Veneklasen Associates

Orleans Health Hub

Ottawa, ON

Exterior Noise Report

March 29, 2019

Noise Criteria
Exterior Noise Environment
Exterior / Interior Noise Calculation

Veneklasen Associates (VA) has completed our review of the Orleans Health Hub project located in Ottawa, Ontario. This report predicts the exterior noise level at the site using measurements and computer modeling. Using this information, interior noise levels were calculated based on the exterior noise exposure and the construction types proposed. From this, the resulting interior noise levels and plane of window noise levels for both road and stationary noise sources were determined. This report represents the results of our findings.

1.0 INTRODUCTION

This study was conducted to determine the impact of the exterior noise sources on the Orleans Health Hub (OHH) project in Ottawa, Ontario. VA's scope of work included calculating the exterior noise levels impacting the site and determining the method, if any, required to reduce the interior and exterior sound levels to meet the applicable code requirements of the Province of Ontario and the City of Ottawa.

The project consists of a single-story building dedicated to outpatient medical treatment with spaces used for Active Rehabilitation, Geriatric Support, Diagnostic Imaging, Mental Health, and Needs- Based Ambulatory Programs. The project is bounded by Mer Bleue Road to the west, Brian Coburn Blvd to the south, undeveloped land to the north, and existing residential use to the east.

2.0 NOISE CRITERIA

L_{eq} (equivalent continuous sound level) is defined as the steady sound pressure level which—over a given period of time—has the same total energy as the actual fluctuating noise. As per the City of Ottawa Environmental Noise Control Guideline, noise levels are expressed in the form $L_{eq(T)}$ which refers to a weighted level of a steady sound carrying the same total energy in the time period T (in hours) as the observed fluctuation sound.

2.1 Transportation Noise – Road and Rail

The City of Ottawa's Environmental Noise Control Guidelines (ENCG) specifies that the recommended Outdoor Living Area (OLA) noise limit is 55 dBA during the day time period. OLA are not applicable to this project and therefore do not need to be considered.

For roadways, the L_{eq} is commonly calculated on basis of a 16- hour (L_{eq16}) daytime (07:00-23:00) and 8-hour (L_{eq8}) nighttime (23:00-07:00) split to assess its impact on residential buildings. ENCG also specifies sound level limits for indoor spaces from the Road and Rail transportation sources. According to the ENCG, sound level limits for General office, Reception areas should not exceed 45 dBA during 07:00 to 23:00 (16 hr Daytime).

2.2 Stationary Noise Sources

Section 3.0 of the 2016 Ottawa ENCG stipulates that a new development in proximity to existing stationary sources of noise and/or the development of a new stationary noise source in proximity to existing noise-sensitive land uses need to comply with the Exclusion Limit Values of one-hour $L_{eq(1hr)}$ given in Table 1 below. The impact of stationary noise on the community is mainly dependent on its location. As per the ENCG, Area Classes for Definition of Stationary Noise Ambient Sound Level, proposed site and the surrounding land uses comes under the "Class 2" area classification.

Table 1 – Guidelines for Stationary Noise

Time of Day	Class 1 Area		Class 2 Area		Class 3 Area		Class 4 Area	
	Outdoor Point of Reception Leq (dBA)	Plane of Window Leq dBA)	Outdoor Point of Reception Leq (dBA)	Plane of Window Leq (dBA)	Outdoor Point of Reception Leq (dBA)	Plane of Window Leq (dBA)	Outdoor Point of Reception Leq (dBA)	Plane of Window Leq (dBA)
07:00-19:00	50	50	50	50	45	45	55	60
19:00-23:00	50	50	45	50	40	40	55	60
23:00-07:00	NA	45	NA	45	NA	40	NA	55

3.0 ALTERNATIVES FOR NOISE ATTENUATION MEASURES

When sound levels are predicted to exceed the sound level criteria, a combination of attenuation measures and warning clauses are recommended by the City of Ottawa and the MOE to modify the development environment.

These attenuation measures may include any or all of the following:

- Distance setback with soft ground
- Insertion of noise insensitive land uses between the source and the sensitive receptor
- Orientation of building to provide shelter
- Construction of sound or acoustic barriers
- Installation of air conditioning and ventilation
- Enhanced construction techniques and construction quality.

3.1 Noise Barrier

When noise levels exceed 55 dBA in the Outdoor Living Area, control measures (barriers) are required to reduce the Leq to below 60 dBA and as close to 55 dBA as technically, economically and administratively feasible.

The noise barriers are compliant with the City standard for noise barriers and have the following characteristics:

- Minimum Hight 2.2 m
- Situated 0.30 m inside the private property line
- A surface mass density not less than 20 kg/sq.m.
- No holes or gaps

3.2 Ventilation Requirement

A forced air heating system provision for a central air conditioning system is required if the plane of window daytime noise levels is between 55 dBA and 65 dBA and/or the night time noise levels are between 50 dBA and 60 dBA.

The installation of central air conditioning system is required when the daytime noise level exceeds 65 dBA and/or the night time noise level exceed 60 dBA.

3.3 Building Component Assessment

When plane of window noise levels exceeds 65 dBA(daytime) or 60 dBA (night time) the exterior cladding system of the building envelope must be acoustically assessed to ensure indoor sound criteria are achieved. This include analysis of the exterior wall, door, and/or glazing system specifications as appropriate.

3.4 Warning Clauses

When predicted noise levels exceed the specified criteria, the City of Ottawa and the MOE recommend warning clauses be registered as a notice on title and incorporated onto the lease/rental/sale agreements to warn potential purchaser/buyers/tenants of the possible elevated noise levels.

The following typical warning clauses are extracted from section C8.1 of the MOE NPC-300 document.

Warning Clauses Type A

“Purchasers/tenants are advised that sound levels dues to increasing road traffic may occasionally interfere with some activities of the dwelling occupants as the sound levels exceed the City’s and Ministry of the Environment’s noise Criteria.”

Warning Clause Type B

“purchases/tenants are advised that despite the inclusion of noise control feature in the development and building units, sound level due to increasing road traffic may on occasion interfere with some activities of the dwelling occupants as the sound levels exceed the City’s and the Ministry of Environment’s noise criteria.”

Warning Clause 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 will allow window and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the City’s and the Ministry of Environment’s noise criteria.”

Warning Clause Type D

“This dwelling unit has been supplied with a central air conditioning system which will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the City’s and the Ministry of the Environment’s noise criteria.”

Warning Clause Type E

“Purchasers/tenants are advised that sound levels due to the proximity of the adjacent industry (facility)(utility), noise from the industry (facility) (utility) may at times be audible.

3.5 Summary of noise Attenuation Measures Requirements

Table 2 Summarizes the required noise attenuation measures and warning clauses should sound criteria be exceeded.

Table 2 – Outdoor, Ventilation, Stationary Sources and Warning clause Requirement Summary

Assessment Location	Leq (dBA)	Outdoor Control Measures	Indoor Control Measures		Warning Clause
			Ventilation Requirement	Building Components	
Outdoor Living Area (OLA)	Less than 55	None required	N/A	N/A	None required
	Between 55 and 60	Control measures (barriers) may not be required but should be considered	N/A	N/A	Required if resultant Leq exceeds 55 dBA Type A
	More than 60	Barriers required	N/A	N/A	Required if resultant /Leq exceeds 55dBA Type B
Plane of Window (POW)	Less than 55	N/A	None Required	None Required	None Required
	Between 55 and 65	N/A	Forced air heating with provision for central air conditioning	None required	Required Type C
	More than 65	N/A	Central Air Conditioning	Acoustical performance of the windows and walls should be specified	Required Type D

4.0 EXTERIOR NOISE ENVIRONMENT

4.1 Noise Measurements

Traffic on Mer Bleu Road, and Brian Coburn Blvd was the primary source of noise affecting the site. VA visited the site on Friday, February 09, 2018 and placed meters by the side of the two roads (10 m and 8 m respectively) to capture the short-term sound levels on the site. Table 3 and Figure 1 show the summary and location of the noise measurements.

Table 3 – Measured and Calculated Sound Levels

Location	Measured Daytime, L_{eq} dBA	Calculated Daytime, 16hr L_{eq16} dBA
Location 1	65.9 (2 hr)	65.9
Location 2	69.2 (1.5 hr)	66.0
Location 3	50.6 (0.5 hr)	50.0

Figure 1 – Aerial View of Project Site Showing Measurement Locations

4.2 Computer Modeling

VA has utilized Brüel & Kjær Predictor version 12.0 environmental noise software to produce traffic noise models built upon both ISO 9613 "Acoustics—Attenuation of sound during propagation outdoors" and the United States Department of Transport Federal Highway Administration's "Traffic Noise Model" version 2.5 algorithms in order to predict vehicular noise levels at various locations. The primary purpose of the computer model was to determine how the noise environment will change due to traffic and site changes.

Traffic volume data for Mer Bleu Road and Brian Coburn Blvd were provided by Appendix B of the Environmental Noise Control Guidelines document of the City of Ottawa. This document indicates that the average annual daily traffic volume for Mer Bleu Road will be 24000 vehicles per day for a 4-Lane Major Collector (4-UMCU) and Brian Coburn Blvd will be 8000 vehicles per day for a 2-Lane Outer Rural Arterial near the extremities of the City (2-RAU). Additional information regarding applicable assumptions and ratios for day/night traffic and car/truck traffic is summarized as follows:

- Heavy truck traffic for this segment is estimated to be 5% of total volume;
- Medium truck traffic for this segment is estimated to be 7% of total traffic volume—the rest is assumed to be car traffic;
- Daytime (7:00 am -11:00 pm) traffic is assumed to be 92%, with the remaining 8% at night (11:00 pm -7:00 am). Speed limit for Mer Bleu Road and Brien Coburn Blvd is 60 km/hr.

5.0 EXTERIOR / INTERIOR NOISE CALCULATION

5.1 Exterior Façade Construction

The plans show that the exterior wall will consist of 12.5 mm phenolic panel, 25 mm air space, 75mm 'Z' girts (vertical), 50mm semi-rigid insulation, 75mm 'Z' girts(horizontal), 75mm semi rigid insulation, 16mm exterior sheathing with a single layer of 16 mm gypsum board on 150 mm steel stud and batt insulation in the cavity. VA's calculations included the roof path, but this was insignificant in the interior noise level calculated. The glazing ratings (glass, frame, and seals) utilized in the calculations are shown in Appendix II.

5.2 Exterior 16hr Noise level

Using the Predictor noise model, noise levels were calculated for daytime conditions at the point representing the anticipated building location. The anticipated site plan is shown in Figure 2 below. The noise contours were generated using Predictor modeling software and verified with discrete receptors using the US Department of Transport Federal Highway Administration "Traffic Noise Model" (TNM) version 2.5. Results are summarized in Table 4 below. Appendix I, Figure 4 and Figure 5 contains the daytime and nighttime noise contour maps generated by the Predictor modeling software.

Figure 2 – Site Plan and Building Locations

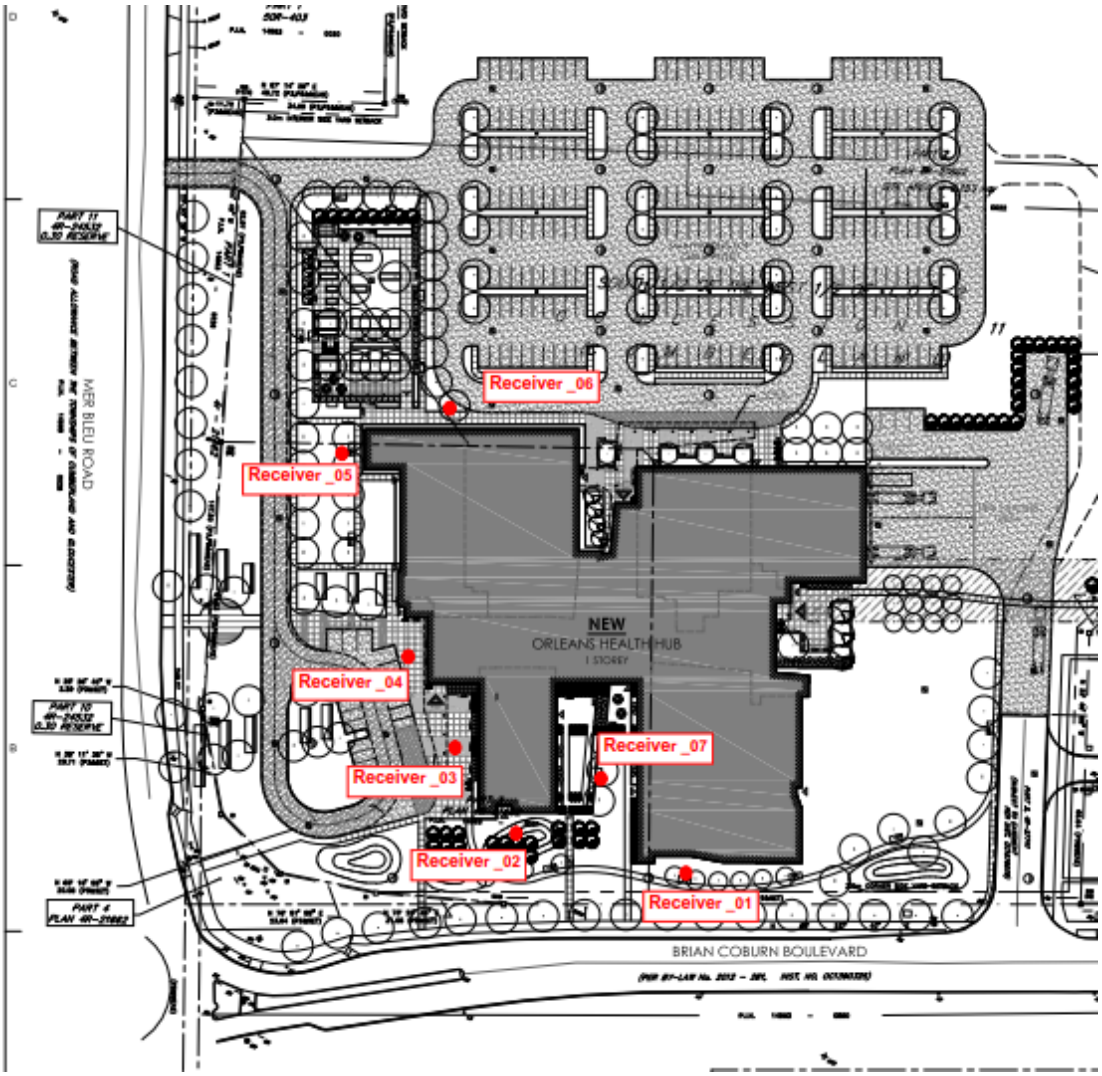


Table 4 – Exterior Noise Levels due to Road Traffic

Receiver Number	Receptor Location	Noise Levels (dBA) Day (07:00-23:00)	Night (23:00-07:00)
1	South of Needs-Based Ambulatory Bldg.	59	51
2	South of Mental Health & Wellness Bldg.	57	49
3	West of Mental Health & Wellness Bldg.	56	48
4	West of Welcome & Reception Area	56	49
5	West of Activity Rehab Area	56	49
6	North of Activity Rehab Area	50	43
7	Outdoor Amenity Area	54	46

5.3 Interior Average Noise Levels Due to Exterior Noise Sources

Based on the computer model and measurements, VA calculated the noise level at different locations across the project site. To simplify the presentation of the exterior noise levels, VA has separated the site into locations based on the sound exposure and required mitigation. The predicted sound levels at each zone, shown in Figure 3 are listed in Table 5 below.

Table 5 – Exterior Noise Level Zones

Location	Exterior Noise Level, L_{eq16} (dBA)
Zone A	59
Zone B	57
Remaining Area	< 56

VA calculated the interior level within different areas of the facility given the measured noise environment and the exterior façade construction described above. Calculations were based on the plans dated November 13, 2017. Table 6 shows the predicted interior L_{eq} noise levels based on the windows and doors with STC ratings as shown and glazing construction as described in Appendix II.

Table 6 – Calculated Interior Noise Levels by Zone

Location	Level	Exterior Noise Level, L_{eq}	Window/ Door Rating	Interior Noise Level, L_{eq}
Zone A	Ground	59	STC 30	31
Zone B	Ground	56-57	STC 30	24-29
Remaining Areas	Ground	< 56	No STC Requirement. STC 30 recommended.	

Comparing the noise level results in Table 4 with the ENCG sound level criteria specified for the plane of window as mention in the Sec 2.1, the predicted noise levels exceed the minimum threshold of 45 dBA. Therefore, attenuation measures are required for the indoor out-patient area. These attenuation measures include the STC ratings given in Table 6, exterior façade construction as mention in Sec 5.1, a ventilation requirement and warning clauses.

Because the windows and doors must be kept closed to meet the noise requirements, mechanical or other means of ventilation should be provided for all areas. The ventilation system shall not compromise the sound insulation capability of the exterior façade assembly.

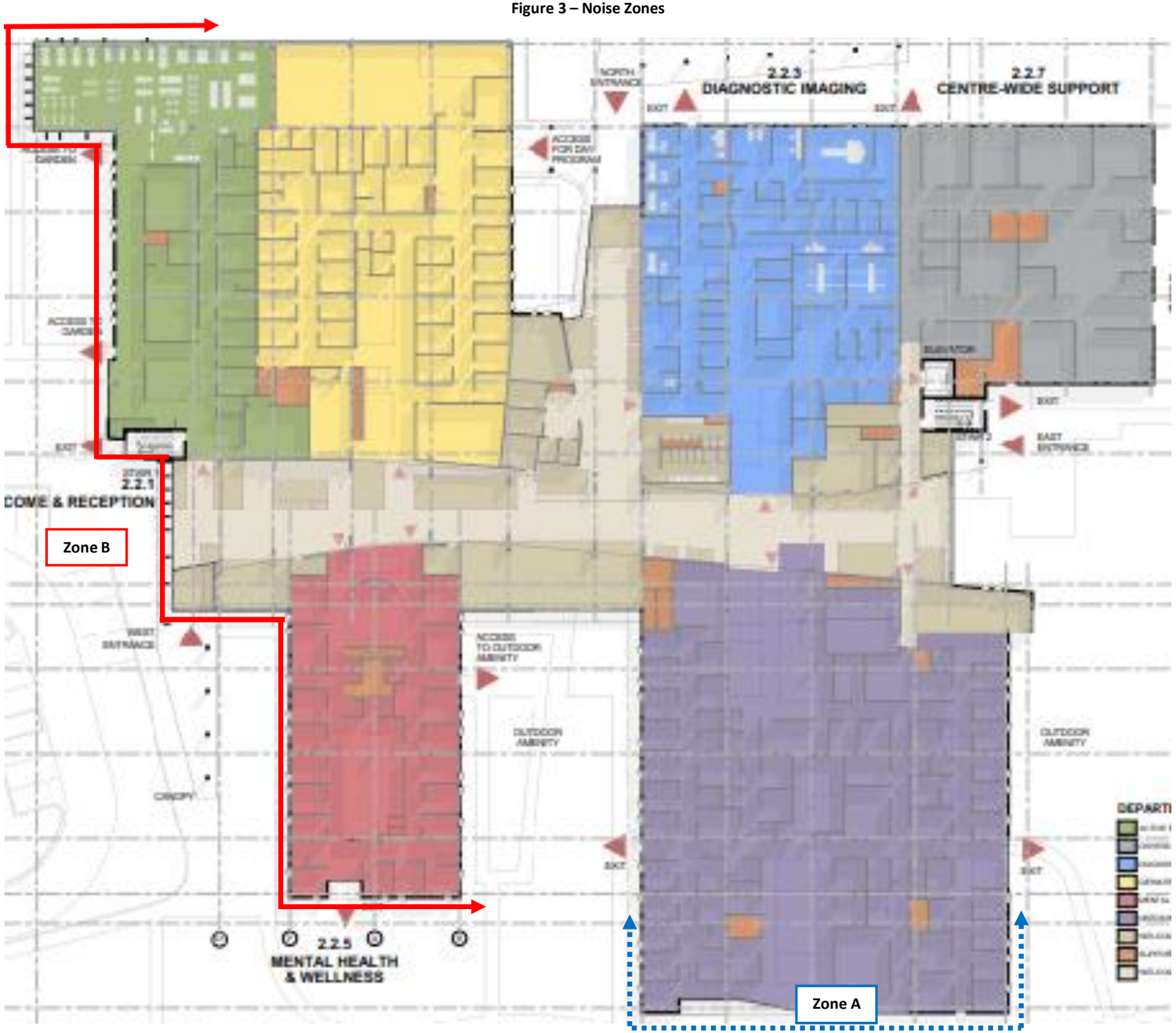
Additionally, warning clauses are required for dwelling units on title relating to the requirement for central air conditioning.

5.4 Stationary Sources

As per VA site observations on Feb 9, 2018, there aren't any significant stationary noise source within 100 m from the proposed site. Therefore, outside stationary sources noise impact analysis is not required for the proposed site.

However, the City of Ottawa ENCG requires that the noise radiated by any use of a facility, when measured at the property line on which the sound is generated, shall not be obnoxious by reason of its intensity, pitch, or dynamic characteristics.

Figure 3 – Noise Zones



The impact of stationary noise sources of the proposed facility on the adjacent noise sensitive land use areas was determined by the Predictor noise modeling software. This program is based on the International Standards Organization (ISO) standard 9613 Part 1 and 2.

The main stationary noise sources at the proposed facility are as follows:

- One 350 kW Emergency Generator;
- One Evapco UT 212-2F9 Cooling Tower;
- Three Air Handling Units;
- One Chiller Unit;
- One Enthalpy Recovery Ventilator.
- Delivery Trucks/loading/unloading

The mechanical units are placed in the mechanical penthouse on the second floor, and the air intakes and the exhaust of those units come out from the north façades of the mechanical penthouse building. Sound power levels (L_W) of the stationary sources were calculated theoretically and entered to the Predictor noise modeling software to generate the noise contours maps to identify the impacted adjacent noise-sensitive land use areas. In this analysis, it is assumed that all the stationary sources operate days and evenings, and night times.

The number of maximum delivery trucks accommodated at the loading/unloading area and parking bay are 3. For the worst-case scenario VA assumed all three trucks are idling and the percentage of working hours is 25% of day and evening period. VA assume no trucks are idling during nighttime.

The results of this assessment indicate that the most impacted areas are located north, north-west, and north-east area to the proposed facility. Noise levels from the existing stationary sources across the study site were found to be 77 dBA to 54 dBA and these levels exceed Class 2 criteria of the City of Ottawa ENCG. To comply with Class 2 criteria, noise control measures are required at the source(s) of the noise. Table 7 shows the anticipated noise levels at the nearby noise-sensitive land-use areas before and after the noise control. Appendix I, Figure 6, Figure 7, Figure 8, and Figure 9 contain the stationary source noise contour maps, with and without noise control measures, generated by the Predictor modeling software

Table 7 – Stationary Sources Noise Level without and with Noise Control Measures

Receiver Location	Description	Predicted Noise Level dBA L_{eq} (1 hr) Without Noise Control		Predicted Noise Level dBA L_{eq} (1 hr) With Noise control		Noise Criteria dBA Leq (1 hr) Day/Evening
		Day/Evening	Night	Day/Evening	Night	
Rec1_Ground	NW Location	77	77	42	42	50/45
Rec2_Ground	E Location	55	54	49	30	50/45
Rec2_Level-1	E Location	57	57	49	32	50/45
Rec2_Level-2	E Location	57	57	50	32	50/45
Rec3_Ground	N Location	66	66	42	40	50/45
Rec4_Ground	NE Location	67	67	43	35	50/45
Rec5_Ground	NE Location	68	68	42	35	50/45
Rec8_Ground	N Location Boundary	67	67	48	44	50/45

The following noise control measures are required in order for the stationary sources to comply with the Class 2 criteria.

- 350 kW Emergency Generator
  - Introduce silencers for air intake, cooler air discharge, and engine air exhaust. See Appendix III, Table 9, Table 10, and Table 11 for silencer dynamic insertion loss (DIL) requirements.
- Evapco UT 212-2F9 Cooling Tower
  - Introduce an Acoustic Louver for the cooling tower opening area. See Appendix III, Table 12 for dynamic insertion loss (DIL) requirements.
- Air Handling Units
  - Introduce 25 mm lining for the outside air intake and exhaust ducts.
- Delivery Truck Idling
  - No delivery truck idling during night time

Based on the initial assessment, stationary impacts predicted and shown in Table 7 exceed the Table 1 sound level criteria for nearby noise sensitive locations. With the implementation of the above-mentioned noise mitigating measures, noise levels at the surrounding noise sensitive location are expected to meet the noise criteria. It is also recommended that the "Type E" warning clause is to be place on purchase and sale agreement to identify a potential concern due to the proximity of the facility

6.0 SUMMARY

The following summarizes the acoustical items required to satisfy the noise criteria as described in this report.

6.1 Transportation Noise-Road and Rail

Outdoor Living Area

- OLA is not applicable to this project and therefore does not need to be considered. Therefore, no "warning clause" required

Interior Spaces

- Interior noise level due to Road and Rail noise sources are less than the guideline value in the Table 1.
- Exterior wall assembly is acceptable as described in Section 5.1.
- The roof assembly was included in our calculations and is not a significant path of sound and can remain as designed.
- Windows and glass doors with minimum STC ratings as shown in Table 8 in Appendix II are required.
- Mechanical ventilation, or other means of natural ventilation, should be provided for all areas.

Warning Clause

The following warning clause should be incorporated into the purchase and lease/rental/seal agreement:

"This out-patient facility has been supplied with a central air conditioning system which 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"

6.2 Stationary Noise Sources

- There are no stationary sources located in the vicinity of the proposed site and therefore no outside stationary noise impact analysis is required to be carried out in this project.
- As shown in the Table 7, site-specific stationary source noise levels exceed the Class 2 criteria as per the City of Ottawa's Environmental Noise Control Guidelines (ENCG).
- The following noise control measures are required in order for the project's stationary noise sources to comply with the guideline values.
    - 350 kW Emergency Generator
        - Introduce silencers for air intake, cooler air discharge, and engine air exhaust. See Appendix III, Table 9, Table 10, and Table 11 for silencer dynamic insertion loss (DIL) requirements.
    - Evapco UT 212-2F9 Cooling Tower
        - Introduce an Acoustic Louver for the cooling tower opening area. See Appendix III, Table 12 for dynamic insertion loss (DIL) requirements.
    - Air Handling Units
        - Introduce 25 mm lining for the outside air intake and exhaust ducts.
    - Delivery Truck Loading/Unloading
        - No delivery truck idling during night time

Warning Clause

The following warning clauses should be incorporated into the purchase and lease/rental/seal agreement:

"Purchasers/tenants are advised that due to the proximity of the adjacent facility, noise from the facility my at times be audible"

Various noise mitigation methods may be utilized to satisfy the noise criteria described in this report. Alteration of mitigation methods that deviate from requirements should be reviewed by the acoustical consultant.

If you have any questions or comments regarding this report, please do not hesitate to contact the undersigned.

Sincerely,
Veneklasen Associates, Inc.

John Zeman, *LEED AP BD+C*
Associate Principal

Hooshang Khosrovani
Principal

Paul Downey, *P.Eng*

APPENDIX I – NOISE CONTOUR MAPS

Figure 4 – Existing Daytime Noise Contour Map (Road)

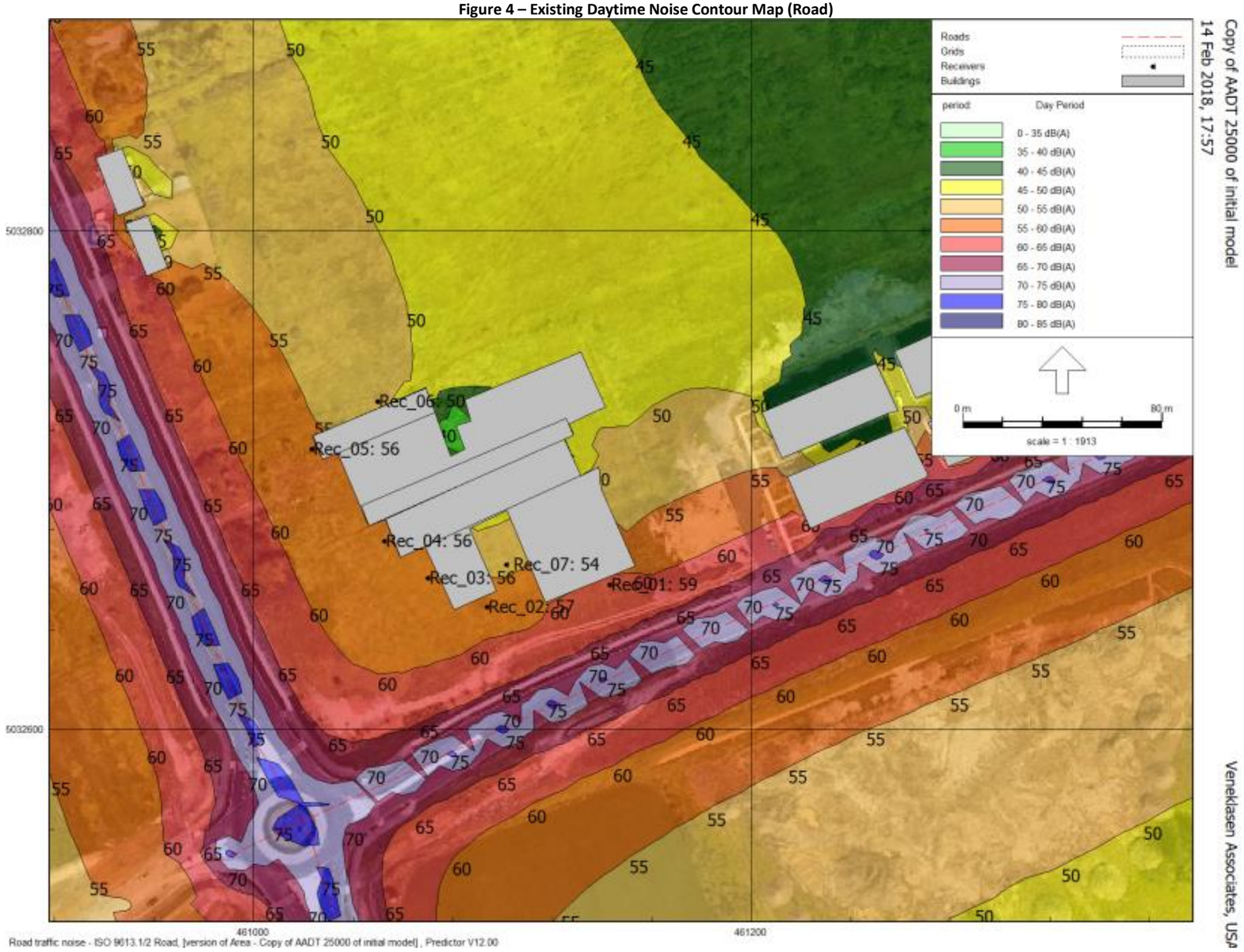


Figure 5 – Existing Nighttime Noise Contour Map (Road)

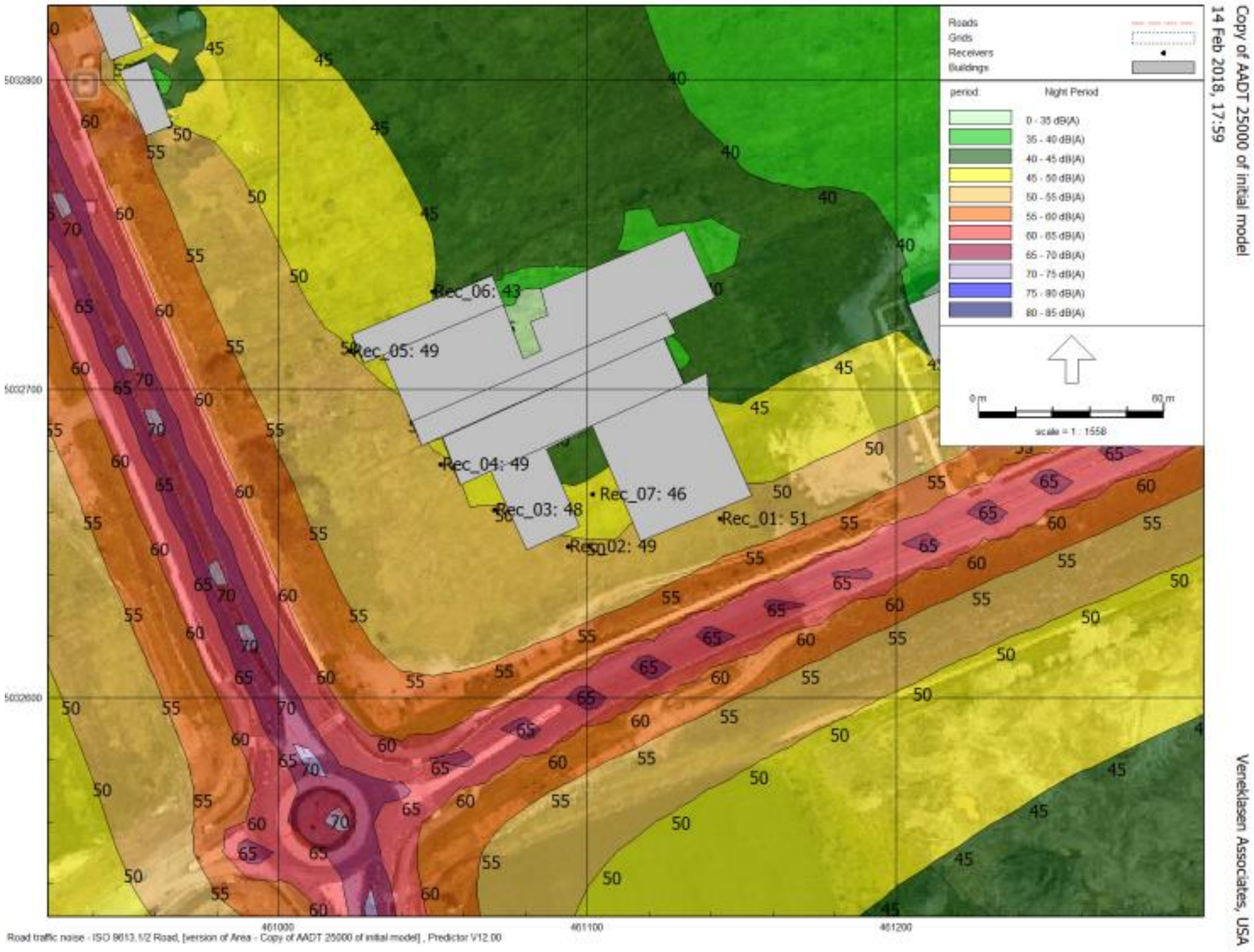


Figure 6 – Noise Contours without Noise Control Day & Evening (Stationary Sources)

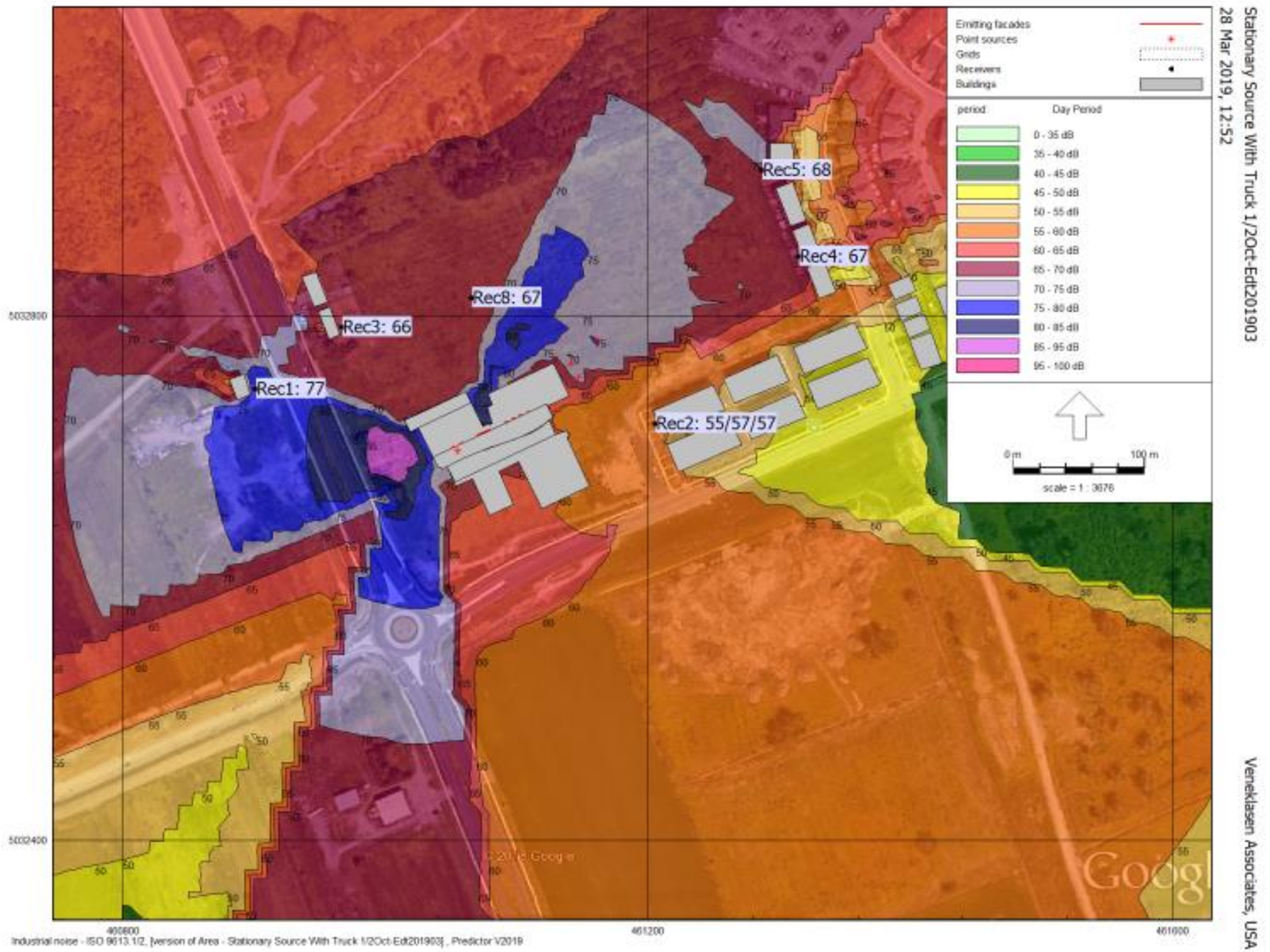


Figure 7 – Noise Contours without Noise Control Nighttime (Stationary Sources)

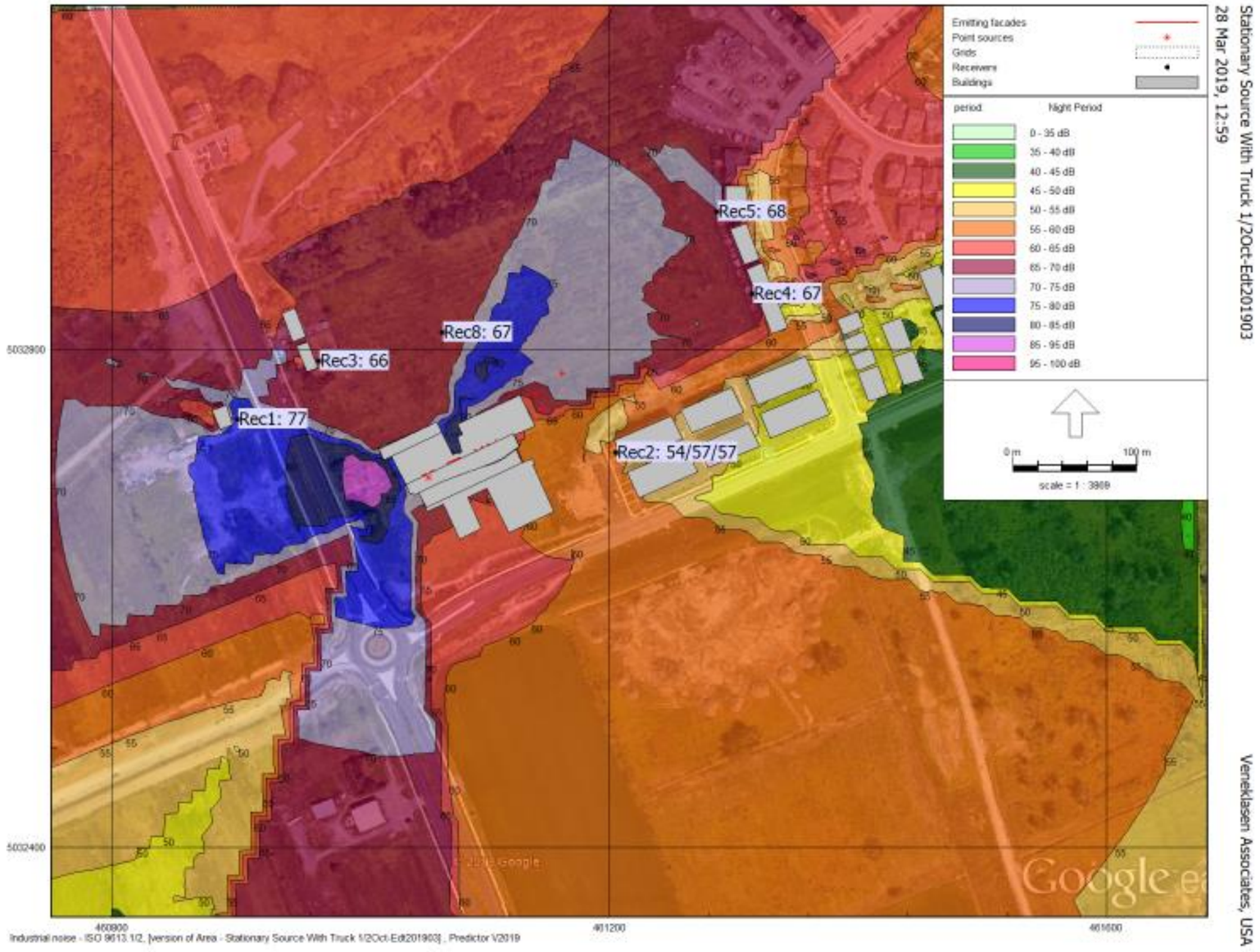


Figure 8 – Noise Contours with Noise Control Employed Day/Evening time (Stationary Sources)

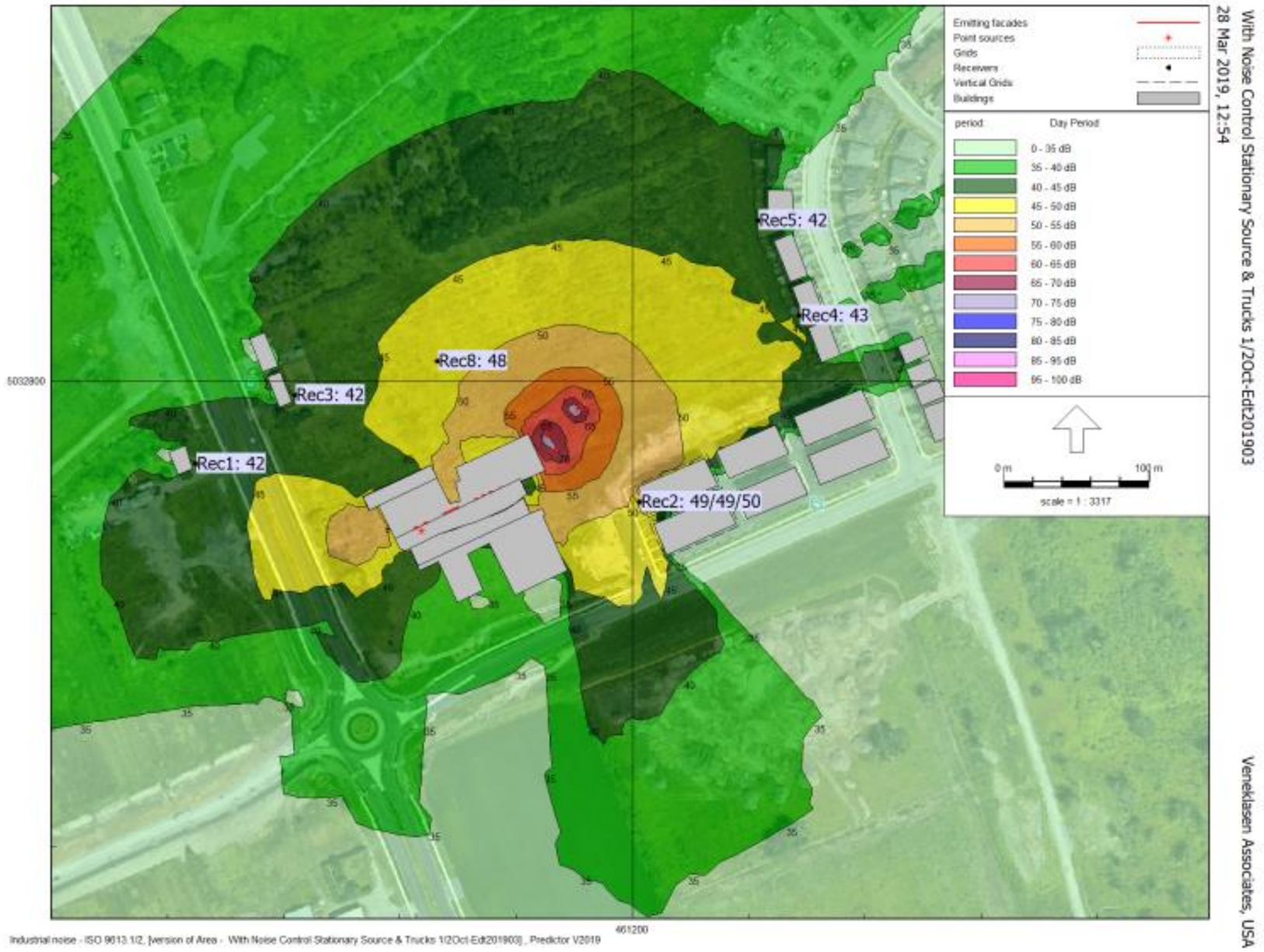


Figure 9 – Noise Contours with Noise Control Employed Nighttime (Stationary Sources)

APPENDIX II – GLAZING REQUIREMENTS

In order to meet the predicted interior noise levels described in Section 5.0, the glazing shall meet the following requirements:

Table 8 – Acoustical Glazing Requirements: Minimum Octave Band Transmission Loss and STC Rating

Nominal Thickness	Minimum Transmission Loss Octave Band Center Frequency (Hz)						Min. STC Rating
	125	250	500	1000	2000	4000	
1" dual	21	18	27	34	37	32	**30**

The transmission loss values in the table above can likely be met with the following glazing assemblies:

STC 30: 1/8" monolithic – 3/4" airspace – 1/8" monolithic

However, it should be noted that an assembly's frame and seals limit the performance of the overall system. The assemblies given above are provided as a basis of design only. Regardless of construction, the octave band transmission loss of the particular system selected must meet the minimum values above. Similarly, it is permissible to use an alternate assembly construction if it meets the transmission loss requirements. *Note that the systems shall not be selected on the basis of STC rating alone.*

Independent laboratory acoustical test reports should be provided for review by the design team to ensure compliance with glazing acoustical performance requirements. Lab shall be a member of the National Voluntary Laboratory Accreditation Program (NVLAP) through the National Institute of Standards and Technology (NIST) for accreditation and shall be pre-approved by Veneklasen Associates. Lab reports shall be in compliance with ASTM standard E90 and be no more than 10 years old (from date of submission on specific project). VA requires invitation to witness acoustical testing completed to demonstrate compliance with the requirements of this report. The tests shall be performed on the entire assembly, including frame and seals. If test reports are not available for the assembly, VA would require that the assembly be tested at a third-party independent lab accredited through NVLAP for ASTM E90.

APPENDIX III – GENERATOR AND COOLING TOWER NOISE MITIGATION

Generator Noise Mitigation

Air Intake Silencer

Introduce a silencer which shall meet or exceed the following dynamic insertion loss (DIL) in each octave band as tabulated below:

Table 9 – Generator Air Intake Silencer

Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
DIL (dB)	15	22	27	35	39	40	40	45

Cooler Discharge Silencer

Introduce a silencer which shall meet or exceed the following dynamic insertion loss (DIL) in each octave band as tabulated below:

Table 10 – Generator Cooler Discharge Silencer

Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
DIL (dB)	6	12	24	34	47	44	32	30

Engine Air Exhaust Silencer

Introduce a silencer which shall meet or exceed the following dynamic insertion loss (DIL) in each octave band as tabulated below:

Table 11 – Engine Air Exhaust Silencer

Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
DIL (dB)	10	28	25	21	15	14	14	14

Cooling Tower Noise Mitigation

Acoustic Louver

Introduce an acoustic Louver which shall meet or exceed the following Insertion Loss (IL) in each Octave Band as tabulated below:

Table 12 – Acoustic Louver for Cooling Tower

Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
IL (dB)	5	7	11	12	13	14	12	10

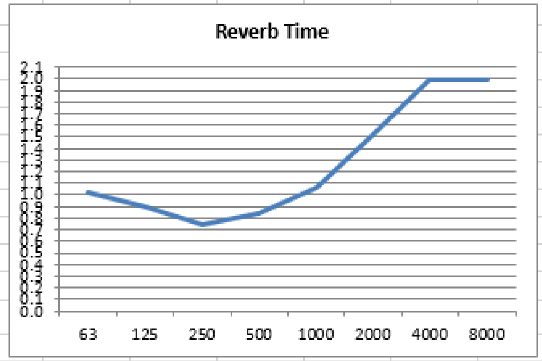
APPENDIX IV – SAMPLE CALCULATIONS

Project Name:

Plan:	ARC
Floor:	Ground
Room:	Gym

Receiving Room Absorption

		Location	Material	Code	Area
Length	83	Ceiling	3" 'N' Acoustideck	65	2490
Width	30	Floor	Linoleum of Concrete	3	2490
Height	32	Walls	1" Gypboard	22	3618
Volume	79680	Furnishings	King Bed	100	747
F/C area	2490	Glazing	1/8" Glass	47	3614
Wall area	7232		Enter Code & Area		
			Enter Code & Area		
			Enter Code & Area		
			Enter Code & Area		
			Total Surface Area(ft^2) =		12959



Total Interior Level:	**29.4**
(excluding 63 Hz):	29.3
Maximum Level:	**-25.5**

	63	125	250	500	1000	2000	4000	8000	dBA
Room Constant	4456	5158	6464	5633	4274	2842	2101	2068	

Exterior Noise Level

	Level	Source type	63	125	250	500	1000	2000	4000	8000	dBA
	55	Mer Bleue	53.7	51.8	47.5	48.2	51.1	49.4	43.4	36.2	**55.0**
		<N/A>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
		<N/A>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
CNEL, LDN, or average:		**Total**	53.7	51.8	47.5	48.2	51.1	49.4	43.4	36.2	**55.0**

	Level	Source type	63	125	250	500	1000	2000	4000	8000	dBA
Maximum:	0	BART fast pass by	-2.7	-7.1	-6.5	-5.0	-5.0	-5.1	-12.4	-18.8	**0.0**

Exterior Assemblies

Average Interior Levels

	Area	Assembly Type	63	125	250	500	1000	2000	4000	8000	dBA
wall	834	1-coat Stucco, 1/2 OSB, 2x6 WS, batt insul, gypsum (STC 40)	30.8	31.6	7.3	0.2	-3.9	-7.2	-6.3	0.0	**16.1**
glazing	3614	WEAL STC 30-31 no lam average	38.7	35.2	32.0	24.3	22.4	19.4	18.7	8.6	**29.2**
door	0	<N/A>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
		<N/A>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
		<N/A>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
		Total	**39.4**	**36.8**	**32.0**	**24.3**	**22.4**	**19.4**	**18.7**	**8.6**	**29.4**
		A-weighted	13.4	20.8	23.0	21.3	22.4	20.4	19.7	7.6	

APPENDIX V – GLOSSARY OF ACOUSTICAL TERMS

Term	Definition
Absorption	A property of material referring to how much sound it absorbs (as opposed to reflecting). In the context of this report, absorption refers to the total quantity of absorption within the receiving space. Absorption is measure in sabins.
A-weighting (dBA)	The sound pressure level in decibels as measured in an A-weighting filter network. The A-weighting de-emphasizes the low frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.
Decibel (dB)	A unit describing the amplitude of sound equivalent to 20 times the logarithm, to the base 10, of the ratio of the pressure of the sound to the reference pressure of 20 μPa. Used to quantify sound pressure levels.
Equivalent Sound Level (Leq)	The time-weighted average noise level during the stated measurement period.
Sabin	A unit used to describe absorption within a space. One sabin is equal to the absorption of a one-square-foot open window.
Sound Pressure Level (SPL)	The amplitude of sound when compared to the reference sound pressure level of 20 μPa. SPL is measured in dB.
Sound Transmission Class (STC)	A single-number metric used to describe the transmission loss performance of a material or assembly across the frequency spectrum. It is intended for use primarily when speech is the noise source.
Transmission Loss (TL)	A measure of the reduction in sound level as a sound wave passes through a material. The higher the transmission loss, the better the material's sound insulating properties.

APPENDIX VI – ACOUSTICAL CALCULATION METHODS

Decibel Addition

Decibels are based on a logarithmic scale; defined as the logarithmic ratio between a measured sound pressure level and a reference sound pressure level. When decibels are added, they are not combined arithmetically, but logarithmically. Decibels are added according to the following equation.

$$SPL_{tot} = 10log\left(10^{(SPL_1/10)}\right) + 10log\left(10^{(SPL_2/10)}\right)$$

Where:
SPL_{tot} = Total Sound Pressure Level (dB or dBA)
SPL_1, SPL_2 = Sound Pressure Level 1, 2 (dB or dBA)

A-Weighting

A-weighting a spectrum is completed by applying standardized weighting factors to a frequency spectrum, either in octave bands or third-octave bands. These resultant A-weighted levels are summed using decibel addition to generate the overall A-weighted level, noted as dBA. In a report, spectral data is typically presented un-weighted, and the overall level is presented with A-weighting.

The octave band A-weighting correction factors are shown in the table below:

	Octave Band Center Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
A-weighting Correction Factor (dB)	-26	-16	-9	-3	0	+1	+1	-1

Acoustical Shielding

The presence of adjacent buildings or façades, changes in terrain, parapets, and other similar barriers provide acoustical shielding, reducing the sound level incident on the exterior façades. Common locations where acoustical shielding occurs include, but are not limited to, the roof, the back, and sides of the building that are not directly facing the noise source.

Acoustical shielding due to building geometry can be separated into two categories: reduction due to reduced area of exposure (side of a building), and shielding from barriers (such as a parapet or sound wall).

Reduction as a result of reduced area of exposure is calculated according to the following equation:

$$\Delta SPL = 10\log_{10}\left(\frac{\theta_{exp}}{180}\right)$$

Where:
ΔSPL = Change in Sound Pressure Level (dB)
θ_{exp} = Angle of exposure (degrees)

Acoustical Attenuation due to Distance

Sound pressure level reduction due to distance is calculated according to the following equation:

$$SPL_2 = SPL_1 + C_S \log\left(\frac{r_1}{r_2}\right)$$

Where:
SPL_1 = Sound Pressure Level at Location 1 (dB or dBA)
SPL_2 = Sound Pressure Level at Location 2 (dB or dBA)
C_S = Source Coefficient; 20 for point source, 10 for a line source
r_1 = Location 1 distance from source (ft.)
r_2 = Location 2 distance from source (ft.)

In some situations, the C_S value is between 10 and 20; selection of this number is an engineering judgment based on the relationship between the source and receiver as well as the type of source.

Interior Noise Calculation

The interior noise calculation takes into account the exterior noise level, the transmission loss of the glazing (including glass, frame, and seals), wall, and roof/ceiling systems, the finishes within the space, and noise exposure due to building geometry and acoustic shielding. The interior sound level is calculated using the equation:

$$SPL_I = SPL_E + 10\,log_{10}(A) - 10log_{10}(R) - TL + 6$$

Where:
SPL_I = the Interior Sound Pressure Level (dB or dBA)
SPL_E = Exterior Sound Pressure Level (dB or dBA)
A = Surface Area exposed to Exterior Noise (sq.ft.)
R = Room Absorption Coefficient (sabins)
TL = Sound Transmission Loss of Exterior Façade Assembly (dB)

This calculation is performed for each exposed façade individually. The total interior sound level is found by using decibel addition to sum the sound level from all exposed façades.