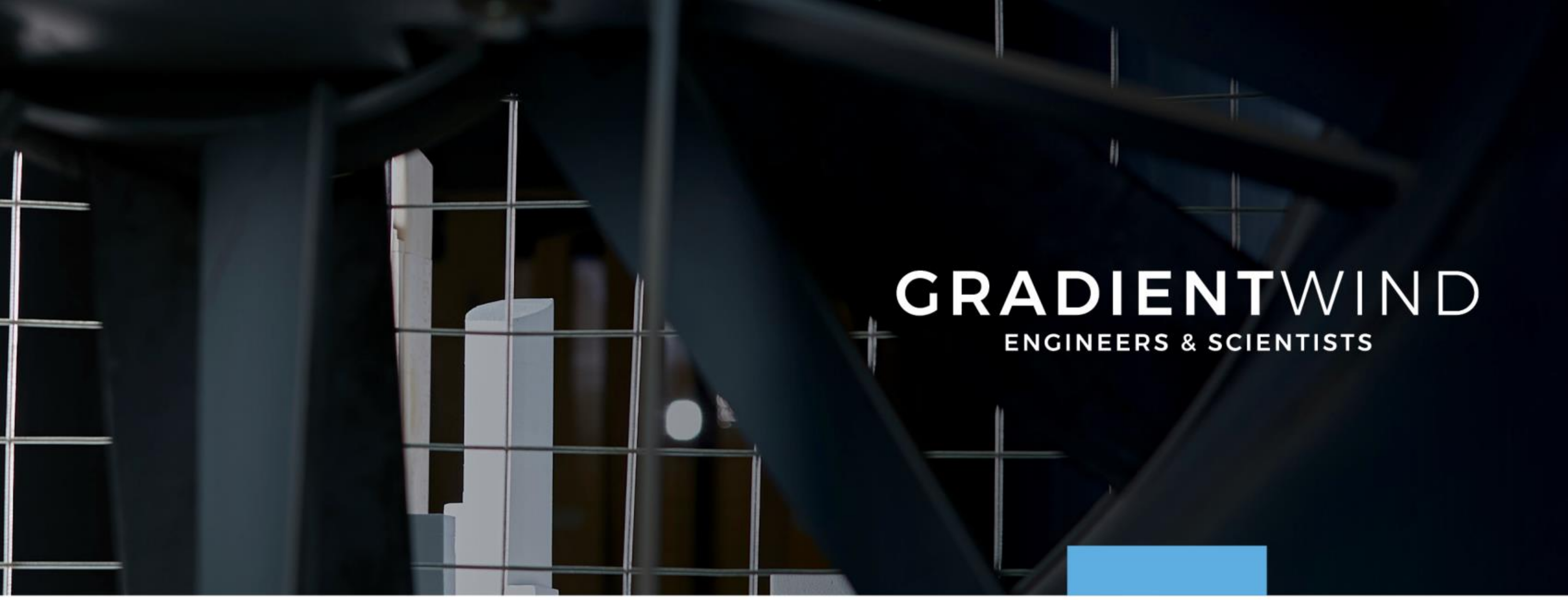
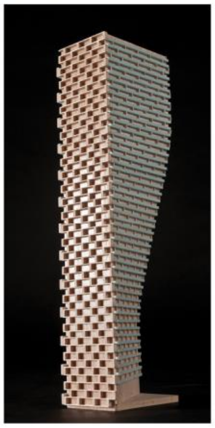
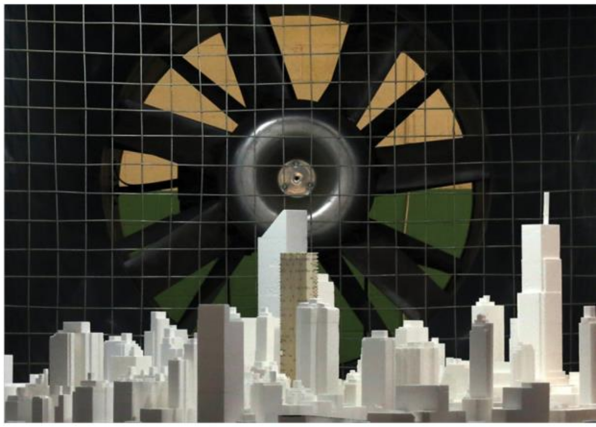


TRANSPORTATION NOISE AND VIBRATION ASSESSMENT

100 Bayshore Drive
Ottawa, Ontario

Report: 19-225-Transportation Noise & Vibration





April 28, 2021

PREPARED FOR
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EXECUTIVE SUMMARY

This report describes a transportation noise and vibration assessment undertaken in support of a Site Plan Control (SPC) application for a proposed development located at 100 Bayshore Drive in Ottawa, Ontario. The development comprises of 2 rectangular towers mounted on a 3-storey shared podium. The parking garage entrance along the west side of the podium is accessed from Woodridge Crescent via an access pathway. There is one level of below grade parking. Floors 1-3 on the podium will include vehicle parking, amenity spaces, building support rooms, as well as access to a pedestrian bridge that connects to the future Bayshore Light Rail Transit (LRT) station. The remaining floors above the podium are designated for residential use. The primary sources of transportation noise include Woodridge Crescent, Highway 417, and the future O-Train Confederation Line LRT operated by the OC Transpo. In addition, this report also provides an analysis of ground borne vibration impacts from the LRT. Figure 1 illustrates a complete site plan with surrounding context.

The assessment is based on (i) theoretical noise prediction methods that conform to the Ministry of the Environment, Conservation and Parks (MECP) and City of Ottawa requirements; (ii) noise level criteria as specified by the City of Ottawa's Environmental Noise Control Guidelines (ENCG); (iii) future vehicular traffic volumes based on the City of Ottawa's Official Plan roadway classifications; (iv) ground borne vibration criteria as specified by the Federal Transit Authority (FTA) Protocol; and (v) architectural drawings provided by Hobin Architecture Incorporated in April 2021.

The results of the current analysis indicate that noise levels will range between 51 and 75 dBA during the daytime period (07:00-23:00) and between 54 and 68 dBA during the nighttime period (23:00-07:00). The highest noise level (75 dBA) occurs at the south façade of each tower, which is nearest and most exposed to Highway 417 and the O-Train LRT. Building components with a higher Sound Transmission Class (STC) rating will be required where exterior noise levels exceed 65 dBA, as indicated in Figure 6.

Results of the calculation also indicate the development will require central air conditioning, or similar mechanical ventilation, which will allow occupants to keep windows closed to maintain a comfortable indoor living environment. A Warning Clause will also be required on all Lease, Purchase and Sale Agreements, as summarized in Section 6. As noise levels at the Level 4 amenity terrace does not exceed 55 dBA, noise mitigation is not required.

Estimated vibration levels at the foundation nearest to the O-Train LRT are expected to be 0.012 mm/s RMS (54 dBV), based on the FTA protocol and an offset distance of 61 m to the nearest track centerline. Details of the calculation are provided in Appendix B. Since predicted vibration levels do not exceed the criterion of 0.10 mm/s RMS at the foundation, concerns due to vibration impacts on the site are not expected. As vibration levels are acceptable, correspondingly, regenerated noise levels are also expected to be acceptable.

With regard to stationary noise impacts, noise levels on the surrounding noise sensitive properties are expected to be negligible as the mechanical equipment will primarily reside in the mechanical level located on the high roof. A stationary noise study is recommended for the site during the detailed design once mechanical plans for the proposed development become available. This study would assess impacts of stationary noise from rooftop mechanical units serving the proposed development on surrounding noise sensitive areas. The assessment will also include recommendations for any noise control measures that may be necessary to ensure noise levels fall below ENCG limits. In the event that noise levels exceed ENCG criteria, noise impacts can generally be minimized by judicious selection and placement of the equipment.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Ivanhoe Cambridge Inc. to undertake a transportation noise and vibration assessment in support of a Site Plan Control (SPC) application for a proposed development located at 100 Bayshore Drive in Ottawa, Ontario. This report summarizes the methodology, results, and recommendations related to the assessment of exterior and interior noise levels generated by local transportation noise and vibration sources.

Our work is based on theoretical noise calculation methods conforming to the City of Ottawa[1] and Ministry of the Environment, Conservation and Parks (MECP)[2] guidelines. Noise calculations were based on architectural drawings provided by Hobin Architecture Incorporated in April 2021, with future vehicle and light rail traffic volumes corresponding to the City of Ottawa's Official Plan (OP) roadway classifications.

2. TERMS OF REFERENCE

The focus of this transportation and vibration noise assessment is a proposed development located at 100 Bayshore Drive in Ottawa, Ontario. The study site is located on a nearly rectangular parcel of land which follows the curve of road providing access to the Bayshore transit station via Woodridge Drive.

The development comprises of 2 rectangular towers mounted on a 3-storey shared podium. The east and west towers will rise approximately 104 meters (m) and 95 m, respectively. The parking garage entrance along the west side of the podium is accessed from Woodridge Crescent via an access pathway. There is one level of below grade parking. Floors 1-3 on the podium will include vehicle parking, amenity spaces, building support rooms, as well as access to a pedestrian bridge that connects to the future Bayshore Light Rail Transit (LRT) station. The remaining floors above the podium are designated for residential use. Balconies/terraces extending less than 4 metres in depth from the façade do not require consideration as Outdoor Living Areas (OLA) as mentioned in the ENCG.

The development will be located immediately north of the existing Transitway. The transitway is scheduled to become a Light Rail Transit corridor as part of Stage 2 of OC Transpo's Confederation Line.

[1] City of Ottawa Environmental Noise Control Guidelines, January 2016
[2] Ontario Ministry of the Environment and Climate Change – Environmental Noise Guidelines, Publication NPC-300, Queens Printer for Ontario, Toronto, 2013

The primary sources of transportation noise include Woodridge Crescent, Highway 417, and the future O-Train Confederation Line LRT operated by the OC Transpo. LRT operations are expected to begin prior to construction of the development. As per City of Ottawa's Official Plan, the light rail line is situated within 75 m from the nearest property line. As a result, a ground vibration impact assessment from the light rail system on the proposed development was conducted following the procedures outlined in the Federal Transit Authorities (FTA) protocol. Figure 1 illustrates a complete site plan with surrounding context.

The development site is bounded by the Accora Village residential neighbourhood to the north and west, a mid-rise commercial building to the east (Bayshore Shopping Centre), and Highway 417 to the south. The existing buildings are serviced by standard HVAC equipment primarily located in a mechanical penthouse (90 Woodridge Crescent) or on a high roof (Bayshore Shopping Centre). The nearest HVAC equipment associated with the Bayshore Shopping Centre is located beyond 100 m from the development property line. With that notion, the nearby existing properties are expected to be in compliance with ENCG noise guidelines as stationary noise impacts are expected to be negligible.

3. OBJECTIVES

The principal objectives of this study are to (i) calculate the future noise levels on the study buildings produced by local transportation traffic, (ii) predict vibration levels on the study building produced from passing light rail trains, (iii) ensure that interior and exterior noise levels do not exceed the allowable limits specified by the City of Ottawa's Environmental Noise Control Guidelines as outlined in Section 4.2 of this report, and (iv) ensure vibration levels do not exceed the allowable limits specified by the FTA.

4. METHODOLOGY

4.1 Background

Noise can be defined as any obtrusive sound. It is created at a source, transmitted through a medium, such as air, and intercepted by a receiver. Noise may be characterized in terms of the power of the source or the sound pressure at a specific distance. While the power of a source is characteristic of that particular source, the sound pressure depends on the location of the receiver and the path that the noise takes to reach the receiver. Measurement of noise is based on the decibel unit, dBA, which is a logarithmic ratio referenced to a standard noise level (2×10^{-5} Pascals). The 'A' suffix refers to a weighting scale, which better represents how the noise is perceived by the human ear. With this scale, a doubling of power results in a 3 dBA increase in measured noise levels and is just perceptible to most people. An increase of 10 dBA is often perceived to be twice as loud.

4.2 Transportation Traffic Noise

4.2.1 Criteria for Transportation Traffic Noise

For surface transportation traffic noise, the equivalent sound energy level, L_{eq}, provides a measure of the time varying noise levels, which is well correlated with the annoyance of sound. It is defined as the continuous sound level, which has the same energy as a time varying noise level over a period of time. For roadways, the L_{eq} is commonly calculated on the basis of a 16-hour (L_{eq16}) daytime (07:00-23:00) / 8-hour (L_{eq8}) nighttime (23:00-07:00) split to assess its impact on residential buildings. The City of Ottawa's Environmental Noise Control Guidelines (ENCG) specifies that the recommended indoor noise limit range (that is relevant to this study) is 50, 45, and 40 dBA for office/reception areas, living rooms, and sleeping quarters, respectively, as listed in Table 1. However, to account for deficiencies in building construction and control peak noise, these levels should be targeted toward 47, 42, and 37 dBA, respectively.

TABLE 1: INDOOR SOUND LEVEL CRITERIA (ROAD AND LRT) [3]

Type of Space	Time Period	L_{eq} (dBA)
General offices, **reception areas**, retail stores, etc.	07:00 – 23:00	50
Living/dining/den areas of **residences**, hospitals, schools, nursing/retirement homes, day-care centres, theatres, places of worship, libraries, individual or semi-private offices, conference rooms, etc.	07:00 – 23:00	45
Sleeping quarters of hotels/motels	23:00 – 07:00	45
Sleeping quarters of **residences**, hospitals, nursing/retirement homes, etc.	23:00 – 07:00	40

Predicted noise levels at the plane of window (POW) dictate the action required to achieve the recommended sound levels. An open window is considered to provide a 10 dBA reduction in noise, while

[3] Adapted from ENCG 2016 – Tables 2.2b and 2.2c

a standard closed window is capable of providing a minimum 20 dBA noise reduction[4]. A closed window due to a ventilation requirement will bring noise levels down to achieve an acceptable indoor environment[5]. Therefore, where noise levels exceed 55 dBA daytime and 50 dBA nighttime, the ventilation for the building should consider the need for having windows and doors closed, which triggers the need for forced air heating with provision for central air conditioning. Where noise levels exceed 65 dBA daytime and 60 dBA nighttime, air conditioning will be required and building components will require higher levels of sound attenuation[6].

The sound level criterion for outdoor living areas is 55 dBA, which applies during the daytime (07:00 to 23:00). When noise levels exceed 55 dBA, mitigation must be provided to reduce noise levels where technically and administratively feasible to acceptable levels at or below the criterion.

4.2.2 Theoretical Roadway Noise Predictions

Noise predictions were performed with the aid of the MECP computerized noise assessment program, STAMSON 5.04, for road analysis. Appendix A includes the STAMSON 5.04 input and output data.

Transportation traffic noise calculations were performed by treating each roadway segment as separate line sources of noise. In addition to the traffic volumes summarized in Table 2, theoretical noise predictions were based on the following parameters:

- Truck traffic on all roadways was taken to comprise 5% heavy trucks and 7% medium trucks, as per ENCG requirements for noise level predictions.
- The day/night split for all streets was taken to be 92%/8%, respectively.
- Ground surfaces were taken to be reflective due to the presence of hard (paved) ground.
- Topography was assumed to be a flat/gentle slope surrounding the study building. Ground elevation was taken to be 63m (geodetic elevation) at the development site. The elevation of Woodridge Crescent and the LRT was taken to be 63m, whereas the elevation of the highway was taken to be 66m.

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[4] Burberry, P.B. (2014). Mitchell's Environment and Services. Routledge, Page 125
[5] MOECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.8
[6] MOECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.1.3

- Receptor heights represent the centre of the plane of window along the building façades, in addition to the outdoor living area situated between the towers on the podium roof closest to Woodridge Crescent.
- For select sources where appropriate, the proposed building as well as the Bayshore Shopping Centre was modelled as a barrier, partially or fully obstructing exposure to the source as illustrated in Figures 3-5.
- Noise receptors were strategically placed at 6 locations around the study area (see Figure 2).
- Receptor distances and exposure angles are illustrated in Figures 3-5.
- LRT noise assessed in STAMSON using RT Custom based on a 4-car SRT.

4.2.1 Transportation Traffic Volumes

The ENCG dictates that noise calculations should consider future sound levels based on a roadway's classification at the mature state of development. Therefore, traffic volumes are based on the roadway classifications outlined in the City of Ottawa's Official Plan (OP) and Transportation Master Plan[7] which provide additional details on future roadway expansions. Average Annual Daily Traffic (AADT) volumes are then based on data in Table B1 of the ENCG for each roadway classification. Table 2 (below) summarizes the AADT values used for each roadway included in this assessment.

TABLE 2: TRANSPORTATION TRAFFIC DATA

Segment	Roadway Traffic Data	Speed Limit (km/h)	Traffic Volumes
Woodridge Crescent	2-Lane Urban Collector	40	**8,000**
Highway 417	8-Lane Freeway	100	**146,664**
O-Train (Confederation Line)	Light Rail Transit (LRT)	70	**540/60***

* Daytime/Nighttime volumes based on the City of Ottawa's Environmental Assessment for the LRT Project

[7] City of Ottawa Transportation Master Plan, November 2013

4.3 Indoor Noise Calculations

The difference between outdoor and indoor noise levels is the noise attenuation provided by the building envelope. According to common industry practice, complete walls and individual wall elements are rated according to the Sound Transmission Class (STC). The STC ratings of common residential walls built in conformance with the Ontario Building Code (2012) typically exceed STC 35, depending on exterior cladding, thickness and interior finish details. For example, brick veneer walls can achieve STC 50 or more. Standard commercially sided exterior metal stud walls have around STC 45. Standard good quality double-glazed non-operable windows can have STC ratings ranging from 25 to 40, depending on the window manufacturer, pane thickness and inter-pane spacing. As previously mentioned, the windows are the known weak point in a partition.

As per Section 4.2, when daytime noise levels from road sources at the plane of the window exceed 65 dBA, calculations must be performed to evaluate the sound transmission quality of the building components to ensure acceptable indoor noise levels. The calculation procedure[8] considers:

- Window type and total area as a percentage of total room floor area
- Exterior wall type and total area as a percentage of the total room floor area
- Acoustic absorption characteristics of the room
- Outdoor noise source type and approach geometry
- Indoor sound level criteria, which varies according to the intended use of a space

Based on published research[9], exterior walls possess specific sound attenuation characteristics that are used as a basis for calculating the required STC ratings of windows in the same partition. Due to the limited information available at the time of the study, which was prepared for a Site Plan Control (SPC) application, detailed floor layouts and building elevations have not been finalized; therefore, detailed STC calculations could not be performed at this time. As a guideline, the anticipated STC requirements for windows have been estimated based on the overall noise reduction required for each intended use of space (STC = outdoor noise level – targeted indoor noise levels).

[8] Building Practice Note: Controlling Sound Transmission into Buildings by J.D. Quirt, National Research Council of Canada, September 1985
[9] CMHC, Road & Rail Noise: Effects on Housing

4.4 Ground Vibration and Ground-borne Noise

Rail systems and heavy vehicles on roadways can produce perceptible levels of ground vibrations, especially when they are in close proximity to residential neighbourhoods or vibration-sensitive buildings. Similar to sound waves in air, vibrations in solids are generated at a source, propagated through a medium, and intercepted by a receiver. In the case of ground vibrations, the medium can be uniform, or more often, a complex layering of soils and rock strata. Also, similar to sound waves in air, ground vibrations produce perceptible motions and regenerated noise known as 'ground-borne noise' when the vibrations encounter a hollow structure such as a building. Ground-borne noise and vibrations are generated when there is excitation of the ground, such as from a train. Repetitive motion of the wheels on the track or rubber tires passing over an uneven surface causes vibrations to propagate through the soil. When they encounter a building, vibrations pass along the structure of the building beginning at the foundation and propagating to all floors. Air inside the building excited by the vibrating walls and floors represents regenerated airborne noise. Characteristics of the soil and the building are imparted to the noise, thereby creating a unique noise signature.

Human response to ground vibrations is dependent on the magnitude of the vibrations, which is measured by the root mean square (RMS) of the movement of a particle on a surface. Typical units of ground vibration measures are millimeters per second (mm/s), or inch per second (in/s). Since vibrations can vary over a wide range, it is also convenient to represent them in decibel units, or dBV. In North America, it is common practice to use the reference value of one micro-inch per second (µin/s) to represent vibration levels for this purpose. The threshold level of human perception to vibrations is about 0.10 mm/s RMS or about 72 dBV. Although somewhat variable, the threshold of annoyance for continuous vibrations is 0.5 mm/s RMS (or 85 dBV), five times higher than the perception threshold, whereas the threshold for significant structural damage is 10 mm/s RMS (or 112 dBV), at least one hundred times higher than the perception threshold level.

4.4.1 Ground Vibration Criteria

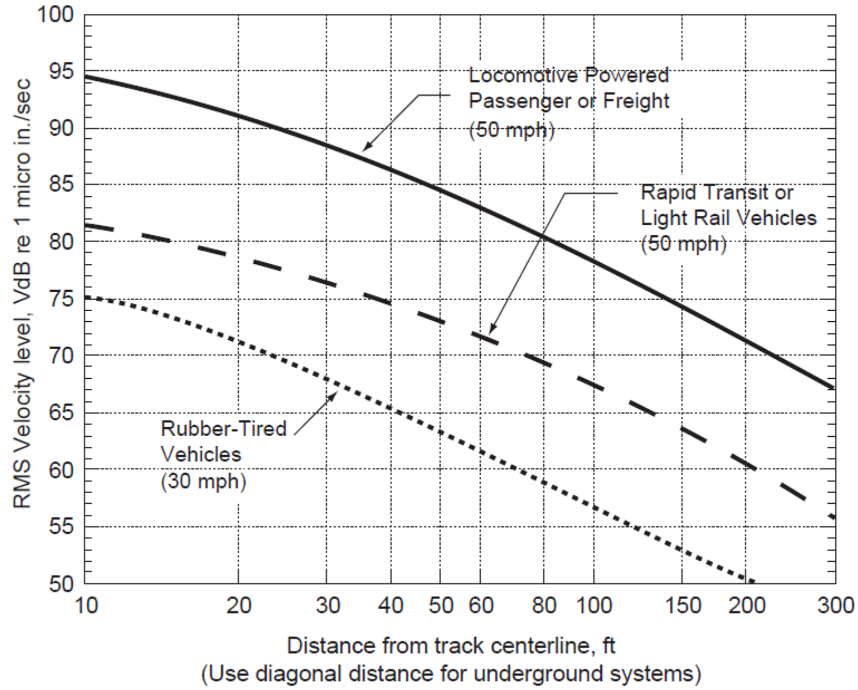
In the United States, the Federal Transportation Authority (FTA) has set vibration criteria for sensitive land uses next to transit corridors. Similar standards have been developed by the MECP. These standards indicate that the appropriate criteria for residences is 0.10 mm/s RMS for vibrations. For main line railways, a document titled *Guidelines for New Development in Proximity to Railway Operations*[10], indicates that vibration conditions should not exceed 0.14 mm/s RMS averaged over a one second time-period at the first floor and above of the proposed building. The Federal Transportation Authority (FTA) criterion was adopted as the appropriate standard for this study. As the main vibration source is due to the light rail line which has frequent events, the 0.10 mm/s RMS (72 dBV) vibration criteria and 35 dBA ground borne noise criteria were adopted for this study.

4.4.2 Theoretical Ground Vibration Prediction Procedure

Potential vibration impacts of the trains were predicted using the Federal Transit Authority's (FTA) *Transit Noise and Vibration Impact Assessment*[11] protocol. The FTA general vibration assessment is based on an upper bound generic set of curves that show vibration level attenuation with distance. These curves, illustrated in the figure on the following page, are based on ground vibration measurements at various transit systems throughout North America. Vibration levels at points of reception are adjusted by various factors to incorporate known characteristics of the system being analyzed, such as operating speed of vehicle, conditions of the track, construction of the track and geology, as well as the structural type of the impacted building structures. The vibration impact on the building was determined using a set of curves for LRT at a speed of 50 mph. Adjustment factors were considered based on the following information:

- The maximum operating speed of the light rail assumed to be 43 mph (70 km/h) at peak. This is considered to be conservative as the trains would be starting and stopping in and out of the station.
- The offset distance between the development and the closest track is 61 m
- The vehicles are assumed to have soft primary suspensions
- Tracks are not welded, though in otherwise good condition
- Soil conditions do not efficiently propagate vibrations
- The building's foundation coupling is large masonry on piles

[10] Dialog and J.E. Coulter Associates Limited, prepared for The Federation of Canadian Municipalities and The Railway Association of Canada, May 2013
[11] C. E. Hanson; D. A. Towers; and L. D. Meister, Transit Noise and Vibration Impact Assessment, Federal Transit Administration, May 2006



FTA GENERALIZED CURVES OF VIBRATION LEVELS VERSUS DISTANCE (ADOPTED FROM FIGURE 10-1, FTA TRANSIT NOISE AND VIBRATION IMPACT ASSESSMENT)

5. RESULTS AND DISCUSSION

5.1 Transportation Traffic Noise Levels

The results of the transportation traffic noise calculations are summarized in Table 3 below. A complete set of input and output data from all STAMSON 5.04 calculations are available in Appendix A.

TABLE 3: EXTERIOR NOISE LEVELS DUE TO TRANSPORTATION TRAFFIC

Receptor Number	Receptor Height Above Grade (m)	Receptor Location	STAMSON 5.04 Noise Level (dBA)	
			Day	Night
1	14.5	OLA – 4th Floor Outdoor Amenity Area	51	N/A*
2	85.6	POW – East Tower – 27th Floor – North Façade	62	54
3	85.6	POW – East Tower – 27th Floor – East Façade	72	64
4	85.6	POW – East Tower – 27th Floor – South Façade	75	67
5	85.6	POW – West Tower – 27th Floor – South Façade	75	68
6	85.6	POW – West Tower – 27th Floor – West Façade	72	64

*Noise levels at an OLA during the nighttime period are not considered as per ENCG

The results of the current analysis indicate that noise levels will range between 51 and 75 dBA during the daytime period (07:00-23:00) and between 54 and 68 dBA during the nighttime period (23:00-07:00). The highest noise level (75 dBA) occurs at the south façade of each tower, which is nearest and most exposed to Highway 417 and the LRT. As noise levels at the Level 4 amenity terrace does not exceed 55 dBA, noise mitigation is not required.

5.2 Noise Control Measures

The noise levels predicted due to roadway and LRT traffic exceed the criteria listed in Section 4.2 for building components. As discussed in Section 4.3, the anticipated STC requirements for windows have been estimated based on the overall noise reduction required for each intended use of space (STC = outdoor noise level – targeted indoor noise levels). As per city of Ottawa requirements, detailed STC calculations will be required to be completed prior to building permit application for each unit type. The

STC requirements for the windows are summarized below for various units within the development (see Figure 6):

- **Bedroom Windows**

(i) Bedroom windows facing south will require a minimum STC of 38.

(ii) Bedroom windows facing east and west will require a minimum STC of 35.

(iii) All other bedroom windows are to satisfy Ontario Building Code (OBC 2012) requirements.

- **Living Room Windows**

(i) Living room windows facing south will require a minimum STC of 33.

(ii) Living room windows facing east and west will require a minimum STC of 30.

(iii) All other living room windows are to satisfy Ontario Building Code (OBC 2012) requirements.

- **Office/Amenity/Reception Area Windows**

(i) Office/amenity/reception area windows facing south will require a minimum STC of 28.

(ii) Office/amenity/reception area windows facing east and west will require a minimum STC of 25.

(iii) All other office/amenity/reception area windows are to satisfy Ontario Building Code (OBC 2012) requirements.

- **Exterior Walls**

(i) Exterior wall components on the south, west, and east façades will require a minimum STC of 45, which will be achieved with brick cladding or an acoustical equivalent according to NRC test data[12].

The STC requirements apply to windows, doors, spandrel panels and curtainwall elements. Exterior wall components on these façades are recommended to have a minimum STC of 45, where a punch window and wall system may be used. A review of window supplier literature indicates that the specified STC ratings can be achieved by a variety of window systems having a combination of glass thickness and inter-pane spacing. We have specified an example window configuration, however several manufacturers and various combinations of window components, such as those proposed, will offer the necessary sound attenuation rating. It is the responsibility of the manufacturer to ensure that the specified window

[12] J.S. Bradley and J.A. Birta. Laboratory Measurements of the Sound Insulation of Building Façade Elements, National Research Council October 2000.

achieves the required STC. This can only be assured by using window configurations that have been certified by laboratory testing. The requirements for STC ratings assume that the remaining components of the building are constructed and installed according to the minimum standards of the Ontario Building Code. The specified STC requirements also apply to swinging and/or sliding patio doors.

Results of the calculations also indicate that the development will require central air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment. In addition to ventilation requirements, Warning Clauses will also be required in all Lease, Purchase and Sale Agreements, as summarized in Section 6.

5.3 Ground Vibrations and Ground-Borne Noise Levels

Estimated vibration levels at the foundation nearest to the O-Train LRT are expected to be 0.012 mm/s RMS (54 dBV), based on the FTA protocol and an offset distance of 61 m to the nearest track centerline. Details of the calculation are provided in Appendix B. Since predicted vibration levels do not exceed the criterion of 0.10 mm/s RMS at the foundation, concerns due to vibration impacts on the site are not expected. As vibration levels are acceptable, correspondingly, regenerated noise levels are also expected to be acceptable.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current analysis indicate that noise levels will range between 51 and 75 dBA during the daytime period (07:00-23:00) and between 54 and 68 dBA during the nighttime period (23:00-07:00). The highest noise level (75 dBA) occurs at the south façade of each tower, which is nearest and most exposed to Highway 417 and the O-Train LRT. Building components with a higher Sound Transmission Class (STC) rating will be required where exterior noise levels exceed 65 dBA, as indicated in Figure 6. As noise levels at the Level 4 amenity terrace does not exceed 55 dBA, noise mitigation is not required.

Results of the calculation also indicate the development will require central air conditioning, or similar mechanical ventilation, which will allow occupants to keep windows closed to maintain a comfortable indoor living environment. A Warning Clause will also be required on all Lease, Purchase and Sale Agreements, as summarized below:

"Purchasers/tenants are advised that despite the inclusion of noise control features in the development and within the building units, sound levels due to increasing roadway and LRT traffic may, on occasion, interfere with some activities of the dwelling occupants, as the sound levels exceed the sound level limits of the City and the Ministry of the Environment, Conservation and Parks. To help address the need for sound attenuation, this development includes:

- *STC rated multi-pane glazing elements*
- *STC rated exterior walls*

This dwelling unit has also been designed with air conditioning. Air conditioning will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the sound level limits of the City and the Ministry of the Environment, Conservation and Parks.

To ensure that provincial sound level limits are not exceeded, it is important to maintain these sound attenuation features."

In addition, the Rail Construction Program Office recommends that the warning clause identified below to be included in all agreements of purchase and sale and lease agreements for the proposed development including those prepared prior to the registration of the Site Plan Agreement:

"The Owner hereby acknowledges and agrees:

i) The proximity of the proposed development of the lands described in Schedule "A" hereto (the "Lands") to the City's existing and future transit operations, may result in noise, vibration, electromagnetic interferences, stray current transmissions, smoke and particulate matter (collectively referred to as "Interferences") to the development;

ii) It has been advised by the City to apply reasonable attenuation measures with respect to the level of the Interferences on and within the Lands and the proposed development; and

iii) *The Owner acknowledges and agrees all agreements of purchase and sale and lease agreements, and all information on all plans and documents used for marketing purposes, for the whole or any part of the subject lands, shall contain the following clauses which shall also be incorporated in all transfer/deeds and leases from the Owner so that the clauses shall be covenants running with the lands for the benefit of the owner of the adjacent road:*

'The Transferee/Lessee for himself, his heirs, executors, administrators, successors and assigns acknowledges being advised that a public transit light-rail rapid transit system (LRT) is proposed to be located in proximity to the subject lands, and the construction, operation and maintenance of the LRT may result in environmental impacts including, but not limited to noise, vibration, electromagnetic interferences, stray current transmissions, smoke and particulate matter (collectively referred to as the Interferences) to the subject lands. The Transferee/Lessee acknowledges and agrees that despite the inclusion of noise control features within the subject lands, Interferences may continue to be of concern, occasionally interfering with some activities of the occupants on the subject lands.

The Transferee covenants with the Transferor and the Lessee covenants with the Lessor that the above clauses verbatim shall be included in all subsequent lease agreements, agreements of purchase and sale and deeds conveying the lands described herein, which covenants shall run with the lands and are for the benefit of the owner of the adjacent road.'"

Estimated vibration levels at the foundation nearest to the O-Train LRT are expected to be 0.012 mm/s RMS (54 dBV), based on the FTA protocol and an offset distance of 61 m to the nearest track centerline. Details of the calculation are provided in Appendix B. Since predicted vibration levels do not exceed the criterion of 0.10 mm/s RMS at the foundation, concerns due to vibration impacts on the site are not expected. As vibration levels are acceptable, correspondingly, regenerated noise levels are also expected to be acceptable.

With regard to stationary noise impacts, noise levels on the surrounding noise sensitive properties are expected to be negligible as the mechanical equipment will primarily reside in the mechanical level located on the high roof. A stationary noise study is recommended for the site during the detailed design once mechanical plans for the proposed development become available. This study would assess impacts of stationary noise from rooftop mechanical units serving the proposed development on surrounding noise sensitive areas. The assessment will also include recommendations for any noise control measures that may be necessary to ensure noise levels fall below ENCG limits. In the event that noise levels exceed ENCG criteria, noise impacts can generally be minimized by judicious selection and placement of the equipment.

This concludes our transportation noise and vibration assessment and report. If you have any questions or wish to discuss our findings, please advise the undersigned.

Sincerely,

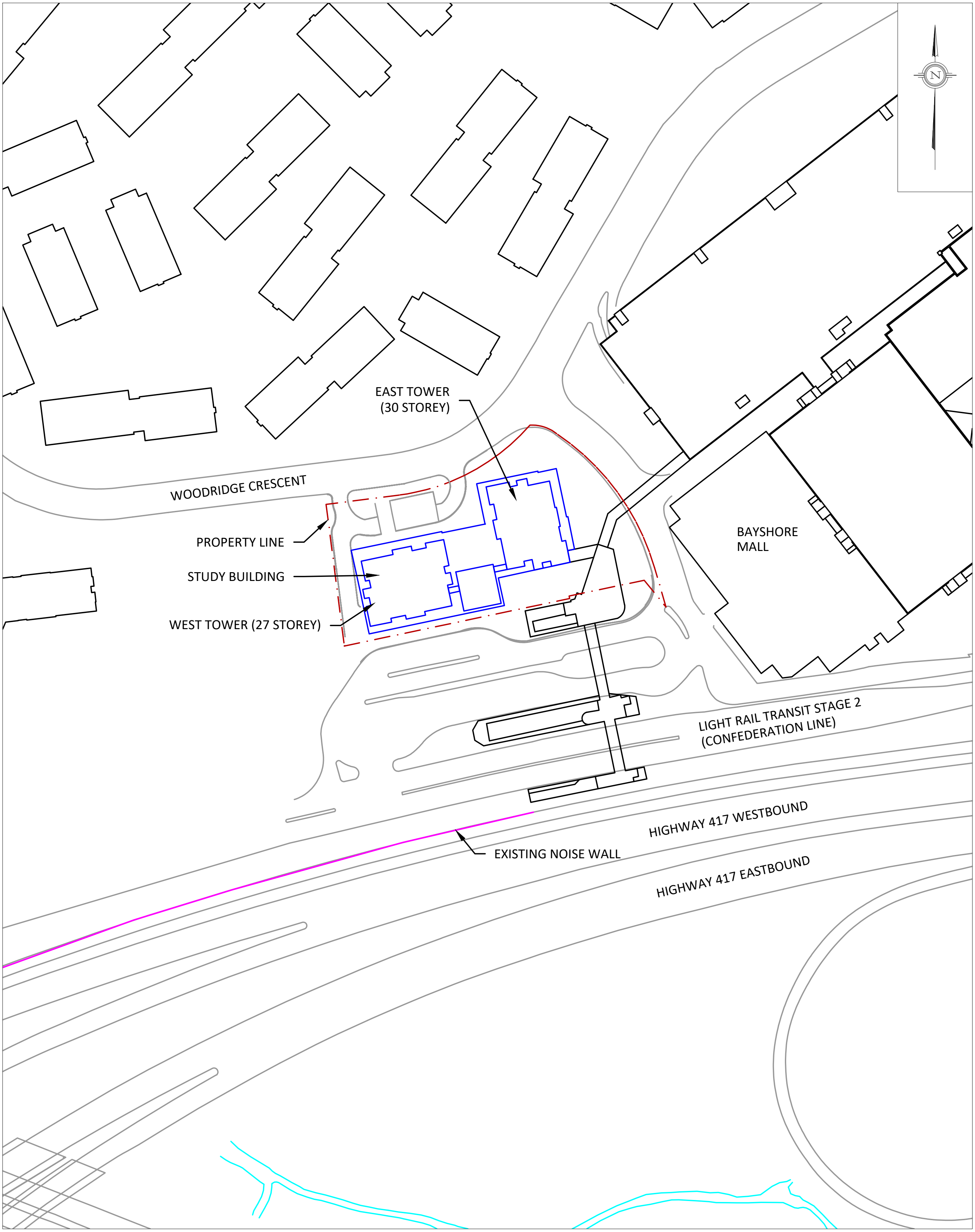
Gradient Wind Engineering Inc.

LICENSED PROFESSIONAL ENGINEER
J. R. FOSTER
100155655
April 28 2021
PROVINCE OF ONTARIO

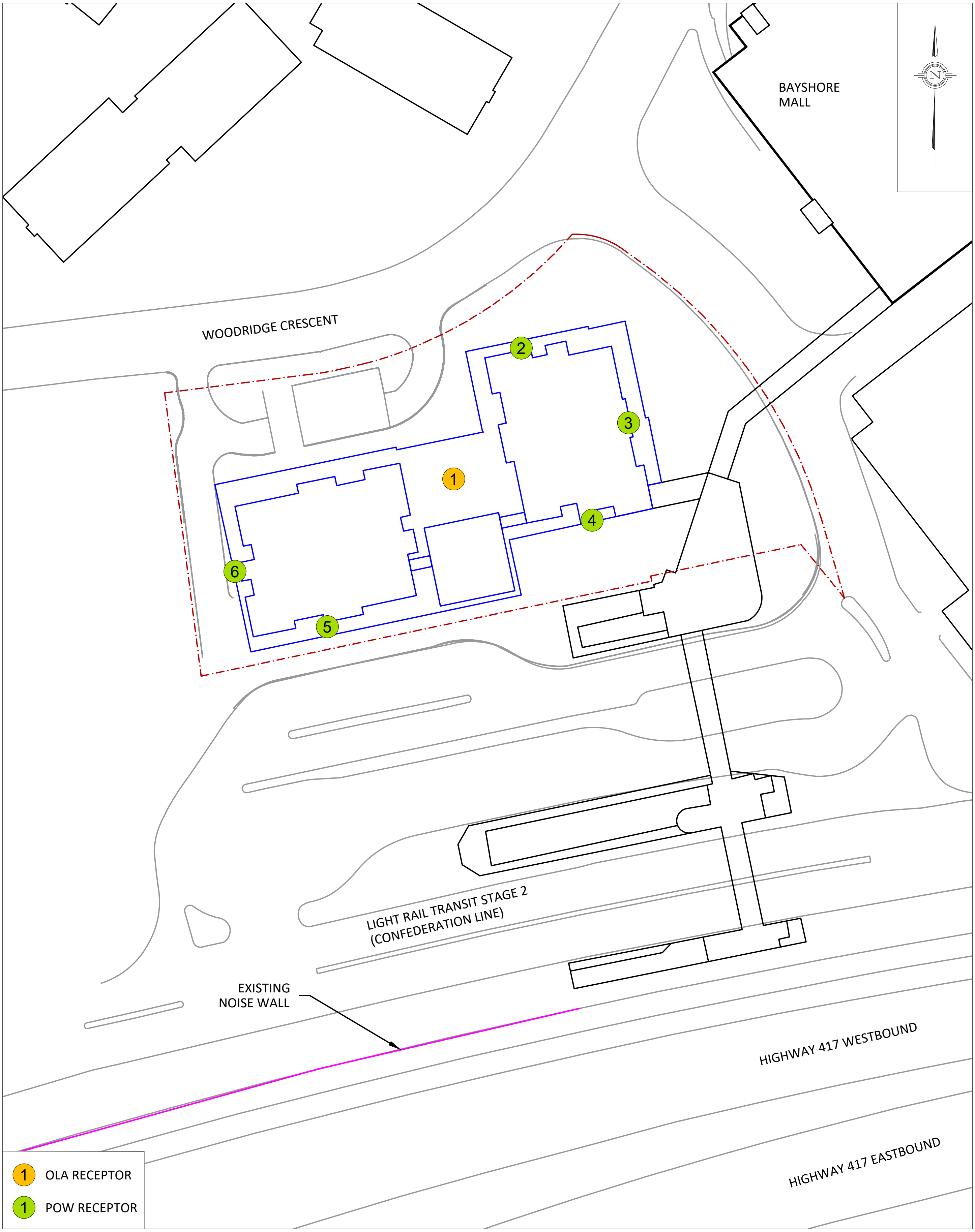
Giuseppe Garro, MASc.
Junior Environmental Scientist

Joshua Foster, P.Eng.
Principal

Gradient Wind File #19-225 - Transportation Noise and Vibration



GRADIENTWIND ENGINEERS & SCIENTISTS 127 WALGREEN ROAD , OTTAWA, ON 613 836 0934 • GRADIENTWIND.COM	PROJECT 100 BAYSHORE DRIVE, OTTAWA TRANSPORTATION NOISE AND VIBRATION ASSESSMENT		DESCRIPTION FIGURE 1: SITE PLAN AND SURROUNDING CONTEXT
	SCALE 1:2000 (APPROX.)	DRAWING NO. GW19-225-1	
	DATE APRIL 15, 2021	DRAWN BY G.G.	



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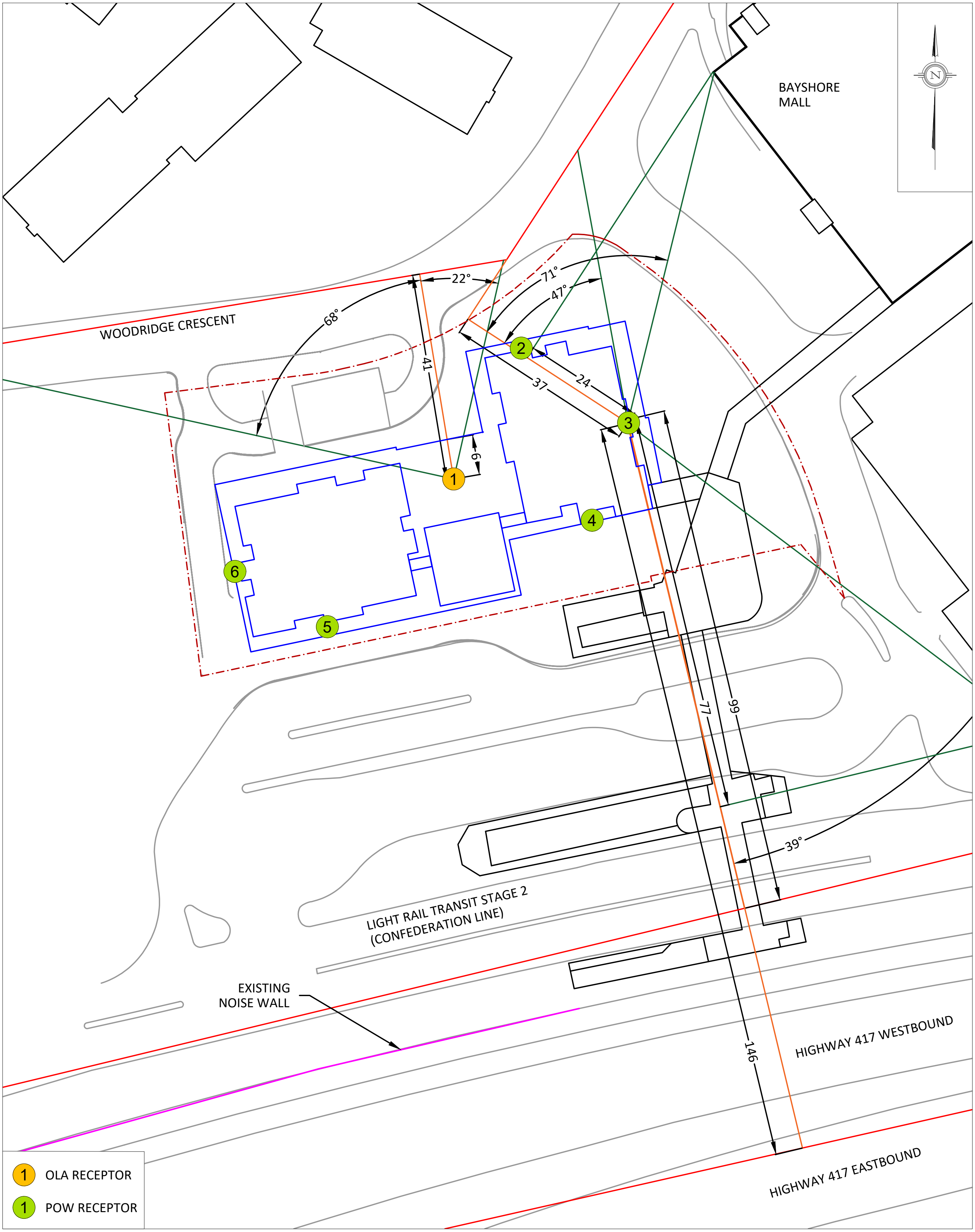
PROJECT	100 BAYSHORE DRIVE, OTTAWA TRANSPORTATION NOISE AND VIBRATION ASSESSMENT		
SCALE	1:1000 (APPROX.)	DRAWING NO.	GW19-225-2
DATE	APRIL 15, 2021	DRAWN BY	G.G.

DESCRIPTION

FIGURE 2:
RECEPTOR LOCATION



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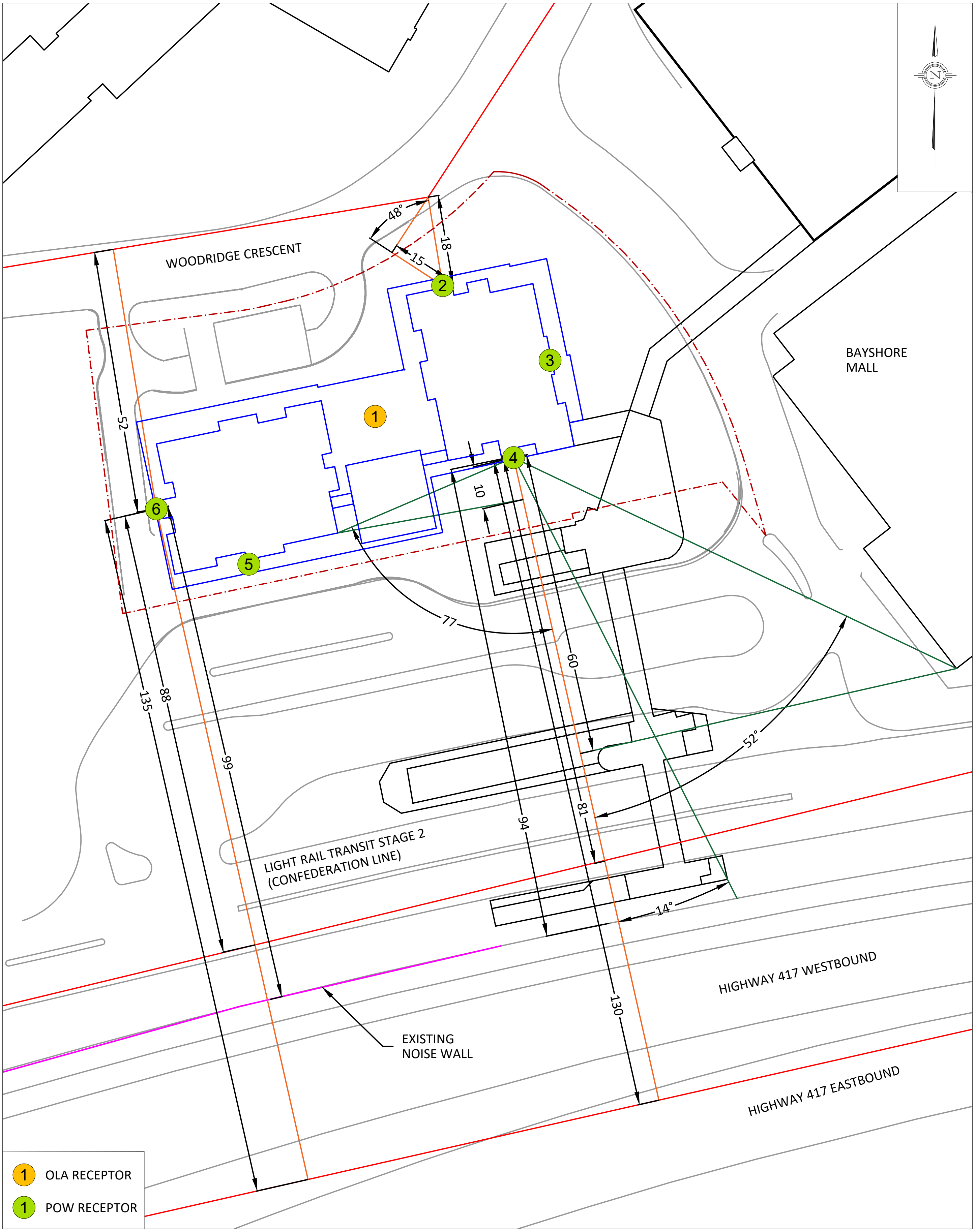
PROJECT	100 BAYSHORE DRIVE, OTTAWA TRANSPORTATION NOISE AND VIBRATION ASSESSMENT		
SCALE	1:1000 (APPROX.)	DRAWING NO.	GW19-225-3
DATE	APRIL 15, 2021	DRAWN BY	G.G.

DESCRIPTION

FIGURE 3:
RECEPTOR 1 AND 3 STAMSON INPUT PARAMATERS



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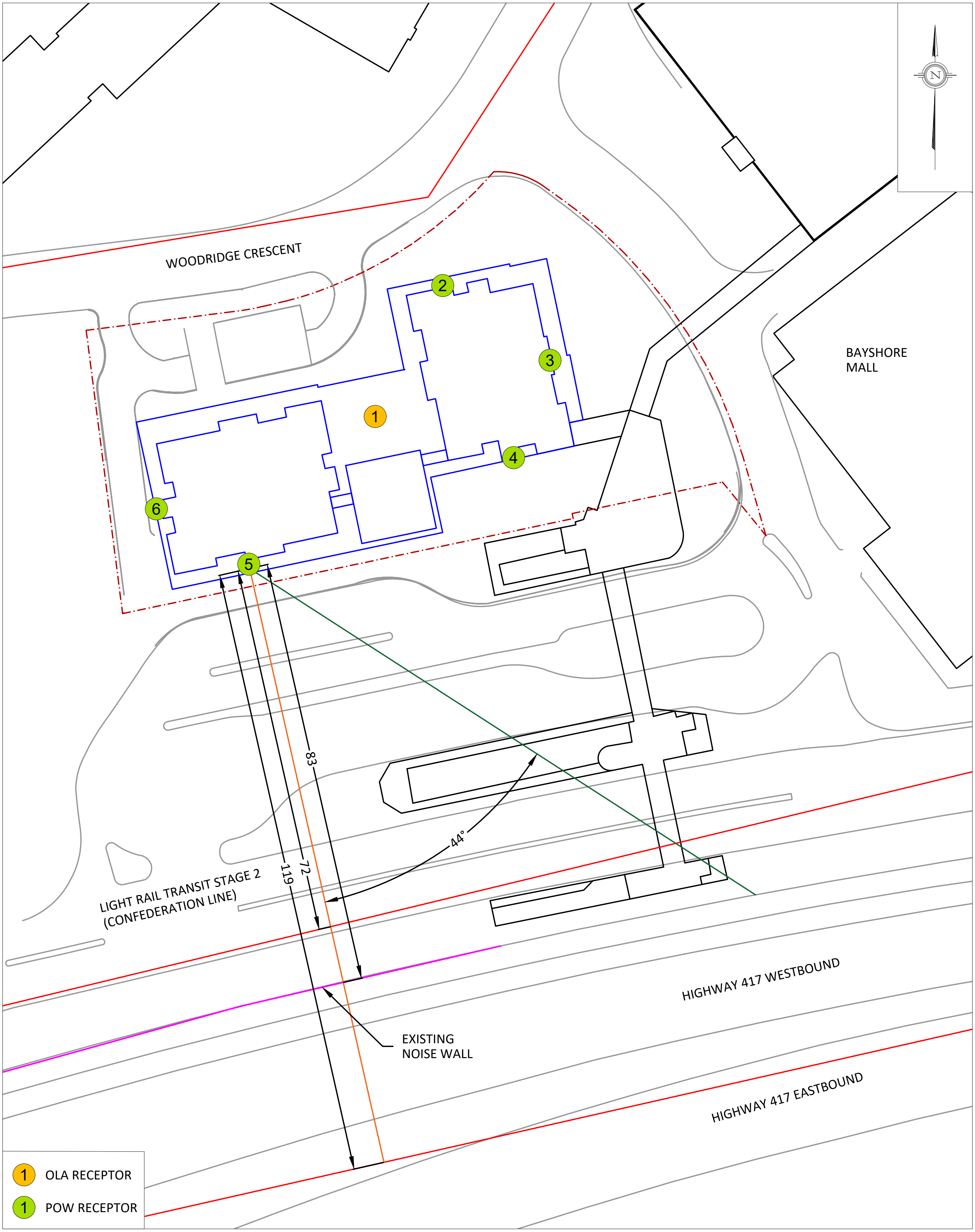
PROJECT	100 BAYSHORE DRIVE, OTTAWA TRANSPORTATION NOISE AND VIBRATION ASSESSMENT		
SCALE	1:1000 (APPROX.)	DRAWING NO.	GW19-225-4
DATE	APRIL 15, 2021	DRAWN BY	G.G.

DESCRIPTION

FIGURE 4:
RECEPTOR 2, 4 AND 6 STAMSON INPUT PARAMATERS



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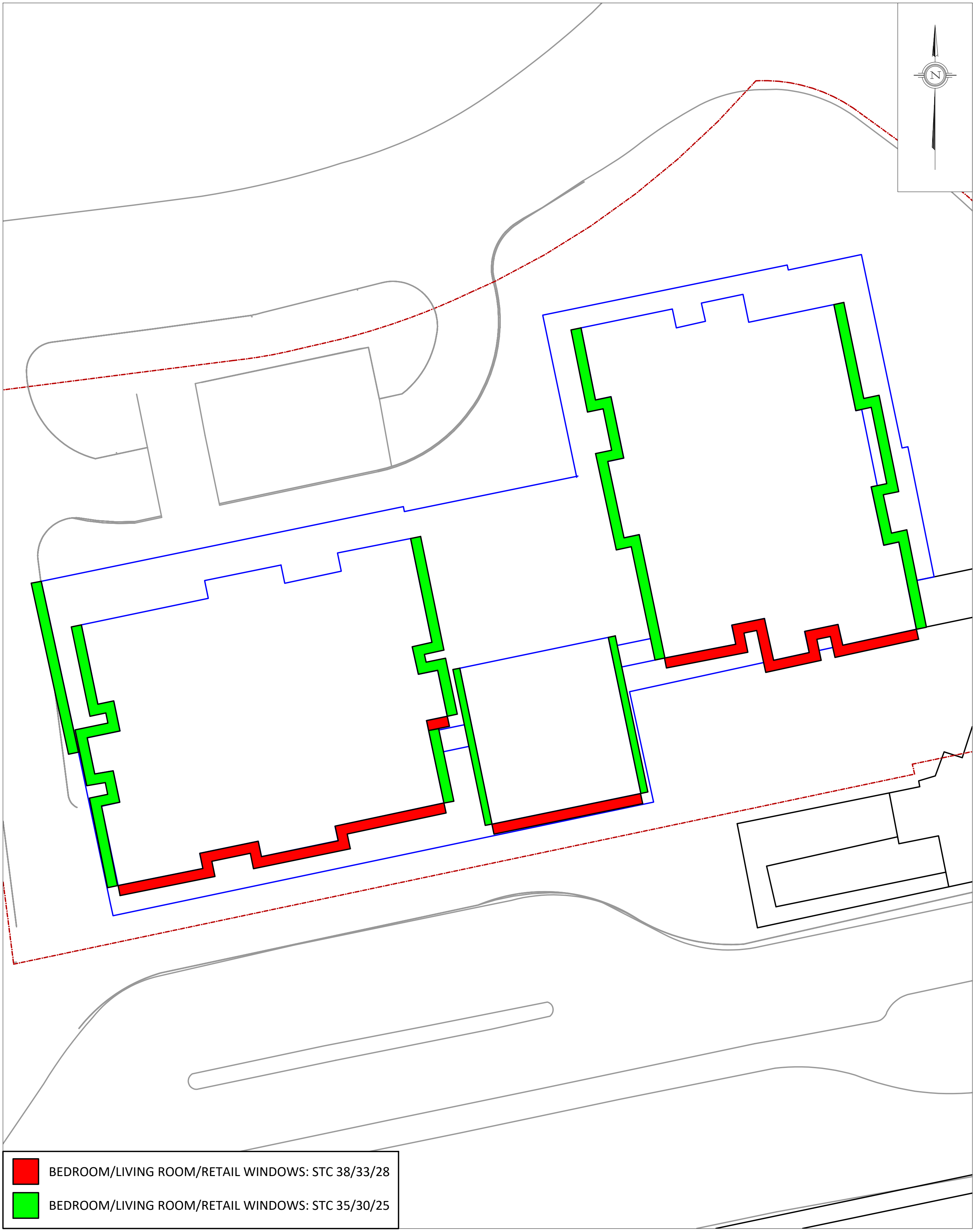
PROJECT	100 BAYSHORE DRIVE, OTTAWA TRANSPORTATION NOISE AND VIBRATION ASSESSMENT		
SCALE	1:1000 (APPROX.)	DRAWING NO.	GW19-225-5
DATE	APRIL 15, 2021	DRAWN BY	G.G.

DESCRIPTION

FIGURE 5:
RECEPTOR 5 STAMSON INPUT PARAMATERS



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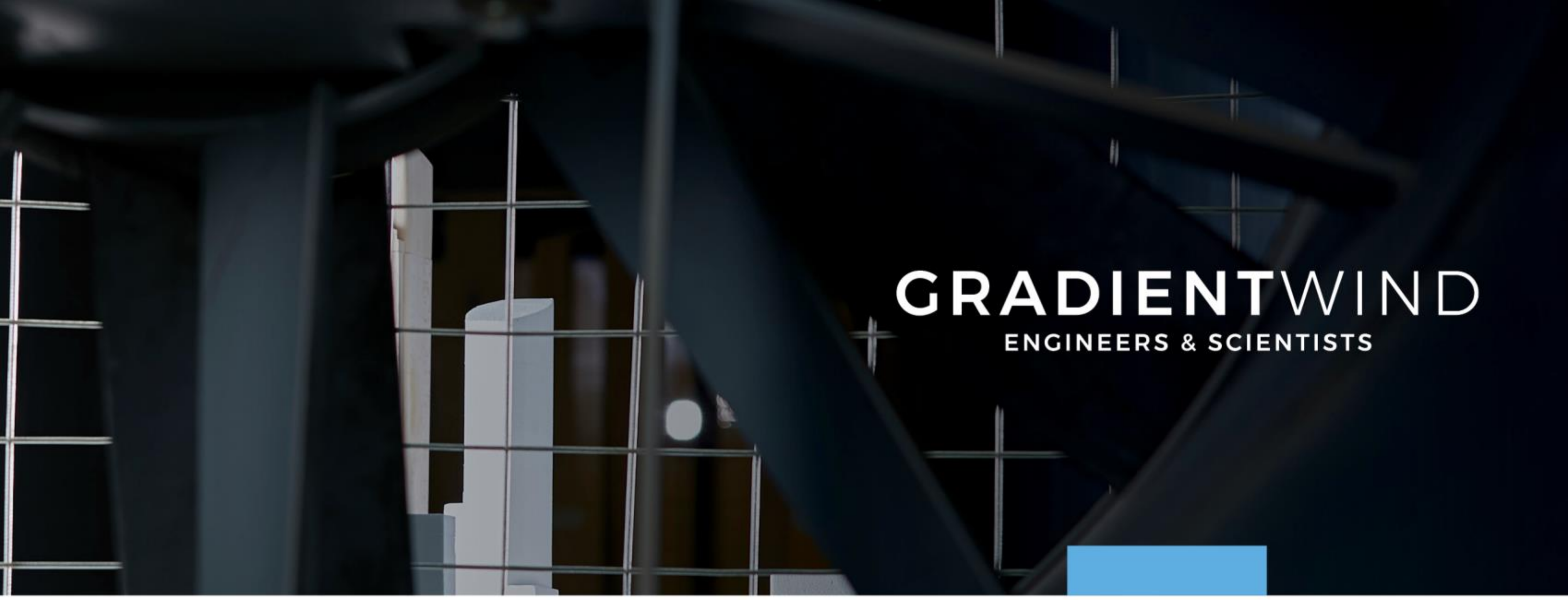
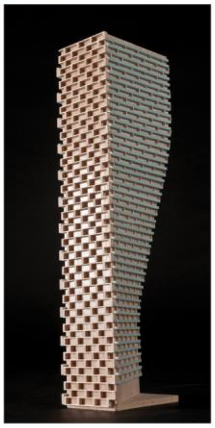
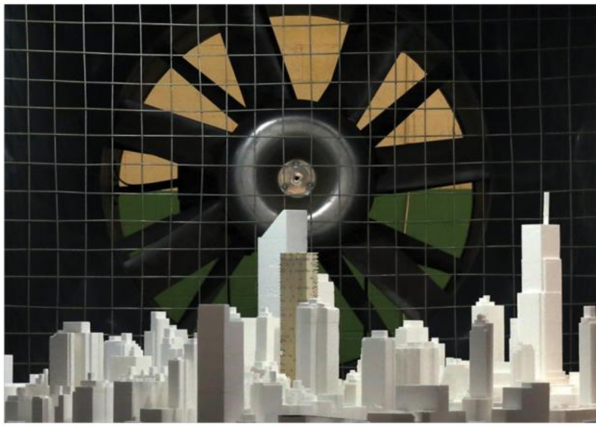
PROJECT	100 BAYSHORE DRIVE, OTTAWA TRANSPORTATION NOISE AND VIBRATION ASSESSMENT			DESCRIPTION FIGURE 6: WINDOW STC REQUIREMENTS
SCALE	1:500 (APPROX.)	DRAWING NO.	GW19-225-6	
DATE	APRIL 15, 2021	DRAWN BY	G.G.	







APPENDIX A

STAMSON 5.04 – INPUT AND OUTPUT DATA

127 WALGREEN ROAD, OTTAWA, ON, CANADA K0A 1L0 | 613 836 0934
GRADIENTWIND.COM

```
STAMSON 5.0        NORMAL REPORT        Date: 17-12-2019 14:31:39
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r1.te                 Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: Woodridge Cs (day/night)
------------------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    40 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   8000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Woodridge Cs (day/night)
----------------------------------------------
Angle1   Angle2           : -68.00 deg   22.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  41.00 / 41.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -68.00 deg   Angle2 : 22.00 deg
Barrier height            :  13.00 m
Barrier receiver distance :   6.00 / 6.00   m
Source elevation          :  63.00 m
Receiver elevation        :  76.00 m
Barrier elevation         :  63.00 m
Reference angle           :   0.00


Results segment # 1: Woodridge Cs (day)
---------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
```

```
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !        1.50 !       12.60 !        75.60

ROAD (0.00 + 51.00 + 0.00) = 51.00 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -68     22   0.00  63.96   0.00  -4.37  -3.01   0.00   0.00  -5.58
51.00
--------------------------------------------------------------------------
--

Segment Leq : 51.00 dBA

Total Leq All Segments: 51.00 dBA


Results segment # 1: Woodridge Cs (night)
-----------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !        1.50 !       12.60 !        75.60

ROAD (0.00 + 43.40 + 0.00) = 43.40 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -68     22   0.00  56.36   0.00  -4.37  -3.01   0.00   0.00  -5.58
43.40
--------------------------------------------------------------------------
--

Segment Leq : 43.40 dBA

Total Leq All Segments: 43.40 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 51.00
                         (NIGHT): 43.40
```

```
STAMSON 5.0        NORMAL REPORT        Date: 17-12-2019 14:31:47
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r2.te               Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: Woodridge C1 (day/night)
------------------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    40 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   8000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Woodridge C1 (day/night)
----------------------------------------------
Angle1   Angle2           : -90.00 deg   0.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  18.00 / 18.00  m
Receiver height           :  85.60 / 85.60  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :  -1.00 deg   Angle2 : 0.00 deg
Barrier height            :   0.00 m
Barrier receiver distance :   1.00 / 1.00   m
Source elevation          :  63.00 m
Receiver elevation        :  63.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00

Road data, segment # 2: Woodridge C2 (day/night)
------------------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    40 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)
```

```
* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   8000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 2: Woodridge C2 (day/night)
----------------------------------------------
Angle1   Angle2           :  48.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  15.00 / 15.00  m
Receiver height           :  85.60 / 85.60  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :  89.00 deg   Angle2 : 90.00 deg
Barrier height            :   0.00 m
Barrier receiver distance :   1.00 / 1.00   m
Source elevation          :  63.00 m
Receiver elevation        :  63.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00


Results segment # 1: Woodridge C1 (day)
---------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
------------+--------------+--------------+---------------
       1.50 !        85.60 !       143.93 !       143.93

ROAD (60.10 + 40.61 + 0.00) = 60.15 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     -1   0.00  63.96   0.00  -0.79  -3.06   0.00   0.00   0.00
60.10
--------------------------------------------------------------------------
--
    -1      0   0.00  63.96   0.00  -0.79 -22.55   0.00   0.00   0.00
40.61*
```

```
    -1       0    0.00   63.96    0.00   -0.79 -22.55    0.00    0.00    0.00
40.61
----------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 60.15 dBA

Results segment # 2: Woodridge C2 (day)
----------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
-------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
-------------+--------------+--------------+---------------
       1.50 !        85.60 !      142.99 !       142.99

ROAD (57.53 + 41.40 + 0.00) = 57.64 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
    48     89   0.00   63.96    0.00    0.00  -6.42    0.00    0.00    0.00
57.53
----------------------------------------------------------------------------
--
    89     90   0.00   63.96    0.00    0.00 -22.55    0.00    0.00   -0.06
41.35*
    89     90   0.00   63.96    0.00    0.00 -22.55    0.00    0.00    0.00
41.40
----------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 57.64 dBA

Total Leq All Segments: 62.08 dBA

Results segment # 1: Woodridge C1 (night)
------------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
-------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
```

```
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
-------------+--------------+--------------+---------------
       1.50 !        85.60 !       143.93 !        143.93

ROAD (52.51 + 33.02 + 0.00) = 52.56 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     -1   0.00  56.36   0.00  -0.79  -3.06   0.00   0.00   0.00
52.51
--------------------------------------------------------------------------
--
    -1      0   0.00  56.36   0.00  -0.79 -22.55   0.00   0.00   0.00
33.02*
    -1      0   0.00  56.36   0.00  -0.79 -22.55   0.00   0.00   0.00
33.02
--------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 52.56 dBA


Results segment # 2: Woodridge C2 (night)
-----------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
-------------+--------------+--------------+---------------
       1.50 !        85.60 !       142.99 !        142.99

ROAD (49.94 + 33.81 + 0.00) = 50.04 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
    48     89   0.00  56.36   0.00   0.00  -6.42   0.00   0.00   0.00
49.94
--------------------------------------------------------------------------
--
    89     90   0.00  56.36   0.00   0.00 -22.55   0.00   0.00  -0.06
33.75*
    89     90   0.00  56.36   0.00   0.00 -22.55   0.00   0.00   0.00
33.81
```

```
--------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 50.04 dBA

Total Leq All Segments: 54.49 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 62.08
                         (NIGHT): 54.49
```

```
STAMSON 5.0        NORMAL REPORT        Date: 17-12-2019 14:31:56
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r3.te                Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: Woodridge Cr (day/night)
------------------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    40 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   8000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Woodridge Cr (day/night)
----------------------------------------------
Angle1   Angle2            :  47.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  37.00 / 37.00  m
Receiver height            :  85.60 / 85.60  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             :  71.00 deg   Angle2 : 90.00 deg
Barrier height             :  12.00 m
Barrier receiver distance  :  24.00 / 24.00  m
Source elevation           :  63.00 m
Receiver elevation         :  63.00 m
Barrier elevation          :  63.00 m
Reference angle            :   0.00

Road data, segment # 2: Hwy 417 (day/night)
-------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)
```

```
* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT): 146664
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 2: Hwy 417 (day/night)
-----------------------------------------
Angle1   Angle2           : -90.00 deg   0.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  : 146.00 / 146.00 m
Receiver height           :  85.60 / 85.60  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -39.00 deg
Barrier height            :  13.00 m
Barrier receiver distance :  77.00 / 77.00  m
Source elevation          :  66.00 m
Receiver elevation        :  63.00 m
Barrier elevation         :  63.00 m
Reference angle           :   0.00

Results segment # 1: Woodridge Cr (day)
---------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
Height  (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
------------+--------------+--------------+--------------
       1.50 !        85.60 !        31.05 !         94.05

ROAD (51.28 + 50.27 + 0.00) = 53.82 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
    47     71   0.00  63.96   0.00  -3.92  -8.75   0.00   0.00   0.00
51.28
--------------------------------------------------------------------------
--
    71     90   0.00  63.96   0.00  -3.92  -9.77   0.00   0.00  -0.17
50.09*
    71     90   0.00  63.96   0.00  -3.92  -9.77   0.00   0.00   0.00
50.27
```

```
--------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 53.82 dBA


Results segment # 2: Hwy 417 (day)
----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
Height  (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
------------+--------------+--------------+---------------
       1.50 !        85.60 !        42.83 !        105.83

ROAD (0.00 + 69.05 + 67.88) = 71.51 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -39   0.00  84.41   0.00  -9.88  -5.48   0.00   0.00  -0.02
69.03*
   -90    -39   0.00  84.41   0.00  -9.88  -5.48   0.00   0.00   0.00
69.05
--------------------------------------------------------------------------
--
   -39      0   0.00  84.41   0.00  -9.88  -6.64   0.00   0.00   0.00
67.88
--------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 71.51 dBA

Total Leq All Segments: 71.58 dBA


Results segment # 1: Woodridge Cr (night)
-----------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
```

```
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       85.60 !       31.05 !        94.05

ROAD (43.69 + 42.68 + 0.00) = 46.22 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
    47     71   0.00  56.36   0.00  -3.92  -8.75   0.00   0.00   0.00
43.69
--------------------------------------------------------------------------
--
    71     90   0.00  56.36   0.00  -3.92  -9.77   0.00   0.00  -0.17
42.50*
    71     90   0.00  56.36   0.00  -3.92  -9.77   0.00   0.00   0.00
42.68
--------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 46.22 dBA

Results segment # 2: Hwy 417 (night)
------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       85.60 !       42.83 !       105.83

ROAD (0.00 + 61.45 + 60.29) = 63.92 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -39   0.00  76.81   0.00  -9.88  -5.48   0.00   0.00  -0.02
61.43*
   -90    -39   0.00  76.81   0.00  -9.88  -5.48   0.00   0.00   0.00
61.45
--------------------------------------------------------------------------
--
   -39      0   0.00  76.81   0.00  -9.88  -6.64   0.00   0.00   0.00
60.29
--------------------------------------------------------------------------
--
```

```
 * Bright Zone !

Segment Leq : 63.92 dBA

Total Leq All Segments: 63.99 dBA


RT/Custom data, segment # 1: WLRT (day/night)
---------------------------------------------
1 - 4-car SRT:
Traffic volume     :   540/60    veh/TimePeriod
Speed              :    70  km/h

Data for Segment # 1: WLRT (day/night)
--------------------------------------
Angle1   Angle2           : -90.00 deg   0.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  99.00 / 99.00  m
Receiver height           :  85.60 / 85.60  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -39.00 deg
Barrier height            :  13.00 m
Barrier receiver distance :  77.00 / 77.00  m
Source elevation          :  63.00 m
Receiver elevation        :  63.00 m
Barrier elevation         :  63.00 m
Reference angle           :   0.00


Results segment # 1: WLRT (day)
-------------------------------

Source height = 0.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
Height  (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
------------+--------------+--------------+---------------
       0.50 !        85.60 !        19.41 !         82.41

RT/Custom (0.00 + 49.76 + 48.60) = 52.23 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-----------------------------------------------------------------------
   -90    -39   0.00  63.44  -8.20  -5.48   0.00   0.00  -0.25  49.51*
   -90    -39   0.00  63.44  -8.20  -5.48   0.00   0.00   0.00  49.76
-----------------------------------------------------------------------
   -39      0   0.00  63.44  -8.20  -6.64   0.00   0.00   0.00  48.60
```

```
-----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 52.23 dBA

Total Leq All Segments: 52.23 dBA


Results segment # 1: WLRT (night)
---------------------------------

Source height = 0.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       0.50 !       85.60 !       19.41 !        82.41

RT/Custom (0.00 + 43.23 + 42.07) = 45.70 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-----------------------------------------------------------------------
   -90    -39   0.00  56.91  -8.20  -5.48   0.00   0.00  -0.25  42.98*
   -90    -39   0.00  56.91  -8.20  -5.48   0.00   0.00   0.00  43.23
-----------------------------------------------------------------------
   -39      0   0.00  56.91  -8.20  -6.64   0.00   0.00   0.00  42.07
-----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 45.70 dBA

Total Leq All Segments: 45.70 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 71.63
                         (NIGHT): 64.06
```

```
STAMSON 5.0        NORMAL REPORT        Date: 17-12-2019 14:32:06
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r4.te               Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: HWY 417 1 (day/night)
---------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT): 146664
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: HWY 417 1 (day/night)
-------------------------------------------
Angle1   Angle2           : -90.00 deg   -14.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  : 130.00 / 130.00 m
Receiver height           :  85.60 / 85.60  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -52.00 deg
Barrier height            :  13.00 m
Barrier receiver distance :  60.00 / 60.00  m
Source elevation          :  66.00 m
Receiver elevation        :  63.00 m
Barrier elevation         :  63.00 m
Reference angle           :   0.00


Road data, segment # 2: HWY 417 2 (day/night)
---------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)
```

```
* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT): 146664
    Percentage of Annual Growth         :   0.00
    Number of Years of Growth           :   0.00
    Medium Truck % of Total Volume      :   7.00
    Heavy Truck  % of Total Volume      :   5.00
    Day (16 hrs) % of Total Volume      :  92.00

Data for Segment # 2: HWY 417 2 (day/night)
-------------------------------------------
Angle1   Angle2           : -14.00 deg   77.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  : 130.00 / 130.00 m
Receiver height           :  85.60 / 85.60  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -14.00 deg   Angle2 : 77.00 deg
Barrier height            :   3.00 m
Barrier receiver distance :  94.00 / 94.00  m
Source elevation          :  66.00 m
Receiver elevation        :  63.00 m
Barrier elevation         :  66.00 m
Reference angle           :   0.00


Results segment # 1: HWY 417 1 (day)
------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       85.60 !       48.17 !       111.17

ROAD (0.00 + 68.27 + 68.27) = 71.28 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -52   0.00  84.41   0.00  -9.38  -6.75   0.00   0.00  -0.02
68.26*
   -90    -52   0.00  84.41   0.00  -9.38  -6.75   0.00   0.00   0.00
68.27
--------------------------------------------------------------------------
--
```

```
   -52    -14   0.00  84.41   0.00  -9.38  -6.75   0.00   0.00   0.00
68.27
-----------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 71.28 dBA


Results segment # 2: HWY 417 2 (day)
------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       85.60 !       23.96 !        89.96

ROAD (0.00 + 72.07 + 0.00) = 72.07 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-----------------------------------------------------------------------------
--
   -14     77   0.00  84.41   0.00  -9.38  -2.96   0.00   0.00   0.00
72.07*
   -14     77   0.00  84.41   0.00  -9.38  -2.96   0.00   0.00   0.00
72.07
-----------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 72.07 dBA

Total Leq All Segments: 74.70 dBA


Results segment # 1: HWY 417 1 (night)
--------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
```

```
       1.50 !       85.60 !       48.17 !       111.17

ROAD (0.00 + 60.68 + 60.68) = 63.69 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -52   0.00  76.81   0.00  -9.38  -6.75   0.00   0.00  -0.02
60.66*
   -90    -52   0.00  76.81   0.00  -9.38  -6.75   0.00   0.00   0.00
60.68
--------------------------------------------------------------------------
--
   -52    -14   0.00  76.81   0.00  -9.38  -6.75   0.00   0.00   0.00
60.68
--------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 63.69 dBA


Results segment # 2: HWY 417 2 (night)
--------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       1.50 !       85.60 !       23.96 !        89.96

ROAD (0.00 + 64.47 + 0.00) = 64.47 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -14     77   0.00  76.81   0.00  -9.38  -2.96   0.00   0.00   0.00
64.47*
   -14     77   0.00  76.81   0.00  -9.38  -2.96   0.00   0.00   0.00
64.47
--------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 64.47 dBA
```

```
Total Leq All Segments: 67.11 dBA


RT/Custom data, segment # 1: WLRT 1 (day/night)
-----------------------------------------------
1 - 4-car SRT:
Traffic volume    :   540/60    veh/TimePeriod
Speed             :    70  km/h

Data for Segment # 1: WLRT 1 (day/night)
----------------------------------------
Angle1   Angle2           : -90.00 deg   0.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  81.00 / 81.00  m
Receiver height           :  85.60 / 85.60  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -52.00 deg
Barrier height            :  13.00 m
Barrier receiver distance :  60.00 / 60.00  m
Source elevation          :  63.00 m
Receiver elevation        :  63.00 m
Barrier elevation         :  63.00 m
Reference angle           :   0.00


RT/Custom data, segment # 2: WLRT 2 (day/night)
-----------------------------------------------
1 - 4-car SRT:
Traffic volume    :   540/60    veh/TimePeriod
Speed             :    70  km/h

Data for Segment # 2: WLRT 2 (day/night)
----------------------------------------
Angle1   Angle2           :   0.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  81.00 / 81.00  m
Receiver height           :  85.60 / 85.60  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :  77.00 deg   Angle2 : 90.00 deg
Barrier height            : 103.60 m
Barrier receiver distance :  10.00 / 10.00  m
Source elevation          :  63.00 m
Receiver elevation        :  63.00 m
Barrier elevation         :  63.00 m
Reference angle           :   0.00
```

Results segment # 1: WLRT 1 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source Height (m)	Receiver Height (m)	Barrier Height (m)	Elevation of Barrier Top (m)
0.50	85.60	22.56	85.56

RT/Custom (0.00 + 49.36 + 50.72) = 53.10 dBA

Angle1	Angle2	Alpha	RefLeq	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	-52	0.00	63.44	-7.32	-6.75	0.00	0.00	-0.17	49.19*
-90	-52	0.00	63.44	-7.32	-6.75	0.00	0.00	0.00	49.36
-52	0	0.00	63.44	-7.32	-5.39	0.00	0.00	0.00	50.72

* Bright Zone !

Segment Leq : 53.10 dBA

Results segment # 2: WLRT 2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source Height (m)	Receiver Height (m)	Barrier Height (m)	Elevation of Barrier Top (m)
0.50	85.60	75.09	138.09

RT/Custom (52.43 + 27.18 + 0.00) = 52.44 dBA

Angle1	Angle2	Alpha	RefLeq	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
0	77	0.00	63.44	-7.32	-3.69	0.00	0.00	0.00	52.43
77	90	0.00	63.44	-7.32	-11.41	0.00	0.00	-17.52	27.18

Segment Leq : 52.44 dBA

Total Leq All Segments: 55.79 dBA

```
Results segment # 1: WLRT 1 (night)
-----------------------------------

Source height = 0.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
Height  (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
------------+--------------+--------------+---------------
       0.50 !        85.60 !        22.56 !         85.56

RT/Custom (0.00 + 42.83 + 44.19) = 46.57 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90    -52   0.00  56.91  -7.32  -6.75   0.00   0.00  -0.17  42.65*
   -90    -52   0.00  56.91  -7.32  -6.75   0.00   0.00   0.00  42.83
----------------------------------------------------------------------
   -52      0   0.00  56.91  -7.32  -5.39   0.00   0.00   0.00  44.19
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 46.57 dBA


Results segment # 2: WLRT 2 (night)
-----------------------------------

Source height = 0.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
Height  (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
------------+--------------+--------------+---------------
       0.50 !        85.60 !        75.09 !        138.09

RT/Custom (45.89 + 20.65 + 0.00) = 45.91 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     0     77   0.00  56.91  -7.32  -3.69   0.00   0.00   0.00  45.89
----------------------------------------------------------------------
    77     90   0.00  56.91  -7.32 -11.41   0.00   0.00 -17.52  20.65
----------------------------------------------------------------------
Segment Leq : 45.91 dBA

Total Leq All Segments: 49.26 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 74.76
                         (NIGHT): 67.18
```

```
STAMSON 5.0        NORMAL REPORT        Date: 15-04-2021 11:47:29
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r5.te               Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: HWY 417 (day/night)
-------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT): 146664
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: HWY 417 (day/night)
-----------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  : 119.00 / 119.00 m
Receiver height           :  85.60 / 85.60  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -44.00 deg   Angle2 : 90.00 deg
Barrier height            :   3.00 m
Barrier receiver distance :  83.00 / 83.00  m
Source elevation          :  66.00 m
Receiver elevation        :  63.00 m
Barrier elevation         :  66.00 m
Reference angle           :   0.00

Results segment # 1: HWY 417 (day)
----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
```

```
------------+-------------+-------------+--------------
       1.50 !       85.60 !       26.03 !        92.03

ROAD (69.49 + 74.13 + 0.00) = 75.41 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -44   0.00  84.41   0.00  -8.99  -5.93   0.00   0.00   0.00
69.49
--------------------------------------------------------------------------
--
   -44     90   0.00  84.41   0.00  -8.99  -1.28   0.00   0.00  -0.01
74.12*
   -44     90   0.00  84.41   0.00  -8.99  -1.28   0.00   0.00   0.00
74.13
--------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 75.41 dBA

Total Leq All Segments: 75.41 dBA

Results segment # 1: HWY 417 (night)
------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       85.60 !       26.03 !        92.03

ROAD (61.89 + 66.53 + 0.00) = 67.82 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -44   0.00  76.81   0.00  -8.99  -5.93   0.00   0.00   0.00
61.89
--------------------------------------------------------------------------
--
   -44     90   0.00  76.81   0.00  -8.99  -1.28   0.00   0.00  -0.01
66.53*
   -44     90   0.00  76.81   0.00  -8.99  -1.28   0.00   0.00   0.00
66.53
```

```
--------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 67.82 dBA

Total Leq All Segments: 67.82 dBA

RT/Custom data, segment # 1: WLRT (day/night)
---------------------------------------------
1 - 4-car SRT:
Traffic volume     :   540/60    veh/TimePeriod
Speed              :    70  km/h

Data for Segment # 1: WLRT (day/night)
--------------------------------------
Angle1   Angle2            : -90.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  72.00 / 72.00  m
Receiver height            :  85.60 / 85.60  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             :  -1.00 deg   Angle2 : 0.00 deg
Barrier height             :   0.00 m
Barrier receiver distance  :   1.00 / 1.00   m
Source elevation           :  63.00 m
Receiver elevation         :  63.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00

Results segment # 1: WLRT (day)
-------------------------------

Source height = 0.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier     ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
------------+--------------+-------------+---------------
       0.50 !        85.60 !      147.42 !       147.42

RT/Custom (53.57 + 34.07 + 53.61) = 56.63 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     -1   0.00  63.44  -6.81  -3.06   0.00   0.00   0.00  53.57
----------------------------------------------------------------------
    -1      0   0.00  63.44  -6.81 -22.55   0.00   0.00   0.00  34.07*
    -1      0   0.00  63.44  -6.81 -22.55   0.00   0.00   0.00  34.07
```

```
------------------------------------------------------------------------
     0      90    0.00   63.44   -6.81   -3.01    0.00    0.00    0.00   53.61
------------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 56.63 dBA

Total Leq All Segments: 56.63 dBA

Results segment # 1: WLRT (night)
----------------------------------

Source height = 0.50 m

Barrier height for grazing incidence
-------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
-------------+--------------+--------------+---------------
       0.50 !        85.60 !       147.42 !       147.42

RT/Custom (47.03 + 27.54 + 47.08) = 50.09 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
------------------------------------------------------------------------
   -90      -1    0.00   56.91   -6.81   -3.06    0.00    0.00    0.00   47.03
------------------------------------------------------------------------
    -1       0    0.00   56.91   -6.81  -22.55    0.00    0.00    0.00   27.54*
    -1       0    0.00   56.91   -6.81  -22.55    0.00    0.00    0.00   27.54
------------------------------------------------------------------------
     0      90    0.00   56.91   -6.81   -3.01    0.00    0.00    0.00   47.08
------------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 50.09 dBA

Total Leq All Segments: 50.09 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 75.47
                          (NIGHT): 67.89
```

```
STAMSON 5.0        NORMAL REPORT        Date: 15-04-2021 11:47:40
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r6.te              Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: WOODRIDGE CR (day/night)
------------------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    40 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   8000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: WOODRIDGE CR (day/night)
----------------------------------------------
Angle1   Angle2            : -90.00 deg   0.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  52.00 / 52.00  m
Receiver height            :  85.60 / 85.60  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             :  -1.00 deg   Angle2 : 0.00 deg
Barrier height             :   0.00 m
Barrier receiver distance  :   1.00 / 1.00   m
Source elevation           :  63.00 m
Receiver elevation         :  63.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00

Road data, segment # 2: HYW 417 (day/night)
-------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)
```

```
* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT): 146664
    Percentage of Annual Growth         :   0.00
    Number of Years of Growth           :   0.00
    Medium Truck % of Total Volume      :   7.00
    Heavy Truck  % of Total Volume      :   5.00
    Day (16 hrs) % of Total Volume      :  92.00

Data for Segment # 2: HYW 417 (day/night)
-----------------------------------------
Angle1   Angle2           :   0.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  : 135.00 / 135.00 m
Receiver height           :  95.40 / 95.40  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :   0.00 deg   Angle2 : 90.00 deg
Barrier height            :   3.00 m
Barrier receiver distance :  99.00 / 99.00  m
Source elevation          :  66.00 m
Receiver elevation        :  63.00 m
Barrier elevation         :  66.00 m
Reference angle           :   0.00

Results segment # 1: WOODRIDGE CR (day)
---------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier     ! Elevation of
Height  (m) ! Height   (m) ! Height  (m) ! Barrier Top  (m)
------------+--------------+-------------+---------------
       1.50 !        85.60 !      146.98 !       146.98

ROAD (55.50 + 36.00 + 0.00) = 55.55 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     -1   0.00  63.96   0.00  -5.40  -3.06   0.00   0.00   0.00
55.50
--------------------------------------------------------------------------
--
    -1      0   0.00  63.96   0.00  -5.40 -22.55   0.00   0.00   0.00
36.00*
    -1      0   0.00  63.96   0.00  -5.40 -22.55   0.00   0.00   0.00
36.00
```

```
-----------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 55.55 dBA

Results segment # 2: HYW 417 (day)
----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver    ! Barrier     ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
-------------+--------------+--------------+---------------
       1.50 !       95.40 !       25.74 !        91.74

ROAD (0.00 + 71.85 + 0.00) = 71.85 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-----------------------------------------------------------------------------
--
     0     90   0.00  84.41   0.00  -9.54  -3.01   0.00   0.00  -0.01
71.84*
     0     90   0.00  84.41   0.00  -9.54  -3.01   0.00   0.00   0.00
71.85
-----------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 71.85 dBA

Total Leq All Segments: 71.95 dBA

Results segment # 1: WOODRIDGE CR (night)
-----------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver    ! Barrier     ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
-------------+--------------+--------------+---------------
       1.50 !       85.60 !      146.98 !       146.98

ROAD (47.90 + 28.41 + 0.00) = 47.95 dBA
```

```
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
   -90     -1   0.00  56.36   0.00  -5.40  -3.06   0.00   0.00   0.00
47.90
----------------------------------------------------------------------------
--
    -1      0   0.00  56.36   0.00  -5.40 -22.55   0.00   0.00   0.00
28.41*
    -1      0   0.00  56.36   0.00  -5.40 -22.55   0.00   0.00   0.00
28.41
----------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 47.95 dBA

Results segment # 2: HYW 417 (night)
------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
-------------+--------------+--------------+---------------
       1.50 !        95.40 !        25.74 !         91.74

ROAD (0.00 + 64.26 + 0.00) = 64.26 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
     0     90   0.00  76.81   0.00  -9.54  -3.01   0.00   0.00  -0.01
64.25*
     0     90   0.00  76.81   0.00  -9.54  -3.01   0.00   0.00   0.00
64.26
----------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 64.26 dBA

Total Leq All Segments: 64.36 dBA
```

```
RT/Custom data, segment # 1: WLRT (day/night)
---------------------------------------------
1 - 4-car SRT:
Traffic volume     :   540/60    veh/TimePeriod
Speed              :    70  km/h

Data for Segment # 1: WLRT (day/night)
--------------------------------------
Angle1   Angle2           :   0.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  88.00 / 88.00  m
Receiver height           :  85.60 / 85.60  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :   0.00 deg   Angle2 : 1.00 deg
Barrier height            :   0.00 m
Barrier receiver distance :   1.00 / 1.00   m
Source elevation          :  63.00 m
Receiver elevation        :  63.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00

Results segment # 1: WLRT (day)
-------------------------------

Source height = 0.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       0.50 !       85.60 !      147.63 !       147.63

RT/Custom (0.00 + 33.20 + 52.69) = 52.74 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     0      1   0.00  63.44  -7.68 -22.55   0.00   0.00   0.00  33.20*
     0      1   0.00  63.44  -7.68 -22.55   0.00   0.00   0.00  33.20
----------------------------------------------------------------------
     1     90   0.00  63.44  -7.68  -3.06   0.00   0.00   0.00  52.69
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 52.74 dBA

Total Leq All Segments: 52.74 dBA
```

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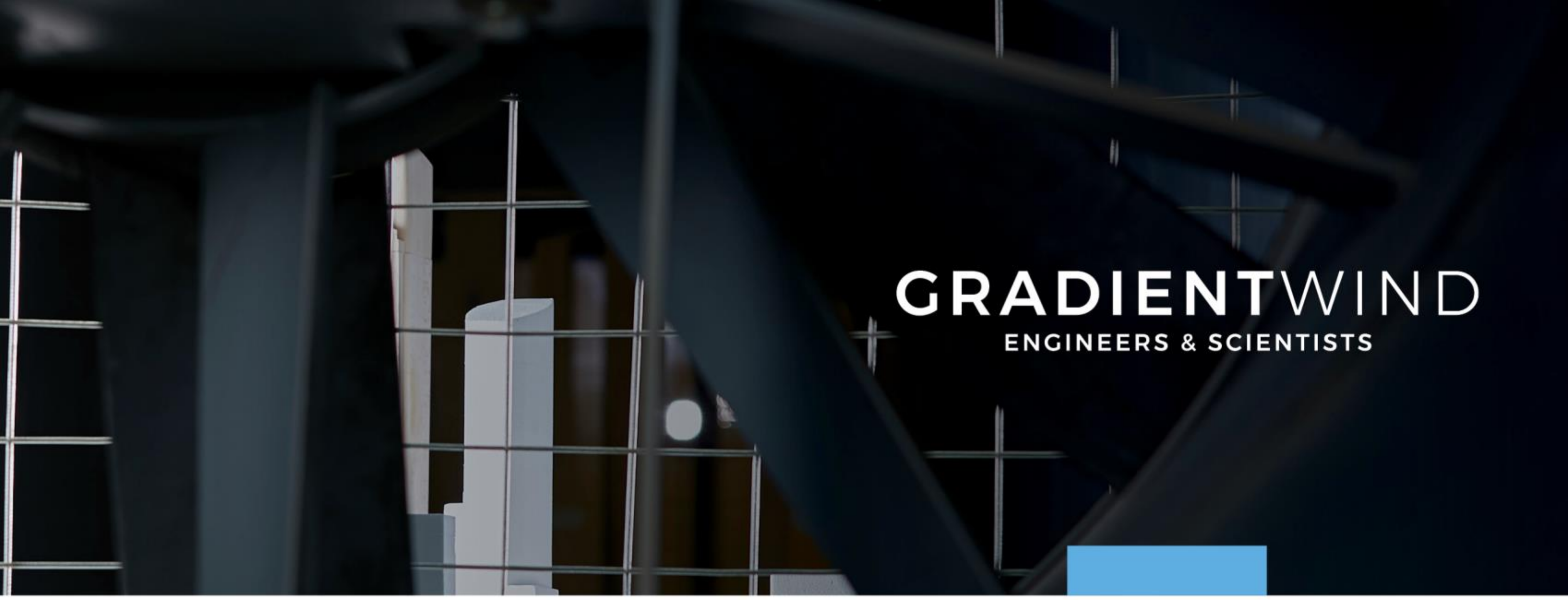
```
Results segment # 1: WLRT (night)
---------------------------------

Source height = 0.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       0.50 !       85.60 !      147.63 !       147.63

RT/Custom (0.00 + 26.67 + 46.16) = 46.21 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     0      1   0.00  56.91  -7.68 -22.55   0.00   0.00   0.00  26.67*
     0      1   0.00  56.91  -7.68 -22.55   0.00   0.00   0.00  26.67
----------------------------------------------------------------------
     1     90   0.00  56.91  -7.68  -3.06   0.00   0.00   0.00  46.16
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 46.21 dBA

Total Leq All Segments: 46.21 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 72.00
                         (NIGHT): 64.43
```



APPENDIX B

FTA VIBRATION CALCULATIONS

GWE19-225 15-Apr-21

Possible Vibration Impacts on 100 Bayshore Drive
Predicted using FTA General Assesment

Train Speed 70 km/h 43 mph

	Distance from C/L	
	(m)	(ft)
LRT	61.0	200.1

	Vibration		
From FTA Manual Fig 10-1			
Vibration Levels at distance from track	61	dBV re 1 micro in/sec	
Adjustment Factors FTA Table 10-1			
Speed reference 50 mph	-1	Speed Limit of 70 km/h (43 mph)	
Vehicle Parameters	0	Assume Soft primary suspension, Wheels run true	
Track Condition	0	Not welded, though in otherwise good condition	
Track Treatments	0	None	
Type of Transit Structure	0	Station	
Efficient vibration Propagation	0	Propagation through rock	
Vibration Levels at Fdn	60		0.025
Coupling to Building Foundation	-10	Large Massonry on Piles	
Floor to Floor Attenuation	-2.0	Ground Floor Ocupied	
Amplification of Floor and Walls	6		
Total Vibration Level	53.68997	dBV or	0.012 mm/s
Noise Level in dBA	18.68997	dBA	

Table 10-1. Adjustment Factors for Generalized Predictions of Ground-Borne Vibration and Noise				
Factors Affecting Vibration Source				
Source Factor	**Adjustment to Propagation Curve**			**Comment**
		Reference Speed		
Speed	Vehicle Speed	50 mph	30 mph	Vibration level is approximately proportional to $20*\log(speed/speed_{ref})$. Sometimes the variation with speed has been observed to be as low as 10 to 15 $\log(speed/speed_{ref})$.
	60 mph	+1.6 dB	+6.0 dB	
	50 mph	0.0 dB	+4.4 dB	
	40 mph	-1.9 dB	+2.5 dB	
	30 mph	-4.4 dB	0.0 dB	
	20 mph	-8.0 dB	-3.5 dB	
Vehicle Parameters (not additive, apply greatest value only)				
Vehicle with stiff primary suspension	+8 dB			Transit vehicles with stiff primary suspensions have been shown to create high vibration levels. Include this adjustment when the primary suspension has a vertical resonance frequency greater than 15 Hz.
Resilient Wheels	0 dB			Resilient wheels do not generally affect ground-borne vibration except at frequencies greater than about 80 Hz.
Worn Wheels or Wheels with Flats	+10 dB			Wheel flats or wheels that are unevenly worn can cause high vibration levels. This can be prevented with wheel truing and slip-slide detectors to prevent the wheels from sliding on the track.
Track Conditions (not additive, apply greatest value only)				
Worn or Corrugated Track	+10 dB			If both the wheels and the track are worn, only one adjustment should be used. Corrugated track is a common problem. Mill scale on new rail can cause higher vibration levels until the rail has been in use for some time.
Special Trackwork	+10 dB			Wheel impacts at special trackwork will significantly increase vibration levels. The increase will be less at greater distances from the track.
Jointed Track or Uneven Road Surfaces	+5 dB			Jointed track can cause higher vibration levels than welded track. Rough roads or expansion joints are sources of increased vibration for rubber-tire transit.
Track Treatments (not additive, apply greatest value only)				
Floating Slab Trackbed	-15 dB			The reduction achieved with a floating slab trackbed is strongly dependent on the frequency characteristics of the vibration.
Ballast Mats	-10 dB			Actual reduction is strongly dependent on frequency of vibration.
High-Resilience Fasteners	-5 dB			Slab track with track fasteners that are very compliant in the vertical direction can reduce vibration at frequencies greater than 40 Hz.

Table 10-1. Adjustment Factors for Generalized Predictions of Ground-Borne Vibration and Noise (Continued)		
Factors Affecting Vibration Path		
Path Factor	**Adjustment to Propagation Curve**	**Comment**
Resiliently Supported Ties	-10 dB	Resiliently supported tie systems have been found to provide very effective control of low-frequency vibration.
Track Configuration (not additive, apply greatest value only)		
Type of Transit Structure	Relative to at-grade tie & ballast: Elevated structure -10 dB Open cut 0 dB	The general rule is the heavier the structure, the lower the vibration levels. Putting the track in cut may reduce the vibration levels slightly. Rock-based subways generate higher-frequency vibration.
	Relative to bored subway tunnel in soil: Station -5 dB Cut and cover -3 dB Rock-based - 15 dB	
Ground-borne Propagation Effects		
Geologic conditions that promote efficient vibration propagation	Efficient propagation in soil +10 dB	Refer to the text for guidance on identifying areas where efficient propagation is possible.
	Propagation in rock layer **Dist.** / **Adjust.** 50 ft +2 dB 100 ft +4 dB 150 ft +6 dB 200 ft +9 dB	The positive adjustment accounts for the lower attenuation of vibration in rock compared to soil. It is generally more difficult to excite vibrations in rock than in soil at the source.
Coupling to building foundation	Wood Frame Houses -5 dB 1-2 Story Masonry -7 dB 3-4 Story Masonry -10 dB Large Masonry on Piles -10 dB Large Masonry on Spread Footings -13 dB Foundation in Rock 0 dB	The general rule is the heavier the building construction, the greater the coupling loss.
Factors Affecting Vibration Receiver		
Receiver Factor	**Adjustment to Propagation Curve**	**Comment**
Floor-to-floor attenuation	1 to 5 floors above grade: -2 dB/floor 5 to 10 floors above grade: -1 dB/floor	This factor accounts for dispersion and attenuation of the vibration energy as it propagates through a building.
Amplification due to resonances of floors, walls, and ceilings	+6 dB	The actual amplification will vary greatly depending on the type of construction. The amplification is lower near the wall/floor and wall/ceiling intersections.
Conversion to Ground-borne Noise		
Noise Level in dBA	Peak frequency of ground vibration: Low frequency (<30 Hz): -50 dB Typical (peak 30 to 60 Hz): -35 dB High frequency (>60 Hz): -20 dB	Use these adjustments to estimate the A-weighted sound level given the average vibration velocity level of the room surfaces. See text for guidelines for selecting low, typical or high frequency characteristics. Use the high-frequency adjustment for subway tunnels in rock or if the dominant frequencies of the vibration spectrum are known to be 60 Hz or greater.