Environmental Noise Assessment

1795 Montreal Road

Ottawa, Ontario

REPORT: GWE18-037 – Environmental Noise

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EXECUTIVE SUMMARY

This document describes an environmental noise assessment performed for a proposed office development located at 1795 Montreal Road, in Ottawa, Ontario. The development comprises a new two-storey office building and a one-storey multi-purpose accessory building. The proposed office building is considered a noise sensitive building. The site is located east of the Beckenham Lane & Montreal Road Intersection. The site is surrounded on all sides by residential zones. The major source of transportation noise is Montreal Road. The major sources of stationary noise are from rooftop mechanical equipment atop the proposed buildings. 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 and Climate Change (MOECC) 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) preliminary architectural drawings received from Christopher Simmonds Architect Inc.

The results of the current analysis indicate that transportation noise levels will range between 61 and 72 dBA during the daytime period (07:00-23:00) and between 54 and 65 dBA during the nighttime period (23:00-07:00). The highest noise levels (i.e. 72 dBA) occurs along the development's south façade, which are nearest and most exposed to Montreal Road. Building components with a higher Sound Transmission Class (STC) rating will be required where exterior noise levels exceed 65 dBA, as indicated on Figure 3. Results of the calculations also indicate that the office building will require air conditioning, which will allow occupants to keep windows closed and maintain a comfortable indoor environment. A Warning Clause will also be required be placed on all Lease or Purchase and Sale Agreements.

Stationary noise levels produced by the building mechanical equipment are expected to fall below ENCG criteria during all hours of the day at nearby sensitive residential dwellings. This assumes the selections and locations of the mechanical equipment are similar to the assumptions stated in this report. Since anticipate noise levels fall below ENCG criteria, the proposed development is expected to be compatible with the existing and future noise sensitive land uses. As stationary noise has only been considered from a feasibility perspective, a review of final equipment selection and locations is required by a qualified acoustical engineer prior to instillation of the equipment.

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1. INTRODUCTION

Gradient Wind Engineering Inc. (GWE) was retained by Christopher Simmonds Architect Inc. to undertake an environmental noise assessment of a proposed office development located at 1795 Montreal Road in Ottawa, Ontario. This report summarizes the methodology, results and recommendations related to an environmental noise assessment. GWE's scope of work involved assessing exterior and interior noise levels generated by local transportation sources, as well as consideration of off-site stationary noise impacts from proposed mechanical equipment associated with the development. The assessment was performed on the basis of theoretical noise calculation methods conforming to the City of Ottawa[1] and Ministry of the Environment and Climate Change (MOECC)[2] guidelines. Noise calculations were based on preliminary architectural drawings and mechanical information received from Christopher Simmonds Architect Inc., and future traffic volumes corresponding to the City of Ottawa's Official Plan (OP) roadway classifications.

2. TERMS OF REFERENCE

The focus of this environmental noise assessment is a proposed office development comprising a new two-storey office building and a one-storey multi-purpose accessory building. The office building is considered noise sensitive and therefore, the subject of the transportation noise assessment. The site is located east of the Beckenham Lane & Montreal Road Intersection. The site is surrounded on all sides by residential zones. The major source of transportation noise is Montreal Road. The major sources of stationary noise are from rooftop mechanical equipment atop the proposed buildings. Figure 1 illustrates a complete site plan with surrounding context.

3. OBJECTIVES

The main goals of this work are to: (i) calculate the future noise levels on the study building produced by local transportation sources, (ii) calculate the future noise levels on surrounding noise-sensitive properties produced by stationary noise sources associated with the development, and (iii) ensure that interior and exterior noise levels do not exceed the allowable limits specified by the City of Ottawa's Environmental Noise Control Guidelines as outlined in Section 4 of this report.

[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

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 vehicle traffic, 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 dBA for semi-private office space, as listed in Table 1. To account for deficiencies in building construction, theses levels should be targeted toward 42 dBA.

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

Type of Space	Time Period	L_{eq} (dBA)	
		Road	Rail
General offices, reception areas, retail stores, etc.	07:00 – 23:00	50	45
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	40
Sleeping quarters of hotels/motels	23:00 – 07:00	45	40
Sleeping quarters of residences, hospitals, nursing/retirement homes, etc.	23:00 – 07:00	40	35

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]. 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 normally triggers the need for central air conditioning. Where noise levels exceed 65 dBA daytime and 60 dBA nighttime, building components will require higher levels of sound attenuation[5].

4.2.1 Transportation Source 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, roadway traffic volumes are based on the roadway classifications outlined in the City of Ottawa's Official Plan (OP) and Transportation Master Plan[6] 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.

[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] MOECC, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.1.3
[6] City of Ottawa Transportation Master Plan, November 2013

TABLE 2: ROADWAY TRAFFIC DATA

Segment	Roadway / Transit Class	Speed Limit (km/h)	Traffic Volumes
Montreal Road	4-UAD	60	**35,000**

4.2.2 Theoretical Transportation Noise Predictions

Noise predictions were performed with the aid of the MOECC computerized noise assessment program, STAMSON 5.04, for road and rail analysis. Roadway traffic noise calculations were performed by treating each roadway as separate line sources of noise, and by using existing building locations as noise barriers. In addition to the traffic volumes summarized in Table 2, theoretical noise predictions were based on the following parameters:

- Truck traffic on Montreal Road was taken to comprise 5% heavy trucks and 7% medium trucks, as per ENCG requirements for noise level predictions.
- The day/night split was taken to be 92% / 8% respectively for Montreal Road.
- Reflective and absorptive intermediate ground surfaces based on specific source-receiver path ground characteristics. Pavement, such as roads and parking lots, is considered as reflective ground, while vegetated space is considered as absorptive ground.
- Site is considered to be flat or gently sloping.
- 8 m barrier assumed for Receptor 1, representing the study building.

Noise receptors were strategically identified at four (4) locations around the proposed office building (see Figure 2). A complete set of input and output data from all STAMSON 5.04 calculations are available in Appendix A, and STAMSON input parameters are illustrated in Figure 4 and 5.

4.3 Indoor Noise Calculations

The difference between outdoor and indoor noise levels is the noise attenuation provided by the building envelope. According to common industry practice, complete walls and individual wall elements are rated according to the Sound Transmission Class (STC). The STC ratings of common commercial walls built in conformance with the Ontario Building Code (2012) typically exceed STC 35, depending on exterior cladding, thickness and interior finish details. For example, 6” metal stud walls with gypsum board sheathing can achieve STC 45 or more. Standard good quality double-glazed non-operable windows can

have STC ratings ranging from 25 to 40, depending on the window manufacturer, pane thickness and inter-pane spacing. As previously mentioned, the windows are the known weak point in a partition.

As per Section 4.2, when daytime noise levels (from road and rail sources) at the plane of the window exceed 65 dBA, calculations must be performed to evaluate the sound transmission quality of the building components to ensure acceptable indoor noise levels. The calculation procedure[7] considers:

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

Based on published research[8], exterior walls possess specific sound attenuation characteristics that are used as a basis for calculating the required STC ratings of windows in the same partition. Due to the limited information, available at the time of the study, which was prepared for site plan approval, detailed floor layouts and building elevations have not been finalized; therefore, detailed STC calculations could not be performed at this time. As a guideline, the anticipated STC requirements for windows have been estimated based on the overall noise reduction required for each intended use of space (STC = outdoor noise level – targeted indoor noise levels).

4.4 Stationary Noise

4.4.1 Assumptions

Preliminary mechanical information for the development has been based on GWE's experience with similar developments. A review of final equipment selection and locations by a qualified acoustical engineer will be required prior to installation of the equipment. The following assumptions have been included in the analysis:

(i) The locations, quantity and tonnage of rooftop units have been assumed based on GWE's experience with similar developments.

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

(ii) The sound data of rooftop units is based on GWE experience on other developments and typical manufactures data.

(iii) During the daytime and evening period (07:00 – 23:00), the rooftop mechanical units (RTU) on the building are in full operation.

(iv) During the nighttime period (23:00 – 07:00), the rooftop mechanical units on the building are in operation 50% of the time.

(v) Screening effects of buildings and parapets have been considered in the modelling. Parapet heights for the office building are 360 mm, while the accessory building does not contain parapets.

The equipment considered in the model consisted of:

(i) 11 X 10 TON RTU (York Model ZF) (S1-11)

4.4.2 Stationary Noise Source Assessment and Criteria

For stationary sources, the L_{eq} is calculated on an hourly interval, while for roadways, the L_{eq} is calculated on the basis of a 16-hour daytime / 8-hour nighttime split. Noise criteria taken from the ENCG apply to points of reception (POR). A POR is defined under ENCG as "any location on a noise sensitive land use where noise from a stationary source is received", this can be an outdoor point of reception or at the plane of window. A POR can be located on an existing or zoned for future use premises of permanent or seasonal residences, hotels/motels, nursing/retirement homes, rental residences, hospitals, camp grounds, and noise sensitive buildings such as schools, places of worship and daycare facilities. According to the ENCG, the recommended maximum noise level for an urban (Class 1) environment at a POR is either the lowest one-hour background noise level due to other sources, or the exclusionary limits outlined in Table 3, whichever is higher. The site and surroundings are considered to be in an urban area as they are in close proximity to an arterial roadway (Montreal Road)

TABLE 3: EXCLUSIONARY LIMITS FOR CLASS 1 AREA

Time of Day	Outdoor Points of Reception	Plane of Window
07:00 – 19:00	50	50
19:00 – 23:00	50	50
23:00 – 07:00	N/A	45

4.4.3 Determination of Noise Source Power Levels

Table 4 summarizes the sound power levels of each source assumed in our analysis. Source locations are illustrated in Figure 6. Rooftop equipment sound power data is from the manufacture's test data.

TABLE 4: EQUIPMENT SOUND POWER LEVELS (dBA)

Source ID	Height above roof/grade (m)	Description	Frequency (Hz)								
			63	125	250	500	1000	2000	4000	8000	Total
S1-11	1.5	RTU 10 TON	54	66	73	77	78	75	75	68	83

4.4.4 Stationary Source Noise Predictions

The impact of the stationary noise sources on the nearby residential areas was determined by computer modelling. Stationary noise source modelling is based on the software program Predictor-Lima developed from the International Standards Organization (ISO) standard 9613 Parts 1 and 2. This computer program is capable of representing three-dimensional surfaces and first reflections of sound waves over a suitable spectrum for human hearing. The methodology has been used on numerous assignments, and has been accepted by the Ministry of the Environment and Climate Change (MOECC) as part of Environmental Compliance Approvals applications.

A total of 16 receptor locations were chosen around the site to measure the noise impact at points of reception (POR) during the daytime and evening period (07:00 – 23:00), as well as the nighttime period (23:00 – 07:00). POR locations included outdoor points of reception (OPOR) and the plane of windows (POW) of the adjacent residential properties. Sensor locations are described in Table 5 and illustrated in Figure 7. All units were represented as point sources in the Predictor model. Table 6 below contains Predictor-Lima calculation settings. These settings are typical and have been based on ISO 9613 standards and guidance from the MOECC.

Ground absorption over the study area was determined based on topographical features (such as water, concrete, grassland, etc.). An absorption value of 0 is representative of hard ground, while a value of 1 represents grass, and similar soft surface conditions. Existing and proposed buildings were added to the model to account for screening and reflection effects from building façades. A Predictor-Lima sample output is available in Appendix B, further modelling data is available upon request.

TABLE 5: RECEPTOR LOCATIONS

Receptor Number	Location	Height Above Grade (m)
R1	POW – 1777 Montreal Road	7.5
R2	OPOR – 1777 Montreal Road	1.5
R3	POW – 49 Cedar Road	2.5
R4	OPOR – 49 Cedar Road	1.5
R5	POW – 45 Cedar Road	2.5
R6	OPOR – 45 Cedar Road	1.5
R7	POW – 41 Cedar Road	2.5
R8	OPOR – 41 Cedar Road	1.5
R9	POW – 1815 Montreal Road	2.5
R10	OPOR – 1815 Montreal Road	1.5
R11	POW – 896 Elmsmere Road	4.5
R12	OPOR – 896 Elmsmere Road	1.5
R13	POW – 896 Elmsmere Road	7.5
R14	OPOR – 896 Elmsmere Road	1.5
R15	POW – 896 Elmsmere Road	7.5
R16	OPOR – 896 Elmsmere Road	1.5

TABLE 6: CALCULATION SETTINGS

Parameter	Setting
Meteorological correction method	Single value for C0
Value C0	2.0
Default ground attenuation factor	1
Ground attenuation factor for roadways and paved areas	0
Temperature (K)	283.15
Pressure (kPa)	101.33
Air humidity (%)	70

5. RESULTS AND DISCUSSION

5.1 Transportation Noise Levels

The results of the roadway traffic noise calculations are summarized in Table 7 below. A complete set of input and output data from all STAMSON 5.04 calculations are available in Appendix A.

TABLE 7: EXTERIOR NOISE LEVELS DUE TO TRANSPORTATION SOURCES

Receptor Number	Receptor Height	Plane of Window Receptor Location	Noise Level (dBA)	
			Day	Night
1	4.5	POW – 2nd Floor North Façade	61	54
2	4.5	POW – 2nd Floor East Façade	68	61
3	4.5	POW – 2nd Floor South Façade	72	65
4	4.5	POW – 2nd Floor West Façade	68	60

The results of the current analysis indicate that noise levels will range between 61 and 72 dBA during the daytime period (07:00-23:00) and between 54 and 65 dBA during the nighttime period (23:00-07:00). The highest noise levels (i.e. 72 dBA) occurs along the development's south façade, which are nearest and most exposed to Montreal Road.

5.1.1 Noise Control Measures (Transportation Sources)

The noise levels predicted due to roadway traffic exceed the criteria listed in Section 4.2 for building components. As discussed in Section 4.3 the anticipated STC requirements for windows have been estimated based on the overall noise reduction required for each intended use of space (STC = outdoor noise level – targeted indoor noise levels). As per city of Ottawa requirements, detailed STC calculations will be required to be completed prior to building permit application for each unit type. The STC requirements for the windows are summarized below for the development (see Figure 3):

- **Office Windows / Glazed Curtin wall**

(i) Office windows facing south on the office building will require a minimum STC of 30

(ii) Office windows facing east and west on the office building will require a minimum STC of 26

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

- **Exterior Walls**

(i) Exterior wall components on the office building's east, south and west façades will require a minimum STC of 45 which will be achieved with 6" metal studs and gypsum board sheathing or an acoustical equivalent according to NRC test data[9].

The STC requirements would apply to windows, doors, spandrel panels and curtainwall elements. Exterior wall components on these façades are recommended to have a minimum STC of 45, where a window / wall system is used. A review of window supplier literature indicates that the specified STC ratings can be achieved by a variety of window systems having a combination of glass thickness and inter-pane spacing. We have specified an example window configuration, however several manufacturers and various combinations of window components, such as those proposed, will offer the necessary sound attenuation rating. It is the responsibility of the manufacturer to ensure that the specified window achieves the required STC. This can only be assured by using window configurations that have been certified by laboratory testing. The requirements for STC ratings assume that the remaining components of the building are constructed and installed according to the minimum standards of the Ontario Building Code. The specified STC requirements also apply to swinging and/or sliding patio doors.

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

5.2 Stationary Noise Levels

As Table 8 (below) summarizes, noise levels fall below ENCG criteria during all hours of the day. Noise contours at 1.5 m above grade can be seen in Figure 8 and 9 for daytime/evening and nighttime conditions. Since the noise levels fall below ENCG criteria, the proposed development is expected to be compatible with the existing and future noise sensitive land uses.

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

TABLE 8: NOISE LEVELS FROM STATIONARY SOURCES

Receptor Number	Receptor Location	1-HR L_{EQ} (dBA)		ENCG Criteria (dBA)		Meets ENCG
		Daytime	Night	Daytime	Night	
R1	POW – 1777 Montreal Road	47	44	50	45	Yes
R2	OPOR – 1777 Montreal Road	49	46	50	-	Yes
R3	POW – 49 Cedar Road	42	39	50	45	Yes
R4	OPOR – 49 Cedar Road	46	43	50	-	Yes
R5	POW – 45 Cedar Road	43	40	50	45	Yes
R6	OPOR – 45 Cedar Road	47	44	50	-	Yes
R7	POW – 41 Cedar Road	41	38	50	45	Yes
R8	OPOR – 41 Cedar Road	42	39	50	-	Yes
R9	POW – 1815 Montreal Road	44	41	50	45	Yes
R10	OPOR – 1815 Montreal Road	44	41	50	-	Yes
R11	POW – 896 Elmsmere Road	44	41	50	45	Yes
R12	OPOR – 896 Elmsmere Road	45	42	50	-	Yes
R13	POW – 896 Elmsmere Road	45	42	50	45	Yes
R14	OPOR – 896 Elmsmere Road	47	44	50	-	Yes
R15	POW – 896 Elmsmere Road	43	40	50	45	Yes
R16	OPOR – 896 Elmsmere Road	43	40	50	-	Yes

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current analysis indicate that transportation noise levels will range between 61 and 72 dBA during the daytime period (07:00-23:00) and between 54 and 65 dBA during the nighttime period (23:00-07:00). The highest noise levels (i.e. 72 dBA) occurs along the development's south façade, which are nearest and most exposed to Montreal Road. Building components with a higher Sound Transmission Class (STC) rating will be required where exterior noise levels exceed 65 dBA, as indicated on Figure 3. Results of the calculations also indicate that the office building will require air conditioning, which will allow occupants to keep windows closed and maintain a comfortable indoor environment. The following Warning Clause[10] will also be required be placed on all Lease or Purchase and Sale Agreements, as summarized below:

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

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

- *STC rated multi-pane glazing elements and spandrel panels*
    - *South façade office windows: STC 30*
    - *East and West façade office windows: STC 26*
- *STC rated exterior walls south and west façades*
    - *STC 45*

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

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

Stationary noise levels fall below ENCG criteria during all hours of the day. Since the noise levels fall below ENCG criteria, the proposed development is expected to be compatible with the existing and future noise sensitive land uses. A review of final equipment selection and locations by a qualified acoustical engineer will be required prior to installation of the equipment.

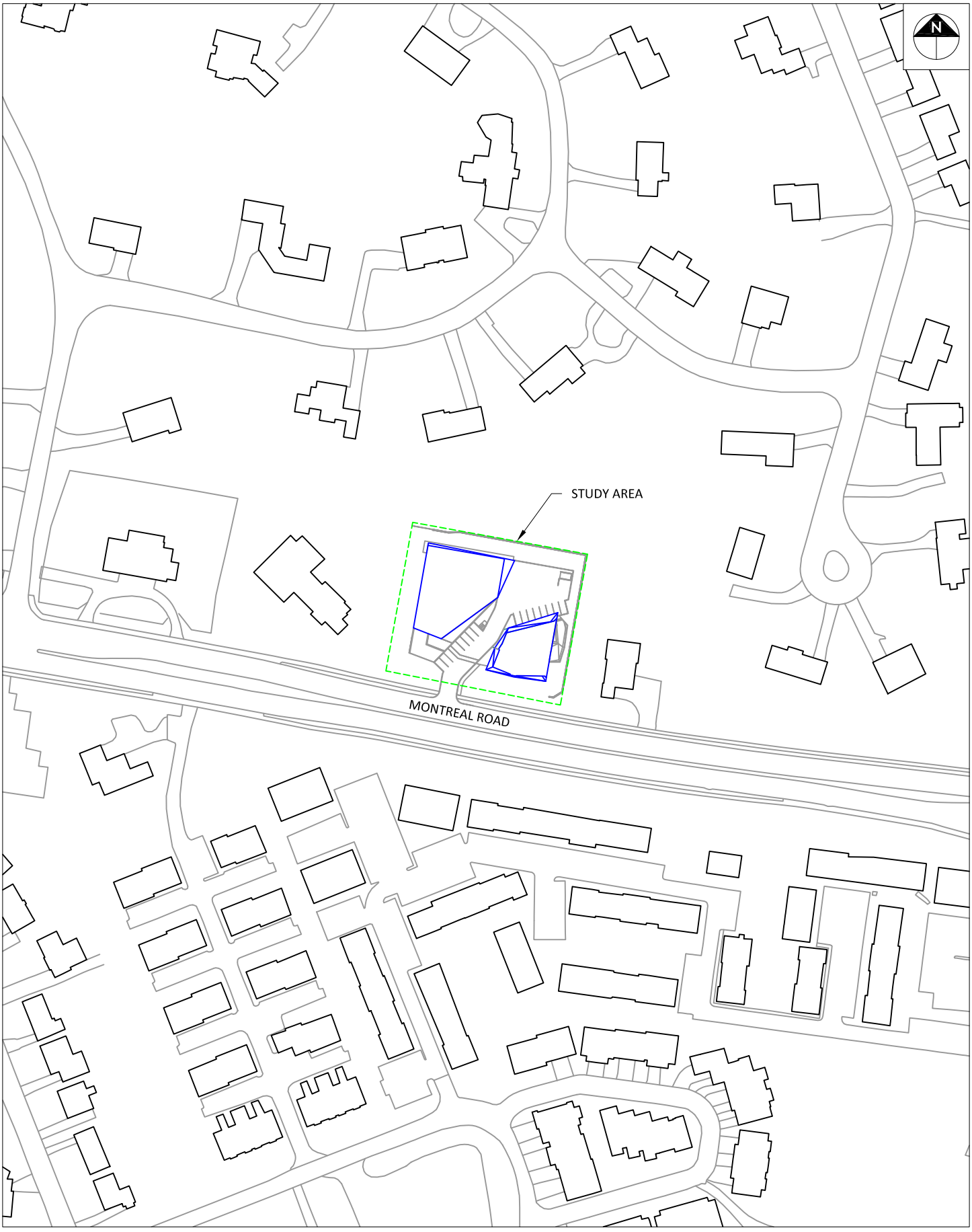
This concludes our assessment and report. If you have any questions or wish to discuss our findings please advise us. In the interim, we thank you for the opportunity to be of service.

Yours truly,

Gradient Wind Engineering Inc.

Michael Lafortune
Environmental Scientist
GWE18-037 – Environmental Noise

Joshua Foster, P.Eng.
Partner



127 Walgreen Road
Ottawa, Ontario
(613) 836 0934

GRADIENT WIND ENGINEERING INC

PROJECT	1795 MONTREAL ROAD ENVIRONMENTAL NOISE ASSESSMENT		DESCRIPTION
SCALE	1:2000 (APPROX.)	DRAWING NO.	GWE18-037-1
DATE	MARCH 29, 2018	DRAWN BY	M.L.

FIGURE 1:
RECEPTOR LOCATIONS

127 Walgreen Road
Ottawa, Ontario
(613) 836 0934
GRADIENT WIND ENGINEERING INC

PROJECT	1795 MONTREAL ROAD ENVIRONMENTAL NOISE ASSESSMENT
SCALE	1:500 (APPROX.)
DRAWING NO.	GWE18-037-2
DATE	MARCH 29, 2018
DRAWN BY	M.L.

DESCRIPTION

FIGURE 2:
ROADWAY TRAFFIC NOISE RECEPTOR LOCATIONS

127 Walgreen Road
Ottawa, Ontario
(613) 836 0934

GRADIENT WIND ENGINEERING INC

PROJECT	1795 MONTREAL ROAD ENVIRONMENTAL NOISE ASSESSMENT		
SCALE	1:500 (APPROX.)	DRAWING NO.	GWE18-037-3
DATE	MARCH 29, 2018	DRAWN BY	M.L.

DESCRIPTION

FIGURE 3:
WINDOW STC REQUIREMENTS

127 Walgreen Road
Ottawa, Ontario
(613) 836 0934

GRADIENT WIND
ENGINEERING INC

PROJECT	1795 MONTREAL ROAD ENVIRONMENTAL NOISE ASSESSMENT		
SCALE	1:500 (APPROX.)	DRAWING NO.	GWE18-037-4
DATE	MARCH 29, 2018	DRAWN BY	M.L.

DESCRIPTION

FIGURE 4:
STAMSON INPUT - RECEPTOR 1 AND 2

127 Walgreen Road
Ottawa, Ontario
(613) 836 0934

GRADIENT WIND ENGINEERING INC

PROJECT	1795 MONTREAL ROAD ENVIRONMENTAL NOISE ASSESSMENT
SCALE	1:500 (APPROX.)
DRAWING NO.	GWE18-037-5
DATE	MARCH 29, 2018
DRAWN BY	M.L.

DESCRIPTION

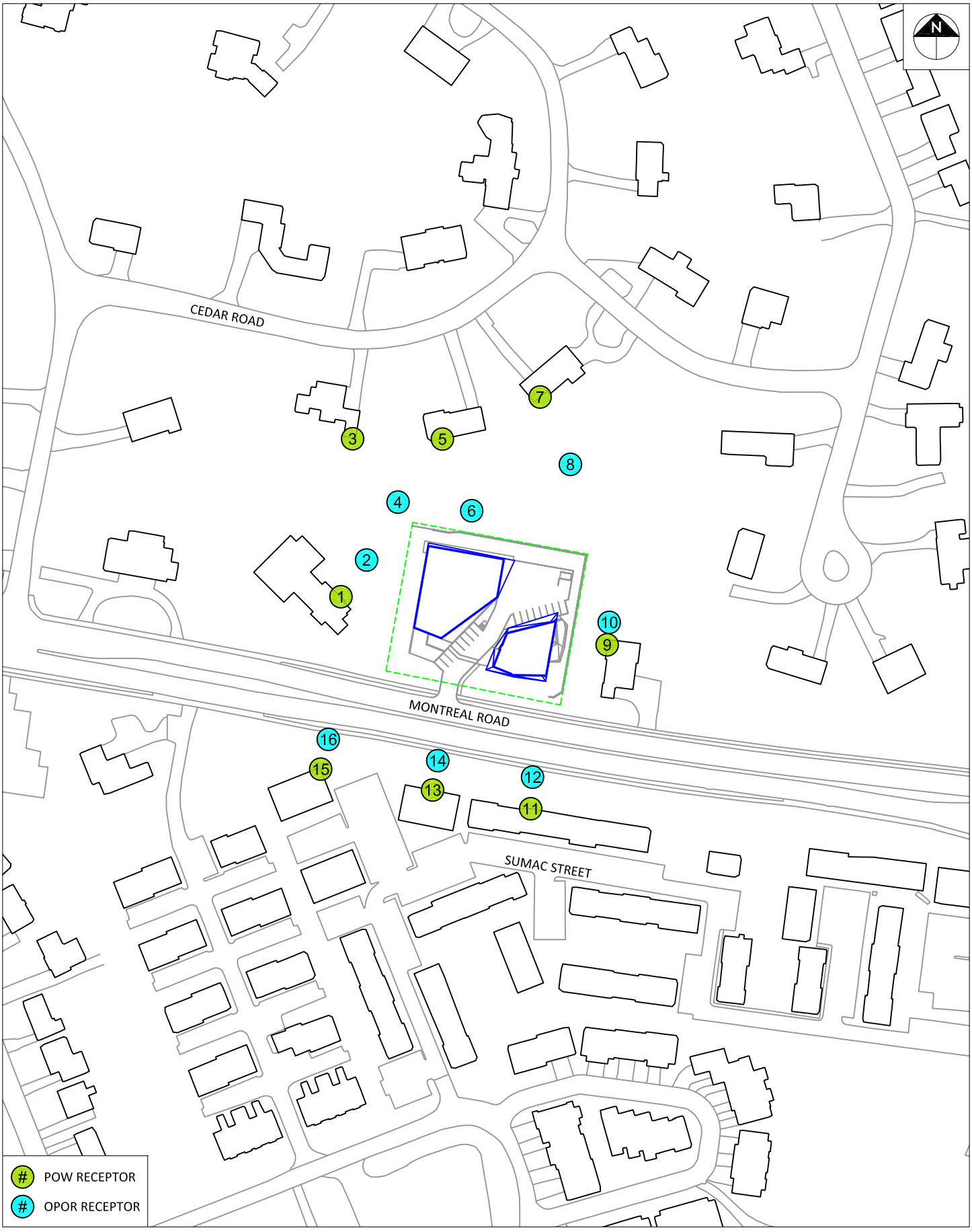
FIGURE 5:
STAMSON INPUT - RECEPTOR 3 AND 4

127 Walgreen Road
Ottawa, Ontario
(613) 836 0934
GRADIENT WIND ENGINEERING INC

PROJECT	1795 MONTREAL ROAD ENVIRONMENTAL NOISE ASSESSMENT		
SCALE	1:500 (APPROX.)	DRAWING NO.	GWE18-037-6
DATE	MARCH 29, 2018	DRAWN BY	M.L.

DESCRIPTION

FIGURE 6:
STATIONARY NOISE SOURCE LOCATIONS



127 Walgreen Road
Ottawa, Ontario
(613) 836 0934

GRADIENT WIND ENGINEERING INC

PROJECT	1795 MONTREAL ROAD ENVIRONMENTAL NOISE ASSESSMENT
SCALE	1:2000 (APPROX.)
DRAWING NO.	GWE18-037-7
DATE	MARCH 29, 2018
DRAWN BY	M.L.

DESCRIPTION

FIGURE 7:
STATIONARY NOISE RECEPTOR LOCATIONS

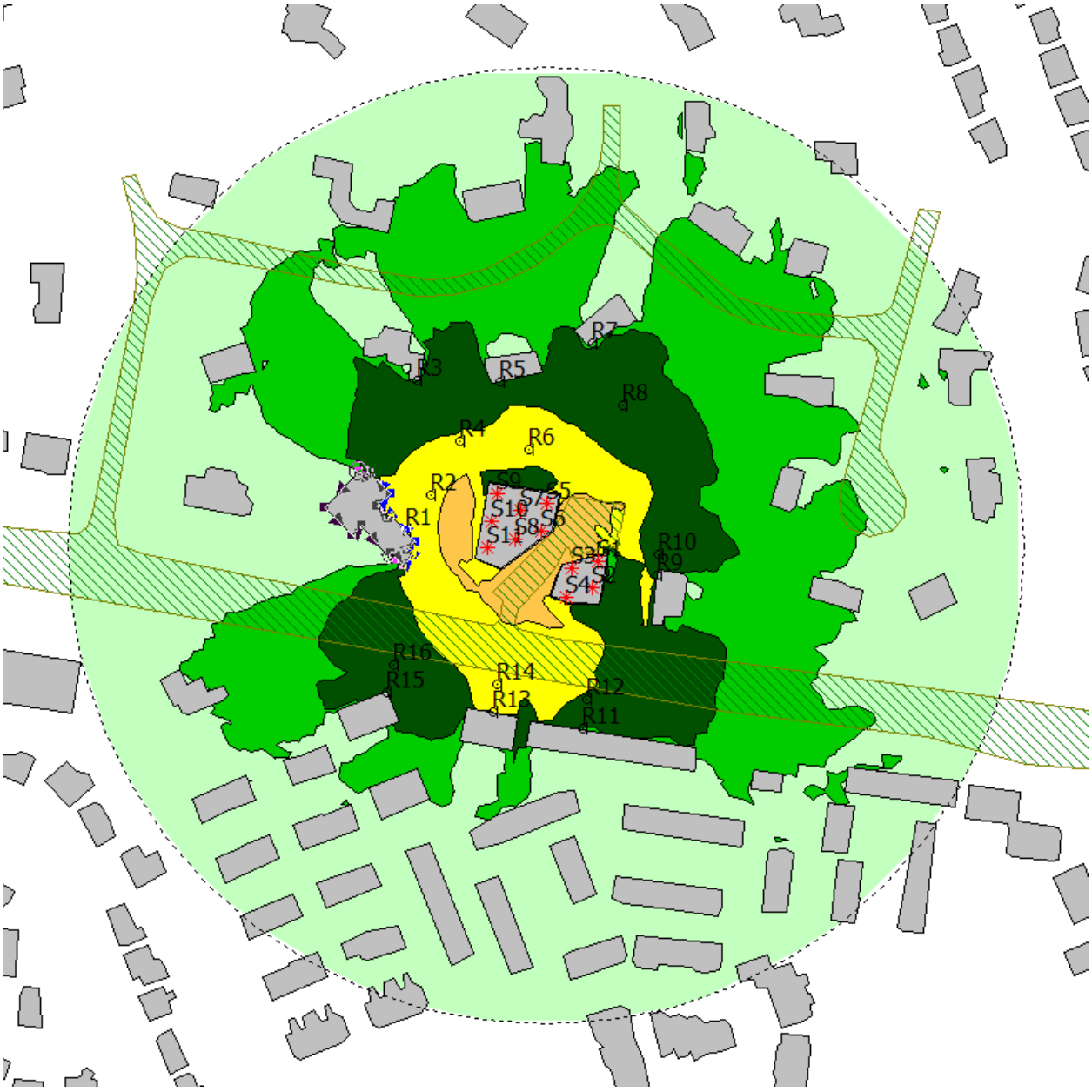
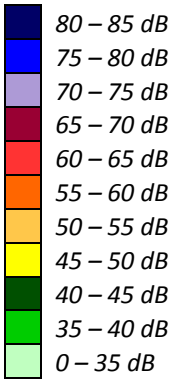


FIGURE 8: DAYTIME/EVENING NOISE CONTOURS (1.5 METERS ABOVE GRADE)



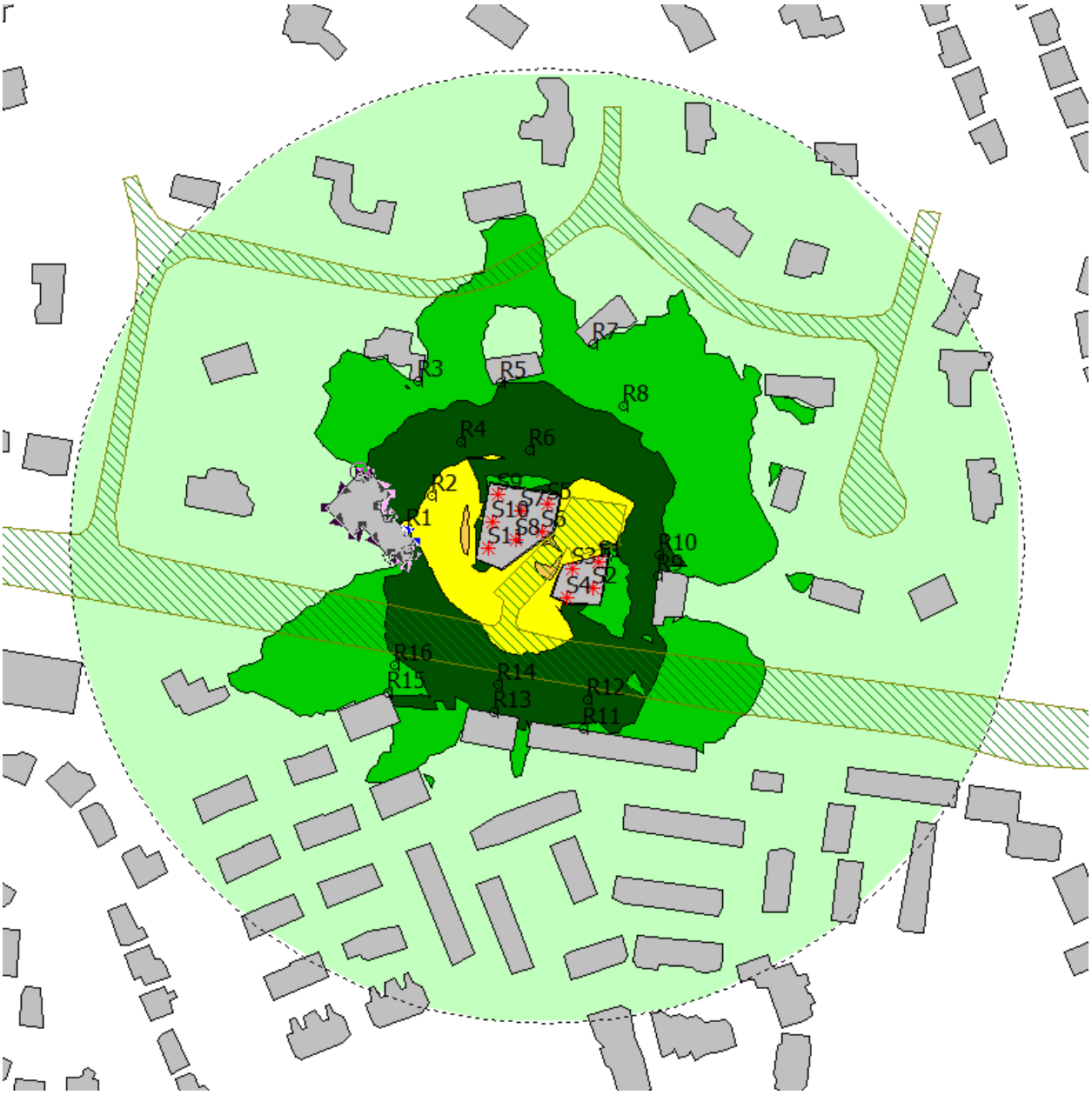
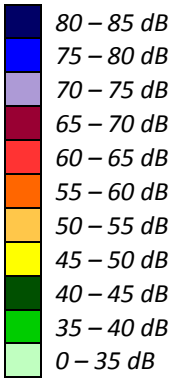


FIGURE 9: NIGHTTIME NOISE CONTOURS (1.5 METERS ABOVE GRADE)



APPENDIX A

STAMSON 5.04 - INPUT AND OUTPUT DATA

```
STAMSON 5.0        NORMAL REPORT        Date: 20-03-2018 37:34:50
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Montreal (day/night)
----------------------------------------------
Car traffic volume  : 28336/2464  veh/TimePeriod  *
Medium truck volume :  2254/196   veh/TimePeriod  *
Heavy truck volume  :  1610/140   veh/TimePeriod  *
Posted speed limit  :    60 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):  35000
    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: Montreal (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  :  38.00 / 38.00  m
Receiver height           :   4.50 / 4.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : 66.00 deg
Barrier height            :   8.00 m
Barrier receiver distance :   1.00 / 1.00   m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Results segment # 1: Montreal (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 !        4.50 !        4.42 !         4.42

ROAD (0.00 + 51.07 + 60.89) = 61.32 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------------
--
   -90     66   0.00  73.68   0.00  -4.04  -0.62   0.00   0.00 -17.95
51.07
-------------------------------------------------------------------------------
--
    66     90   0.00  73.68   0.00  -4.04  -8.75   0.00   0.00   0.00
60.89
-------------------------------------------------------------------------------
--

Segment Leq : 61.32 dBA

Total Leq All Segments: 61.32 dBA
```

```
Results segment # 1: Montreal (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 !        4.50 !        4.42 !         4.42

ROAD (0.00 + 43.48 + 53.29) = 53.72 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------------
--
   -90     66   0.00  66.08   0.00  -4.04  -0.62   0.00   0.00 -17.95
43.48
-------------------------------------------------------------------------------
--
    66     90   0.00  66.08   0.00  -4.04  -8.75   0.00   0.00   0.00
53.29
-------------------------------------------------------------------------------
--

Segment Leq : 53.72 dBA

Total Leq All Segments: 53.72 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 61.32
                           (NIGHT): 53.72
```

STAMSON 5.0 NORMAL REPORT Date: 20-03-2018 206:05:48
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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

Road data, segment # 1: Montreal (day/night)

Car traffic volume	: 28336/2464	veh/TimePeriod *
Medium truck volume	: 2254/196	veh/TimePeriod *
Heavy truck volume	: 1610/140	veh/TimePeriod *
Posted speed limit	: 60	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)	: 35000
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: Montreal (day/night)

Angle1 Angle2	: -90.00 deg	0.00 deg
Wood depth	: 0	(No woods.)
No of house rows	: 0 / 0	
Surface	: 2	(Reflective ground surface)
Receiver source distance	: 25.00 / 25.00	m
Receiver height	: 4.50 / 4.50	m
Topography	: 1	(Flat/gentle slope; no barrier)
Reference angle	: 0.00	

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

Source height = 1.50 m

ROAD (0.00 + 68.45 + 0.00) = 68.45 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90      0   0.00  73.68   0.00  -2.22  -3.01   0.00   0.00   0.00
68.45
-------------------------------------------------------------------------
--

Segment Leq : 68.45 dBA

Total Leq All Segments: 68.45 dBA


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

Source height = 1.50 m

ROAD (0.00 + 60.85 + 0.00) = 60.85 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90      0   0.00  66.08   0.00  -2.22  -3.01   0.00   0.00   0.00
60.85
-------------------------------------------------------------------------
--

Segment Leq : 60.85 dBA

Total Leq All Segments: 60.85 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 68.45
                           (NIGHT): 60.85
```

STAMSON 5.0 NORMAL REPORT Date: 20-03-2018 37:35:02
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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

Road data, segment # 1: Montreal (day/night)

Car traffic volume	: 28336/2464	veh/TimePeriod *
Medium truck volume	: 2254/196	veh/TimePeriod *
Heavy truck volume	: 1610/140	veh/TimePeriod *
Posted speed limit	: 60	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)	: 35000
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: Montreal (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	: 21.00 / 21.00	m
Receiver height	: 4.50 / 4.50	m
Topography	: 1	(Flat/gentle slope; no barrier)
Reference angle	: 0.00	

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

Source height = 1.50 m

ROAD (0.00 + 72.21 + 0.00) = 72.21 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90     90   0.00  73.68   0.00  -1.46   0.00   0.00   0.00   0.00
72.21
-------------------------------------------------------------------------
--

Segment Leq : 72.21 dBA

Total Leq All Segments: 72.21 dBA


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

Source height = 1.50 m

ROAD (0.00 + 64.62 + 0.00) = 64.62 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90     90   0.00  66.08   0.00  -1.46   0.00   0.00   0.00   0.00
64.62
-------------------------------------------------------------------------
--

Segment Leq : 64.62 dBA

Total Leq All Segments: 64.62 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 72.21
                           (NIGHT): 64.62
```

```
STAMSON 5.0        NORMAL REPORT        Date: 20-03-2018 37:35:06
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Montreal (day/night)
----------------------------------------------
Car traffic volume  : 28336/2464  veh/TimePeriod  *
Medium truck volume :  2254/196   veh/TimePeriod  *
Heavy truck volume  :  1610/140   veh/TimePeriod  *
Posted speed limit  :    60 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):  35000
    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: Montreal (day/night)
-------------------------------------------
Angle1   Angle2           :  12.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  25.00 / 25.00  m
Receiver height           :   4.50 / 4.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 67.83 + 0.00) = 67.83 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
    12     90   0.00  73.68   0.00  -2.22  -3.63   0.00   0.00   0.00
67.83
-------------------------------------------------------------------------
--

Segment Leq : 67.83 dBA

Total Leq All Segments: 67.83 dBA


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

Source height = 1.50 m

ROAD (0.00 + 60.23 + 0.00) = 60.23 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
    12     90   0.00  66.08   0.00  -2.22  -3.63   0.00   0.00   0.00
60.23
-------------------------------------------------------------------------
--

Segment Leq : 60.23 dBA

Total Leq All Segments: 60.23 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 67.83
                           (NIGHT): 60.23
```

APPENDIX B

PREDICTOR LIMA SAMPLE OUTPUT

Testfile openend: ######## 3:19:50 PM

Cross section for receiver R5 and source S9

ItemType	Id	Distance	X	Y	Hgrnd	Height
Receiver	R5	0	374674.1	5034461	97.33	2.5
Heightline	LWPOLYLIN	27.188	374673.3	5034434	98	0
Cluster	412	42.251	374672.9	5034419	98.71	4.32
Barrier	LWPOLYLIN	42.655	374672.9	5034419	103.03	1
Pointsourc	S9	46.927	374672.8	5034415	103.03	1.5

L(wr)	54	54	66	73	77	78	75	75	68	
A(ground)	-3	-3	1.32	7.3	3.58	0.43	0	0	0	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0.01	0.02	0.05	0.09	0.17	0.46	1.55	5.51	
A(geo)	44.46	44.46	44.46	44.46	44.46	44.46	44.46	44.46	44.46	
C(meteo)	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	
L(p)	12.23	12.22	19.89	20.88	28.56	32.63	29.77	28.68	17.72	| 36.58

Cross section for receiver R5 and source S9
Reflection calculation in facade LWPOLYLINE

ItemType	Id	Distance	X	Y	Hgrnd	Height
Receiver	R5	0	374674.1	5034461	97.33	2.5
Heightline	LWPOLYLIN	24.245	374661.9	5034440	98	0
Heightline	LWPOLYLIN	39.572	374654.2	5034427	100	0
Heightline	LWPOLYLIN	70.543	374638.7	5034400	102	0
Heightline	LWPOLYLIN	72.3	374637.8	5034399	102	0
Building(R)	LWPOLYLIN	74.485	374636.7	5034397	102.26	9
Heightline	LWPOLYLIN	104.809	374664	5034410	100	0
Cluster	412	109.096	374667.8	5034412	99.26	3.77
Barrier	LWPOLYLIN	109.589	374668.3	5034412	103.03	1
Pointsourc	S9	114.63	374672.8	5034415	103.03	1.5

L(wr)	54	54	66	73	77	78	75	75	68	
A(ground)	-3	-3	2.18	10.73	5.2	0.61	0	0	0	
A(veg)	0	0	0	0	0	0	0	0	0	
A(sit)	0	0	0	0	0	0	0	0	0	
A(bld)	0	0	0	0	0	0	0	0	0	
A(air)	0	0.01	0.05	0.12	0.22	0.42	1.11	3.76	13.41	
A(geo)	52.19	52.19	52.19	52.19	52.19	52.19	52.19	52.19	52.19	
A(refl)	--	--	-0.97	-0.97	-0.97	-0.97	-0.97	-0.97	-0.97	
C(meteo)	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	
L(p)	--	--	10.31	8.69	18.11	23.5	20.43	17.78	1.13	| 26.8

Cross section for receiver R5 and source S9
Reflection calculation in facade POLYLINE

ItemType	Id	Distance	X	Y	Hgrnd	Height
Receiver	R5	0	374674.1	5034461	97.33	2.5
Cluster	124	1.096	374673	5034461	97.39	3.48
Cluster	124	3.591	374670.5	5034461	97.51	3.36
Heightline	LWPOLYLIN	13.059	374661.1	5034460	98	0
Heightline	LWPOLYLIN	53.589	374620.9	5034455	100	0
Heightline	LWPOLYLIN	64.559	374610	5034454	102	0
Heightline	LWPOLYLIN	120.159	374554.8	5034447	104	0
Heightline	LWPOLYLIN	151.78	374523.4	5034444	104	0
Ground	LWPOLYLIN	155.99	374519.2	5034443	70	0
Ground	LWPOLYLIN	164.409	374510.8	5034442	70	0
Cluster	1	191.238	374484.2	5034439	103.97	6.26
Cluster	1	199.709	374475.8	5034438	104.27	5.96
Building(R)	POLYLINE	207.363	374468.2	5034437	104	11.89
Cluster	1	214.73	374475.5	5034436	104.51	5.72
Cluster	1	233.896	374494.5	5034434	104.42	5.81
Ground	LWPOLYLIN	248.386	374508.9	5034433	70	0
Ground	LWPOLYLIN	256.623	374517.1	5034432	70	0
Heightline	LWPOLYLIN	330.459	374590.5	5034424	104	0
Cluster	399	352.558	374612.5	5034421	102.49	8.78
Heightline	LWPOLYLIN	359.053	374618.9	5034420	102	0
Cluster	399	363.334	374623.2	5034420	101.99	9.27
Heightline	LWPOLYLIN	401.604	374661.2	5034416	100	0
Cluster	412	408.757	374668.3	5034415	99.17	3.86
Barrier	LWPOLYLIN	409.158	374668.7	5034415	103.03	1
Pointsourc	S9	413.253	374672.8	5034415	103.03	1.5

L(wr)	54	54	66	73	77	78	75	75	68
A(ground)	-5.13	-5.13	4.99	11.8	5.65	0.56	-0.12	-0.12	-0.12
A(barrier)	3.61	4.06	0.32	0	4.15	8.53	11.09	13.74	16.56
A(veg)	0	0	0	0	0	0	0	0	0
A(sit)	0	0	0	0	0	0	0	0	0
A(bld)	0	0	0	0	0	0	0	0	0
A(air)	0.01	0.05	0.17	0.43	0.8	1.51	3.99	13.54	48.31
A(geo)	63.32	63.32	63.32	63.32	63.32	63.32	63.32	63.32	63.32
A(refl)	--	--	--	--	--	--	-0.97	-0.97	-0.97
C(meteo)	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31

L(p)	--	--	--	--	--	--	-4.56	-16.76	-61.33	| -4.3

Cross section for receiver R5 and source S9
Reflection calculation in facade LWPOLYLINE

ItemType	Id	Distance	X	Y	Hgrnd	Height
Receiver	R5	0	374674.1	5034461	97.33	2.5
Cluster	412	47.448	374689	5034416	97.37	5.66
Barrier	LWPOLYLIN	47.902	374689.1	5034416	103.03	1
Barrier(R)	LWPOLYLIN	66.254	374694.9	5034399	103.03	1
Pointsourc	S9	93.495	374672.8	5034415	103.03	1.5

Height	Source	Per	LAeq	32	63	125	250	500	1000	2000	4000	8000
2.5	S9	1	37.02	12.23	12.22	20.34	21.14	28.94	33.13	30.25	29.02	17.81
2.5	S9	2	--	--	--	--	--	--	--	--	--	--
2.5	S9	3	34.01	9.22	9.21	17.33	18.13	25.93	30.12	27.24	26.01	14.8
2.5	S9	4	--	--	--	--	--	--	--	--	--	--

Height	Per	LAeq	32	63	125	250	500	1000	2000	4000	8000
2.5	1	37.02	12.23	12.22	20.34	21.14	28.94	33.13	30.25	29.02	17.81
2.5	2	--	--	--	--	--	--	--	--	--	--
2.5	3	34.01	9.22	9.21	17.33	18.13	25.93	30.12	27.24	26.01	14.8
2.5	4	--	--	--	--	--	--	--	--	--	--

Testfile closed: ######## 3:19:50 PM