

Appendix A3

Ontario Line Project

**Lakeshore East Joint Corridor Early
Works – Noise and Vibration Early Works
Report**

Metrolinx

Noise and Vibration Early Works Report

Ontario Line Lakeshore East Joint Corridor Early Works

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Executive Summary

ES.1 Ontario Line Early Works Overview and Purpose

The Ontario Line Project (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, Environmental Impact Assessment Report, 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 Environmental Conditions Report 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 Environmental Conditions Report 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 Environmental Conditions Report.

Ontario Line early works are components of the Project that are proposed to proceed before the completion of the Ontario Line environmental impact assessment process. An overview of the Project is provided in **Section 1.2**. Early works are defined in Ontario Regulation 341/20: Ontario Line Project under the Environmental Assessment Act as follows:

“any components of the Ontario Line Project that Metrolinx proposes to proceed with before the completion of the Ontario Line assessment process, such as station construction, rail corridor expansion, utility relocation or bridge replacement or expansion.”

The Lakeshore East Joint Corridor early works are considered to be of strategic importance in enabling the timely implementation of the Project. These early works are being advanced where the Project interfaces with GO Expansion and the East Harbour Station (East Harbour Station is situated immediately to the west of the Lakeshore East Joint Corridor early works). Advancing early works and supporting environmental and technical studies in this area provides planning and design efficiencies for the Project, GO Expansion and the East Harbour Station, and facilitates the timely implementation of these projects.

These early works will set the groundwork for other major construction for the Project, reducing risk of construction delays to the main contracts by completing the joint corridor work in advance of the main contracts.

AECOM Canada Limited (AECOM) was retained by Metrolinx and Infrastructure Ontario to complete the Ontario Line Lakeshore East Joint Corridor Early Works Report for the Project. This Final Noise and Vibration Early Works Report (this Report) supports the Ontario Line Final Lakeshore East Joint Corridor Early Works Report and has been prepared for the Project to document the assessment of Lakeshore East Joint Corridor early works (**Figure ES-1**).

The Lakeshore East Joint Corridor early works are planned along the Lakeshore East rail corridor between approximately Eastern Avenue and Pape Avenue and will include:

- Reconfiguration of existing GO tracks to support future Ontario Line infrastructure;
- Replacement of the existing rail bridges at Queen Street East, Dundas Street East and Logan Avenue;
- Construction of new bridges at Dundas Street East and Logan Avenue to support future Ontario Line tracks;
- Construction of the foundations for GO Overhead Catenary System (OCS) poles and supporting infrastructure to accommodate future fourth GO track;
- Construction of retaining walls; and
- Construction of noise barriers, including east of Pape Avenue.

The Lakeshore East Joint Corridor early works components and construction activities are further described in **Section 1.3**.

The purpose of this Report is to:

- Assess the temporary construction noise and vibration associated with the Lakeshore East Joint Corridor early works; and
- Provide noise and vibration mitigation and monitoring recommendations for future work associated with the Lakeshore East Joint Corridor early works temporary construction.

This Report supports the Ontario Line Lakeshore East Joint Corridor Early Works Report prepared for Lakeshore East Joint Corridor early works in accordance with Ontario Regulation 341/20: Ontario Line Project.

Refer to **Section 1** of this Report for more information related to the Project and a detailed early works description.

A glossary of terminology is provided in **Appendix A**.

Figure ES-1: Lakeshore East Joint Corridor Early Works Conceptual Design



Figure ES-1: Lakeshore East Joint Corridor Early Works Conceptual Design



ES.2 Methodology

This Report documents the assessment of Lakeshore East Joint Corridor early works construction impacts related to noise and vibration. Impacts associated with the Project operations are not part of the early works, and will be addressed as part of the Environmental Impact Assessment Report under a separate cover. Note that the assessment of the Lakeshore East Joint Corridor operational noise and vibration impacts is documented in the Lakeshore East Joint Corridor Noise and Vibration Operations Report found in Appendix C of the Ontario Line Final Lakeshore East Joint Corridor Early Works Report. As the Lakeshore East Joint Corridor early works include installation of noise barriers and vibration mitigation technologies to address noise and vibration impacts associated with Joint Corridor operation, the Lakeshore East Joint Corridor Noise and Vibration Operations Report is included in this Report to provide the details of the operational noise and vibration assessment and identification of mitigation measures.

Detailed methodology is provided in **Section 3**.

Local Environmental Conditions

AECOM has conducted baseline measurements as described in the Ontario Line Final Environmental Conditions Report (AECOM, 2020a)¹, to characterise the existing noise and vibration levels throughout the proposed Ontario Line Study Area (including areas not associated with the early works). The baseline measurements included collection of continuous noise measurements over several days at locations representative of noise sensitive receivers.

Baseline vibration measurements were not required, as the construction vibration assessment in this Report uses absolute vibration levels, which are not affected by the existing vibration levels. Throughout the majority of the early works area, existing vibration levels are expected to be below human perceptibility, except in close proximity to the existing rail lines.

Impact Assessment

Noise and vibration criteria from various sources were reviewed for applicability to the Project; sources include the City of Toronto, the Ministry of the Environment, Conservation and Parks, Metrolinx, and the United States Federal Transit Administration. Criteria from the local sources were applied and supplemented using

1. The Ontario Line Final Environmental Conditions Report (AECOM, 2020a) was published on November 20, 2020 in accordance with Ontario Regulation 341/20: Ontario Line Project.

criteria from the Federal Transit Administration where necessary. Criteria reviewed included:

- Ministry of the Environment, Conservation, and Parks Guideline NPC-115;
- Ministry of the Environment, Conservation, and Parks Guideline NPC-118;
- City of Toronto By-law 878-2019;
- Federal Transit Administration Transit Noise and Vibration Impact Assessment Manual;
- Ministry of the Environment, Conservation, and Parks Guideline NPC-119; and
- City of Toronto By-law 514-2008.

A screening was conducted to determine areas which required detailed assessment of specific receivers. Noise and vibration sensitive locations surrounding the early works project sites at the Lakeshore East Joint Corridor were selected to be representative of the worst-case (located closest to the Lakeshore East Joint Corridor Early Works Project Footprint) points of reception and selected in accordance with Ministry of the Environment, Conservation and Parks noise and vibration guidelines. Other possible receiver locations would have lower predicted noise and vibration impacts. Noise and vibration levels were predicted in accordance with methods accepted by the Ministry of the Environment, Conservation and Parks and levels were compared against applicable criteria limits for noise and vibration, respectively. Applicable guidelines and criteria are outlined in **Section 2**.

ES.3 Local Environmental Conditions

Noise

The relevant baseline noise results representing the existing local environmental noise conditions for the areas surrounding the Lakeshore East Joint Corridor early works are summarized in **Table ES-1** below.

Vibration

Baseline vibration measurements were not required, as the construction vibration assessment in this Report uses absolute limits that do not change based upon the existing vibration levels. The local environment does not have any normally occurring sources of perceptible vibration; the most significant source of vibration near the Lakeshore East Joint Corridor early works are the existing rail lines. Thus, for the majority of the Lakeshore East Joint Corridor Study Area, existing vibration levels are expected to be below human perceptibility, except in close proximity to the existing rail lines.

Table ES-1: Relevant Baseline Noise Measurement Data

Monitoring Location	Daytime (07:00-19:00) Average $L_{eq, 1hr}$ (dBA)	Daytime (07:00-19:00) Min $L_{eq, 1hr}$ (dBA)	Daytime (07:00-19:00) Max $L_{eq, 1hr}$ (dBA)	Evening (19:00-23:00) Average $L_{eq, 1hr}$ (dBA)	Evening (19:00-23:00) Min $L_{eq, 1hr}$ (dBA)	Evening (19:00-23:00) Max $L_{eq, 1hr}$ (dBA)	Night (23:00-07:00) Average $L_{eq, 1hr}$ (dBA)	Night (23:00-07:00) Min $L_{eq, 1hr}$ (dBA)	Night (23:00-07:00) Max $L_{eq, 1hr}$ (dBA)
MO_01S Pape Avenue	65	59	73	58	56	60	53	47	62
MO_02S Wardell Street	64	61	66	62	59	63	52	43	63

ES.4 Potential Impacts, Mitigation Measures and Monitoring Activities

Section 5 and **Section 6** includes information related to potential impacts, mitigation measures, and monitoring activities. Potential impacts may result from early works construction activities, including annoyance and disruption of sleep and other activities due to noise, and damage to buildings and other structures due to vibration. A number of mitigation measures and monitoring activities are recommended to minimize the potential impacts during construction.

Refer to **Table ES-2** for a complete list of potential impacts, mitigation measures, and monitoring activities for the Lakeshore East Joint Corridor early works.

The predicted construction levels are estimates based on conservative assumptions, reference equipment levels and the Lakeshore East Joint Corridor early works information available to date. Results may vary as the construction methods and techniques, equipment, and construction areas are refined. If project-specific noise and vibration limits are exceeded during construction, the prediction models can be used to determine which sources are causing the greatest impacts, and mitigation can be investigated for those specific sources.

Noise

Section 5 includes relevant assumptions and key inputs into the assessment of construction noise. Construction noise levels were predicted and compared against applicable criteria. Analysis of the results indicated that criteria may be exceeded, and thus mitigation measures are required.

Noise screening was conducted to determine if detailed noise predictions would be required. Results showed that there are noise sensitive receivers within the noise screening area, thus detailed noise predictions are required and were conducted at representative worst-case receivers.

Noise predictions were conducted at representative worst-case receivers and indicated that noise level criteria can be exceeded, with mitigation measures required to meet the noise level criteria.

Mitigation measures are to be further refined as planning progresses, and can include restriction on hours of operation, inclusion of upgraded construction hoarding/temporary movable barriers between construction noise sources and sensitive points of reception, enclosures and silencers. Noise monitoring may be required where noise level limits may be exceeded. See **Table ES-2** for further details.

A number of general as well as site-specific noise mitigation recommendations and monitoring strategies have been compiled and are outlined in **Section 6**.

Vibration

Section 5 includes relevant assumptions and key inputs into the assessment of construction vibration. Vibration Zones of Influence were calculated and mapped in accordance with the City of Toronto construction vibration by-law (514-2008). The mapping was used to determine if any buildings would fall within areas where there is potential for building damage and vibration monitoring is expected to be required.

Analysis of the results indicated that mitigation measures are required. Mitigation measures are to be further refined and updated as project planning progresses and may include operating equipment at lower vibration settings and using alternative construction methods.

A number of general as well as site-specific vibration mitigation recommendations and monitoring strategies/requirements have been compiled and are outlined in **Section 6**.

ES.5 Permits and Approvals

As noted in **Section 7**, at this time, provincial noise or vibration permits or approvals are not anticipated to be required for the Lakeshore East Joint Corridor early works construction. This will be confirmed as project planning progresses.

A construction vibration control form is typically required to accompany a building permit as per the City of Toronto By-law 514-2008. This will be confirmed during design and implementation phases of the Lakeshore East Joint Corridor early works.

Should a building permit be required, Metrolinx will consult with the City of Toronto.

Metrolinx as a Crown agency of the Province of Ontario is exempt from certain municipal processes and requirements. In these circumstances, Metrolinx will engage with the municipalities to incorporate municipal requirements as a best practice, where practical, and may obtain associated permits and approvals.

Table ES-2: Potential Noise and Vibration Impacts, Mitigation Measures and Monitoring Activities for the Lakeshore East Joint Corridor Early Works

Environmental Component	Potential Impacts	Mitigation Measure(s)	Monitoring Activities
<p>Construction Noise</p> <p>Note: Details of the operational noise impacts and planned mitigation are included in the Lakeshore East Joint Corridor Noise and Vibration Operations Report, found in Appendix C of the Ontario Line Final Lakeshore East Joint Corridor Early Works Report.</p>	<ul style="list-style-type: none"> ■ Environmental noise may cause annoyance and disturb sleep and other activities. ■ The severity of the noise effects resulting from construction projects varies, depending on: <ul style="list-style-type: none"> – Scale, location and complexity of the project – Construction methods, processes and equipment deployed – Total duration of construction near sensitive noise receivers – Construction activity periods (days, hours, time period) – Number and proximity of noise-sensitive sites to construction area(s) 	<ul style="list-style-type: none"> ■ Establish and apply project specific noise criteria/limits. Construction noise impact mitigation measures to be considered to meet project specific noise criteria/exposure limits include but are not limited to the following: <ul style="list-style-type: none"> – Siting construction staging and laydown areas to avoid/reduce adverse impacts to sensitive receivers where feasible. – Use construction equipment compliant with noise level specifications in Ministry of Environment, Conservation, and Parks guidelines NPC-115 and NPC-118. – Keep equipment in good working order and operate with effective muffling devices. – Equipment enclosures for equipment such as generators and compressors. – Additional equipment silencers/mufflers. – Use of upgraded construction hoarding (considering requirements from Canadian Standards Association Z107.9 for noise barriers) between construction equipment and noise sensitive receivers. – Use of localized movable noise barriers/screens for specific equipment and operations. – Minimize simultaneous operation of equipment where feasible. – Implement a no idling policy on site (unless necessary for equipment operation). – Restrict construction hours where feasible: <ul style="list-style-type: none"> • Perform construction during daytime hours where feasible. If night time construction is necessary, the activities with the highest noise levels should be conducted during day time 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. • Consider construction duration limits for construction with adjacent noise sensitive locations such as: 9 Lewis Street, 18 Saulter Street, 2 Paisley Avenue, 15 Tiverton Avenue, 400 Carlaw Avenue, 138 First Street, 369 Pape Avenue, 2 Egan Avenue, and 165 Galt Avenue. – Limit the number of heavy trucks on site to the minimum required. – Stage construction vehicles away from noise sensitive locations, if feasible. – Undertake noise monitoring and regular reporting throughout the construction phase. Where noise level limits are exceeded, additional noise mitigation measures shall be implemented. – Develop a communications protocol which includes timely resolution of complaints. – Additional mitigation measures not listed above may be considered. 	<ul style="list-style-type: none"> ■ 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 with monitor(s) located strategically to capture the worst-case construction related noise levels at receiver locations based on planned construction activities, their locations, and the number, geographic distribution and proximity of noise sensitive receivers. ■ Monitoring at locations where there are persistent complaints, as required.
<p>Construction Vibration</p> <p>Note: Details of the operational vibration impacts and planned mitigation are included in the Lakeshore East Joint Corridor Noise and Vibration Operations Report, found in Appendix C of the Ontario Line Final Lakeshore East Joint Corridor Early Works Report.</p>	<ul style="list-style-type: none"> ■ Exposure to vibration may result in public annoyance and complaints. Vibration may also cause damage to buildings and other structures. 	<ul style="list-style-type: none"> ■ Project-specific construction vibration criteria limits will be established and applied, where appropriate. Vibration limits for the structures in the Riverdale Heritage District (near Tiverton Street and Dundas Street East) will be reviewed and design vibration limits should be confirmed by a qualified specialist during the next phases of design. Construction vibration impact mitigation measures to be considered include but are not limited to the following to meet applicable vibration criteria: <ul style="list-style-type: none"> – Siting construction staging and laydown areas to avoid/reduce adverse impacts to sensitive receivers where possible. – Utilize equipment with low vibration emissions where possible. – Off-site construction of components away from sensitive areas. – Restrict construction hours where feasible: <ul style="list-style-type: none"> • Perform construction during daytime hours where feasible. If night time construction is necessary, the activities with the highest vibration levels should be conducted during the daytime periods where feasible. 	<ul style="list-style-type: none"> ■ Monitoring will be undertaken at locations within the Zone of Influence to ensure compliance with the City of Toronto By-law 514-2008 and to identify the need for additional mitigation if required. ■ Monitoring will be undertaken to ensure compliance with other applicable vibration level limits identified, as required. ■ Monitoring will be undertaken to verify mitigation measure(s) effectiveness.

Environmental Component	Potential Impacts	Mitigation Measure(s)	Monitoring Activities
		<ul style="list-style-type: none"> ■ Review vibration assessment based upon refined site staging, construction areas/equipment, and building locations prior to the commencement of construction, and update if necessary. ■ Review and refine the construction activities to avoid potential impacts to vibration sensitive receivers (within the City of Toronto By-law 514-2008 Zone of Influence). Conduct monitoring and pre-construction inspections in accordance with the City of Toronto By-law 514-2008. Monitoring and preconstruction requirements can be determined by calculation of Zone of Influence of construction equipment. The vibration sensitive locations within the Zone of Influence, to be reviewed as project planning progresses, are initially identified as: <ul style="list-style-type: none"> – 9/11 Lewis Street (Residential), – 20 Saulter Street (Residential), – 33 Saulter Street (Residential), – 1 Strange Street (Commercial), – 791 Queen Street East (Mixed-use Residential), – 400 Eastern Avenue (Commercial), – 7/9 Dibble Street (Commercial), – 38/46 McGee Street (Commercial), – 56 McGee Street (Commercial), – 70 McGee Street (Commercial), – Structure in 80 McGee Street (Park), – 870 Queen Street East (Institutional), – 2 to 14 Paisley Avenue (Residential), – 15/17/17A/17B Tiverton Avenue (Residential), – Backyard structures in 25 and 27 Tiverton Avenue (Residential), – 444 Logan Avenue (Residential), – 388 to 400 Logan Avenue (Residential), – 400 Carlaw Avenue (Commercial), – 445 Logan Avenue (Residential), – 231 First Avenue (Residential), – 234 to 238 First Avenue (Residential), – 843 Gerrard Street East (Commercial), – Riverdale Shopping Centre (425 to 471 Carlaw Avenue – Commercial); – 369 Pape Avenue (Residential), – 1 Egan Avenue (Residential), – 2 Egan Avenue (Residential), – 302/304 Jones Avenue (Commercial – Residential), – 165 Galt Avenue (Residential), – 162 Galt Avenue (Residential), and – 1000 Gerrard Street East (Commercial). ■ Provide smooth surfaces for trucks to travel and route heavily loaded trucks away from vibration sensitive sites where possible. 	<ul style="list-style-type: none"> ■ Pre-construction building inspection of the potentially impacted buildings adjacent to the early works construction sites are to be undertaken in accordance with City of Toronto By-law 514-2008. Continuous vibration monitoring along the construction site property lines closest to these structures will be initiated as warranted. ■ Monitoring at locations where there are persistent complaints, if required.

Environmental Component	Potential Impacts	Mitigation Measure(s)	Monitoring Activities
		<ul style="list-style-type: none"> ■ Operate construction equipment on lower vibration settings where available. ■ Maximize distance between equipment and sensitive receivers where feasible. ■ Do not operate equipment where the City of Toronto By-law 514-2008 prohibited limits are predicted to be exceeded. Alternative construction methods and/or equipment with lower vibration emissions or power settings can be used if they do not exceed the City of Toronto's prohibited vibration limits. ■ As Project planning and design progress, conduct a review to identify any sensitive structures/operations that require more stringent vibration limits than the limits in City of Toronto By-law 514-2008; assess requirements, review/revise vibration limits for these locations and, if necessary, develop mitigation measures. US Federal Transit Administration Report No. 0123, Transit Noise and Vibration Impact Assessment Manual (2018) could be used as a source of additional criteria. ■ Review other applicable vibration limits that may apply, such as the City of Toronto Specification GN117SS. ■ Develop communications protocol which includes timely resolution of complaints. ■ Additional mitigation measures not listed above may be considered. 	

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Appendices

Appendix A. Terminology

Appendix B. Example Calculation

1. Introduction

1.1 Purpose of the Ontario Line Early Works

The Ontario Line Project (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, Environmental Impact Assessment Report, 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 Environmental Conditions Report 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 Environmental Conditions Report 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 Environmental Conditions Report.

Ontario Line early works are components of the Project that are proposed to proceed before the completion of the Ontario Line environmental impact assessment process. An overview of the Project is provided in **Section 1.2**. Early works are defined in Ontario Regulation: 341/20: Ontario Line Project under the Environmental Assessment Act as follows:

“any components of the Ontario Line Project that Metrolinx proposes to proceed with before the completion of the Ontario Line assessment process, such as station construction, rail corridor expansion, utility relocation or bridge replacement or expansion.”

Lakeshore East Joint Corridor early works are considered to be of strategic importance to enabling the timely implementation of the Project. These early works are being advanced where the Project interfaces with GO Expansion and the East Harbor Station (East Harbour Station is situated immediately to the west of the Lakeshore East Joint Corridor early works). Advancing early works and supporting environmental and technical studies in this area provides planning and design efficiencies for the Project and GO Expansion, and facilitates the timely implementation of both.

These early works will set the groundwork for other major construction for the Project, reducing risk of construction delays to the main P3 contracts by completing the joint corridor work in advance of the main contracts. Lakeshore East Joint Corridor early works are described in detail in **Section 1.3**.

1.1.1 Purpose of this Report

AECOM Canada Limited (AECOM) was retained by Metrolinx and Infrastructure Ontario to complete the Ontario Line Lakeshore East Joint Corridor Early Works Report for the Project. This Noise and Vibration Early Works Report (this Report) supports the Ontario Line Final Lakeshore East Joint Corridor Early Works Report and has been prepared for the Project to document the assessment of Lakeshore East Joint Corridor early works (**Figure 1-1**). The early works components and construction activities are described in **Section 1.3**.

The purpose of this Report is to:

- Assess the temporary construction noise and vibration impacts due to the Lakeshore East Joint Corridor early works; and,
- Provide noise and vibration mitigation and monitoring recommendations for the Lakeshore East Joint Corridor early works temporary construction.

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

A glossary of terminology is provided in **Appendix A**.

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

Reg. Section	Requirement	Report Section
Section 8(2)(2)	The rationale for proceeding with the early works.	Section 1.1
Section 8(2)(4)	A description of the local environmental conditions at the site of the early works.	Section 4
Section 8(2)(6)	Metrolinx's assessment and evaluation of the impacts that the preferred method of carrying out the early works and other methods might have on the environment, and Metrolinx's criteria for assessment and evaluation of those impacts.	Section 5
Section 8(2)(7)	A description of any measures proposed by Metrolinx for mitigating any negative impacts that the preferred method of carrying out the early works might have on the environment.	Section 6
Section 8(2)(8)	A description of the means Metrolinx proposes to use to monitor or verify the effectiveness of mitigation measures proposed.	Section 6
Section 8(2)(9)	A description of any municipal, provincial, federal or other approvals or permits that may be required for the early works.	Section 7

1.2 Ontario Line Project Overview

Metrolinx, an agency of the Province of Ontario, is proceeding with the planning and development of the Ontario Line, 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 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 with a combination of elevated (i.e., above existing rail corridor/roadway), tunnelled (i.e., underground), and at-grade (i.e., at grade with existing rail corridor/roadway) segments at various locations.

1.3 Early Works Description

1.3.1 Project Description

The Lakeshore East Joint Corridor early works are planned along the Lakeshore East rail corridor between approximately Eastern Avenue and Pape Avenue and will include:

- Reconfiguration of existing GO tracks to support future Ontario Line infrastructure,
- Replacement of the existing rail bridges at Queen Street East, Dundas Street East and Logan Avenue,
- Construction of two new bridges at Dundas Street East and Logan Avenue to support future Ontario Line tracks,
- Construction of the foundations for GO Overhead Catenary System (OCS) poles and supporting infrastructure to accommodate future fourth GO track;
- Construction of retaining walls; and
- Construction of noise barriers, including east of Pape Avenue.

The Lakeshore East Joint Corridor early works will support the future Ontario Line infrastructure located between Eastern Avenue and Pape Avenue (e.g., Leslieville and Gerrard stations, and Ontario Line tracks). These early works will also streamline implementation of GO Expansion through the construction of supporting infrastructure

for the future fourth track for the Lakeshore East GO corridor and the foundations for GO Overhead Catenary System (OCS) poles. The noise barriers constructed as part of these early works will mitigate noise impacts from both Ontario Line and GO operations.

Lakeshore East Joint Corridor early works components are shown in **Figure 1-1** and described in sections below.

Locations of noise walls recommended to be constructed as part of the Lakeshore East Joint Corridor Early Works Project were established in the Lakeshore East Joint Corridor Noise and Vibration Operations Report, a copy of which is provided in Appendix C of the Ontario Line Final Lakeshore East Joint Corridor Early Works Report.

1.3.2 Early Works Project Footprint and Study Area

The Lakeshore East Joint Corridor Early Works Project Footprint, shown in **Figure 1-2**, is defined as the area of direct disturbance associated with the early works construction activities, including anticipated required construction staging and laydown areas and construction access. Construction is anticipated to occur primarily within the existing Metrolinx right-of-way (Metrolinx-owned rail corridor/properties). The extent of lands anticipated to be temporarily impacted by construction staging/laydown and access will continue to be refined and reduced to the extent feasible as project planning progresses.

The Lakeshore East Joint Corridor Early Works Project Footprint extends from approximately 325 metres east of the Lower Don River in the west, follows the Lakeshore East rail corridor northeast from Eastern Avenue in the southwest to Jones Avenue in the northeast.

For the purpose of this Report, the Lakeshore East Joint Corridor Study Area, also shown in **Figure 1-2**, includes the Lakeshore East Joint Corridor Early Works Project Footprint and an approximately 250 metre buffer based upon the night time noise screening distance.

The Lakeshore East Joint Corridor Study Area was developed using noise and vibration screening areas which were determined by calculating the distances where the applicable criteria are predicted to be met, using conservative approach where it was assumed that all construction equipment listed in **Table 3-1** would be active. The approximately 250 metre night time noise screening area was the largest and was thus used to define the Lakeshore East Joint Corridor Study Area.

The Lakeshore East Joint Corridor Study Area assessed in this Report is specific to the noise and vibration impact assessment. The study areas for other environmental disciplines are outlined in the Ontario Line Final Lakeshore East Joint Corridor Early Works Report.

1.3.3 Construction Activities

Table 1-2 provides a description of the anticipated construction activities for the Lakeshore East Joint Corridor early works. These typical activities serve as the basis for the assessment of construction-related potential environmental impacts. These activities may be expanded, further refined, or found to be unnecessary as project planning progresses.

Table 1-2: Anticipated Construction Activities for the Ontario Line Lakeshore East Joint Corridor Early Works

Anticipated Construction Activity	Description	Associated Equipment
Site Preparation	<ul style="list-style-type: none"> ■ Mobilization of equipment and temporary facilities to the site. ■ Clearing and grubbing of vegetation, tree removal and protection. ■ Protection of trees & sensitive environmental features. ■ Erection of temporary and permanent fences. ■ Installation of environmental management features (e.g., erosion and sediment controls). ■ Dewatering works. ■ Preparation of temporary laydown areas including access roads, fencing and lighting. ■ Preparation of temporary access roads to construction sites including temporary shoring, access roads, fencing, signage, gate and lighting. ■ Temporary closure of road curb lanes. ■ Removal of roadway, sidewalks, buildings and retaining walls impacted by temporary or permanent conditions. 	<ul style="list-style-type: none"> ■ Site compaction equipment and grading equipment ■ Vegetation removal equipment ■ Excavation equipment ■ Haulage/dump trucks
Site Servicing / Removals / Demolition	<ul style="list-style-type: none"> ■ Relocation and/or extension of services and utilities on the site; which may include both underground and aerial services and utilities (e.g., sewers, water, electrical, communications, gas). This may also involve installation of utilities within the site. Includes utilities on the rail corridor and off the rail corridor. ■ Demolition and/or alteration of existing structures such as retaining walls and existing bridges. ■ Removal and reinstatement of railway track. ■ Locates and daylighting of underground utilities. 	<ul style="list-style-type: none"> ■ Excavation equipment including backhoe, dump trucks, spoil removal equipment, jackhammers, vacuum truck and high rail equipment ■ Track stabilizer ■ Hand tools ■ Mobile crane ■ Flatbed trucks ■ Boom truck ■ Spreader for track work
Construction of Structures	<ul style="list-style-type: none"> ■ All structures will be constructed using standard civil construction techniques. ■ Includes noise walls, pre-cast and cast-in-place retaining walls including stormwater management, grounding, bonding and backfill using selected material. 	<ul style="list-style-type: none"> ■ Foundation placement equipment ■ Augured piles or rammed aggregate piers ■ Drill rigs ■ Mobile cranes and hoists ■ Concrete trucks, pumps and vibrators
Construction of Bridges	<ul style="list-style-type: none"> ■ Will be constructed using standard civil construction techniques. ■ Dewatering is anticipated. ■ Includes stormwater management grounding and bonding. 	<ul style="list-style-type: none"> ■ Augured piles or rammed aggregate piers ■ Drill rigs ■ Mobile cranes and hoists. Concrete trucks, pumps and vibrators ■ Flatbed trucks, crane, excavators, and light equipment ■ Back hoe ■ Jack hammers
Temporary Road / Sidewalk Closures	<ul style="list-style-type: none"> ■ All road / sidewalk closures will follow standard traffic control management guidelines. 	<ul style="list-style-type: none"> ■ Temporary traffic control devices such as signs, signals, barriers, traffic barrels
Site Grading and Earthworks	<ul style="list-style-type: none"> ■ Removal of topsoil and excavation of unsuitable material and disposal off site ■ Borrow additional material for fill ■ Grading and compaction of track bed including subdrain ■ Installation of sub ballast and pre-ballasting 	<ul style="list-style-type: none"> ■ Excavator ■ Dozer ■ Motor grader ■ Compactor ■ Water truck ■ Dump trucks
Management of Stormwater	<ul style="list-style-type: none"> ■ All precipitation falling within the site will be managed as stormwater within a designed system of collection, conveyance, retention and discharge features, as required. The system will be designed and operated in compliance with applicable standards and regulatory requirements. Surface flows within the site will be managed within the site to ensure discharge to off-site receivers (i.e., municipal storm sewers) is appropriate in terms of water quantity and quality. 	<ul style="list-style-type: none"> ■ Site compaction equipment and general grading equipment ■ Groundwater pumping equipment
Track Construction	<ul style="list-style-type: none"> ■ Staged realignment of existing tracks (rail on timber ties). ■ Installation of 4 tracks in final position including ballast utilizing new rail and new concrete ties. 	<ul style="list-style-type: none"> ■ High rail excavators, Track laying machine, ballast regulator, stabilizer
Signaling Infrastructure Alteration/Installation	<ul style="list-style-type: none"> ■ Staged upgrade of track signals to reflect temporary staged realignment of tracks and installation of four tracks in a final position. ■ Relocation of existing bridge and bungalow including temporary track crossings, bridge foundations, aspects, bungalow, power supply, conduits and cables. Removal from site of existing signal bridge and bungalow. 	<ul style="list-style-type: none"> ■ Backhoe. ■ Vacuum truck ■ High rail crane ■ Drill rig ■ Concrete pump and concrete trucks
Fiber Optic Cable (FOC) Relocation	<ul style="list-style-type: none"> ■ Staged relocation of multiple Fiber Optic Cable (FOC) to reflect temporary staged realignment of tracks and installation of four tracks in a final position, including multiple conduits, hand wells, split steel casings and splicing. 	<ul style="list-style-type: none"> ■ Backhoe ■ Vacuum truck

Figure 1-1: Lakeshore East Joint Corridor Early Works Conceptual Design



Figure 1-1: Lakeshore East Joint Corridor Early Works Conceptual Design



Figure 1-2: Lakeshore East Joint Corridor Early Works Project Footprint and Lakeshore East Joint Corridor Study Area



2. Applicable Guidelines and Criteria

The guidelines, criteria, and municipal by-laws applicable to the early works construction noise and vibration are summarized in the subsections below.

2.1 Noise

2.1.1 Ministry of the Environment, Conservation and Parks

For construction noise, the Ministry of the Environment, Conservation, and Parks sets out noise emission standards for various types of construction equipment in their publications NPC-115 (Ministry of the Environment, 1978) and NPC-118 (Ministry of the Environment, 1978). The sound emission standards outlined in NPC-115 and NPC-118, for typical construction equipment and vehicles, are reproduced in the **Table 2-1** to **Table 2-5** below.

Table 2-1: NPC-115 Quiet Zone and Residential Area Sound Emission Standards for Excavation Equipment, Dozers, Loaders, Backhoes or Other Equipment Capable of Being used for Similar Application

Date of Manufacture	Maximum Sound Level (dBA) as determined using Publication NPC-103 – Procedures Section 6 Power Rating Less than 75 kilowatts	Maximum Sound Level (dBA) as determined using Publication NPC-103 – Procedures Section 6 Power Rating 75 kilowatts and Larger
January 1, 1979 to December 31, 1980	85	88
January 1, 1981 and after	83	85

Table 2-2: NPC-115 Sound Emission Standards for Pneumatic Pavement Breakers

Standard	Date of Manufacture	Maximum Sound Level (dBA) as measured using Publication NPC-103
Quiet Zone Sound Emission	January 1, 1979 and after	85
Residential Area Sound Emission	January 1, 1979 to December 31, 1980	90
Residential Area Sound Emission	January 1, 1981 and after	85

Table 2-3: NPC-115 Sound Emission Standards for Portable Air Compressors

Standard	Date of Manufacture	Maximum Sound Level (dBA) as measured using Publication NPC-103
Quiet Zone Sound Emission	January 1, 1979 to December 31, 1980	76
Quiet Zone Sound Emission	January 1, 1981 and after	70
Residential Area Sound Emission	January 1, 1979 and after	76

Table 2-4: NPC-115 Sound Emission Standards for Tracked Drills

Standard	Date of Manufacture	Maximum Sound Level (dBA) as measured using Publication NPC-103, Section 6
Quiet Zone and Residential Area Sound Emission	January 1, 1981 and after	100

Table 2-5: NPC-118 Sound Emission Standards for Heavy Vehicles with Governed Diesel Engines

Date of Manufacture	Maximum Sound Level (dBA) as measured using Publication NPC-103, Section 9
Prior to January 1, 1979	100
January 1, 1979 and after	95

2.1.2 Municipal Guidelines

Construction noise in the City of Toronto is typically addressed using City of Toronto Noise By-law 878-2019 (City of Toronto, 2019). However, as the Project qualifies as “Government Work” as per By-law 878-2019 (exempt from By-law requirements), the Project is exempt from the City of Toronto’s Noise By-law.

2.1.3 Other Guidance

Receiver based noise level limits provide a basis for the assessment of construction noise impacts to communities from construction over extended periods of time. The United States Federal Transit Administration’s Transit Noise and Vibration Impact Assessment Manual (United States Federal Transit Administration, 2018 – referred to as the Federal Transit Administration Guide) is widely used as a reference for construction noise and vibration impact assessment and the eight-hour criteria have been used in past Metrolinx noise impact assessments.

The average daytime criterion is defined as a rolling eight-hour (any consecutive eight hours during a time period longer than eight hours) energy average ($L_{eq, 8hr}$) over the course of the daytime, which is defined as 07:00 to 23:00 (Ministry of the Environment, 2013) for noise assessments in Ontario; this daytime noise level limit is 80 dBA. The average night time criterion is defined as the eight-hour energy average ($L_{eq, 8hr}$) during the night time, which is defined as 23:00 to 07:00 (Ministry of the Environment, 2013); this night time noise level limit is 70 dBA. These assessment criteria have been adopted for use in the Lakeshore East Joint Corridor early works construction noise impact assessment and are summarized in **Table 2-6**.

Table 2-6: Adopted Construction Noise Assessment Criteria

Time Period	Criteria ($L_{eq, 8hr}$)
Daytime (07:00 – 23:00)	80 dBA
Night time (23:00 – 07:00)	70 dBA

2.2 Vibration

2.2.1 Ministry of the Environment, Conservation and Parks

The Ministry of the Environment, Conservation and Parks regulates vibration from blasting operations using NPC-119 (Ministry of the Environment, 1978), and impulse vibration from stationary facilities such as forging shops using NPC-207 (Ministry of the Environment, 1983). As blasting is not proposed for the Project, and NPC-207 is only applicable to long term operation of a stationary source of vibration, Ministry of the Environment, Conservation and Parks does not have any guidelines applicable to construction vibration associated with the Lakeshore East Joint Corridor early works.

2.2.2 Municipal Guidelines

The City of Toronto regulates construction vibration using By-law 514-2008 (City of Toronto, 2008). By-law 514-2008 sets out a screening area (Zone of Influence) where vibration levels are predicted to exceed 5 millimetres per second. Should this Zone of Influence extend beyond the boundaries of the construction site, construction vibration monitoring, preconstruction surveys, and pre-construction consultation with property owners and occupants within the Zone of Influence are required. Furthermore, By-law 514-2008 defines vibration limits (prohibited levels) for various frequencies that must not be exceeded. The City of Toronto prohibited vibration levels are presented in **Table 2-7** below.

Table 2-7: City of Toronto Prohibited Vibration Levels

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

As Project planning and design progress, other criteria/vibration limits that may apply such as the City of Toronto Specification GN117SS which includes limits for trunk sewers and other structures may be considered and implemented.

2.2.3 Other Guidance

Construction vibration can be a concern for felt vibration and annoyance. To review the potential for vibration to be felt, the typical threshold for vibration annoyance (0.14 millimetres per second root mean square velocity, in accordance with the Ministry of the Environment and Energy and GO Transit, 1994) for operational vibration sources was used as the basis for the review.

Buildings potentially more susceptible to vibration damage, such as structures on heritage designated or listed properties, can be a factor in the analysis of construction vibration. The Federal Transit Administration Guide includes vibration damage criteria for buildings classified as “extremely susceptible to vibration damage”. The limit is 0.12 inches per second, (equivalently 3.0 millimetres per second). This limit has been adopted for the assessment of the potential construction vibration impacts to known or potential built heritage resources (i.e., buildings/structures with known or potential heritage significance).

3. Methodology

This Report documents the assessment of Lakeshore East Joint Corridor early works construction impacts related to noise and vibration. Impacts associated with Project operations will be addressed as part of the Environmental Impact Assessment Report, under separate cover and are not part of the Lakeshore East Joint Corridor early works. Note that the assessment of the Lakeshore East Joint Corridor operational noise and vibration impacts is documented in the Lakeshore East Joint Corridor Noise and Vibration Operations Report found in Appendix C of the Ontario Line Final Lakeshore East Joint Corridor Early Works Report. As the Lakeshore East Joint Corridor early works include installation of noise barriers and vibration mitigation technologies to address noise and vibration impacts associated with Joint Corridor operation, the Lakeshore East Joint Corridor Noise and Vibration Operations Report is included in this Report to provide the details of the operational noise and vibration assessment and identification of mitigation measures.

Noise and vibration impacts due to the construction of the early works are temporary and will cease once construction has been completed.

3.1 Local Environmental Conditions

AECOM has conducted baseline measurements as described in the Ontario Line Final Environmental Conditions Report (AECOM, 2020a)², to characterise the existing noise and vibration levels within the Ontario Line Study Area.

Data relevant to the Lakeshore East Joint Corridor early works construction have been included in **Section 4** below.

Continuous noise measurements were collected over several days at locations representative of noise sensitive receivers. Noise measurements were conducted using Quest SoundPro Type 1 and 2 sound level meters. Data collected during inclement weather conditions were discounted from statistical analysis.

Baseline vibration measurements were not required, as the construction vibration assessment in this Report uses absolute limits that do not change based upon the existing vibration levels. The local environment does not have any normally occurring sources of perceptible vibration; the most significant source of vibration near the early

2. The Ontario Line Final Environmental Conditions Report (AECOM, 2020a) was published on November 30, 2020 in accordance with Ontario Regulation 341/20: Ontario Line Project.

works locations are the existing rail lines. Thus, for the majority of the Lakeshore East Joint Corridor Study Area, existing vibration levels are expected to be below human perceptibility, except in close proximity to the existing rail lines.

3.2 Impact Assessment

The early works impact assessment and development of mitigation measures and monitoring activities considered the following:

- Lakeshore East Joint Corridor early works components as described in **Section 1.3.1**;
- The Lakeshore East Joint Corridor Early Works Project Footprint and Lakeshore East Joint Corridor Study Area as described in **Section 1.3.2**;
- Lakeshore East Joint Corridor construction activities as described in **Section 1.3.3**; and,
- Local environmental conditions within the Lakeshore East Joint Corridor Study Area as described in **Section 4**.

Noise and vibration criteria from various sources – City of Toronto, the Ministry of the Environment, Conservation and Parks, and the United States Federal Transit Administration - were reviewed for applicability to the Project. Criteria from the Federal Transit Administration Guide was used to supplement local criteria. Criteria reviewed and adopted for this assessment are summarized in **Section 2**.

Mitigation measures and monitoring activities have been recommended to mitigate the identified potential negative impacts within the Lakeshore East Joint Corridor Study Area. The results of the impact assessment are provided in **Section 5**, and recommended mitigation measures and monitoring activities outlined in **Section 6**.

Please note that the impact assessment will be reviewed prior to commencement of construction using the most up-to-date information on construction methods and techniques, equipment, and refined construction areas, and updated as required.

3.2.1 Noise

The construction noise assessment evaluated the potential impacts to the representative nearby noise sensitive receivers. Noise sensitive receivers are defined as properties that accommodate a dwelling unit(s), are used for noise sensitive commercial purposes, such as sleeping facilities, or for noise sensitive institutional purposes such as educational facilities.

First, a noise screening was conducted to determine if receiver-specific noise predictions were required. The noise screening was completed by determining the distances where the day or night time criteria are predicted to be met, assuming all construction equipment in **Table 3-2** was active, using a conservative approach to determine the screening distance, which assumed flat ground and no shielding or other noise attenuation effects (see **Appendix B** of this Report). The screening distances were then used to create screening areas on maps to determine if any possible sensitive receivers were located within the screening areas (see **Section 5.1**). Assessed representative receivers were selected based upon their location within the noise screening area and their proximity to the Lakeshore East Joint Corridor Early Works Project Footprint, as receivers located further away would have lower noise impacts from the Project. The assessed representative noise receivers are further described in **Section 5.1**.

Noise predictions at selected representative receivers include the modeling of various scenarios, using detailed noise calculation algorithms which can account for building and geometric noise shielding effects, ground effects, and air attenuation. The receiver-specific noise predictions were conducted for the nearest (to the Lakeshore East Joint Corridor Early Works Project Footprint) representative noise sensitive receivers (highest noise exposures).

An acoustic model using the International Organization for Standardization 9613 (International Organization for Standardization, 1996) prediction algorithms was prepared. As the construction equipment cannot all operate in the same physical position, the equipment was modelled as operating over an area closest to the assessed representative receiver. Activities that can only occur at certain locations, for example rail works and bridge construction, was modeled at those specific locations.

For the purpose of this study, a conservative approach was used where it was assumed that equipment could operate anytime.

Other assumptions include:

- Adjacent residential properties were assumed to be occupied by residents over the course of construction; and
- Ground absorption would have a negligible effect and has been set to zero.

The predicted construction noise levels are estimates based on conservative assumptions, reference equipment noise levels and the Lakeshore East Joint Corridor early works information (Lakeshore East Joint Corridor Early Works Project Footprint and construction activities as outlined in **Section 1.3**) available to date. Results were compared to guideline limits and mitigation recommendations were made to reduce the noise impacts. The impact assessment and assumptions shall be reviewed prior to the commencement of construction

using the most up-to-date information on construction methods and techniques, equipment, and refined construction areas, and updated if required.

3.2.2 Vibration

Vibration receivers are defined as any structure where vibration criteria could be exceeded. The assessment of construction vibration was based on the City of Toronto's definition of Zone of Influence; the area (zone) in which vibration levels are predicted to be at, or above the screening threshold. Zone of Influence mapping determines which locations may be above the applicable criteria and where vibration controls may need to be implemented.

The Lakeshore East Joint Corridor early works vibration Zone of Influence was calculated using the Federal Transit Administration Guide's construction vibration propagation equations to calculate the distances where the screening threshold is met. These distances define the Zone of Influence.

A conservative approach was used, where construction equipment operations within the construction areas were assumed to be unrestricted to specific areas, and the equipment with the maximum vibration levels was used as the basis of assessment. As a result, Lakeshore East Joint Corridor early works vibration Zone of Influence is based upon the equipment with the highest vibration levels operating at the edge of the Lakeshore East Joint Corridor Early Works Project Footprint.

Screening distances for the other applicable vibration criteria (City of Toronto By-law prohibited limit, Federal Transit Administration Guide limit for buildings extremely susceptible to building damage, and human perceptibility, discussed in **Section 2.2**) were also mapped.

Structures within the Lakeshore East Joint Corridor Early Works Project Footprint were assumed to be the responsibility of Metrolinx and have not been included as receivers in this analysis.

The predicted construction vibration Zones of Influence are based on conservative assumptions, reference equipment vibration levels and the Lakeshore East Joint Corridor early works information available to date (**Section 1.3**) Representative vibration receivers were identified using the Zone of Influence as described above and are further described in **Section 5.2**. Assessment results were compared to vibration criteria and mitigation recommendations are made to avoid or reduce the vibration impacts based on the calculated Zone of Influence. The impact assessment and assumptions shall be reviewed prior to the commencement of construction using the most up-to-date information on construction methods and techniques, equipment, and refined construction areas, and updated if required.

3.3 Construction Activities and Equipment

Preliminary construction activities associated with the Lakeshore East Joint Corridor early works are provided in **Table 1-2**. Construction activities were consolidated into assessment scenarios based upon the following:

- Activities that do not have associated construction noise or vibration equipment, such as temporary road closures, have not been included in this assessment;
- Activities that occur simultaneously with other activities, such as storm water management, have been included in the assessment of the other assessed construction activities; and,
- Activities that are similar to other activities which should have similar noise and vibration impacts, such as temporary track diversion, and installation of trackwork, have been assessed in the same scenario.

The construction equipment listed in **Table 1-2** has also been supplemented based on past project experience with similar construction activities.

The consolidated construction site activity scenarios include:

- Site Preparation/Removals/Demolition;
- Site Services (Utility Relocation/Protection)³;
- Demolition;
- Excavation/Grading;
- Structure Construction (including retaining wall construction and noise wall installation);
- Bridge Span Installation; and
- Trackwork.

Construction equipment, and reference construction equipment noise and vibration source data are presented in **Table 3-1** and **Table 3-2**, respectively. Exact construction equipment quantities, types, and staging will be determined as project planning progresses, in advance of construction and may vary from the tables below; updates will be conducted as required. Reference data were sourced from the Federal Transit Administration Guide and the United States Federal Highway Administration's Roadway Construction Noise Model (United States Federal Highway Administration, 2006).

3. Note that signaling and fiber optic cabling are considered utilities in the context of the assessment of construction noise and vibration in this report.

Table 3-1: Assumed Construction Equipment by Activity

Equipment	Site Preparation	Site Services (utility relocation/ protection)	Demolition	Excavation/ Grading	Structure Construction	Bridge Span Installation	Track-work
Auger Piling Equipment	-	-	-	-	X	-	-
Rammed Aggregate Piers	-	-	-	-	X	-	-
Backhoe	X	X	X	X	X	-	X
Chainsaw	X	-	-	-	-	-	-
Compactor (ground)	X	-	-	X	-	-	X
Compressor (air)	-	X	X	-	X	X	-
Concrete Mixer Truck	-	-	-	-	X	-	-
Concrete Pump Truck	-	-	-	-	X	-	-
Concrete Saw	-	X	X	-	-	-	-
Crane (mobile)	-	-	X	-	X	X	X
Dozer	X	-	X	X	-	-	-
Dump/ Water/ Flatbed/ Concrete Truck Movements	6 per hour	6 per hour	6 per hour	6 per hour	6 per hour	6 per hour	6 per hour
Excavator	X	X	X	X	-	-	X
Front End Loader	X	X	-	X	-	-	-
Generator	-	-	X	-	X	-	-
Grader	X	-	-	X	-	-	-
Hoe Ram	-	-	X	-	-	-	-
Jack Hammer	-	X	X	X	-	-	-
Man Lift	-	-	X	-	X	X	-
Pavement Scarifier	-	-	X	-	-	-	-
Pumps	X	-	-	X	-	-	-
Rail Saw	-	-	-	-	-	-	X
Roller	X	-	-	X	-	-	-
Vibratory Concrete Mixer	-	-	-	-	X	-	-
Vacuum Excavator	-	X	-	-	-	-	-
Ballast Equalizer	-	-	-	-	-	-	X
Ballast Tamper	-	-	-	-	-	-	X
Spike Driver	-	-	-	-	-	-	X
Tie Cutter	-	-	-	-	-	-	X
Tie Handler	-	-	-	-	-	-	X
Tie Inserter	-	-	-	-	-	-	X

Table 3-2: Reference Construction Equipment Data

Equipment	Reference Noise Data Sound Level at 15.24 m / 50 ft (dBA)	Reference Noise Data Acoustical Usage Factor (%)	Reference Vibration Data PPV at 7.62 m / 25 ft (mm/s)	Reference Vibration Data RMSV at 7.62 m / 25 ft (VdB ref 1 micro-inch/s)
Auger Piling Equipment	85	20	2.261	87
Rammed Aggregate Pier ¹	90	20	2.261	87
Backhoe ²	80	40	0.076	58
Chain Saw	85	20	Negligible	Negligible
Compactor (ground) ³	80	20	0.889	79
Compressor (air)	80	40	Negligible	Negligible
Concrete Mixer Truck	85	40	1.930	86
Concrete Pump Truck	82	20	1.930	86
Concrete Saw	90	20	Negligible	Negligible
Crane (mobile)	85	16	Negligible	Negligible
Dozer	85	40	2.261	87
Dump/Flatbed/ Water Truck	84	40	1.930	86
Excavator ⁴	80	40	2.261	87
Front End Loader ⁴	80	40	2.261	87
Generator	82	50	Negligible	Negligible
Grader ⁴	85	40	2.261	87
Hoe Ram	90	20	2.261	87
Jack Hammer	89	20	0.889	79
Man Lift	85	20	Negligible	Negligible
Pavement Scarifier ⁵	85	20	0.076	58
Pumps	77	50	Negligible	Negligible
Rail Saw ⁶	90	20	Negligible	Negligible
Roller	85	20	5.334	94
Vibratory Concrete Mixer ³	80	20	0.889	79
Vacuum Excavator	85	40	Negligible	Negligible
Ballast Equalizer ⁵	82	40	0.076	58
Ballast Tamper ¹	83	40	0.076	58
Spike Driver ⁸	77	20	0.889	79
Tie Cutter ⁹	84	20	Negligible	Negligible
Tie Handler ¹⁰	80	40	Negligible	Negligible
Tie Inserter ¹⁰	85	40	Negligible	Negligible

- Notes:
- (1) Assumed similar to hoe ram in Federal Transit Administration Guide and Roadway Construction Noise Model
 - (2) Assumed similar to small dozer in Federal Transit Administration Guide (vibration)
 - (3) Assumed similar to jack hammer in the Federal Transit Administration Guide (vibration)
 - (4) Assumed similar to large dozer in the Federal Transit Administration Guide (vibration)
 - (5) Assumed similar to grader/small dozer in the Federal Transit Administration Guide (vibration)
 - (5) Assumed similar to concrete saw
 - (6) Assumed similar acoustical usage factor as a grader/loader and vibration as a grader/small dozer
 - (7) Assumed similar acoustical usage factor and vibration impact as a jack hammer
 - (8) Assumed similar acoustical usage factor as a concrete saw
 - (9) Assumed similar acoustical usage factor as a loader

4. Local Environmental Conditions

4.1 Noise

As discussed in **Section 3.1**, data for the relevant monitoring locations are presented in **Table 4-1** with monitoring locations shown on **Figure 4-1**.

4.2 Vibration

As discussed in **Section 3.1**, baseline vibration measurements were not required as the construction vibration assessment in this Report uses absolute limits that do not change based upon the existing vibration levels.

Table 4-1: Relevant Baseline Noise Measurement Data

Monitoring Location	Daytime (07:00-19:00) Average $L_{eq, 1hr}$ (dBA)	Daytime (07:00-19:00) Min $L_{eq, 1hr}$ (dBA)	Daytime (07:00-19:00) Max $L_{eq, 1hr}$ (dBA)	Evening (19:00-23:00) Average $L_{eq, 1hr}$ (dBA)	Evening (19:00-23:00) Min $L_{eq, 1hr}$ (dBA)	Evening (19:00-23:00) Max $L_{eq, 1hr}$ (dBA)	Night (23:00-07:00) Average $L_{eq, 1hr}$ (dBA)	Night (23:00-07:00) Min $L_{eq, 1hr}$ (dBA)	Night (23:00-07:00) Max $L_{eq, 1hr}$ (dBA)
MO_01S Pape Avenue	65	59	73	58	56	60	53	47	62
MO_02S Wardell Street	64	61	66	62	59	63	52	43	63

Figure 4-1: Noise Monitoring Locations near the Lakeshore East Joint Corridor Early Works Project Footprint



5. Impact Assessment Results

Potential impacts of the noise and vibration associated with the construction of Lakeshore East Joint Corridor early works have been assessed and are described in the following subsections.

Recommended mitigation measures and monitoring activities are presented in **Section 6**.

5.1 Noise

As discussed in **Section 3.2.1** a noise screening was conducted based upon conservative assumptions to determine if receiver-specific noise predictions are required. Noise screening mapping for Lakeshore East Joint Corridor early works is presented on **Figure 5-1**. Results of the noise screening show that a number of noise sensitive receivers are within the screening distance, necessitating receiver-specific noise predictions.

Assessed representative receivers were selected based upon their location within the noise screening area and their proximity to the Lakeshore East Joint Corridor Early Works Project Footprint, as receivers located further away would have lower noise impacts from the Project.

The nearest assessed representative noise sensitive receivers are:

- 9 Lewis Street (Residential);
- 18 Saulter Street (Residential);
- 791 Queen Street East (Mixed-use Residential);
- 89 McGee Street (Residential);
- 812 Queen Street East (Mixed-use Residential);
- 14 Wardell Street (Residential);
- 2 Paisley Avenue (Residential);
- 1054 Dundas Street East (Residential);
- 15 Tiverton Avenue (Residential);
- 400 Carlaw Avenue (Residential);
- 444 Logan Avenue (Residential);

- 445 Logan Avenue (Residential);
- 138 First Street (Residential);
- 885 Gerrard Street East (Residential);
- 383 Gerrard Street (Commercial – Residential);
- 369 Pape Avenue (Residential);
- 2 Egan Avenue (Residential); and
- 165 Galt Avenue (Residential).

Potential noise sensitive receivers further away will have lower construction noise exposures.

The Lakeshore East Joint Corridor Early Works Project Footprint is otherwise surrounded by commercial, industrial, and park lands, none of which are considered noise sensitive. The predicted noise levels from the construction of the Lakeshore East Joint Corridor early works are presented in **Table 5-1**.

Note that the results in this table were based upon conservative assumptions and methods, which predict higher noise levels than expected in real world conditions.

Results above indicate that, without mitigation, the noise levels at the majority of the assessed noise sensitive locations are predicted to be above the night time noise criterion during most construction scenarios. The majority of assessed worst case representative locations are predicted to have temporary construction noise levels in excess of the daytime noise criterion due to the proximity of noise sensitive receivers adjacent to the Lakeshore East Joint Corridor Early Works Project Footprint.

Construction activities taking place at the bridges (e.g., bridge span installation) are predicted to have more localized noise impacts (in comparison with project wide activities such as trackwork) due to their localized activity.

Mitigation measure recommendations to reduce the noise impacts are presented in **Section 6**.

Table 5-1: Construction Noise Prediction Results

Representative Receiver	Assessment Criteria (day $L_{eq,8hr}$ / night $L_{eq,8hr}$)	Predicted $L_{eq, 8hr}$ [dBA] Site Preparation	Predicted $L_{eq, 8hr}$ [dBA] Site Services (utility relocation/ protection)	Predicted $L_{eq, 8hr}$ [dBA] Demolition	Predicted $L_{eq, 8hr}$ [dBA] Excavation/ Grading	Predicted $L_{eq, 8hr}$ [dBA] Structure Construction	Predicted $L_{eq, 8hr}$ [dBA] Bridge Span Installation	Predicted $L_{eq, 8hr}$ [dBA] Trackwork
9 Lewis Street (Residential)	80/70	94	94	95	94	76	76	76
18 Saulter Street (Residential)	80/70	88	89	90	89	85	80	85
791 Queen Street East (Mixed-use Residential)	80/70	86	86	88	86	86	75	86
89 McGee Street (Residential)	80/70	85	85	86	85	86	82	86
812 Queen Street East (Mixed-use Residential);	80/70	88	88	90	89	88	85	88
14 Wardell Street (Residential)	80/70	85	85	87	85	86	71	86
2 Paisley Avenue (Residential)	80/70	94	94	96	94	92	86	92
1054 Dundas Street East (Residential);	80/70	87	87	88	87	86	85	86
15 Tiverton Avenue (Residential)	80/70	91	92	93	92	92	84	92
400 Carlaw Avenue (Residential)	80/70	92	93	94	93	92	84	92
444 Logan Avenue (Residential)	80/70	87	87	89	87	83	82	83
445 Logan Avenue (Residential)	80/70	87	88	89	88	84	78	83
138 First Street (Residential)	80/70	90	90	92	90	85	74	85
885 Gerrard Street East (Residential)	80/70	81	81	82	81	79	76	79
383 Gerrard Street (Commercial – Residential)	80/70	84	84	85	84	78	73	78
369 Pape Avenue (Residential)	80/70	89	89	91	89	90	63	90
2 Egan Avenue (Residential)	80/70	90	90	92	90	89	59	88
165 Galt Avenue (Residential)	80/70	92	93	94	93	90	50	90

5.2 Vibration

The construction equipment with the greatest potential impact for this project is the vibratory roller, and thus the screening distances calculated were based on the vibratory roller. The screening distances are:

- For perceptible vibration (annoyance) 0.14 mm/s (RMSV) – 33 metres;
- For buildings extremely susceptible to vibration damage 3.0 mm/s – 11.1 metres;
- City of Toronto Screening 5.0 millimetres per second – 7.9 metres; and
- City of Toronto Prohibited Limit 8.0 millimetres per second – 5.8 metres.

Mapping of the vibration screening distances in **Figure 5-2** shows that, without mitigation, construction vibration levels are expected to exceed the City of Toronto prohibited limit at:

- 9/11 Lewis Street (Residential),
- 20 Saulter Street (Residential),
- 33 Saulter Street (Residential),
- 1 Strange Street (Commercial),
- 791 Queen Street East (Mixed-use Residential),
- 400 Eastern Avenue (Commercial),
- 7/9 Dibble Street (Commercial),
- 38/44/46 McGee Street (Commercial),
- 56 McGee Street (Commercial),
- 70 McGee Street (Commercial),
- Structure in 80 McGee Street (Park),
- 870 Queen Street East (Institutional),
- 2 to 14 Paisley Avenue (Residential),
- 15/17/17A/17B Tiverton Avenue (Residential),
- 444 Logan Avenue (Residential),
- 388 to 400 Logan Avenue (Residential),
- 400 Carlaw Avenue (Commercial),

- 445 Logan Avenue (Residential),
- 231 First Avenue (Residential),
- 234 to 238 First Avenue (Residential),
- 843 Gerrard Street East (Commercial),
- Riverdale Shopping Centre (425 to 471 Carlaw Avenue – Commercial);
- 369 Pape Avenue (Residential),
- 1 Egan Avenue (Residential),
- 2 Egan Avenue (Residential),
- 302/304 Jones Avenue (Commercial – Residential),
- 165 Galt Avenue (Residential),
- 162 Galt Avenue (Residential), and
- 1000 Gerrard Street East (Commercial).

A detailed review of expected vibration levels (with finalized construction areas and equipment) with respect to these structures is required and will be completed as project planning progresses, in advance of construction commencement.

As shown on **Figure 5-2**, construction vibration is predicted to be potentially perceptible at many locations adjacent to the Lakeshore East Joint Corridor early works Project Footprint. Depending on the final construction equipment and equipment operational areas, this area could change significantly. As a result, a listing of locations that may perceive construction vibration would be too preliminary and is expected to change significantly as project planning progresses and constructability plans are advanced. **Figure 5-2** can be used to as the basis of future analysis of perceptible vibration. As discussed above, predictions have been based upon conservative assumptions on equipment operational areas (whereas in practice, equipment would not be expected to operate continuously at the perimeter of the Project Footprint), and occasional vibration at the threshold of perception may not result in a complaint.

There are properties located along Tiverton Avenue and First Avenue (Riverdale Heritage District) that are known or potential built heritage resources. Vibration limits are required to be reviewed for these locations as some of these buildings could be considered more susceptible to vibration damage (see **Section 2.2.3**). Note that some of these properties abut the project footprint.

There is also an area listed as under study by the City of Toronto Heritage Register as a heritage conservation district on Queen Street East (Riverside), west of the project

footprint. The buildings closest to the Lakeshore East Joint Corridor Early Works Project Footprint are not listed on the City of Toronto Heritage Register. Vibration limits are required to be reviewed for structures within this potential heritage conservation district as some of these structures could be considered more susceptible to vibration damage (see **Section 2.2.3**).

There are no other structures or properties that are known or potential built heritage resources within the screening distance for structures extremely susceptible to building damage.

Figure 5-1: Noise Screening for the Lakeshore East Joint Corridor Early Works Project Footprint



DRAFT FOR ILLUSTRATIVE PURPOSES

Legend 			Ontario Line Project Early Works Study Area - Lakeshore East Joint Corridor Noise Screening	
0 0.275 0.55 Kilometers DATUM: NAD 1983 UTM Zone 17N			Data Sources: Contains Information licensed under the Open Government Licence Ontario, Ministry of Energy, Northern Development and Mines, City of Toronto and Metrolinx. Keymap provided by ESRI.	
METROLINX		AECOM		
Aug. 2021 P#: 6061173		REV. 00 Figure 5-1		

Figure 5-2: Vibration Screening for the Lakeshore East Joint Corridor Early Works Project Footprint



6. Potential Impacts, Mitigation Measures and Monitoring Activities

In accordance with Section 8(2)(6), 8(2)7 and 8(2)8 of Ontario Regulation 341/20: Ontario Line Project, this section describes the potential impacts, mitigation measures, and monitoring activities to verify the effectiveness of mitigation measures associated with the Lakeshore East Joint Corridor early works.

The results of the impact assessment outlined in **Section 5** indicate that mitigation and monitoring will be required. Recommended mitigation measures and monitoring activities to be carried forward and refined (as required as project planning progresses) are summarized below. Additional mitigation measures may be considered as project planning progresses. Note that noise and vibration impacts due to the construction of the Lakeshore East Joint Corridor early works are temporary and will cease once construction has been completed. A summary of potential impacts, mitigation measures, commitments, and monitoring activities to verify mitigation measure effectiveness for this Project is provided in **Table 6-1**.

6.1 Mitigation Measures - General Recommendations

General mitigation recommendations are typical measures applicable to most construction projects and include best practices to decrease potential impacts. Preliminary recommendations to be further refined and updated in the next phases of design are described in the subsections below.

6.1.1 Noise

Mitigation measures to be investigated as project planning progresses for construction noise levels to meet the applicable criteria include but are not limited to the following:

- Comply with applicable noise guidelines from the Ministry of the Environment, Conservation, and Parks including NPC-115 and NPC-118;
- Operate construction equipment during daytime hours and avoid night time operations where feasible, in an effort to minimize the potential for complaints;
- If construction will occur outside of normal daytime hours, inform local residents of the type of construction and expected duration outside of daytime hours prior to commencing work;

- Use of upgraded construction hoarding (considering requirements from Canadian Standards Association Z107.9, Standard for Certification of Noise Barriers) between construction equipment and noise sensitive receivers;
- Evaluate acoustic enclosures for equipment such as generators and compressors and additional equipment silencers/mufflers;
- Use of localized noise barriers for specific equipment and construction activities/operations;
- Minimize simultaneous operation of equipment where possible;
- Implement a no idling policy on site (unless necessary for equipment operation);
- Use of broadband back up signals instead of tonal backup signals;
- Limit the number of heavy trucks on site to the minimum required;
- Develop a communications protocol which includes timely resolution of complaints;
- Establish and apply project specific construction noise criteria/exposure limits (monitoring could be used to enforce these limits);
- Arrange staging areas such that loudest operations and equipment are located away from noise sensitive locations where feasible; and,
- Arrange site to avoid vehicle traveling in reverse if feasible.

Review of mitigation requirements should be completed, and updated as required, as project planning progresses to account for design and construction methodology updates.

6.1.2 Vibration

Mitigation measures to be investigated during the next phases of design for construction vibration levels to meet applicable criteria include but are not limited to the following:

- Update vibration assessment based upon finalized site staging, construction operational areas, and building locations, as required; location and number of buildings within the Zone of Influence may change. Zone of Influence mapping was based upon a vibratory roller. The associated Zone of Influence setback distances could decrease, if equipment with lower vibration emissions is used;
- Update vibration assessment for sensitive infrastructure in vicinity of Lakeshore East Joint Corridor Early Works Project Footprint, as required;

- Conduct monitoring and preconstruction inspections in accordance with City of Toronto By-law 514-2008. Monitoring and preconstruction requirements can be determined by the distance between the construction equipment operation area and sensitive receivers;
- Provide smooth surfaces for trucks to travel;
- Operate during daytime where possible;
- Route heavily loaded trucks away from vibration sensitive sites where possible;
- Manage the sequence of construction phases such as demolition, earth-moving, and ground-impacting operations to not occur in the same period, to the extent feasible;
- Operate construction equipment on lower vibration settings where available;
- Maximize distance between equipment and sensitive receivers where feasible; and,
- Do not operate equipment at setback distances less than the prohibited Zone of Influence. Use alternative means of construction within these distances that result in vibration levels below the City of Toronto’s prohibited vibration limits. Note that Zone of Influence was calculated based upon generic equipment. Equipment with lower vibration emissions, or power settings, can be used provided that vibration levels do not exceed the City of Toronto’s prohibited vibration limits.

Review of mitigation requirements should be completed, and updated as required, as project planning progresses to account for design and construction methodology updates.

6.2 Mitigation Measures - Site Specific Recommendations

Mitigation recommendations specific to the Lakeshore East Joint Corridor early works, subject to review as project planning progress and updated as required, are described in **Section 6.2.1** and **Section 6.2.2** below.

6.2.1 Noise

Mitigation measures will be subject to review as project planning progress and updated as required for construction noise levels to be below applicable criteria limits. The

following noise mitigation measures should be considered to decrease the construction noise impacts:

- Consider construction daytime work shift duration limits for the construction adjacent to noise sensitive locations such as 9 Lewis Street, 18 Saulter Street, 2 Paisley Avenue, 15 Tiverton Avenue, 400 Carlaw Avenue, 138 First Street, 369 Pape Avenue, 2 Egan Avenue, and 165 Galt Avenue.
- Use temporary movable noise screens for the loudest construction activities; and
- Consider construction duration limits during night time.

6.2.2 Vibration

Mitigation measures, subject to review as project planning progress and updated as required, for construction vibration levels to be below applicable criteria limits include:

- Review and refine the construction activities taking place in the vicinity of vibration sensitive receivers (within the City of Toronto Zone of Influence) to meet applicable vibration limits. Mitigation and monitoring requirements could potentially be removed for structures where the updated vibration impact assessment indicates that the applicable vibration limits are not anticipated to be exceeded. The vibration sensitive locations within the Zone of Influence are identified in this assessment as:
 - 9/11 Lewis Street (Residential),
 - 20 Saulter Street (Residential),
 - 33 Saulter Street (Residential),
 - 1 Strange Street (Commercial),
 - 791 Queen Street East (Mixed-use Residential),
 - 400 Eastern Avenue (Commercial),
 - 7/9 Dibble Street (Commercial),
 - 38/46 McGee Street (Commercial),
 - 56 McGee Street (Commercial),
 - 70 McGee Street (Commercial),
 - Structure in 80 McGee Street (Park),
 - 870 Queen Street East (Institutional),
 - 2 to 14 Paisley Avenue (Residential),
 - 15/17/17A/17B Tiverton Avenue (Residential),
 - Backyard structures in 25 and 27 Tiverton Avenue (Residential),
 - 444 Logan Avenue (Residential),

- 388 to 400 Logan Avenue (Residential),
 - 400 Carlaw Avenue (Commercial),
 - 445 Logan Avenue (Residential),
 - 231 First Avenue (Residential),
 - 234 to 238 First Avenue (Residential),
 - 843 Gerrard Street East (Commercial),
 - Riverdale Shopping Centre (425 to 471 Carlaw Avenue – Commercial);
 - 369 Pape Avenue (Residential),
 - 1 Egan Avenue (Residential),
 - 2 Egan Avenue (Residential),
 - 302/304 Jones Avenue (Commercial – Residential),
 - 165 Galt Avenue (Residential),
 - 162 Galt Avenue (Residential), and
 - 1000 Gerrard Street East (Commercial).
- The Riverdale Heritage District (near Tiverton Street and Dundas Street East) is a known built heritage resource. The design vibration limits of the structures in the Riverdale Heritage District should be confirmed by a qualified specialist during the next phases of project planning.

6.3 Potential Impacts, Mitigation Measures and Monitoring Activities Summary

Table 6-1 below presents a summary of potential impacts, mitigation measures and monitoring activities to verify mitigation measure effectiveness.

Table 6-1: Potential Noise and Vibration Impacts, Mitigation Measures and Monitoring Activities for the Lakeshore East Joint Corridor Early Works

Environmental Component	Potential Impacts	Mitigation Measure(s)	Monitoring Activities
<p>Construction Noise</p> <p>Note: Details of the operational noise impacts and planned mitigation are included in the Lakeshore East Joint Corridor Noise and Vibration Operations Report, found in Appendix C of the Ontario Line Final Lakeshore East Joint Corridor Early Works Report.</p>	<ul style="list-style-type: none"> ■ Environmental noise may cause annoyance and disturb sleep and other activities. ■ The severity of the noise effects resulting from construction projects varies, depending on: <ul style="list-style-type: none"> – Scale, location and complexity of the project – Construction methods, processes and equipment deployed – Total duration of construction near sensitive noise receivers – Construction activity periods (days, hours, time period) – Number and proximity of noise-sensitive sites to construction area(s) 	<ul style="list-style-type: none"> ■ Establish and apply project specific noise criteria/limits. Construction noise impact mitigation measures to be considered to meet project specific noise criteria/exposure limits include but are not limited to the following: <ul style="list-style-type: none"> – Siting construction staging and laydown areas to avoid/reduce adverse impacts to sensitive receivers where feasible. – Use construction equipment compliant with noise level specifications in Ministry of Environment, Conservation, and Parks guidelines NPC-115 and NPC-118. – Keep equipment in good working order and operate with effective muffling devices. – Equipment enclosures for equipment such as generators and compressors. – Additional equipment silencers/mufflers. – Use of upgraded construction hoarding (considering requirements from Canadian Standards Association Z107.9 for noise barriers) between construction equipment and noise sensitive receivers. – Use of localized movable noise barriers/screens for specific equipment and operations. – Minimize simultaneous operation of equipment where feasible. – Implement a no idling policy on site (unless necessary for equipment operation). – Restrict construction hours where feasible: <ul style="list-style-type: none"> • Perform construction during daytime hours where feasible. If night time construction is necessary, the activities with the highest noise levels should be conducted during day time 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. • Consider construction duration limits for construction with adjacent noise sensitive locations such as: 9 Lewis Street, 18 Saulter Street, 2 Paisley Avenue, 15 Tiverton Avenue, 400 Carlaw Avenue, 138 First Street, 369 Pape Avenue, 2 Egan Avenue, and 165 Galt Avenue. – Limit the number of heavy trucks on site to the minimum required. – Stage construction vehicles away from noise sensitive locations, if feasible. – Undertake noise monitoring and regular reporting throughout the construction phase. Where noise level limits are exceeded, additional noise mitigation measures shall be implemented. – Develop a communications protocol which includes timely resolution of complaints. – Additional mitigation measures not listed above may be considered. 	<ul style="list-style-type: none"> ■ 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 with monitor(s) located strategically to capture the worst-case construction related noise levels at receiver locations based on planned construction activities, their locations, and the number, geographic distribution and proximity of noise sensitive receivers. ■ Monitoring at locations where there are persistent complaints, as required.
<p>Construction Vibration</p> <p>Note: Details of the operational vibration impacts and planned mitigation are included in the Lakeshore East Joint Corridor Noise and Vibration Operations Report, found in Appendix C of the Ontario Line Final Lakeshore East Joint Corridor Early Works Report.</p>	<ul style="list-style-type: none"> ■ Exposure to vibration may result in public annoyance and complaints. Vibration may also cause damage to buildings and other structures. 	<ul style="list-style-type: none"> ■ Project-specific construction vibration criteria limits will be established and applied, where appropriate. Vibration limits for the structures in the Riverdale Heritage District (near Tiverton Street and Dundas Street East) will be reviewed and design vibration limits should be confirmed by a qualified specialist during the next phases of design. Construction vibration impact mitigation measures to be considered include but are not limited to the following to meet applicable vibration criteria: <ul style="list-style-type: none"> – Siting construction staging and laydown areas to avoid/reduce adverse impacts to sensitive receivers where possible. – Utilize equipment with low vibration emissions where possible. – Off-site construction of components away from sensitive areas. – Restrict construction hours where feasible: <ul style="list-style-type: none"> • Perform construction during daytime hours where feasible. If night time construction is necessary, the activities with the highest vibration levels should be conducted during the daytime periods where feasible. – Review vibration assessment based upon refined site staging, construction areas/equipment, and building locations prior to the commencement of construction, and update if necessary. – Review and refine the construction activities to avoid potential impacts to vibration sensitive receivers (within the City of Toronto By-law 514-2008 Zone of Influence). Conduct monitoring and pre-construction inspections in accordance with the City of Toronto By-law 514-2008. Monitoring and preconstruction requirements can be determined by 	<ul style="list-style-type: none"> ■ Monitoring will be undertaken at locations within the Zone of Influence to ensure compliance with the City of Toronto By-law 514-2008 and to identify the need for additional mitigation if required. ■ Monitoring will be undertaken to ensure compliance with other applicable vibration level limits identified, as required. ■ Monitoring will be undertaken to verify mitigation measure(s) effectiveness. ■ Pre-construction building inspection of the potentially impacted buildings adjacent to the early works construction sites are to be undertaken in accordance with City of Toronto By-law 514-2008. Continuous vibration monitoring along the construction

Environmental Component	Potential Impacts	Mitigation Measure(s)	Monitoring Activities
		<p>calculation of Zone of Influence of construction equipment. The vibration sensitive locations within the Zone of Influence, to be reviewed as project planning progresses, are initially identified as:</p> <ul style="list-style-type: none"> • 9/11 Lewis Street (Residential), • 20 Saulter Street (Residential), • 33 Saulter Street (Residential), • 1 Strange Street (Commercial), • 791 Queen Street East (Mixed-use Residential), • 400 Eastern Avenue (Commercial), • 7/9 Dibble Street (Commercial), • 38/46 McGee Street (Commercial), • 56 McGee Street (Commercial), • 70 McGee Street (Commercial), • Structure in 80 McGee Street (Park), • 870 Queen Street East (Institutional), • 2 to 14 Paisley Avenue (Residential), • 15/17/17A/17B Tiverton Avenue (Residential), • Backyard structures in 25 and 27 Tiverton Avenue (Residential), • 444 Logan Avenue (Residential), • 388 to 400 Logan Avenue (Residential), • 400 Carlaw Avenue (Commercial), • 445 Logan Avenue (Residential), • 231 First Avenue (Residential), • 234 to 238 First Avenue (Residential), • 843 Gerrard Street East (Commercial), • Riverdale Shopping Centre (425 to 471 Carlaw Avenue – Commercial); • 369 Pape Avenue (Residential), • 1 Egan Avenue (Residential), • 2 Egan Avenue (Residential), • 302/304 Jones Avenue (Commercial – Residential), • 165 Galt Avenue (Residential), • 162 Galt Avenue (Residential), and • 1000 Gerrard Street East (Commercial). <ul style="list-style-type: none"> – Provide smooth surfaces for trucks to travel and route heavily loaded trucks away from vibration sensitive sites where possible. – Operate construction equipment on lower vibration settings where available. – Maximize distance between equipment and sensitive receivers where feasible. – Do not operate equipment where the City of Toronto By-law 514-2008 prohibited limits are predicted to be exceeded. Alternative construction methods and/or equipment with lower vibration emissions or power settings can be used if they do not exceed the City of Toronto’s prohibited vibration limits. – As Project planning and design progress, conduct a review to identify any sensitive structures/operations that require more stringent vibration limits than the limits in City of Toronto By-law 514-2008; assess requirements, review/revise vibration limits for these locations and, if necessary, develop mitigation measures. US Federal Transit Administration Report No. 0123, Transit Noise and Vibration Impact Assessment Manual (2018) could be used as a source of additional criteria. – Review other applicable vibration limits that may apply, such as the City of Toronto Specification GN117SS. – Develop communications protocol which includes timely resolution of complaints. – Additional mitigation measures not listed above may be considered. 	<p>site property lines closest to these structures will be initiated as warranted.</p> <ul style="list-style-type: none"> ■ Monitoring at locations where there are persistent complaints, if required.

7. Permits and Approvals

At this time, provincial noise or vibration permits or approvals are not anticipated to be required for the Lakeshore East Joint Corridor early works construction. This will be confirmed as project planning progresses.

A construction vibration control form is typically required to accompany a building permit as per the City of Toronto By-law 514-2008. This will be confirmed during the design and implementation phases of the Lakeshore East Joint Corridor early works.

Should a building permit be required, Metrolinx will consult with the City of Toronto.

Metrolinx as a Crown agency of the Province of Ontario is exempt from certain municipal processes and requirements. In these circumstances, Metrolinx will engage with the municipalities to incorporate municipal requirements as a best practice, where practical, and may obtain associated permits and approvals.

8. References

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Ontario Line Final Environmental Conditions Report. Prepared for Metrolinx.

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City of Toronto, 2019:

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International Organization for Standardization, 1996:

ISO 9613-2: Acoustics - Attenuation of Sound during Propagation Outdoors Part 2: General Method of Calculation

Ministry of the Environment and Energy (MOEE) and GO Transit, 1994:

MOEE/Go Transit Noise and Vibration Protocol.

Ontario Ministry of the Environment, 1978:

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Publication NPC-118: Motorized Conveyances.

Ontario Ministry of the Environment, 1978:

Publication NPC-119: Blasting.

Ontario Ministry of the Environment, 1983:

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United States Federal Highway Administration, 2006:

Roadway Construction Noise Model.

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Transit Noise and Vibration Impact Assessment Manual, September

Appendix A

Terminology

Appendix A. Terminology

Term	Definition
Sound	Pressure wave travelling through a medium, such as air.
Noise	Unwanted sound.
Acoustics	The science of sound propagation and transmission.
Vibration	Oscillation of a parameter that defines the motion of a mechanical system.
Decibel, dB	A logarithmic ratio, not strictly a unit, used to describe sound levels. For sound pressure, the reference level is 20 micro pascals (threshold of hearing).
Frequency	The rate at which an event is repeated. Measured in Hertz (Hz), where 1 Hz = 1 oscillation/sec. Normal human hearing extends over a range of frequencies from about 20 Hz to about 20 kHz.
Octave Band	A band of frequencies where the upper limiting frequency is twice the lower limiting frequency. Octave bands are identified by their centre-frequencies. The octave bands standardized for acoustic measurements include those centred at 31.5, 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz.
A-Weighting Network, dBA	A frequency weighting network intended to represent the variation in the ear's ability to hear different frequencies. Overall sound levels calculated or measured using the A-weighting network are indicated by dBA rather than dB.
Sound Pressure Level (SPL, L_p)	A measurement of instantaneous sound pressure and equal to 10 times the logarithm (base 10) of the ratio of the instantaneous sound pressure of a sound divided by the reference sound pressure of 20 μ Pa (0 dB). Reported and measured in decibels (dB or dBA).
L_{eq} - "Equivalent sound level"	Value of a constant sound pressure level which would result in the same total sound energy as would the measured time-varying sound pressure level over equivalent time duration. The $L_{eq, 1hr}$, for example, describes the equivalent continuous sound level over a 1-hour period.
Peak Particle Velocity (PPV)	The peak signal value of an oscillating vibration velocity waveform. Can be expressed in mm/s.
Root Mean Square Velocity (RMSV)	The square root of the mean-square value of an oscillating vibration velocity waveform, where the mean-square value is obtained by squaring the value of amplitudes at each instant in time and then averaging these values over the sample time.
Vibration Decibel, VdB	A logarithmic ratio, not strictly a unit, used to describe felt vibration.

Appendix B

Example Calculation

Job Name:	Ontario Line Early Works
Job Number:	60611173
Date:	2-Nov-21
Title:	Vibration Zone of Influence
Description:	Bylaw 514

Zone of Influence - Bylaw 514

Equipment	8.0 mm/s		5.0 mm/s		TypeIV	
	m		m	ft	m	ft
Auger Pile	3.3		4.5	14.6	6.2	20.5
Backhoe	0.3		0.5	1.5	0.7	2.1
Ground compactor	1.8		2.4	7.8	3.4	11.0
concrete mix truck	3.0		4.0	13.2	5.6	18.4
Concrete pump truck	3.0		4.0	13.2	5.6	18.4
Dozer	3.3		4.5	14.6	6.2	20.5
Dump/flatbed truck	3.0		4.0	13.2	5.6	18.4
excavator	3.3		4.5	14.6	6.2	20.5
front end loader	3.3		4.5	14.6	6.2	20.5
grader	3.3		4.5	14.6	6.2	20.5
hoe ram	3.3		4.5	14.6	6.2	20.5
jack hammer	1.8		2.4	7.8	3.4	11.0
pavement scarifier	0.3		0.5	1.5	0.7	2.1
roller	5.8		7.9	25.9	11.1	36.3
vibratory concrete mixer	1.8		2.4	7.8	3.4	11.0
Ballast equalizer	0.3		0.5		0.7	
ballast tamper	3.3		4.5		6.2	
spike driver	1.8		2.4		3.4	

Job Name:	Ontario Line Early Works
Job Number:	60611173
Date:	2-Nov-21
Title:	Vibration Zone of Influence
Description:	Vibration Zone of Influence Calculation - 0.14 mm/s

Zone of Influence - 0.14 mm/s

Equipment	Lv,criteria for calc	Zone of influence	
		m	ft
Auger Pile	74.8258864	19	64
Backhoe	74.8258864	2	7
Ground compactor	74.8258864	10	34
concrete mix truck	74.8258864	18	59
Concrete pump truck	74.8258864	18	59
Dozer	74.8258864	19	64
Dump/flatbed truck	74.8258864	18	59
excavator	74.8258864	19	64
front end loader	74.8258864	19	64
grader	74.8258864	19	64
hoe ram	74.8258864	19	64
jack hammer	74.8258864	10	34
pavement scarifier	74.8258864	2	7
roller	74.8258864	33	109
vibratory concrete mixer	74.8258864	10	34
Ballast equalizer	74.8258864	2	7
ballast tamper	74.8258864	19	64
spike driver	74.8258864	10	34