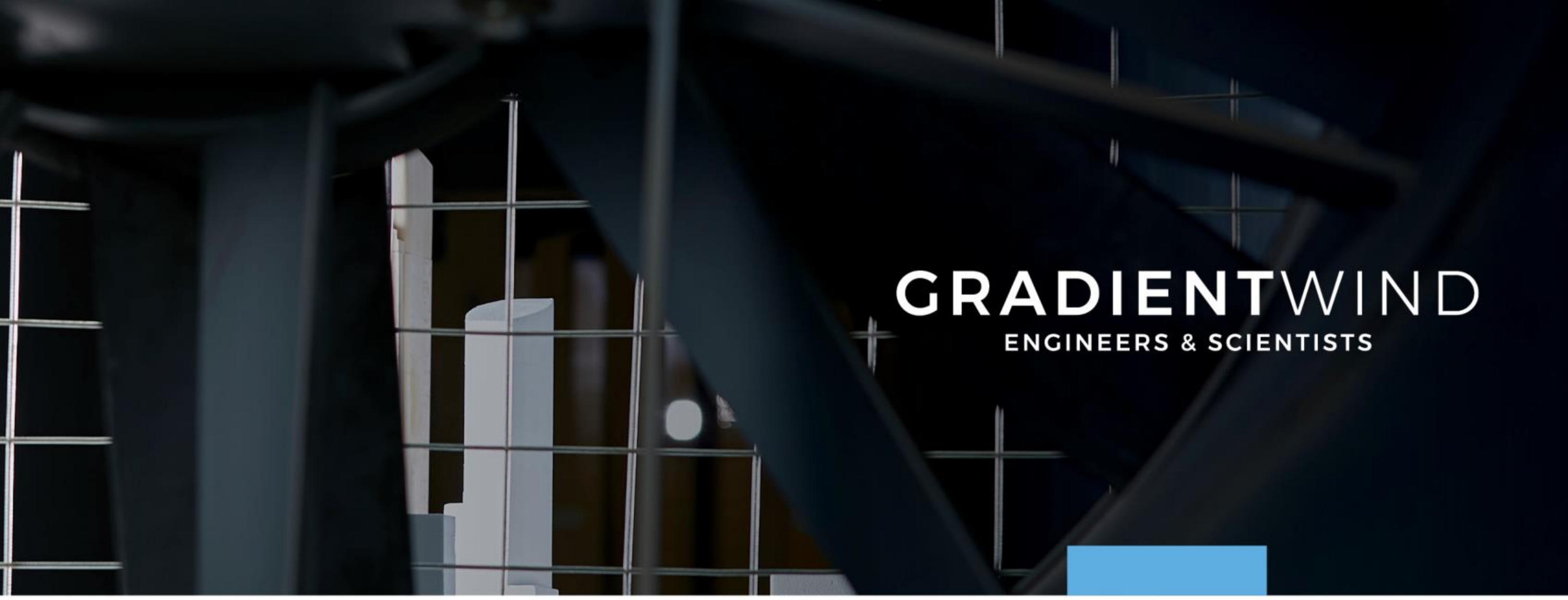
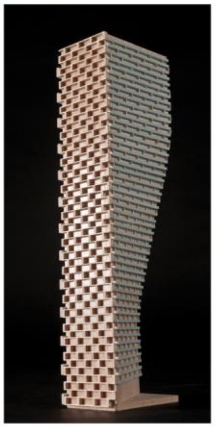
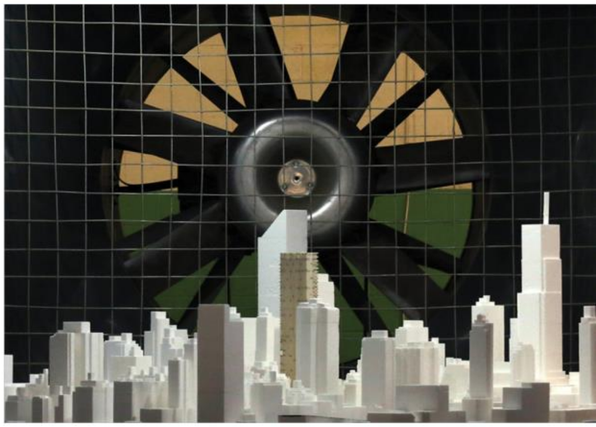


TRANSPORTATION NOISE AND VIBRATION FEASIBILITY ASSESSMENT

Tunney's Pasture Site
Servicing – Public Road Redevelopment
Ottawa, Ontario

Report: 22-226- Transportation Noise and





August 29, 2024

PREPARED FOR
Canada Lands Corporation
c/o Arcadis Professional Services (Canada) Inc.
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EXECUTIVE SUMMARY

This report describes a roadway traffic noise and vibration feasibility assessment undertaken to satisfy the requirements for a draft plan of subdivision application submissions for the proposed Site Servicing and Public Roadway Redevelopment of the Tunney's Pasture government office campus in Ottawa, Ontario. A draft plan of subdivision for Phase 1 of the redevelopment was provided for this assessment which only includes potential roadway right of way and edge of pavement details. As this study is part of a preliminary assessment, all buildings were ignored as potential screening elements. Development Blocks 1 and 2 are located in the northeast corner of the site. Block 3 is located on the southwest corner of the site and Blocks 4 and 5 are north of the transit station. Several other blocks include roadway right of way and easements, however, most of the lands will be retained by the federal government. Figure 1 illustrates a complete site plan with the surrounding context. The development Blocks considered in this assessment are highlighted in yellow in Figure 1.

The assessment is based on (i) theoretical noise prediction methods that conform to the Ministry of the Environment, Conservation and Parks (MECP) NPC-300, Ministry of Transportation Ontario (MTO), and City of Ottawa Environmental Noise Control Guidelines (ENCG) guidelines; (ii) future vehicular traffic volumes corresponding to roadway classification, roadway traffic volumes obtained from the City of Ottawa, and LRT information from the Rail Implementation Office; (iii) draft plan of subdivision drawings provided by Arcadis in July 2024; and (iv) ground-borne vibration criteria as specified by the Federal Transit Authority (FTA) Protocol.

The results of the current study indicate that noise levels due to transportation traffic over the site will range between approximately 58 and 65 dBA during the daytime period (07:00-23:00). The highest transportation noise levels will occur along Parkdale Avenue and Scott Street.

Results of the calculations also indicate that a number of blocks fronting along Scott Street, Parkdale Avenue, the internal collectors, and the Kichi Zibi Mikan Parkway will require consideration of noise mitigation measures during design development. All of the development Blocks will require forced air heating with provision for central air conditioning. With windows closed standard building components will be sufficient to attenuate indoor noise levels. Some treatment of the outdoor areas may be required, such as screening or orientating areas away from roadway noise.

Based on preliminary vibration calculations following FTA methodology, ground vibrations at the property line of the closest parcel of land are expected to fall below FTA vibration criteria, and vibration mitigation is not anticipated. For any development within 75 m of the LRT line, a future detailed vibration study will be required.

At the time of site plan approval, future detailed noise assessments would be performed for each block to determine site-specific noise mitigation and appropriate warning clauses.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Arcadis Professional Services (Canada) Inc. (Arcadis), on behalf of Canada Lands Corporation (CLC), to undertake a transportation noise and vibration feasibility assessment as part of the Tunney's Pasture Site Servicing and Public Roadway Redevelopment in Ottawa, Ontario. The project will involve a draft plan of subdivision to be submitted to the City of Ottawa for planning approval. This report summarizes the expected noise impacts across the site, ignoring building massing as a preliminary study to determine where future noise studies would be required and outline potential noise control measures for each land parcel. Gradient Wind's scope of work involved assessing exterior noise levels throughout the site, generated by local roadway and transit traffic, as well as vibration levels generated by light rail activity.

This assessment is based on theoretical noise calculation methods conforming to the Ministry of the Environment, Conservation and Parks (MECP) NPC-300[1], Ministry of Transportation Ontario (MTO)[2], and City of Ottawa Environmental Noise Control Guidelines (ENCG)[3] guidelines. Noise calculations were based on the draft plan of subdivision drawings provided by Arcadis in July 2024, with future traffic volumes corresponding to roadway classification and theoretical roadway capacities, and recent satellite imagery.

2. TERMS OF REFERENCE

The focus of this transportation noise and vibration feasibility assessment is the Tunney's Pasture government office campus in Ottawa, Ontario. The Site Servicing and Public Roadway Redevelopment project is looking at ways to redevelop portions of the site to meet future needs of the federal government office space and increase opportunities for public and private partnerships to transform the site into a mixed-use community. A draft plan of subdivision for Phase 1 of the redevelopment plan was provided for this assessment which only includes potential roadway right of way and edge of pavement details. As this study is part of a preliminary assessment, all buildings were ignored as potential screening elements. Development Blocks 1 and 2 are located in the northeast corner of the site. Block 3 is located on the

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

[2] Ministry of Transportation Ontario, "*Environmental Guide for Noise*", August 2021

[3] City of Ottawa Environmental Noise Control Guidelines, January 2016

southwest corner of the site and Blocks 4 and 5 are north of the transit station. Several other blocks include roadway right of way and easements, however, most of the lands will be retained by the federal government.

The site is surrounded by the Ottawa River approximately 400 metres to the north, and mainly residential areas in the east, south and west with a few commercial areas. The major sources of surface transportation are Kichi Zibi Mikan Parkway to the north, Parkdale Avenue to the east, Scott Street to the south, the Confederation Light Rail Transit (LRT) system to the south, currently under construction, and three (3) potential collector roadways internal to the site. No other planned Collectors, Major Collectors, or Arterial roadways are planned based on the City of Ottawa's Official Plan Schedule E. Therefore, all other local roadways internal to the site have been treated as local roads, which are considered insignificant and were not included in the analysis. Figure 1 illustrates the site location with the surrounding context. The parcels of land included as part of this study are highlighted in yellow.

With regard to stationary noise impacts, a stationary noise study is recommended for each site during the detailed design once mechanical plans become available. As there are no building plans available as stationary noise study could not be undertaken at this time. The buildings will be designed to conform with the City of Ottawa's ENCG sound level limits. Noise impacts can generally be minimized by judicious selection and placement of the equipment, and incorporating silencers, and screens where necessary.

3. OBJECTIVES

The principal objectives of this study are to (i) calculate the future noise levels on the study sites produced by local transportation sources, (ii) predict vibration levels on the study sites produced from the LRT system, and (iii) explore potential noise mitigation where required.

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 Roadway Traffic Noise and Light Rail Transit (LRT)

4.2.1 Criteria for Roadway Traffic Noise and LRT

For surface roadway traffic noise and LRT, 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. NPC-300 specifies that the recommended indoor noise limit range (that is relevant to this study) is 50, 45 and 40 dBA for retail/office/indoor amenity space, living rooms, and sleeping quarters, respectively, as listed in Table 1.

TABLE 1: INDOOR SOUND LEVEL CRITERIA (ROAD & LRT)[4]

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

[4] MOECP, Environmental Noise Guidelines, NPC 300 – Part C, Table C-9

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[5]. A closed window due to a ventilation requirement will bring noise levels down to achieve an acceptable indoor environment[6]. Therefore, where noise levels exceed 55 dBA during daytime and 50 dBA at 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[7].

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 but are less than 60 dBA mitigation should be provided to reduce noise levels where technically and administratively feasible to acceptable levels at or below the criterion. When noise levels exceed 60 dBA noise mitigation is required to reduce noise levels where technically and administratively feasible.

4.2.2 Roadway 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[8] 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.

[5] Burberry, P.B. (2014). Mitchell's Environment and Services. Routledge, Page 125
[6] MOECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.8
[7] MOECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.1.3
[8] City of Ottawa Transportation Master Plan, November 2013

TABLE 2: ROADWAY AND LRT TRAFFIC DATA

Segment	Roadway/Transit Class	Speed Limit (km/h)	Projected AADT Count
Parkdale Avenue	2-Lane Urban Arterial – Undivided (2-UAU)	50	**15,000**
Scott Street	2-Lane Urban Arterial – Undivided (2-UAU)	50	**15,000**
Kichi Zibi Mikan Parkway	4-Lane Urban Arterial-Divided (4-UAD)	60	**35,000**
Colombine Driveway	2-Lane Urban Collector (2-UCU)	40	**8,000**
Sir Fredrick Banting Driveway	2-Lane Urban Collector (2-UCU)	40	**8,000**
Tunney's Pasture Driveway	2-Lane Urban Collector (2-UCU)	40	**8,000**
Confederation Line LRT	LRT Transit	50	**540 /60***

* - Daytime/nighttime volumes

4.2.3 Theoretical Roadway Traffic Noise Predictions

The impact of transportation noise sources on the development was determined by computer modelling. Transportation noise source modelling is based on the software program *Predictor-Lima* which utilizes the United States Federal Highway Administration's Traffic Noise Model (TNM) to represent the roadway line sources. This computer program can represent three-dimensional surfaces and first reflections of sound waves over a suitable spectrum for human hearing.

The TNM analysis model has been recognized by the Ministry of Transportation Ontario (MTO) as the recommended noise model for transportation projects (ref. Environmental Guide for Noise, 2022 by the Ministry of Transportation (MTO)[9]). The Ministry of Environment, Conservation and Parks has also

[9] Ministry of Transportation, Environmental Guide for Noise, 2022. Retrieved from Environmental Guide for Noise 2022

adopted the TMN model as per their "Draft Guideline Noise Pollution Control Publications 306 (NPC-306)[10].

A set of comparative calculations was performed in the current Ontario traffic noise prediction model STAMSON for comparisons to Predictor simulation results. The STAMSON model is, however, older and requires each receptor to be calculated separately. STAMSON also does not accurately account for building reflections and multiple screening elements, and curved road geometry. A total of 6 receptor locations were identified around the site, as illustrated in Figure 2.

Roadway noise calculations were performed by treating each segment as separate line sources of noise, and by using existing and proposed building locations as noise barriers. In addition to the traffic volumes summarized in Table 2, theoretical noise predictions were based on the following parameters:

- The main site has a relatively flat topography, while the transitway and LRT are in a trench at a lower elevation of approximately 4-5 metres below the average grade of the site. These factors were considered in our modelling.
- Building massing of the site conservatively ignored
- Confederation LRT modelled as 4-car SRT source in STAMSON
- Confederation LRT modelled as a moving source in Predictor

4.3 Ground Vibration and 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 or subway. Repetitive motion of the wheels on the track or rubber tires passing over an uneven surface causes vibration to propagate through the soil. When

[10] Ministry of Environment, Conservation and Parks, Ontario, "Methods to determine Sound Levels Due to Road and Rail Traffic", Draft February 12, 2020

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

The Canadian Railway Association and Canadian Association of Municipalities have set standards for new sensitive land developments within 300 metres of a railway right-of-way, as published in their document *Guidelines for New Development in Proximity to Railway Operations*[11], which 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.

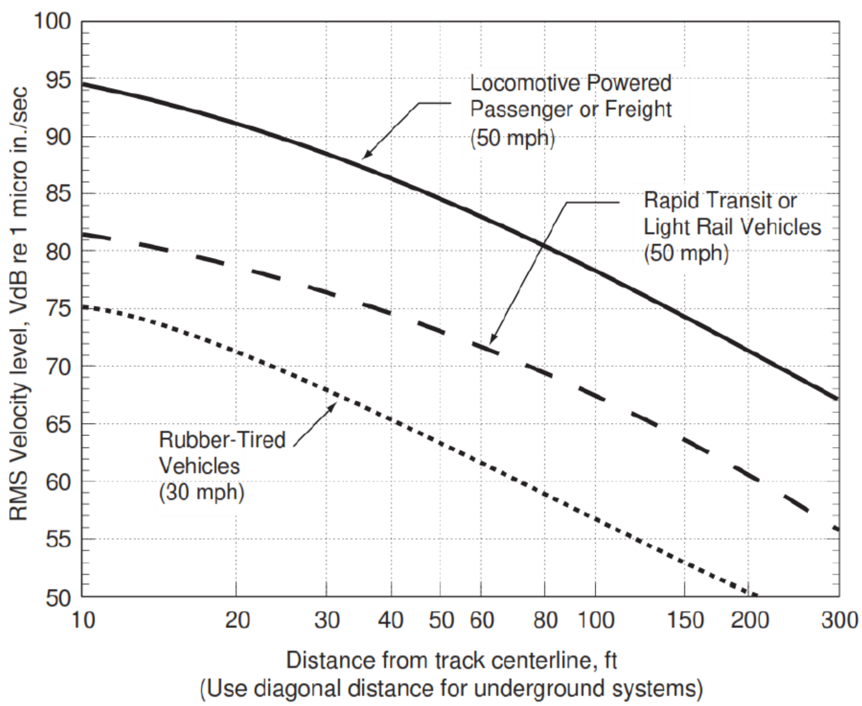
4.3.2 Theoretical Ground Vibration Prediction Procedure

Potential vibration impacts of the trains were predicted using the Federal Transit Authority's (FTA) *Transit Noise and Vibration Impact Assessment*[12] 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,

[11] Dialog and J.E. Coulter Associates Limited, prepared for The Federation of Canadian Municipalities and The Railway Association of Canada, May 2013
[12] John A. Volpe National Transportation Systems Center, Transit Noise and Vibration Impact Assessment, Federal Transit Administration, September 2018

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 Rapid Transit at a speed of 50 mph. Adjustment factors were considered based on the following information:

- The maximum operating speed of the LRT line is 31 mph (50 km/h) as trains move in and out of the station
- The setback distance between the development blocks and the closest track is 30 m.
- The vehicles are assumed to have soft primary suspensions.
- Tracks are welded, and otherwise in good condition.
- Soil conditions do not efficiently propagate vibrations.
- The building's foundation will bear on bedrock.
- Type of transit structure is Station.



FTA GENERALIZED GROUND SURFACE VIBRATION LEVELS VERSUS DISTANCE
(ADOPTED FROM FIGURE 6-4, FTA TRANSIT NOISE AND VIBRATION IMPACT ASSESSMENT)

5. RESULTS

5.1 Roadway Traffic Noise Levels

The results of the transportation noise calculations for the daytime period are shown in Figure 3 which covers the entire study site. Figure 3 illustrates noise contours produced by a *TNM* at 10 m above grade to represent midrise buildings. Discrete POR were also placed at ground level at key locations throughout the site. Table 3 below shows the daytime results from the TNM with comparison to some receptors using STAMSON.

TABLE 3: EXTERIOR NOISE LEVELS DUE TO ROADWAY & LRT TRAFFIC SOURCES

Receptor Number	Receptor Height Above Grade/Roof (m)	Receptor Location	Daytime Noise Level (dBA)	
			TMN	STAMSON
R1	1.5	Northwest Corner of the site	61	60
R2	1.5	Westside of Block 1	59	N/A
R3	1.5	East side Block 4	65	67
R4	1.5	Middle Block 2	58	N/A
R5	1.5	South side Block 5	57	N/A
R6	1.5	Middle of Block 3	58	60

As shown above, the results calculated from *Predictor-Lima* generally have good correlation with calculations performed in STAMSON 5.04. A tolerance of 3 dBA between models is generally considered acceptable given human hearing cannot detect a change in sound level of less than 3 dBA. For receptor 5, the larger difference in predicted noise levels is likely do to the fact that the TMN model is a more advanced algorithm and better accounts for screening and ground absorption, and other attenuation factors. As stated in Section 4.3.1, all buildings on-site were conservatively ignored. Results of the calculations also indicate that a number of blocks fronting along Scott Street, Parkdale Avenue, the internal collectors, and the Kichi Zibi Mikan Parkway will require consideration of noise mitigation measures during design development. These measures are in Section 5.4, with the aim to reduce the L_{eq} to as close to 55 dBA as technically, economically and administratively feasible.

5.1.1 Noise Control Measures

The OLA noise levels predicted due to transportation traffic, at a number of POR, exceed the criteria listed in the ENCG for outdoor living areas, as discussed in Section 4.2. Therefore, noise control measures as described below from Table 2.3a in the ENCG, in order of preference, will be required to reduce the L_{eq} to 55 dBA:

- Distance setback with soft landscaped ground
- Insertion of noise-insensitive land uses between the source and sensitive points of reception
- Orientation of buildings to provide sheltered zones
- Shared outdoor amenity areas
- Earth berms (sound barriers)
- Acoustic barriers

Distance setback, insertion of noise-insensitive land uses, and building orientation to provide sheltered zones for OLA are recommended to be the primary noise control measures to reduce noise levels to or below 55 dBA in these areas. However, if these measures are not applicable for technical or administrative reasons, then the insertion of earth berms and acoustic barriers between sensitive OLA and sources of noise are required. The use of earth berms or acoustic barriers would be the work of a future detailed study at the time of site plan approval.

Additionally, the blocks with noise levels over 55 dBA will likely require noise control measures to ensure indoor sound level criteria are satisfied, which trigger ventilation requirements and potential upgraded building components. These measures, illustrated in Figure 2, are based on the contour noise levels shown in Figure 3. The worst-case noise level contour lines were generated at 10 metres above the ground to represent midrise buildings. Therefore, noise control measures, described in Table 4 may be required for the various blocks. As this is a preliminary assessment, noise control recommendations are of a general nature; specific mitigation requirements would be the work of future studies. Applicable warning clauses for tenants and owners would be included according to the noise recommendations.

Note: Block numbers are separate and different from POR numbers as shown in Table 3.

TABLE 4: GENERAL NOISE RECOMMENDATIONS

Block Number	Noise Recommendations	Noise Level (dBA)
1	Forced Air Heating with provision for Central Air Conditioning/ treatment of OLA	55-65
2	Forced Air Heating with provision for Central Air Conditioning/ treatment of OLA	55-65
3	Forced Air Heating with provision for Central Air Conditioning/ treatment of OLA	55-60
4	Forced Air Heating with provision for Central Air Conditioning/ treatment of OLA	55-60
5	Forced Air Heating with provision for Central Air Conditioning/ treatment of OLA	55-60

5.2 Ground Vibrations and Ground-Borne Noise Levels

Based on an offset distance of 30 metres between the Confederation LRT line and the property line, the estimated vibration levels at the nearest point of reception are expected to be 0.022 mm/s RMS based on the United States Federal Transit Authority (US FTA) protocol. Details of the calculations are provided in Appendix A. Since predicted vibration levels are below the criterion of 0.1 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 calculated vibration levels were found to be 57 dBV, ground-borne noise levels of 22 dBA are expected to fall below the FTA criterion of 35 dBA. For any development within 75 m of the LRT line, a future detailed vibration study will be required.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current study indicate that noise levels due to transportation traffic over the site will range between approximately 58 and 65 dBA during the daytime period (07:00-23:00). The highest transportation traffic noise levels will occur along Parkdale Avenue and Scott Street.

Results of the calculations also indicate that a number of blocks fronting along Scott Street, Parkdale Avenue, the internal collectors, and the Kichi Zibi Mikan Parkway will require consideration of noise mitigation measures during design development. All of the development Blocks will require forced air heating with provision for central air conditioning. With windows closed standard building components will be sufficient to attenuate indoor noise levels. Some treatment of the outdoor areas may be required, such as screening or orientating areas away from roadway noise.

Based on preliminary vibration calculations following FTA methodology, ground vibrations at the property line of the closest parcel of land are expected to fall below FTA vibration criteria, and vibration mitigation is not anticipated. For any development within 75 m of the LRT line, a future detailed vibration study will be required.

At the time of site plan approval, future detailed noise assessments would be performed for each block to determine site-specific noise mitigation and appropriate warning clauses.

This concludes our roadway traffic noise and vibration feasibility 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.

LICENSED PROFESSIONAL ENGINEER
J. R. FOSTER
100155655
Aug 29, 2024
PROVINCE OF ONTARIO

Efser Kara, MSc, LEED GA
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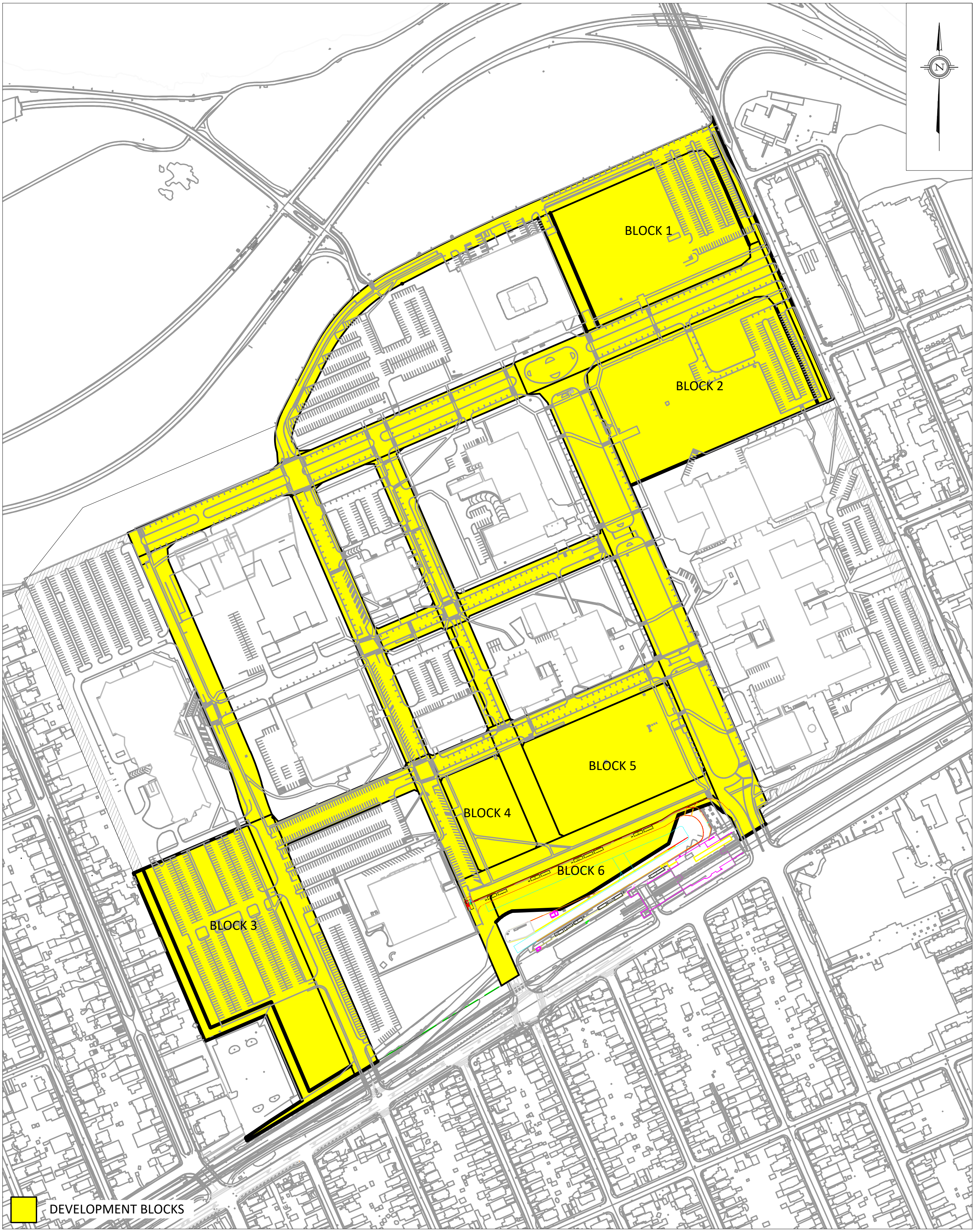
Joshua Foster, P.Eng.
Lead Engineer

Gradient Wind File 22-226- Transportation Noise and Vibration Feasibility



GRADIENTWIND
ENGINEERS & SCIENTISTS

127 WALGREEN ROAD , OTTAWA, ON
613 836 0934 • GRADIENTWIND.COM

PROJECT	TUNNEY'S PASTURE - TRANSPORTATION NOISE & VIBRATION ASSESSMENT		DESCRIPTION: FIGURE 1: PLAN OF SUBDIVISION AND SURROUNDING CONTEXT
SCALE	1:5000 (APPROX.)	DRAWING NO. GW22-226-1	
DATE	AUGUST 16, 2024	DRAWN BY J.F.	

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PROJECT	TUNNEY'S PASTURE - TRANSPORTATION NOISE & VIBRATION ASSESSMENT		
SCALE	1:5000 (APPROX.)	DRAWING NO.	GW22-226-2
DATE	AUGUST 16, 2024	DRAWN BY	J.F.

DESCRIPTION

FIGURE 2:
RECEPTOR LOCATIONS AND NOISE CONTROL

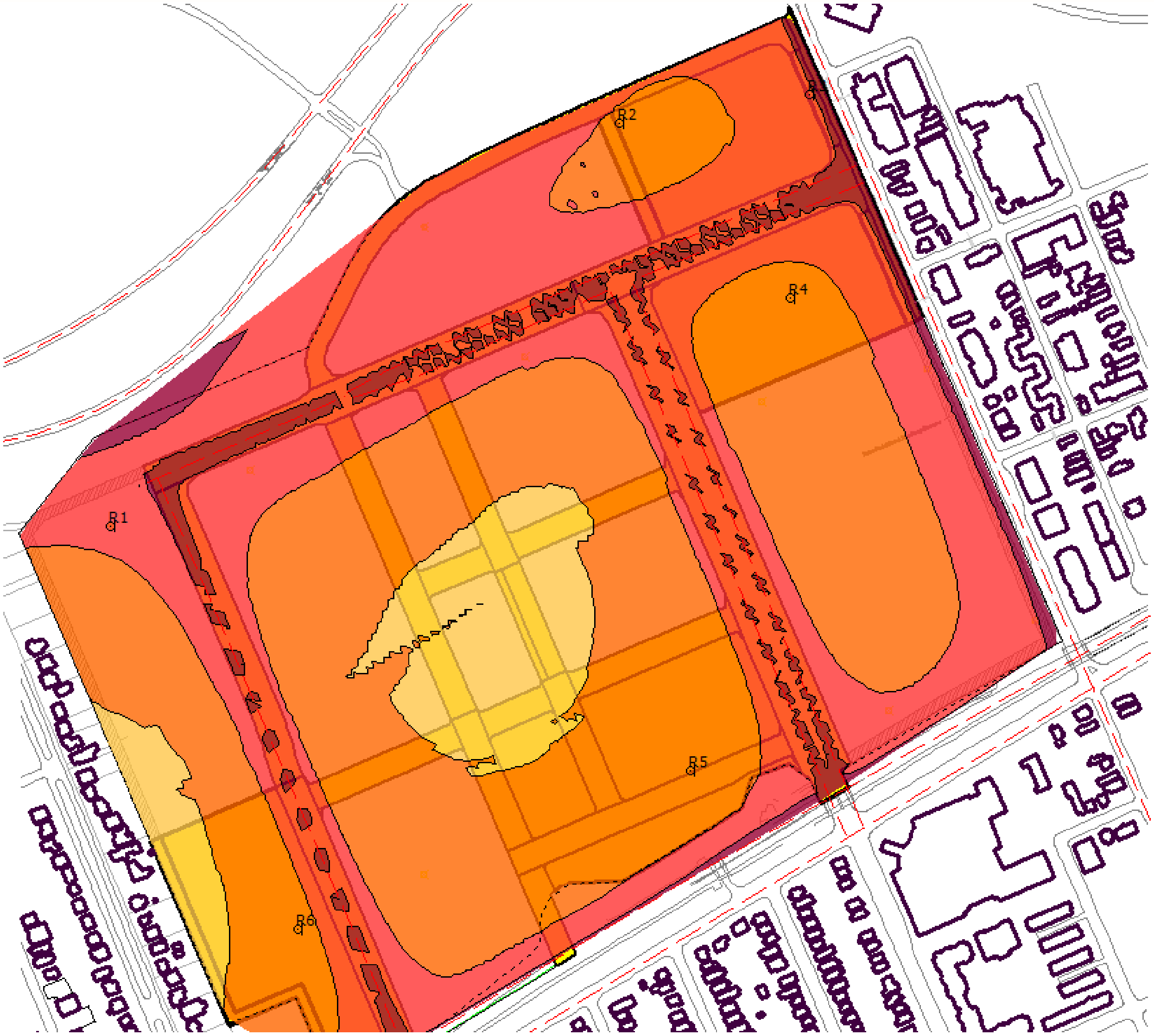
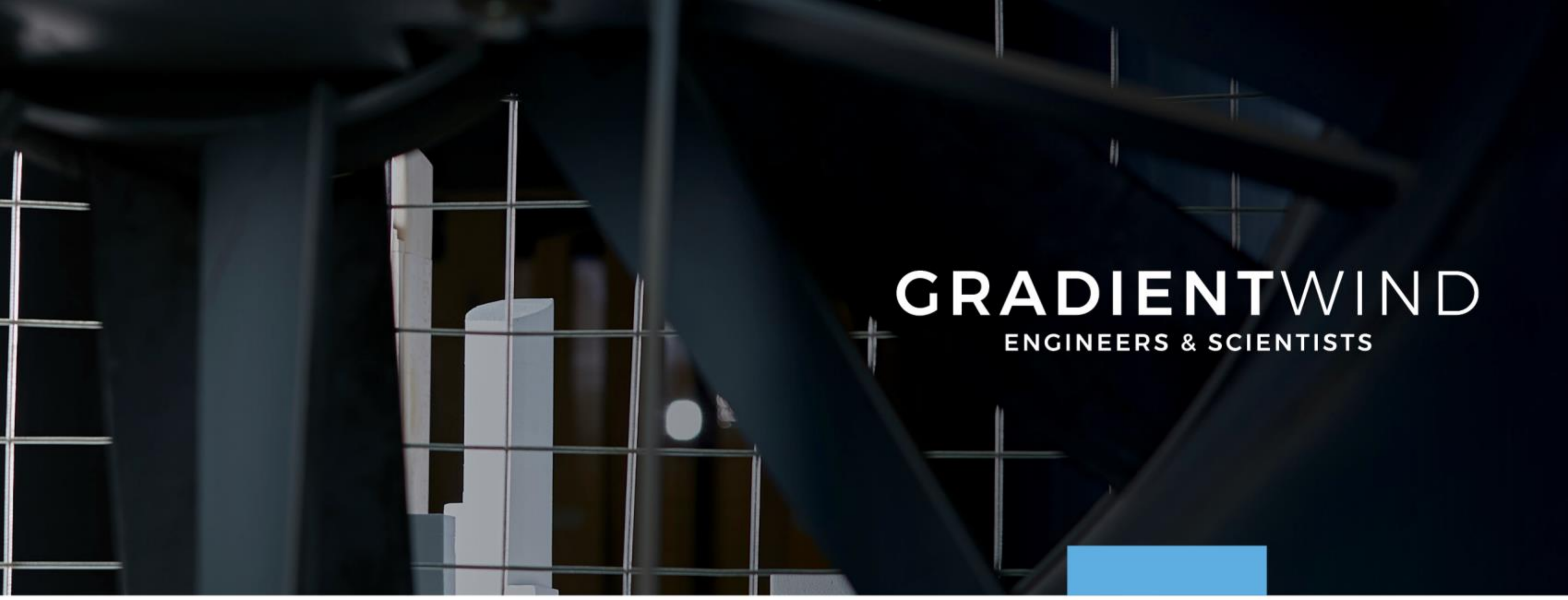
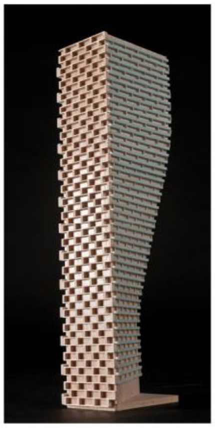
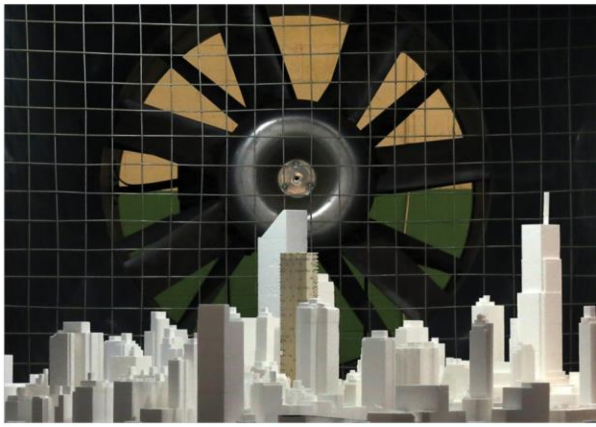


FIGURE 3: DAYTIME TRAFFIC NOISE CONTOURS
(10 M ABOVE GRADE)

80 – 85 dB
75 – 80 dB
70 – 75 dB
65 – 70 dB
60 – 65 dB
55 – 60 dB
50 – 55 dB
45 – 50 dB
40 – 45 dB
35 – 40 dB
0 – 35 dB







APPENDIX A

FTA VIBRATION CALCULATIONS

Train Speed		50 km/h		31 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	-4	Speed Limit of 50 km/h (31 mph)	
Vehicle Parameters	0	Assume Soft primary suspension, Wheels run true	
Track Condition	0	none	
Track Treatments	0	none	
Type of Transit Structure	-5	Station	
Efficient vibration Propagation	0	Propagation through rock	
Vibration Levels at Property Line	59		0.022

Total Vibration Level	56.84783	dBV or	0.01767	mm/s
Noise Level in dBA	21.84783	dBA		