Noise and Vibration Impact Assessment Report

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Ontario Line Technical Advisor

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Executive Summary

ES.1 Project Overview and Study Purpose

Metrolinx, an agency of the Province of Ontario, is proceeding with the planning and development of the Ontario Line (the Project), extending from Exhibition/Ontario Place to the Ontario Science Centre in the City of Toronto.

The Project is being assessed in accordance with Ontario Regulation 341/20: Ontario Line Project under the *Environmental Assessment Act*. Ontario Regulation 341/20: Ontario Line Project outlines a Project-specific environmental assessment process that includes an Environmental Conditions Report (ECR), Environmental Impact Assessment Report (EIAR), and an opportunity for Early Works Report(s) for assessment of works that are ready to proceed in advance of the Environmental Impact Assessment Report. The ECR documents the local environmental conditions of the Ontario Line Study Area and provides a preliminary description of the potential environmental impacts from the Project. Information outlined in the ECR is used to inform the Early Works Report(s) and Environmental Impact Assessment Report, which study environmental impacts in further detail and confirm and refine preliminary mitigation measures identified in the ECR.

The Project is a new approximately 15.6-kilometre subway line with connections to Line 1 (Yonge-University) subway service at Osgoode and Queen Stations, Line 2 (Bloor-Danforth) subway service at Pape Station, and Line 5 (Eglinton Crosstown) Light Rail Transit (LRT) service at the future Science Centre Station. Fifteen stations are proposed, with additional connections to three GO Transit lines (Lakeshore East, Lakeshore West and Stouffville), and the Queen, King, Bathurst, Spadina, Harbourfront, and Gerrard/Carlton streetcar routes. The Project will reduce crowding on Line 1 and provide connections to new high-order rapid transit neighbourhoods. The Project will be constructed in a dedicated right-of-way (RoW) with a combination of elevated (i.e., above existing rail corridor/roadway), tunnelled (i.e., underground), and at-grade (i.e., at the same elevation as the existing rail corridor) segments at various locations.

ES.2 Construction Noise

The construction noise assessment examines construction of all project components, including stations, the Operations, Maintenance and Storage Facility (OMSF), and elevated, tunneled and at-grade segments of the Project. A receptor-based noise assessment has been completed to assess noise emitted by construction equipment and noise experienced at receptors.

Construction equipment used for the Project is expected to meet the MECP NPC-115 and NPC-118 requirements. Sound level limits from these documents have been used as maximum equipment sound levels where available. Where sound levels for construction equipment was not provided in the NPC documents, these have been supplemented with construction equipment noise levels from the US FTA Manual.

Prior to the start of construction, noise emissions of the selected construction equipment should be reviewed to confirm whether they are within the NPC-115 and NPC-118 limits. If they are expected to exceed the limits, noise control options should be investigated and implemented to bring them into compliance.

Receptor-Based Noise Assessment

A receptor-based construction noise assessment was completed for the Project in accordance with the United States Federal Transit Administration (US FTA) Manual (2018). A receptor-based assessment compares predicted noise levels at selected receptors (the locations where noise will be experienced) to applicable limits. Construction noise impacts were compared against US FTA limits as they are regularly applied on transit projects throughout Canada and the United States. This assessment was completed based on a conceptual understanding of the typical construction activities that are anticipated to be required for the Project.

The unmitigated receptor-based construction noise assessment for the Project indicates that several locations may experience Project construction noise that exceeds the FTA limits. Impacted areas that need construction noise mitigation are identified in this report and are shown in Appendix F, Figures F-1-1 to F-1-22.

Hoarding used as noise barriers, with a minimum height of 5m, is recommended for areas along the alignment where there will be ground-level construction, such as at-grade trackwork or facilities, and staging or laydown areas. With this mitigation in place, construction noise levels are predicted to meet limits at most locations (5 locations are identified that may still exceed the daytime limits, and 6 for nighttime limits). At these locations, additional operational constraints and physical mitigations identified in Section 4.5.3 will be required. A worst-case scenario has been used in this assessment. Construction approaches should be refined to limit the potential noise levels identified through this worst-case scenario approach. These refinements to construction can include, but are not limited to, reducing the amount of equipment operating overnight, restricting the location of active equipment to ensure it is further away from receptors, or applying site-specific mitigation approaches, as needed.

This conceptual assessment focuses on identified construction areas (i.e., construction staging/ laydown areas, exit/entry shafts, at-grade track and facility locations) required to facilitate Project development. The potential noise impact from supporting activities such as haul routes will be assessed as the construction planning process advances and route details are provided. The specific routes, truck volumes and scheduling will be assessed for potential noise impacts during the construction period and reviewed by Metrolinx for compliance with applicable limits as part of the planning and approval process.

Impact pile driving is not expected to occur as a part of Project construction. In the event that it is determined during construction planning that impact piling is required, an assessment will be done demonstrating the ability to operate while complying with applicable criteria, prior to approval of the construction plan. Mitigations would then be implemented as required (e.g., noise shrouds).

Toronto Transit Commission (TTC) streetcars are to be temporarily diverted from a portion of Queen Street to accommodate the Project. Construction noise has been assessed for the new and upgraded trackwork and is expected to meet the applicable limits for daytime noise levels. An assessment was completed for streetcar noise along the new diversion routes. The noise impact from streetcar operations on the diversion route is not expected to result in a noticeable increase in noise levels for nearby receptors compared to current traffic.

At a minimum, noise monitoring is recommended for the areas where the predicted construction noise is expected to exceed the criteria limits after standard construction mitigation, as a precautionary measure. The minimum areas where construction noise monitoring is recommended are described in Section 4.5.4 of this report.

ES.3 Operations Noise

Section 5 presents the operational noise assessment for the Project. The operations assessment within this report includes train movements in the north section of the Project (Pape Station to Science Centre Station), as well as stationary sources (e.g., HVAC, transformers, and maintenance equipment) at the OMSF. Above-ground operational train noise impacts from Exhibition Station to Pape Station are not considered as part of this assessment, as they have been addressed under separate reports (AECOM, November 2021/February 2022, Appendix Q). Operational noise from underground tunnels in the Downtown and Pape areas are assessed for surface features related to ventilation, but these sections will not otherwise result in airborne noise, and are addressed through the vibration assessment and its associated ground-borne noise (GBN) impact.

For stationary noise sources, predicted sound levels at representative receptors were compared to the MECP noise limits provided in NPC-300. The representative receptors were identified as discussed in Section 3 and are shown in Appendix E, Figures E-1-1 to E-1-22.

For noise from train movements, sound level limits for light rail projects from the MOEE/TTC Draft Protocol for Noise and Vibration Assessment for the Proposed Scarborough Rapid Transit Extension (TTC Protocol, May 1993) were applied since these are most representative of this subway project. Predicted daytime and nighttime noise levels from the trains were compared against the higher of pre-Project sound levels or 55 dBA (daytime) and 50 dBA (nighttime). If the difference is greater than 5 dB, then noise mitigation is required. Additionally, the train noise assessment considered the single vehicle passby sound level, which is limited at the receptor to a fixed criterion of 80 dBA, independent of pre-Project noise levels. Train noise impacts and verification of mitigation requirements are discussed in Sections 5.5.1 and 5.5.2, respectively.

The proposed OMSF is predicted to meet NPC-300 criteria with the operational/design limitations listed in Section 5.2.1.2. These include design considerations such as maximum sound levels for selected equipment, equipment enclosures and facility layout. As described in Section 5.5.4, stations, emergency egress buildings (EEBs) and emergency service buildings also require noise mitigation within their design to meet NPC-300 (per criteria in Section 5.2.1.1). Additionally, comfort ventilation equipment (i.e., make-up air units, louvres) are identified with a maximum sound pressure level limit (60 dBA at 1 m), as per the TTC Design manual for stations, to ensure stations meet acceptable noise levels at adjacent or nearby sensitive receptors.

For train movements on the elevated guideway, noise criteria are expected to be met without additional mitigation based on this assessment.

In summary, Ontario Line shows compliance with applicable noise guidelines for train operations. Stationary operations (e.g., OMSF, emergency ventilation) show compliance with provincial regulatory criteria. Noise monitoring is recommended to verify effectiveness of mitigation measures and inform adaptive management if required.

Additionally, Metrolinx has committed to providing a noise barrier along part of the alignment near Leaside Park Drive and at the OMSF. These barriers are expected to provide additional noise attenuation and/or shielding for parts of the study area, to further reduce noise. Any additional attenuation or shielding provided by these barriers is not considered in this assessment.

ES.4 Construction Vibration

Section 6 presents the vibration assessment for the Project construction of 15 stations, the OMSF, and above-ground and tunnelled portions of the Project.

Vibration impacts from construction equipment and activities for the Project are concerns as they may either cause cosmetic damage and/or human discomfort. These construction vibration impacts have been considered under full construction operational conditions (e.g., construction equipment locations within the site, activities that could be 24 hours, etc.). For nighttime construction impacts, only the trackwork, tunneling and station excavation have been considered as the likely construction activities requiring nighttime work.

The construction phases for the Project include site preparation, site servicing, demolition, excavation/grading, trackwork, and tunneling. For each construction phase, the construction activities for the Project were considered, and a list of construction equipment was prepared. The construction activities and associated equipment were considered as required for the at-grade/elevated track, tunneling, stations, bridge construction, OMSF and staging areas. The construction equipment has been assumed based on a preliminary understanding of the construction requirements and will be finalized as part of Project design.

For cosmetic damage from ground-borne vibration (GBV), the applied criteria are based on the zone of influence (ZOI) limit from the City of Toronto Code (2021) for buildings and structures, from the US FTA Manual (2018) for heritage buildings, and from OPSS 120 (2014) for underground pipelines. The human perception of vibration velocity was adopted from the MOEE/GO Protocol (1995). A summary of applied assessment criteria is shown in Table 6-4.

The GBN criteria are based on the US FTA GBN limit of occasional train passby events (Section 6.1.4).

Two assessment methods were employed for construction vibration for general above-ground construction activities and underground construction activities. Construction vibration impact due to general activities above-ground was conducted based on the methodology from the US FTA Manual (2018) using a reference vibration velocity at a known distance. Vibration impact due to the underground construction activity, specifically the operation of the tunnel boring machine (TBM), was estimated based on the method proposed by the Transportation Research Lab (TRL 2000) using empirical data.

A construction ZOI is the land in or adjacent to a construction site, including any buildings or structures, that is potentially impacted by vibrations from construction, where the vibration is equal to or greater than the vibration criteria for that activity. The highest levels of construction vibration (i.e., GBV) in the Project are expected to be associated with compaction with a vibratory roller, truck activities in staging areas, and operation of the TBM. Minimum setback distances beyond which the GBV would not exceed the ZOI threshold are included in Table 6-5. The ZOIs are shown in Appendix H. By applying mitigation options such as maintaining the minimum setback distance for construction equipment or considering construction equipment with low vibration levels, it is anticipated that the GBV vibration limits can be met for the Project.

Although tunneling operations using TBMs will occur during the day and night, GBN from TBM operation may lead to interior noise that would be more noticeable, and potentially disturbing, at night. Required attenuation for nighttime operation was determined based on the location of the nearest sensitive receptors (mainly residential and hospitals) where people could be expected to be at home or sleeping during the night. The ZOIs for GBN from tunneling are shown in Table 6-6. The approximate ZOIs for tunneling activity are shown in Appendix H.

The Four Seasons Centre for the Performing Arts (Four Seasons) is considered the most sensitive receptor due to its Project proximity and vibration-sensitive use. The Four Seasons auditorium has been vibration-isolated in its design to address existing subway and streetcar vibration. However, even with the vibration isolation of the auditorium, the Four Seasons building falls with the GBN ZOI (for the auditorium) and has been addressed in Section 7.4.4 to identify additional mitigation measures for operations.

The ZOIs in Appendix H are to be reviewed during construction, and any sensitive receptors that fall within these distances should be reviewed to confirm appropriate mitigation. Construction mitigation that can be considered to address vibration impacts is identified in Appendix K. Where construction vibration impacts are anticipated for the buildings within the ZOI, the owners/occupiers of the buildings should be notified with the plans and timings for the construction. In addition, a detailed construction vibration mitigation and monitoring plan should be developed once the equipment type, actual location of the equipment and construction scenarios are known. Full details regarding the recommended mitigation and monitoring are included in Section 6.4.

ES.5 Operations Vibration

Section 7 presents the operational vibration assessment for the Project. The potential impact of the railway traffic is considered in terms of at-grade track, elevated track, tunnelled track, station track, and tracks associated with the OMSF.

Railway traffic is a source of GBV and GBN. The vibration generated by train operations along the track propagates to nearby buildings through the soil. The transmitted vibration in the buildings causes the floors, walls and ceilings to vibrate, which may be felt on the structure (i.e., GBV) and/or may be heard as interior noise (i.e., GBN). Special trackwork, such as crossovers and switches, increases the level of GBV and/or GBN as rail traffic passes over them.

For the assessment of operational vibration, the guidelines (criteria and analysis methodology) described in the US FTA Manual are considered for this assessment. Vibration impacts were predicted at sixty-five (65) representative points of reception along the alignment and the results were compared to the vibration criteria to determine the type of mitigation that may be required. From this, areas requiring mitigation were identified along the alignment to reduce vibration to within criteria, thus providing acceptable vibration impacts at the nearest sensitive receptors.

For the Downtown section of the alignment, a combination of high-resilience fasteners, light mass-spring (LMS) system, and floating slab track (FST) system is recommended as the base case for this assessment (though alternatives that achieve the same vibration reduction can be considered) to control GBV and GBN. The approximate locations requiring mitigation are described in Table 7-4 and shown in Appendix I.

For the tunnel, the assessment indicates that GBV is at or below the limit at all points of reception (PORs) but that without mitigation GBN exceeds the limit at most PORs due to the dominant frequency of rock-confined tunnel. Therefore, some form of mitigation is required along a majority of the downtown tunnel to control GBN in building interiors. The assessment demonstrates that the three sites with the highest potential for impact can be effectively addressed by applying FST, (though alternatives that achieve the same vibration reduction can be considered):

- Bell Media at 299 Queen St. West
- Four Seasons Centre for the Performing Arts at 145 Queen Street West
- St. Michael’s Hospital at 36 Queen Street East

The inclusion of FST into the design requires transition track on either side for the approach and departure of the trains.

For the Pape section of the alignment, the assessment demonstrates that mitigation can be effectively achieved through a combination of an LMS system and an FST system to control GBV and GBN (though alternatives that achieve the same vibration reduction can be considered). The approximate locations recommended to have this mitigation are described in Table 7-5. The LMS system provides an effective mitigation approach for the entire Pape section, except for the following two locations, where greater mitigation may be required:

- Double crossover near 810 Pape Avenue
- Minton Place Portal near 154 Hopedale Avenue

The double crossover and the Minton Place Portal area is recommended to have FST (though alternatives that achieve the same vibration reduction can be considered) due to the high vibration generated from the crossover and the shallow depth of the portal area.

This assessment is preliminary based on current design and the inputs and assumptions listed in Section 7.3. The assessment should be updated against the defined criteria as the design progresses. For the Downtown and Pape tunnel sections, a detailed impact analysis should be performed once the design has been confirmed, as indicated by the US FTA Manual, to better determine the vibration propagation characteristics of the soil at both the Downtown and Pape locations.

Table ES-1. Summary of Potential Impacts, Mitigation and Monitoring

Environmental Component	Potential Impact	Mitigation Measure(s)	Monitoring
Construction Noise	Environmental noise may cause annoyance and disturb activities. The severity of the noise impacts resulting from construction projects varies, depending on: • Scale, location and complexity of the project • Construction methods, processes and equipment deployed • Duration and time of construction near noise receptors (days and time of construction) • Number and proximity of noise-sensitive sites to construction area(s)	**Construction Equipment Noise Emissions:** Equipment should be acquired based on MECP NPC-115 and NPC-118 to ensure acceptable construction equipment noise levels are maintained for the project. **Receptor-Based Assessment:** Impacted areas that need mitigation are highlighted on Figures F-1-1 through F-1-22 (Appendix F). The following recommendations for construction are proposed: • Noise barriers with a minimum height of 5 m in place of construction hoarding are recommended as primary means of control. The noise barrier hoarding should have a minimum surface density (mass per unit of face area) of 20 kg/m^2 (4 lb/ft^2) or an acoustic performance of STC 32 (per CSA-Z107.9-00) and be free of gaps and cracks. • Enclosed conveyors and drives are recommended for moving spoils from tunnels to storage areas at the construction sites. • Ventilation fans with silencers for tunnels during TBM operations, such that the noise emanating from them at the nearest receptors will be no higher than the construction noise limit. • Generators with acoustic enclosure and silencers for TBM operations, such that the noise emanating from them at the nearest receptors will be no higher than the construction noise limit. • Quieter hydrovac trucks for soil conditioning at the entry shaft for tunneling operations, such that the noise emanating from them at the nearest receptors will be no higher than the construction noise limit. With the additional operational constraints and physical mitigations identified above, daytime levels should be within the construction noise limits at receptor locations. However, seven construction locations are predicted to exceed nighttime limits without further mitigation (Table 4-9). Thus, additional operational constraints may be required, to conduct work during nighttime hours. A detailed Construction Noise Assessment and Management Plan should be completed based on the actual location of the equipment and manufacturer's' sound levels to identify the specific mitigation required for each location and to ensure that the noise limits are met for the Project construction. Construction noise impact mitigation measures to be considered include but are not limited to the following: • Perform construction during daytime hours where 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. • Use equipment compliant with NPC-115 and NPC-118 as well as selecting the quieter option when multiple options are available. • Limit the number of heavy trucks on site to the minimum required. • Stage construction vehicles away from noise sensitive locations, if feasible. • Keep equipment in good working order and operate with effective muffling devices. • Undertake noise monitoring and regular reporting throughout the construction phase. Where noise level limits are exceeded, additional noise mitigation measures shall be implemented. • Use localized movable noise barriers/screens for specific equipment and operations.	A Construction Noise Management Plan should be developed that will incorporate the following recommendations for noise monitoring and addressing noise complaints: 1. 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 measures(s) effectiveness. 2. Continuous noise monitoring should be completed at each geographically distinct active construction site associated with the Project, which have been identified in Figures F-2-1 through F-2-22 of the report. Monitor(s) are to be 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. 3. Monitoring at locations where there are persistent complaints, as required. A Communication and Complaint Protocol should be established for the Project. Additional example monitoring suggestions are included in Appendix L.

Environmental Component	Potential Impact	Mitigation Measure(s)	Monitoring
		• Reduce simultaneous operation of equipment where feasible. • Implement a no idling policy on site (unless necessary for equipment operation). • Develop a communications protocol which includes timely resolution of complaints. • Additional mitigation measures not listed above may be considered.	

Operation Noise	Environmental noise may cause disturbance and/or annoyance.
	Airborne noise will result from the operations of the project and may be a concern for noise-sensitive areas.
		Train movements in the OLN are predicted to show compliance with applicable criteria without additional mitigation, based on the assessment of existing design information. For train movements in at-grade sections in the OLW and OLS, noise barriers of varying heights are anticipated to reduce noise below applicable criteria (AECOM, Appendix Q).
		The following stationary sources also require noise mitigation/verification:
		• Potential impact from operational noise from stations, emergency exits and emergency services ventilation design to be reassessed as the design details are finalized. Preliminary dynamic insertion loss requirements for fire ventilation intake and discharge silencers at Stations are shown in Table 5-11. Space planning for intake and discharge openings should also allow for silencers up to 7.5 m in length to achieve the acoustic requirements.
		• As part of the future detailed design of the stations, comfort ventilation systems (e.g., makeup air handling units, fans, etc.) should be selected so that they meet operational noise limits at the nearest receptors. To achieve this, and in coordination with TTC station design guidance, this ventilation equipment should be selected such that it does not generate more than 60 dBA at 1m. Table 5-10 shows the receptor setback distances from station comfort ventilation noise sources as 1 m.
		• Portal jet fans to be fitted with mitigation as required to meet NPC-300 criteria.
		• Outdoor audio paging system will be required to meet MECP NPC-300 noise limits at adjacent receptors, and the system will be designed to do so by limiting speaker volume and positioning speakers away from adjacent residences.
		• Transformers and generators, when sufficiently detailed, will also be required to meet MECP NPC-300 noise limits at adjacent receptors. Applicable mitigation (enclosures, silencers) will be provided to meet these limits for transformers and generators.
		• The OMSF was assessed based on assumptions and operations discussed in this report. Mitigation to be included in the OMSF design includes:
		  ○ Operation with OMSF doors closed (a central cooling system may be required in the garage area) or construction of a sound attenuating vestibule around the door openings.
		  ○ Power substation portable emergency generators to be fitted with mitigation as required to meet NPC-300 criteria.
		  ○ As OMSF design progresses, verify assumptions (Section 5.4.2.3), equipment operating scenarios and maximum sound power levels in Section 5.4.5.
			Detailed operational monitoring procedures are recommended and will be defined further in the design process. The following procedures are preliminary recommendations and will be refined as design progresses:
			1. Station, emergency exit and emergency services noise levels for fire ventilation and comfort ventilation should be monitored at the nearest points of reception. Further, the 60 dBA at 1 m limit should be confirmed for comfort ventilation.
			2. OMSF noise should be monitored at the receptors noted in Table 5-13.
			3. Operational noise from train movements on tracks to be monitored for representative receptors and for at least the first 5 years of operation.
			The monitored locations should be approximately equally distributed along the Project Footprint and vary from year to year. Priority should be placed on locations near special trackwork or tight-radius curves.
			Additional example monitoring suggestions are included in Appendix L.

Construction Vibration	Vibration may cause damage to buildings, utilities and other structures.
	Exposure to vibration may result in public annoyance and complaints.
	Vibration from tunneling can cause annoyance, interfere with human activities and vibration-sensitive equipment operation.
		The following measures should be considered to mitigate vibration impacts from the Project construction:
		• The owners of properties within the ZOIs (Appendix H) should be notified before commencing any nearby construction activities.
		• Mitigation options such as maintaining the minimum setback distance for construction equipment or considering construction equipment with low vibration levels is recommended. Some examples include but are not limited to:
		• A non-vibratory roller is recommended for operation in proximity to building structures. A vibratory roller may only be used at least 11 m (Heritage) or 8 m (other structure) away from the structure, or if the vibration level is tested through sample vibration measurements to confirm a suitable setback distance.
			The following procedures are recommended for vibration monitoring:
			• Vibration monitoring will be undertaken at locations within the zone of influence to ensure compliance with applicable criteria (Table 6-5) and to identify the need for additional mitigation if required.
			• Monitoring will be undertaken to verify mitigation measures(s) effectiveness.
			  ○ Monitoring for perceptible vibration should be monitored in terms of root mean square (RMS, mm/s).
			  ○ Monitoring for structural damage should be monitored in terms of peak particle velocity (PPV, mm/s).

Environmental Component	Potential Impact	Mitigation Measure(s)	Monitoring
		• Caisson drilling shall be monitored, and the auguring speed should be controlled in accordance with the monitored vibration level. • Excavators may only be used at least 6.5 m (Heritage) or 4.5 m (other structure) away from the structure, or if the vibration level is tested through sample vibration measurements to confirm an alternate suitable setback distance. Use of alternative smaller equipment such as a backhoe is recommended. • Heavily loaded trucks and equipment should be routed away from residential streets and vibration-sensitive sites. • The sequence of construction phases such as demolition, earth-moving, and ground-impacting operations should be managed so as not to occur in the same time period and avoiding nighttime activity. • For tunneling with TBM, the cutting force can be reduced by a speed reduction. The supporting force should be adjusted according to the monitored vibration velocity (see Section 6.4.3.2) to ensure that vibration velocity is below the limits. • Additional construction vibration mitigation practices are summarized in Appendix K. It is recommended that the contractor conduct test vibration measurements to check conditions at specific setback distances if they plan to have construction activities at or closer than the setback distances. • Sample tests should be performed for all significant vibration-generating equipment anticipated to operate within the ZOI to confirm that vibration levels are compliant with the allowable limits. The measured vibration levels can be used to estimate setback distances and/or the operational condition at a certain distance at which the construction equipment should be allowed to operate. This testing would not discharge the contractor from their responsibility to continuously monitor vibration levels at sensitive receptors and adhere to the specified vibration limits. **Pre-Construction Activities:** • A pre-construction consultation should be conducted with the property owners for underground structures within the identified ZOI (Figure H-1-1 to H-1-22) for cosmetic damage, in accordance with Municipal By-law No.514-2008 • Pre-construction measurements of background vibration and pre-construction inspections (i.e., identify existing cracks in walls, floors, and exterior cladding of the first two storeys above grade and interior finishes of all storeys below grade) is recommended. A vibration mitigation plan and a vibration monitoring program should be prepared. Identified sensitive receptor locations (i.e., St. Michael's Hospital, Bell Media Headquarters, Four Seasons Centre for the Performing Arts) should be assessed in detail by conducting vibration measurements from mock-up construction activities prior to commencement of construction (see Section 6.3.1). The measured vibration should be analysed in 1/3-octave bands over the frequency range 8 to 80 Hz and assessed with the criteria provided in Table 6-4. The criteria limits for the vibration-sensitive equipment are also included in Appendix O. The purpose of conducting these measurements is to verify and refine the predictions for these vibration-sensitive locations and ensure that construction activities will meet the vibration criteria at these locations.	• Pre-construction and post-construction building inspection of the potentially impacted buildings adjacent to construction sites are to be conducted. • Continuous vibration monitoring along the construction site property lines closest to the aforementioned structures will be initiated as warranted. • Monitoring at locations where there are persistent complaints will be undertaken, if required. A Communications and Complaints Protocol to address construction vibration complaints should be established for the Project. Additional example monitoring suggestions are included in Appendix L.

Environmental Component	Potential Impact	Mitigation Measure(s)	Monitoring
Operations Vibration	Vibration may cause cosmetic damage or impact human comfort.	For the Downtown section of the alignment, mitigation is required to control GBV and GBN. Mitigation options are identified in this report to meet applicable criteria, including high-resilience fasteners, LMS system, and FST system. Alternative mitigations can be considered provided they meet applicable vibration limits For the tunnel, mitigation is required along the entire downtown tunnel to control GBN in building interiors. FST, is recommended at three (3) locations (or alternative mitigation that achieves the same vibration isolation): • Bell Media at 299 Queen St. West • Four Seasons Centre for the Performing Arts at 145 Queen Street West • St. Michael's Hospital at 36 Queen Street East Due to the flexible character of FST, transition track sections of at least half a train length are required at both ends of the FST to avoid changes in the depth of track as trains travel from regular track to the more flexible FST track. LMS system is recommended to be implemented through the entire Pape section of the alignment and FST is recommended at the following two locations: • Double crossover near 810 Pape Avenue • Minton Place Portal near 154 Hopedale Avenue An alternative mitigation method that achieves the same vibration isolation may also be used. No mitigation is required for the elevated track sections.	Detailed operational monitoring procedures are recommended and will be defined further as the design is finalized. The following procedures are preliminary recommendations and will be refined as design progresses: Operational vibration from train movements on tracks to be monitored for representative receptors and for at least the first 5 years of operation. The monitored locations should be approximately equally distributed along the Project Footprint and vary from year to year. Priority should be placed on locations near special trackwork or tight-radius curves. Additional example monitoring suggestions are included in Appendix L.

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Appendices

Abbreviations

ABN	Airborne Noise
ATO	Automated Train Operation
Cadna/A	Computer Aided Noise Abatement Software
dB	Decibel
dBA	Decibel, A-weighted
dBAI	Decibel, A-weighted sound pressure level of an impulsive sound
EA	Environmental Assessment
EASR	Environmental Activity Sector Registry
ECA	Environmental Compliance Approval
ECR	Environmental Conditions Report
EIAR	Environmental Impact Assessment Report
EEB	Emergency Egress Building
FST	Floating Slab Track
FTA	Federal Transit Administration (U.S.)
GBN	Ground-borne Noise
GBV	Ground-borne Vibration
HC	Health Canada
HVAC	Heating, Ventilation and Air conditioning
Hz	Hertz
ISO	International Organization for Standardization
Km	Kilometre(s)
L_{eq}	Energy Equivalent Sound Level over a period of time. If time period is not specified than it is over one hour.

$L_{eq(16)}$	16 hour Energy Equivalent Sound Level. For example, a daytime sound level averaged over the hours 7am-11pm.
$L_{eq(8)}$	8 hour Energy Equivalent Sound Level. For example, a nighttime sound level averaged over the hours 11pm-7am.
LIO	Land Information Ontario
L_{max}	Maximum Measured Sound Level within the measuring period
L_{passby}	Energy Equivalent Sound Level over the duration of a light rail vehicle passby
LMS	Light Mass Spring (system)
LRT	Light Rail Transit
m	Metre(s)
MECP	Ministry of the Environment, Conservation and Parks
MNRF	Ministry of Natural Resources and Forestry
MOEE	Ministry of Energy and Environment (former title of MECP agency)
MTM	Modified Transverse Mercator
NPC	Noise Pollution Control
OL	Ontario Line
OLN	Ontario Line North
OLS	Ontario Line South
OLTA	Ontario Line Technical Advisor
OLW	Ontario Line West
OMSF	Operations and Maintenance Storage Facility
OPSS	Ontario Provincial Standard Specification
ORNAMENT	Ontario Road Noise Analysis Method for Environment and Transportation
POR	Point of Reception
PPV	Peak Particle Velocity

RMS	Root Mean Square
RoW	Right-of-Way
SEM	Sequential Excavation Method
SEL	Sound Exposure Level
SLM	Sound level meter
TBM	Tunnel Boring Machine
TNM	Traffic Noise Model
TTC	Toronto Transit Commission
US FHWA	United States Federal Highway Administration
US FTA	United States Federal Transit Administration
ZOI	Zone of Influence

Glossary

Term	Description
Acoustical usage factor	The fraction of time that construction equipment operates in a given period, hence the fraction of time that the equipment generates noise.
At-grade track	Track that is approximately on the same level as street level, including track on raised or banked ground. Distinguished from track that is on elevated guideway/viaduct or underground.
Airborne noise (ABN)	Sound transmitted through the air prior to arriving at a receptor and including many common sounds such as road or rail traffic, aircraft, conversation, dogs barking. ABN is also referred to as “noise”.
Ambient sound level or ambient noise	All-encompassing sound that is associated with a given environment, usually a composite of sounds from many sources near and far. Includes noise from all sources other than the sound of interest.
Anthropogenic	Generated by or originating from human activity. Examples of anthropogenic sound sources are road traffic and rail traffic.
A-weighting	The weighting network used to account for changes in noise level sensitivity as a function of frequency. The A-weighting network de-emphasizes the high (i.e., 6.3 kHz and above) and low (i.e., below 1 kHz) frequencies, and emphasizes the frequencies between 1 kHz and 6.3 kHz, to simulate the relative response of the human ear. See also: frequency weighting.
Baseline	The existing acoustical environment or baseline acoustical conditions prior to the operation of the Project. See also: pre-Project conditions.
Cadna/A	Computer Aided Noise Abatement 3D modelling software for the calculation, presentation, assessment and prediction of environmental noise.
Calibration	Procedure used to verify a sound level meter’s measurement accuracy. This is accomplished using a reference source of a known sound pressure level and frequency. Field verification of calibration takes place before and after the sound level measurement programs.
Cosmetic damage	The formation of hairline cracks on drywall surfaces, or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in mortar joints of brick/concrete block construction.

Term	Description
Crest Factor	The ratio of the peak amplitude to the RMS amplitude. It is used to convert a PPV to an RMS vibration level.
Daytime	The daytime period for noise impact is defined as either: • 7am to 7pm for stationary noise assessment (e.g., OMSF) as per MECP NPC-300, or • 7am to 11pm for rail noise impact as per US FTA.
Decibel (dB)	A logarithmic quantity of any measured physical parameter and commonly used in the measurement of sound. The decibel (dB) provides the possibility of representing a large span of sound levels in a simplified manner. The difference between the sound pressures for virtual silence versus a loud sound is a factor of 1:1,000,000 or more, therefore it is less cumbersome to use a small range of equivalent values: 0 to 130 dB. It is used for both sound pressure level as well as sound power level.
Decibel, A-weighted (dBA)	A-weighted decibels (dBA). Most common units for expressing sound levels approximating the response of the human ear.
Decibel, A-weighted, impulsive (dBAI)	The A-weighted sound level of an impulsive (short-duration) sound. Typically assessed with different limits than steady sources, which are based on the quantity of events in a given time period.
Direct fixation trackwork	Direct fixation track is a method of securing rail tracks to the supporting ties. They do not provide vibration isolation to the supporting ties or structure.
Early Works	The Early Works are components of the Ontario Line Project that are proposed to proceed before the completion of the Ontario Line assessment process (provided in O. Reg. 341/20). Early Works are considered to be of strategic importance in enabling the timely implementation of the Project.
Efficient soil propagation	Efficient vibration propagation through the soil over longer distances and with less energy loss than non-efficient soil.
Elevated Track	The tracks above street level on a viaduct or other elevated structure (usually constructed from steel, cast iron, concrete, or bricks).
Energy equivalent sound level	An energy-average sound level (L_{eq}) over a specified period that would have the same sound energy as the actual (i.e., time varying) sound over the same period. It represents the average sound pressure level encountered for the period. The period is often added as a suffix to the label (i.e., $L_{eq(24)}$ for the 24-hour equivalent sound level).

Term	Description
Existing ambient	The existing acoustical environment or baseline acoustical conditions prior to the operation of the Project. See also: existing ambient, pre-Project conditions.
Floating slab track (FST)	Floating slab track typically consists of a concrete slab being placed directly onto discrete natural rubber bearings.
Frequency	The number of times per second that the sine wave of sound repeats itself. It can be expressed in cycles per second, or Hertz (Hz). Frequency equals speed of sound/wavelength.
Frequency weighting (A, B, and C weighting)	A method used to account for changes in sensitivity as a function of frequency. Three standard weighting networks, A, B and C, are used to account for different responses to sound pressure levels. Note: The absence of frequency weighting is referred to as linear response or unweighted response. The most commonly used weighting is A-weighting (see also A-weighting).
Ground-borne noise (GBN)	Noise heard inside a building resulting from the propagation of ground-borne vibration (GBV) energy through nearby structures such as building foundations.
Ground-borne vibration (GBV)	Vibration generated from the passby of vehicle on rail, propagated through the ground or structure into a receiving building.
Ground Truthing	An exercise where all buildings within the Project Footprint are visited to visually inspect whether they are classified as a noise or vibration sensitive receptor.
Hertz (Hz)	The unit of frequency also expressed as cycles per second.
Impulsive noise source	A noise source which emits an "impulsive sound". An impulsive sound is a single pressure pulse or a single burst of pressure pulses while quasi-steady impulsive sound is a sequence of impulsive sounds from the same source.
In situ	In the original place.
Joint Corridor	The shared railway corridor that will be used by OL trains, GO trains and VIA trains.
Nighttime	The nighttime period for noise impact is defined as either: • 7pm to 7am for stationary noise assessment (e.g., OMSF) as per MECP NPC-300, or • 11pm to 7am for rail noise impact as per US FTA.
Noise	Unwanted sound.

Term	Description
Octave band	The interval between two frequencies having a ratio of two to one. For acoustical measurements, the octaves start at 1,000 Hz centre frequency and go up or down from that point, at the 2:1 ratio. From 1,000 Hz, the next filter's centre frequency is 2,000 Hz, the next is 4,000 Hz, or 500 Hz, 250 Hz, etc. Octave filtering is usually referred to as the class of octave filters typically 1, 3 or 12, thus creating full octaves, one-third octaves, or one-twelfth octaves.
OnCorr	The GO Expansion OnCorr Program. In this report, OnCorr refers to the tracks used by GO/VIA trains. See also Joint Corridor.
Overburden	For the purposes of this study, the overburden is the material overlaying the bedrock within the Project study area.
Parcel Fabric	A dataset consisting of a continuous surface of connected parcels. Commonly used to delineate the legal subdivisions of land (e.g., property boundaries).
Peak particle velocity (PPV)	The peak particle velocity (PPV) is the maximum instantaneous positive or negative peak of the vibration signal. PPV is often used in construction vibration monitoring and assessment since PPV is related to the stresses experienced by buildings during construction.
Point of Reception (POR)	A noise receptor such as a residence, campground, daycare, school, church, or hospital as defined in Ontario Ministry of the Environment, Conservation and Parks Publication NPC-300. See also Receptor.
Pre-Project conditions	See also: baseline; existing ambient.
Pre-start-up Operation	Train movements before revenue service is planned to start, when trains leave the OMSF and travel along the track to begin service at the start of the day.
Project Footprint	The Project Footprint captures the anticipated extent of Project components as well as temporary lands (e.g., staging, laydown) required during construction.
Receptor	Generic term for a specific property or location susceptible to adverse environmental impacts related to the Project. Such properties or locations include, but are not limited to, residences, institutional, commercial, and industrial buildings. See also Point of Reception, Sensitive receptor.

Term	Description
Reference sound level	Reference sound levels for road and rail sources were obtained from TNM and FTA and used in the model to predict noise effects at PORs. The reference sound level produced by rail with specified number of cars and train speed at a given distance.
Representative receptor	The receptor most exposed to Project noise or GBV compared to other receptors in the area. Represents a group of receptors with similar or lower exposure to Project noise or vibration in the area. For Project noise, this group of receptors is expected to be vary over a range of 5 dB or less.
Roadheader	A roadheader is a piece of excavating equipment consisting of a boom-mounted cutting head, a loading device (conveyor) and a crawler travelling track to move the machine forward.
Root mean square (RMS)	The root mean square (RMS) of a vibration velocity signal is the continuous vibration level that has the same vibrational energy as the original signal.
Sensitive receptor	A sensitive receptor that is a location (building or structure) especially susceptible to adverse noise and/or vibration impacts related to the Project. Specifically, Project impacts that generate noise or vibration may affect the community at these locations as either residences, institutional, commercial and industrial buildings or other uses, or potential damage (from vibration) to these buildings or structures. See also Receptor
Sequential excavation method (SEM)	A method used for the construction of shallow mined tunnels using an excavator and a roadheader in a sequential manner using supports.
Sleepers	Sleepers are the components on which the rails are arranged with proper gauge. The sleepers rest on the concrete base. The load from the rails when the train passes is taken by the sleepers and distributed to the base.
Slope Distance	Direct distance from the vibration source to a receptor, as distinguished from the horizontal or vertical distance.
Soil Classification	Description of the soil based on seismic response such as shear wave velocity (V_s) and/or standard penetration resistance (N_{60}) in accordance with National Building Code: • Very dense soil and soft rock: $360 < V_s < 760$, $N_{60} > 50$ • Stiff soil: $180 < V_s < 360$, $15 \le N_{60} \le 50$ • Soft soil: $V_s < 180$, $N_{60} < 15$

Term	Description
Soil, hard	Stiff, clay-like soil; more efficient for vibration propagation.
Soil, soft	Sandy soil type, the least efficient soil type for vibration propagation.
Sound level	Generally, sound level refers to the weighted sound pressure level obtained by frequency weighting, usually A-weighted and expressed in decibels.
Sound level meter (SLM)	An instrument consisting of a microphone, an amplifier, and a data logger and analyzer equipped with frequency-weighting networks that is used to measure sound levels.
Sound power level (PWL)	The total sound energy radiated by a source per unit time. The unit of measurement is the Watt. The acoustical power radiated from a given sound source as related to a reference power level (i.e., typically 1E-12 watts, or 1 picowatt) and expressed as decibels. A sound power level of 1 watt = 120 decibels relative to a reference level of 1 picowatt.
Sound pressure	The root-mean-square of the instantaneous sound pressures during a specified time interval in a stated frequency band.
Sound pressure level (SPL)	Logarithmic ratio of the root-mean-square sound pressure to the sound pressure at the threshold of human hearing (i.e., 20 micropascals).
Special trackwork	A generic term in rail design referring to turnouts, crossovers, track crossings, derails, and similar track discontinuities.
Spectrum	The amplitude of sound within a range of frequencies/frequency bands and usually referred to by the center frequency of that band. It is given by a set of numbers that describe the amplitude of sound at each frequency band.
Spoils	Spoils are material brought up during an excavation, tunneling or mining activity.
Stationary source	A source of sound that is stationary. As defined in NPC-300, it is a source of sound or combination of sources of sound that are included and normally operated within the property lines of a facility.
Steady noise source	A noise source which emits sound as steady, continuous noise. This is typically associated with continuous operation of stationary equipment.

Term	Description
Structural Damage	Minor structural damage includes the formation of large cracks or loosening and falling of plaster or drywall surfaces, or cracks through bricks/concrete blocks. Major structural damage includes damage to structural elements of the building, cracks in support columns, loosening of joints, splaying of masonry cracks, etc.
Railcar mover	A road-rail vehicle fitted with couplers for moving small numbers of railroad cars around in a rail siding or small yard (i.e., trackmobile).
Tail Tracks	Tracks which extend beyond the last station on a rail transit system, to allow for trains to park off the main line.
Traffic Noise Model (TNM)	Algorithm provided by United States Federal Highway Administration and widely used across North America for road traffic noise predictions.
Truing Station	A station used for the maintenance of wheels to eliminate wheel flats from the treads and restore the wheel profile to reduce noise, reduce damage and wear to wheels and rails.
Tunnel boring machine (TBM)	A tunnel boring machine is a piece of equipment designed to bore circular tunnels through a range of soil types from dense hard rock to relatively soft sand. It can produce a smooth, directional tunnel while leaving surrounding rock relatively undisturbed.
Urban Hum	Ubiquitous noise typical of urban areas and predominantly due to a combination of distant and local transportation noise and other human activities.
Vibration	Vibration is defined as an oscillatory (i.e., moves back and forth) motion of an element or particle. Because the motion is oscillatory, there is no net movement of the vibrating element or particle and the average of the motion is zero. Rail related vibration is described in terms of the velocity. The velocity represents the instantaneous speed of the element or particle.
Weighting	Adjustment of sound level data to reflect receptor sensitivities to different frequencies. A-weighting is used to represent human hearing, which is more sensitive to speech-dominant frequencies around 1 kHz than to lower frequencies (i.e., around 63 Hz).
Zone of Influence (ZOI)	The ZOI is defined as the land in or adjacent to a construction site or rail track, including any buildings or structures, that is potentially impacted by noise or vibration from rail activities (either construction or operations).

1 Introduction

1.1 Project Overview

Metrolinx, an agency of the Province of Ontario, is proceeding with the planning and development of the Ontario Line [OL] (the Project), extending from Exhibition/Ontario Place to the Ontario Science Centre in the City of Toronto.

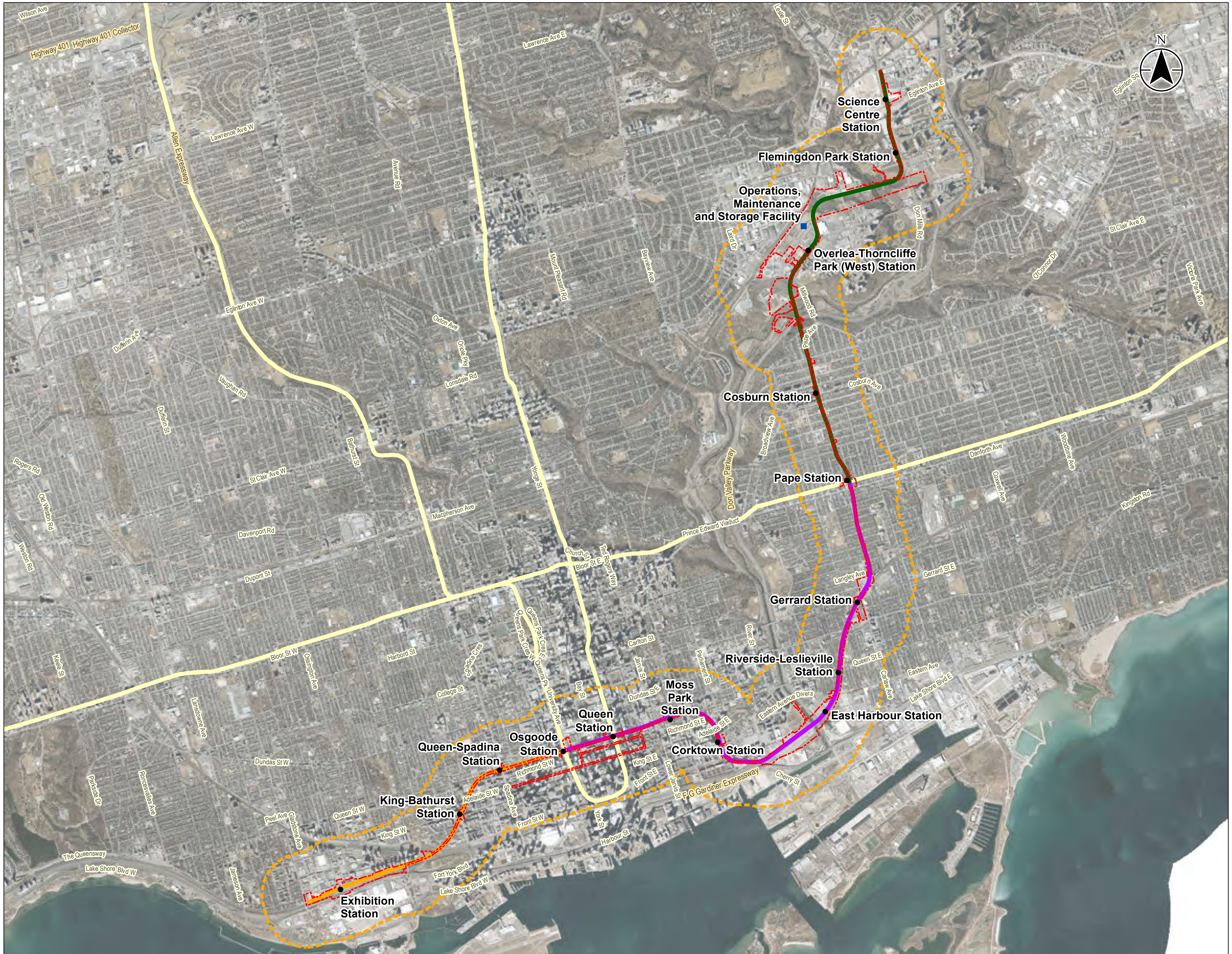
The Project is a new approximately 15.6-kilometre subway line with connections to Line 1 (Yonge-University) subway service at Osgoode and Queen Stations, Line 2 (Bloor-Danforth) subway service at Pape Station, and Line 5 (Eglinton Crosstown) Light Rail Transit (LRT) service at the future Science Centre Station. Fifteen stations are proposed, with additional connections to three GO Transit lines (Lakeshore East, Lakeshore West and Stouffville), and the Queen, King, Bathurst, Spadina, Harbourfront, and Gerrard/Carlton streetcar routes. The Project will reduce crowding on Line 1 and provide connections to new high-order rapid transit neighbourhoods. The Project will be constructed in a dedicated right-of-way (RoW) with a combination of elevated (i.e., above existing rail corridor/roadway), tunnelled (i.e., underground), and at-grade (i.e., at the same elevation as the existing rail corridor) segments at various locations.

An overview of the Project Footprint is shown in Figure 1-1. Detailed figures showing the footprint and Project components are found in Appendix A, Figures A-1 to A-19.

1.2 Purpose of the Ontario Line Environmental Impact Assessment Report

The Project is being assessed in accordance with Ontario Regulation 341/20: Ontario Line Project under the *Environmental Assessment Act*. Ontario Regulation 341/20: Ontario Line Project outlines a Project-specific environmental assessment (EA) process that includes an Environmental Conditions Report (ECR), Environmental Impact Assessment Report (EIAR), and an opportunity for Early Works Report(s) for assessment of works that are ready to proceed in advance of the EIAR. The ECR documents the local environmental conditions of the OL Study Area and provides a preliminary description of the potential environmental impacts of the Project. Information provided in the ECR is used to inform the Early Works Report(s) and the EIAR, which study environmental impacts in further detail and confirm and refine preliminary mitigation measures identified in the ECR.

The EIAR includes environmental impact assessment results, proposed mitigation measures, proposed monitoring activities, potentially required permits and approvals and a record of consultation, among other information, to meet Ontario Regulation 341/20: OL Project requirements.



Stantec

Legend

- Project Footprint
- Study Area (500 m Buffer)
- Station Location
- Operations, Maintenance and Storage Facility
- Ontario Line West
- Ontario Line South
- Ontario Line North
- Existing Subway

0 1 2 km

1:47,500 (At original document size of 11x17)

Notes

1. Coordinate System: NAD27 MTM zone 10
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2020.
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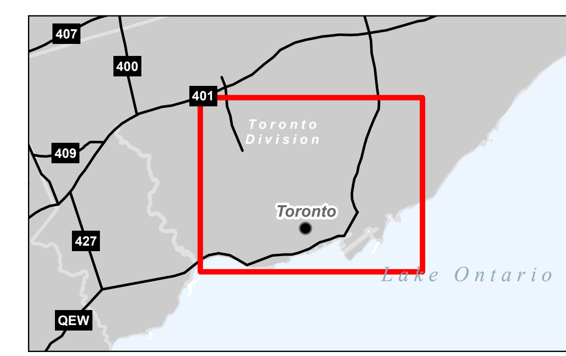


Project Location
City of Toronto, ON

160560009 REV4
Prepared by BCC on 2022-01-28
Technical Review by CL on 2021-06-10

Client/Project
HDR CORPORATION
ONTARIO LINE TA

Figure No.
1-1

Title
Project Overview

1.3 Purpose of the Noise and Vibration Impact Assessment Report

This report forms part of the EIAR and has been prepared to assess potential noise and vibration impacts and identify proposed mitigation measures and monitoring activities to verify mitigation effectiveness.

The objectives of the noise and vibration impact assessment are:

- To identify noise and vibration sensitive areas that may be impacted by the construction and operations of the Project;
- To recommend mitigation measures to reduce noise and vibration impacts; and,
- To identify locations that require noise or vibration monitoring to verify mitigation effectiveness.

This impact assessment includes construction and operational noise impact from the OL Project, including train movements in Ontario Line North (OLN) section, the operations maintenance and storage facility (OMSF) and ventilation along the Project. Ground-borne noise (GBN) due to vibration from underground train operations has been considered along the entire alignment. The above-ground operations noise impacts of GO and OL train movements within Ontario Line West (OLW) and Ontario Line South (OLS) sections have been assessed within the following reports:

- AECOM – Metrolinx Noise and Vibration Operations Report – Ontario Line and GO Lakeshore East Joint Corridor (November 2021)
- AECOM – Metrolinx Noise and Vibration Operations Report – Ontario Line and GO Lakeshore West Joint Corridor (February 2022)

These documents are referred to where applicable in this report and provided as reference in Appendix Q. Further information about the Project components is found in Section 1.4.

This impact assessment includes construction noise impact for the OL Project footprint. Additional assessments for above-ground construction noise impacts associated with the Early Works within the OLW and OLS have been assessed within the following reports:

- AECOM – Metrolinx Noise and Vibration Early Works Report – Ontario Line East Harbour Station Early Works(November 2021)
- AECOM – Metrolinx Noise and Vibration Early Works Report – Ontario Line Lower Don Bridge and Don Yard Early Works (August 2021)
- AECOM – Metrolinx Noise and Vibration Early Works Report – Ontario Line Corktown Station Early Works (July 2021)
- AECOM – Metrolinx Noise and Vibration Early Works Report – Ontario Line Exhibition Station Early Works (February 2021)
- AECOM, Metrolinx Noise and Vibration Early Works Report – Ontario Line Lakeshore East Joint Corridor Early Works (November 2021)

This Report has been prepared in accordance with Ontario Regulation 341/20: Ontario Line Project and contains the information outlined in Table 1-1.

Table 1-1. Report Contents in Accordance with Ontario Regulation 341/20: Ontario Line Project

Reg. Section	Requirement	Report Section
Section 15(2)4	A description of the local environmental conditions at the site of the Ontario Line Project.	Section 2
Section 15(2)6	Metrolinx's assessment and evaluation of the impacts that the preferred method of carrying out the Ontario Line Project and other methods might have on the environment, and Metrolinx's criteria for assessment and evaluation of those impacts.	Sections 4.1 - 4.2, 5.1 - 5.2, 6.1 and 7.1 (Criteria) Sections 4.4, 4.5.1 and 4.5.2 Sections 5.4, 5.4.1, 5.4.3, 5.4.4 and 5.4.5 Sections 6.3 and 6.4.1 Sections 7.3, 7.4.1 and 7.4.2 (Assessment)
Section 15(2)7	A description of any measures proposed by Metrolinx for mitigating any negative impacts that the preferred method of carrying out the Ontario Line Project might have on the environment.	Sections 4.5.3 – 4.5.4 Sections 5.5.2, 5.5.6, 5.5.7 Sections 6.4.2, 7.4.3, 7.4.4
Section 15(2)8	A description of the means Metrolinx proposes to use to monitor or verify the effectiveness of mitigation measures proposed.	Section 4.5.4 Section 5.5.7 Section 6.4.3 Section 7.4.5
Section 15(2)9	A description of any municipal, provincial, federal or other approvals or permits that may be required for the Ontario Line Project.	Section 4.5.5 Section 5.5.10 Section 6.4.5 Section 7.4.7

1.4 Project Description

For readability, the Project has been divided into three sections: OLW, OLS, and OLN.

Select Project components are proposed to proceed before the completion of the Environmental Impact Assessment process and have been assessed under separate cover, as part of the Ontario Line Early Works Reports. These include early works at Exhibition Station, Corktown

Station, Lower Don Bridge and Don Yard, East Harbour Station, and the Lakeshore East Joint Corridor.

Ontario Line West

The OLW section extends from Exhibition Station (a terminus and interchange point with the Lakeshore West GO Transit corridor) to the TTC Line 1 interchange at Osgoode Station.

At Exhibition Place, the OLW tracks and platform will be located at-grade on the north side of the Lakeshore West GO Transit corridor. An above-grade concourse is planned to span both sets of tracks to facilitate cross-track access to the OL and GO Transit platforms. As the tracks extend eastwards from Exhibition Station they gradually descend, and the tracks will be below-grade before entering the portal to transition the subway underground. Between Exhibition Station and the portal, retaining walls will be installed to facilitate the gradual descent of the subway line. The location of supporting structures will be confirmed as design advances, but based on current information, it is anticipated that a traction power substation may be located east of the Exhibition portal, and an EEB may be located in the Ordnance Park area.

The subway tunnel continues underground at an approximate depth of 30 m to King/Bathurst Station. Beyond King/Bathurst Station, the tunnel continues northeast before curving to arrive at Queen/Spadina Station. From there, the tunnel extends east under Queen Street to an interchange station under the existing TTC Osgoode Station. The OL Osgoode Station will be an interchange station with the existing TTC Line 1 Osgoode Station.

Ontario Line South

The OLS section extends from the east side of Osgoode Station to just south of Pape Station.

The OLS tracks continue from Osgoode Station through the subway tunnels east under Queen Street to an interchange station under the existing TTC Line 1 Queen Station. The Ontario Line Queen Station will be connected with TTC Line 1 Queen Station and the PATH system. An underground track crossover will be constructed east of Queen Station for maintenance and emergency diversion purposes. East of the crossover, the tunnels continue under Queen Street East to the Moss Park Station, located on the north side of Queen Street East between George Street and Sherbourne Street. From Moss Park Station the tunnels turn south and travels underground to Corktown Station near the intersection of Berkeley Street and King Street East. An EEB connected to the station will be located on the east side of Berkeley Street, north of Front Street. From Corktown Station, the tunnels turn southeast and travels under Distillery Lane.

An EEB will be located west of Cherry Street in the Metrolinx Union Station Rail Corridor RoW with emergency access provided from Cherry Street and Lakeshore Boulevard East. An additional EEB is proposed at the foot of Tannery Road in the Metrolinx Union Station Rail Corridor RoW. The tunnels reach the surface at the Don Yard Portal, located just west of the Don River, to the north of the existing GO Transit Union Station Rail Corridor and Don Yard train storage facility and to the southeast of Mill Street. Retaining walls will be constructed from the portal face on both sides of the tracks as the elevation ascends from below grade to at-grade.

The tracks will cross the Lower Don River on a new bridge, the Lower Don Bridge, that will be constructed on the north side of the existing rail bridge. Once the tracks cross the Lower Don River, the tracks will be located on the northwest side of the Joint Corridor that runs from the Don Valley Parkway in the south to Gerrard Street East in the north.

The East Harbour Station will be located south of Eastern Avenue and Broadview Avenue and will support transfer between Ontario Line and GO transit through the station concourse. Moving northeast along the Joint Corridor, the tracks will enter the Riverside/Leslieville Station at Queen Street East. The tracks continue into Gerrard Station at Gerrard Street East and Carlaw Avenue, with a new rail bridge at the intersection of Gerrard Street East and Carlaw Avenue to accommodate the tracks. North of Gerrard Station, the tracks begin to descend from the Gerrard portal underground. The Gerrard portal is situated south of the intersection of Pape Avenue and Langley Street immediately north of the Joint Corridor. Once underground at the Gerrard portal, the subway tunnels will continue north along Pape Avenue to Pape Station at Danforth Avenue and Pape Avenue. An EEB is planned to be located at Bain Avenue and Pape Avenue.

Ontario Line North

The OLN section extends from Pape Station to Science Centre Station.

Pape Station will interchange with the existing TTC Line 2 Pape Station. North of Pape Station, under Pape Avenue, between Browning Avenue and Sammon Avenue, an underground track crossover, the Sammon Avenue Crossover, will be constructed for maintenance and emergency diversion purposes. From the Sammon Avenue Crossover, the tunnel continues north crossing under Pape Avenue to run along the west side of Pape Avenue RoW to Cosburn Station which is planned to be located on the west side of Pape Avenue at Cosburn Avenue. The tunnel continues north to the Minton Place portal, which includes an EEB. The portal face is on the southern valley wall of the Don Valley, north of Hopedale Avenue.

The underground segment of OLN will emerge from the southern valley wall of the Don Valley west of the Don Valley Crossing Bridge on an elevated structure that will span the Don Valley Parkway and the Don River. The elevated guideway will continue along the northwest side of Overlea Boulevard to the Thorncliffe Park Station, located at Thorncliffe Park Drive. East of Thorncliffe Park Station, the elevated guideway turns north, then east, crossing over Beth Nealson Drive (which will run underneath the guideway) and crossing the west branch of the West Don River to arrive at Flemingdon Park Station. Flemingdon Park Station is located on the west side of Don Mills Road, just north of Gateway Boulevard. North of Flemingdon Park Station, a crossover will be constructed for maintenance and emergency diversion purposes. The elevated guideway then travels north crossing from the west side to the east side of Don Mills Road to Science Centre Station, located at Don Mills Drive and Eglinton Avenue East. This station will have an underground tunnel connection to the existing TTC Line 5 (the Eglinton Crosstown LRT). North of Science Centre Station, a crossover will be constructed for maintenance and emergency diversion purposes.

The Operations, Maintenance and Storage Facility (OMSF) will be located north of Thorncliffe Park Station. The OMSF will provide storage, inspection, maintenance, and repair services for the Project.

2 Study Area

The study area for this noise and vibration impact assessment has been identified based on the Project Footprint (January, 2022) and applicable guidance.

The Project Footprint is defined as the area of direct disturbance associated with the construction and operation activities, including anticipated required construction staging and laydown areas and access requirements. The Project Footprint includes the total area potentially affected by the proposed construction activities and operations of the Project, which includes the three OL corridor sections (OLW, OLS, and OLN) and the OMSF. The extent of proposed physical works from construction and operation includes, but is not limited to, temporary laydown and staging areas, potential road detours, new bridges, tunnelling and associated openings (including vent shafts and emergency egress buildings (EEBs)), new stations and platforms, portals, retaining walls and barriers, railway track realignments, the operations, maintenance and storage facility (OMSF), new power supply and transformers, and utility relocations.

The study area for the noise and vibration impact assessment was determined based on the area around the Project Footprint in which Project impacts have the potential to be experienced. For the purposes of this assessment the study area is defined as 500 m from the Project Footprint. Project Footprint. The study area is shown in Appendix B, Figure B-1 to Figure B-7.

2.1 Land Use Description

The Ontario Line passes through residential, commercial, and industrial land uses. Industrial uses are concentrated near Exhibition Station and Ontario Science Centre Station.

Starting in OLW, from the southwest end close to Exhibition Station, residential and commercial uses are located north of the corridor, with the Gardiner Expressway to the south and Exhibition Place beyond.

As the corridor passes by the Union Station Rail Corridor, the mix of land uses becomes predominantly residential, transitioning to a residential/employment mix into the downtown core. The Bell Media Headquarters, Osgoode Hall and the Campbell House Museum are in this section. Toronto City Hall, though also defined in this section, is further from the Project Footprint than other closer sensitive receptors (St. Michaels Hospital), such that it is not identified as a specific point of reception in the assessment.

The Four Seasons Centre for the Performing Arts is located at the boundary between OLW and OLS. Farther east is the St. Michael's Hospital. Approaching the Don Yard, the Distillery District features a mix of commercial and residential uses in former industrial buildings, as well as the Young Centre for Performing Arts and the Berkeley Street Theatre.

Commercial and light industrial uses are located east of the Don River, including automotive repair shops and a former industrial complex, now known as East Harbour. This is at the transition between the OLS section and the OLN section.

Where the corridor runs largely parallel to Pape Avenue, single-family residential areas dominate. As the corridor passes over the Don Valley Parkway and transitions to the Thorncliffe Park neighbourhood, the land use transitions to a residential/commercial/employment industrial mix, which continues to the end of the corridor, north of Eglinton Avenue East.

Proposed residential developments and residential developments under construction are located throughout the area.

Zoning maps for the study area are included in Appendix C.

2.2 Points of Reception

Review of the study area allowed for identification of representative Points of Reception (PORs). These PORs were selected through desktop study followed by field verifications. The baseline noise and vibration studies and receptor verification are detailed in Section 3. Section 3 discusses applicable receptors used in this assessment and the details of these are expanded on in Sections 4 and 5. The receptor inventory is shown in Appendix E (Figure E-1-1 to Figure E-1-22).

The following sensitive receptors were noted to be of interest for the assessment:

- Factory Theatre
- Bell Media Headquarters
- The Four Seasons Centre for the Performing Arts
- St. Michael's Hospital
- Elgin Winter Garden
- Super Sonics Post Production
- Alumnae Theatre Company
- Canadian Stage
- Young Centre for the Performing Arts
- Osgoode Hall
- Campbell House

These receptor locations may present special concerns and, where applicable, they are highlighted in this assessment.

2.3 Geotechnical Summary

As reference information for assessing vibration propagation, a review of the soil types for the Project Footprint, as well as depth of bedrock for the tunneled sections was completed.

Table 2-1 summarizes the soil types above bedrock along the Project Footprint.

Table 2-1. Geotechnical Summary: Soil Types

Location	Soil Type(s)
Downtown Tunnel (Exhibition to Don Yard Portal)	• Medium/hard soil type • The native soil underlying fill materials are in general comprised of stiff to hard silty clay and silty clay glacial till soil
Pape Tunnel (Gerrard Portal to Minton Place Portal)	• Soft soil type • The native soil underlying fill materials are in general comprised of very stiff to hard silty/clay layers and dense to very dense silty/sandy soil.
Exhibition Station to East Harbour Station	• Hard soil type
East Harbour Station to Science Centre Station	• Soft soil type • For the Thorncliffe segment, the native soil underlying fill materials are in general comprised of stiff to hard silty/clayey layers and compact to very dense silty/sandy soil

For the Downtown tunnel, the top of the bedrock varies between approximately 5 m and 14 m below grade. The tunnel is located within bedrock except for the portal areas, where it transitions from at-grade to full tunnel depth. The cover of bedrock over the obvert (top) of the tunnel varies from 1 m to 20 m and is generally between 12 m and 16 m.

For the Pape Tunnel, the top of the bedrock varies between approximately 25 m and 45 m below grade. The tunnel will be located within the soil overburden. The distance between the invert (bottom) of the tunnel and bedrock varies from 2 m to 24 m.

3 Consolidated Baseline Noise and Vibration Assessment

3.1 Noise and Vibration Metrics

Various noise and vibration metrics are used to address these impacts for the Project. Table 3-1 below summarizes the metrics, and how they are applied for the Project. These metrics have been defined based on the following reference documents:

- Ministry of the Environment, Conservation and Parks (MECP) Environmental Noise Guideline – Stationary and Transportation Sources – Approval and Planning (NPC-300, 2013)
- US FTA Transit Noise and Vibration Impact Assessment Manual (US FTA, 2018)

These metrics were used to define the applicable construction and operation limits for noise and vibration as they relate to the Project and were also used in the collection of baseline information to support the assessment. Baseline measurements based on these metrics are provided in Section 3.2, while the noise and vibration limits are defined in Sections 4.2 and 5.2 (noise) and Sections 6.1 and 7.1 (vibration).

Table 3-1. Noise and Vibration Metrics

Metric		Unit	Definition	Applicable Source Type
Noise	$L_{EQ,1}$	dBA	One-hour equivalent sound level	Stationary Sources, Construction
	$L_{EQ,16}$	dBA	Daytime (0700 – 2300h) equivalent sound level	Light Rail
	$L_{EQ,8}$	dBA	Nighttime (2300 – 0700h) equivalent sound level	Light Rail
	Adjusted Noise Impact	dB	5 dB relative to the higher of pre-Project sound levels or 55 dBA (daytime) and 50 dBA (nighttime)	Light Rail
Vibration	Root Mean Square (RMS) Maximum Velocity	mm/s	The maximum RMS for a pass-by signal arithmetically averaged over a rolling 1 second time interval	Light Rail, Tunneling
	Peak Particle Velocity (PPV)	mm/s	Peak particle velocity during an event	Construction

3.2 Monitoring Studies

3.2.1 Previous Studies

This baseline study builds on information presented in the Ontario Line Project Final Environmental Conditions Report (ECR) – Noise and Vibration Report (AECOM, May 2020).

The ECR was prepared in accordance with Section 4 of the Ontario Regulation 341/20: Ontario Line Project. This section includes a review of the ECR, and includes information considered for interpretation of these results and its use as part of determining baseline noise and vibration conditions in the Project area. Full details and results can be reviewed in the referenced report.

3.2.2 Outdoor Noise Monitoring Methodology Summary

Unattended noise measurements (collected by AECOM) were collected at 17 locations representative of the noise-sensitive receptors near the Project and are detailed in the ECR. These locations are shown in Figure D-1 in Appendix D. The measurements were collected using 3M QuestPro Sound Level meters (SLMs), which were set to log noise levels in 15-minute intervals ($L_{eq,\ 15min}$). The SLMs were installed at a height of approximately 3 m above the ground, as this would represent higher floors (e.g., 2nd storey bedrooms) with more exposure to Project noise impacts.

Noise data was collected over multiple days to ensure enough data was available to represent the baseline after being processed to remove noise samples that may have been influenced by high winds (i.e., wind speeds greater than 20 km/hr), precipitation or periods with activity not representative of the typical acoustic environment (i.e., construction). The ECR presents the calculated $L_{eq,\ 1hr}$, $L_{eq,\ 8hr}$ and $L_{eq,\ 16hr}$ metrics for defining the existing ambient environment.

3.2.3 Environmental Conditions Report Noise Monitoring Results

Table 3-2 shows the main results of the ECR (collected by AECOM) used in the noise assessment. See Appendix D for complete ECR results. The following notes are included in the ECR report:

- Evening periods (19:00 to 23:00) were not measured at locations MO_01W and MO_05S due to access restraints.
- The daytime period measurements for MO_03S were excluded due to intrusive daytime construction noise.
- Data that could potentially be used as representative for areas without measured data are highlighted in grey in the result tables. The representative data has been selected based on alternative locations or time periods where ambient noise levels are expected to be similar or lower.
- The collected longer-term averages (Leq,16hr (day) and Leq, 8hr (night)) are generally higher than 55 dBA (day) and 50 dBA (night).
- The minimum $L_{eq,\ 1hr}$ during the nighttime hours ranges from 43 to 58 dBA.

3.2.4 Supplemental Noise Monitoring

Noise monitoring collected by OLTA was completed in November and December 2020. Five locations where AECOM completed monitoring in 2019 were chosen by OLTA to compare 2019 vs. 2020 sound levels. For all locations, 2020 daytime ($L_{eq,\ 16hr}$ (day)) and nighttime ($L_{eq,\ 8hr}$ (night)) average levels were between 2 to 18 decibel (dB) lower than those recorded in 2019. This is expected to be due to COVID-19 pandemic-related travel restrictions, and the associated reduction in road vehicle traffic. Pandemic-related reductions in road vehicle traffic are assumed to be temporary, with the expectation that future sound levels will recover to at least those recorded in 2019, when service is expected to begin on OL. Therefore, 2020 noise monitoring results are not used in this report.

The Four Seasons Centre for the Performing Arts was identified as a sensitive receptor with additional concerns, as it operates as a world-class opera house. Review of the acoustic design requirements of the facility identified that it requires stringent indoor noise levels to be met for acceptable performance, such that indoor noise levels measurements were required to establish its baseline. Indoor noise levels were recorded inside the Four Seasons Centre for the Performing Arts on the stage of the main auditorium (R. Fraser Elliott Hall), as shown in Table 3-3. Observations by OLTA staff indicate surface transportation as well as Toronto Transit Commission (TTC) subway are inaudible in the main auditorium at stage level (see Appendix D).

Table 3-2. Noise Measurement Results (Outdoor) (Environmental Conditions Report)

Monitor ID	Location	Min, 1-Hour Leq (dBA)			16-Hour Leq (dBA)	8-Hour Leq (dBA)
		7 AM to 7 PM (Daytime)	7 PM to 11 PM (Evening)	11 PM to 7 AM (Night-time)	7 AM to 11 PM (16-Hour Daytime)	11 PM to 7 AM (8-Hour Night-time)
MO_01W[1]	Richmond Street West	67	59	59	66	61
MO_02W	Adelaide Street West	61	61	58	65	62
MO_03W	Hanna Avenue	58	61	54	63	59
MO_01S	Pape Avenue	59	56	47	64	55
MO_02S	Wardell Street	61	59	43	64	56
MO_03S[2]	Rolling Mills Road/Mill Street	63	63	50	63	60
MO_04S	Erin Street	61	61	55	64	59
MO_05S[3]	Richmond Street East	66	55	55	65	60
MO_01N[4]	Windom Road	53	54	48	58	53
MO_02N	St. Dennis Drive	61	65	56	67	61
MO_03N	Vanderhoof Avenue	59	63	55	67	60
MO_04N[5]	Don Mills Road/Overlea Boulevard	57	60	53	64	58
MO_05N	William Morgan Drive	57	60	53	64	58
MO_06N	Leaside Park Drive	53	54	48	58	53

Monitor ID	Location	Min, 1-Hour Leq (dBA)			16-Hour Leq (dBA)	8-Hour Leq (dBA)
		7 AM to 7 PM (Daytime)	7 PM to 11 PM (Evening)	11 PM to 7 AM (Night-time)	7 AM to 11 PM (16-Hour Daytime)	11 PM to 7 AM (8-Hour Night-time)
MO_07N	Minton Place/Hopedale Avenue	55	53	46	59	52
MO_08N	Gowan Avenue	53	50	44	59	51
MO_09N	Gertrude Place	48	48	45	53	49

Notes:

[1] Evening noise data not measured due to access restraints. Levels assumed to be represented by nighttime data. Leq,16h calculated using this assumption.

[2] Daytime noise data considered invalid due to nearby construction. Levels assumed to be represented by evening data.

[3] Evening noise data not measured due to access restraints. Levels assumed to be represented by nighttime data. Leq,16h calculated using this assumption.

[4] Noise levels assumed to be represented by MO_06N (as per ECR report (AECOM, 2020).

[5] Noise levels assumed to be represented by MO_05N (as per ECR Report (AECOM, 2020).

Table 3-3. Measured Sound Levels at Four Seasons Centre for the Performing Arts (Indoor)

Description	Sound Pressure Level (dB) at 1/1 Octave Band Centre Frequency (Hz)					
	31.5	63	125	250	500	1000
N-1 Criterion	55	47	22	13	8	4
Measured by Stantec – Average[2]	43	36	29[1]	27[1]	24[1]	16[1]
Maximum[2]	48	40	31	28	20	16
Minimum[2]	38	32	27	26	16	13

Notes:

[1] Transit sources typically generate sound levels that are more prominent in the octave band centred at 31.5 Hz and 63 Hz. A review of audio data from the recordings indicates regular security patrols through the building, which may have influenced sound levels. The doors to the main auditorium may have remained open, which would result in higher than usual noise levels from human activity just outside the auditorium.

[2] Sound levels are based on a 20-minute sample between 5 pm and 6pm on a weekday (adequate to capture at least 3 to 4 TTC subway passbys). Spectra were recorded on a 1-second basis for the average, maximum and minimum.

3.2.5 Vibration Monitoring Methodology Summary

Unattended vibration measurements were collected at eleven sites including four theatres, one concert hall, one recording studio, one recreation centre, and one hospital near the Project, as well as three locations near portal entrances. These locations are identified in Figure D-1 in Appendix D. At each measurement site, one to three locations were selected for the installation of the accelerometers, in potentially sensitive indoor locations as well as outdoor locations close to the planned alignment of the Project.

Measurements at the Four Seasons Centre for the Performing Arts were conducted over a period of approximately eight hours, using two accelerometers with nominal sensitivity of 100 mv/g and a RION DA-20 data recorder with sampling frequency of 2,560 Hz. Since there were some persistent human activities/footfall in the auditorium until around 18:00, only the data between 6:30 PM and 10:30 PM was processed. The vibration data was processed to obtain RMS velocity in the time-domain and the energy averaged maximum RMS velocity in 1/3-octave frequency bands. The lowest and highest frequency bands used in the analysis were 1 Hz and 500 Hz, respectively. The entire data set was divided into one-hour data blocks, and then the one-second RMS velocity with 50% overlap was calculated for each data block.

3.2.6 Vibration Monitoring Results

Table 3-4 shows the results of the vibration monitoring study from the ECR (collected by AECOM) and supplemental OLTA vibration monitoring.

Table 3-4. Vibration Monitoring Results

Monitor ID[1]	Location	Measurement Point		RMS Velocity (mm/s)	
				Max. 1 sec. Energy Average	Dominant Frequency Range (Hz)
MO_01V	Canadian Stage Theatre	Ground Level	Main Stage	0.0644	16 to 25
		Basement Level	Storage Room	0.0108	20 to 50
MO_02V	Alumnae Theatre Company	Ground Level	Entrance	0.0261	16 to 20
		Basement Level	Costume Storage	0.0067	16 to 20
MO_03V	Super Sonics Post Production	Outdoor Walkway		0.0826	16
MO_04V	St. Michael's Hospital	Basement Level (B2)	MRI Room	0.0164	20
			Data Centre	0.0097	31.5
		5th Floor	Operation Room	0.0197	10 and 80
MO_05V	Elgin Winter Garden Theatre Centre	Ground Level	Emergency Entrance	0.0276	12.5 to 16
		Basement Level	Water Heater Room	0.0240	16 to 20

Monitor ID[1]	Location	Measurement Point		RMS Velocity (mm/s)	
				Max. 1 sec. Energy Average	Dominant Frequency Range (Hz)
MO_06V	Four Seasons Centre for the Performing Arts	Ground Level	Education Centre	0.0181	10 to 16
		Basement Level	Mechanical Room (P3)	0.0426	10 to 12.5
VM_FSPC		Main Auditorium	Underside of slab – above isolation pads	Below 0.02	n/a (isolated)
		Main auditorium	Underside of slab – below isolation pads	Below 0.02	20
MO_07V	Factory Theatre	Outdoor – near old entrance	0.0122	16	MO_07V
VM_OU_01	Ordnance Triangle Park	Outdoor		Below 0.04	10 to 12.5
VM_OU_02	Carlaw & Gerrard	Outdoor		Below 0.1	From 8 to 20
VM_OU_03	Minton Place	Outdoor		Below 0.1	n/a (broadband)
VM_OU_04	Jimmie Simpson Recreation Centre	Outdoor		Below 0.05	20

Note:

1 Monitor IDs beginning with MO represent data collected by AECOM. Monitor IDs beginning with VM represent data collected by Stantec.

3.3 Study Area Receptor Determination

A database of the potential receptors for noise and vibration was developed for the Project, based on building development in 2020. This multiple stage approach, adopted from the United States Federal Transit Association (US FTA) approach for transit impacts, involved the following:

- Definition of receptor classifications and assessment locations
- Desktop review to define receptors based on land uses and building type on-site verification/updates of compiled receptor information (ground truthing)
- Notes about acoustic environment observations
- Creation and refinement of receptor list for assessment purposes

Further details of each of these stages are provided in this section.

3.3.1 Receptor Classifications

Table 3-5 shows the receptor definitions for noise assessment obtained from NPC-300 (MECP 2013) and Metrolinx guidance.

Table 3-5. Receptor Definition Summary

Sensitive Land Use		Heavy and Light Rail, Stationary Sources, Layovers, and Ancillary Facilities	
Type	**Examples**	**Noise Receptor**	**Vibration Receptor**
Residential	Single detached dwelling, townhomes, multi-unit building, high rise building	Plane of window and outdoor living area	5 to 10 m from the building foundation parallel to the source (and at least 15 m from OL tracks)
Industrial	Industries with equipment sensitive to vibration, such as scanning electron microscopes, high accuracy printing presses, or machining shops.	Not assessed	
Commercial	Hotels and motels	Plane of window only	
Institutional	Places of worship in residential areas	Plane of window only	
	Educational facilities, daycares, hospitals, long-term care facilities, courthouses, libraries	Plane of window only	

Sensitive Land Use		Heavy and Light Rail, Stationary Sources, Layovers, and Ancillary Facilities	
Type	**Examples**	**Noise Receptor**	**Vibration Receptor**
Vacant Properties	With approved site plans, approved condominium plans or draft approved plans of subdivision	Plane of window and outdoor living area (if location known)	
	All other vacant properties	Not assessed	Not assessed

3.3.2 GIS Data Processing and Receptor Identification

In the noise and vibration study area (Appendix B), the following City of Toronto open data sets were compiled to create a basis for identifying potential receptors:

- Zoning data
- Municipal address
- Land use data
- Building footprints
- Parcel fabric (property boundaries)

In addition to this property information, ground elevation data was added from the Ministry of Natural Resources and Forestry (MNRF) Land Information Ontario (LIO) data hub.

From this, a consolidated summary of the areas zoned for potential sensitive land uses (i.e., residential, commercial, institutional) in the study area was refined into an inventory of points of reception for assessing noise and vibration.

3.3.3 Ground Truthing Field Verification

OLTA deployed a field team to review and confirm the information compiled from the desktop exercises detailed in Section 3.3.2. Using the software ArcGIS Collector, the team conducted a visual review of existing land uses in the noise and vibration study area. Field verification allowed for the confirmation of the anticipated land use. If it was observed to be a more sensitive land use than expected from the compiled GIS data, then the land use category was updated.

During the field study, posted signage was noted for upcoming developments. This information was used to identify items such as future use; confirmation of the form of the building; and general built-form and receptor heights.

Properties appearing to be vacant or under construction were noted and then verified with the City of Toronto development application database to confirm existing development proposals. Vacant lots with known development applications were assumed to be developed after construction of the Ontario Line. Vacant lots without development applications were assumed as remaining vacant.

3.3.4 Acoustic Environment Observations

The acoustic environment varied along the subway route but was dominated by anthropogenic noise during the daytime hours. For homes with line-of-sight exposure to transportation corridors (e.g., areas exposed to Don Mills Road, Don Valley Parkway, Queen Street), anthropogenic noise is expected to dominate through the daytime and nighttime periods.

3.3.5 Determination of Noise and Vibration Receptors

3.3.5.1 Noise Receptors

The desktop study and the field verification (Sections 3.3.2 and 3.3.3) resulted in a list of over 3,000 potential receptors. A refined list of 260 representative receptors was defined from the potential receptor list based on those expected to be most impacted by construction and operations from the Project, in accordance with the type of study (i.e., construction and operational noise impact). This refined list is expected to address all of the potential receptors, as the other potential receptors are less impacted from Project noise due to further distance away and/or shielding from other buildings.

The representative receptors that will be used to estimate compliance with applicable noise criteria are listed in Appendix E (Table E-1) and are shown in Figures E-1-1 through E-1-22 in Appendix E.

3.3.5.2 Vibration Receptors

For vibration impacts, Section 3.2.6 indicates root mean square (RMS) values below the criteria in the US FTA Transit Noise and Vibration Impact Assessment Manual (US FTA, 2018) for human annoyance and building damage (0.1 mm/s). Therefore, baseline vibration levels will not be applied in the vibration impact assessment to determine compliance and a list of vibration receptors for which to apply measured baseline levels has not been produced from this study. Vibration impacts from the Project will be assessed against the applicable criteria, taking into account the building type (e.g., residential, commercial/institutional, highly-sensitive buildings such as TV studios/concert halls, heritage buildings) and the ZOI of vibration from construction and operations.

3.4 Application of Monitoring Results

Local road traffic was observed to be a dominant ambient noise source in the vicinity of the Project. The ambient monitors captured baseline noise data at approximately 3 meters above grade. However, many receptors in the Thorncliffe/OLN area are multi-storey buildings with differing exposure to road traffic, based on both height and position relative to the roads. While the FTA supports the application of monitoring through a clustering approach, Metrolinx has indicated that a combination of measurements and modeling can be used to determine baseline noise conditions at representative receptors higher than 3 metres above grade.

3.4.1 Application of Measured Baseline

To apply the noise monitoring metrics in Table 3-1 to the representative receptors in Appendix E, the receptors were clustered according to proximity to ambient monitoring locations. Table 3-6 illustrates the clustering of the receptors and applicable ambient monitoring locations from Figure D-1, along with the ambient noise levels applicable for operational noise impacts. Figures E-2 and E-3 in Appendix E illustrate the clusters listed in Table 3-6. Ambient noise levels are used, as described in Section 5, for assessing current construction and operational noise impact (e.g., OSMF) at nearby receptors.

To address potential future noise level from the Project related to train activities, future operational and ambient noise levels are predicted and used for comparison, as described in Section 3.4.2. Thus, measured ambient noise levels are not used for assessing future operational noise levels from train activities.

For vibration impact, Section 3.2.6 indicates RMS values below 0.1 mm/s, which is lower than the US FTA criteria for human annoyance and building damage.

Table 3-6. Receptor Clusters and Applied Ambient Monitor Noise Data

Monitor[1]	Cluster[2]	ID[3]	Min 1hr Leq, D / E / N[4] dBA	Day, Leq, 16hr dBA	Night, Leq, 8hr dBA
MO_03W	CCL_DT_01	CR_TYPE_001 through CR_TYPE_018	58 / 61 / 54	63	59
MO_02W	CCL_DT_02	CR_TYPE_019 through CR_TYPE_026	61 / 61 / 58	65	62
MO_01W	CCL_DT_03	CR_TYPE_027 through CR_TYPE_066	67 / 59 / 59	66	61
MO_03S / 05S	CCL_DT_04	CR_TYPE_067 through CR_TYPE_083	63 / 63 / 50 66 / 55 / 55	63 65	60 60
MO_02S	CCL_DT_05	CR_TYPE_084 through CR_TYPE_092	61 / 59 / 43	64	56

Monitor[1]	Cluster[2]	ID[3]	Min 1hr Leq, D / E / N[4] dBA	Day, Leq, 16hr dBA	Night, Leq, 8hr dBA
MO_08N	CCL_PA_01	CR_TYPE_093 through CR_TYPE_174a	53 / 50 / 44	59	51
MO_04N / 05N	CCL_LEA_01	CR_TYPE_175 through CR_TYPE_209	57 / 60 / 53	64	58
MO_04S	OCL_DT_01	SR_TYPE_001 through SR_TYPE_006 ER_TYPE_001 to 004	61 / 61 / 55	64	59
MO_09N	OCL_PA_01	SR_RESD_007 and SR_RESD_008 ER_TYPE_005 to 008	48 / 48 / 45	53	49
MO_07N	OCL_TCF_01	RR_TYPE_001 through RR_TYPE_009 ER_TYPE_009 MR_TYPE_008 to 010	55 / 53 / 46	59	52
MO_06N	OCL_TCF_02	RR_TYPE_010 through RR_TYPE_020 MR_TYPE_001 through MR_TYPE_007	53 / 54 / 48	58	53

Notes:

1 As per Table 3-1, Figure D-1

2 CCL – Construction Receptor Cluster, OCL – Operation Receptor Cluster, DT: Downtown, LEA: Leaside, PA: Pape, TCF: Thorncliffe

3 TYPE – as in Table 3-5. CR: construction receptor, RR: rail receptor, MR: OMSF receptor, SR: station receptor, ER: emergency exit receptor4

4 D=Daytime, E= Evening, N=Nighttime

3.4.2 Application of Predicted Baseline

To predict baseline sound levels from road traffic, the software was configured to implement the United States Federal Highway Administration (FHWA) Traffic Noise Model (TNM) algorithm. Road traffic inputs are shown in Appendix N. As a conservative assumption, road traffic data from 2019 is assumed to be applicable for future service years acknowledging that future traffic is expected to increase the future baseline.

To address potential future noise level from the Project related to train passby noise, future operational and ambient noise levels are predicted and used for comparison. As noted above, measured ambient noise levels are not used for assessing future noise levels from train activities when comparing the potential increase in the future noise level, as the current ambient noise generally increases over time in urban environments.

Baseline noise conditions due to traffic have been modelled using 2019 traffic data from the City of Toronto, as described in Section 5.2.1.3. The Federal Highway Administration Traffic Noise Model version 2.5 (FHWA TNM v2.5) is used within the overall noise model for the Project to predict baseline noise at the representative receptors.

4 Construction Noise Impact Assessment

4.1 Regulatory Overview

Sections 4.1.1 and 4.1.2 provide details regarding the regulatory context for the construction noise assessment.

4.1.1 Provincial Context

The Ministry of the Environment, Conservation and Parks (MECP) Publication Noise Pollution Control (NPC)-115 “Model Municipal Noise Control By-law” (MECP, August 1978) and NPC-118 “Motorized Conveyances” (MECP, August 1982) are the applicable provincial noise guidelines for construction of the Project. Both NPC-115 and NPC-118 limit noise emissions from construction equipment in Ontario. These NPC publications stipulate noise limits on individual pieces of construction equipment rather than site-wide combined performance limits or sound level at nearby receptors.

Since Metrolinx is a provincial agency, and the City of Toronto’s guidance defers to provincial noise guidance, this assessment considers the construction noise impact against provincial guidelines.

4.1.2 US Federal Transit Administration Guidance

US FTA Transit Noise and Vibration Impact Assessment Manual (US FTA, 2018) provides comprehensive rail-specific guidance that is widely used and accepted in North America for rail projects, including for assessment and management of construction noise.

4.2 Applicable Criteria

Section 4.2.1 through Section 4.2.3 provide the applicable criteria (noise limits) for construction of the Project.

4.2.1 Summary of Applied Assessment Criteria

The NPC-115 and NPC-118 equipment noise limits are used for the construction noise emission assessment. The limits are summarized in Table 4-1 and are source based limits.

Construction noise at applicable PORs is assessed against the construction noise limits provided in the US FTA Manual and they are summarized in Table 4-2. US FTA limits were adopted for construction noise as they are consistently used on transit projects throughout Canada/US, as well as for consistency with other parts of the Project (Early Works), which adopted them as well.

4.2.2 Provincial Noise Emission Limits for Construction Equipment

Table 4-1. NPC-115 and NPC-118 Noise Emission Limits

Type of Equipment	Maximum Sound Pressure Level (dBA)
Excavation equipment, bulldozers, loaders, backhoes or other equipment or other equipment capable of being used for a similar application [1]	83 (for Power Rating less than 75 kW) at 15 m
	85 (for Power Rating 75 kW and greater) at 15 m
Pneumatic Pavement Breakers [2]	85 at 7 m
Portable Air Compressors [3]	76 at 7 m
Track Drills [1]	100 at 15 m
Heavy Vehicle with Governed Diesel Engines [3]	95 at 15 m

Notes:

1 Maximum Sound Level (dBA) determined per Publication NPC-103 - Procedures, Section 6.

2 Maximum Sound Level (dBA) determined per Publication NPC-103 - Procedures, Section 7.

3 Maximum Sound Level (dBA) determined per Publication NPC-103 - Procedures, Section 9.

4.2.3 US FTA Limits for Construction Noise

In Ontario, the typical time period for daytime construction operations is 07:00 to 23:00. As per the US FTA Manual guidance, an eight-hour energy average (Leq (8hr)) noise level was applied to assess construction noise during the daytime period. When considering equipment used for nighttime operations, a nighttime period of 23:00 to 07:00 was used. From this nighttime equipment, the eight-hour energy average ($L_{eq\ (8hr)}$) nighttime noise level was determined, and assessed to construction daytime noise limits, as per the US FTA Manual.

The FTA recommends the noise criteria shown in Table 4-2. The US FTA Manual does not provide construction noise criteria for institutional uses. Therefore, this assessment applies the FTA residential criteria minus 5 dB for institutional uses.

Table 4-2. FTA Limits for Construction Noise

Land Use	$L_{eq\ (8hr)}$ Sound Levels (dBA)[1] Day	$L_{eq\ (8hr)}$ Sound Levels (dBA)[1] Night
Residential	80	70
Commercial	85	85
Industrial	90	90

Note:

1 Criteria for institutional receptors are considered as 5 dB less than the criteria for residential receptors

4.3 Project Construction Noise Considerations

The construction activities and equipment used on this Project vary with the location within the Project Footprint and the construction phase. This section describes airborne noise impacts from above-ground construction, as well as airborne noise associated with tunneling entry/exit shafts. These considerations use a worst-case approach to provide a conservative assessment of potential construction noise impacts. GBN is generated from GBV and therefore, noise impacts from underground construction activities are described and assessed in Section 6 - Construction Vibration Impact Assessment.

Project construction is expected to be conducted in three (3) shifts per day, five (5) days per week with reduced operations on weekends. As some construction activities may occur during the nighttime hours, this assessment considers both daytime and nighttime criteria. The trackwork, tunneling and station excavation are the only construction phases anticipated to occur during the nighttime, based on the current conceptual construction schedule. If additional nighttime activities are identified, or at locations not previously considered, further assessment will be required. Further details on construction scheduling are included in Section 4.4.1.

Table 4-3 lists the types of construction activities expected for each phase and considered in this assessment.

Table 4-3. Construction Phases and Activities

Construction Phases	Expected Activities
Site preparation	• Mobilization of equipment • Clearing and grubbing of vegetation • Erection of temporary/permanent fences (as required)
Site servicing	• Installation of new utilities • Relocation and/or extension of services and utilities at the site including both underground and services and utilities (e.g., sewers, water, electrical, communication, gas)
Demolition	• Removal/demolition of some existing structure to enable construction of the Project
Excavation/grading	• Earth-moving and rock moving activities on the sites • Grading • Preparing excavations for foundations
Structures	• Construction of new buildings/structures • Constructing foundations for buildings (OMSF/stations)
Trackwork	• Installation of trackwork at OMSF and along corridor
Tunneling	• Tunneling activities from Exhibition Station to the Don Yard, and Gerrard Stations to Minton Place

Staging and laydown areas are near the construction sites and are included in the construction noise assessment. Sections 4.3.1 through 4.3.6 expand on the Project description provided in Section 1.1 to provide context for the construction of each Project component in terms of its potential noise impacts and parameters for assessment. A summary of the expected Project elements and construction phases is shown in Table 4-4. This table also indicates whether the phases are expected to occur only during the daytime or during the nighttime also. A complete listing of the expected equipment for each expected construction type is included in Section 4.4.

Table 4-4. Summary of Project Elements and Construction Phases

Project Elements	Site Preparation	Site Servicing	Demolition	Excavation/ Grading	Structure	Trackwork	Tunneling
Tunnel Boring Machine (TBM) Entry Shaft	D	D	-	D/N	-	-	D/N
Tunnel Boring Machine (TBM) Exit Shaft	D	D	D	D/N	-	-	-
Stations	D	D	D	D/N	D	-	-
At-Grade Corridor	D	D	-	D/N	-	D/N	-
Elevated Corridor and Bridges	D	D	-	D/N	-	D/N	-
OMSF	D	D	D	D/N	D	D/N	-

* D = Expected only in the daytime hours. D/N expected to occur in the day and nighttime hours.

4.3.1 At-Grade/Elevated Track

The construction of at-grade and elevated tracks requires site preparation, site servicing, and construction of piers and trackworks, which can generate airborne noise. Track installation will also take place for the at-grade/elevated tracks across the Project.

4.3.2 Tunnelling

Two tunnels are being constructed, the Downtown tunnel (from Exhibition Station Portal to the Don Yard Portal) and the Pape Tunnel (from Gerrard Station Portal to Minton Place Portal). Track installation within the tunnels is not a concern for construction noise, as the noise from this activity does not involve significant activities of vibration impact, that would be expected outside the tunnel itself.

Airborne noise is associated with the use of the Tunnel Boring Machine (TBM) entry and exit shafts and from the associated equipment at entry shafts during operation of the TBM and is assessed in this report. The locations of the exit and entry shafts are listed in Table 4-5. For TBM operation underground, airborne noise is not a concern at nearby receptors and is not assessed. GBN generated from tunneling vibration is assessed in Section 6.

Table 4-5. Entry and Exit Shaft Locations

Entry Shaft - Location	Entry Shaft - Section	Exit Shaft - Location	Exit Shaft - Section
Exhibition Station	OLW	Osgoode Station	OLW
Corktown Station	OLS	Queen Station	OLS
Gerrard Station	OLS	Pape Station	OLS
Pape Station	OLN	Minton Place	OLN

The entry shafts for the TBMs will have staging areas to accommodate equipment associated with their operation and spoil removed from below ground. Tunneling spoil will be temporarily stored at the site and transported out of the Project Footprint by rail cars or trucks. Two TBMs will be used for each tunnel, one from each entry shaft to create two parallel tunnels along the alignment. The entry of the TBMs at any shaft is staggered by 2-3 months and the tunneling will progress at a speed of about 14-28 m per day, depending on soil conditions.

Equipment assumed to be at the entry shaft includes the following, to be confirmed as detailed design advances:

- Ventilation plant (one fan/tunnel)
- Grout plant (pumps and tanker delivery)
- Conveyor belt system (one per tunnel)

- Tunnel segment delivery trucks
- Multi-service vehicle for segments transportation (two per tunnel)
- 20-ton dump truck for transporting spoil to the secondary staging area
- Front end loader in the spoil area
- Excavator in the spoil area
- Hydrovac trucks for soil conditioning
- Crane
- Substation
- Generator

Tunneling between Osgoode and Queen Stations, and between Corktown Station and Don Yard, is anticipated to be completed by Sequential Excavation Method (SEM) and roadheaders will also be used for these segments.

Equipment associated with exit shafts is expected to be less than entry shafts (since it is only used for extraction), and would include auger, dozers and dump trucks.

4.3.3 Stations

Stations will be constructed using cut-and-cover methods and/or TBM/SEM, depending on the station site. For cut-and-cover, the construction requires site preparation and site servicing, demolition of existing structures at some locations, excavation/grading and construction which can generate noise.

Noise from at-grade construction activities is assessed for the stations and associated staging areas listed in Section 1. GBN from TBM and SEM is assessed in Section 6.

4.3.4 Bridge Construction

Bridge construction is expected within the Project footprint at several areas such as Don River Crossing and grade separations. These components are all are considered as part of this construction assessment.

4.3.5 Construction of the Operations, Maintenance and Storage Facility

Construction of the OMSF requires site preparation, site servicing, excavation/grading, demolition of the existing structures, and construction of the OMSF building and tracks on the OMSF site.

4.3.6 Haul Routes

This conceptual assessment focuses on key construction areas required to facilitate Project development and does not consider supporting activities such as haul routes. The potential noise impact from haul routes will be assessed as the construction planning process occurs and more details on the routes are provided. The specific routes, truck volumes and scheduling will be assessed for potential noise impacts during construction and reviewed by Metrolinx for compliance with applicable limits as part of the planning and approval process.

4.3.7 Queen Street Streetcar Diversion

Portions of the Queen Street streetcar line on either side of Yonge Street will require detours to make way for construction work of the Ontario Line Queen station under the current TTC Queen station. All vehicles, including streetcars, are planned to be diverted off Queen Street for about four and a half years, from early 2023 into 2027. During this period, streetcars will run on special diversion routes on Richmond Street and Adelaide Street by way of York Street and Church Street, with additional track on Adelaide Street between York Street and Spadina Avenue. Figures A-4 through A-6 in Appendix A illustrate the area in which streetcar trackwork will occur for the Queen Street streetcar diversion.

The construction noise impact of the streetcar diversion is assessed in Section 4.5.2.1. The operational noise resulting from streetcar movements on these streets is assessed in Section 5.5.7.

4.4 Construction Assessment Methodology

This section describes the assessment methodology for the Project construction noise based on the construction activities described for the Project in Section 4.3. Equipment sound levels are determined using the MECP NPC-115 and NPC-118 limits and the US FTA Manual values where MECP limits are not available. The receptor-based noise assessment is conducted by comparing predicted sound levels at the receptors to the applicable noise limits for the receptors.

Potential noise impacts from construction equipment are assessed as per the applicable guidelines in Section 4.2.

Table 4-6 lists the expected construction equipment types and quantities for each of the construction activities discussed in Section 4.3. Equipment inventory along with acoustical usage factor (i.e., the fraction of time that any construction equipment operates in a given period) and sound levels utilized for this assessment are summarized in Table 4-6. Equipment sound levels for the assessment are adopted from the MECP guidelines and US FTA Manual.

Table 4-6. Construction Equipment Table – Sound Level, Usage Factor, Construction Phase, Construction Phase Equipment

Construction Equipment[1]	Sound Power Levels[2] (dBA)	Acoustical Usage Factor[3] (%)	Equipment Quantities Site Preparation[4]	Equipment Quantities Site Servicing	Equipment Quantities Demolition	Equipment Quantities Excavation/Grading	Equipment Quantities Structure	Equipment Quantities Trackwork	Equipment Quantities TBM Entry Shaft	Equipment Quantities TBM Exit Shaft
Auger	114	50	-	-	-	-	1	-	-	1/shaft
Backhoe	113	40	-	1	1	1	1	1	-	-
Chainsaw	110	20	1	-	-	-	-	-	-	-
Compactor	107	20	1	-	-	1	-	1	-	-
Compressor	98	40	-	1	1	-	1	-	-	-
Concrete Mix	113	40	-	-	-	-	1	-	-	-
Concrete Pump	107	20	-	-	-	-	1	-	-	-
Concrete Saw	115	20	-	1	1	-	-	-	-	-
Conveyor	93	100	-	-	-	-	-	-	1/portal	-
Conveyor Motor	107	100	-	-	-	-	-	-	2/portal	-
Crane	107	16	-	-	1	-	1	1	1/shaft	-
Dozer	113	40	1	-	1	1	-	-	-	1/shaft
Dump Truck	112	40	1	1	1	1	1	1	40/shaft	2/shaft
Front End Loader	113	40	1	1	-	1	-	-	1/shaft	-
Generator	111	50	-	-	1	-	1	-	1/shaft	-
Grader	113	40	1	-	-	1	-	-	-	-
Hoe Ram	112	10	-	-	1	-	-	-	-	-
Jack Hammer	110	20	-	1	1	1	-	-	-	-
Man Lift	110	20	-	-	1	-	1	-	-	-
Pavement Scarifier	110	20	-	-	1	-	-	-	-	-
Pumps	106	50	1	-	-	1	-	-	1/portal	-
Rail Saw	115	20	-	-	-	-	-	1	-	-
Rammed Aggregate	112	10	-	-	-	-	1	-	-	-

Construction Equipment[1]	Sound Power Levels[2] (dBA)	Acoustical Usage Factor[3] (%)	Equipment Quantities Site Preparation[4]	Equipment Quantities Site Servicing	Equipment Quantities Demolition	Equipment Quantities Excavation/Grading	Equipment Quantities Structure	Equipment Quantities Trackwork	Equipment Quantities TBM Entry Shaft	Equipment Quantities TBM Exit Shaft
Roller	110	20	1	-	-	1	-	-	-	-
Equalizer	110	40	-	-	-	-	-	1 (For At-Grade only)	-	-
Tamper	111	40	-	-	-	-	-		-	-
Spike Driver	102	20	-	-	-	-	-		-	-
Tie Cutter	109	20	-	-	-	-	-	1	-	-
Tie Handler	108	40	-	-	-	-	-	1	-	-
Tie Inserter	113	40	-	-	-	-	-	1	-	-
Transformer	91	100	-	-	-	-	-	-	1/shaft	-
Truck Hydrovac	113	40	-	-	-	-	-	-	2/shaft	
Tunnel Ventilation Fan	117	100	-	-	-	-	-	-	2/portal	-
Vibratory Concrete Mix	101	20	-	-	-	-	1	-	-	-

Notes:

1 Only 25% of the equipment is considered for small construction sites (e.g., stations between portals) as their footprint is not large enough to accommodate all equipment within the construction footprint.

2 Sound levels presented accounts for acoustical usage factor and is only applicable to construction noise. Equipment sound levels are determined using the MECP NPC-115 and NPC-118 limits and the US FTA Manual values where MECP limits are not available. Sound power level is the absolute (maximum) sound energy generated by the equipment. It is independent of the distance from the equipment.

3 Acoustic usage factor is the amount of time (%) the construction equipment is expected to operate in a given hour/day.

4 Site preparation is also applicable to Hydro One / Sewer Bypass Site Preparation in analysis

4.4.1 Assumptions

For the construction noise assessment, the following assumptions are noted:

- All construction equipment and activities are located within construction staging areas, shaft construction locations and along the track alignment that are all within the Project Footprint.
- The assessment adopts the US FTA Manual reference construction equipment noise levels
- Construction activities are estimated to occur 8 hours per day and 5 days per week, except for TBM/SEM operations. TBM is expected to operate two 12-hour shifts and 6 days per week with the 7th day as a maintenance day for the TBM and supporting equipment. SEM is expected to operate two 10-hour shifts and 5 days per week. Construction schedules are to be reviewed and finalized during detailed design.
- Although non-TBM/SEM construction activities are expected during daytime only, the noise impact is assessed for daytime and nighttime periods to cover the worst-case scenario.
- The types and quantity of construction equipment considered for each construction phase/activity are estimated as presented in Table 4-6. These are based on the OLTA's estimate of the construction equipment expected for each phase of construction.
- Impact pile driving is not expected to occur as a part of this Project construction. In the event that it is determined during construction planning that impact piling is required, an assessment will be done demonstrating the ability to operate while complying with applicable criteria prior to approval of the construction plan. Mitigations would then be implemented as required (e.g., noise shrouds).
- Only 25% of the equipment is considered for small construction sites (e.g., stations between portals) as their footprint is not large enough to accommodate all equipment within the construction footprint.
- The acoustical usage factor shown in Table 4-6 for the construction equipment is taken from US Federal Highway Administration Guide (US FHWA).

The potential noise impact from the haul routes will be assessed as the construction planning process occurs and more details on the routes are provided. The specific routes, truck volumes and scheduling will be assessed for potential noise impacts during the construction and reviewed by Metrolinx for compliance with applicable limits as part of the planning and approval process.

4.4.2 Construction Noise Assessment Methodology

Maximum construction equipment sound levels are based on the limits within MECP NPC-115 and NPC-118 as applicable. Equipment sound levels for equipment that is not identified in NPC-115 and NPC-118 are taken from the US FTA Manual. These sound levels are shown in Table 4-1.

Sound levels are predicted at the receptors for the receptor-based noise assessment and considers geometric spreading calculations (excluding ground topography) and duty cycles of construction equipment as provided in the US FTA Manual. The following formula is provided in the referenced documents:

$$L_{EQ\ (point\ of\ reception)} = SPL_{equipment\ @\ ref} - 20 * \log (D_{point\ of\ reception} / D_{ref}) + 10 * \log (D.C.)$$

Where:

- $L_{EQ\ (point\ of\ reception)}$ = sound level of the piece of equipment at the point of reception (dBA);
- $SPL_{equipment}$ = sound pressure level of the equipment at a reference distance (usually 15 m);
- $D_{point\ of\ reception}$ = straight line distance from equipment to point of reception (m);
- D_{ref} = reference distance provided in $SPL_{equipment}$ (m); and
- *D.C.* = fraction of time, or duty cycle, that a piece of equipment usually operates.

For noise assessments in Ontario, the daytime period corresponds to the 16-hour period between 07:00 and 23:00 and nighttime period corresponds to the 8-hour period between 23:00 and 07:00.

The daytime and nighttime sound levels at the PORs for various construction scenarios are calculated using Computer Aided Noise Abatement Software (Cadna/A) noise modelling software to account for the building screening effect. Cadna/A is an acoustic modelling software published by Datakustik GmbH and configured to implement the ISO 9613-2 environmental sound propagation algorithms. Ground absorption in the model is set to 0 as per the US FTA modelling practice. The predicted sound levels are compared with the limits in Table 4-2 for this assessment.

4.5 Potential Impacts, Mitigation Measures and Monitoring Activities

4.5.1 Construction Equipment Noise Emissions

Construction equipment used for the Project is expected to meet the MECP NPC-115 and NPC-118 requirements. Sound level limits from these documents have been used as maximum equipment sound levels where available. Construction equipment sound levels are taken from the US FTA Manual where MECP limits are not available.

Table 4-7 lists the construction equipment anticipated for the Project, and either the maximum sound level as per the NPC-115 and NPC-118 limits or their typical sound levels based on the US FTA Manual where equipment is not defined in the NPC guidelines. Equipment should be acquired based on meeting the MECP NPC-115 and NPC-119 noise limits, or the FTA sound levels identified in this assessment where not provided in the NPC guidelines.

Table 4-7. Construction Equipment Noise Emission Assessment

Type of Equipment	Maximum Sound Pressure Levels at 15 m (dBA) for Typical Construction Equipment[1]
Auger	85
Backhoe	85
Chainsaw	85
Compactor	82
Compressor	70
Concrete Mix	85
Concrete Pump	82
Concrete Saw	90
Crane	83
Dozer	85
Dump Truck	84
Excavator	85
Front End Loader	85
Generator	82
Grader	85
Hoe Ram	90
Jack Hammer	85
Man Lift	85
Pavement Scarifier	85
Pumps	77
Rail Saw	90
Rammed Aggregate	90
Roller	85

Type of Equipment	Maximum Sound Pressure Levels at 15 m (dBA) for Typical Construction Equipment[1]
Equalizer	82
Tamper	83
Spike Driver	77
Tie Cutter	84
Tie Handler	80
Tie Inserter	85
Transformer	60
Truck Hydrovac	85
Tunnel Ventilation Fan	85
Vibratory Concrete Mix	76

Note:

[1] Sound level limit based on MECP documents or as published in the US FTA Manual are used for the assessment. Similar equipment is considered for the equipment that is not listed in the Manual.

Prior to start of construction, noise emissions of the construction equipment considered for the Project should be reviewed with respect to the NPC-115 and NPC-118 limits. If they are expected to exceed the limits, noise control options should be investigated and implemented. Noise control options are discussed in the mitigation details in Section 4.5.3.

4.5.2 Unmitigated Construction Noise Impacts

A receptor-based noise assessment was completed for the Project in accordance with the US FTA Manual.

The construction phases summarized in Table 4-3 were assessed as per the methodology described in Section 4.4.2 for the receptor-based noise assessment for the Project. The construction phases and activities are defined conceptually to be conservative, allowing flexibility in reducing the potential for impacts, where warranted, as construction strategies are finalized. Unmitigated sound levels for all eight construction phases at the PORs were predicted and assessed with the US FTA noise limits provided in Section 4.2.3.

Construction activities are expected to occur 8 hours per day and 5 days per week, except for TBM/SEM operations. TBM is expected to operate two 12-hour shifts and 6 days per week with the 7th day as a maintenance day for the TBM and supporting equipment. SEM is expected to operate two 10-hour shifts and 5 days per week. The trackwork, tunneling and station excavation are the only construction phases to occur during the nighttime.

Unmitigated Project construction sound levels for day and night are summarized and assessed in Table 4-8. For the construction stages expected to occur during the daytime only, predicted exceedances over daytime limits are underlined. For construction stages that are expected to occur during the daytime and nighttime periods, predicted exceedances are marked as bold for nighttime exceedance, and both bold and underlined for if the daytime criteria is also exceeded.

Table 4-8. Unmitigated Construction Noise Assessment

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/ Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA)	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_RESD_001	66	65	73	66	66	66	**74**	-	80 / 70	Exhibition Station & Entry Portal
CR_INDT_002	69	68	67	69	69	69	72	-	90 / 90	
CR_comm_003	72	71	80	72	72	72	67	-	85 / 85	
CR_COMM_004	66	65	61	66	66	66	74	-	85 / 85	
CR_COMM_005	72	71	56	72	72	72	78	-	85 / 85	
CR_RESD_006	67	66	74	67	67	67	**74**	-	80 / 70	
CR_COMM_007	67	66	73	67	67	67	74	-	85 / 85	
CR_COMM_008	62	61	67	62	62	62	58	-	85 / 85	
CR_COMM_009	71	70	67	71	71	71	70	-	85 / 85	
CR_COMM_010	72	71	76	72	72	72	71	-	85 / 85	
CR_RESD_011	71	70	68	**71**	71	**71**	**74**	-	80 / 70	
CR_INST_012	69	68	61	**69**	69	**69**	**75**	-	75 / 65	
CR_RESD_013	71	70	56	**71**	71	**71**	**82**	-	80 / 70	
CR_RESD_014	71	70	42	**71**	71	-	**76**	-	80 / 70	
CR_RESD_015	69	68	54	69	69	-	**72**	-	80 / 70	
CR_INDT_016	62	61	41	62	62	-	55	-	90 / 90	
CR_RESD_017	60	59	42	60	60	-	60	-	80 / 70	
CR_INDT_018	72	71	35	72	72	-	40	-	90 / 90	
CR_RESD_019	74	73	75	**74**	74	-	-	-	80 / 70	Bathurst-King Station
CR_RESD_020	72	71	72	**72**	72	-	-	-	80 / 70	
CR_RESD_021	75	74	74	**75**	75	-	-	-	80 / 70	
CR_RESD_022	82	81	82	**82**	82	-	-	-	80 / 70	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/ Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA)	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_RESD_023	80	79	79	**80**	80	-	-	-	80 / 70	Queen-Spadina Station
CR_RESD_024	81	80	81	**81**	81	-	-	-	80 / 70	
CR_RESD_025	74	73	74	**74**	74	-	-	-	80 / 70	
CR_RESD_026	74	73	74	**74**	74	-	-	-	80 / 70	
CR_RESD_027	82	81	82	**82**	82	-	-	-	80 / 70	
CR_RESD_028	70	69	70	70	70	-	-	-	80 / 70	
CR_RESD_029	80	79	80	**80**	80	-	-	-	80 / 70	
CR_RESD_030	72	71	72	**72**	72	-	-	-	80 / 70	
CR_RESD_031	72	71	72	**72**	72	-	-	-	80 / 70	
CR_RESD_032	73	72	73	**73**	73	-	-	-	80 / 70	
CR_RESD_033	78	77	78	**78**	78	-	-	-	80 / 70	
CR_RESD_034	75	74	75	**75**	75	-	-	-	80 / 70	
CR_INDT_035	82	81	82	82	82	-	-	-	90 / 90	
CR_RESD_036	85	84	-	**85**	85	-	67	-	80 / 70	Osgoode Station
CR_COMM_037	76	75	-	76	76	-	68	-	85 / 85	
CR_RESD_038	82	81	-	**82**	82	-	45	-	80 / 70	
CR_RESD_038a	82	81	-	**82**	82	-	48	-	80 / 70	
CR_INST_039	76	75	-	**76**	76	-	**67**	-	75 / 65	
CR_RESD_040	71	70	-	**71**	71	-	**71**	-	80 / 70	
CR_RESD_041	70	69	-	70	70	-	68	-	80 / 70	
CR_INST_042	72	71	-	**72**	72	-	**71**	-	75 / 65	
CR_FSPC_043	70	69	-	**70**	70	-	**81**	-	75 / 65	
CR_INST_044	76	75	-	**76**	76	-	**71**	-	75 / 65	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/ Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA)	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_INDT_045	74	73	-	74	74	-	57	-	90 / 90	Queen Station
CR_RESD_046	74	73	-	**74**	74	-	58	-	80 / 70	
CR_INST_047	71	70	-	**71**	71	-	42	-	75 / 65	
CR_COMM_048	72	71	-	72	72	-	53	-	85 / 85	
CR_COMM_049	74	73	-	74	74	-	58	-	85 / 85	
CR_INDT_050	74	73	-	74	74	-	70	-	90 / 90	
CR_HOSP_051	74	73	-	**74**	74	-	**82**	-	75 / 65	
CR_HOSP_051	74	73	-	**74**	74	-	49	-	75 / 65	
CR_COMM_052	74	73	-	74	74	-	76	-	85 / 85	
CR_COMM_053	74	73	-	74	74	-	75	-	85 / 85	
CR_RESD_054	71	70	-	**71**	71	-	-	-	80 / 70	Moss Park Station
CR_INST_055	71	70	-	**71**	71	-	-	-	75 / 65	
CR_RESD_056	71	70	-	**71**	71	-	-	-	80 / 70	
CR_RESD_057	67	66	-	67	67	-	-	-	80 / 70	
CR_RESD_058	71	70	-	**71**	71	-	-	-	80 / 70	
CR_RCTR_059	74	73	-	74	74	-	-	-	85 / 85	
CR_RESD_060	70	69	-	70	70	-	-	-	80 / 70	
CR_RESD_061	69	68	-	69	69	-	-	-	80 / 70	
CR_RESD_062	66	65	-	66	66	-	-	-	80 / 70	
CR_RESD_063	67	66	-	67	67	-	-	-	80 / 70	
CR_RESD_064	71	70	-	**71**	71	-	-	-	80 / 70	
CR_RESD_065	71	70	-	**71**	71	-	-	-	80 / 70	
CR_RESD_066	68	67	-	68	68	-	-	-	80 / 70	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/ Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA)	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_RESD_067	75	74	73	**75**	75	-	**80**	-	80 / 70	Corktown Station (Entry Portal) and Don Yard
CR_INST_068	74	73	74	**74**	74	-	**81**	-	75 / 65	
CR_RESD_069	75	74	70	**75**	75	-	**77**	-	80 / 70	
CR_RESD_070	74	73	71	**74**	74	-	**77**	-	80 / 70	
CR_COMM_071	75	74	70	75	75	-	85	-	85 / 85	
CR_RESD_072	75	74	71	**75**	75	-	**85**	-	80 / 70	
CR_COMM_073	75	74	71	75	75	-	79	-	85 / 85	
CR_COMM_074	74	73	68	74	74	-	74	-	85 / 85	
CR_RESD_075	68	67	63	68	68	-	**75**	-	80 / 70	
CR_RESD_076	69	68	64	69	69	-	**77**	-	80 / 70	
CR_RESD_077	70	69	65	70	70	-	**82**	-	80 / 70	
CR_RESD_078	63	62	-	63	63	63	60	-	80 / 70	
CR_RESD_079	65	64	-	65	65	65	**72**	-	80 / 70	
CR_RESD_080	62	61	-	62	62	62	**76**	-	80 / 70	
CR_RESD_081	58	57	-	58	58	58	**76**	-	80 / 70	
CR_RESD_082	65	64	-	65	65	65	**74**	-	80 / 70	
CR_RESD_083	63	62	-	63	63	63	**77**	-	80 / 70	
CR_INDT_084	54	53	54	54	54	54	-	-	90 / 90	East Harbour Station
CR_INDT_085	71	70	58	71	71	71	-	-	90 / 90	
CR_INDT_086	58	57	57	58	58	58	-	-	90 / 90	
CR_INDT_087	73	72	57	73	73	73	-	-	90 / 90	
CR_COMM_088	65	64	66	65	65	65	-	-	85 / 85	
CR_INDT_089	68	67	73	68	68	68	-	-	90 / 90	
CR_COMM_089a	74	73	84	74	74	74		-	85 / 85	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/ Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA)	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_COMM_090	65	64	56	65	65	65	-	-	85 / 85	
CR_RESD_091	74	73	77	**74**	74	**74**	-	-	80 / 70	
CR_RESD_092	74	73	79	**74**	74	**74**	-	-	80 / 70	
CR_RESD_093	67	66	53	67	67	67	-	-	80 / 70	Riverside/Leslieville Station
CR_COMM_094	67	66	52	67	67	67	-	-	85 / 85	
CR_RESD_095	66	65	53	66	66	66	-	-	80 / 70	
CR_RESD_096	65	64	53	65	65	65	-	-	80 / 70	
CR_RESD_097	67	66	54	67	67	67	-	-	80 / 70	
CR_INST_098	66	65	52	**66**	66	**66**	-	-	75 / 65	
CR_RESD_099	65	64	47	65	65	65	-	-	80 / 70	
CR_RESD_100	63	62	56	63	63	63	-	-	80 / 70	Between Leslieville and Gerrard Station
CR_RESD_101	62	61	58	62	62	62	-	-	80 / 70	
CR_RESD_102	63	62	59	63	63	63	-	-	80 / 70	
CR_RESD_103	72	71	66	**72**	72	**72**	-	-	80 / 70	
CR_RESD_104	66	65	55	66	66	66	-	-	80 / 70	
CR_RESD_105	74	73	60	**74**	74	**74**	-	-	80 / 70	
CR_RESD_106	71	70	67	**71**	71	**71**	65	-	80 / 70	Gerrard Station & Entry Portal
CR_RESD_107	68	67	68	68	68	68	66	-	80 / 70	
CR_RESD_108	71	70	70	**71**	71	**71**	70	-	80 / 70	
CR_RESD_109	69	68	75	69	69	69	64	-	80 / 70	
CR_RESD_110	70	69	77	70	70	70	63	-	80 / 70	
CR_RESD_111	70	69	77	70	70	70	63	-	80 / 70	
CR_RESD_112	68	67	70	68	68	68	70	-	80 / 70	
CR_COMM_113	70	69	74	70	70	70	62	-	85 / 85	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/ Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA)	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_RESD_114	72	71	75	**72**	72	**72**	**75**	-	80 / 70	
CR_RESD_115	66	65	68	66	66	66	64	-	80 / 70	
CR_INDT_116	68	67	71	68	68	68	65	-	90 / 90	
CR_RESD_117	75	74	85	**75**	75	**75**	67	-	80 / 70	
CR_RESD_118	73	72	78	**73**	73	**73**	66	-	80 / 70	
CR_COMM_119	70	69	68	70	70	70	57	-	85 / 85	
CR_RESD_120	70	69	77	70	70	70	**74**	-	80 / 70	
CR_COMM_121	65	64	68	65	65	65	71	-	85 / 85	
CR_COMM_122	68	67	72	68	68	68	72	-	85 / 85	
CR_RESD_123	73	72	81	**73**	73	**73**	**72**	-	80 / 70	
CR_RESD_124	72	71	81	**72**	72	**72**	**82**	-	80 / 70	
CR_RESD_125	72	71	76	**72**	72	**72**	**86**	-	80 / 70	
CR_RESD_126	73	72	77	**73**	73	**73**	**88**	-	80 / 70	
CR_RESD_127	73	72	77	**73**	73	**73**	**90**	-	80 / 70	
CR_RESD_128	70	69	75	70	70	70	**89**	-	80 / 70	
CR_RESD_128a	70	69	68	70	70	70	**75**	-	80 / 70	
CR_RESD_128b	70	69	57	70	70	70	70	-	80 / 70	
CR_INST_129	67	66	74	**67**	67	**67**	**82**	-	75 / 65	
CR_RESD_130	89	88	59	**89**	89	-	-	-	80 / 70	Between Gerrard & Pape Station
CR_COMM_131	86	85	67	**86**	86	-	68	-	85 / 85	Pape Station & Entry / Exit Portal
CR_RESD_132	63	62	67	63	63	-	**73**	-	80 / 70	
CR_RESD_133	67	66	72	67	67	-	**80**	-	80 / 70	
CR_RESD_134	72	71	77	**72**	72	-	**81**	-	80 / 70	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/ Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA)	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_COMM_135	72	71	76	72	72	-	76	-	85 / 85	
CR_RESD_136	73	72	76	**73**	73	-	**76**	-	80 / 70	
CR_COMM_137	76	75	80	76	76	-	79	-	85 / 85	
CR_COMM_138	76	75	80	76	76	-	83	-	85 / 85	
CR_RESD_139	73	72	75	**73**	73	-	**76**	-	80 / 70	
CR_RESD_140	78	77	77	**78**	78	-	**79**	-	80 / 70	
CR_RESD_141	79	78	66	**79**	79	-	67	-	80 / 70	
CR_RESD_142	79	78	66	**79**	79	-	66	-	80 / 70	
CR_RESD_143	84	83	66	**84**	84	-	65	-	80 / 70	
CR_RESD_144	75	74	59	**75**	75	-	61	-	80 / 70	
CR_RESD_145	76	75	86	**76**	76	-	**74**	-	80 / 70	
CR_RESD_146	76	75	84	**76**	76	-	**74**	-	80 / 70	
CR_RESD_147	77	76	88	**77**	77	-	**77**	-	80 / 70	
CR_RESD_148	76	75	85	**76**	76	-	**78**	-	80 / 70	
CR_RESD_149	77	76	-	**77**	77	-	-	-	80 / 70	Between Pape and Cosburn Stations
CR_RESD_150	80	79	-	**80**	80	-	-	-	80 / 70	
CR_RESD_151	80	79	-	**80**	80	-	-	-	80 / 70	
CR_RESD_152	81	80	-	**81**	81	-	-	-	80 / 70	
CR_RESD_153	80	79	-	**80**	80	-	-	-	80 / 70	
CR_RESD_154	79	78	-	**79**	79	-	-	-	80 / 70	
CR_RESD_155	78	77	-	**78**	78	-	-	-	80 / 70	
CR_RESD_156	76	75	78	**76**	76	-	-	-	80 / 70	Cosburn Station
CR_RESD_157	74	73	76	**74**	74	-	-	-	80 / 70	
CR_RESD_158	73	72	76	**73**	73	-	-	-	80 / 70	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/ Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA)	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_RESD_159	73	72	75	**73**	73	-	-	-	80 / 70	
CR_RESD_160	72	71	75	**72**	72	-	-	-	80 / 70	
CR_RESD_161	74	73	75	**74**	74	-	-	-	80 / 70	
CR_RESD_162	72	71	74	**72**	72	-	-	-	80 / 70	
CR_RESD_163	70	69	72	70	70	-	-	-	80 / 70	
CR_RESD_164	66	65	69	66	66	-	-	-	80 / 70	
CR_RESD_165	70	69	70	70	70	-	-	-	80 / 70	North of Cosburn Station
CR_RESD_166	73	72	76	**73**	73	-	-	-	80 / 70	
CR_RESD_167	79	78	70	**79**	79	-	-	-	80 / 70	
CR_RESD_168	78	77	76	**78**	78	-	-	-	80 / 70	
CR_RESD_169	80	79	79	**80**	80	-	-	-	80 / 70	
CR_RESD_170	74	73	71	**74**	74	-	-	-	80 / 70	
CR_RESD_171	76	75	74	**76**	76	**76**	**77**	61	80 / 70	Exit Portal (Minton Pl)
CR_RESD_172	79	78	76	**79**	79	**79**	**80**	61	80 / 70	
CR_RESD_173	76	75	74	**76**	76	**76**	**79**	64	80 / 70	
CR_RESD_174	83	82	85	**83**	83	**83**	**83**	62	80 / 70	
CR_INST_174a	65	64	52	65	65	65	-	72	75 / 65	
CR_RESD_175	69	68	66	69	69	69	-	59	80 / 70	Overlea Station & Elevated Corridor
CR_INDT_176	72	71	56	72	72	72	-	53	90 / 90	
CR_INDT_177	72	71	57	72	72	72	-	55	90 / 90	
CR_INDT_178	71	70	62	71	71	71	-	52	90 / 90	
CR_RESD_179	70	69	60	70	70	70	-	56	80 / 70	
CR_RESD_180	67	66	63	67	67	67	-	60	80 / 70	
CR_RESD_181	69	68	68	69	69	69	-	59	80 / 70	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/ Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA)	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_RESD_182	69	68	70	69	69	69	-	59	80 / 70	
CR_INDT_183	71	70	69	71	71	71	-	69	90 / 90	
CR_COMM_184	69	68	73	69	69	69	-	62	85 / 85	
CR_COMM_185	70	69	75	70	70	70	-	63	85 / 85	
CR_COMM_186	73	72	75	73	73	73	-	65	85 / 85	
CR_COMM_187	64	63	63	64	64	64	-	63	85 / 85	
CR_COMM_188	63	62	62	63	63	63	-	64	85 / 85	
CR_INDT_189	70	69	78	70	70	70	-	61	90 / 90	OMSF
CR_INDT_190	70	69	74	70	70	70	-	62	90 / 90	
CR_COMM_191	66	65	71	66	66	66	-	59	85 / 85	
CR_INDT_192	71	70	75	71	71	71	-	62	90 / 90	
CR_INDT_193	67	66	67	67	67	67	-	66	90 / 90	
CR_INDT_194	70	69	66	70	70	70	-	68	90 / 90	
CR_INST_194a	65	64	63	65	65	65		63	75 / 65	
CR_INST_195	60	59	-	60	60	60	-	59	75 / 65	Flemingdon Park Station & Elevated Corridor
CR_RESD_196	59	58	-	59	59	59	-	67	80 / 70	
CR_COMM_196a	59	58	-	59	59	59		65	85 / 85	
CR_COMM_197	67	66	-	67	67	67	-	49	85 / 85	
CR_RESD_198	67	66	-	67	67	67	-	56	80 / 70	
CR_RESD_199	67	66	-	67	67	67	-	53	80 / 70	
CR_INST_200	62	61	-	62	62	62	-	53	75 / 65	
CR_INST_201	52	51	-	52	52	52	-	46	75 / 65	
CR_INST_202	64	63	-	64	64	64	-	55	75 / 65	
CR_INST_203	67	66	-	**67**	67	**67**	-	48	75 / 65	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/ Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA)	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_RESD_204	66	65	-	66	66	66	-	51	80 / 70	
CR_RESD_205	67	66	-	67	67	67	-	51	80 / 70	
CR_RESD_206	67	66	56	67	67	67	-	-	80 / 70	Ontario Science Centre Station & Elevated Corridor
CR_INST_207	74	73	58	**74**	74	**74**	-	-	75 / 65	
CR_COMM_208	76	75	54	76	76	76	-	-	85 / 85	
CR_INDT_209	70	69	64	70	70	70	-	-	90 / 90	

Notes:

1 Corresponding addresses for these PORs are included in Appendix E.

2 US FTA Criteria

3 Criteria for institutional receptors are considered as 5 dB less than the criteria for residential receptors.

4 Bold indicates exceedance of nighttime limits, Underline indicates exceedance of daytime limits.

Unmitigated sound levels at the highlighted receptors are expected to exceed the criteria limits for the indicated construction phases. The impacted receptors are mostly residential and institutional receptors surrounding the construction site. Impacted areas that need mitigation are highlighted in Figures F-1-1 to F-1-22 in Appendix F. Construction noise mitigation to address the identified exceedances is discussed in Section 4.5.3.

4.5.2.1 Queen Street Streetcar Diversion Construction Noise Impact

Based on current understanding of the construction required for the Queen streetcar diversion, a noise assessment was carried out for representative areas within the footprint. It was assumed that construction will be restricted to daytime and that a combination of equipment such as jackhammers, bulldozers and excavators may operate simultaneously within a construction zone, moving around the zone as needed to complete the stages of construction. Noise propagation calculations were done for typical setbacks along the route at residential receptor heights on the second or third floor (i.e., above entrance lobbies or retail/commercial spaces). The assessment predicts that construction noise for the streetcar tracks along the diversion route will meet daytime construction noise limits for residential receptors (see Table 4-2).

4.5.3 Construction Noise Mitigation

Based on the results of the receptor-based construction noise assessment, construction noise mitigation measures are recommended to reduce or eliminate negative potential effects at the PORs. The areas that are recommended for noise mitigation during construction are highlighted in Figures F-1-1 to F-1-22 in Appendix F.

Noise barriers in place of construction hoarding are a typical noise mitigation for construction sites. Noise barriers that are 5 m high are recommended for the Project construction at all locations, and at a minimum where unmitigated results predicted an exceedance. Taller barriers may be impractical to build (structurally or cost-prohibitive) to address the upper levels of high-rise or institutional buildings and are not considered in this assessment. To be considered as a noise barrier, the barrier hoarding should have a minimum surface density (mass per unit of face area) of 20 kg/m^2 (4 lb/ft^2) or an acoustic performance of STC 32 (per CSA-Z107.9-00) and be free of gaps and cracks. Typical noise barrier installations as hoarding are presented in Appendix J. Additional recommended measures include mitigation for some fans, generators and conveyors including:

- Enclosed conveyors and drives are recommended for moving spoils from tunnels to storage area at the construction site.
- Ventilation fans with silencers for tunnels during TBM operations. The overall sound power level of the ventilation fans with silencer should be limited to 107 dBA.
- Generators with acoustic enclosure and silencers for TBM operations. The overall sound pressure level of the generators should be limited to 82 dBA at 15 m.
- Quieter hydrovac trucks for soil conditioning at the entry shaft for tunneling operations. The overall sound pressure level of the hydrovac should be limited to 85 dBA at 15 m.

These additional mitigation measures were assumed to be applied as needed to meet the noise limits at each receptor (with less mitigation needed in cases where limits are more easily met), or to reduce the potential noise impact to the extent possible.

With the recommended 5-m high noise barriers as well as the noted additional mitigation measures, sound levels are expected to meet the US FTA criteria limits at the modelled receptors, except at 4 locations during the daytime and 7 locations during the night. A total of 3 locations show daytime exceedances, and 5 locations show nighttime exceedances, that are considered minor (5 dB or less) over the criteria, such that additional physical and/or operational mitigations should address them (see Appendix K). The physical and/or operational mitigations are not provided in the modelling due to the complexity of interaction in modelling combinations of these mitigations; thus the general approach is to consider implementing these mitigations as required on a more detailed site-by-site constructability approach as design advances. There are two locations with higher exceedances (more than 5 dB) above the criteria during nighttime construction, and one location with higher exceedances above the criteria during daytime construction, such that more stringent physical and/or operational mitigations would be required to meet the identified limits.

Potential noise impacts after the application of these construction noise mitigation measures are provided in Table 4-9. For the construction stages expected to occur during the daytime only, predicted exceedances over daytime limits are underlined. For construction stages that are expected to occur during the daytime and nighttime periods, predicted exceedances are marked as bold for nighttime exceedance, and both bold and underlined for if the daytime criteria is also exceeded.

Table 4-9. Mitigated Construction Sound Levels

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA))	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_RESD_001	64	63	66	64	64	64	70	-	80 / 70	Exhibition Station & Entry Portal
CR_INDT_002	69	68	67	69	69	69	63	-	90 / 90	
CR_comm_003	72	71	80	72	72	72	58	-	85 / 85	
CR_COMM_004	66	65	61	66	66	66	67	-	85 / 85	
CR_COMM_005	72	71	56	72	72	72	69	-	85 / 85	
CR_RESD_006	60	59	65	60	60	60	68	-	80 / 70	
CR_COMM_007	57	56	62	57	57	57	63	-	85 / 85	
CR_COMM_008	62	61	67	62	62	62	51	-	85 / 85	
CR_COMM_009	71	70	67	71	71	71	61	-	85 / 85	
CR_COMM_010	72	71	76	72	72	72	62	-	85 / 85	
CR_RESD_011	70	69	68	70	70	70	65	-	80 / 70	
CR_INST_012	67	66	61	**67**	67	**67**	**66**	-	75 / 65	
CR_RESD_013	71	70	55	**71**	71	**71**	**78**	-	80 / 70	
CR_RESD_014	70	69	42	70	70	-	70	-	80 / 70	
CR_RESD_015	69	68	53	69	69	-	66	-	80 / 70	
CR_INDT_016	62	61	40	62	62	-	49	-	90 / 90	
CR_RESD_017	60	59	40	60	60	-	53	-	80 / 70	
CR_INDT_018	72	71	35	72	72	-	34	-	90 / 90	
CR_RESD_019	69	68	69	69	69	-	-	-	80 / 70	Bathurst-King Station
CR_RESD_020	65	64	64	65	65	-	-	-	80 / 70	
CR_RESD_021	69	68	70	69	69	-	-	-	80 / 70	
CR_RESD_022	82	81	82	**82**	82	-	-	-	80 / 70	
CR_RESD_023	79	78	79	**79**	79	-	-	-	80 / 70	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA))	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_RESD_024	81	80	81	**81**	81	-	-	-	80 / 70	
CR_RESD_025	66	65	65	66	66	-	-	-	80 / 70	
CR_RESD_026	68	67	67	68	68	-	-	-	80 / 70	
CR_RESD_027	70	69	69	70	70	-	-	-	80 / 70	Queen-Spadina Station
CR_RESD_028	65	64	66	65	65	-	-	-	80 / 70	
CR_RESD_029	78	77	78	**78**	78	-	-	-	80 / 70	
CR_RESD_030	63	62	62	63	63	-	-	-	80 / 70	
CR_RESD_031	63	62	63	63	63	-	-	-	80 / 70	
CR_RESD_032	62	61	63	62	62	-	-	-	80 / 70	
CR_RESD_033	75	74	75	**75**	75	-	-	-	80 / 70	
CR_RESD_034	73	72	72	**73**	73	-	-	-	80 / 70	
CR_INDT_035	72	71	72	72	72	-	-	-	90 / 90	
CR_RESD_036	83	82	-	**83**	83	-	67	-	80 / 70	Osgoode Station
CR_COMM_037	73	72	-	73	73	-	65	-	85 / 85	
CR_RESD_038	78	77	-	**78**	78	-	45	-	80 / 70	
CR_RESD_38a	67	66	-	67	67	-	45	-	80 / 70	
CR_INST_039	72	71	-	**72**	72	-	**67**	-	75 / 65	
CR_RESD_040	68	67	-	68	68	-	**71**	-	80 / 70	
CR_RESD_041	67	66	-	67	67	-	68	-	80 / 70	
CR_INST_042	65	64	-	65	65	-	**69**	-	75 / 65	
CR_FSPC_043	69	68	-	**69**	69	-	**77**	-	75 / 65	
CR_INST_044	75	74	-	**75**	75	-	**71**	-	75 / 65	
CR_INDT_045	73	72	-	73	73	-	54	-	90 / 90	Queen Station
CR_RESD_046	74	73	-	**74**	74	-	55	-	80 / 70	
CR_INST_047	70	69	-	**70**	70	-	42	-	75 / 65	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA))	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_COMM_048	72	71	-	72	72	-	53	-	85 / 85	
CR_COMM_049	74	73	-	74	74	-	56	-	85 / 85	
CR_INDT_050	74	73	-	74	74	-	70	-	90 / 90	
CR_HOSP_051	74	73	-	**74**	74	-	**<u>82</u>**	-	75 / 65	
CR_HOSP_051a	64	63	-	64	64	-	49	-	75 / 65	
CR_COMM_052	74	73	-	74	74	-	76	-	85 / 85	
CR_COMM_053	74	73	-	74	74	-	75	-	85 / 85	
CR_RESD_054	69	68	-	69	69	-	-	-	80 / 70	Moss Park Station
CR_INST_055	64	63	-	64	64	-	-	-	75 / 65	
CR_RESD_056	68	67	-	68	68	-	-	-	80 / 70	
CR_RESD_057	65	64	-	65	65	-	-	-	80 / 70	
CR_RESD_058	69	68	-	69	69	-	-	-	80 / 70	
CR_RCTR_059	74	73	-	74	74	-	-	-	85 / 85	
CR_RESD_060	68	67	-	68	68	-	-	-	80 / 70	
CR_RESD_061	68	67	-	68	68	-	-	-	80 / 70	
CR_RESD_062	66	65	-	66	66	-	-	-	80 / 70	
CR_RESD_063	67	66	-	67	67	-	-	-	80 / 70	
CR_RESD_064	64	63	-	64	64	-	-	-	80 / 70	
CR_RESD_065	69	68	-	69	69	-	-	-	80 / 70	
CR_RESD_066	68	67	-	68	68	-	-	-	80 / 70	
CR_RESD_067	68	67	67	68	68	-	70	-	80 / 70	Corktown Station (Entry Portal) and Don Yard
CR_INST_068	67	66	65	**67**	67	-	**66**	-	75 / 65	
CR_RESD_069	72	71	69	**72**	72	-	**71**	-	80 / 70	
CR_RESD_070	69	68	64	69	69	-	67	-	80 / 70	
CR_COMM_071	68	67	64	68	68	-	76	-	85 / 85	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA))	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_RESD_072	67	66	64	67	67	-	**75**	-	80 / 70	
CR_COMM_073	68	67	65	68	68	-	69	-	85 / 85	
CR_COMM_074	71	70	68	71	71	-	70	-	85 / 85	
CR_RESD_075	66	65	63	66	66	-	**72**	-	80 / 70	
CR_RESD_076	67	66	64	67	67	-	**73**	-	80 / 70	
CR_RESD_077	68	67	65	68	68	-	**75**	-	80 / 70	
CR_RESD_078	63	62	-	63	63	63	60	-	80 / 70	
CR_RESD_079	65	64	-	65	65	65	67	-	80 / 70	
CR_RESD_080	62	61	-	62	62	62	69	-	80 / 70	
CR_RESD_081	58	57	-	58	58	58	68	-	80 / 70	
CR_RESD_082	65	64	-	65	65	65	68	-	80 / 70	
CR_RESD_083	63	62	-	63	63	63	**72**	-	80 / 70	
CR_INDT_084	54	53	54	54	54	54	-	-	90 / 90	East Harbour Station
CR_INDT_085	71	70	58	71	71	71	-	-	90 / 90	
CR_INDT_086	58	57	57	58	58	58	-	-	90 / 90	
CR_INDT_087	73	72	57	73	73	73	-	-	90 / 90	
CR_COMM_088	65	64	66	65	65	65	-	-	85 / 85	
CR_INDT_089	68	67	73	68	68	68	-	-	90 / 90	
CR_COMM_089a	74	73	84	74	74	74	-	-	85 / 85	
CR_COMM_090	65	64	56	65	65	65	-	-	85 / 85	
CR_RESD_091	57	56	60	57	57	57	-	-	80 / 70	
CR_RESD_092	57	56	71	57	57	57	-	-	80 / 70	
CR_RESD_093	57	56	51	57	57	57	-	-	80 / 70	Riverside/Leslieville Station
CR_COMM_094	67	66	51	67	67	67	-	-	85 / 85	
CR_RESD_095	63	62	52	63	63	63	-	-	80 / 70	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA))	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_RESD_096	65	64	53	65	65	65	-	-	80 / 70	
CR_RESD_097	67	66	53	67	67	67	-	-	80 / 70	
CR_INST_098	60	59	51	60	60	60	-	-	75 / 65	
CR_RESD_099	65	64	46	65	65	65	-	-	80 / 70	
CR_RESD_100	63	62	54	63	63	63	-	-	80 / 70	Between Leslieville and Gerrard Station
CR_RESD_101	62	61	56	62	62	62	-	-	80 / 70	
CR_RESD_102	62	61	55	62	62	62	-	-	80 / 70	
CR_RESD_103	63	62	59	63	63	63	-	-	80 / 70	
CR_RESD_104	62	61	49	62	62	62	-	-	80 / 70	
CR_RESD_105	59	58	58	59	59	59	-	-	80 / 70	
CR_RESD_106	65	64	62	65	65	65	63	-	80 / 70	Gerrard Station & Entry Portal
CR_RESD_107	67	66	64	67	67	67	65	-	80 / 70	
CR_RESD_108	65	64	63	65	65	65	66	-	80 / 70	
CR_RESD_109	68	67	75	68	68	68	56	-	80 / 70	
CR_RESD_110	69	68	77	69	69	69	56	-	80 / 70	
CR_RESD_111	70	69	77	70	70	70	52	-	80 / 70	
CR_RESD_112	68	67	70	68	68	68	66	-	80 / 70	
CR_COMM_113	70	69	74	70	70	70	58	-	85 / 85	
CR_RESD_114	63	62	65	63	63	63	61	-	80 / 70	
CR_RESD_115	61	60	63	61	61	61	60	-	80 / 70	
CR_INDT_116	60	59	63	60	60	60	58	-	90 / 90	
CR_RESD_117	64	63	74	64	64	64	55	-	80 / 70	
CR_RESD_118	66	65	70	66	66	66	60	-	80 / 70	
CR_COMM_119	66	65	61	66	66	66	52	-	85 / 85	
CR_RESD_120	65	64	71	65	65	65	66	-	80 / 70	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA))	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_COMM_121	60	59	68	60	60	60	62	-	85 / 85	
CR_COMM_122	67	66	71	67	67	67	66	-	85 / 85	
CR_RESD_123	63	62	71	63	63	63	61	-	80 / 70	
CR_RESD_124	65	64	72	65	65	65	67	-	80 / 70	
CR_RESD_125	71	70	76	**71**	71	**71**	**77**	-	80 / 70	
CR_RESD_126	65	64	70	65	65	65	**71**	-	80 / 70	
CR_RESD_127	64	63	64	64	64	64	68	-	80 / 70	
CR_RESD_128	69	68	75	69	69	69	**72**	-	80 / 70	
CR_RESD_128a	67	66	63	67	67	67	60	-	80 / 70	
CR_RESD_128b	59	58	54	59	59	59	53	-	80 / 70	
CR_INST_129	69	68	71	**69**	69	**69**	**71**	-	75 / 65	
CR_RESD_130	77	76	46	**77**	77	-	-	-	80 / 70	Between Gerrard & Pape Station
CR_COMM_131	76	75	61	76	76	-	61	-	85 / 85	Pape Station & Entry / Exit Portal
CR_RESD_132	60	59	62	60	60	-	59	-	80 / 70	
CR_RESD_133	61	60	65	61	61	-	66	-	80 / 70	
CR_RESD_134	65	64	70	65	65	-	68	-	80 / 70	
CR_COMM_135	61	60	65	61	61	-	62	-	85 / 85	
CR_RESD_136	68	67	69	68	68	-	67	-	80 / 70	
CR_COMM_137	71	70	74	71	71	-	69	-	85 / 85	
CR_COMM_138	76	75	79	76	76	-	82	-	85 / 85	
CR_RESD_139	69	68	72	69	69	-	70	-	80 / 70	
CR_RESD_140	70	69	70	70	70	-	70	-	80 / 70	
CR_RESD_141	75	74	66	**75**	75	-	66	-	80 / 70	
CR_RESD_142	69	68	60	69	69	-	57	-	80 / 70	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA))	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_RESD_143	73	72	59	**73**	73	-	53	-	80 / 70	
CR_RESD_144	72	71	58	**72**	72	-	58	-	80 / 70	
CR_RESD_145	64	63	74	64	64	-	61	-	80 / 70	
CR_RESD_146	66	65	74	66	66	-	63	-	80 / 70	
CR_RESD_147	69	68	77	69	69	-	**71**	-	80 / 70	
CR_RESD_148	69	68	76	69	69	-	**76**	-	80 / 70	
CR_RESD_149	68	67	-	68	68	-	-	-	80 / 70	Between Pape and Cosburn Stations
CR_RESD_150	70	69	-	70	70	-	-	-	80 / 70	
CR_RESD_151	68	67	-	68	68	-	-	-	80 / 70	
CR_RESD_152	62	61	-	62	62	-	-	-	80 / 70	
CR_RESD_153	71	70	-	**71**	71	-	-	-	80 / 70	
CR_RESD_154	69	68	-	69	69	-	-	-	80 / 70	
CR_RESD_155	68	67	-	68	68	-	-	-	80 / 70	
CR_RESD_156	67	66	69	67	67	-	-	-	80 / 70	Cosburn Station
CR_RESD_157	73	72	76	**73**	73	-	-	-	80 / 70	
CR_RESD_158	65	64	69	65	65	-	-	-	80 / 70	
CR_RESD_159	69	68	72	69	69	-	-	-	80 / 70	
CR_RESD_160	64	63	67	64	64	-	-	-	80 / 70	
CR_RESD_161	74	73	75	**74**	74	-	-	-	80 / 70	
CR_RESD_162	61	60	64	61	61	-	-	-	80 / 70	
CR_RESD_163	57	56	60	57	57	-	-	-	80 / 70	
CR_RESD_164	60	59	63	60	60	-	-	-	80 / 70	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA))	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_RESD_165	70	69	70	70	70	-	-	-	80 / 70	North of Cosburn Station
CR_RESD_166	73	72	76	**73**	73	-	-	-	80 / 70	
CR_RESD_167	79	78	70	**79**	79	-	-	-	80 / 70	
CR_RESD_168	78	77	76	**78**	78	-	-	-	80 / 70	
CR_RESD_169	80	79	79	**80**	80	-	-	-	80 / 70	
CR_RESD_170	74	73	71	**74**	74	-	-	-	80 / 70	
CR_RESD_171	70	69	68	70	70	70	**71**	56	80 / 70	Exit Portal (Minton Pl)
CR_RESD_172	69	68	68	69	69	69	**74**	59	80 / 70	
CR_RESD_173	68	67	68	68	68	68	**73**	64	80 / 70	
CR_RESD_174	71	70	73	**71**	71	**71**	**72**	53	80 / 70	
CR_INST_174a	58	57	46	58	58	58	-	64	75 / 65	
CR_RESD_175	69	68	66	69	69	69	-	59	80 / 70	Overlea Station & Elevated Corridor
CR_INDT_176	72	71	56	72	72	72	-	53	90 / 90	
CR_INDT_177	72	71	57	72	72	72	-	55	90 / 90	
CR_INDT_178	71	70	62	71	71	71	-	52	90 / 90	
CR_RESD_179	70	69	60	70	70	70	-	56	80 / 70	
CR_RESD_180	67	66	63	67	67	67	-	60	80 / 70	
CR_RESD_181	69	68	68	69	69	69	-	59	80 / 70	
CR_RESD_182	69	68	70	69	69	69	-	59	80 / 70	
CR_INDT_183	71	70	69	71	71	71	-	69	90 / 90	
CR_COMM_184	69	68	73	69	69	69	-	62	85 / 85	
CR_COMM_185	70	69	75	70	70	70	-	63	85 / 85	
CR_COMM_186	73	72	75	73	73	73	-	65	85 / 85	
CR_COMM_187	64	63	63	64	64	64	-	63	85 / 85	
CR_COMM_188	63	62	62	63	63	63	-	64	85 / 85	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA))	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_INDT_189	70	69	78	70	70	70	-	61	90 / 90	OMSF
CR_INDT_190	70	69	74	70	70	70	-	62	90 / 90	
CR_COMM_191	66	65	71	66	66	66	-	59	85 / 85	
CR_INDT_192	71	70	75	71	71	71	-	62	90 / 90	
CR_INDT_193	67	66	67	67	67	67	-	66	90 / 90	
CR_INDT_194	70	69	66	70	70	70	-	68	90 / 90	
CR_INST_194a	65	64	63	65	65	65	-	63	75 / 65	
CR_INST_195	59	58	-	59	59	59	-	59	75 / 65	Flemingdon Park Station & Elevated Corridor
CR_RESD_196	59	58	-	59	59	59	-	67	80 / 70	
CR_COMM_196a	59	58	-	59	59	59	-	65	85 / 85	
CR_COMM_197	67	66	-	67	67	67	-	49	85 / 85	
CR_RESD_198	67	66	-	67	67	67	-	56	80 / 70	
CR_RESD_199	67	66	-	67	67	67	-	53	80 / 70	
CR_INST_200	62	61	-	62	62	62	-	53	75 / 65	
CR_INST_201	51	50	-	51	51	51	-	46	75 / 65	
CR_INST_202	64	63	-	64	64	64	-	55	75 / 65	
CR_INST_203	62	61	-	62	62	62	-	47	75 / 65	
CR_RESD_204	66	65	-	66	66	66	-	51	80 / 70	
CR_RESD_205	67	66	-	67	67	67	-	51	80 / 70	

POR ID[1]	Site Preparation (Day, dBA)	Site Servicing (Day, dBA)	Demolition (Day, dBA)	Excavation/Grading (Day/Night, dBA)	Structure (Day, dBA)	Trackwork (Day/Night, dBA))	Tunneling (Day/Night, dBA)	Hydro One / Sewer Bypass Site Preparation (Day, dBA)	Day / Night Criteria (dBA)[2, 3]	Receptor Area
CR_RESD_206	67	66	56	67	67	67	-	-	80 / 70	Ontario Science Centre Station & Elevated Corridor
CR_INST_207	59	58	44	59	59	59	-	-	75 / 65	
CR_COMM_208	76	75	52	76	76	76	-	-	85 / 85	
CR_INDT_209	70	69	64	70	70	70	-	-	90 / 90	

Notes:
1 Corresponding addresses for these PORs are included in Appendix E.
2 US FTA Criteria
3 Criteria for institutional receptors are considered as 5 dB less than the criteria for residential receptors.
4 Bold indicates exceedance of nighttime limits, Underline indicates exceedance of daytime limits.

Based on the results of Table 4-9, the application of 5 m noise barriers and the following mitigation noted below will not be sufficient to meet the identified limits in all cases. For the receptors with exceedences, additional mitigation will need to be considered, and should include:

- Refinement of the conservative construction scenarios used in this assessment should be completed to optimize site specific construction activities. This should include consideration of equipment selection, duration and location of use, and reduction of activity during the night or in locations where exceedances are predicted.
- Construction controls such as the use of quieter equipment, equipment enclosure, and equipment silencers should be applied.

Best construction practices for the Project are summarized in Appendix K. With the additional mitigation identified above, it should be feasible to meet the identified noise limits.

A detailed construction noise assessment and management plan should be completed based on the actual location of the equipment and manufacturer's sound levels to identify the specific mitigation required for each location and to ensure that the noise limits are met for the Project construction.

Monitoring is recommended for the receptors indicated and is discussed in Section 4.5.4.

4.5.4 Construction Monitoring

A Construction Noise Management Plan should be developed that will incorporate the following recommendations for noise monitoring and addressing noise complaints:

- 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 measures(s) effectiveness.
- Continuous noise monitoring should be completed at each geographically distinct active construction site associated with the Project, which have been identified in Figures F-2-1 through F-2-22 of the report. Monitor(s) are to be 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 recommendations are provided in more detail in Appendix L.
- Monitoring at locations where there are persistent complaints, as required.

A Communication and Complaint Protocol should be established for the Project.

4.5.5 Permits and Approvals

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 City of Toronto to incorporate municipal requirements as a best practice, where practical.

4.5.6 Summary of Potential Impacts, Mitigation Measures and Monitoring Activities

Table 4-10 summarizes the mitigation measures and monitoring activities discussed in this Section 4.

Table 4-10. Summary of Potential Impacts, Mitigation and Monitoring for Construction Noise

Environmental Component	Potential Impact	Mitigation Measure(s)	Monitoring
Construction Noise	Environmental noise may cause annoyance and disturb activities. The severity of the noise impacts resulting from construction projects varies, depending on: • Scale, location and complexity of the project • Construction methods, processes and equipment deployed • Duration and time of construction near noise receptors (days and time of construction) • Number and proximity of noise-sensitive sites to construction area(s)	**Construction Equipment Noise Emissions:** Equipment should be acquired based on MECP NPC-115 and NPC-118 to ensure acceptable construction equipment noise levels are maintained for the project. **Receptor-Based Assessment:** Impacted areas that need mitigation are highlighted on Figures F-1-1 through F-1-22 (Appendix F). The following recommendations for construction are proposed: • Noise barriers with a minimum height of 5 m in place of construction hoarding are recommended as primary means of control. The noise barrier hoarding should have a minimum surface density (mass per unit of face area) of 20 kg/m^2 (4 lb/ft^2) or an acoustic performance of STC 32 (per CSA-Z107.9-00) and be free of gaps and cracks. • Enclosed conveyors and drives are recommended for moving spoils from tunnels to storage areas at the construction sites. • Ventilation fans with silencers for tunnels during TBM operations, such that the noise emanating from them at the nearest receptors will be no higher than the construction noise limit. • Generators with acoustic enclosure and silencers for TBM operations, such that the noise emanating from them at the nearest receptors will be no higher than the construction noise limit. • Quieter hydrovac trucks for soil conditioning at the entry shaft for tunneling operations, such that the noise emanating from them at the nearest receptors will be no higher than the construction noise limit. With the additional operational constraints and physical mitigations identified above, daytime levels should be within the construction noise limits at receptor locations. However, seven construction locations are predicted to exceed nighttime limits without further mitigation (Table 4-9). Thus, additional operational constraints may be required, to conduct work during nighttime hours. A detailed Construction Noise Assessment and Management Plan should be completed based on the actual location of the equipment and manufacturer's' sound levels to identify the specific mitigation required for each location and to ensure that the noise limits are met for the Project construction. Construction noise impact mitigation measures to be considered include but are not limited to the following: • Perform construction during daytime hours where 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. • Use equipment compliant with NPC-115 and NPC-118 as well as selecting the quieter option when multiple options are available. • Limit the number of heavy trucks on site to the minimum required. • Stage construction vehicles away from noise sensitive locations, if feasible. • Keep equipment in good working order and operate with effective muffling devices. • Undertake noise monitoring and regular reporting throughout the construction phase. Where noise level limits are exceeded, additional noise mitigation measures shall be implemented. • Use localized movable noise barriers/screens for specific equipment and operations.	A Construction Noise Management Plan should be developed that will incorporate the following recommendations for noise monitoring and addressing noise complaints: 1. 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 measures(s) effectiveness. 2. Continuous noise monitoring should be completed at each geographically distinct active construction site associated with the Project, which have been identified in Figures F-2-1 through F-2-22 of the report. Monitor(s) are to be 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. 3. Monitoring at locations where there are persistent complaints, as required. A Communication and Complaint Protocol should be established for the Project. Additional example monitoring suggestions are included in Appendix L.

Environmental Component	Potential Impact	Mitigation Measure(s)	Monitoring
		• Reduce simultaneous operation of equipment where feasible. • Implement a no idling policy on site (unless necessary for equipment operation). • Develop a communications protocol which includes timely resolution of complaints. • Additional mitigation measures not listed above may be considered.	

5 Operations Noise Impact Assessment

5.1 Regulatory Overview

This section provides details regarding reference documents for determining noise limits during operations of the Project. The operational assessment includes the noise emissions from stationary sources such as operations at the OMSF and stations as well as from the movement of the trains.

The Project assessment considers airborne noise resulting from train operations. The GBN resulting from train operations (where GBN results from vibrations transmitted through the ground into building structures, generating indoor noise) is provided in Section 7.

Because Metrolinx is a provincial agency, and the City of Toronto’s guidance defers to provincial noise guidance, this assessment considers the operations noise impact against provincial guidelines.

5.1.1 Provincial Context

The provincial context for stationary sources of sound is the MECP NPC-300 (MECP, 2013). This guideline provides sound level limits that are applied by the MECP to stationary sources according to the surrounding land use of the noise sources.

NPC-300 provides separate receptor-based limits for steady noise (e.g., heating ventilation and air conditioning (HVAC) and exhaust fans), impulsive noise (e.g., rail car coupling), and emergency equipment. Emergency equipment that is operated for testing purposes (e.g., emergency generators) is assessed as steady noise sources separately from other non-emergency steady noise sources and is subject to more relaxed criteria. Impulsive noise is noise of short-duration (i.e., shorter than one second), such as rail car coupling, and is also assessed separately from steady noise sources, with its own set of noise criteria.

Stationary noise sources are assessed against minimum background sound levels, based on a predictable worst-case post-Project scenario. As per NPC-300, the sound level limit is assessed at noise-sensitive PORs and expressed in terms of a one-hour equivalent sound level (1-hr L_{eq}). The 1-hr L_{eq} is defined as the higher of the applicable exclusion limit or the minimum existing background sound level for that point of reception.

The Project study area around the Project stationary noise sources is defined as Class 1, as per the MECP guidance, which is typical of a major population centre where the background sound level is dominated by the activities of people or ”urban hum.” NPC-300 provides limits for stationary sources that are steady, impulsive or for emergency use. For steady or impulsive sounds, NPC-300 defines the limits as the higher of the background sound level or the exclusionary limits.

Table 5-1 in Section 5.2.1 shows the applicable sound level limits for stationary sources of noise. Note that nighttime sound levels, and nighttime limits, are lower than those during the daytime.

Impulsive sources are assessed separately from steady sources, with limits that depend on the number of occurrences in a 1-hour period. The limit becomes more stringent as the number of impulses increases. The impulsive noise limits are shown in Table 5-2 in Section 5.2.1.

Emergency equipment operating in emergency situations is excluded from compliance with provincial sound level limits. However, planned non-emergency operation (e.g., during testing) must comply with provincial sound level limits. The MECP states that emergency sources are to be assessed separately from non-emergency equipment and are allowed a sound level limit that is 5 dB higher than the associated limit for non-emergency equipment. The MECP NPC-300 limits for a Class 1 area are shown in Table 5-3 in Section 5.2.1.

5.1.2 Transit Context

The US FTA methods are used for assessment of LRT operational noise, and ISO 9613 is used (as referenced in NPC-300) for stationary sources and ancillary facilities. The US FTA provides guidance for determining pre-project sound levels and the determination of receptors and land uses requiring assessment.

The light rail noise impact limits are adopted from the MOEE/TTC Draft Protocol for Noise and Vibration Assessment for the Proposed Scarborough Rapid Transit Extension (TTC Protocol, May 11, 1993) where the adjusted noise impact is the difference between the pre-project and post-project noise levels. Additionally, the TTC Protocol provides a passby sound level limit for individual trains. The passby limit is not dependent on the pre-Project sound levels.

5.1.3 Other Guidance Documents

For HVAC noise related to stations, this assessment applies an additional localized sound level limit based on the TTC Design Manual “DM-0403-00 Station Acoustics” (the TTC Design Manual, August 2011). This manual requires all ancillary equipment such as HVAC at stations (excluding emergency ventilation) that generates noise to the outdoors to be designed to meet a sound pressure level of 60 dBA at 1 m.

5.2 Applicable Criteria

Sections 5.2.1 provides the applicable criteria (noise limits) for Project operations.

5.2.1 Provincial Criteria for Stationary Sources

5.2.1.1 Stationary Sources at Stations and Emergency Egress Buildings

Stations that are underground are expected to have airborne noise sources related to mechanical ventilation. NPC-300 provides receptor-based limits for these sources. Baseline monitoring indicates that existing sound levels are higher than the MECP exclusionary limits for

Class 1 (urban) areas for many areas around the planned stations that are underground. Because stations are expected to operate into the nighttime hours, the nighttime limits were used for determination of compliance since they are more stringent. Table 5-4 summarizes the applied noise criteria at each underground station.

Outdoor point of reception (POR) sound level limits apply only during daytime and evening time periods. Sound level limits during the nighttime period only apply to the plane of window for noise-sensitive spaces. In general, outdoor PORs are protected during the nighttime because of meeting sound level limits at the plane of window. Therefore, a specific assessment of outdoor PORs has not been completed.

In addition to the above criteria, the TTC Design Manual requires all ancillary equipment such as HVAC at stations (excluding emergency ventilation) to be designed to meet 60 dBA at 1 m in public areas.

This assessment is conceptual in nature and does not account for specific locations of EEBs, which will be confirmed and further assessed as design progresses.

5.2.1.2 Stationary Sources at the OMSF

The OMSF includes noise sources of both steady and impulsive quality, as well as emergency equipment. Stationary sources at the OMSF are subject to the same provincial Class-based limits as those at the stations.

Within the OMSF area, urban hum dominates the acoustic environment during the daytime, evening, and nighttime. This urban hum is mainly due to moderate-to-heavy traffic on nearby highways, railways, and other nearby industrial and commercial operations. These characteristics are consistent with the MECP Class 1 Area designation and therefore the Class 1 limit shown in Table 5-1 is applied for this assessment.

Background sound levels are established by monitoring performed over a minimum period of 48 hours. As per MECP guidance, the lowest 1-hr L_{eq} should be selected to represent the background sound level. As part of the Project, background noise measurements were completed by AECOM in 2020 for a duration of 5 days or longer and are provided in Section 3. These background levels establish the applicable limits for PORs and assume that the measurement locations are representative and influenced by similar background noise sources. Where receptors may not be represented by the background measurements, the MECP Class 1 area exclusionary criteria were adopted as a conservative limit.

In addition to steady noise sources (such as ventilation fans), operations at the OMSF may include coupling of a railcar mover to trainsets that are not moving using their own traction units. This coupling is an impulse noise source and is subject to the NPC-300 impulsive noise limits shown in Table 5-2. Daytime operations may include up to 6 impulses, while nighttime operations may include up to 4 impulses. Planned non-emergency operation (e.g., testing) of emergency equipment must comply with the NPC-300 Class 1 sound level limits in Table 5-3.

5.2.1.3 Applied Noise Limits (Provincial)

Table 5-1. MECP Sound Level Limits for Stationary Noise Sources

Time Period	Exclusion Limit (dBA) * Class 1 Area	
	Plane of Window to Noise Sensitive Spaces [1]	Outdoor Points of Reception [1]
Daytime (0700-1900)	50 or background	50 or background
Evening (1900-2300)	50 or background	50 or background
Nighttime (2300-0700)	45 or background	n/a

Note:

[1] The plane of window is typically the most exposed upper-storey window to a noise sensitive indoor space, such as a bedroom. The outdoor point of reception is typically an outdoor space intended for the quiet enjoyment of the outdoors, such as a private backyard or shared outdoor amenity (e.g., outdoor barbecue area).

Table 5-2. MECP Sound Level Limits for Impulsive Noise Sources

Actual Number of Impulses in 1-Hour Period	Exclusionary Limits for Class 1 Area (L_{LM}, dBAI)			
	Plane of Window		Outdoor Point of Reception	
	07:00 – 23:00	23:00 – 07:00	07:00 – 23:00	23:00 – 07:00
9 or more	50	45	50	n/a
7 to 8	55	50	55	n/a
5 to 6	60	55	60	n/a
4	65	60	65	n/a
3	70	65	70	n/a
2	75	70	75	n/a
1	80	75	80	n/a

Table 5-3. MECP Sound Level Limits for Emergency Equipment

Time Period	Sound Level Limits (dBA) Plane of Window	Sound Level Limits (dBA) Outdoor Point of Reception
Daytime (07:00 – 23:00)	55 or background + 5dB	55 or background + 5dB

Table 5-4. Applied Criteria for Stations with Airborne Noise Sources

Station Name	Nighttime Sound Level Limit (dBA)
King/Bathurst	55 (at night – established in baseline measurements)
Queen/Spadina	
Osgoode	
Queen	
Moss Park	
Corktown	
Pape	45 (night – Ministry Class 1 Urban)
Cosburn	

5.2.2 Criteria for Light Rail Sources

5.2.2.1 Receptor-based Criteria

Both the US FTA and TTC provide guidance for establishing criteria for Light Rail trains. The TTC Protocol provides two receptor-based criteria for Light Rail trains. The first of these criteria applies over a 16-hour daytime and 8-hour nighttime periods and is described as the Daytime/ Nighttime Adjusted Noise Impact. These adjusted noise impacts apply to the equivalent sound levels ($L_{eq,6\text{-}hr}$ or $L_{eq,8\text{-}hr}$) over the given time period. The threshold for impact is based on a 5 dB increase over the higher of pre-project sound levels or 55/50 dBA (day/night). The TTC guide indicates that prediction and measurement methods were in the process of development at the time the guide was drafted. The US FTA states in 2018 that the pre-Project sound levels can be established through measurement, prediction, or a combination of both.

For daytime periods (07:00 to 23:00), the 16-hr L_{eq} from future train movements is predicted from available data, such as the individual train sound level, number of trains and train speeds along the alignment nearby the receptor. This 16-hr L_{eq} from the train is compared against the higher of pre-project sound levels or 55 dBA. If the difference between the train sound level and pre-project sound level (or 55 dBA) is greater than 5 dB, noise mitigation is required to reduce the sound level to the respective limit (pre-Project sound level or 55 dBA during daytime).

For nighttime periods (23:00 to 07:00), the procedure is the same as for daytime, except that the averaging period is 8 hours, and the nighttime adjusted noise impact is based on the higher of pre-Project levels or 50 dBA.

The second criterion is for a single vehicle passby sound level (L_{passby}), which is limited at the receptor to 80 dBA. The L_{passby} criterion not dependent on pre-Project sound levels nor time of day. The rail noise criteria are summarized in Table 5-5.

Table 5-5. TTC Noise Criteria for Light Rail Projects[1]

Time Period	Limit
Daytime Adjusted Noise Impact	5 dB relative to the higher of: pre-project sound levels or 55 dBA
Nighttime Adjusted Noise Impact	5 dB relative to the higher of: pre-project sound levels or 50 dBA
Passby Sound Level	80 dBA

[1] Reference TTC Protocol, May, 1993

Pre-Project Noise Levels

Pre-Project noise levels have been measured through the Project, through a baseline measurement program described in Section 3. The pre-Project sound levels include the average L_{eq} for the associated time period (16-hour daytime, 8-hour nighttime), for the daytime and nighttime adjusted noise impact. The L_{passby} criterion is not dependent on pre-Project sound levels and is set by the TTC Protocol.

Local road traffic was observed to be a dominant ambient noise source in the vicinity of Project. The ambient monitors captured noise data at approximately 3 meters above grade, while some receptors in the Thorncliffe Park (OLN) area are multi-storey buildings with differing exposure to road traffic, based on both height and position relative to the roads. In the Thorncliffe Park (OLN) portion of the Project, measured pre-Project sound levels were further refined through a predictive analysis using City of Toronto road traffic data for the year 2019. This combination of measured and predicted pre-Project sound levels is supported by the US FTA, as described in Section 5.2.2.1.

Future road traffic data, after the Project is in operation, is assumed to be greater than year 2019 road traffic data, based on historical population growth patterns. This makes the 2019 road traffic data a conservative basis for establishing future ambient. In the Thorncliffe Park (OLN) area, both measured and predicted pre-Project sound levels were found to be greater than 55 dBA in the daytime and greater than 50 dBA in the nighttime at the representative receptors. Therefore, the average noise limits during daytime and nighttime are 5 dB above the pre-Project sound levels.

5.3 Project Operations Noise Considerations

Project operations for the areas identified below generate airborne noise, which may be a concern for noise-sensitive areas surrounding the Project. GBN for operations, which is generated when vibration energy propagates through nearby structures, such as building foundations, is addressed in Section 7.

5.3.1 Train Noise (At-Grade/Elevated Track)

Noise emissions from trains running on at-grade track located in the OLW and OLS sections of the Project were assessed within Early Works (AECOM, November 2021/February 2022, Appendix Q). Noise emitted from the trains traversing the at-grade and elevated track (including the bridge over the Don Valley Parkway and Don River) in the OLN section is included in this assessment.

5.3.2 Stations and Emergency Egress Buildings

Noise sources associated with all stations include HVAC systems for comfort ventilation. For underground stations, fire ventilation systems are supplied for emergency response for stations and tunnels. Fire ventilation systems are also supplied at EEBs from underground tunnels. Fire ventilation design is not yet finalized, and detailed analysis is not included in this assessment. The designs will be expected to meet MECP NPC-300 noise limits at adjacent receptors provided comfort ventilation and fire ventilation systems meet 60 dBA at 1 m (see section 5.1.3). It is expected that this ventilation criterion can be achieved with standard mitigation measures (e.g., quieter equipment, enclosures, silencers and barriers).

At the Portals, emergency ventilation will be provided by jet fans installed within the tunnel itself. These jet fans are expected to operate during planned testing. It is understood that jet fans will be provided with noise controls (exhaust/intake silencers, casing enclosures) to maintain compliance with MECP NPC-300 noise limits. Noise from portal jet fans is addressed on this basis for the purpose of EA, to be refined during detailed design.

Outdoor audio paging systems will be required to meet MECP NPC-300 noise limits at adjacent receptors, and the system will be designed to do so by limiting speaker volume and positioning speakers away from adjacent residences. Transformers and generators, when sufficiently detailed, will also be required to MECP NPC-300 noise limits at adjacent receptors. Applicable mitigation (enclosures, silencers) will be provided to meet these limits for transformers and generators. Noise from this equipment or audio system is addressed on this basis for the purpose of EA, to be refined during detailed design.

Noise barriers have been recommended and will be implemented along the Lakeshore East joint corridor. These barriers will also be included in the station design at Riverside-Leslieville and Gerrard Stations so that future combined Ontario Line and GO noise levels are at or below existing average noise levels at the majority of nearby receptors.

5.3.3 Operations, Maintenance and Storage Facility

The Facility is planned to consist of a main OMSF building, access road, train washing building, a truing station, paint booth building, transformers and train storage area. The provided site layout is shown in Figure G-1 in Appendix G. The layout of the OMSF may be updated as design progresses. The site is assumed to be operational 24 hours a day, seven days a week using rotating shifts. Shifts are assumed to be three (3) shifts a day, five (5) days a week, with reduced operations on weekends.

The OMSF building will be required to service trains using a variety of preventive and corrective maintenance programs consistent with train reliability and based on component change-out with limited overhaul capabilities. The OMSF building will consist of office space, utility storage and maintenance/storage areas. Maintenance activities on the rail cars will include bogie and drive unit change-outs, window replacement, sanding, welding, grinding, cleaning and part painting. It is assumed that full wheel change-outs on axles will be accomplished off-site.

Non-impulsive noise sources at the OMSF will include rail car maintenance within the OMSF building, HVAC equipment/ventilation fans, wheel truing, truck movements on the access road, train idling/movements, a trackmobile and transformers.

Three generators are anticipated to be used as emergency equipment and tested monthly in accordance with manufacturer recommendations. One emergency generator will be installed and used to supply emergency power to the OMSF. The OMSF will also have two exterior plug-ins which will allow mobile generators to be connected to supply emergency power (if required).

The Facility yard will be a fully automated train operation (ATO) system, except for access to the maintenance facility where trains will be manually operated by a trackmobile. The trackmobile will couple with each five-car train and transfer it to and from the repair bays of the OMSF building. Therefore, car coupling will only occur when rail cars are delivered to and from the OMSF building. The train yard speed limit is 10 km/h.

Because the OMSF operation system is ATO, access within the yard will be restricted and fenced. Provision is made for emergency egress and a maintenance/delivery vehicle to access all on-site locations at all times. The road speed limit is 30 km/h.

The train washing building will be used for rail car cleaning operations and will consist of platforms and walkways to accommodate vehicle inspections and cleaning. A painting area is allowed for in the south-west of the site for future fleet repainting needs using mobile equipment. Painting of components and panels will be conducted inside the workshop. At the wheel truing station, up to two axles (four wheels) will be re-profiled with lathes simultaneously. Transformers in the traction power substation and at the OMSF will supply electricity to the site. Two outdoor pad-mounted 3,000 kVA transformers will be used to step down the power (27.6 kV to 600 Vac) from the traction power substation to be used by the OMSF. Four 4,000 kW traction power transformers will step down the power to be used in the yard (27.6 kV to 1500VDC). The transformers will be enclosed by a building and ventilated.

It is anticipated that up to a maximum of 44 trains will be stored in the train storage area: 40 trains will be active and 4 trains will be spares. Between the hours of 05:00 and 06:00, a maximum of 24 trains will travel out of storage and be distributed back into the transit system. The remaining 16 trains will also follow the same process between the hours of 06:00 and 09:30. It is anticipated that, as an ATO system, train warning devices (horns) will not be used on the system.

The OMSF building will be heated, ventilated and cooled by a central heating and cooling system. The OMSF building will also be vented with additional localized exhaust fans in maintenance/storage areas.

Trucks will be used to deliver products to and from the site. These deliveries are expected to be relatively infrequent, with one truck considered in the worst-case hour during daytime and evening periods. No truck traffic will occur during the nighttime period.

5.3.4 Underground Trains

Noise emitted from trains traversing the tunneled track and crossovers located in underground tunnels is not expected to be a significant noise source and is not included in this assessment. Except for the Minton Place Portal, noise emissions from the portals associated with these tunnels were assessed within Early Works Reports (see AECOM, November 2021/February 2022, Appendix Q). The noise emitted from trains entering and exiting the Minton Place Portal is included in this assessment.

It is understood that portal jet fans will be provided with noise controls (exhaust/intake silencers, casing enclosures) to maintain compliance with MECP NPC-300 noise limits. Noise from portal jet fans is addressed on this basis for the purpose of EA, and should be refined during detailed design.

5.3.5 Power Substations

The traction power system and stations will be designed to receive portable emergency generators in the event of temporary power loss. Scheduled testing/maintenance operation of these emergency generators will not be within Metrolinx lands. Traction power substations are not yet sufficiently designed for noise assessment. However, the scheduled testing/maintenance of these power substations is required to meet applicable MECP NPC-300 limits and they will be required to achieve applicable setback distances from adjacent residences and/or fitted with noise mitigation (silencers, enclosures) to meet the NPC-300 requirements.

5.3.6 Existing Transit Infrastructure

The Project will interchange with existing transit infrastructure including GO Transit lines, TTC subway and streetcar systems. However, the Project is intended to be a standalone transit system and not directly connect to those existing systems. The Project has considered combined noise impact from the Project and GO Transit in the Lakeshore East Joint Corridor and Lakeshore West Joint Corridor and those assessments are included within Early Works (see AECOM, Appendix Q). This noise assessment includes the OLN segment, which does not have any existing rail transit infrastructure.

5.4 Methodology

This section describes the assessment methodology for the Project operations noise.

5.4.1 Assessed Points of Reception

The operations noise assessment methodology uses the representative Points of Reception (PORs) that were established in Section 3, as summarized in Appendix E.

5.4.2 Assumptions

5.4.2.1 Trains

For this operational assessment, the following assumptions are noted:

- Train sound exposure level (SEL) is 80 dBA at 7.5 m, at a reference speed of 80 km/h (per US FTA Manual for LRT).
- FTA notes that air turbulence may be a noise source for trains above 144 km/h. Train speeds are well below 144 km/h for this assessment, so the train noise is predominantly from the wheel-rail interface.
- A 5 dB increase on the elevated guideway is included to account for noise re-radiated from the concrete structure (FTA).
- The speed factor is assumed to be 20 dB, from the reference speed of 80 km/h.
- The Minton Place Portal is considered as a point source resulting in a sound pressure 4 dB higher than the related tracks, at a distance of 25 m from the portal (per Eglinton Crosstown LRT project (J.E. Coulter, 2010)).
- For each track direction, 496 trains travel between 07:00 and 23:00 (daytime), and 81 trains travel between 23:00 and 07:00 (nighttime), based on service levels in Appendix M and OMSF operational data for the pre-service hour (05:00 to 06:00).
- For 16-hour daytime, and 8-hour nighttime periods, trains travel at up to 90% operational speeds for each segment, shown in Appendix M.
- For single train passby, trains are modeled traveling at 80 km/h. This is faster than the 90% operation speeds in Appendix M, and is a conservative worst-case representation of the pre-service hour (05:00 to 06:00).
- Trains are conservatively considered as idling for 1-minute at Thorncliffe Park, Flemingdon Park and Ontario Science Centre stations, with all auxiliaries (heating/ cooling) operating at maximum.
- The track elevation and alignment are based on design information available at the time of this report (January 2022).

- Track curve radii are large enough (>305 m) that wheel squeal does not occur.
- The sound from train horns/whistles was not considered in this assessment as they are safety devices and therefore exempt from the assessed criteria. Train horns/whistles are also not considered within station areas for general operations.
- Sound power level used to represent crossovers on the elevated track in the OLN is 98 dBA as per Canadian Transportation Agency (CTA) Railway Noise Measurement and Reporting Methodology (CTA, 2011).
- City of Toronto road traffic from year 2019, without a growth factor, is assumed to represent future road traffic prior to Ontario Line service. This is conservative, given road traffic typically increases over time.

5.4.2.2 Stations

Details of the fire ventilation system are not available at the time of this assessment. Therefore, the generic operational and sound power data presented in Table 5-6 and Table 5-7 have been considered. This data was obtained from the Eglinton Crosstown LRT project (J.E. Coulter, 2010).

Table 5-6. Emergency Ventilation System Basis of Design

Operation Mode	Description	Fan Airflow Rate (m^3/s)	Fan Speed (rpm)	Total Pressure (Pa)
Emergency	Fans operate at full speed. Emergency situations excluded from assessment. Routine testing carried out during the daytime up to 2 min per fan.	94	1200	1250
Maintenance	Fans can operate for a full hour at 3/4 speed during overnight track maintenance.	71	900	703
Normal	Fans operate for a full hour at 1/2 speed during normal tunnel operations.	47	600	313

Table 5-7. Generic Emergency Ventilation System Fan Sound Power Levels

Operation Mode	63 Hz (dB)	125 Hz (dB)	250 Hz (dB)	500 Hz (dB)	1 kHz (dB)	2 kHz (dB)	4 kHz (dB)	8 kHz (dB)	Overall (dBA)
Emergency	116	114	130	116	115	112	107	105	**123**
Maintenance	109	107	123	109	108	105	100	98	**116**
Normal	98	96	112	98	97	94	89	87	**105**

Due to the apparent tonal quality of the generic sound data, a +5 dB penalty has been applied to the assessment in accordance with the MECP Publication NPC-104 Guideline.

Since the locations of the intake/discharge openings around the stations are undefined at this stage of design, one intake and one discharge opening are assumed for each station to supply two fans each. Based on the assumed generic operation modes and sound data, the worst-case scenario considered is all four fans operating over the nighttime period in maintenance mode for a full hour. Since nighttime sound level limits are lower, the daytime and evening sound level limits will be satisfied by meeting nighttime sound level limits.

Similar HVAC equipment information could not be referenced for station comfort ventilation. Therefore, HVAC noise sources were not modelled and instead minimum setback distances from receptors are specified in conjunction with a maximum allowable sound level of 60 dBA at 1 m. This maximum allowable sound level limit is based on the TTC Design Manual sound level limit of 60 dBA at 1m from public areas for all ancillary equipment.

5.4.2.3 Operations, Maintenance and Storage Facility

For this operational assessment of the OMSF, the following assumptions are noted:

1. The combined aggregate sound pressure level of the HVAC/exhaust units on the east side of the OMSF building would not exceed 78 dBA at 5 m. Similarly, it was assumed that the combined aggregate sound pressure level of the HVAC/exhaust units on the west side of the OMSF building would not exceed 78 dBA at 5 m.
2. The trackmobile idling sound pressure level would not exceed 83 dBA at 5 m. The trackmobile would idle for five minutes for each set of cars it couples. Therefore, idling would occur for 30 minutes (5 min x 6 cars) during the daytime/evening, and 20 minutes (5 min x 4 cars) during the nighttime.
3. The combined aggregate sound pressure level of the HVAC/exhaust units for the train washing building would not exceed 73 dBA at 5 m.
4. The combined aggregate sound pressure level of the ventilation units for the traction power substation building would not exceed 61 dBA at 5 m.
5. That each wheel-truing lathe sound pressure level would not exceed 73 dBA at 5 m.
6. The combined aggregate sound pressure level of the HVAC/exhaust units for the paint booth building would not exceed 73 dBA at 5 m.
7. The following repair equipment is expected to be located within the OMSF building:
    - Presses
    - Saws
    - Grinders
    - Air compressor
    - Drill Press

- Two electric forklifts
- Two paint booths
- Parts Washer
- Plasma Cutter
- Power Washer
- Lathe
- Lifts
- Sanders
- Train Washer
- Trash Compactor
- Welders

8. Activities paint booth and train washing building will be completed with the doors closed. Breakout noise through the building from the contained equipment is considered insignificant.
9. No horn testing will take place at the site.
10. No bulk power substation transformers will be located at the site.
11. Traction power substation transformers will be enclosed in a building and there will be no tonal characteristics.
12. Heavy traffic on access roads will be limited during daytime and evening (1 vehicle per hour) with no nighttime heavy traffic.
13. A maximum of 6 car couples/hour will occur during the daytime/evening hours and 4 car couples/hour during the nighttime hours. Since the closest POR is west of the Facility, it was assumed that all six of the couples during the day and all four during the night occur on the west side of the OMSF building.
14. Forty-four trains will be stored in the yard with a maximum of forty active trains idling simultaneously.
15. Between 5 am and 6 am (worst-case hour), twenty-four trains will leave the yard and be distributed back into the transit system (Pre-start-up Operation).
16. Each of the three generators will be installed in a weather-proof enclosure with an exhaust silencer to ensure the individual maximum sound pressure level does not exceed 94 dBA at 5 m. All emergency generators were assumed to be tested once per month for 30 minutes during daytime hours only.
17. Under a worst-case operating hour, it was assumed that all 40 active trains would be idling simultaneously and a maximum of 24 trains will travel from the storage area to the eastern part of the property and back into the transit system. It was assumed the idling sound pressure level (including heating and cooling units) would not exceed 58 dBA at

5 m and the movements (10 km/h) sound pressure level would not exceed 72 dBA at 5 m.

18. A combined sound pressure level of 63 dBA at 5 m was assumed for the two outdoor pad-mounted 3,000 kVA transformers.
19. Indoor noise sources that are enclosed by a building/structure with no significant openings were deemed insignificant and not included in the assessment.
20. An appropriate lubricant will be applied to the tracks and the curved portions of the track will be designed to eliminate rail squeal.
21. All existing infrastructure within the construction boundary will be removed. Existing receptors within that area were not considered in the assessment.

The OMSF and stations will require an MECP Environmental Compliance Approval (ECA) or Environmental Activity Sector Registry (EASR) for air and noise for operation, which will confirm these assumptions and ensure compliance with NPC-300 or equivalent noise limits.

5.4.3 Train Noise Assessment Methodology

Airborne noise for revenue track rail movements is assessed from the Minton Place Portal, through Thorncliffe Park, to the north end of the tracks north of Science Centre station.

Airborne noise for above-ground rail movements in other parts of the Project (i.e., Joint Corridor near Exhibition Station and the Lakeshore East Joint Corridor) is assessed within Early Works (see AECOM, November 2021/February 2022, Appendix Q). GBN from train movements underground is discussed in Section 7 as it is calculated from GBV.

A predictive analysis was performed using the commercially available software package Cadna/A, a computerized version of the algorithms contained in the ISO 9613 standard. This model includes geometrical divergence (distance attenuation), barrier effects due to intervening structures, ground effects and atmospheric absorption. The model considers a downwind condition (conservative), in which the wind direction is always oriented from each source location towards each POR. To predict future sound levels from train movements, the Cadna/A software was configured to implement the US FTA train noise assessment algorithm, using the parameters in Section 5.4.2.1. The guideway on either side of the elevated track is considered to be self-shielding, where noise through the bottom of the elevated supporting tracks is negligible. All train noise is expected to radiate from above the structure, or through openings adjacent to the structure supporting each set of tracks.

Representative site terrain data was used for this assessment. A ground absorption coefficient of 0.2 was used representing hard, sound-reflective surfaces. Two orders of reflection were considered in the assessment.

Typical Ontario meteorological parameters were used in the model, They include a temperature of 10 degrees Celsius and a relative humidity of 70%.

To predict baseline sound levels from road traffic, the software was configured to implement the United States Federal Highway Administration (FHWA) Traffic Noise Model (TNM) algorithm. Road traffic inputs are shown in Appendix N. As a conservative assumption, road traffic data from 2019 is assumed to be applicable for future service years acknowledging that future traffic are expected to increase the future baseline.

5.4.4 Station Noise Assessment Methodology

The noise impact from the fire ventilation system is modelled using the Cadna/A software package. Noise modelling has considered the following variables to assess impact to receptors:

- Fan sound levels
- Distance attenuation
- Screening effects due to existing buildings and topography
- Atmospheric absorption
- Ground attenuation
- Worst-case downwind/light temperature inversion meteorological conditions

5.4.5 OMSF Assessment Methodology

Potential noise impacts from the operation of the OMSF are assessed as per the applicable guidelines discussed in Section 5.2, and the assessment methodology is discussed in this section. The planned location and layout of the OMSF, which may evolve as planning and design progress, is shown in Figure G-1 in Appendix G.

The Facility's operation will include emergency equipment, non-impulsive (steady) sources and impulsive sources. Preliminary information on the Facility operations/noise sources was provided to OLTA based on Project information current at time of assessment. Detailed information on emergency generator sizing, exhaust systems, or HVAC requirements was not available at the time of this report. Worst-case sound power levels were assumed for each of these items to show compliance with applicable MECP criteria. Once further design information becomes available (i.e., equipment capacities), this assessment will be updated as part of the MECP ECA (Air & Noise) required for operation of the OMSF, and the equipment must be designed and selected to meet the sound power levels assumed in this assessment. OMSF noise source locations are shown in Figures G-2 and G-3.

The assessed significant noise sources are summarized in Table 5-8, including sound power levels, sound characteristics, and any noise control measures. The sound power level is the sound energy emitted by the source. This is different than the sound pressure level (which is the loudness we hear) though both are measured in dBA. The sound pressure level changes with distance from the source, whereas the sound power level remains constant. The MECP NPC-104 guideline prescribes adjustments for sources with special qualities or characters of sound. They are punitive adjustments which apply to noise sources with subjectively annoying characteristics, including tonal sounds, quasi-impulsive sounds and beating sounds (sounds with cyclically varying amplitudes). The rail car wheel squeal is expected to exhibit tonal characteristics on the curved portions of track, based on the ISO standard 1996-2:2017.

Impulsive sound pressure levels are measured in dBAI and are directly compared to applicable MECP criteria in accordance with NPC-300. Therefore, impulsive sound levels do not require a separate adjustment.

5.4.5.1 Emergency Generators

Emergency generators were assessed separately according to the assumed testing schedule and sound level detailed in Section 5.4.2.3.

5.4.5.2 Non-Impulsive Noise Sources

When the trackmobile transfers rail cars in and out of the OMSF, there is a potential for idling while the rail cars are coupled. The trackmobile idling was represented by a point source of the west entrance to the OMSF maintenance bays.

Rail cars (segments of five) will be stored at the site and moved in and out of the OMSF building for routine maintenance by a trackmobile at the site speed limit of 10 km/h. Rail car movements were represented by a line noise source, which extends from the east rail entrance through the OMSF to the west rail entrance. As the cars are moved on bends in the tracks, the wheels may squeal. It is assumed that an appropriate lubricant will be applied to the tracks and curved portions of the track will be designed to reduce or eliminate rail squeal such that it is not a noise concern for the OMSF.

Trucks are used to deliver products to and from the site. These deliveries are expected to be relatively infrequent, with one truck modeled in the worst-case hour during daytime and evening periods. No truck traffic will occur during the nighttime period.

5.4.5.3 Impulsive Noise Sources

Impulsive noise sources at the OMSF may occur when the trackmobile couples with rail cars to transfer them from the yard to the OMSF building. The trackmobile is expected to be used when trains are not moving using their onboard traction systems. Other coupling events are not considered, as the trainsets are not expected to have cars decoupled frequently once they have been joined.

The worst-case daytime hour includes six rail car couples and the worst-case nighttime hour includes four rail car couples where the trackmobile couples and moves each rail car set into one of the OMSF building maintenance bays.

Although the impulsive events are not expected to be frequent, these events have been included in this assessment as a conservative representation of worst-case noise levels.

Table 5-8. OMSF Noise Source Summary Table

Source ID	Source Description	Sound Power Level (emitted by each source, in dBA)
ES1	Emergency Generator 1	116
ES2	Emergency Generator 2	116
ES3	Emergency Generator 3	116
S1	OMSF Building East Door	113[1]
S2	OMSF Building West Door	113[1]
S3A	HVAC and Exhaust Fans - OMSF Building East	100
S3B	HVAC and Exhaust Fans - OMSF Building West	100
S4	Access Road	106
S5	Train Movements for Maintenance (6 trains/hour - day) (4 trains/hour - night)	94
S6	Trackmobile Idling	105
S8	Train Washing Building Ventilation	95
S10	Traction Power Substation Ventilation	83
S11A	Wheel Truing Station Lathe 1	100[1]
S11B	Wheel Truing Station Lathe 2	100[1]
S12A	Train Movements from Car Storage Area (15 trains/hour)	94
S12B	Train Movements from Car Storage Area (9 trains/hour)	94
S14 to S53	Train Idling (40 trains)	80
S54	Paint Booth Ventilation	95
S55	OMSF Pad-Mounted Transformers	90[1]
IP1 to IP6	Rail Car Coupling	119[2]

Notes:

1 Includes +5 dB penalty for tonality

2 Logarithmic Mean Impulse Sound levels L_{LM} in dBAI

5.5 Potential Impacts, Mitigation Measures and Monitoring Activities

5.5.1 Train Noise Impacts (At-Grade/Elevated Track)

The OLN at-grade and elevated track noise impact (including the bridge spanning the Don Valley Parkway and Don River) is assessed in this section. Other at-grade sections (Lakeshore East & Exhibition) are addressed within Early Works Reports (see AECOM, November 2021/ February 2022, Appendix Q). Crossovers have been considered within the elevated section of the OLN guideway.

Table 5-9 shows the predicted noise impact at the applicable receptors for the OLN above-ground track where noise impact thresholds are +5 dB above representative baseline levels.

Table 5-9. Predicted Sound Levels from Train (OLN)

Address	POR ID	Train (Day / Night) Sound Level (dBA)	Existing Day / Night Baseline Sound Level (dBA)[1]	Day / Night Limit (dBA)[2]	Train Lpassby Level (dBA)	Lpassby Limit (dBA)	Compliance with Limit (Y/N)
170 Hopedale Ave	RR_RESD_001	56 / 51	55 / 50	60 / 55	64	80	Y
1 Leaside Park Dr	RR_RESD_002	62 / 57	60 / 54	65 / 59	67	80	Y
2A Leaside Park Dr	RR_RESD_003	63 / 58	62 / 55	67 / 60	69	80	Y
16F Leaside Park Dr	RR_RESD_004	63 / 58	63 / 56	68 / 61	69	80	Y
14 Overlea Blvd	RR_INST_005	57 / 52	60 / 54	65 / 59	78	80	Y
20 Overlea Blvd	RR_INST_006	56 / 51	60 / 53	65 / 58	77	80	Y
11 Thorncliffe Park Dr	RR_RESD_007	57 / 52	58 / 51	63 / 56	61	80	Y
4 Thorncliffe Park Dr	RR_INST_008	53 / 48	55 / 50	60 / 55	60	80	Y
4 Thorncliffe Park Dr	RR_INST_009	54 / 49	55 / 50	60 / 55	62	80	Y
10 William Morgan Dr	RR_INST_010	56 / 51	55 / 50	60 / 55	57	80	Y
130 Overlea Blvd	RR_INST_011	52 / 47	59 / 53	64 / 58	56	80	Y
735 Don Mills Rd	RR_RESD_012	52 / 47	61 / 54	66 / 59	57	80	Y
770 Don Mills Rd South	RR_INST_013	51 / 46	55 / 50	60 / 55	59	80	Y
770 Don Mills Rd North	RR_INST_014	58/ 53	60 / 54	65 / 59	66	80	Y

Address	POR ID	Train (Day / Night) Sound Level (dBA)	Existing Day / Night Baseline Sound Level (dBA)[1]	Day / Night Limit (dBA)[2]	Train Lpassby Level (dBA)	Lpassby Limit (dBA)	Compliance with Limit (Y/N)
770 Don Mills Rd (HousingNow)	RR_FRES_015	65 / 60	63 / 57	68 / 62	73	80	Y
7 St Dennis Dr	RR_RESD_016	56 / 51	62 / 56	67 / 61	64	80	Y
7 Rochefort Dr South	RR_RESD_017	59 / 54	63 / 57	68 / 62	65	80	Y
7 Rochefort Dr North	RR_RESD_018	60 / 55	65 / 58	70 / 63	66	80	Y
797 Don Mills Rd	RR_RESD_019	64 / 59	67 / 60	72 / 65	71	80	Y
805 Don Mills Rd (HousingNow)	RR_FRES_020	66 / 61	66 / 60	71 / 65	76	80	Y
1180 Eglinton Ave E	RR_FRES_021	58 / 54	65 / 58	70 / 63	66	80	Y
843 Don Mills Rd	RR_FRES_022	54 / 50	64 / 58	69 / 63	65	80	Y
849 Don Mills Rd	RR_INST_023	60 / 55	63 / 56	68 / 61	74	80	Y

Notes:

[1] Existing Day / Night baseline was established as the higher of pre-project sound from 2019 City of Toronto road traffic data, or 55 / 50 dBA.

[2] Day / Night limits are 5 dB above the existing baseline.

Note – Due to design updates received after the release of the DRAFT report in February 2022, two crossovers have been added to the assessment of operational noise in the OLN section. This updated table includes updated assessment due to the additional consideration of noise from these crossovers.

5.5.2 Train Noise Verification for Mitigation

Train noise is predicted to be compliant without additional mitigation in the OLN section. Other at-grade sections in the OLW and OLS are noted to require noise barriers as addressed within Early Works Reports (see AECOM, November 2021/February 2022, Appendix Q). In addition, Metrolinx has committed to incorporating a noise barrier along part of the alignment at Leaside Park Drive (shown in Appendix P). This barrier may provide additional noise attenuation and/or shielding for areas of the study area. Any additional attenuation or shielding provided by this barrier is not considered in this assessment.

The analysis within this report is based on a conceptual design, and should be verified as design progresses, to consider the potential future need for mitigation. GBN from train movements underground is discussed in Section 7 as it is calculated from GBV.

Once a candidate train and track combination is selected, measurements of airborne noise should be completed for a sample of train movements, at speeds representative of the expected operating speeds for the Project. Airborne noise measurements are to be compared to the SEL used in this assessment. If measurements show SELs greater or lower than those in this assessment, predicted sound levels should be reviewed for compliance with assessed criteria.

As detailed design progresses, the operational speeds and number of trains (i.e., train volume) in the daytime and nighttime will be verified against the speeds and number of trains used in this analysis (Appendix M).

5.5.3 Station Comfort Ventilation Noise Impacts

As part of the future detailed design of the stations, comfort ventilation systems should be selected to comply with a maximum sound level limit of 60 dBA at 1 m from all mechanical louvers and rooftop HVAC equipment.

The distance setback from rooftop equipment or mechanical louvers was estimated using available design data and aerial imagery, as shown in Table 5-10.

Table 5-10. Receptor Setback Distances from Station Comfort Ventilation Noise Sources

Station Name	Current Setback between Existing Receptors and Proposed Comfort HVAC at OL Stations	Required Setback Distance for a Maximum Sound Level of 60 dBA
Exhibition	18 m	1 m
Bathurst-King Queen-Spadina Osgoode Queen Moss Park Corktown	6 m	
East Harbour Leslieville Gerrard Pape Cosburn	18 m	
Thorncliffe Park Flemingdon Park Science Centre	13 m	

The current setback distances will allow for compliance with the design criterion. As design progresses, comfort ventilation systems should be located more than 1 m from any planned or existing noise receptors to avoid additional mitigation. If comfort ventilation sources are located closer than 1 m to planned or existing noise receptors, other mitigation options such as silencers/louvers and lower noise fan selections may be required.

5.5.4 Station Fire Ventilation Noise Impacts

Since fire ventilation intake and discharge opening locations are unknown at this stage, an assumed worst-case setback distance at each station to existing receptors was used to assess compliance with background sound level limits. Table 5-11 summarizes the assessed potential impact from emergency ventilation.

All stations with fire ventilation systems (i.e., all underground stations) are expected to exceed the background sound level limit based on the modelled scenario and require noise mitigation to achieve compliance. Fire ventilation intake and discharge silencers are expected, for compliance with the MECP noise criteria at Stations listed in Table 5-4. Preliminary minimum silencer requirements for the fire ventilation systems are summarized in Table 5-11 to illustrate the ability of the Project to comply with the criteria with mitigation in place. For simplicity, locations with similar predicted noise impact are grouped with the same silencer insertion loss requirement. With these silencers, the emergency ventilation noise limits are expected to be met. Once fire ventilation locations are confirmed, silencer requirements may be reduced if final design does not represent the worst-case assumption used in this assessment.

Table 5-11. Preliminary Dynamic Insertion Loss Requirements for Fire Ventilation Intake and Discharge Openings

Station / Building Name	Minimum Octave Band Dynamic Insertion Loss (dB) Requirements per Fan							
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Queen-Spadina Station Queen Station Moss Park Station Corktown Station	23	30	53	44	47	46	40	35
Bathurst-King Station Osgoode Station Pape Station Crossover (Fulton Ave) Cosburn Station	11	19	42	33	36	34	28	23

Details such as sizes and pressure drop are to be determined as part of the mechanical detailed design review of the stations. Fire ventilation fan selections should consider the potential pressure drop that may be imposed by the above silencer requirements. Space planning for intake and discharge openings should also allow for silencers up to 7.5 m in length to achieve these requirements. Once planned locations for the fire ventilation discharge and intake openings are known, this assessment should be revised to reflect actual planned locations. Table 5-12 shows the predicted mitigated emergency ventilation sound impact at the assumed locations.

Table 5-12. Emergency Ventilation System Sound Level Impact to Receptors

Location Name[1]	Receptor ID	Assumed Worst Case Setback Distance to Receptors (m)	Predicted Sound Level at Receptor (dBA)	Background Sound Level Limit (dBA)	Sound Level Excess (dBA)	Mitigation Required (Y/N)	Mitigated Sound Level at Receptor (dBA)
Bathurst King Station	SR_RESD_001	2.5	105	55	50	Y	53
Queen-Spadina Station	SR_RESD_002	13	95	55	40	Y	55
Osgoode Station	SR_RESD_003	2.5	105	55	50	Y	54
Queen Station	SR_RESD_004	65	81	55	26	Y	41
Moss Park Station	SR_RESD_005	50	83	55	28	Y	46
Corktown Station	SR_RESD_006	18	92	55	37	Y	52
Pape Station	SR_RESD_007	15	94	45	49	Y	45
Crossover (Fulton Ave)	ER_RESD_008	15	94	45	49	Y	45
Cosburn Station	SR_RESD_008	12	92	45	47	Y	45

Note:
[1] All other stations are located at grade or are elevated and are not expected to include fire ventilation systems.

5.5.5 OMSF Noise Impacts

The noise impacts on the representative PORs from OMSF operations were predicted and the results are summarized in Table 5-13, Table 5-14 and Table 5-15, representing stationary noise, impulsive noise, and emergency equipment noise, respectively. These sources were modelled and assessed against applicable provincial sound level limits, assuming that OMSF doors are maintained closed as recommended in Section 5.5.6.

Table 5-13. Acoustic Assessment Summary Table – Stationary Noise Sources

POR ID	POR Description	Predicted Noise Levels at POR (D / E / N[1], L_{eq} dBA)	Verified by Acoustic Audit (Y/N)	Noise Limit (D / E / N[1], L_{eq} dBA)	Complies with Noise Limits? (Y/N)
MR_INST_001	10 William Morgan Drive	43 / 43 / 43	N	55 / 53 / 46	Y
MR_RESD_002	735 Don Mills Road	35 / 35 / 35	N	55 / 53 / 46	Y
MR_RESD_003	200 Gateway Boulevard	36 / 36 / 36	N	55 / 53 / 46	Y
MR_RESD_004	12 Thorncliffe Park Drive	44 / 44 / 43	N	55 / 53 / 46	Y
MR_RESD_005	160 Vanderhoof Avenue	43 / 43 / 42	N	55 / 53 / 46	Y
MR_INST_006	736 Don Mills Road	35 / 35 / 35	N	55 / 53 / 46	Y
MR_RESD_007	26 Malcolm Road	40 / 40 / 39	N	55 / 53 / 46	Y
MR_INST_008	14 Overlea Boulevard	47 / 47 / 46	N	53 / 54 / 48	Y
MR_RESD_009	16F Leaside Park Drive	44 / 44 / 44	N	53 / 54 / 48	Y
MR_RESD_010	21 Overlea Boulevard	43 / 43 / 43	N	53 / 54 / 48	Y

1 D=daytime, E= Evening, N=Nighttime

Table 5-14. Acoustic Assessment Summary Table – Impulsive Noise Sources

POR ID	POR Description	Predicted Noise Levels at POR (D / E / N[1], L_{LM} dBAI)	Verified by Acoustic Audit (Y/N)	Noise Limit (D / E / N[1], L_{LM} dBAI	Complies with Noise Limits? (Y/N)
MR_INST_001	10 William Morgan Drive	51 / 51 / 35	N	60[2] / 60[2] / 60[3]	Y
MR_RESD_002	735 Don Mills Road	27 / 27 / 25	N		Y
MR_RESD_003	200 Gateway Boulevard	25 / 25 / 23	N		Y
MR_RESD_004	12 Thorncliffe Park Drive	53 / 53 / 51	N		Y
MR_RESD_005	160 Vanderhoof Avenue	60 / 60 / 59	N		Y
MR_INST_006	736 Don Mills Road	40 / 40 / 23	N		Y
MR_RESD_007	26 Malcolm Road	42 / 42 / 41	N		Y
MR_INST_008	14 Overlea Boulevard	53 / 53 / 51	N		Y
MR_RESD_009	16F Leaside Park Drive	54 / 54 / 52	N		Y
MR_RESD_010	21 Overlea Boulevard	53 / 53 / 51	N		Y

Notes:

1 D=daytime, E= Evening, N=Nighttime

2 Limit based on a worst-case scenario of 6 impulses in one hour for daytime and evening operations.

3 Limit based on a worst-case scenario of 4 impulses in one hour for nighttime operations.

Table 5-15. Acoustic Assessment Summary Table – Emergency Equipment

POR ID	POR Description	Predicted Noise Levels at POR (D / E / N[1], L_{eq} dBA)	Verified by Acoustic Audit (Y/N)	Noise Limit (D / E / N[1], L_{eq} dBA)	Complies with Noise Limits? (Y/N)
MR_INST_001	10 William Morgan Drive	55 / 55 / —	N	60 / 58 / 51	Y
MR_RESD_002	735 Don Mills Road	48 / 48 / —	N	60 / 58 / 51	Y
MR_RESD_003	200 Gateway Boulevard	50 / 50 / —	N	60 / 58 / 51	Y
MR_RESD_004	12 Thorncliffe Park Drive	48 / 48 / —	N	60 / 58 / 51	Y

POR ID	POR Description	Predicted Noise Levels at POR (D / E / N[1], L_{eq} dBA)	Verified by Acoustic Audit (Y/N)	Noise Limit (D / E / N[1], L_{eq} dBA)	Complies with Noise Limits? (Y/N)
MR_RESD_005	160 Vanderhoof Avenue	55 / 55 / —	N	60 / 58 / 51	Y
MR_INST_006	736 Don Mills Road	49 / 49 / —	N	60 / 58 / 51	Y
MR_RESD_007	26 Malcolm Road	36 / 36 / —	N	60 / 58 / 51	Y
MR_INST_008	14 Overlea Boulevard	46 / 46 / —	N	58 / 59 / 53	Y
MR_RESD_009	16F Leaside Park Drive	46 / 46 / —	N	58 / 59 / 53	Y
MR_RESD_010	21 Overlea Boulevard	47 / 47 / —	N	58 / 59 / 53	Y

Note:
[1] D=daytime, E= Evening, N=Nighttime
"—" means not applicable.

5.5.6 OMSF Noise Mitigation

The following mitigation measures are recommended in this assessment to show compliance with applicable MECP criteria at the PORs:

- Maintain the OMSF doors closed (a central cooling system may be required in the garage area) or construct a sound attenuating vestibule around the door openings.
- Ensure power substation portable emergency generators are fitted with mitigation as required to meet NPC-300 criteria.
- As design progresses, verify assumptions (Section 5.4.2.3), equipment operating scenarios, and maximum sound power levels in Section 5.4.5.

In addition, Metrolinx has committed to incorporating a noise barrier south of the OMSF near Leaside Park Drive. This barrier is anticipated to provide additional noise attenuation for areas of the study area and/or shielding to further reduce noise levels. Any additional attenuation or shielding provided by this barrier is not considered in this assessment. The location of this barrier is shown in Appendix P.

5.5.7 Queen Street Streetcar Diversion Operations Noise Impact

The Queen Street streetcar diversion routes shown in Appendix A (Figures A-4 through A-6) were assessed for noise impact. The diversion routes run along Richmond Street between York Street and Church Street for westbound streetcars; and on Adelaide Street between York Street and Church Street for eastbound streetcars, with additional track along Adelaide between York Street and Spadina Avenue. The purpose of this diversion is to move streetcar traffic off of Queen Street and around the areas of Queen Street that require surface construction. This allows for the Queen Street streetcar to continue service during the Queen Street construction. The additional noise due to streetcars was assessed for daytime (16 hours) and nighttime (8 hours), with 50% of streetcars travelling on Richmond (westbound) and 50% travelling on Adelaide (eastbound). The streetcars were found to add less than 0.5 dB to overall noise levels compared to existing daytime and nighttime traffic noise levels. Therefore, the noise impact from streetcar operations on the diversion route is not expected to result in a noticeable increase in overall noise levels for nearby receptors compared to current traffic.

5.5.8 Operations Monitoring

Detailed operations monitoring procedures are recommended and will be defined further in the design process when the alignment and train-specific parameters are finalized. The following procedures are preliminary recommendations to be refined as design progresses:

Operational noise should be monitored for impact at the rail, station, and OMSF receptors (as listed in Table 5-9 and Table 5-12 to Table 5-15, respectively), as follows:

- The operational train movement monitored locations should be approximately equally distributed along the Project Footprint and vary from year to year. Priority should be placed on locations near special trackwork or tight-radius curves.
- Station noise levels for fire ventilation and comfort ventilation should be confirmed by noise measurement (minimum 1hr Leq duration) at the nearest points of reception during commissioning. Further, the 60 dBA at 1 m limit should be confirmed for comfort ventilation.
- OMSF noise levels should be confirmed by noise measurement (minimum 1hr Leq duration) at the nearest points of reception during commissioning. Operational noise from train movements to be monitored annually for at least the first 5 years of operation.

5.5.9 Follow-Up Work

5.5.9.1 Stations, EEB, ESBs

Once ventilation equipment basis-of-design selections are completed, the minimum dynamic insertion loss requirements should be verified for compliance with the applicable MECP criteria in Table 5-4 and TTC design guidance in Section 5.1.3 as applicable. Once EEBS and ESB locations have been confirmed, mitigation should be identified to comply with MECP criteria.

5.5.9.2 OMSF

Once the final layout, operational scenarios and equipment are confirmed for the OMSF, the analysis presented in this report should be revisited to confirm that the predicted noise levels at the PORs are within the applied MECP criteria, as shown in Table 5-1, Table 5-2 and Table 5-3.

5.5.10 Permits and Approvals

Metrolinx will obtain all required permits and approvals. However, 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 City of Toronto to incorporate municipal requirements as a best practice to the extent possible.

Approvals as provided through the MECP (i.e., ECA or EASR) will be required for the stations, traction power sub-stations, and the OMSF except for equipment or activities exempted by O. Reg. 524/98 – Exemptions from Section 9 of the Act, prior to their construction and operation. This permit/registry will complete the noise impact assessment for the OMSF and stations, including confirming assumptions and assessment in this report with the final operating equipment.

5.5.11 Summary of Potential Impacts, Mitigation Measures and Monitoring Activities

Table 5-16 summarizes the mitigation measures and monitoring activities discussed in this Section 5.

Table 5-16. Summary of Potential Impacts, Mitigation and Monitoring for Operation Noise

Environmental Component	Potential Impact	Mitigation Measure(s)	Monitoring

Operation Noise	Environmental noise may cause disturbance and/or annoyance.
	Airborne noise will result from the operations of the project and may be a concern for noise-sensitive areas.
		Train movements in the OLN are predicted to show compliance with applicable criteria without additional mitigation, based on the assessment of existing design information. For train movements in at-grade sections in the OLW and OLS, noise barriers of varying heights are anticipated to reduce noise below applicable criteria (AECOM, Appendix Q).
		The following stationary sources also require noise mitigation/verification:
		• Potential impact from operational noise from stations, emergency exits and emergency services ventilation design to be reassessed as the design details are finalized. Preliminary dynamic insertion loss requirements for fire ventilation intake and discharge silencers at Stations are shown in Table 5-11. Space planning for intake and discharge openings should also allow for silencers up to 7.5 m in length to achieve the acoustic requirements.
		• As part of the future detailed design of the stations, comfort ventilation systems (e.g., makeup air handling units, fans, etc.) should be selected so that they meet operational noise limits at the nearest receptors. To achieve this, and in coordination with TTC station design guidance, this ventilation equipment should be selected such that it does not generate more than 60 dBA at 1m. Table 5-10 shows the receptor setback distances from station comfort ventilation noise sources as 1 m.
		• Portal jet fans to be fitted with mitigation as required to meet NPC-300 criteria.
		• Outdoor audio paging system will be required to meet MECP NPC-300 noise limits at adjacent receptors, and the system will be designed to do so by limiting speaker volume and positioning speakers away from adjacent residences.
		• Transformers and generators, when sufficiently detailed, will also be required to meet MECP NPC-300 noise limits at adjacent receptors. Applicable mitigation (enclosures, silencers) will be provided to meet these limits for transformers and generators.
		• The OMSF was assessed based on assumptions and operations discussed in this report. Mitigation to be included in the OMSF design includes:
		  ○ Operation with OMSF doors closed (a central cooling system may be required in the garage area) or construction of a sound attenuating vestibule around the door openings.
		  ○ Power substation portable emergency generators to be fitted with mitigation as required to meet NPC-300 criteria.
		  ○ As OMSF design progresses, verify assumptions (Section 5.4.2.3), equipment operating scenarios and maximum sound power levels in Section 5.4.5.
			Detailed operational monitoring procedures are recommended and will be defined further in the design process. The following procedures are preliminary recommendations and will be refined as design progresses:
			1. Station, emergency exit and emergency services noise levels for fire ventilation and comfort ventilation should be monitored at the nearest points of reception. Further, the 60 dBA at 1 m limit should be confirmed for comfort ventilation.
			2. OMSF noise should be monitored at the receptors noted in Table 5-13.
			3. Operational noise from train movements on tracks to be monitored for representative receptors and for at least the first 5 years of operation.
			The monitored locations should be approximately equally distributed along the Project Footprint and vary from year to year. Priority should be placed on locations near special trackwork or tight-radius curves.
			Additional example monitoring suggestions are included in Appendix L.

6 Construction Vibration Impact Assessment

6.1 Regulatory Overview and Criteria

Section 6.1.1 through Section 6.1.4 provide details regarding documents referenced for determining vibration limits during construction.

6.1.1 Federal Context

There are no federally regulated criteria, limits or guidelines for assessing construction vibration in Canada.

6.1.2 Provincial Context

Ontario Provincial Standard Specification (OPSS) 120 (2014) specifies the ground vibration limits for structural damage to underground structures, including pipelines. These have been adopted for the Project for construction vibration impacts to underground services. The vibration limits for underground structures shown in Table 6-1 are adopted for this assessment of the vibration impact zone, referred to as the zone of influence (ZOI).

Table 6-1. Ontario Provincial Standard Specification 120 Vibration Limits

Element	Frequency of Vibration (Hz)	Vibration Peak Particle Velocity (mm/s)
Structures and Pipelines	≤ 40	20
	> 40	50
Concrete and Grout < 72 hours from placement	N/A	10

6.1.3 Municipal Context

The City of Toronto’s By-law No.514-2008 limits construction vibration in terms of peak particle velocity (PPV) in millimeters per second (mm/s) for building damage. The by-law exempts government work but Metrolinx adopts the construction vibration limits outlined in the code. Therefore, the vibration limits provided in the code are considered for this assessment.

The City of Toronto’s construction vibration limits are applicable to structures that may experience construction vibration, and they are established to avoid potential for cosmetic damage (e.g., hairline cracking on plaster) to structures from construction vibration. Construction vibration levels are considered acceptable if they are within the limits for the applicable frequency ranges. The City of Toronto vibration limits are provided in Table 6-2.

Table 6-2. City of Toronto Construction Vibration Prohibition Limits

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

The vibration limits provided in Table 6-2 are maximum thresholds, on a frequency basis, not to be exceeded during construction. In addition to the prohibition limit of vibration in the table above, the City of Toronto defines the ZOI vibration limit for buildings or structures that are potentially impacted by vibrations from construction activities. The ZOI vibration limit is PPV (measured or estimated) which is equal to or greater than 5 mm/s regardless of frequency. This construction vibration assessment is based on the vibration ZOI limit of 5 mm/s for non-heritage structures.

6.1.4 Other Guidance

Construction vibration limits related potential damage of standard building constructions (not heritage) are defined based on the City of Toronto's Bylaw 514-2008 criteria. For heritage structures, the City's bylaw is supplemented with guidance from the United States (US) Federal Transit Administration (FTA) Noise and Vibration Impact Assessment Manual (FTA 2018). The FTA identifies a 3 mm/s PPV criteria for Heritage Buildings and Structures, which has been used in this construction vibration assessment.

Construction vibration also generates annoyance at vibration levels much less than those for potential damage to structures. To address this, the MOEE/GO Transit Draft Protocol for Noise and Vibration Assessment (MOEE/GO Protocol 1995) was adopted.

The MOEE/GO Protocol (1995) provides a vibration limit of 0.14 mm/s Root-Mean-Square (RMS) for human perception (annoyance) from GBV. The vibration velocity of 0.14 mm/s RMS is used for this assessment.

The transmitted vibration could generate indoor noise caused by the vibration of building structures such as floor and walls. This noise is referred to as GBN. The City of Toronto Code does not provide any GBN limits for construction activities. The FTA sets limits for GBN for transit operations but not for construction activities. However, considering that construction activity is equivalent to occasional train passby events (from 30 to 70 movements per day), the GBN limits from the FTA are adopted in this assessment, as shown in Table 6-3.

Table 6-3. Ground-borne Noise Limits

Type of Structure	Ground-borne Noise Limit [1] (dBA, ref. 20 micro-Pa)
Residences and Auditoriums	38
Institutions and Theatres	43
Concert Halls/TV Studios/Recording Studios	25
Four Seasons – R. Elliott Fraser Hall[2]	17

From US FTA Manual (2018)

Notes:

[1] Limits aligned with those for occasional train movements, as opposed to those for frequent train movements, as the impact from tunneling is not expected to be long-term.

[2] The criterion for Four Season (equivalent N-1 limit) is based on its acoustic report design criteria for subway (Wolfe 2007).

6.1.5 Applied Assessment Criteria

The applied criteria for construction vibration impact are summarized in Table 6-4. The GBV criteria were applied for all construction activities including tunneling, while GBN criteria were applied only for the tunneling activities due to the expected nighttime operation of the TBM.

For cosmetic damage from GBV, the applied criteria are based on the ZOI limit from the City of Toronto Code (2021), the limit for heritage buildings from the US FTA Manual (2018) and the limit for pipelines from OPSS 120 (2014). The human perception of vibration velocity was adopted from the MOEE/GO Protocol (1995).

The GBN criteria are based on the FTA GBN limit of occasional event of train passbys as discussed in Section 6.1.4.

Table 6-4. Applied Criteria for Construction Vibration Assessment

Assessment	Type of Structure	Criteria	Source
GBV	Heritage Buildings and Structures	3 mm/s PPV	US FTA Manual
	Buildings and Structures (except Heritage)	5 mm/s PPV	City of Toronto Code ZOI limit
	Underground Utility Structures (e.g., pipelines)	20 mm/s PPV	OPSS 120
	Human Perception	0.14 mm/s RMS	MOEE/GO Protocol
GBN	Residences and Auditoriums	38 dBA	US FTA Manual
	Institutions and Theatres	43 dBA	
	Concert Halls/TV Studios/Recording Studios	25 dBA	
	Four Seasons – R. Elliott Fraser Hall	17 dBA	Four Seasons requirement to meet N-1 background noise criteria

6.2 Description of Construction Activity

Vibration impacts from construction equipment and activities for the Project are concerns for cosmetic damage and human comfort. The construction activities and equipment used on this Project vary with the location in the Project Footprint and the construction phase as discussed in Section 4.3. This section provides further information on vibration impacts from above ground construction as GBV, as well as GBN through tunnelling.

The site is assumed to be operational 24 hours a day, seven days a week using rotating shifts. Shifts are assumed to be three (3) shifts a day, five (5) days a week with reduced operations on weekends. The trackwork, tunneling and station excavation are the only construction phases to occur during the nighttime based on Project information provided at the time of assessment.

The types of construction activities expected and considered in this assessment are shown in Table 4-3. These include site preparation, site servicing, demolition, excavation/grading, structures, trackwork and tunneling.

6.2.1 At-Grade/Elevated Track

Construction of at-grade and elevated tracks requires site preparation, site servicing, pier construction and track installation. For at-grade track sections, the compaction of the track base would be the most significant source of vibration.

6.2.2 Tunnelling

Two tunnels are being constructed, the Downtown tunnel (from Exhibition Portal to the Don Yard Portal) and the Pape Tunnel (from Gerrard Station Portal to Minton Place Portal). For the construction of the entry and exit shafts and excavations are expected to be the main construction activities. The exit and entry shaft locations are listed in Table 4-5.

Tunneling between Osgoode and Queen Stations, and between Corktown Station and Don Yard, will be completed by a SEM with the help of roadheaders. Current review of roadheaders and SEM has not identified any vibration-specific concerns with them, such that the vibration impact from roadheaders and SEM is considered to be the same as TBM operations and no separate assessment is conducted for roadheaders. Tunneling operation is expected 24 hours per day and 7 days per week.

6.2.3 Stations

Stations will be constructed using cut-and-cover and/or TBM/SEM, depending on the station site. Station construction at-grade requires site preparation and site servicing, demolition of existing structures, excavation/grading and construction of station structures. The most significant source of construction vibration at the at-grade stations would be soil compaction with the vibratory roller.

The underground stations will be constructed by tunneling using TBM, roadheader and SEM. The dominant construction activity for the underground stations will be TBM operation.

6.2.4 Bridge Construction

Bridge construction is expected within the Project footprint at several areas such as Don River Crossing and grade separations. These components are all are considered as part of this construction assessment.

6.2.5 Operations, Maintenance and Storage Facility

Construction of the OMSF requires site preparation, site servicing, excavation/grading, demolition of the existing structures and construction of the OMSF building and. The soil compaction would be the most significant source of vibration.

6.2.6 Staging Area

Truck and equipment movements are considered as the dominant activities in the staging areas during the construction period.

6.3 Methodology

Two assessment methods were employed for construction vibration for general above-ground construction activities and underground construction activities:

- Construction vibration impact due to general activities above-ground was conducted based on the methodology from the US FTA Manual (2018) using reference vibration velocity at a known distance.
- Vibration impact due to the underground construction activity, specifically the operation of the TBM, was estimated based on the method proposed by Transportation Research Lab (TRL 2000) using empirical data.

6.3.1 General Construction Assessment Methodology

The parameters discussed in the following sections are assumed based on current Project design (November, 2021).

For this construction vibration assessment, OLTA has made the following assumptions:

- All construction equipment and activity are located with construction staging areas, shaft construction locations and along the track alignment that are all within the Project Footprint.
- The assessment adopts the US FTA Manual reference for construction equipment vibration levels.
- The types of construction equipment considered for each construction phase/activity are estimated as presented in Table 4-6. These are based on the OLTA's best estimate of the construction equipment expected for each phase of construction.
- Impact pile driving is not expected to occur as a part of this Project construction. In the event that it is determined during construction planning that impact piling is required, an assessment will be done demonstrating the ability to operate while complying with applicable criteria prior to approval of the construction plan. Mitigations would then be implemented as required which could include lower vibration piling methods (e.g., vibratory piling).

The US FTA Manual includes the following equation, to estimate general construction vibration in PPV:

$$PPV = PPV_{ref} \cdot \left(\frac{D_{ref}}{D}\right)^n$$

Where:

PPV = the vibration level of the piece of equipment at the point of reception (mm/s)

PPV_{ref} = the reference vibration velocity of the piece of equipment at a reference distance D_{ref} of 7.6 m (mm/s)

D = the straight-line distance from the equipment to the point of reception (m)

n = propagation coefficient based on soil class (FTA recommended value = 1.5)

The worst-case scenario was assumed in evaluating the vibration impact at receptor locations, such that the equipment generating the most significant vibration operates at the closest possible distance to each vibration-sensitive receptor. The fundamental equation used in the model is based on propagation relationships of vibration through soil. The extent to which vibrations may be experienced depends on several factors:

- The type of equipment
- The vibration frequency generated by the equipment
- Ground conditions - for example, soil type, moisture content and presence of rock
- Topography

Due to the factors above, there is inherent variability in GBV predictions without site-specific measurement data. The various formulae which have been developed empirically to predict vibration levels at a receiving point do not consider the variability of ground strata, the equipment-soil interaction process, coupling between the ground and the foundations, etc. Hence, these formulae can only provide a conservative first assessment of whether the vibrations emanating from a construction site are likely to constitute a problem.

A more accurate and less conservative assessment can be achieved by calibration of the site, i.e., the establishment of a site-specific formula. In the case of a specific item of equipment, the data necessary for the derivation of the formula can be obtained from one or more trial drives using the equipment onsite and recording the vibration levels at various distances from the machinery position. Vibration measurements may also be taken on structures to provide information on the coupling between the soil and the foundations and amplification effects within a building.

The RMS velocity was calculated from the predicted PPV divided by the crest factor. The US FTA Manual recommends a crest factor of 4 for the RMS conversion for random vibration and Caltrans (2020) recommends a crest factor of 1.4 for a harmonic oscillator such as vibratory roller.

6.3.2 TBM Assessment Methodology

The potential GBV and GBN impacts from TBM operations are assessed separately from general construction vibration impact since the assessment methodology provided in the US FTA Manual is for surface construction activities. Current review of roadheaders and SEM has not identified any vibration-specific concerns with them, such that the vibration due to operation of the roadheader as part of SEM is considered to be same as the vibration due to TBM operation and all discussion/results hereafter can be considered applicable to both.

The TBM generates GBV and GBN during tunneling. Two major ways that vibration from the TBM is generated are the force generated from cutting through soil/rock, and the force generated to support the soil/rock cutting force. The cutting force is the impulsive force that acts on the face of the excavation by the cutting discs, and the supporting force is created by the hydraulic cylinders on a supporting structure to provide the thrusting pressure to push the TBM forward. In addition, the level of GBV is dependent upon the ground condition (i.e., damping in the soil) and the setback distance from the TBM.

The TBM vibration ZOI is calculated in accordance with Transportation Research Lab (TRL) Report 429 “Ground-borne Vibration Caused by Mechanized Construction Works” (TRL 2000) as follows:

$$PPV = 180 * r^{-1.3}$$

Where:

PPV = predicted peak particle velocity (mm/s)

r = distance from source to point of assessment (m), 10 (m) ≤ r ≤ 100 (m)

The distance, *r*, from source to assessment location is the distance from the tunnel perimeter to the closest building foundation (called slope distance). Note that the distance from source to point of assessment (*r*) is limited to a range from 10 m to 100 m. The RMS velocity is calculated from the predicted PPV. A crest factor of 4 was applied for TBM operation based on measurement results from other tunneling projects.

Since the TBM will operate during nighttime hours, the GBN was estimated from the following equation as provided in TRL Report 429 (TRL, 2000):

$$L_p = 127 - 54 \times \log r$$

Where:

L_p = indoor sound pressure level (dBA, ref. 20 µPa)

r = distance from source to point of assessment (m), 10 (m) ≤ r ≤ 100 (m)

6.4 Potential Impacts, Mitigation Measures and Monitoring Activities

6.4.1 Impact Assessment

The highest levels of construction vibration (GBV) in this Project are expected to be associated with the compaction with a vibratory roller, truck activities in staging areas and operation of TBM. Table 6-5 presents the minimum setback distances beyond which the GBV would not exceed the ZOI threshold by the noted equipment of highest vibration. The approximate ZOIs for general construction activities are shown in Appendix H, Figures H-1-1 to H-1-22. For details of heritage buildings shown on these figures, refer to the Ontario Line Heritage Detailed Design Report (OLTA, February 2022). Other construction equipment not identified in Table 6-5 would meet acceptable vibration level irrespective of setback distance.

The ZOI for GBN from tunneling is shown in Table 6-6. Since the TBM is expected to operate in the nighttime period and interior noise from GBN may be more noticeable at night, GBN is assessed only for the tunneling activity. The Four Seasons Centre for the Performing Arts (Four Seasons) is considered the most sensitive receptor due to its proximity and vibration-sensitive use. The Four Seasons performing auditorium has been vibration isolated in its design to address existing subway and streetcar vibration. However, the Four Seasons building falls within the GBN ZOI for the TBM operation, and the predicted (unmitigated) level is expected to exceed the criteria. Approximate ZOIs for tunneling activity are shown in Appendix H, Figures H-2-1 to H-2-11. For details of heritage buildings, refer to the Ontario Line Heritage Detailed Design Report (OLTA, February 2022).

The ZOI in Appendix H are to be reviewed during construction, and any PORs that fall within these distances should be reviewed to confirm appropriate mitigation. Where construction vibration/noise impacts are anticipated for buildings within the ZOI, the building owners/ occupiers should be notified with the plans and timings for the construction.

Table 6-5. Minimum Setback Distances for Construction Vibration

Type of Receptor	Criteria	Earthwork / Demolition (Vibratory Roller)	Staging Area (Trucks)	Tunneling[1] (TBM / roadheader/ SEM)
Heritage Buildings and Structures[2]	3 mm/s PPV	11 m	6 m	23 m
Buildings and Structures (except Heritage)	5 mm/s PPV	8 m	4 m	16 m
Underground Utility Structures[1] (e.g., pipelines)	20 mm/s PPV	3 m	2 m	6 m
Human Perception	0.14 mm/s RMS	69 m	17 m	85 m

Notes:

1 Slope distance between the foundation of building/structure and the tunnel edge

2 Heritage buildings are indicated on Figures H-1-1 to H-1-22 and Figures H-2-1 to H-2-11 in Appendix H corresponding to the Ontario Line Heritage Detailed Design Report (OLTA, February 2022).

Table 6-6. Minimum Setback Distances for GBN (Tunnel Section Only)

Type of Structure	Criteria	Slope Distance
Residences and Auditoriums	38 dBA	44 m
Institutions (i.e., St. Michael's Hospital, Osgoode Hall) and Theatres	43 dBA	36 m
Concert Halls/TV Studios/Recording Studios	25 dBA	76 m
Four Seasons – R. Elliott Fraser Hall[1]	17 dBA	46 m

Note:
[1] Approximate 20 dB reduction of the existing isolation system (Wolfe, 2007) was considered.

6.4.2 Construction Mitigation

Based on the established Project construction vibration ZOIs, construction activities that may affect adjacent structures require mitigation measures. The following mitigation measures are proposed to reduce negative potential vibration impacts from construction activities on the PORS within these ZOIs:

1. The owners of the properties within the ZOIs should be notified before commencing any nearby construction activities.
2. Mitigation options such as maintaining the minimum setback distance for construction equipment or considering construction equipment with low vibration levels is recommended:
   a. A non-vibratory roller is recommended for operation in proximity to building structures. A vibratory roller may only be used at least 11 m (Heritage) or 8 m (other structure) away from the structure, or if the vibration level is tested through sample vibration measurements to confirm a suitable setback distance.
   b. Caisson drilling shall be monitored, and the auguring speed should be controlled in accordance with the monitored vibration level.
   c. Excavators may only be used at least 6.5 m (Heritage) or 4.5 m (other structure) away from the structure, or if the vibration level is tested through sample vibration measurements to confirm an alternate suitable setback distance. Use of alternative smaller equipment such as a backhoe is recommended.
   d. Heavily-loaded trucks and equipment should be routed away from residential streets and vibration-sensitive sites.
   e. The sequence of construction phases such as demolition, earth-moving, and ground-impacting operations should be managed so as not to occur in the same time period and avoiding nighttime activity.

3. Since vibration levels in practice are highly dependent on the equipment models and modes of operation as well as local ground conditions, it is recommended that the contractor conduct test vibration measurements to check conditions at specific setback distances. Sample tests should be performed for all significant vibration-generating equipment anticipated to operate within the ZOI to confirm that vibration levels are compliant with the allowable limits. The measured vibration levels can be used to estimate setback distances and/or the operational condition at a certain distance in which the construction equipment should be allowed to operate. This testing would not discharge the contractor from their responsibility to continuously monitor vibration levels at vibration-sensitive receptors and adhere to the specified vibration limits.
4. For tunneling with TBM, the cutting force can be reduced by a speed reduction. The supporting force should be adjusted according to the monitored vibration velocity (see Section 6.4.3.2) to ensure that vibration velocity is below the limits.

Recommended construction vibration mitigation practices, are summarized in Appendix K.

6.4.3 Construction Monitoring

6.4.3.1 Pre-Construction Activities

Municipal By-law No.514-2008 requires a pre-construction consultation with the property owners including underground structures within the identified ZOI (Figures H-1-1 to H-1-22) for cosmetic damage. Further, a commitment to conduct pre-construction measurements of background vibration and pre-construction inspections (i.e., identify existing cracks in walls, floors and exterior cladding of the first two storeys above grade and interior finishes of all storeys below grade) is required. In addition, a vibration mitigation plan and a vibration monitoring program should be prepared.

Some identified sensitive receptor locations (i.e., St. Michael's Hospital, Bell Media Headquarters, Four Seasons Centre for the Performing Arts) should be assessed in detail by conducting vibration measurements from mock-up construction activities prior to commencement of construction (see Section 6.3.1). The measured vibration should be analysed in 1/3-octave bands over the frequency range 8 to 80 Hz and assessed with the criteria provided in Table 6-4. The criteria limits for the vibration-sensitive equipment are also included in Appendix O.

The purpose of conducting these measurements is to verify and refine the predictions to these vibration-sensitive locations and ensure that construction activities will meet the vibration criteria at these locations. Further, vibration measurements of mock-up construction activities can be considered where construction may take place at or closer than the setbacks identified in this report, to ensure compliance to vibration limits.

Pre-construction and post-construction building inspection of the potentially impacted buildings adjacent to construction sites are to be conducted. Continuous vibration monitoring along the construction site property lines closest to these structures will be initiated as warranted.

6.4.3.2 Monitoring Activities

Based on the established Project construction vibration ZOIs, vibration monitoring should be conducted for the structures where the minimum setback distances required for construction vibration (Table 6-5) cannot be maintained.

Perceptible vibration should be monitored in terms of RMS (mm/s) while structural damage should be monitored in terms of PPV (mm/s). Conversion between RMS and PPV requires assumptions about the vibration signal that can lead to erroneous conclusions. Therefore, each term (RMS, PPV) should be measured directly. The conversion from PPV to RMS using a crest factor is not acceptable for monitoring purposes. The construction vibration monitoring equipment should be capable of taking measurements in three axes (i.e., transverse, vertical and longitudinal) simultaneously.

Monitoring of vibration levels will be conducted with both alert and action levels; where action levels require investigation into exceedances, and alert levels are provided as warnings against exceeding limits. If vibration levels above the relevant action limits are measured and attributed to the construction activities, the contractor should take action to adjust operations at the offending source to rectify the potential excess. If determined to be reasonably necessary, additional measurements will be conducted to assess and rectify the source of the exceedance. In addition, construction monitoring may be warranted when:

- The duration of construction is over a month
- The construction includes pile driving
- Nighttime construction is anticipated
- The anticipated community response to the construction is negative

The type of Vibration Monitoring Program established is anticipated to be based on the ZOI, the Project location, duration, and receptor proximity. The monitoring types include:

- Type 1: Monitoring continuously throughout the Project (for receptors in the ZOI).
- Type 2: Monitoring during the most impactful phase of the Project only (for receptors outside of the ZOI but within 50 m of the boundary of the construction site).
- Type 3: Monitoring in response to complaints only (typically for the receptors outside of the ZOI and may be beyond 50 m of the boundary of the construction site).

A Communications Protocol and a Complaints Protocol to address construction vibration complaints should be established for the Project.

6.4.4 Follow-Up Work

The construction vibration ZOIs are based on the preliminary construction equipment list and assumptions for the Project. A construction vibration mitigation and monitoring plan should be developed when the equipment type, actual location of the equipment, and construction timing are known. It is recommended that these ZOIs be considered throughout the construction planning process and that the assessment be updated accordingly. The mitigation measures described above to reduce potential impacts from tunneling GBN will be implemented, as required.

A detailed construction vibration assessment will need to be completed to review underground pipelines and utilities.

6.4.5 Permits and Approvals

No permits or approvals are identified for construction vibration on the Project.

6.4.6 Summary of Potential Impacts, Mitigation Measures and Monitoring Activities

Table 6-7 summarizes the mitigation measures and monitoring activities discussed in this Section 6.

Table 6-7. Summary of Potential Impacts, Mitigation and Monitoring for Construction Vibration

Environmental Component	Potential Impact	Mitigation Measure(s)	Monitoring

Construction Vibration	Vibration may cause damage to buildings, utilities and other structures.
	Exposure to vibration may result in public annoyance and complaints.
	Vibration from tunneling can cause annoyance, interfere with human activities and vibration-sensitive equipment operation.
		The following measures should be considered to mitigate vibration impacts from the Project construction:
		• The owners of properties within the ZOIs (Appendix H) should be notified before commencing any nearby construction activities.
		• Mitigation options such as maintaining the minimum setback distance for construction equipment or considering construction equipment with low vibration levels is recommended. Some examples include but are not limited to:
		• A non-vibratory roller is recommended for operation in proximity to building structures. A vibratory roller may only be used at least 11 m (Heritage) or 8 m (other structure) away from the structure, or if the vibration level is tested through sample vibration measurements to confirm a suitable setback distance.
		• Caisson drilling shall be monitored, and the auguring speed should be controlled in accordance with the monitored vibration level.
		• Excavators may only be used at least 6.5 m (Heritage) or 4.5 m (other structure) away from the structure, or if the vibration level is tested through sample vibration measurements to confirm an alternate suitable setback distance. Use of alternative smaller equipment such as a backhoe is recommended.
		• Heavily loaded trucks and equipment should be routed away from residential streets and vibration-sensitive sites.
		• The sequence of construction phases such as demolition, earth-moving, and ground-impacting operations should be managed so as not to occur in the same time period and avoiding nighttime activity.
		• For tunneling with TBM, the cutting force can be reduced by a speed reduction. The supporting force should be adjusted according to the monitored vibration velocity (see Section 6.4.3.2) to ensure that vibration velocity is below the limits.
		• Additional construction vibration mitigation practices are summarized in Appendix K. It is recommended that the contractor conduct test vibration measurements to check conditions at specific setback distances if they plan to have construction activities at or closer than the setback distances.
		• Sample tests should be performed for all significant vibration-generating equipment anticipated to operate within the ZOI to confirm that vibration levels are compliant with the allowable limits. The measured vibration levels can be used to estimate setback distances and/or the operational condition at a certain distance at which the construction equipment should be allowed to operate. This testing would not discharge the contractor from their responsibility to continuously monitor vibration levels at sensitive receptors and adhere to the specified vibration limits.
		Pre-Construction Activities:
		• A pre-construction consultation should be conducted with the property owners for underground structures within the identified ZOI (Figure H-1-1 to H-1-22) for cosmetic damage, in accordance with Municipal By-law No.514-2008
		• Pre-construction measurements of background vibration and pre-construction inspections (i.e., identify existing cracks in walls, floors, and exterior cladding of the first two storeys above grade and interior finishes of all storeys below grade) is recommended.
		A vibration mitigation plan and a vibration monitoring program should be prepared.
		Identified sensitive receptor locations (i.e., St. Michael's Hospital, Bell Media Headquarters, Four Seasons Centre for the Performing Arts) should be assessed in detail by conducting vibration
			The following procedures are recommended for vibration monitoring:
			• Vibration monitoring will be undertaken at locations within the zone of influence to ensure compliance with applicable criteria (Table 6-5) and to identify the need for additional mitigation if required.
			• Monitoring will be undertaken to verify mitigation measures(s) effectiveness.
			  ○ Monitoring for perceptible vibration should be monitored in terms of root mean square (RMS, mm/s).
			  ○ Monitoring for structural damage should be monitored in terms of peak particle velocity (PPV, mm/s).
			• Pre-construction and post-construction building inspection of the potentially impacted buildings adjacent to construction sites are to be conducted.
			• Continuous vibration monitoring along the construction site property lines closest to the aforementioned structures will be initiated as warranted.
			• Monitoring at locations where there are persistent complaints will be undertaken, if required.
			A Communications and Complaints Protocol to address construction vibration complaints should be established for the Project.
			Additional example monitoring suggestions are included in Appendix L.

Environmental Component	Potential Impact	Mitigation Measure(s)	Monitoring
		measurements from mock-up construction activities prior to commencement of construction (see Section 6.3.1). The measured vibration should be analysed in 1/3-octave bands over the frequency range 8 to 80 Hz and assessed with the criteria provided in Table 6-4. The criteria limits for the vibration-sensitive equipment are also included in Appendix O. The purpose of conducting these measurements is to verify and refine the predictions for these vibration-sensitive locations and ensure that construction activities will meet the vibration criteria at these locations.	

7 Operations Vibration Impact Assessment

7.1 Regulatory Overview and Criteria

Section 7.1.1 through Section 7.1.2 provide details regarding documents referenced for determining vibration limits during operations.

7.1.1 US FTA

The US FTA Manual is commonly used for operations vibration assessment of transit systems. The criteria for environmental impact from GBV and GBN from the US FTA Manual are shown in Table 7-1.

Based on the train service levels (see Appendix M), it is expected that more than 70 events will occur per day for the Project and, therefore, the limits for "frequent events" as per the US FTA Manual are applied for this assessment.

Table 7-1. US FTA Vibration Limits

Type of Receptor	Ground-borne Vibration (GBV) - Limit[1]	Ground-borne Noise (GBN) - Limit[1]
Highly Sensitive Building	0.045 mm/s (65 VdB)	n/a
Residence	0.1 mm/s (72 VdB)	35 dBA
Institutional/Commercial	0.14 mm/s (75 VdB)	40 dBA
Concert halls, TV studios, recording studios	0.045 mm/s (65 VdB)	25 dBA
Auditorium/Theaters	0.1 mm/s (72 VdB)	30/35 dBA

Note: VdB is reference to 1 micro-in/s; velocity is in RMS; dBA is reference to 20 micro-Pa

7.1.2 Other Guidance Documents

The TTC and MECP recognize that transit facilities produce vibration that may affect neighbouring properties in urbanized areas. The MOEE/TTC Draft Protocol for Noise and Vibration Assessment for the Proposed Scarborough Rapid Transit Extension (1993) identifies the framework within which criteria will be applied for limiting GBV. The MOEE/TTC Draft Protocol states an operations vibration limit of 0.1 mm/s RMS (i.e., 72 VdB ref 1 x 10^{-6} in/sec) for residential properties within 15 m of track. This limit is for human perception.

7.1.3 Applied Assessment Criteria

For the assessment of operational vibration, the guidelines described in the US FTA Manual are considered for this assessment. The applicable operational GBV and GBN criteria are summarized in Table 7-2.

Table 7-2. Applied Criteria for Operational Vibration Assessment

Type of Receptor	Ground-borne Vibration (GBV) - Limit[1]	Ground-borne Noise (GBN) - Limit[1]
Highly Sensitive Building	0.045 mm/s (65 VdB)	n/a
Residence	0.1 mm/s (72 VdB)	35 dBA
Institutional/Commercial	0.14 mm/s (75 VdB)	40 dBA
Concert halls, TV studios, recording studios	0.045 mm/s (65 VdB)	25 dBA
Auditorium/Theaters	0.1 mm/s (72 VdB)	30/35 dBA
Four Seasons – R. Elliott Fraser Hall	0.045 mm/s (65 VdB)	17 dBA[2]

Notes:

1 VdB is reference to 1 micro-in/s; velocity is in RMS; dBA is reference to 20 micro-Pa.

2 The criterion for Four Season (equivalent N-1 limit) is based on its acoustic report design criteria for subway (Wolfe 2007).

7.2 Description of Assessment Area

Railway traffic is a source of GBV and GBN. The vibration generated by the train moving along the rail track propagates to nearby buildings through the soil. The transmitted vibration in the building causes the floors, walls and ceilings to vibrate, which may be heard as interior noise (GBN).

Special trackwork, such as crossovers and switches, increase the level of GBV or GBN. The potential impact of the railway traffic is considered in terms of at-grade/elevated track, tunnelled track, stations track, and tracks associated with the OMSF.

7.2.1 At-Grade/Elevated Track

At-grade track is located in the OLW and OLS sections of the Project, and both at-grade and elevated track are located in the OLN section. In the elevated sections, vibration energy propagates horizontally from concrete piers, which are the equivalent of point sources of vibration energy. In general, the elevated track is not a significant source of GBV/GBN. For at-grade track, the vibration energy propagates directly from the rail to the ground. Both sources of vibration energy (GBV) can propagate through nearby structures such as building foundations, creating GBN heard inside the building.

7.2.2 Tunnelled Track

There are two parallel tunnels along the alignment. The Downtown tunnel is from the Exhibition Portal to the Don Yard Portal. The Pape tunnel is from the Gerrard Station Portal to the Minton Place Portal. The tunneled tracks are generally at 25 to 30 m depth (except near tunnel portals). However, utilities, building foundations and/or piles may be closer than 30 m to the tunnel, depending on their depth. The Downtown tunnel will be constructed in bedrock, while the Pape tunnel will be constructed approximately 25 m deep within the soil overburden. Though vibration from bedrock-based tunnel is typically lower than soil-based tunnel in general, the transmitted vibration can travel a further distance in bedrock.

7.2.3 Stations

Operational activities at the stations are not expected to generate significant GBV to neighbouring structures as the train speed is lower approaching and leaving the stations. Further, trains are proposed to be vibration-isolated between the tracks and stations, further reducing GBV from the stations. However, the maximum train speed was considered in this assessment. This is considered the worst-case (conservative) operation scenario based on the pre- and post-hour service deployment in which the train may not stop at the station. Therefore, to determine unmitigated worst-case impacts, the station is considered in this assessment to be standard track without the train slowing.

7.2.4 Operations, Maintenance and Storage Facility

Trains in the OMSF and associated marshaling yards are expected to operate at low speeds and are not a concern for GBV to neighbouring residences. The maintenance activities in the facility are not a source of GBV. Therefore, an assessment for vibration originating from the OMSF is not included in this assessment.

7.2.5 Joint Corridor Operations

As the subway line crosses the Don River from the Don Yard Portal, it will enter the joint Ontario Line Subway/GO corridor segment at-grade where the subway tracks will run on the northwest side the existing Lakeshore East/Stouffville GO Rail service lines (the Joint Corridor). The Ontario Line study area in the Joint Corridor is shared with GO and VIA train traffic. GO Trains are heavier and faster than the OL trains and as a result, the GBV impacts of a GO or VIA passby are expected to be much higher than the OL train. The GBV or GBN impact due to GO or VIA train passbys is assessed separately from the Project. Detailed analysis of combined vibration impacts (i.e., OL and GO trains) or mitigation measures for GO trains is not included in the scope of this vibration impact assessment. Refer to Appendix Q for more information on the joint corridor segments.

7.3 Methodology

This section describes the methodology for the Project operational vibration assessment.

7.3.1 General Assumptions

For this operational vibration assessment, OLTA has made the following assumptions:

- The tunnel depth is based on the tunnel profile, with tunnels at depths of 25-30 m, with depths reduced as they come to portal openings at grade
- OL trains travel at maximum operational speed of 80 km/hr
- Propagation of vibration in the OL Joint Corridor is not efficient
- Direct fixation trackwork will be used for the unmitigated tracks
- Depth of receptor building foundation are considered to be:
    - Residential house – 3 m below grade
    - Highrise tower 15 storey or below – 7 m below grade
    - Highrise tower more than 15 storey – 13 m below grade

For the downtown tunnel, building foundation documents were reviewed as described in Section 7.4.1.1, but for ease of assessment, the building categories above were defined to capture building depths along the alignment.

7.3.2 Point of Reception Locations

The PORs for this vibration assessment were identified using a proximity approach to the Project components and building uses (e.g., residential, institutional/commercial, concert halls/TV studios). Vibration impacts were predicted at sixty-five (65) representative PORs along the alignment and the results were compared to the vibration criteria in Table 7-2. The identified representative PORs are summarized in Table 7-4 to Table 7-6. The approximate locations of the PORs are shown in Figures I-1-1 to I-1-18 in Appendix I.

7.3.3 Operational Vibration Assessment Methodology

For this assessment, the criteria and analysis methodology provided in the US FTA Manual for GBV assessments were used to estimate the potential impact of GBV generated by the future operation of the Project.

The prediction of operational vibration impact on the identified receptors was conducted in accordance with the general vibration assessment procedure proposed by the US FTA Manual. The basic approach for the general vibration assessment is to utilize a base curve that predicts the overall GBV as a function of distance from the source, as follows:

$$L_v = 85.88 - 1.06\log(D) - 2.32\log(D)^2 - 0.87\log(D)^3$$

Where:

L_v = vibration velocity level, VdB (ref. 1 micro-in/sec)

D = slope distance between closest track and building foundation, ft

Adjustments to the curve are then applied to account for factors such as vehicle speed, geological conditions, building type, and receiver location within the building.

A source adjustment factor for speed is applied to the above GBV equation when vehicle speeds deferred from the reference speed of 80.5 km/hr. For the purposes of this assessment, the trains were considered to be travelling at 100% operational speeds for each segment. The speeds are expected to be lower along curved segments of track, as well as between locations where the trains come to a stop and have limited distance to accelerate (i.e., tail tracks, stations). The speed profiles shown in Appendix M were reviewed and 80 km/hr was identified as the maximum speed along the corridor during pre-startup operations. The maximum OL train speed assessed in this analysis is conservatively assessed as 80 km/hr.

The adjustment for speed was applied using the following equation provided in the US FTA Manual.

$$Adj_{speed}(dB) = 20\log\left(\frac{speed}{speed_{ref}}\right)$$

Where:

Adj_{speed} = adjustment factor for speed

Speed = speed of vehicle (km/hr)

Speedref = reference speed of 80.5 km/hr

Additional adjustment factors were applied according to the US FTA Manual. The applied parameters and assumptions used in this analysis for each section are summarized in Table 7-3.

The conversion from GBV to GBN was conducted based on the dominant frequency provided by the US FTA Manual. It should be noted that for a significant mitigation option providing more than 5 dB of attenuation, the dominant frequency was considered to be below 30 Hz (low frequency) in accordance with the US FTA Manual.

Table 7-3. FTA Vibration Model Inputs and Assumptions

	Source/Path Factor	Downtown Underground	Pape Underground	Elevated Track
Train Definition	Train Type	LRT		
	Train Speed	80 km/h		
	Stiff Suspension	No		
	Resilient Wheels	No		
	Worn Wheels	No		
Rail Definition	Rail Type	Continuous Welded Rail		
	Worn or Corrugated Track	No		
	Special Trackwork	Yes (identified crossovers)		
Path Definition	Efficient Propagation in Soil	Yes	Yes	Yes
	Propagation in Rock Layer	Yes	No	No
GBN Conversion	Dominant Frequency	High (> 60 Hz) - Tunnel in bedrock	Typical (30 - 60 Hz)	Typical (30 - 60 Hz)

7.4 Potential Impacts, Mitigation Measures and Monitoring Activities

The predicted vibration impacts on the identified PORs are summarized in this section.

7.4.1 Impact Assessment

7.4.1.1 Downtown Section (OLW/OLS)

A total of forty-six (46) PORs were identified for assessment in the Downtown section of the alignment between the Exhibition Station area and the Don Yard, including residential, institutional, and sensitive receptors identified that may require special attention. These include Bell Media and Super Sonics Post Production (assessed as "TV/Recording studios"), the Four Seasons Centre for the Performing Arts (assessed as "Concert Hall") and several receptors assessed as "Theatres", including the Factory Theatre, Elgin Winter Garden, Alumnae Theatre Company, Canadian Stage, and the Young Centre for the Performing Arts.

All PORs were assessed for GBV and GBN at the 1st floor. Building depths were determined from City of Toronto building information, architectural and structural drawings, or other sources of information such as the number of parking levels below ground. Where such information was not available, residential towers up to 15 storeys were considered to have a foundation depth of 7 m and residential towers of 15 to 50+ storeys to have a foundation depth of 13 m. The assessed distances from the rail to the receptor (building foundation) are given in Table 7-4, where the distance represents the direct path from the rail to the nearest foundation element.

The predicted GBV and GBN levels with and without mitigation measures are summarized in Table 7-4. As indicated in the table, implementation of vibration mitigation of track will be required for much of the underground tunnel section. Section 7.4.3 describes the potential mitigation options considered for this assessment. Details of the mitigation measures are provided in Section 7.4.4 (alternative mitigation that achieves the same vibration isolation may be considered)

7.4.1.2 Joint Corridor (OLS)

The assessment of potential vibration impacts due to the operation of the OL trains in the Joint Corridor sections of the Project (OLS) are addressed in the following reports:

- AECOM – Metrolinx Noise and Vibration Operations Report – Ontario Line and GO Lakeshore East Joint Corridor (November 2021)
- AECOM – Metrolinx Noise and Vibration Operations Report – Ontario Line and GO Lakeshore West Joint Corridor (February 2022)

These are included as reference in Appendix Q.

7.4.1.3 Pape Section (OLN)

The Pape tunnel will run under predominantly residential neighbourhoods with low-rise (2-3 storey) houses and some apartment blocks. It was noted that these low-rise houses may also have basement apartments. Vibration impact was assessed at fourteen representative residential PORs between Gerrard Portal and Minton Place Portal, as listed in Table 7-5.

To provide a conservative assessment, the houses are considered to be wooden frame housing (i.e., with brick veneer), soil propagation was considered to be efficient (i.e., vibration propagates for longer distances with less energy loss), and vibration impacts were assessed at the first floor of dwellings since they are likely to contain bedrooms. Building foundations were considered to be 3 m below grade.

The predicted GBV and GBN levels with and without mitigation measures are summarized in Table 7-5. As indicated in the table, implementation of vibration mitigation of track will be required on the entire Pape tunnel section. Details of the mitigation measures are provided in Section 7.4.4. Mitigation options are described in Section 7.4.3.

7.4.1.4 Thorncliffe Section (OLN)

Five vibration sensitive PORs were identified in the section from Don Valley Parkway to Ontario Science Centre. Normally, the elevated track is not a significant vibration source due to the mass of the elevated concrete structure. However, if the supporting pier is directly placed on or adjacent to the foundation structure of a building, then there could be a concern. The track alignment is not shown to have piers adjacent or on building structures for the Thorncliffe section. Vibration impact was assessed at the identified PORs as listed in Table 7-6.

The predicted GBV and GBN levels without mitigation measures are summarized in Table 7-6. As indicated in the table, no vibration mitigation of the track will be required on the entire elevated section as compliance with criteria is expected.

7.4.2 Impact Assessment Results

Table 7-4 to Table 7-6 provide the full vibration impact assessment results for Ontario Line at the assessed PORs. Predicted vibration levels that are above the criteria are shown as bold. The mitigation options listed in the tables are described in Section 7.4.3 and provide a conceptual recommendation that can be feasibly implemented to meet the Project limits.

Table 7-4. Operational Vibration Impacts – Downtown Section (OLW/OLS)

Receptor				Vibration Criteria		Predicted Vibration: Unmitigated		Required Attenuation[4] (dB)	Mitigation Option for Minimum Attenuation to meet Criteria	Predicted Vibration: Mitigated	
POR ID	Building Type	Description	Slope Distance[1] (m)	GBV[2] (mm/s)	GBN[3] (dBA)	GBV[2] (mm/s)	GBN[3] (dBA)			GBV[2] (mm/s)	GBN[3] (dBA)
VO_POR01	Institutional	2 Fraser Ave	20	0.14	40	**0.447**	50	**10**	**Light Mass-Spring System**	0.140	25
VO_POR02	Residence	59 E Liberty St	32	0.1	35	0.025	**40**	**5**	**High-Resilience Fasteners**	0.014	35
VO_POR03	Residence	51 E Liberty St	27	0.1	35	0.032	**42**	**7**	**Light Mass-Spring System**	0.010	2
VO_POR04	Residence	Future development [5]	24	0.1	35	0.035	**43**	**8**	**Light Mass-Spring System**	0.011	3
VO_POR05	Residence	11 – 25 Ordnance St	19	0.1	35	0.045	**45**	**10**	**Light Mass-Spring System**	0.014	5
VO_POR06	Residence	125 / 133 Niagara St [5]	51	0.1	35	0.016	**36**	**1**	**High-Resilience Fasteners**	0.009	31
VO_POR07	Residence	89-109 Niagara St [5]	25	0.1	35	0.032	**42**	**7**	**Light Mass-Spring System**	0.010	2
VO_POR08	Residence	601 Wellington St W	34	0.1	35	0.040	**44**	**9**	**Light Mass-Spring System**	0.013	4
VO_POR09	Residence	64-86 Bathurst St [5]	18	0.1	35	0.045	**45**	**10**	**Light Mass-Spring System**	0.014	5
VO_POR10	Residence	647-665 King St W [5]	19	0.1	35	0.040	**44**	**9**	**Light Mass-Spring System**	0.013	4
VO_POR11	Residence	525 Adelaide St W	19	0.1	35	0.040	**44**	**9**	**Light Mass-Spring System**	0.013	4
VO_POR12	Theatre	125 Bathurst St (Factory Theatre)	72	0.1	35	0.014	35	0	N/A	N/A	N/A
VO_POR13	Residence	115 Portland St [5]	60	0.1	35	0.013	34	0	N/A	N/A	N/A
VO_POR14	Residence	135-141 Portland St [5]	21	0.1	35	0.040	**44**	**9**	**Light Mass-Spring System**	0.013	4
VO_POR15	Residence	534 Richmond St W	33	0.1	35	0.045	**45**	**10**	**Light Mass-Spring System**	0.014	5
VO_POR16	Residence	520 Richmond St W [5]	23	0.1	35	0.035	**43**	**8**	**Light Mass-Spring System**	0.011	3
VO_POR17	Residence	322 / 324 Queen St W [5]	33	0.1	35	0.025	**40**	**5**	**High-Resilience Fasteners**	0.014	35
VO_POR18	Residence	375 Queen St W [5]	23	0.1	35	0.035	**43**	**8**	**Light Mass-Spring System**	0.011	3
VO_POR19	TV Studios	299 Queen St W (Bell Media)	28	0.045	25	0.028	**41**	**16**	**Floating Slab**	0.005	0
VO_POR20	Institutional	180 Queen St W	16	0.14	40	0.050	**46**	**6**	**Light Mass-Spring System**	0.016	6

Receptor				Vibration Criteria		Predicted Vibration: Unmitigated		Required Attenuation[4] (dB)	Mitigation Option for Minimum Attenuation to meet Criteria	Predicted Vibration: Mitigated	
POR ID	Building Type	Description	Slope Distance[1] (m)	GBV[2] (mm/s)	GBN[3] (dBA)	GBV[2] (mm/s)	GBN[3] (dBA)			GBV[2] (mm/s)	GBN[3] (dBA)
VO_POR21	Residence	219 Queen St W	18	0.1	35	0.035	**43**	**8**	**Light Mass-Spring System**	0.011	3
VO_POR22	Concert Halls	145 Queen St W (Four Seasons)	22	0.045	25	0.035	**43**	**18**	**Floating Slab**	0.006	0
VO_POR23	Residence	123 Queen St W (Sheraton Centre)	6	0.1	35	0.100	**52**	**17**	**Light Mass-Spring System**	0.032	12
VO_POR24	Institutional	20 Queen St W	23	0.14	40	0.035	**43**	**3**	**High-Resilience Fasteners**	0.020	38
VO_POR25	Institutional	2 Queen St E	21	0.14	40	0.040	**44**	**4**	**High-Resilience Fasteners**	0.022	39
VO_POR26	Theatre	189 Yonge St (Elgin Winter Garden)	64	0.1	35	0.016	**36**	**1**	**High-Resilience Fasteners**	0.009	31
VO_POR27	Institutional	30 Bond St (St Mike's Patient Tower)	22	0.14	40	0.112	**53**	**13**	**Floating Slab**	0.020	8
VO_POR28	Residence	89 Queen St E	30	0.1	35	0.028	**41**	**6**	**Light Mass-Spring System**	0.009	1
VO_POR29	Residence	88 Queen St E [5]	20	0.1	35	0.040	**44**	**9**	**Light Mass-Spring System**	0.013	4
VO_POR30	Residence	90-104 Queen St E [5]	20	0.1	35	0.040	**44**	**9**	**Light Mass-Spring System**	0.013	4
VO_POR31	Residence	209 Queen St E	38	0.1	35	0.020	**38**	**3**	**High-Resilience Fasteners**	0.011	33
VO_POR32	Residence	265-283 Queen St E [5]	17	0.1	35	0.045	**45**	**10**	**Light Mass-Spring System**	0.014	5
VO_POR33	Residence	132 Berkeley St	23	0.1	35	0.035	**43**	**8**	**Light Mass-Spring System**	0.011	3
VO_POR34	Recording studios	135 Berkeley St (Super Sonics Post Production)	68	0.045	25	0.014	**35**	**10**	**Light Mass-Spring System**	0.004	0
VO_POR35	Residence	470-472 Richmond St E	27	0.1	35	0.032	**42**	**7**	**Light Mass-Spring System**	0.010	2
VO_POR36	Residence	120 Parliament St	15	0.1	35	0.050	**46**	**11**	**Light Mass-Spring System**	0.016	6
VO_POR37	Theatre	70 Berkeley St (Alumnae Theatre Company)	15	0.1	35	0.071	**49**	**14**	**Light Mass-Spring System**	0.022	9
VO_POR38	Residence	318 King St E	16	0.1	35	0.050	**46**	**11**	**Light Mass-Spring System**	0.016	6
VO_POR39	Theatre	26 Berkeley St (Canadian Stage)	16	0.1	35	0.071	**49**	**14**	**Light Mass-Spring System**	0.022	9
VO_POR40	Residence	39 Parliament St	12	0.1	35	0.063	**48**	**13**	**Light Mass-Spring System**	0.020	8
VO_POR41	Residence	37 Parliament St [5]	13	0.1	35	0.056	**47**	**12**	**Light Mass-Spring System**	0.018	7
VO_POR42	Theatre	50 Tank House Lane (Young Centre for the Performing Arts)	102	0.1	35	0.008	30	0	N/A	N/A	N/A

Receptor				Vibration Criteria		Predicted Vibration: Unmitigated		Required Attenuation[4] (dB)	Mitigation Option for Minimum Attenuation to meet Criteria	Predicted Vibration: Mitigated	
POR ID	Building Type	Description	Slope Distance[1] (m)	GBV[2] (mm/s)	GBN[3] (dBA)	GBV[2] (mm/s)	GBN[3] (dBA)			GBV[2] (mm/s)	GBN[3] (dBA)
VO_POR43	Residence	125 Mill St [5]	51	0.1	35	0.014	35	0	N/A	N/A	N/A
VO_POR44	Residence	Future Development [5]	61	0.1	35	0.045	30	0	N/A	N/A	N/A
VO_POR45	Residence	Future Development [5]	37	0.1	35	0.089	**36**	**1**	**High-Resilience Fasteners**	0.050	31
VO_POR46	Institutional	Future development (TDSB) [5]	42	0.14	40	0.079	35	0	N/A	N/A	N/A

Notes:
[1] Slope distance is the direct distance from the rail to the building foundation/pile.
[2] GBV: Ground-borne Vibration in mm/s (RMS)
[3] GBN: Ground-borne Noise in dBA (ref. 20 micro-Pa)
[4] Required attenuation in dB is the greater of GBV above criterion (measured in VdB re: 10 nm/sec) or GBN above criterion.
[5] Future development assessed.

Table 7-5. Operational Vibration Impacts – Pape Section (OLN)

Receptor				Vibration Criteria		Predicted Vibration: Unmitigated		Required Attenuation[4] (dB)	Mitigation Option for Minimum Attenuation to meet Criteria	Predicted Vibration: Mitigated	
POR ID	Building Type	Description	Slope Distance[1] (m)	GBV[2] (mm/s)	GBN[3] (dBA)	GBV[2] (mm/s)	GBN[3] (dBA)			GBV[2] (mm/s)	GBN[3] (dBA)
VO_POR47	Residence	235 Langley Ave	33	0.1	35	**0.158**	**41**	**6**	**Light Mass-Spring System**	0.050	16
VO_POR48	Institutional	220 Langley Ave	7	0.14	40	**0.447**	**50**	**15**	**Light Mass-Spring System**	0.140	25
VO_POR49	Residence	409 Pape Ave	19	0.1	35	**0.282**	**46**	**11**	**Light Mass-Spring System**	0.089	21
VO_POR50	Residence	450 Pape Ave	17	0.1	35	**0.282**	**46**	**11**	**Light Mass-Spring System**	0.089	21
VO_POR51	Residence	506 Pape Ave	23	0.1	35	**0.224**	**44**	**9**	**Light Mass-Spring System**	0.071	19
VO_POR52	Residence	566 Pape Ave	29	0.1	35	**0.178**	**42**	**7**	**Light Mass-Spring System**	0.056	17
VO_POR53	Residence	4 Hazelwood Ave	26	0.1	35	**0.200**	**43**	**8**	**Light Mass-Spring System**	0.063	18
VO_POR54	Residence	810 Pape Ave	27	0.1	35	**0.200**	**43**	**8**	**Light Mass-Spring System**	0.063	18
VO_POR55	Residence	261 Fulton Ave	38	0.1	35	**0.447**	**50**	**15**	**Floating Slab**	0.079	20
VO_POR56	Residence	179 Gowan Ave	15	0.1	35	**0.316**	**47**	**12**	**Light Mass-Spring System**	0.100	22
VO_POR57	Residence	95 Gamble Ave	17	0.1	35	**0.158**	**41**	**6**	**Light Mass-Spring System**	0.050	16
VO_POR58	Residence	1100 Pape Ave	17	0.1	35	**0.282**	**46**	**11**	**Light Mass-Spring System**	0.063	18
VO_POR59	Residence	12 Minton Place	13	0.1	35	**0.355**	**48**	**13**	**Light Mass-Spring System**	0.079	20
VO_POR60	Residence	154 Hopedale Ave	9	0.1	35	**0.316**	**47**	**12**	**Floating Slab**	0.063	18

Notes:

1 Slope distance is the direct distance from the rail to the building foundation/pile.

2 GBV: Ground-borne Vibration in mm/s (RMS)

3 GBN: Ground-borne Noise in dBA (ref. 20 micro-Pa)

4 Required attenuation is the greater of GBV above criterion or GBN above criterion.

Table 7-6. Operational Vibration Impacts – Thorncliffe Section (OLN)

Receptor				Vibration Criteria		Predicted Vibration: Unmitigated		Required Attenuation[4] (dB)	Mitigation Option for Minimum Attenuation to meet Criteria
POR ID	Building Type	Description	Distance[1] (m)	GBV[2] (mm/s)	GBN[3] (dBA)	GBV[2] (mm/s)	GBN[3] (dBA)		
VO_POR61	Institutional	2 Overlea Blvd. (Salvation Army)	15	0.14	40	0.056	32	0	N/A
VO_POR62	Residence	1 Leaside Park Dr	50	0.1	35	0.018	22	0	N/A
VO_POR63	Institutional	16 Overlea Blvd.	9	0.14	40	0.112	38	0	N/A
VO_POR64	Residence	797 Don Mills Rd.	14	0.1	35	0.063	33	0	N/A
VO_POR65	Theatre	770 Don Mills Rd North (IMAX Science Centre)	38	0.1	35	0.040	29	0	N/A

Notes:

1 Distance is the horizontal distance from the base of the elevated guideway pier to the building.

2 GBV: Ground-borne Vibration in mm/s (RMS)

3 GBN: Ground-borne Noise in dBA (ref. 20 micro-Pa)

4 Required attenuation is the greater of GBV above criterion or GBN above criterion.

7.4.3 Track Mitigation Options

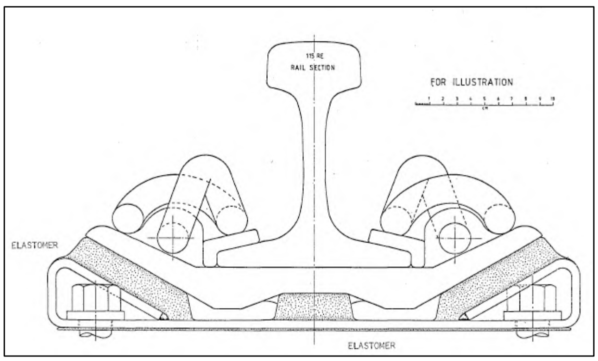
The operational vibration impact assessment indicates that feasible mitigation options can be identified for GBV or GBN for all Project sections to meet Project limits, and that the elevated track in the OLN section is not anticipated to require mitigation. Details of mitigation options recommended based on the current conceptual design are described in this section.

Three track treatment options are proposed as GBV or GBN mitigation measures for the Project and are described below. Note that alternative designs may be considered providing that they achieve the same attenuation presented below.

7.4.3.1 Resilient Rail Fastener

High attenuation resilient rail fasteners, such as those illustrated in Figure 7-1, are used to fasten the rails to the ties or to the concrete track slabs. By making use of fasteners that are less stiff in the vertical direction, it is possible to reduce the GBV or GBN by as much as 4 to 8 dB at frequencies above 30 to 40 Hz. In this assessment, a 5 dB reduction is considered in accordance with the US FTA Manual.

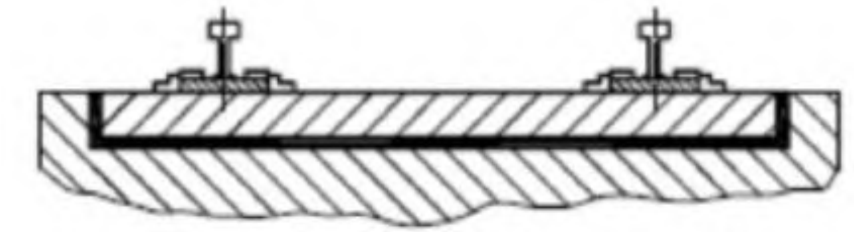
Figure 7-1. Schematic of Resilient Rail Fastener



7.4.3.2 Light Mass-Spring (LMS) System

A light mass-spring (LMS) system, such as the one illustrated in Figure 7-2, is an isolation system using a continuous resilient pad between the rail track and the concrete base. Depending on the stiffness and the mass of the concrete, this system provides approximately 8 to 10 dB of reduction in the frequency range above 15 Hz. In this assessment, a 10 dB reduction is considered. Light mass-spring system attenuation is not identified in the US FTA manual; the mat reduction in the FTA has therefore been adopted.

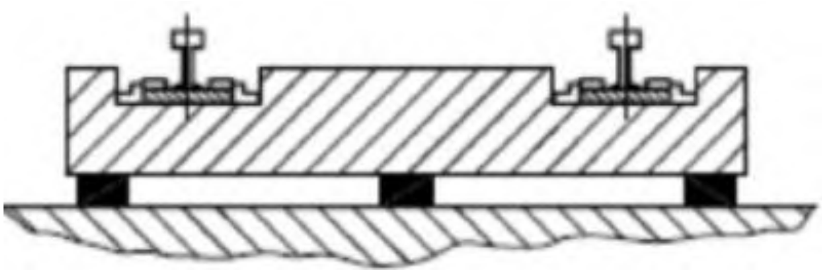
Figure 7-2. Schematic of Light Mass-Spring System



7.4.3.3 Floating Slab Track (FST)

Floating slab track (FST) consists of a "floating concrete rail slab" sitting within a concrete trough separated by an elastic resilient material with an airspace, as illustrated in Figure 7-3. The slab and resilient material act as a light mass-spring system. In high load situations, or where a high reduction in vibration is required, the slab can be supported by resilient pads (or steel coil springs) on a concrete foundation. The tracks are then mounted on or within the floating slab, depending on the need for direct fixation or embedded rail. Vibration mitigation can be improved by selecting isolation materials for the rail fixing. This mitigation method may provide up to a 15 dB reduction in vibration as used in the US FTA Manual. The design frequency of typical continuous or double-tie floating slabs is 16 Hz. However, the isolation frequency of low-frequency floating slabs may be on the order of 5 to 8 Hz.

Figure 7-3. Schematic of Floating Slab Track



7.4.4 Vibration Mitigation Recommendations

7.4.4.1 Vibration Mitigation – Downtown Section (OLW/OLS)

For the Downtown section of the alignment, a combination of high-resilience fasteners, LMS system, and FST system are recommended (or alternative mitigation that achieves the same vibration isolation) to control GBV and GBN, as listed in Table 7-4.

For the at-grade section near Exhibition Station, all PORs were identified exceeding the GBN limits and some exceed GBV limits. Since POR location VO_POR01 is the end of OL Project, the operational speed will be less than 80 km/h. Therefore, the actual vibration impact will be lower than predicted and a lesser mitigation option is expected to be sufficient.

For the tunnel, the assessment indicates that GBV is at or below the limit at all PORs but that without mitigation GBN exceeds the limit at most PORs due to the dominant frequency of rock-confined tunnel. Therefore, some form of mitigation is required along the entire downtown tunnel to control GBN in building interiors. The assessment demonstrates that the three sites with the highest potential for impact can be addressed by applying the most significant mitigation, FST (or alternative mitigation that achieves the same vibration isolation). These locations are:

- Bell Media at 299 Queen St. West (VO_POR18)
- Four Seasons Centre for the Performing Arts at 145 Queen Street West (VO_POR21)
- St. Michael's Hospital at 36 Queen Street East (VO_POR25)

Due to the flexible character of FST, transition track sections of at least half a train length are required at both ends of the FST to avoid abrupt changes in system deflection behaviour.

7.4.4.2 Vibration Mitigation – Joint Corridor (OLS)

Vibration mitigation for the Joint Corridor is addressed within separate reports (AECOM, November 2021/February 2022, Appendix Q).

7.4.4.3 Vibration Mitigation – Pape Section (OLN)

For the Pape section of the alignment, the assessment demonstrates that mitigation can be effectively achieved through a combination of LMS system and FST system is recommended (or alternative mitigation that achieves the same vibration isolation) to control GBV and GBN, as listed in Table 7-5. The LMS system provides an effective mitigation approach for the entire Pape section except for the following two locations as shown in the figure, where greater mitigation may be required:

- Double crossover near 810 Pape Avenue (VO_POR55)
- Minton Place Portal near 154 Hopedale Avenue (VO_POR61)

FST is recommended (or alternative mitigation that achieves the same vibration isolation) for the double crossover and the Minton Place Portal area due to the high vibration generated from the crossover and the shallow depth of the portal area.

7.4.4.4 Vibration Mitigation – Thorncliffe Section (OLN)

No mitigation is required for the elevated track sections, as listed in Table 7-6.

7.4.5 Vibration Monitoring Program

Detailed operational monitoring procedures are recommended and will be defined further in the design process as the design is finalized. The following procedures are preliminary recommendations and will be refined as design progresses.

Operational vibration from train movements on tracks to be monitored annually for representative receptors for at least the first 5 years of operation. The monitored locations should be approximately equally distributed along the Project Footprint and vary from year to year. Priority should be placed on locations near special trackwork or tight-radius curves.

The monitored locations should be approximately equally distributed along the Project Footprint and vary from year to year. Priority should be placed on locations near special trackwork or tight-radius curves.

7.4.6 Follow-Up

This assessment is preliminary based on current design and the inputs and assumptions listed in Section 7.3. For the Downtown and Pape tunnel sections, a detailed impact analysis should be performed as indicated by the US FTA Manual to better determine the vibration propagation characteristics of the soil at each site.

7.4.7 Permits and Approvals

No permits or approvals are identified for operational vibration on the Project.

7.4.8 Summary of Potential Impacts, Mitigation Measures and Monitoring Activities

Table 7-7 summarizes the mitigation measures and monitoring activities discussed in this Section 7.

Table 7-7. Summary of Potential Impacts, Mitigation and Monitoring for Operations Vibration

Environmental Component	Potential Impact	Mitigation Measure(s)	Monitoring
Operations Vibration	Vibration may cause cosmetic damage or impact human comfort.	For the Downtown section of the alignment, mitigation is required to control GBV and GBN. Mitigation options are identified in this report to meet applicable criteria, including high-resilience fasteners, LMS system, and FST system. Alternative mitigations can be considered provided they meet applicable vibration limits For the tunnel, mitigation is required along the entire downtown tunnel to control GBN in building interiors. FST, is recommended at three (3) locations (or alternative mitigation that achieves the same vibration isolation): • Bell Media at 299 Queen St. West • Four Seasons Centre for the Performing Arts at 145 Queen Street West • St. Michael's Hospital at 36 Queen Street East Due to the flexible character of FST, transition track sections of at least half a train length are required at both ends of the FST to avoid changes in the depth of track as trains travel from regular track to the more flexible FST track. LMS system is recommended to be implemented through the entire Pape section of the alignment and FST is recommended at the following two locations: • Double crossover near 810 Pape Avenue • Minton Place Portal near 154 Hopedale Avenue An alternative mitigation method that achieves the same vibration isolation may also be used. No mitigation is required for the elevated track sections.	Detailed operational monitoring procedures are recommended and will be defined further as the design is finalized. The following procedures are preliminary recommendations and will be refined as design progresses: Operational vibration from train movements on tracks to be monitored for representative receptors and for at least the first 5 years of operation. The monitored locations should be approximately equally distributed along the Project Footprint and vary from year to year. Priority should be placed on locations near special trackwork or tight-radius curves. Additional example monitoring suggestions are included in Appendix L.

8 References

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Sign-Off Sheet

This document entitled Noise and Vibration Impact Assessment Report was prepared by Stantec Consulting Ltd. ("Stantec") as part of the Ontario Line Technical Advisor for the account of HDR Inc. (the "Client") and its end client Metrolinx. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by ______________________
(signature)

Mohammed Salim, P.Eng.
Senior Noise and Vibration Engineer

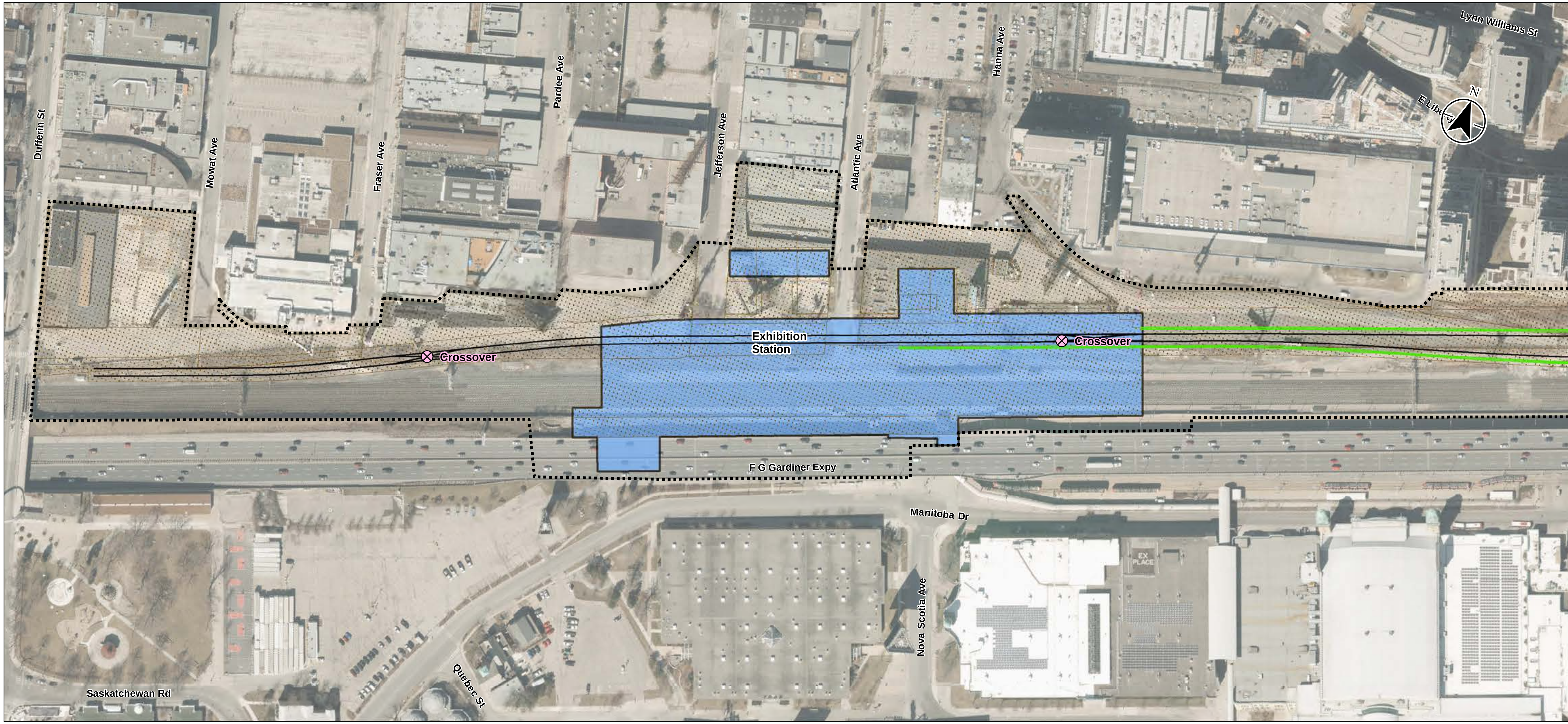
Prepared by ______________________
(signature)

Jihyun (Ken) Cho, PhD, P.Eng., INCE
Senior Noise and Vibration Engineer

Reviewed by Babic, Frank — Digitally signed by Babic, Frank Date: 2022.04.11 16:16:36 -04'00'
(signature)

Frank Babic, P.Eng., INCE
Principal, Acoustics Practice Area Lead Ontario

Appendix A. Project Component Figures



Legend

- Project Footprint

Alignment - Current

- Track Alignment Centerline
- Portal
- Crossover
- Station
- Construction Staging and Construction Area

0 40 80 metres

1:2,500 (At original document size of 11x17)

Notes

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Technical Review by CL on 2021-06-10

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Figure No.

A-1

Title

Project Footprint and Project Components

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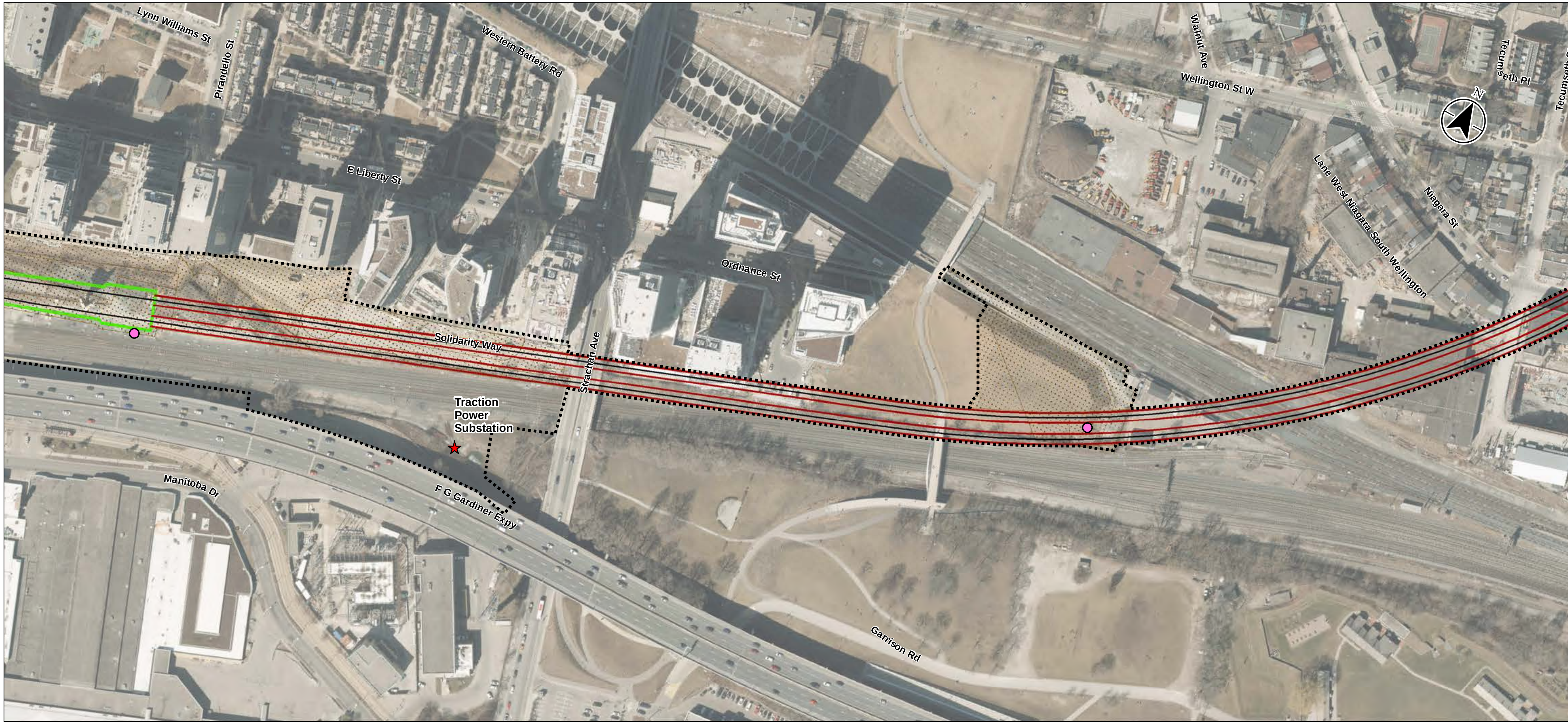

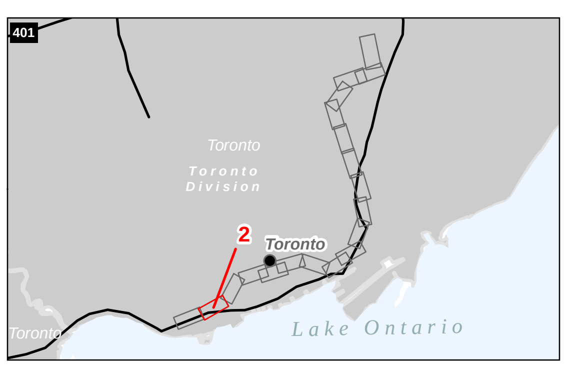

Legend

- Project Footprint

Alignment - Current

- Track Alignment Centerline
- Tunnels
- Portal
- Emergency Egress Building (EEB)
- Traction Power Substation
- Construction Staging and Construction Area

0 40 80 metres

1:2,500 (At original document size of 11x17)

Notes

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Figure No.
A-2

Title
Project Footprint and Project Components

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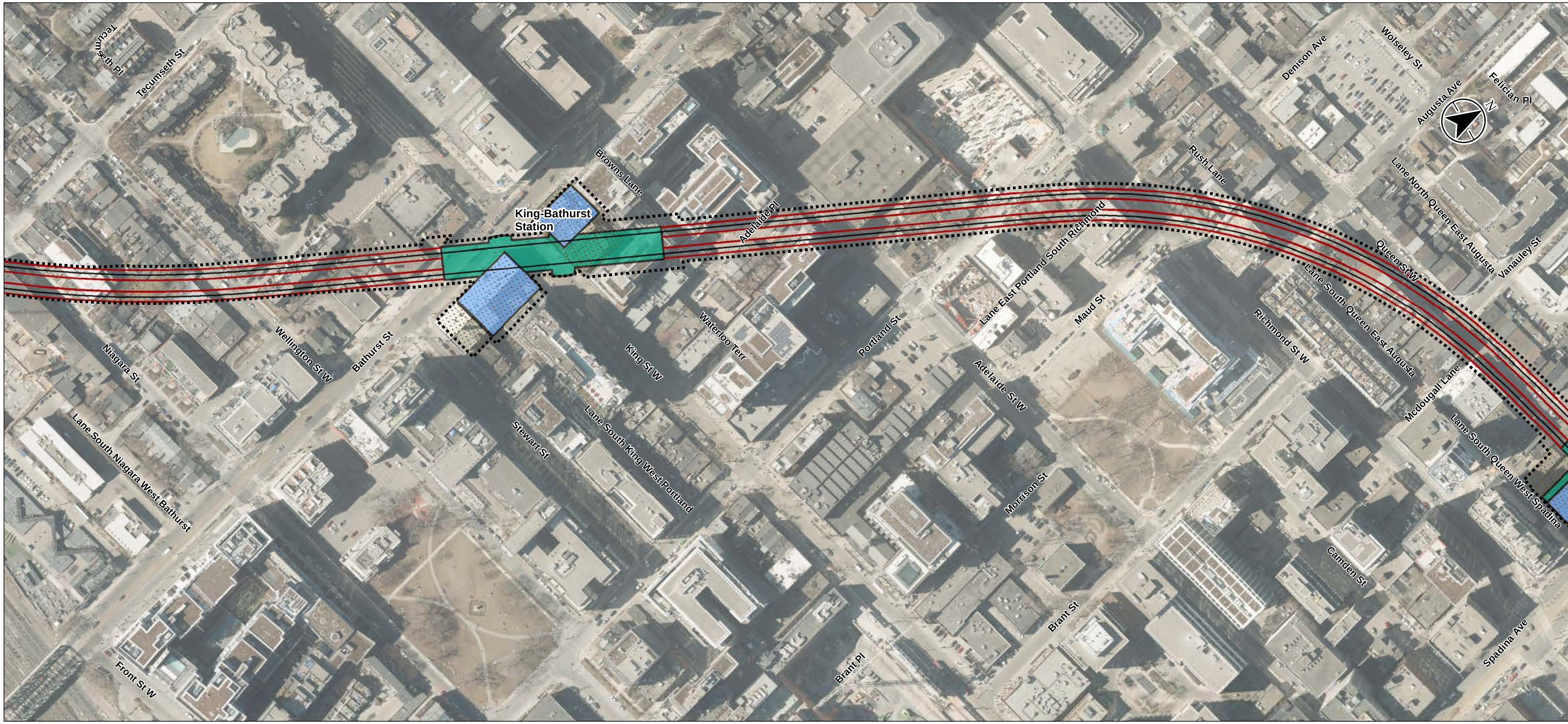

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Legend
- Project Footprint

Alignment - Current
- Track Alignment Centerline
- Tunnels
- Station
- Station Platform - Subsurface Level
- Construction Staging and Construction Area

0 40 80 metres
1:2,500 (At original document size of 11x17)

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Figure No.
A-3

Title
Project Footprint and Project Components

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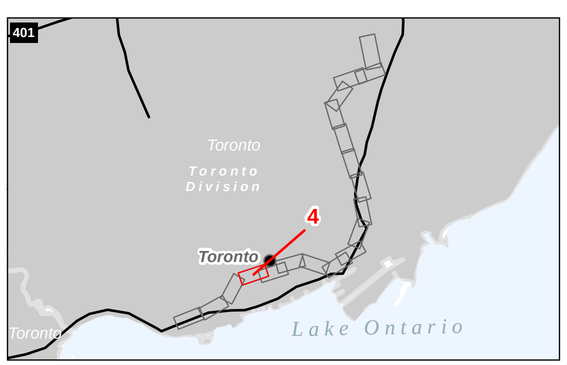

Legend

Project Footprint

Alignment - Current

Track Alignment Centerline

Tunnels

Station

Station Platform - Subsurface Level

Streetcar Diversion

Construction Staging and Construction Area

0 50 100 metres

1:3,000 (At original document size of 11x17)

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Figure No.
A-4

Title
Project Footprint and Project Components

Notes
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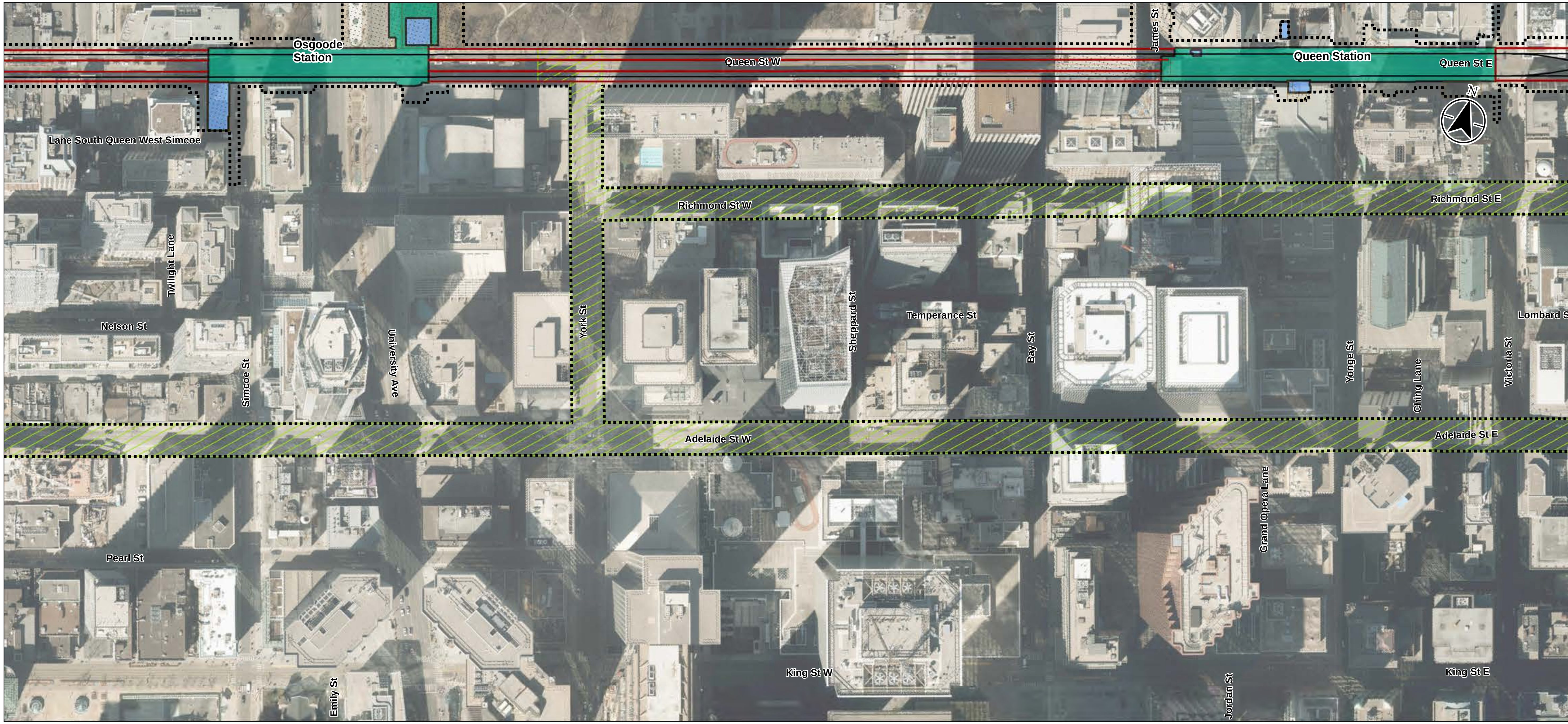

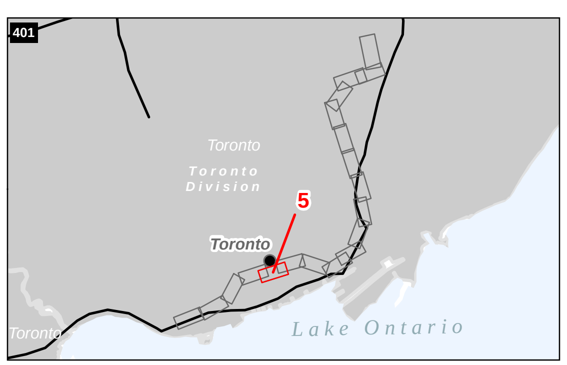

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Legend
- Project Footprint

Alignment - Current
- Track Alignment Centerline
- Tunnels
- Station
- Station Platform - Subsurface Level
- Streetcar Diversion
- Construction Staging and Construction Area

0 40 80 metres
1:2,500 (At original document size of 11x17)

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Figure No.
A-5

Title
Project Footprint and Project Components

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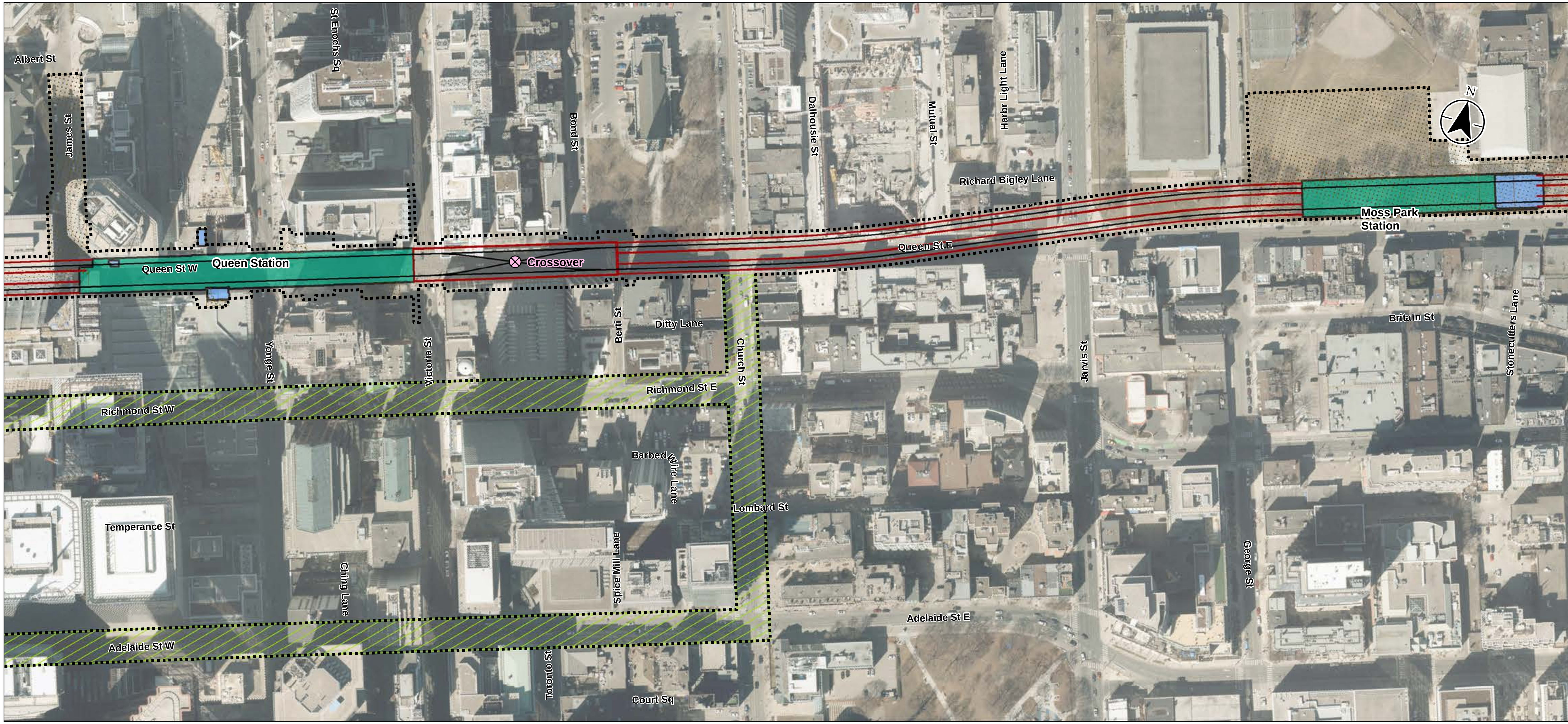

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Legend
- Project Footprint

Alignment - Current
- Track Alignment Centerline
- Tunnels
- Crossover
- Station
- Station Platform - Subsurface Level
- Streetcar Diversion
- Construction Staging and Construction Area

0 40 80 metres
1:2,500 (At original document size of 11x17)

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Figure No.
A-6

Title
Project Footprint and Project Components

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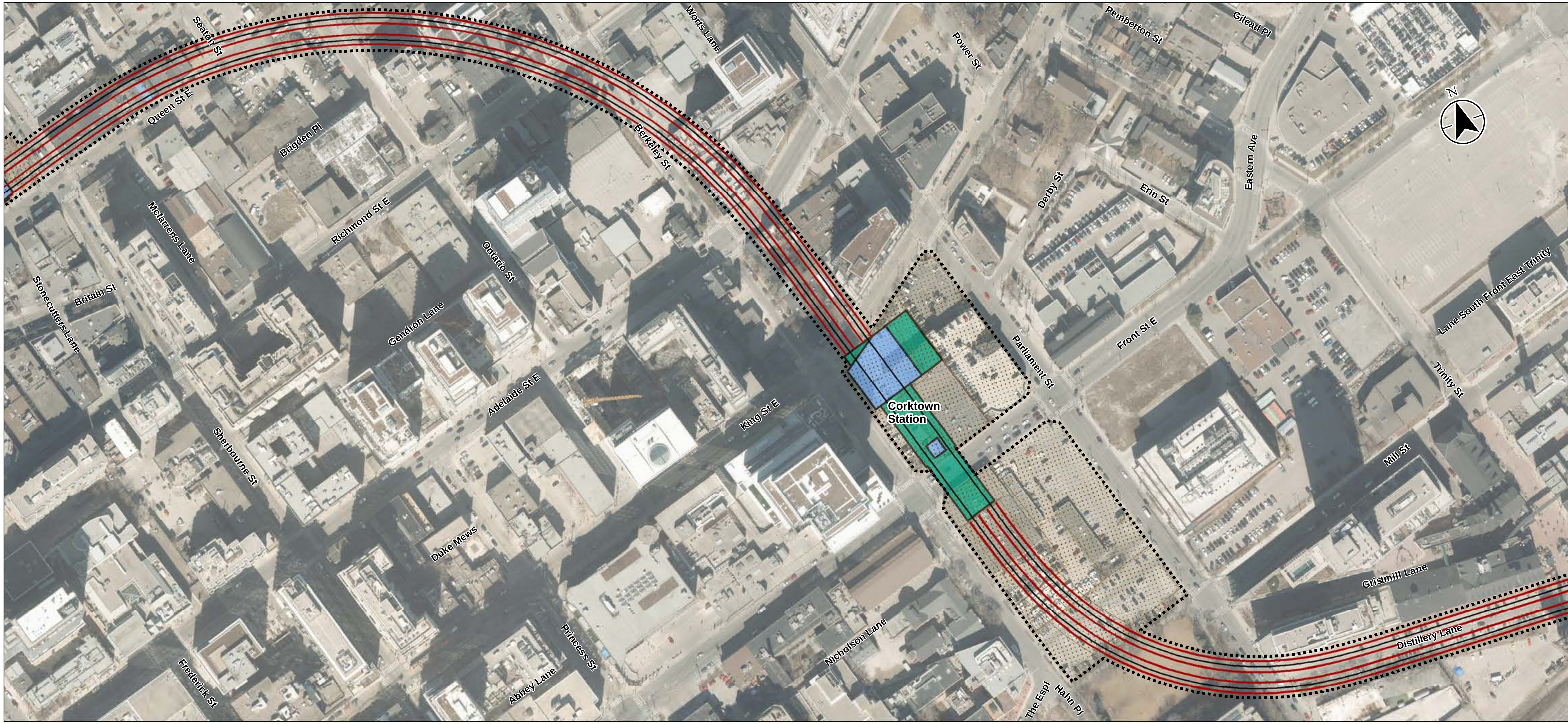

Legend

Project Footprint

Alignment - Current

- Track Alignment Centerline
- Tunnels
- Station
- Station Platform - Subsurface Level
- Construction Staging and Construction Area

0 40 80 metres

1:2,500 (At original document size of 11x17)

Notes

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Figure No.
A-7

Title
Project Footprint and Project Components

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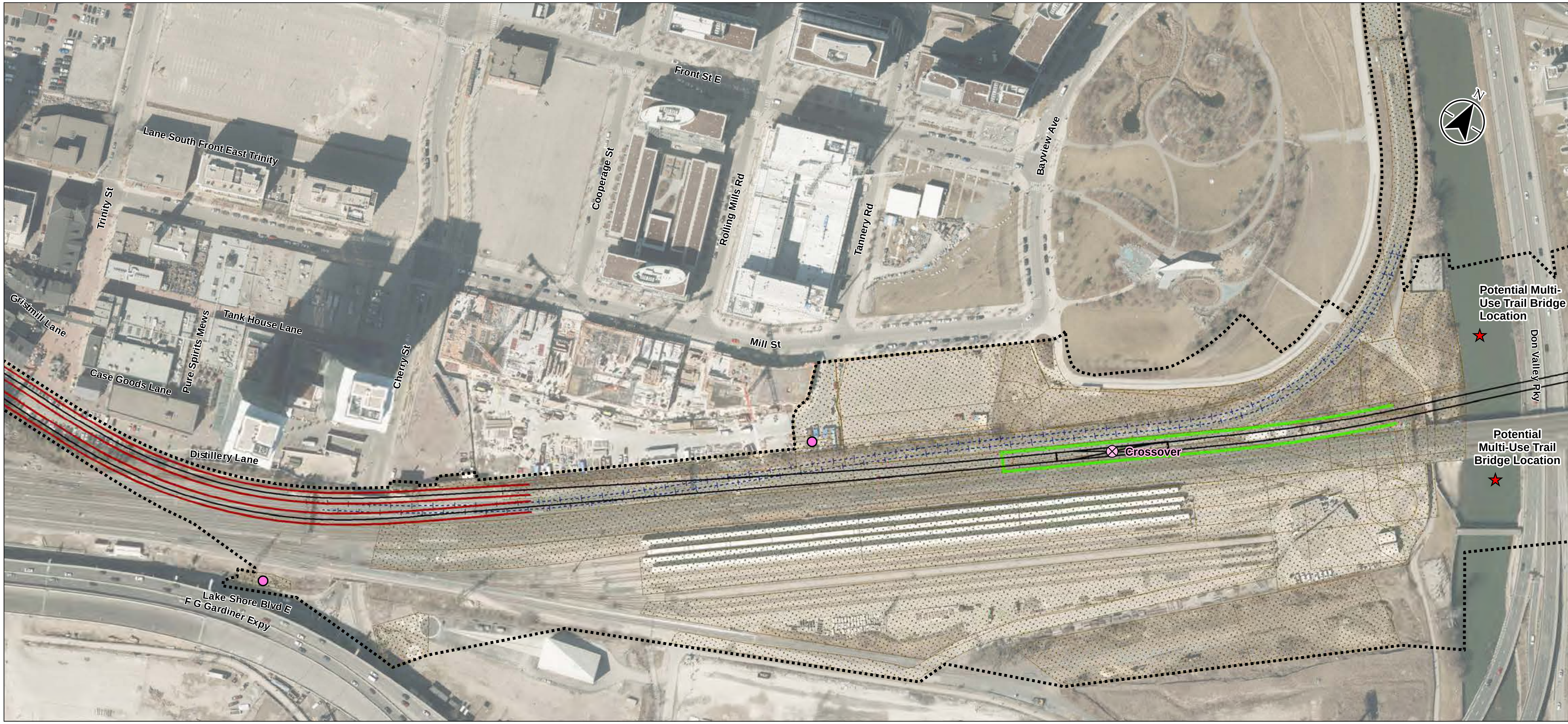

Legend

Project Footprint

Alignment - Current

- Track Alignment Centerline
- Tunnels
- Portal
- Emergency Egress Building (EEB)
- Crossover
- Potential Multi-Use Trail Bridge Location
- RH Final Alignment
- Construction Staging and Construction Area

0 40 80 metres

1:2,500 (At original document size of 11x17)

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Figure No.
A-8

Title
Project Footprint and Project Components

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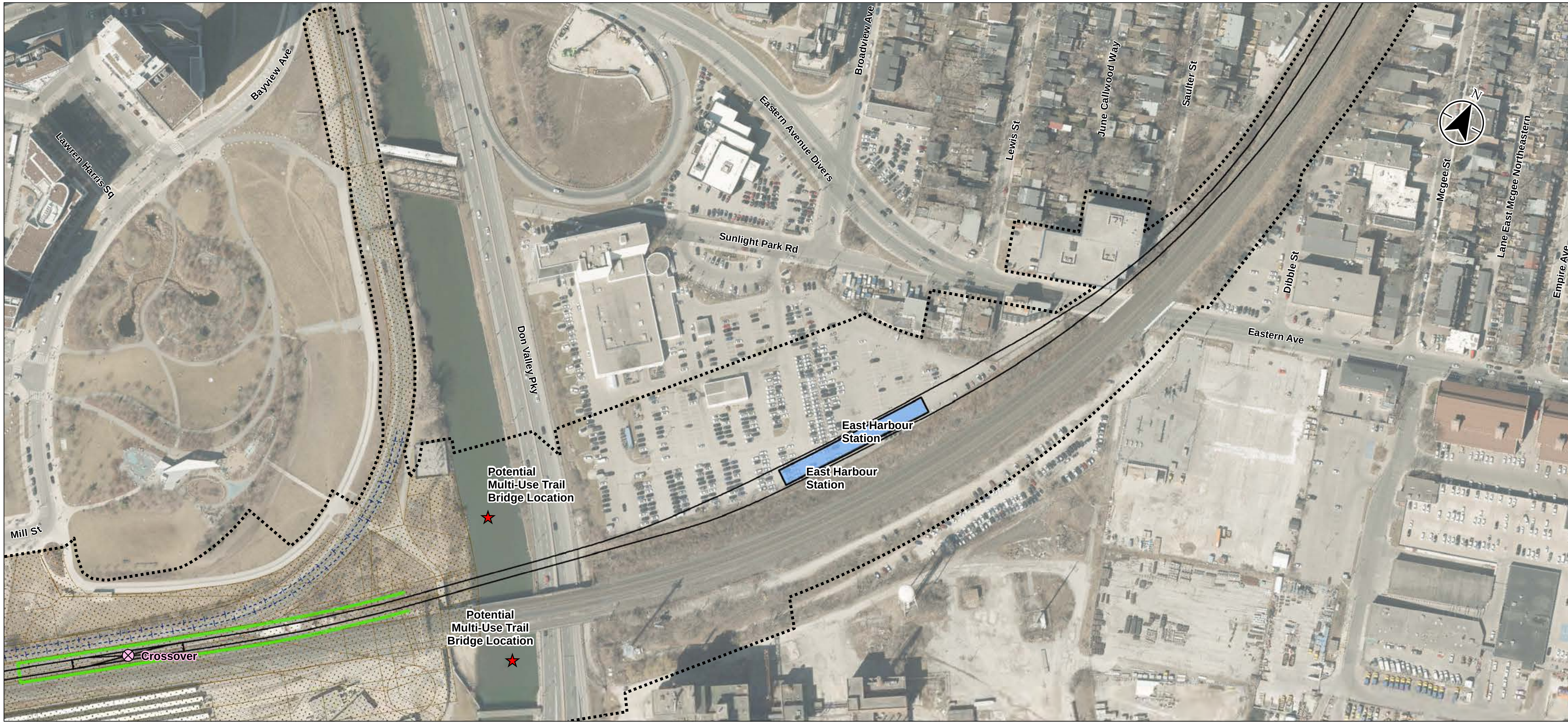

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Legend
- Project Footprint

Alignment - Current
- Track Alignment Centerline
- Portal
- Crossover
- Potential Multi-Use Trail Bridge Location
- RH Final Alignment
- Station
- Construction Staging and Construction Area

0 40 80 metres
1:2,500 (At original document size of 11x17)

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Figure No.
A-9

Title
Project Footprint and Project Components

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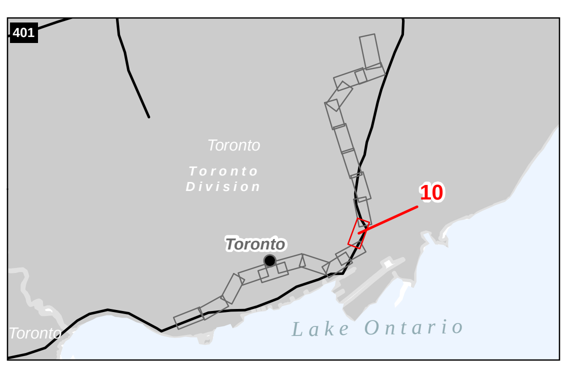

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Legend
- Project Footprint

Alignment - Current
- Track Alignment Centerline
- Station
- Construction Staging and Construction Area

0 40 80 metres
1:2,500 (At original document size of 11x17)

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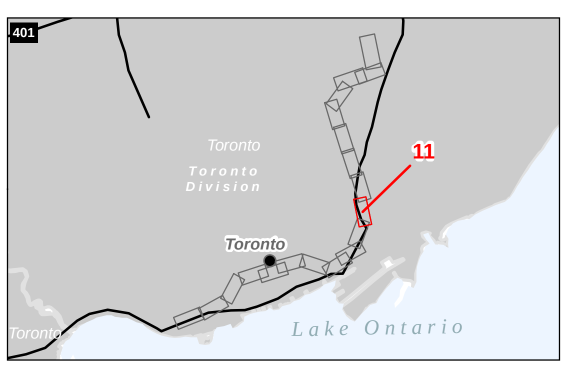
Figure No.
A-10

Title
Project Footprint and Project Components



Legend
- Project Footprint

Alignment - Current
- Track Alignment Centerline
- Tunnels
- Portal
- Emergency Egress Building (EEB)
- Proposed Sewer Relocation
- Station
- Construction Staging and Construction Area

0 40 80 metres
1:2,500 (At original document size of 11x17)

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Figure No.
A-11

Title
Project Footprint and Project Components

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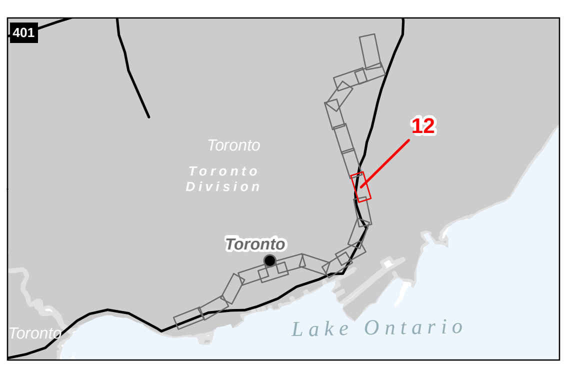

Legend

- Project Footprint

Alignment - Current

- Track Alignment Centerline
- Tunnels
- Emergency Egress Building (EEB)
- Station
- Station Platform - Subsurface Level
- Construction Staging and Construction Area

0 40 80 metres

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Figure No.
A-12

Title
Project Footprint and Project Components

Notes
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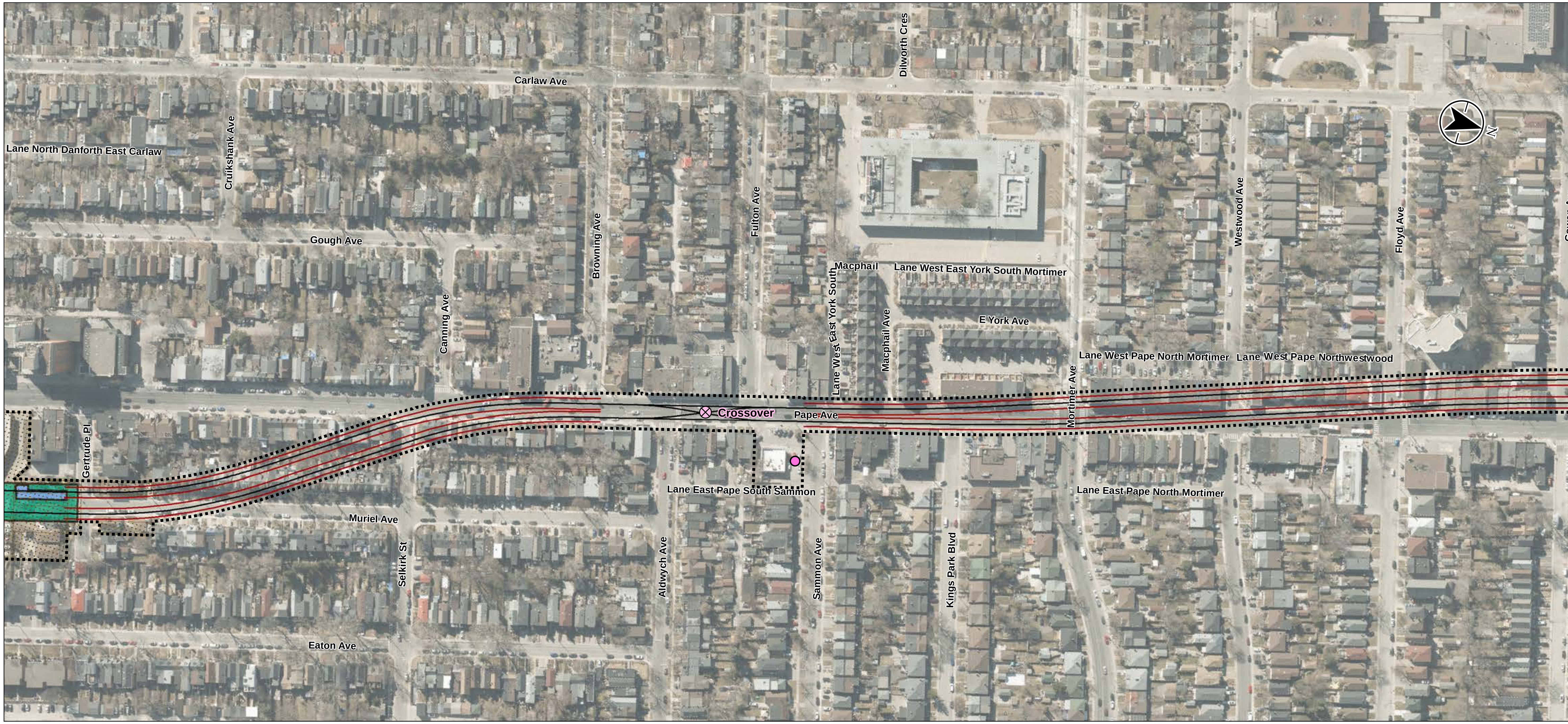

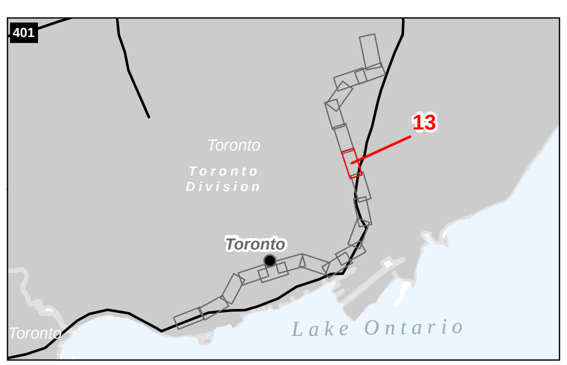

Legend

- Project Footprint

Alignment - Current

- Track Alignment Centerline
- Tunnels
- Emergency Egress Building (EEB)
- Crossover
- Station
- Station Platform - Subsurface Level
- Construction Staging and Construction Area

0 40 80 metres

1:2,500 (At original document size of 11x17)

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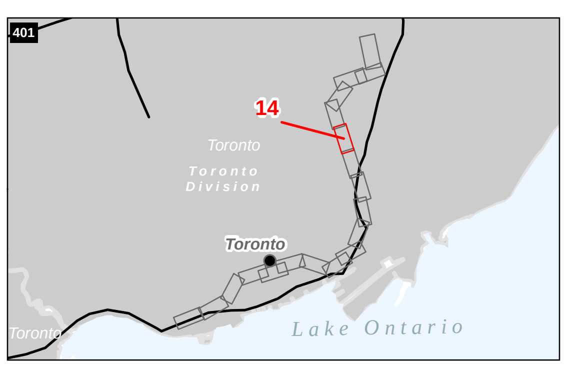
Figure No.
A-13

Title
Project Footprint and Project Components



Legend

- Project Footprint

Alignment - Current

- Track Alignment Centerline
- Tunnels
- Station
- Station Platform - Subsurface Level
- Construction Staging and Construction Area

0 40 80 metres

1:2,500 (At original document size of 11x17)

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Figure No.
A-14

Title
Project Footprint and Project Components

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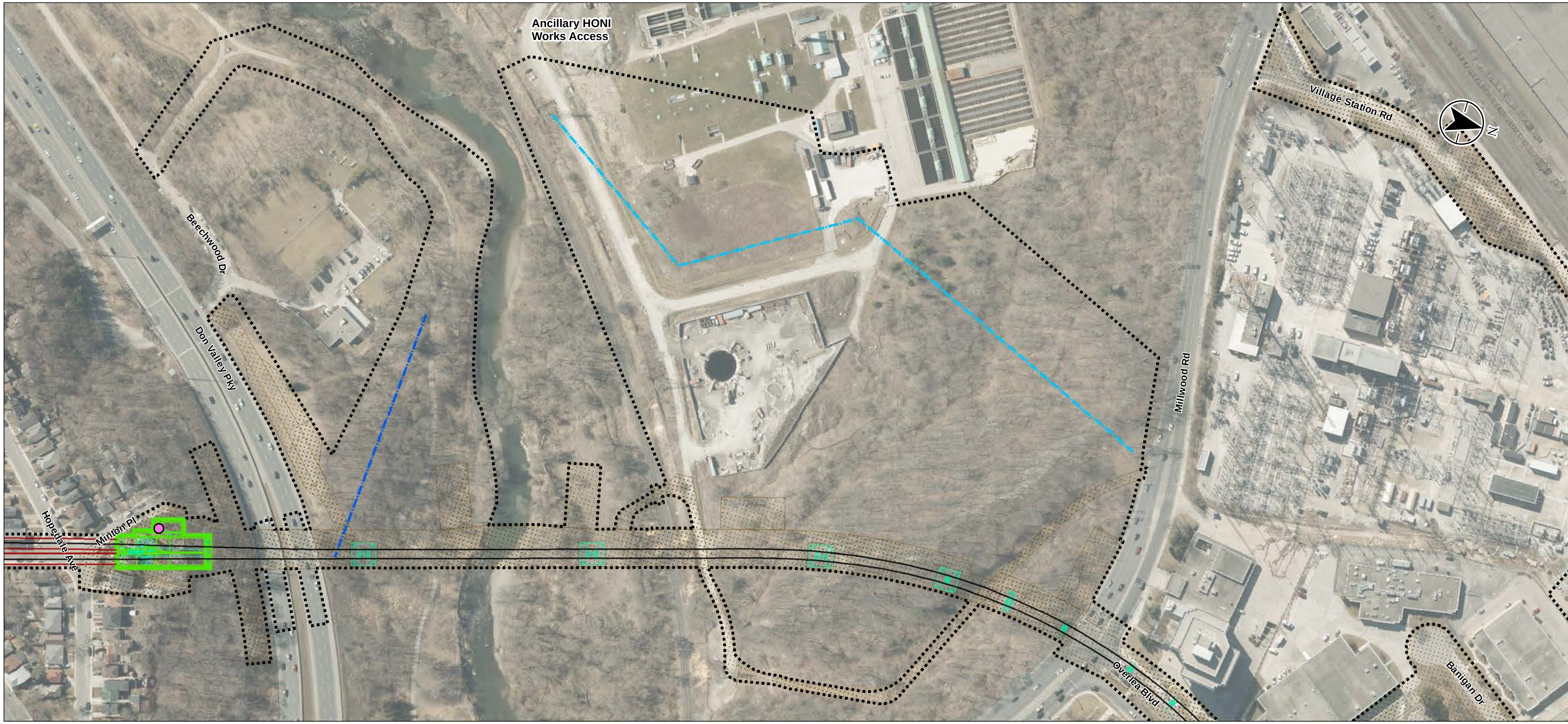

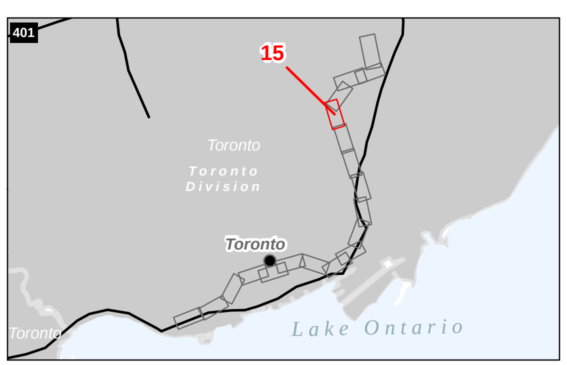

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Legend
- Project Footprint

Alignment - Current
- Track Alignment Centerline
- Tunnels
- Portal
- Elevated Guideway
- Emergency Egress Building (EEB)
- Proposed HONI Realignment
- Proposed Sewer Bypass
- Construction Staging and Construction Area

0 40 80 metres
1:2,500 (At original document size of 11x17)

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Figure No.
A-15

Title
Project Footprint and Project Components

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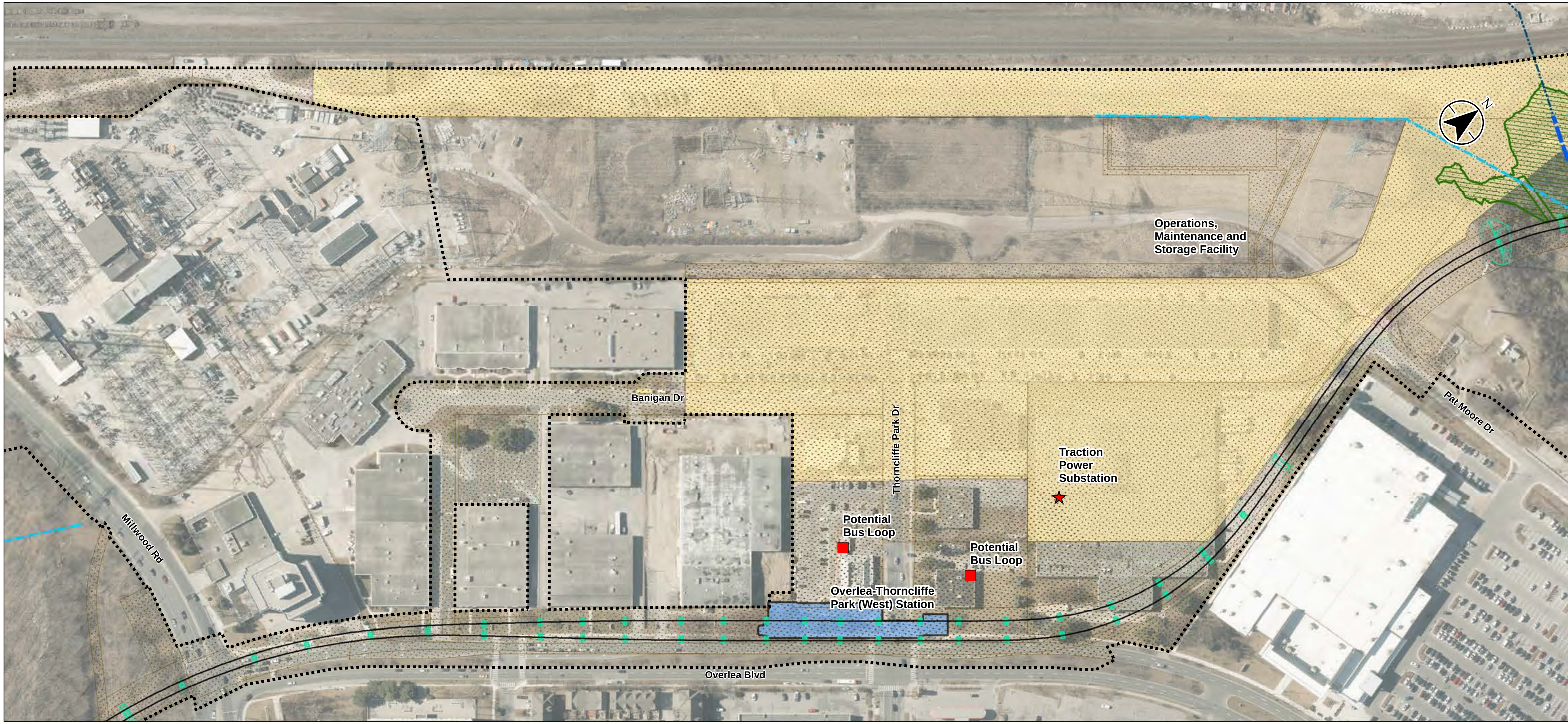

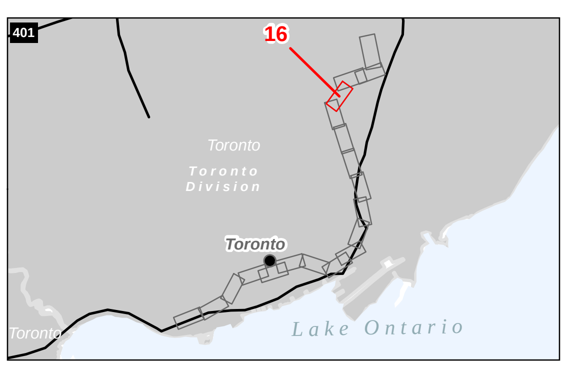

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Legend
- Project Footprint

Alignment - Current
- Track Alignment Centerline
- Elevated Guideway
- Potential Bus Loop
- Traction Power Substation
- Proposed HONI Realignment
- Existing Storm Sewer
- Storm Sewer Extension
- Station
- Operations, Maintenance and Storage Facility
- OMSF Bridge Fill Area
- Construction Staging and Construction Area

0 40 80 metres
1:2,500 (At original document size of 11x17)

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ONTARIO LINE TECHNICAL ADVISOR

Project Location
Toronto, ON

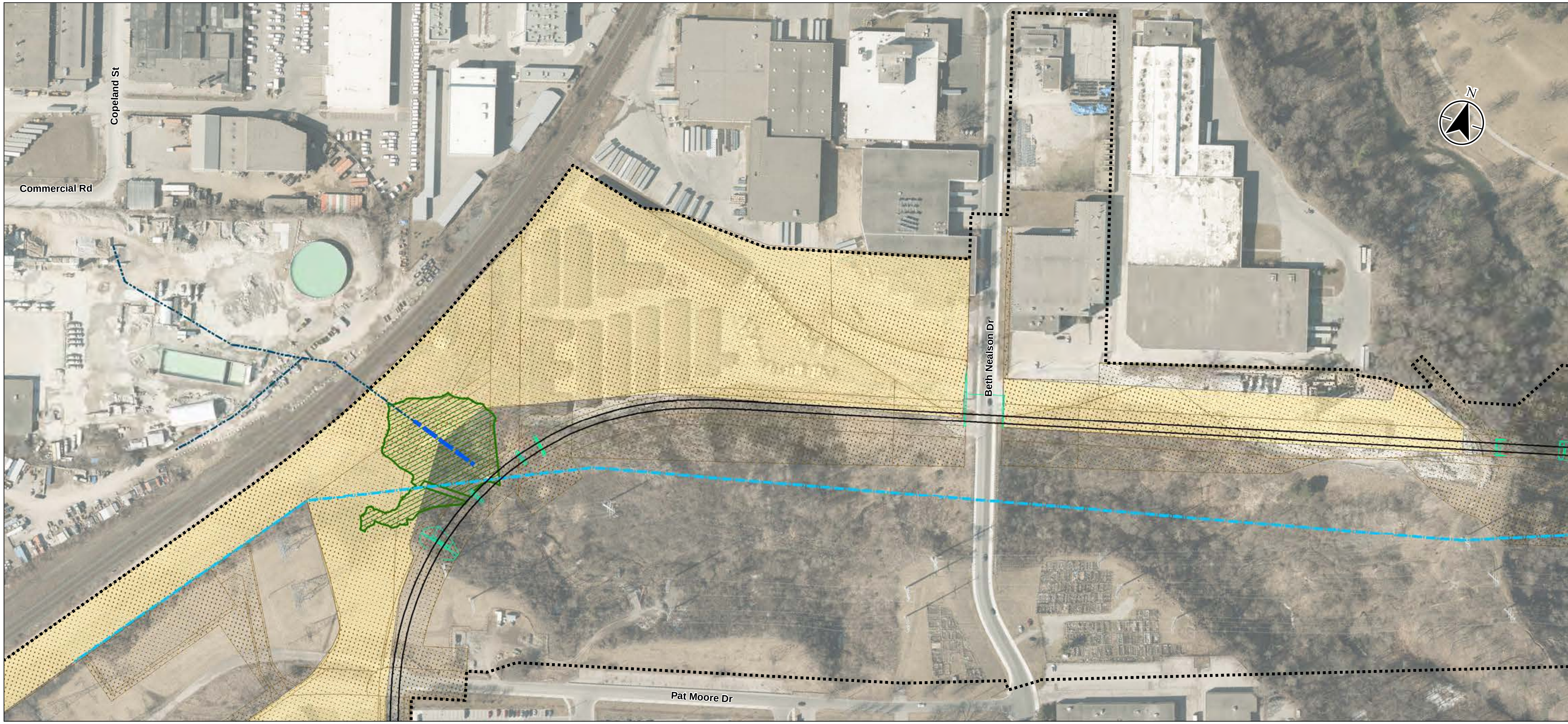
Prepared by BCC on 2022-03-10
Technical Review by CL on 2021-06-10

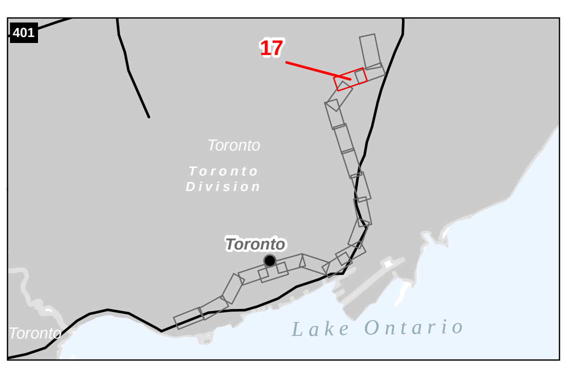
Client/Project
160560009 REVA
HDR CORPORATION
ONTARIO LINE TA

Figure No.
A-16

Title
Project Footprint and Project Components

\\cd1215-f01\work_group\01609\active\160560009\1_data\gis_cad\gis\mxds\atmospheric\report_figures\20211125_Noise_Report_rev4\160560009_NR_FigA1-19_ProjectFootprintMapbook.mxd Revised: 2022-03-10 By: bcowper





Legend

Project Footprint

Alignment - Current

Track Alignment Centerline

Elevated Guideway

Proposed HONI Realignment

Existing Storm Sewer

Storm Sewer Extension

Operations, Maintenance and Storage Facility

OMSF Bridge Fill Area

Construction Staging and Construction Area

0 50 100 metres

1:2,750 (At original document size of 11x17)

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ONETEAM
ONTARIO LINE TECHNICAL ADVISOR

Project Location
Toronto, ON

Prepared by BCC on 2022-03-10
Technical Review by CL on 2021-06-10

Client/Project
160560009 REVA
HDR CORPORATION
ONTARIO LINE TA

Figure No.
A-17

Title
Project Footprint and Project Components

Notes
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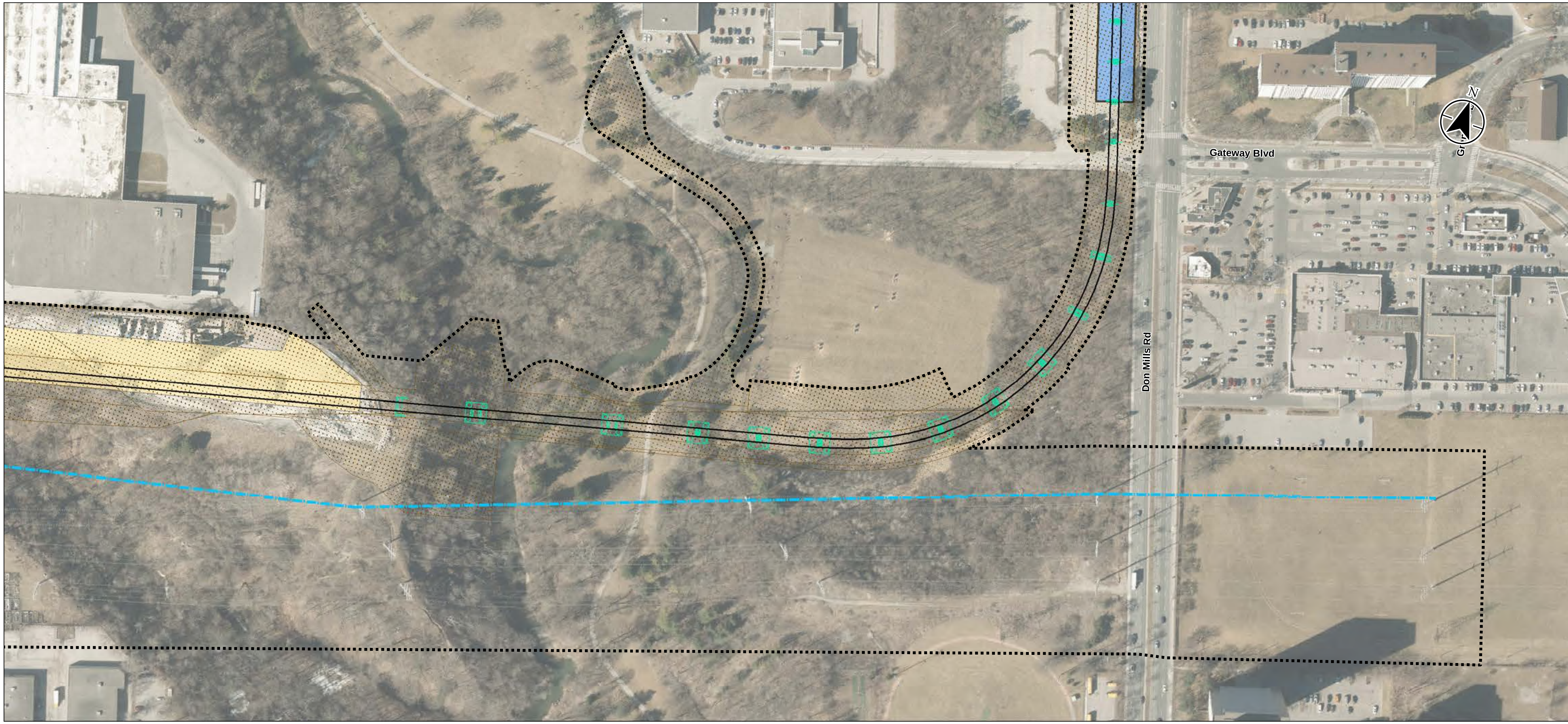

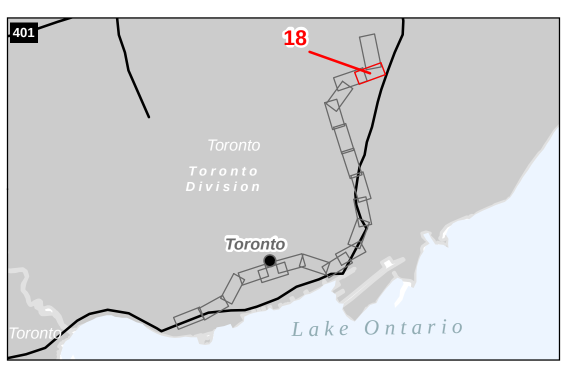

Legend

- Project Footprint

Alignment - Current

- Track Alignment Centerline
- Elevated Guideway
- Proposed HONI Realignment
- Station
- Operations, Maintenance and Storage Facility
- Construction Staging and Construction Area

0 40 80 metres

1:2,500 (At original document size of 11x17)

Notes

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ONE TEAM
ONTARIO LINE TECHNICAL ADVISOR

Project Location
Toronto, ON

Prepared by BCC on 2022-03-10
Technical Review by CL on 2021-06-10

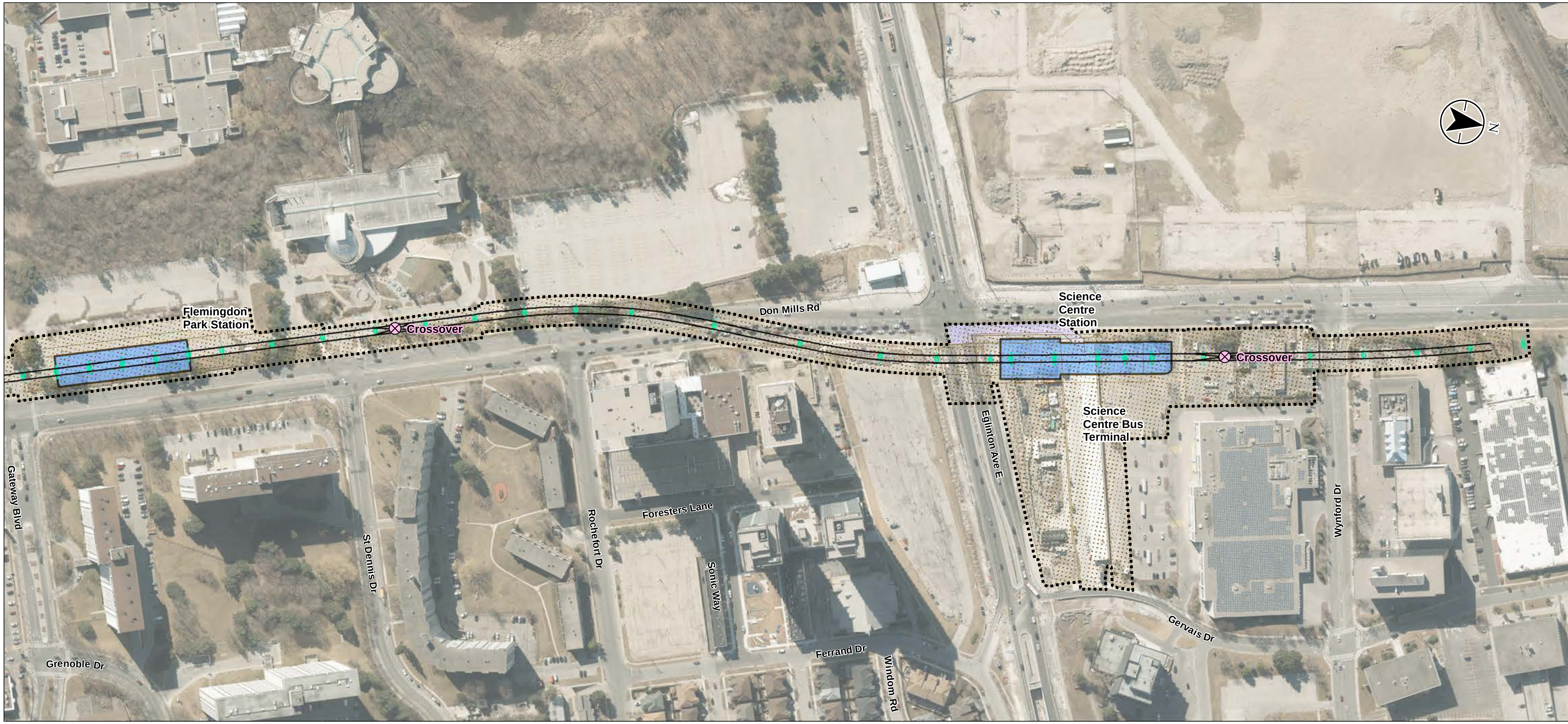
Client/Project
160560009 REVA

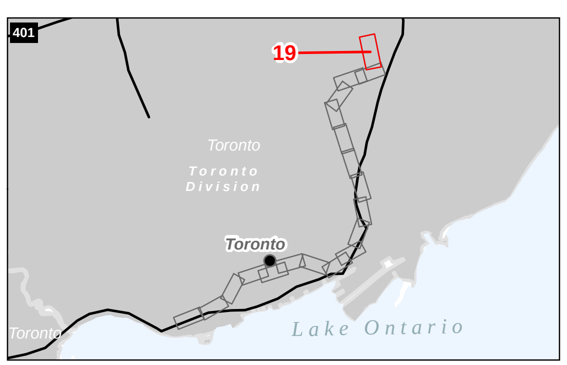
HDR CORPORATION
ONTARIO LINE TA

Figure No.
A-18

Title
Project Footprint and Project Components

\\cd1215-f01\work_group\01605\active\160560009\1_data\gis_cad\gis\mxds\atmospheric\report_figures\20211125_Noise_Report_rev4\160560009_NR_FigA1-19_ProjectFootprintMapbook.mxd Revised: 2022-03-10 By: bcowper





Legend

- Project Footprint

Alignment - Current

- Track Alignment Centerline
- Elevated Guideway
- Crossover
- Station
- Pedestrian Tunnel
- Construction Staging and Construction Area

0 50 100 metres

1:3,000 (At original document size of 11x17)

Notes

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Project Location
Toronto, ON

Prepared by BCC on 2022-03-10
Technical Review by CL on 2021-06-10

Client/Project
160560009 REVA
HDR CORPORATION
ONTARIO LINE TA

Figure No.
A-19

Title
Project Footprint and Project Components

\\cd1215-f01\work_group\01605\active\160560009\11_data\gis_cad\gis\mxds\atmospheric\report_figures\20211125_Noise_Report_rev4\160560009_NR_FigA1-19_ProjectFootprintMapbook.mxd Revised: 2022-03-10 By: bcowper

Appendix B. Study Area

![Stantec]

Legend

- Project Footprint
- Study Area (500 m Buffer)
- At or Above Grade Features
- Below Grade Features
- Waterbody

Notes
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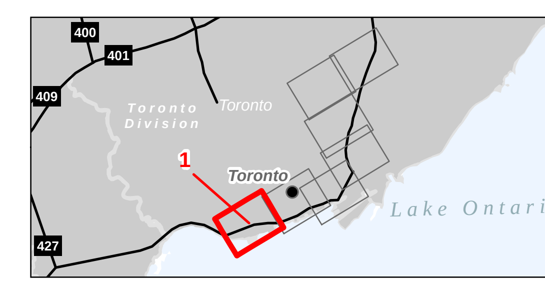


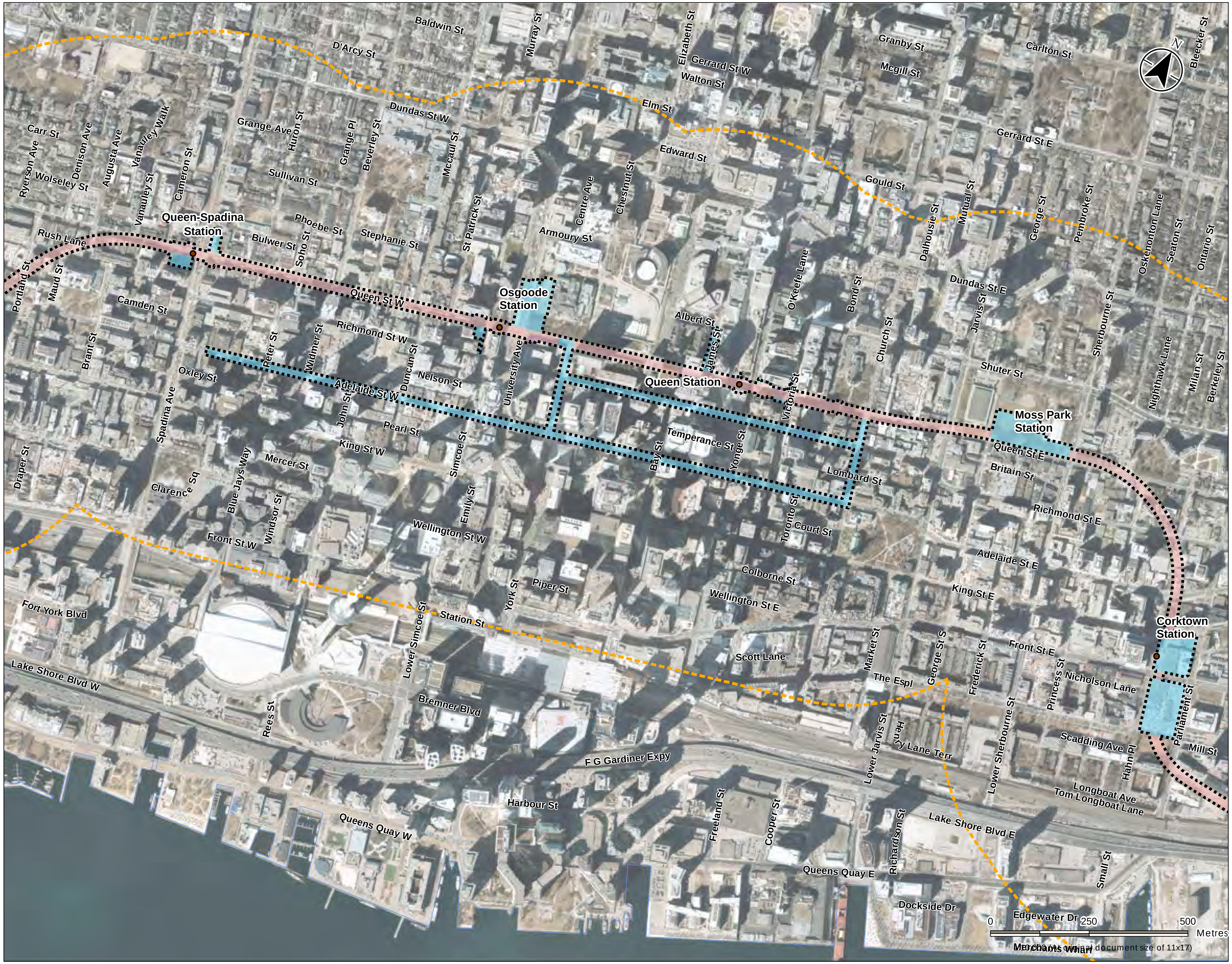
Project Location
City of Toronto, ON

160560009 REV4
Prepared by BCC on 2022-02-01
Technical Review by ABC on yyyy-mm-dd
Independent Review by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

Figure No.
B-1

Title
Project Study Area



Stantec

Legend

- Project Footprint
- Study Area (500 m Buffer)
- At or Above Grade Features
- Below Grade Features
- Waterbody

Notes

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Project Location
City of Toronto, ON

160560009 REV4
Prepared by BCC on 2022-02-01
Technical Review by ABC on yyyy-mm-dd
Independent Review by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

Figure No.
B-2

Title
Project Study Area

Stantec

Legend

- Project Footprint
- Study Area (500 m Buffer)
- At or Above Grade Features
- Below Grade Features
- Waterbody

Notes
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Project Location
City of Toronto, ON

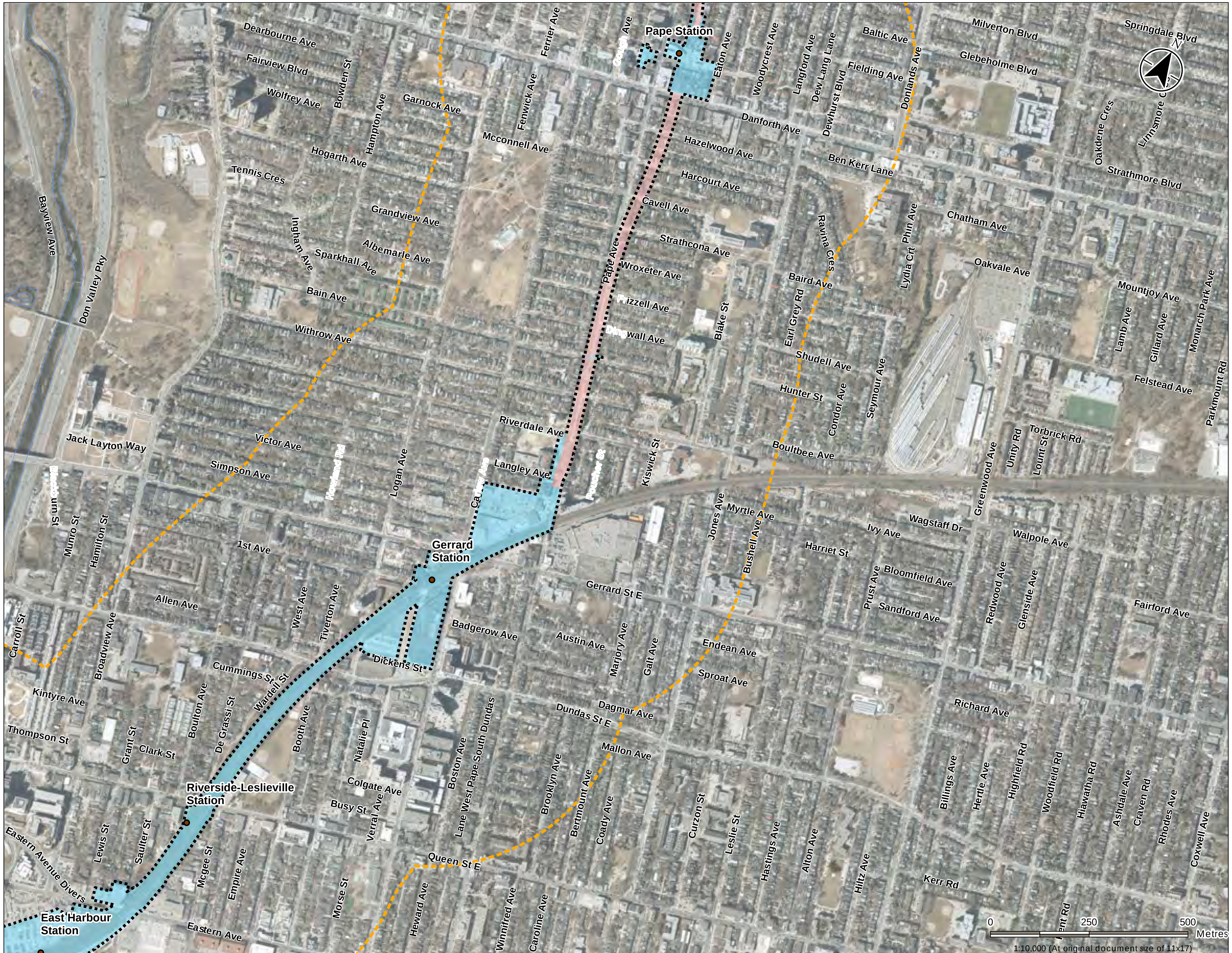
160560009 REV4
Prepared by BCC on 2022-02-01
Technical Review by ABC on yyyy-mm-dd
Independent Review by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

Figure No.
B-3

Title
Project Study Area

\\cd1215-f01\work_group\01605\active\160560009\11_data\gis_cad\gis\mxds\atmospheric\report_figures\20211125_Noise_Report_rev4\160560009_NR_FigB1-7_ProjectStudyAreaMapbook.mxd Revised: 2022-02-01 By: lvcourier



Stantec

Legend

- Project Footprint
- Study Area (500 m Buffer)
- At or Above Grade Features
- Below Grade Features
- Waterbody

Notes
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Project Location
City of Toronto, ON

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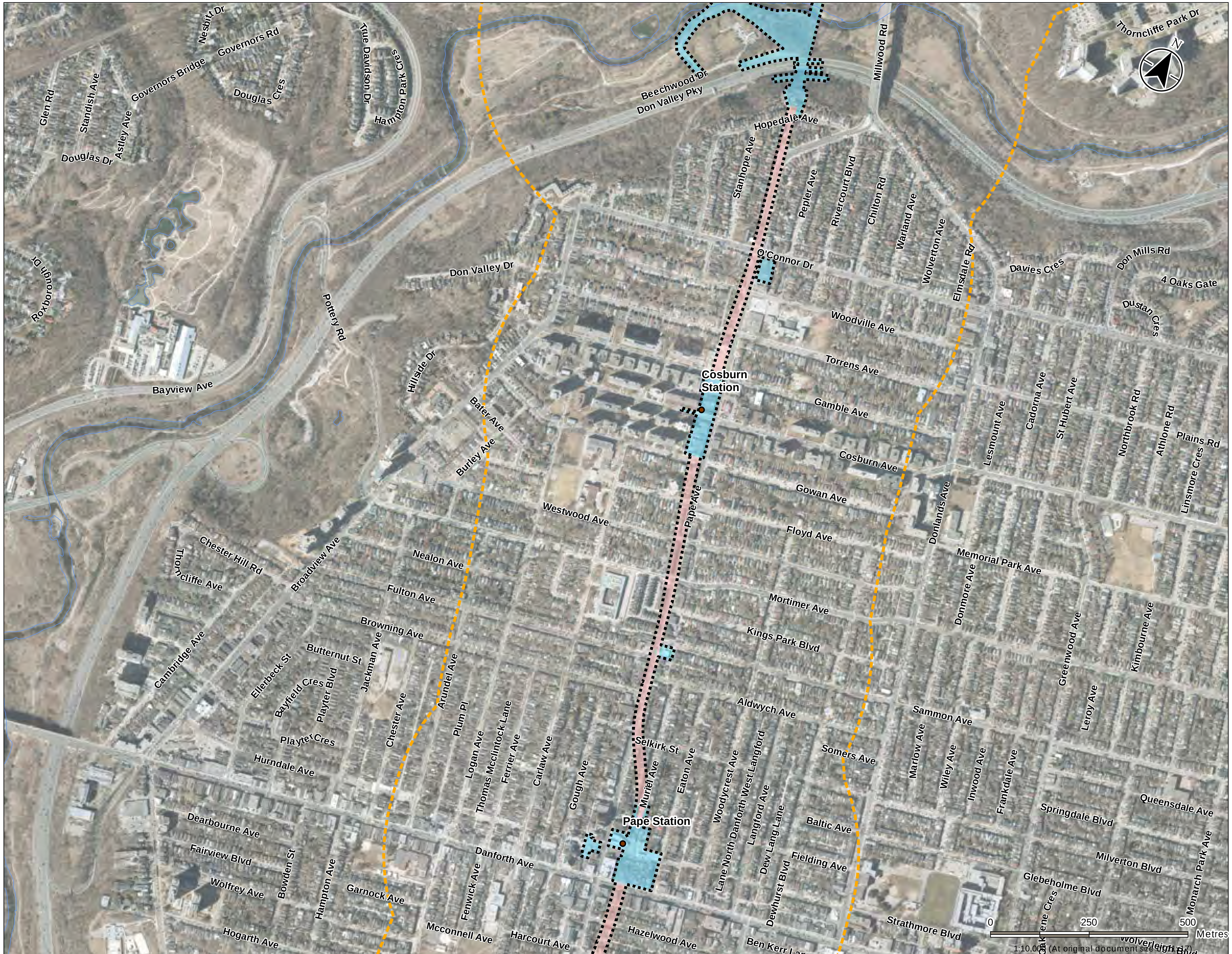
Independent Review by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

Figure No.
B-4

Title
Project Study Area



Stantec

Legend

- Project Footprint
- Study Area (500 m Buffer)
- At or Above Grade Features
- Below Grade Features
- Waterbody

Notes
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Project Location
City of Toronto, ON

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Technical Review by ABC on yyyy-mm-dd
Independent Review by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

Figure No.
B-5

Title
Project Study Area

Stantec

Legend

- Project Footprint
- Study Area (500 m Buffer)
- At or Above Grade Features
- Waterbody

Notes

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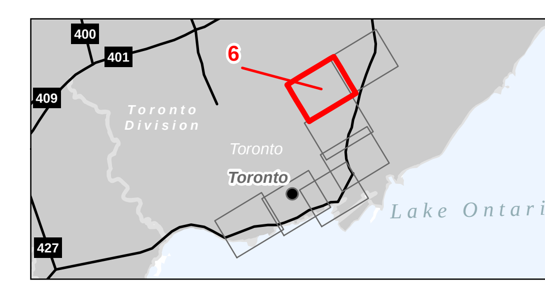

Project Location
City of Toronto, ON

160560009 REV4
Prepared by BCC on 2022-02-01
Technical Review by ABC on yyyy-mm-dd
Independent Review by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

Figure No.
B-6

Title
Project Study Area

Stantec

Legend

- Project Footprint
- Study Area (500 m Buffer)
- At or Above Grade Features
- Waterbody

Notes
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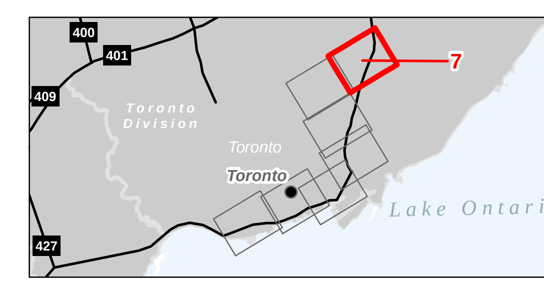


Project Location
City of Toronto, ON

160560009 REV4
Prepared by BCC on 2022-02-01
Technical Review by ABC on yyyy-mm-dd
Independent Review by ABC on yyyy-mm-dd

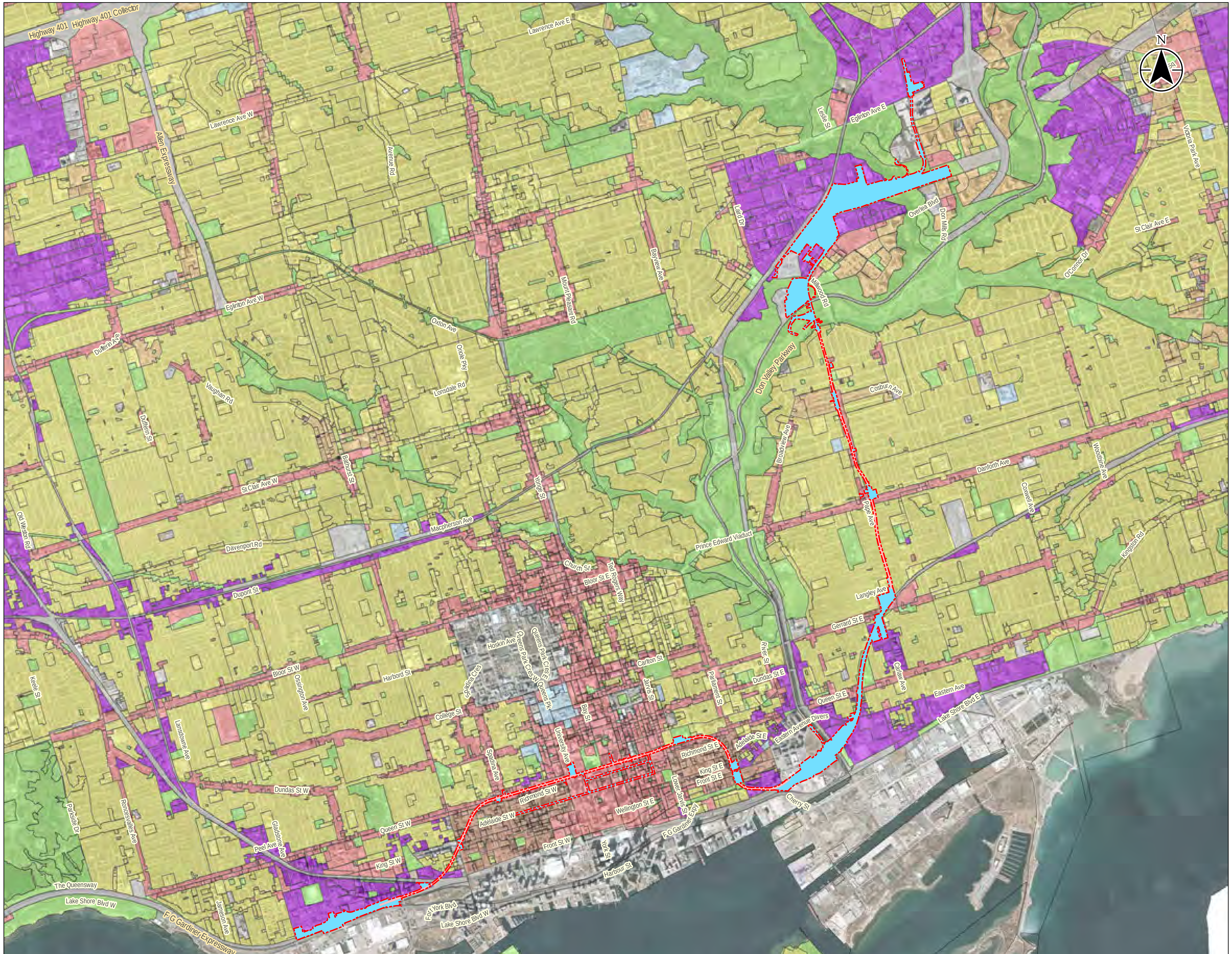
Client/Project
HDR CORPORATION
ONTARIO LINE TA

Figure No.
B-7

Title
Project Study Area

\\cd1215-f01\work_group\01605\active\160560009\11_data\gis_cad\gis\mxds\atmospheric\report_figures\20211125_Noise_Report_rev4\160560009_NR_FigB1-7_ProjectStudyAreaMapbook.mxd   Revised: 2022-02-01 By: bcowper

Appendix C. Zoning



Stantec

Legend

- Project Footprint
- Above Grade Element
- Below Grade Element

City of Toronto Zoning Categories

- Residential
- Residential Apartment
- Commercial
- Commercial Residential
- Commercial Residential Employment
- Employment Industrial
- Institutional
- Open Space
- Utility and Transportation
- Area Not Classified by City of Toronto

0 1,100 2,200 Metres

1:45,000 (At original document size of 11x17)

Notes
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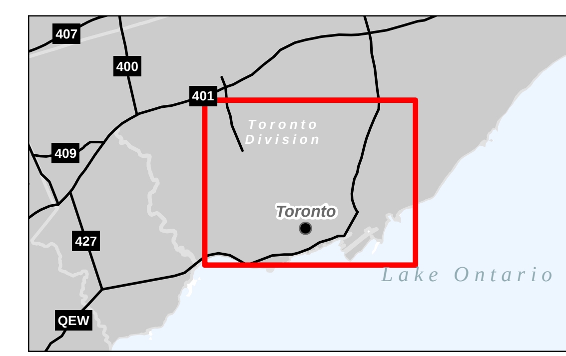

Project Location
City of Toronto, ON

160560009 REV4
Prepared by BCC on 2022-02-01

Client/Project
HDR CORPORATION
ONTARIO LINE TA

Figure No.
C-0

Title
City of Toronto Zoning Categories - Overview

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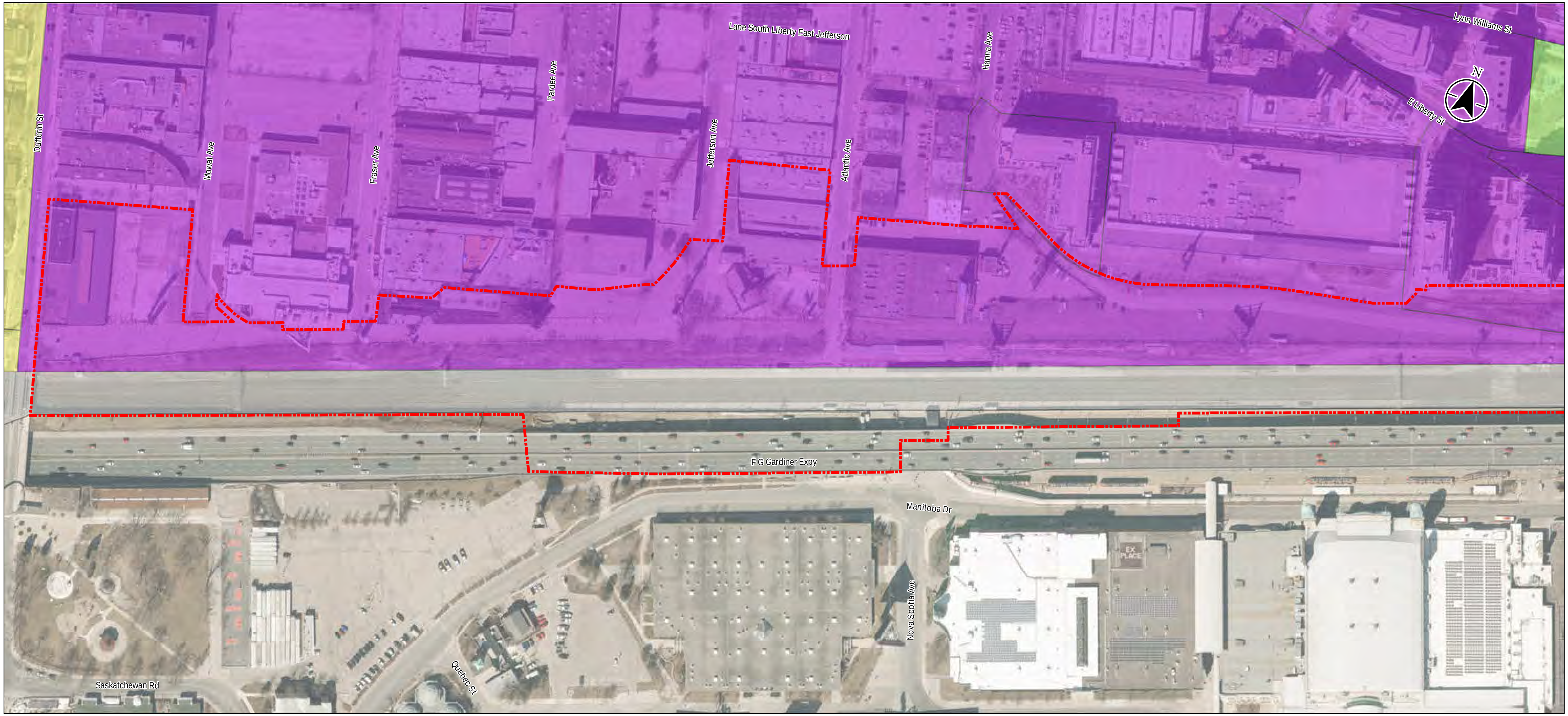

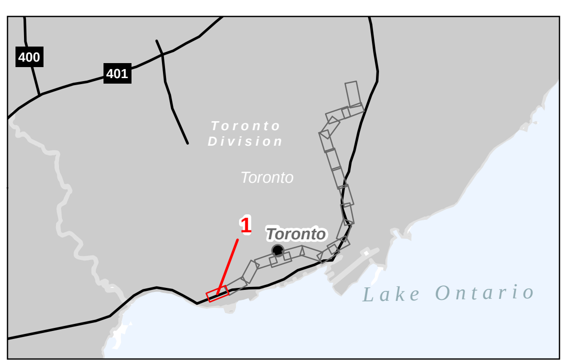

Legend

Project Footprint

City of Toronto Zoning Categories

- Residential
- Employment Industrial
- Open Space
- Utility and Transportation
- Area Not Classified by City of Toronto

0 40 80 metres

1:2,500 (At original document size of 11x17)

Notes

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Project Location
Toronto, ON

Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

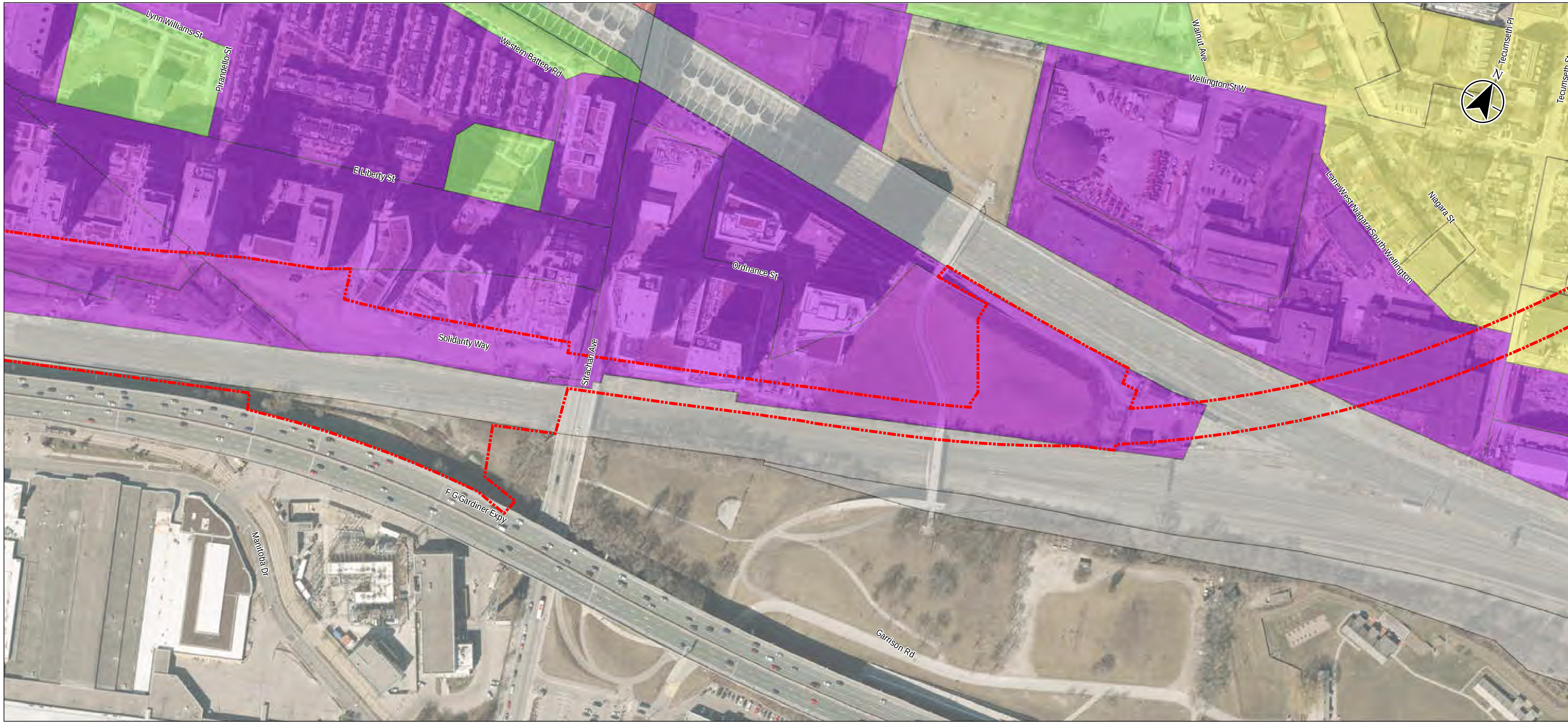
Client/Project
HDR CORPORATION
ONTARIO LINE TA

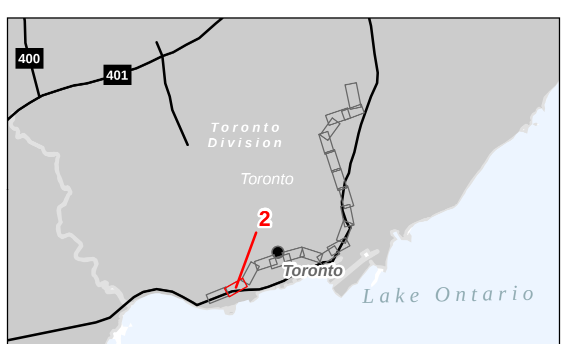
160560009 REVA

Figure No.
C-1

Title
City of Toronto Zoning Categories

\\cd1215-f01\work_group\01605\active\160560009\11_data\gis_cad\gis\mxds\atmospheric\report_figures\20211125_Noise_Report_rev4\160560009_NR_FigC1-19_ZoningMapbook.mxd Revised: 2022-02-01 By: bcowper





Legend

- Project Footprint

City of Toronto Zoning Categories

- Residential
- Commercial Residential
- Employment Industrial
- Open Space
- Utility and Transportation
- Area Not Classified by City of Toronto

0 40 80 metres

1:2,500 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
C-2

Title
City of Toronto Zoning Categories

Notes

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Notes
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Legend
Project Footprint
City of Toronto Zoning Categories
- Residential
- Commercial Residential
- Commercial Residential Employment
- Employment Industrial
- Open Space
- Utility and Transportation
- Area Not Classified by City of Toronto

0 40 80 metres
1:2,500 (At original document size of 11x17)

Stantec

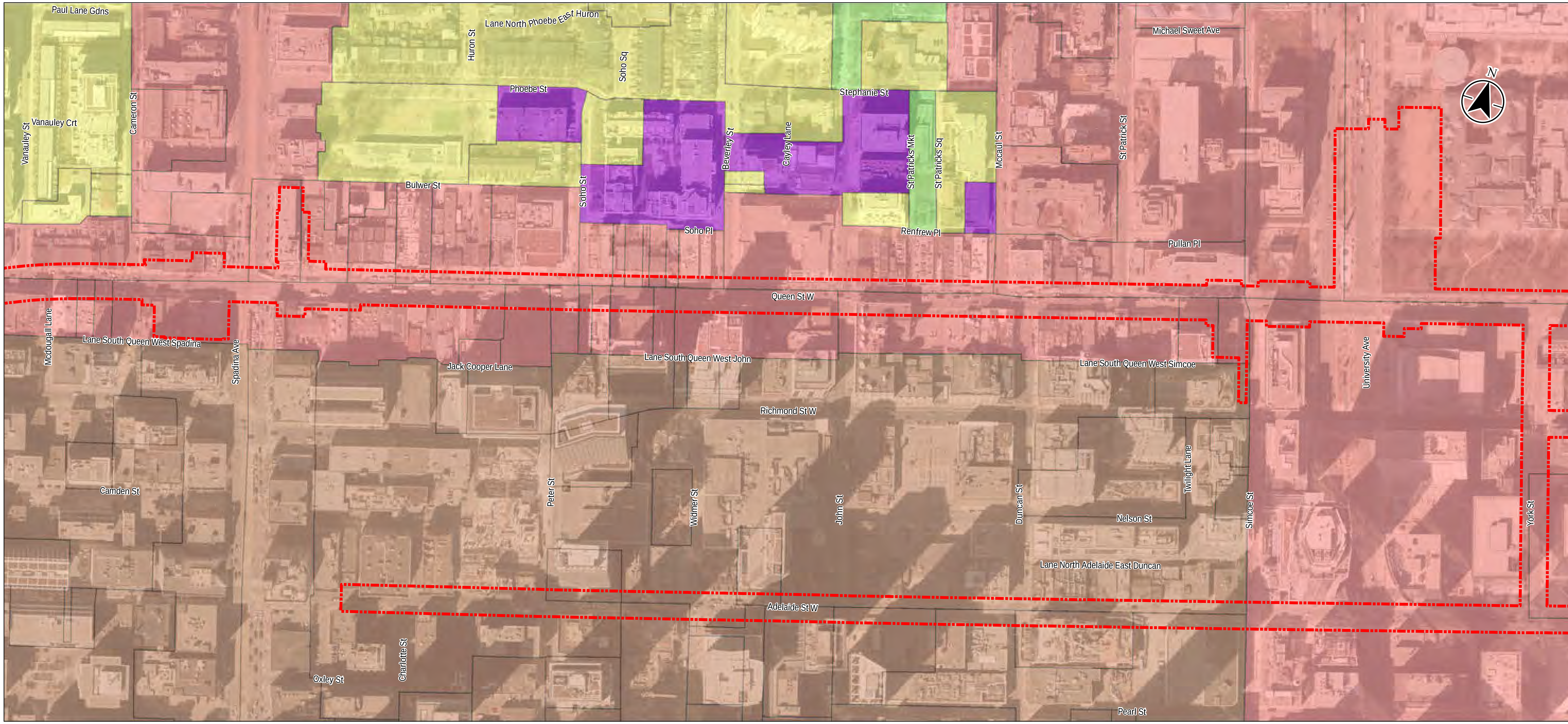
Project Location
Toronto, ON

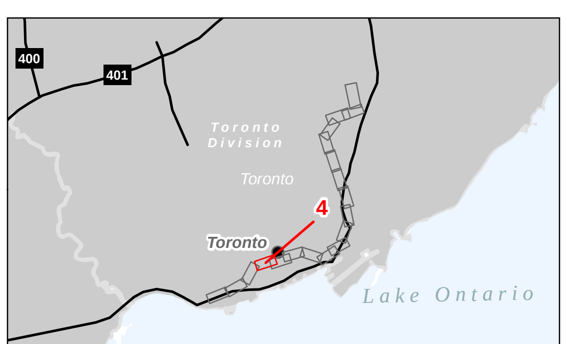
Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

Client/Project
160560009 REVA
HDR CORPORATION
ONTARIO LINE TA

Figure No.
C-3

Title
City of Toronto Zoning Categories





Legend

Project Footprint

City of Toronto Zoning Categories

- Residential
- Commercial Residential
- Commercial Residential Employment
- Employment Industrial
- Open Space

0 50 100 metres

1:3,000 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
C-4

Title
City of Toronto Zoning Categories

Notes
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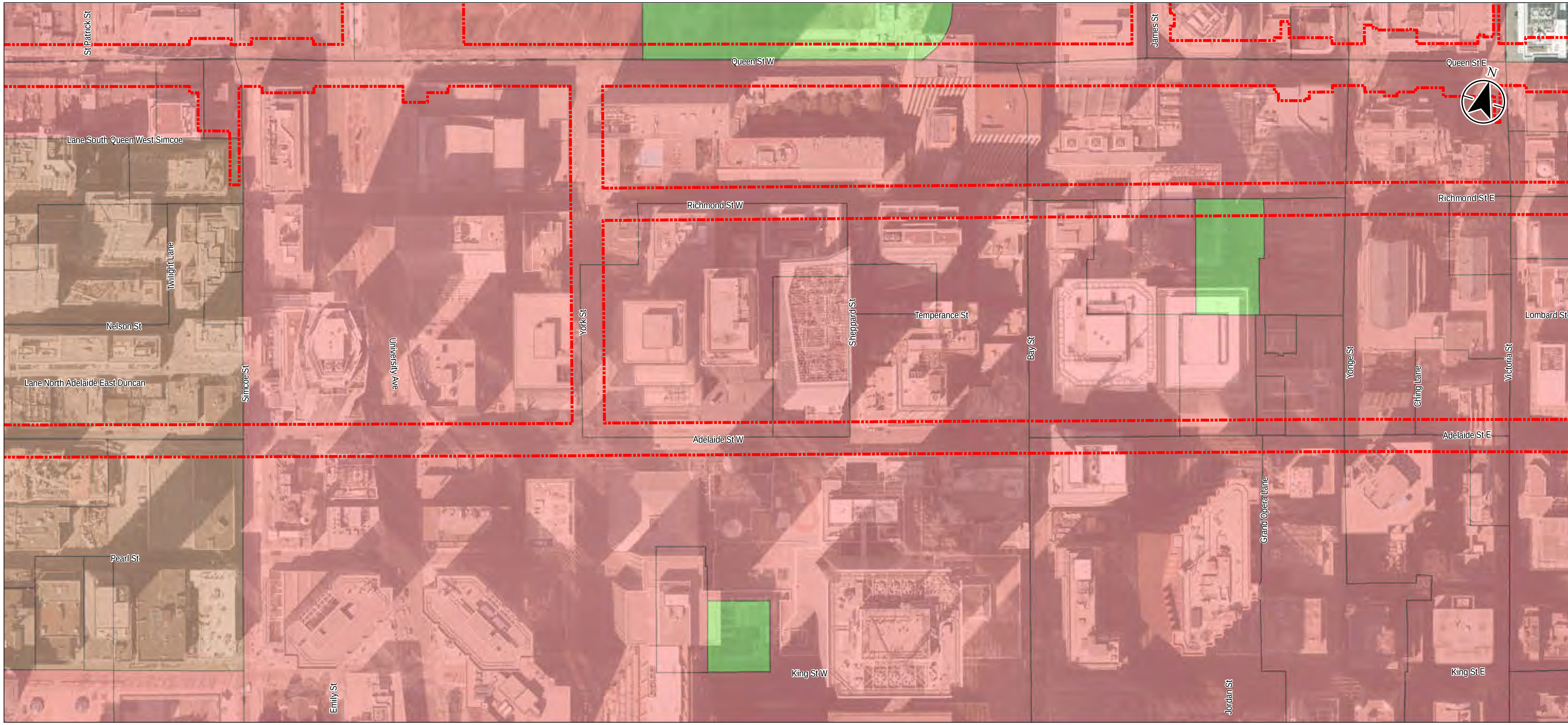

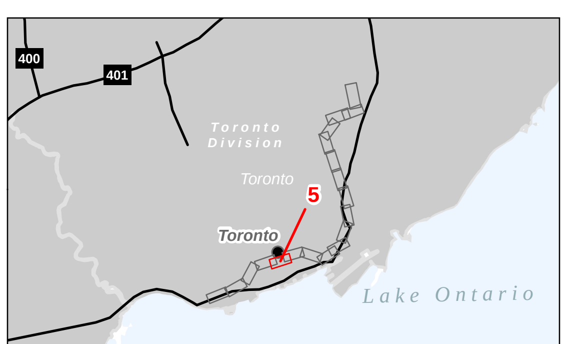

Legend

Project Footprint

City of Toronto Zoning Categories

- Commercial Residential
- Commercial Residential Employment
- Open Space
- Area Not Classified by City of Toronto

0 40 80 metres

1:2,500 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
C-5

Title
City of Toronto Zoning Categories

Notes
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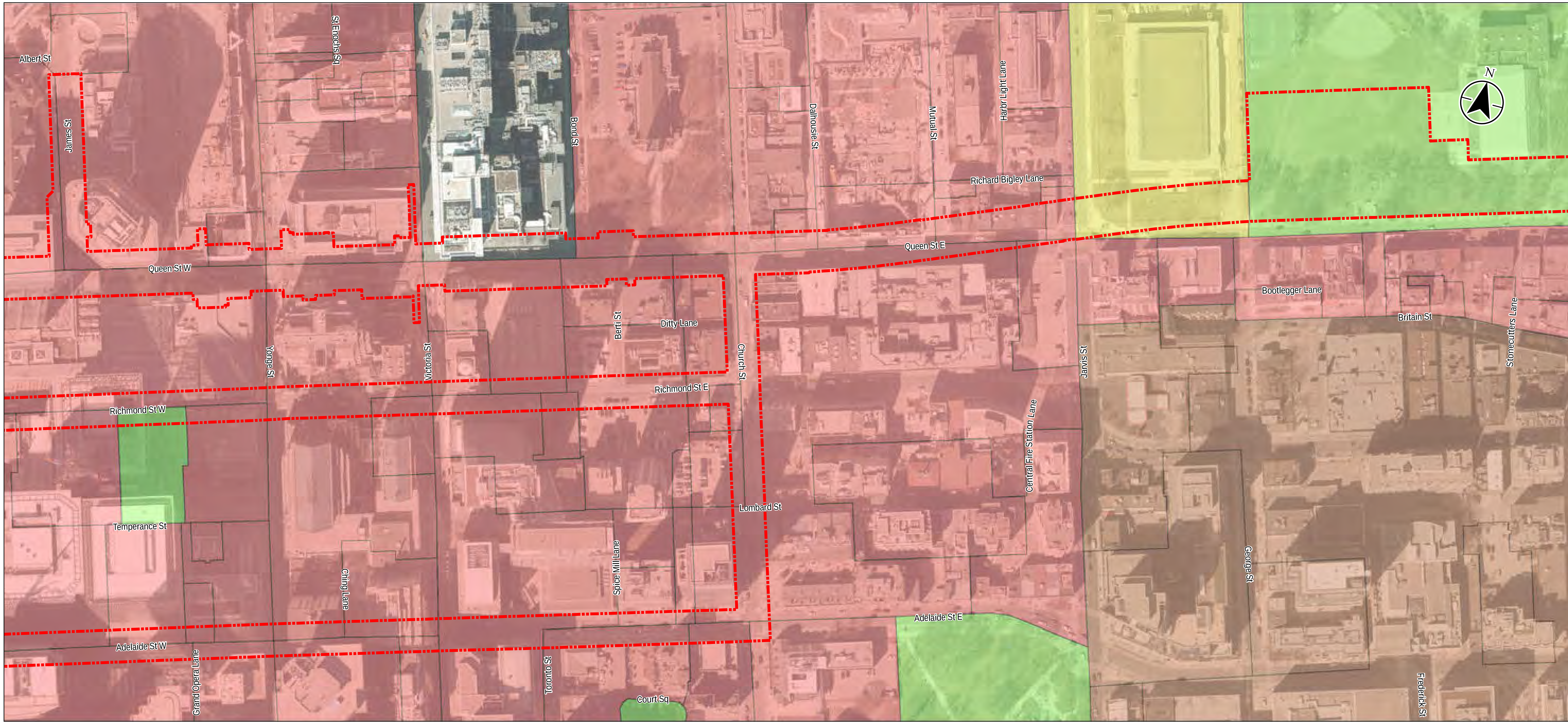

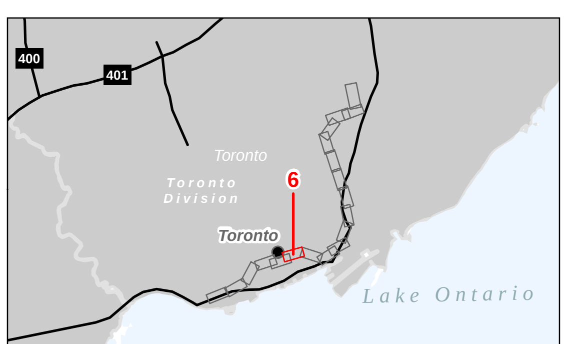

Legend

Project Footprint

City of Toronto Zoning Categories

- Residential
- Commercial Residential
- Commercial Residential Employment
- Open Space
- Area Not Classified by City of Toronto

0 40 80 metres

1:2,500 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
C-6

Title
City of Toronto Zoning Categories

Notes
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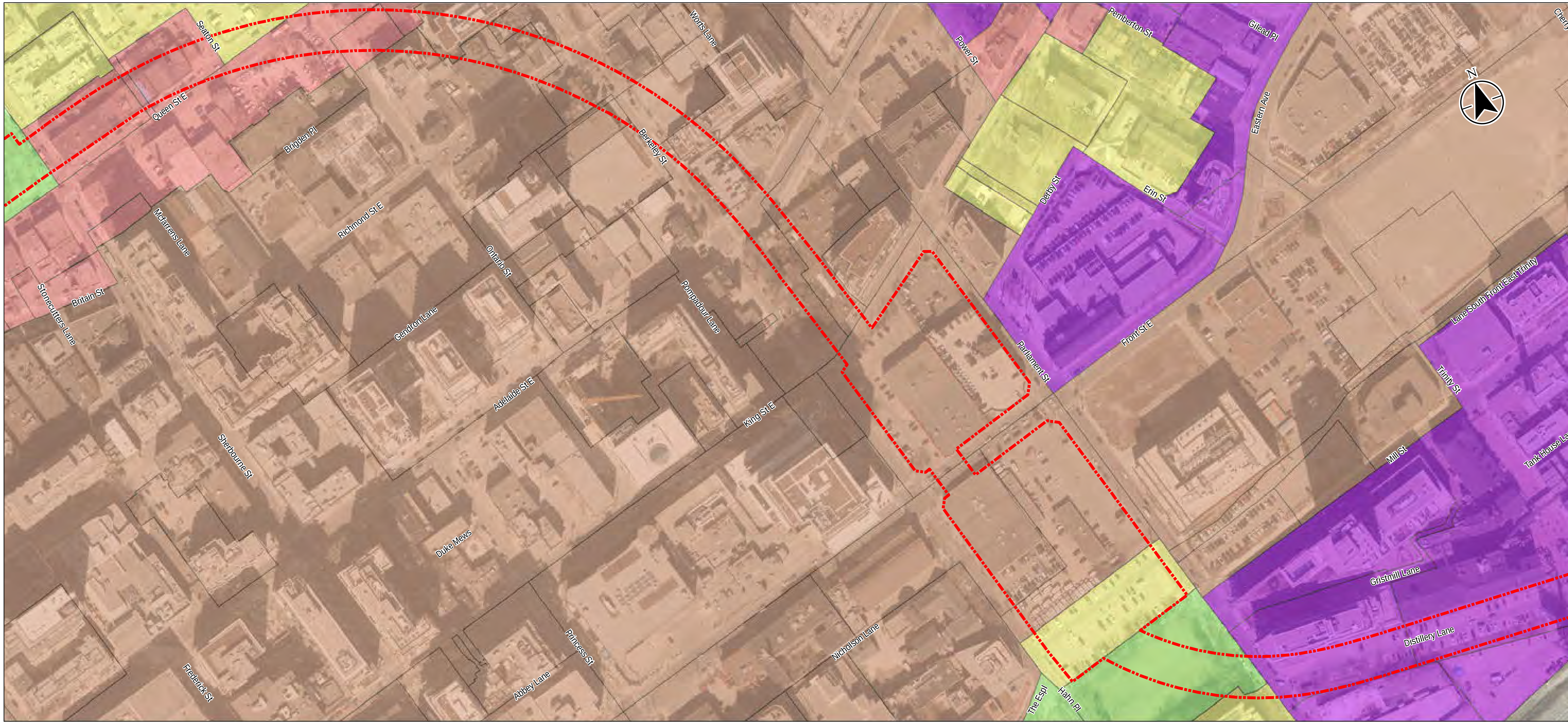

Legend

Project Footprint

City of Toronto Zoning Categories

- Residential
- Commercial Residential
- Commercial Residential Employment
- Employment Industrial
- Open Space
- Area Not Classified by City of Toronto

0 40 80 metres

1:2,500 (At original document size of 11x17)

Notes

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Project Location
Toronto, ON

Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
C-7

Title
City of Toronto Zoning Categories

\\cd1215-f01\work_group\01605\active\160560009\11_data\gis_cad\gis\mxds\atmospheric\report_figures\20211125_Noise_Report_rev4\160560009_NR_FigC1-19_ZoningMapbook.mxd Revised: 2022-02-01 By: bcowper

Legend

Project Footprint

City of Toronto Zoning Categories

- Commercial Residential Employment
- Employment Industrial
- Utility and Transportation
- Area Not Classified by City of Toronto

0 40 80 metres

1:2,500 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

Client/Project
160560009 REVA
HDR CORPORATION
ONTARIO LINE TA

Figure No.
C-8

Title
City of Toronto Zoning Categories

Notes
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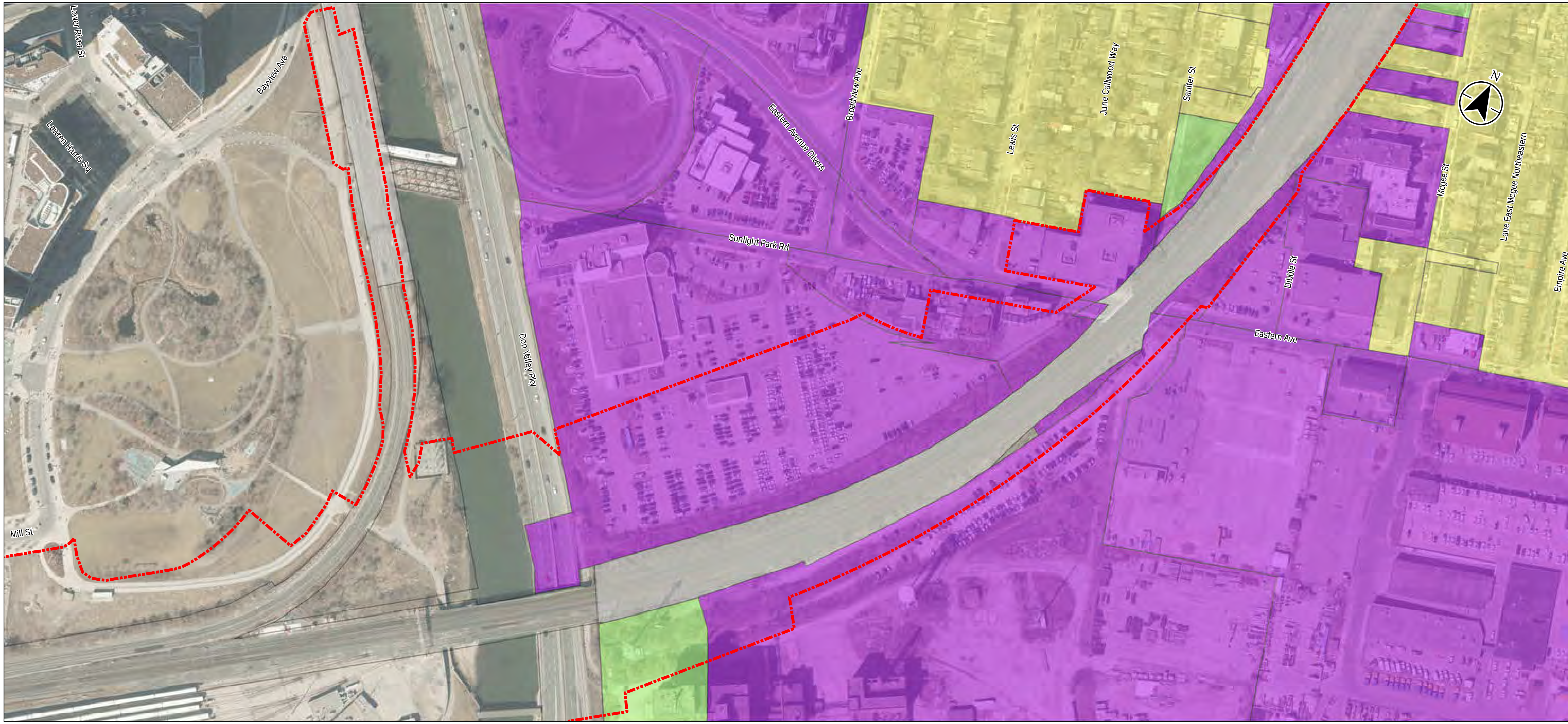

Notes

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Legend

- Project Footprint

City of Toronto Zoning Categories

- Residential
- Employment Industrial
- Open Space
- Utility and Transportation
- Area Not Classified by City of Toronto

0 40 80 metres

1:2,500 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

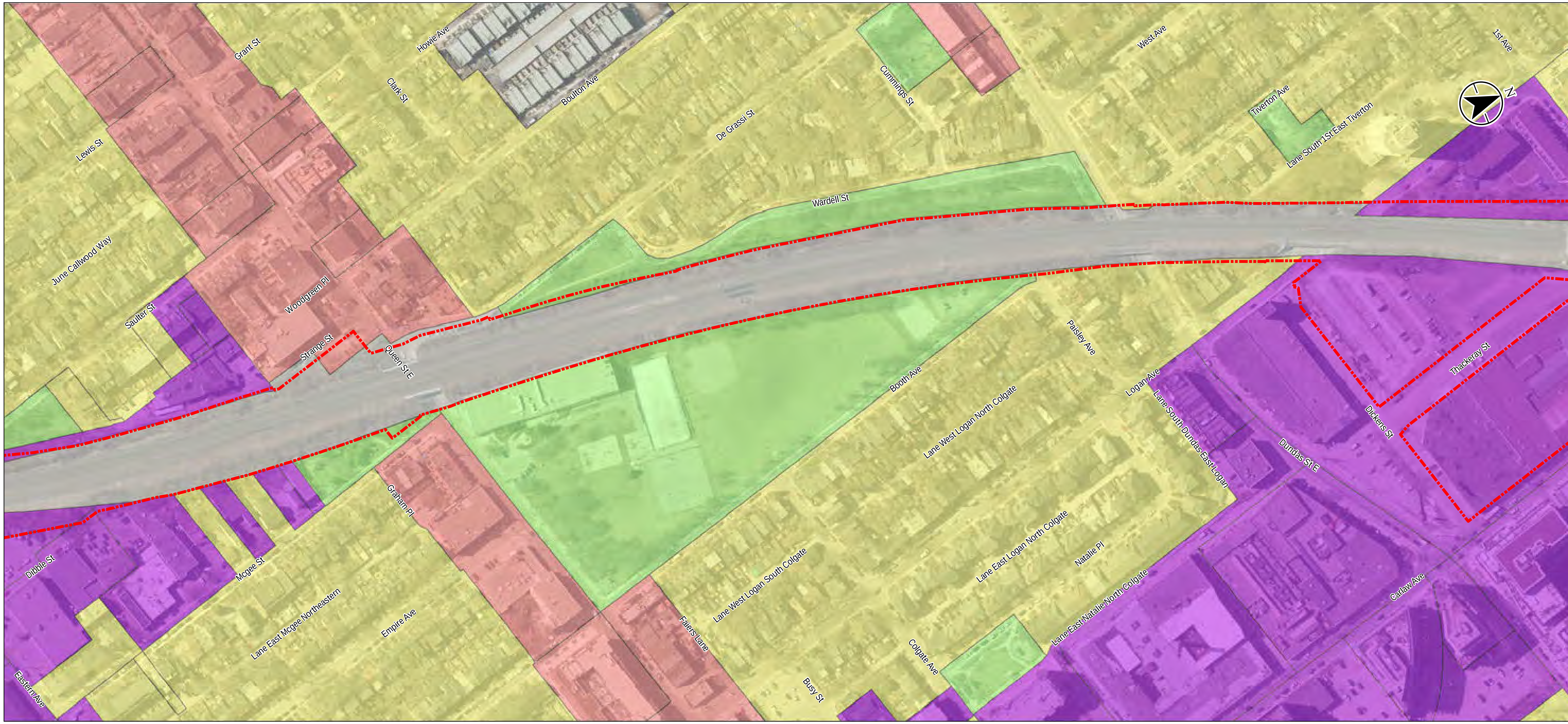
Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

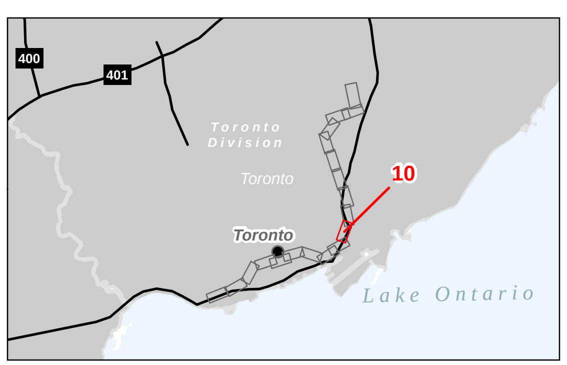
Client/Project
160560009 REVA
HDR CORPORATION
ONTARIO LINE TA

Figure No.
C-9

Title
City of Toronto Zoning Categories

\\cd1215-f01\work_group\01605\active\160560009\11_data\gis_cad\gis\mxds\atmospheric\report_figures\20211125_Noise_Report_rev4\160560009_NR_FigC1-19_ZoningMapbook.mxd Revised: 2022-02-01 By: bcowper





Legend

Project Footprint

City of Toronto Zoning Categories

- Residential
- Commercial Residential
- Employment Industrial
- Open Space
- Utility and Transportation
- Area Not Classified by City of Toronto

0 40 80 metres

1:2,500 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
C-10

Title
City of Toronto Zoning Categories

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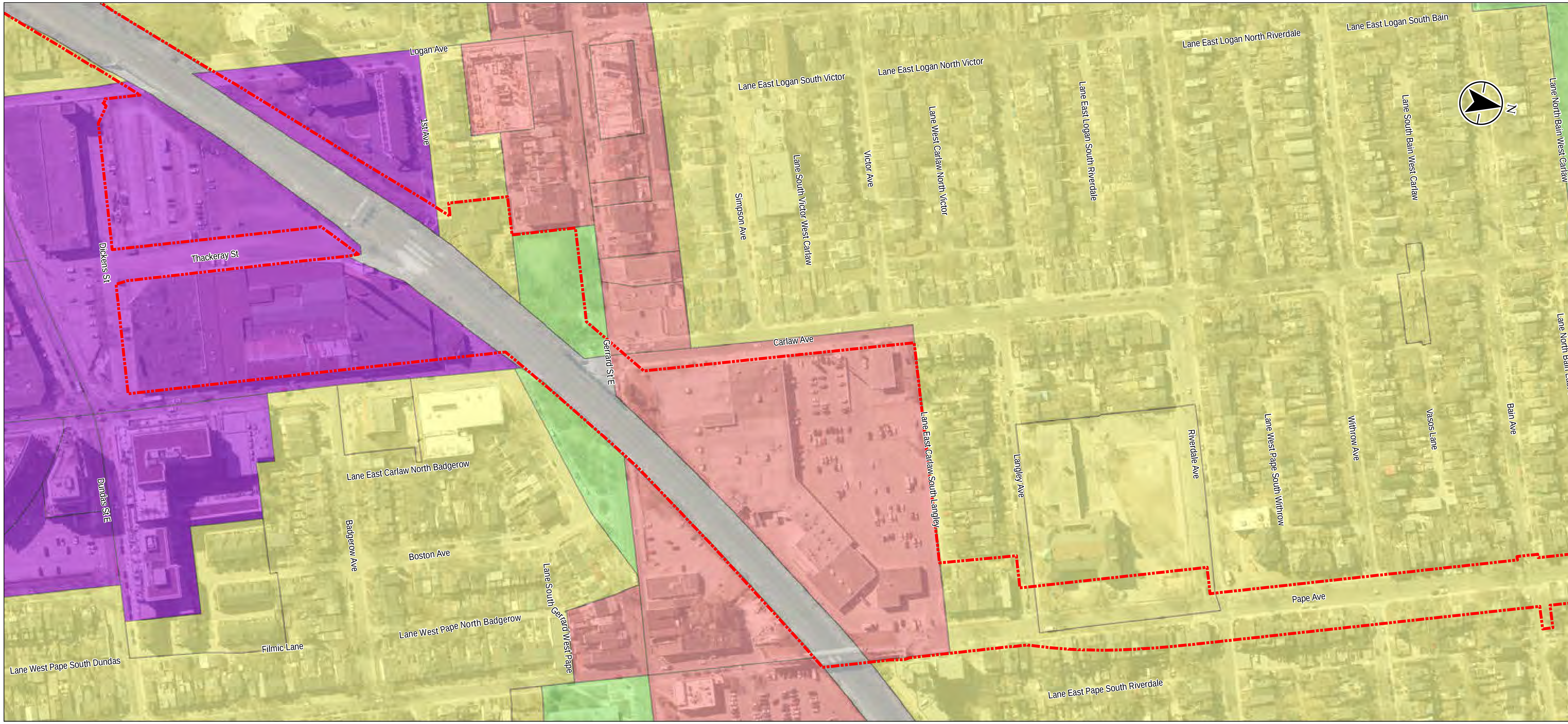

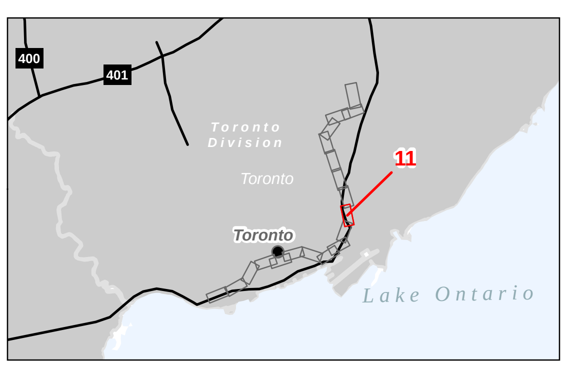

Legend

- Project Footprint

City of Toronto Zoning Categories

- Residential
- Commercial Residential
- Employment Industrial
- Open Space
- Utility and Transportation

0 40 80 metres

1:2,500 (At original document size of 11x17)

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Project Location
Toronto, ON

Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

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HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
C-11

Title
City of Toronto Zoning Categories

Notes

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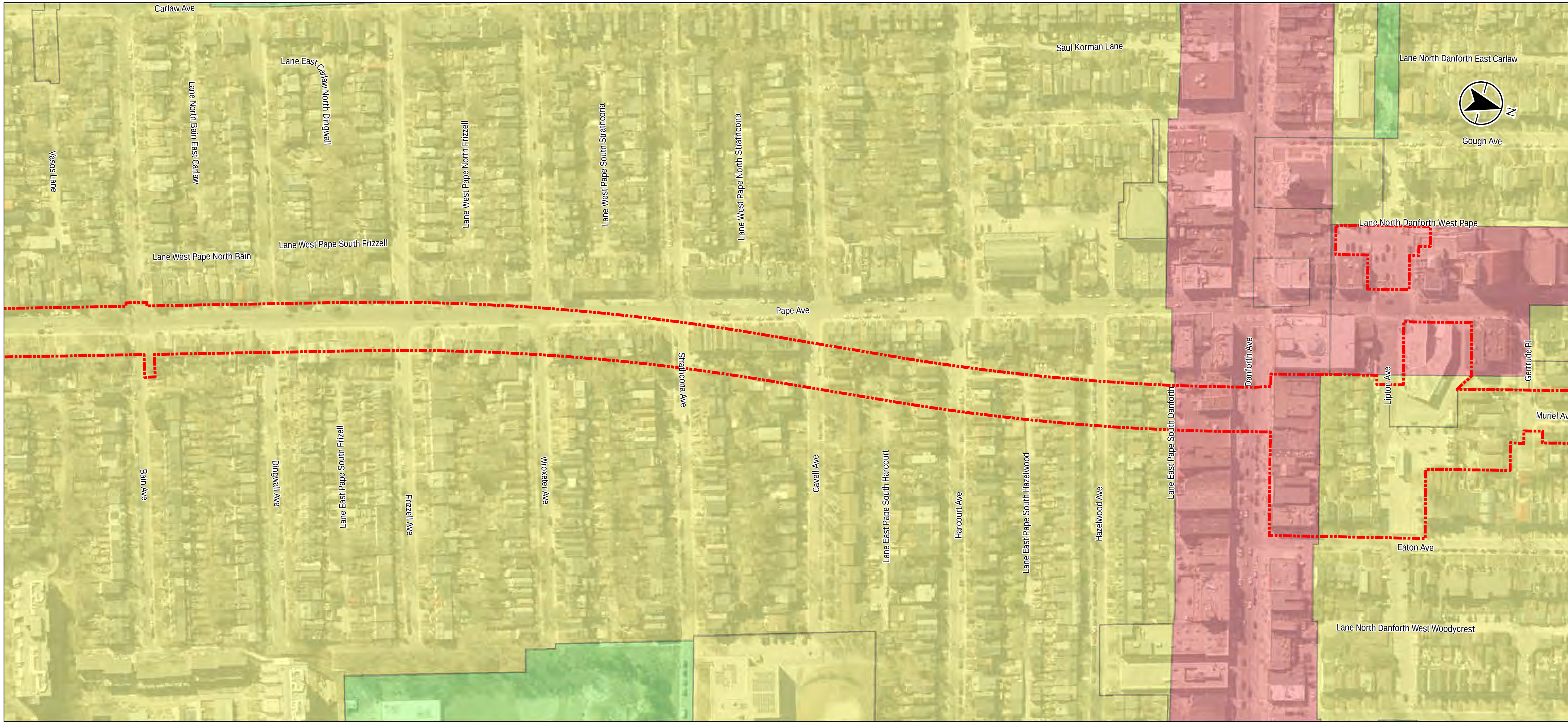

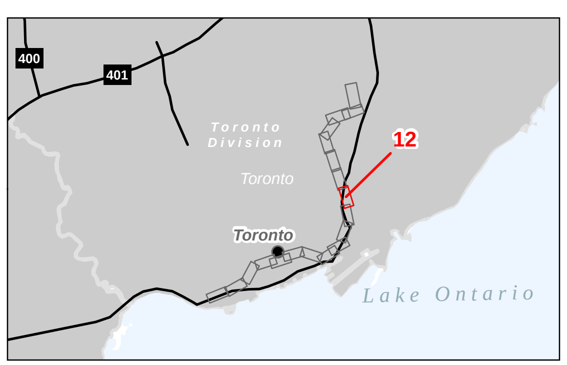

Legend

Project Footprint

City of Toronto Zoning Categories

Residential

Commercial Residential

Open Space

0 40 80 metres

1:2,500 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
C-12

Title
City of Toronto Zoning Categories

Notes
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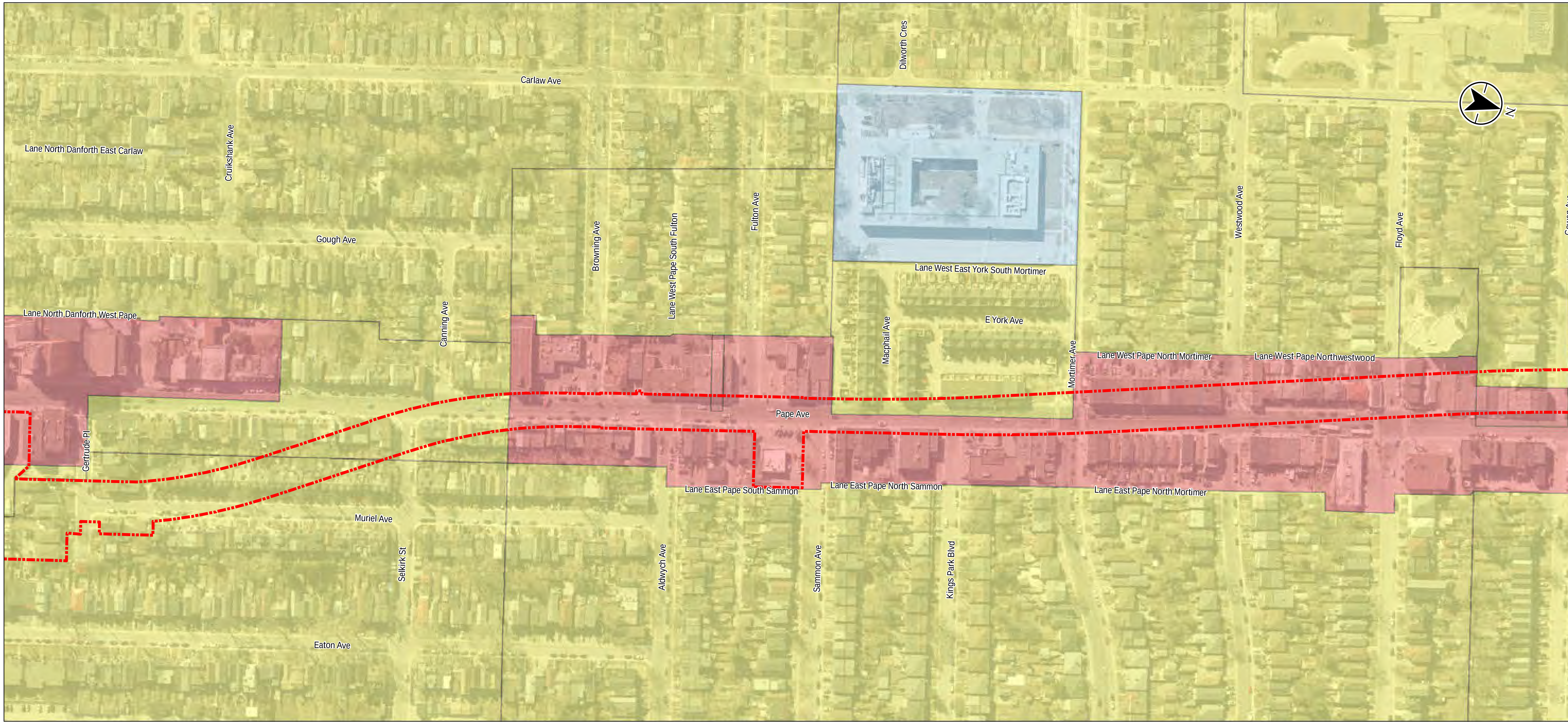

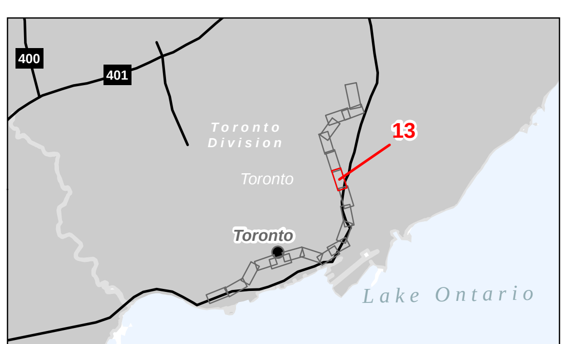

Notes
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Legend
Project Footprint
City of Toronto Zoning Categories
Residential
Residential Apartment
Commercial Residential
Institutional

0 40 80 metres
1:2,500 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

Client/Project
160560009 REVA
HDR CORPORATION
ONTARIO LINE TA

Figure No.
C-13

Title
City of Toronto Zoning Categories

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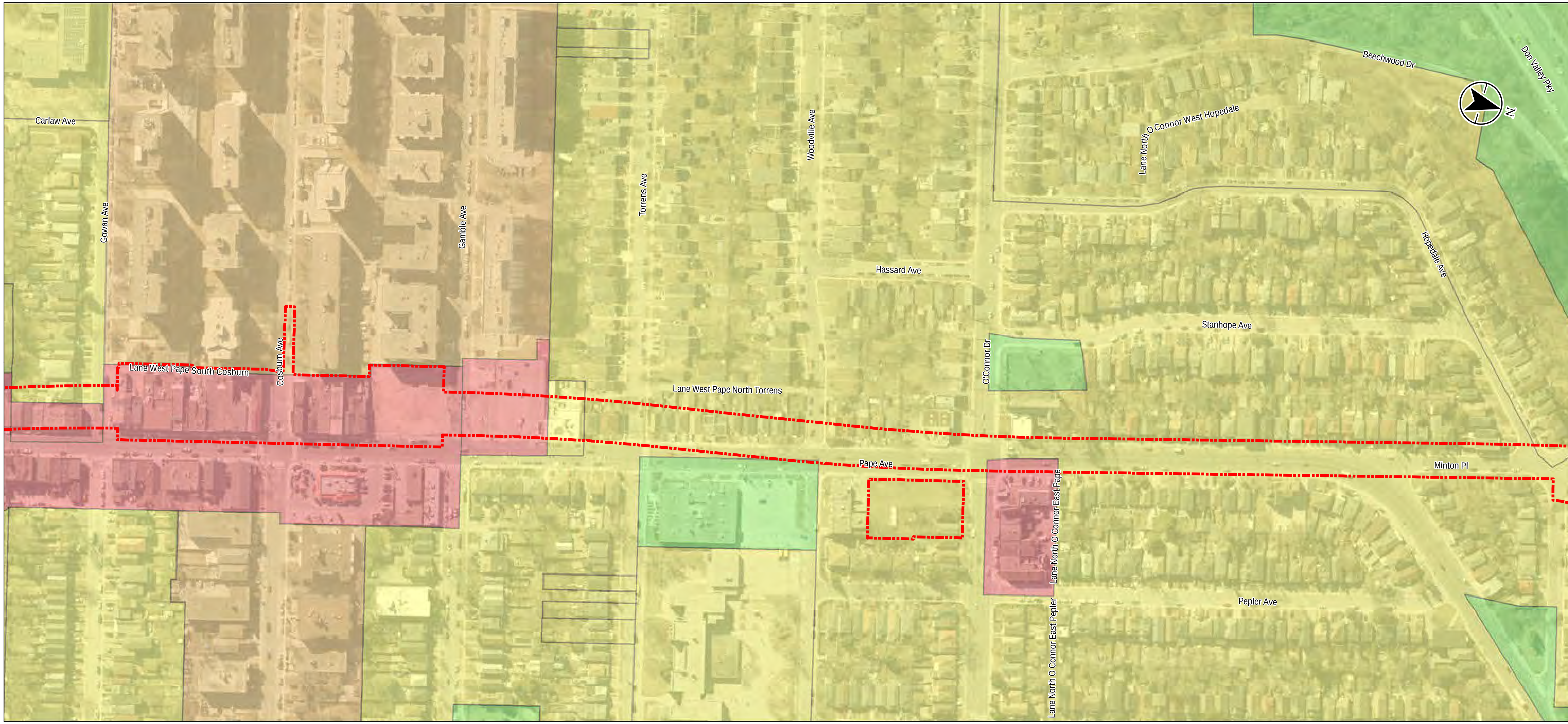

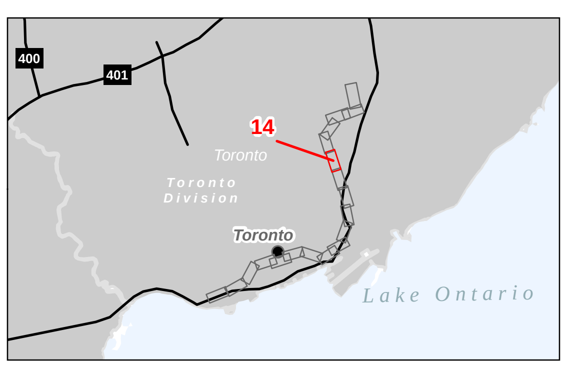

Legend

- Project Footprint

City of Toronto Zoning Categories

- Residential
- Residential Apartment
- Commercial Residential
- Open Space

0 40 80 metres

1:2,500 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

Client/Project
160560009 REVA
HDR CORPORATION
ONTARIO LINE TA

Figure No.
C-14

Title
City of Toronto Zoning Categories

Notes
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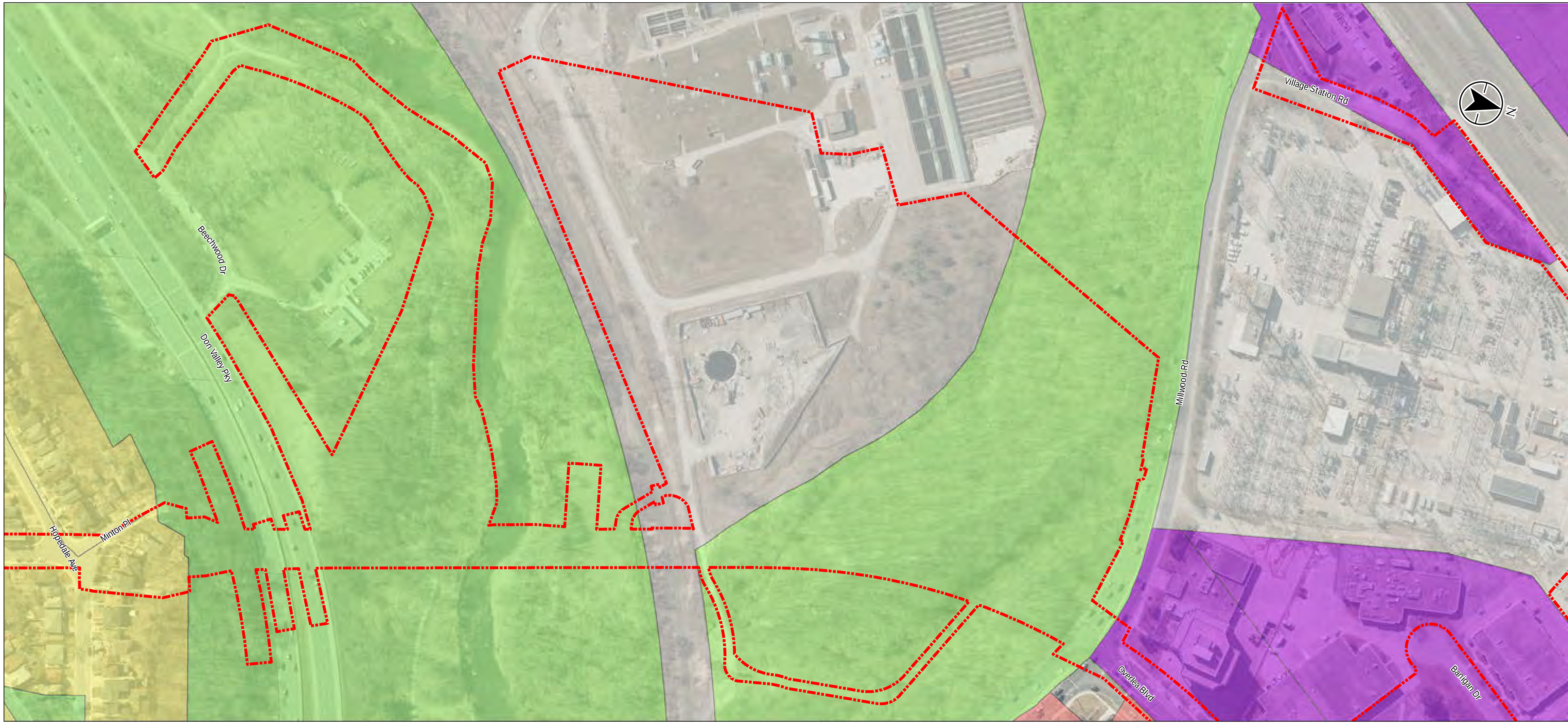

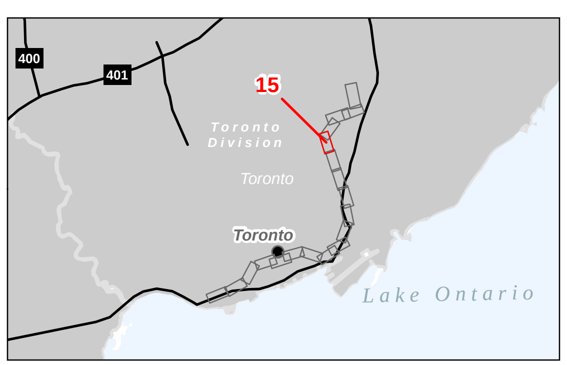

Legend

Project Footprint

City of Toronto Zoning Categories

- Residential
- Commercial Residential
- Employment Industrial
- Open Space
- Utility and Transportation
- Area Not Classified by City of Toronto

0 40 80 metres

1:2,500 (At original document size of 11x17)

Notes

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Project Location
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TR by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
C-15

Title
City of Toronto Zoning Categories

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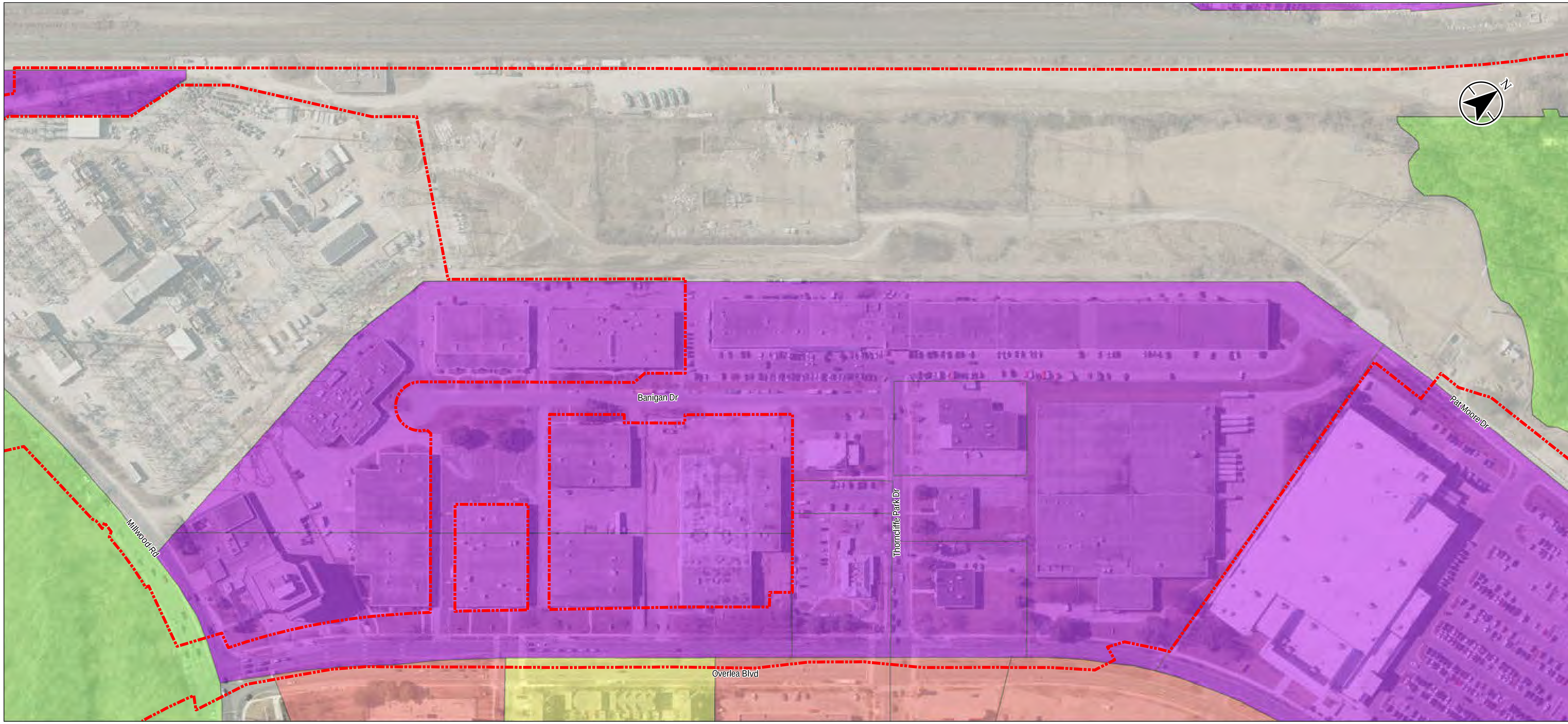

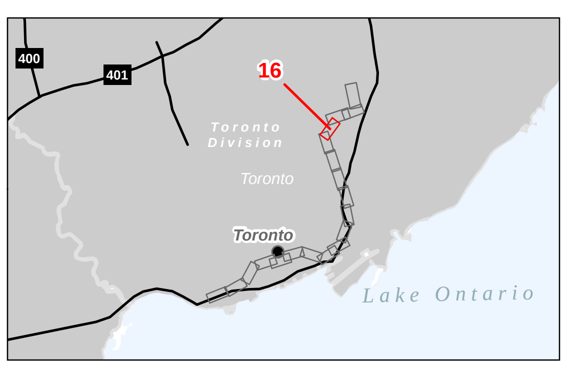

Legend

Project Footprint

City of Toronto Zoning Categories

- Residential
- Commercial Residential
- Employment Industrial
- Open Space
- Utility and Transportation
- Area Not Classified by City of Toronto

0 40 80 metres

1:2,500 (At original document size of 11x17)

Notes

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Project Location
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TR by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
C-16

Title
City of Toronto Zoning Categories

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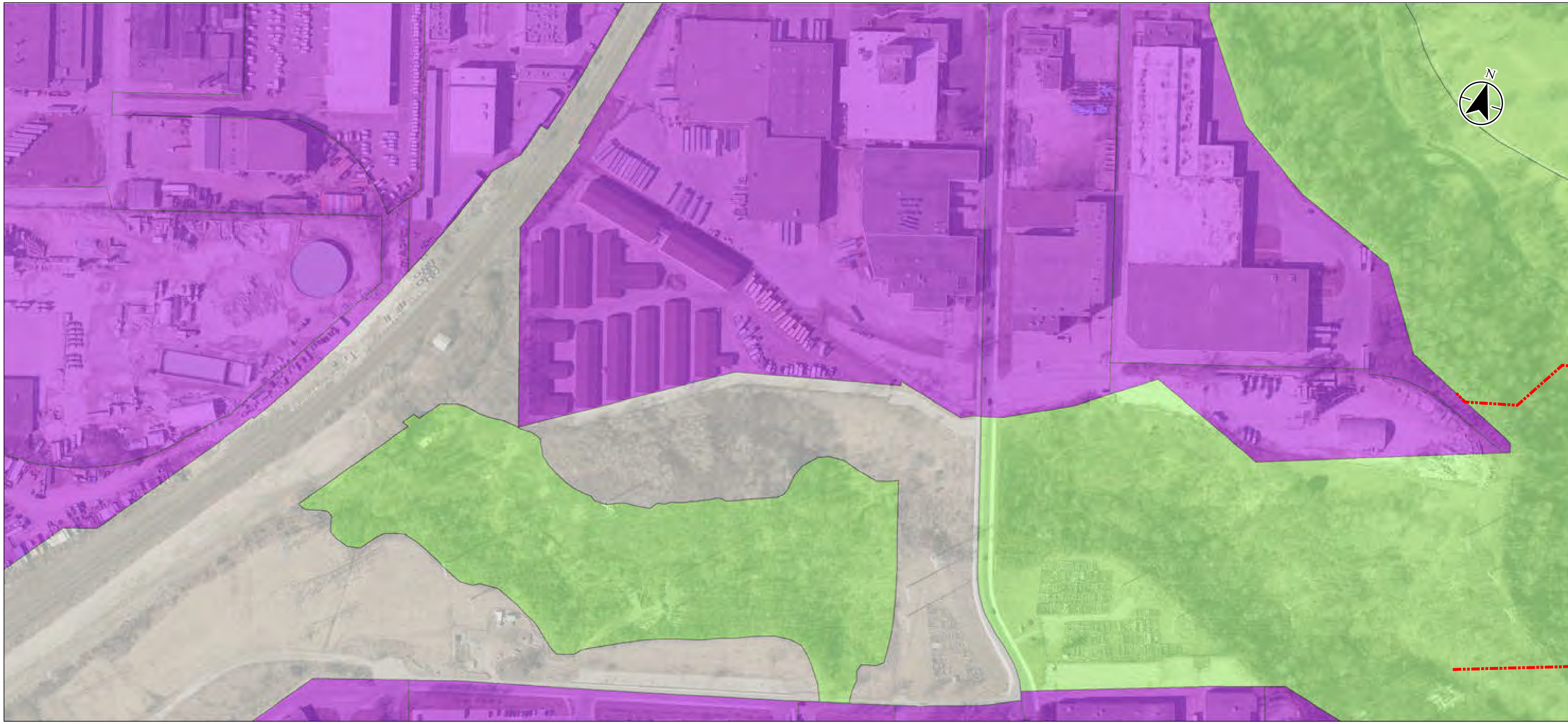

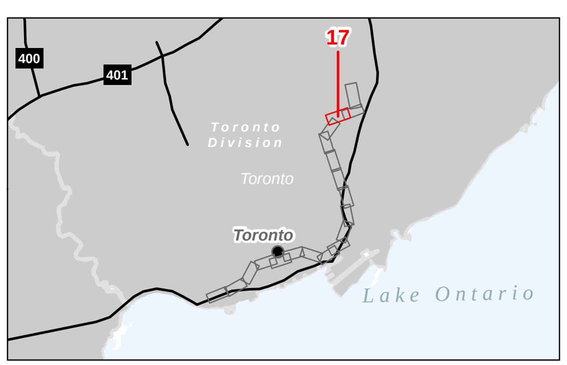

Legend

Project Footprint

City of Toronto Zoning Categories

Employment Industrial

Open Space

Utility and Transportation

0 50 100 metres

1:2,750 (At original document size of 11x17)

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Project Location
Toronto, ON

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TR by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
C-17

Title
City of Toronto Zoning Categories

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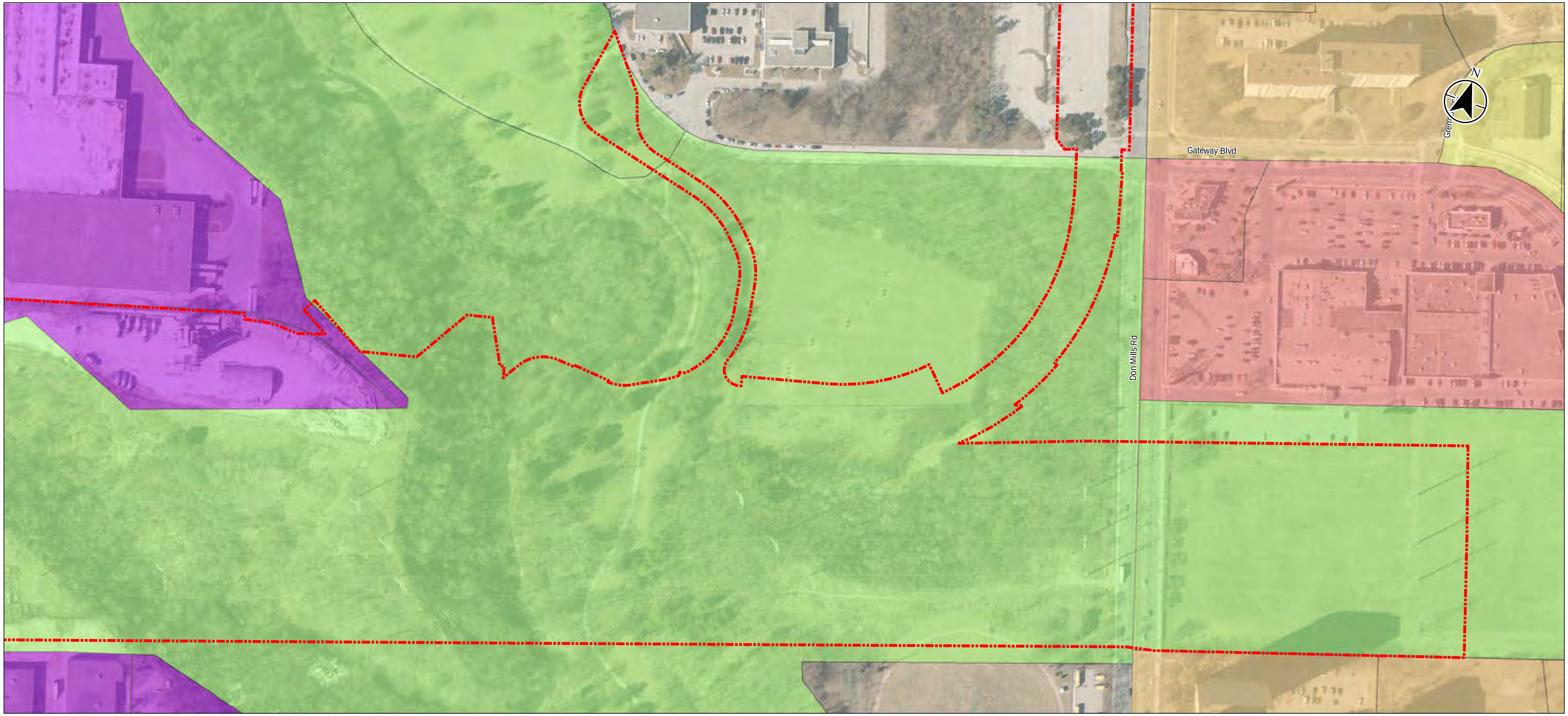

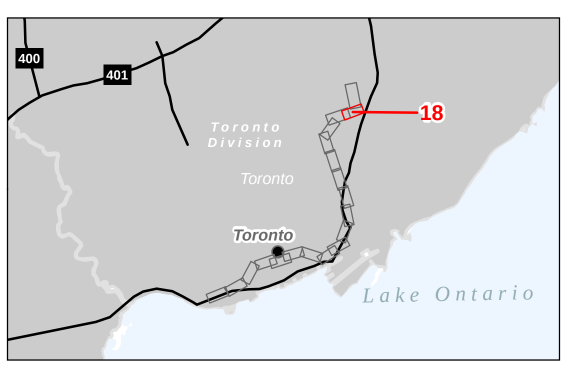

Legend

- Project Footprint

City of Toronto Zoning Categories

- Residential
- Residential Apartment
- Commercial Residential
- Employment Industrial
- Open Space
- Area Not Classified by City of Toronto

0 40 80 metres

1:2,500 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

Client/Project
160560009 REVA

HDR CORPORATION
ONTARIO LINE TA

Figure No.
C-18

Title
City of Toronto Zoning Categories

Notes
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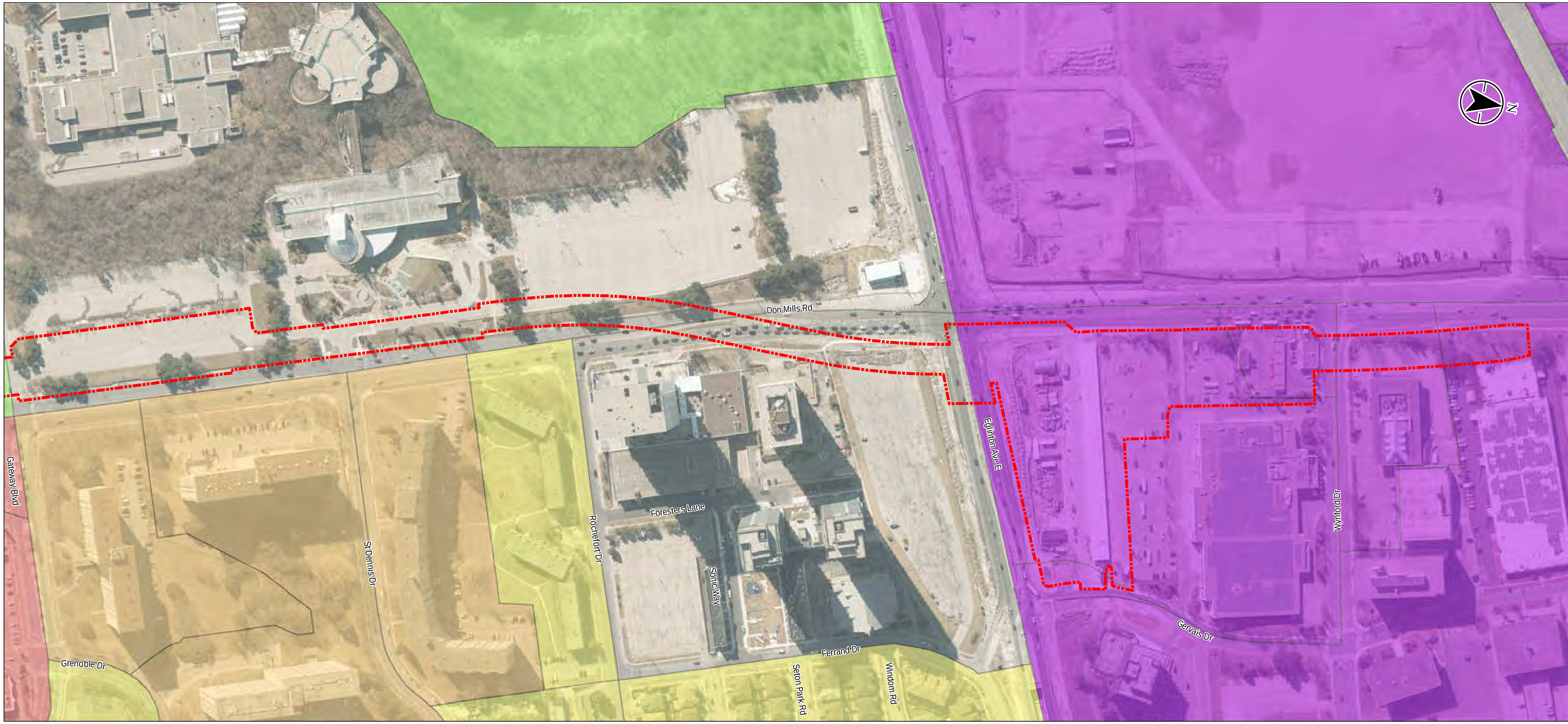

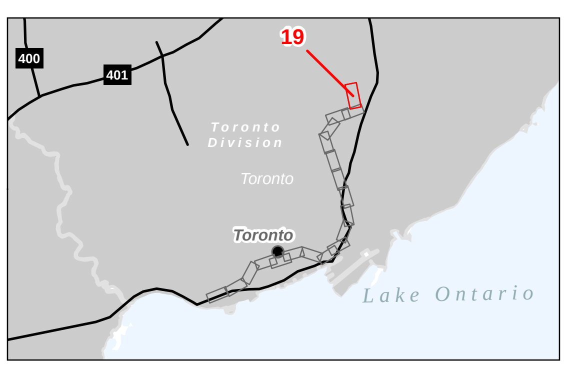

Legend

Project Footprint

City of Toronto Zoning Categories

- Residential
- Residential Apartment
- Commercial Residential
- Employment Industrial
- Open Space
- Utility and Transportation
- Area Not Classified by City of Toronto

0 50 100 metres

1:3,000 (At original document size of 11x17)

Notes
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Project Location
Toronto, ON

Prepared by BCC on 2022-02-01
TR by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

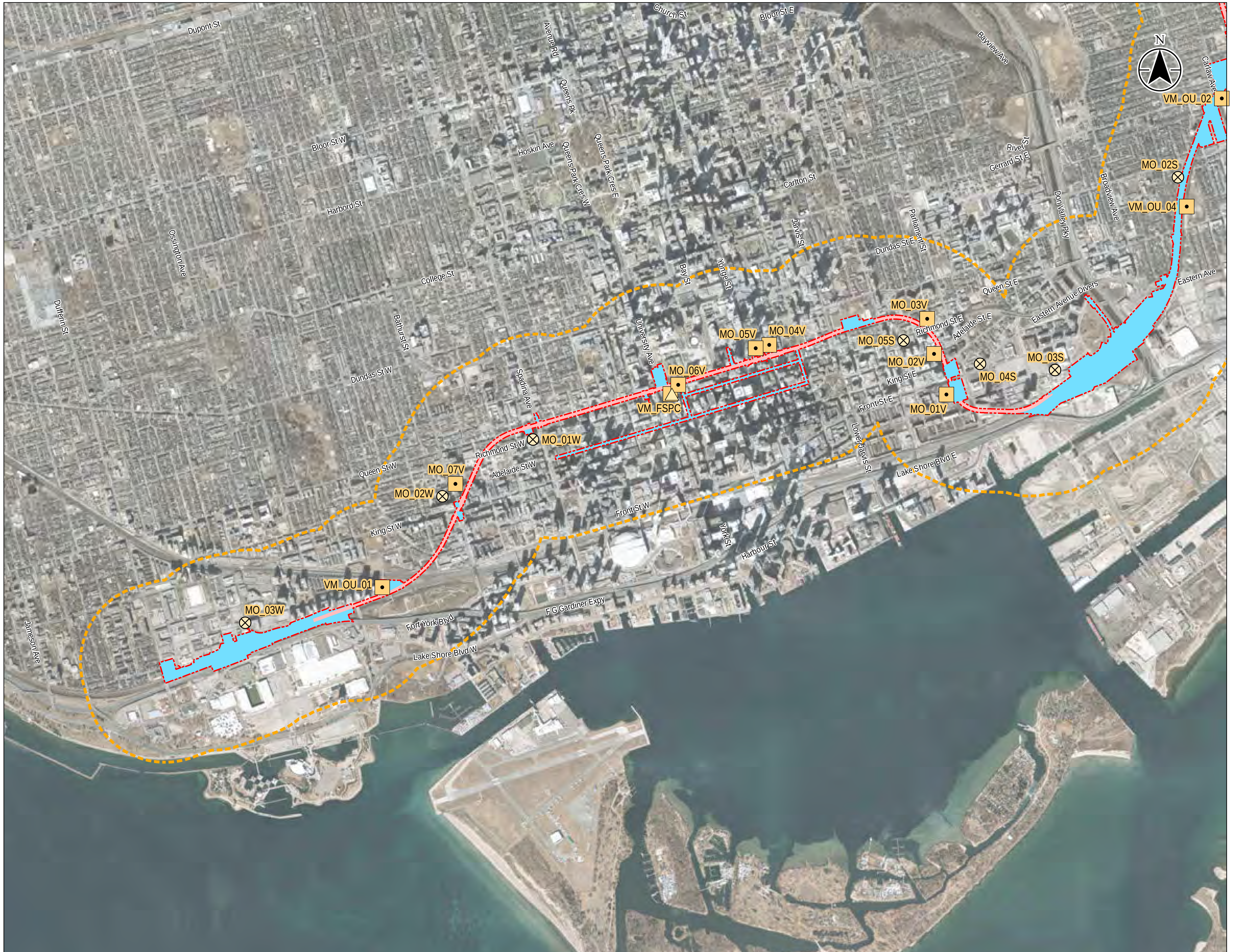
160560009 REVA

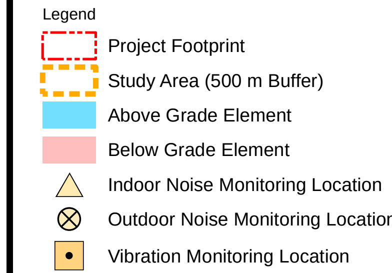
Figure No.
C-19

Title
City of Toronto Zoning Categories

\\cd1215-f01\work_group\01605\active\160560009\11_data\gis_cad\gis\mxds\atmospheric\report_figures\20211125_Noise_Report_rev4\160560009_NR_FigC1-19_ZoningMapbook.mxd Revised: 2022-02-01 By: bcowper

Appendix D. Baseline Noise and Vibration Monitoring Locations & Supporting Measurement Data





0 625 1,250 Metres

1:25,000 (At original document size of 11x17)

Notes
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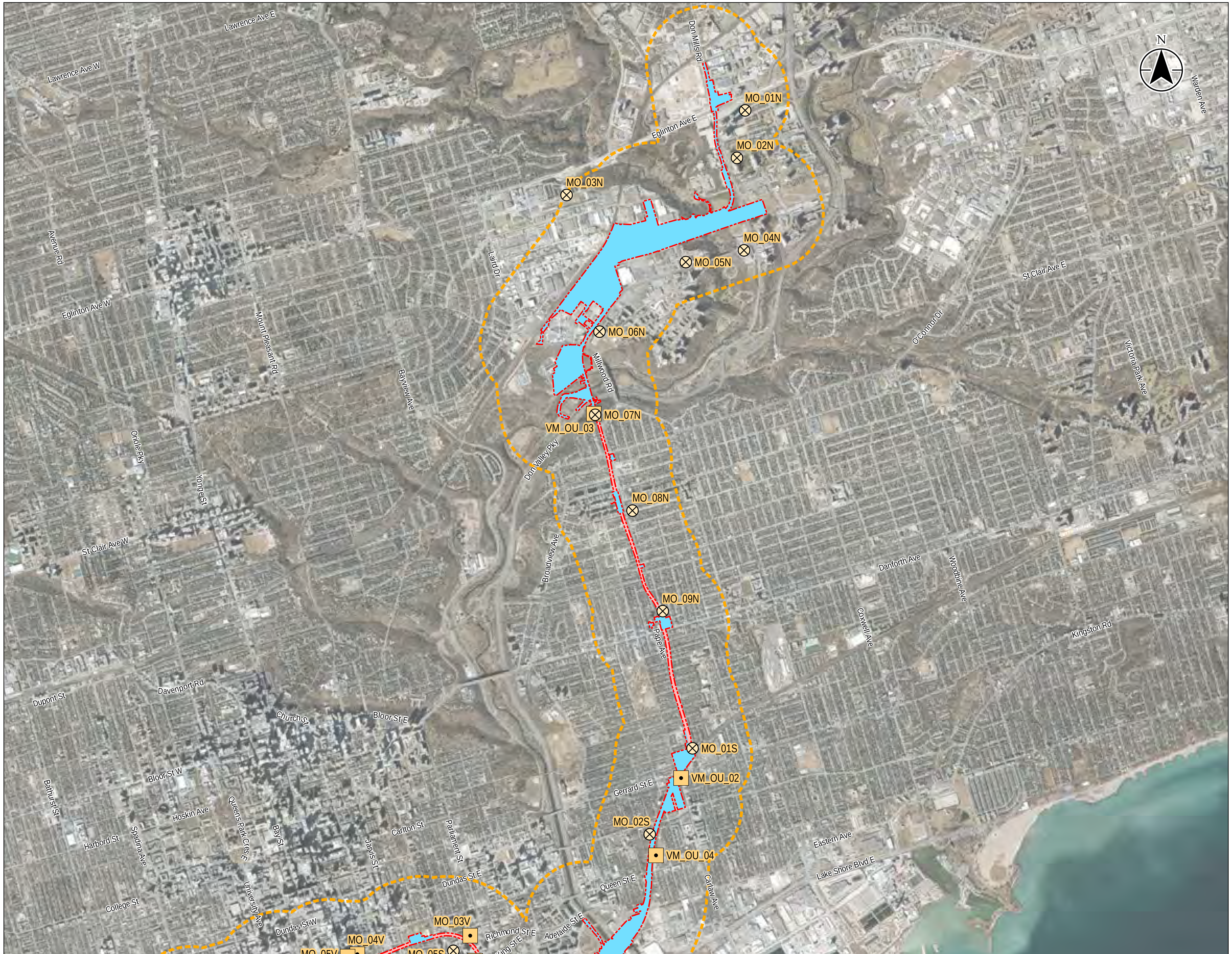
Project Location
Coity of Toronto, ON

160560009 REV4
Prepared by BCC on 2022-02-01
Technical Review by ABC on yyyy-mm-dd
Independent Review by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

Figure No.
D-1-1

Title
Baseline Noise and Vibration Monitoring - Downtown Region



Stantec

Legend

- Project Footprint
- Study Area (500 m Buffer)
- Above Grade Element
- Below Grade Element
- Indoor Noise Monitoring Location
- Outdoor Noise Monitoring Location
- Vibration Monitoring Location

0 875 1,750 Metres

1:35,000 (At original document size of 11x17)

Notes
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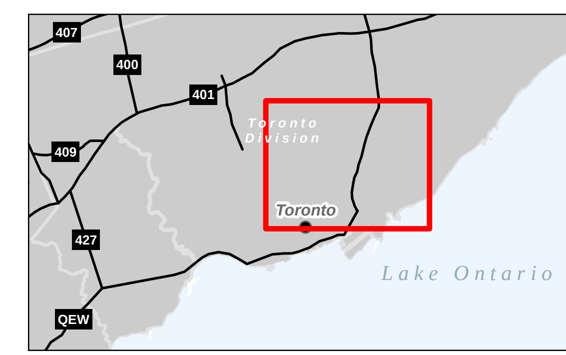

Project Location
Coity of Toronto, ON

160560009 REV4
Prepared by BCC on 2022-02-01
Technical Review by ABC on yyyy-mm-dd
Independent Review by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

Figure No.
D-1-2

Title
Baseline Noise and Vibration Monitoring - Lakeshore East / Pape / North Region

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Memo

Date:	Thursday, March 04, 2021
Project:	Ontario Line TA
To:	Mark Knight, Stantec
From:	Jihyun Cho (Ken), Stantec
Subject:	Ontario Line – Baseline Vibration Measurement (Four Seasons Centre for the Performing Arts)

A concern regarding vibration impacts due to the planned Ontario Line Project was identified for the Four Seasons Centre for the Performing Arts (Four Seasons). The Four Seasons is located south of the planned Ontario Line alignment. The project team from Stantec conducted baseline vibration measurements to assess the existing vibration condition at the Four Seasons.

Metrics

To measure the response of humans (or vibration sensitive equipment) to vibration, vibration velocity (mm/s) is the most used metric, however averaged amplitude of vibration is a more appropriate metric since the human body (or equipment) requires a certain period to respond to vibration. To assess the vibration response of humans or equipment, the root-mean-square (RMS) amplitude is typically used. The RMS value is the square root of the average of the squared amplitudes of the signal that can be described as the smoothed vibration amplitude for an average time period. The averaging time period of RMS is typically one (1) second for transit projects as recommended in the *FTA Manual*[1].

Measurement Location and Instrumentation

Stantec conducted vibration measurements on January 12, 2021 at the main auditorium of the Four Seasons as shown in Figure 1. The measurement location was selected due to the concern raised by the Four Seasons management that the auditorium is the most vibration sensitive space in the facility. The auditorium is constructed on vibration isolation bearings, and there is a space below the auditorium to access the mechanical systems and isolation bearings. Two (2) accelerometers were placed in the space below the auditorium at the middle of a bay: one (1) on the foundation slab and one (1) under the auditorium floor slab as shown on the photo in Figure 1.

Two (2) accelerometers with nominal sensitivity of 100 mv/g were employed for the measurements. The sensor signals were recorded in a digital form using a RION DA-20 data recorder with sampling frequency of 2,560 Hz for about eight (8) hours. The accelerometers were calibrated before the measurements with a single frequency vibration calibrator. Since there were some persistent human activities / footfall in the auditorium until around 6:00 PM, only the data between 6:30 PM and 10:30 PM was processed. Between

1 FTA Report No.0123 (2018), Transit Noise and Vibration Impact Assessment Manual, Federal Transit Administration, U.S. Department of Transportation

6:30 PM and 10:30 PM, security patrols may still have contributed occasional footfall in the auditorium, but not as regularly as prior to 6:00 PM.

Methods

The vibration data was processed with MATLAB© analysis software (version 2020b) to obtain RMS velocity in the time-domain and the energy averaged maximum RMS velocity in 1/3-octave frequency bands. The lowest and highest frequency bands used in the analysis were 1 Hz and 500 Hz, respectively. The entire data set was divided into one-hour data blocks, and then the one-second RMS velocity with 50% overlap was calculated for each data block.

Results

The vibration measurement results are summarized in Table 1, and the processed one-hour data block results are shown in Figure 2 to Figure 5. Excluding some impulsive vibrations on the isolated slab, the RMS vibration velocities were measured to be below 0.2 mm/s (RMS) at both foundation and isolated slabs as shown in the figures (first two plots in each figure). The impulsive vibrations in the isolated slab would be due to localized human activities on the auditorium slab such as footfalls from regular security patrols.

The one-second energy averaged maximum RMS value is typically employed to measure human response to transit vibration impacts. The one-second energy averaged maximum RMS velocity (mm/s) with its dominant frequency are shown in Figure 2, Figure 3, Figure 4, and Figure 5 (last plot in each figure). As shown in the figures, there was high amplitude vibration below 10 Hz, but the data below 10 Hz was not considered in the analysis since the data below 10 Hz would be low frequency noise from accelerometers or isolated mechanical systems, or both. Excluding the results below 10 Hz, the dominant frequency transmitted into the foundation slab is 20 Hz (dotted line in the figures). The 20 Hz dominant peak in the transmitted vibration is completely disappeared on the isolated floor slab due to the isolation bearings (solid line), as shown in the figures. The measured one-second energy averaged maximum RMS velocity is below 0.02 mm/s at both foundation floor and isolated slab.

Table 1 Summary of Vibration Measurement Results

Location	RMS Velocity (mm/s)	Energy Averaged Maximum Velocity	
		RMS Velocity (mm/s)	Dominant Frequency (Hz)
Foundation Floor	Below 0.2	Below 0.02	20
Isolated Slab	Below 0.2	Below 0.02	n/a (isolated)

Conclusion

The measured baseline vibration results in this memo are used for baseline conditions in the Ontario Line Project, including both operational vibration impact assessment and construction vibration impact assessment.

Figure 1 Measurement Location and Sensor Setup

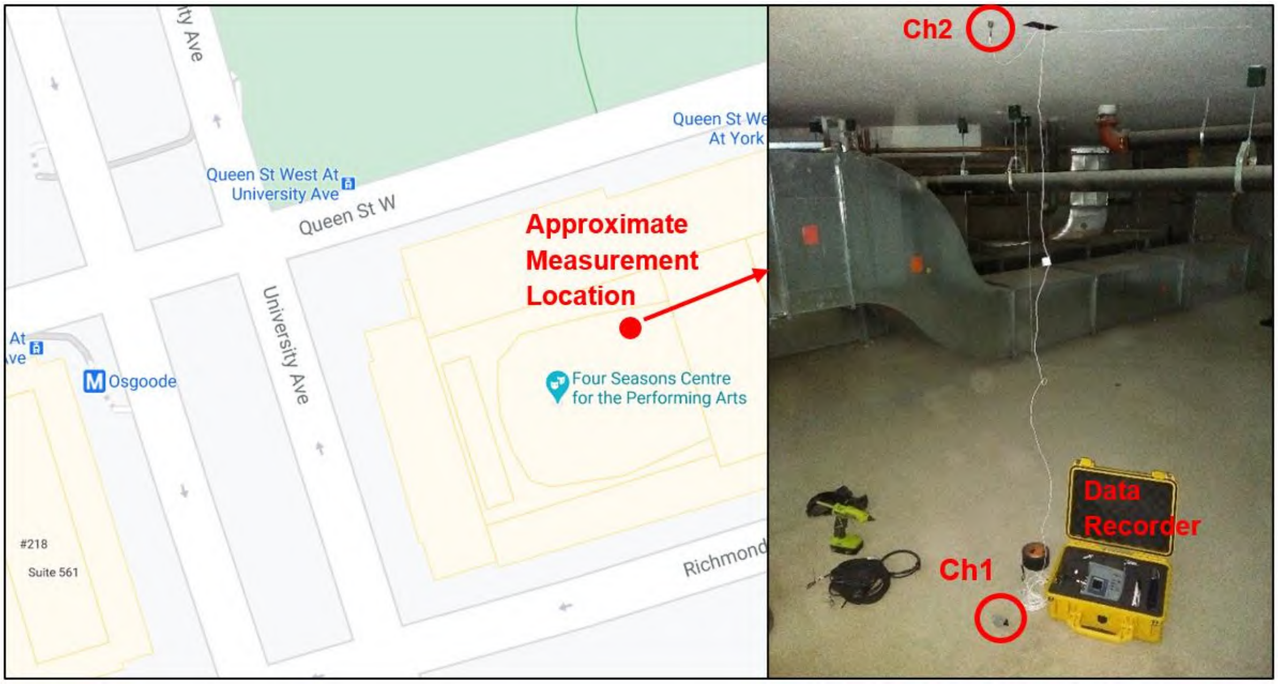


Figure 2 Vertical Vibration Velocity (mm/s, RMS) – January 12, 2021 from 6:30 PM to 7:30 PM

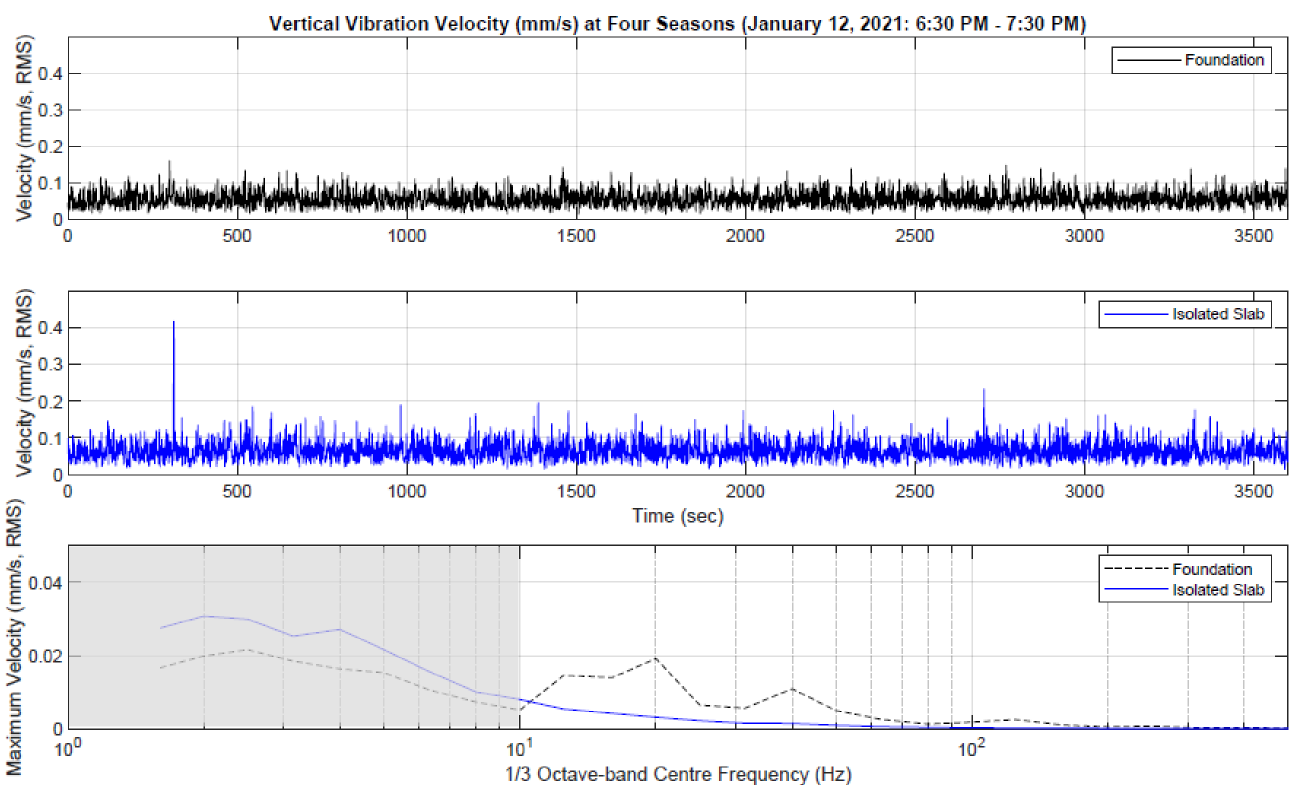


Figure 3 Vertical Vibration Velocity (mm/s, RMS) – January 12, 2021 from 7:30 PM to 8:30 PM

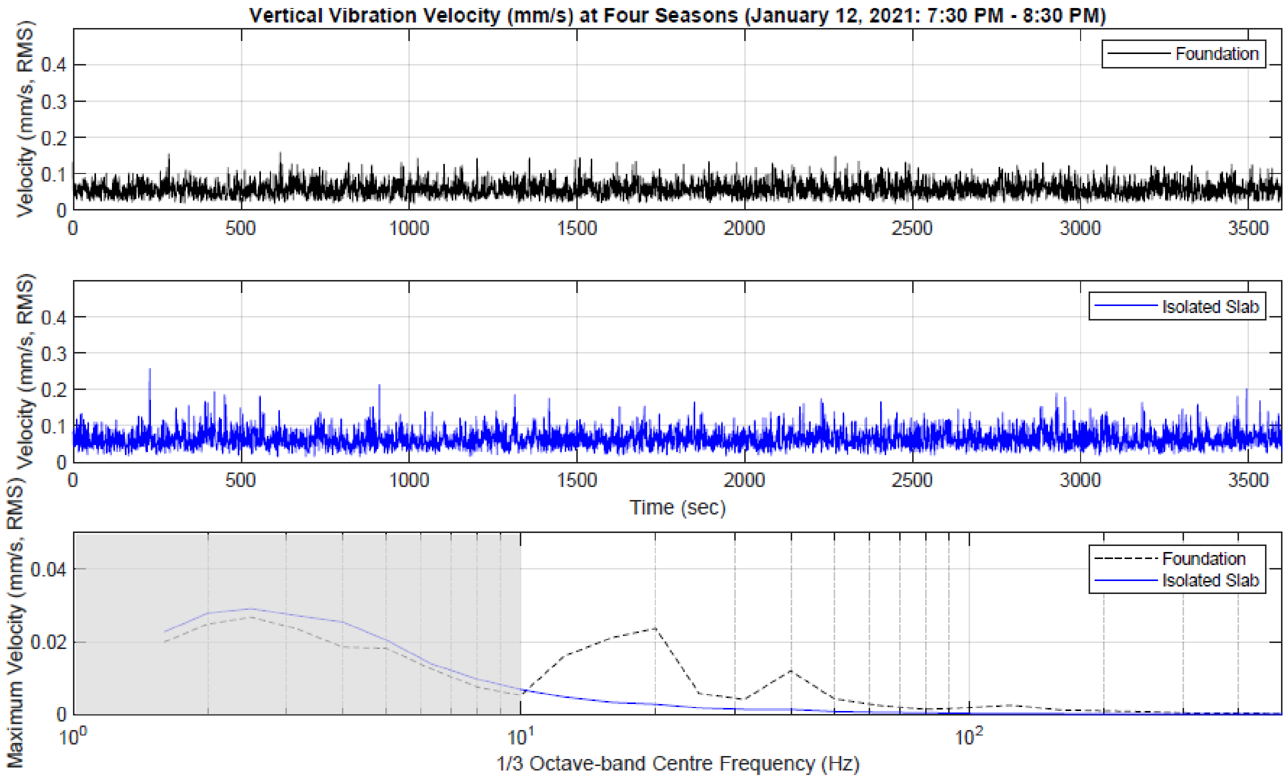


Figure 4 Vertical Vibration Velocity (mm/s, RMS) – January 12, 2021 from 8:30 PM to 9:30 PM

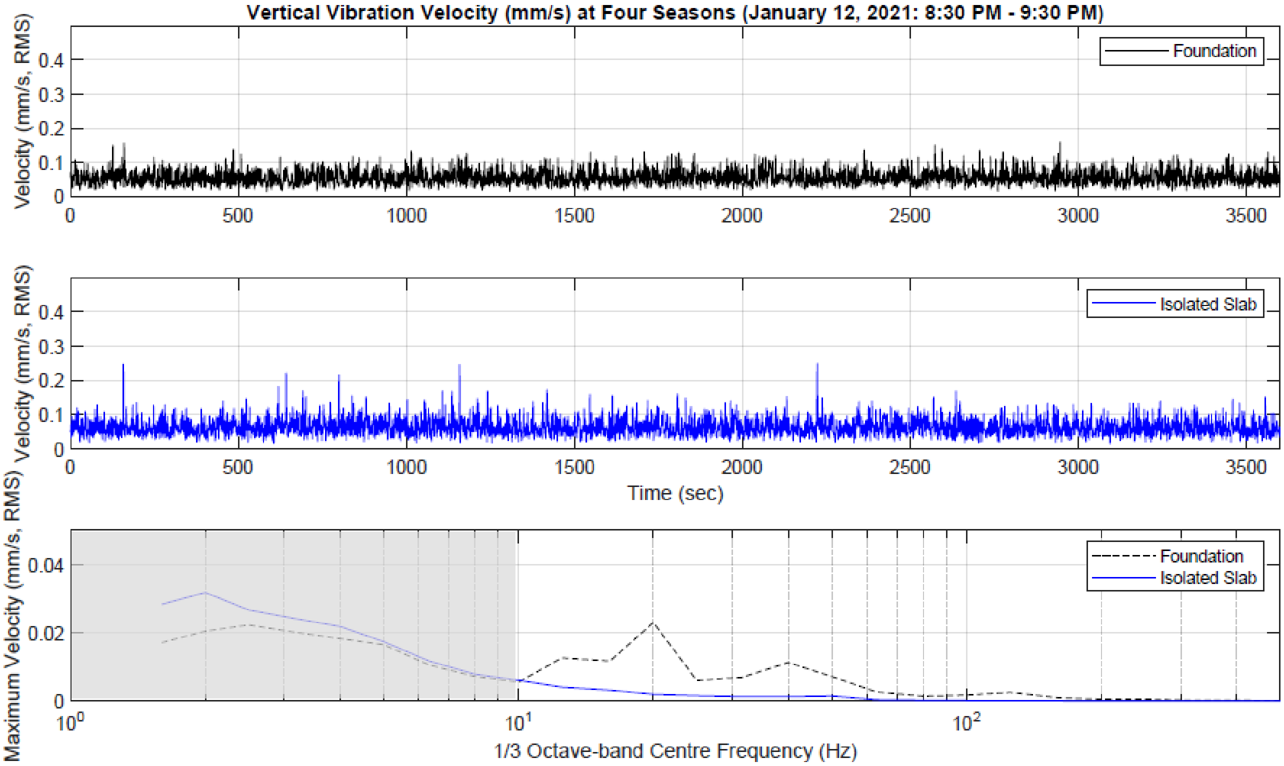


Figure 5 Vertical Vibration Velocity (mm/s, RMS) – January 12, 2021 from 9:30 PM to 10:30 PM

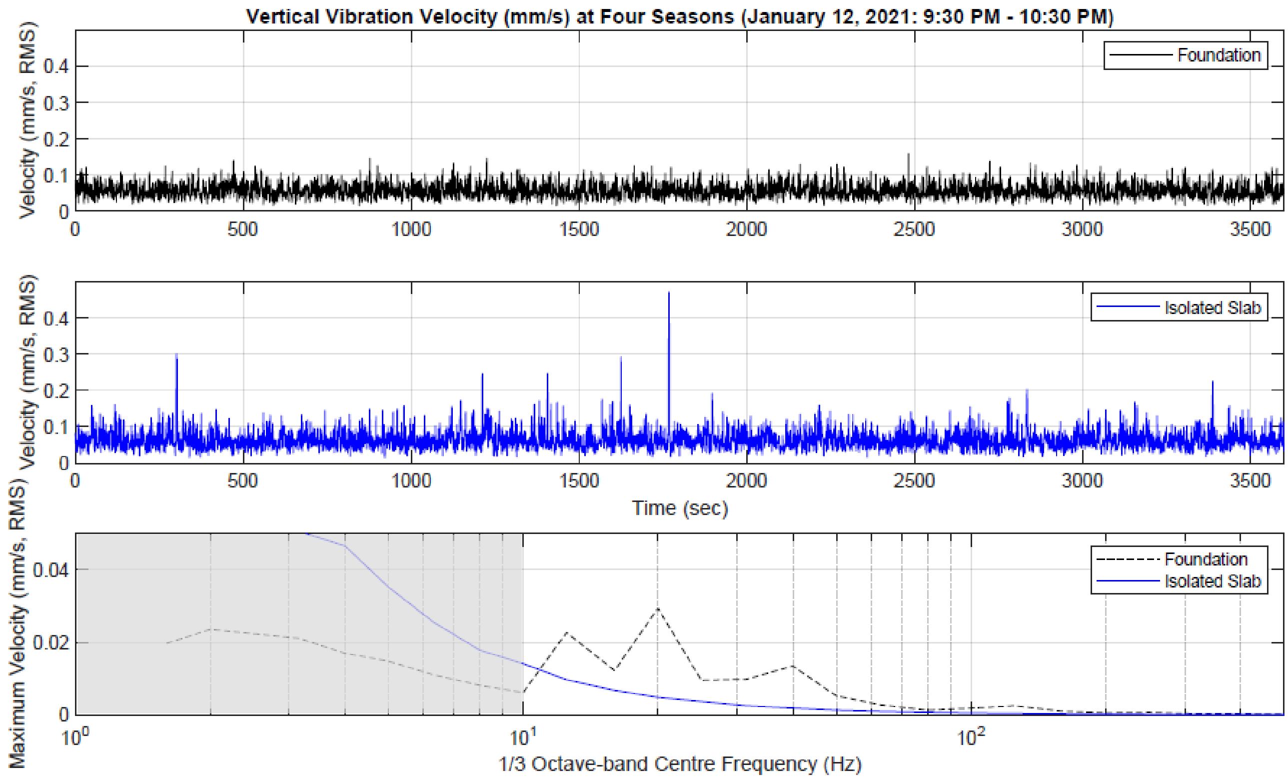


Table D-1: Environmental Conditions Report Noise Measurement Data

Monitor ID	Location	7 AM to 7 PM (Daytime)			7 PM to 11 PM (Evening)			11 PM to 7 AM (Night-time)				7 AM to 11 PM (16-Hour Daytime)	
		Min.$L_{eq, 1hr}$ (dBA)	Max.$L_{eq, 1hr}$ (dBA)	Avg.$L_{eq, 1hr}$ (dBA)	Min.$L_{eq, 1hr}$ (dBA)	Max.$L_{eq, 1hr}$ (dBA)	Avg.$L_{eq, 1hr}$ (dBA)	Min.$L_{eq, 1hr}$ (dBA)	Max.$L_{eq, 1hr}$ (dBA)	Avg.$L_{eq, 1hr}$ (dBA)	$L_{eq, 8hr}$ (dBA)	Avg.$L_{eq, 1hr}$ (dBA)	$L_{eq, 16hr}$ (dBA)
MO_01W[1]	Richmond Street West	67	67	67	59	64	61	59	64	61	61	66	66
MO_02W	Adelaide Street West	61	72	66	61	71	64	58	69	62	62	65	65
MO_03W	Hanna Avenue	58	67	62	61	63	62	54	64	59	59	63	63
MO_01S	Pape Avenue	59	73	65	56	60	58	47	62	53	55	63	64
MO_02S	Wardell Street	61	66	64	59	63	62	43	63	52	56	63	64
MO_03S[2]	Rolling Mills Road/Mill Street	63	65	64	63	65	64	50	66	58	60	64	63
MO_04S	Erin Street	61	69	64	61	67	62	55	63	58	59	64	64
MO_05S[3]	Richmond Street East	66	66	66	55	65	58	55	65	58	60	64	65
MO_01N[4]	Windom Road	53	63	59	54	61	58	48	60	53	53	58	58
MO_02N	St. Dennis Drive	61	69	67	65	67	66	56	65	60	61	67	67
MO_03N	Vanderhoof Avenue	59	70	67	63	67	64	55	70	59	60	66	67
MO_04N[5]	Don Mills Road/Overlea Boulevard	57	68	63	60	64	62	53	63	58	58	63	64
MO_05N	William Morgan Drive	57	68	63	60	64	62	53	63	58	58	63	64
MO_06N	Leaside Park Drive	53	63	59	54	61	58	48	60	53	53	58	58
MO_07N	Minton Place/Hopedale Avenue	55	70	59	53	65	57	46	57	51	52	59	59
MO_08N	Gowan Avenue	53	71	57	50	57	53	44	68	50	51	56	59
MO_09N	Gertrude Place	48	60	53	48	52	51	45	54	49	49	53	53

Notes:

[1] Evening noise data not measured due to access restraints. Levels assumed to be represented by night-time data.

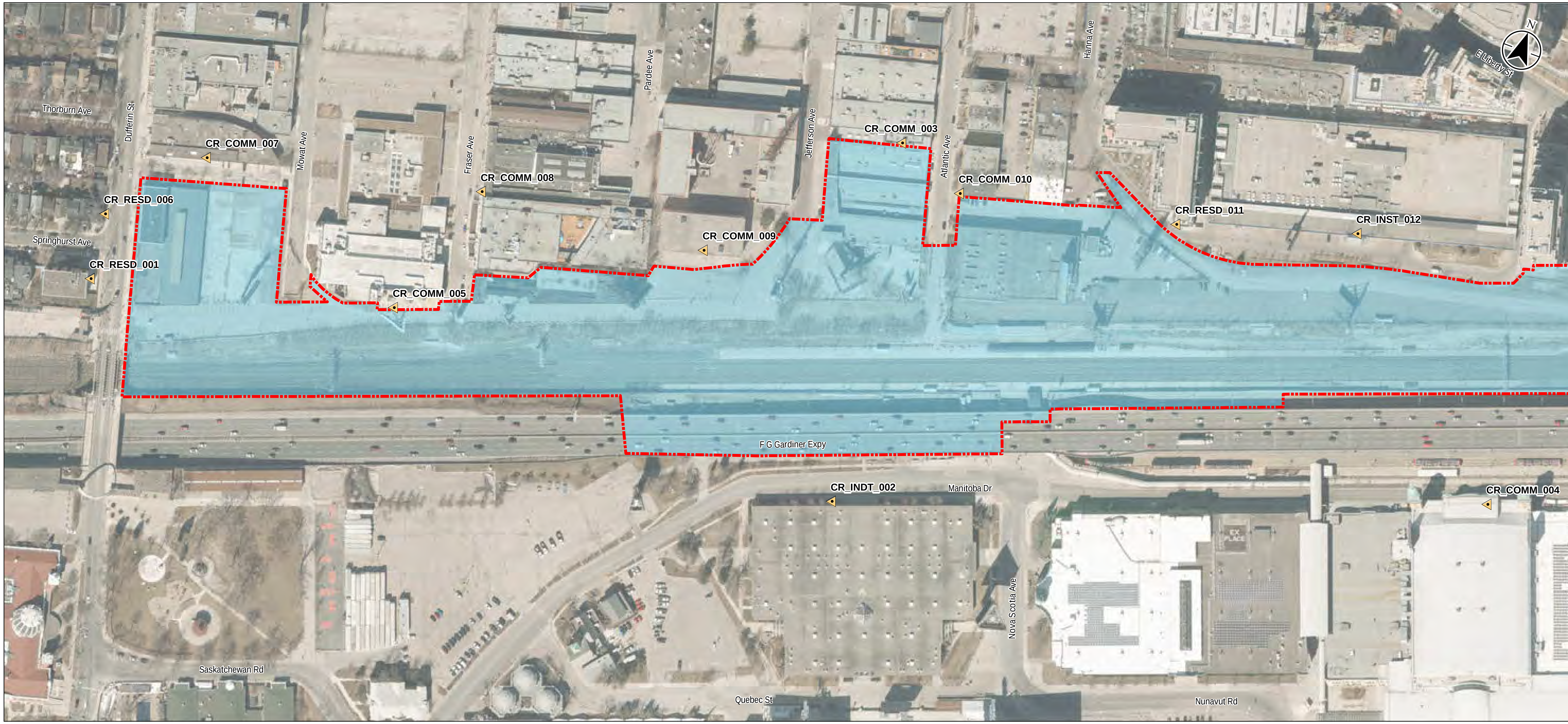
[2] Daytime noise data considered invalid due to nearby construction. Levels assumed to be represented by evening data.

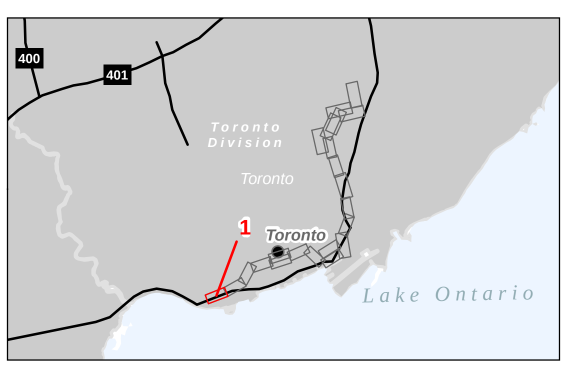
[3] Evening noise data not measured due to access restraints. Levels assumed to be represented by night-time data.

[4] Noise levels assumed to be represented by MO_06N.

[5] Noise levels assumed to be represented by MO_05N.

Appendix E. Baseline Receptor Inventory





Legend

- Construction Receptor
- Project Footprint
- Above Grade Element

0 40 80 metres

1:2,500 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

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TR by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
E-1-1

Title
Representative Receptors

Notes
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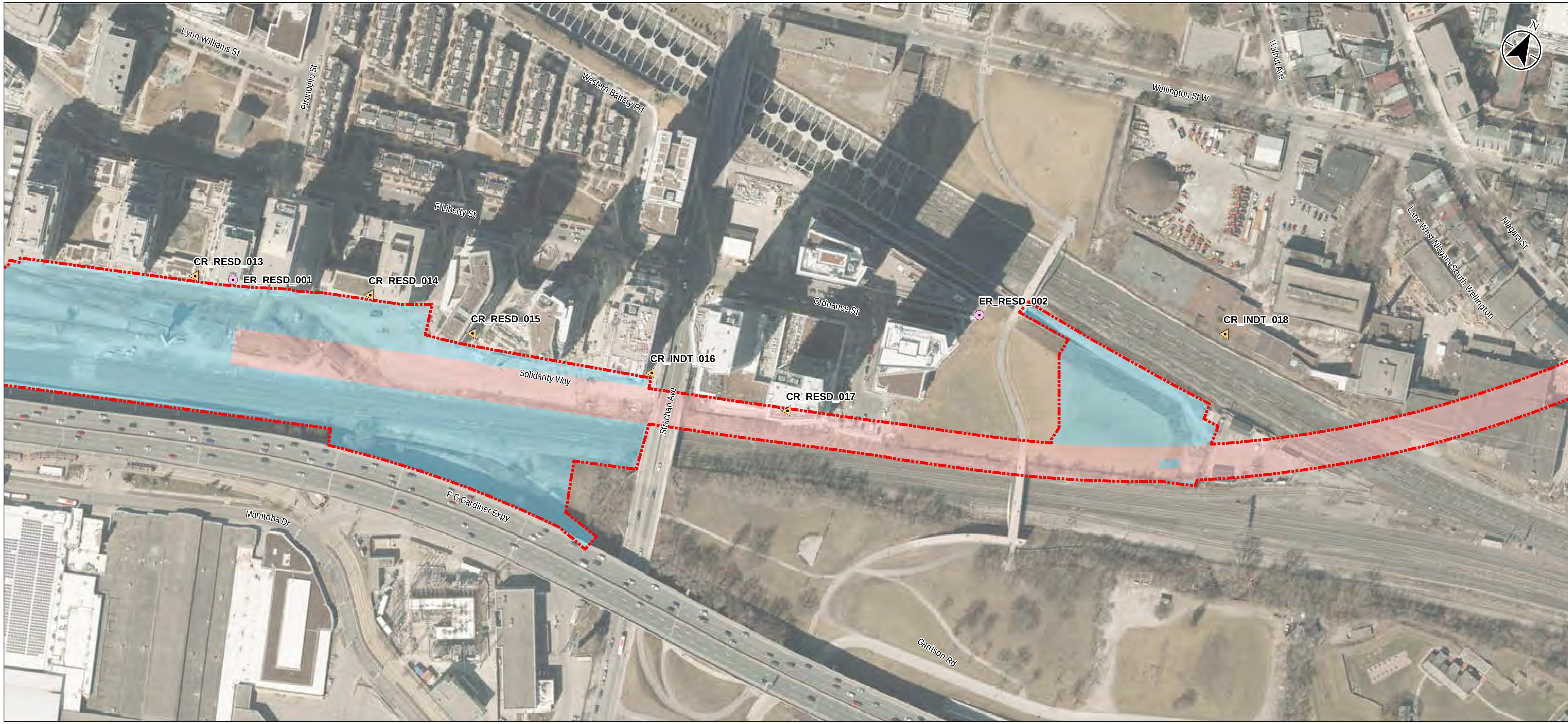

Legend

- Construction Receptor
- Emergency Exit / Service Receptors
- Project Footprint
- Above Grade Element
- Below Grade Element

0 40 80 metres

1:2,500 (At original document size of 11x17)

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Figure No.
E-1-2

Title
Representative Receptors

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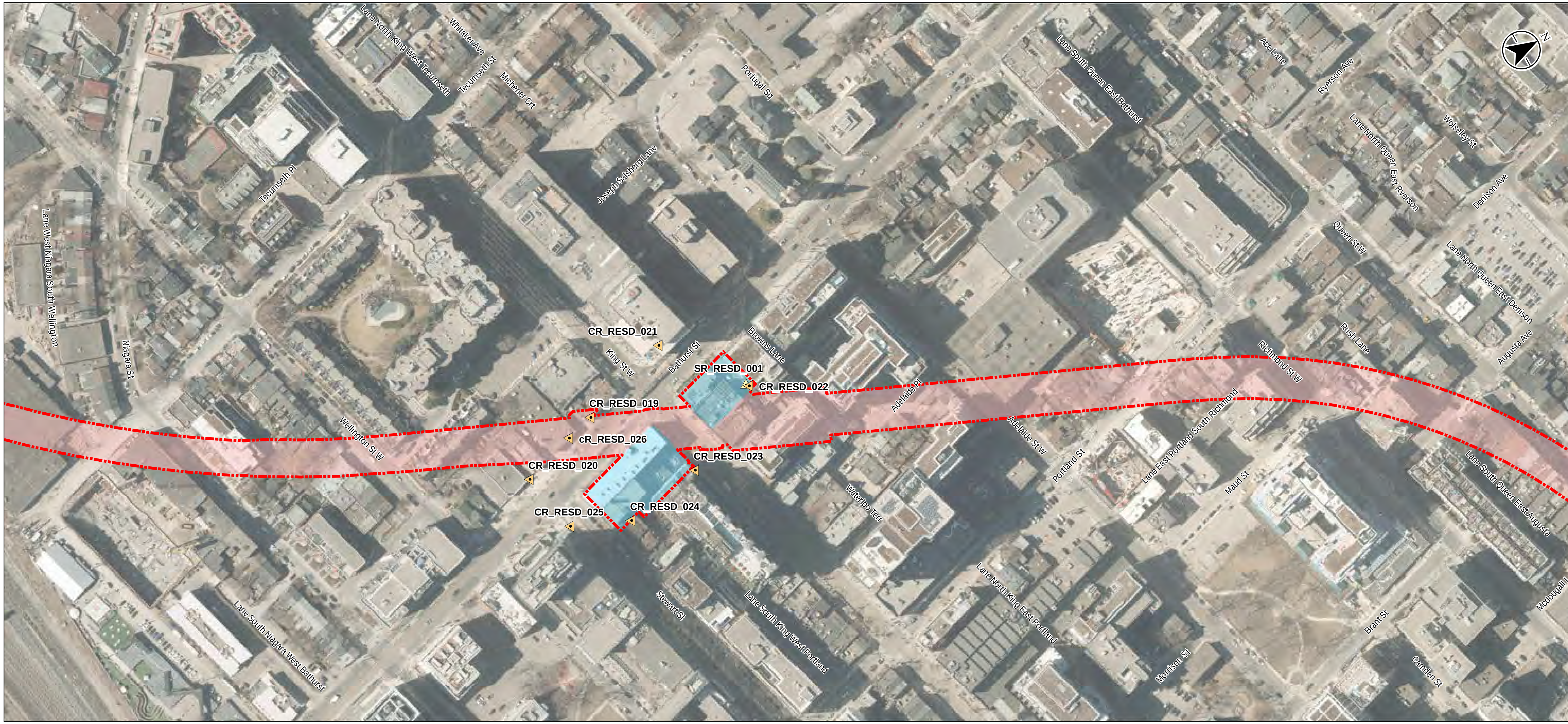

Legend
- Construction Receptor
- Station Receptor
- Project Footprint
- Above Grade Element
- Below Grade Element

0 40 80 metres
1:2,500 (At original document size of 11x17)

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Figure No.
E-1-3

Title
Representative Receptors

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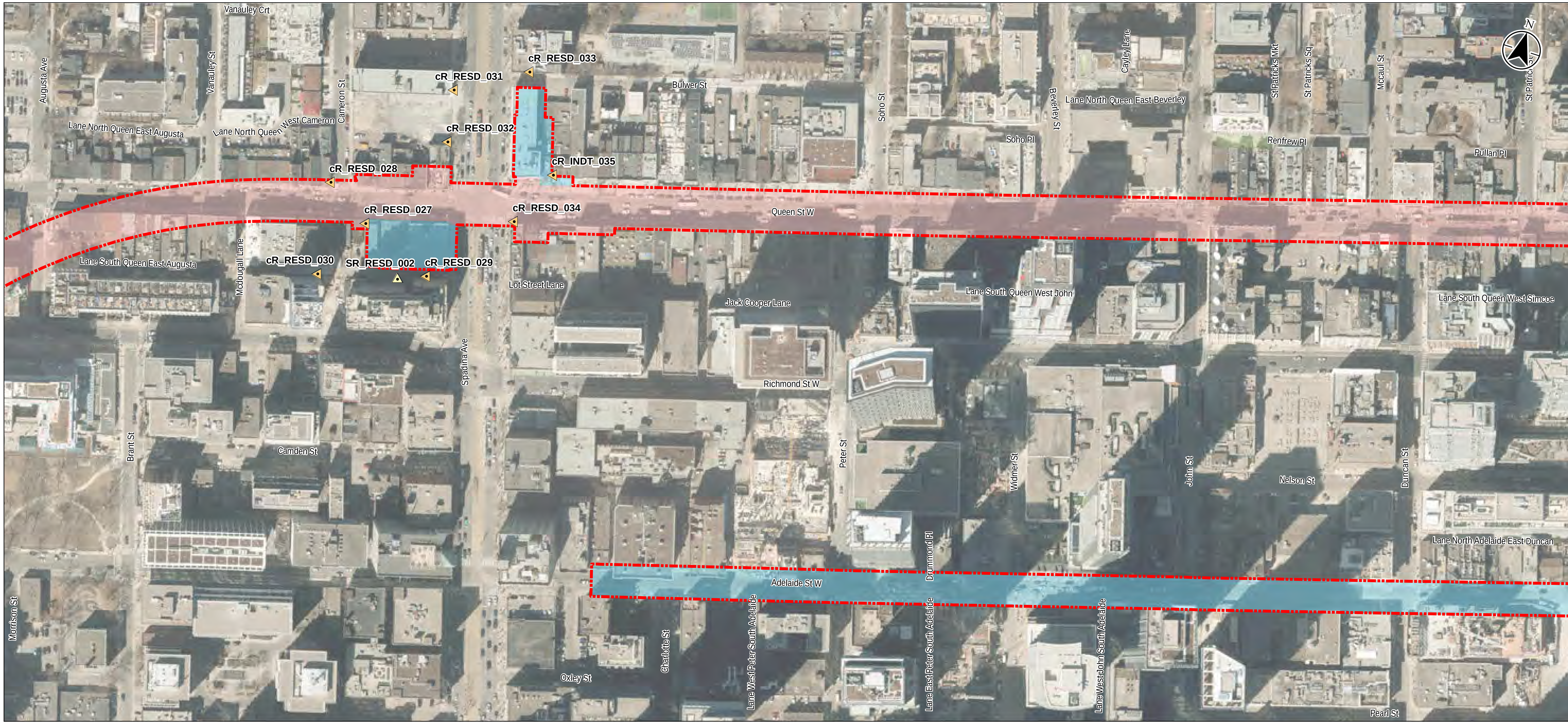

Legend

- Construction Receptor
- Station Receptor
- Project Footprint
- Above Grade Element
- Below Grade Element

0 40 80 metres

1:2,500 (At original document size of 11x17)

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Figure No.
E-1-4

Title
Representative Receptors

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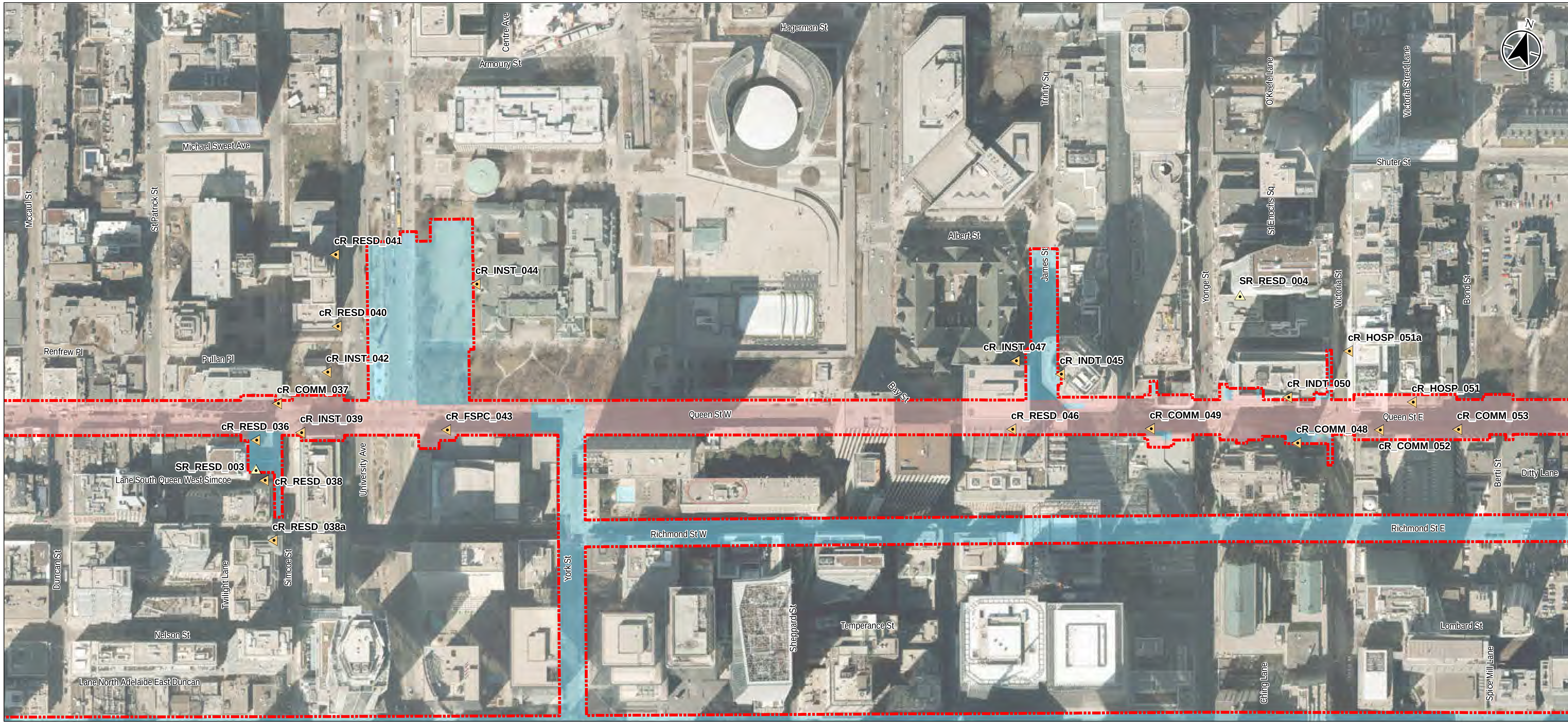

Legend
- Construction Receptor
- Station Receptor
- Project Footprint
- Above Grade Element
- Below Grade Element

0 50 100 metres
1:3,000 (At original document size of 11x17)

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Figure No.
E-1-5

Title
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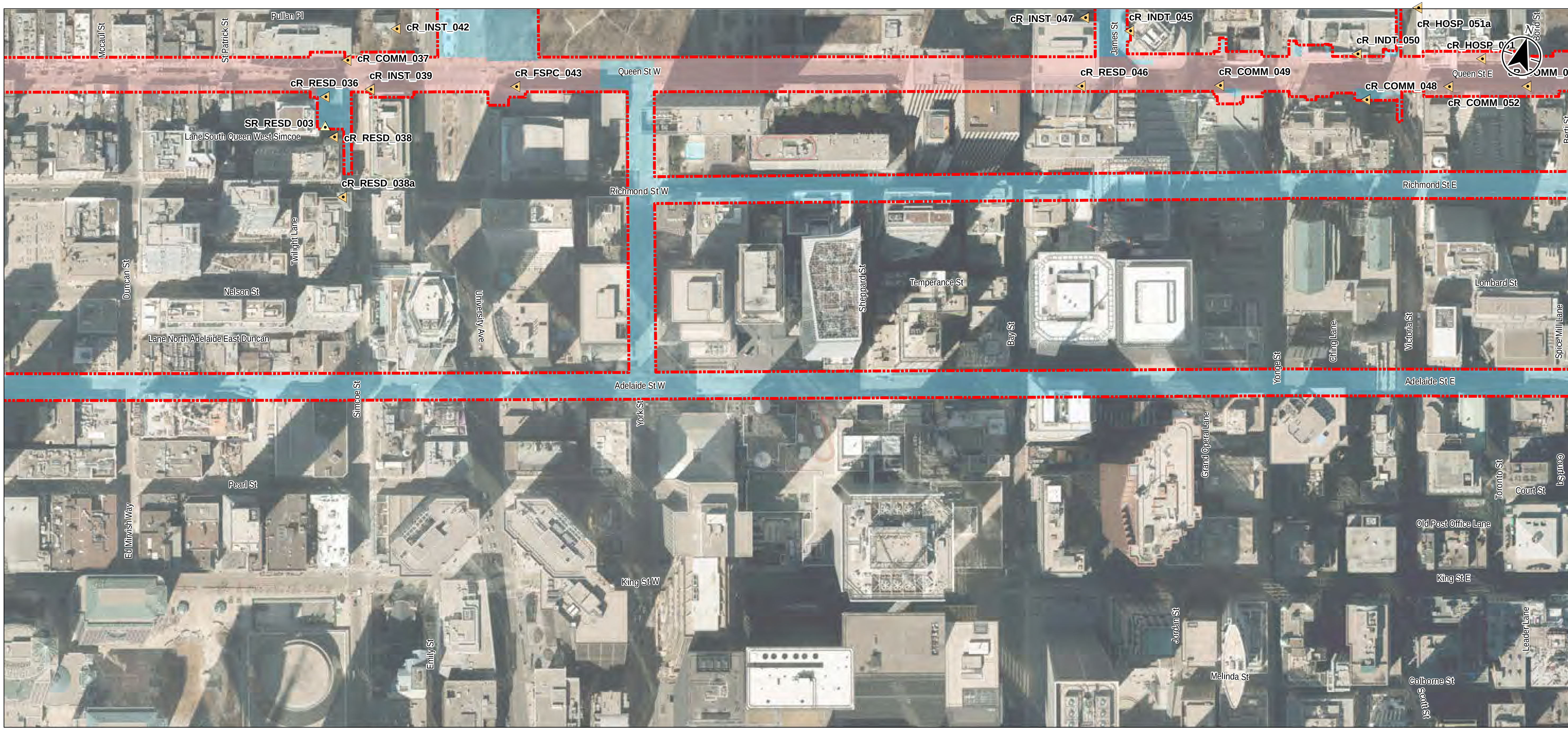

Legend
- Construction Receptor
- Station Receptor
- Project Footprint
- Above Grade Element
- Below Grade Element

0 50 100 metres

1:3,000 (At original document size of 11x17)

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Figure No.
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Title
Representative Receptors

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Legend

- Construction Receptor
- Station Receptor
- Project Footprint
- Above Grade Element
- Below Grade Element

0 40 80 metres

1:2,500 (At original document size of 11x17)

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Figure No.
E-1-7

Title
Representative Receptors

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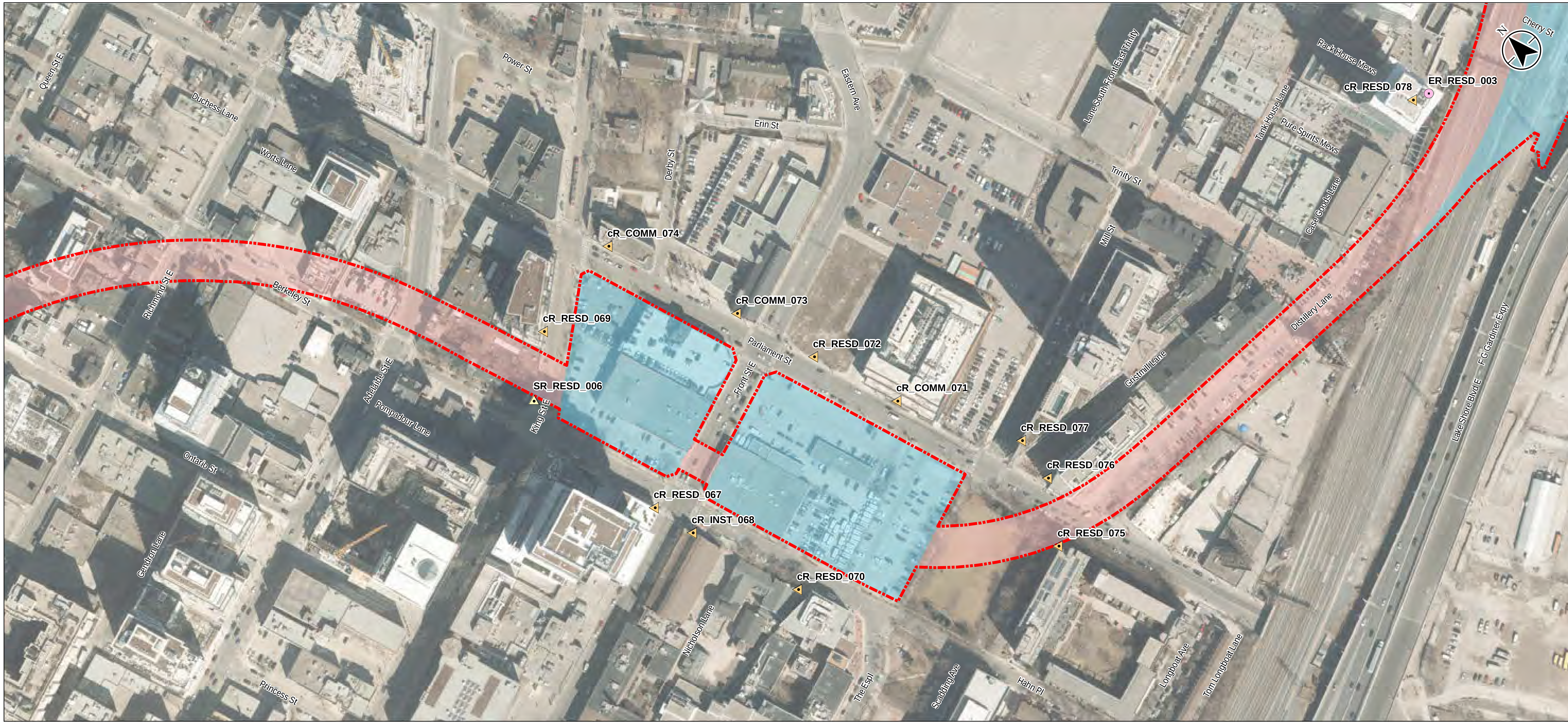

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Legend
- Construction Receptor
- Station Receptor
- Emergency Exit / Service Receptors
- Project Footprint
- Above Grade Element
- Below Grade Element

0 40 80 metres
1:2,500 (At original document size of 11x17)

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Figure No.
E-1-8

Title
Representative Receptors

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Legend

- Construction Receptor
- Emergency Exit / Service Receptors
- Project Footprint
- Above Grade Element
- Below Grade Element

0 40 80 metres

1:2,500 (At original document size of 11x17)

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Figure No.
E-1-9

Title
Representative Receptors

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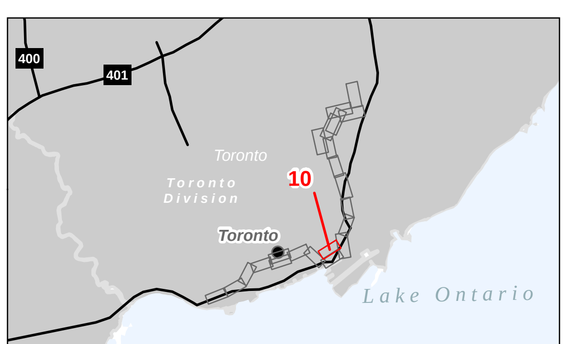

Legend

- Construction Receptor
- Project Footprint
- Above Grade Element

0 40 80 metres

1:2,500 (At original document size of 11x17)

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Figure No.
E-1-10

Title
Representative Receptors

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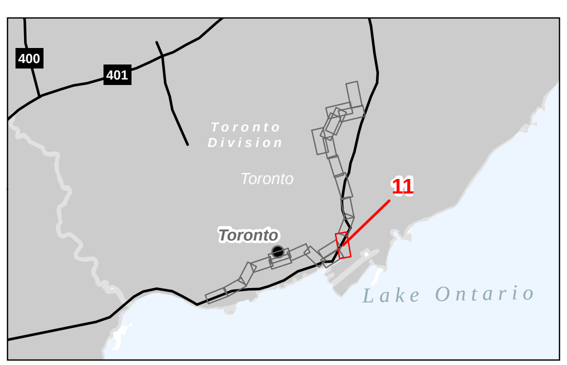

Legend

- Construction Receptor
- Project Footprint
- Above Grade Element

0 40 80 metres

1:2,500 (At original document size of 11x17)

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Figure No.
E-1-11

Title
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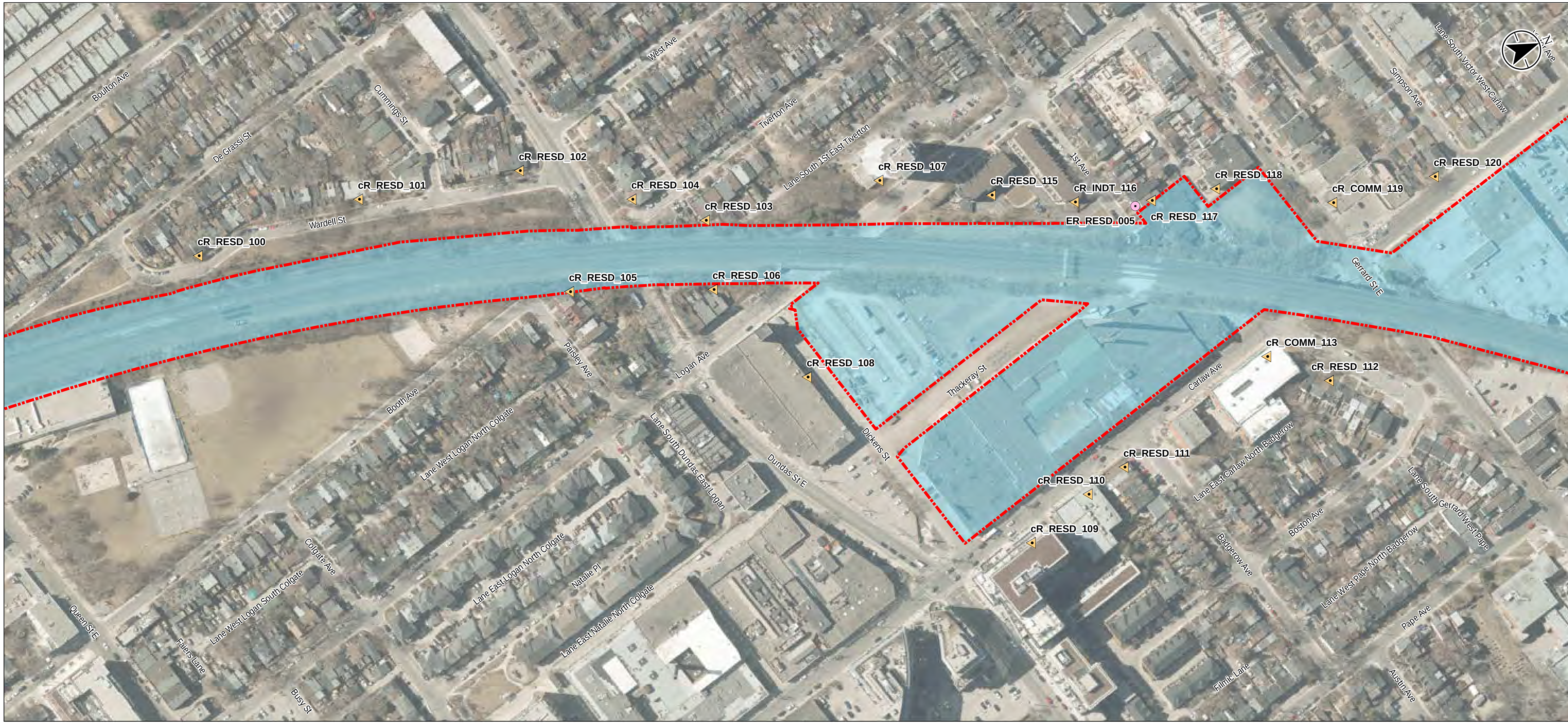

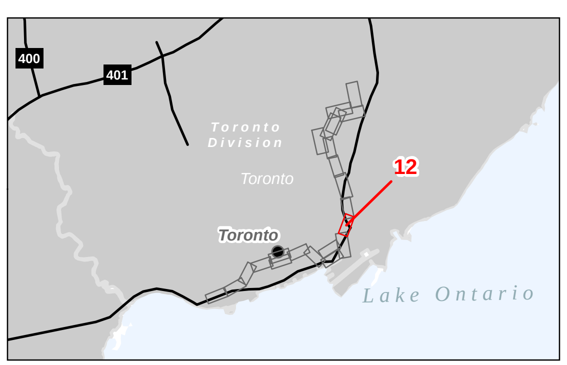

Legend
- Construction Receptor
- Emergency Exit / Service Receptors
- Project Footprint
- Above Grade Element

0 40 80 metres
1:2,500 (At original document size of 11x17)

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Figure No.
E-1-12

Title
Representative Receptors

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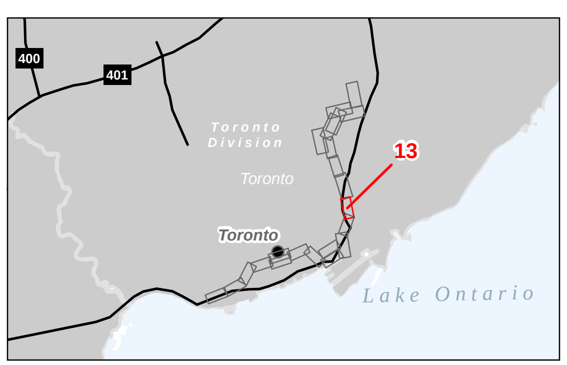

Legend

- Construction Receptor
- Emergency Exit / Service Receptors
- Project Footprint
- Above Grade Element
- Below Grade Element

0 40 80 metres

1:2,500 (At original document size of 11x17)

Stantec

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Figure No.
E-1-13

Title
Representative Receptors

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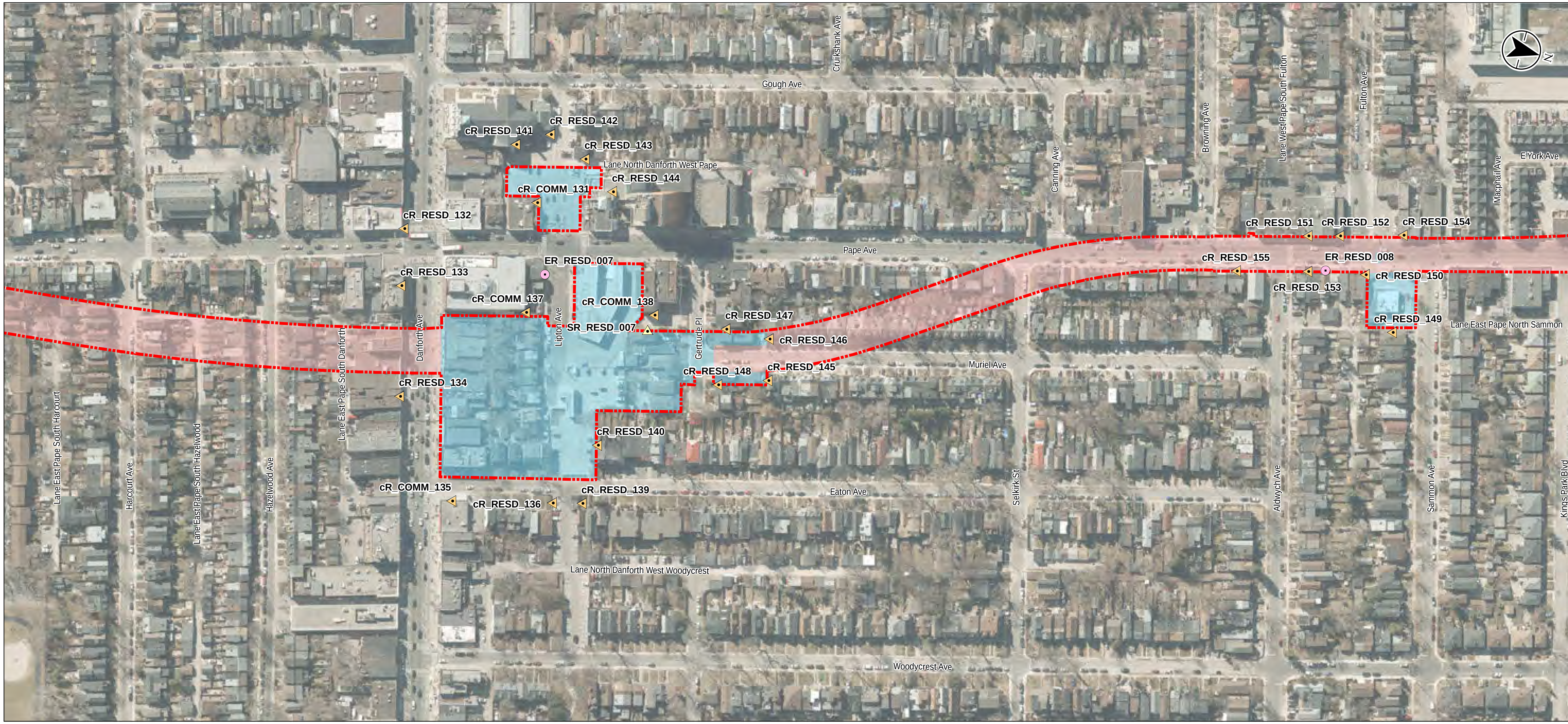

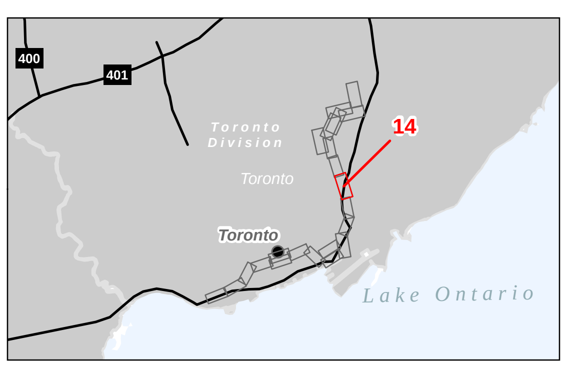

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Legend

- Construction Receptor
- Station Receptor
- Emergency Exit / Service Receptors
- Project Footprint
- Above Grade Element
- Below Grade Element

0 40 80 metres

1:2,500 (At original document size of 11x17)

Stantec

Project Location
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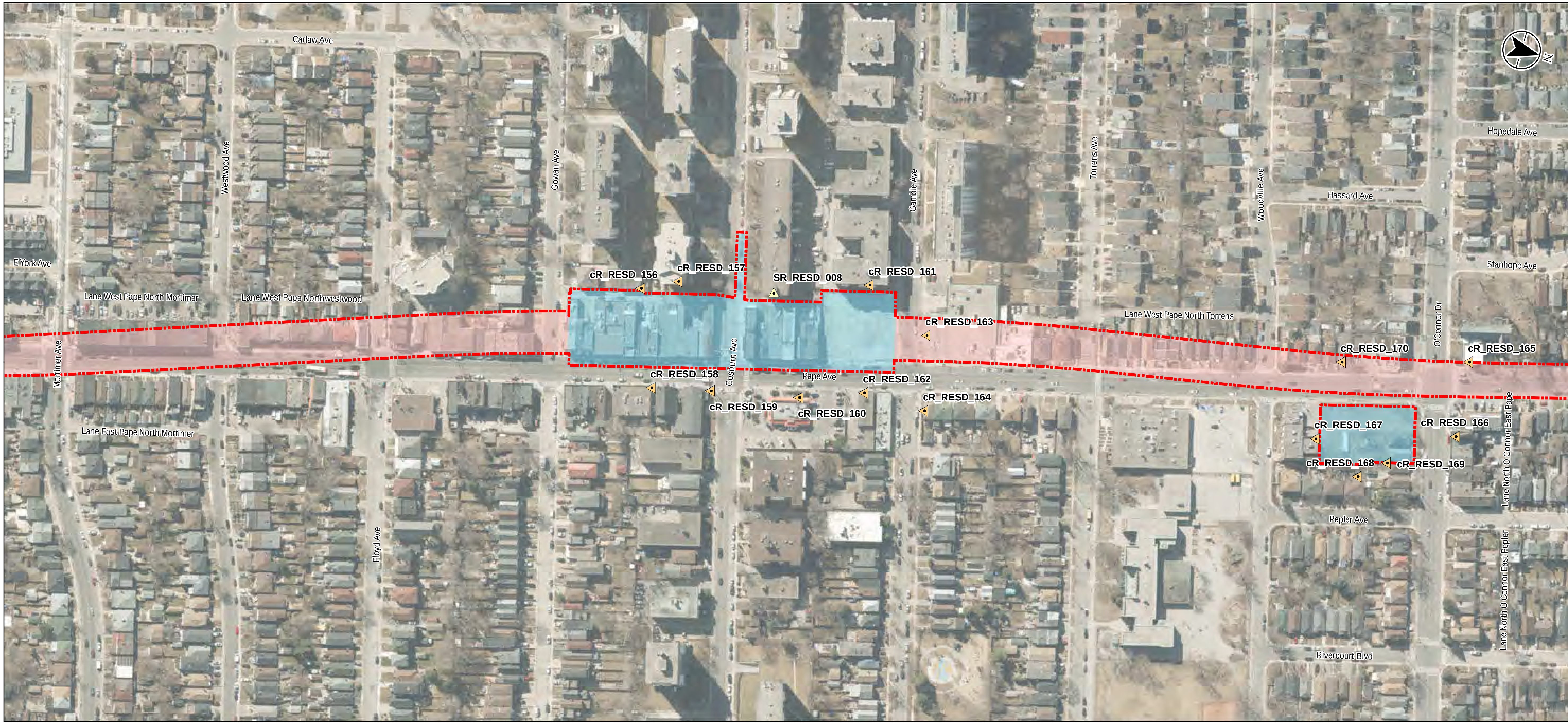
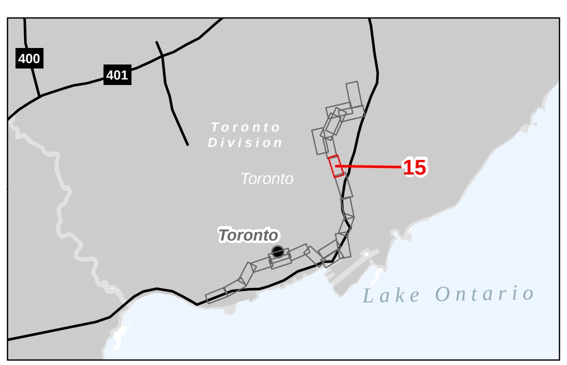
ONTARIO LINE TA

Figure No.
E-1-14

Title
Representative Receptors





Legend
- Construction Receptor
- Station Receptor
- Project Footprint
- Above Grade Element
- Below Grade Element

0 40 80 metres
1:2,500 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

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TR by ABC on yyyy-mm-dd

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160560009 REVA
HDR CORPORATION
ONTARIO LINE TA

Figure No.
E-1-15

Title
Representative Receptors

Notes
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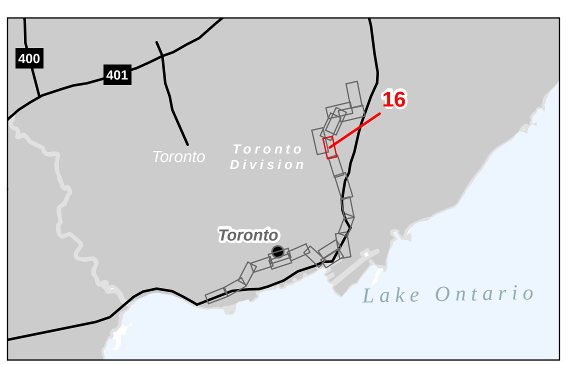

Legend

- Construction Receptor
- Rail Receptor
- Emergency Exit / Service Receptors
- Project Footprint
- Above Grade Element
- Below Grade Element

0 40 80 metres

1:2,500 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

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TR by ABC on yyyy-mm-dd

Client/Project
160560009 REVA

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ONTARIO LINE TA

Figure No.
E-1-16

Title
Representative Receptors

Notes
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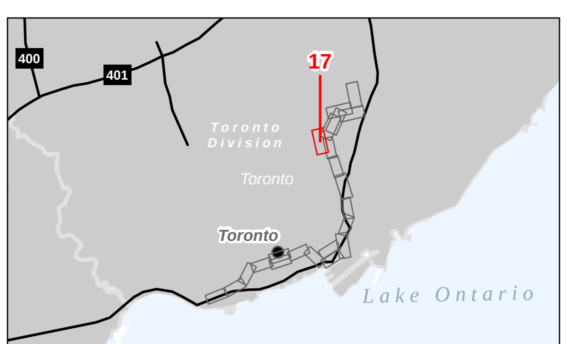

Legend

- OMSF Receptor
- Project Footprint
- Above Grade Element

0 50 100 metres

1:3,000 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

Prepared by BCC on 2022-03-10
TR by ABC on yyyy-mm-dd

Client/Project
160560009 REVA
HDR CORPORATION
ONTARIO LINE TA

Figure No.
E-1-17

Title
Representative Receptors

Notes
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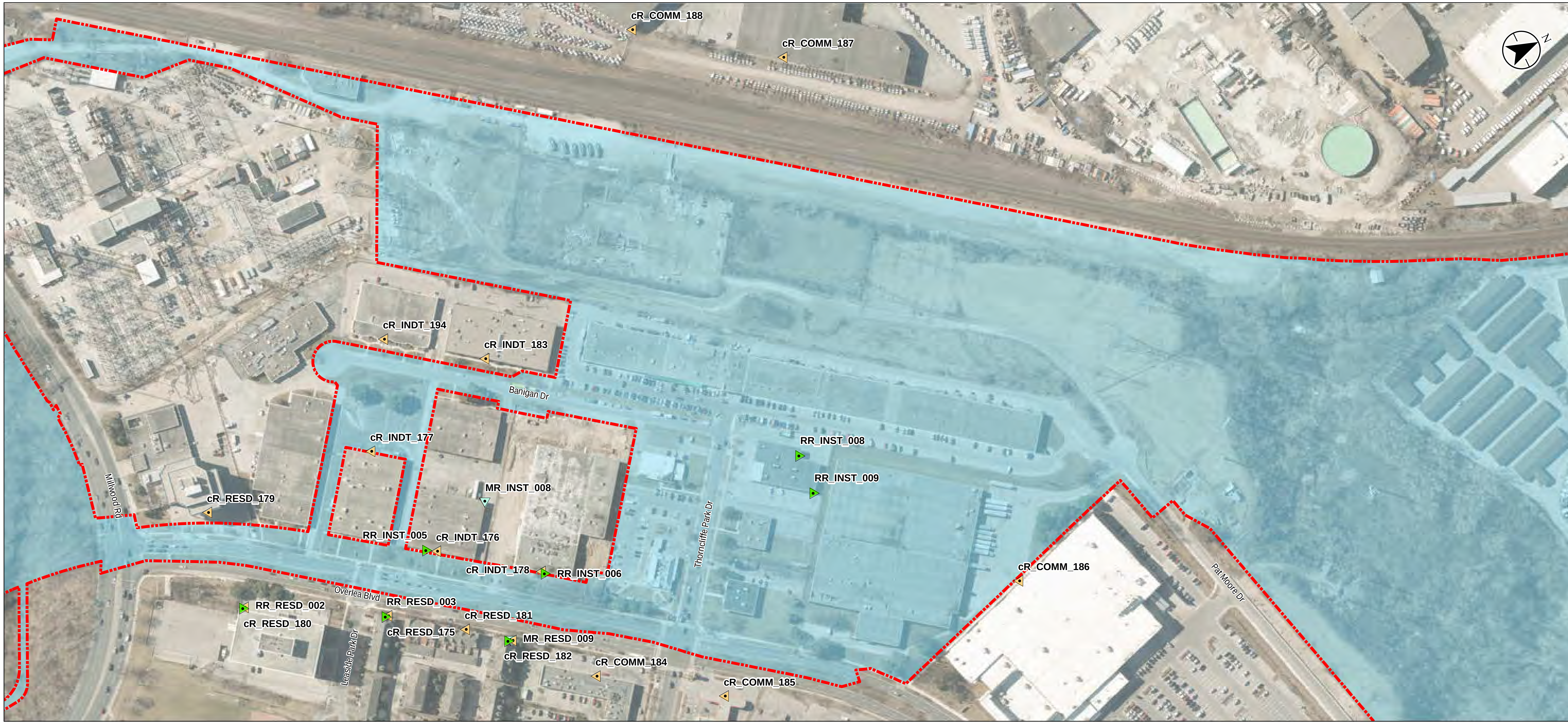

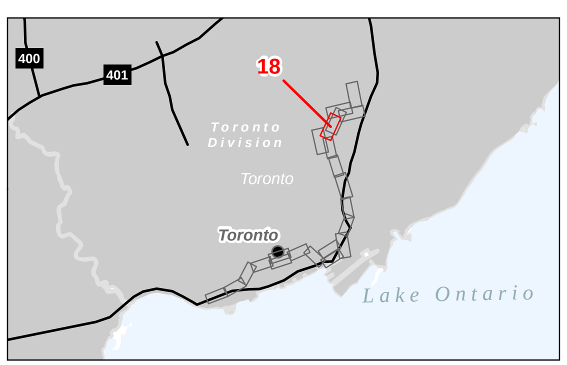

Legend

- Construction Receptor
- OMSF Receptor
- Rail Receptor
- Project Footprint
- Above Grade Element

0 50 100 metres

1:3,000 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

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Client/Project
HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
E-1-18

Title
Representative Receptors

Notes
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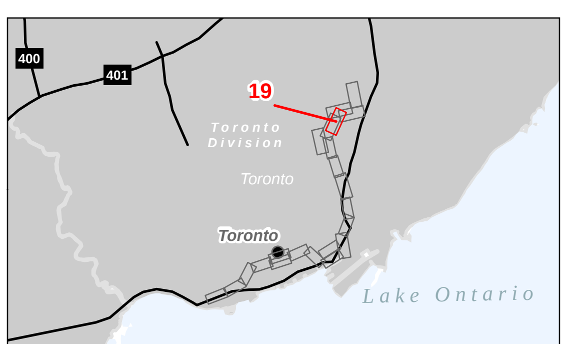

Notes
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Legend
- Construction Receptor
- OMSF Receptor
- Rail Receptor
- Project Footprint
- Above Grade Element

0 50 100 metres
1:3,000 (At original document size of 11x17)

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Project Location
Toronto, ON

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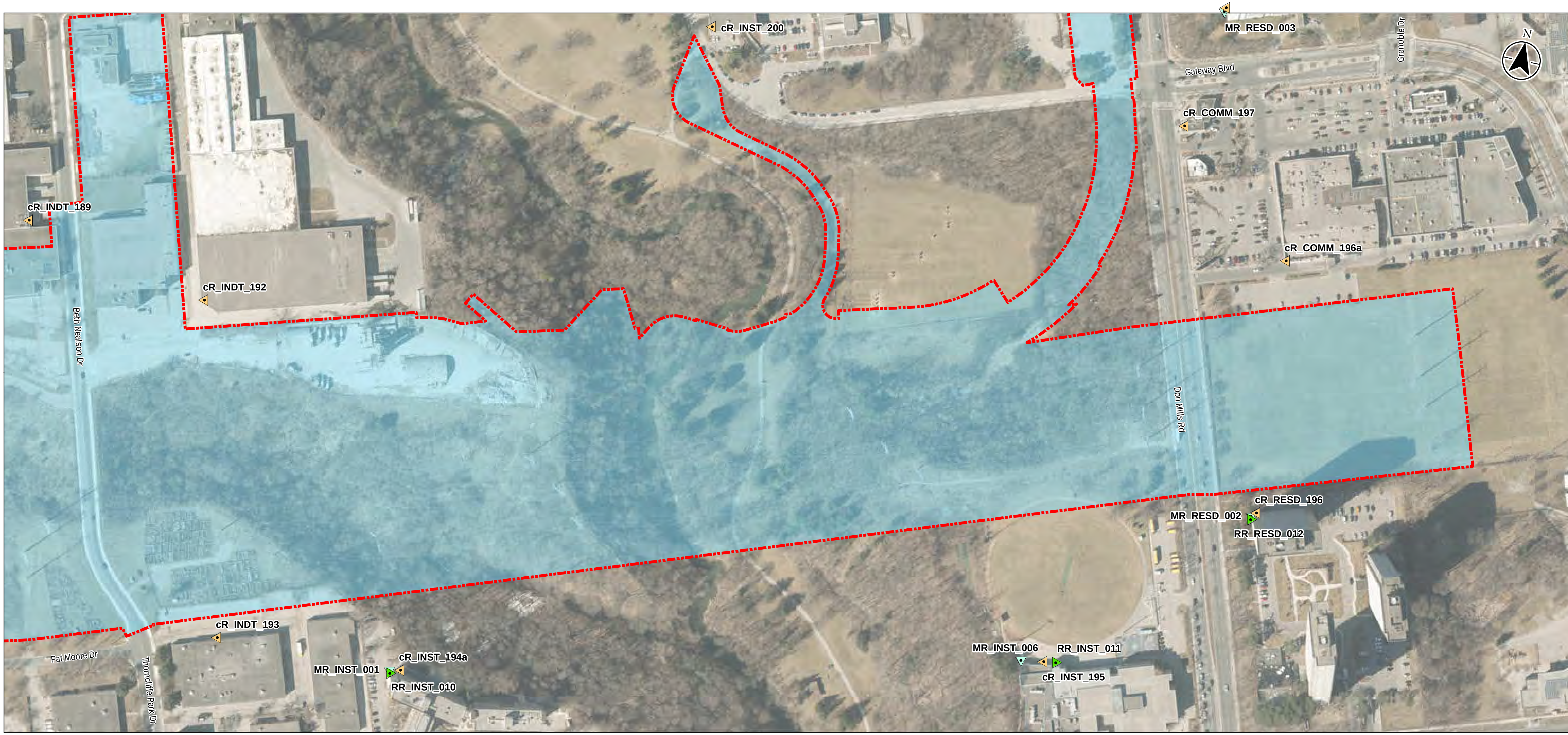
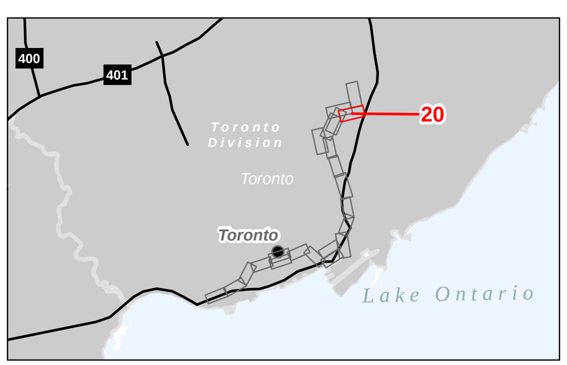
Client/Project
160560009 REVA
HDR CORPORATION
ONTARIO LINE TA

Figure No.
E-1-19

Title
Representative Receptors





Legend
- Construction Receptor
- OMSF Receptor
- Rail Receptor
- Project Footprint
- Above Grade Element

0 50 100 metres

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ONTARIO LINE TA

160560009 REVA

Figure No.
E-1-20

Title
Representative Receptors

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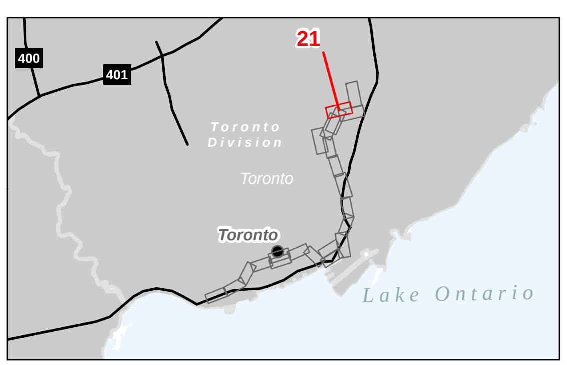

Legend

- Construction Receptor
- OMSF Receptor
- Project Footprint
- Above Grade Element

0 50 100 metres

1:3,000 (At original document size of 11x17)

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Project Location
Toronto, ON

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Client/Project
160560009 REVA
HDR CORPORATION
ONTARIO LINE TA

Figure No.
E-1-21

Title
Representative Receptors

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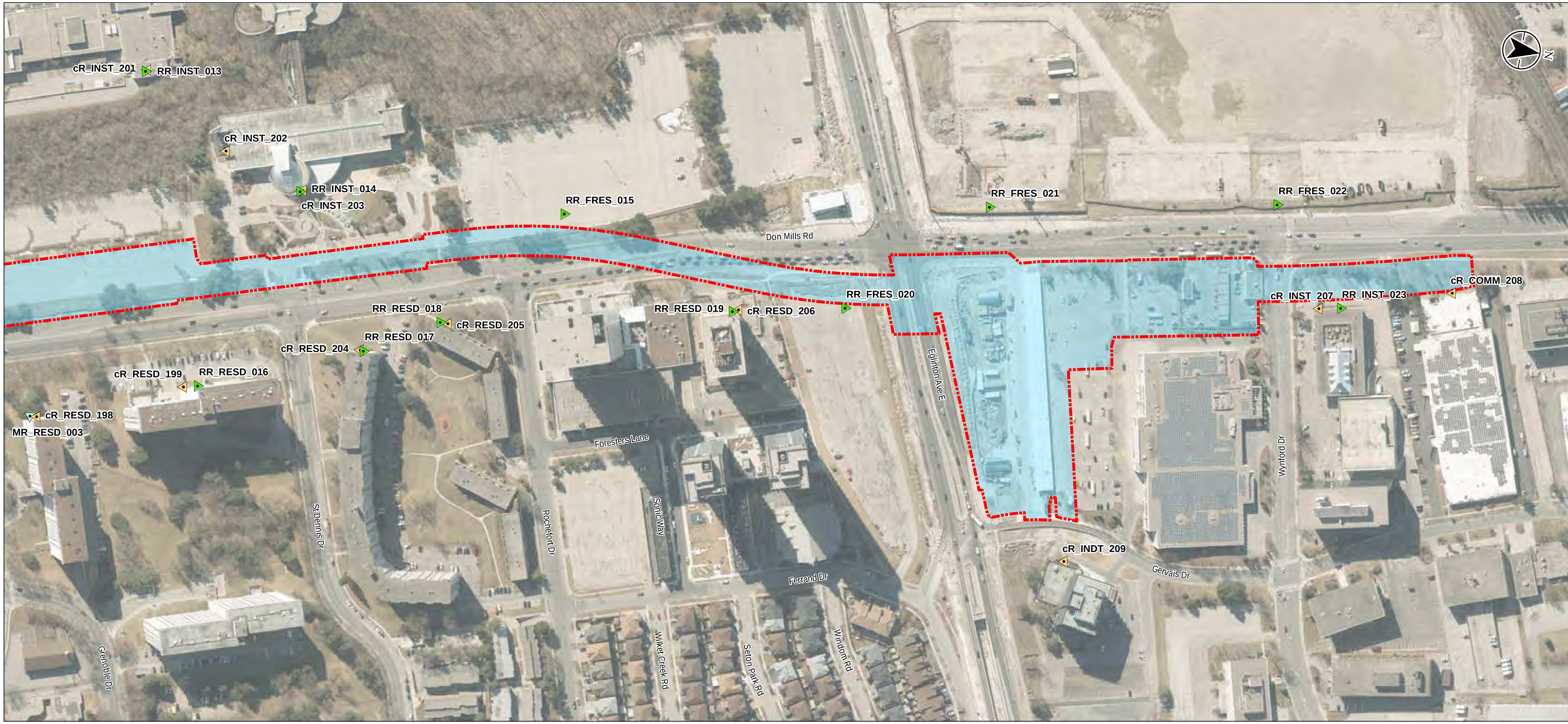

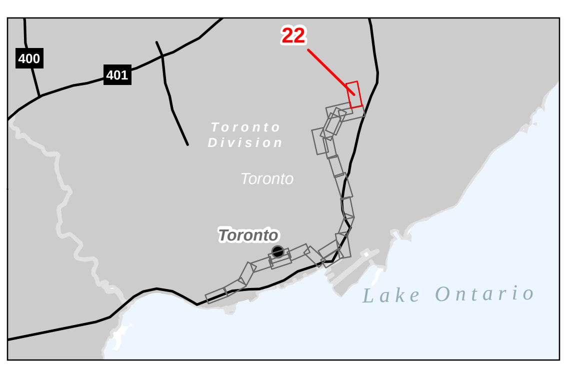

Legend
- Construction Receptor
- OMSF Receptor
- Rail Receptor
- Project Footprint
- Above Grade Element

0 50 100 metres

1:3,000 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

Prepared by BCC on 2022-03-10
TR by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
E-1-22

Title
Representative Receptors

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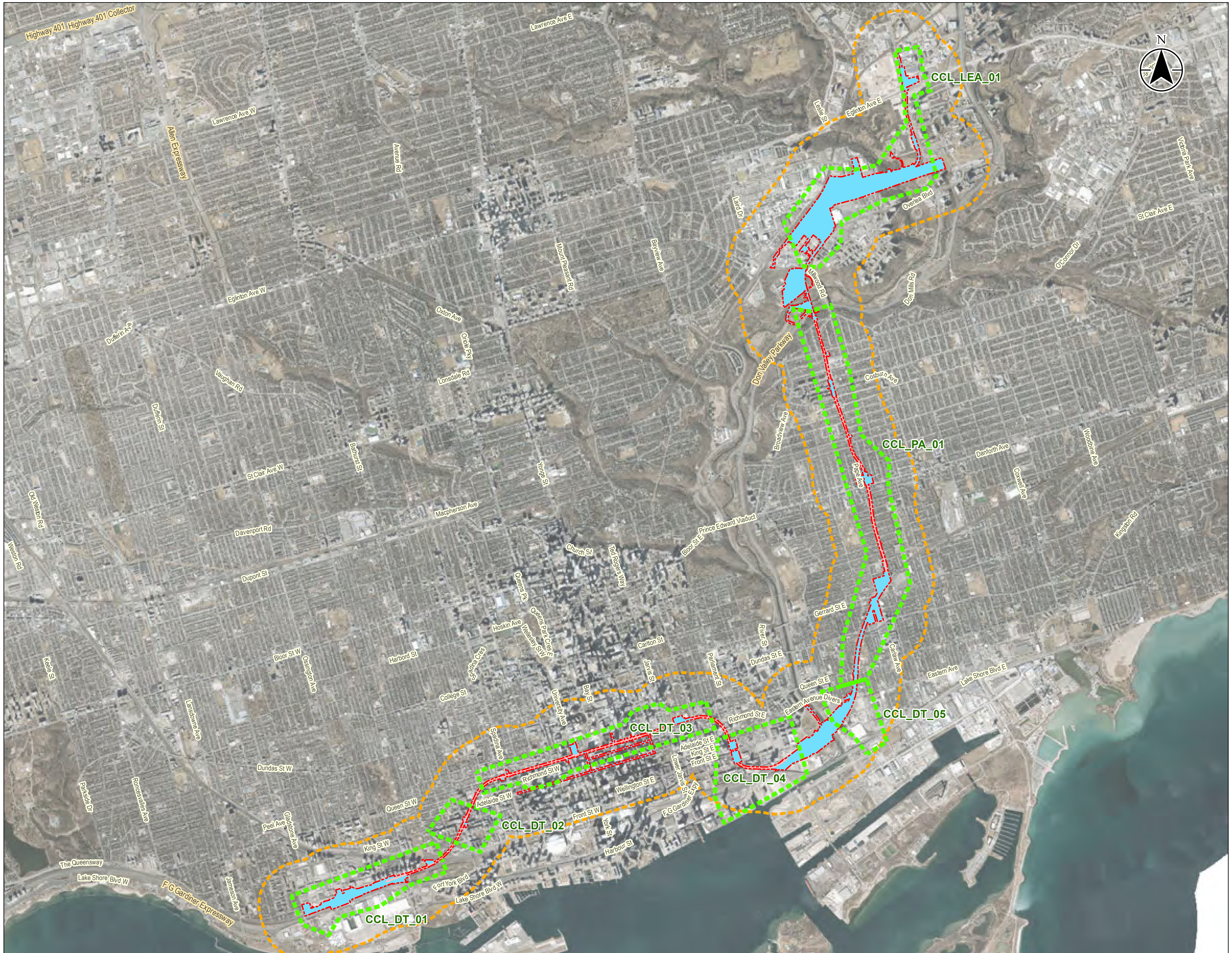

Stantec

Legend

- Project Footprint
- Study Area (500 m Buffer)
- Above Grade Element
- Below Grade Element
- Cluster Area

0 1,100 2,200 Metres

1:46,000 (At original document size of 11x17)

Notes

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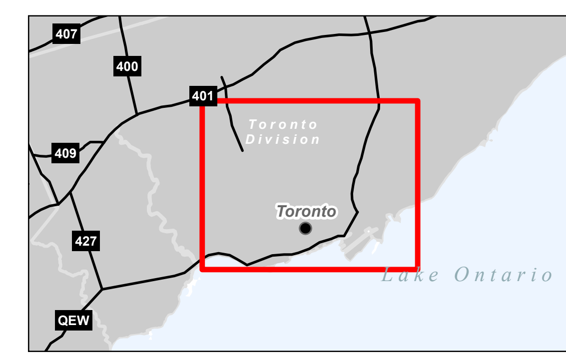


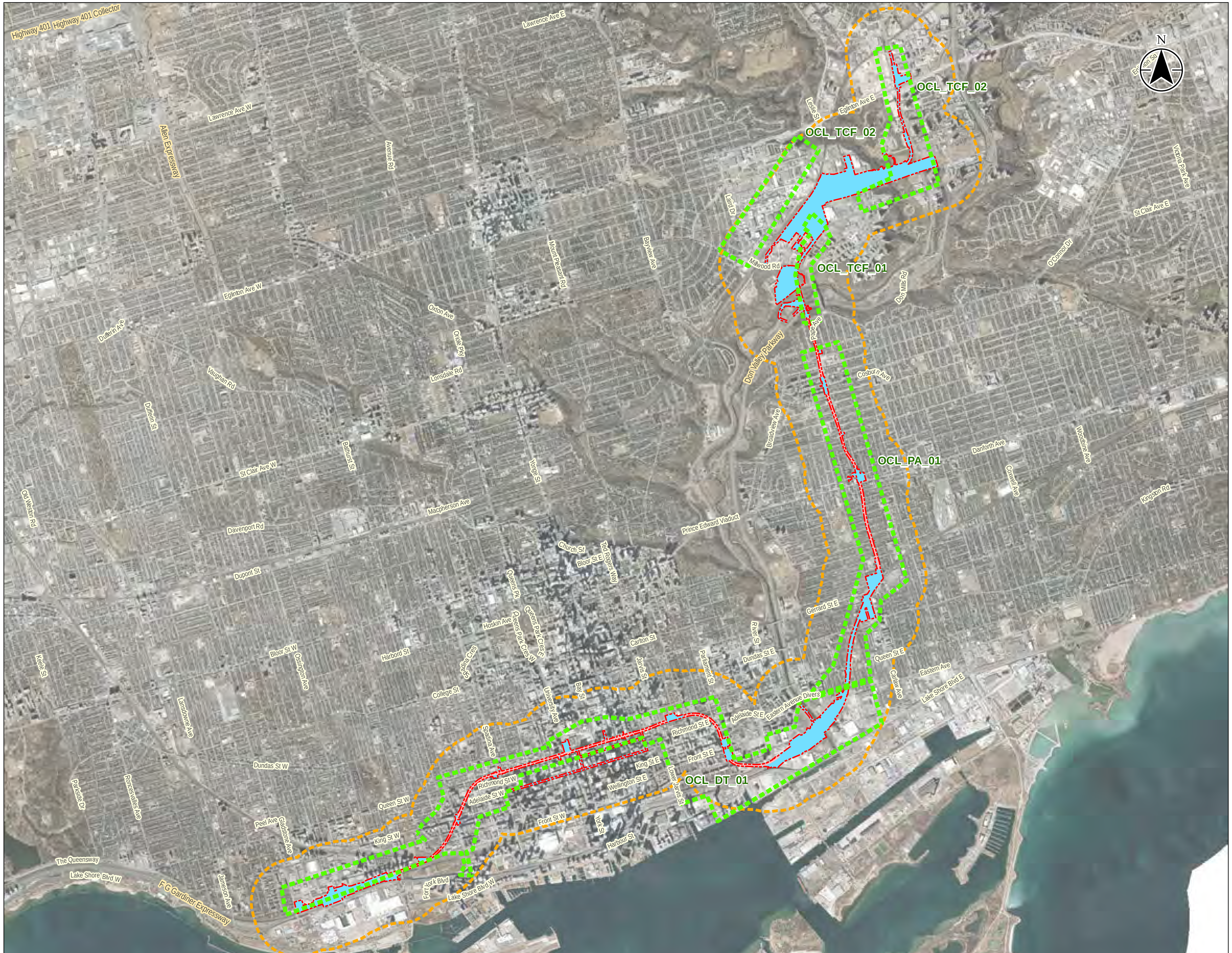
Project Location
Coity of Toronto, ON

160560009 REV4
Prepared by BCC on 2022-02-01
Technical Review by ABC on yyyy-mm-dd
Independent Review by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

Figure No.
E-2

Title
Construction Receptor Clusters



Stantec

Legend

- Project Footprint
- Study Area (500 m Buffer)
- Above Grade Element
- Below Grade Element
- Cluster Area

0 1,100 2,200 Metres

1:46,000 (At original document size of 11x17)

Notes

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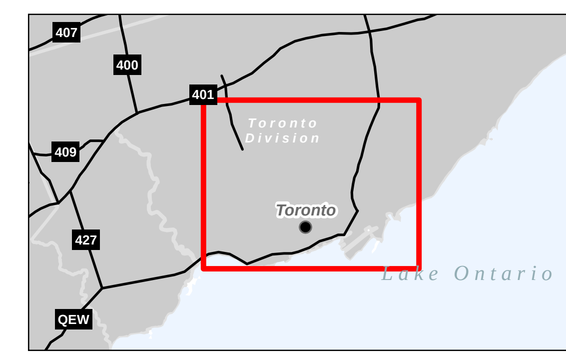

Project Location
Coity of Toronto, ON

160560009 REV4
Prepared by BCC on 2022-02-01
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Independent Review by ABC on yyyy-mm-dd

Client/Project
HDR CORPORATION
ONTARIO LINE TA

Figure No.
E-3

Title
Operations Noise Receptor Clusters

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Table E-1: Representative Receptor List (Noise)

ID[1,2]	Receptor Address	H[3] (m)	X[4] (m)	Y[4] (m)	Receptor Type[5]
CR_RESD_001	1 Springhurst Ave	7.5	310762	4832525	Construction Receptor
CR_INDT_002	200 Manitoba Dr	1.5	311244	4832556	Construction Receptor
CR_INDT_003	28 Atlantic Ave	4.5	311207	4832781	Construction Receptor
CR_COMM_004	45 Manitoba Dr	1.5	311628	4832697	Construction Receptor
CR_COMM_005	2-20 Fraser Ave	4.5	310945	4832574	Construction Receptor
CR_RESD_006	2 Springhurst Ave	4.5	310756	4832566	Construction Receptor
CR_COMM_007	159 Dufferin St	1.5	310803	4832621	Construction Receptor
CR_COMM_008	19 Fraser Ave	1.5	310972	4832661	Construction Receptor
CR_COMM_009	2A Jefferson Ave	1.5	311114	4832675	Construction Receptor
CR_COMM_010	15 Atlantic Ave	1.5	311251	4832764	Construction Receptor
CR_RESD_011	5 Hanna Ave	7.5	311385	4832793	Construction Receptor
CR_INST_012	9 Hanna Ave	7.5	311493	4832827	Construction Receptor
CR_RESD_013	65 East Liberty St	7.5	311704	4832888	Construction Receptor
CR_RESD_014	57 East Liberty St	7.5	311806	4832929	Construction Receptor
CR_RESD_015	25 Solidarity Way	7.5	311873	4832938	Construction Receptor
CR_INDT_016	14 Strachan Ave	7.5	311984	4832969	Construction Receptor
CR_RESD_017	11 Ordnance St	7.5	312070	4832988	Construction Receptor
CR_INDT_018	10R Ordnance St	7.5	312288	4833159	Construction Receptor
CR_RESD_019	92 Bathurst St	4.5	312631	4833517	Construction Receptor
CR_RESD_020	74 Bathurst St	1.5	312647	4833465	Construction Receptor
CR_RESD_021	694 King St W	7.5	312613	4833576	Construction Receptor
CR_RESD_022	662 King St W	7.5	312662	4833613	Construction Receptor
CR_RESD_023	645 King St W	7.5	312692	4833558	Construction Receptor
CR_RESD_024	58 Stewart St	7.5	312700	4833508	Construction Receptor
CR_RESD_025	61 Stewart St	4.5	312685	4833473	Construction Receptor

ID[1,2]	Receptor Address	H[3] (m)	X[4] (m)	Y[4] (m)	Receptor Type[5]
CR_RESD_026	86 Bathurst St	4.5	312636	4833499	Construction Receptor
CR_RESD_027	459 Queen St W	4.5	313078	4834061	Construction Receptor
CR_RESD_028	410A Queen St W	4.5	313050	4834079	Construction Receptor
CR_RESD_029	154 Spadina Ave	7.5	313124	4834041	Construction Receptor
CR_RESD_030	452 Richmond St W	4.5	313059	4834022	Construction Receptor
CR_RESD_031	180 Spadina Ave	7.5	313106	4834157	Construction Receptor
CR_RESD_032	166A Spadina Ave	4.5	313112	4834125	Construction Receptor
CR_RESD_033	177 Spadina Ave	7.5	313147	4834182	Construction Receptor
CR_RESD_034	439 Queen St W	7.5	313166	4834090	Construction Receptor
CR_INDT_035	372 Queen St W	4.5	313181	4834125	Construction Receptor
CR_RESD_036	215 Queen St W	7.5	313846	4834284	Construction Receptor
CR_COMM_037	180 Queen St W	1.5	313854	4834315	Construction Receptor
CR_RESD_038	205 Queen St W	7.5	313861	4834257	Construction Receptor
CR_RESD_038a	140 Simcoe Street	7.5	313880	4834216	Construction Receptor
CR_INST_039	151 Simcoe St	7.5	313877	4834299	Construction Receptor
CR_ RESD _040	330 University Ave	7.5	313880	4834383	Construction Receptor
CR_ RESD _041	330 University Ave	7.5	313863	4834434	Construction Receptor
CR_INST_042	160 Queen St W	4.5	313883	4834348	Construction Receptor
CR_FSPC_043	145 Queen St W	7.5	313981	4834332	Construction Receptor
CR_INST_044	130 Queen St W	7.5	313971	4834443	Construction Receptor
CR_INDT_045	20 Queen St W	7.5	314410	4834503	Construction Receptor
CR_RESD_046	401 Bay St	7.5	314387	4834453	Construction Receptor
CR_INST_047	50 Queen St W	7.5	314375	4834503	Construction Receptor
CR_COMM_048	3 Queen St E	7.5	314594	4834504	Construction Receptor
CR_COMM_049	1 Queen St W	7.5	314486	4834483	Construction Receptor
CR_INDT_050	2 Queen St E	7.5	314578	4834535	Construction Receptor

ID[1,2]	Receptor Address	H[3] (m)	X[4] (m)	Y[4] (m)	Receptor Type[5]
CR_HOSP_051	31 Queen St E	7.5	314668	4834558	Construction Receptor
CR_HOSP_051a	31 Queen St E	7.5	314612	4834581	Construction Receptor
CR_COMM_052	111 Victoria St	7.5	314651	4834531	Construction Receptor
CR_COMM_053	37 Queen St E	7.5	314707	4834548	Construction Receptor
CR_RESD_054	205 Queen St E	7.5	315215	4834700	Construction Receptor
CR_INST_055	130 Queen St E	4.5	315082	4834719	Construction Receptor
CR_RESD_056	185 Queen St E	7.5	315153	4834681	Construction Receptor
CR_RESD_057	163 Queen St E	4.5	315096	4834664	Construction Receptor
CR_RESD_058	187 Queen St E	7.5	315174	4834687	Construction Receptor
CR_RCTR_059	215 Queen St E	1.5	315233	4834767	Construction Receptor
CR_RESD_060	225 Queen St E	4.5	315283	4834719	Construction Receptor
CR_RESD_061	229 Queen St E	4.5	315299	4834724	Construction Receptor
CR_RESD_062	235 Queen St E	4.5	315325	4834732	Construction Receptor
CR_RESD_063	129 1/2 Sherbourne St	7.5	315313	4834784	Construction Receptor
CR_RESD_064	197 Queen St E	4.5	315200	4834694	Construction Receptor
CR_RESD_065	215 Queen St E	7.5	315249	4834709	Construction Receptor
CR_RESD_066	245 Queen St E	4.5	315378	4834747	Construction Receptor
CR_RESD_067	240 Front St E	4.5	315739	4834386	Construction Receptor
CR_INST_068	239 Front St E	1.5	315745	4834358	Construction Receptor
CR_RESD_069	318 King St E	7.5	315766	4834513	Construction Receptor
CR_RESD_070	2 Berkeley St	4.5	315767	4834287	Construction Receptor
CR_COMM_071	43A Parliament St	4.5	315894	4834328	Construction Receptor
CR_RESD_072	301 Front St E	4.5	315876	4834384	Construction Receptor
CR_COMM_073	68 Parliament St	4.5	315860	4834437	Construction Receptor
CR_COMM_074	77 Parliament St	7.5	315832	4834523	Construction Receptor

ID[1,2]	Receptor Address	H[3] (m)	X[4] (m)	Y[4] (m)	Receptor Type[5]
CR_RESD_075	42 Parliament St	7.5	315903	4834193	Construction Receptor
CR_RESD_076	2 Distillery Lane	7.5	315928	4834228	Construction Receptor
CR_RESD_077	5 Mill St	7.5	315932	4834256	Construction Receptor
CR_RESD_078	70 Distillery Lane	7.5	316255	4834238	Construction Receptor
CR_RESD_079	390 Cherry St	7.5	316308	4834295	Construction Receptor
CR_RESD_080	50 Tank House Lane	7.5	316290	4834353	Construction Receptor
CR_RESD_081	90 Mill St	7.5	316244	4834394	Construction Receptor
CR_RESD_082	180 Mill St	7.5	316474	4834459	Construction Receptor
CR_RESD_083	170 Mill St	7.5	316403	4834437	Construction Receptor
CR_INDT_084	685 Lake Shore Blvd E	1.5	317420	4834463	Construction Receptor
CR_INDT_085	21 Don Valley Parkway N	1.5	317055	4834666	Construction Receptor
CR_INDT_086	50 Booth Ave	1.5	317392	4834884	Construction Receptor
CR_INDT_087	1 Sunlight Park Rd	4.5	316924	4834818	Construction Receptor
CR_COMM_088	405 Eastern Ave	1.5	317237	4834956	Construction Receptor
CR_INDT_089	346 Eastern Ave	1.5	317065	4834991	Construction Receptor
CR_COMM_089a	341 Sunlight Park Rd	1.5	317062	4834921	Construction Receptor
CR_COMM_090	38 Mc Gee St	1.5	317233	4835130	Construction Receptor
CR_RESD_091	20 Saulter St	1.5	317148	4835056	Construction Receptor
CR_RESD_092	9 Lewis St	1.5	317105	4835015	Construction Receptor
CR_RESD_093	67 Saulter St	1.5	317185	4835206	Construction Receptor
CR_COMM_094	70 Mc Gee St	1.5	317243	4835237	Construction Receptor
CR_RESD_095	791 Queen St E	7.5	317178	4835266	Construction Receptor
CR_RESD_096	807A Queen St E	4.5	317263	4835326	Construction Receptor
CR_RESD_097	812 Queen St E	4.5	317185	4835328	Construction Receptor
CR_INST_098	870 Queen St E	1.5	317251	4835354	Construction Receptor

ID[1,2]	Receptor Address	H[3] (m)	X[4] (m)	Y[4] (m)	Receptor Type[5]
CR_RESD_099	12 De Grassi St	4.5	317192	4835377	Construction Receptor
CR_RESD_100	14 Wardell St	1.5	317201	4835527	Construction Receptor
CR_RESD_101	52 Wardell St	1.5	317205	4835633	Construction Receptor
CR_RESD_102	84 Wardell St	1.5	317224	4835733	Construction Receptor
CR_RESD_103	15 Tiverton Ave	1.5	317295	4835830	Construction Receptor
CR_RESD_104	2A Tiverton Ave	1.5	317266	4835792	Construction Receptor
CR_RESD_105	2 Paisley Ave	1.5	317306	4835734	Construction Receptor
CR_RESD_106	400 Logan Ave	4.5	317337	4835819	Construction Receptor
CR_RESD_107	444 Logan Ave	7.5	317311	4835940	Construction Receptor
CR_RESD_108	7 Dickens St	4.5	317409	4835854	Construction Receptor
CR_RESD_109	347A Carlaw Ave	7.5	317556	4835947	Construction Receptor
CR_RESD_110	349 Carlaw Ave	7.5	317541	4835991	Construction Receptor
CR_RESD_111	1A Badgerow Ave	1.5	317533	4836018	Construction Receptor
CR_RESD_112	887 Gerrard St E	1.5	317529	4836157	Construction Receptor
CR_COMM_113	881 Gerrard St E	7.5	317501	4836126	Construction Receptor
CR_RESD_114	936 Gerrard St E	1.5	317602	4836308	Construction Receptor
CR_RESD_115	449 Logan Ave	4.5	317345	4836002	Construction Receptor
CR_INDT_116	231 First Ave	1.5	317367	4836049	Construction Receptor
CR_RESD_117	238 First Ave	4.5	317384	4836094	Construction Receptor
CR_RESD_118	843 Gerrard St E	4.5	317392	4836134	Construction Receptor
CR_COMM_119	842 Gerrard St E	1.5	317426	4836199	Construction Receptor
CR_RESD_120	462 Carlaw Ave	4.5	317434	4836264	Construction Receptor
CR_RESD_121	344 Pape Ave	4.5	317650	4836301	Construction Receptor
CR_RESD_122	369 Pape Ave	7.5	317660	4836380	Construction Receptor
CR_RESD_123	479 Carlaw Ave	4.5	317429	4836388	Construction Receptor
CR_RESD_124	241 Langley Ave	4.5	317543	4836449	Construction Receptor

ID[1,2]	Receptor Address	H[3] (m)	X[4] (m)	Y[4] (m)	Receptor Type[5]
CR_RESD_125	387 Pape Ave	7.5	317610	4836452	Construction Receptor
CR_RESD_126	387 Pape Ave	4.5	317601	4836468	Construction Receptor
CR_RESD_127	393 Pape Ave	4.5	317595	4836479	Construction Receptor
CR_RESD_128	393 Pape Ave	7.5	317591	4836493	Construction Receptor
CR_RESD_128a	423 Pape Ave	4.5	317570	4836567	Construction Receptor
CR_RESD_128b	450 Pape Ave	4.5	317506	4836613	Construction Receptor
CR_INST_129	220 Langley Ave	7.5	317549	4836495	Construction Receptor
CR_RESD_130	497 Pape Ave	4.5	317501	4836803	Construction Receptor
CR_COMM_131	708 Pape Ave	4.5	317247	4837516	Construction Receptor
CR_RESD_132	649 Danforth Ave	4.5	317286	4837441	Construction Receptor
CR_RESD_133	669 Danforth Ave	4.5	317320	4837449	Construction Receptor
CR_RESD_134	699 Danforth Ave	4.5	317387	4837467	Construction Receptor
CR_COMM_135	730 Danforth Ave	4.5	317441	4837516	Construction Receptor
CR_RESD_136	15 Eaton Ave	4.5	317437	4837579	Construction Receptor
CR_COMM_137	731 Pape Ave	4.5	317315	4837528	Construction Receptor
CR_COMM_138	751 Pape Ave	4.5	317295	4837606	Construction Receptor
CR_RESD_139	21 Eaton Ave	4.5	317430	4837598	Construction Receptor
CR_RESD_140	24 Eaton Ave	4.5	317383	4837594	Construction Receptor
CR_RESD_141	606 Danforth Ave	7.5	317216	4837494	Construction Receptor
CR_RESD_142	71 Gough Ave	4.5	317204	4837513	Construction Receptor
CR_RESD_143	79X Gough Ave	4.5	317213	4837538	Construction Receptor
CR_RESD_144	730 Pape Ave	7.5	317228	4837560	Construction Receptor
CR_RESD_145	1 Muriel Ave	4.5	317315	4837685	Construction Receptor
CR_RESD_146	4 Muriel Ave	4.5	317290	4837679	Construction Receptor
CR_RESD_147	6 Gertrude Pl	4.5	317291	4837651	Construction Receptor
CR_RESD_148	14 Gertrude Pl	1.5	317326	4837656	Construction Receptor

ID[1,2]	Receptor Address	H[3] (m)	X[4] (m)	Y[4] (m)	Receptor Type[5]
CR_RESD_149	9 Sammon Ave	1.5	317180	4838052	Construction Receptor
CR_RESD_150	887 Pape Ave	4.5	317150	4838026	Construction Receptor
CR_RESD_151	846 Pape Ave	4.5	317136	4837985	Construction Receptor
CR_RESD_152	850 Pape Ave	1.5	317131	4838004	Construction Receptor
CR_RESD_153	873 Pape Ave	4.5	317158	4837991	Construction Receptor
CR_RESD_154	854 Pape Ave	4.5	317120	4838042	Construction Receptor
CR_RESD_155	867 Pape Ave	4.5	317170	4837948	Construction Receptor
CR_RESD_156	134R Gowan Ave	4.5	316937	4838549	Construction Receptor
CR_RESD_157	101 Cosburn Ave	7.5	316926	4838570	Construction Receptor
CR_RESD_158	1039 Pape Ave	4.5	316995	4838573	Construction Receptor
CR_RESD_159	1041 Pape Ave	4.5	316986	4838609	Construction Receptor
CR_RESD_160	1045 Pape Ave	1.5	316974	4838663	Construction Receptor
CR_RESD_161	95 Gamble Ave	7.5	316894	4838685	Construction Receptor
CR_RESD_162	1051 Pape Ave	1.5	316960	4838701	Construction Receptor
CR_RESD_163	1068-1070 Pape Ave	1.5	316914	4838728	Construction Receptor
CR_RESD_164	1059 Pape Ave	4.5	316960	4838740	Construction Receptor
CR_RESD_165	7810 O'Connor Dr	4.5	316833	4839057	Construction Receptor
CR_RESD_166	132 O'Connor Dr	7.5	316880	4839062	Construction Receptor
CR_RESD_167	1083 Pape Ave	4.5	316906	4838979	Construction Receptor
CR_RESD_168	14A Pepler Ave	4.5	316921	4839011	Construction Receptor
CR_RESD_169	133 O'Connor Dr	4.5	316908	4839026	Construction Receptor
CR_RESD_170	1298 Pape Ave	4.5	316856	4838981	Construction Receptor
CR_RESD_171	155 Hopedale Ave	4.5	316777	4839377	Construction Receptor
CR_RESD_172	154 Hopedale Ave	4.5	316738	4839382	Construction Receptor
CR_RESD_173	30 Minton Pl	4.5	316715	4839399	Construction Receptor
CR_RESD_174	166 Hopedale Ave	4.5	316772	4839407	Construction Receptor

ID[1,2]	Receptor Address	H[3] (m)	X[4] (m)	Y[4] (m)	Receptor Type[5]
CR_INST_174a	44 Beechwood Dr	1.5	316584	4839504	Construction Receptor
CR_RESD_175	2A Leaside Park Dr	7.5	316771	4840164	Construction Receptor
CR_INDT_176	14-16 Overlea Blvd	1.5	316743	4840218	Construction Receptor
CR_INDT_177	3A Banigan Dr	1.5	316654	4840206	Construction Receptor
CR_INDT_178	20 Overlea Blvd	4.5	316791	4840282	Construction Receptor
CR_RESD_179	2 Overlea Blvd	4.5	316643	4840076	Construction Receptor
CR_RESD_180	1 Leaside Park Dr	7.5	316718	4840070	Construction Receptor
CR_RESD_181	17C Overlea Blvd	7.5	316805	4840212	Construction Receptor
CR_RESD_182	16F Leaside Park Dr	7.5	316828	4840240	Construction Receptor
CR_INDT_183	14-20 Banigan Dr	1.5	316629	4840313	Construction Receptor
CR_COMM_184	25 Overlea Blvd	1.5	316879	4840285	Construction Receptor
CR_COMM_185	8 Thorncliffe Park Dr	1.5	316934	4840365	Construction Receptor
CR_COMM_186	36 Overlea Blvd	4.5	316952	4840601	Construction Receptor
CR_COMM_187	55 Esandar Dr	1.5	316522	4840612	Construction Receptor
CR_COMM_188	51 Esandar Dr	1.5	316454	4840519	Construction Receptor
CR_INDT_189	50 Beth Nealson Dr	1.5	317169	4841121	Construction Receptor
CR_INDT_190	215 Wicksteed Ave	1.5	317061	4841091	Construction Receptor
CR_COMM_191	207 Wicksteed Ave	1.5	316885	4841113	Construction Receptor
CR_INDT_192	45 Beth Nealson Dr	4.5	317309	4841090	Construction Receptor
CR_INDT_193	111 Thorncliffe Park Dr	1.5	317371	4840845	Construction Receptor
CR_INDT_194	8 Banigan Dr	4.5	316583	4840251	Construction Receptor
CR_INST_194a	10 William Morgan Dr	7.5	317511	4840850	Construction Receptor
CR_INST_195	130 Overlea Blvd	1.5	317980	4840956	Construction Receptor
CR_RESD_196	735 Don Mills Rd	7.5	318113	4841098	Construction Receptor
CR_COMM_196a	747 Don Mills Rd	4.5	318096	4841287	Construction Receptor

ID[1,2]	Receptor Address	H[3] (m)	X[4] (m)	Y[4] (m)	Receptor Type[5]
CR_COMM_197	751 Don Mills Rd	1.5	318000	4841370	Construction Receptor
CR_RESD_198	200 Gateway Blvd	7.5	318012	4841463	Construction Receptor
CR_RESD_199	7 St Dennis Dr	7.5	317970	4841567	Construction Receptor
CR_INST_200	766 Don Mills Rd	1.5	317639	4841369	Construction Receptor
CR_INST_201	770 Don Mills Rd	1.5	317742	4841497	Construction Receptor
CR_INST_202	770 Don Mills Rd	1.5	317791	4841566	Construction Receptor
CR_INST_203	770 Don Mills Rd	1.5	317809	4841628	Construction Receptor
CR_RESD_204	10 St Dennis Dr	7.5	317919	4841692	Construction Receptor
CR_RESD_205	7 Rochefort Dr	10.5	317887	4841753	Construction Receptor
CR_RESD_206	797 Don Mills Rd	10.5	317837	4841965	Construction Receptor
CR_INST_207	849 Don Mills Rd	1.5	317757	4842392	Construction Receptor
CR_COMM_208	875 Don Mills Rd	1.5	317727	4842488	Construction Receptor
CR_INDT_209	15 Gervais Dr	7.5	317978	4842239	Construction Receptor
MR_INST_001	10 William Morgan Drive	19.5	317504	4840847	OMSF Operations
MR_RESD_002	735 Don Mills Road	76.5	318111	4841094	OMSF Operations
MR_RESD_003	200 Gateway Boulevard	49.5	318013	4841460	OMSF Operations
MR_RESD_004	12 Thorncliffe Park Drive	31.5	316984	4840312	OMSF Operations
MR_RESD_005	160 Vanderhoof Avenue	55.5	316647	4841393	OMSF Operations
MR_INST_006	736 Don Mills Road	7.5	317965	4840953	OMSF Operations
MR_RESD_007	26 Malcolm Road	4.5	315978	4840190	OMSF Operations
MR_INST_008	14 Overlea Boulevard	1.5	316726	4840267	OMSF Operations
MR_RESD_009	16F Leaside Park Drive	7.5	316828	4840240	OMSF Operations

ID[1,2]	Receptor Address	H[3] (m)	X[4] (m)	Y[4] (m)	Receptor Type[5]
MR_RESD_010	21 Overlea Boulevard	61.5	316929	4840236	OMSF Operations
RR_RESD_001	170 Hopedale Ave	4.5	316801	4839432	Operations, Rail Receptor
RR_RESD_002	1 Leaside Park Dr	19.5	316718	4840070	Operations, Rail Receptor
RR_RESD_003	2A Leaside Park Dr	10.5	316771	4840164	Operations, Rail Receptor
RR_RESD_004	16F Leaside Park Dr	10.5	316827	4840239	Operations, Rail Receptor
RR_INST_005	14 Overlea Blvd	1.5	316739	4840213	Operations, Rail Receptor
RR_INST_006	20 Overlea Blvd	1.5	316793	4840285	Operations, Rail Receptor
RR_RESD_007	11 Thorncliffe Park Dr	30	316918	4840224	Operations, Rail Receptor
RR_INST_008	4 Thorncliffe Park Dr	1.5	316796	4840495	Operations, Rail Receptor
RR_INST_009	4 Thorncliffe Park Dr	1.5	316826	4840493	Operations, Rail Receptor
RR_INST_010	10 William Morgan Dr	18	317505	4840847	Operations, Rail Receptor
RR_INST_011	130 Overlea Blvd	18	317991	4840958	Operations, Rail Receptor
RR_RESD_012	735 Don Mills Rd	16.5	318111	4841097	Operations, Rail Receptor
RR_INST_013	770 Don Mills Rd South	9	317742	4841498	Operations, Rail Receptor
RR_INST_014	770 Don Mills Rd North	1.5	317809	4841628	Operations, Rail Receptor
RR_FRES_015	770 Don Mills Rd (HousingNow)	15.5	317789	4841826	Operations, Rail Receptor
RR_RESD_016	7 St Dennis Dr	16.5	317966	4841579	Operations, Rail Receptor

ID[1,2]	Receptor Address	H[3] (m)	X[4] (m)	Y[4] (m)	Receptor Type[5]
RR_RESD_017	7 Rochefort Dr South	24	317918	4841696	Operations, Rail Receptor
RR_RESD_018	7 Rochefort Dr North	10	317886	4841749	Operations, Rail Receptor
RR_RESD_019	797 Don Mills Rd	13	317838	4841963	Operations, Rail Receptor
RR_FRES_020	805 Don Mills Rd (HousingNow)	15.5	317820	4842045	Operations, Rail Receptor
RR_FRES_021	1180 Eglinton Ave E	25.5	317726	4842138	Operations, Rail Receptor
RR_FRES_022	843 Don Mills Rd	25.5	317685	4842349	Operations, Rail Receptor
RR_INST_023	849 Don Mills Rd	7.5	317752	4842410	Operations, Rail Receptor
ER_RESD_001	65 East Liberty St	4.5	311726	4832898	Operations, Emergency Exit Receptor
ER_RESD_002	50 Ordnance St	4.5	312147	4833098	Operations, Emergency Exit Receptor
ER_RESD_003	70 Distillery Ln	4.5	316266	4834234	Operations, Emergency Exit Receptor
ER_FRES_004	125R Mill St	4.5	316530	4834417	Operations, Emergency Exit Receptor
ER_RESD_005	238 First Ave	4.5	317383	4836084	Operations, Emergency Exit Receptor
ER_RESD_006	495 Pape Ave	4.5	317505	4836806	Operations, Emergency Exit Receptor
ER_RESD_008	879 Pape Ave	4.5	317154	4838001	Operations, Emergency Exit Receptor
ER_RESD_009	160 Hopedale Ave	4.5	316771	4839418	Operations, Emergency Exit Receptor
SR_RESD_001	662 King St W	3	312662	4833613	Operations, Station Receptor
SR_RESD_002	434 Richmond St W	3	313107	4834035	Operations, Station Receptor

ID[1,2]	Receptor Address	H[3] (m)	X[4] (m)	Y[4] (m)	Receptor Type[5]
SR_RESD_003	205 Queen St W	3	313852	4834264	Operations, Station Receptor
SR_RESD_004	195 Yonge St	21	314521	4834598	Operations, Station Receptor
SR_RESD_005	205 Queen St E	4.5	315215	4834699	Operations, Station Receptor
SR_RESD_006	302 King St E	1.5	315733	4834487	Operations, Station Receptor
SR_RESD_007	5 Gertrude Pl	1.5	317305	4837604	Operations, Station Receptor
SR_RESD_008	1034 Pape Ave	1.5	316915	4838629	Operations, Station Receptor

Notes:

1 CR – Construction Receptor, SR – Station Receptor, MR – OMSF Receptor, RR – Rail Receptor, ER – Emergency Exit Receptor

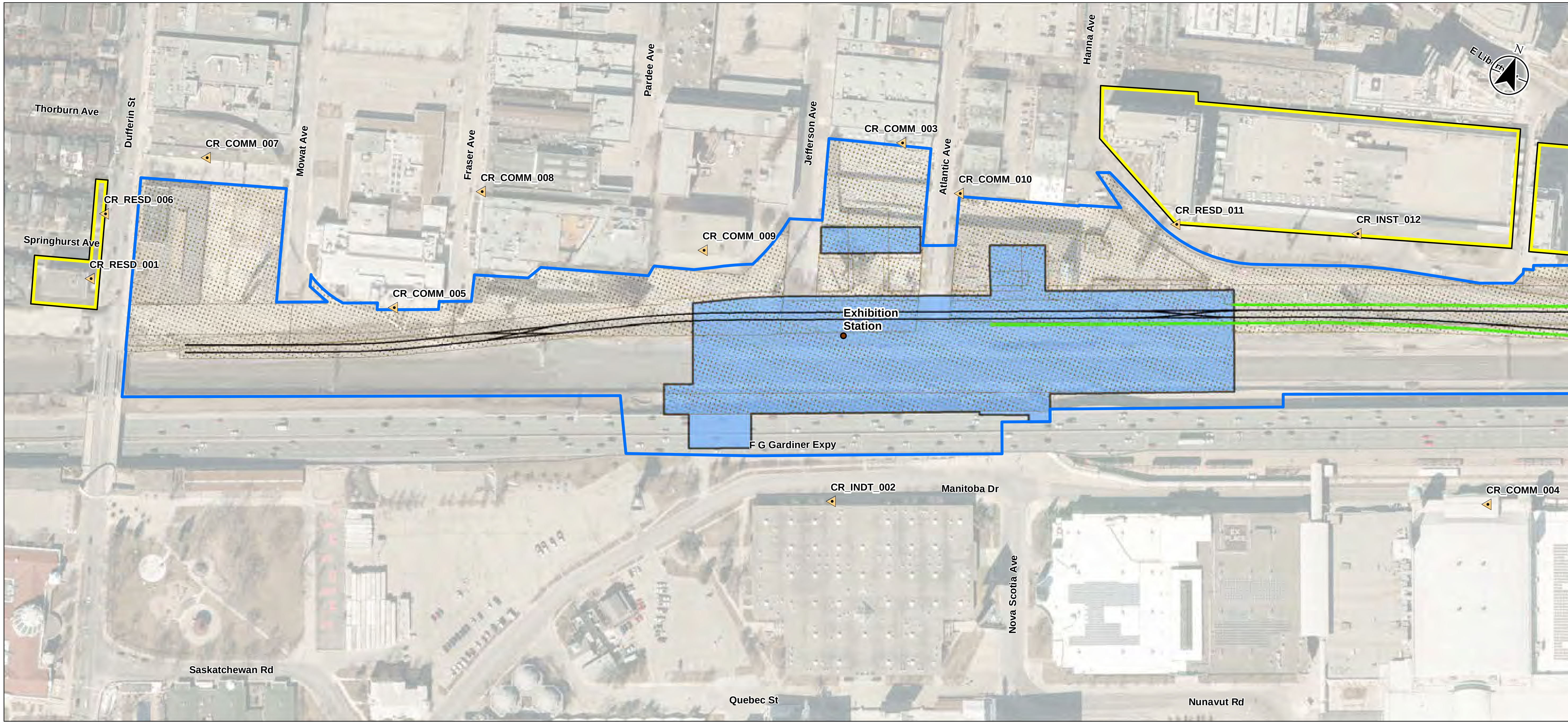
2 COMM: commercial, FRES: Future Residential, FSPC: Four Seasons Centre for the Performing Arts, HOSP: hospital, INDT: industrial, INST: institutional, RCTR: recreation centre, RESD: residential

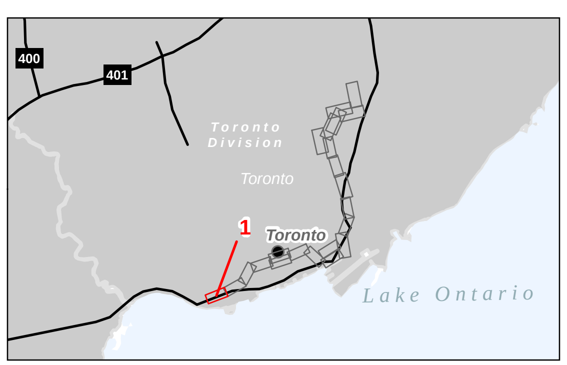
3 Receptor heights (H) are based on City of Toronto Building data and the MNRF LIO elevation data. For example, a receptor height of 1.5 m represents a first story window. A receptor height of 10.5 m represents a fourth storey window. Where multiple heights are possible at a location, the receptor height with the most exposure to the noise source will be used.

4 Coordinates are in MTM10, NAD27

5 Receptor types identifies what type of project impact (construction activity, rail activity, OMSF activity, etc.) would most affect that receptor location.

Appendix F. Construction Noise Mitigation and Monitoring Figures





Legend

- Above Grade Project Element Footprint

Alignment - Current

- Track Alignment Centerline
- Portal
- Station
- Construction Staging and Construction Area
- Assessed Noise Receptor Impacted
- Identified Areas for Mitigation

0 40 80 metres

1:2,500 (At original document size of 11x17)

Notes
1. Coordinate System: NAD27 MTM zone 10
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Stantec

Project Location
Toronto, ON

Prepared by BCC on 2022-03-10
TR by ABC on yyyy-mm-dd

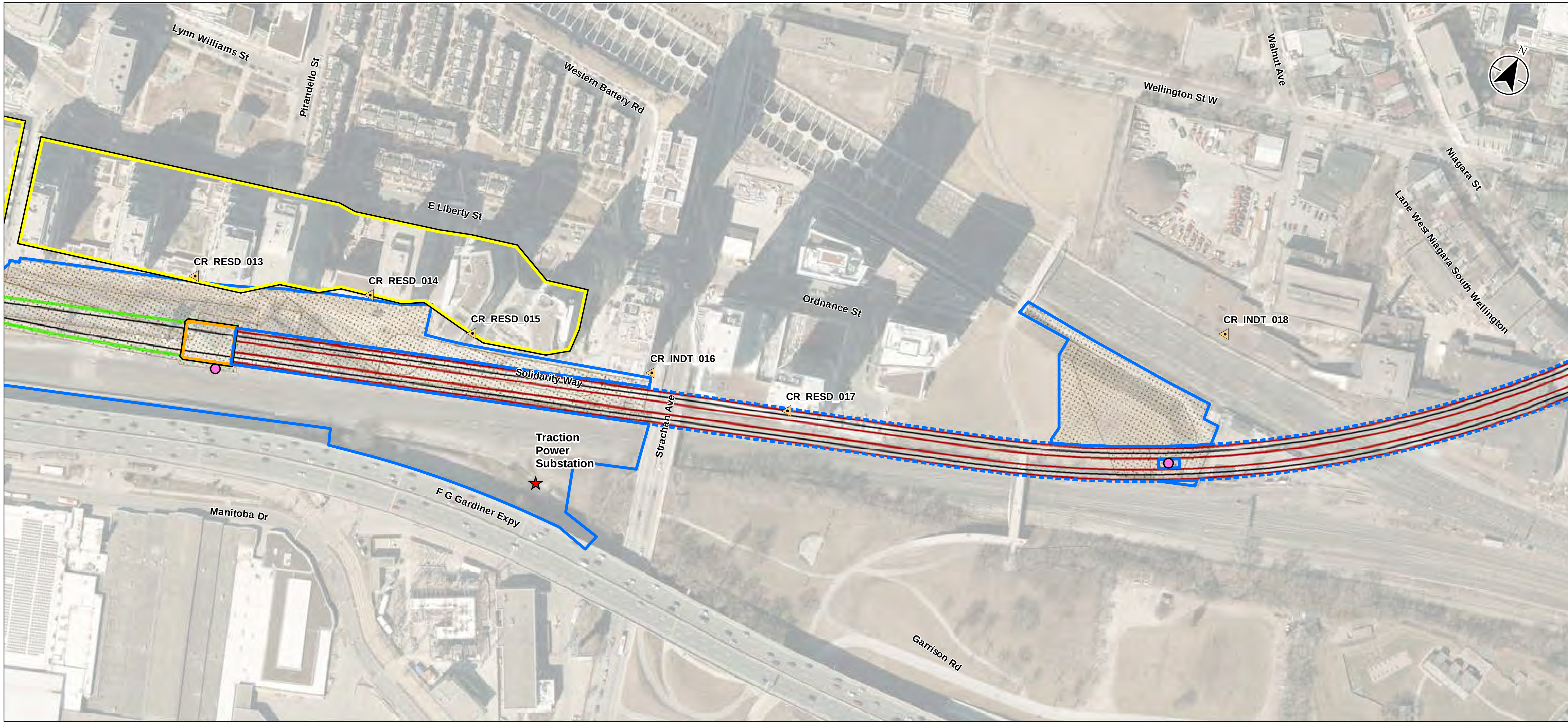
Client/Project
HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
F-1-1

Title
Construction Noise Impacted Area (Area Identified for Mitigation)

\\cd1215-f01\work_group\01605\active\160560009\11_data\gis_cad\gis\mxds\atmospheric\report_figures\20211125_Noise_Report_rev4\160560009_NR_FigF-1-01-22_NoiseMitigation.mxd Revised: 2022-03-10 By: bcowper



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Legend
- Above Grade Element - Pier, Bridge, Shaft
- Above Grade Project Element Footprint
- Below Grade Project Element Footprint

Alignment - Current
- Track Alignment Centerline
- Tunnels
- Portal
- Emergency Egress Building (EEB)
- Traction Power Substation
- Construction Staging and Construction Area
- Assessed Noise Receptor Impacted
- Identified Areas for Mitigation

0 40 80 metres

1:2,500 (At original document size of 11x17)

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Project Location
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TR by ABC on yyyy-mm-dd

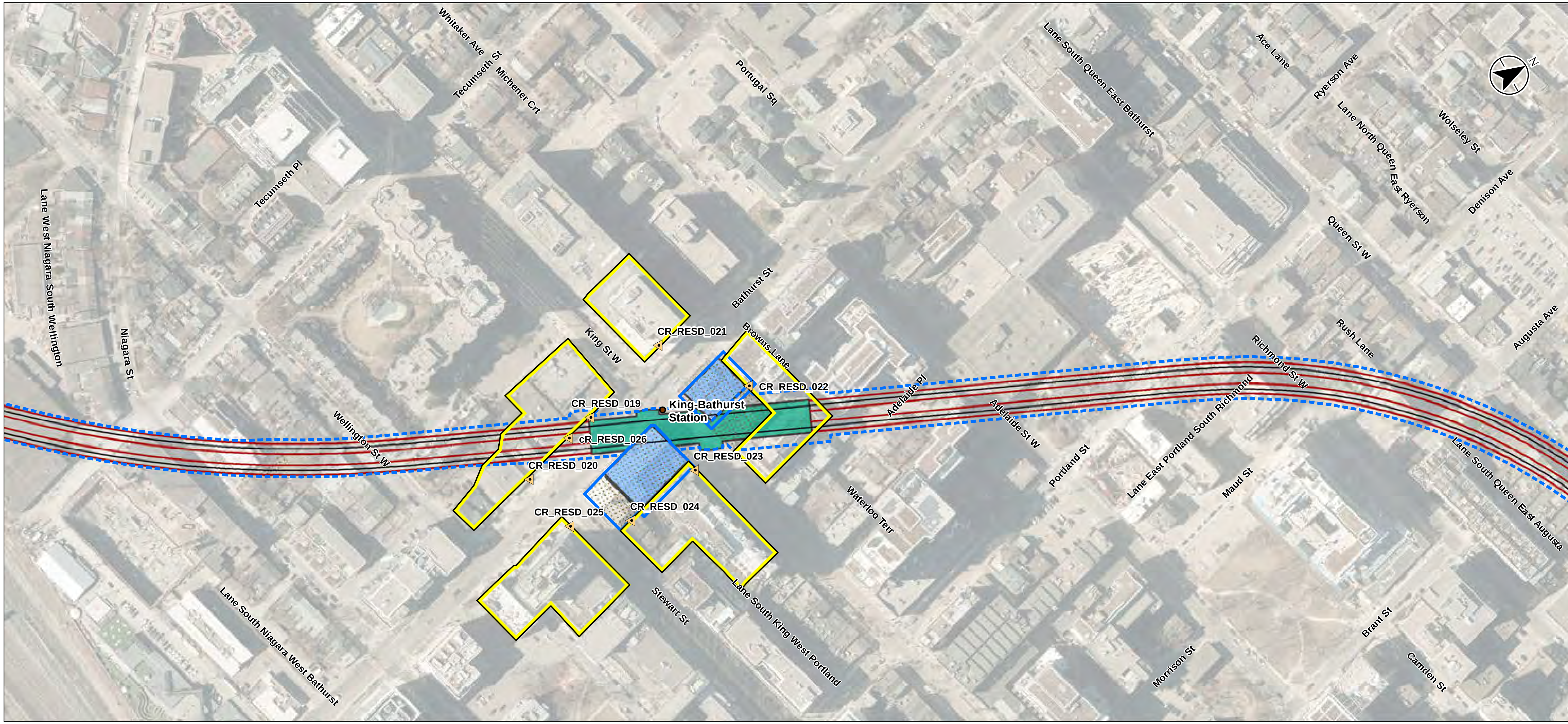
Client/Project
HDR CORPORATION
ONTARIO LINE TA

160560009 REVA

Figure No.
F-1-2

Title
Construction Noise Impacted Area (Area Identified for Mitigation)

\\cd1215-f01\work_group\01605\active\160560009\11_data\gis_cad\gis\mxds\atmospheric\report_figures\20211125_Noise_Report_rev4\160560009_NR_FigF-1-01-22_NoiseMitigation.mxd Revised: 2022-03-10 By: bcowper



Notes
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Legend
- Above Grade Project Element Footprint
- Below Grade Project Element Footprint

Alignment - Current
- Track Alignment Centerline
- Tunnels
- Station
- Station Platform - Subsurface Level
- Construction Staging and Construction Area
- Assessed Noise Receptor Impacted
- Identified Areas for Mitigation

0 40 80 metres
1:2,500 (At original document size of 11x17)

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Project Location
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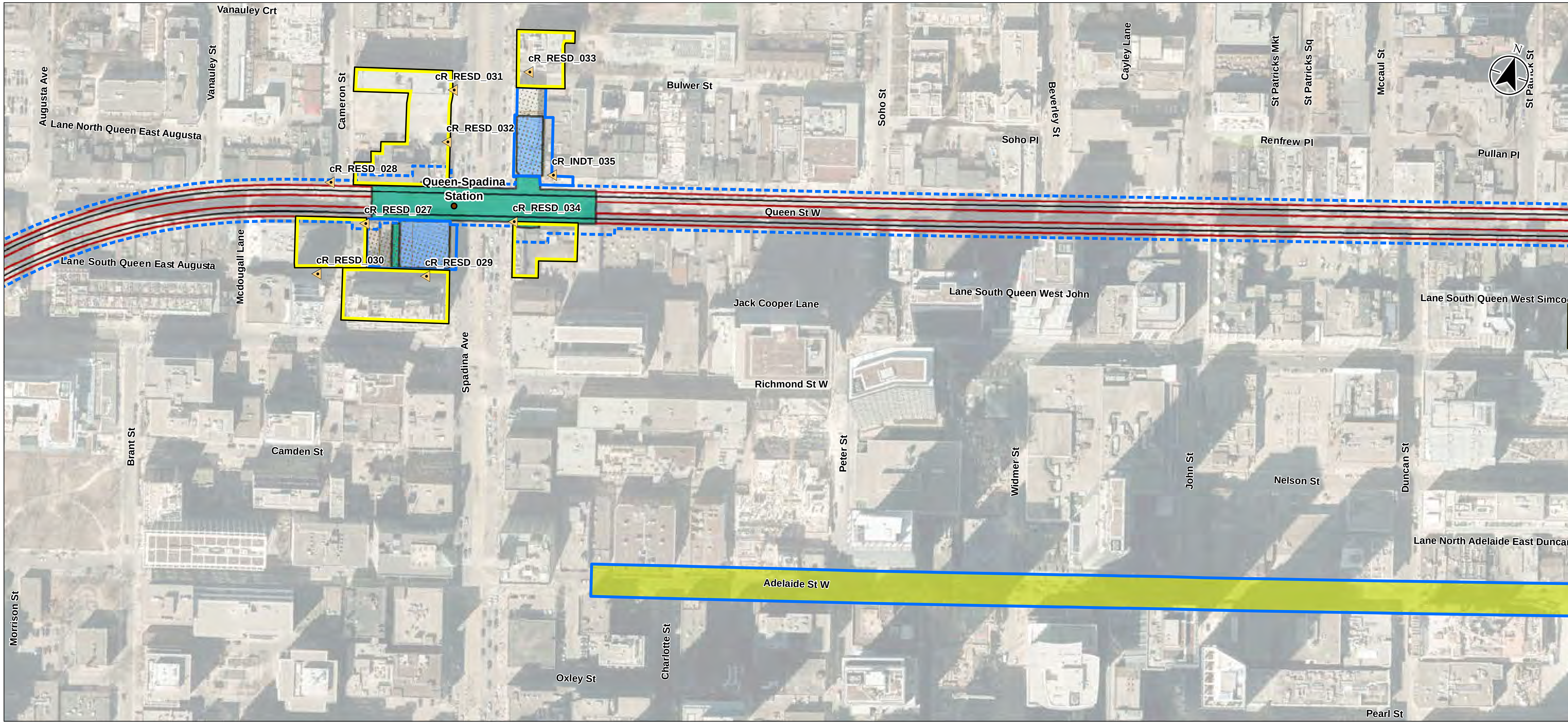
160560009 REVA
HDR CORPORATION
ONTARIO LINE TA

Figure No.
F-1-3

Title
Construction Noise Impacted Area (Area Identified for Mitigation)

\\cd1215-f01\work_group\01605\active\160560009\11_data\gis_cad\gis\mxds\atmospheric\report_figures\20211125_Noise_Report_rev4\160560009_NR_FigF-1-01-22_NoiseMitigation.mxd Revised: 2022-03-10 By: bcowper



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Legend
- Above Grade Project Element Footprint
- Below Grade Project Element Footprint

Alignment - Current
- Track Alignment Centerline
- Tunnels
- Station
- Station Platform - Subsurface Level
- Streetcar Diversion
- Construction Staging and Construction Area
- Assessed Noise Receptor Impacted
- Identified Areas for Mitigation

0 40 80 metres
1:2,500 (At original document size of 11x17)

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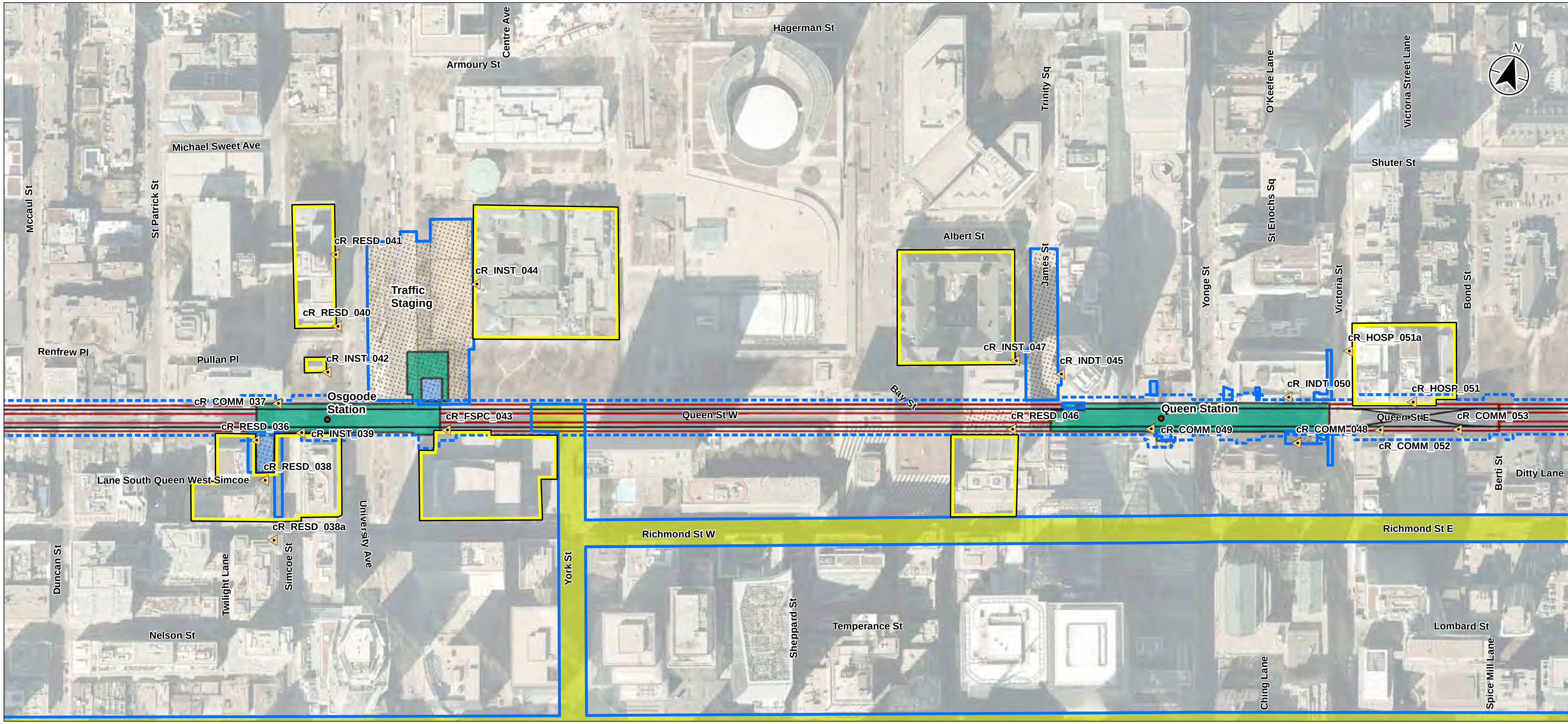
Figure No.
F-1-4

Title
Construction Noise Impacted Area (Area Identified for Mitigation)



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Legend

- Above Grade Project Element Footprint
- Below Grade Project Element Footprint

Alignment - Current

- Track Alignment Centerline
- Tunnels
- Station
- Station Platform - Subsurface Level
- Streetcar Diversion
- Construction Staging and Construction Area
- Assessed Noise Receptor Impacted
- Identified Areas for Mitigation

0 50 100 metres

1:3,000 (At original document size of 11x17)

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Project Location
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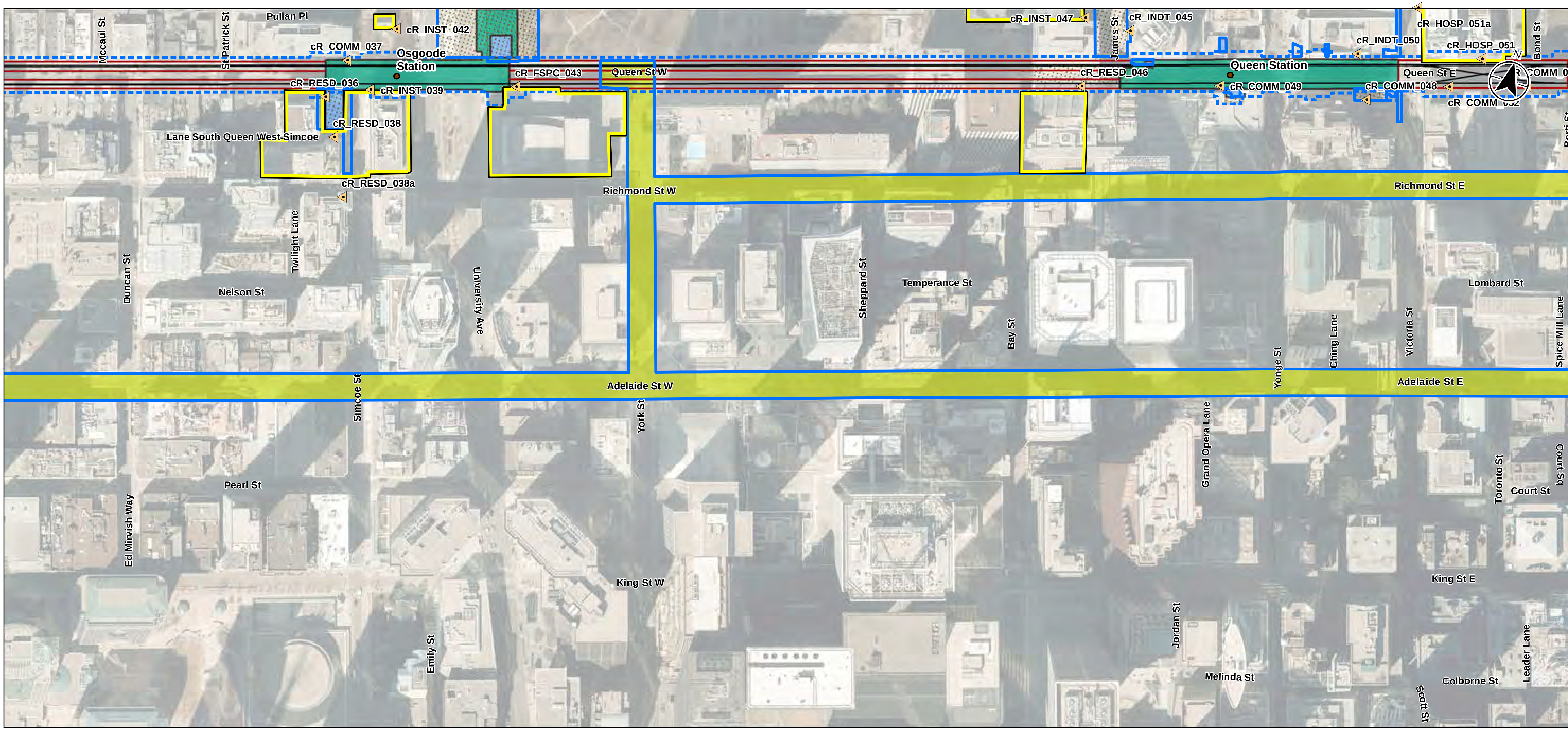
Figure No.
F-1-5

Title
Construction Noise Impacted Area (Area Identified for Mitigation)



Notes
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Legend
- Above Grade Project Element Footprint
- Below Grade Project Element Footprint

Alignment - Current
- Track Alignment Centerline
- Tunnels
- Station
- Station Platform - Subsurface Level
- Streetcar Diversion
- Construction Staging and Construction Area
- Assessed Noise Receptor Impacted
- Identified Areas for Mitigation

0 50 100 metres
1:3,000 (At original document size of 11x17)

Stantec

Project Location
Toronto, ON

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TR by ABC on yyyy-mm-dd

Client/Project
160560009 REVA
HDR CORPORATION
ONTARIO LINE TA

Figure No.
F-1-6

Title
Construction Noise Impacted Area (Area Identified for Mitigation)