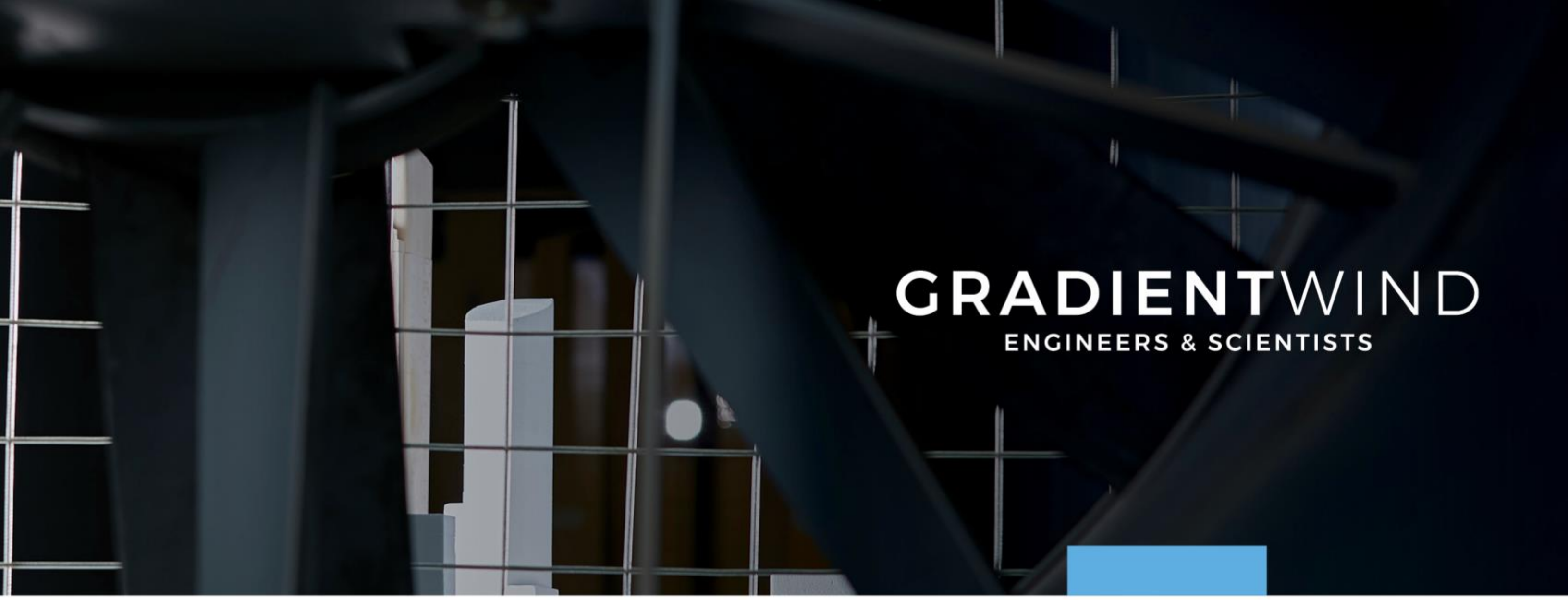
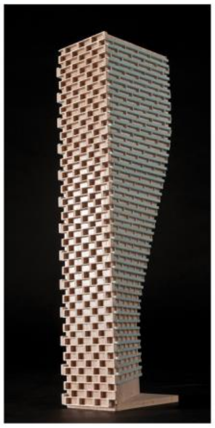


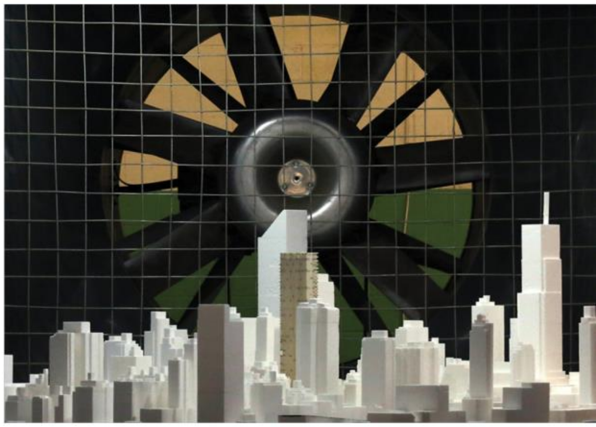
GRADIENTWIND
ENGINEERS & SCIENTISTS

TRANSPORTATION NOISE & VIBRATION ASSESSMENT

Gladstone Village Phase 1
Ottawa, Ontario

REPORT: 21-082-Noise & Vibration





September 23, 2021

PREPARED FOR
Ottawa Community Housing Corporation
c/o Diamond Schmitt Architects
384 Adelaide Street West, Suite 100
Toronto, Ontario, Canada M5V 1R7

PREPARED BY
Michael Lafortune, C.E.T., Environmental Scientist
Joshua Foster, P.Eng., Principal

EXECUTIVE SUMMARY

This report describes a transportation noise & vibration assessment for the proposed rental residential development, Gladstone Village Phase 1, located at 933 Gladstone Avenue in Ottawa, Ontario. Phase 1 comprises 18 and 9-storey towers connected by a common 5-storey podium including some potential commercial and amenity space and 3.5-storey townhomes, including shared underground parking garage accessed by a new street. The subject site is surrounded by low-rise residential buildings to the east, with light industrial properties to the south, west and north. The primary sources of transportation noise include Somerset Street West, Preston Street, Gladstone Avenue, Highway 417, and the O-Train Trillium LRT Line which is also a source of ground vibration. 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; and (iv) architectural drawings prepared by Diamond Schmitt.

The results of the current analysis indicate that noise levels will range between 48 and 65 dBA during the daytime period (07:00-23:00) and between 43 and 57 dBA during the nighttime period (23:00-07:00). The highest noise level (65 dBA) occurs at the south tower's south façade, which is nearest and most exposed to the LRT corridor and Highway 417.

The noise levels predicted due to transportation sources fall below the criteria listed in Section 4.2 for building components. The results also indicate that the development will require forced air heating with provision for air conditioning, which if installed at the owner's discretion will allow occupants to keep windows closed and maintain a comfortable living environment. In addition to ventilation requirements, Warning Clauses will also be required be placed on all Lease, Purchase and Sale Agreements, as summarized in Section 6. Noise levels at the proposed outdoor living areas, in the form of rooftop terraces, fall below the ENCG limit. Noise control measures for OLAs is therefore not required.

Off-site stationary noise impacts from the proposed building can generally be minimized by judicious selection and placement of the equipment. Where necessary, noise screens and silencers can be placed into the design. It is recommended a stationary noise study be conducted once mechanical plans for the proposed building become available. This study would assess impacts of stationary noise from rooftop mechanical units serving the proposed building on surrounding noise-sensitive areas. This study will include recommendations for any noise control measures that may be necessary to ensure noise levels fall below ENCG limits.

Gradient Wind conducted an observation of all properties within 100 m of the study site (see buffer in Figure 1) and identified no significant sources of stationary noise.

Vibration levels due to transit activity in the area are expected to fall below the criterion of 0.10 mm/s at the nearest façade. Thus, mitigation for vibrations is not required.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Ottawa Community Housing to undertake a transportation noise & vibration assessment for the proposed rental residential development, Gladstone Village Phase 1, located at 933 Gladstone Avenue in Ottawa, Ontario (hereinafter referred to as “subject site” or “Phase 1”). This report summarizes the methodology, results, and recommendations related to the assessment of exterior noise and vibration levels generated by local roadway and LRT traffic.

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 prepared by Diamond Schmitt, with future roadway traffic volumes corresponding to the City of Ottawa’s Official Plan (OP) roadway classifications.

2. TERMS OF REFERENCE

The full study site is located on an 32,000 square metre (m^2) trapezoidal parcel of land in the northwestern portion of the OCH’s landholdings, bordered by Gladstone Avenue (south), existing low-rise housing (east), the Trillium light rail train (LRT) corridor (west), and a surplus Public Works Canada Yard (north). The parcel will be subdivided into multiple buildable blocks with new public streets (with municipal services). The proposed buildings complemented by new pathways, a street with tree frontage connecting Oak Street to Gladstone Avenue, and a north ‘woonerf’ street. Other blocks not forming part of Phase 1 will be developed as subsequent future phases. Phase 1 comprises 18 and 9-storey towers connected by a common 5-storey podium including some potential commercial and amenity space and 3.5-storey townhomes, including shared underground parking garage accessed by a new street.

The subject site is surrounded by low-rise residential buildings to the east, with light industrial properties to the south, west and north. The primary sources of transportation noise include Somerset Street West,

[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

Preston Street, Gladstone Avenue, Highway 417, and the O-Train Trillium LRT Line which is also a source of ground vibration. Figure 1 illustrates a complete site plan with surrounding context.

3. OBJECTIVES

The principal objectives of this study are to (i) calculate the future noise and vibration levels on the study buildings produced by local roadway and light rail transit (LRT) traffic, and (ii) ensure that exterior noise and vibration 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.

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 Noise

4.2.1 Criteria for Transportation Noise

For surface transportation 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 45 and 40 dBA for living rooms and sleeping quarters respectively for roadway and transit as listed in Table 1.

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

Type of Space	Time Period	Roadway and LRT 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 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].

[3] Adapted from ENCG 2016 – Tables 2.2b and 2.2c
[4] Burberry, P.B. (2014). Mitchell's Environment and Services. Routledge, Page 125
[5] MECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.8
[6] MECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.1.3

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 Transportation 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.

Roadway 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.
- Trillium Line LRT modeled using 4-car SRT function in STAMSON.
- Ground surfaces were taken to be reflective and absorptive based on the presence of hard (paved) and soft (landscaped) ground.
- Topography was assumed to be a flat/gentle slope surrounding the study building. The Trillium Line is approximately 5 m below site grade.
- Noise receptors were strategically placed at 9 locations around the study area (see Figure 2).
- Receptor distances and exposure angles are illustrated in Figures 3-5.

4.2.3 Roadway Traffic and LRT 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. Trillium Line LRT volumes

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

and speed are based on Gradient Wind's past experience with the Trillium Line on other projects. Table 2 (below) summarizes the AADT values used for each roadway/LRT included in this assessment.

TABLE 2: ROADWAY TRAFFIC AND LRT DATA

Segment	Roadway Traffic Data	Speed Limit (km/h)	Traffic Volumes
Somerset Street West	2-Lane Urban Arterial	50	**15,000**
Preston Street	2-Lane Urban Arterial	50	**15,000**
Gladstone Avenue	2-Lane Major Collector	50	**12,000**
Highway 417	8-Lane Freeway	100	**146,664**
Trillium Line LRT	LRT	50	**192/24***

* - Daytime/nighttime volumes

4.3 Ground Vibration & Ground-borne Noise

Transit 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.

4.3.1 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 a partnership between the MOECP and the Toronto Transit Commission[8]. These standards indicate that the appropriate criteria for residential buildings is 0.10 mm/s RMS for vibrations. For main line railways, a document titled Guidelines for New Development in Proximity to Railway Operations[9], 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. As the main vibration source is due to the LRT lines, which will have frequent events, the 0.10 mm/s RMS (72 dBV) vibration criteria and 35 dBA ground borne noise criteria were adopted for this study.

4.3.2 Theoretical Ground Vibration Prediction Procedure

Potential vibration impacts of the future Confederation LRT rail line, currently under construction, were predicted using the FTA's Transit Noise and Vibration Impact Assessment[10] 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 below, 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

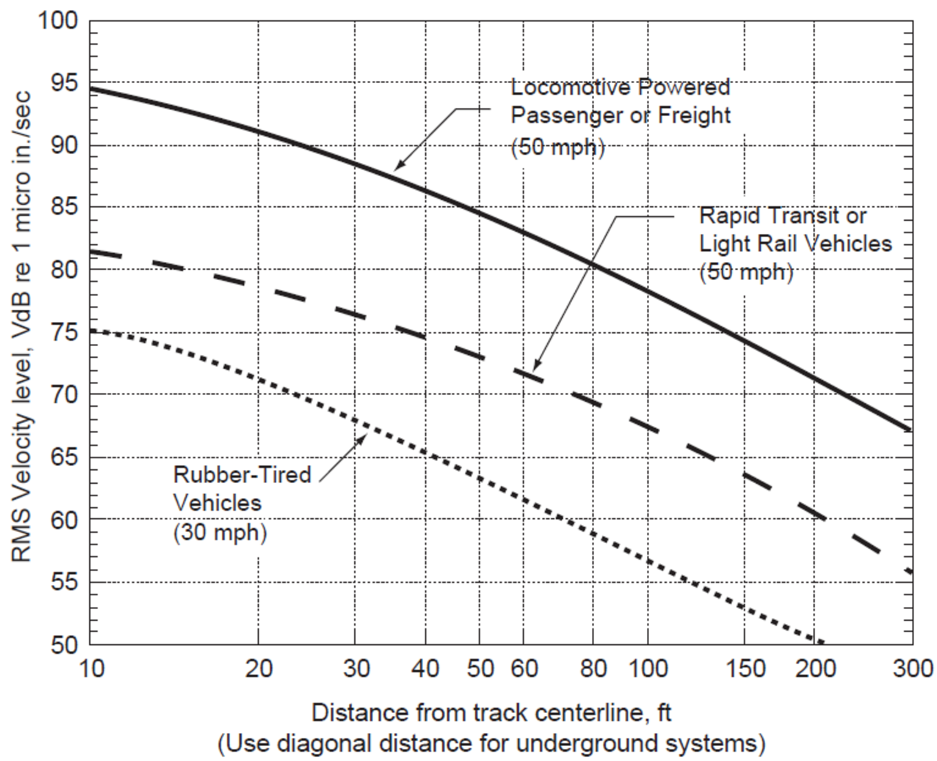
---

[8] MOECP/TTC Protocol for Noise and Vibration Assessment for the Proposed Yonge-Spadina Subway Loop, June 16, 1993

[9] Dialog and J.E. Coulter Associates Limited, prepared for The Federation of Canadian Municipalities and The Railway Association of Canada, May 2013

[10] C. E. Hanson; D. A. Towers; and L. D. Meister, Transit Noise and Vibration Impact Assessment, Federal Transit Administration, May 2006.

geology, as well as the structural type of the impacted building structures. Based on the setback distance of the closest building, initial vibration levels were deduced from a curve for light rail trains at 50 miles per hour (mph) and applying an adjustment factor of -1.2 dBV to account for an operational speed of 43.4 mph (70 km/h). The track was assumed to be jointed with no welds. Details of the vibration calculations are presented in Appendix B.



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 Noise Levels

The results of the transportation 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 SOURCES

Receptor Number	Receptor Height Above Grade (m)	Receptor Location	STAMSON 5.04 Noise Level (dBA)	
			Day	Night
1	55	POW – North Tower – North Façade	56	48
2	55	POW – North Tower – South Façade	49	43
3	55	POW – North Tower – West Façade	54	48
4	27.5	POW – South Tower – East Façade	54	47
5	27.5	POW – South Tower – South Façade	65	57
6	11.5	OLA – Podium Terrace	48	N/A
7	24.5	OLA – North Tower Terrace	56	N/A
8	1.5	OLA – Ground Level Amenity	49	N/A
9	8.5	POW – Podium – West Façade	50	44

5.2 Ground Vibrations & Ground-borne Noise Levels

Based on an offset distance of 30 metres between the Trillium Line and the nearest building foundation, the estimated vibration level at the nearest point of reception is expected to be 0.028 mm/s RMS 61 dBV) based on the FTA protocol. Details of the calculation are provided in Appendix B. Since predicted vibration levels are below the criterion of 0.10 mm/s RMS, no mitigation will be required.

According to the United States Federal Transit Authority's vibration assessment protocol, ground borne noise can be estimated by subtracting 35 dB from the velocity vibration level in dBV. Since measured vibration levels were found to be less than 0.10 mm/s peak partial velocity (ppv), ground borne noise levels are also expected to be below the ground borne noise criteria of 35 dB.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current analysis indicate that noise levels will range between 48 and 65 dBA during the daytime period (07:00-23:00) and between 43 and 57 dBA during the nighttime period (23:00-07:00). The highest noise level (65 dBA) occurs at the south tower's south façade, which is nearest and most exposed to the LRT corridor and Highway 417.

The noise levels predicted due to transportation sources fall below the criteria listed in Section 4.2 for building components. The results also indicate that the development will require forced air heating with provision for air conditioning, which if installed at the owner's discretion will allow occupants to keep windows closed and maintain a comfortable living environment. In addition to ventilation requirements, the following Type A and Type C Warning Clauses will also be required be placed on all Lease, Purchase and Sale Agreements. Noise levels at the proposed outdoor living areas, in the form of rooftop terraces, fall below the ENCG upper limit. Noise control measures for OLAs is not required.

Type A

> *"Purchasers/tenants are advised that sound levels due to increasing road and rail traffic may occasionally interfere with some activities of the dwelling occupants as the sound levels exceed the sound level limits of the Municipality and the Ministry of the Environment, Conservation and Parks."*

Type C

> *"This dwelling unit has been designed with the provision for adding central air conditioning at the occupant's discretion. Installation of central air conditioning by the occupant in low and medium density developments will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the sound level limits of the Municipality and the Ministry of the Environment, Conservation and Parks."*

Off-site stationary noise impacts from the proposed building can generally be minimized by judicious selection and placement of the equipment. Where necessary, noise screens and silencers can be placed into the design. It is recommended a stationary noise study be conducted once mechanical plans for the proposed building become available. This study would assess impacts of stationary noise from rooftop mechanical units serving the proposed building on surrounding noise-sensitive areas. This study will include recommendations for any noise control measures that may be necessary to ensure noise levels fall below ENCG limits.

Gradient Wind conducted an observation of all properties within 100 m of the study site (see buffer in Figure 1) and identified no significant sources of stationary noise.

Vibration levels due to railway activity in the area are expected to fall below the criterion of 0.10 mm/s at the nearest façade to the LRT rail line. Thus, mitigation for vibrations is not required.

This concludes our transportation noise & vibration assessment and report. If you have any questions or wish to discuss our findings, please advise us. In the interim, we thank you for the opportunity to be of service.

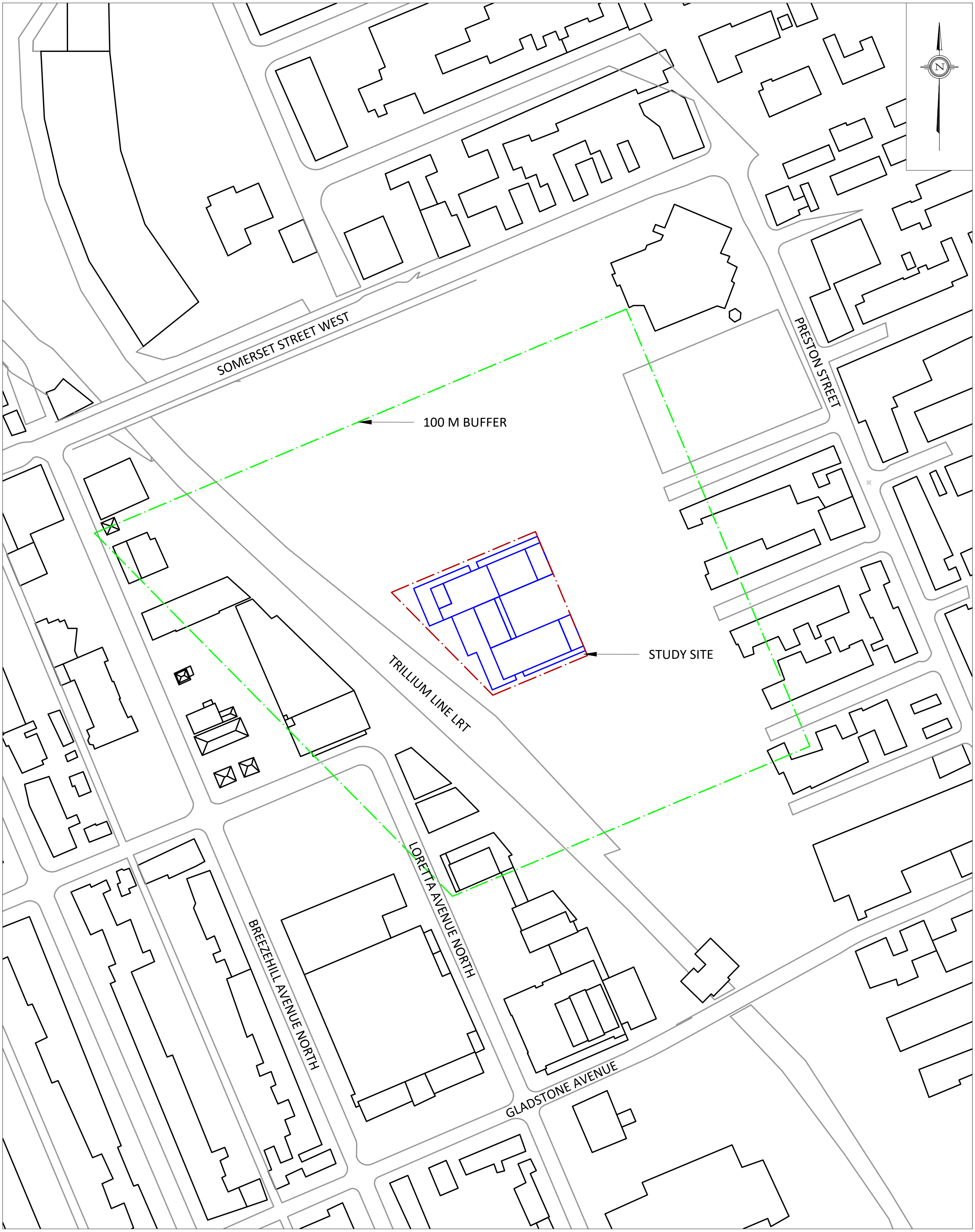
Sincerely,

Gradient Wind Engineering Inc.

Michael Lafortune, C.E.T.
Environmental Scientist

Joshua Foster, P.Eng.
Principal

Gradient Wind File #21-082-Noise & Vibration



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127 WALGREEN ROAD , OTTAWA, ON
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PROJECT	GLADSTONE VILLAGE PHASE 1, OTTAWA TRANSPORTATION NOISE & VIBRATION ASSESSMENT		
SCALE	1:3000 (APPROX.)	DRAWING NO.	GW21-082-1
DATE	SEPTEMBER 23, 2021	DRAWN BY	M.L.

DESCRIPTION

FIGURE 1:
SITE PLAN AND SURROUNDING CONTEXT

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PROJECT	GLADSTONE VILLAGE PHASE 1, OTTAWA TRANSPORTATION NOISE & VIBRATION ASSESSMENT		
SCALE	1:1000 (APPROX.)	DRAWING NO.	GW21-082-2
DATE	SEPTEMBER 23, 2021	DRAWN BY	M.L.

DESCRIPTION

FIGURE 2:
RECEPTOR LOCATIONS

GRADIENTWIND ENGINEERS & SCIENTISTS 127 WALGREEN ROAD , OTTAWA, ON 613 836 0934 • GRADIENTWIND.COM	PROJECT: GLADSTONE VILLAGE PHASE 1, OTTAWA TRANSPORTATION NOISE & VIBRATION ASSESSMENT		DESCRIPTION: FIGURE 3: STAMSON INPUT PARAMETERS - RECEPTOR 1,2,4,5
	SCALE: 1:3000 (APPROX.)	DRAWING NO.: GW21-082-3	
	DATE: SEPTEMBER 23, 2021	DRAWN BY: M.L.	

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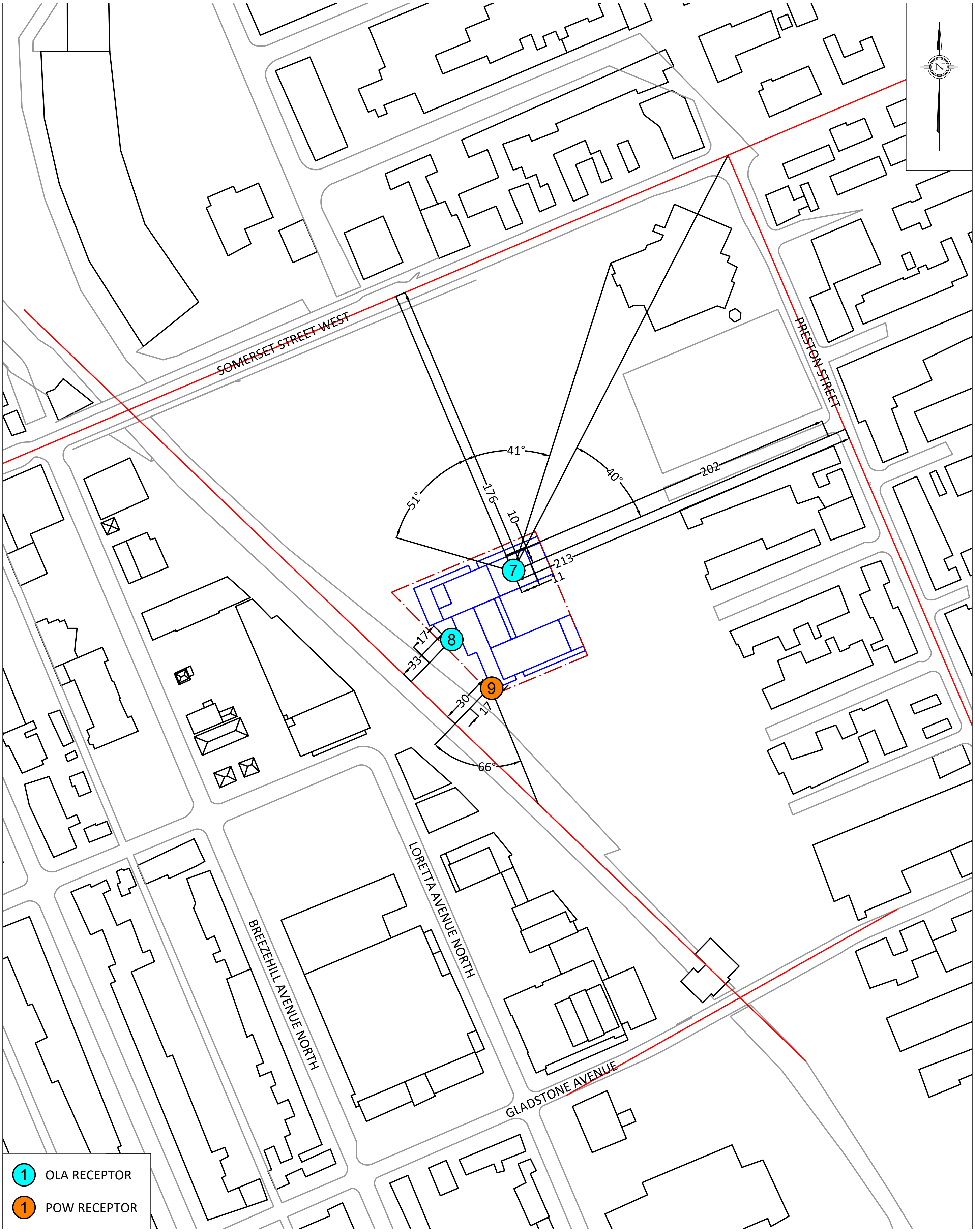
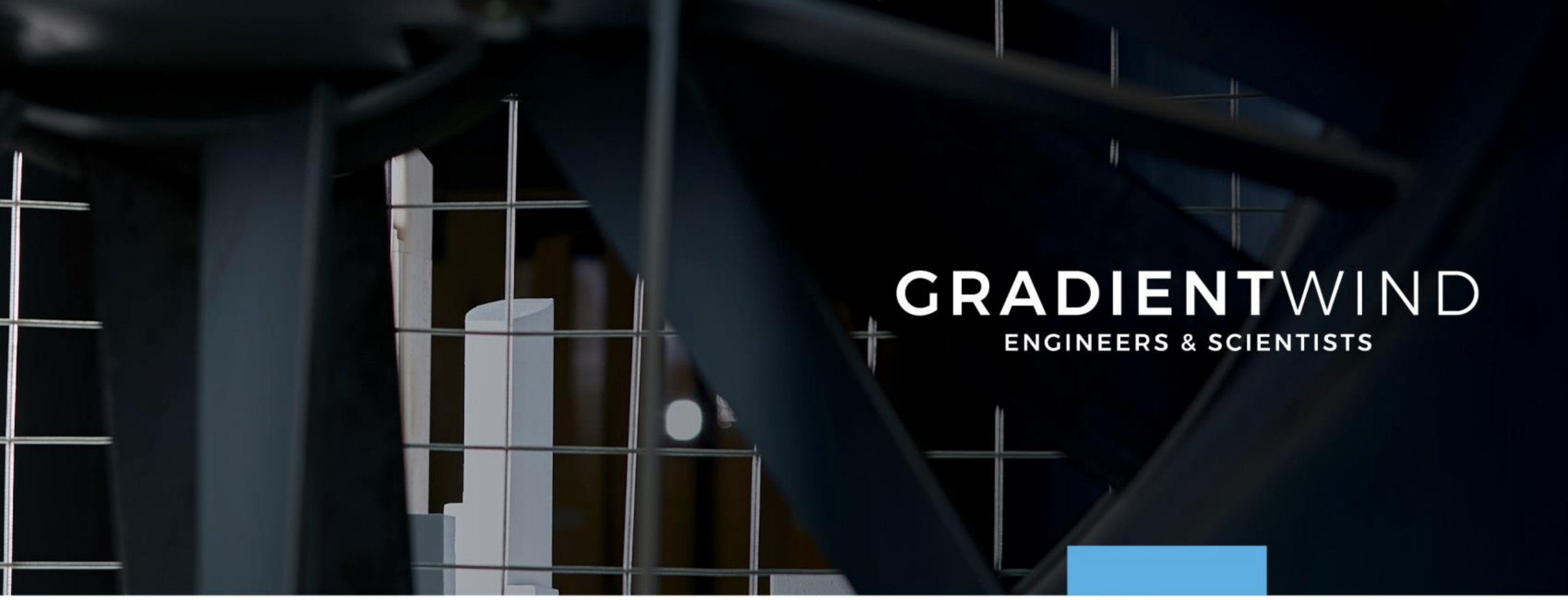
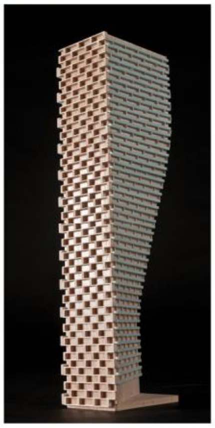
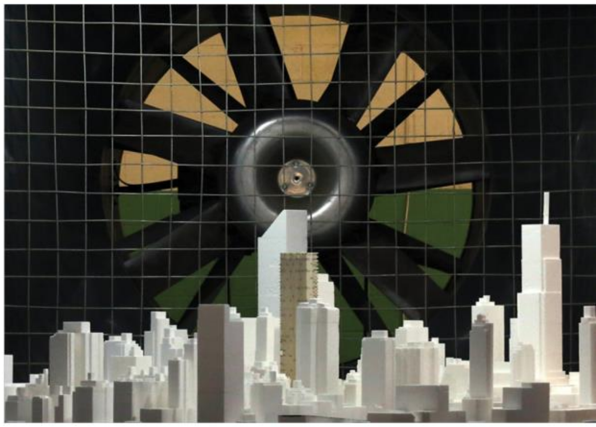
PROJECT GLADSTONE VILLAGE PHASE 1, OTTAWA TRANSPORTATION NOISE & VIBRATION ASSESSMENT		DESCRIPTION FIGURE 4: STAMSON INPUT PARAMETERS - RECEPTOR 3,6
SCALE 1:3000 (APPROX.)	DRAWING NO. GW21-082-4	
DATE SEPTEMBER 23, 2021	DRAWN BY M.L.	



GRADIENTWIND ENGINEERS & SCIENTISTS	PROJECT	GLADSTONE VILLAGE PHASE 1, OTTAWA TRANSPORTATION NOISE & VIBRATION ASSESSMENT		DESCRIPTION
127 WALGREEN ROAD , OTTAWA, ON 613 836 0934 • GRADIENTWIND.COM	SCALE: 1:3000 (APPROX.)	DRAWING NO.: GW21-082-5		FIGURE 5: STAMSON INPUT PARAMETERS - RECEPTOR 7-9
	DATE: SEPTEMBER 23, 2021	DRAWN BY: M.L.		







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: 18-08-2021 14:51:35
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Somerset (day/night)
--------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 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):  15000
    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: Somerset (day/night)
------------------------------------------
Angle1   Angle2            : -45.00 deg   52.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   : 165.00 / 165.00 m
Receiver height            :  55.00 / 55.00  m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00
```

```
Results segment # 1: Somerset (day)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 55.38 + 0.00) = 55.38 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -45     52   0.00  68.48   0.00 -10.41  -2.69   0.00   0.00   0.00
55.38
--------------------------------------------------------------------------
--

Segment Leq : 55.38 dBA

Total Leq All Segments: 55.38 dBA


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

Source height = 1.50 m

ROAD (0.00 + 47.78 + 0.00) = 47.78 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -45     52   0.00  60.88   0.00 -10.41  -2.69   0.00   0.00   0.00
47.78
--------------------------------------------------------------------------
--

Segment Leq : 47.78 dBA

Total Leq All Segments: 47.78 dBA
```

```
RT/Custom data, segment # 1: LRT (day/night)
--------------------------------------------
1 - 4-car SRT:
Traffic volume    :   192/24    veh/TimePeriod
Speed             :    50  km/h

Data for Segment # 1: LRT (day/night)
-------------------------------------
Angle1   Angle2           :  23.00 deg   52.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  52.00 / 52.00  m
Receiver height           :  55.00 / 55.00  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :  23.00 deg   Angle2 : 52.00 deg
Barrier height            :   3.00 m
Barrier receiver distance :  39.00 / 39.00  m
Source elevation          :  -5.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :  -5.00 m
Reference angle           :   0.00
```

```
Results segment # 1: LRT (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 !        55.00 !        15.38 !         10.38

RT/Custom (0.00 + 42.70 + 0.00) = 42.70 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
    23     52   0.00  56.02  -5.40  -7.93   0.00   0.00   0.00  42.70*
    23     52   0.00  56.02  -5.40  -7.93   0.00   0.00   0.00  42.70
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 42.70 dBA

Total Leq All Segments: 42.70 dBA
```

```
Results segment # 1: LRT (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 !       55.00 !       15.38 !        10.38

RT/Custom (0.00 + 36.68 + 0.00) = 36.68 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
    23     52   0.00  50.00  -5.40  -7.93   0.00   0.00   0.00  36.68*
    23     52   0.00  50.00  -5.40  -7.93   0.00   0.00   0.00  36.68
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 36.68 dBA

Total Leq All Segments: 36.68 dBA



TOTAL Leq FROM ALL SOURCES (DAY): 55.61
                         (NIGHT): 48.10
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-08-2021 14:51:39
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


RT/Custom data, segment # 1: LRT (day/night)
--------------------------------------------
1 - 4-car SRT:
Traffic volume    :   192/24    veh/TimePeriod
Speed             :    50 km/h

Data for Segment # 1: LRT (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   23.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  43.00 / 43.00  m
Receiver height           :  55.00 / 55.00  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : 23.00 deg
Barrier height            :   3.00 m
Barrier receiver distance :  23.00 / 23.00  m
Source elevation          :  -5.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :  -5.00 m
Reference angle           :   0.00
```

```
Results segment # 1: LRT (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 !       55.00 !       28.17 !        23.17

RT/Custom (0.00 + 49.43 + 0.00) = 49.43 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     23   0.00  56.02  -4.57  -2.02   0.00   0.00  -0.01  49.42*
   -90     23   0.00  56.02  -4.57  -2.02   0.00   0.00   0.00  49.43
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 49.43 dBA

Total Leq All Segments: 49.43 dBA

Results segment # 1: LRT (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 !       55.00 !       28.17 !        23.17

RT/Custom (0.00 + 43.41 + 0.00) = 43.41 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     23   0.00  50.00  -4.57  -2.02   0.00   0.00  -0.01  43.40*
   -90     23   0.00  50.00  -4.57  -2.02   0.00   0.00   0.00  43.41
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 43.41 dBA

Total Leq All Segments: 43.41 dBA
TOTAL Leq FROM ALL SOURCES (DAY): 49.43
                         (NIGHT): 43.41
```

```
STAMSON 5.0         NORMAL REPORT         Date: 18-08-2021 14:51:44
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Somerset (day/night)
--------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 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):  15000
    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: Somerset (day/night)
------------------------------------------
Angle1   Angle2           : -42.00 deg   0.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 176.00 / 176.00 m
Receiver height           :  55.00 / 55.00  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Results segment # 1: Somerset (day)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 51.47 + 0.00) = 51.47 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -42      0   0.00  68.48   0.00 -10.69  -6.32   0.00   0.00   0.00
51.47
--------------------------------------------------------------------------
--

Segment Leq : 51.47 dBA

Total Leq All Segments: 51.47 dBA


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

Source height = 1.50 m

ROAD (0.00 + 43.87 + 0.00) = 43.87 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -42      0   0.00  60.88   0.00 -10.69  -6.32   0.00   0.00   0.00
43.87
--------------------------------------------------------------------------
--

Segment Leq : 43.87 dBA

Total Leq All Segments: 43.87 dBA
```

```
RT/Custom data, segment # 1: LRT (day/night)
--------------------------------------------
1 - 4-car SRT:
Traffic volume    :   192/24    veh/TimePeriod
Speed             :    50  km/h

Data for Segment # 1: LRT (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   78.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  44.00 / 44.00  m
Receiver height           :  55.00 / 55.00  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : 78.00 deg
Barrier height            :   3.00 m
Barrier receiver distance :  30.00 / 30.00  m
Source elevation          :  -5.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :  -5.00 m
Reference angle           :   0.00
```

```
Results segment # 1: LRT (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 !       55.00 !       19.43 !        14.43

RT/Custom (0.00 + 51.05 + 0.00) = 51.05 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     78   0.00  56.02  -4.67  -0.30   0.00   0.00  -0.01  51.04*
   -90     78   0.00  56.02  -4.67  -0.30   0.00   0.00   0.00  51.05
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 51.05 dBA

Total Leq All Segments: 51.05 dBA
Results segment # 1: LRT (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 !       55.00 !       19.43 !        14.43

RT/Custom (0.00 + 45.03 + 0.00) = 45.03 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     78   0.00  50.00  -4.67  -0.30   0.00   0.00  -0.01  45.02*
   -90     78   0.00  50.00  -4.67  -0.30   0.00   0.00   0.00  45.03
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 45.03 dBA

Total Leq All Segments: 45.03 dBA
TOTAL Leq FROM ALL SOURCES (DAY): 54.28
                         (NIGHT): 47.50
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-08-2021 14:51:48
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Preston (day/night)
-------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 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):  15000
    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: Preston (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   : 199.00 / 199.00 m
Receiver height            :  27.50 / 27.50  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             : -10.00 deg   Angle2 : 90.00 deg
Barrier height             :   6.00 m
Barrier receiver distance  : 188.00 / 188.00 m
Source elevation           :   0.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00
```

```
Results segment # 1: Preston (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 !       27.50 !        2.93 !         2.93

ROAD (53.73 + 43.61 + 0.00) = 54.13 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
   -90    -10   0.00  68.48   0.00 -11.23  -3.52   0.00   0.00   0.00
53.73
----------------------------------------------------------------------------
--
   -10     90   0.00  68.48   0.00 -11.23  -2.55   0.00   0.00 -11.09
43.61
----------------------------------------------------------------------------
--

Segment Leq : 54.13 dBA

Total Leq All Segments: 54.13 dBA
```

```
Results segment # 1: Preston (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 !       27.50 !        2.93 !         2.93

ROAD (46.13 + 36.01 + 0.00) = 46.54 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -10   0.00  60.88   0.00 -11.23  -3.52   0.00   0.00   0.00
46.13
--------------------------------------------------------------------------
--
   -10     90   0.00  60.88   0.00 -11.23  -2.55   0.00   0.00 -11.09
36.01
--------------------------------------------------------------------------
--

Segment Leq : 46.54 dBA

Total Leq All Segments: 46.54 dBA



TOTAL Leq FROM ALL SOURCES (DAY): 54.13
                         (NIGHT): 46.54
```

```
STAMSON 5.0        NORMAL REPORT        Date: 23-09-2021 15:39:09
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Gladstone (day/night)
---------------------------------------------
Car traffic volume  :  9715/845   veh/TimePeriod  *
Medium truck volume :   773/67    veh/TimePeriod  *
Heavy truck volume  :   552/48    veh/TimePeriod  *
Posted speed limit  :    50 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):  12000
    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: Gladstone (day/night)
-------------------------------------------
Angle1   Angle2            : -26.00 deg   6.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   : 231.00 / 231.00 m
Receiver height            :  27.50 / 27.50  m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00
```

```
Road data, segment # 2: 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: 417 (day/night)
-------------------------------------
Angle1   Angle2            : -90.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance  : 412.00 / 412.00 m
Receiver height            :  27.50 / 27.50  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             : -90.00 deg   Angle2 : 90.00 deg
Barrier height             :   3.00 m
Barrier receiver distance : 393.00 / 393.00 m
Source elevation           :  10.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :  10.00 m
Reference angle            :   0.00
```

```
Results segment # 1: Gladstone (day)
------------------------------------

Source height = 1.50 m

ROAD (0.00 + 48.13 + 0.00) = 48.13 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -26      6   0.00  67.51   0.00 -11.88  -7.50   0.00   0.00   0.00
48.13
--------------------------------------------------------------------------
--

Segment Leq : 48.13 dBA


Results segment # 2: 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 !       27.50 !        2.23 !        12.23

ROAD (0.00 + 64.51 + 0.00) = 64.51 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  84.41   0.00 -14.39   0.00   0.00   0.00  -5.51
64.51
--------------------------------------------------------------------------
--

Segment Leq : 64.51 dBA

Total Leq All Segments: 64.61 dBA
```

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

Source height = 1.50 m

ROAD (0.00 + 40.54 + 0.00) = 40.54 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
   -26      6   0.00  59.91   0.00 -11.88  -7.50   0.00   0.00   0.00
40.54
----------------------------------------------------------------------------
--

Segment Leq : 40.54 dBA


Results segment # 2: 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 !       27.50 !        2.23 !        12.23

ROAD (0.00 + 56.91 + 0.00) = 56.91 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
   -90     90   0.00  76.81   0.00 -14.39   0.00   0.00   0.00  -5.51
56.91
----------------------------------------------------------------------------
--

Segment Leq : 56.91 dBA

Total Leq All Segments: 57.01 dBA
```

```
RT/Custom data, segment # 1: LRT (day/night)
--------------------------------------------
1 - 4-car SRT:
Traffic volume    :   192/24    veh/TimePeriod
Speed             :    50  km/h

Data for Segment # 1: LRT (day/night)
-------------------------------------
Angle1   Angle2             : -90.00 deg   24.00 deg
Wood depth                  :      0       (No woods.)
No of house rows            :      0 / 0
Surface                     :      1       (Absorptive ground surface)
Receiver source distance    :  43.00 / 43.00  m
Receiver height             :  27.50 / 27.50  m
Topography                  :      2       (Flat/gentle slope; with barrier)
Barrier angle1              : -90.00 deg   Angle2 : 24.00 deg
Barrier height              :   3.00 m
Barrier receiver distance   :  24.00 / 24.00  m
Source elevation            :  -5.00 m
Receiver elevation          :   0.00 m
Barrier elevation           :  -5.00 m
Reference angle             :   0.00
```

```
Results segment # 1: LRT (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 !       27.50 !       14.64 !         9.64

RT/Custom (0.00 + 49.47 + 0.00) = 49.47 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-----------------------------------------------------------------------
   -90     24   0.00  56.02  -4.57  -1.98   0.00   0.00  -0.02  49.45*
   -90     24   0.00  56.02  -4.57  -1.98   0.00   0.00   0.00  49.47
-----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 49.47 dBA

Total Leq All Segments: 49.47 dBA
```

```
Results segment # 1: LRT (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 !        27.50 !        14.64 !          9.64

RT/Custom (0.00 + 43.45 + 0.00) = 43.45 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     24   0.00  50.00  -4.57  -1.98   0.00   0.00  -0.02  43.43*
   -90     24   0.00  50.00  -4.57  -1.98   0.00   0.00   0.00  43.45
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 43.45 dBA

Total Leq All Segments: 43.45 dBA



TOTAL Leq FROM ALL SOURCES (DAY): 64.74
                         (NIGHT): 57.20
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-08-2021 14:51:59
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


RT/Custom data, segment # 1: LRT (day/night)
--------------------------------------------
1 - 4-car SRT:
Traffic volume    :   192/24    veh/TimePeriod
Speed             :    50 km/h

Data for Segment # 1: LRT (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  46.00 / 46.00  m
Receiver height           :  11.50 / 11.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : 90.00 deg
Barrier height            :  10.00 m
Barrier receiver distance :  10.00 / 10.00  m
Source elevation          :  -5.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :  -5.00 m
Reference angle           :   0.00
```

```
Results segment # 1: LRT (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 !        11.50 !        13.02 !          8.02

RT/Custom (0.00 + 48.30 + 0.00) = 48.30 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  56.02  -4.87   0.00   0.00   0.00  -0.18  50.97*
   -90     90   0.39  56.02  -6.76  -0.96   0.00   0.00   0.00  48.30
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 48.30 dBA

Total Leq All Segments: 48.30 dBA

Results segment # 1: LRT (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 !        11.50 !        13.02 !          8.02

RT/Custom (0.00 + 42.28 + 0.00) = 42.28 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  50.00  -4.87   0.00   0.00   0.00  -0.18  44.95*
   -90     90   0.39  50.00  -6.76  -0.96   0.00   0.00   0.00  42.28
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 42.28 dBA

Total Leq All Segments: 42.28 dBA
TOTAL Leq FROM ALL SOURCES (DAY): 48.30
                         (NIGHT): 42.28
```

```
STAMSON 5.0        NORMAL REPORT        Date: 20-08-2021 09:41:08
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r7.te              Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: Preston (day/night)
-------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 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):  15000
    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: Preston (day/night)
-----------------------------------------
Angle1   Angle2           : -40.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  : 213.00 / 213.00 m
Receiver height           :  24.50 / 24.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :   0.00 deg   Angle2 : 90.00 deg
Barrier height            :   6.00 m
Barrier receiver distance : 202.00 / 202.00 m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 2: Somerset (day/night)
--------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 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):  15000
    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: Somerset (day/night)
------------------------------------------
Angle1   Angle2           : -51.00 deg   41.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 176.00 / 176.00 m
Receiver height           :  24.50 / 24.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -51.00 deg   Angle2 : 41.00 deg
Barrier height            :  23.00 m
Barrier receiver distance :  11.00 / 11.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Results segment # 1: Preston (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 !       24.50 !        2.68 !         2.68

ROAD (50.43 + 42.61 + 0.00) = 51.09 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -40      0   0.00  68.48   0.00 -11.52  -6.53   0.00   0.00   0.00
50.43
--------------------------------------------------------------------------
--
     0     90   0.00  68.48   0.00 -11.52  -3.01   0.00   0.00 -11.34
42.61
--------------------------------------------------------------------------
--

Segment Leq : 51.09 dBA
```

```
Results segment # 2: Somerset (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 !       24.50 !       23.06 !        23.06

ROAD (0.00 + 54.87 + 0.00) = 54.87 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -51     41   0.00  68.48   0.00 -10.69  -2.91   0.00   0.00  -4.99
49.88*
   -51     41   0.00  68.48   0.00 -10.69  -2.91   0.00   0.00   0.00
54.87
--------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 54.87 dBA

Total Leq All Segments: 56.39 dBA
```

```
Results segment # 1: Preston (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 !        24.50 !         2.68 !          2.68

ROAD (42.83 + 35.01 + 0.00) = 43.49 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -40      0   0.00  60.88   0.00 -11.52  -6.53   0.00   0.00   0.00
42.83
--------------------------------------------------------------------------
--
     0     90   0.00  60.88   0.00 -11.52  -3.01   0.00   0.00 -11.34
35.01
--------------------------------------------------------------------------
--

Segment Leq : 43.49 dBA
```

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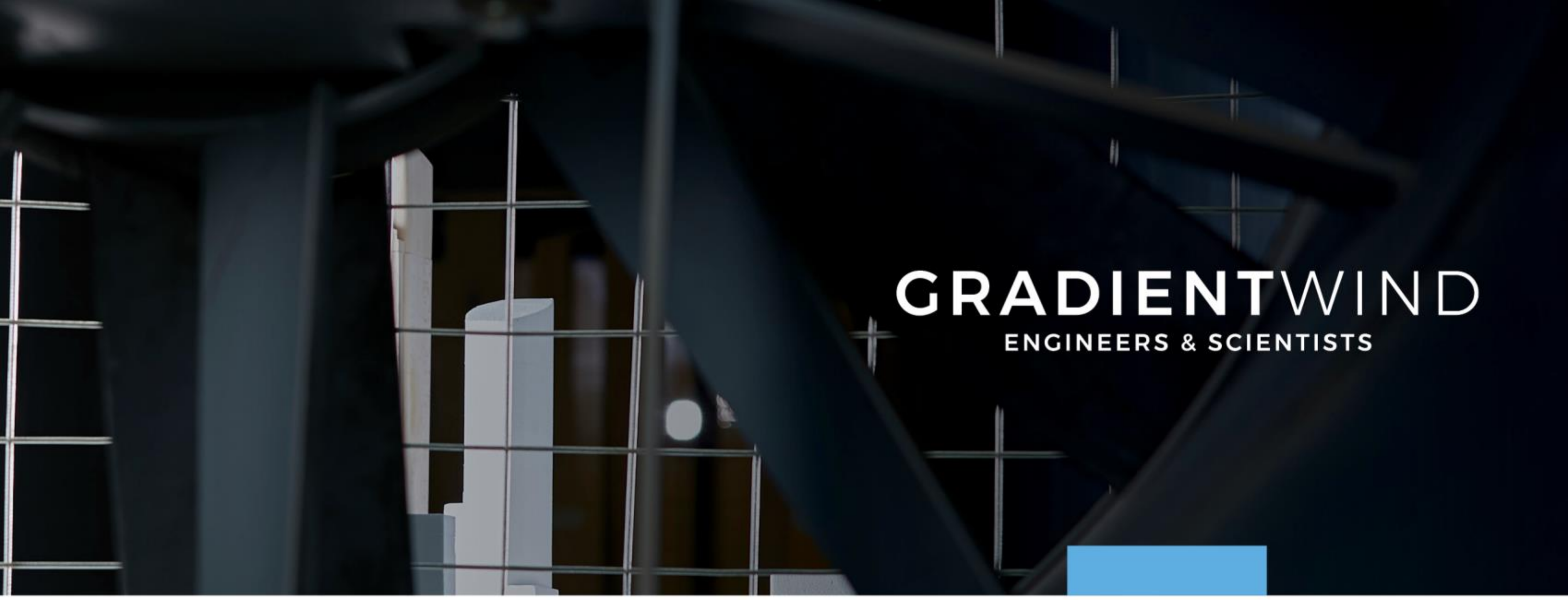
```
Results segment # 2: Somerset (night)
--------------------------------------

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 !       24.50 !       23.06 !        23.06

ROAD (0.00 + 47.27 + 0.00) = 47.27 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-----------------------------------------------------------------------------
--
   -51     41   0.00  60.88   0.00 -10.69  -2.91   0.00   0.00  -4.99
42.28*
   -51     41   0.00  60.88   0.00 -10.69  -2.91   0.00   0.00   0.00
47.27
-----------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 47.27 dBA

Total Leq All Segments: 48.79 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 56.39
                         (NIGHT): 48.79
```

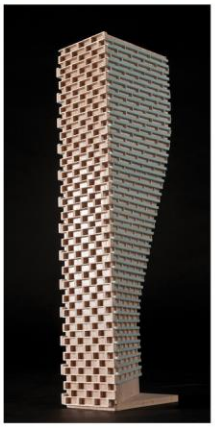
```
STAMSON 5.0        NORMAL REPORT        Date: 18-08-2021 14:52:09
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r8.te                Time Period: Day/Night 16/8 hours
Description:


RT/Custom data, segment # 1: LRT (day/night)
--------------------------------------------
1 - 4-car SRT:
Traffic volume    :   192/24    veh/TimePeriod
Speed             :    50 km/h

Data for Segment # 1: LRT (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  33.00 / 33.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : 90.00 deg
Barrier height            :   3.00 m
Barrier receiver distance :  17.00 / 17.00  m
Source elevation          :  -5.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :  -5.00 m
Reference angle           :   0.00
```

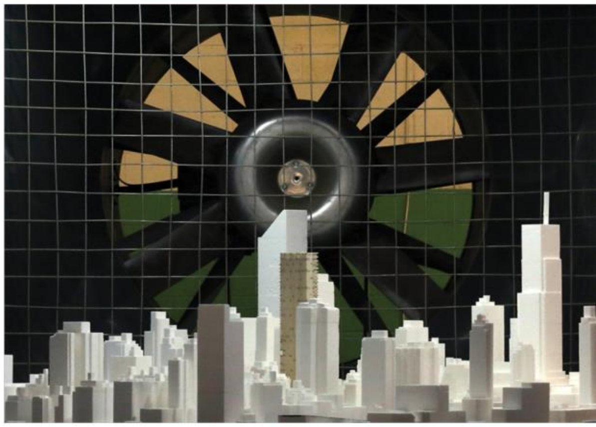
```
Results segment # 1: LRT (day)
------------------------------

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 !        1.50 !        3.41 !        -1.59

RT/Custom (0.00 + 48.88 + 0.00) = 48.88 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.51  56.02  -5.17  -1.19   0.00   0.00  -4.66  45.00*
   -90     90   0.66  56.02  -5.68  -1.46   0.00   0.00   0.00  48.88
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 48.88 dBA

Total Leq All Segments: 48.88 dBA

Results segment # 1: LRT (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 !        1.50 !        3.41 !        -1.59

RT/Custom (0.00 + 42.86 + 0.00) = 42.86 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.51  50.00  -5.17  -1.19   0.00   0.00  -4.66  38.98*
   -90     90   0.66  50.00  -5.68  -1.46   0.00   0.00   0.00  42.86
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 42.86 dBA

Total Leq All Segments: 42.86 dBA
TOTAL Leq FROM ALL SOURCES (DAY): 48.88
                         (NIGHT): 42.86
```

```
STAMSON 5.0        NORMAL REPORT        Date: 31-08-2021 10:48:11
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r9.te               Time Period: Day/Night 16/8 hours
Description:


RT/Custom data, segment # 1: LRT (day/night)
--------------------------------------------
1 - 4-car SRT:
Traffic volume    :   192/24    veh/TimePeriod
Speed             :    50 km/h

Data for Segment # 1: LRT (day/night)
-------------------------------------
Angle1   Angle2            : -66.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   :  30.00 / 30.00  m
Receiver height            :   8.45 / 8.45   m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             : -66.00 deg   Angle2 : 90.00 deg
Barrier height             :   3.00 m
Barrier receiver distance  :  17.00 / 17.00  m
Source elevation           :  -5.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :  -5.00 m
Reference angle            :   0.00


Results segment # 1: LRT (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 !         8.45 !         6.11 !         1.11

RT/Custom (0.00 + 50.08 + 0.00) = 50.08 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -66     90   0.30  56.02  -3.92  -1.20   0.00   0.00  -0.09  50.81*
   -66     90   0.48  56.02  -4.46  -1.49   0.00   0.00   0.00  50.08
----------------------------------------------------------------------

 * Bright Zone !
```

```
Segment Leq : 50.08 dBA

Total Leq All Segments: 50.08 dBA

Results segment # 1: LRT (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 !         8.45 !         6.11 !          1.11

RT/Custom (0.00 + 44.06 + 0.00) = 44.06 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -66     90   0.30  50.00  -3.92  -1.20   0.00   0.00  -0.09  44.79*
   -66     90   0.48  50.00  -4.46  -1.49   0.00   0.00   0.00  44.06
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 44.06 dBA

Total Leq All Segments: 44.06 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 50.08
                          (NIGHT): 44.06
```







APPENDIX B

FTA VIBRATION CALCULATIONS

127 WALGREEN ROAD, OTTAWA, ON, CANADA K0A 1L0 | 613 836 0934
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GW21-082 20-Aug-21

Possible Vibration Impacts on Gladstone Village Phase 1
Perdicted using FTA General Assesment

Train Speed 70 km/h 43 mph

	Distance from C/L	
	(m)	(ft)
LRT	30.0	98.4

Vibration

From FTA Manual Fig 10-1		
Vibration Levels at distance from track	68	dBV re 1 micro in/sec
Adjustment Factors FTA Table 10-1		
Speed reference 50 mph	-1	Speed Limit of 95 km/h (60 mph)
Vehicle Parameters	0	Assume Soft primary suspension, Weels run true
Track Condition	0	None
Track Treatments	0	None
Type of Transit Structure	0	None
Efficient vibration Propagation	0	Propagation through rock
Vibration Levels at Fdn	67	0.056
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	60.8	dBV or 0.028 mm/s
Noise Level in dBA	25.8	dBA

Table 10-1. Adjustment Factors for Generalized Predictions of Ground-Borne Vibration and Noise

Source Factor	Adjustment to Propagation Curve			Comment
Factors Affecting Vibration Source				
		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.