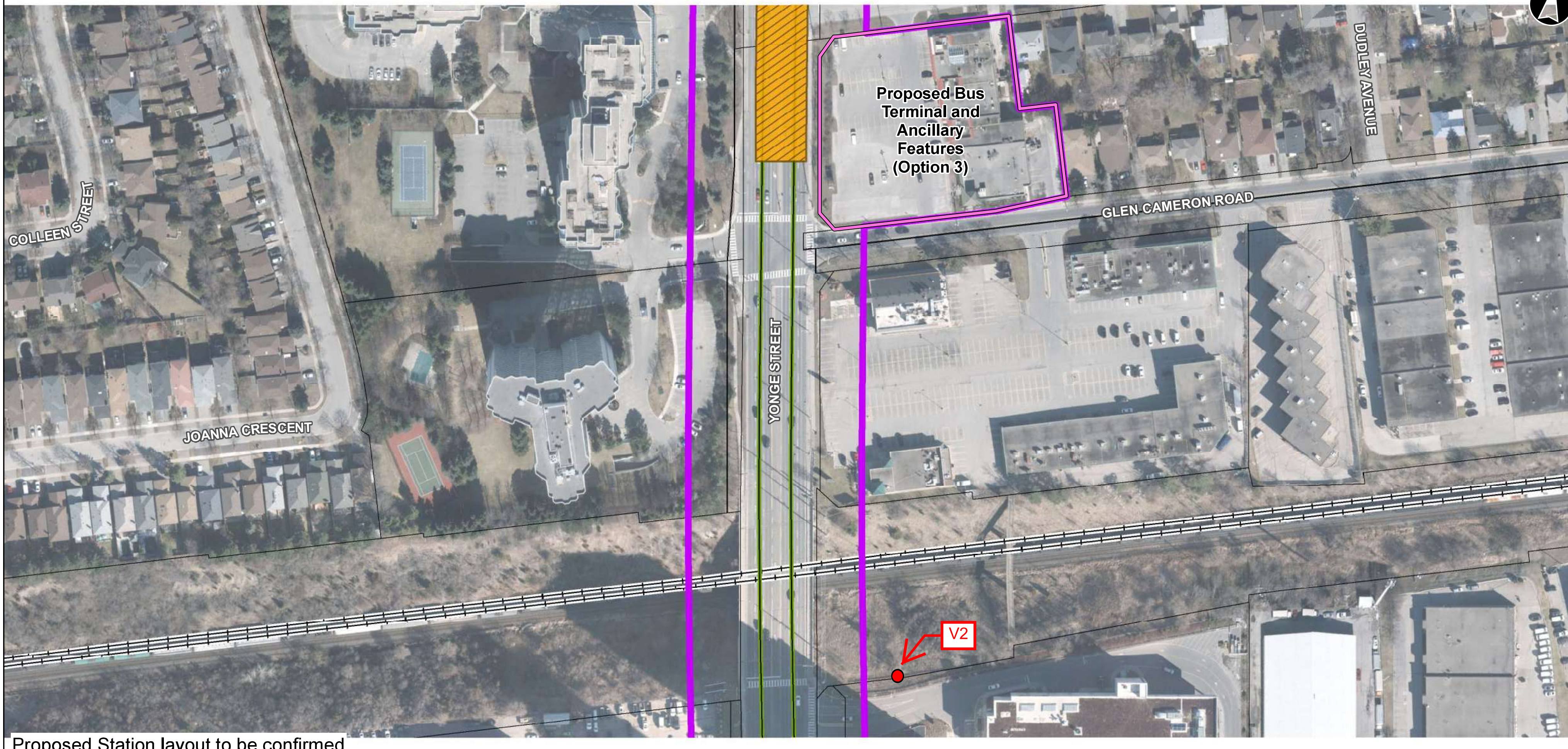
Datum: NAD27 MTM zone 10

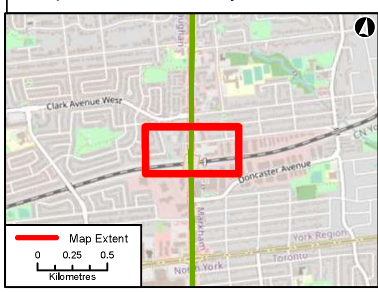
Segment 1 - Figure 9

METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0





Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Confirmed Station Platform Area
- Proposed Bus Terminal and Ancillary Features
- Existing CN Track
- Property Fabric
- Vibration Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

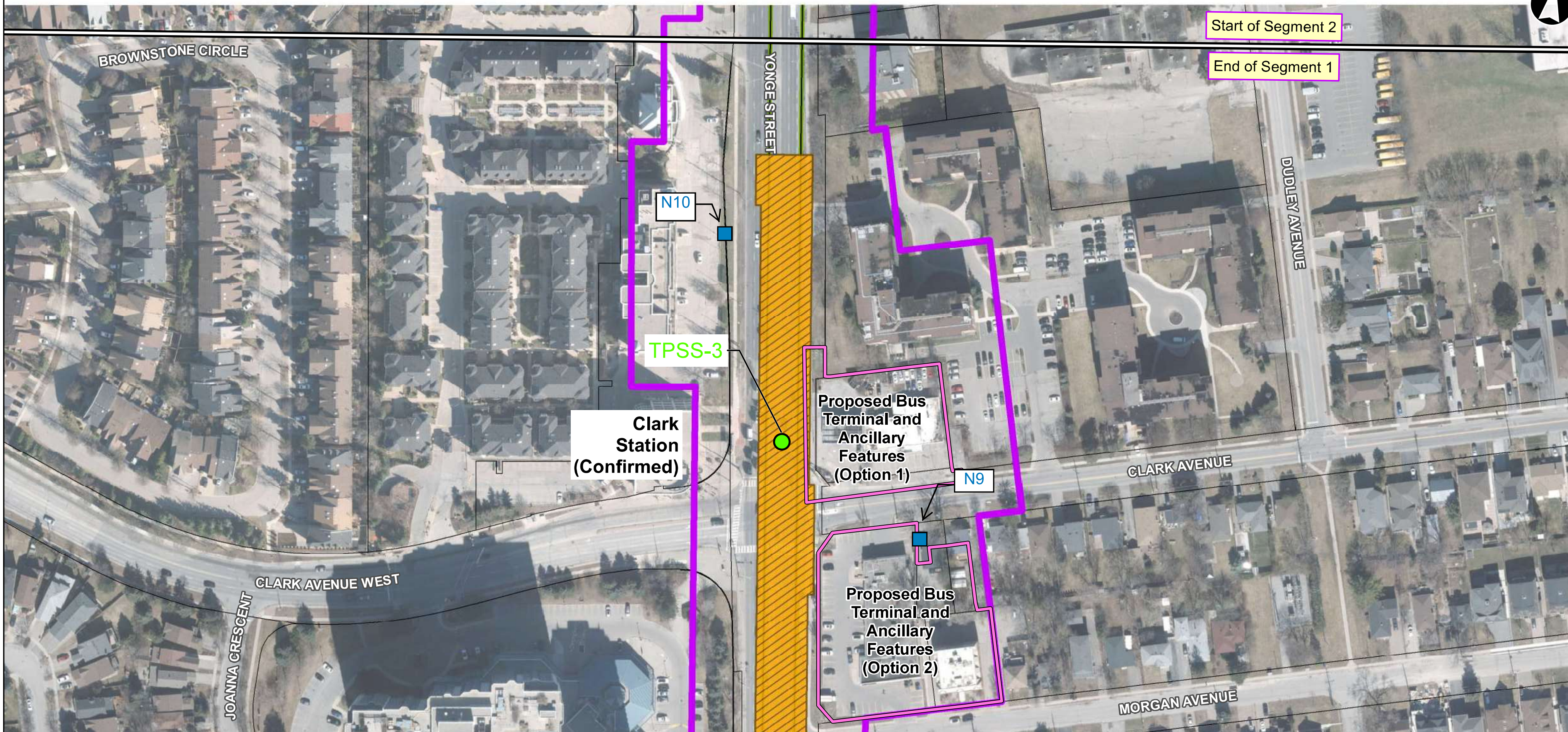
0 25 50
Metres
Datum: NAD27 MTM zone 10

Segment 1 - Figure 10

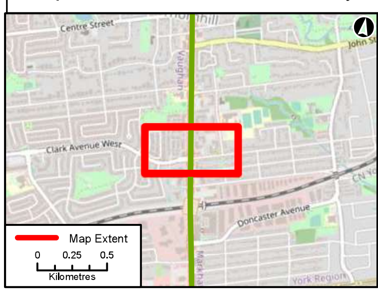
METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600	
P 067400	Rev 0	



Proposed Station and TPSS layout to be confirmed



Legend

- Study Area Segment Breakline
- Study Area
- Proposed Subway Alignment (Below Grade)
- Confirmed Station Platform Area
- Proposed Bus Terminal and Ancillary Features
- Proposed TPSS Location
- Property Fabric
- Noise Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

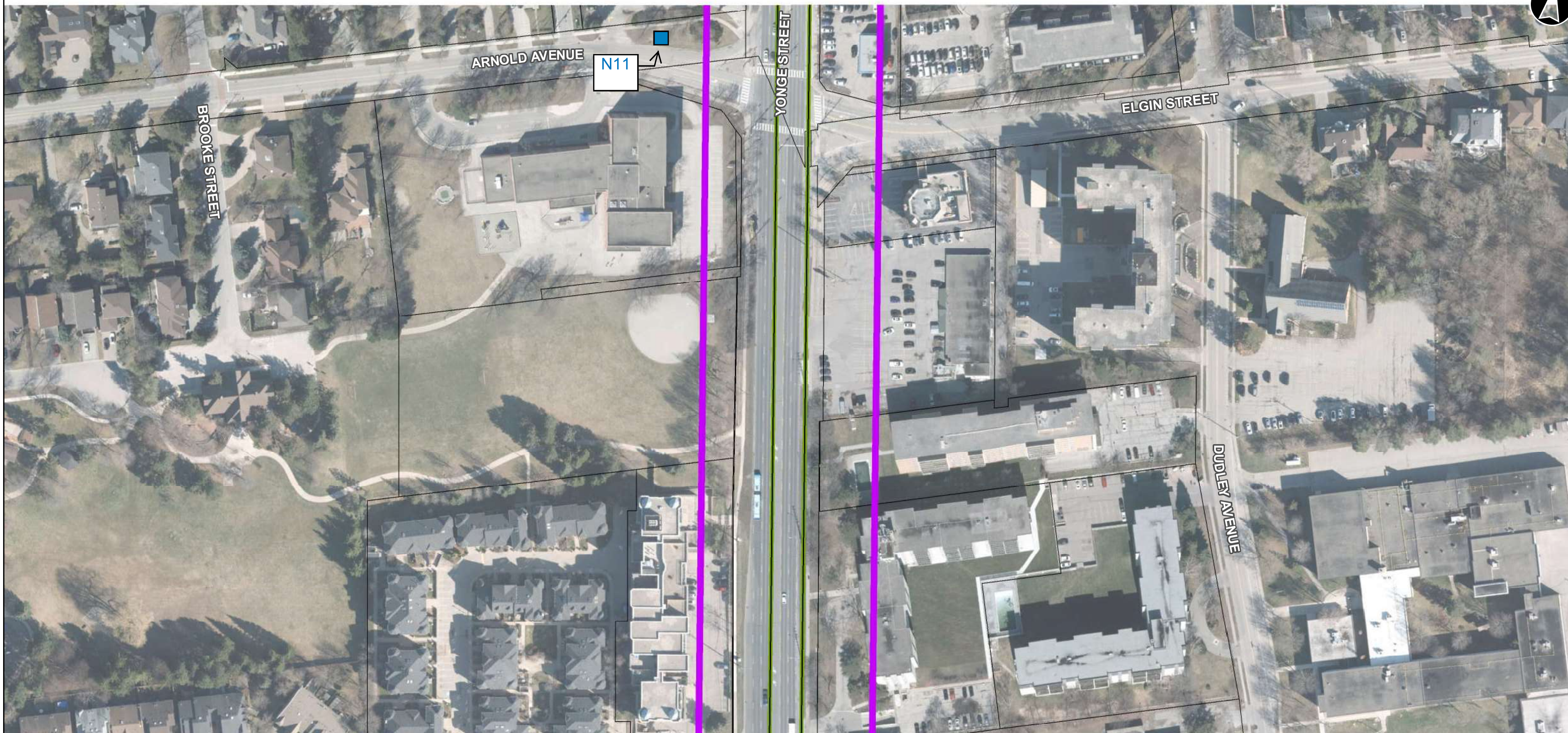
0 25 50
Metres
Datum: NAD27 MTM zone 10

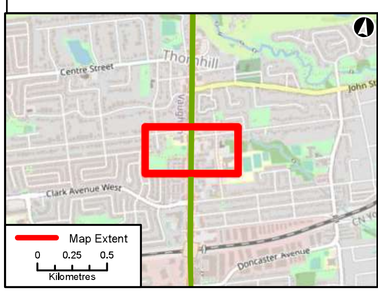
Segment 1/2 - Figure 11

METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0





Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Property Fabric
- Noise Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

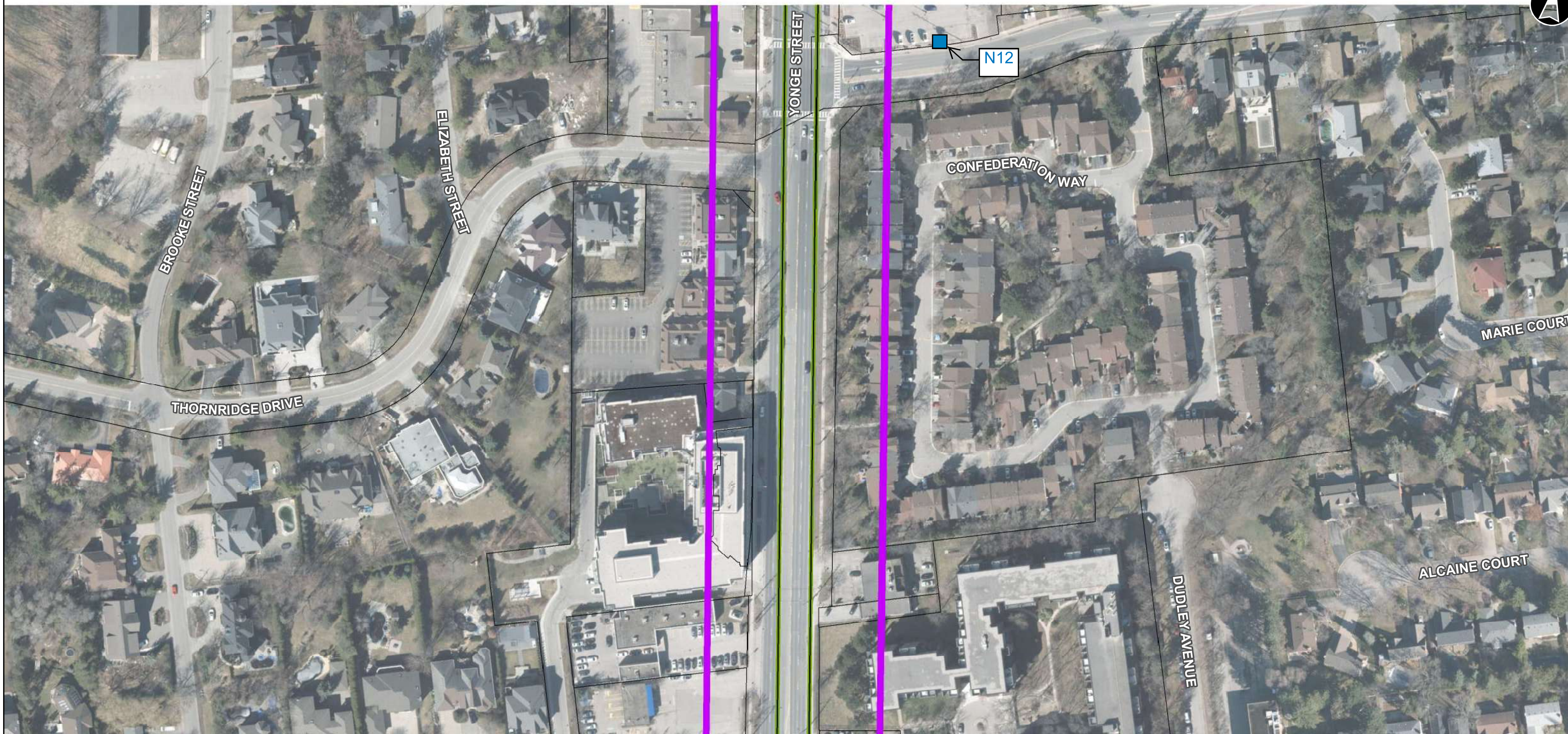
0 25 50
Metres
Datum: NAD27 MTM zone 10

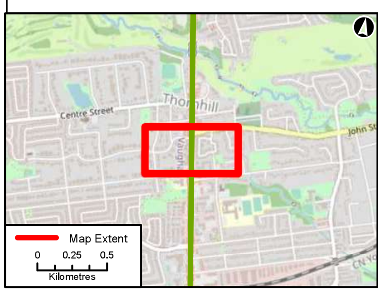
Segment 2 - Figure 12

METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0





Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Property Fabric
- Noise Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

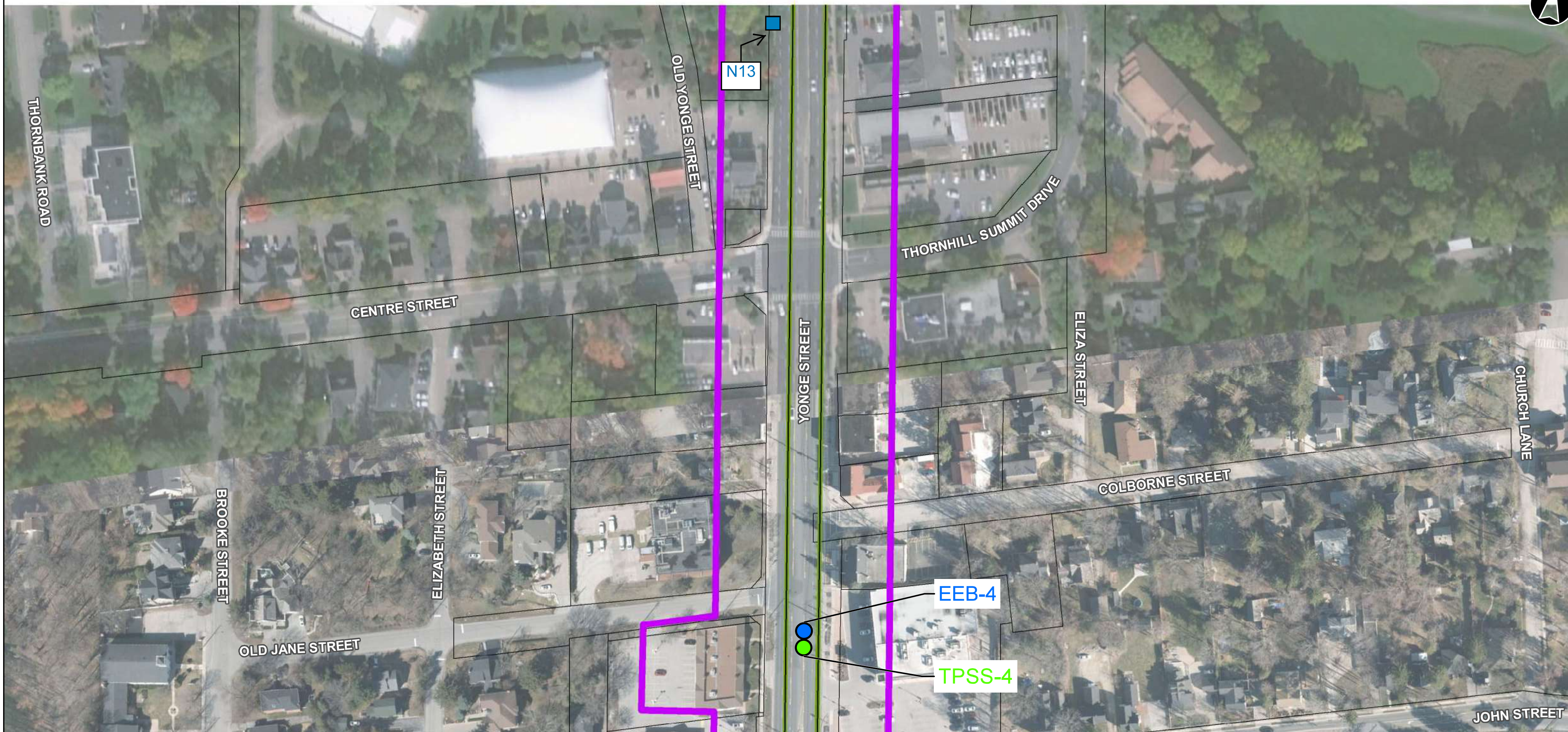
0 25 50
Metres
Datum: NAD27 MTM zone 10

Segment 2 - Figure 13

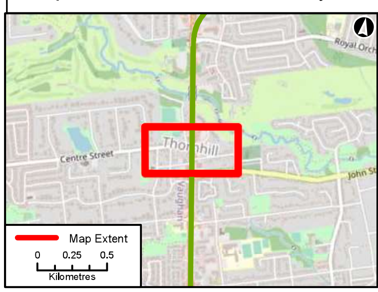
METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0



Proposed EEB and TPSS layout to be confirmed



Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Proposed TPSS Location
- Proposed EEB Location
- Property Fabric
- Noise Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

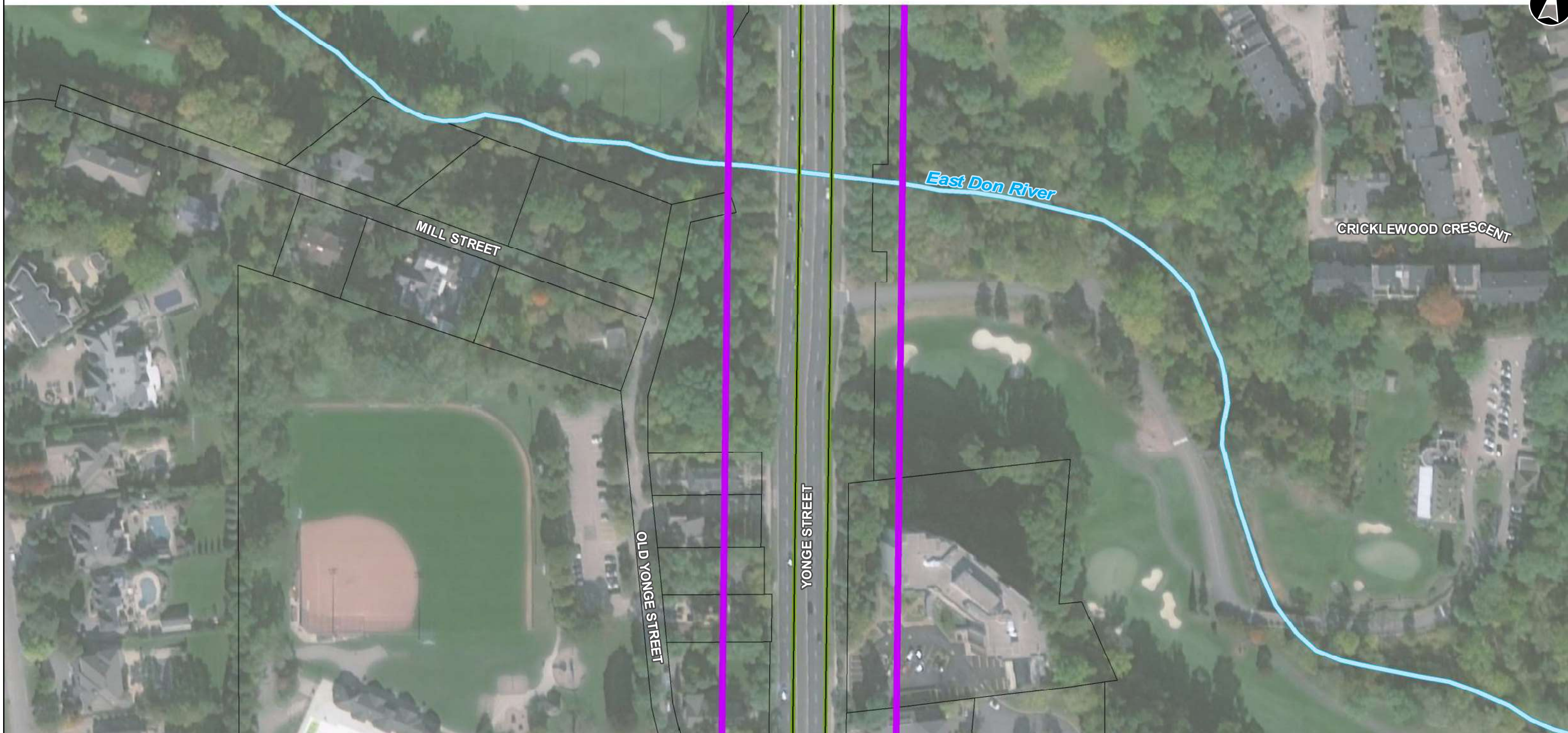
0 25 50
Metres
Datum: NAD27 MTM zone 10

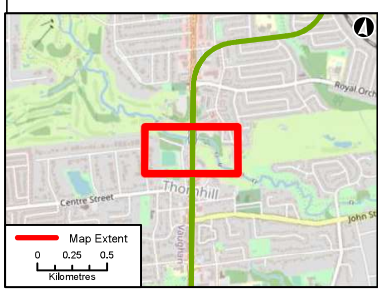
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 2 - Figure 14

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One





Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Watercourse
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

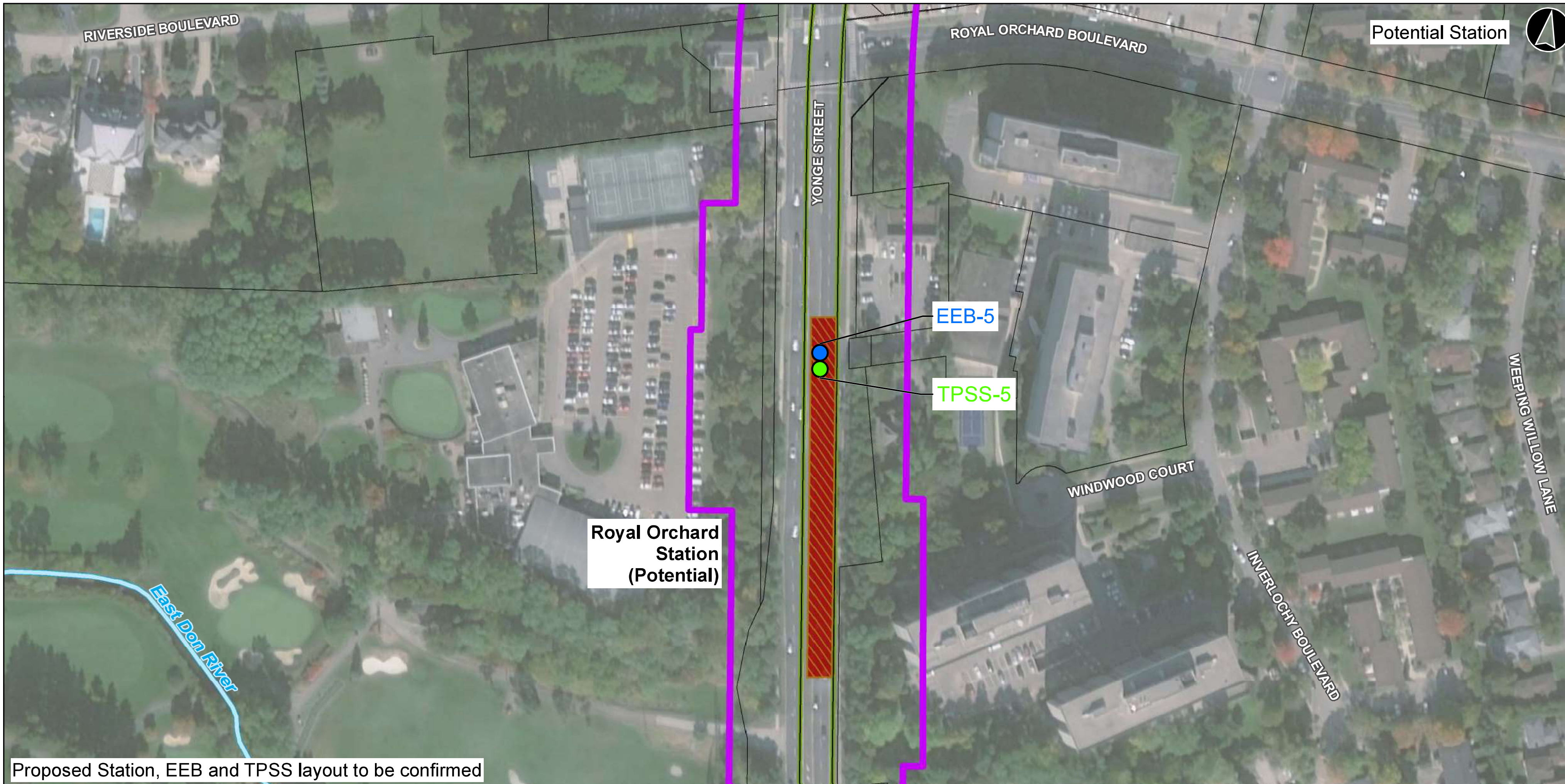
0 25 50
Metres
Datum: NAD27 MTM zone 10

Segment 2 - Figure 15

METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0



Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Potential Station Platform Area
- Proposed TPSS Location
- Proposed EEB Location
- Watercourse
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50
Metres

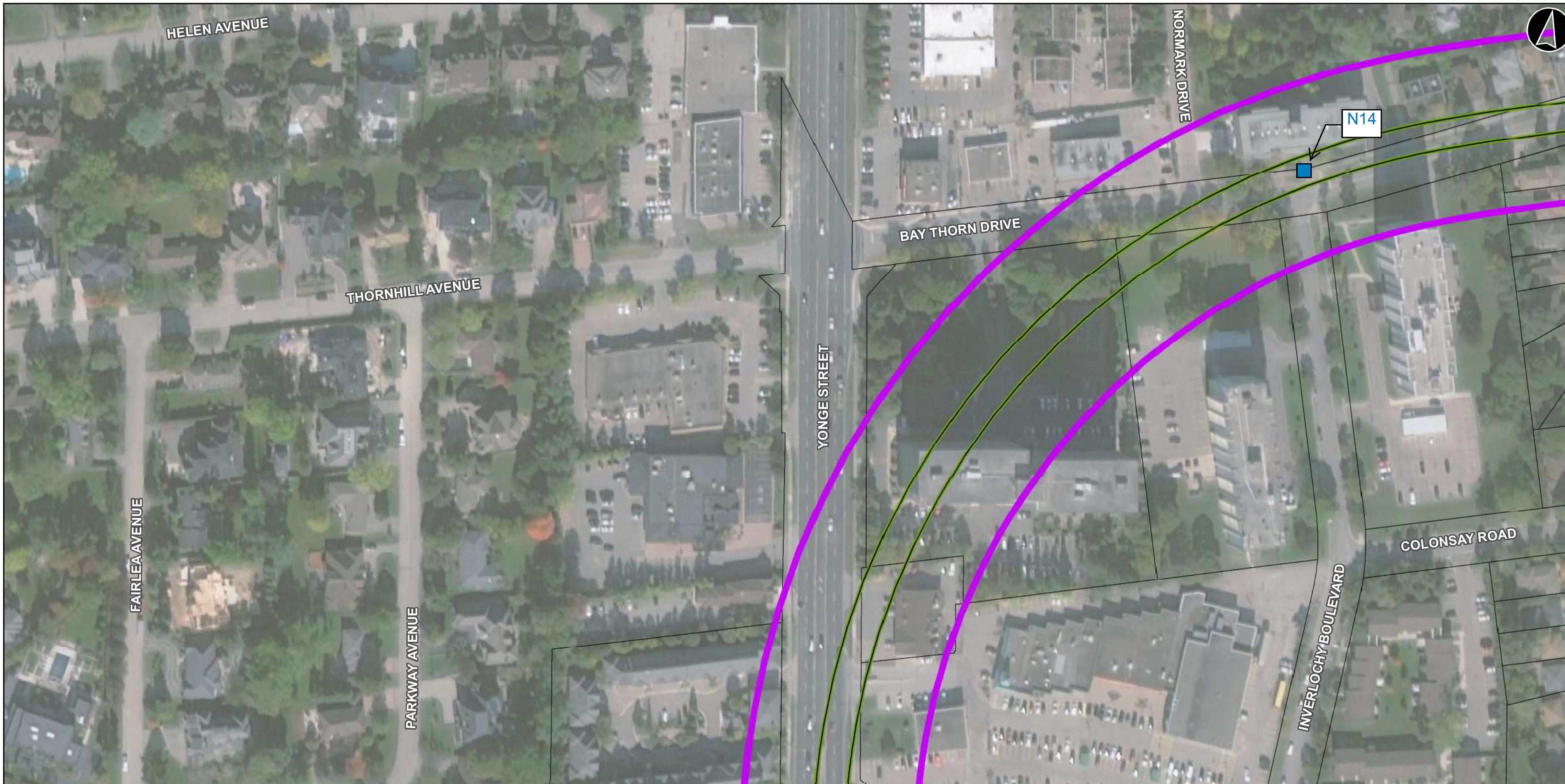
Datum: NAD27 MTM zone 10

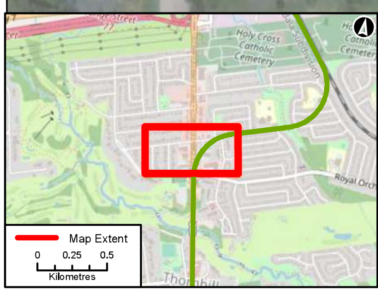
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 2 - Figure 16

Jan, 2022 | 1:1,600
P 067400 | Rev 0

METROLINX
Infrastructure Ontario
One





Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Property Fabric
- Noise Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50
Metres
Datum: NAD27 MTM zone 10

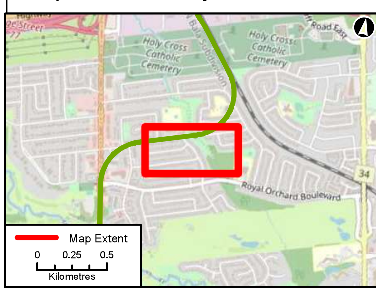
Segment 2 - Figure 17

METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0

Proposed EEB layout to be confirmed



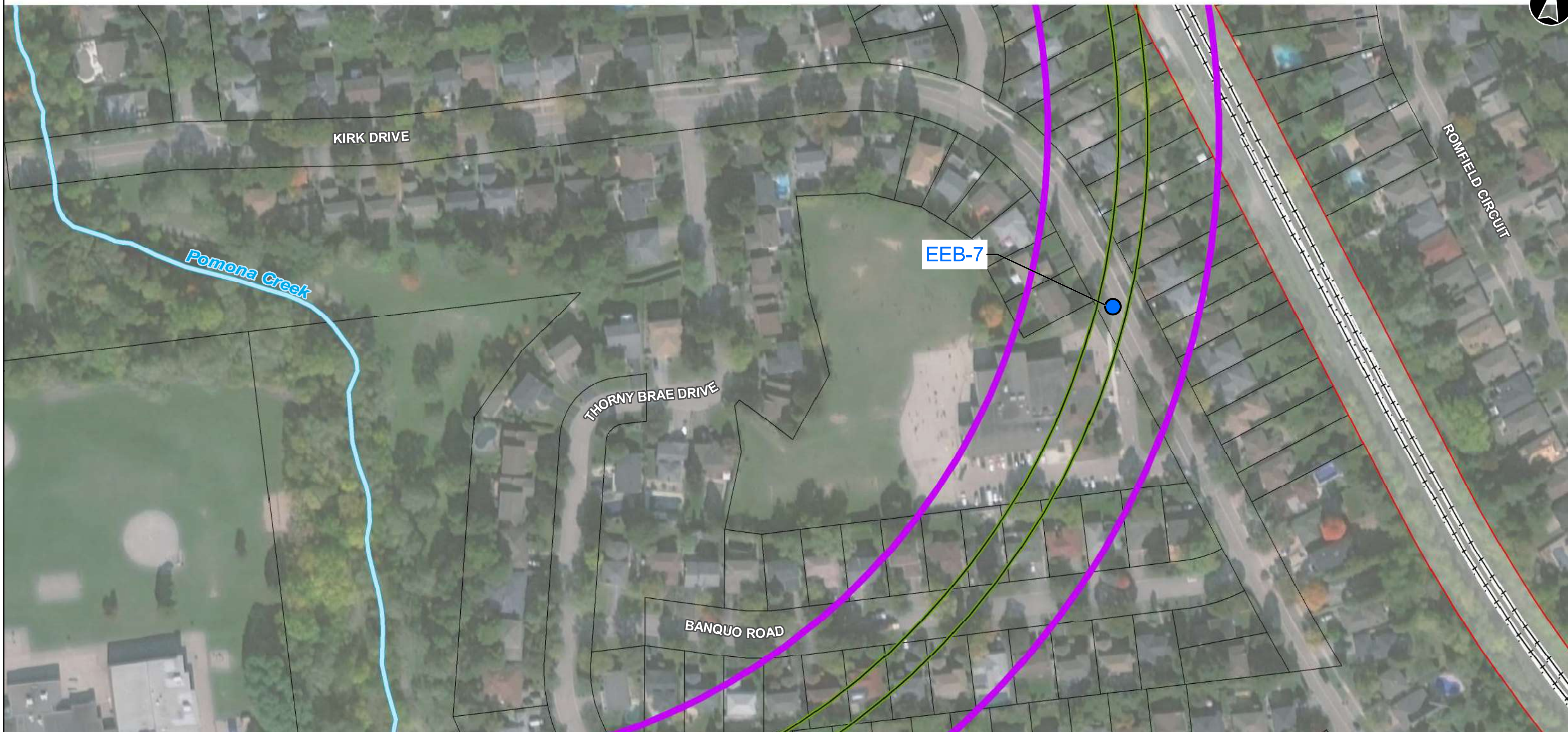
Legend

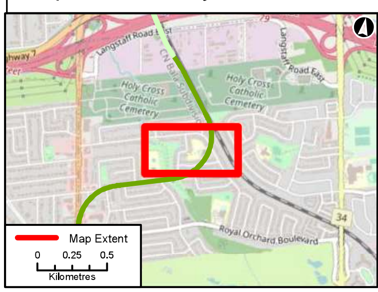
- Study Area
- Proposed Subway Alignment (Below Grade)
- Proposed EEB Location
- Watercourse
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50 Metres Datum: NAD27 MTM zone 10	**Segment 2 - Figure 18**		METROLINX Infrastructure Ontario
Data Sources: Aerial imagery provided by ESRI dated 2019. Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.	Jan, 2022	1:1,600	One
	P 067400	Rev 0	





Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Proposed EEB Location
- Existing CN Track / Metrolinx Richmond Hill Corridor
- Watercourse
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

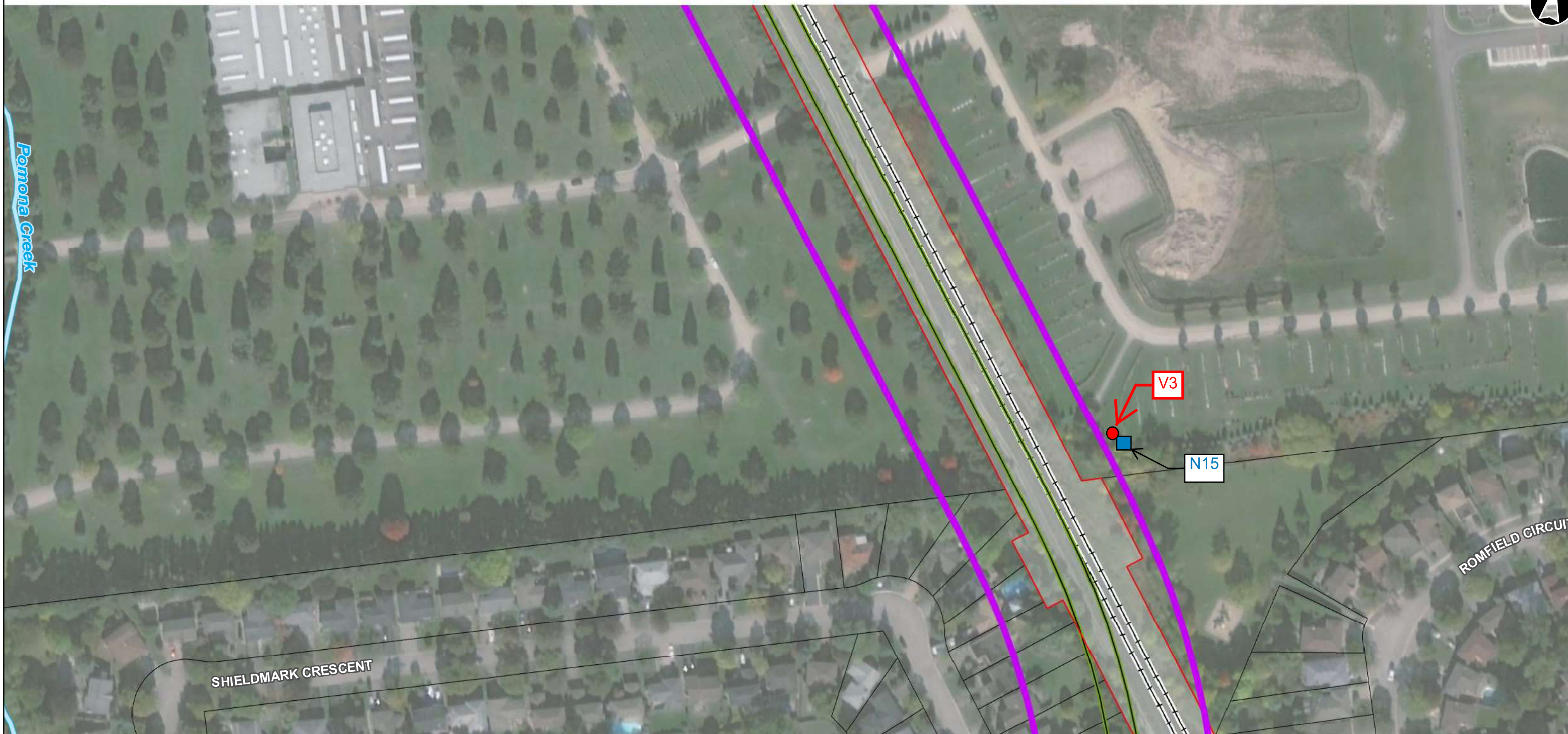
0 25 50
Metres
Datum: NAD27 MTM zone 10

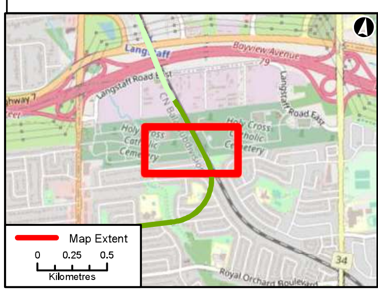
Segment 2 - Figure 19

METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0





Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Existing CN Track / Metrolinx Richmond Hill Corridor
- Watercourse
- CN Right-of-Way
- Property Fabric
- Noise Monitoring Location
- Vibration Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

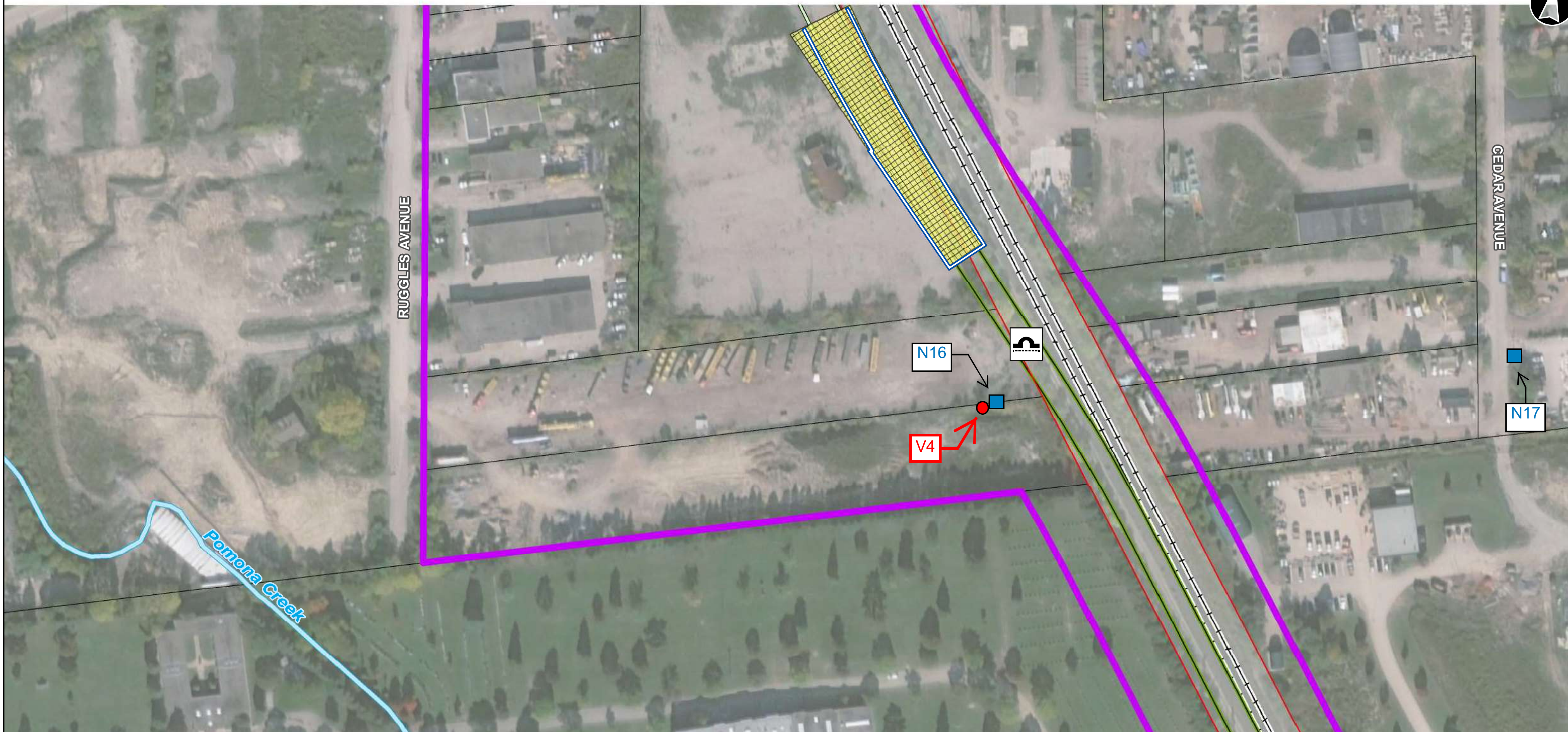
0 25 50
Metres
Datum: NAD27 MTM zone 10

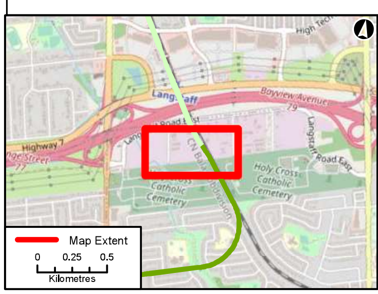
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 2 - Figure 20

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario





Legend

- Study Area
- Proposed Subway Alignment (At Grade)
- Proposed Subway Alignment (Below Grade)
- Proposed Launch Shaft
- Proposed Portal Structure
- Proposed Culvert Relocation
- Existing CN Track / Metrolinx Richmond Hill Corridor
- Watercourse
- CN Right-of-Way
- Property Fabric
- Noise Monitoring Location
- Vibration Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50 Metres

Datum: NAD27 MTM zone 10

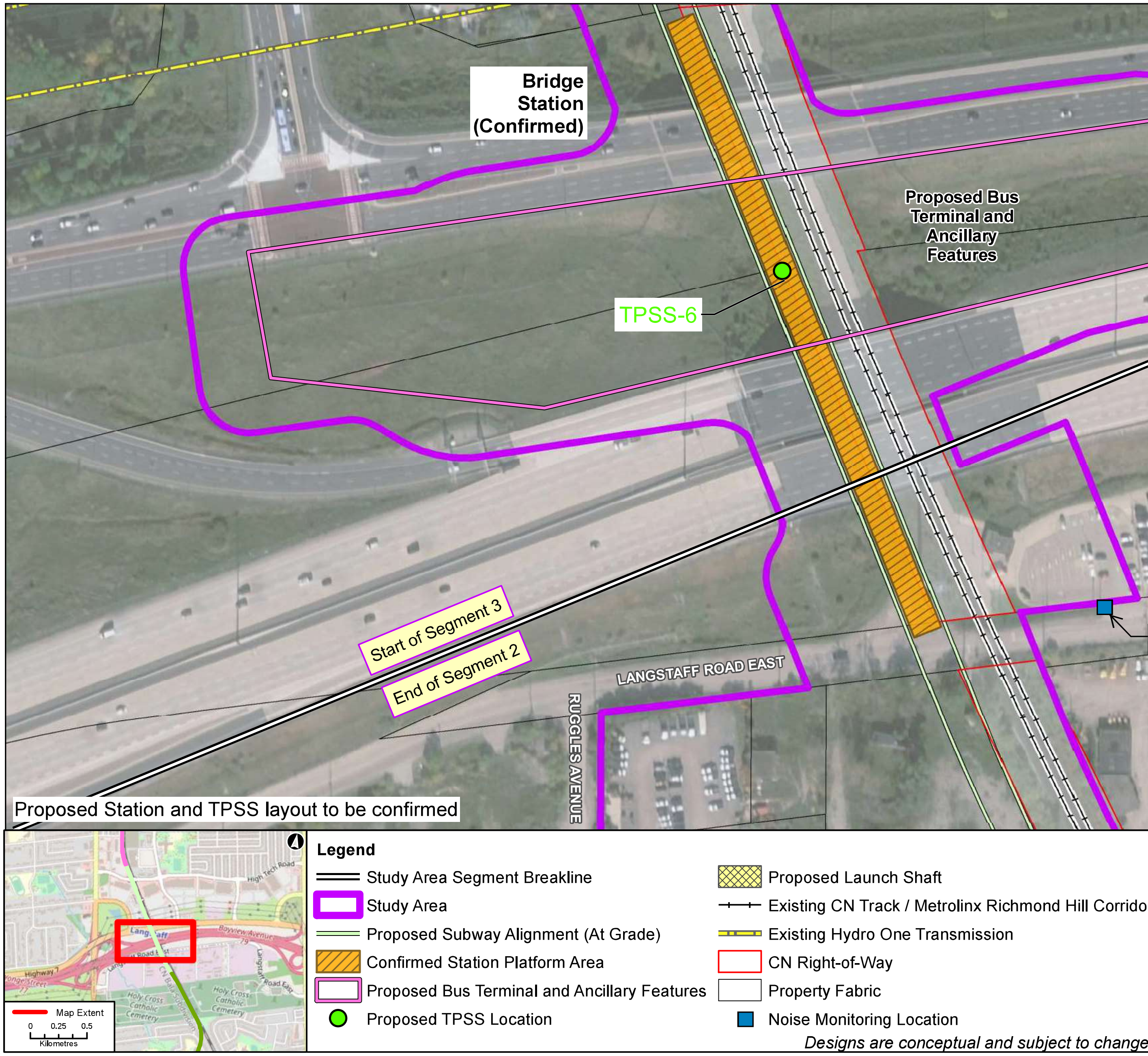
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 2 - Figure 21

Jan, 2022 | 1:1,600

P 067400 | Rev 0

METROLINX
Infrastructure Ontario



Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

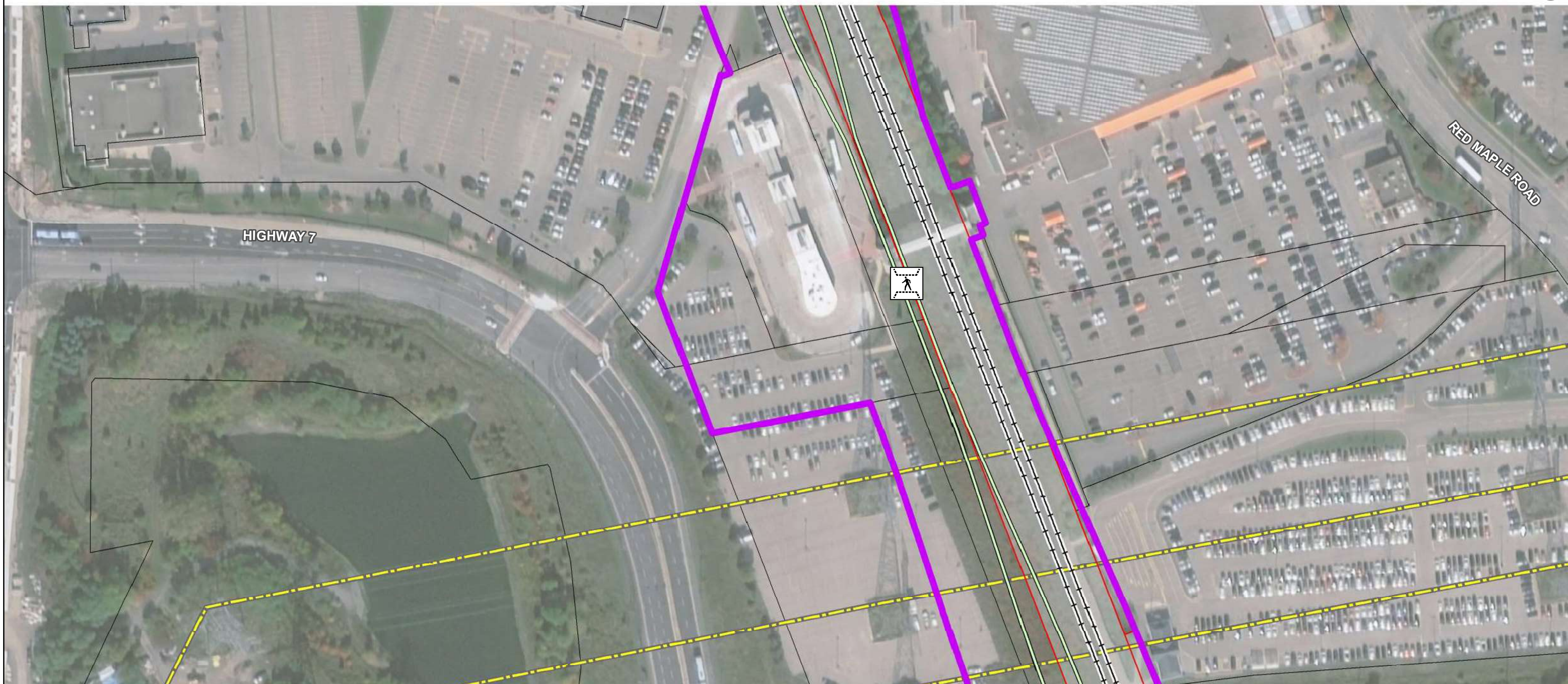
0 25 50
Metres
Datum: NAD27 MTM zone 10

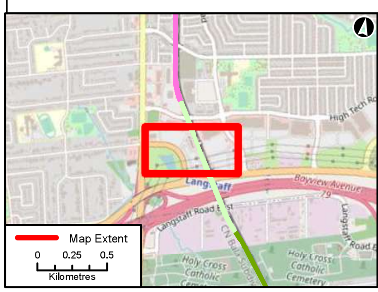
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 2/3 - Figure 22

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One





Legend

- Study Area
- Proposed Subway Alignment (At Grade)
- Proposed Temporary Pedestrian Bridge
- Existing CN Track / Metrolinx Richmond Hill Corridor
- Existing Hydro One Transmission
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

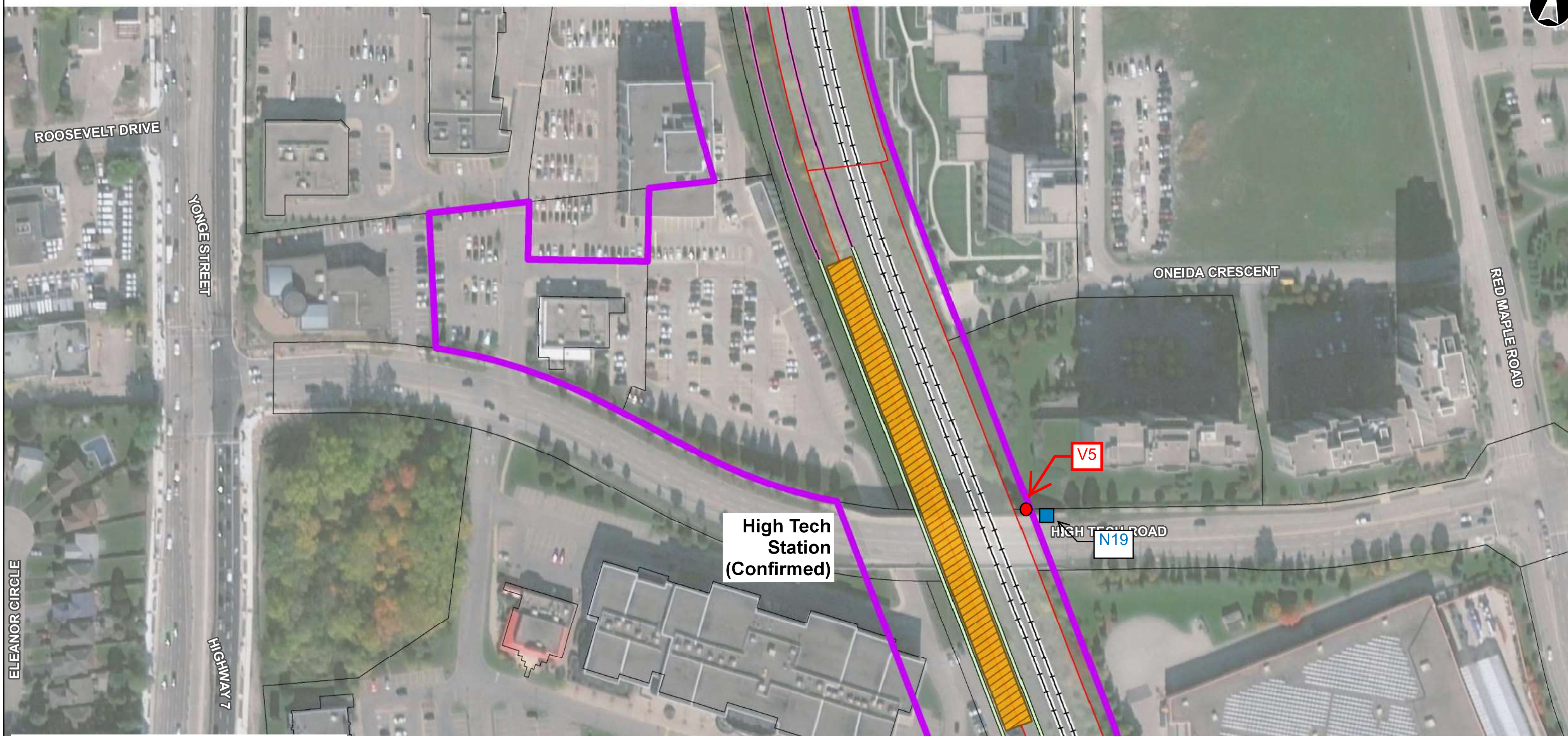
0 25 50
Metres
Datum: NAD27 MTM zone 10

Segment 3 - Figure 23

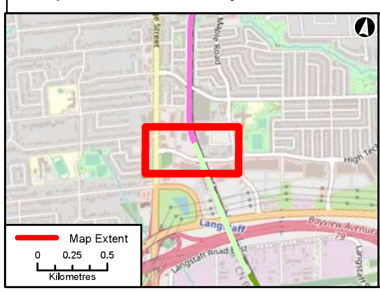
METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0



Proposed Station layout to be confirmed



Legend

- Study Area
- Proposed Subway Alignment (At Grade)
- Proposed Train Storage Facility Alignment
- Confirmed Station Platform Area
- Existing CN Track / Metrolinx Richmond Hill Corridor
- CN Right-of-Way
- Property Fabric
- Noise Monitoring Location
- Vibration Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

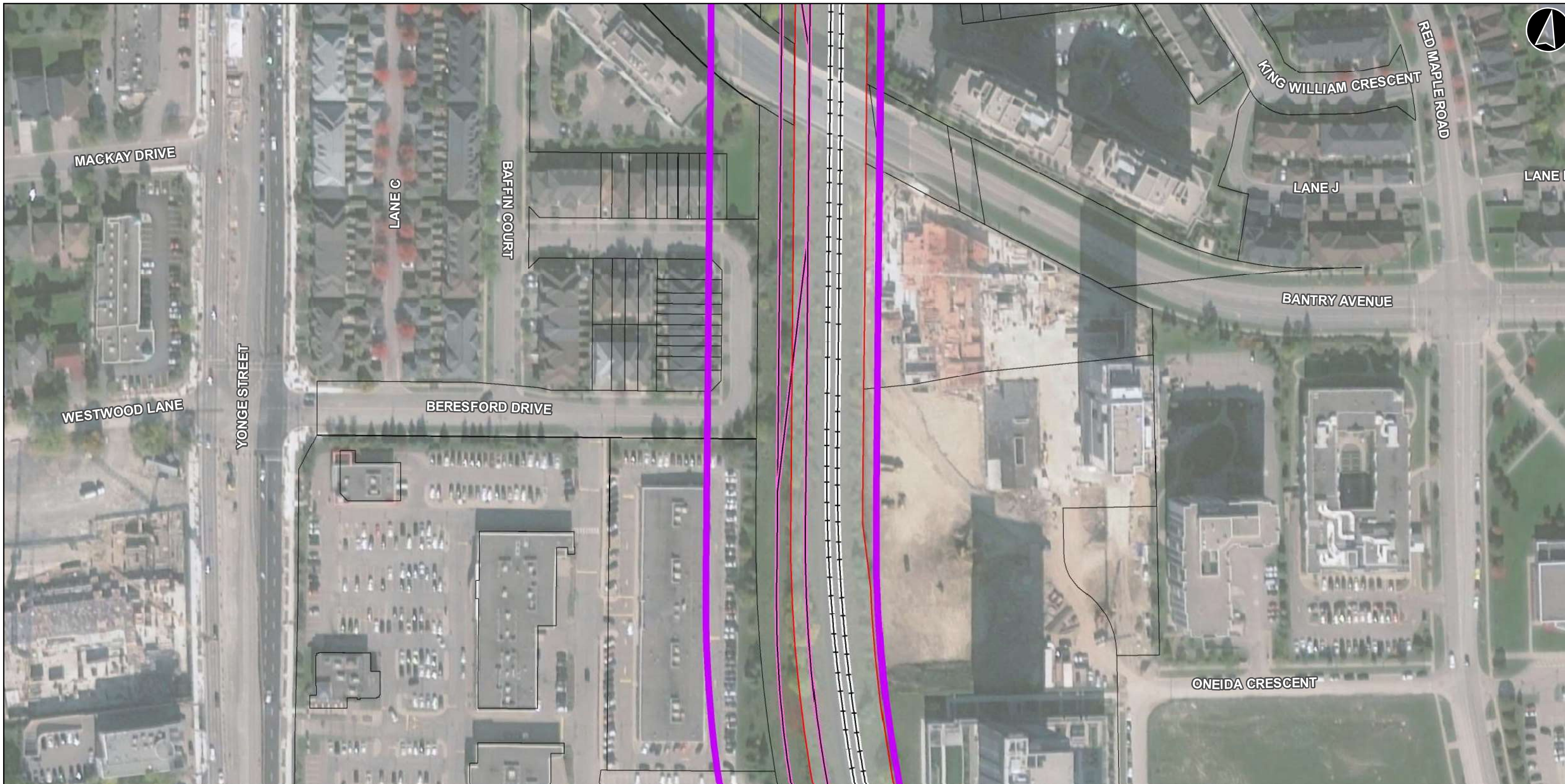
0 25 50
Metres
Datum: NAD27 MTM zone 10

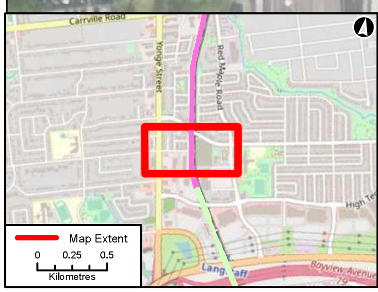
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 3 - Figure 24

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One





Legend

- Study Area
- Proposed Train Storage Facility Alignment
- Existing CN Track / Metrolinx Richmond Hill Corridor
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

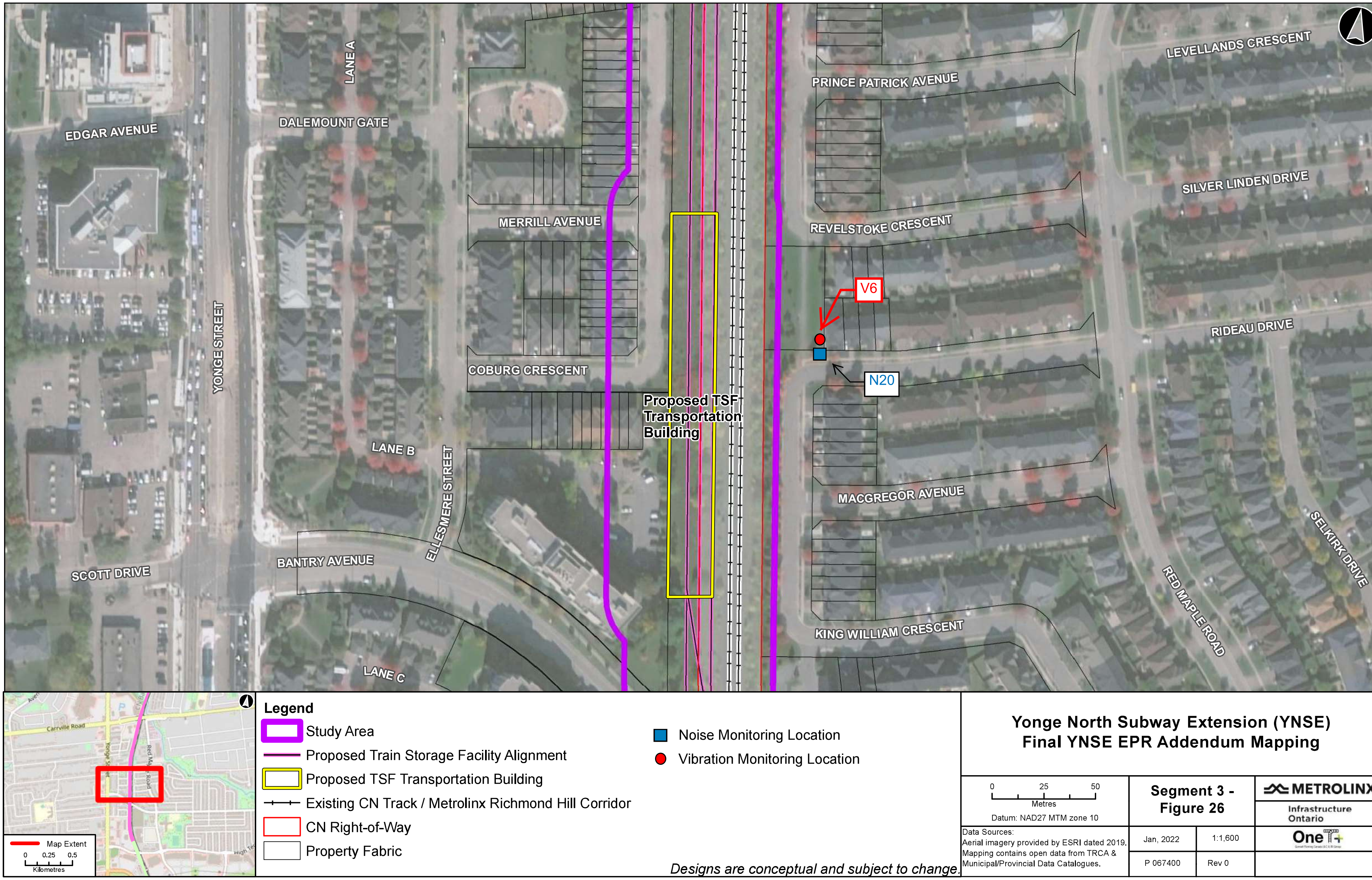
0 25 50
Metres
Datum: NAD27 MTM zone 10

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 3 - Figure 25

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One



Legend

- Study Area
- Proposed Train Storage Facility Alignment
- Proposed TSF Transportation Building
- Existing CN Track / Metrolinx Richmond Hill Corridor
- CN Right-of-Way
- Property Fabric
- Noise Monitoring Location
- Vibration Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

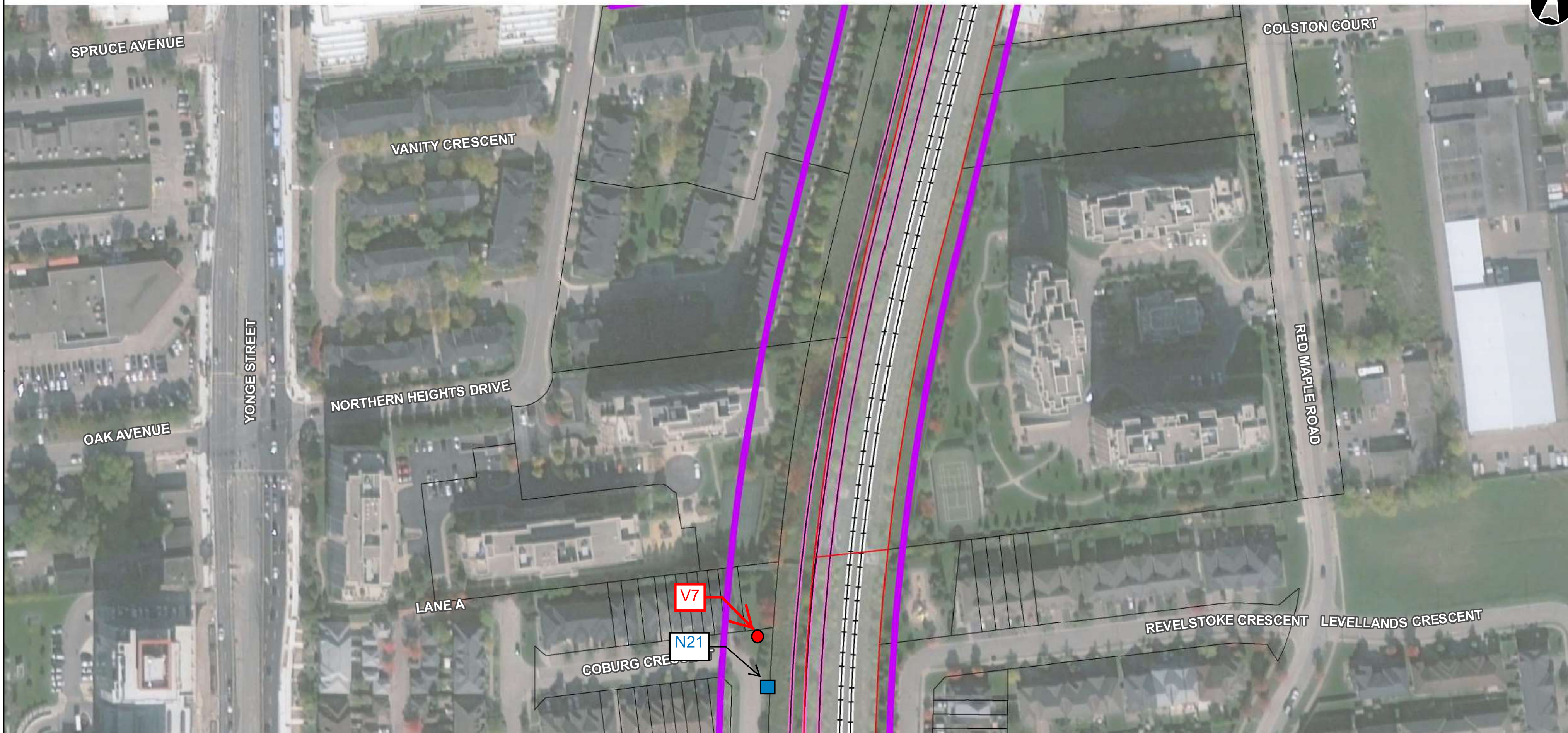
0 25 50
Metres
Datum: NAD27 MTM zone 10

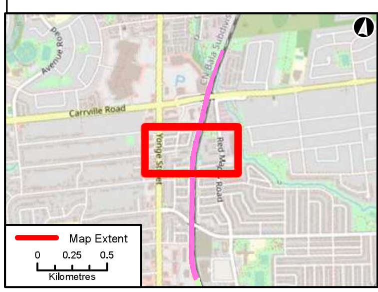
Segment 3 - Figure 26

METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0





Legend

- Study Area
- Proposed Train Storage Facility Alignment Existing
- CN Track / Metrolinx Richmond Hill Corridor CN
- Right-of-Way
- Property Fabric
- Noise Monitoring Location
- Vibration Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

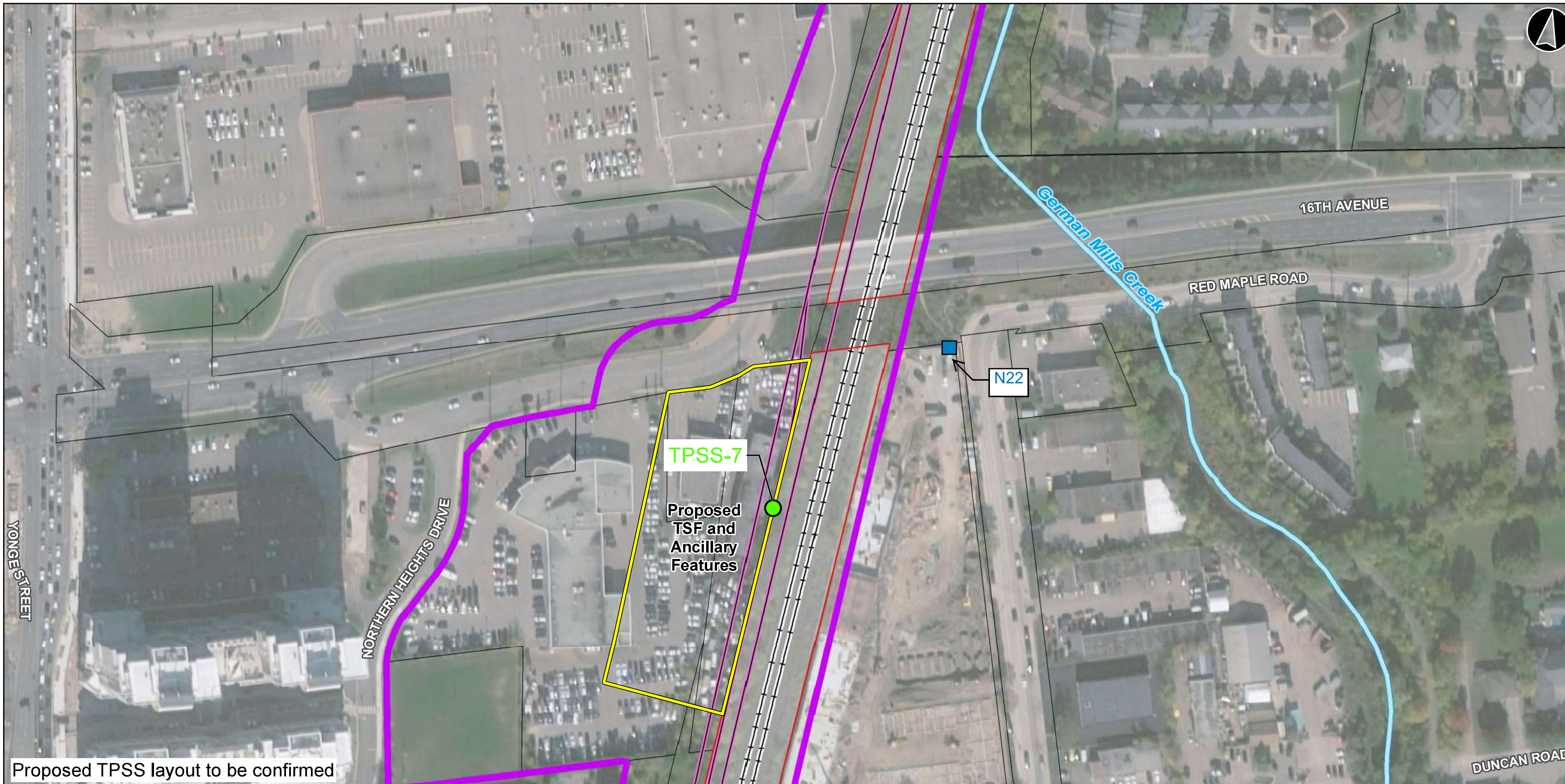
0 25 50
Metres
Datum: NAD27 MTM zone 10

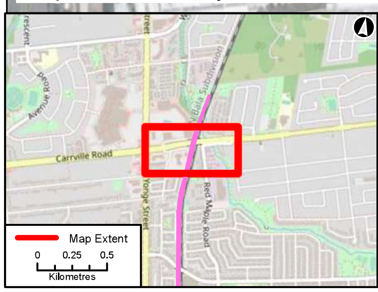
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 3 - Figure 27

Jan, 2022 | 1:1,600
P 067400 | Rev 0

METROLINX
Infrastructure Ontario
One





Legend

- Study Area
- Proposed Train Storage Facility Alignment
- Proposed TSF and Ancillary Features
- Proposed TPSS Location
- Existing CN Track / Metrolinx Richmond Hill Corridor
- Watercourse
- CN Right-of-Way
- Property Fabric
- Noise Monitoring Location

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

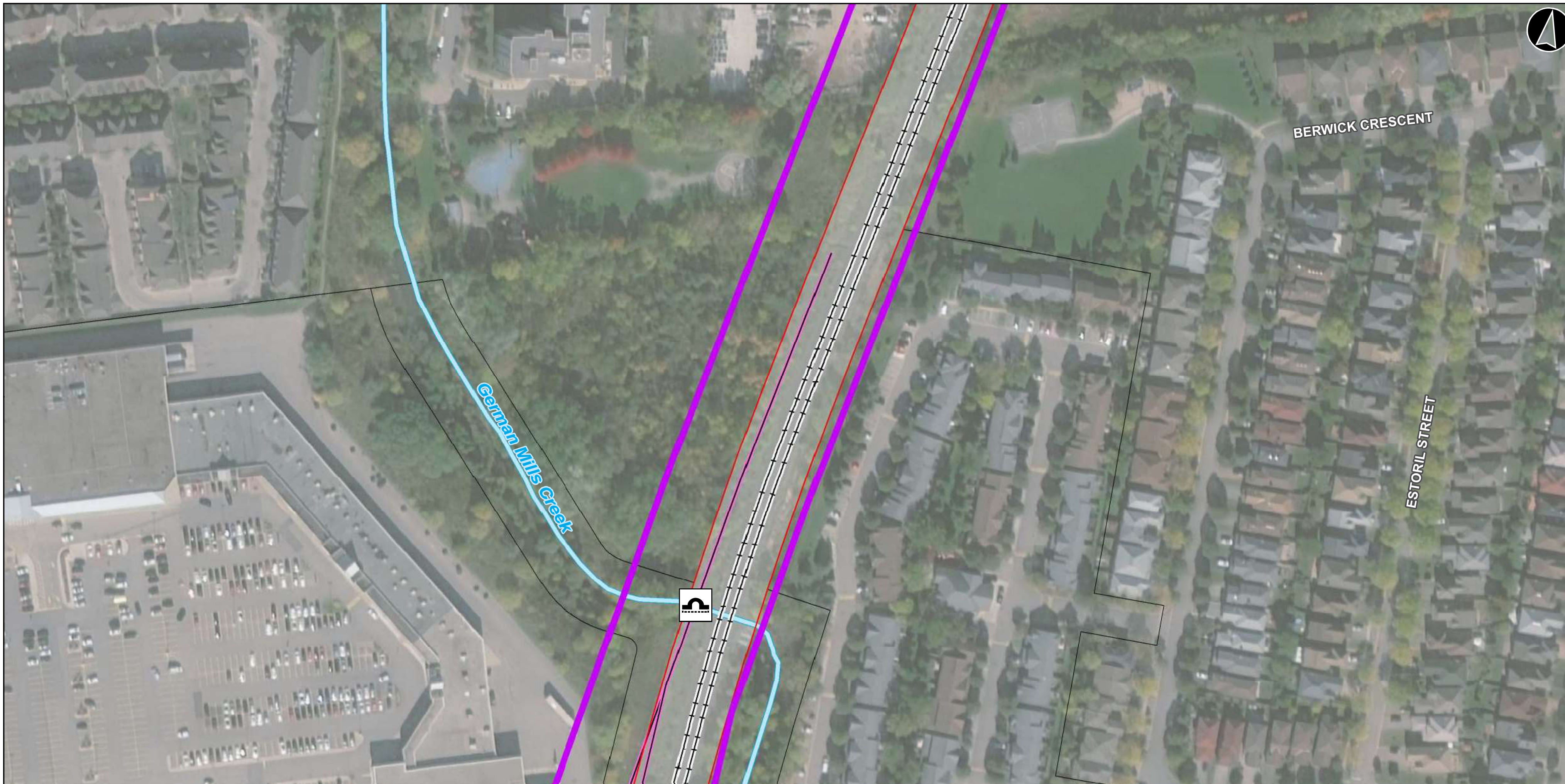
0 25 50
Metres
Datum: NAD27 MTM zone 10

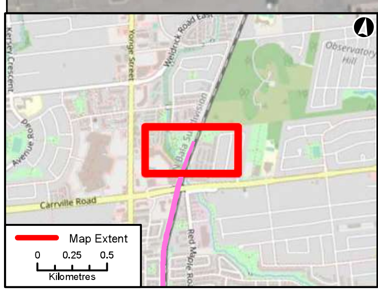
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 3 - Figure 28

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One





Legend

- Study Area
- Proposed Train Storage Facility Alignment
- Proposed Culvert Replacement
- Existing CN Track / Metrolinx Richmond Hill Corridor
- Watercourse
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

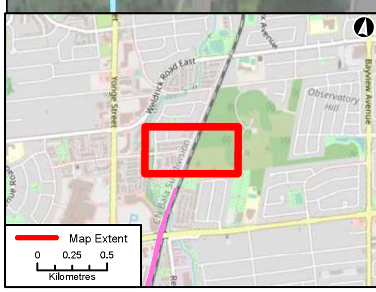
0 25 50
Metres
Datum: NAD27 MTM zone 10

Segment 3 - Figure 29

METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0



Legend

- Study Area
- Existing CN Track / Metrolinx Richmond Hill Corridor
- Watercourse
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50
Metres
Datum: NAD27 MTM zone 10

Segment 3 - Figure 30

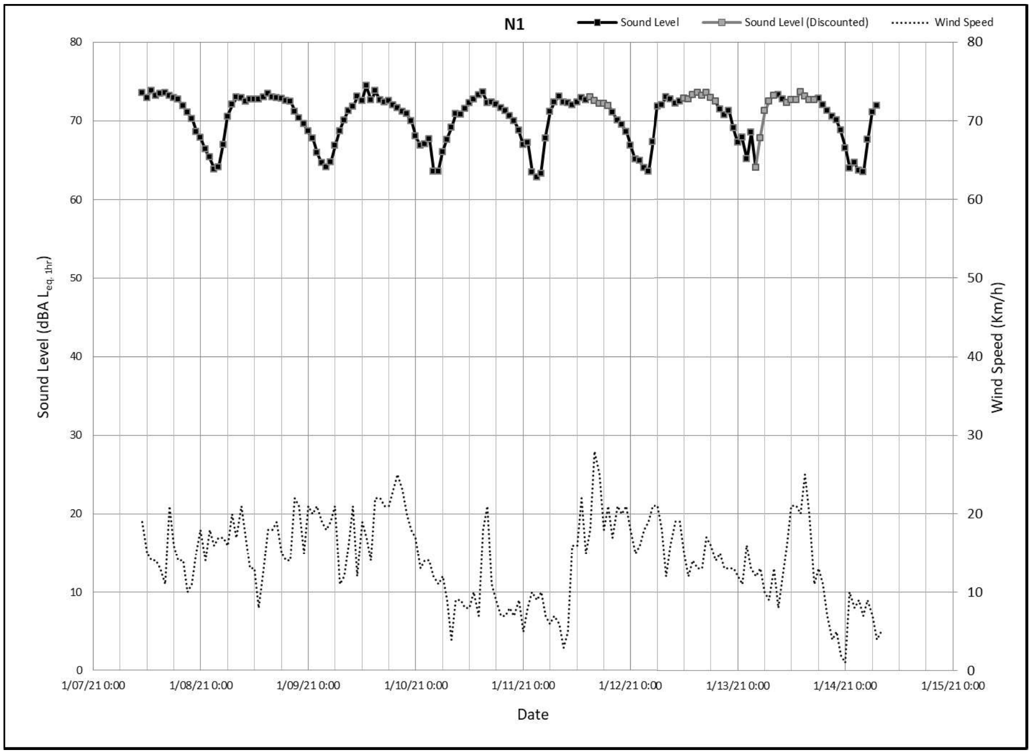
METROLINX
Infrastructure Ontario
One

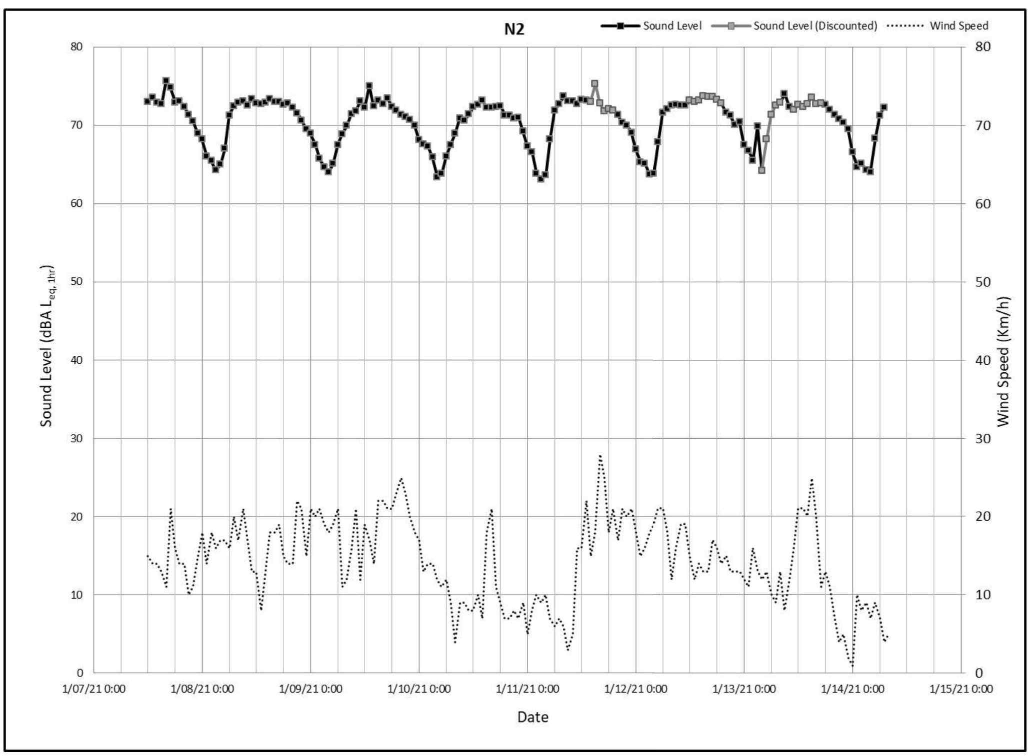
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

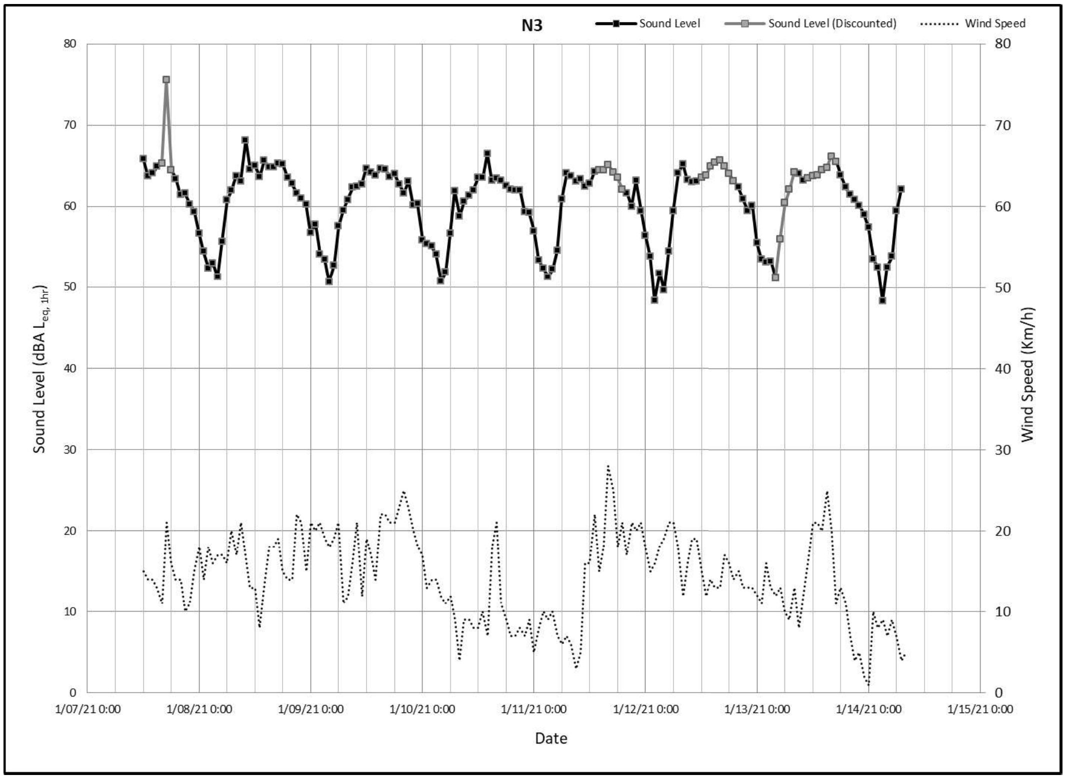
Jan, 2022	1:1,600
P 067400	Rev 0

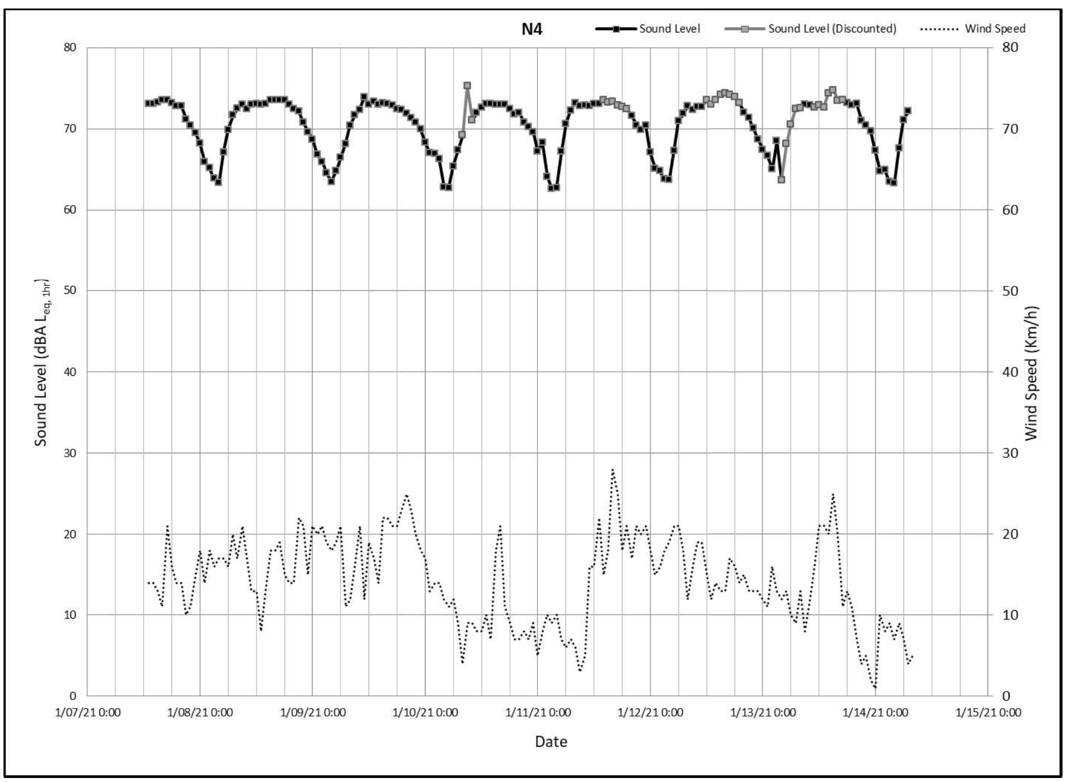
APPENDIX B: NOISE AND VIBRATION MONITORING MEASUREMENTS

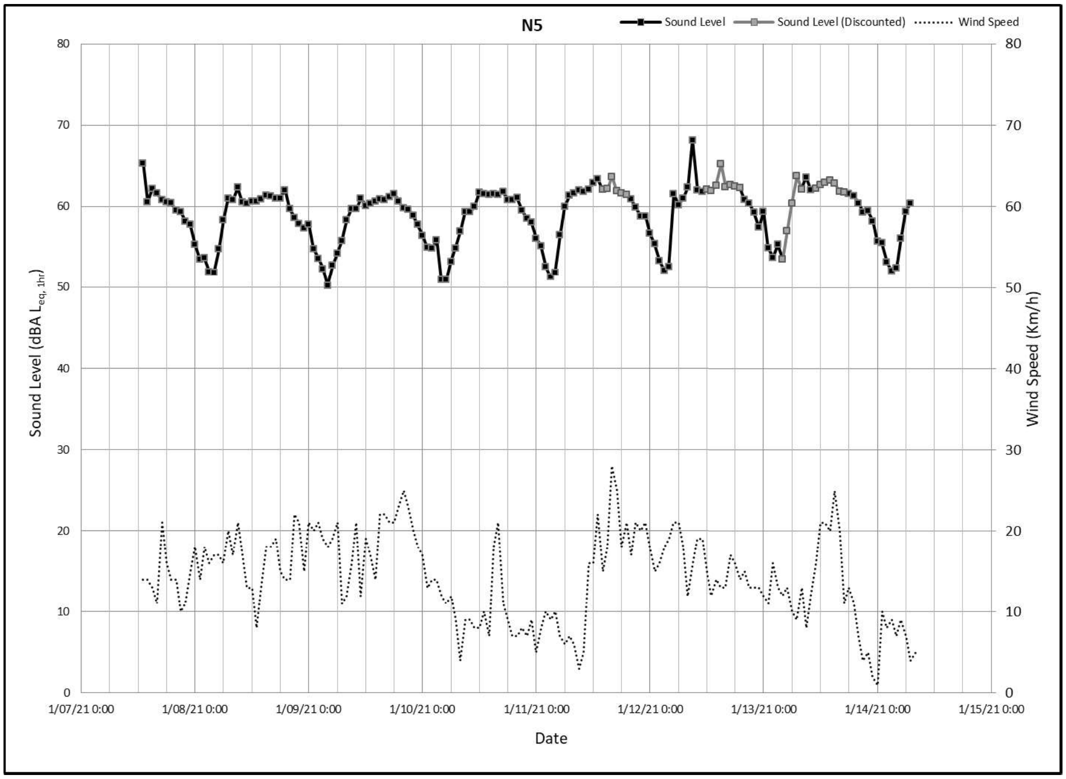
Noise Levels Measured at N1 – N22 (See Monitoring Locations in Appendix A)

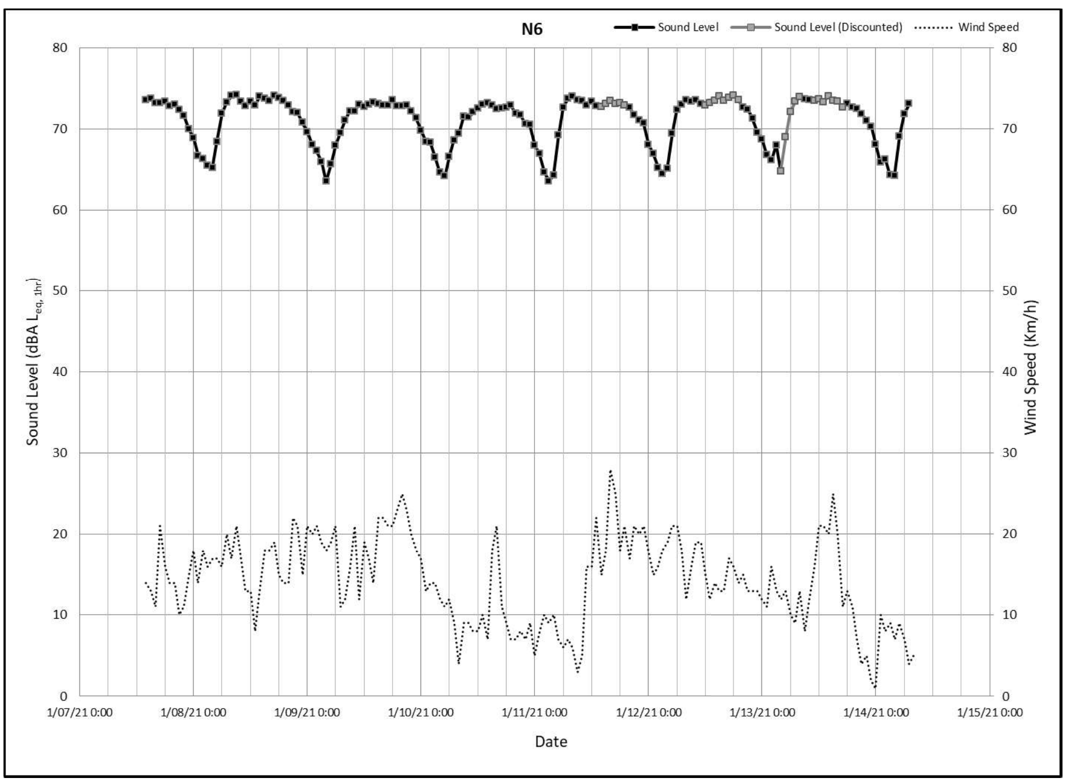


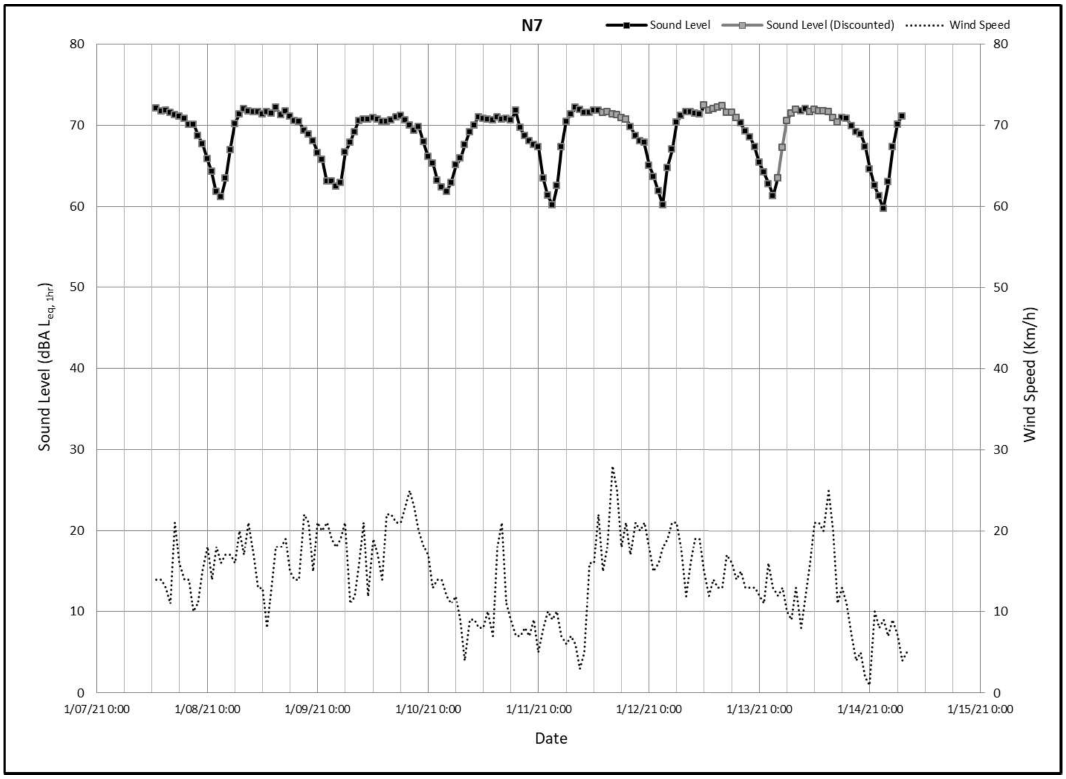


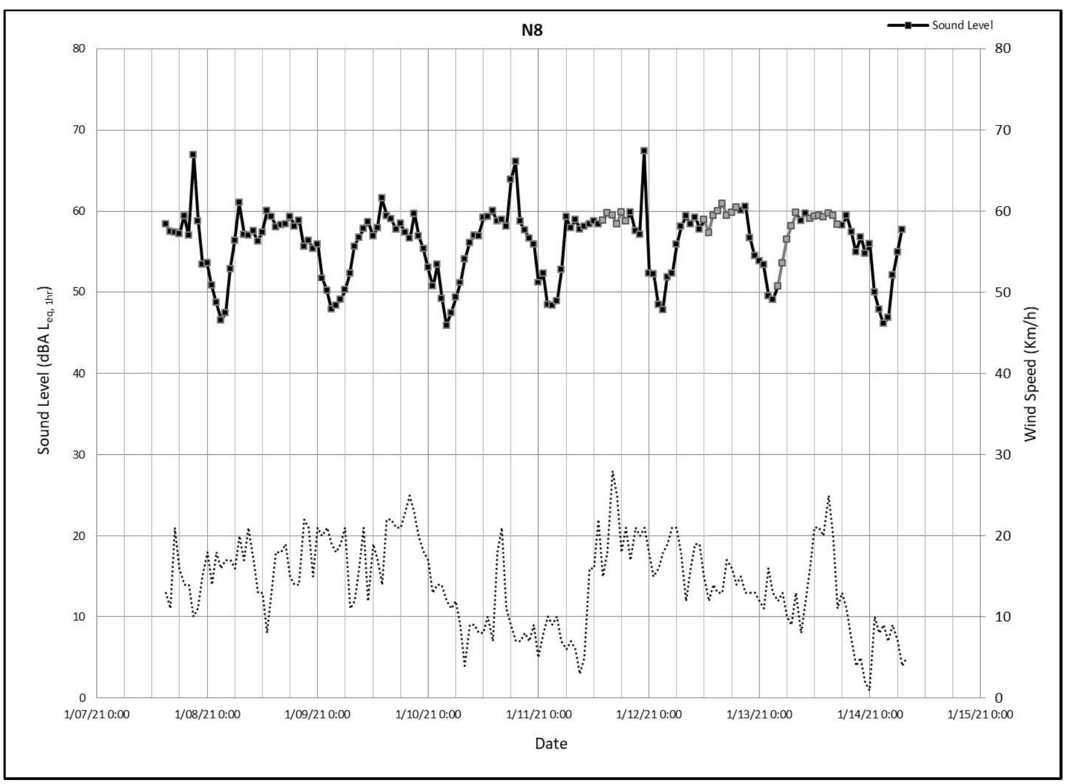

N3
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA Leq, 1hr)
Wind Speed (Km/h)
0
10
20
30
40
50
60
70
80
1/07/21 0:00
1/08/21 0:00
1/09/21 0:00
1/10/21 0:00
1/11/21 0:00
1/12/21 0:00
1/13/21 0:00
1/14/21 0:00
1/15/21 0:00
Date

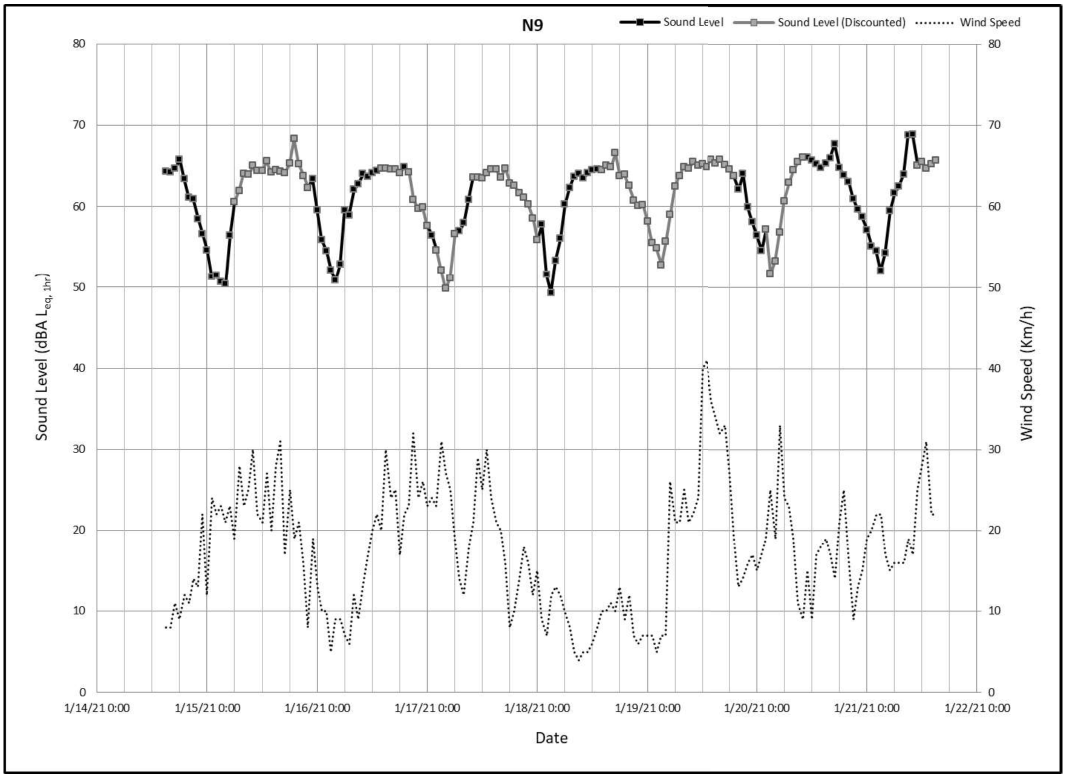

N4
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA Leq, 1hr)
Wind Speed (Km/h)
0
10
20
30
40
50
60
70
80
1/07/21 0:00
1/08/21 0:00
1/09/21 0:00
1/10/21 0:00
1/11/21 0:00
1/12/21 0:00
1/13/21 0:00
1/14/21 0:00
1/15/21 0:00
Date

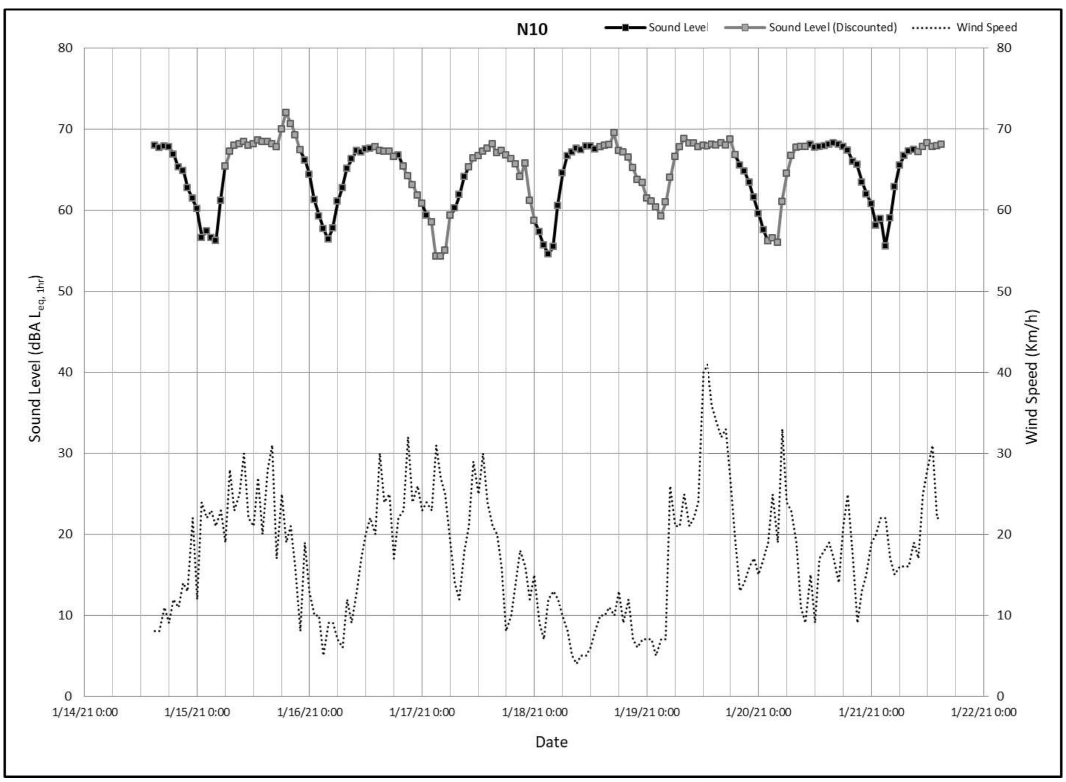

N5
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA $L_{eq, 1hr}$)
Wind Speed (Km/h)
1/07/21 0:00
1/08/21 0:00
1/09/21 0:00
1/10/21 0:00
1/11/21 0:00
1/12/21 0:00
1/13/21 0:00
1/14/21 0:00
1/15/21 0:00
Date

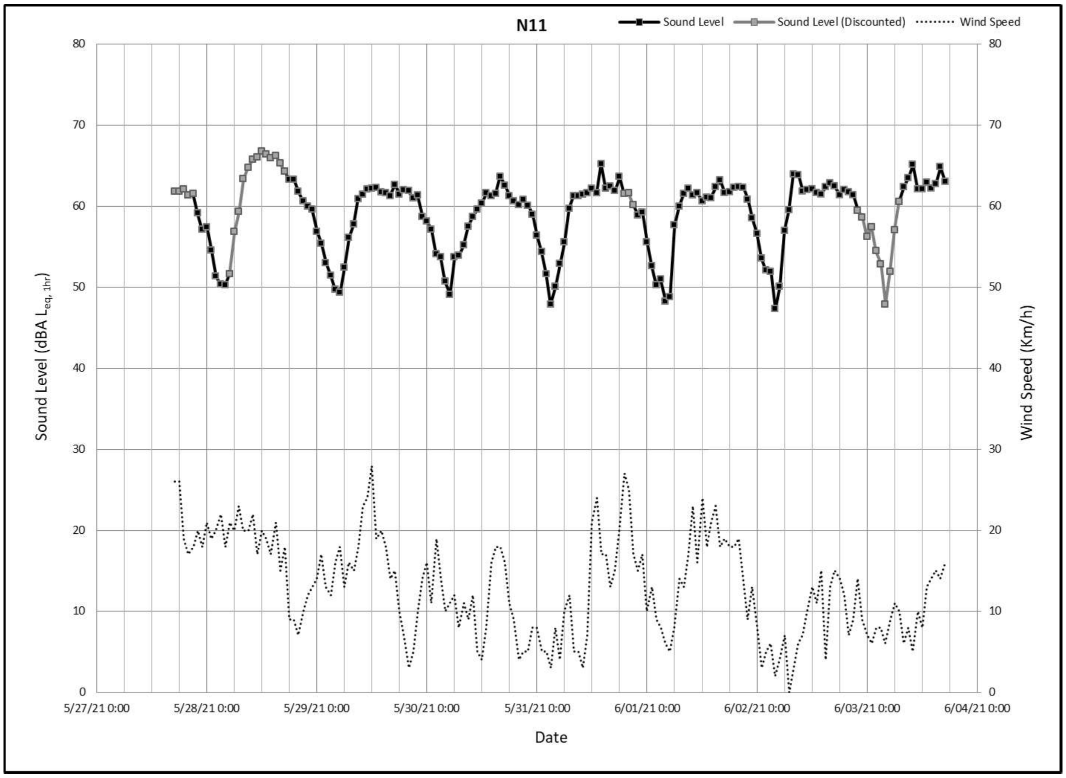

N6
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA $L_{eq, 1hr}$)
Wind Speed (Km/h)
1/07/21 0:00
1/08/21 0:00
1/09/21 0:00
1/10/21 0:00
1/11/21 0:00
1/12/21 0:00
1/13/21 0:00
1/14/21 0:00
1/15/21 0:00
Date

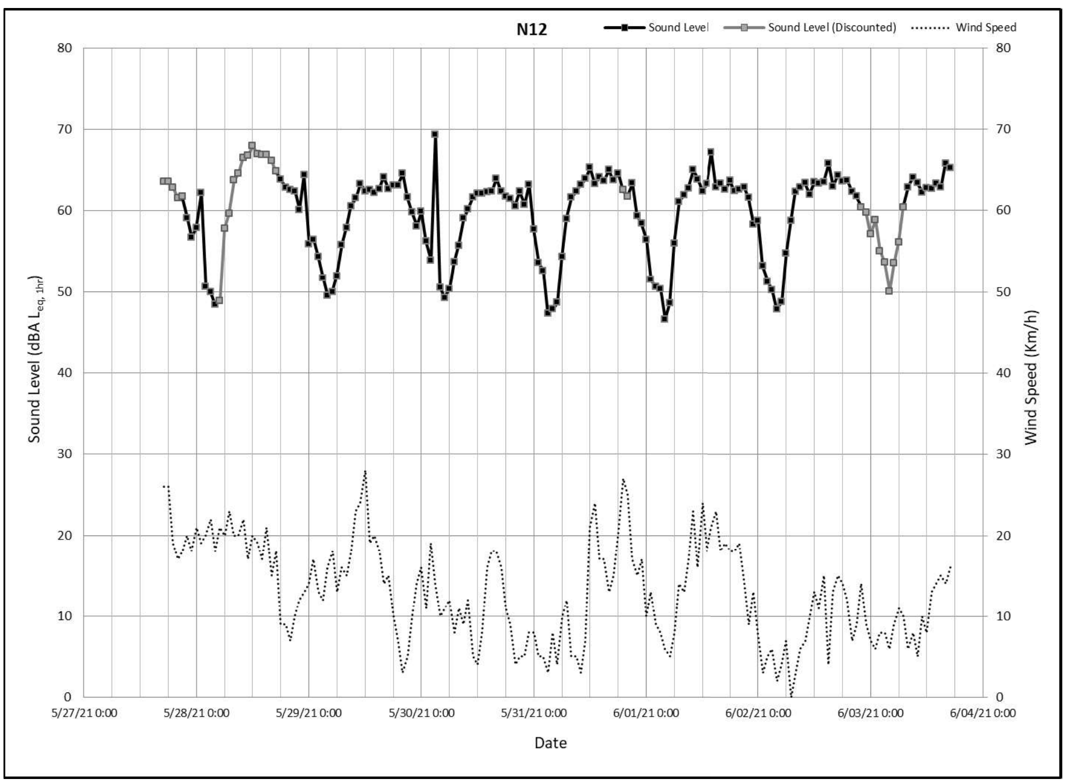

N7
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA L eq, 1hr)
Wind Speed (Km/h)
Date
1/07/21 0:00
1/08/21 0:00
1/09/21 0:00
1/10/21 0:00
1/11/21 0:00
1/12/21 0:00
1/13/21 0:00
1/14/21 0:00
1/15/21 0:00

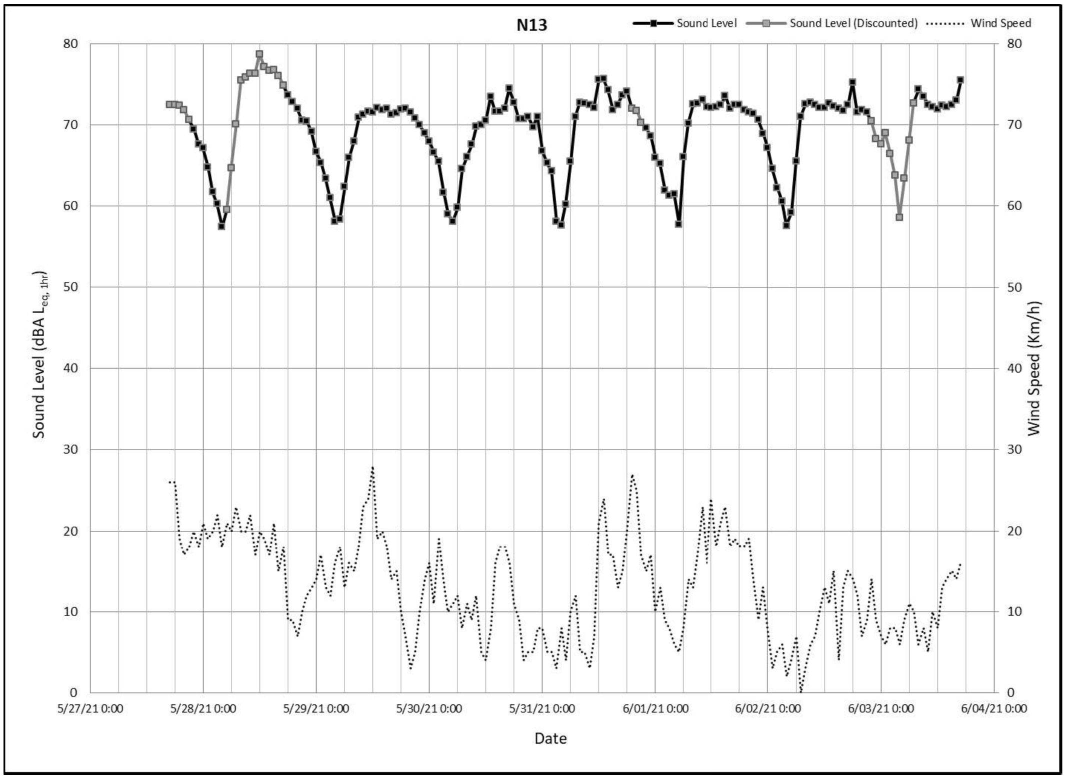

N8
Sound Level
Sound Level (dBA L eq, 1hr)
Wind Speed (Km/h)
Date
1/07/21 0:00
1/08/21 0:00
1/09/21 0:00
1/10/21 0:00
1/11/21 0:00
1/12/21 0:00
1/13/21 0:00
1/14/21 0:00
1/15/21 0:00

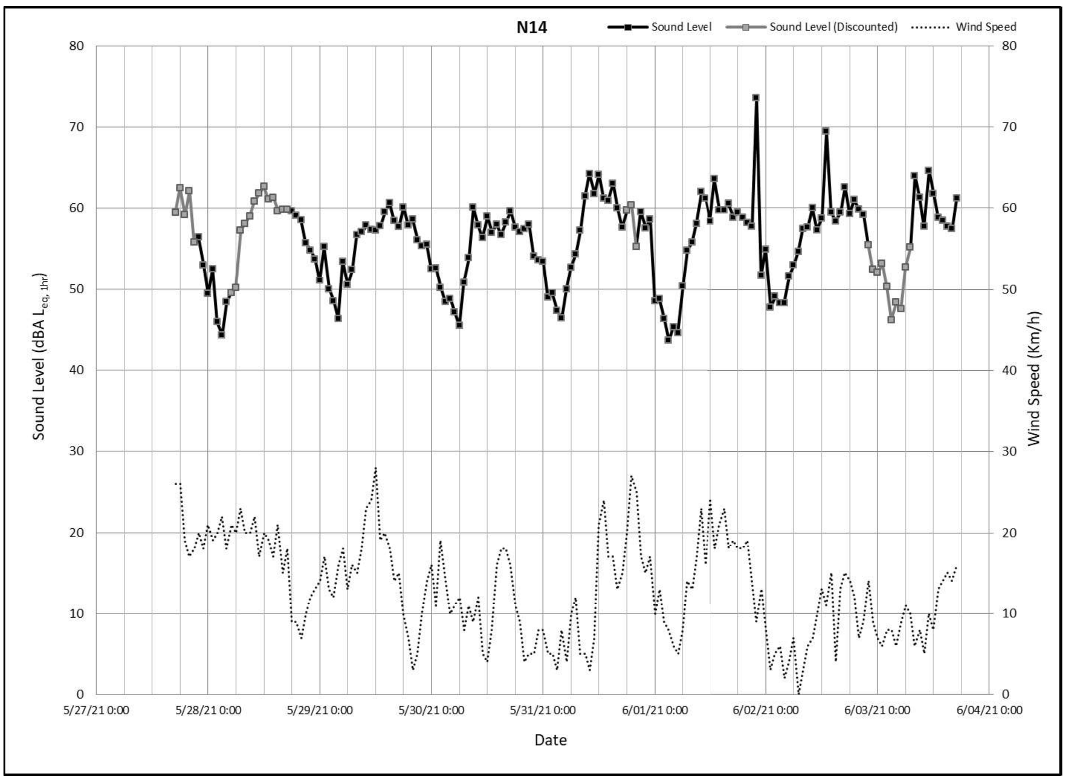

N9
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA Leq, 1hr)
Wind Speed (Km/h)
1/14/21 0:00
1/15/21 0:00
1/16/21 0:00
1/17/21 0:00
1/18/21 0:00
1/19/21 0:00
1/20/21 0:00
1/21/21 0:00
1/22/21 0:00
Date

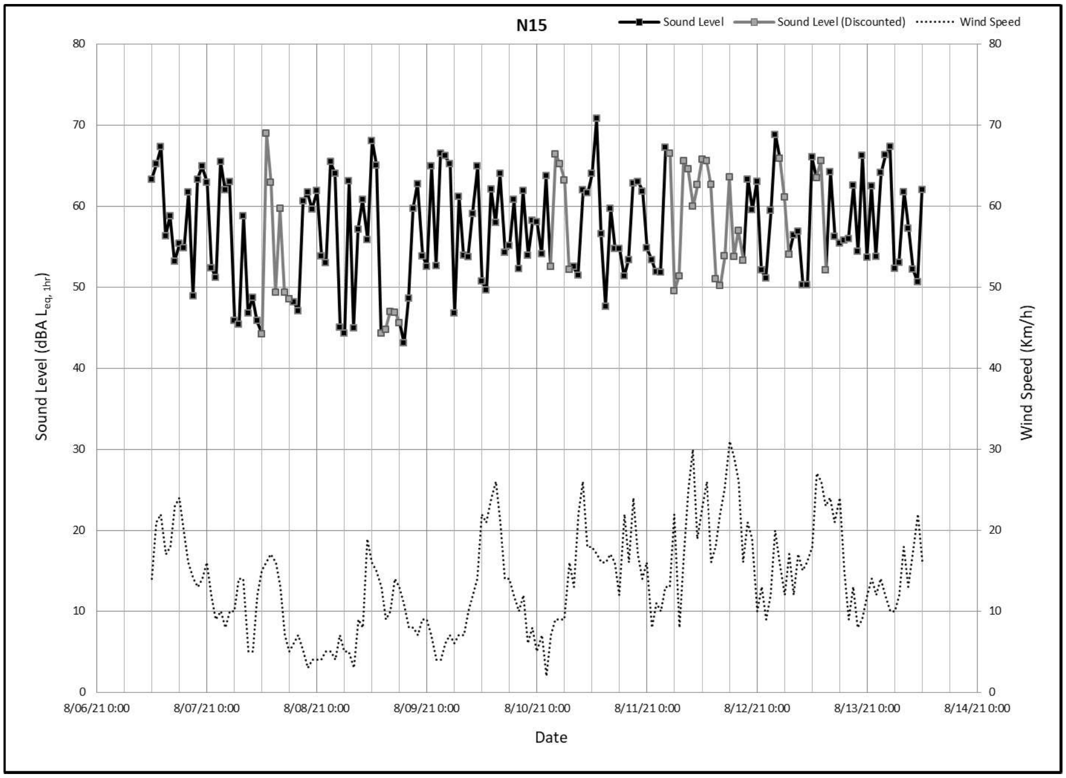

N10
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA Leq, 1hr)
Wind Speed (Km/h)
1/14/21 0:00
1/15/21 0:00
1/16/21 0:00
1/17/21 0:00
1/18/21 0:00
1/19/21 0:00
1/20/21 0:00
1/21/21 0:00
1/22/21 0:00
Date

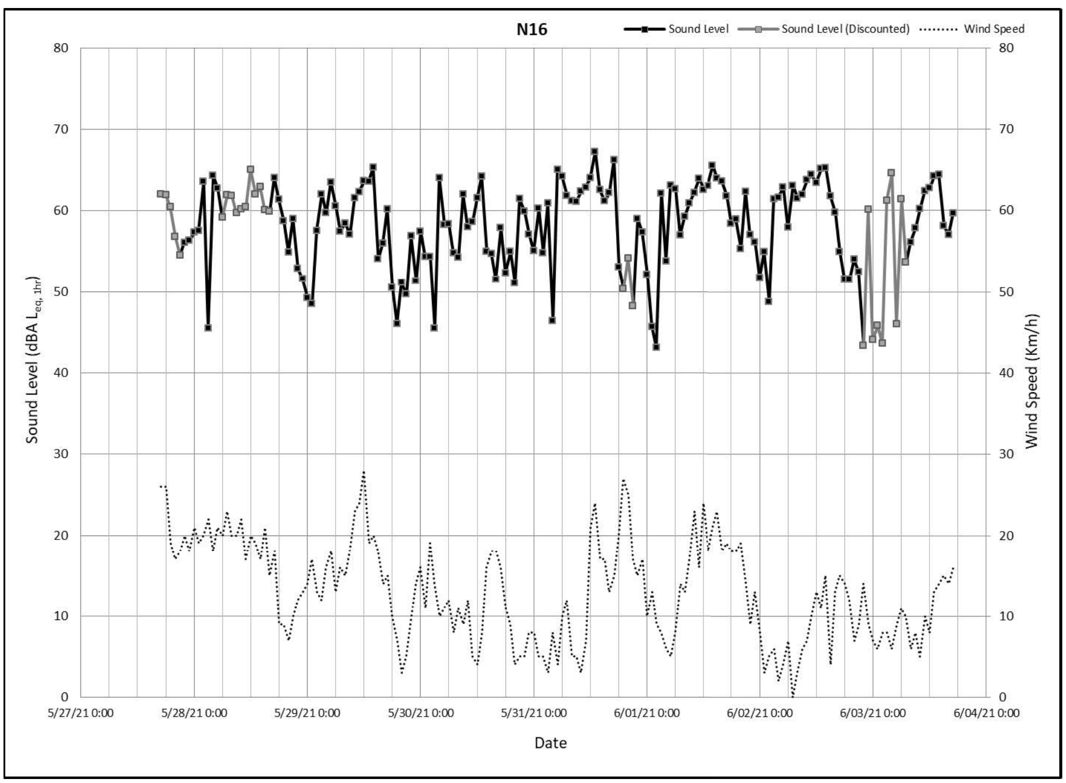

N11
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA $L_{eq,\ 1hr}$)
Wind Speed (Km/h)
0
10
20
30
40
50
60
70
80
5/27/21 0:00
5/28/21 0:00
5/29/21 0:00
5/30/21 0:00
5/31/21 0:00
6/01/21 0:00
6/02/21 0:00
6/03/21 0:00
6/04/21 0:00
Date

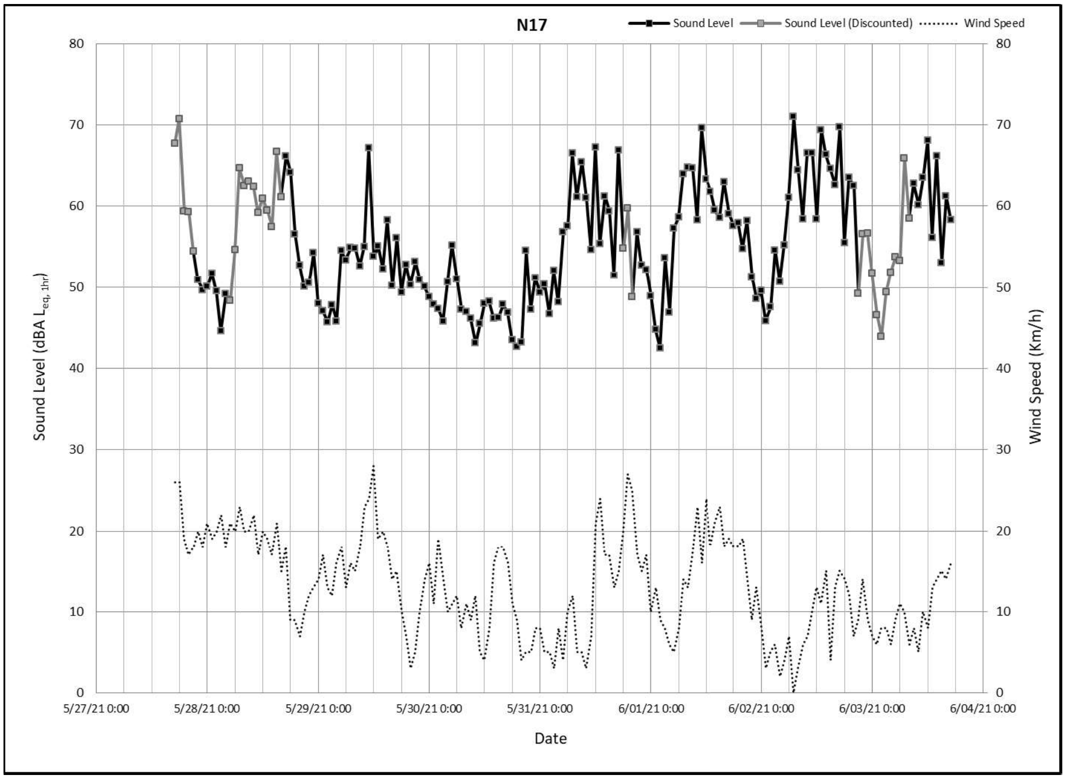

N12
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA $L_{eq,\ 1hr}$)
Wind Speed (Km/h)
0
10
20
30
40
50
60
70
80
5/27/21 0:00
5/28/21 0:00
5/29/21 0:00
5/30/21 0:00
5/31/21 0:00
6/01/21 0:00
6/02/21 0:00
6/03/21 0:00
6/04/21 0:00
Date

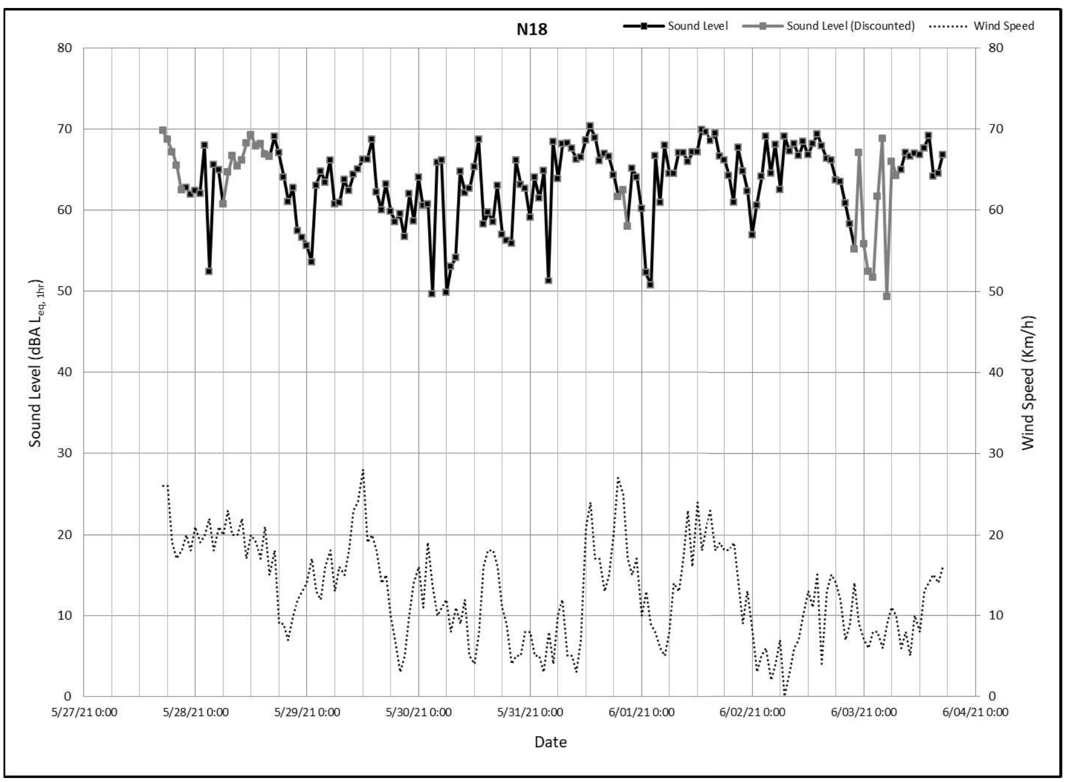

N13
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA Leq, 1hr)
Wind Speed (Km/h)
0
10
20
30
40
50
60
70
80
5/27/21 0:00
5/28/21 0:00
5/29/21 0:00
5/30/21 0:00
5/31/21 0:00
6/01/21 0:00
6/02/21 0:00
6/03/21 0:00
6/04/21 0:00
Date

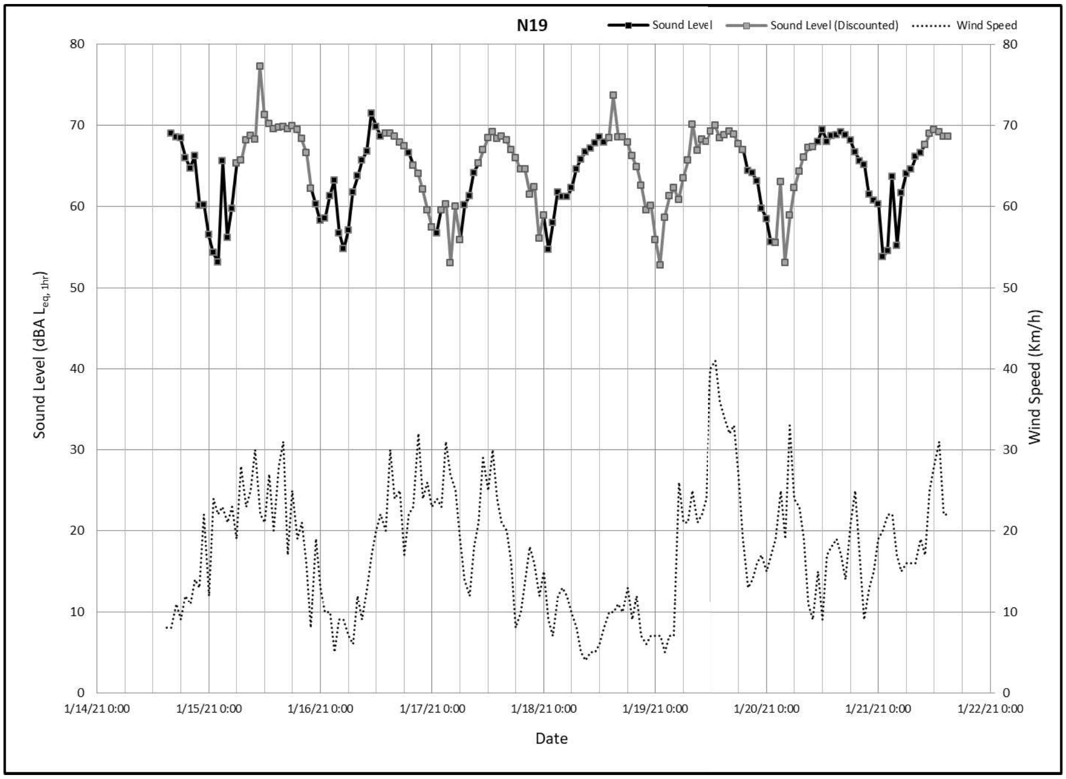

N14
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA Leq, 1hr)
Wind Speed (Km/h)
0
10
20
30
40
50
60
70
80
5/27/21 0:00
5/28/21 0:00
5/29/21 0:00
5/30/21 0:00
5/31/21 0:00
6/01/21 0:00
6/02/21 0:00
6/03/21 0:00
6/04/21 0:00
Date

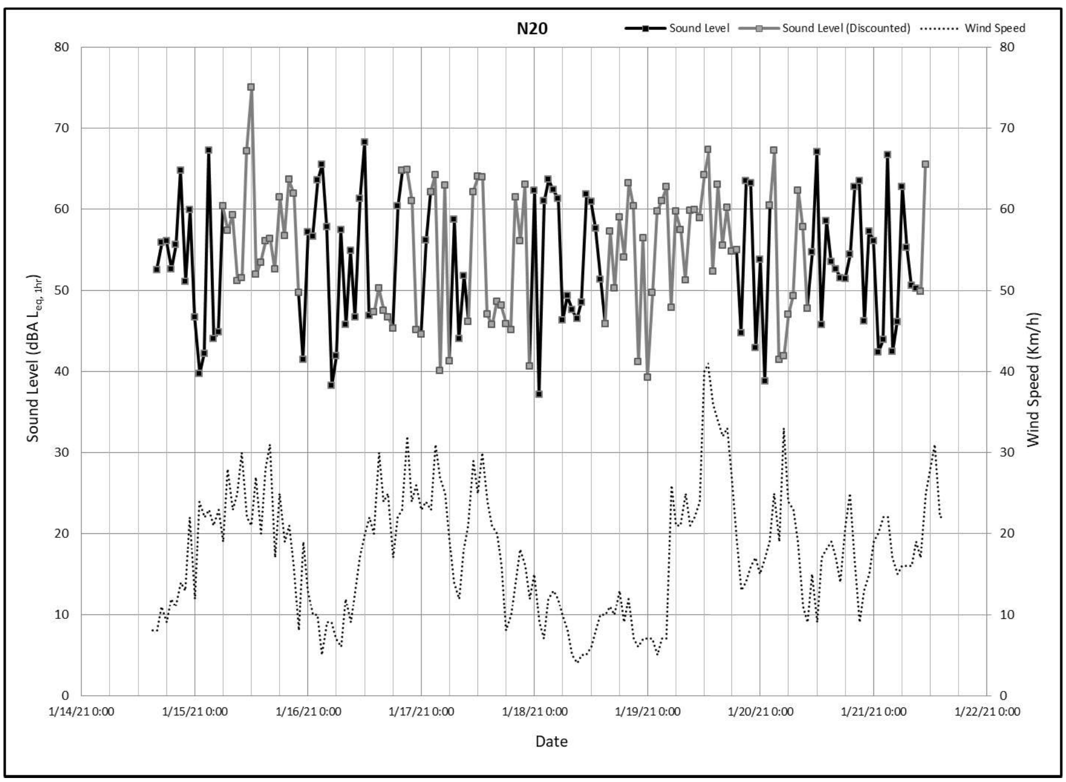

N15
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA $L_{eq, 1hr}$)
Wind Speed (Km/h)
8/06/21 0:00
8/07/21 0:00
8/08/21 0:00
8/09/21 0:00
8/10/21 0:00
8/11/21 0:00
8/12/21 0:00
8/13/21 0:00
8/14/21 0:00
Date

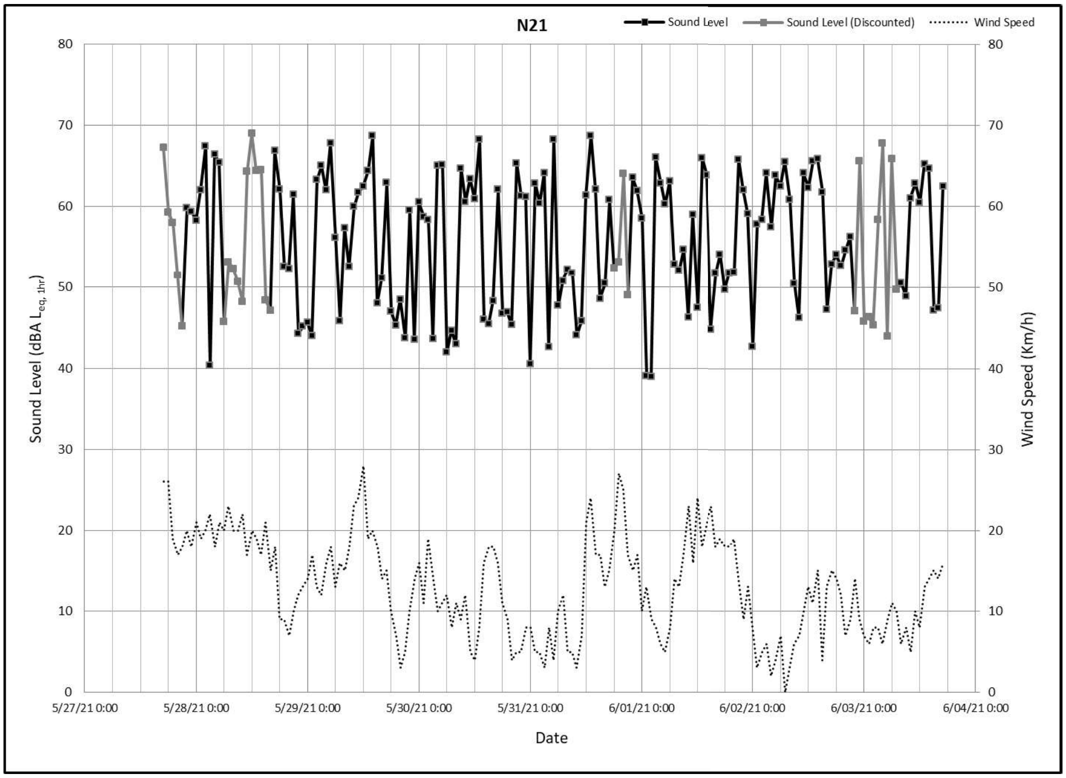

N16
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA $L_{eq, 1hr}$)
Wind Speed (Km/h)
5/27/21 0:00
5/28/21 0:00
5/29/21 0:00
5/30/21 0:00
5/31/21 0:00
6/01/21 0:00
6/02/21 0:00
6/03/21 0:00
6/04/21 0:00
Date


N17
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA L eq, 1hr)
Wind Speed (Km/h)
Date
5/27/21 0:00
5/28/21 0:00
5/29/21 0:00
5/30/21 0:00
5/31/21 0:00
6/01/21 0:00
6/02/21 0:00
6/03/21 0:00
6/04/21 0:00


N18
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA L eq, 1hr)
Wind Speed (Km/h)
Date
5/27/21 0:00
5/28/21 0:00
5/29/21 0:00
5/30/21 0:00
5/31/21 0:00
6/01/21 0:00
6/02/21 0:00
6/03/21 0:00
6/04/21 0:00


N19
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA $L_{eq, 1hr}$)
Wind Speed (Km/h)
Date
1/14/21 0:00
1/15/21 0:00
1/16/21 0:00
1/17/21 0:00
1/18/21 0:00
1/19/21 0:00
1/20/21 0:00
1/21/21 0:00
1/22/21 0:00


N20
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA $L_{eq, 1hr}$)
Wind Speed (Km/h)
Date
1/14/21 0:00
1/15/21 0:00
1/16/21 0:00
1/17/21 0:00
1/18/21 0:00
1/19/21 0:00
1/20/21 0:00
1/21/21 0:00
1/22/21 0:00


N21
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA Leq, 1hr)
Wind Speed (Km/h)
Date
5/27/21 0:00
5/28/21 0:00
5/29/21 0:00
5/30/21 0:00
5/31/21 0:00
6/01/21 0:00
6/02/21 0:00
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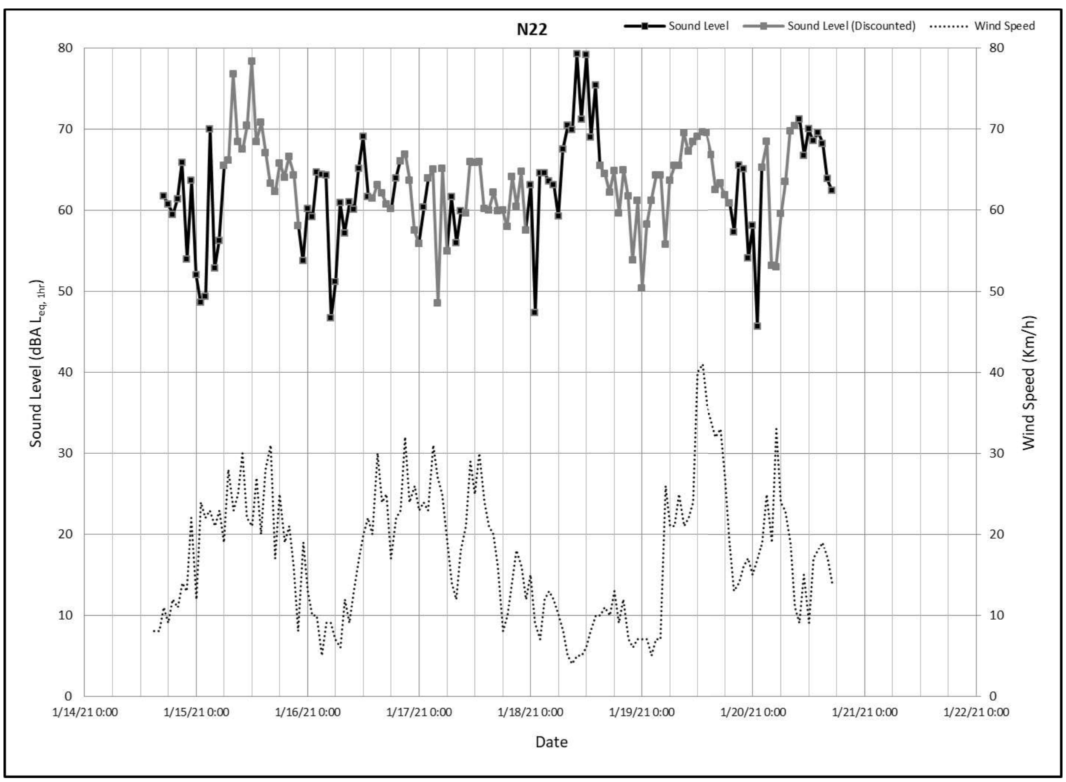
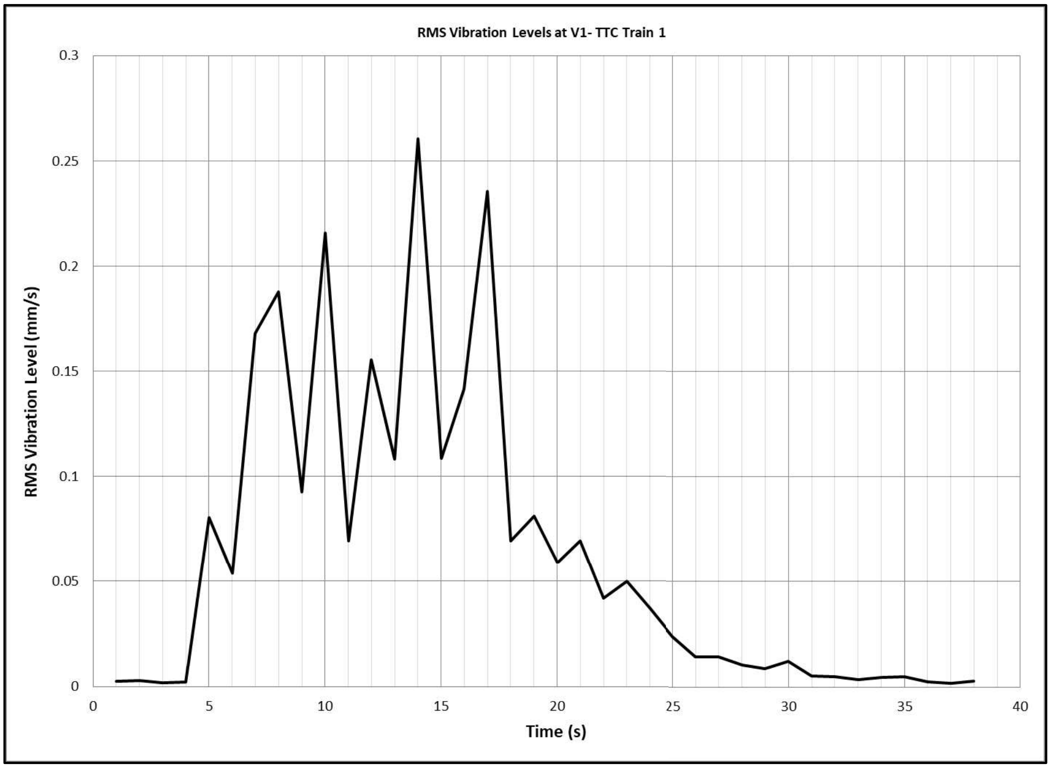
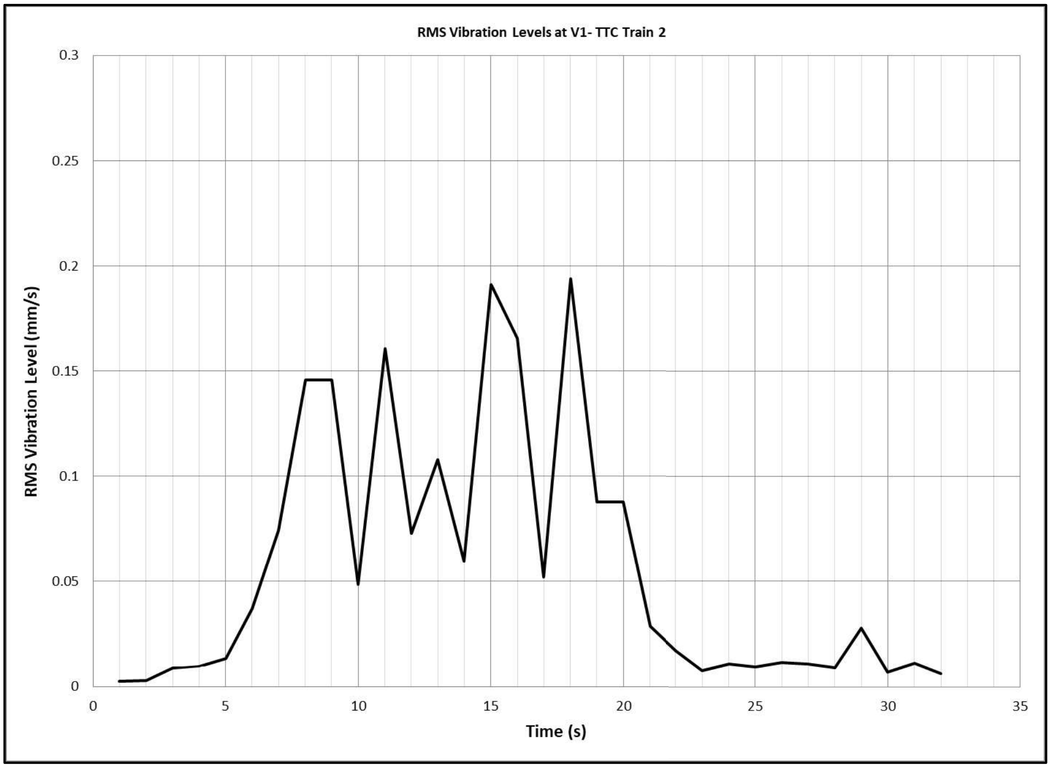
6/04/21 0:00


N22
Sound Level
Sound Level (Discounted)
Wind Speed
Sound Level (dBA Leq, 1hr)
Wind Speed (Km/h)
Date
1/14/21 0:00
1/15/21 0:00
1/16/21 0:00
1/17/21 0:00
1/18/21 0:00
1/19/21 0:00
1/20/21 0:00
1/21/21 0:00
1/22/21 0:00

Vibration Levels Measured at V1 – V7 (See Monitoring Locations in Appendix A)




RMS Vibration Levels at V1- TTC Train 2
RMS Vibration Level (mm/s)
Time (s)
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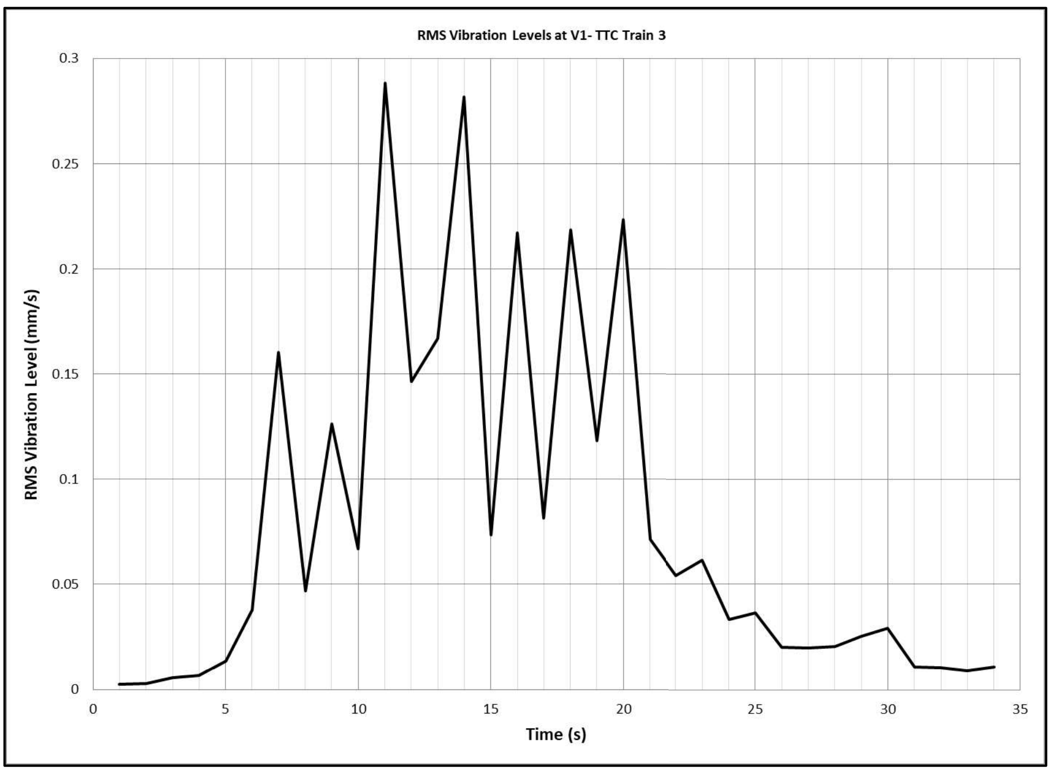
0.05
0.1
0.15
0.2
0.25
0.3
0
5
10
15
20
25
30
35


RMS Vibration Levels at V1- TTC Train 3
RMS Vibration Level (mm/s)
Time (s)
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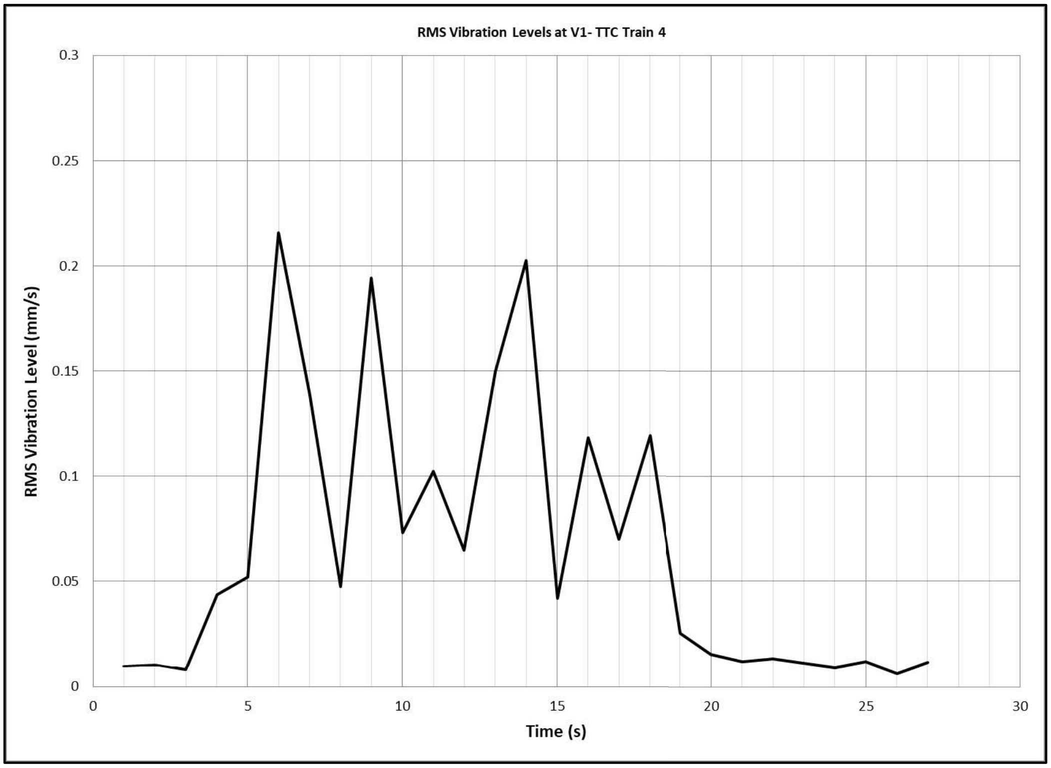
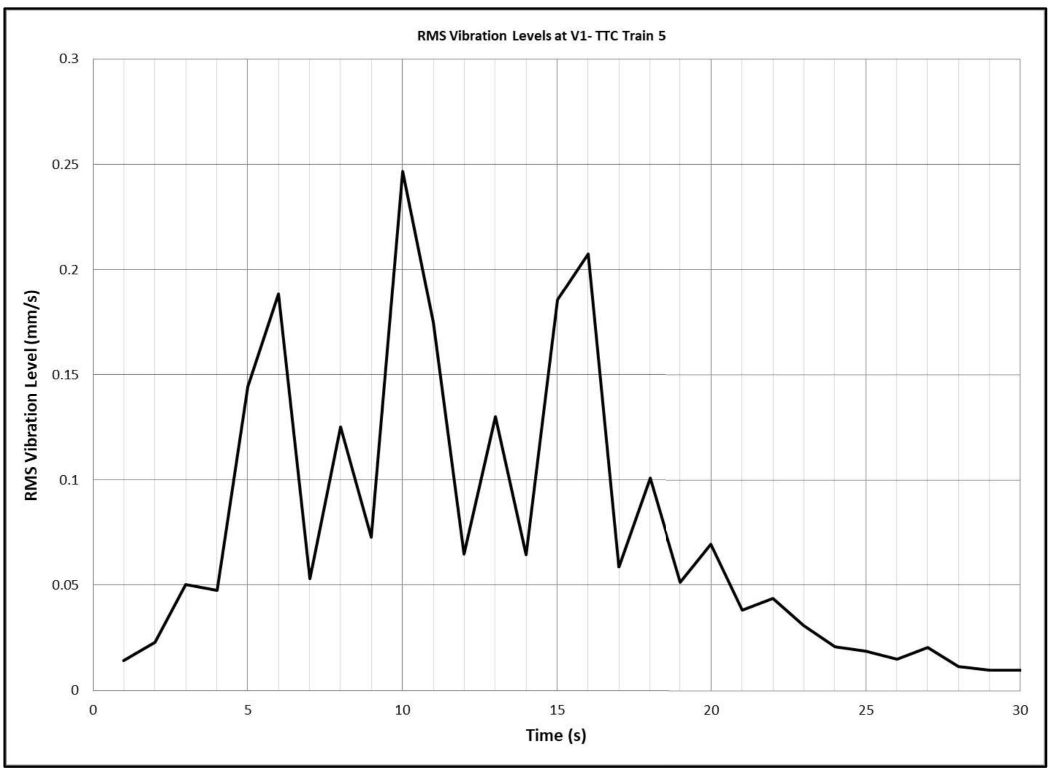
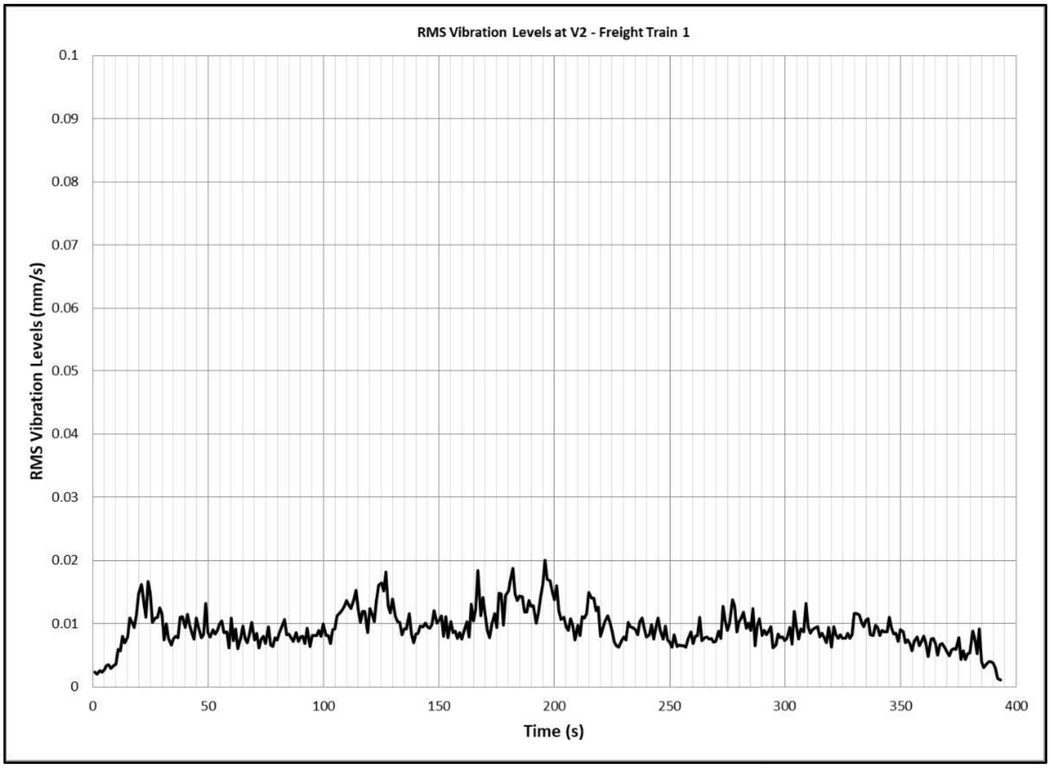
0.15
0.2
0.25
0.3
0
5
10
15
20
25
30
35


RMS Vibration Levels at V1- TTC Train 4
RMS Vibration Level (mm/s)
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20
25
30
Time (s)


RMS Vibration Levels at V1- TTC Train 5
RMS Vibration Level (mm/s)
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20
25
30
Time (s)


RMS Vibration Levels at V2 - Freight Train 1
RMS Vibration Levels (mm/s)
Time (s)
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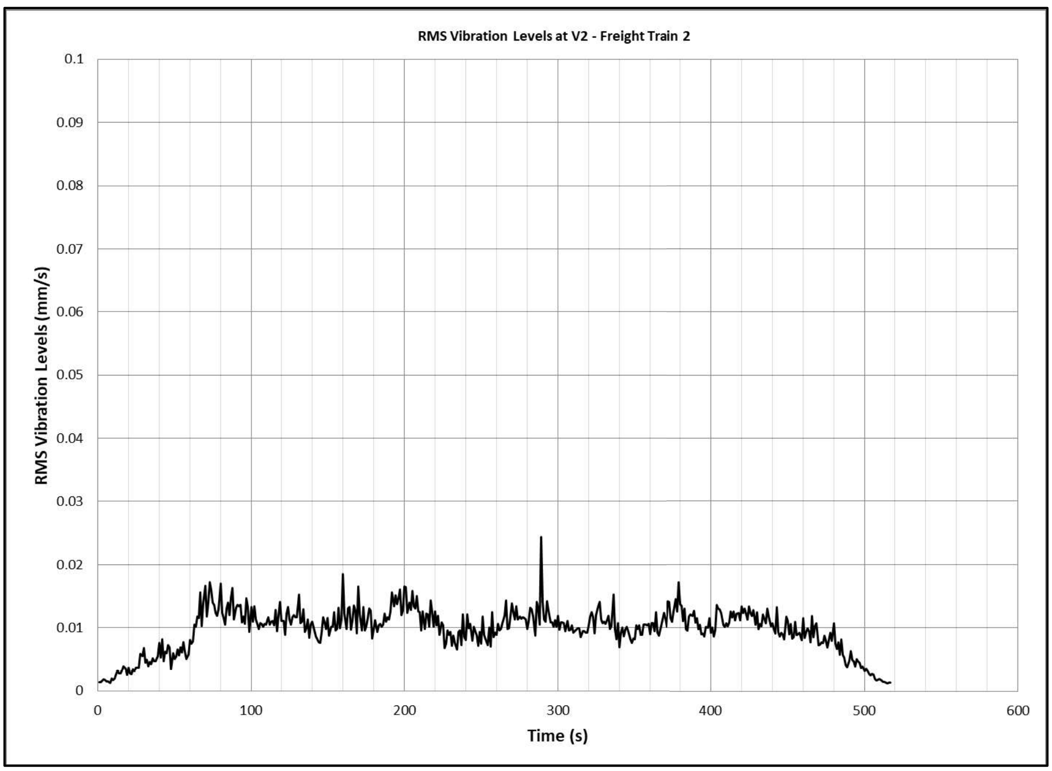
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0
50
100
150
200
250
300
350
400


RMS Vibration Levels at V2 - Freight Train 2
RMS Vibration Levels (mm/s)
Time (s)
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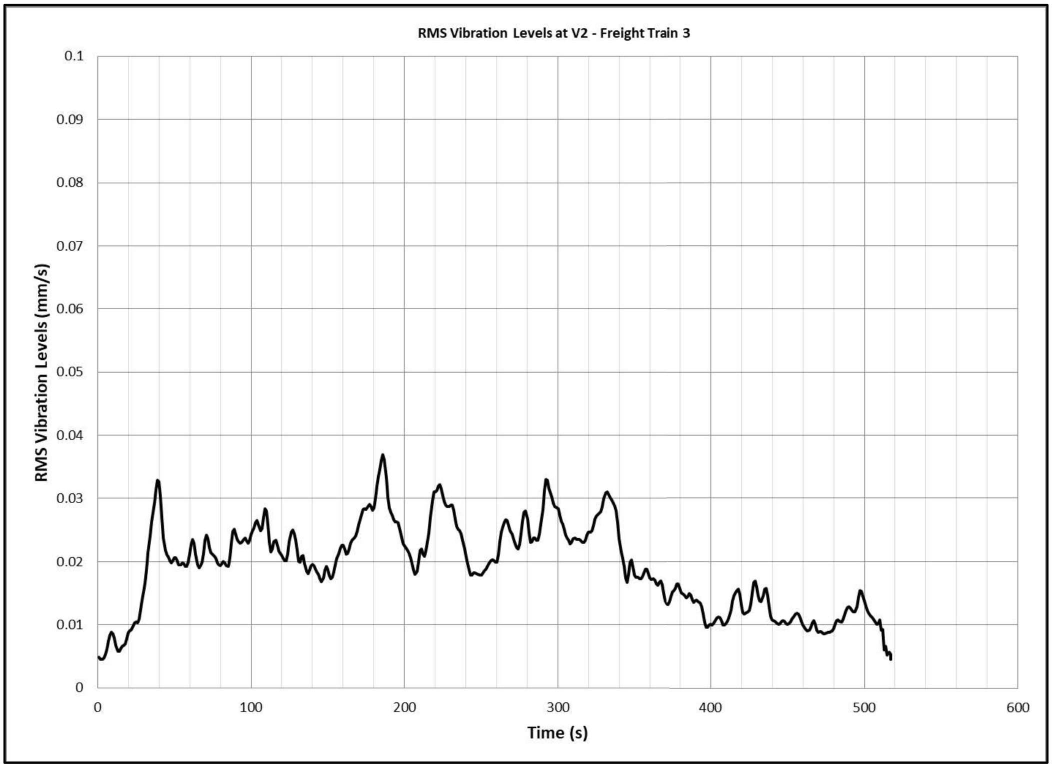
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0
100
200
300
400
500
600


RMS Vibration Levels at V2 - Freight Train 3
RMS Vibration Levels (mm/s)
Time (s)
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0.01
0.02
0.03
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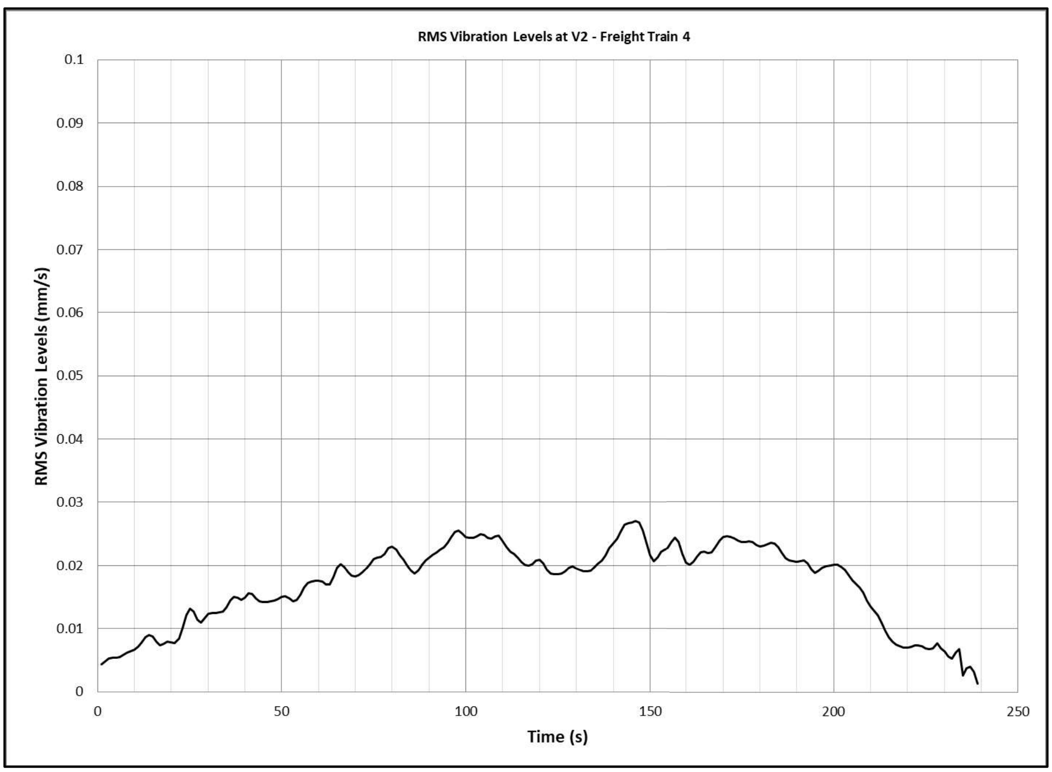
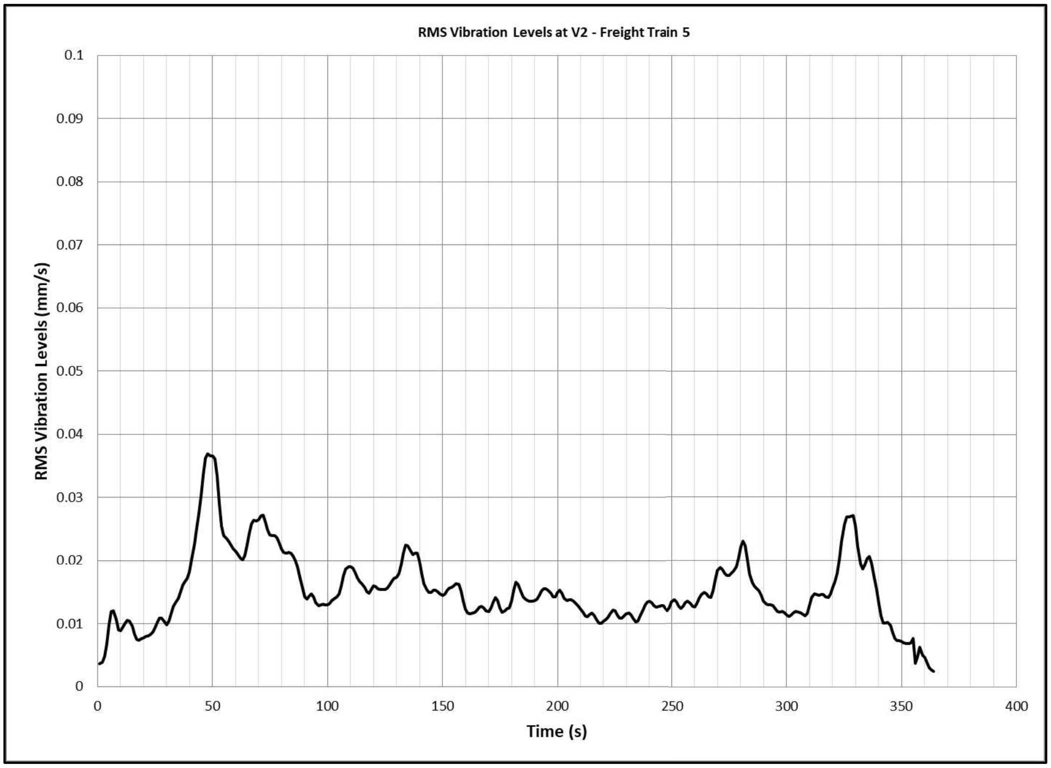
0.05
0.06
0.07
0.08
0.09
0.1
100
200
300
400
500
600


RMS Vibration Levels at V2 - Freight Train 4
RMS Vibration Levels (mm/s)
Time (s)
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
50
100
150
200
250


RMS Vibration Levels at V2 - Freight Train 5
RMS Vibration Levels (mm/s)
Time (s)
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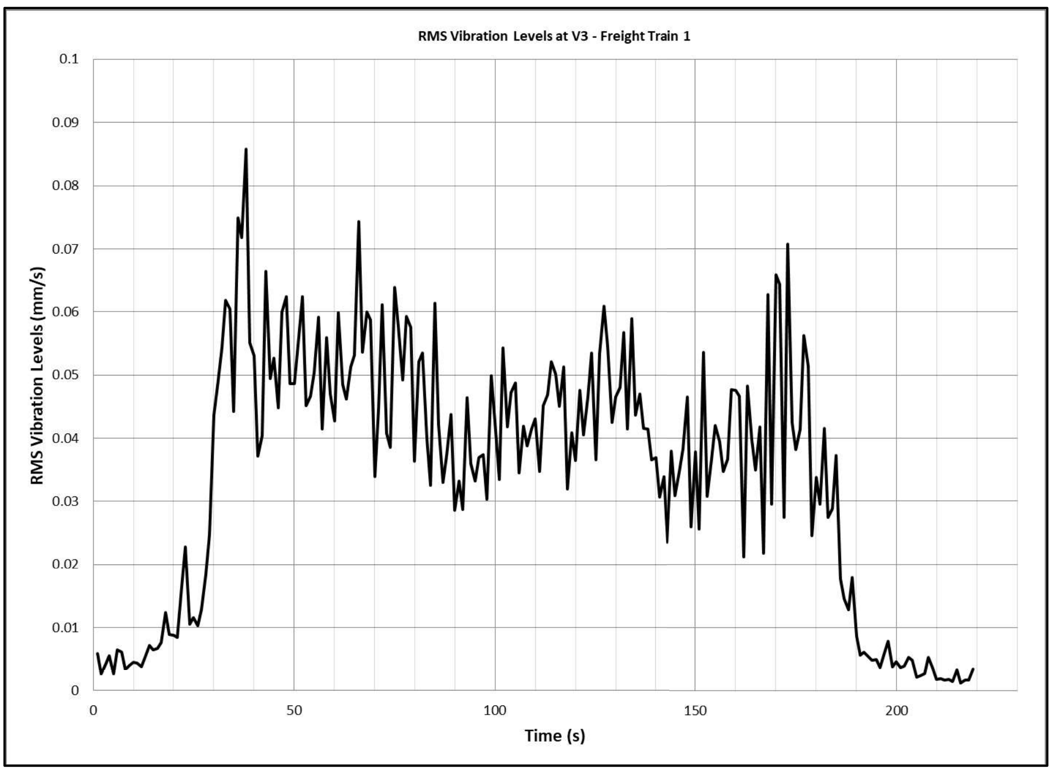
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0
50
100
150
200
250
300
350
400


RMS Vibration Levels at V3 - Freight Train 1
RMS Vibration Levels (mm/s)
Time (s)
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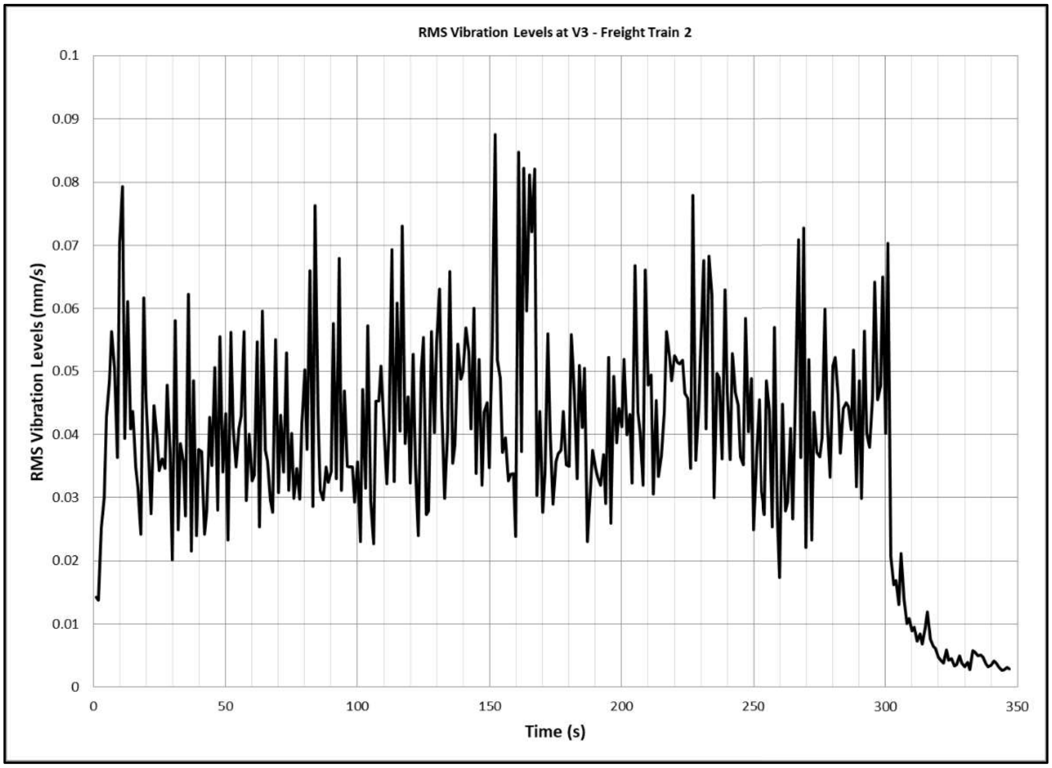
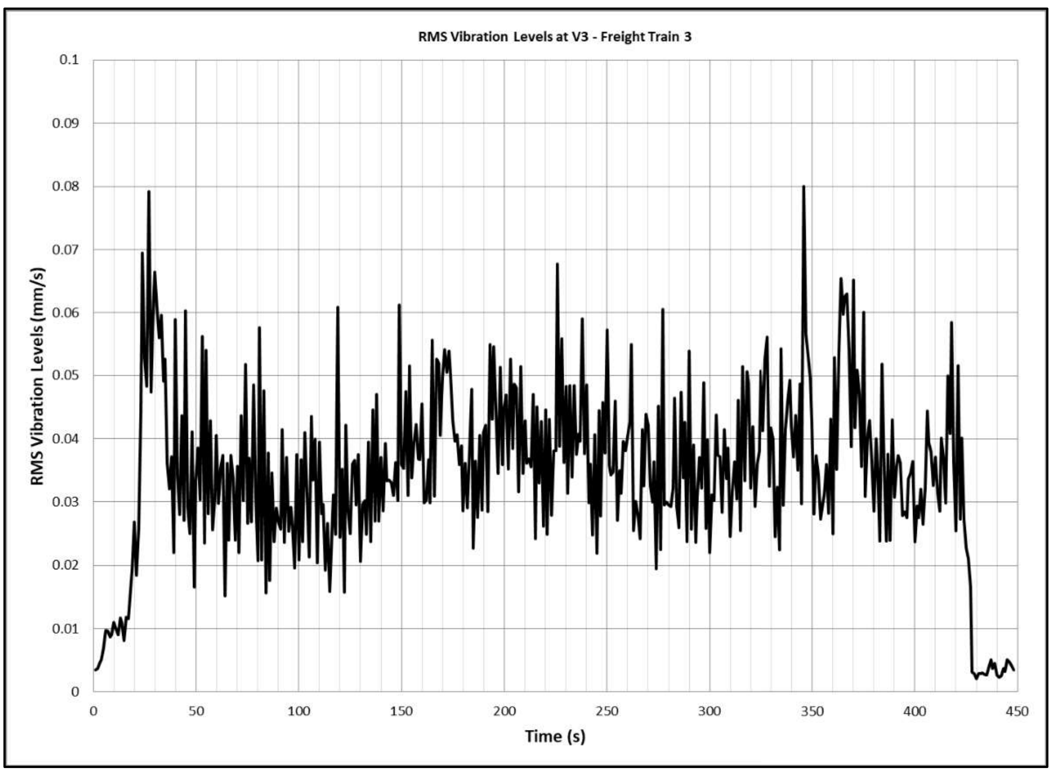
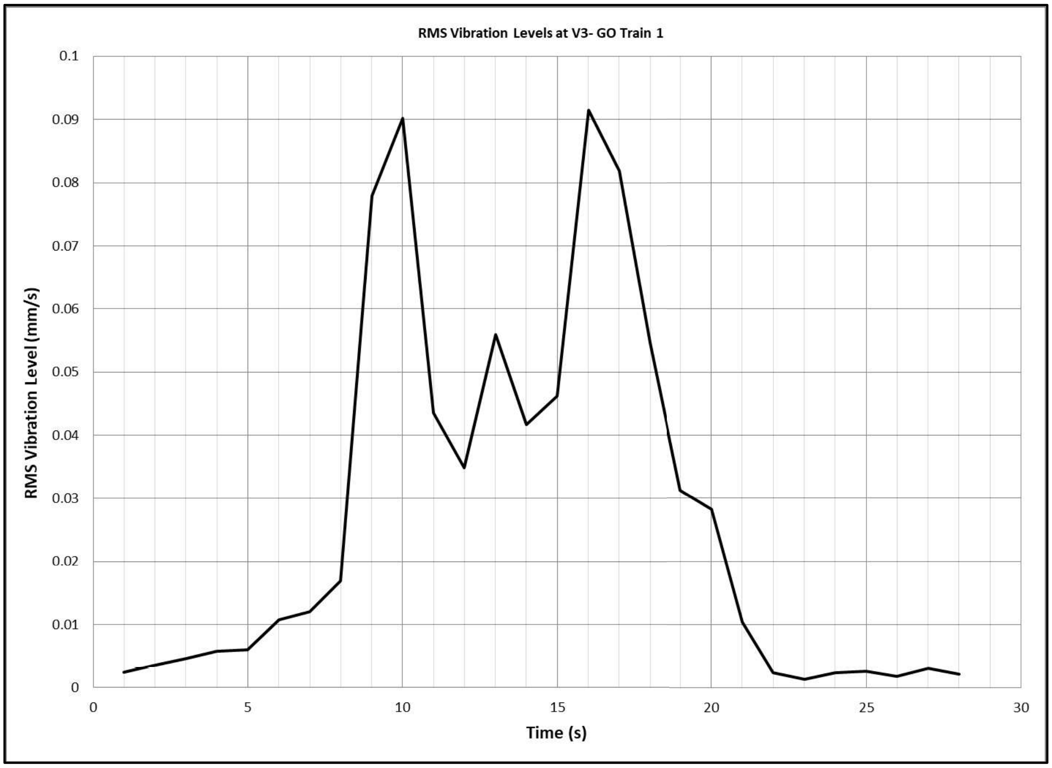
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0
50
100
150
200


RMS Vibration Levels at V3 - Freight Train 2
RMS Vibration Levels (mm/s)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
50
100
150
200
250
300
350
Time (s)

1


RMS Vibration Levels at V3 - Freight Train 3
RMS Vibration Levels (mm/s)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
50
100
150
200
250
300
350
400
450
Time (s)


RMS Vibration Levels at V3- GO Train 1
RMS Vibration Level (mm/s)
0.1
0.09
0.08
0.07
0.06
0.05
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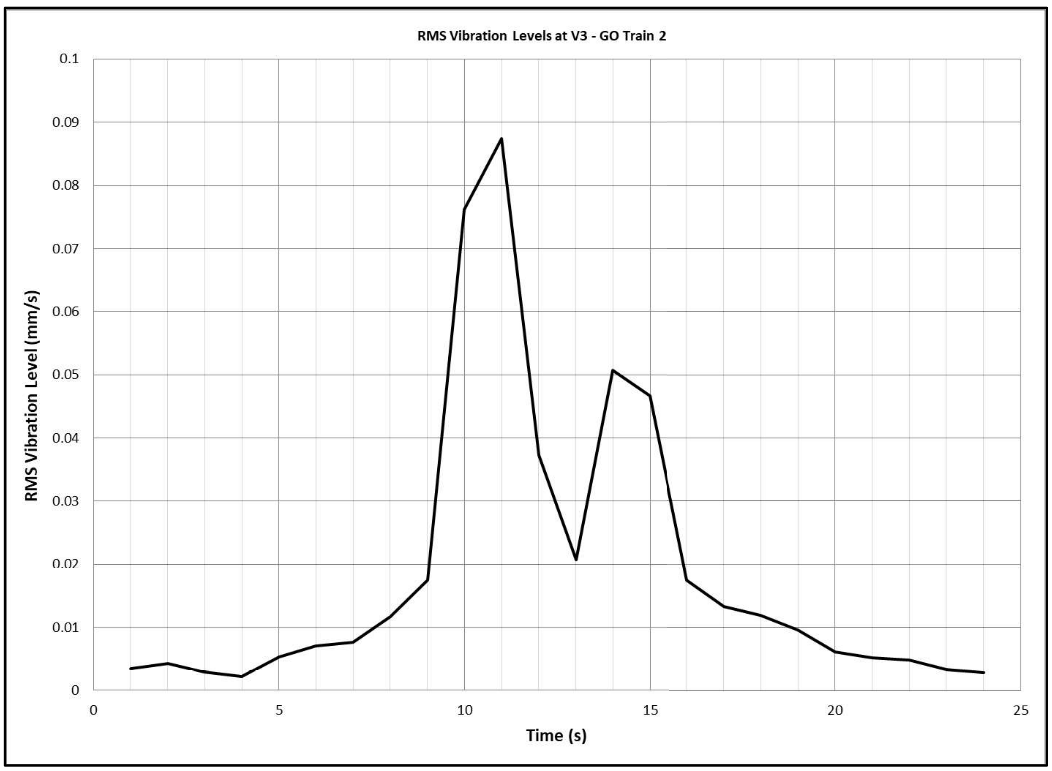
10
15
20
25
30
Time (s)


RMS Vibration Levels at V3 - GO Train 2
RMS Vibration Level (mm/s)
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0.09
0.08
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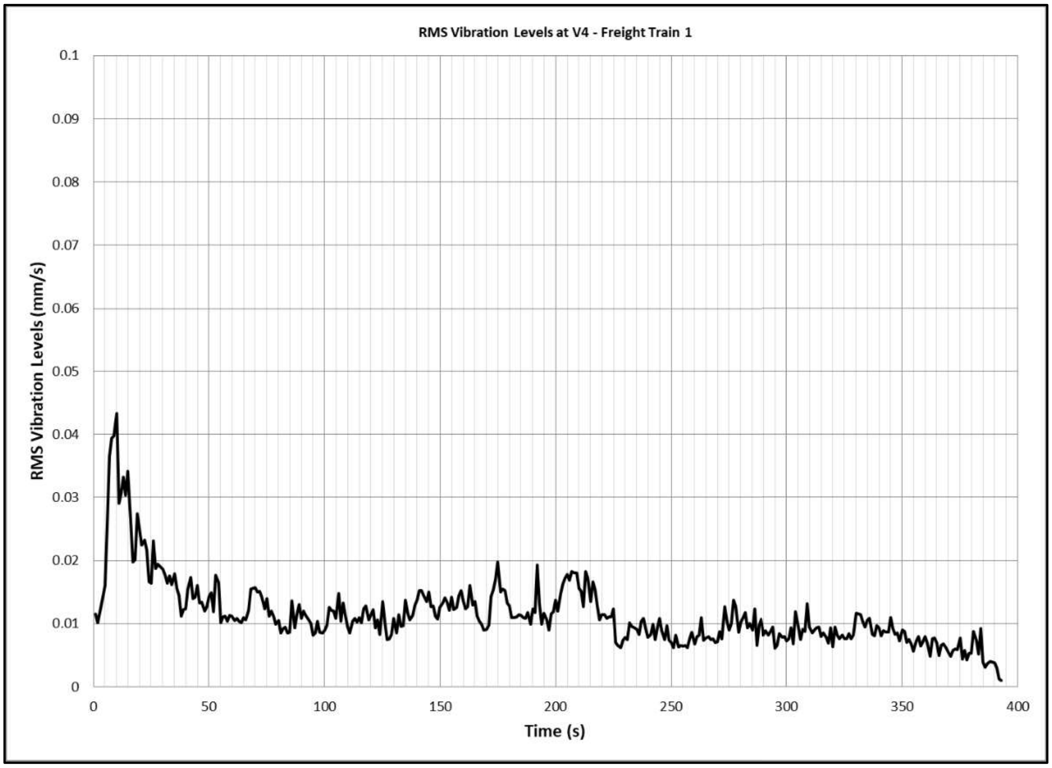
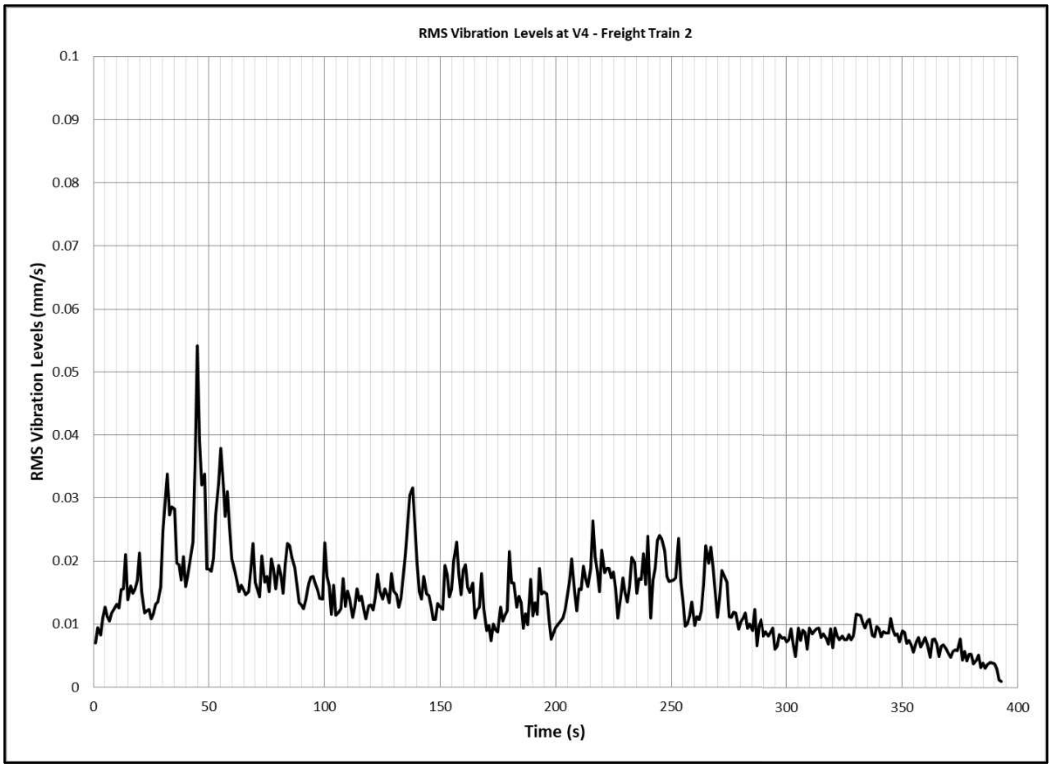
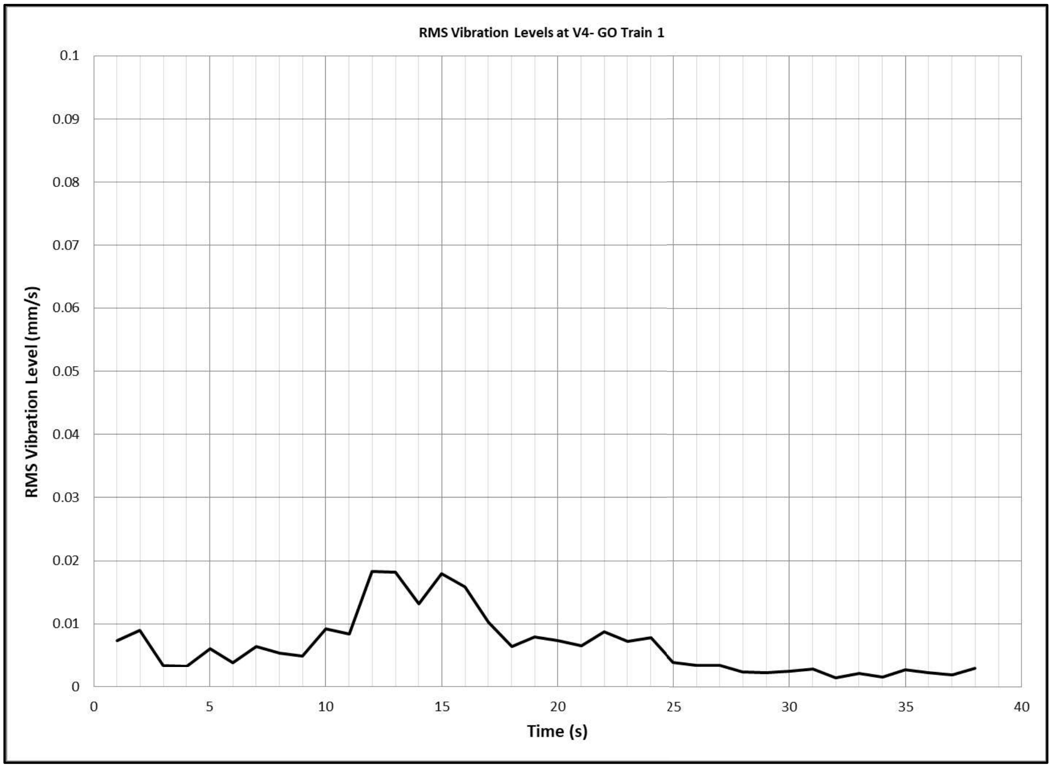
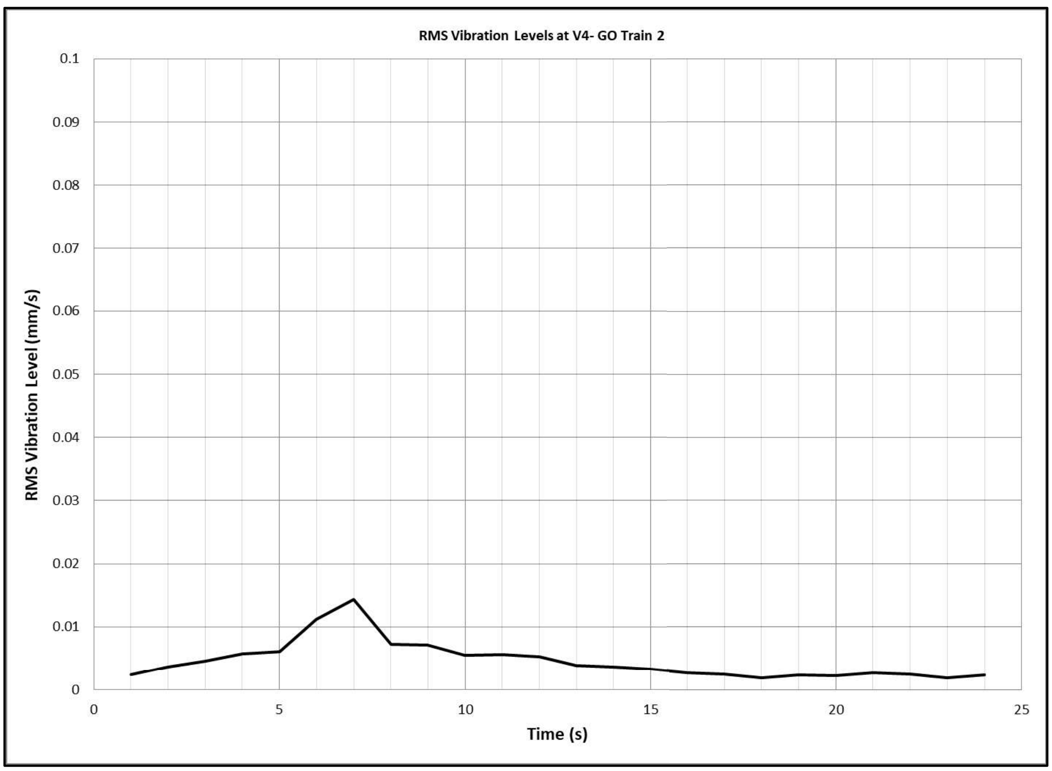
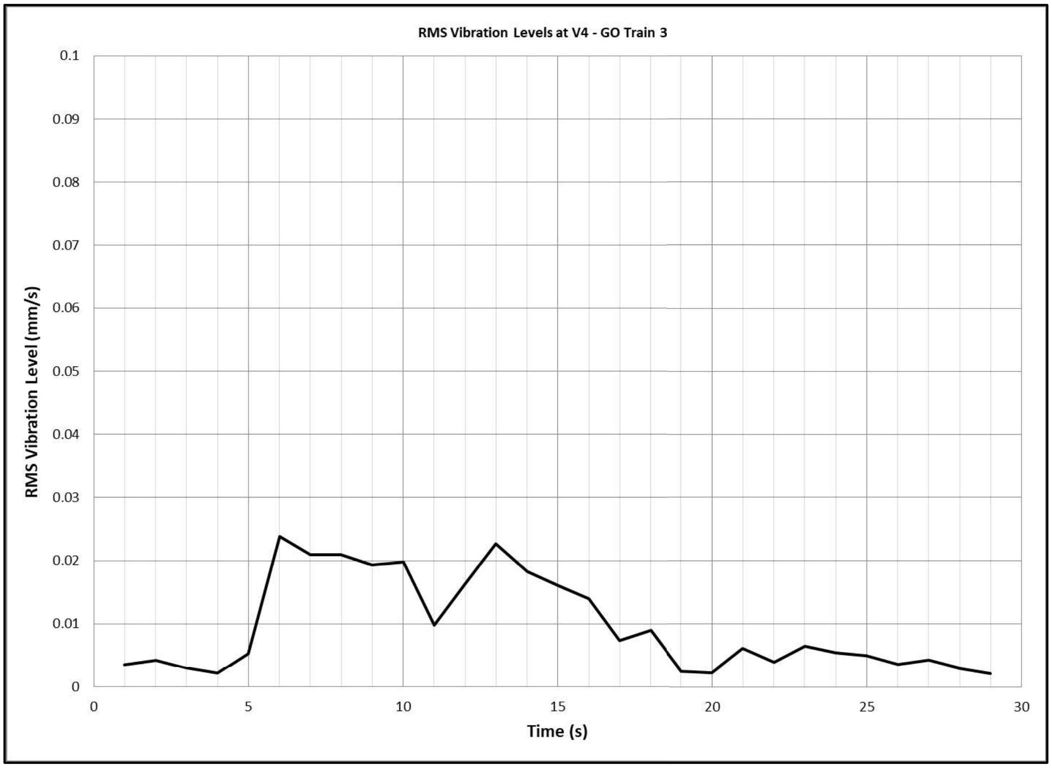
0.03
0.02
0.01
0
0
5
10
15
20
25
Time (s)


RMS Vibration Levels at V4 - Freight Train 1
RMS Vibration Levels (mm/s)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
50
100
150
200
250
300
350
400
Time (s)


RMS Vibration Levels at V4 - Freight Train 2
RMS Vibration Levels (mm/s)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
50
100
150
200
250
300
350
400
Time (s)


RMS Vibration Levels at V4- GO Train 1
RMS Vibration Level (mm/s)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
5
10
15
20
25
30
35
40
Time (s)


RMS Vibration Levels at V4- GO Train 2
RMS Vibration Level (mm/s)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
5
10
15
20
25
Time (s)


RMS Vibration Levels at V4 - GO Train 3
RMS Vibration Level (mm/s)
Time (s)
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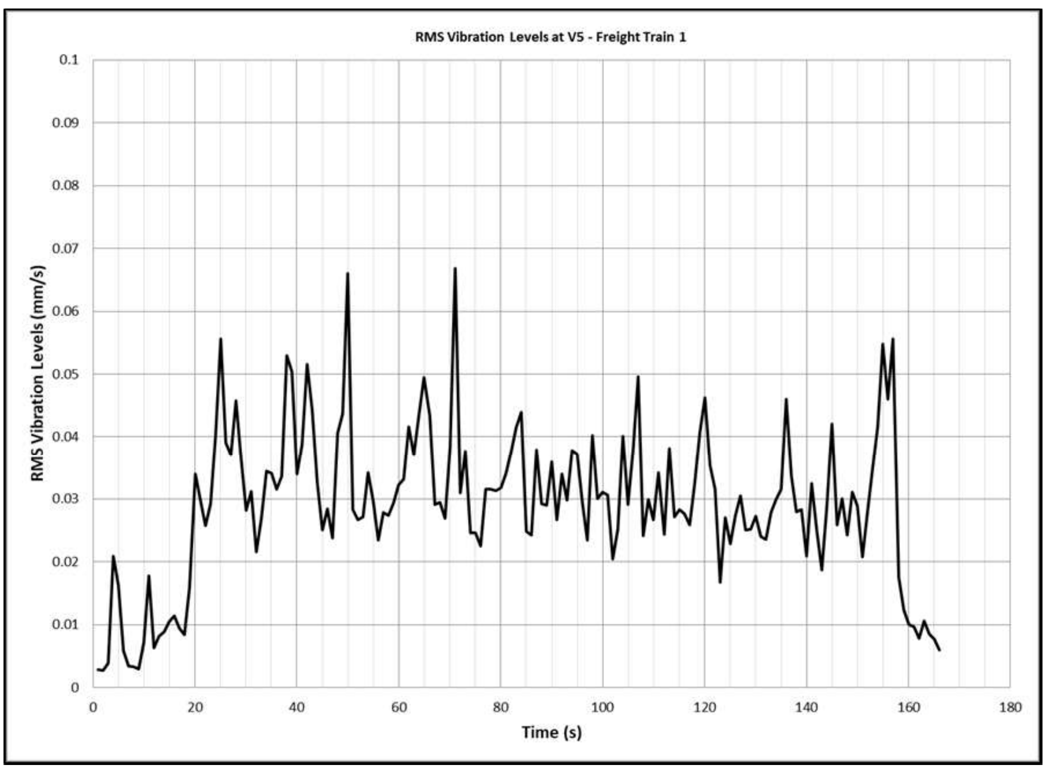
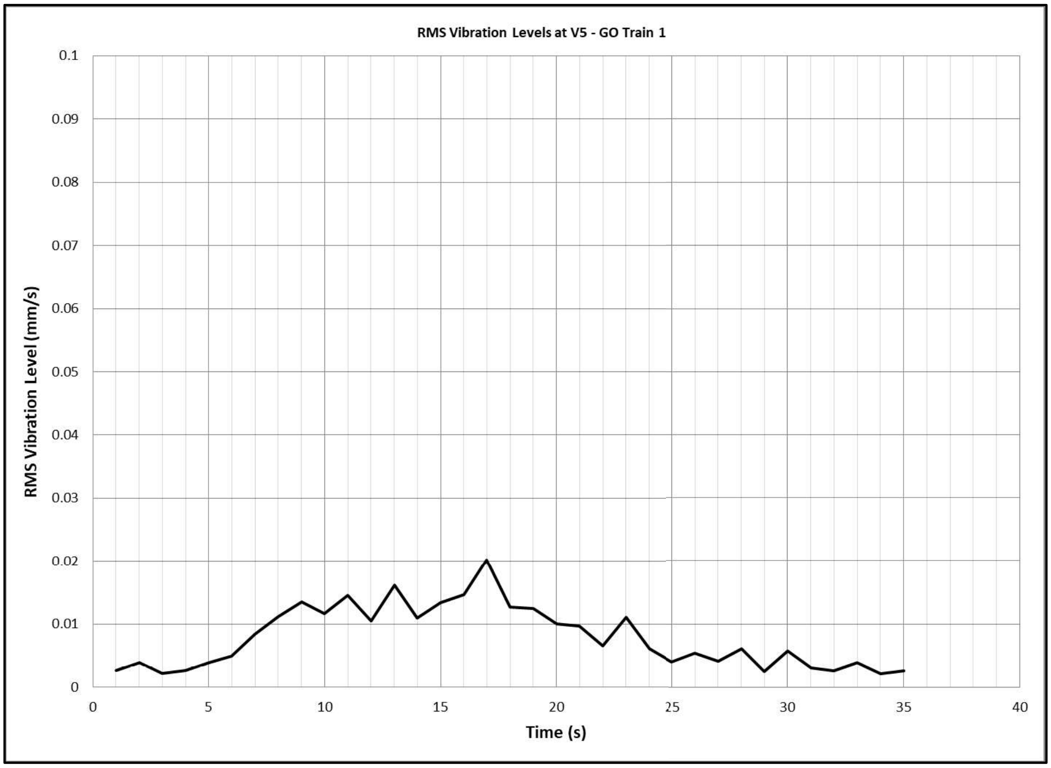
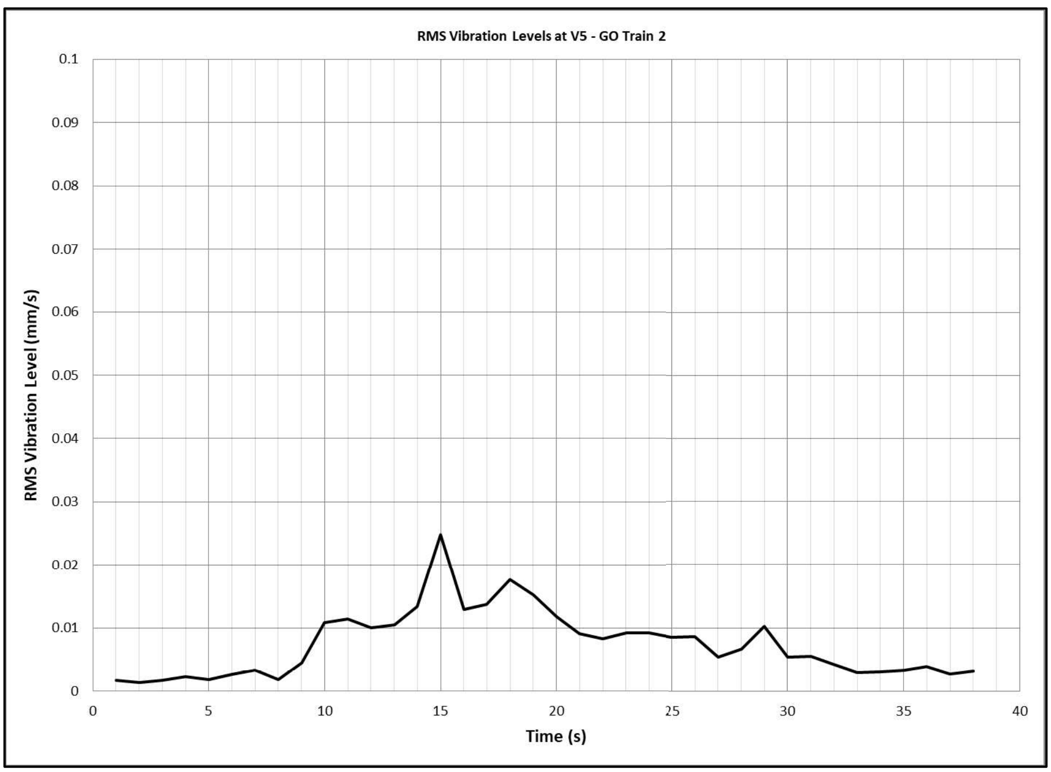
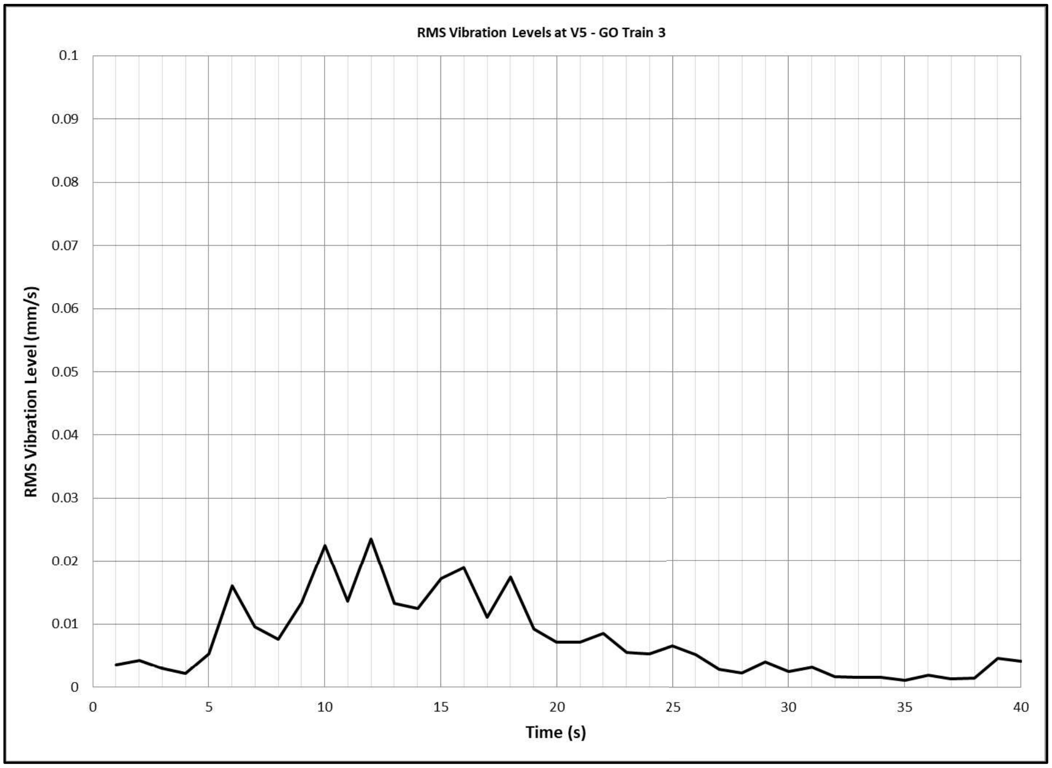
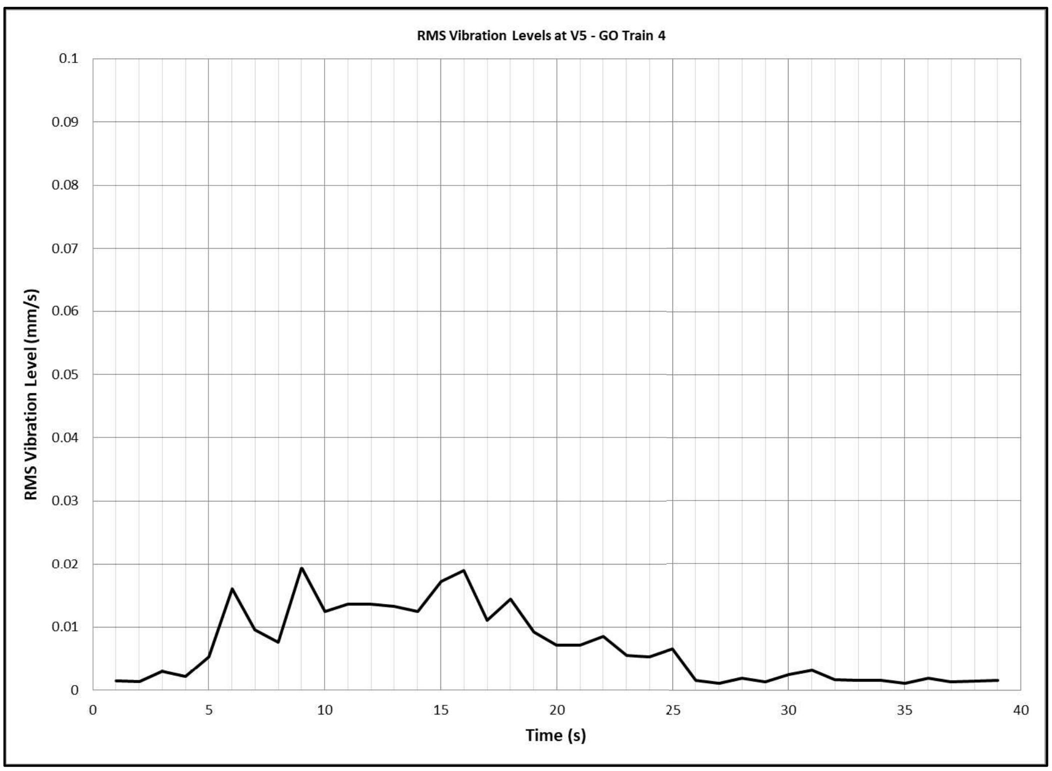
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
5
10
15
20
25
30


RMS Vibration Levels at V5 - Freight Train 1
RMS Vibration Levels (mm/s)
Time (s)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
40
60
80
100
120
140
160
180


RMS Vibration Levels at V5 - GO Train 1
RMS Vibration Level (mm/s)
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
Time (s)
0
5
10
15
20
25
30
35
40


RMS Vibration Levels at V5 - GO Train 2
RMS Vibration Level (mm/s)
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
Time (s)
0
5
10
15
20
25
30
35
40


RMS Vibration Levels at V5 - GO Train 3
RMS Vibration Level (mm/s)
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0
5
10
15
20
25
30
35
40
Time (s)


RMS Vibration Levels at V5 - GO Train 4
RMS Vibration Level (mm/s)
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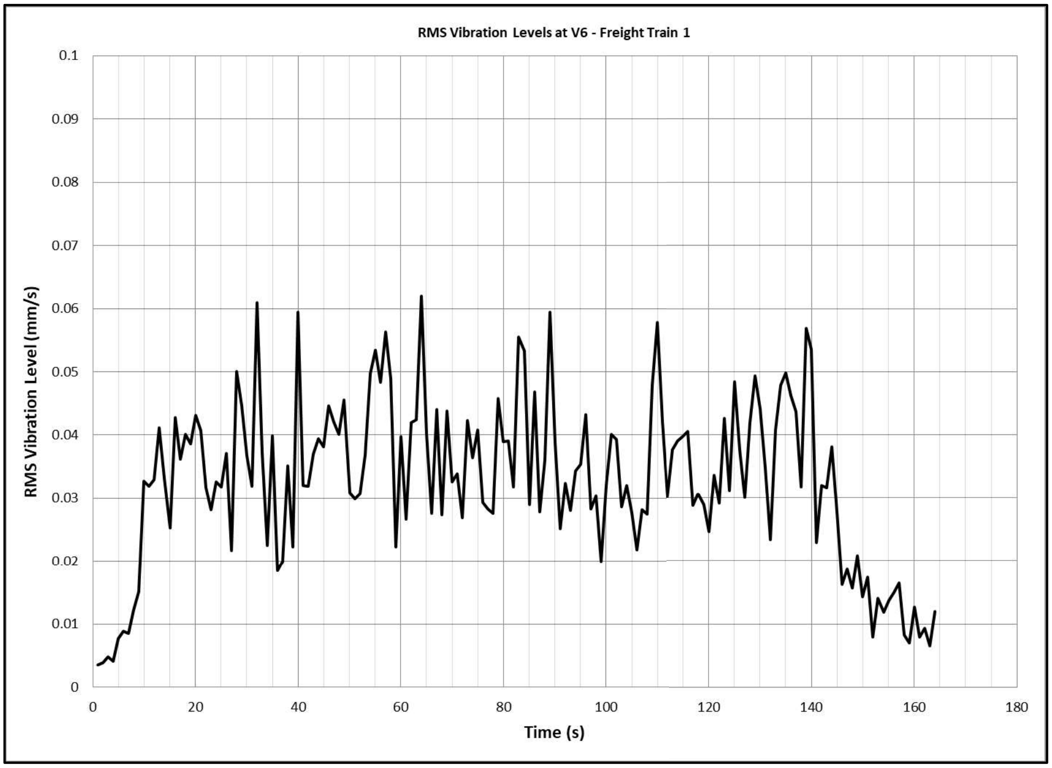
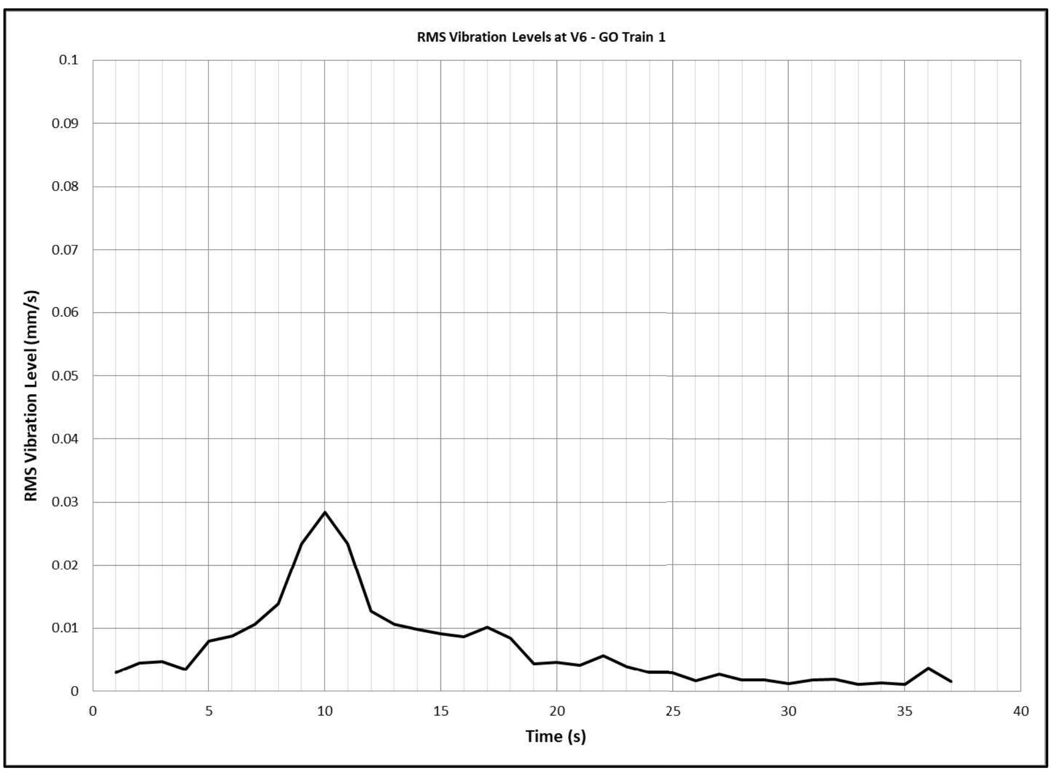
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0
5
10
15
20
25
30
35
40
Time (s)


RMS Vibration Levels at V6 - Freight Train 1
RMS Vibration Level (mm/s)
Time (s)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20
40
60
80
100
120
140
160
180


RMS Vibration Levels at V6 - GO Train 1
RMS Vibration Level (mm/s)
Time (s)
0.1
0.09
0.08
0.07
0.06
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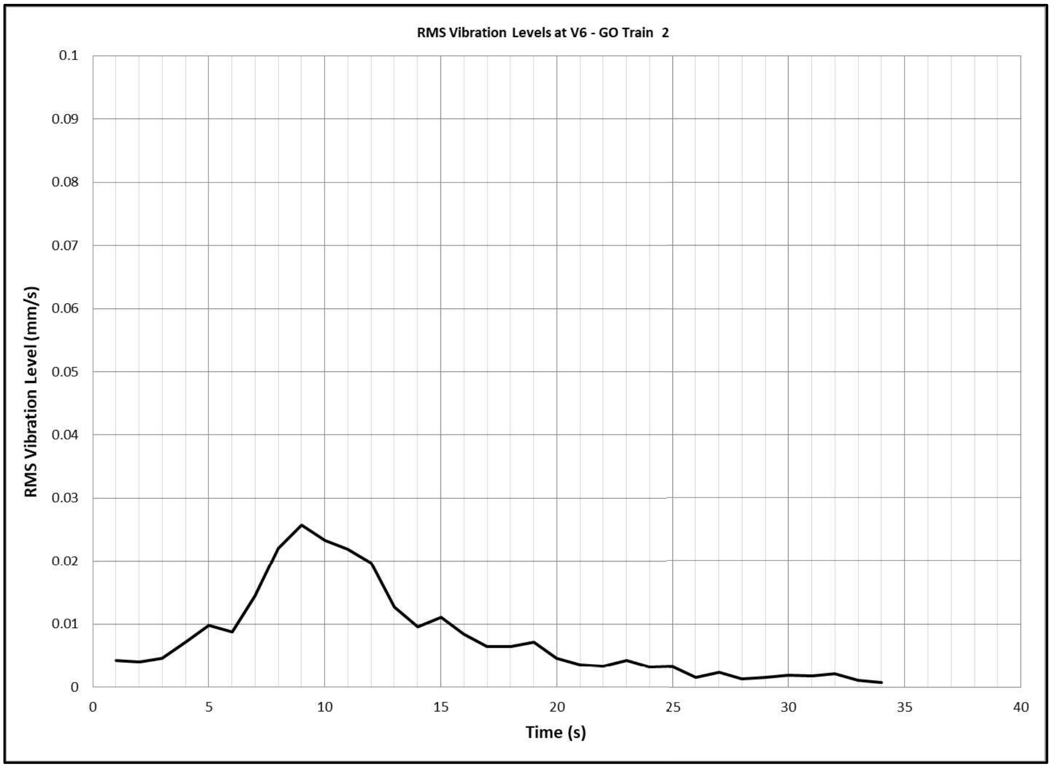
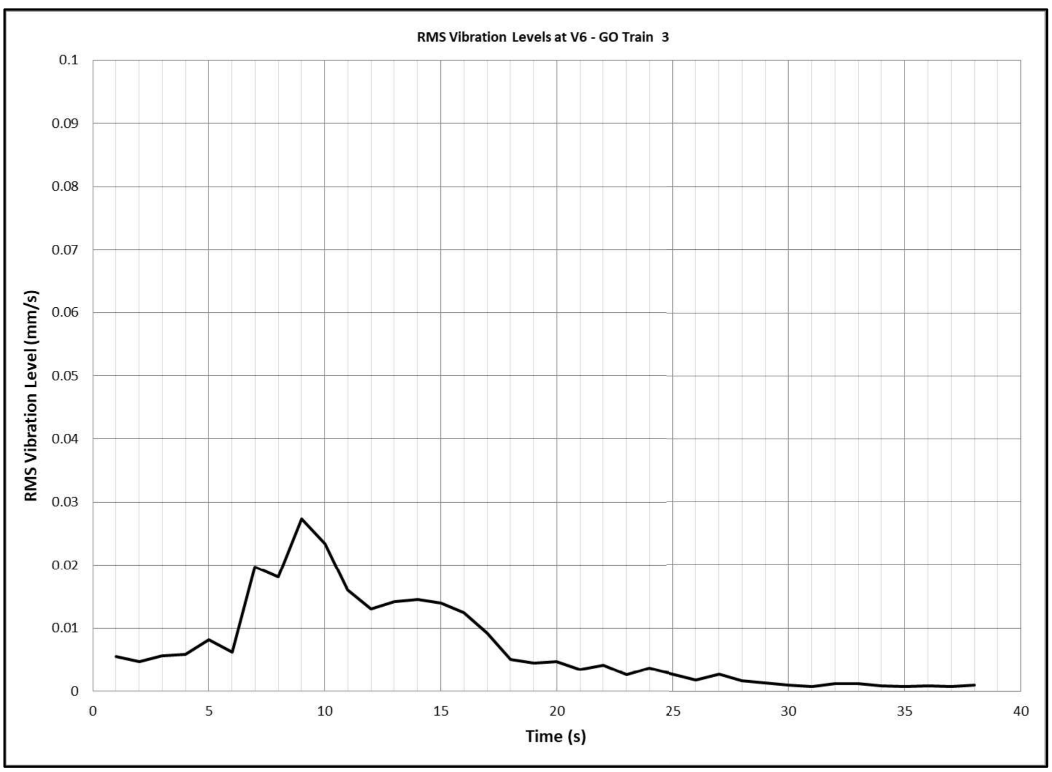
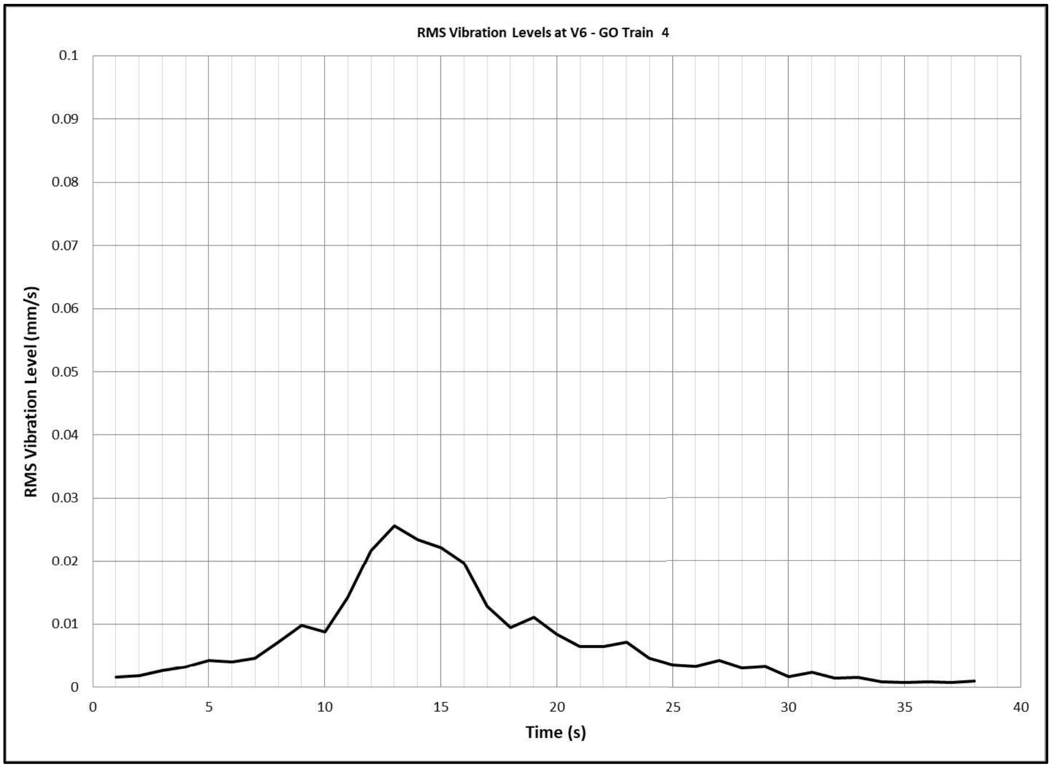
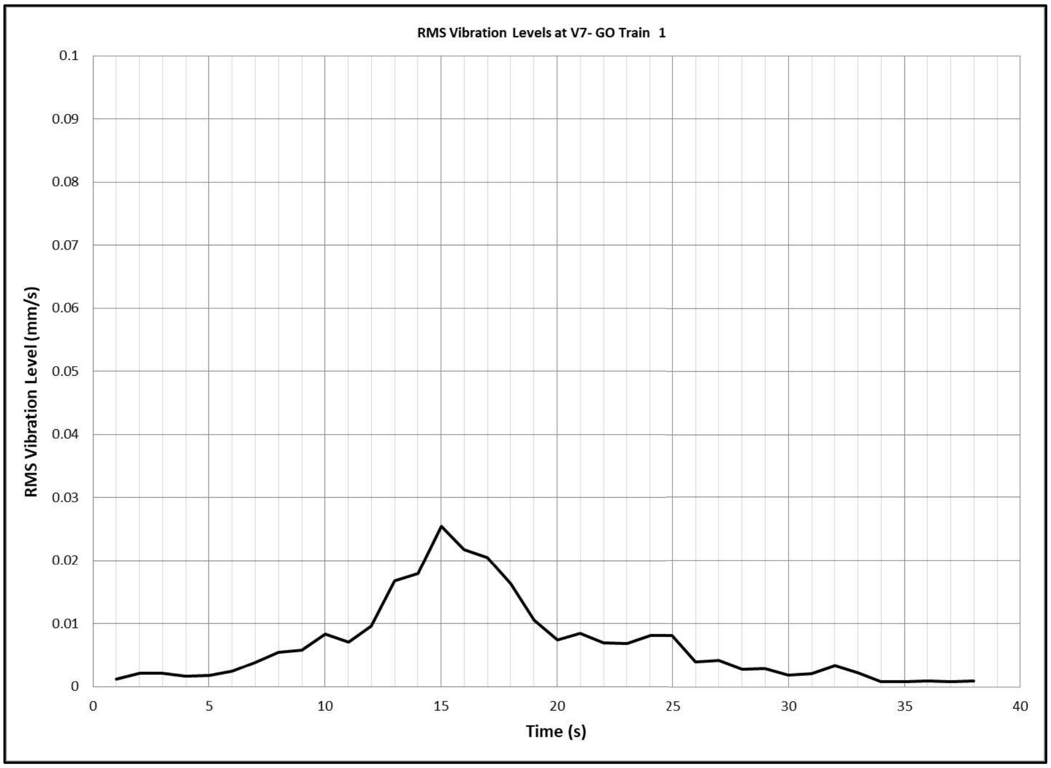
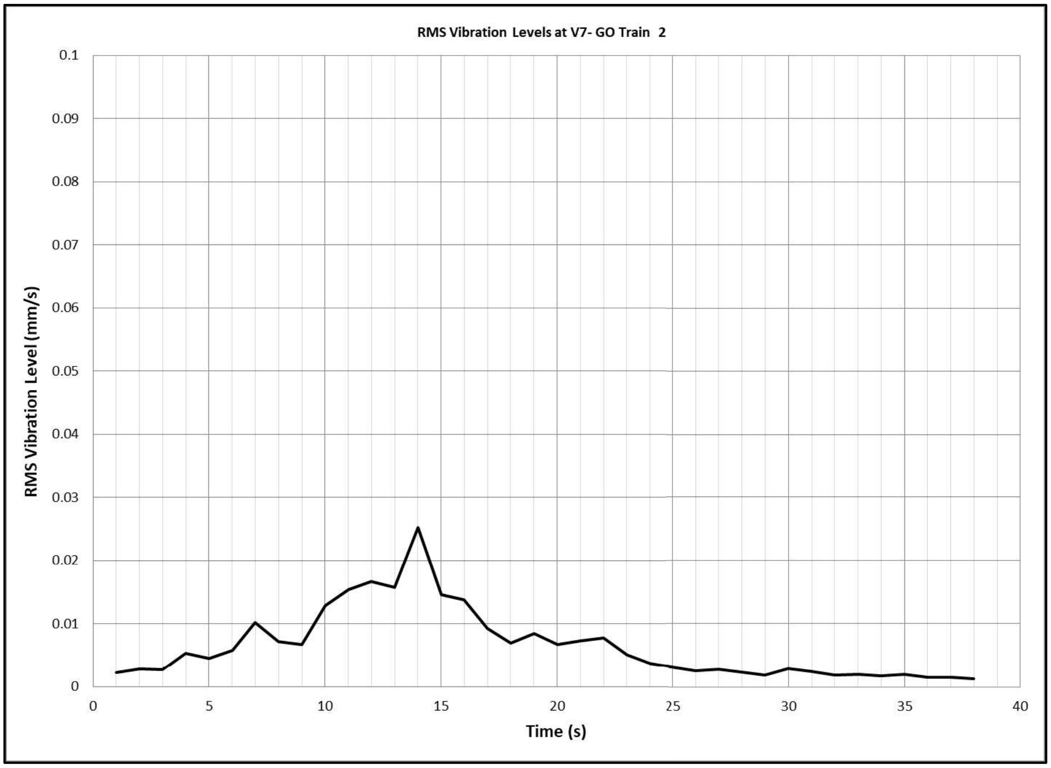
20
25
30
35
40


RMS Vibration Levels at V6 - GO Train 2
RMS Vibration Level (mm/s)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
5
10
15
20
25
30
35
40
Time (s)


RMS Vibration Levels at V6 - GO Train 3
RMS Vibration Level (mm/s)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
5
10
15
20
25
30
35
40
Time (s)


RMS Vibration Levels at V6 - GO Train 4
RMS Vibration Level (mm/s)
Time (s)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
5
10
15
20
25
30
35
40


RMS Vibration Levels at V7- GO Train 1
RMS Vibration Level (mm/s)
Time (s)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
5
10
15
20
25
30
35
40


RMS Vibration Levels at V7- GO Train 2
RMS Vibration Level (mm/s)
0.1
0.09
0.08
0.07
0.06
0.05
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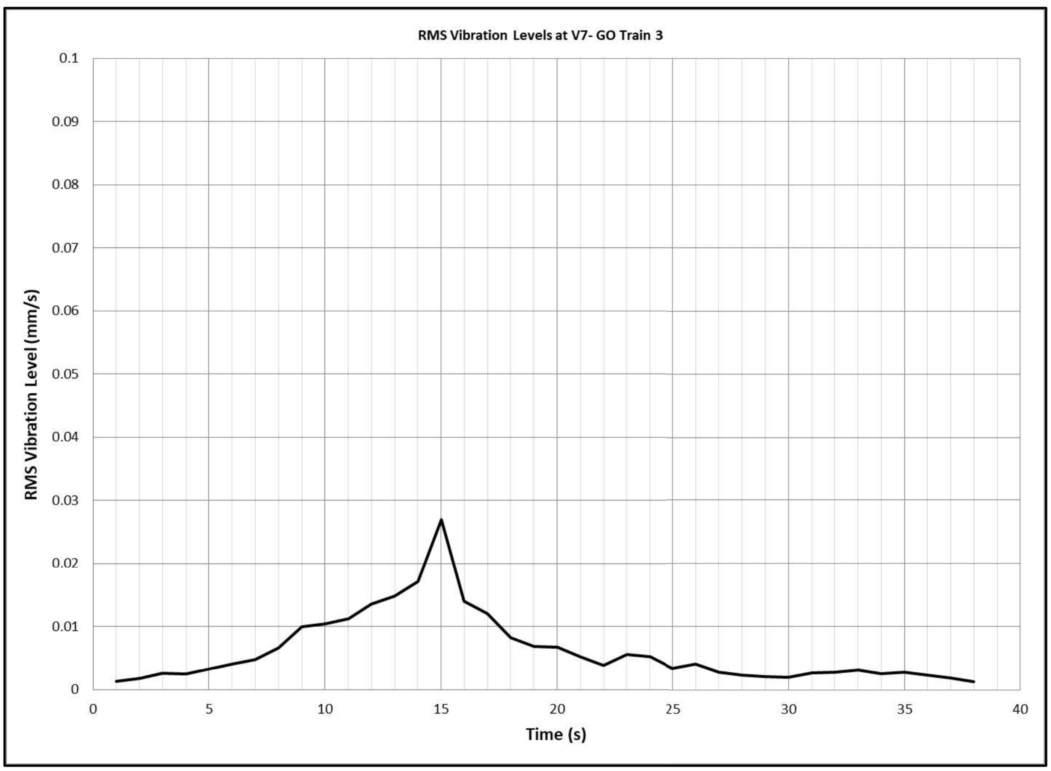
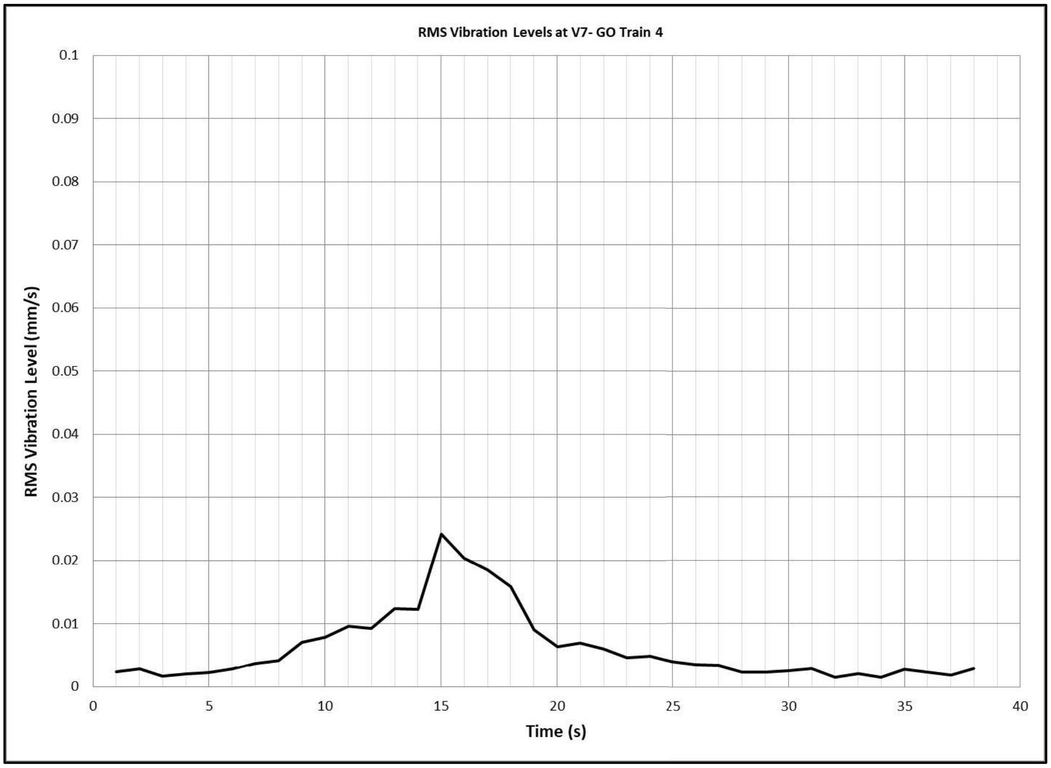
0.03
0.02
0.01
0
0
5
10
15
20
25
30
35
40
Time (s)


RMS Vibration Levels at V7- GO Train 3
RMS Vibration Level (mm/s)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
5
10
15
20
25
30
35
40
Time (s)


RMS Vibration Levels at V7- GO Train 4
RMS Vibration Level (mm/s)
Time (s)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
5
10
15
20
25
30
35
40

PART B – YNSE EPR ADDENDUM IMPACT ASSESSMENT REPORT

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LIST OF FIGURES

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APPENDICES

B 1.0 Purpose

The purpose of this section is to document the Noise and Vibration Impact Assessment that has been carried out as part of the Yonge North Subway Extension (YNSE) EPR Addendum, including identification of potential effects, a description of proposed mitigation measures (if required), and monitoring recommendations.

The scope of the noise and vibration assessment is essentially divided into three principal components: the air-borne noise generated by the stations, the noise and vibration generated by the trains running through the underground tunnel and the at grade segment, and the noise and vibration generated during the construction of the tunnel, the stations, and other facilities associated with the YNSE.

B 2.0 Approach

B 2.1 Impact Assessment Criteria

The Noise and Vibration Impact Assessment evaluates the project's noise and vibration effects for the following phases of work:

1. Operations and Maintenance
2. Construction

The sound and vibration from the Operational and Construction Phases are assessed based on the criteria and guidance documents summarized below.

B 2.1.1 Operational Phase Criteria

B 2.1.1.1 MOEE/TTC Protocol

The protocol which applies to the below grade component of this project is the MOEE/TTC Draft Protocol for Noise and Vibration Assessment for the Proposed Yonge-Spadina Subway Loop (Draft, 1993). The MOEE/TTC Draft Protocol provides the following limits:

1. The subway vehicle passby noise should not exceed 80 dBA L_{eq} passby at any point of reception.
2. The ground-borne vibration velocity level should not exceed 0.10 mm/s root mean square (rms) as measured on the ground outside a point of reception.

The vibration limit of 0.10 mm/s is shown in **Figure B 2-1** relative to some typical environmental vibration levels. For transit such as subways, a vibration level of 0.10 mm/s is considered the limit for tactile (i.e., feelable) vibration.

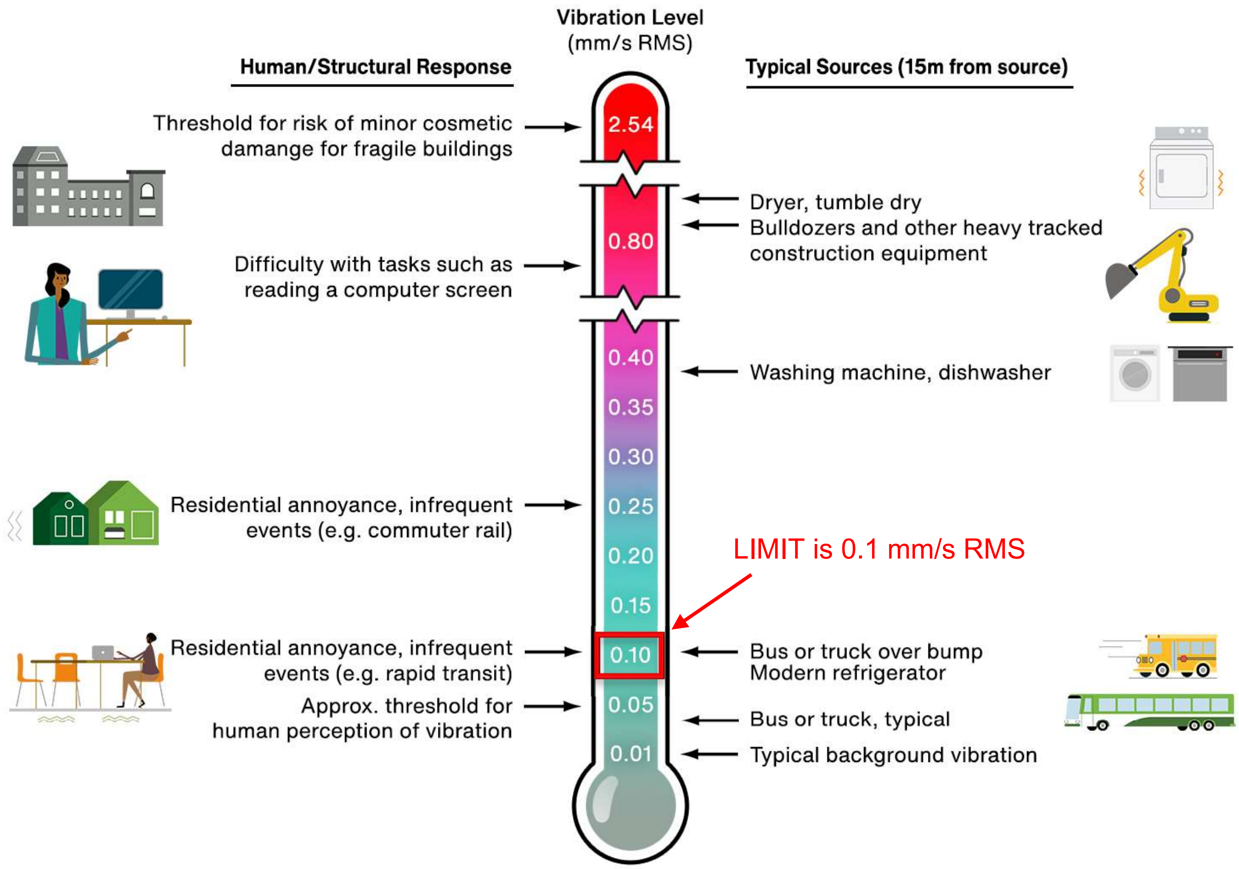

Figure B 2-1 Ground-Borne Vibration Limit (FTA and miscellaneous)

B 2.1.1.2 MOEE/GO Transit Protocol

The protocol which applies to the above-grade component of the project is the MOEE/GO Transit Draft Protocol for Noise and Vibration Assessment (Draft #9, 1995). The MOEE/GO Transit Draft Protocol states that the future sound level produced by the project in operation should not exceed:

1. The sound level existing rail activity combined with the ambient sound level or 55 dBA $L_{eq,16hr}$, whichever is greater during the daytime period (07:00 – 23:00); and
2. The sound level existing rail activity combined with the ambient sound level or 50 dBA $L_{eq,8hr}$, whichever is greater during the nighttime period (23:00 – 07:00).

For the purposes of the above assessment, the MOEE/GO Transit Protocol classifies excesses above the target criteria (such as when the future project sound levels exceed the existing ambient or 55 dBA during the daytime and/or 50 dBA during the nighttime as the adjusted noise impact. The following summarizes the range of adjusted noise impacts:

1. Insignificant: Adjusted Noise Impact between 0 and 2.99 dB
2. Noticeable: Adjusted noise impact between 3 and 4.99 dB

3. Significant: Adjusted noise impact between 5 and 9.99 dB
4. Very Significant: Adjusted noise impact above 10 dB.

When a significant or very significant noise impact is expected, mitigation needs to be evaluated based on administrative, operational, economic, and technical feasibility.

Where mitigation is considered, the objective is to mitigate the sound levels to the higher of their pre-project or exclusionary guideline levels (55 dB $L_{eq,16hr}$ or 50 dB $L_{eq,\ 8hr}$).

B 2.1.1.3 NPC-300

In both of the above protocols, noise associated with ancillary facilities (e.g., traction power substations, bus terminals, etc.) were to be assessed based on NPC-205. NPC-205 has since been updated and replaced by NPC-300, Environmental Noise Guideline - Stationary and Transportation Sources - Approval and Planning. This is the guideline document that applies to and is used to assess all long-term operational sources of stationary noise.

As per NPC-300, the hourly equivalent ($L_{eq,1hr}$) sound level from stationary sources is compared to the $L_{eq,1hr}$ of the ambient sound or the minimum exclusion criteria (50 dBA daytime and 45 dBA nighttime), whichever is greater. The ambient sound level consists of the noise generated from roadway sources and excludes sources such as lightly used railways and aircraft. For the evaluation of stationary noise sources, heavily used railways with at least 40 trains per day and 20 trains per night can be included in the ambient, after a -10 dB adjustment. The noise assessment is to be cumulative, combining all sources of noise that can reasonably be expected to operate at the same time. Typically, the quietest ambient sound level period is used as an evaluation of the worst-case situation. If the facility's sound level can remain below the quietest ambient sound level during that period, then the facility is likely to meet the guidelines during all periods of the day.

Under NPC-300, stationary sources of noise that operate for emergencies are exempt from the noise guidelines. The periodic testing of emergency equipment is required to be assessed. Due to the infrequent nature of such testing, the noise from such activities may be assessed separately from the other noise sources from a given facility. The noise from testing of emergency equipment is also permitted to generate an additional 5 dB of noise above the ambient or the minimum exclusion criteria before noise control measures are required.

Layover facilities, such as the Train Storage Facility, are referenced in both the MOEE/GO Transit Draft Protocol and *NPC-300*. Similar to stationary sources, layovers are evaluated based on a comparison of the layover facility noise to the higher of 55 dBA $L_{eq,1hr}$ or the ambient hourly equivalent sound level.

Where the facility exceeds the guidelines, noise control needs to be implemented, as per *NPC-300*. Unlike operational noise, there is no allowable excess above the stationary noise criteria. The noise from facilities is required to meet the above sound level limits.

B 2.1.1.4 Federal Transit Administration

The MOEE/TTC, MOEE/GO Transit, and NPC-300 guidelines are the core criteria developed by the province and transit agencies for the assessment of noise and vibration sources associated with transit projects. The respective protocols provide limits for ground-borne vibration (vibration that is felt or tactile perception) and air-borne noise. The above-protocols do not provide limits for ground-borne noise (also referred to as vibration-induced noise), which is the audible rumble generated by ground-borne vibration that is re-radiated from a building's surfaces as noise. **Figure B 2-2** below provides a graphical representation of the ground-borne noise and vibration as it affects a nearby sensitive receptor.

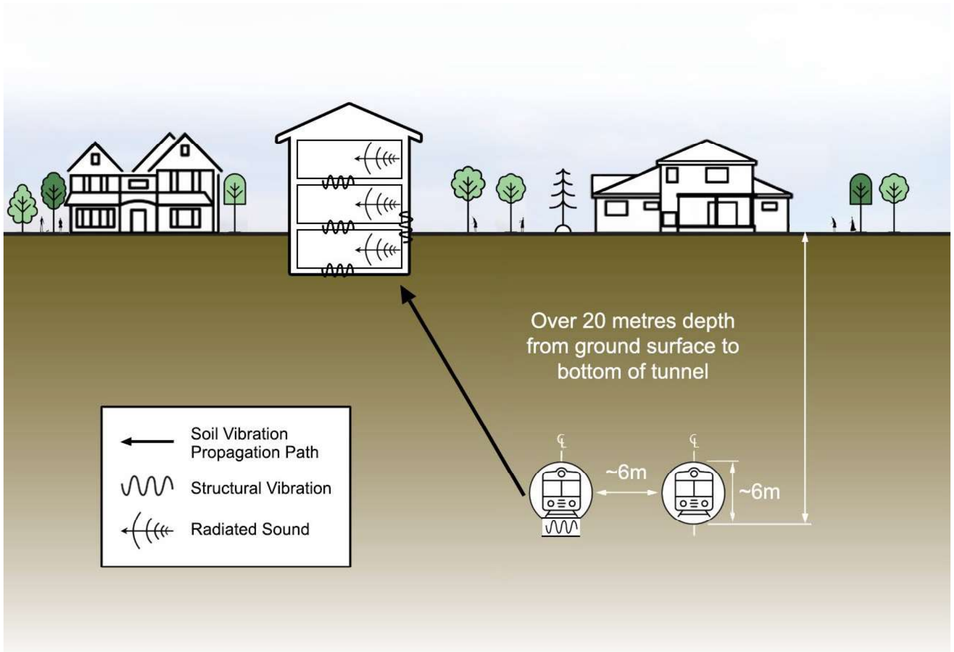

Figure B 2-2 Vibration Propagation Characteristics

Elements of the United States' Federal Transit Administration's Noise and Vibration Impact Assessment Manual (FTA Manual) have been used on recent transit projects to address the gap in guidelines for ground-borne noise. For frequent rail service, the FTA Manual provides the following guidelines:

1. A maximum ground-borne vibration velocity level of 0.045 mm/s rms for Category 1 buildings where vibration would interfere with interior operations.
2. A maximum ground-borne vibration velocity level of 0.10 mm/s rms and ground-borne noise level of 35 dBA for Category 2 buildings such as residences and other buildings where people normally sleep.
3. A maximum ground-borne vibration velocity level of 0.14 mm/s rms and ground-borne noise level of 40 dBA for Category 3 buildings such as institutional and other buildings with primarily daytime use.
4. Maximum ground-borne noise levels of 25 dBA for concert halls, TV studios, and recording studios, 30 dBA for auditoria, and 35 dBA for theatres.

The standard indoor limit of 35 dBA for residences is provided alongside other environmental sound levels in **Figure B 2-3**.

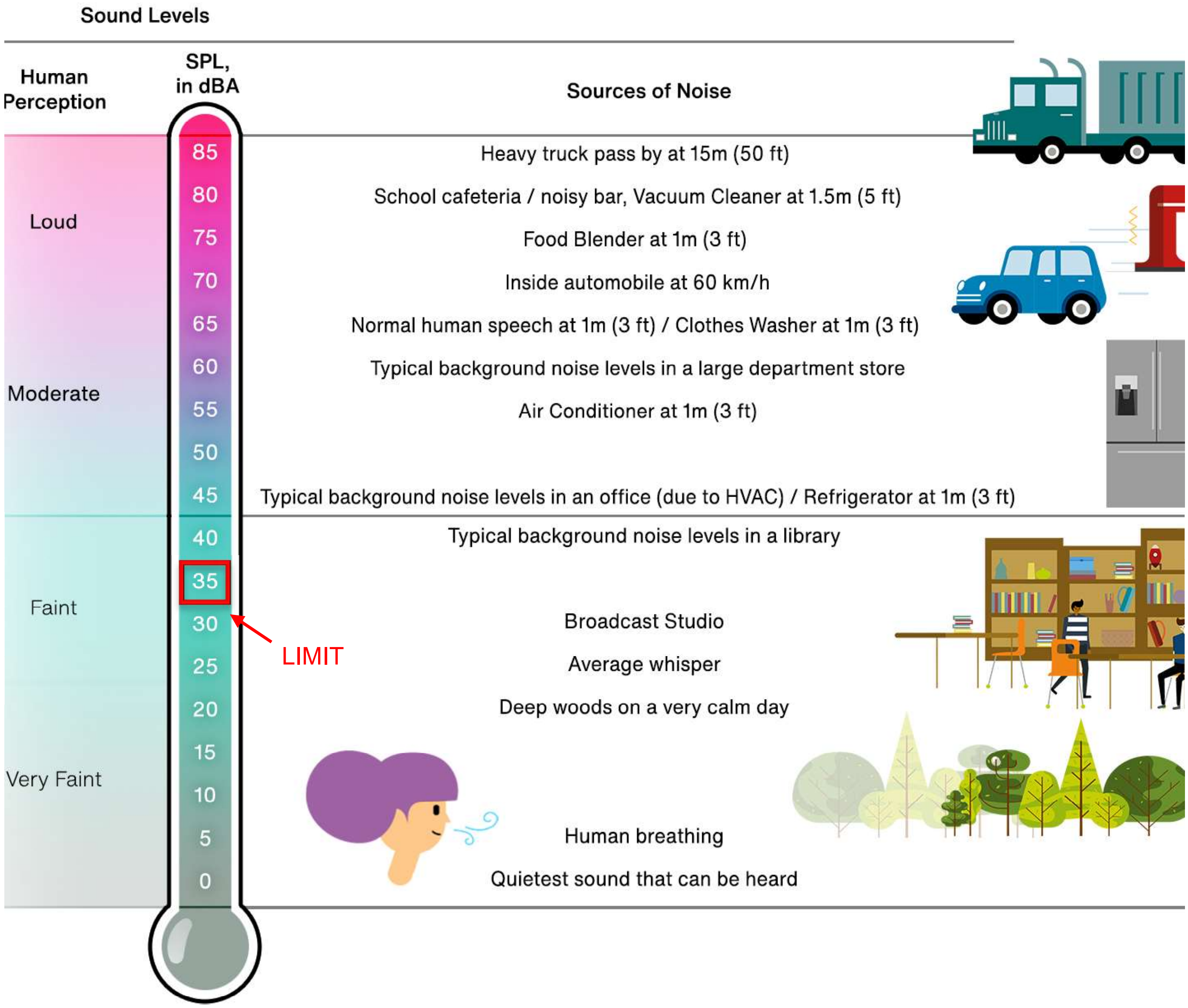

Figure B 2-3 Ground-borne Noise Limit at Residences within the Context of Sound Levels and Various Sound Sources

The above noise and vibration criteria and guidance documents are summarized in **Table B 2-1**Error! Reference source not found..

Table B 2-1 Summary of Operational Noise and Vibration Criteria

Source	Guideline Document	Point of Assessment	Descriptor	Limit
Revenue vehicle operations noise	MOEE/GO Transit Draft Protocol	Exterior façade of receptor or outdoor living areas of residential receptors, whichever is closer	$L_{eq,16h}$ and $L_{eq,8h}$	Daytime (07:00-23:00): Not to exceed 55 dBA or ambient $L_{eq,16h}$, whichever is greater by 5 dBA or more. Nighttime (23:00-07:00): Not to exceed 50 dBA or pre-project $L_{eq,8h}$, whichever is greater by 5 dBA or more.
Revenue vehicle passby noise	MOEE/TTC Draft Protocol	All locations beyond 15 m from the nearest track's centreline, with exception of within 100 m of special track work areas.	$L_{eq,passby}$	Not to exceed 80 dBA $L_{eq,passby}$
Stationary equipment noise (including ventilation shafts, bus terminals, and substations)	NPC-300	Exterior façade of sensitive receptor or outdoor living areas of residential receptors, whichever is closer	$L_{eq,1h}$	Maximum of quietest ambient L_{eq},1hr or 50 dBA during daytime (7:00-19:00) and evening (19:00-23:00) or 45 dBA during nighttime (23:00-7:00) *Testing of emergency equipment is permitted to make 5 dB more noise under the same conditions and may be assessed separately from the other noise sources.
Layovers (such as the train storage yard)	MOEE/GO Transit Draft Protocol and NPC-300	Exterior façade of sensitive receptor or outdoor living areas of residential receptors, whichever is closer	$L_{eq,1h}$	Maximum of ambient $L_{eq,1hr}$ or 55 dBA $L_{eq,1hr}$
Revenue Vehicle passby vibration	FTA Manual	Ground buildings where vibration could interfere with interior operations (e.g., concert halls, television studios, recording studios, vibration-sensitive research and	Vertical vibration velocity	Not to exceed 0.045 mm/sec rms

Source	Guideline Document	Point of Assessment	Descriptor	Limit
		manufacturing facilities, hospitals with vibration-sensitive equipment, etc.)		
	MOEE/TTC Draft Protocol and FTA Manual	Ground residences and buildings where people normally sleep (residential buildings, hotels, hospitals, etc.)	Vertical vibration velocity	Not to exceed 0.10 mm/sec rms
		Ground outside institutional land uses with primarily daytime use	Vertical vibration velocity	Not to exceed 0.14 mm/sec rms
Revenue Vehicle passby ground borne noise measured as maximum passby sound pressure level using slow response	FTA Manual	Inside concert halls, television studios, recording studios	$L_{max,S}$	25 dBA
	FTA Manual	Inside auditoriums	$L_{max,S}$	30 dBA
	FTA Manual	Inside residences and buildings where people normally sleep (e.g., residential buildings, hotels, hospitals); and theatres	$L_{max,S}$	35 dBA
	FTA Manual	Inside institutional buildings without vibration-sensitive equipment (e.g., schools, places of worship, office buildings, other institutions)	$L_{max,S}$	40 dBA

B 2.1.1.5 Receptors

The above protocols use various terms to refer to points of assessment/calculation, including receptors, receivers, noise sensitive areas, etc. The term receptors will be used for consistency. Receptors considered for assessment per the above-referenced criteria include:

1. Residences (including single family homes, retirement homes, apartment buildings, condominiums, etc.)
2. Hotels, motels, campgrounds, trailer parks, etc.
3. Institutional facilities such as schools, universities, libraries, and daycares/childcare facilities
4. Places of worship such as churches, mosques, synagogues, etc.
5. Hospitals
6. Commercially sensitive facilities such as recording studios, theatres, research facilities, banquet halls, etc. as applicable based on respective criteria above.

Under the protocols and guidelines, the daytime sound levels are to be evaluated in outdoor living areas of low-rise development (3m from a façade, 1.5m high) or at the planes of the buildings' windows. The nighttime sound levels are to be evaluated at the plane of a window at least 15m away from the nearest track.

The vibration levels are typically determined at a point located parallel to the closest façade of a building in a direction parallel to the tracks (i.e., along the corridor not towards it). This is to ensure the measurement of the vibration levels is not affected by the reflections from the foundation of structures. Measurements in front of a building structure can yield higher levels due to the reflections, depending upon the distance between the measurement point and the below grade structure.

Existing developments, developments with approved site plans, approved condominium plans, or approved draft plans of subdivision are considered as receptors. Lands that are zoned for such uses but for which there are no approved plans are not considered as such future developments will be required by the municipalities to take into consideration the project prior to their approval.

Given the substantial below grade component of the project, not all receptors sensitive to operational noise will be sensitive to operational vibration. As such, receptors will be identified based on if they are exposed to operational noise, operational vibration, or both.

Receptors sensitive to operational noise and vibration were identified using a combination of aerial imaging, land-use planning approvals, and field reviews. The intent is not to document impacts at all receptors but to evaluate a representative sample of potential worst-case impacts.

B 2.1.2 Construction Phase Criteria

While not required under current provincial guidelines requiring the assessment of construction noise and vibration, noise and vibration during the construction phase have been reviewed. The following provide a description of the evaluation criteria that are used.

B 2.1.2.1 Construction Noise

All construction equipment used should adhere to the noise limits provided in NPC-115. All trucks used in conjunction with the construction activity should also adhere to Transport Canada's limits of vehicle noise (Motor Vehicle Safety Regulations, Noise Emissions Standard 1106).

The Province of Ontario does not provide any guidelines for receptor-based sound levels during construction. **Table B 2-2** describes the receptor-based limits for construction noise that were adopted to assess the potential noise impacts resulting from construction activities for the purposes of this assessment.

Table B 2-2 Adopted Construction Noise Criteria

Land Use	L_{eq} (16-hour, 8-hour) (dBA)	
	Day (7:00 to 23:00)	Night (23:00 to 7:00 the following day)
Residential	Louder of: 75 or Baseline+5	Louder of: 65 or Baseline+3
Institutional	Louder of: 70 or Baseline+5	Louder of: 60 or Baseline+3
Commercial	Louder of: 80 or Baseline+5	Not Applicable
Industrial	Louder of: 85 or Baseline+5	Not Applicable
Station	Louder of: 85 or Baseline+5	Louder of: 70 or Baseline+5

- L_{eq} (day) is the average energy equivalent noise level over a 16-hour period (7:00 – 23:00).
- L_{eq} (night) is the average energy equivalent noise level over an 8-hour period (23:00 – 7:00).

B 2.1.2.2 Construction Vibration

Similar to construction noise, the Province of Ontario does not provide vibration limits from construction activity aside from blasting (addressed in NPC-119). As blasting will not be used for the construction of this project, there are no provincial requirements for construction vibration.

The City of Toronto enforces construction vibration limits in its By-Law 514-2008. These limits are intended to avoid structural damage during construction activities that cause significant vibration. The limits for construction vibration are summarized in **Table B 2-3** below:

Table B 2-3 City of Toronto Construction Vibration Limits

	Vibration Peak Particle Velocity (mm/s)
Less than 4	8
4 to 10	15
More than 10	25

The City of Toronto, in by-law 514-2008, defines the construction zone-of-influence (ZOI) as “area of land within or adjacent to a construction site, including any buildings or structures, that potentially may be impacted by vibrations emanating from a construction activity where the peak particle velocity measured at the point of reception is equal to or greater than 5 mm/s PPV at any frequency or such greater area where specific site conditions are identified by the professional engineer.” The City of Markham, City of Vaughan, and City of Richmond Hill do not have similar construction vibration by-laws.

The FTA Manual also provides vibration limits for construction as outlined in **Table B 2-4**.

Table B 2-4 FTA Construction Vibration Limits

Building Category	Peak Particle Velocity (in/sec)	Peak Particle Velocity (mm/s)
Reinforced concrete, steel, or timber (no plaster)	0.5	12.7
Engineered concrete and masonry	0.3	7.6
Non-engineered timber and masonry buildings	0.2	5.1
Buildings extremely susceptible to vibration damage (such as some heritage structures)	0.1	3.1

Caltrans (California Department of Transportation) provides useful standards on vibration annoyance depending on if the vibration sources are transient or continuous/frequent in their Transportation and Construction Vibration Guidance Manual (April 2020). The vibration levels for a given human response are summarized in **Table B 2-5**.

Table B 2-5 Caltrans Construction Vibration

Human Response	Transient Sources Peak Particle Velocity (mm/s)	Continuous/Frequent Intermittent Sources Peak Particle Velocity (mm/s)
Barely perceptible	1.0	0.3
Distinctly Perceptible	6.35	1.0
Strongly Perceptible	22.9	2.5
Severe	50.8	10.2

The peak particle velocity is used in the above tables is the metric that is most commonly used to assess the potential for vibration damage due to construction. Human response is based on the terms of root mean square velocity. The conversion from peak particle velocity to root mean square velocity changes depending on the waveform. For a sinusoidal wave, such as from a vibratory compactor, the conversion factor is approximately 0.71. The conversion factor can drop to 0.25 for some sources. As such, the root mean square velocity is typically lower than the peak particle velocity by 0.25 to 0.71. As noted, the above standards help document the potential impact of construction noise and vibration and the potential benefit or importance of mitigation measures.

The construction vibration limit for non-engineered timber and masonry buildings (i.e., 5 mm/s), which corresponds to the vibration ZOI, was used to assess all building structures in the assessment as a conservative approach.

B 2.1.2.3 Receptors

Similar to the operational phase, there are several definitions of receptors throughout the various reference documents. For the purposes of this construction noise and vibration assessment, the following receptors are considered:

1. Residential
2. Institutional
3. Commercial
4. Industrial

Existing developments, developments with approved site plans, approved condominium plans, or approved draft plans of subdivision are considered as receptors. Lands that are zoned for such uses but for which there are no approved plans are not considered as such future developments will be required by the municipalities to take into consideration the project prior to their approval.

Receptors sensitive to construction noise and vibration were identified using a combination of aerial imaging, land-use planning approvals, and field reviews.

Given the substantial below grade component of the project, not all receptors sensitive to construction noise will be sensitive to construction vibration. As such, receptors will be identified based on if they are exposed to construction noise, construction vibration, or both.

B 2.2 Methodology

The Noise and Vibration existing conditions information was used as the basis from which the potential effects (positive and negative) of constructing, operating, and maintaining the Project were identified.

A four-step process was followed to assess potential impacts associated with the Project and to identify mitigation measures and monitoring activities (as required):

- **Step 1** – Identify potential impacts resulting from the construction and operation of the Project;
- **Step 2** – Establish mitigation measures to eliminate or reduce potential adverse effects, as well as monitoring activities to verify and validate that mitigation measures are functioning effectively;
- **Step 3** – Carry out consultation with stakeholders/regulatory authorities; update impact assessment results and/or proposed mitigation and monitoring measures as appropriate; and
- **Step 4** – Document impact assessment results.

For the purposes of differentiating the various types of potential environmental impacts associated with the Project, impacts were characterized and grouped as follows:

Table B 2-6 Characterization of Potential Impacts

Effect	Description
Construction Impacts	Potential temporary effects (e.g., disruption/disturbance) on existing Study Area features or receptors due to construction activities associated with the Project (e.g., construction of new tracks, tunnelling, storage facility, bridge modifications, etc.).
Operations and Maintenance Impacts	Potential permanent effects on existing Study Area features (i.e., displacement or removal) or receptors due to operations and/or maintenance activities associated with the Project (e.g., operation of the new subway system/trains, operation of train storage facility, etc.).

Following the impact assessment, mitigation measures and monitoring activities were identified to avoid or minimize project impacts based on a combination of general best management practices and Project-specific mitigation measures, as appropriate.

B 2.3 Mapping

The GIS mapping database initially prepared during the existing conditions phase was updated and augmented with additional data collected and updated mapping was prepared to assist in the analysis of potential effects. The detailed mapping is provided in Appendix A.

B 2.4 Identification of Receptors

Table B 2-7 summarizes the representative receptors selected for the project. As noted, not all receptors are sensitive to both construction and operational noise and vibration. Similarly, not all receptors are sensitive to both noise and vibration. Receptors designated as V are sensitive only to ground-borne noise and vibration given their location along the below grade alignment. Receptors designated as R are sensitive to both air-borne noise and ground-borne noise and vibration. The overall receptor locations for each segment are shown in **Figure B 2-4, Figure B 2-5** and **Figure B 2-6** below. More detailed receptor mapping is provided in **Appendix B**.

Table B 2-7 Representative Receptors

Segment	Receptor Number	Description	Receptor Sensitivity			
			Operational Noise	Operational Vibration	Construction Noise	Construction Vibration
1	R1	High-rise Residential	N	Y	Y	Y
	V1	High-rise Residential	N	Y	N	Y
	V2	High-rise Residential	N	Y	N	Y
	R2	High-rise Residential	Y	Y	Y	Y
	R3	High-rise Residential	Y	Y	Y	Y
	R4	Low-rise Residential	Y	Y	Y	Y
	R5	High-rise Residential	Y	Y	Y	Y

Segment	Receptor Number	Description	Receptor Sensitivity			
			Operational Noise	Operational Vibration	Construction Noise	Construction Vibration
	R6	Low-rise Residential	Y	Y	Y	Y
	R7	High-rise Residential	Y	Y	Y	Y
	R8	High-rise Residential	N	Y	Y	Y
	R9	High-rise Residential	N	Y	Y	Y
	V3	High-rise Residential	N	Y	N	Y
	R10	Low-rise Residential	Y	Y	Y	Y
	R11	Low-rise Residential	Y	Y	Y	Y
	R12	High-rise Residential	Y	Y	Y	Y
	R13	Funeral Home	Y	Y	Y	Y
	R14	Low-rise Residential	Y	Y	Y	Y
	R15	Low-rise Residential	Y	Y	Y	Y
	R16	Low-rise Residential	Y	Y	Y	Y
	R17	Low-rise Residential	Y	Y	Y	Y
	R18	Low-rise Residential	Y	Y	Y	Y
	R19	Low-rise Residential	Y	Y	Y	Y
	R20	High-rise Residential	N	Y	Y	Y
	R21	Low-rise Residential	N	Y	Y	Y
	V4	High-rise Residential	N	Y	N	Y
	V5	High-rise Residential	N	Y	N	Y
	V6	High-rise Residential	N	Y	N	Y
2	R22	Low-rise Residential	Y	Y	Y	Y
	R23	High-rise Residential	Y	Y	Y	Y
	R24	High-rise Residential	Y	Y	Y	Y
	R25	High-rise Residential	Y	Y	Y	Y
	R26	High-rise Residential	Y	Y	Y	Y
	V7	High-rise Residential	N	Y	N	Y
	V8	High-rise Residential	N	Y	N	Y
	V9	Low-rise Residential	N	Y	N	Y

Segment	Receptor Number	Description	Receptor Sensitivity			
			Operational Noise	Operational Vibration	Construction Noise	Construction Vibration
	V10	Low-rise Residential	N	Y	N	Y
	R27	Low-rise Residential	Y	Y	Y	Y
	R28	Low-rise Residential	Y	Y	Y	Y
	V11	Church	N	Y	N	Y
	V12	High-rise Residential	N	Y	N	Y
	R29	Golf Club	Y	Y	Y	Y
	R30	High-rise Residential	Y	Y	Y	Y
	R31	High-rise Residential	Y	Y	Y	Y
	R32	Church	Y	Y	Y	Y
	V13	High-rise Residential	N	Y	N	Y
	R33	High-rise Residential	N	Y	N	Y
	R34	High-rise Residential	N	Y	N	Y
	V14	Low-rise Residential	N	Y	N	Y
	R35	Low-rise Residential	N	Y	Y	Y
	R36	Low-rise Residential	N	Y	Y	Y
	V15	Low-rise Residential	N	Y	N	Y
	V16	Low-rise Residential	N	Y	N	Y
	V17	Low-rise Residential	N	Y	N	Y
	R37	School	N	Y	Y	Y
	R38	Low-rise Residential	N	Y	Y	Y
	R39	Low-rise Residential	N	Y	Y	Y
	R40	Low-rise Residential	Y	Y	Y	Y
3	R41	Church	Y	Y	Y	Y
	V18	Theatre	N	Y	N	Y
	R42	High-rise Residential	Y	Y	Y	Y
	R43	High-rise Residential	Y	Y	Y	Y
	R44	Low-rise Residential	Y	Y	Y	Y
	R45	High-rise Residential	Y	Y	Y	Y

Segment	Receptor Number	Description	Receptor Sensitivity			
			Operational Noise	Operational Vibration	Construction Noise	Construction Vibration
	R46	Low-rise Residential	Y	Y	Y	Y
	R47	High-rise Residential	Y	Y	Y	Y
	R48	Low-rise Residential	Y	Y	Y	Y
	R49	High-rise Residential	Y	Y	Y	Y
	R50	Low-rise Residential	Y	Y	Y	Y
	R51	Low-rise Residential	Y	Y	Y	Y
	R52	Low-rise Residential	Y	Y	Y	Y
	R53	Low-rise Residential	Y	Y	Y	Y
	R54	Low-rise Residential	Y	Y	Y	Y
	R55	High-rise Residential	Y	Y	Y	Y
	R56	High-rise Residential	Y	Y	Y	Y
	R57	Low-rise Residential	Y	Y	Y	Y
	R58	Low-rise Residential	Y	Y	Y	Y
	R59	Low-rise Residential	Y	Y	Y	Y
	R60	Low-rise Residential	Y	Y	Y	Y

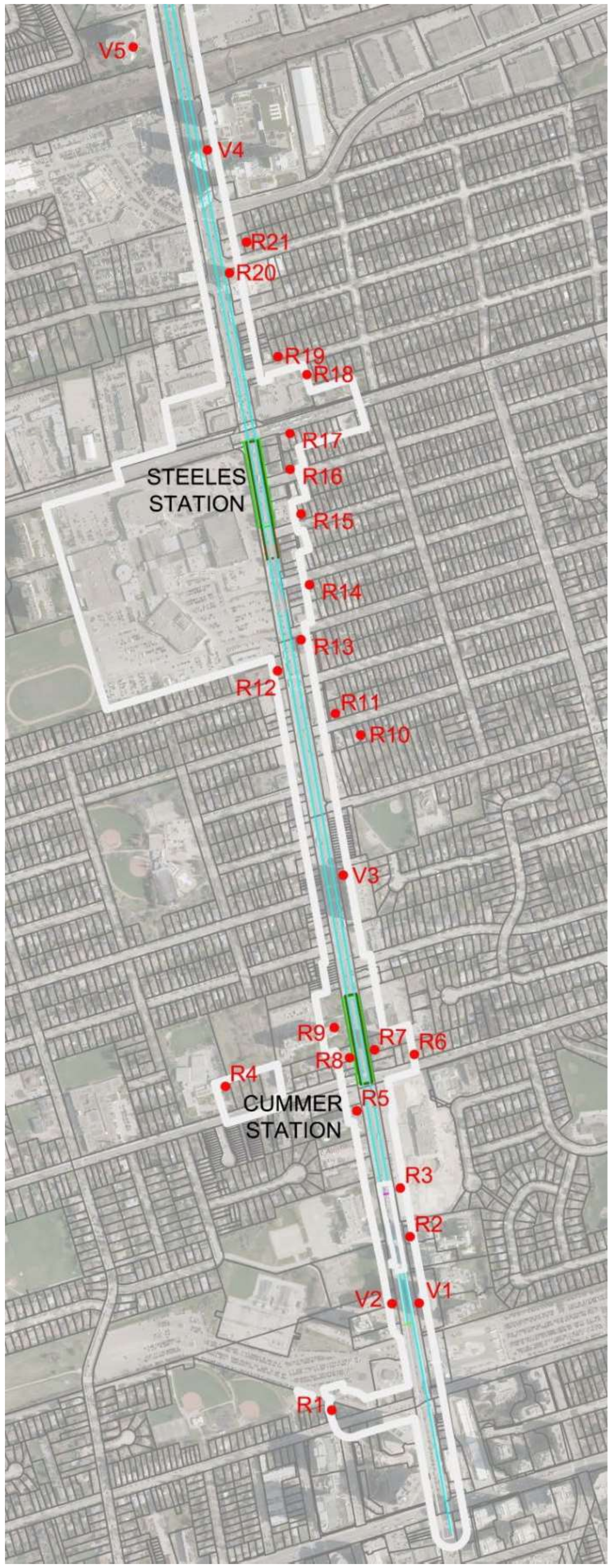

Figure B 2-4 Segment 1 Receptor Locations

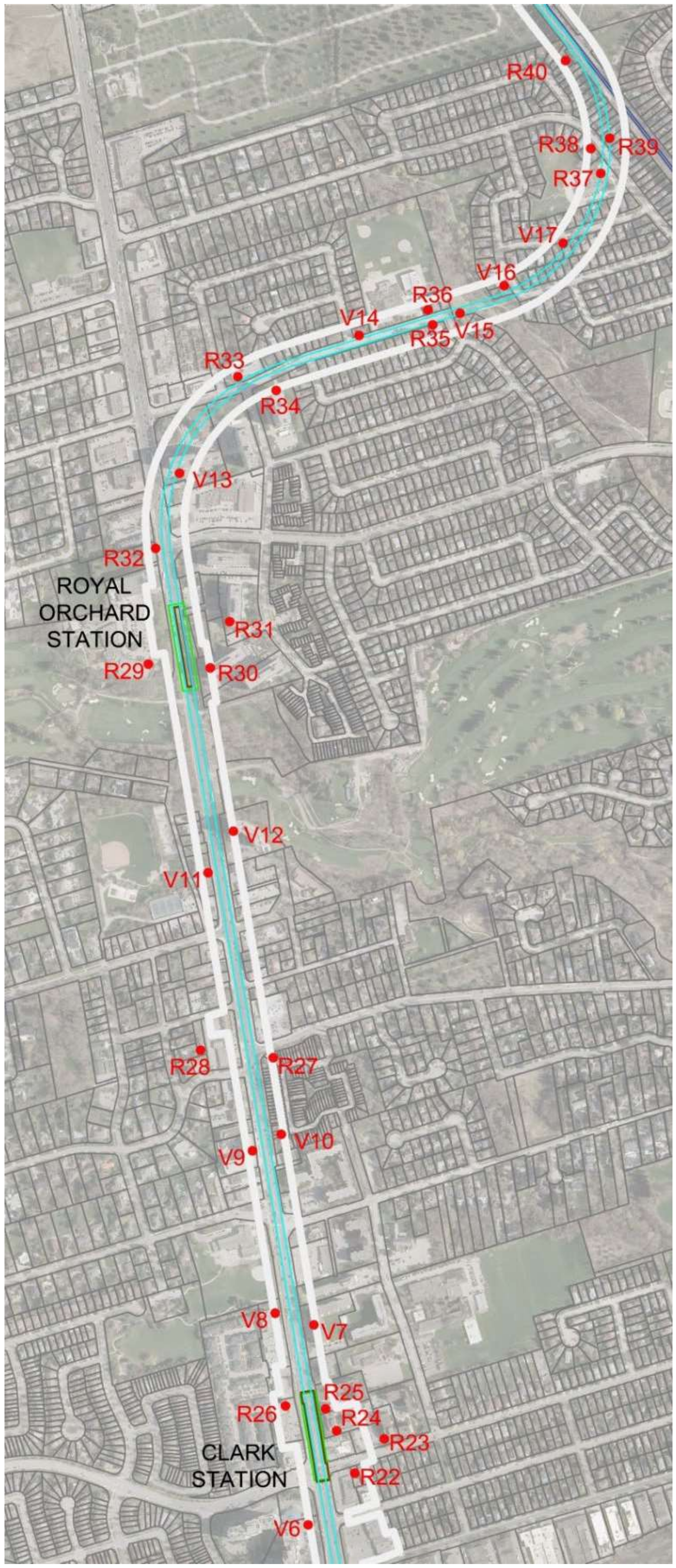

Figure B 2-5 Segment 2 Receptor Locations

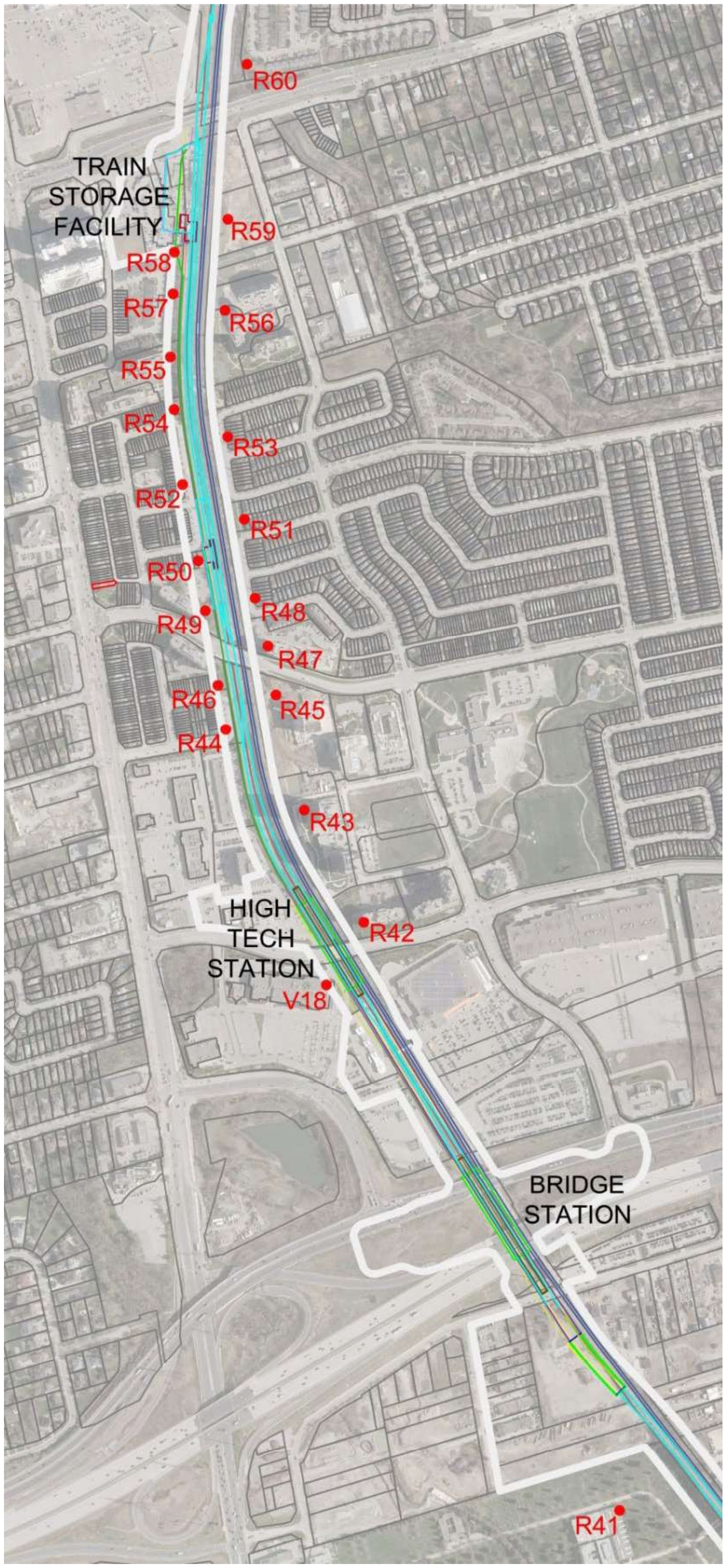

Figure B 2-6 Segment 3 Receptor Locations

B 3.0 Impact Assessment – Operational Noise

B 3.1 Scope

The operational noise assessment reviews the following project components:

1. Stationary noise from stations, including ventilation shafts, mechanical equipment such as exhaust fans, bus terminals, and a bus loop.
2. Operational subway noise from the subway when it operates at grade.
3. Operational noise from the train storage facility.

B 3.1.1 Stations and Portal

All public areas of underground stations are passively ventilated and conditioned using the piston effect of passing trains. Back of house areas such as electrical rooms, break rooms, etc. require cooling and ventilation. This is often addressed via internal mechanical systems that intake and exhaust air to the outdoors. Exhaust fans are provided for various rooms as well. The mechanical and electrical design of the stations is typically not completed at such an early stage. Reasonable estimates of mechanical and electrical equipment, along with their quantities and sound levels, are provided in **Table B 3-1**.

Table B 3-1 Typical Below Grade Station Equipment

Equipment	Sound Power Level (dBA L_w)	Quantity
Condensing Units	68	8
Air Handling Units/Rooftop Units	80	1
Exhaust Fans	78	6
HRV	75	1
Transformers	75	4

Above-ground stations may require more active ventilation of enclosed areas due to the lack of piston effect of the trains. Similarly, the mechanical design is typically not completed at such an early stage. Reasonable estimates of mechanical and electrical equipment, along with their quantities and sound levels, are provided in **Table B 3-2**.

Table B 3-2 Typical At Grade Station Equipment

Equipment	Sound Power Level (dBA L_w)	Quantity
Condensing Units	68	8
Air Handling Units/Rooftop Units	80	2
Exhaust Fans	78	4

Equipment	Sound Power Level (dBA L_w)	Quantity
TPSS Building	85	1

Bus station buildings are typically provided with several air-handling units as well. However, the sound from the mechanical equipment is usually relatively insignificant as compared to the noise from the buses.

Each underground station is also provided with four tunnel ventilation system (TVS) exhaust fans. TVS fans are intended to provide emergency smoke dispersion during fires and other emergency events. While intended for emergency operations, such fans can be used during non-emergency situations as well. Non-emergency use can include supplemental ventilation during congested subway operations or during periods of very warm weather. Sound levels for the TVS fans are estimated based on previous project experience. The TVS fan sound levels are shown in **Table B 3-3.**

Table B 3-3 TVS Fan Sound Data

Condition	Octave Band Sound Power Level (dB)								Overall
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	(dBA)
Full Speed	114	114	122	126	123	119	113	105	127
Half Speed	99	107	111	108	104	98	90	84	109

The above sound levels represent the condition during emergency operations when each fan is operating at full design speed. In general, the following summarize the operational characteristics of the TVS:

1. One fan at each end of the station operates at 50% speed throughout the day
2. During maintenance periods (late night), one fan at each end of the station will operate at 50% speed (maintenance includes track welding, grinding, etc.)
3. Fans are tested at 50% speed once per month for fifteen minutes at the most. Only one fan is tested at any one time. The fans may occasionally be tested to 100% speed for a few minutes each.

In terms of environmental noise, the maintenance period operation is the most critical as the fans generate the highest non-emergency sound levels when the ambient (guideline) sound levels are the lowest.

The portal will also be provided with two tunnel ventilation fans.

TVS fans are typically provided with silencers. **Table B 3-4** provides some typical silencer insertion losses.

Table B 3-4 TVS Fan Silencer Insertion Losses

Octave Band Insertion Loss (dB)							
63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
10	20	30	45	55	45	30	20

Buses using and idling at the bus terminals/loops are considered stationary noise sources. There are a total of 3 bus terminals proposed and one bus loop. Hourly bus volumes have been estimated based on the routes expected to use those bus terminals and loops. The volumes are summarized in **Table B 3-5**.

Table B 3-5 Bus Facility Volumes

Bus Facility	Morning Peak Buses (0600-0700)			Late Night Buses (2200-2300)			Overnight Buses (0200-0300)		
	TTC	YRT	GO	TTC	YRT	GO	TTC	YRT	GO
Cummer	10	-	-	4	-	-	0	-	-
Steeles	28	20	-	23	20	-	5	4	-
Clark	-	16	-	-	10	-	-	2	-
Bridge	-	86	48	-	30	15	-	10	5

A total of 7 traction powered substations (TPSS) are proposed for the project. These will include three (3) at Steeles, Clark, and Royal Orchard Stations, one (1) TPSS at EEB 1, one (1) TPSS at EEB 4, one (1) TPSS at Bridge Station, and one (1) TPSS at the Train Storage Facility (TSF), immediately south of 16th Ave. TPSSs generally consist of transformers along with associated cooling equipment. From outdoors, the dominant source of noise is typically from the cooling equipment.

TPSS building sound power levels are estimated at 85 dBA L_w. Tonal noises are generally considered of higher nuisance. MECP suggests adding 5 dB to noise sources that sound tonal. A tonality correction is not applied as the noise is dominated by the cooling systems from the TPSS building/enclosure. The transformers alone are more than 5 dB quieter. Hence, in the absence of noise from the cooling systems, the sound of the transformers alone and the tonality correction would still be less than 85 dBA L_w.

B 3.1.2 Subway

The YNSE will use the same subway vehicles as are currently deployed on Line 1 (Yonge-University-Spadina) and Line 4 (Sheppard). Air-borne noise from the below grade is generally insignificant. Some noise may escape through the ventilation shafts and will be reviewed as part of the ventilation shaft noise assessment.

The final subway schedule is still under development. A total of 3 scenarios are investigated for the project as outlined in **Table B 3-6**.

Table B 3-6 Subway Volumes

Service Level	Total Trains	Nighttime Trains	Daytime Trains
1. Current (210s Headways)	650	111	538
2. Planned (100s Peak Headways)	933	168	765
3. Planned (100s Headways)	1259	168	1091

The above volumes are estimated based on current TTC schedules and hours of operation. The subway does not operate regular revenue service between 1:30am and 5:30am. The peak periods are from 5:30am to 9:00am and 3:00pm to 7:00pm.

Subway noise for the at-grade component is based on the maximum allowable levels provided by the TTC in **Table B 3-7**. This is slightly conservative as this typical train passbys would produce lower sound levels and are also not expected to operate at the maximum speeds noted below.

The subway speeds are as follows:

1. 80 km/hr through tangent track, slightly lower speeds at curves
2. 20 km/hr within the TSF
3. 30 km/hr between the TSF and High Tech Station

The at-grade alignment terminates just south of Bantry Avenue. The TSF boundary starts at Bantry Avenue and extends approximately to Moonlight Lane, north of 16th Avenue.

The volumes in **Table B 3-6** are representative of the volumes south of High Tech Station. Between High Tech Station and the TSF, there are planned to be approximately 30 train movements during the day and 15 at night.

B 3.1.3 Train Storage Facility

The TSF/layover will be strictly used for overnight storage and cleaning of the trains. There will be no major maintenance completed at the facility. A total of 15 trains will be stored at the yard. As the final schedule is still being developed, it is assumed that all 15 trains will leave during the hourly period between 5:00am and 6:00am. This is the busiest period in terms of TSF activity. Some trains will return during the day after the morning rush hour and will depart prior to the afternoon rush hour. The trains will trickle back in through the remainder of the day. Subway vehicle noise data was provided by the TTC, reflective of both yard-specific conditions (slow speed and stationary conditions) and mainline conditions (high speed). These are summarized in **Table B 3-7**.

Table B 3-7 Subway Vehicle Sound Data

Condition	Sound Level (dBA)
Low speed (20 km/hr.)	73 @ 7.5m from track centreline
High speed (80 km/hr.)	78 @ 25m from track centreline
Stationary	72@ 7.5m from track centreline

While primarily used for train storage, the TSF will also include a support building as well as a standalone TPSS. The equipment associated with the TSF are summarized in **Table B 3-8**.

Table B 3-8 Typical TSF Equipment

Equipment	Sound Power Level (dBA L_w)	Quantity
Condensing Units	68	8
Air Handling Units/Rooftop Units	80	2
Exhaust Fans	78	4

Equipment	Sound Power Level (dBA L_W)	Quantity
TPSS Building	85	1

B 3.2 Approach

B 3.2.1 Prediction Procedures

Operational sound levels are calculated using the CadnaA computer program which allows for 3D acoustical modelling using a variety of prediction procedures. These prediction procedures are summarized below:

1. ISO-9631-2 is the provincially accepted prediction procedure for stationary sources.
2. For transit sources, such as the at grade guideway, the provincially accepted prediction procedure used is that of the Federal Transit Administration.
3. For roadways and highways, the preferred prediction procedure at the time of publication is ORNAMENT (Ontario Road Noise Analysis Method for Environment and Transportation). CadnaA can be used with reference sound levels from the ORNAMENT prediction procedure, as per previous transit projects. MECP is releasing updated guidance (NPC-306 - Methods to Determine Sound Levels Due to Road and Rail Traffic) on roadway noise prediction procedures and methods that should be adopted during the detailed design of the project.
4. Unlike the comparison of operational noise for guideway or surface transit or transportation sources, the assessment of stationary sources relies on the absolute sound level of the background or ambient. As such, the accuracy of the calculated sound levels is more critical in these cases. ORNAMENT is an empirical prediction procedure that was based on sound level measures of various vehicles at the time. Trucks and buses have especially been getting quieter and quieter. Consequently, calculated sound levels using ORNAMENT may overpredict the absolute sound levels, depending on the truck percentage. The extent of the overprediction is largely an extent of the percentage of trucks along that route. The measured sound levels conducted as part of the existing conditions study can be used to confirm if the calculated sound levels from road traffic need to be adjusted to be more representative of the true background sound levels.

B 3.2.2 Roadway and Highway Traffic Volumes

Existing traffic average annual daily traffic (AADT) and 24-hour traffic volumes were provided by the various municipalities along the corridor. Growth factors and future 2041 traffic volumes for roadways at key intersections were provided by the OneT+ traffic consultant. While opening day is predicted to be 2031, a future horizon year of 2041 is used. This is consistent with most planning policies. Traffic volumes and bus terminal volumes usually require some time to stabilize after a project's completion.

As noted, the criteria for stationary sources are based on a set of minimum exclusion criteria or the ambient sound level. The greatest impact for stationary sources occurs when the delta/difference between the facility's noise output and the background sound level are greatest. As such, the existing 24-hour counts provide a profile of the daily 2041 traffic that may be present when the project is completed.

The existing and future traffic volumes are provided in **Table B 3-9**.

Table B 3-9 Roadway Traffic Volumes

Road	From	To	Existing Traffic Volumes		Future Traffic Volumes		Truck	Speed Limit
			Year	AADT	Without Project	With Project	%	(km/)
16th Avenue	Yonge Street	Red Maple Road	2021	33,584	47,666	47,666	5	50
Yonge Street	16th Avenue	Bantry Avenue	2021	48,953	56,820	55,524	5	60
Bantry Avenue	Yonge Street	Red Maple Road	2019	5,974	9,880	9,690	5	50
High Tech Road	Yonge Street	Red Maple Road	2017	13,370	32,930	31,260	5	50
Garden Avenue	Yonge Street	Pearson Avenue	2019	4,873	9,980	9,980	3	40
Langstaff Road	Yonge Street	Cedar Avenue	2020	1,591	5,060	4,870	10	40
Royal Orchard Boulevard	Yonge Street	Inverlochy Boulevard	2019	4,736	7,730	7,510	2	40
Yonge Street	Royal Orchard Boulevard	Centre Street	2019	50,831	73,464	73,260	5	60
Elgin Street	Yonge Street	Dudley Avenue	2019	3,391	4,750	4,790	1	40
Clark Avenue	Yonge Street	Dudley Avenue	2017	6,243	5,830	5,850	5	40
Yonge Street	Steeles Avenue East	Meadowview Avenue	2019	54,515	61,969	64,802	5	60
Steeles Avenue East	Yonge Street	Hilda Avenue	2019	43,796	30,430	27,460	5	60
Steeles Avenue East	Yonge Street	Willowdale Boulevard	2019	39,771	29,460	29,000	5	60
Yonge Street	Cummer Avenue	Turnberry Court	2019	48,401	67,263	68,504	4	60
Yonge Street	Cummer Avenue	Wedgewood Drive	2019	46,765	61,705	65,847	4	60
Cummer Avenue	Yonge Street	Hilda Avenue	2019	11,539	9,960	8,260	6	40
Drewry Avenue	Yonge Street	Silverview Drive	2019	11,638	10,210	10,400	6	40
Yonge Street	Finch Avenue	Bishop Avenue	2019	39,274	51,234	51,234	5	60
Yonge Street	Finch Avenue	Olive Avenue	2019	37,709	50,010	50,010	5	60
Finch Avenue	Yonge Street	Duplex Avenue	2019	32,003	24,190	23,330	4	50
Finch Avenue	Yonge Street	Doris Avenue	2019	27,806	22,360	22,860	4	50

Highway 407 volumes have been used in the calculations but are commercially confidential. The future 16th Avenue Traffic Volumes are derived from York Region's 16th Avenue Widening Environmental Assessment (2018).

B 3.2.3 Railway Traffic Volumes

The at grade alignment runs adjacent to the CN Bala Subdivision. The CN corridor primarily carries GO Transit and CN Freight traffic.

A less critical railway that runs perpendicular to the below grade alignment is CN's York Subdivision, which carries only freight traffic.

The existing railway traffic volumes are provided below.

Table B 3-10 Existing CN Bala Subdivision Railway Traffic

Train Type	Direction	Segment	Time Period	Trains per Period	Train Configuration	Speed (km/h)	Throttle Setting
CN	North and South	Within Study Area	Daytime	12	4 Locomotives 140 Cars	80	5
			Nighttime	4			
GO	North	Within Study Area	Daytime	6	1 Locomotives 12 Cars	88	8
			Nighttime	0			
	South	Within Study Area	Daytime	3			5
			Nighttime	3			

Table B 3-11 Existing CN York Subdivision Railway Traffic

Train Type	Direction	Segment	Time Period	Trains per Period	Train Configuration	Speed (km/h)	Throttle Setting
CN	East and West	Within Study Area	Daytime	18	4 Locomotives 140 Cars	72	5
			Nighttime	2			

Future GO Transit volumes were provided by Metrolinx. To be conservative, it is assumed that future CN traffic will remain approximately the same. This will tend to lower the ambient sound levels and increase the relative impact of new subway service in this corridor. Future volumes are summarized in

Table B 3-12.

Table B 3-12 Future CN Bala Subdivision Railway Traffic

Train Type	Direction	Segment	Time Period	Trains per Period	Train Configuration	Speed (km/h)	Throttle Setting
CN	North and South	Within Study Area	Daytime	12	4 Locomotives 140 Cars	80	5
			Nighttime	4			
GO	North	Within Study Area	Daytime	12	1 Locomotives 12 Cars	88	8
			Nighttime	1			
	South	Within Study Area	Daytime	9			5
			Nighttime	4			

Table B 3-13 Future CN York Subdivision Railway Traffic

Train Type	Direction	Segment	Time Period	Trains per Period	Train Configuration	Speed (km/h)	Throttle Setting
CN	East and West	Within Study Area	Daytime	18	4 Locomotives 140 Cars	72	5
			Nighttime	2			

B 3.3 Segment 1 – Finch Station to Clark Station

Figures 1 to 11 in **Appendix A** provide an overview of the infrastructure proposed within this segment. Refer to **Appendix B** for more detailed corridor plans/mapping and corresponding receptor locations.

B 3.3.1 Potential Impacts

Table B 3-14 provides the predicted sound levels from all stationary sources within Segment 1 (including stations, ventilation equipment, traction power substations, bus terminals, etc.). In all cases, the sound levels from the stationary sources are predicted to meet the guideline limits. Mitigation measures are not warranted.

Table B 3-14 Segment 1 Stationary Source Sound Levels

Receptor	Predicted Sound Levels (dBA $L_{eq,1hr}$)		MECP Guideline Sound Levels (dBA $L_{eq,1hr}$)		Project Component
	Daytime	Nighttime	Daytime	Nighttime	
R4	51	42	53	46	Cummer Station
R5	43	43	64	57	Cummer Station

Receptor	Predicted Sound Levels (dBA $L_{eq,1hr}$)		MECP Guideline Sound Levels (dBA $L_{eq,1hr}$)		Project Component
	Daytime	Nighttime	Daytime	Nighttime	
R6	39	39	60	53	Cummer Station
R7	49	49	63	56	Cummer Station
R8	45	45	65	58	Cummer Station
R9	54	54	63	56	Cummer Station
R12	49	42	62	55	Steeles Station
R13	52	44	67	60	Steeles Station
R14	49	42	55	47	Steeles Station
R15	48	40	57	50	Steeles Station
R16	49	42	55	48	Steeles Station
R17	39	39	68	61	Steeles Station
R18	38	34	57	50	Steeles Station
R19	41	37	58	51	Steeles Station

Table B 3-15 provides a prediction of the cumulative noise from the bus terminal at Steeles Station and the bus loop at Cummer Avenue. The cumulative noise includes the noise from the buses as well as any stationary sources of sound associated with the station or facility itself. Similarly, due to either the modest operations or the lack of nearby sensitive receptors, the bus facilities are not expected to generate a noise impact. Mitigation measures are not required.

Table B 3-15 Steeles Station Bus Terminal and Cummer Loop Sound Levels

Bus Terminal	Representative Receptor	Morning Peak Period (6:00 - 7:00)		Late Night Period (22:00 - 23:00)		Overnight Period (2:00 - 3:00)	
		Sound Levels (dBA $L_{eq,1hr}$)					
		Predicted	Guideline	Predicted	Guideline	Predicted	Guideline
Cummer Bus Loop	R4	51	54	49	53	N/A[1]	N/A
Steeles Station	R16	49	56	49	55	42	48

1. Note that the overnight period was not assessed at Cummer Station as buses are not expected to use the loop during the nighttime.

B 3.3.2 Mitigation Measures

Based on the assessment, the sound levels from the noise sources in Segment 1 are expected to meet the applicable guideline limits without further noise control measures. Inherent to the design are mitigation measures such as silencers for the tunnel ventilation system and selection of quiet mechanical and electrical equipment. Noisier equipment, for example, may require additional noise mitigation in order to meet the limits. An updated analysis will be completed as the mechanical/electrical design of the facilities progresses.

B 3.4 Segment 2 – Clark Station to Portal/Launch Shaft

Figures 12 to 22 in **Appendix A** provide an overview of the infrastructure proposed within this segment. Refer to **Appendix B** for more detailed corridor plans/mapping and corresponding receptor locations.

B 3.4.1 Potential Impacts

Table B 3-16 provides the predicted sound levels for all stationary sources associated with Segment 2, between the Portal and Clark Station. Note the impact of the portal itself will be assessed in **Section B 3.5**.

Table B 3-16 Segment 2 Stationary Source Sound Levels

Receptor	Predicted Sound Levels (dBA $L_{eq,1hr}$)		MECP Guideline (dBA $L_{eq,1hr}$)		Project Component
	Daytime	Nighttime	Daytime	Nighttime	
R22	51	45	62	55	Clark Station
R23	49	46	58	51	Clark Station
R24	60	53	59	51	Clark Station
R25	43	43	65	58	Clark Station
R26	52	52	64	57	Clark Station
R27	36	36	62	55	TPSS
R28	43	43	55	48	TPSS
R29	39	39	60	53	Royal Orchard Station
R30	54	54	64	57	Royal Orchard Station
R31	40	40	60	53	Royal Orchard Station
R32	42	42	62	55	Royal Orchard Station

As peak bus terminal volumes vary, the operational scenarios for the bus terminal at Clark Station have been assessed separately. The predicted sound levels are summarized in **Table B 3-17**. As can be seen, there is a modest 2 dB impact predicted at the worst case. This impact is entirely due to the operational noise from the bus terminal. The stationary sources associated with the station itself (such as the TPSS, tunnel ventilation systems, etc.) do not significantly contribute to this excess. Mitigation measures are discussed in the following section.

Table B 3-17 Clark Station Bus Terminal Sound Levels

Bus Terminal	Representative Receptor	Morning Peak Buses (6:00 - 7:00)		Late Night Buses (22:00 - 23:00)		Overnight Buses (2:00 - 3:00)	
		Sound Levels (dBA $L_{eq,1hr}$)					
		Predicted	Guideline	Predicted	Guideline	Predicted	Guideline
Clark Station	R24	**60**	59	57	59	**53**	51

B 3.4.2 Mitigation Measures

Based on the assessment, the sound levels from the mechanical and electrical noise sources in Segment 2 are expected to meet the applicable guideline limits without further noise control measures. Inherent to the design are mitigation measures such as silencers for the tunnel ventilation system and selection of quiet mechanical and electrical equipment. Noisier equipment, for example, may require additional noise mitigation in order to meet the limits. An updated analysis should be completed as the mechanical/electrical design of the facilities progresses.

Due to the height of the receptor (R24 is a 6-storey building), a 5.5m tall noise barrier is recommended along the north extent of the Clark Station bus terminal. With the barrier in place, the sound levels are predicted to be below or equal to the guideline limits as shown in **Table B 3-18**.

Table B 3-18 Clark Station Bus Terminal Sound Levels with Noise Barrier

Bus Terminal	Representative Receptor	Morning Peak Period (6:00 - 7:00)		Late Night Period (22:00 - 23:00)		Overnight Period (2:00 - 3:00)	
		Sound Levels (dBA $L_{eq,1hr}$)					
		Predicted	Guideline	Predicted	Guideline	Predicted	Guideline
Clark Station	R24	57	59	55	59	51	51

The predicted excess is ~ approximately 2 dB, which is relatively minor. NPC-300 requires mitigation for any excess even if it is relatively insignificant. In this case, the minor excess is predicted to be mitigated by a 5.5m tall noise barrier. Given that most agencies are moving towards electric buses, which are quieter than their diesel counterparts, the need for a noise barrier should be reviewed as the design develops during the Detailed Design phase. The noise mitigation needed could be reduced or eliminated through the increased use of electric buses.

B 3.5 Segment 3 – Portal/Launch Shaft to Moonlight Lane

Figures 22 to 30 in **Appendix A** provide an overview of the infrastructure proposed within this segment. Refer to **Appendix B** for more detailed corridor plans/mapping and corresponding receptor locations.

B 3.5.1 Potential Impacts

Table B 3-19 provides the predicted sound levels during the peak operational period of the train storage facility. As noted, the guideline limit of 55 dBA $L_{eq,1hr}$ is slightly exceeded at several receptors to the west of the storage tracks. Mitigation measures are discussed in the following section.

Table B 3-19 Predicted Sound Levels for Train Storage Facility

Receptor	Sound Levels (dBA $L_{eq,1hr}$)	MECP Guideline Limit (dBA $L_{eq,1hr}$)	Project Component
R43	48	55	TSF
R44	52	55	TSF
R45	52	55	TSF
R46	**59**	55	TSF
R47	**63**	55	TSF
R48	**56**	55	TSF
R49	**66**	55	TSF
R50	54	55	TSF
R51	49	55	TSF
R52	**56**	55	TSF
R53	52	55	TSF
R54	**56**	55	TSF
R55	55	55	TSF
R56	52	55	TSF
R57	**56**	55	TSF
R58	41	55	TSF
R59	54	55	TSF
R60	52	55	TSF

Table B 3-20 provides the predicted sound levels for the remainder of the stationary sources along the at grade alignment. Given the substantial setback between the facilities and nearby receptors, excesses are not predicted, and mitigation is not required.

Table B 3-20 Segment 3 Stationary Source Sound Levels

Receptor	Predicted Sound Levels (dBA $L_{eq,1hr}$)		Guideline (dBA $L_{eq,1hr}$)		Project Component
	Daytime	Nighttime	Daytime	Nighttime	
R40	45	35	56	49	Portal
R41	50	41	58	51	Portal
R42	48	40	61	54	High Tech Station

The nearest representative receptor to Bridge Station is more than 500m from the bus terminal. The sound levels from the Bridge Station bus terminal at that receptor are provided in **Table B 3-21**.

Table B 3-21 Bridge Station Bus Terminal Review

Bus Terminal	Representative Receptor	Morning Peak Period (6:00 – 7:00)		Late Night Period (22:00 – 23:00)		Overnight Period (2:00 – 3:00)	
		Sound Levels (dBA $L_{eq,1hr}$)					
		Predicted	Guideline	Predicted	Guideline	Predicted	Guideline
Bridge Station	R41	50	59	46	58	41	50

As noted previously, the TSF boundary is approximately at Bantry Avenue. South of Bantry Avenue is the start of the operations of the subway. The sound levels between Bantry Avenue and High Tech Station are modest due to the lack of significant subway train traffic as compared to the full volume of trains that operates between High Tech Station and the Portal. Full service starts just north of High Tech Station. The assessment has reviewed the maximum permissible train volumes as a first step. The operational sound levels from the subway are summarized in **Table B 3-22.**

Table B 3-22 Operational Subway Sound Levels (Maximum Service Levels)

Receptor	Existing		Subway Only		Future With Subway	
	Day (dBA $L_{eq,16hr}$)	Night (dBA $L_{eq,8hr}$)	Day (dBA $L_{eq,16hr}$)	Night (dBA $L_{eq,8hr}$)	Day (dBA $L_{eq,16hr}$)	Night (dBA $L_{eq,8hr}$)
R40	70	67	49	44	71	68
R41	66	60	55	50	68	62
R42	69	65	66	61	71	67
R43	67	65	56	52	68	66

Receptor	Existing		Subway Only		Future With Subway	
	Day (dBA $L_{eq,16hr}$)	Night (dBA $L_{eq,8hr}$)	Day (dBA $L_{eq,16hr}$)	Night (dBA $L_{eq,8hr}$)	Day (dBA $L_{eq,16hr}$)	Night (dBA $L_{eq,8hr}$)
R44	68	65	60	56	69	66
R45	69	66	54	51	70	67
R46	68	65	58	54	69	66
R47	68	65	48	45	68	65

Notes: **Existing** includes current noise from road and rail sound sources
Subway Only includes noise only from the subway trains
Future With Subway includes noise from subway trains, road and other rail sound sources

Table B 3-23 Error! Reference source not found. provides a comparison between the subway sound levels and the existing ambient as well as a comparison of the total future sound levels (Future With Subway) with the existing ambient. As seen in **Table B 3-22** and **Table B 3-23,** the subway does not result in an increase in the ambient sound levels present at critical receptors. The increase in the future sound levels is predominantly a result of minor service increases in GO Transit railway traffic and roadway traffic. The subway itself only results in a minor increase in sound levels at one receptor (R42). The modest increase in sound is primarily a result of the relatively quiet sound levels from electrified subway service as well as the lack of noise sensitive receptors between High Tech Station and the portal. Given the insignificant contribution of the subway sound levels (as the subway sound levels are lower than or equal to the existing sound levels), noise mitigation measures are not warranted. Similarly, the subway service is expected to comply with the $L_{eq,passby}$ limit of 80 dBA at 15m or more from normal trackwork at all receptors. The assessment has been completed based on the maximum number of trains proposed (Scenario 3). The interim scenarios would have even lower sound levels and correspondingly lower impacts. The minor increases in sound levels noted below may not be realized for several years until GO Transit ridership reaches sufficient levels.

Table B 3-23 Operational Subway Noise Impacts

Receptor	Subway vs. Existing		Future With Project vs. Existing		Future With Project vs. Without Project	
	Day (dBA $L_{eq,16hr}$)	Night (dBA $L_{eq,8hr}$)	Day (dBA $L_{eq,16hr}$)	Night (dBA $L_{eq,8hr}$)	Day (dBA $L_{eq,16hr}$)	Night (dBA $L_{eq,8hr}$)
R40	0	0	1	1	0	0
R41	0	0	2	2	0	0
R42	0	0	2	2	1	1
R43	0	0	1	1	0	0
R44	0	0	1	1	0	0
R45	0	0	1	1	0	0
R46	0	0	1	1	0	0

Receptor	Subway vs. Existing		Future With Project vs. Existing		Future With Project vs. Without Project	
	Day (dBA $L_{eq,16hr}$)	Night (dBA $L_{eq,8hr}$)	Day (dBA $L_{eq,16hr}$)	Night (dBA $L_{eq,8hr}$)	Day (dBA $L_{eq,16hr}$)	Night (dBA $L_{eq,8hr}$)
R47	0	0	0	0	0	0

Notes: **Subway vs. Existing** provides the comparison of the subway only sound levels to the existing ambient sound levels as per the MECP protocols. This indicates that the project does not generate any noise impacts based on the guidelines, even at the project's highest (most frequent) service level.

Future With Project vs. Existing compares the total future sound levels, inclusive of rail, road, and subway against the existing ambient road and railway sound levels. This demonstrates that the growth in sound levels would not be as a result of the project.

Future With Project vs. Future Without Project compares the future sound levels inclusive of rail, road, and subway against the future sound levels (inclusive of road and rail) without the subway. This similarly demonstrates that some of the increase in sound levels would occur regardless of the subway extension project.

B 3.5.2 Mitigation Measures

B 3.5.2.1 TSF Mitigation Measures

Sound levels from the TSF building and TPSS are expected to meet the applicable limits and do not require further mitigation measures. Sound levels from the TSF trackwork are predicted to exceed the guideline limit of 55 dBA $L_{eq,1hr}$ at the nearest residences. The exceedance is caused by a combination of rolling noise along tangent track, impact noise at special trackwork, and to a lesser degree the idling noise before trains depart for service.

A 5.5m high noise barrier is recommended along the western extent of the TSF area from approximately Bantry Avenue to south of 16th Avenue and is shown in the figures below. The final height and extent of the noise barrier will be subject to further refinement during the Detailed Design phase. In order to limit noise reflections, the side of the barrier facing the TSF should be acoustically absorptive.

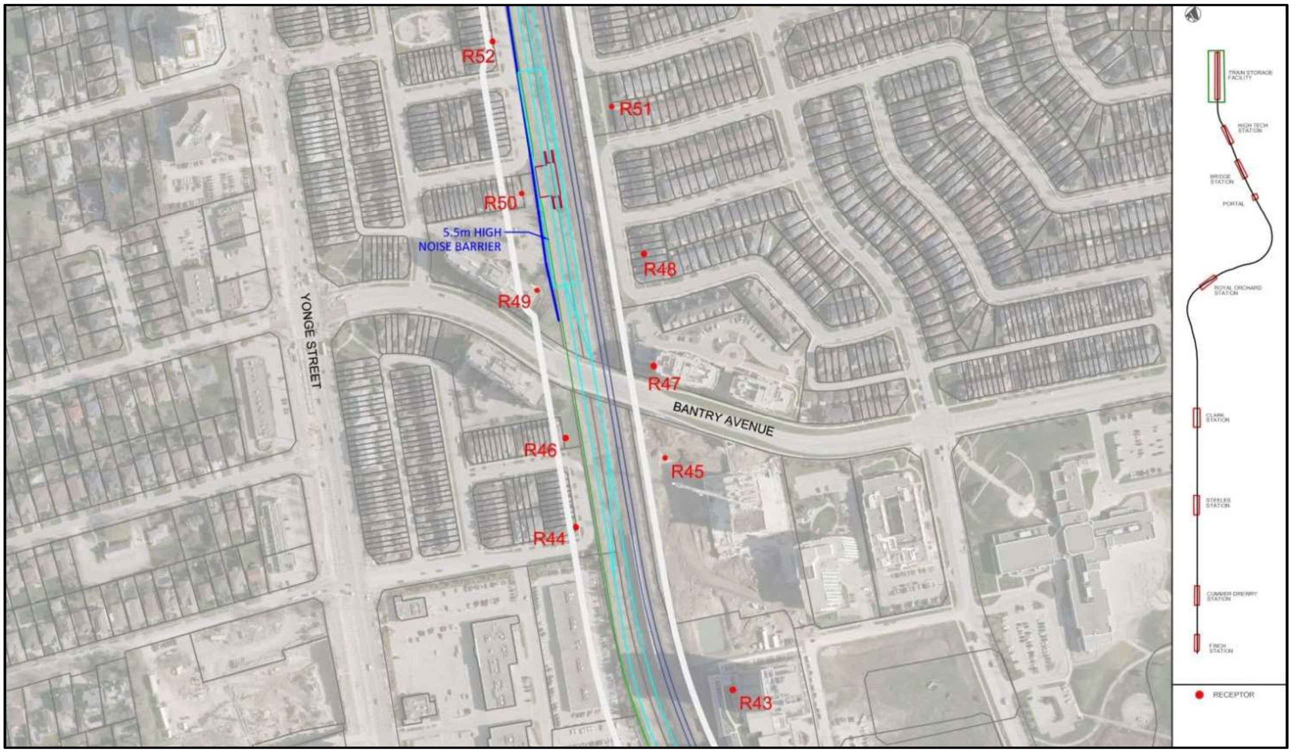

Figure B 3-1 TSF Noise Barrier Part 1

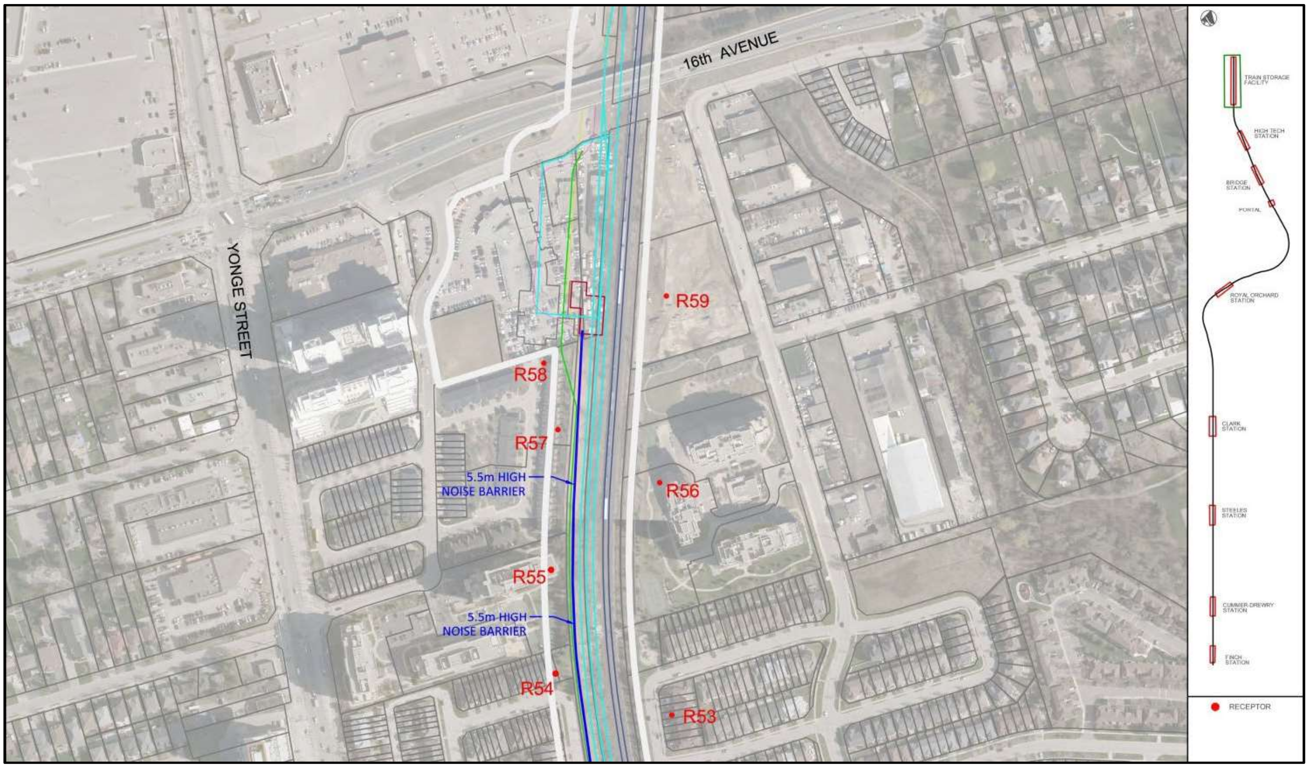

Figure B 3-2 TSF Noise Barrier Part 2

In addition, all special trackwork associated with the TSF should be provided with moveable point frogs. In traditional frogs, such as railbound manganese frogs (RBM), there is a permanent gap at the crossover. This results in a "clickety clack" type noise as vehicles pass over. Moveable point frogs have, as the name implies, moving points which close the gap and create a continuous rail. Moveable point frogs greatly reduce the impact noise generated by trains that travel across and through the special trackwork. Due to the heights of nearby apartment buildings, noise barriers alone may not be sufficient to mitigate the noise from the special trackwork.

Table B 3-24 Train Storage Facility Sound Levels with Mitigation

Receptor	Sound Levels (dBA $L_{eq,1hr}$)	MECP Guideline Limit (dBA $L_{eq,1hr}$)	Project Component
R43	38	55	TSF
R44	44	55	TSF
R45	42	55	TSF
R46	45	55	TSF
R47	48	55	TSF
R48	49	55	TSF
R49	51	55	TSF

Receptor	Sound Levels (dBA $L_{eq,1hr}$)	MECP Guideline Limit (dBA $L_{eq,1hr}$)	Project Component
R50	45	55	TSF
R51	49	55	TSF
R52	48	55	TSF
R53	52	55	TSF
R54	46	55	TSF
R55	54	55	TSF
R56	52	55	TSF
R57	49	55	TSF
R58	40	55	TSF
R59	54	55	TSF
R60	52	55	TSF

B 3.5.2.2 Facilities Mitigation Measures

Based on the assessment, the sound levels from the mechanical and electrical noise sources associated with the remaining facilities in Segment 3 (inclusive of High Tech and Bridge Stations and the Portal) are expected to meet the applicable guideline limits without further noise control measures. Inherent to the design are mitigation measures such as silencers for the tunnel ventilation system and selection of quiet mechanical and electrical equipment. Noisier equipment, for example, may require additional noise mitigation in order to meet the limits. An updated analysis should be completed as the mechanical/electrical design of the facilities progresses.

The above-grade facilities analysis has been completed to demonstrate that it is feasible to meet the noise criteria with practical mitigation measures. The locations of specific above-grade project elements are still being determined within the study area. Updated assessments will be completed in subsequent design phases to confirm mitigation measures needed for compliance with the criteria.

B 3.5.2.3 At Grade Alignment Mitigation Measures

The increases in sound levels at nearby receptors as a result of the project are minor and do not trigger the need for noise mitigation measures. This is part due to the relatively low sound levels from electric subway trains. There are also few noise sensitive receptors between High Tech Station and the Portal as the lands are predominantly commercial or industrial. As well, there are relatively few trains between the train storage facility and High Tech Station where there are more residential receptors.

B 4.0 Impact Assessment – Operational Vibration

B 4.1 Scope

The operational vibration assessment focuses on the ground-borne noise and vibration generated by subway vehicles along the proposed alignment and project facilities such as the TSF. Ground-borne vibration refers to vibration that travels through the soil that may be felt (i.e., tactile vibration). Ground-borne noise refers to ground-borne vibration that enters a building and is reradiated from that building's surfaces as noise (i.e., audible vibration, vibration-induced noise, or the "rumble" of passing trains).

For below grade transit systems, ground-borne noise is often the most critical. In most cases, ground-borne noise will reach the guideline limits before the vibration levels reach the limits for ground-borne vibration.

For at grade systems, ground-borne vibration is often the most critical. This is typically a result of the lower frequency vibration typical of tie-on-ballast tracks and the increased distance between the tracks and adjacent receptors.

The operational vibration will review the vibration generated by the below grade segment, the at grade segment, and at the TSF. Otherwise, there are no significant sources of operational vibration associated with this project.

B 4.2 Approach

There are a number of variables involved in the prediction of vibration levels. The soil conditions, presence of rock or boulders, and type of construction equipment (which includes power output and frequency of operation) all play a factor in the generation of vibration. The distance to an object and type of soil or intermediary layer affect the propagation of vibration. At the receptor, the type of building (how it is built) and the coupling of the soil to the structure play a factor in the resulting indoor vibration levels.

Operational vibration levels are calculated based on the FTA Manual's General Vibration Assessment Method. The procedure typically expresses vibration velocity in terms of vibration decibels (VdB) and converts the vibration levels into ground-borne sound levels depending on the frequency content of the sound.

The FTA manual provides the following adjustments for conversion to ground-borne noise based on the dominant frequency of vibration. These conversion factors are provided in **Table B 4-1**.

Table B 4-1 FTA Conversion Factors for Ground-borne Noise

Frequency	Conversion to Ground-borne Noise	Notes
Low (<30 Hz)	-50	Typical for subways surrounded by cohesionless sandy soil, vibration from isolated track support systems (i.e., mitigated vibration), most surface tracks (tie-on-ballast)
Mid (30 Hz to 60 Hz)	-35	Base case for most subways, surface track for when the soil is very stiff with a high clay content
High (>60 Hz)	-20	Subways when the transit structure is founded in rock or when there is the presence of stiff, clayey soil.

For at grade vibration, which is built on tie-on-ballast track, a conversion factor of -50 dB is typically used to convert the vibration velocity (expressed in VdB) to the A-weighted sound levels. Measurements of existing TTC subways at grade indicate a dominant frequency of approximately 40-50 Hz. A conversion factor of -35 dB is more appropriate in this case as a conservative adjustment.

In most vibration measurements of below grade subway systems in Toronto, the dominant frequency is between 32.5 Hz and 160 Hz where vibration isolation is not provided. It would be appropriate to use a conversion factor between -20 and -35 dB to estimate ground-borne noise from the below grade alignment. Measurements of subway systems in various locations of the GTA with vibration isolation indicate a dominant frequency of approximately 31.5-40 Hz. Some vibration energy remains in the 50-63 Hz range. Given the measurements completed along transit systems, a conversion factor of -20 dB is used to estimate ground-borne noise within in the “no mitigation case”. This is slightly conservative as it would yield a higher ground-borne noise level than using the FTA’s suggested conversion factors but is more representative of conditions measured at various locations along the existing subway network. The “with mitigation” ground-borne noise levels will vary depending on the mitigation measure (floating slab track, resilient tie block, etc.).

B 4.3 Assumptions

The following are key inputs into the calculation procedure for the operations phase:

- The subway design speed is 80 km/hr. The actual speeds are approximately 5-10 km/hr slower than the design speed.
- The subway design speed when using special trackwork is 20 km/hr.
- The speed within the TSF is 20 km/hr.
- The speed between High Tech Station and the TSF is 30 km/hr.
- All track between the portal and the terminus of the project is to be tie-on-ballast.
- To be conservative, soils are assumed to propagate vibration efficiently. According to the FTA prediction procedure, this results in 10 dB more noise and 3x as much vibration. Realistically, this is likely to overpredict the vibration levels by 2-3 dB. Detailed vibration propagation testing should be completed during Detailed Design to confirm the propagation characteristics of the soil.
- The tracks are to be continuously welded and in good repair (i.e., no corrugation).
- Vibration levels are predicted outdoors at the ground floor level as per the MECP/TTC protocol.
- Ground-borne noise levels are predicted indoors at the closest occupied floor (basements for low-rise homes and ground or second floors for multi-family dwellings or institutional uses).

B 4.4 Segment 1 – Finch Station to Clark Station

Figures 1 to 11 in **Appendix A** provide an overview of the infrastructure proposed within this segment. Refer to **Appendix B** for more detailed corridor plans/mapping and corresponding receptor locations.

B 4.4.1 Potential Impacts

Table B 4-1 provides the predicted vibration and ground-borne noise levels for representative receptors along Segment 1.

Table B 4-2 Segment 1 - Predicted Vibration Levels

Receptor	Switches Nearby	Ground-borne Vibration (mm/s RMS)			Ground-borne Noise (dBA)		
		Predicted	MOEE Limit/Guideline	Impact	Predicted	FTA Limit/Guideline	Impact
V2	No	**0.29**	0.10	0.19	**48**	35	13
R2	No	**0.28**	0.10	0.18	**48**	35	13
R3	No	**0.26**	0.10	0.16	**47**	35	12
R4	No	0.02	0.10	0	32	35	0
R5	No	**0.28**	0.10	0.18	**48**	35	13
R6	No	0.08	0.10	0	**46**	35	11
R7	No	**0.26**	0.10	0.16	**47**	35	12
R8	No	**0.30**	0.10	0.2	**49**	35	14
R9	No	**0.20**	0.10	0.1	**45**	35	10
V3	No	**0.27**	0.10	0.17	**48**	35	13
R10	No	0.05	0.10	0	**43**	35	8
R11	No	**0.12**	0.10	0.02	**50**	35	15
R12	No	**0.25**	0.10	0.15	**49**	35	14
R13	No	**0.33**	0.14	0.19	**54**	40	14
R14	Yes	**0.22**	0.10	0.12	**55**	35	20
R15	Yes	**0.19**	0.10	0.09	**54**	35	19
R16	No	**0.13**	0.10	0.03	**50**	35	15
R17	No	0.09	0.10	0	**47**	35	12
R18	No	0.04	0.10	0	**40**	35	5
R19	No	0.10	0.10	0	**48**	35	13
R20	No	**0.24**	0.10	0.14	**47**	35	12
R21	No	**0.11**	0.10	0.01	**49**	35	14
V4	No	**0.19**	0.10	0.09	**45**	35	10
V5	No	0.09	0.10	0	**38**	35	3
V6	No	**0.13**	0.10	0.03	**41**	35	6

Note: **Bolded numbers** and grey cells indicate exceedance of applicable criteria

Table B 4-2Error! Reference source not found. indicates that vibration levels may exceed the criteria by up to 0.20 mm/s for ground-borne vibration and up to 20 dBA for ground-borne noise at a number of receptors. As such, mitigation measures should be implemented to adequately control the operational vibration levels.

B 4.4.2 Mitigation Measures

Table B 4-3 summarizes the performance needed from the vibration mitigation measures in order to meet the respective limits. The analysis is conservative and may over predict the potential impacts. The indicative measures are readily available and proven technologies that are predicted to achieve required reductions and are provided to demonstrate the feasibility of meeting the criteria. During detailed design, further studies will be completed to identify location-specific mitigation measures to be used.

Table B 4-3 Segment 1 - Vibration Mitigation Recommendations

Receptor	Reduction Needed to control Ground-borne Vibration (dB)	Reduction Needed to control Ground-borne Noise (dB)	Indicative Mitigation Measures
V2	9	13	Resilient tie block
R2	9	13	Resilient tie block
R3	8	12	Resilient tie block
R4	0	0	Resilient tie block*
R5	9	13	Resilient tie block
R6	0	11	Resilient tie block
R7	8	12	Resilient tie block
R8	10	14	Resilient tie block /floating slab track
R9	6	10	Resilient tie block
V3	9	13	Resilient tie block
R10	0	8	Resilient tie block
R11	2	15	Resilient tie block
R12	8	14	Resilient tie block
R13	10	19	Resilient tie block/moveable point frogs
R14	7	20	Resilient tie block/moveable point frogs
R15	6	19	Resilient tie block/moveable point frogs
R16	2	15	Resilient tie block/moveable point frogs

Receptor	Reduction Needed to control Ground-borne Vibration (dB)	Reduction Needed to control Ground-borne Noise (dB)	Indicative Mitigation Measures
R17	0	12	Resilient tie block
R18	0	5	Resilient tie block
R19	0	13	Resilient tie block
R20	8	12	Resilient tie block
R21	1	14	Resilient tie block
V4	6	10	Resilient tie block
V5	0	3	Resilient tie block*
V6	2	6	Resilient tie block

*Different mitigation measures are not able to be transitioned in such a small area. Hence, even if mitigation is not required for a particular receptor, it is assumed to be provided due to the impacts predicted at other nearby receptors.

According to the FTA General Assessment Procedure, floating slab track can provide a reduction in vibration levels of approximately 15 dB. As such, it would be suitable to employ floating slab track (as shown in **Figure B 4-1)** in areas where reductions of 10 dB or more are needed in the vibration levels. In general, controlling ground-borne noise is more challenging than controlling ground-borne vibration. That is, achieving the ground-borne noise limits will usually result in achieving ground-borne vibration levels that are well below the limits.

For areas where such high performance is not required, alternative track vibration isolation can be considered. Resilient tie block systems consist of a series of precast concrete tie blocks (lower mass) that sit on vibration isolation pads. According to the FTA general assessment procedure, high attenuation resilient tie block (or low vibration track) can provide reductions of up to 10 dB in the overall levels. Depending on the soil propagation characteristics, reductions of 15-20 dBA can be expected in the A-weighted sound levels. There are several kinds of resilient tie block that can be used.

The existing TTC subway systems in Toronto employ a type of floating slab track known as the double tie floating slab (also referred to as a discontinuous floating slab). The floating slab consists of a series of precast concrete slabs that rest of rubber isolation pucks. The TTC double tie floating slab track has been measured to provide more than 15 dB reduction in the vibration levels as compared to the older subway systems at similar depths. The system is highly effective at controlling ground-borne noise. A reduction of more than 25 dB in the A-weighted sound levels can be achieved with this system in place. At the closest receptors, sound levels of less than 30 dBA can be expected with floating slab track in place. Again, there are a variety of floating slab configurations and types that can be used to provide the necessary vibration isolation.

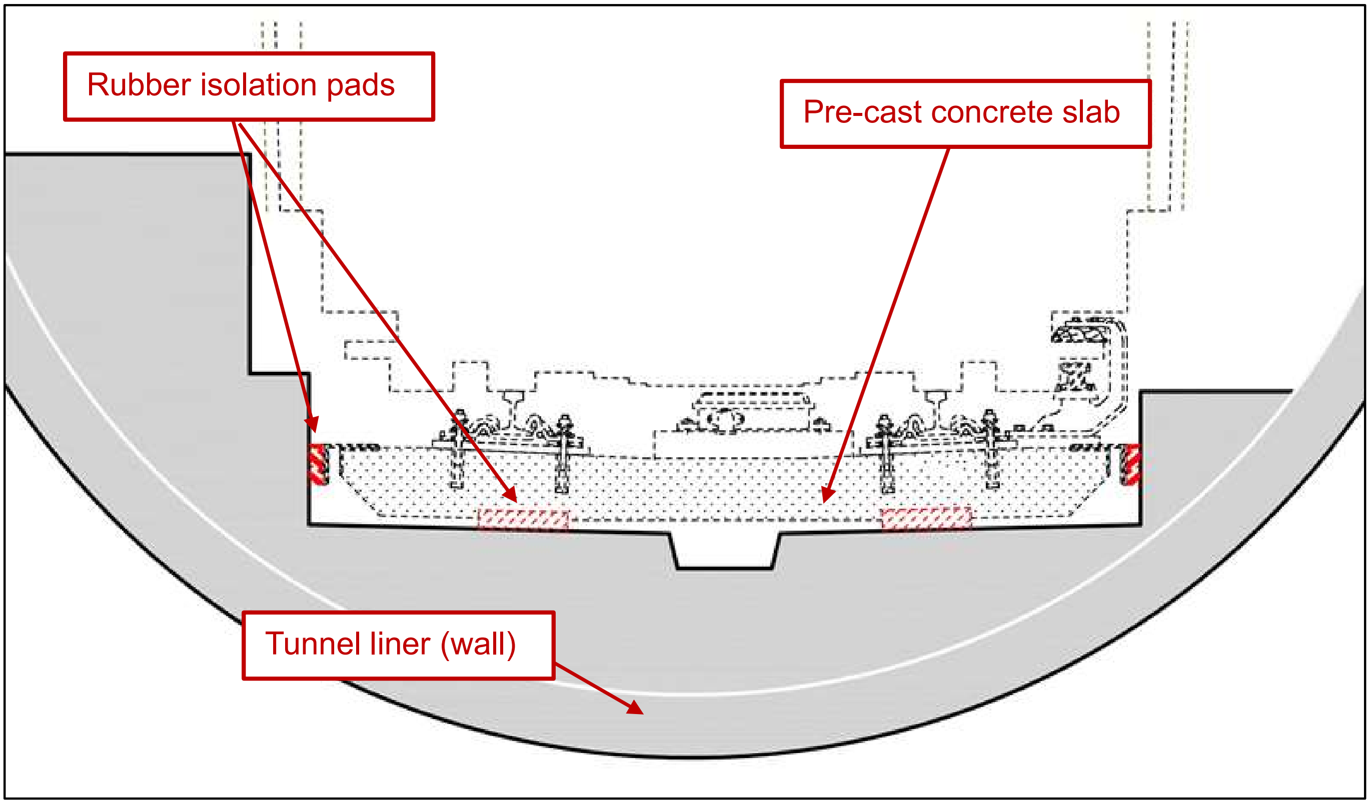

Figure B 4-1 Cross-Section of TTC Floating Slab Track

B 4.5 Segment 2 – Clark Station to Portal/Launch Shaft

Figures 11 to 22 in **Appendix A** provide an overview of the infrastructure proposed within this segment. Refer to **Appendix B** for more detailed corridor plans/mapping and corresponding receptor locations.

B 4.5.1 Potential Impacts

Table B 4-4 provides the predicted vibration and ground-borne noise levels for representative receptors along Segment 2.

Table B 4-4 Segment 2 - Predicted Vibration Levels

Receptor	Speed (km/h)	Ground-borne Vibration (mm/s RMS)			Ground-borne Noise (dBA)		
		Predicted	MOEE Limit/Guideline	Impact	Predicted	FTA Limit/Guideline	Impact
R22	80	**0.11**	0.10	0.01	**49**	35	14
R23	80	0.03	0.10	0	32	35	0
R24	80	**0.21**	0.10	0.11	**47**	35	12
R25	80	**0.24**	0.10	0.14	**49**	35	14
R26	80	**0.15**	0.10	0.05	**43**	35	8

Receptor	Speed (km/h)	Ground-borne Vibration (mm/s RMS)			Ground-borne Noise (dBA)		
		Predicted	MOEE Limit/Guideline	Impact	Predicted	FTA Limit/Guideline	Impact
V7	80	**0.21**	0.10	0.11	**50**	35	15
V8	80	**0.18**	0.10	0.08	**47**	35	12
V9	80	**0.23**	0.10	0.13	**49**	35	14
V10	80	**0.18**	0.10	0.08	**53**	35	18
R27	80	**0.17**	0.10	0.07	**52**	35	17
R28	80	0.06	0.10	0	**44**	35	9
V11	80	0.14	0.14	0	**47**	40	7
V12	80	**0.14**	0.10	0.04	**44**	35	9
R29	80	0.08	0.10	0	**44**	35	9
R30	80	**0.12**	0.10	0.02	**43**	35	8
R31	80	0.06	0.10	0	**36**	35	1
R32	80	0.11	0.14	0	**45**	40	5
V13	80	**0.13**	0.10	0.03	**41**	35	6
R33	80	**0.14**	0.10	0.04	**44**	35	9
R34	80	**0.13**	0.10	0.03	**43**	35	8
V14	80	**0.16**	0.10	0.06	**52**	35	17
R35	80	**0.19**	0.10	0.09	**53**	35	18
R36	80	**0.18**	0.10	0.08	**53**	35	18
V15	80	**0.29**	0.10	0.19	**57**	35	22
V16	80	**0.32**	0.10	0.22	**58**	35	23
V17	80	**0.31**	0.10	0.21	**58**	35	23
R37	80	**0.32**	0.14	0.18	**54**	40	14
R38	80	**0.26**	0.10	0.16	**56**	35	21
R39	80	**0.32**	0.10	0.22	**58**	35	23
R40	80	**0.22**	0.10	0.12	**55**	35	20
R41	80	0.04	0.14	0	35	40	0

Note: **Bolded numbers** and grey cells indicate exceedance of applicable criteria

While no exceedances are predicted at some receptors, **Table B 4-4** indicates that vibration levels may exceed the criteria for ground-borne vibration and ground-borne noise at other receptors. As such, mitigation measures should be implemented to adequately control the operational vibration levels. As discussed below, predicted exceedances are expected to be readily mitigatable using conventional technologies.

B 4.5.2 Mitigation Measures

Table B 4-5 below summarizes the reduction needed from the vibration mitigation measures in order to meet the respective limits. The analysis is conservative and may over predict the potential impacts. The indicative measures are readily available and proven technologies that are predicted to achieve required reductions and are provided to demonstrate the feasibility of meeting the criteria. During detailed design, further studies will be completed to identify location-specific mitigation measures to be used.

Table B 4-5 Segment 2 - Vibration Mitigation Recommendations

Receptor	Reduction Needed to control Ground-borne Vibration (dB)	Reduction Needed to control Ground-borne Noise (dB)	Indicative Mitigation Measures
R22	1	14	Resilient tie block
R23	0	0	Resilient tie block*
R24	7	12	Resilient tie block
R25	8	14	Resilient tie block
R26	4	8	Resilient tie block
V7	6	15	Resilient tie block
V8	5	12	Resilient tie block
V9	7	14	Resilient tie block
V10	5	18	Resilient tie block
R27	5	17	Resilient tie block
R28	0	9	Resilient tie block
V11	3	12	Resilient tie block
V12	3	9	Resilient tie block
R29	0	9	Resilient tie block
R30	2	8	Resilient tie block
R31	0	1	Resilient tie block*
R32	1	10	Resilient tie block
V13	2	6	Resilient tie block
R33	3	9	Resilient tie block

Receptor	Reduction Needed to control Ground-borne Vibration (dB)	Reduction Needed to control Ground-borne Noise (dB)	Indicative Mitigation Measures
R34	2	8	Resilient tie block
V14	4	17	Resilient tie block
R35	5	18	Resilient tie block
R36	5	18	Resilient tie block
V15	9	22	Floating slab track
V16	10	23	Floating slab track
V17	10	23	Floating slab track
R37	10	19	Floating slab track
R38	8	21	Floating slab track
R39	10	23	Floating slab track
R40	7	20	Floating slab track
R41	0	0	-

*Different mitigation measures are not able to be transitioned in such a small area. Hence, even if mitigation is not required for a particular receptor, it is assumed to be provided due to the impacts predicted at other nearby receptors.

According to the FTA General Assessment Procedure, floating slab track can provide a reduction in vibration levels of approximately 15 dB. As such, it would be suitable to employ floating slab track (as shown in **Figure B 4-1**) in areas where reductions of 10 dB or more are needed in the vibration levels. In general, controlling ground-borne noise is more challenging than controlling ground-borne vibration. That is, achieving the ground-borne noise limits will usually result in achieving ground-borne vibration levels that are well below the limits.

For areas where such high performance is not required, alternative track vibration isolation can be considered. Resilient tie block systems consist of a series of precast concrete tie blocks (lower mass) that sit on vibration isolation pads. According to the FTA general assessment procedure, high attenuation resilient tie block (or low vibration track) can provide reductions of up to 10 dB in the overall levels. Depending on the soil propagation characteristics, reductions of 15-20 dBA can be expected in the A-weighted sound levels. There are several kinds of resilient tie block that can be used.

The existing TTC subway systems in Toronto employ a type of floating slab track known as the double tie floating slab (also referred to as a discontinuous floating slab). The floating slab consists of a series of precast concrete slabs that rest of rubber isolation pucks. The TTC double tie floating slab track has been measured to provide more than 15 dB reduction in the vibration levels as compared to the older subway systems at similar depths. The system is highly effective at controlling ground-borne noise. A reduction of more than 25 dB in the A-weighted sound levels can be achieved with this system in place. At the closest receptors, sound levels of less than 30 dBA can be expected with floating slab track in place. As noted previously, there are a variety of floating slab configurations and types that can be used to provide the necessary vibration isolation.

The industry standard criteria for ground-borne noise and vibration at residential receptors are 35 dBA and 0.10 mm/s, respectively. In order to reduce the potential impact of tunneling under existing low-rise homes in a mature residential neighbourhood, Metrolinx is committed to achieving ground-borne noise levels of less than 30 dBA and ground-borne vibration levels of less than 0.05 mm/s. Though subject to further refinement as the design progresses, this would entail installing floating slab track approximately between the north end of Royal Orchard Station and the south end of the portal. As noted previously, based on the depths through the residential community, floating slab track can achieve sound levels of less than 30 dBA. The corresponding ground-borne vibration level would be less than 0.05 mm/s, and would be imperceptible.

B 4.6 Segment 3 – Portal/Launch Shaft to Moonlight Lane

Figures 22 to 30 in **Appendix A** provide an overview of the infrastructure proposed within this segment. Refer to **Appendix B** for more detailed corridor plans/mapping and corresponding receptor locations.

B 4.6.1 Potential Impacts

Table B 4-6 provides the predicted ground-borne noise and vibration levels for the at grade segment between the TSF and the Portal.

Table B 4-6 Segment 3 - Predicted Vibration Levels

Receptor	Switches Nearby	Track Type	Speed (km/h)	Ground-borne Vibration Level (mm/s RMS)			Ground-borne Sound Level (dBA)		
				Predicted	MOEE Limit	Excess	Predicted	FTA Limit	Excess
V18	Yes	Ballast	80	**0.54**	0.10	0.44	**50**	35	15
R42	No	Ballast	80	0.09	0.10	0	30	35	0
R43	No	Ballast	80	0.09	0.10	0	28	35	0
R44	Yes	Ballast	30	**0.28**	0.10	0.18	**47**	35	12
R45	Yes	Ballast	30	0.03	0.10	0	19	35	0
R46	Yes	Ballast	30	**0.31**	0.10	0.21	**48**	35	13
R47	No	Ballast	20	0.03	0.10	0	20	35	0
R48	No	Ballast	20	0.02	0.10	0	25	35	0
R49	Yes	Ballast	20	**0.19**	0.10	0.09	**37**	35	2
R50	Yes	Ballast	20	**0.22**	0.10	0.12	**45**	35	10
R51	Yes	Ballast	20	0.04	0.10	0	31	35	0
R52	Yes	Ballast	20	**0.18**	0.10	0.08	**43**	35	8
R53	No	Ballast	20	0.03	0.10	0	26	35	0
R54	No	Ballast	20	0.07	0.10	0	34	35	0

Receptor	Switches Nearby	Track Type	Speed (km/h)	Ground-borne Vibration Level (mm/s RMS)			Ground-borne Sound Level (dBA)		
				Predicted	MOEE Limit	Excess	Predicted	FTA Limit	Excess
R55	No	Ballast	20	0.06	0.10	0	27	35	0
R56	No	Ballast	20	0.02	0.10	0	17	35	0
R57	No	Ballast	20	0.06	0.10	0	34	35	0
R58	No	Ballast	20	0.05	0.10	0	33	35	0
R59	No	Ballast	20	0.03	0.10	0	27	35	0
R60	Yes	Ballast	20	0.04	0.10	0	29	35	0

Note: **Bolded numbers** and grey cells indicate exceedance of applicable criteria

As seen in the table above, the vibration levels exceed the criteria at several receptors along the alignment, both for ground-borne vibration and for ground-borne noise, mitigation measures have been investigated. These are reviewed in the next section.

B 4.6.2 Mitigation Measures

The vibration levels from the TSF and at grade alignment are generally predicted to be below the limits except for areas where there are existing residential uses or other sensitive uses located close to special trackwork. In these areas, reductions of up to 10 dB are needed in order to meet the limits for ground-borne vibration and noise. This can typically be achieved by ballast mats. As the noise impact assessment (**Section B 3.0**) indicated that moveable point frogs were needed to control air borne noise, the combination of ballast mats and moveable point frogs is expected to be sufficient to control the ground-borne noise and vibration levels from the TSF.

Higher vibration levels are also expected at V18 (a theatre) due to the proximity of the tracks and the nearby switches. A combination of ballast mats and monoblock frogs can be used to achieve an overall 15 dB reduction in the sound levels. In terms of controlling vibration levels, a combination of ballast mats and monoblock frogs would be sufficient to meet the limits at the theatre.

The noise and vibration aspects of special trackwork, including the locations of such features, will be reviewed further during detailed design.

Table B 4-7 below summarizes the reduction needed from the vibration mitigation measures in order to meet the respective limits. The analysis is conservative and may over predict the potential impacts. The indicative measures are conventional technologies that are predicted to achieve required reductions and are provided to demonstrate feasibility using conventional technologies. During detailed design, further studies will be completed to identify location-specific mitigation measures to be used.

Table B 4-7 Segment 3 - Vibration Mitigation Recommendations

Receptor	Reduction Needed to control Ground-borne Vibration (dB)	Reduction Needed to control Ground-borne Noise (dB)	Indicative Mitigation Measures
V18	15	15	Ballast mat/monoblock or moveable point frog
R42	0	0	-
R43	0	0	-
R44	9	12	Ballast mat/moveable point frog
R45	0	0	-
R46	10	13	Ballast mat/moveable point frog
R47	0	0	-
R48	0	0	-
R49	6	2	Moveable point frog
R50	7	10	Ballast mat/moveable point frog
R51	0	0	-
R52	5	8	Moveable point frog
R53	0	0	-
R54	0	0	-
R55	0	0	-
R56	0	0	-
R57	0	0	-
R58	0	0	-
R59	0	0	-
R60	0	0	-

In terms of controlling vibration levels, implementation of a combination of ballast mats and monoblock frogs is anticipated to meet the limits. As noted in the Operational Noise Assessment (**Section B 3.0**), moveable point frogs are needed to control the air-borne sound levels. As such, they are assumed to be provided to control the vibration levels as well. The noise and vibration aspects of special trackwork, including the specific locations of such features, will be reviewed further during detailed design.

B 5.0 Impact Assessment – Construction Noise and Vibration

The impact of construction noise and vibration on nearby receptors has been reviewed. As the project has not reached the Detail Design stage, specifics of equipment to be used in the construction process have not been determined.

Receptor-based limits on construction noise have not been developed by the MECP. For the purposes of this assessment, receptor-based limits outlined in **Section B 2.1.2** were used.

The following sections will review the potential sound levels during construction, during the daytime and nighttime, derived using a conservative approach (further discussed in **Section B 5.2**). Noise and vibration mitigation measures will be recommended where feasible, in order to reduce the impact of construction noise and vibration on adjacent receptors. This impact assessment will be updated prior to commencement of construction using the most up-to-date information on construction methods and equipment, as required.

B 5.1 Scope

The assessment will focus on predicting the general construction sound levels at nearby receptors. Construction activity is typically very variable. Equipment on construction sites are rarely used continuously. On many sites, the equipment also moves around, resulting in a moving-point source. This would mean that sound levels could be lower at one receptor at one point of the day and higher at another, and the reverse at another time of day. As the specifics of construction sequencing and staging are yet unknown, only a general assessment can be completed.

The FTA guideline provides sound levels for typical equipment used in construction activity. Similarly, the US Federal Highway Administration (FHWA) also publishes equipment sound levels and typical usage factors (given that most equipment does not run continuously for hours and hours at a time). Construction equipment measurement data from recent projects has been used as well.

The sound levels at receptors have been calculated based on the typical equipment used, the usage factor for such equipment, and the location of the equipment within the work zones.

The proposed subway will involve several different facilities and construction approaches. The components of the construction include:

1. Subway tunnels and trackwork
2. At grade alignment and trackwork
3. Below grade stations and associated surface structures (including traction power substations and bus terminals)
4. At grade stations and other at grade structures (including traction power substations and bus terminals)
5. Emergency exit buildings
6. Train storage facility
7. Launch shaft and portal structure

B 5.2 Assumptions

Stations such as Cummer Station, Clark Station, and Steeles Station were assumed to be constructed using a top-down or cut-and-cover method. Given the depth, Royal Orchard Station was assumed to be built using the sequential excavation method (SEM). Bridge Station and High Tech Station, by virtue of being at grade, were assumed to be simpler to construct and involve fewer construction equipment.

The precise locations, layouts, and extents of construction staging and laydown areas have not been identified at this stage in project planning. Preliminary areas for the purposes of this assessment were assumed based upon typical construction activities and previous projects. Construction equipment used at various phases of construction have been determined based on experience from past subway construction projects. Only major stages of construction have been reviewed at this time.

The following tables outline the assumed construction phases and equipment for the project components.

Table B 5-1 Typical Equipment Used for Below Grade Stations

Construction Equipment	Sound Level Assumed at 15m (dBA)	Site Preparation	Shoring	Excavation	Concrete Forming	Restoration
Auger Drill Rig	85	-	2	-	-	-
Anchor Drill Rig	80	-	-	1	-	-
Backhoe w/hammer	90	1	-	-	-	-
Compactor	80	1	-	-	-	1
Compressors	76	-	-	2	2	-
Concrete Pump Truck	82	-	-	-	2	-
Concrete Trucks	80	-	2	-	4	-
Dozer	80	-	-	-	-	1
Dump Trucks	78	1	2	4	-	4
Excavator	80	-	-	2	-	-
Generator	70	-	-	2	2	-
Grader	80	-	-	-	-	1
Hydrovac Truck	82	1	-	-	-	-
Loader	80	-	2	-	-	-
Mobile Crane	78	1	2	1	1	-
Paver	80	-	-	-	-	1
Roller	80	-	-	-	-	1
Saw Cutting Equipment	90	1	-	-	-	-
Tower Crane	75	-	-	1	1	-

Construction Equipment	Sound Level Assumed at 15m (dBA)	Site Preparation	Shoring	Excavation	Concrete Forming	Restoration
Ventilation Fans	75	-	-	2	2	-

Table B 5-2 Typical Equipment for SEM Stations

	Sound Level Assumed at 15m (dBA)	Site Preparation	Shoring	Excavation	Concrete Forming	Restoration
Auger Drill Rig	85	-	2	-	-	-
Anchor Drill Rig	80	-	-	1	-	-
Backhoe w/hammer	90	1	-	-	-	-
Compactor	80	1	-	-	-	1
Compressors	76	-	-	2	2	-
Concrete Pump Truck	82	-	-	-	2	-
Concrete Trucks	80	-	2	-	4	-
Dozer	80	-	-	-	-	1
Bin Truck	80	-	-	4	-	-
Dump Trucks	78	1	2	4	-	4
Excavator	80	-	-	2	-	-
Generator	70	-	-	2	2	-
Grader	80	-	-	-	-	1
Hydrovac Truck	82	1	-	-	-	-
Loader	80	-	2	-	-	-
Mobile Crane	78	1	2	1	1	-
Paver	80	-	-	-	-	1
Roller	80	-	-	-	-	1
Saw Cutting Equipment	90	1	-	-	-	-
Gantry Crane	75	-	-	2	2	-
Ventilation Fans	75	-	-	2	2	-

Table B 5-3 Typical Equipment Used for At Grade Stations and Other At Grade Structures

Construction Equipment	Sound Level Assumed at 15m (dBA)	Site Preparation	Shoring	Excavation	Concrete Forming	Restoration
Auger Drill Rig	85	-	2	-	-	-
Anchor Drill Rig	80	-	-	1	-	-
Backhoe w/hammer	90	1	-	-	-	-
Compactor	80	1	-	-	-	-
Compressors	76	-	-	2	2	2
Concrete Pump Truck	82	-	-	-	2	-
Concrete Trucks	80	-	2	-	4	-
Dozer	80	-	-	-	-	1
Dump Trucks	78	1	2	4	-	4
Excavator	80	1	-	2	-	-
Generator	70	1	-	2	2	2
Grader	80	-	-	-	-	-
Hydrovac Truck	82	1	-	-	-	-
Loader	80	-	2	-	-	-
Mobile Crane	78	-	2	2	2	1
Paver	80	-	-	-	-	1
Roller	80	-	-	-	-	1
Saw Cutting Equipment	90	1	-	-	-	-

Table B 5-4 Typical Equipment Used for EEBs

Construction Equipment	Sound Level Assumed at 15m (dBA)	Site Preparation	Shoring	Excavation	Concrete Forming	Restoration
Auger Drill Rig	85	-	1	-	-	-
Anchor Drill Rig	80	-	-	1	-	-
Backhoe w/hammer	90	1	-	-	-	-
Compactor	80	1	-	-	-	1
Compressors	76	-	-	1	1	-

Construction Equipment	Sound Level Assumed at 15m (dBA)	Site Preparation	Shoring	Excavation	Concrete Forming	Restoration
Concrete Pump Truck	82	-	-	-	1	-
Concrete Trucks	80	-	1	-	4	-
Dozer	80	-	-	-	-	-
Dump Trucks	78	1	1	4	-	2
Excavator	80	1	-	1	-	-
Generator	70	-	-	1	1	-
Grader	80	-	-	-	-	-
Hydrovac Truck	82	1	-	-	-	-
Loader	80	-	1	-	-	-
Mobile Crane	78	-	1	1	1	1
Paver	80	-	-	-	-	1
Roller	80	-	-	-	-	1
Saw Cutting Equipment	90	1	-	-	-	-

Table B 5-5 Typical Equipment for Launch Shaft and Tunnelling

Construction Equipment	Sound Level Assumed at 15m (dBA)	Site Preparation	Shoring	Excavation	Concrete Forming	Tunneling	Restoration
Auger Drill Rig	85	-	3	-	-	-	-
Anchor Drill Rig	80	-	-	1	-	-	-
Backhoe w/hammer	90	1	-	-	-	-	-
Compactor	80	1	-	-	-	-	1
Compressors	76	-	-	2	2	2	-
Concrete Pump Truck	82	-	-	-	2	2	-
Concrete Trucks	80	-	4	-	6	8	-
Dozer	80	-	-	-	-	-	1
Dump Trucks	78	1	4	6	-	8	4

Excavator	80	-	-	2	-	2	-
Generator	70	-	-	2	2	-	-
Grader	80	-	-	-	-	-	1
Hydrovac Truck	82	1	-	-	-	-	-
Loader	80	-	3	-	-	2	-
Mobile Crane	78	1	2	2	2	2	-
Paver	80	-	-	-	-	-	1
Roller	80	-	-	-	-	-	1
Saw Cutting Equipment	90	1	-	-	-	-	-
Tower Crane	75	-	-	-	1	1	-
Ventilation Fans	75	-	-	-	-	2	-

Table B 5-6 Typical Equipment for At Grade Alignment

Construction Equipment	Sound Level Assumed at 15m (dBA)	Site Preparation	Track Installation
Compactor	80	1	-
Chainsaw/Chippers	85	1	-
Dozer	80	1	-
Dump Trucks	78	2	-
Hydrovac Truck	82	1	-
Mobile Crane	78	-	1
Speed Swing	85	-	1
Mark VI Tamper	85	-	1
Rail Ballast Regulator	85	-	1
Thermite Welder	73	-	1

Table B 5-7 Typical Equipment Used at Extraction Shaft

Construction Equipment	Sound Level Assumed at 15m (dBA)	Site Preparation	Shoring	Excavation	Restoration
Auger Drill Rig	85	-	1	-	-
Anchor Drill Rig	80	-	-	1	-

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Construction Equipment	Sound Level Assumed at 15m (dBA)	Site Preparation	Shoring	Excavation	Restoration
Backhoe w/hammer	90	1	-	-	-
Compactor	80	1	-	-	1
Compressors	76	-	-	2	-
Concrete Pump Truck	82	-	-	-	-
Concrete Trucks	80	-	1	-	-
Dozer	80	-	-	-	1
Dump Trucks	78	2	1	4	2
Excavator	80	-	-	2	-
Generator	70	-	-	2	-
Grader	80	-	-	-	1
Hydrovac Truck	82	1	-	-	-
Loader	80	-	1	-	-
Mobile Crane	78	1	1	1	-
Paver	80	-	-	-	1
Roller	80	-	-	-	1
Saw Cutting Equipment	90	1	-	-	-

The various construction stages for above components are described below.

- **Site preparation**: In preparation for the construction of the stations, emergency exit buildings, extraction shaft, and ancillary facilities, medians and curbs will need to be removed and utilities and traffic lights will need to be identified and relocated. This could potentially include demolition of buildings, once such buildings have been identified as required for the project’s construction. This phase of work involves equipment such as a backhoe (with hammer attachment), dump trucks, saw cutting equipment, compactors, mobiles cranes and hydrovac trucks. For the At-grade alignment, launch shaft, and portal section, site preparation will consist of clearing the current vegetation and subsequently grading the area to allow for the TBM installation and track installation. In addition to the equipment used above, chain saws and chippers will be used to clear the vegetation.
- **Shoring**: Prior to excavation of the station box, a combination of soldier piles and lagging/secant piles using drilled caissons will be used to support the adjacent soil and prevent collapse. This phase of work involves the use of auger drill rigs, loaders, dump trucks, concrete trucks, and mobile cranes.
- **Excavation**: Once shoring is completed, excavation (including removal of asphalt topping and roadbed) will begin. Excavation involves removing the soil down to the station depth. This phase of works involves excavators, dump trucks, anchor drill rigs, mobile/tower/gantry cranes, generators and compressors.

- **Concrete Forming**: Once excavation is complete, concrete forming of the station box begins. This phase of work involves concrete trucks, concrete pump trucks, mobile/tower/gantry cranes, generators, compressors and ventilation fans. Cranes will typically be located at ground level, mainly around the future entrance.
- **Restoration**: Once the station structures and ancillary facilities have been completed the roadways will need to be repaved and surrounding areas landscaped and restored. This phase of work involves standard roadway construction equipment such as pavers, rollers, dump trucks and compactors.
- **Tunneling**: Tunnel boring machines used to construct the tunnels will be installed at the launch shaft. The soil extracted by the TBM's is assumed to be carried by rail cars operating on temporary rails to the launch shaft where it is extracted using conveyor systems. Simultaneously tunnel liners used to support the soil above the tunnels are transported from the surface to the TBM face using the service rail cars. This phase of work involves concrete trucks, concrete pump trucks, dump trucks, excavators, loaders, mobile cranes, and compressors, all located at the launch shaft.

  Track Installation: Rail track will be installed in the above grade section between the portal and the TSF. This phase of work involves the use of standard railway construction equipment such as a rail ballast regulator, rail tamper, speed swing, thermite welding, dump trucks and mobile crane.

B 5.3 Construction Noise Assessment

At this level of design, detailed construction staging plans and laydown areas have not been developed. The precise locations, layouts and extents of construction staging and laydown areas have not been identified at this stage in project planning. Construction sound levels have been predicted based on preliminary areas, typical construction activities and previous projects proposed. Further assessments can be completed as the design progresses during subsequent phases of the project to include final site plans and construction methods.

Construction noise is highly variable as construction activity tends to ebb and flow during various stages and times of day. Adjustments such as equipment duty cycle (i.e., how much time a particular piece of equipment operates) have been made to the equipment sound levels to generate the average daytime exposure. Equipment such as drill rigs do not operate continuously at the same sound level. Some equipment, such as generators or compressors, can operate for longer periods at a time.

Construction equipment sound levels are based on measured data, reference data from the FHWA and/or FTA, or NPC-115, where applicable.

B 5.3.1 Segment 1 – Finch Station to Clark Station

Table B 5-8 provides the predicted sound levels for construction activities between the Cummer Station and Finch Station. Without mitigation, sound levels are expected to be elevated in areas where construction is occurring close to residential receptors. Without mitigation, the phase with the highest predicted sound levels is predicted to be the shoring phase of work. As noted previously, construction noise is variable. The predicted sound levels are a representation of worst-case periods when construction equipment is operating nearby. Sound levels will typically be lower during a majority of construction activity with each phase of construction.

Table B 5-8 Segment 1 Construction Sound Levels

Receptor	Site Preparation	Shoring	Excavation	Concrete Forming	Restoration
R1	75	N/A	75	74	76
R2	72	70	64	66	68
R3	75	81	75	73	76
R4	74	57	70	67	73
R5	74	79	75	71	74
R6	75	83	75	75	75
R7	74	83	75	76	75
R8	76	84	75	76	76
R9	77	84	76	76	76
R10	70	70	64	66	69
R11	70	70	65	68	70
R12	65	62	61	60	61
R13	67	65	66	62	62
R14	64	64	61	63	68
R15	69	72	71	71	67
R16	69	72	71	71	69
R17	74	73	72	73	75
R18	58	61	56	57	54
R19	65	66	64	66	62
R20	70	70	66	68	71
R21	75	81	75	73	76

B 5.3.2 Segment 2 – Clark Station to Portal/Launch Shaft

Table B 5-9 Error! Reference source not found. provides the predicted sound levels for construction activities between the Portal/Launch Shaft and Clark Station. Without mitigation, sound levels are expected to be elevated in areas where construction is occurring close to residential receptors. Without mitigation, the phase with highest predicted sound levels is predicted to be the shoring phase of work. As noted previously, construction noise is variable. Hence, the predicted sound levels are a representation of worst-case periods when construction equipment is operating nearby. Sound levels will typically be lower during a majority of construction activity with each phase of construction.

Table B 5-9 Segment 2 Construction Sound Levels

Receptor	Site Preparation	Shoring	Excavation	Concrete Forming	Restoration
R22	73	77	71	72	76
R23	70	69	66	66	65
R24	73	78	76	71	74
R25	72	81	76	74	75
R26	76	82	77	75	74
R27	68	69	64	66	64
R28	73	75	70	69	70
R29	72	71	66	68	66
R30	76	85	77	75	73
R31	72	70	66	66	65
R32	71	71	65	71	68
R35	73	76	73	75	75
R36	74	84	76	76	74
R37	76	78	73	76	73
R38	76	82	76	75	75
R39	73	76	71	74	74

B 5.3.3 Segment 3 – Portal/Launch Shaft to Moonlight Lane

Error! Reference source not found. provides the predicted sound levels at receptors closest to the Launch Shaft/Portal during both preparation of the Launch Shaft as well as during tunneling operations. Given the distance between the launch shaft area and existing receptors, excesses over the construction sound level limits are not expected.

Table B 5-10 Launch Shaft/Portal Construction Sound Levels

Receptor	Site Preparation	Shoring	Excavation	Concrete Forming	Tunneling	Track Installation	Restoration
R40	55	58	52	54	54	50	55
R41	58	61	55	57	58	54	61

Table B 5-11 provides the predicted sound levels during construction activities between the TSF and the Portal/Launch Shaft. Without mitigation, sound levels are expected to be elevated during most phases of construction activity. The ambient sound levels are relatively high along the railway corridor which will reduce the noise impact from construction activities. Note that at Receptors R43 to R54, the only applicable construction phases are site preparation and track installation as there are no ancillary facilities or other project elements proposed near these receptors.

Table B 5-11 TSF and At Grade Construction Sound Levels

Receptor	Site Preparation	Shoring	Excavation	Concrete Forming	Restoration	Track Installation
R42	70	72	69	71	69	71
R43	71	N/A[1]				69
R44	74					74
R45	68					68
R46	76					73
R47	75					74
R48	73					72
R49	76					76
R50	72					75
R51	75					74
R52	76					75
R53	72					71
R54	75					77
R55	75	60	58	62	51	76
R56	73	63	61	64	53	74
R57	73	62	64	66	55	72
R58	75	74	72	73	76	61
R59	69	68	64	64	62	66
R60	68	52	49	51	59	69

1. These phases of construction are not applicable to these receptors as construction associated with these phases is not expected to occur near those receptors.

B 5.3.4 Construction Noise Mitigation and Monitoring

Construction activities are a temporary condition and construction noise ceases once construction is complete. While the predicted sound levels are conservative, they indicate that, without mitigation, certain phases of construction are expected to exceed the noise limits used in this assessment. Mitigation measures to reduce construction noise levels, and corresponding monitoring activities are outlined in **Section B 6.0**.

B 5.4 Construction Vibration Assessment

B 5.4.1 Scope and Approach

As noted in the previous section, there will be several different phases of work associated with all surface construction activities. Tunnelling and tunneling support activities, while not a source of airborne noise along the below grade alignment, will generate ground-borne vibration and noise. The following section outlines the predicted vibration levels, and where appropriate, ground-borne noise levels, resulting from construction activities for the proposed alignment.

Similar to the noise assessment, the details of construction methods and approach have not been finalized. Much of the actual approach used will depend on the contractor's designs and approaches. A preliminary vibration assessment has been completed in order to document the potential vibration levels and recommend mitigation and monitoring, where appropriate, and will be updated/refined prior to construction based on the most up-to-date information regarding construction methods and equipment, as required.

The FTA provides typical vibration levels for various pieces of equipment and a formula in which to calculate the vibration levels at various distances. This simple formula for attenuation with distance attempts to simplify the relationship that soil conditions and associated soil damping have on construction vibration. The reference vibration levels for hydraulic breakers were obtained from Caltrans as the levels correlate with field measurements of hydraulic breakers. Vibration sources levels were also derived and confirmed via measurements from experience on similar scale subway construction projects.

The vibration assessment is broken down into two categories: surface construction and tunnelling.

B 5.4.2 Surface Construction Assessment

For all surface construction, the vibration levels are typically dominated by two types of equipment: vibratory compactors and hydraulic breakers. Vibratory compactors encompass drum rollers, ballast tampers, plate tampers and other such equipment that are intended to compact soil via oscillating motion. Hydraulic breakers include vibratory hammers, chippers, hoe rams, etc., which are used to break concrete, asphalt, etc.

Since most, if not all, surface construction will include the use of vibratory compactors and/or hydraulic breakers, the potential vibration impact can be reviewed by calculating the vibration levels from these two activities. Of the equipment used on such projects, these two pieces of equipment typically produce the highest vibration levels. All other equipment produces lower vibration levels and would be expected to meet the applicable criteria assuming the vibratory compactors and hydraulic breakers also meet the limits.

As noted in **Section B 2.1.2.2**, the construction vibration zone-of-influence (ZOI) is defined as the area where vibration levels from construction are expected to equal or exceed 5 mm/s PPV. In terms of perceptible vibration, a ZOI of 0.14 mm/s RMS is used.

Table B 5-12 provides the various setbacks at which specific pieces of equipment produce peak particle velocities of 5 mm/s. The ZOI will be approximately 9m for hydraulic breakers and vibratory rollers, 5m for auger drill rigs and dozers and 3m for most other equipment.

The recommended limit for vibration in areas where people normally sleep is 0.14 mm/s RMS. This limit will provide an indication when vibration is likely to be perceived at receptors, even when there is no potential for structural damage. The peak particle vibration levels have been converted to root-mean square vibration levels using a conversion factor of approximately 0.25. **Table B 5-12** also provides the various setbacks at which specific pieces of equipment produce vibrations levels of 0.14 mm/s RMS. The calculated setbacks would indicate that nearly all equipment used could result in vibration levels potentially causing perceptible vibration when used in close proximity to structures. Vibratory equipment such as hydraulic breakers and compactors may generate vibration levels that could be perceived more than 60m away. Note that such equipment may not be used continuously or during all phases of construction.

Table B 5-12 Zone of Influence Setbacks

Construction Equipment	Setback Needed to Achieve 5 mm/s PPV (m)	Setback Needed to Achieve 0.14 mm/s RMS (m)
Hydraulic Breaker	9.0	65
Compactor	8.0	60
Auger Drill Rig	4.5	27
Bulldozer	4.5	27
Loaded Trucks	3.2	23
Jackhammer	1.6	12

The construction vibration analysis indicates there are several structures/buildings within the construction vibration ZOI and more within the perceptible vibration ZOI. Note that just because buildings are within the ZOI does not mean they are likely to suffer damage. They will however need to be reviewed and potentially monitored to ensure vibration levels do not reach those required for damage. Mitigation measures are discussed in **Section B 5.4.5**.

B 5.4.3 Tunnel Construction Assessment

During tunnel construction, there are two primary sources of noise and vibration: the TBMs and the temporary service locomotives. Temporary service locomotives are used to ferry tunnel liner segments and other materials to and from the TBM throughout the tunnelling phase. In some cases, the contractors may be able to use rubber tired multi-service vehicles. These vehicles produce minimal vibration levels. More commonly, contractors use locomotives and rail cars that operate on temporary rails. The rail cars are similar to subways in terms of operation vibration as the vibration is generated by the wheel-rail interaction. The rail is installed directly to the concrete tunnel liner. The rail is installed along with the TBM advance, and therefore there is often no time to weld the rails. The jointed rail is a common source of vibration and often the most critical since the service locomotives operate continuously throughout the tunneling process. This assessment has been completed conservatively, assuming temporary service locomotives operate on a rail-based system. The TBMs, while also continuous, pass by a given area in a matter of days. As such, any elevated vibration levels are temporary and transient.

TBM vibration levels can vary widely depending on soil composition. Vibration levels will tend to be elevated when drilling through rock or headwalls. Peak particle velocities from the TBM have been estimated using the Transportation Research Library's (TRL) Report 429, "Groundborne vibration caused by mechanised construction works". The predicted vibration levels are shown in **Table B 5-13**. The root mean square vibration velocities are calculated based on a crest factor of 4. As noted previously, the peak particle velocities represent the response of structures while the root mean square velocities are representative of human response.

Table B 5-13 Predicted TBM Vibration Levels

Receptor	Lower Range TBM Vibration (mm/s PPV)	Upper Range TBM Vibration (mm/s PPV)	Lower Range TBM Vibration (mm/s RMS)	Upper Range TBM Vibration (mm/s RMS)
R3	0.32	3.25	0.08	0.81
R4	0.02	0.19	0.00	0.05
R5	0.33	3.34	0.08	0.84
R6	0.08	0.75	0.02	0.19
R7	0.31	3.05	0.08	0.76
R8	0.37	3.68	0.09	0.92
R9	0.22	2.16	0.05	0.54
V3	0.33	3.31	0.08	0.83
R10	0.05	0.52	0.01	0.13
R11	0.12	1.22	0.03	0.31
R12	0.31	3.09	0.08	0.77
R13	0.44	4.37	0.11	1.09
R14	0.12	1.24	0.03	0.31
R15	0.11	1.07	0.03	0.27
R16	0.13	1.31	0.03	0.33
R17	0.09	0.91	0.02	0.23
R18	0.04	0.41	0.01	0.10
R19	0.09	0.93	0.02	0.23
R20	0.27	2.70	0.07	0.67
R21	0.11	1.08	0.03	0.27
V4	0.20	1.97	0.05	0.49
V5	0.09	0.86	0.02	0.22
V6	0.13	1.27	0.03	0.32
R22	0.11	1.11	0.03	0.28
R23	0.03	0.35	0.01	0.09
R24	0.24	2.40	0.06	0.60
R25	0.29	2.88	0.07	0.72
R26	0.16	1.61	0.04	0.40
V7	0.23	2.33	0.06	0.58

Receptor	Lower Range TBM Vibration (mm/s PPV)	Upper Range TBM Vibration (mm/s PPV)	Lower Range TBM Vibration (mm/s RMS)	Upper Range TBM Vibration (mm/s RMS)
V8	0.20	1.99	0.05	0.50
V9	0.25	2.53	0.06	0.63
V10	0.19	1.89	0.05	0.47
R27	0.17	1.72	0.04	0.43
R28	0.06	0.61	0.02	0.15
V11	0.13	1.30	0.03	0.33
V12	0.14	1.41	0.04	0.35
R29	0.07	0.72	0.02	0.18
R30	0.12	1.16	0.03	0.29
R31	0.06	0.56	0.01	0.14
R32	0.10	1.02	0.03	0.26
V13	0.12	1.17	0.03	0.29
R33	0.13	1.31	0.03	0.33
R34	0.12	1.21	0.03	0.30
V14	0.15	1.53	0.04	0.38
R35	0.18	1.83	0.05	0.46
R36	0.18	1.81	0.05	0.45
V15	0.32	3.23	0.08	0.81
V16	0.36	3.57	0.09	0.89
V17	0.34	3.36	0.08	0.84
R37	0.36	3.57	0.09	0.89
R38	0.30	3.00	0.08	0.75
R39	0.36	3.57	0.09	0.89
R40	0.25	2.48	0.06	0.62

In most cases, the TBM is expected to operate in softer soils. As such, the lower range of vibration levels are likely to be more typical. Even when drilling through rock, the vibration levels from the TBM are expected to be well below the threshold of 5 mm/s PPV for typical wood-framed/non-engineered buildings. Based on the typical vibration levels, the TBM vibration is expected to be well below the levels required for structural damage. This is to be expected due to the depth of the tunnel and due to the nature of the TBM vibration.

The TBM vibration levels may be felt, though clear perception is unlikely in areas with soft soils.

Ground-borne noise associated with TBMs is usually very low unless drilling through rock. In either case, the dominant frequency of vibration is often low (less than 30 Hz). Based on the range above, the ground-borne noise levels may range from 22 dBA at the lowest to 42 dBA at the highest (i.e., when drilling through rock).

As noted, the vibration levels from the service locomotive are similar to those from rapid transit systems. While sometimes lighter (on a per axle load), the vehicles have stiffer suspensions. The source vibration levels predicted below are similar to those measured by Hatch (Tunnelling Construction Noise and Vibration Impact Study, 2016) at similar setbacks and depths. It should be noted that rail locomotives also travel at much lower speeds given that they operate in a construction environment on temporary supports. **Table B 5-14** provides the predicted service train vibration levels. The suggested limits are based on the daytime/nighttime use of the facility. Lower limits are suggested for areas where people may sleep.

Table B 5-14 Predicted Service Train Vibration Levels

Receptor	Ground-borne Vibration (mm/s RMS)		Ground-borne Noise (dBA)	
	Predicted	Suggested Guideline	Predicted	Suggested Guideline
R3	**0.17**	0.14	**42**	38
R4	0.01	0.14	27	38
R5	**0.18**	0.14	**43**	38
R6	0.05	0.14	**41**	38
R7	**0.17**	0.14	**42**	38
R8	**0.20**	0.14	**43**	38
R9	0.13	0.14	**40**	38
V3	**0.18**	0.14	**42**	38
R10	0.04	0.14	37	38
R11	0.08	0.14	**45**	38
R12	**0.17**	0.14	**44**	38
R13	**0.22**	0.20	**49**	43
R14	0.08	0.14	**45**	38
R15	0.07	0.14	**44**	38
R16	0.09	0.14	**45**	38
R17	0.06	0.14	**42**	38
R18	0.03	0.14	35	38
R19	0.06	0.14	**42**	38
R20	**0.16**	0.14	**42**	38

Receptor	Ground-borne Vibration (mm/s RMS)		Ground-borne Noise (dBA)	
	Predicted	Suggested Guideline	Predicted	Suggested Guideline
R21	0.07	0.14	**44**	38
V4	0.13	0.14	**40**	38
V5	0.06	0.14	33	38
V6	0.08	0.14	36	38
R22	0.07	0.14	**44**	38
R23	0.02	0.14	27	38
R24	0.14	0.14	**42**	38
R25	**0.16**	0.14	**44**	38
R26	0.10	0.14	**38**	38
V7	0.14	0.14	**45**	38
V8	0.12	0.14	**42**	38
V9	**0.15**	0.14	**44**	38
V10	0.12	0.14	**48**	38
R27	0.11	0.14	**47**	38
R28	0.04	0.14	**39**	38
V11	0.09	0.20	42	43
V12	0.10	0.14	**39**	38
R29	0.05	0.14	38	38
R30	0.08	0.14	38	38
R31	0.04	0.14	31	38
R32	0.07	0.20	40	43
V13	0.09	0.14	36	38
R33	0.10	0.14	**39**	38
R34	0.09	0.14	38	38
V14	0.11	0.14	**47**	38
R35	0.13	0.14	**48**	38
R36	0.12	0.14	**48**	38
V15	**0.19**	0.14	**52**	38
V16	**0.22**	0.14	**53**	38

Receptor	Ground-borne Vibration (mm/s RMS)		Ground-borne Noise (dBA)	
	Predicted	Suggested Guideline	Predicted	Suggested Guideline
V17	**0.21**	0.14	**53**	38
R37	**0.22**	0.20	**49**	43
R38	**0.17**	0.14	**51**	38
R39	**0.22**	0.14	**53**	38
R40	**0.15**	0.14	**50**	38

Note: **Bolded numbers** and grey cells indicate exceedance of applicable criteria

As can be seen from **Table B 5-14**, without mitigation, the vibration levels are likely to exceed the suggested limits in areas where the receptors are closest to the alignment. Mitigation measures have been considered given the 24-hour nature of tunneling. These are discussed in **Section B 5.4.5**.

B 5.4.4 Heritage Structures

Similar to most transit projects in an urban environment, there are several heritage structures located along the proposed alignment. These heritage structures or resources have been identified in the Cultural Heritage Report: Existing Conditions and Preliminary Impact Assessment. Heritage structures are sometimes more susceptible to vibration-induced damage as compared to newer structures. Not all heritage structures are prone to such concerns. To be conservative, and in line with FTA guidelines, a vibration limit of 3.0 mm/s PPV is suggested for heritage buildings that may be susceptible to damage. During detailed design, and once an updated construction vibration assessment is completed, the buildings within the construction vibration ZOI should be reviewed and inspected by a qualified specialist. Lower vibrations limits should be considered wherever warranted. Vibration monitoring of these buildings should be considered where warranted by these detailed investigations, along with pre- and post-construction condition surveys.

B 5.4.5 Construction Vibration Mitigation Measures and Monitoring

Similar to construction noise, construction vibration is a temporary condition and ceases once construction is complete.

Noise and vibration levels associated with the TBM passage are expected to last 2-3 days at a given receptor location. Vibration from the passing TBMs is predicted to be well below the prohibited vibration limit, even for nearby heritage structures.

The vibration from the temporary service train can be effectively controlled using solutions such as resilient fasteners that can provide effective vibration isolation of the temporary track to, as indicated by results presented in **Table B 5-15** below which provides the predicted vibration levels with vibration isolation of the tracks in place. The use of rubber tired service vehicles, however, would result in even lower noise and vibration levels and should be considered.

In terms of surface construction, without mitigation, the ZOIs for construction vibration (including the ZOI for perceptible vibration from construction activity) are predicted to intersect several buildings. This analysis has been based on preliminary information and assumptions on method. A more detailed assessment should be completed prior to the start of construction.

Mitigation measures to reduce construction vibration levels and corresponding monitoring activities are outlined in **Section B 6.0**.

Table B 5-15 Predicted Vibration Levels from Service Train with Mitigation

Receptor	Ground-borne Vibration (mm/s RMS)		Ground-borne Noise (dBA)	
	Predicted	Suggested Guideline	Predicted	Suggested Guideline
R3	0.06	0.14	24	38
R4	0.00	0.14	10	38
R5	0.07	0.14	26	38
R6	0.02	0.14	24	38
R7	0.06	0.14	25	38
R8	0.08	0.14	26	38
R9	0.05	0.14	23	38
V3	0.07	0.14	25	38
R10	0.01	0.14	20	38
R11	0.03	0.14	28	38
R12	0.06	0.14	27	38
R13	0.08	0.20	32	43
R14	0.03	0.14	28	38
R15	0.03	0.14	27	38
R16	0.03	0.14	28	38
R17	0.02	0.14	25	38
R18	0.01	0.14	18	38
R19	0.02	0.14	25	38
R20	0.06	0.14	25	38
R21	0.03	0.14	27	38
V4	0.05	0.14	23	38
V5	0.02	0.14	16	38
V6	0.03	0.14	19	38
R22	0.03	0.14	27	38
R23	0.01	0.14	10	38
R24	0.05	0.14	25	38

Receptor	Ground-borne Vibration (mm/s RMS)		Ground-borne Noise (dBA)	
	Predicted	Suggested Guideline	Predicted	Suggested Guideline
R25	0.06	0.14	27	38
R26	0.04	0.14	21	38
V7	0.05	0.14	28	38
V8	0.05	0.14	25	38
V9	0.06	0.14	27	38
V10	0.05	0.14	31	38
R27	0.04	0.14	30	38
R28	0.02	0.14	22	38
V11	0.03	0.20	25	43
V12	0.04	0.14	22	38
R29	0.02	0.14	21	38
R30	0.03	0.14	21	38
R31	0.01	0.14	14	38
R32	0.03	0.20	23	43
V13	0.03	0.14	19	38
R33	0.04	0.14	22	38
R34	0.03	0.14	21	38
V14	0.04	0.14	30	38
R35	0.05	0.14	31	38
R36	0.05	0.14	31	38
V15	0.07	0.14	35	38
V16	0.08	0.14	36	38
V17	0.08	0.14	36	38
R37	0.08	0.20	32	43
R38	0.06	0.14	34	38
R39	0.08	0.14	36	38
R40	0.05	0.14	33	38

B 6.0 Summary of Potential Impacts, Mitigation Measures and Monitoring Activities

The following table summarizes the key project components/activities, potential noise and vibration effects, commitments to mitigation measures and monitoring activities identified through the YNSE EPR Addendum process for the operational and construction phases of the project.

Table B 6-1 Summary of Operational and Construction Noise & Vibration Mitigation Measures and Monitoring Requirements

Project Phase	Environmental Component	Potential Impacts	Mitigation Measures	Monitoring Activities
CONSTRUCTION	• Construction Noise along the Alignment	• Without mitigation, environmental noise may cause annoyance and disturb sleep and other activities.	• Establish and apply project specific noise criteria/limits. • Complete updated Construction Noise Impact Assessment studies during subsequent design phases using most up-to-date information regarding construction methods, equipment and staging. • Prior to commencement of construction, develop and submit a Construction Noise Management Plan. • Develop a Communications Protocol which includes timely resolution of complaints. Construction noise impact mitigation measures to be considered to meet project specific noise criteria/exposure limits include but are not limited to the following: • Ensure the equipment meets specifications and ensure that modifications have not been made to the equipment's silencing. • Operate equipment with silencers/mufflers where required. • Use construction equipment that meets provincial criteria in NPC-115. • Ensure smooth surfaces throughout the construction zones to help reduce the tailgate banging of dump trucks and other impulsive noises. • Develop construction staging plans that reduce noise at nearby sensitive receptors, to the extent feasible. This can include ensuring a minimum separating distance from stationary equipment (such as generators and compressors), selecting truck staging areas that are as far away from critical areas as possible, designing optimal truck routes that minimize on site movement (especially reversing) and that avoid traversing the quieter residential streets. • Schedule noisy activities during the daytime periods, wherever feasible. If nighttime construction is necessary, the activities with the highest noise levels should be conducted during daytime periods where feasible. • If construction will occur outside of normal daytime hours, inform local residents before construction of type of construction and expected duration outside of daytime hours. • Provide silencers for any ventilation fans and direct such fans away from sensitive receptors. • Connect equipment to permanent power wherever feasible to reduce the use of portable generators. • Erect temporary noise barriers or acoustic enclosures around noisy equipment such as concrete pumps, compressors, or generators, as required. • Use of upgraded construction hoarding (considering requirements from Canadian Standards Association Z107.9 for noise barriers) between construction equipment and noise sensitive receivers. • Erect temporary or semi-permanent noise barriers of sufficient height around long-term construction zones wherever feasible. • Where feasible, provide a smooth and asphalt coated deck for any cut and cover excavation. • Equipment should be provided with broadband backup alarms, where feasible. • Where feasible, outfit shoring drill rigs with auger cleaner attachments. Where such attachments are not practical, manual cleaning of the attachments should be considered. • Minimize simultaneous operation of equipment, where feasible. • Implement a no idling policy on site (unless necessary for equipment operation). • Limit the number of heavy trucks on site to the minimum required, where feasible. • Undertake noise monitoring and regular reporting throughout the construction phase. Where noise level limits are exceeded, additional noise mitigation measures shall be implemented. • Additional mitigation measures not listed above may be considered.	• Noise levels will be monitored where the impact assessment indicates that noise limits may be exceeded, to identify if any additional mitigation is required and verify mitigation measure(s) effectiveness. • Continuous noise monitoring should be completed at each geographically distinct active construction site associated with the Project with monitor(s) located strategically to capture the worst-case construction related noise levels at receiver locations based on planned construction activities, their locations, and the number, geographic distribution and proximity of noise sensitive receivers. • Monitoring at locations where there are persistent complaints, as required.

Project Phase	Environmental Component	Potential Impacts	Mitigation Measures	Monitoring Activities
CONSTRUCTION	• Construction Vibration and Tunneling-generated Ground-Borne Noise along the Alignment	• Without mitigation, environmental vibration may cause annoyance and disturb sleep and other activities. • Without mitigation, vibration may cause damage to nearby structures, including heritage buildings.	• Establish and apply project-specific vibration limits. • As project planning and design progress, conduct a review to identify any heritage structures and other vibration-sensitive structures/locations, buildings, or infrastructure vulnerable to vibration and/or vibration damage (e.g., sound recording studios), assess requirements and, if necessary, develop structure/location-specific mitigation measures. • Prior to construction, complete updated Construction Vibration Impact Assessment studies during subsequent design phases that includes assessment of the vibration ZOI based upon refined site staging, construction areas/equipment, and building locations, as required. • Develop and implement a Construction Vibration Management Plan. • Complete pre-construction condition surveys for properties within the construction ZOI and at all potentially affected heritage structures and establish a baseline prior to any work beginning, as required. • Increase setback distance between the construction vibration source and nearby buildings to the extent feasible. • Schedule vibration intensive activities during the daytime periods wherever possible. • Select construction methods and equipment with the least vibration impacts. • Consideration should be given to using lower settings on hydraulic breakers and vibratory compactors to reduce the vibration levels. • Where feasible, use equipment with lower vibration levels. • Where feasible, saw cuts should be completed prior to demolition works to minimize vibration transfer. • Ensure smooth surfaces throughout construction zones to reduce vibration. • Implement vibration isolation solutions such as resilient fasteners for the temporary tracks used by the temporary service locomotives during tunneling or use rubber-tired service vehicles, as required. • Reduce the gaps between adjoining rail segments in the temporary tracks. • Conduct regular inspection and maintenance of the temporary tracks, service trains and railway cars during tunneling operations. • Develop communications protocol which includes timely resolution of complaints. • Additional mitigation measures not listed above may be considered.	• Monitor vibration continuously at structures deemed to be within the construction ZOI to ensure compliance with applicable vibration limits, to verify mitigation measures effectiveness and to identify the need for additional mitigation if required. • During TBM operations, vibration monitoring along the alignment is recommended. • Monitoring at locations where there are persistent complaints, if required.
OPERATION	• Train Operations Noise along the At Grade Alignment	• Without mitigation, environmental noise may cause annoyance and disturb sleep and other activities. • If operations are projected to cause a 5-dB increase or greater in the average energy equivalent noise (referred to as "L_{eq}") relative to the existing noise level or the MECP objective of 55 dBA for daytime and 50 dBA for night-time, whichever is higher, then mitigation is required to be reviewed and implemented where feasible.	• Complete updated Noise and Vibration Impact Assessment Studies during Detailed Design. <u>Mitigation at the Source:</u> • Deploy vehicle and track technology and related maintenance measures to maintain compliance with the noise and vibration exposure criteria defined below. <u>Mitigation Criteria:</u> • Meet the airborne noise exposure criteria in the 1995 MOEE/GO Transit Draft Noise and Vibration Protocol.	• Complete pre- and post-construction measurement of sound levels to confirm the predictions. • Complete regular maintenance inspections and implement corrective measures wherever needed. • During normal vehicle replacement, consider procuring vehicles that reduce noise and vibration.
	• Stationary Source Noise – Train Storage Facility	• Without mitigation, environmental noise may cause annoyance and disturb sleep and other activities. • If project operations are predicted to exceed 55 dBA Leq,1hr at any time, implement mitigation measures to meet the criterion level.	• Complete updated Noise and Vibration Impact Assessment Studies during Detailed Design. • Accommodate a 5.5m tall noise barrier along the western extent of the train storage facility, subject to further detailed design. • Implement quiet special trackwork such as moveable point frogs to reduce the impact noise from the tracks sufficient to meet the minimum criteria noted. • As part of detailed design, complete a more detailed analysis to confirm any necessary noise control measures to meet NPC-300 criteria. Select mechanical and electrical equipment such that the sound levels meet NPC-300 criteria.	• Complete pre- and post-construction measurement of sound levels to confirm the predictions. • Complete regular maintenance inspections and implement corrective measures wherever needed. • During normal vehicle replacement, consider procuring vehicles that reduce noise and vibration.

Project Phase	Environmental Component	Potential Impacts	Mitigation Measures	Monitoring Activities
	• Stationary Sources Noise - Stations, Traction Power Supply Substations, Bus Terminals/Loops, and Portal Structure	• Without mitigation, environmental noise may cause annoyance and disturb sleep and other activities. • All ancillary facilities, including stations, bus terminals, and traction power substations are to comply with NPC-300.	• Complete updated Noise and Vibration Impact Assessment Studies during Detailed Design. • All tunnel ventilation fan systems are to be provided with silencers as required to reduce noise and comply with NPC-300 limits. • Provide a 5.5m tall noise barrier at Clark Station's bus terminal, where specific location, height and extent are subject to further detailed design. • As part of detailed design, complete a more detailed analysis to confirm any necessary noise control measures to meet NPC-300 criteria. Select mechanical and electrical equipment such that the sound levels meet NPC-300 criteria.	• Complete pre- and post-construction measurement of sound levels to confirm the predictions. • Complete regular maintenance inspections and implement corrective measures wherever needed to minimize noise and vibration.
OPERATION	• Train Operations Vibration along Underground Alignment	• Without mitigation, environmental vibration may cause annoyance and disturb sleep and other activities. • If operations are projected to exceed the ground-borne noise and vibration limits, implement mitigation measures.	• Complete updated Noise and Vibration Impact Assessment Studies during Detailed Design. Mitigation per this Noise and Vibration Impact Assessment Report: • Complete more detailed studies to predict ground-borne noise and vibration levels in order to meet the vibration criteria outlined in this report. Mitigation at the Source: • Implement mitigation measures such as floating slab track, ballast mats, resilient fasteners, moveable point frogs, etc. as needed to mitigate vibration levels. • Implement regular vehicle and infrastructure maintenance to maintain compliance with the noise and vibration exposure criteria. Mitigation Criteria: • Meet the ground-borne noise and vibration criteria in the 1995 MOEE/TTC Transit Noise and Vibration Protocol and the ground-borne noise criteria in the 2018 Federal Transit Administration Noise and Vibration Impact Assessment Manual. • Achieve ground-borne noise and ground-borne vibration levels of less than 30 dBA and 0.05 mm/s, respectively, in areas (Segment 2) where the alignment passes beneath low-rise residential buildings in an established neighborhood.	• Complete post-construction measurement of vibration levels to confirm the predictions. • Complete regular maintenance inspections and implement corrective measures wherever needed. • During normal vehicle replacement, consider procuring vehicles that reduce noise and vibration.
	• Train Operations Vibration along the At Grade Alignment	• Without mitigation, environmental vibration may cause annoyance and disturb sleep and other activities. • If operations are projected to exceed the ground-borne noise and vibration limits, implement mitigation measures.	• Complete updated Noise and Vibration Impact Assessment Studies during Detailed Design. Mitigation per this Noise and Vibration Impact Assessment Report: • Complete more detailed studies to predict ground-borne noise and vibration levels in order to meet the vibration criteria outlined in this report. Mitigation at the Source: • Implement mitigation measures such as floating slab track, ballast mats, resilient fasteners, moveable point frogs, etc. as needed to mitigate vibration levels. • Implement regular vehicle and infrastructure maintenance to maintain compliance with the noise and vibration exposure criteria. Mitigation Criteria: • Meet the ground-borne noise and vibration criteria in the 1995 MOEE/TTC Transit Noise and Vibration Protocol and the ground-borne noise criteria in the 2018 Federal Transit Administration Noise and Vibration Impact Assessment Manual.	• Complete post-construction measurement of vibration levels to confirm the predictions. • Complete regular maintenance inspections and implement corrective measures wherever needed. • During normal vehicle replacement, consider procuring vehicles that reduce noise and vibration.
	• Stationary Source Vibration – Train Storage Facility	• Without mitigation, environmental vibration may cause annoyance and disturb sleep and other activities. • If operations are projected to exceed the ground-borne noise and vibration limits, implement mitigation measures.	• Complete updated Noise and Vibration Impact Assessment Studies during Detailed Design. Mitigation per this Noise and Vibration Impact Assessment Report: • Complete more detailed studies to predict ground-borne noise and vibration levels in order to meet the vibration criteria outlined in this report.	• Complete pre- and post-construction measurement of sound levels to confirm the predictions. • Complete regular maintenance inspections and implement corrective measures wherever needed to minimize noise and vibration.

Project Phase	Environmental Component	Potential Impacts	Mitigation Measures	Monitoring Activities
			Mitigation at the Source: • Implement mitigation measures such as floating slab track, ballast mats, resilient fasteners, moveable point frogs, etc. as needed to mitigate vibration levels. • Implement regular vehicle and infrastructure maintenance to maintain compliance with the noise and vibration exposure criteria. Mitigation Criteria: • Meet the ground-borne vibration criteria in the 1995 MOEE/TTC Transit Noise and Vibration Protocol and the ground-borne noise criteria in the 2018 Federal Transit Administration Noise and Vibration Impact Assessment Manual.	• During normal vehicle replacement, consider procuring vehicles that minimize noise and vibration.
	• Stationary Sources Vibration - Stations, Traction Power Supply Substations, Bus Terminals/Loops, and Portal Structure	• Without mitigation, environmental vibration may cause annoyance and disturb sleep and other activities. • If operations are projected to exceed the ground-borne noise and vibration limits, implement mitigation measures.	• Ancillary facilities such as traction power supply substations, bus terminals/loops and portal structures are not significant sources of operational vibration. Mitigation measures are not required.	• None.

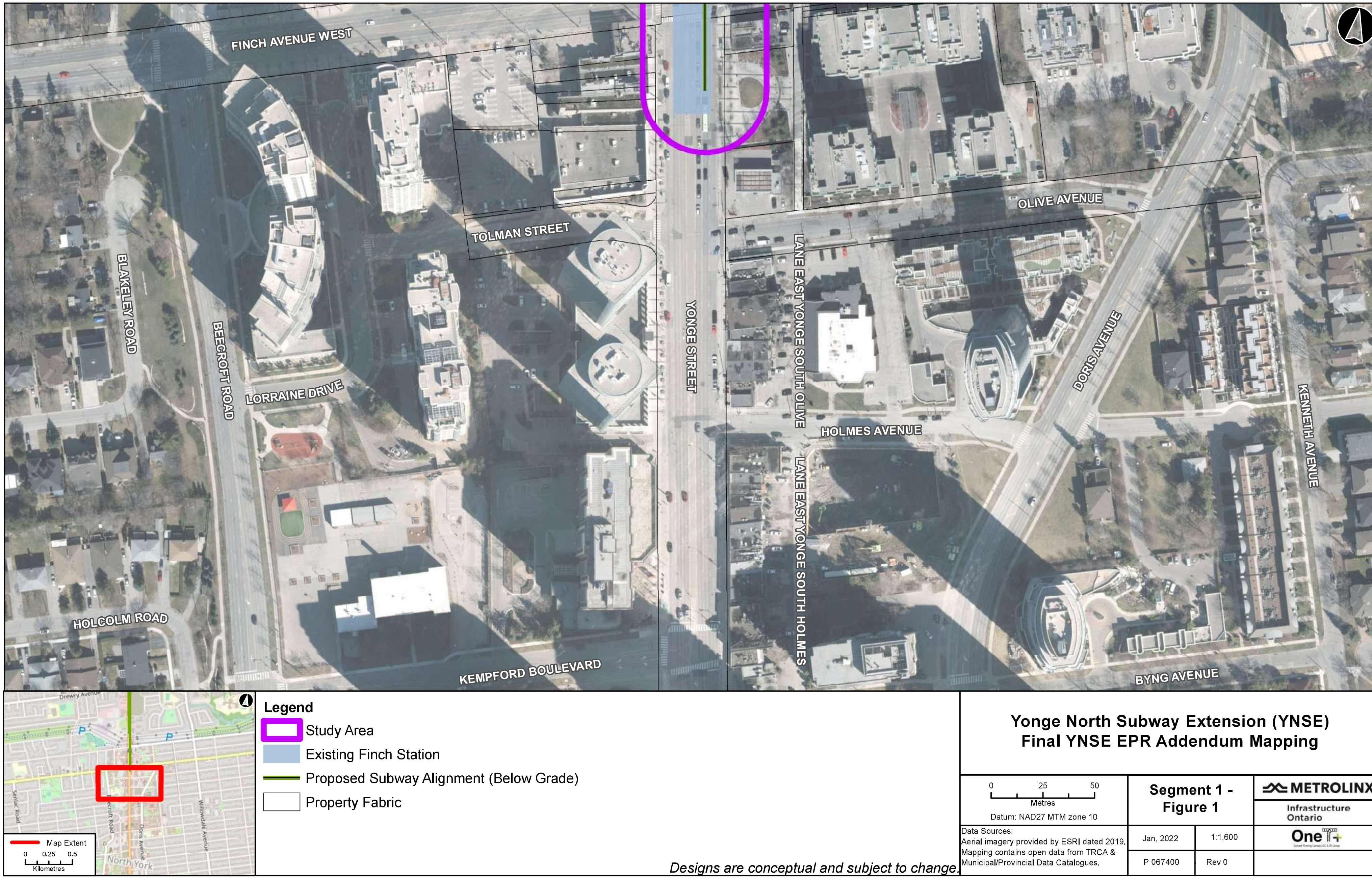
B 7.0 Permits and Approvals

No federal permits/approvals pertaining to noise and vibration have been identified.

In accordance with MECP requirements, the train storage facility and traction power substation may require registrations under the Environmental Activity Sector Registry (EASR). This will be confirmed during the detailed design and implementation phases of the Project.

Noise and vibration impact studies may need to be provided as part of the municipal site plan approval process for any permanent infrastructure. Metrolinx, as a Crown Agency of the Province of Ontario, is exempt from certain municipal processes and requirements. In these instances, Metrolinx will engage with the municipalities to incorporate municipal requirements as a best practice, where practical, and may obtain associated permits and approvals. Metrolinx shall continue to communicate and engage with the municipalities during detailed design and construction planning to address municipal concerns.

APPENDIX A: CORRIDOR MAPPING



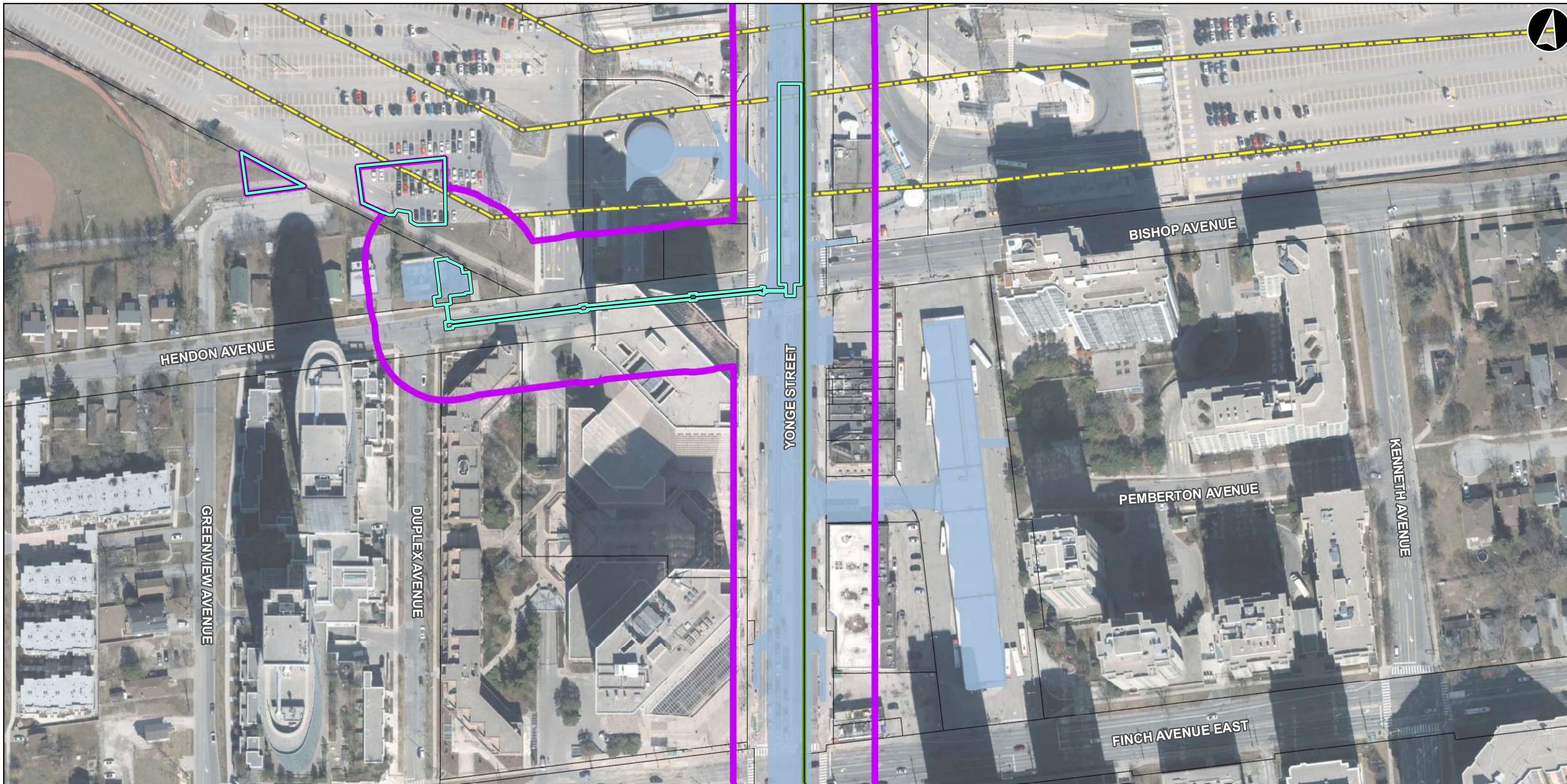
Legend

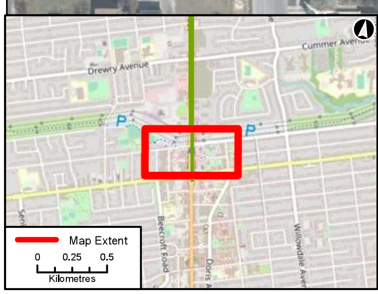
- Study Area
- Existing Finch Station
- Proposed Subway Alignment (Below Grade)
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50 Metres Datum: NAD27 MTM zone 10	**Segment 1 - Figure 1**	METROLINX Infrastructure Ontario
Data Sources: Aerial imagery provided by ESRI dated 2019. Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.	Jan, 2022 | 1:1,600 P 067400 | Rev 0	One





Legend

- Study Area
- Existing Finch Station
- Proposed Finch Station Modifications
- Proposed Subway Alignment (Below Grade)
- Existing Hydro One Transmission
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50 Metres Datum: NAD27 MTM zone 10	**Segment 1 - Figure 2**		METROLINX Infrastructure Ontario
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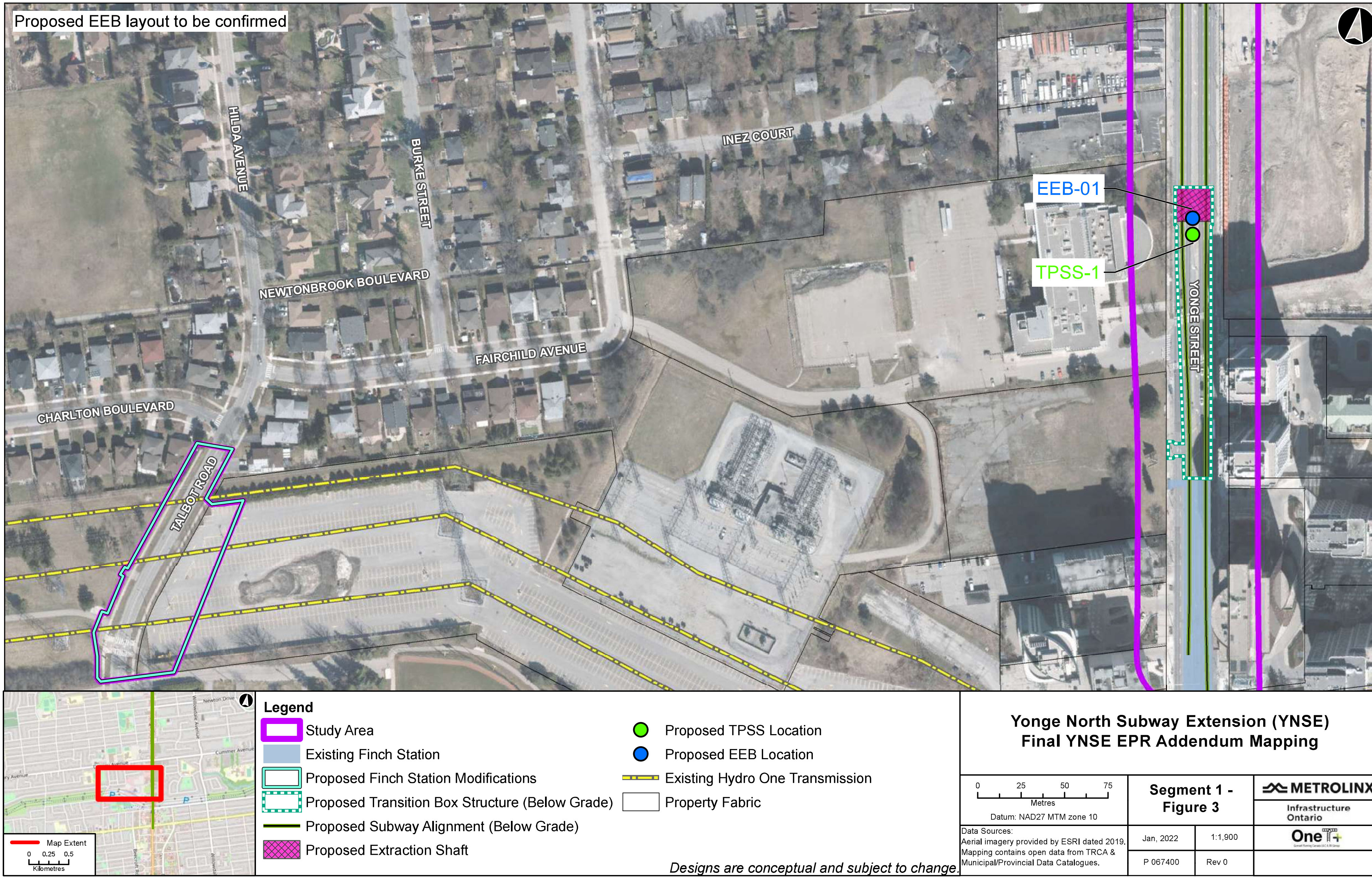
	P 067400	Rev 0	



Proposed EEB layout to be confirmed
HILDA AVENUE
BURKE STREET
INEZ COURT
NEWTONBROOK BOULEVARD
FAIRCHILD AVENUE
CHARLTON BOULEVARD
TALBOT ROAD
YONGE STREET
EEB-01
TPSS-1
Map Extent
0 0.25 0.5
Kilometres
Legend
Study Area
Existing Finch Station
Proposed Finch Station Modifications
Proposed Transition Box Structure (Below Grade)
Proposed Subway Alignment (Below Grade)
Proposed Extraction Shaft
Proposed TPSS Location
Proposed EEB Location
Existing Hydro One Transmission
Property Fabric
Designs are conceptual and subject to change.
Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping
0 25 50 75
Metres
Datum: NAD27 MTM zone 10
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.
Segment 1 - Figure 3
Jan, 2022
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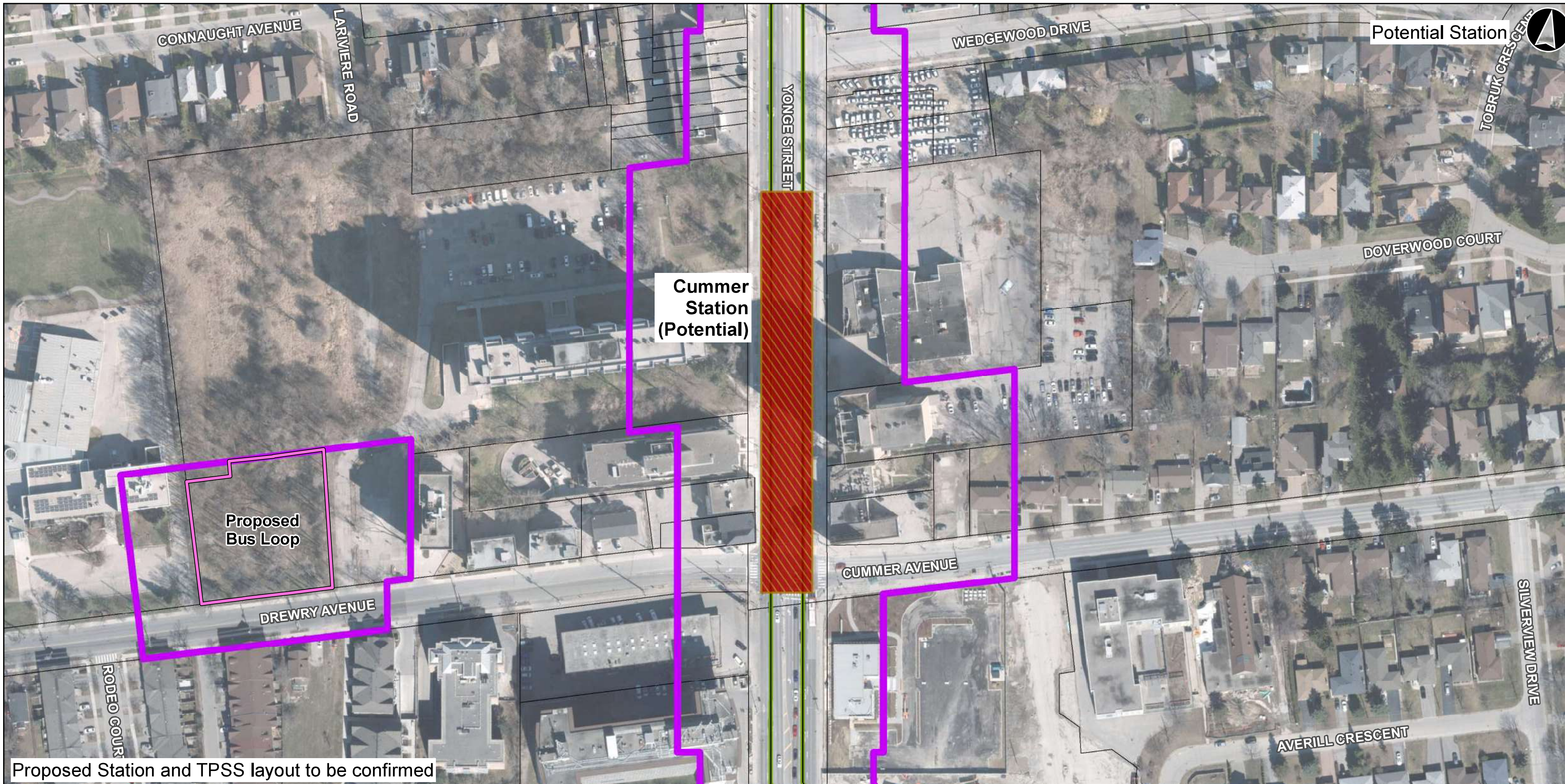
Rev 0
METROLINX
Infrastructure Ontario
One



Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Potential Station Platform Area
- Proposed Bus Loop
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50
Metres
Datum: NAD27 MTM zone 10

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 1 - Figure 4

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Infrastructure Ontario
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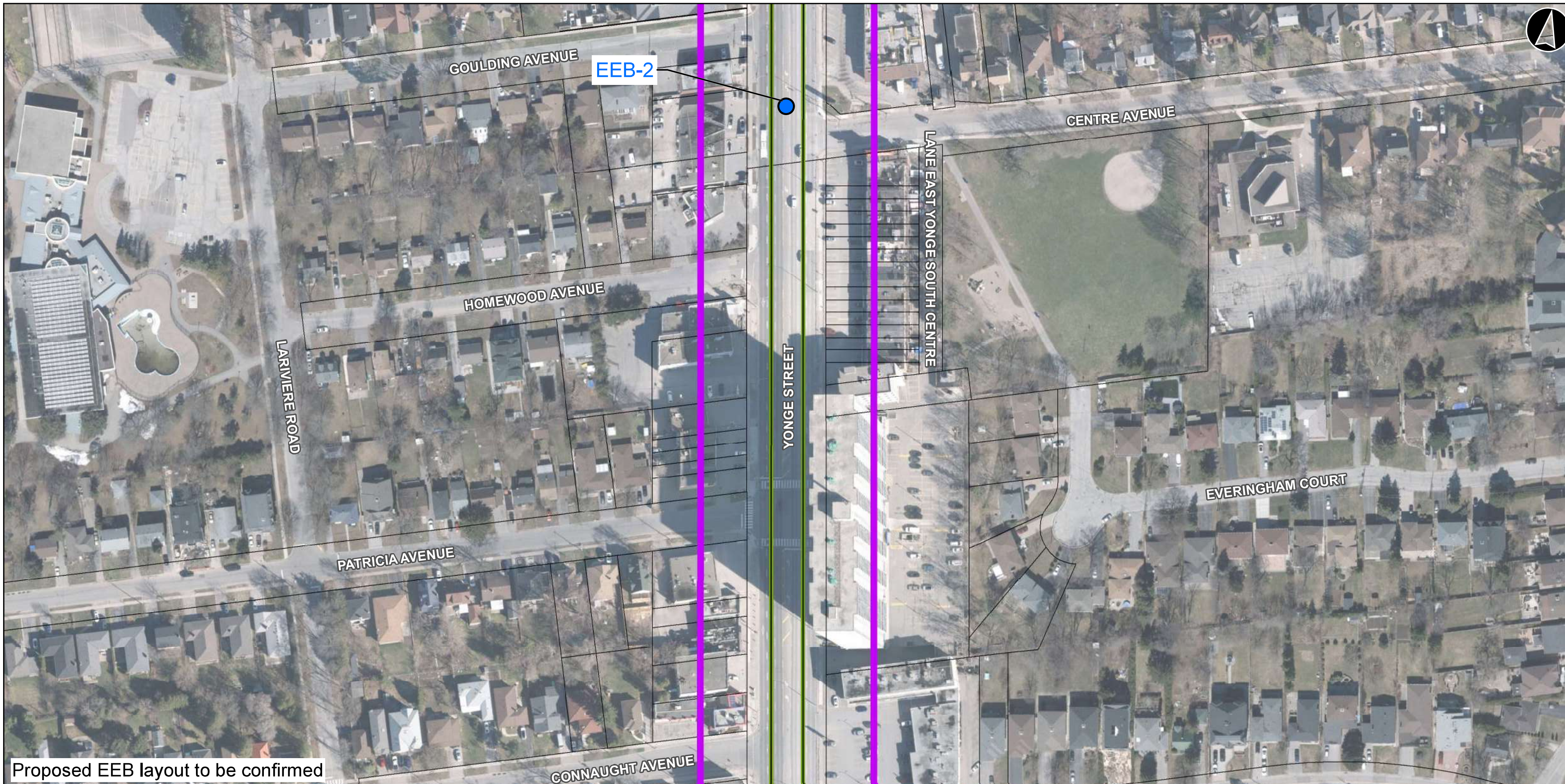

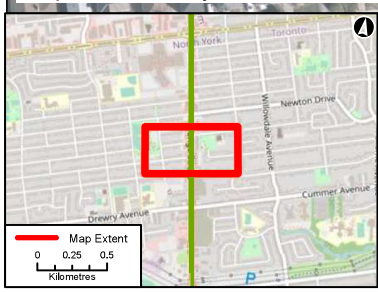

Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Proposed EEB Location
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50
Metres
Datum: NAD27 MTM zone 10

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 1 - Figure 5

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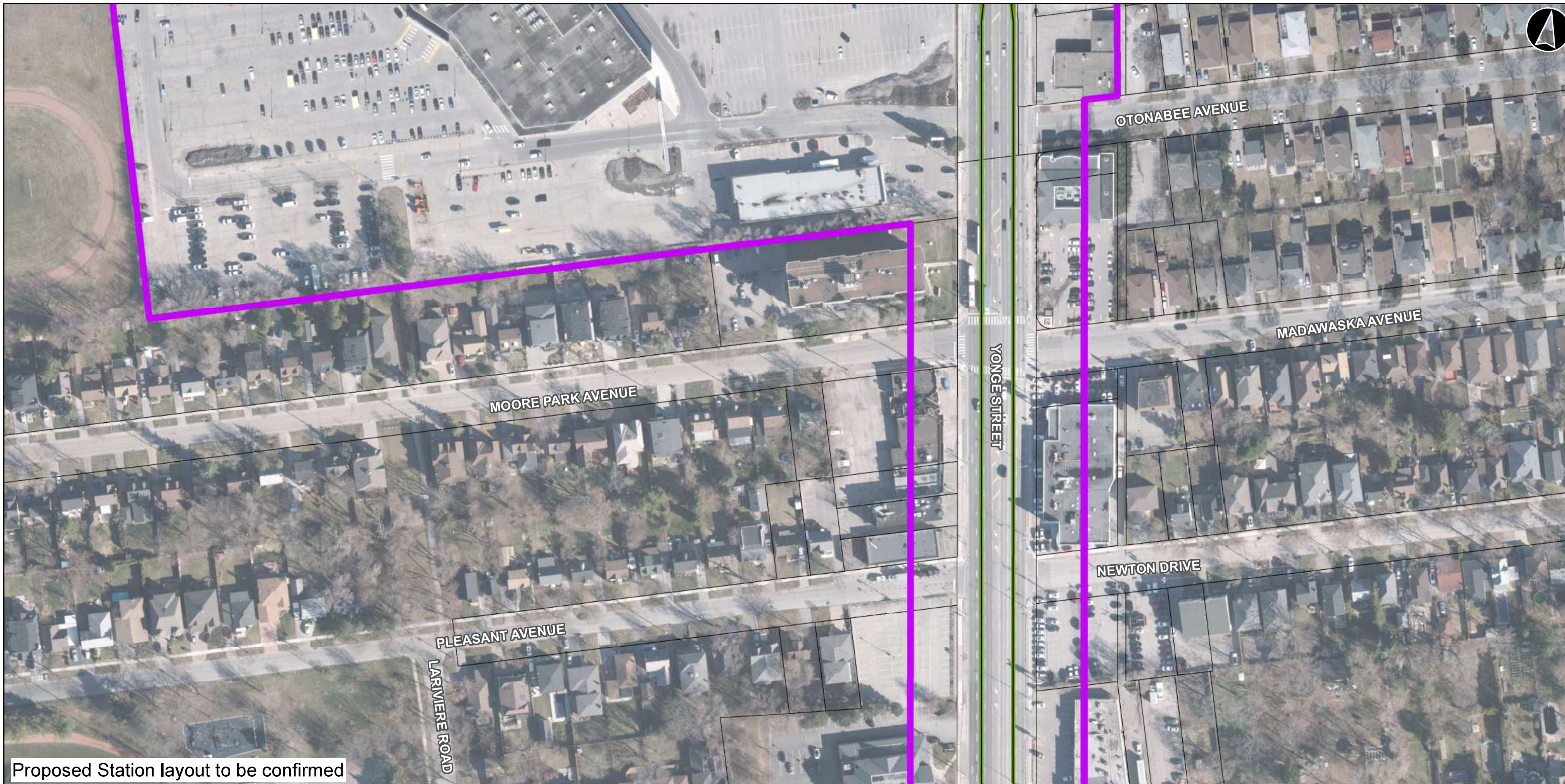
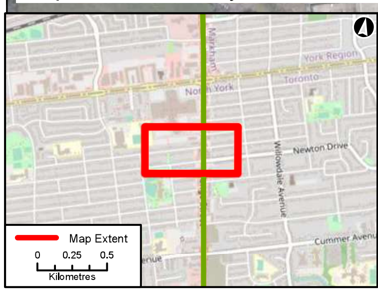
Infrastructure Ontario
One





Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50
Metres
Datum: NAD27 MTM zone 10

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 1 - Figure 6		METROLINX / Infrastructure Ontario
Jan, 2022	1:1,600	One
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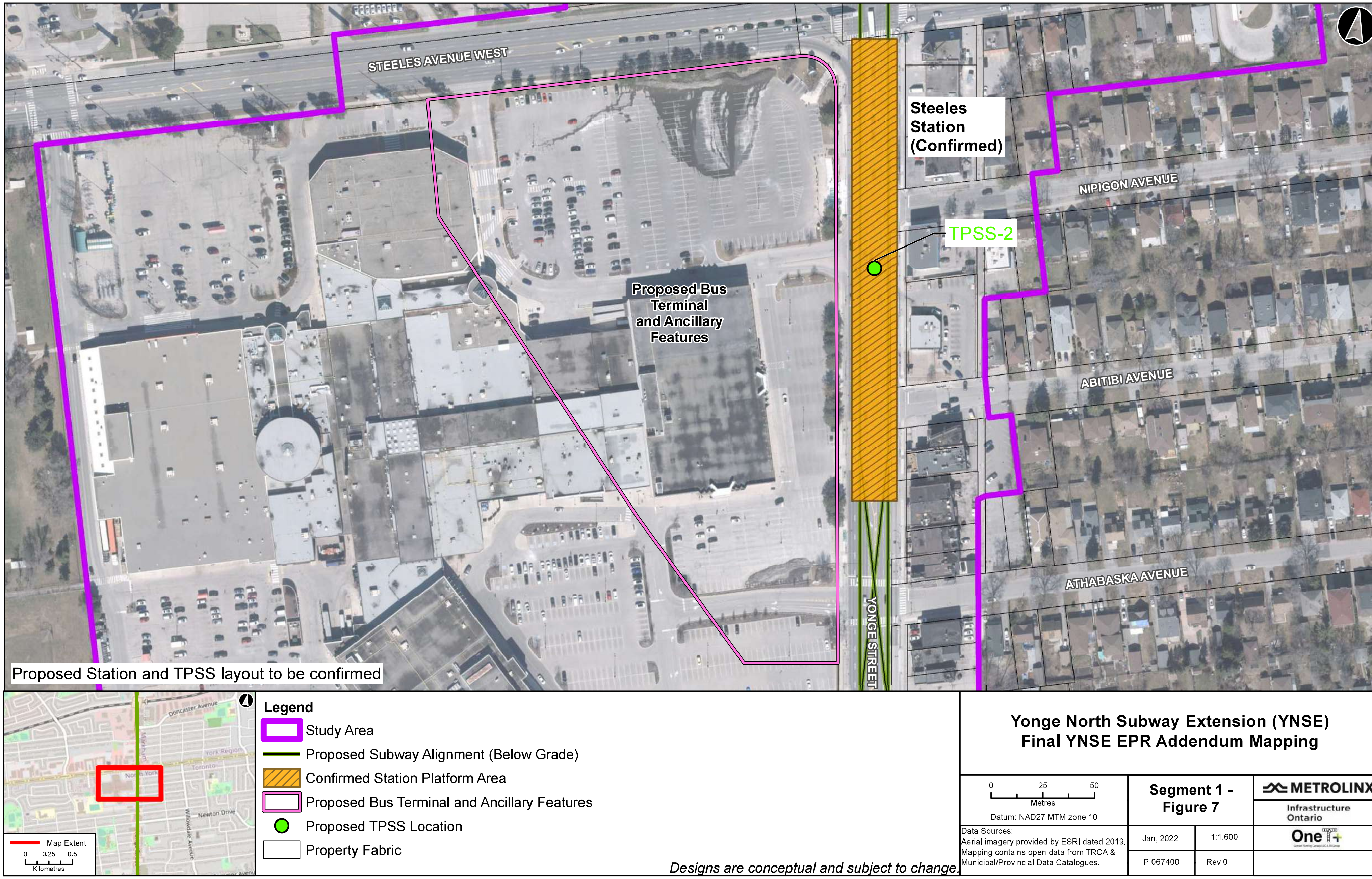

Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Confirmed Station Platform Area
- Proposed Bus Terminal and Ancillary Features
- Proposed TPSS Location
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50
Metres
Datum: NAD27 MTM zone 10

Segment 1 - Figure 7

METROLINX
Infrastructure Ontario
One

Data Sources:
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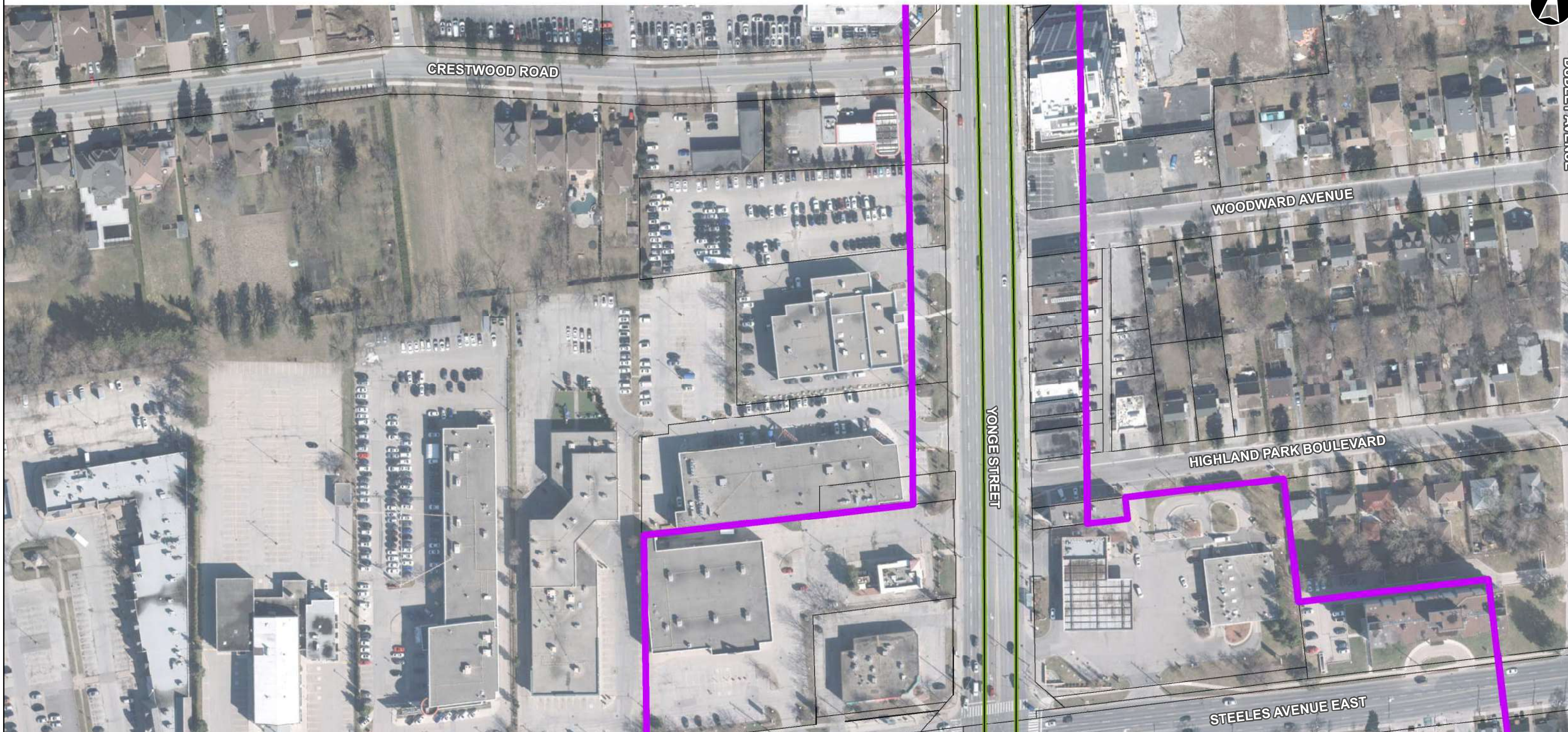
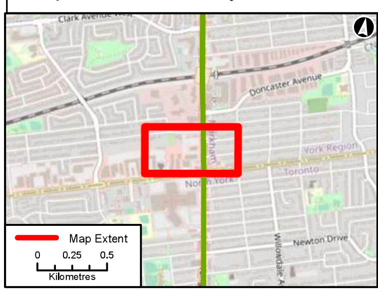
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0



Proposed Station layout to be confirmed



Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50
Metres
Datum: NAD27 MTM zone 10

Segment 1 - Figure 8

METROLINX
Infrastructure Ontario
One

Data Sources:
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Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

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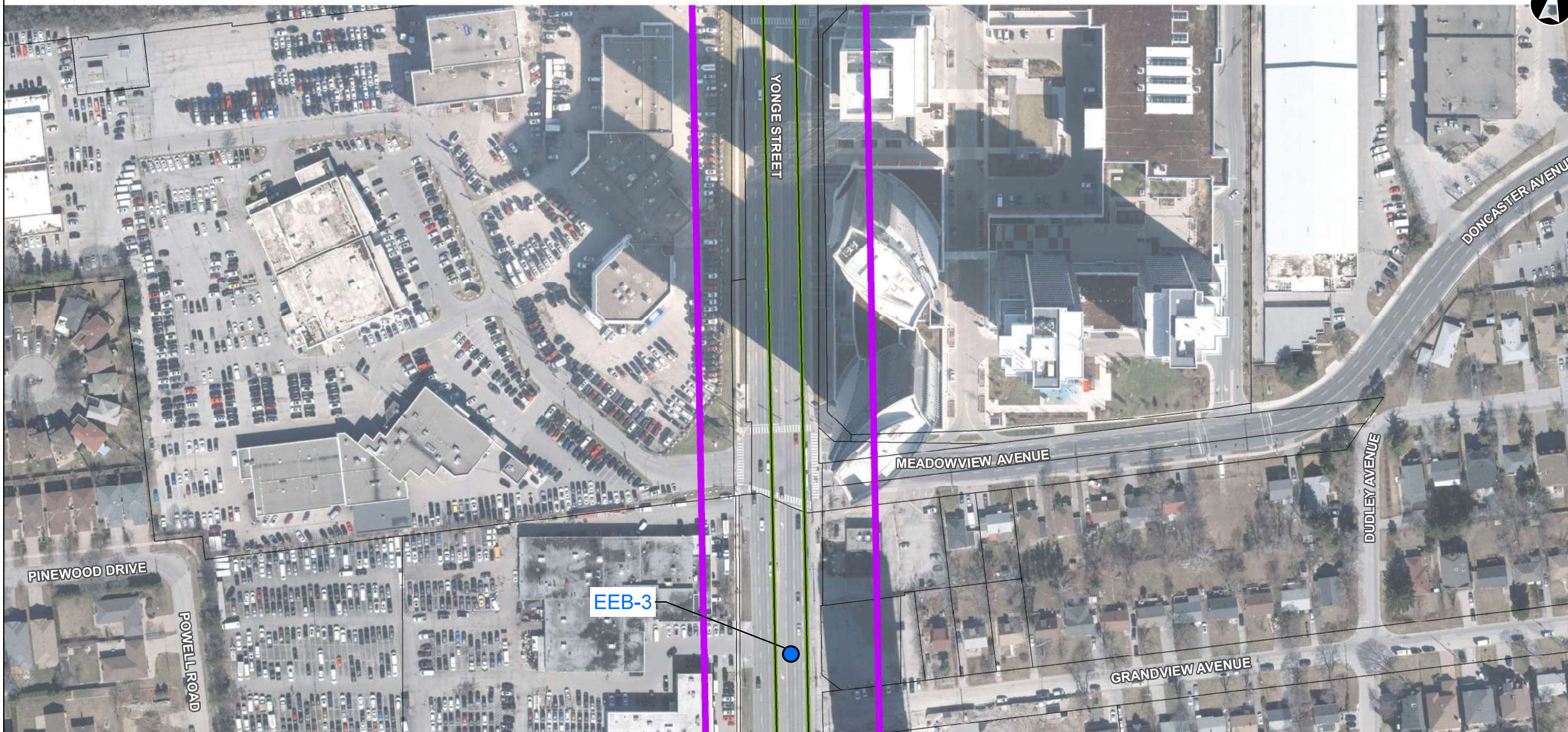
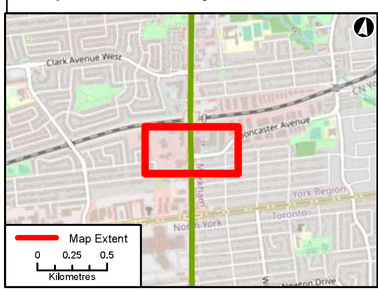


Proposed EEB layout to be confirmed



Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Proposed EEB Location
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

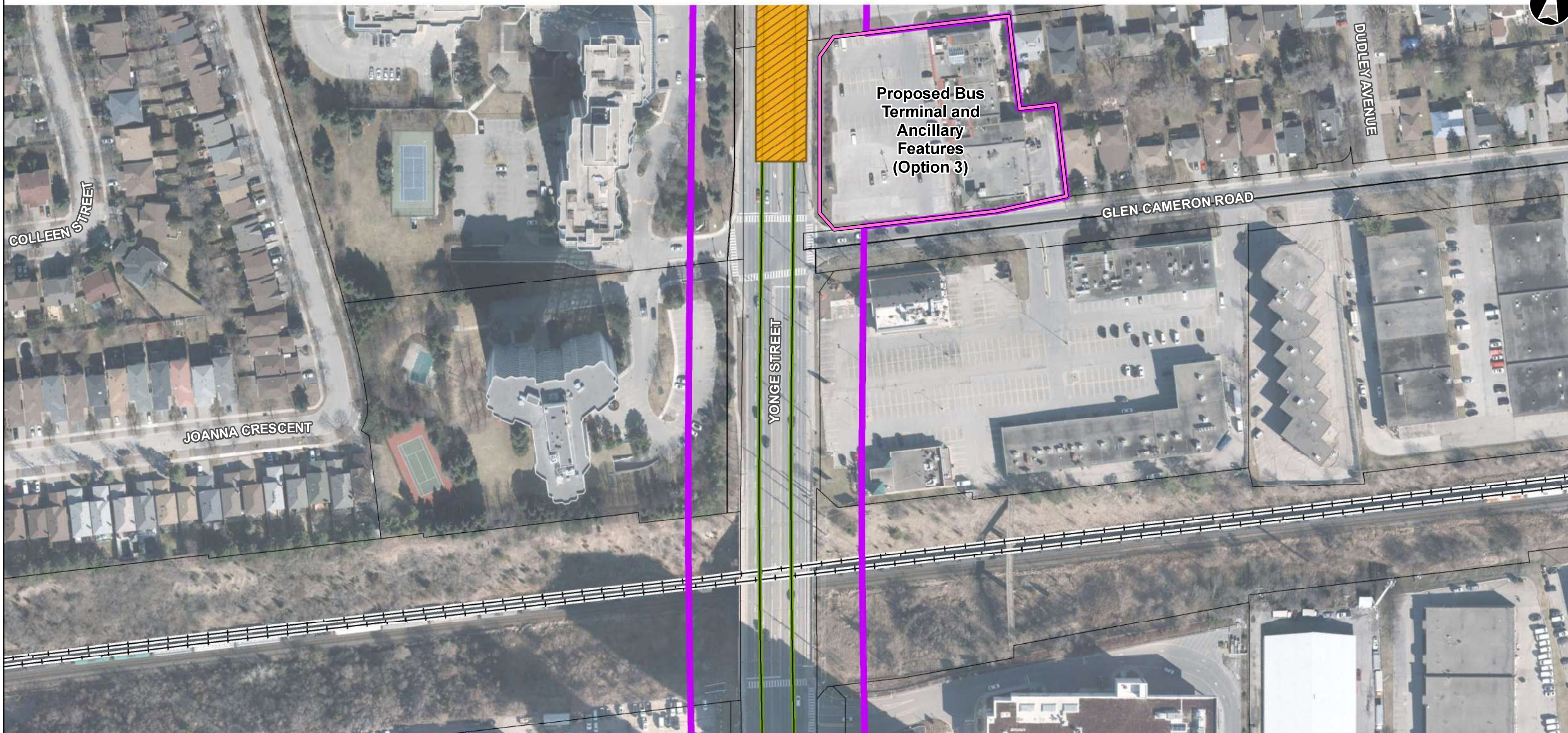
0 25 50
Metres
Datum: NAD27 MTM zone 10

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

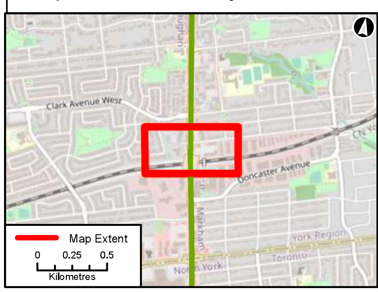
Segment 1 - Figure 9

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One



Proposed Station layout to be confirmed



Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Confirmed Station Platform Area
- Proposed Bus Terminal and Ancillary Features
- Existing CN Track
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

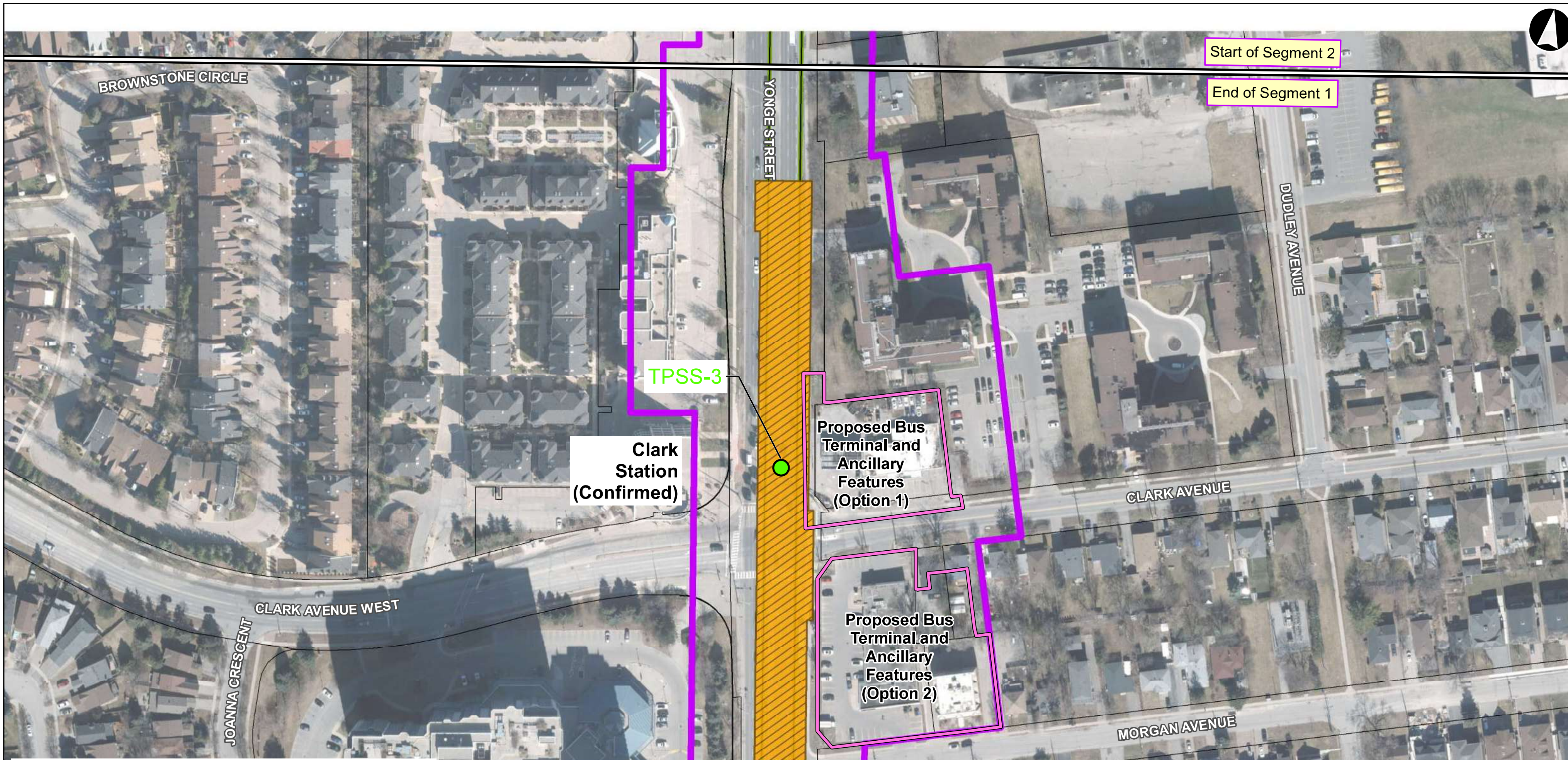
0 25 50
Metres
Datum: NAD27 MTM zone 10

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

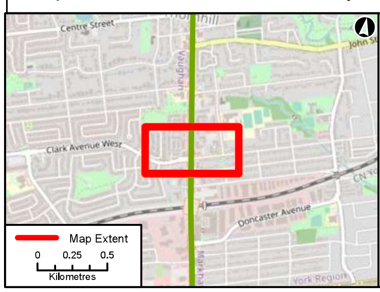
Segment 1 - Figure 10

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One



Proposed Station and TPSS layout to be confirmed



Legend

- Study Area Segment Breakline
- Study Area
- Proposed Subway Alignment (Below Grade)
- Confirmed Station Platform Area
- Proposed Bus Terminal and Ancillary Features
- Proposed TPSS Location
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50 Metres

Datum: NAD27 MTM zone 10

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

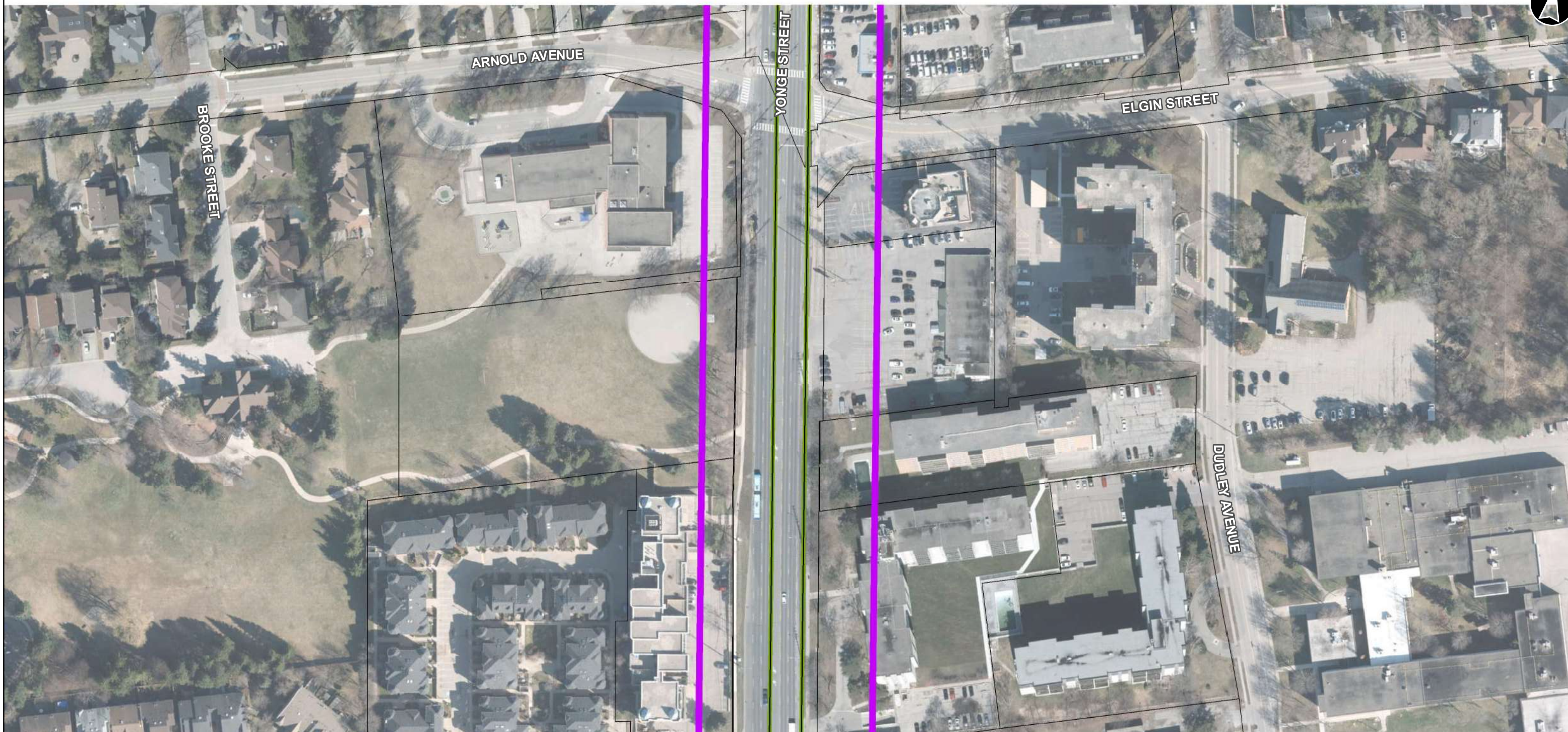
Segment 1/2 - Figure 11

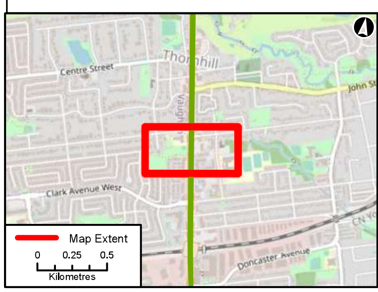
Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX

Infrastructure Ontario

One





Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

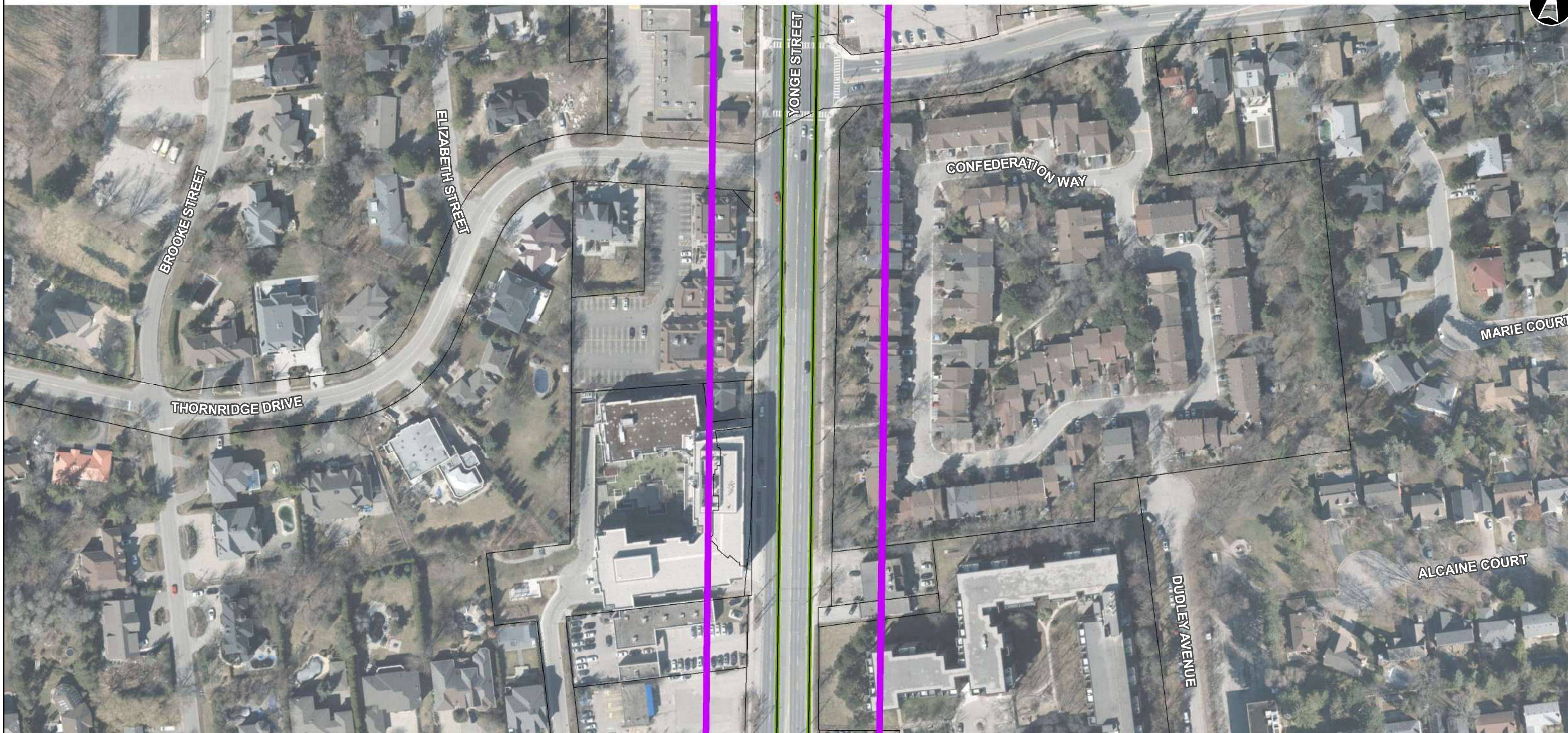
0 25 50
Metres
Datum: NAD27 MTM zone 10

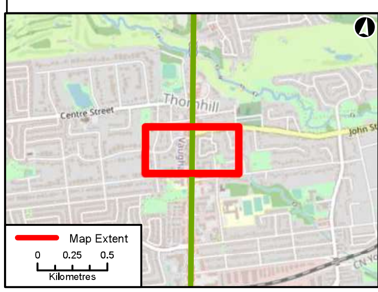
Segment 2 - Figure 12

METROLINX
Infrastructure Ontario
OneT+

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600	
P 067400	Rev 0	





Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

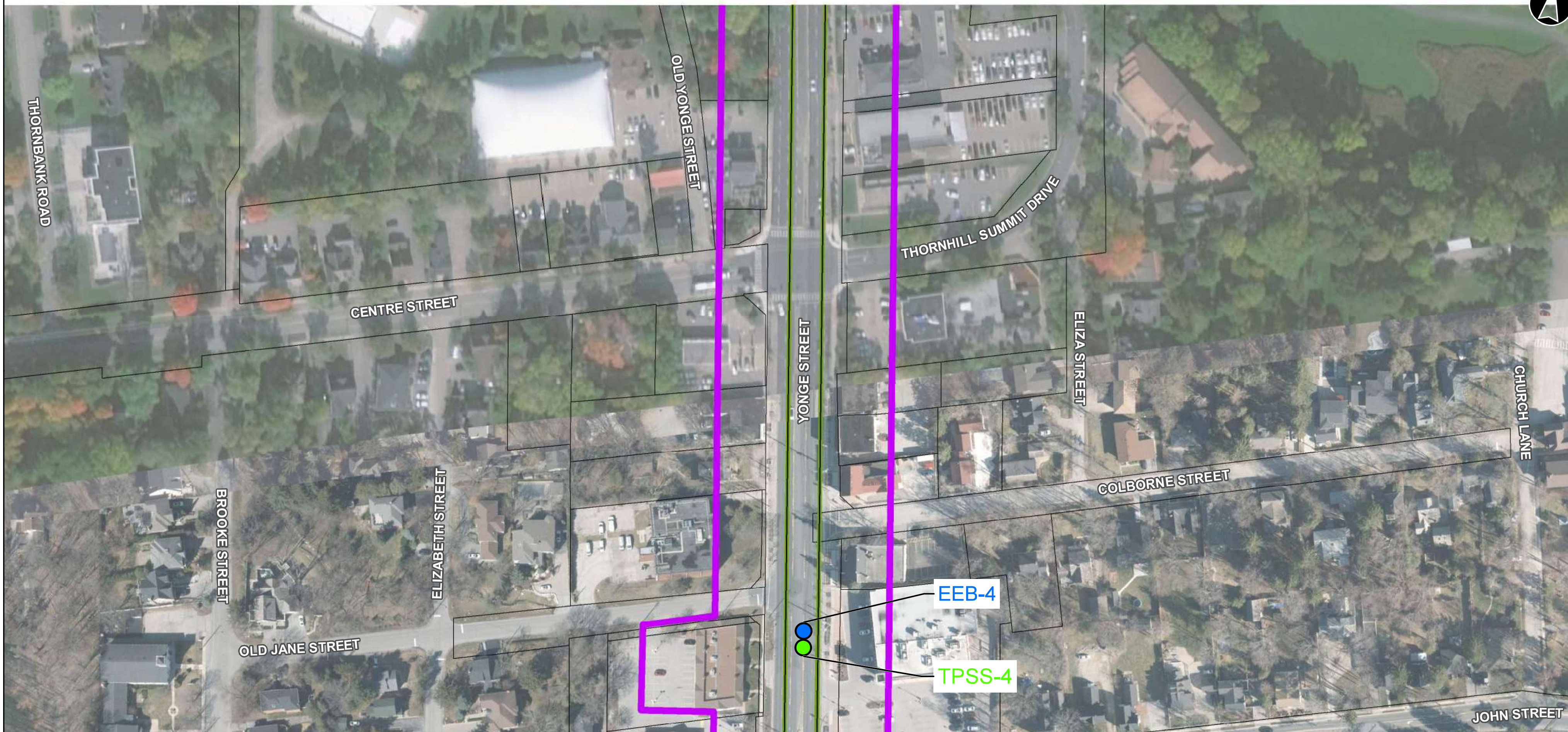
0 25 50
Metres
Datum: NAD27 MTM zone 10

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

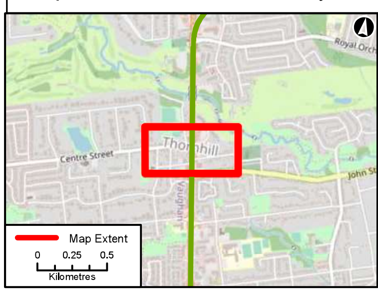
Segment 2 - Figure 13

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One



Proposed EEB and TPSS layout to be confirmed



Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Proposed TPSS Location
- Proposed EEB Location
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

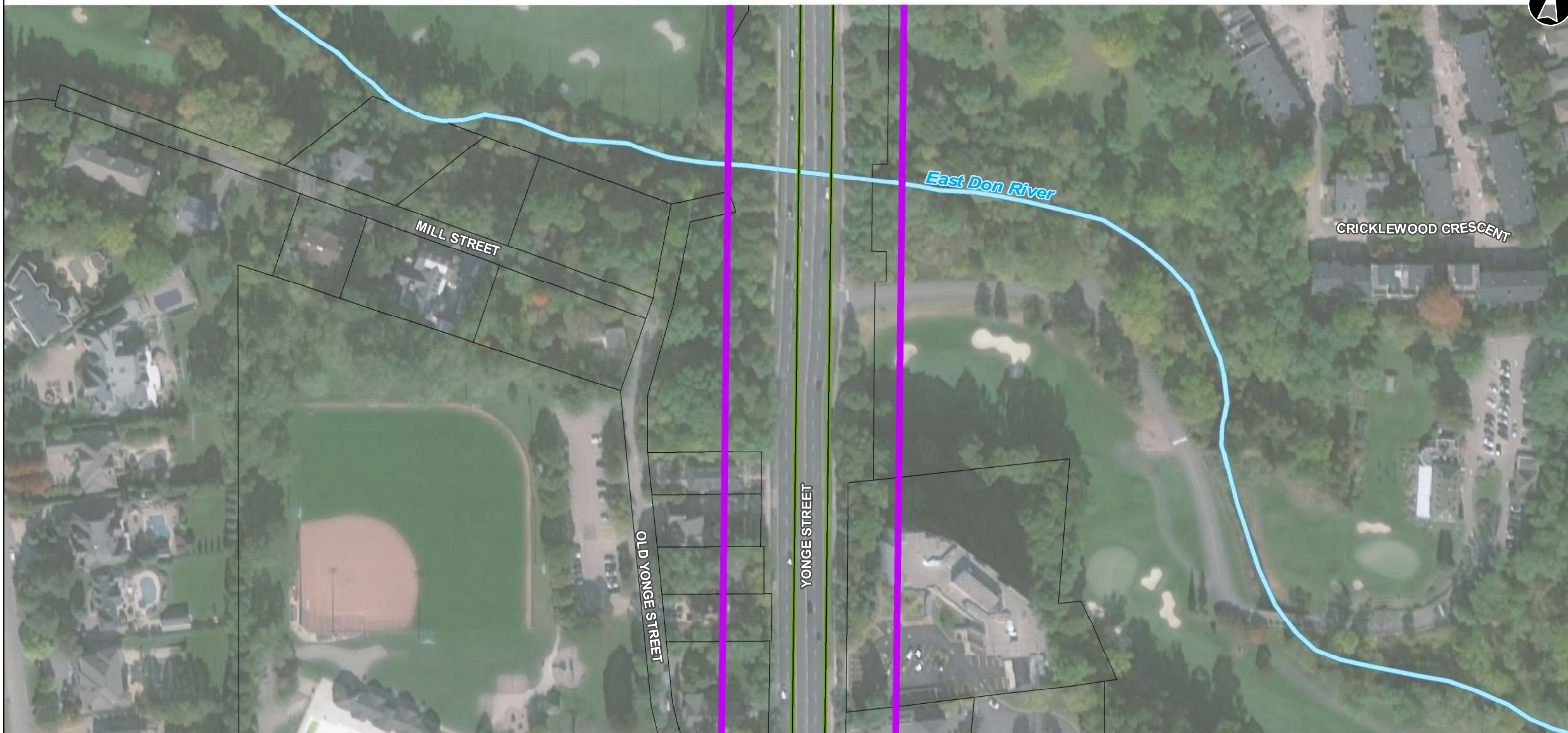
0 25 50
Metres
Datum: NAD27 MTM zone 10

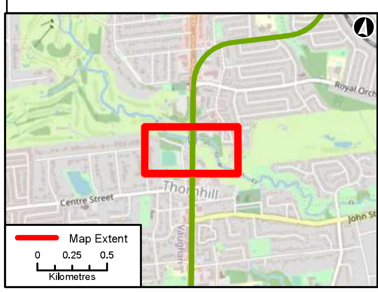
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 2 - Figure 14

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One





Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Watercourse
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

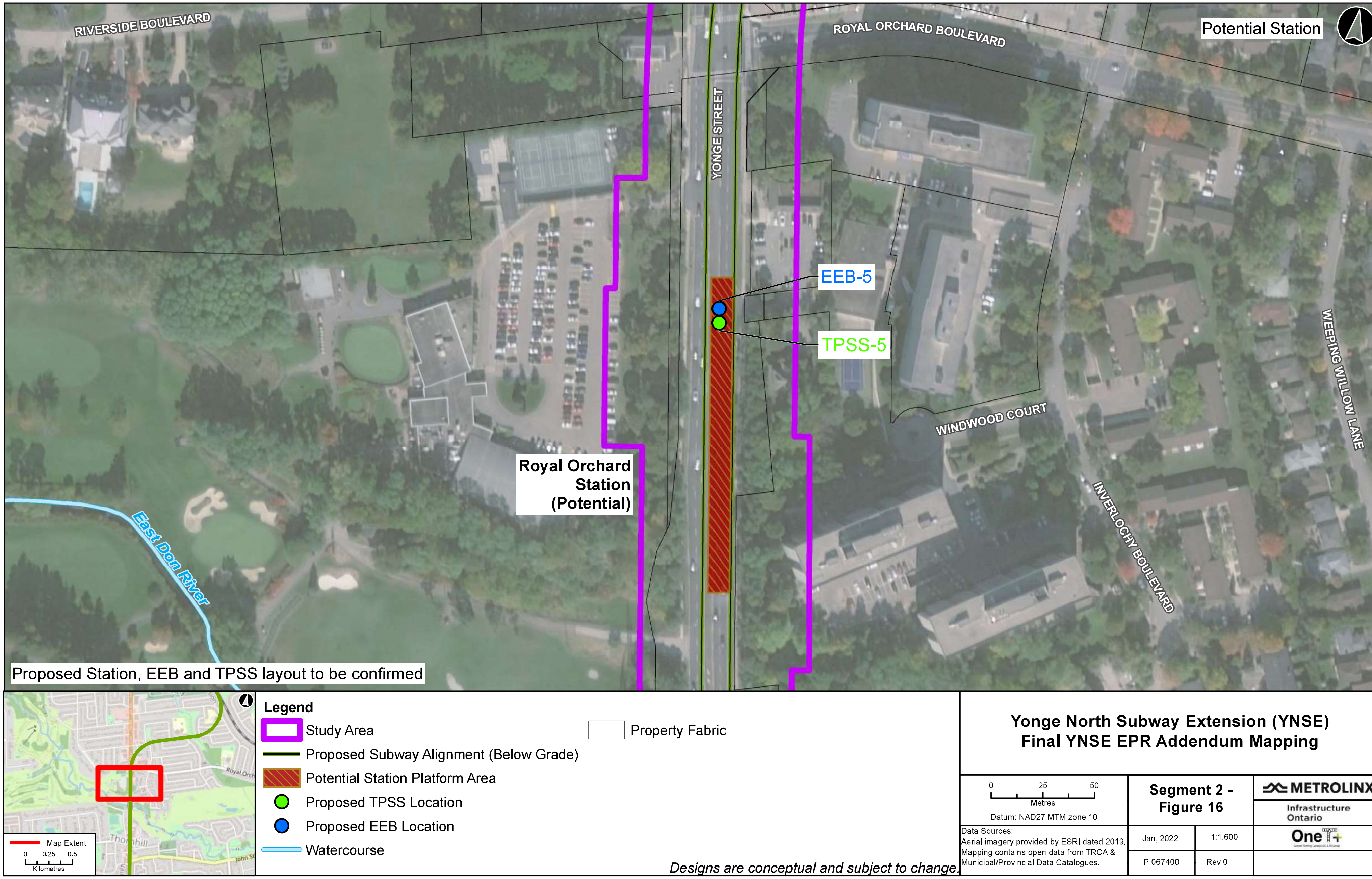
0 25 50
Metres
Datum: NAD27 MTM zone 10

Segment 2 - Figure 15

METROLINX
Infrastructure Ontario

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600	One
P 067400	Rev 0	



Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Potential Station Platform Area
- Proposed TPSS Location
- Proposed EEB Location
- Watercourse
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50
Metres

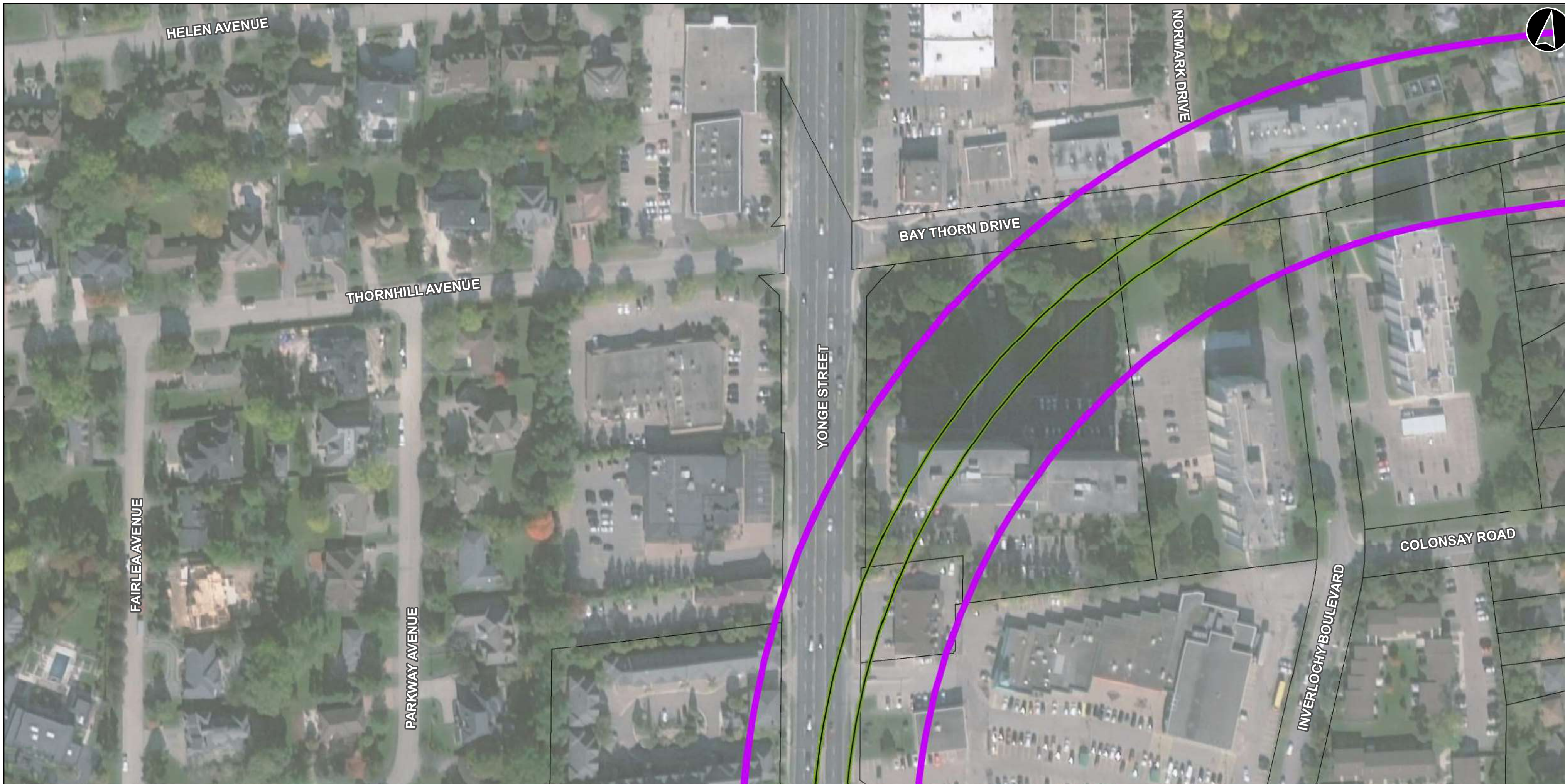
Datum: NAD27 MTM zone 10

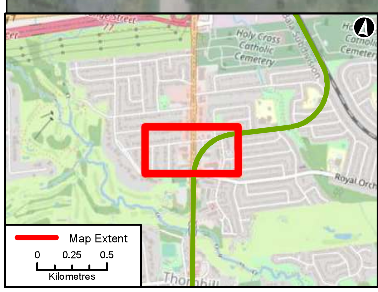
Segment 2 - Figure 16

METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600	
P 067400	Rev 0	





Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50
Metres
Datum: NAD27 MTM zone 10

Segment 2 - Figure 17

METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0

Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Proposed EEB Location
- Watercourse
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

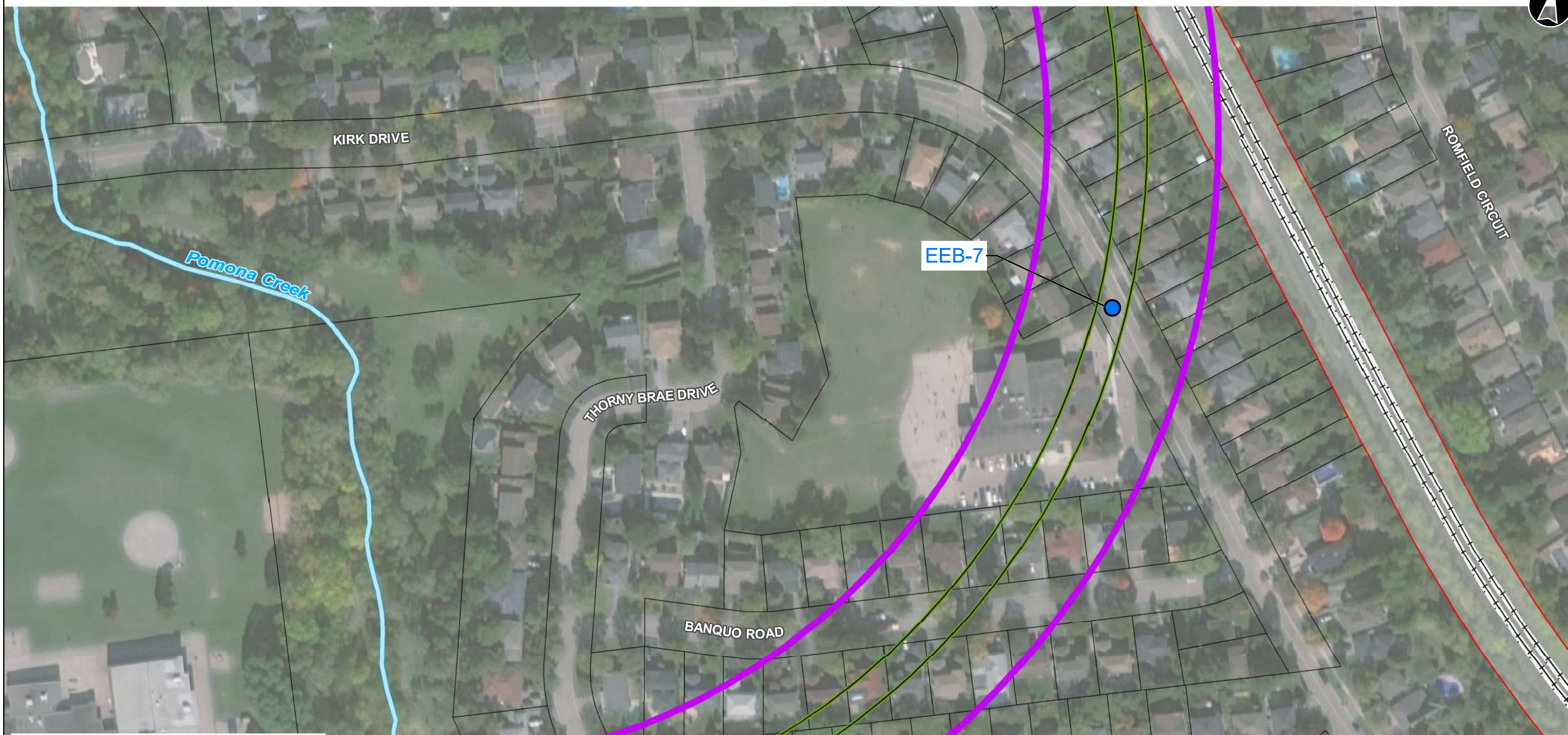
0 25 50
Metres
Datum: NAD27 MTM zone 10

Segment 2 - Figure 18

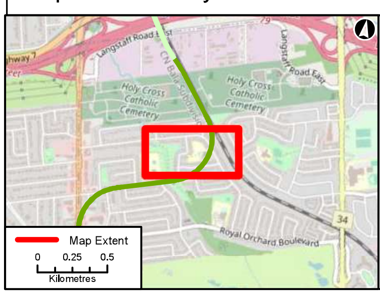
METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0



Proposed EEB layout to be confirmed



Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Proposed EEB Location
- Existing CN Track / Metrolinx Richmond Hill Corridor
- Watercourse
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

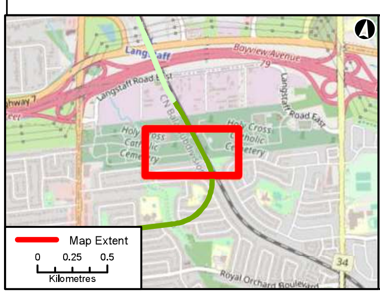
0 25 50
Metres
Datum: NAD27 MTM zone 10

Segment 2 - Figure 19

METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0



Legend

- Study Area
- Proposed Subway Alignment (Below Grade)
- Existing CN Track / Metrolinx Richmond Hill Corridor
- Watercourse
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

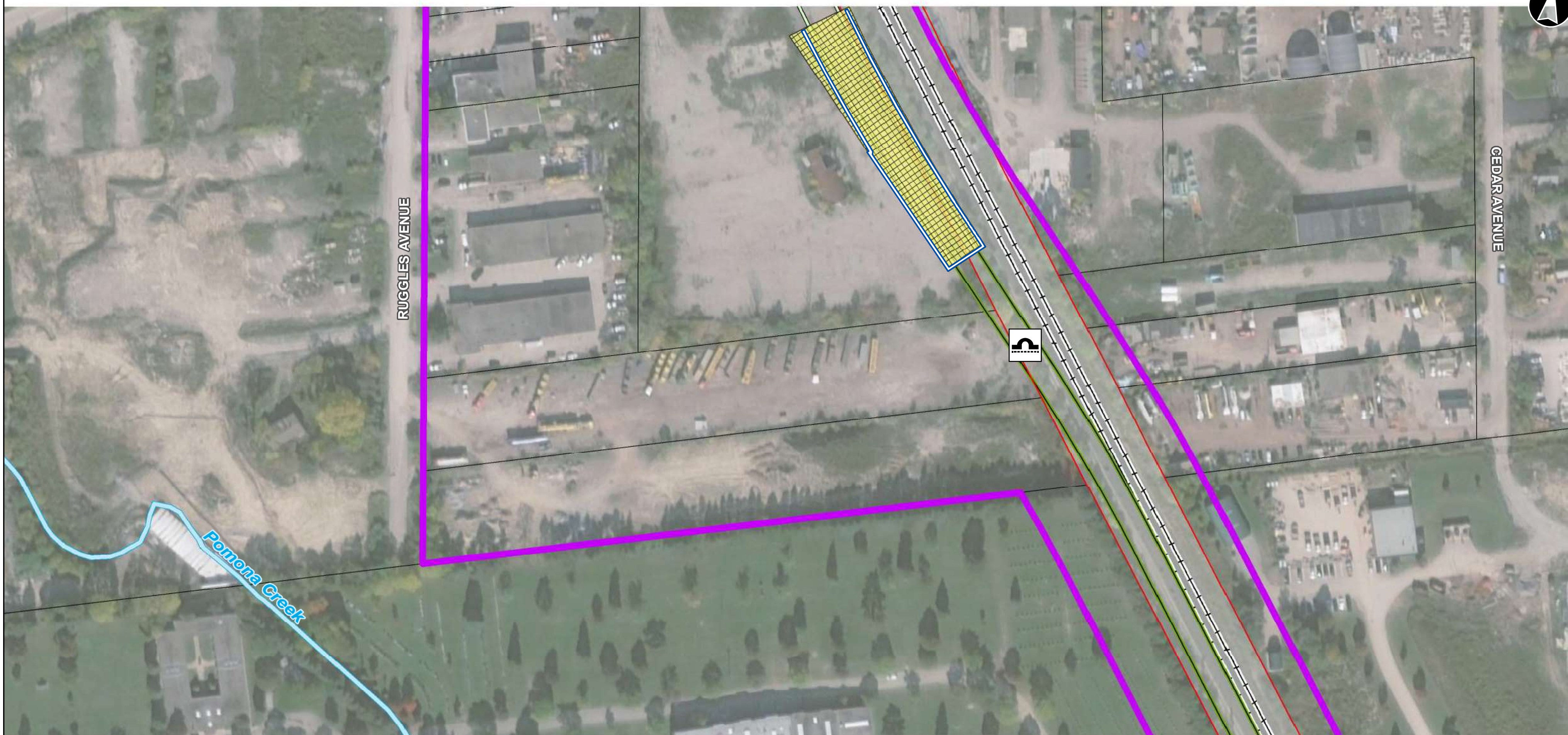
0 25 50
Metres
Datum: NAD27 MTM zone 10

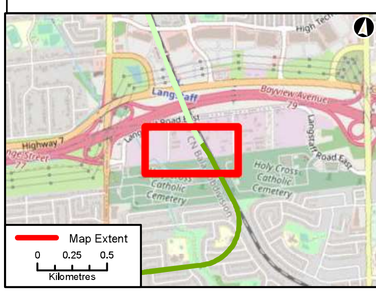
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 2 - Figure 20

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One





Legend

- Study Area
- Proposed Subway Alignment (At Grade)
- Proposed Subway Alignment (Below Grade)
- Proposed Launch Shaft
- Proposed Portal Structure
- Proposed Culvert Relocation
- Existing CN Track / Metrolinx Richmond Hill Corridor
- Watercourse
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

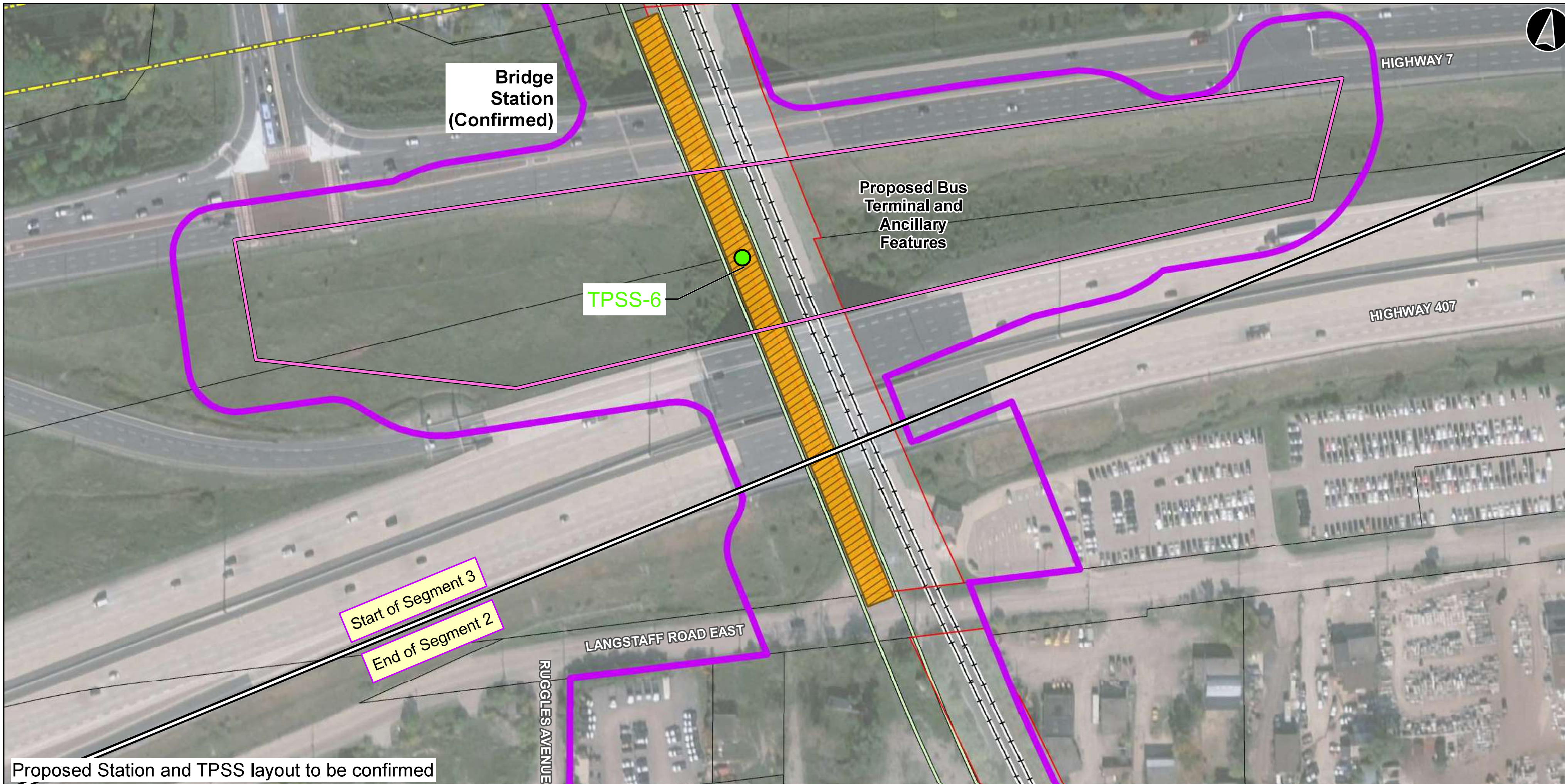
0 25 50
Metres
Datum: NAD27 MTM zone 10

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 2 - Figure 21

Jan, 2022	1:1,600	
P 067400	Rev 0	

METROLINX
Infrastructure Ontario
One



Legend

- Study Area Segment Breakline
- Study Area
- Proposed Subway Alignment (At Grade)
- Confirmed Station Platform Area
- Proposed Bus Terminal and Ancillary Features
- Proposed TPSS Location
- Proposed Launch Shaft
- Existing CN Track / Metrolinx Richmond Hill Corridor
- Existing Hydro One Transmission
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

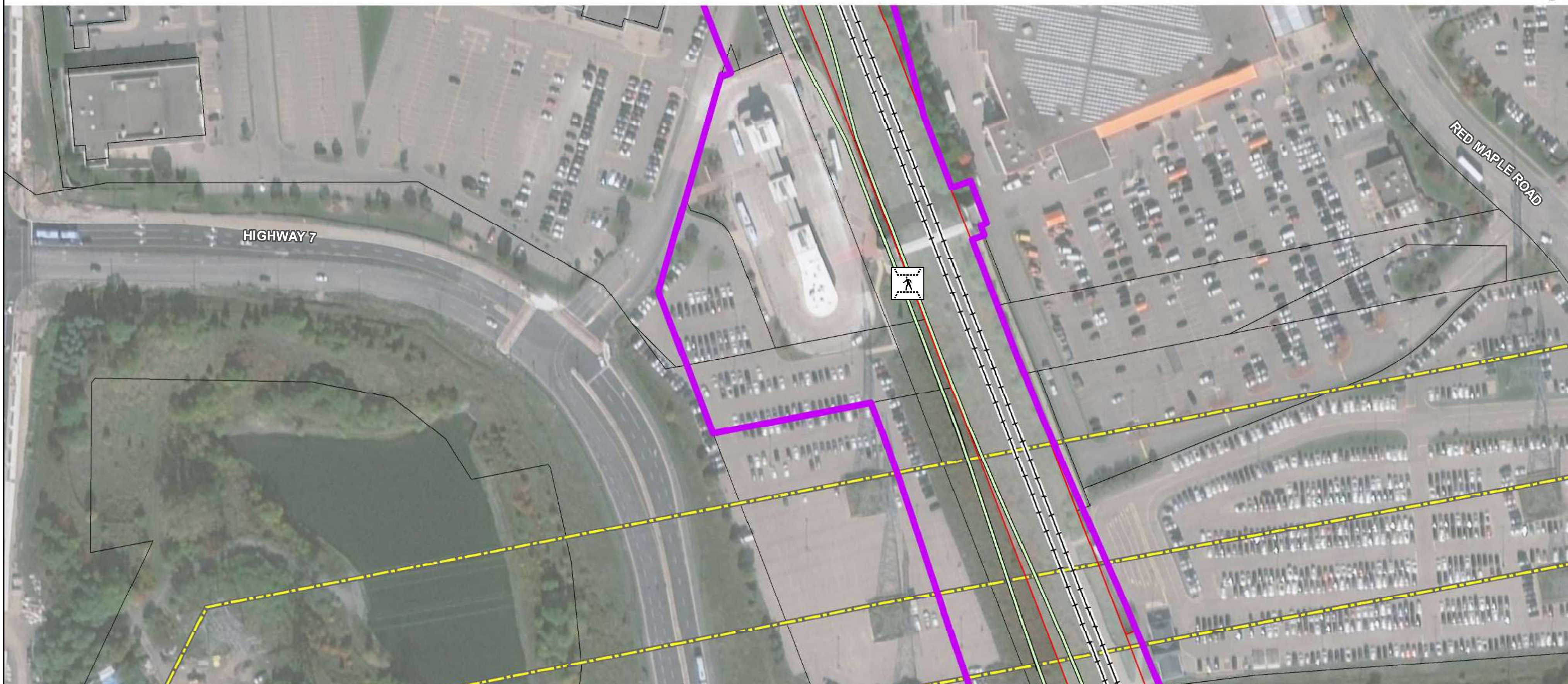
0 25 50
Metres
Datum: NAD27 MTM zone 10

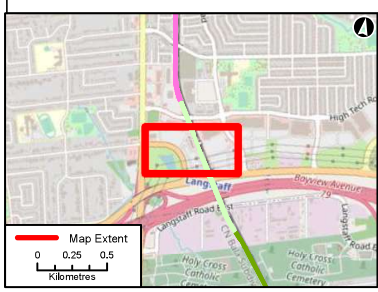
Segment 2/3 - Figure 22

METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0





Legend

- Study Area
- Proposed Subway Alignment (At Grade)
- Proposed Temporary Pedestrian Bridge
- Existing CN Track / Metrolinx Richmond Hill Corridor
- Existing Hydro One Transmission
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50
Metres

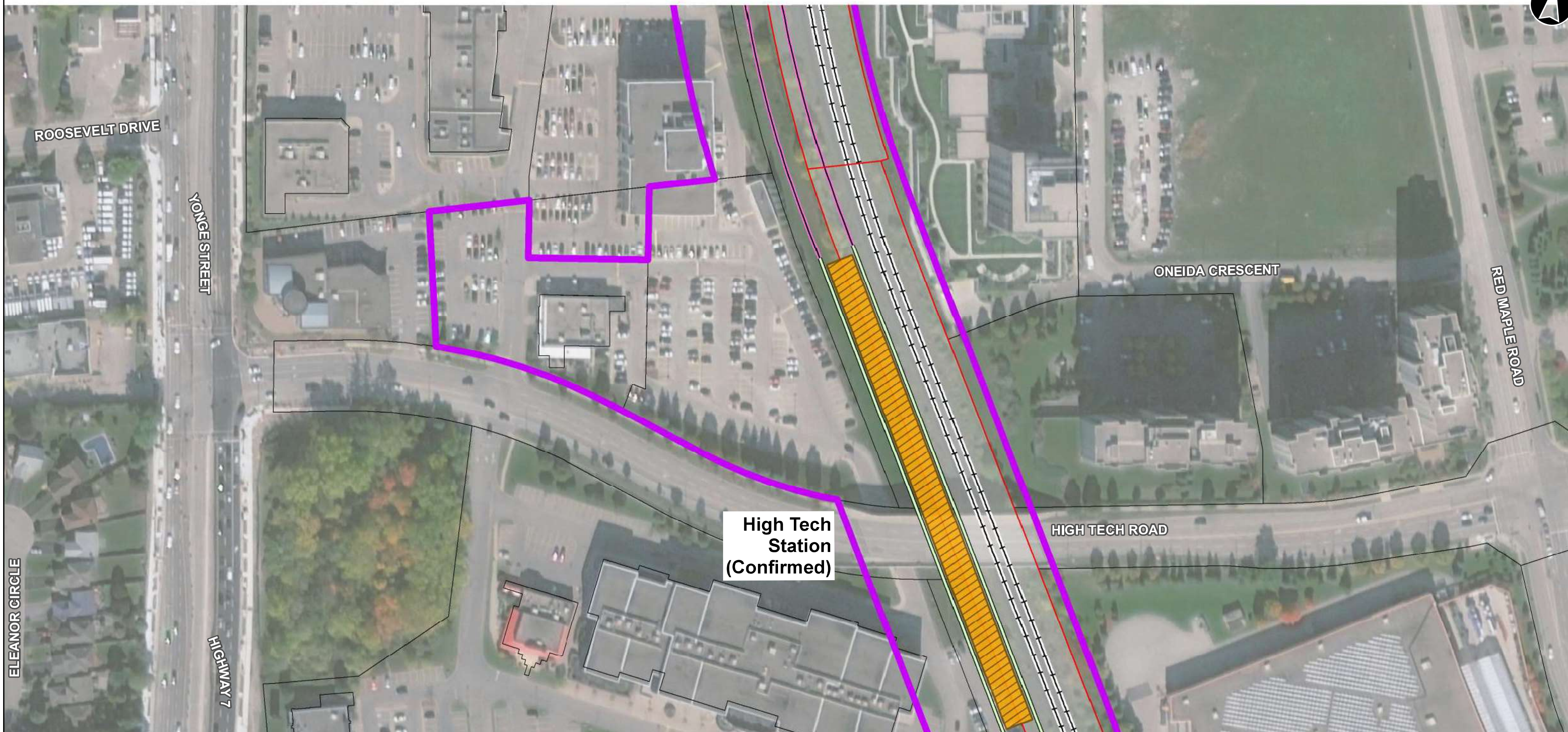
Datum: NAD27 MTM zone 10

Segment 3 - Figure 23

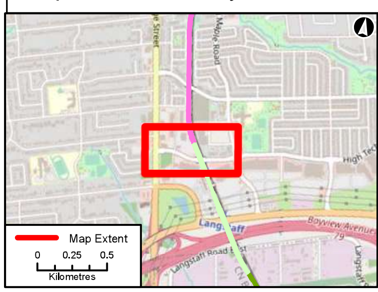
METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0



Proposed Station layout to be confirmed



Legend

- Study Area
- Proposed Subway Alignment (At Grade)
- Proposed Train Storage Facility Alignment
- Confirmed Station Platform Area
- Existing CN Track / Metrolinx Richmond Hill Corridor
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

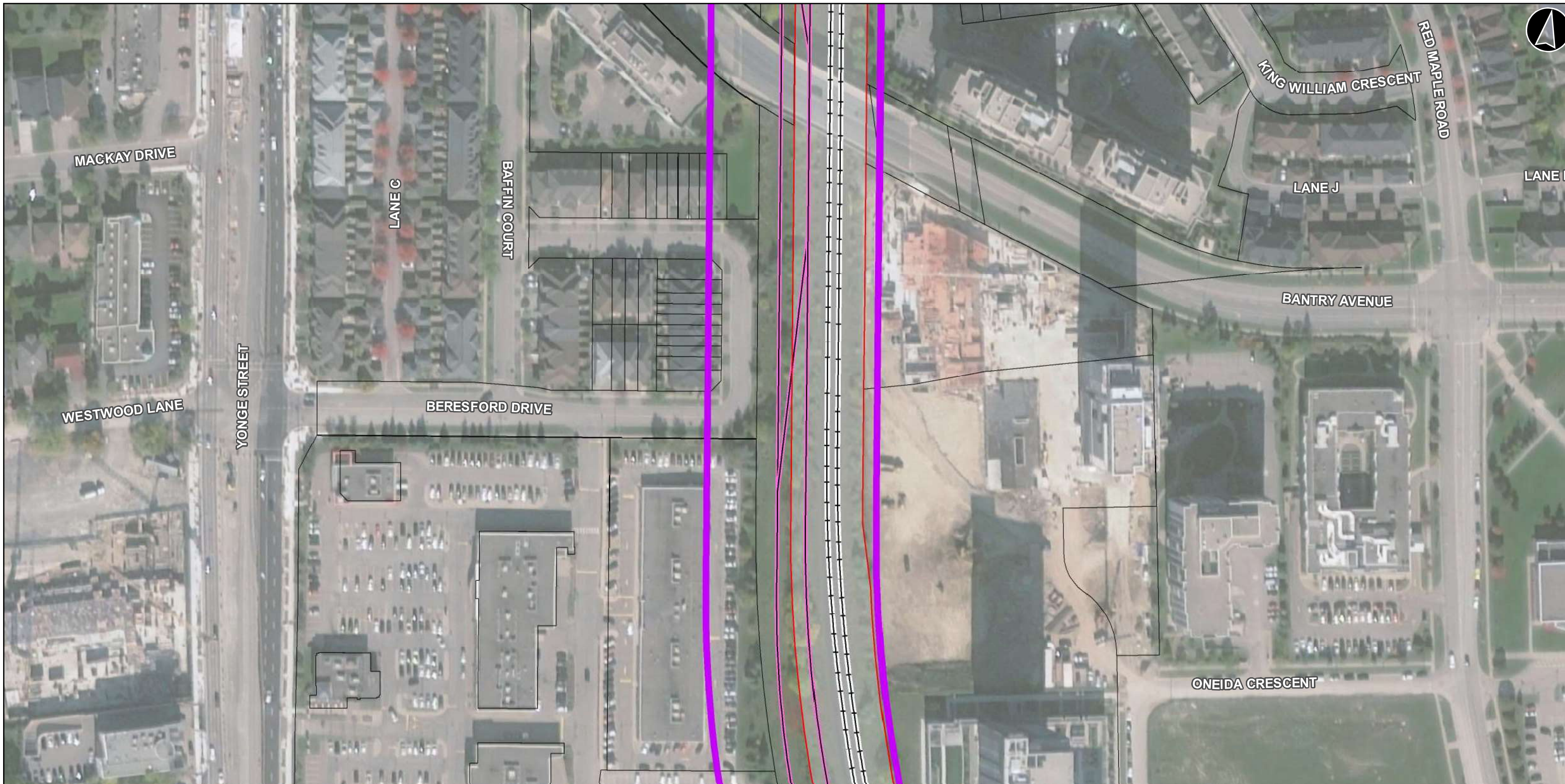
0 25 50
Metres
Datum: NAD27 MTM zone 10

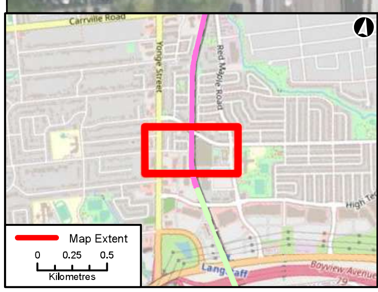
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 3 - Figure 24

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One





Legend

- Study Area
- Proposed Train Storage Facility Alignment
- Existing CN Track / Metrolinx Richmond Hill Corridor
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

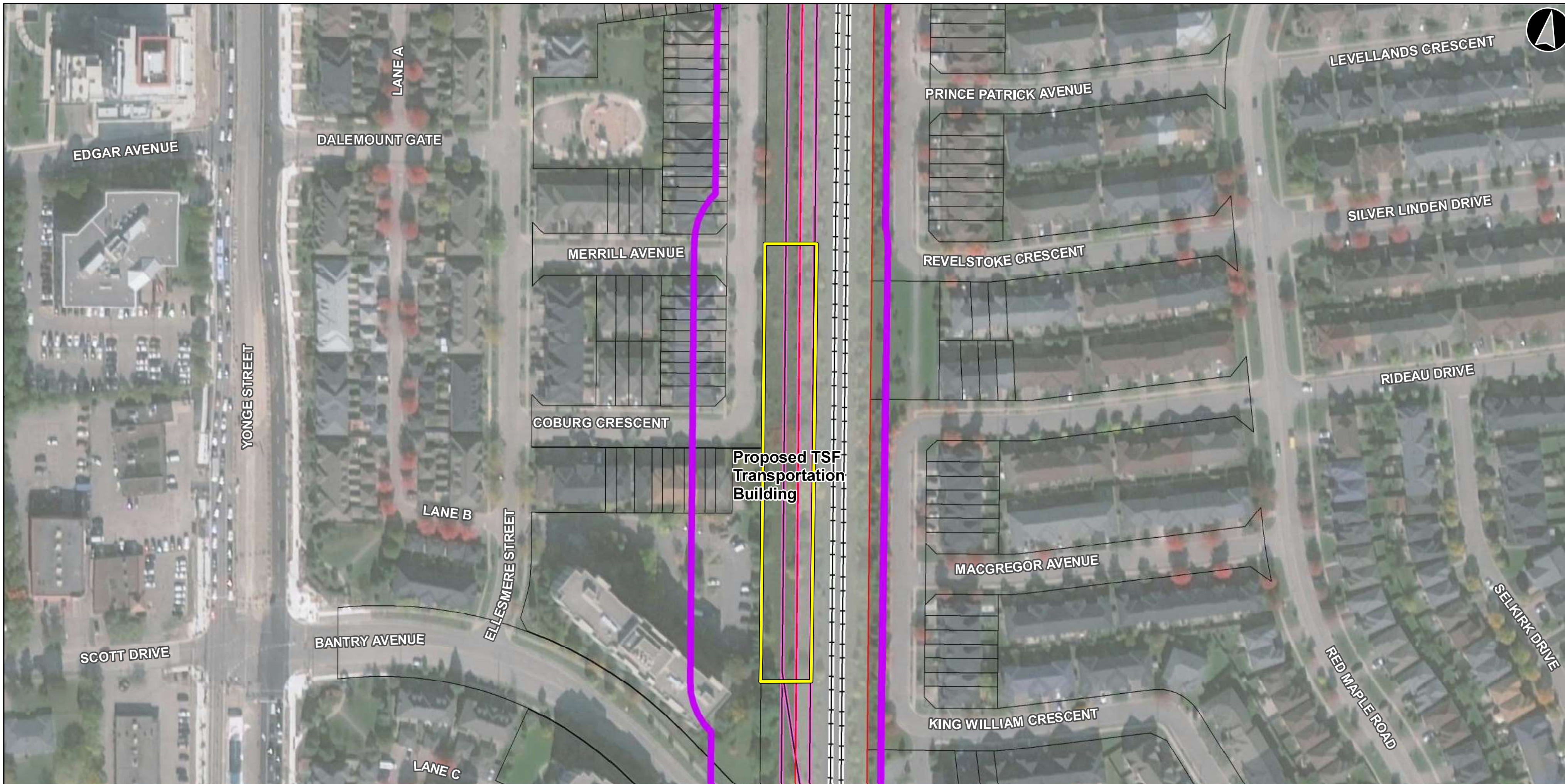
0 25 50
Metres
Datum: NAD27 MTM zone 10

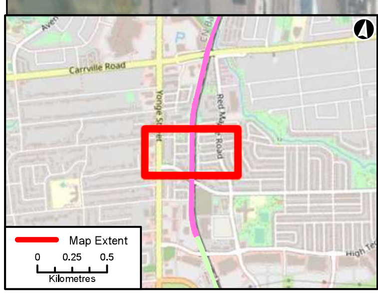
Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 3 - Figure 25

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One





Legend

- Study Area
- Proposed Train Storage Facility Alignment
- Proposed TSF Transportation Building
- Existing CN Track / Metrolinx Richmond Hill Corridor
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

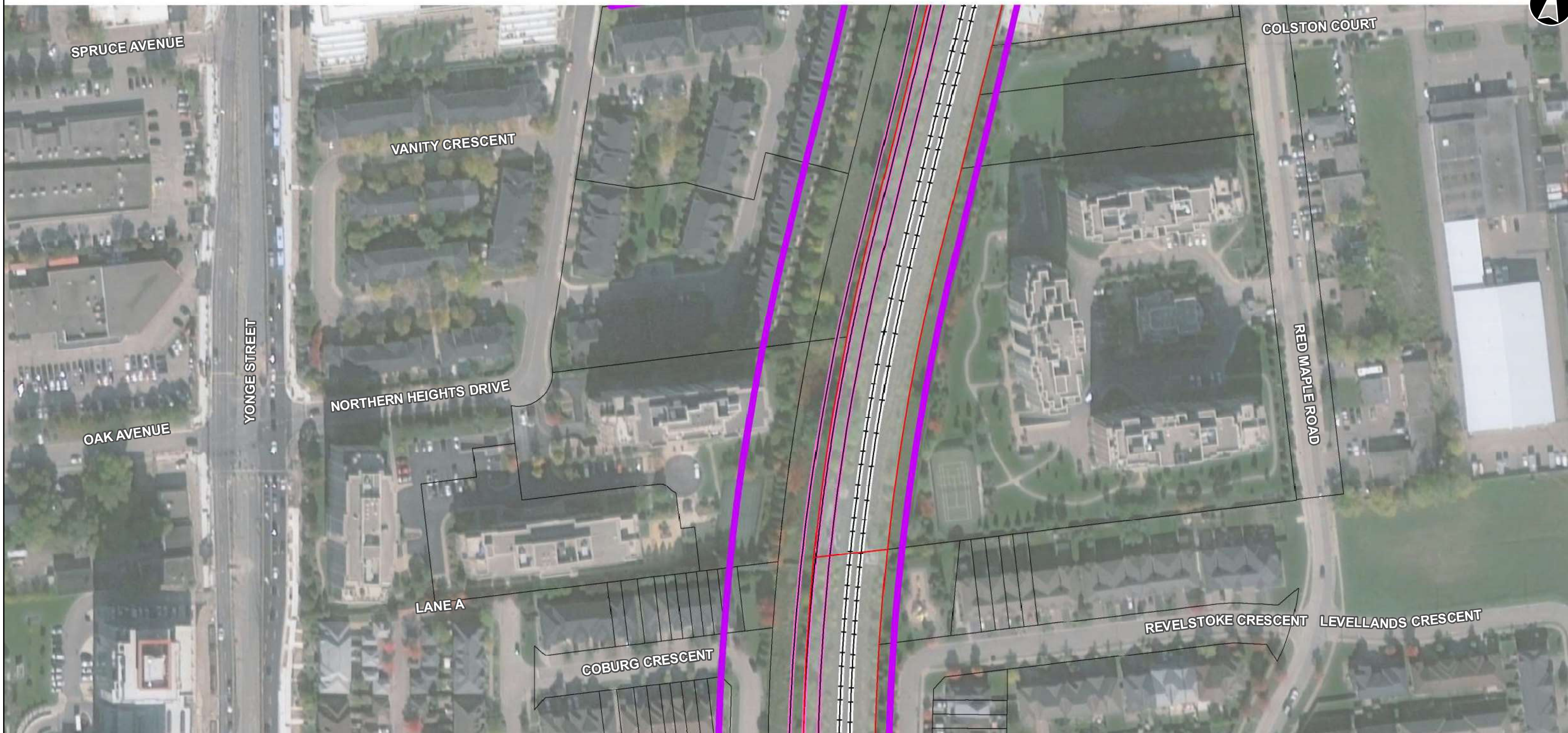
0 25 50
Metres
Datum: NAD27 MTM zone 10

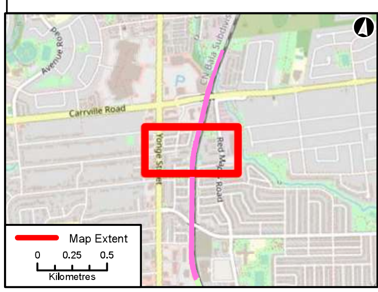
Segment 3 - Figure 26

METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600	
P 067400	Rev 0	





Legend

- Study Area
- Proposed Train Storage Facility Alignment
- Existing CN Track / Metrolinx Richmond Hill Corridor
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

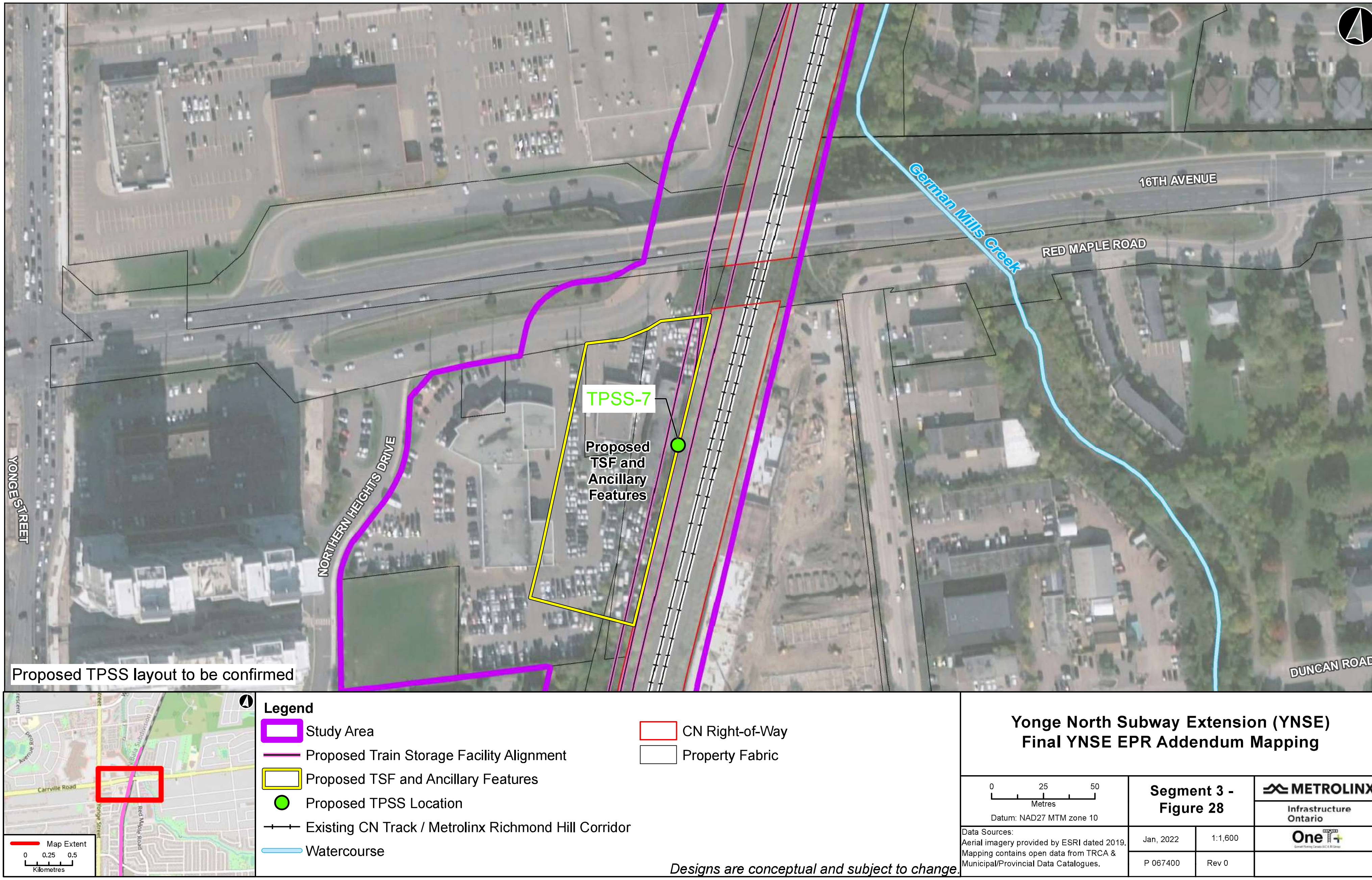
0 25 50
Metres
Datum: NAD27 MTM zone 10

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 3 - Figure 27

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One



Legend

- Study Area
- Proposed Train Storage Facility Alignment
- Proposed TSF and Ancillary Features
- Proposed TPSS Location
- Existing CN Track / Metrolinx Richmond Hill Corridor
- Watercourse
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

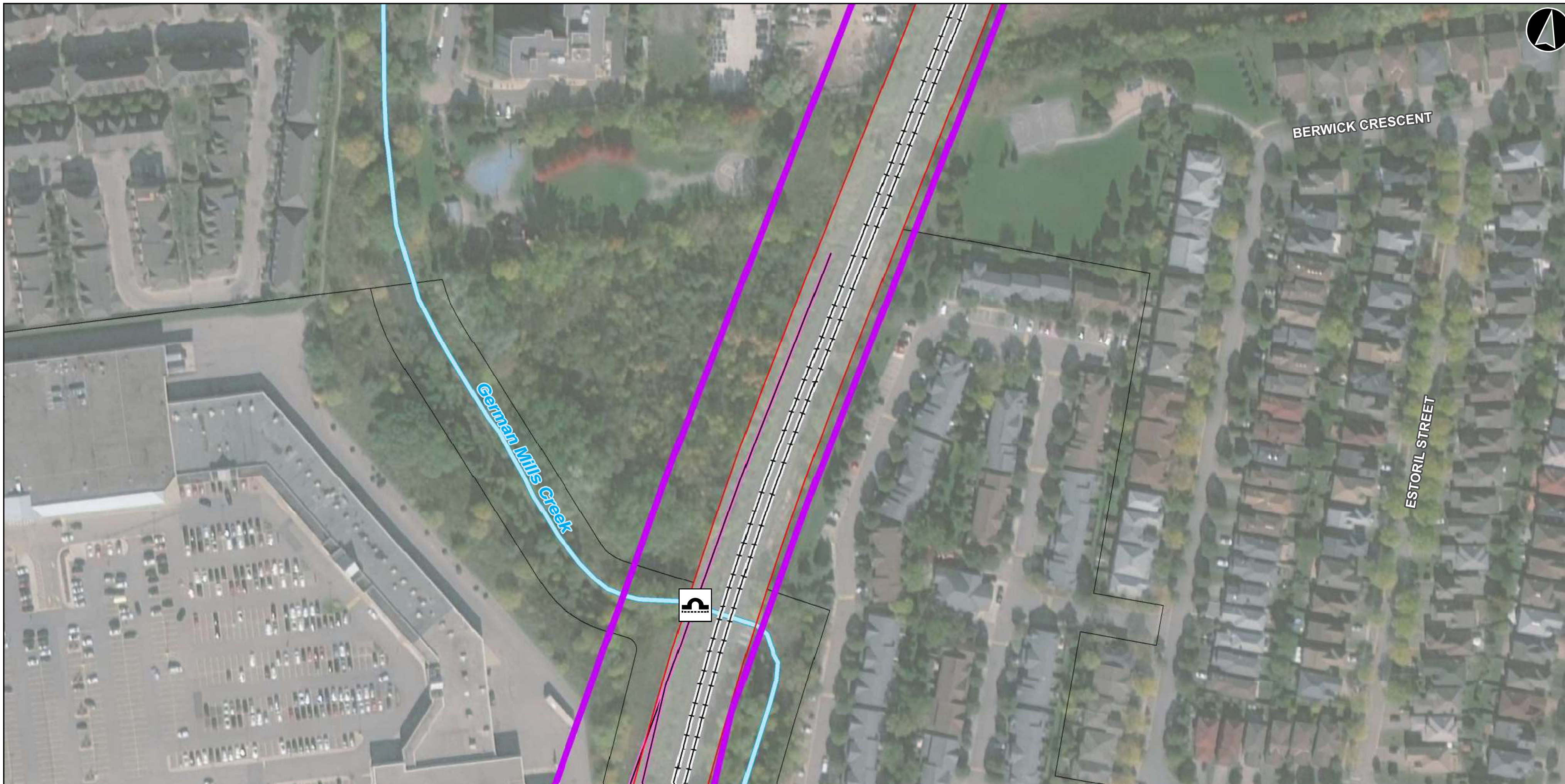
0 25 50
Metres
Datum: NAD27 MTM zone 10

Segment 3 - Figure 28

METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0



Legend

- Study Area
- Proposed Train Storage Facility Alignment
- Proposed Culvert Replacement
- Existing CN Track / Metrolinx Richmond Hill Corridor
- Watercourse
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

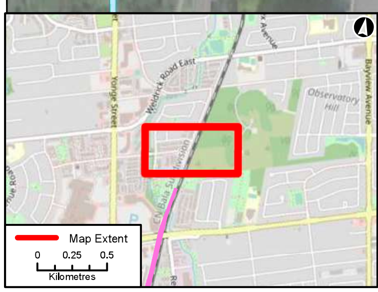
0 25 50
Metres
Datum: NAD27 MTM zone 10

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Segment 3 - Figure 29

Jan, 2022	1:1,600
P 067400	Rev 0

METROLINX
Infrastructure Ontario
One



Legend

- Study Area
- Existing CN Track / Metrolinx Richmond Hill Corridor
- Watercourse
- CN Right-of-Way
- Property Fabric

Designs are conceptual and subject to change.

Yonge North Subway Extension (YNSE)
Final YNSE EPR Addendum Mapping

0 25 50
Metres
Datum: NAD27 MTM zone 10

Segment 3 - Figure 30

METROLINX
Infrastructure Ontario
One

Data Sources:
Aerial imagery provided by ESRI dated 2019.
Mapping contains open data from TRCA & Municipal/Provincial Data Catalogues.

Jan, 2022	1:1,600
P 067400	Rev 0

APPENDIX B: FIGURES

Figure 1: Cummer Station and Extraction Shaft

Figure 2: Steeles Station

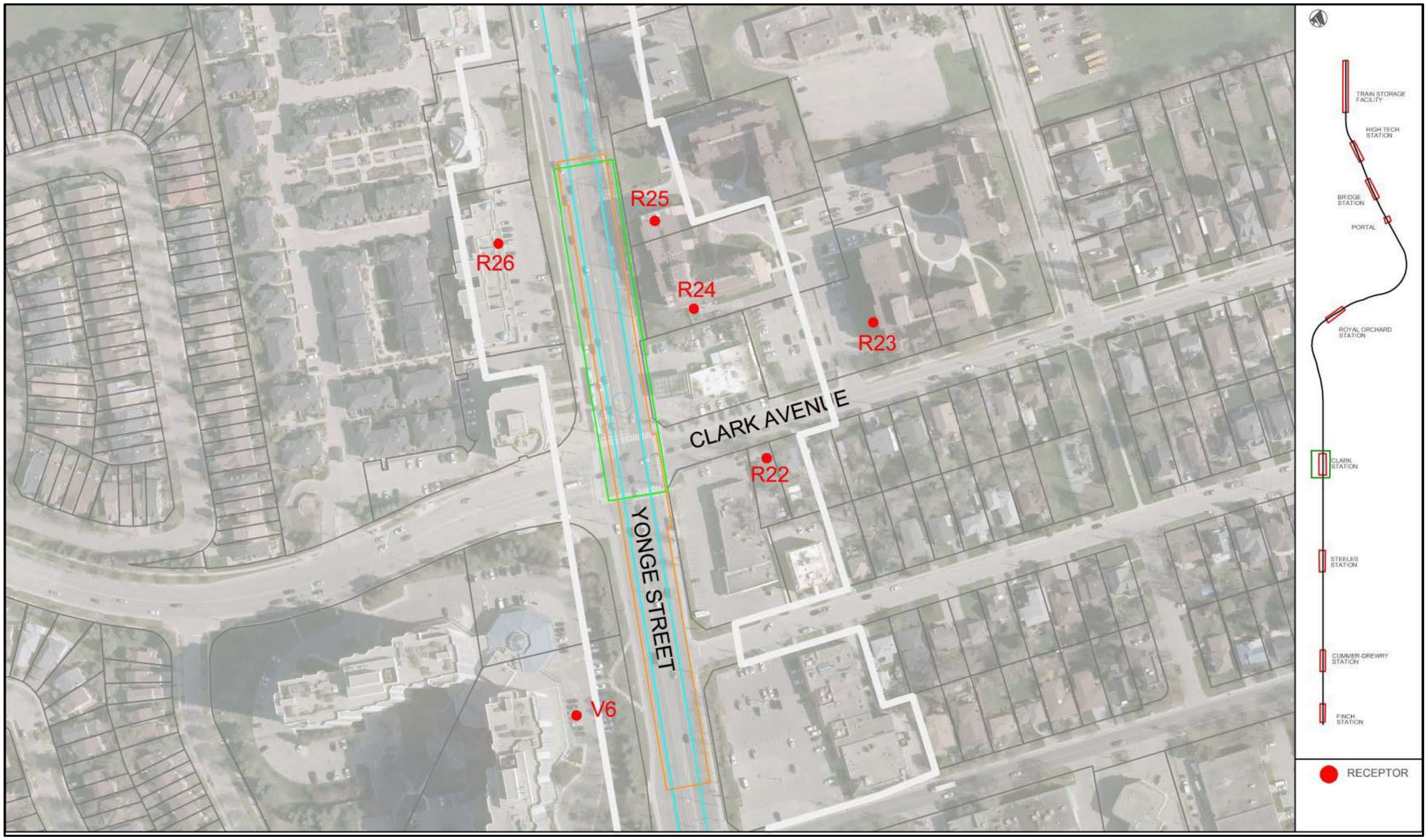


Figure 3: Clark Station

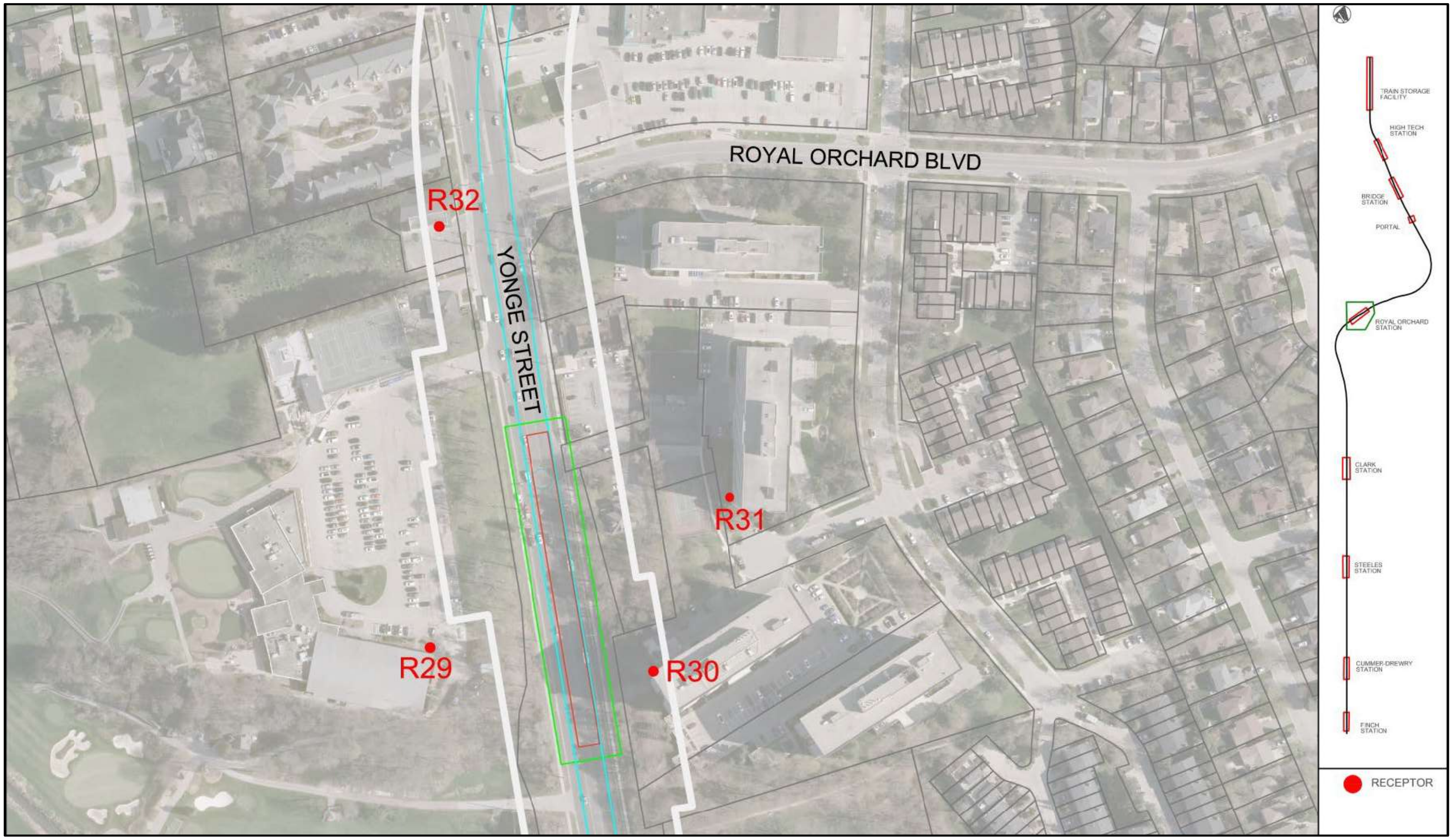


Figure 4: Royal Orchard Station

Figure 5: Bridge Station and Portal

Figure 6: High Tech Station

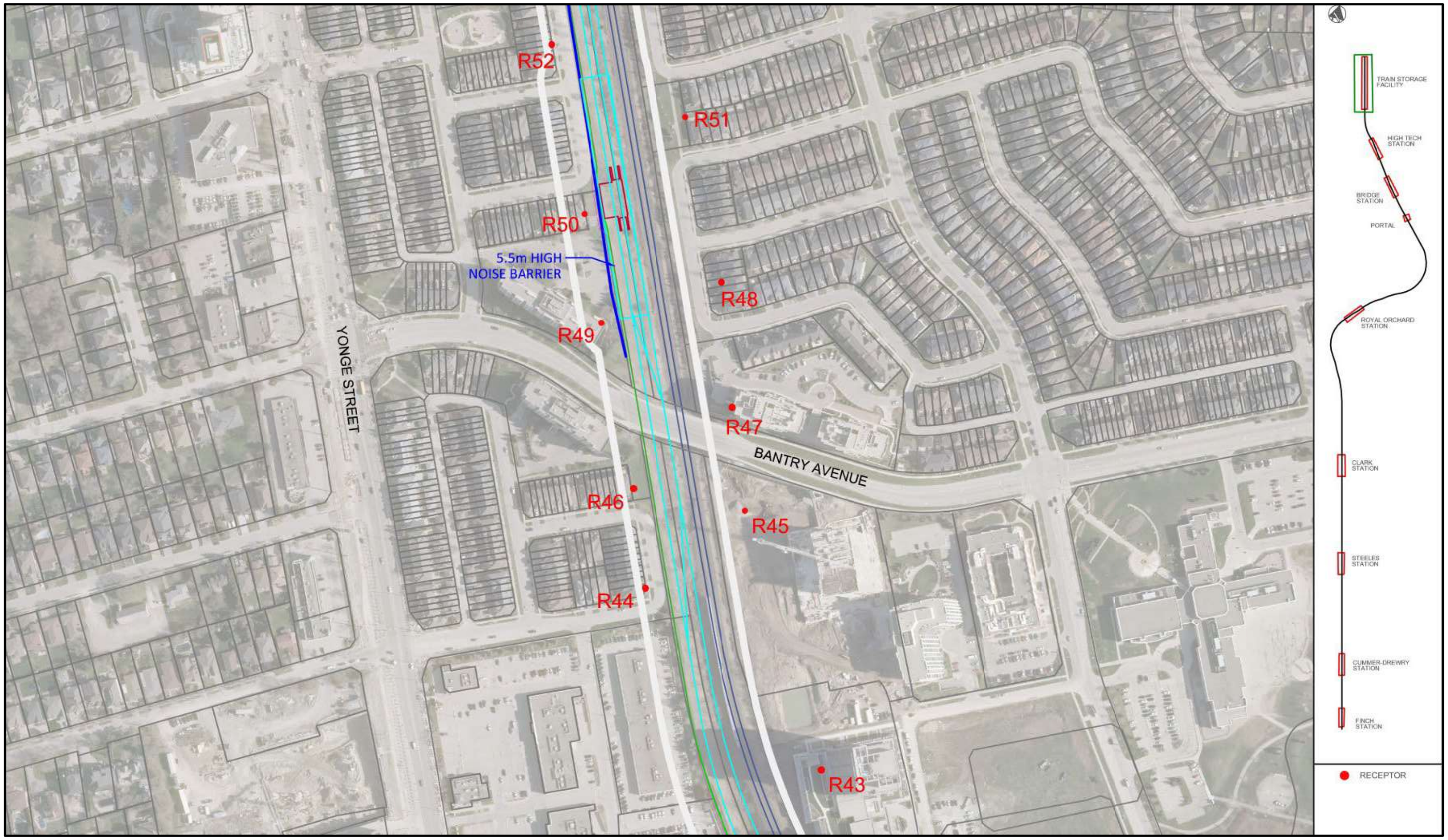


Figure 7: Train Storage Facility Part 1

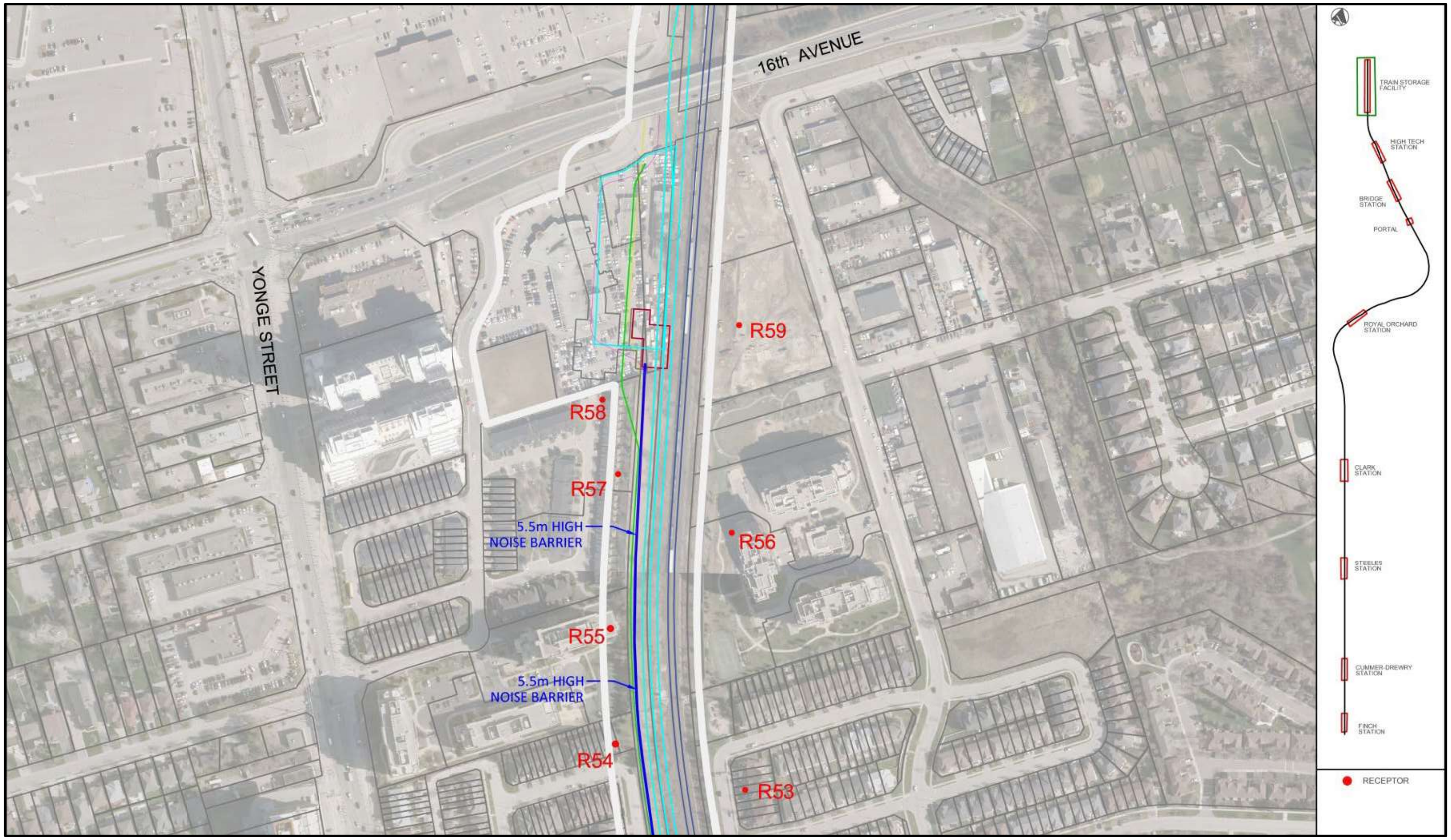


Figure 8: Train Storage Facility Part 2

Figure 9: At Grade Part 1 Average Daytime Existing Sound Levels

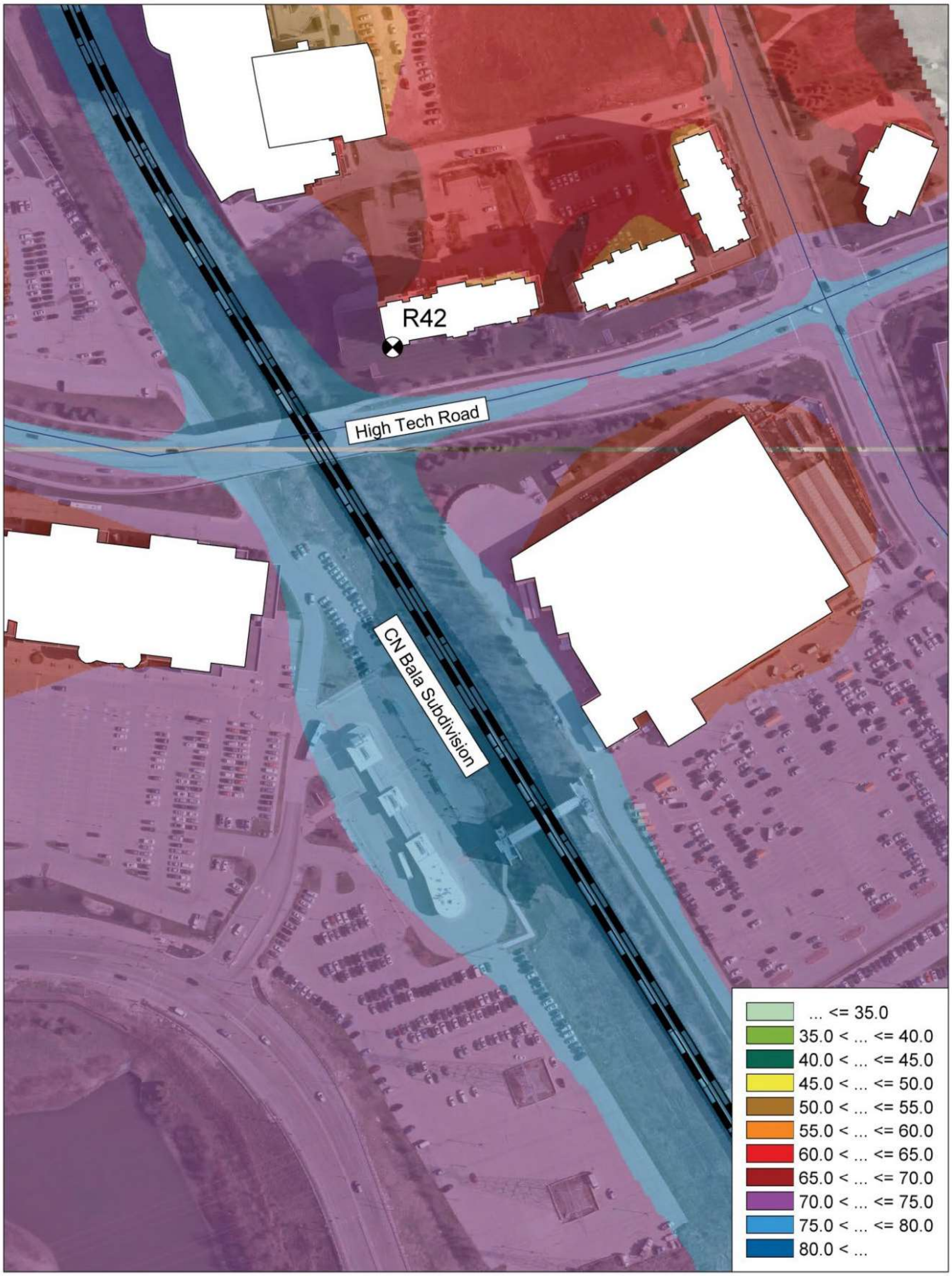


Figure 10: At Grade Part 2 Average Daytime Existing Sound Levels

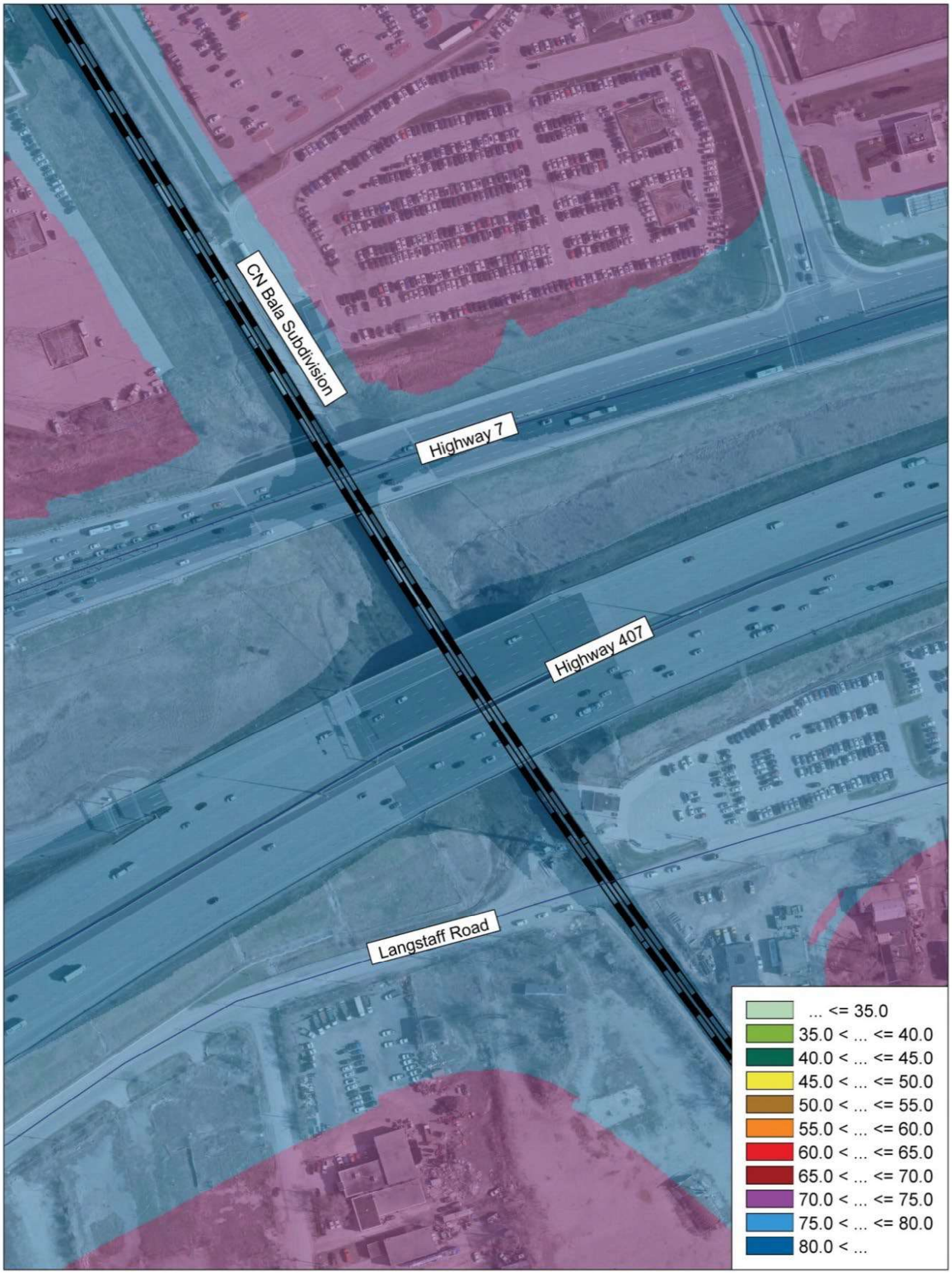


Figure 11: At Grade Part 3 Average Daytime Existing Sound Levels

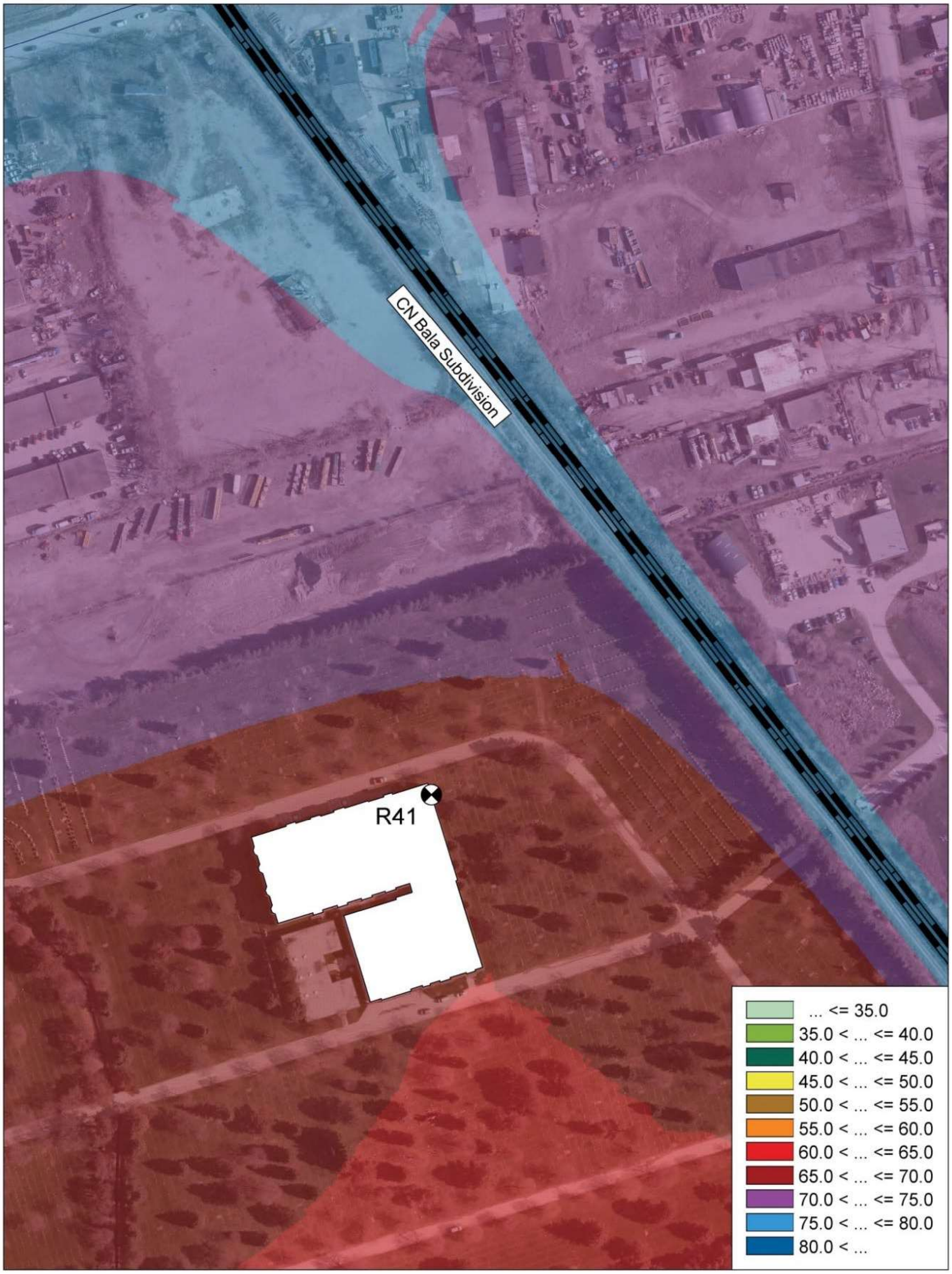


Figure 12: At Grade Part 4 Average Daytime Existing Sound Levels

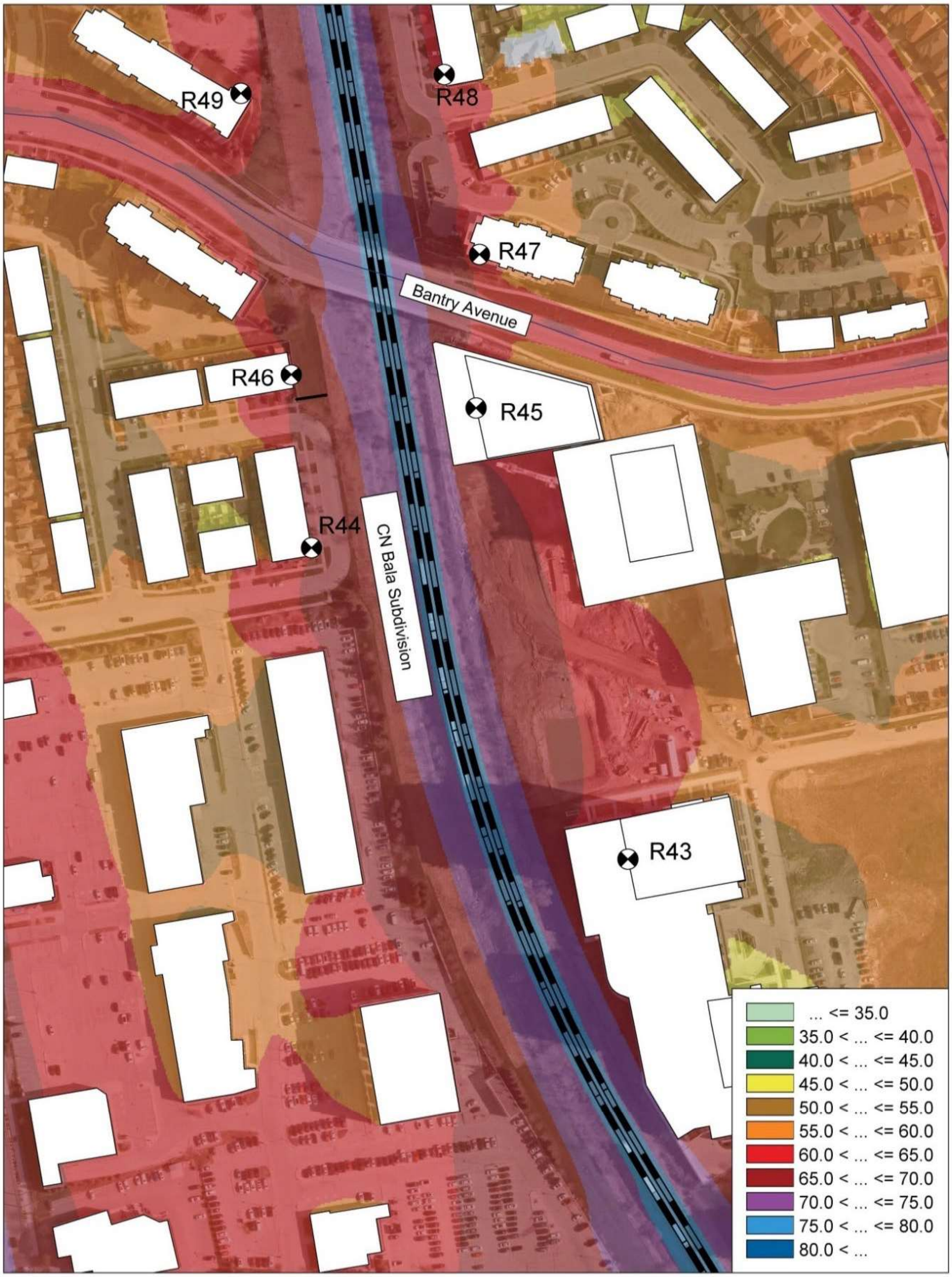


Figure 13: At Grade Part 1 Nighttime Average Existing Sound Levels

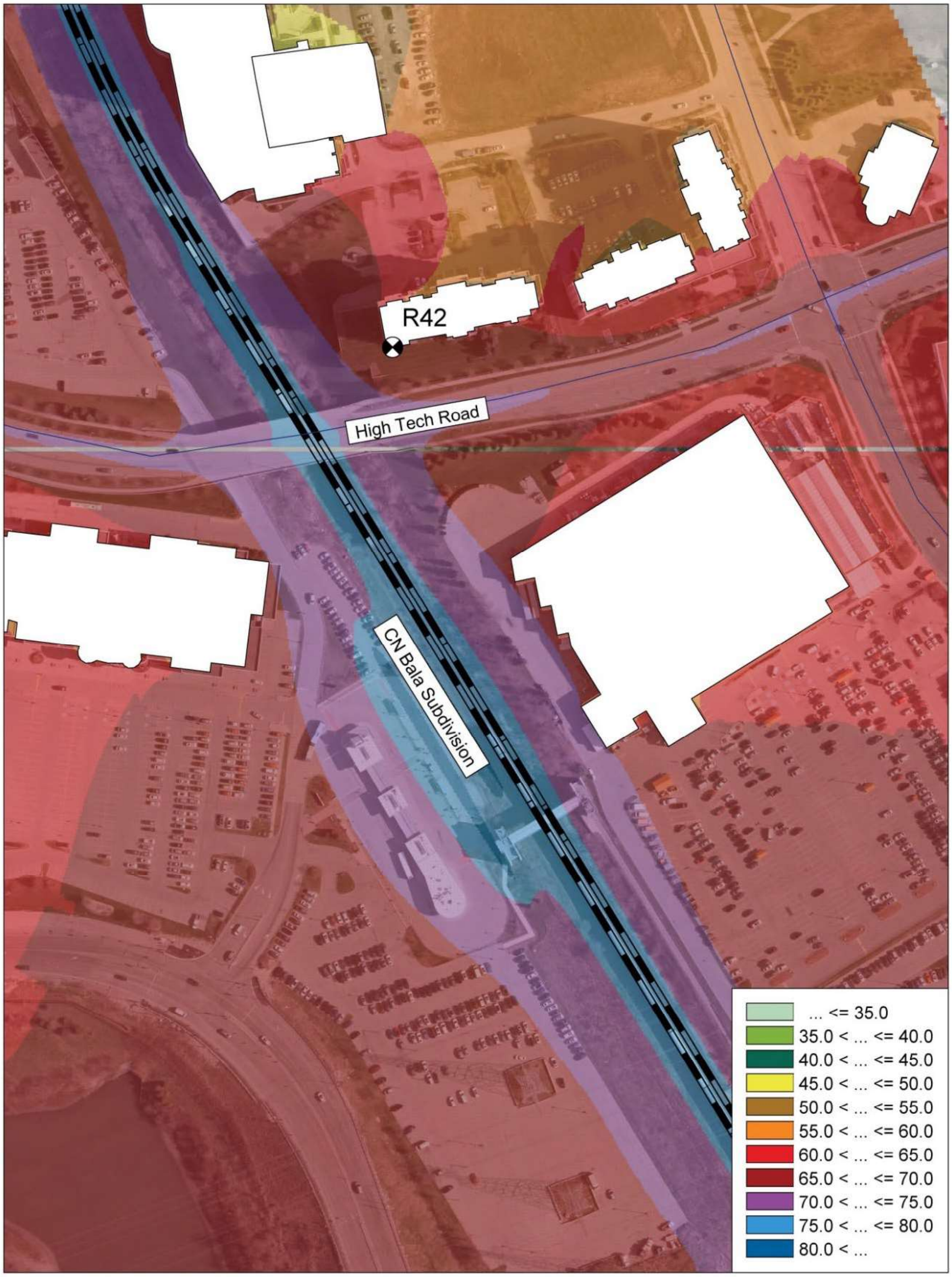


Figure 14: At Grade Part 2 Average Nighttime Existing Sound Levels

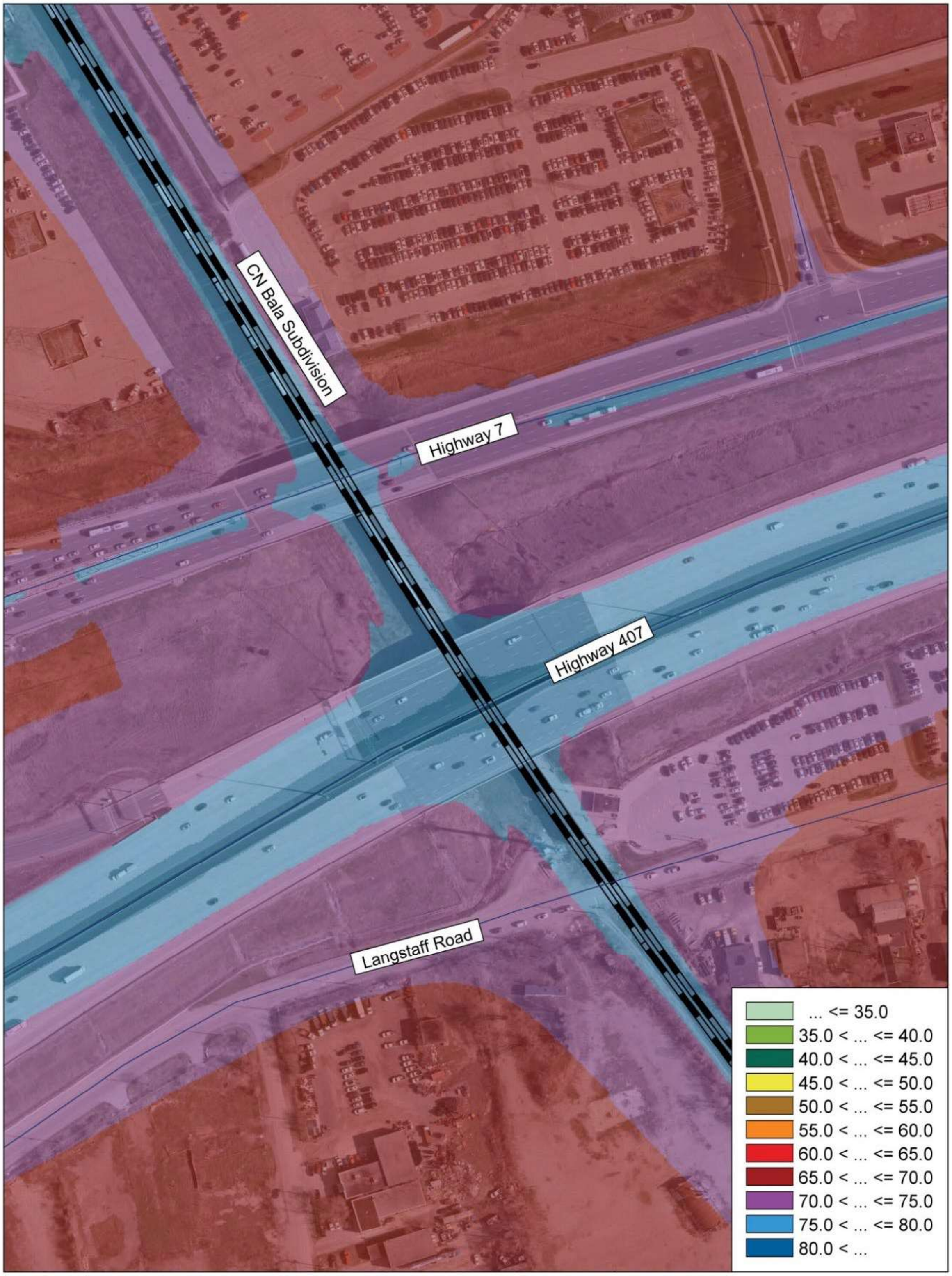


Figure 15: At Grade Part 3 Nighttime Average Existing Sound Levels

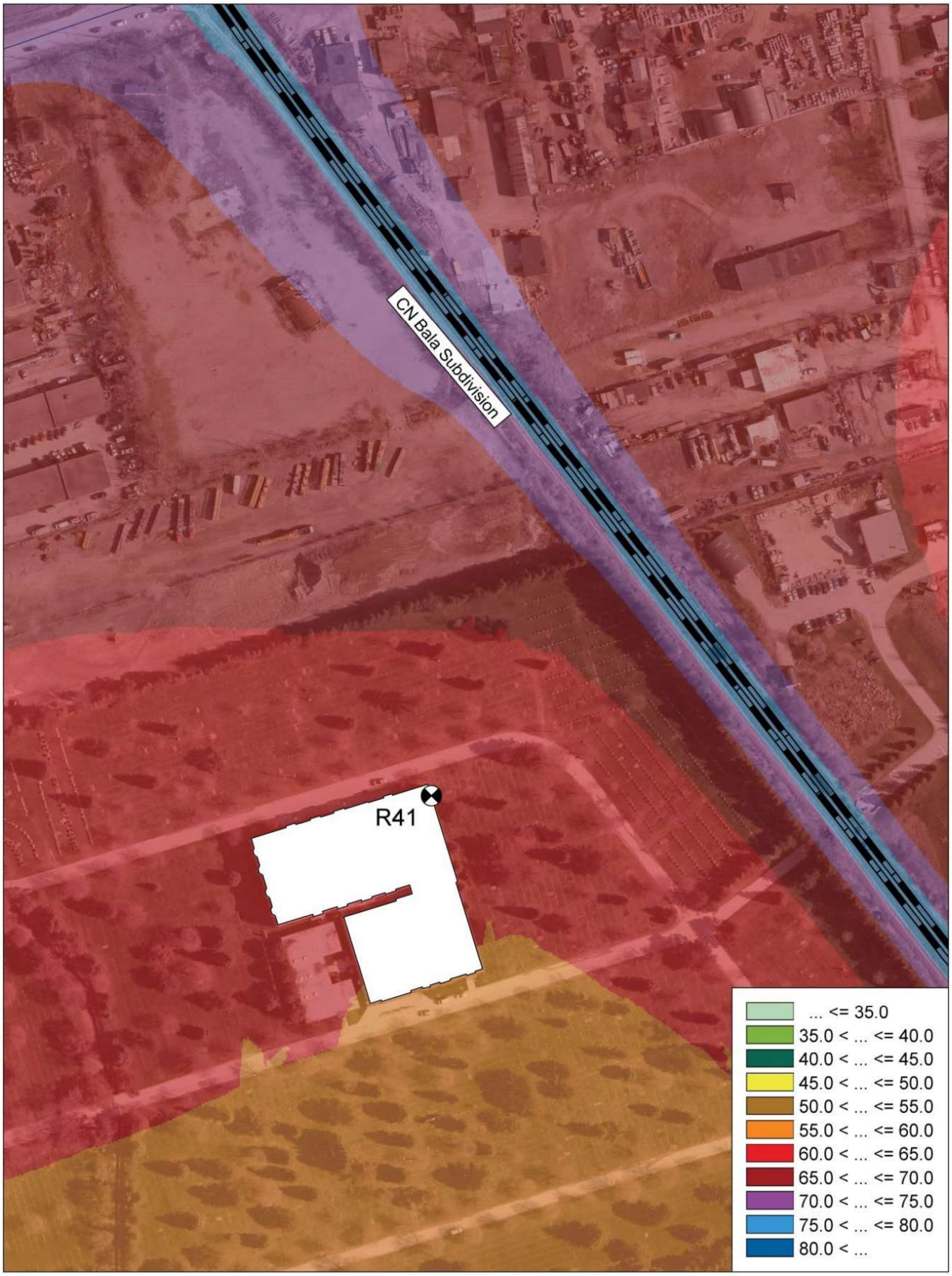


Figure 16: At Grade Part 4 Nighttime Average Existing Sound Levels

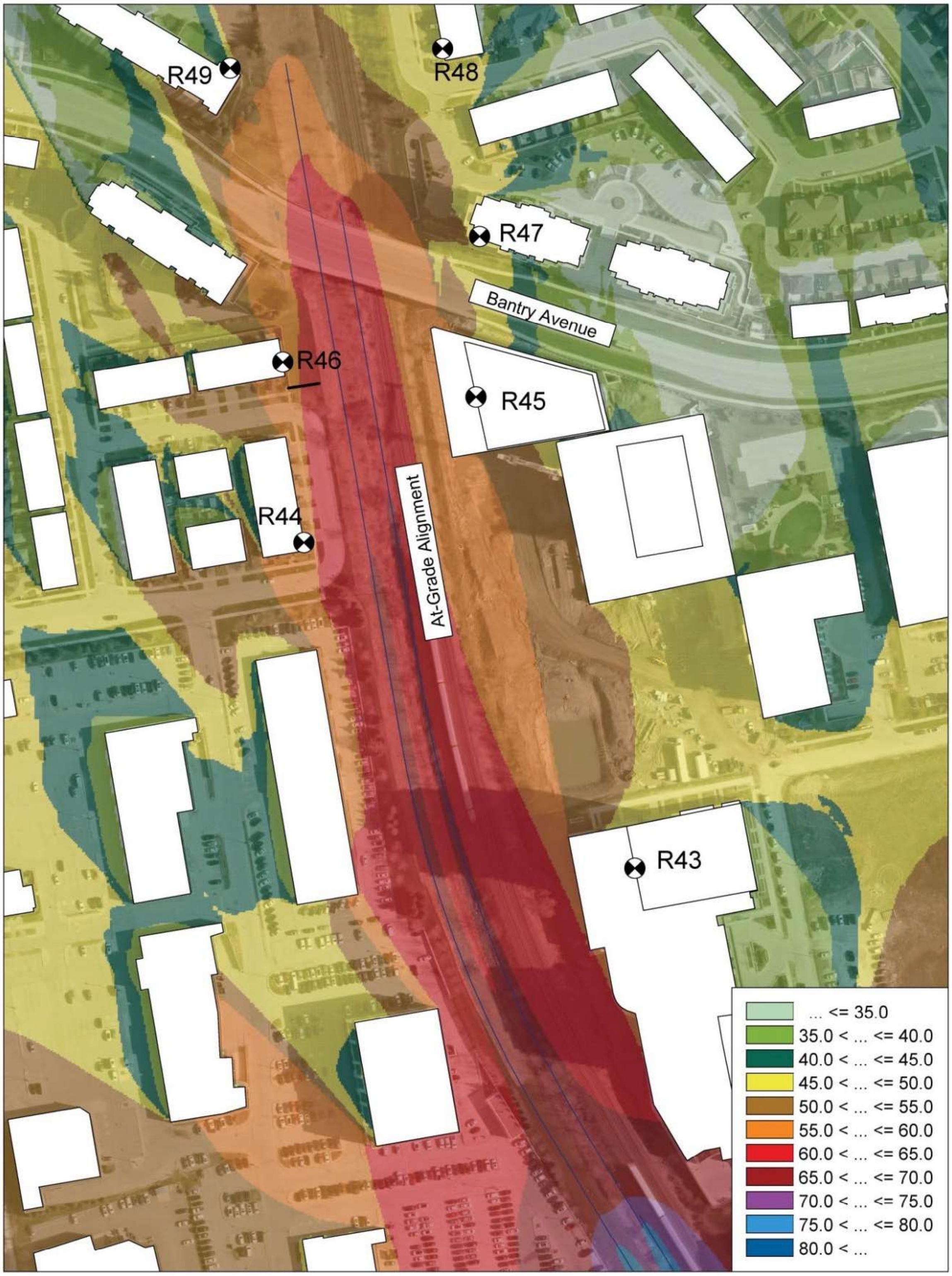


Figure 17: At Grade Alignment Part 1 Daytime Sound Levels

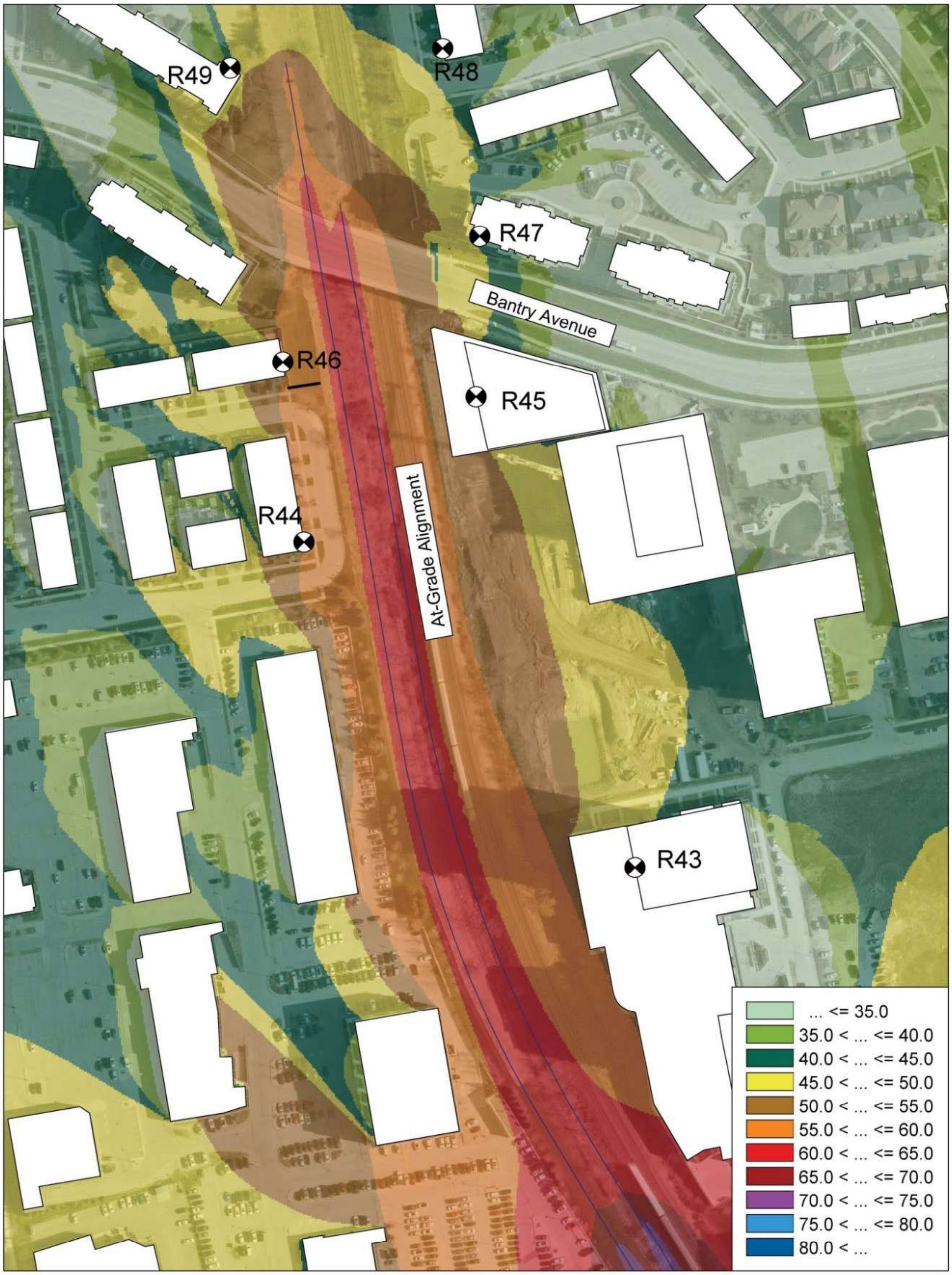


Figure 18: At Grade Alignment Part 1 Nighttime Sound Levels

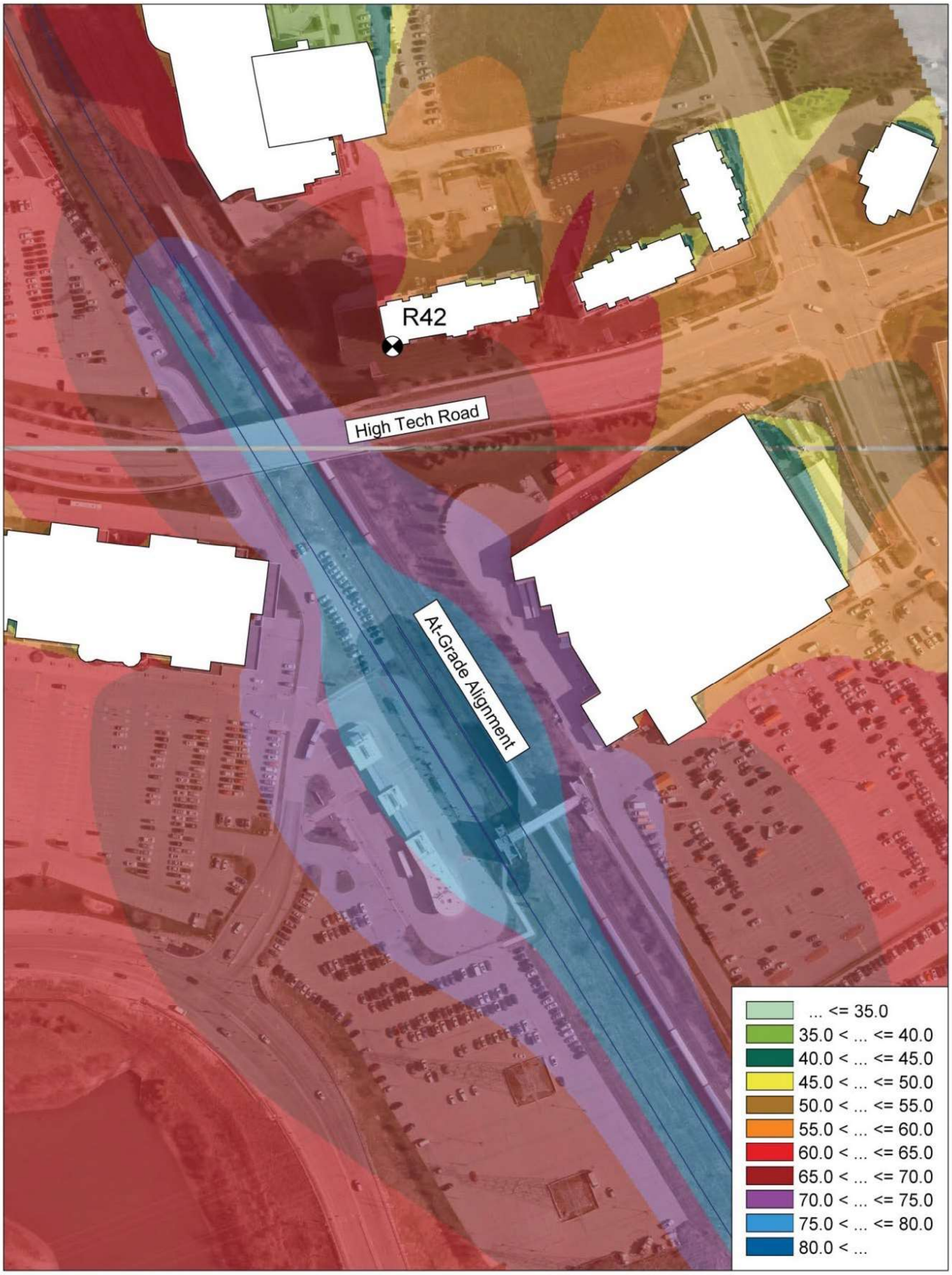


Figure 19: At Grade Alignment Part 2 Daytime Sound Levels

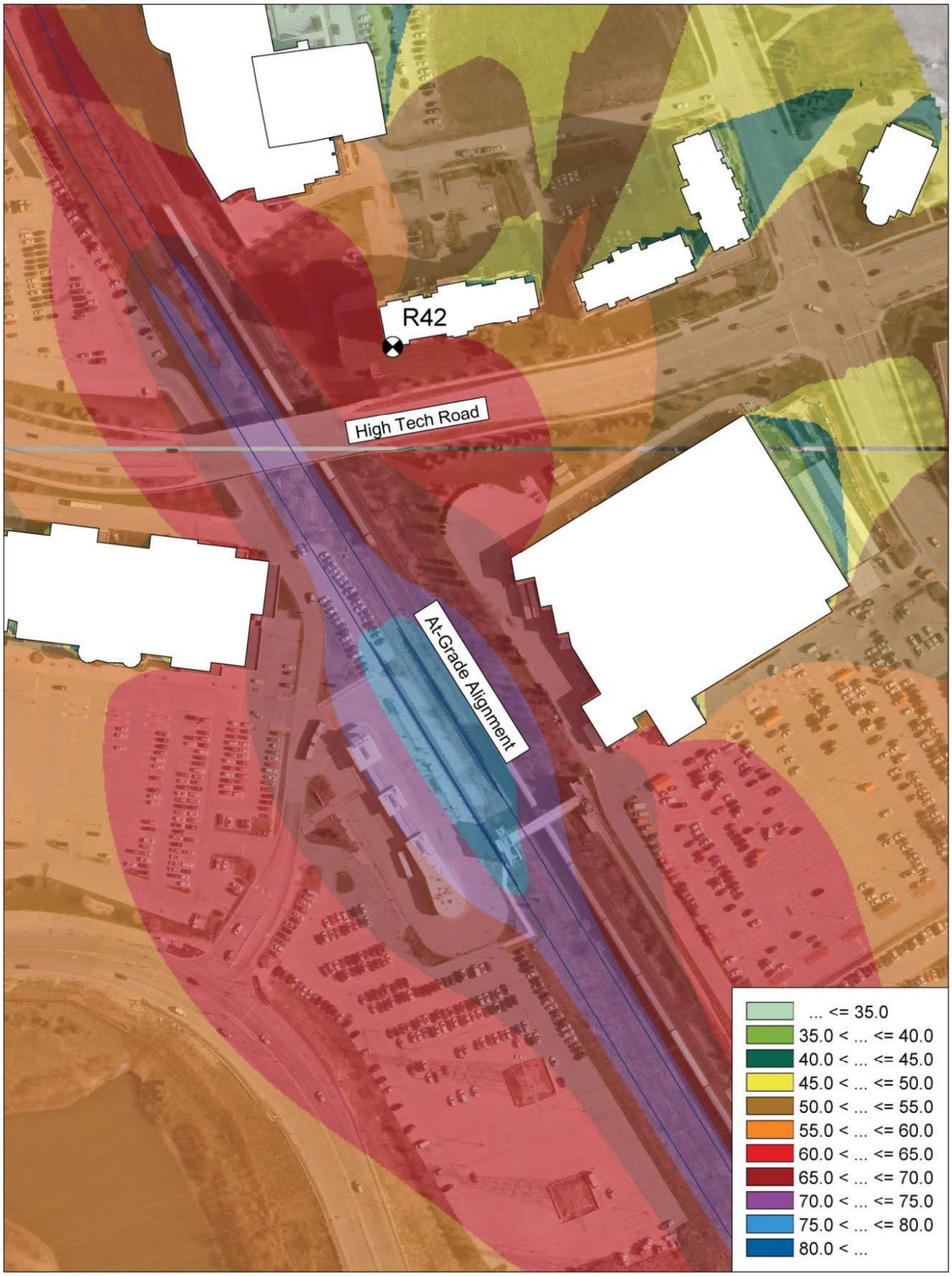


Figure 20: At Grade Alignment Part 2 Nighttime Sound Levels

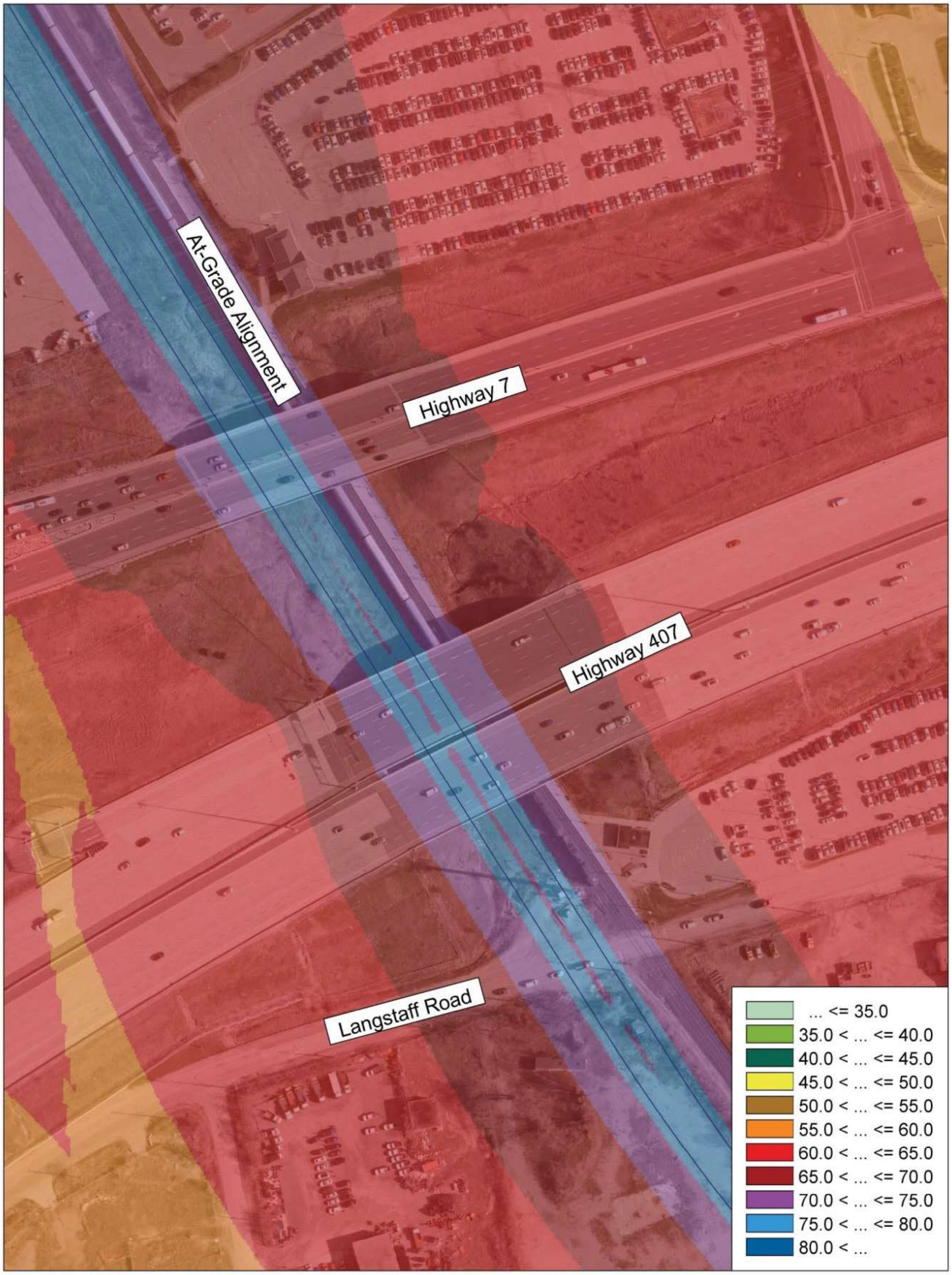


Figure 21: At Grade Alignment Part 3 Daytime Sound Levels

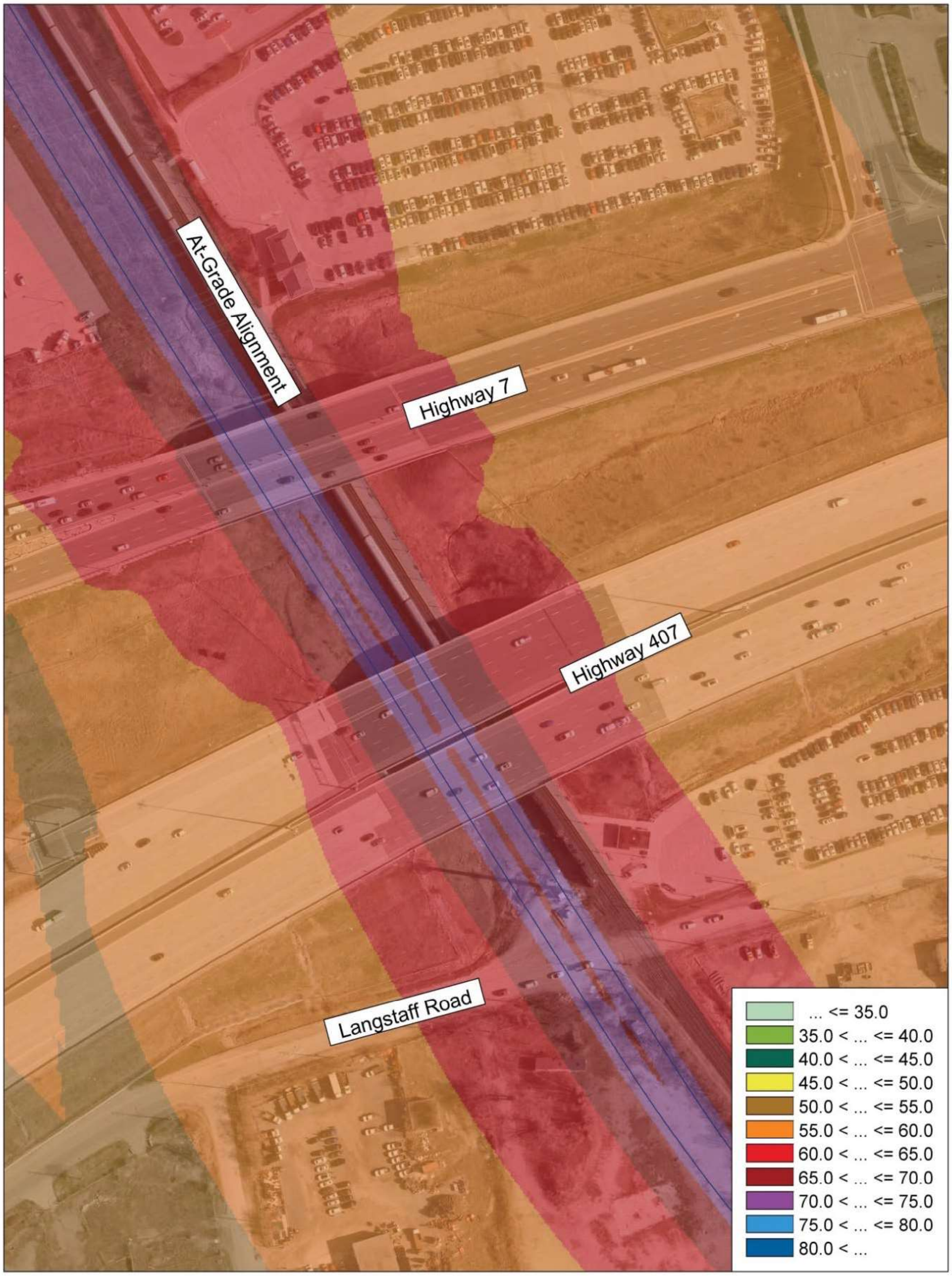


Figure 22: At Grade Alignment Part 3 Nighttime Sound Levels

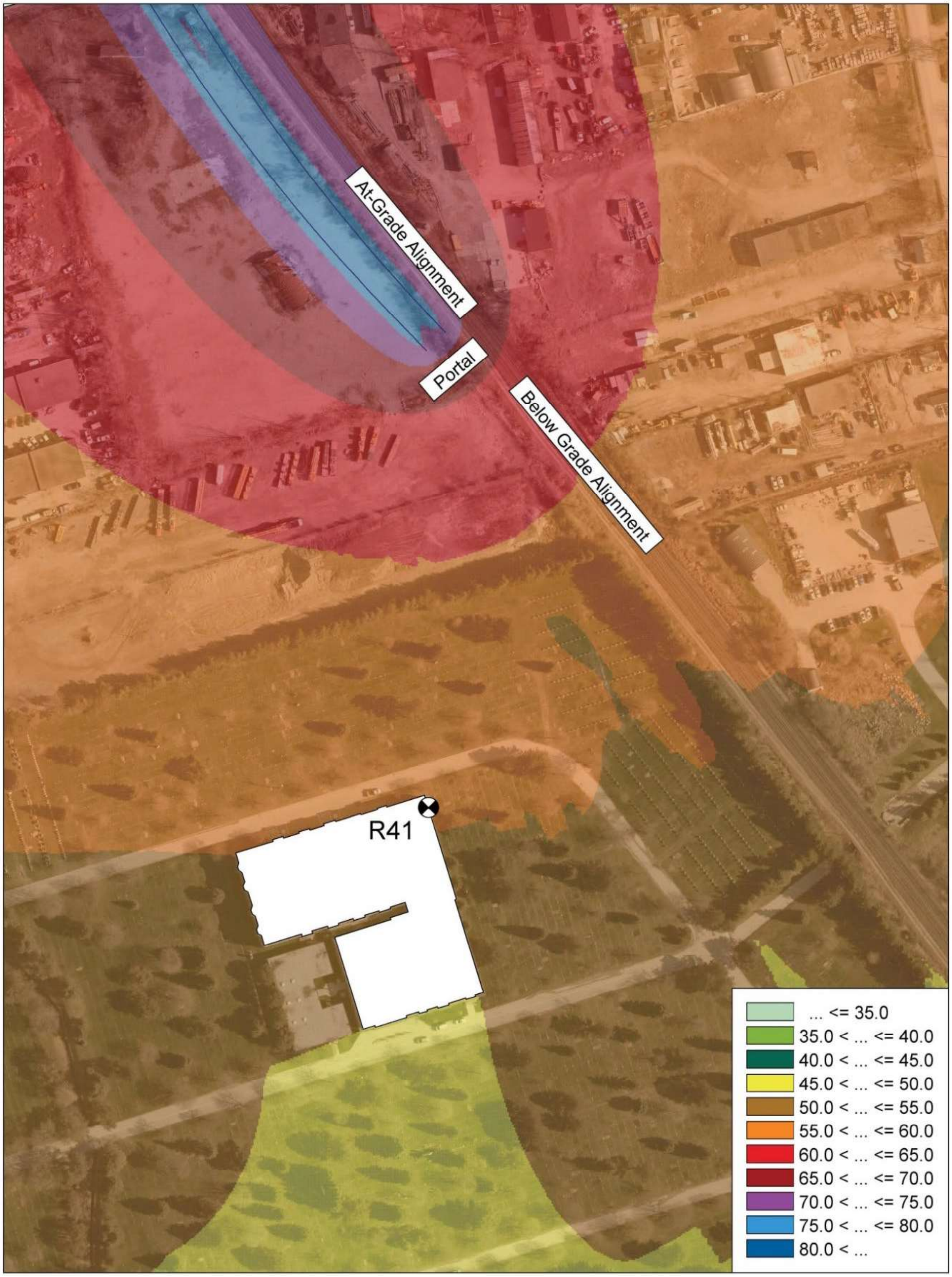


Figure 23: At Grade Alignment Part 4 Daytime Sound Levels

APPENDIX C: DEFINITIONS

Term	Description
Ambient Noise and Vibration	The pre-project background sound and vibration levels. Used interchangeably with background or baseline sound and vibration levels.
A-Weighting	A standardized filter for sound level measures with respect to frequency to mimic the effects of human hearing. Human hearing is less sensitive at low and very high frequencies. Abbreviated as dBA.
Auger Cleaner	Power operated cleaning tool that helps remove the soil from the helical drilling attachment used in shoring activities.
Ballast Mats	Ballast mats are rubber or elastomeric mats installed under the ballast layer of the track structure to help reduce the transmission of vibration.
Decibels	The decibel (abbreviated dB) is the unit used to measure the intensity of a sound. It is measured on a logarithmic scale. Increasing a sound intensity by a factor of 10 raises its level by 10 dB. Decibels are expressed relative to 20 micro pascals, which are a measure of pressure.
Frequency	The number of times that a periodically occurring quantity repeats itself in a period. With reference to noise and vibration signals, the number of cycles per second and is measured in hertz (Hz).
Ground-borne Noise	Vibration that enters a building and is radiated from that building's surfaces as noise. Simply, vibration turns the surfaces into drum skins. Ground-borne noise is also referred to as vibration-induced noise and is characterized by the rumble often heard along older subway systems.
Ground-borne Vibration	Vibration that travels through the soil and is received at a structure or building.
Hertz	The unit of acoustic or vibration frequency representing cycles per second (abbreviated Hz). 1 Hz is one cycle per second.
Moveable Point Frog	A Movable point frog is a dual-sided, sliding switch point that is power operated. The gap in the flangeway is eliminated by moving the nose of the frog in the direction in which the train is traveling. Moveable point frogs can greatly reduce or eliminate the noisy and vibration intensive hammering at the rail joints from typical frogs/crossovers.
Monoblock Frogs	Monoblock frogs have a center that consists of cast steel or machined and welded from rolled steel. Monoblock frogs can greatly reduce or eliminate the noisy and vibration intensive hammering at the rail joints from typical frogs/crossovers.
Noise	Unwanted sound.
L_{eq}	Equivalent Sound Level. The index that best represents human response for cumulative noise exposure over a specific time interval.
Octave Band	A standardized division of a frequency spectrum in which the interval between two divisions is a frequency ratio of 2.
Peak Particle Velocity (PPV)	The peak signal value of an oscillating vibration velocity waveform. Often used to assess the potential for structural damage.

Term	Description
Resilient Tie Block	Design where the rail is supported on individual concrete blocks set on rubber/elastomer isolation pads in order to reduce the transmission of vibration from the rail into the surrounding environment.
Root Mean Square Velocity (RMS)	The square root of the mean-square value of an oscillating waveform, where the mean-square value is obtained by squaring the value of amplitudes at each instant of time and then averaging these values over the sample time. Root mean square (RMS) amplitude is used to describe the "smoothed" vibration amplitude and is measured in mm/s. Typically used to assess human response to environmental vibration.
Sound	A physical disturbance (pressure wave) in air that is capable of being detected by the human ear.
Sound Power Level	Sound power is the total sound energy emitted by a source. It is a theoretical value and is calculated based on measurements.
Sound Pressure Level	The sound pressure level (SPL) is a logarithmic measure of the ratio of a sound pressure over a reference sound pressure (corresponding to the hearing threshold of a young, healthy ear), quoted as a decibel (dB.) Sound pressure levels decrease with distance and are often expressed with a reference distance.
Special Trackwork	Fabricated track components and accessories needed to direct rail cars from one track to another or to cross intersecting tracks.
Tonality	Noise that is concentrated in a narrow part of the spectrum or contains a high proportion of energy at a single frequency (a pure tone). Tonal noises are considered more annoying than broadband sounds and are typically penalized by adding a correction as per MECP requirements.
Vibration	The oscillation of a particle (back and forth) from a defined position. Environmental vibration levels are usually measured in velocity (mm/s).
Zone of Influence	The area of land within or adjacent to a construction site, including any buildings or structures, that potentially may be impacted by vibrations emanating from a construction activity where the peak particle velocity measured at the point of reception is equal to or greater than 5 mm/s.

APPENDIX D: REFERENCES

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