GRADIENTWIND
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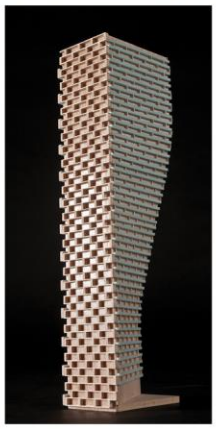
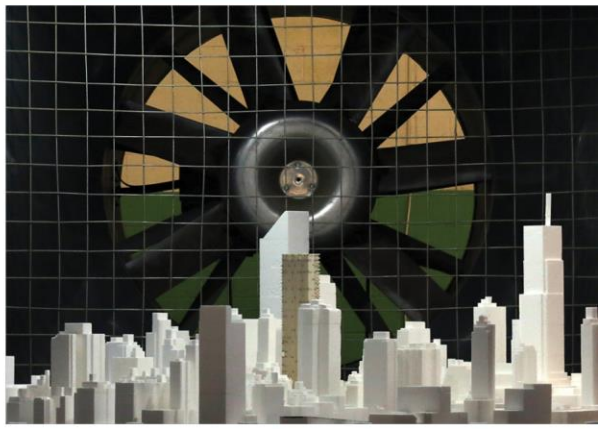
ROADWAY TRAFFIC NOISE FEASIBILITY ASSESSMENT

439 Churchill Avenue North
Ottawa, Ontario

Report: 22-039-T.Noise Feasibility





March 10, 2022

PREPARED FOR

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5882 Leitrim Road
Ottawa, ON K0A 1A0

PREPARED BY

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EXECUTIVE SUMMARY

This report describes a roadway traffic noise feasibility assessment undertaken to satisfy the requirements for a Zoning By-law Amendment (ZBA) application submission for a proposed residential building located at 439 Churchill Avenue North in Ottawa, Ontario. The development comprises an existing 2 story building which will have an additional level added to it as well as extensions on the south and east elevations. The major sources of roadway traffic noise are Churchill Avenue North to the west and Byron Avenue to the north. Figure 1 illustrates a complete site plan with surrounding context.

The assessment is based on (i) theoretical noise prediction methods that conform to the Ministry of the Environment, Conservation and Parks (MECP) and City of Ottawa requirements; (ii) noise level criteria as specified by the City of Ottawa's Environmental Noise Control Guidelines (ENCG); (iii) future vehicular traffic volumes based on the City of Ottawa's Official Plan roadway classifications; and (iv) architectural drawings prepared by Open Plan Architects Inc. in February 2022.

The results of the current analysis indicate that noise levels will range between 48 and 68 dBA during the daytime period (07:00-23:00) and between 41 and 60 dBA during the nighttime period (23:00-07:00). The highest noise level (68 dBA) occurs at the west façade, which is nearest and most exposed to Churchill Avenue North.

The noise levels predicted due to roadway traffic exceed the criteria listed in the ENCG for upgraded building components. Building components with a higher Sound Transmission Class (STC) rating will be required where exterior noise levels exceed 65 dBA. Due to the limited information available at the time of the study, which was prepared for a ZBA application submission, detailed STC calculations could not be performed at this time. A detailed review of window and wall assemblies should be performed by a qualified engineer with expertise in acoustics during the detailed design stage of the development.

Results of the calculations also indicate that the development will require central air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment. Warning Clauses will also be required to be placed on all Lease, Purchase and Sale Agreements.

No OLA's (Outdoor Living Areas) were specified on the building massing since any private baclonies or terraces which extend less than 4 m from the building façade do not qualify as such, per MECP guidelines.

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

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1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Grepault Development Ltd. to undertake a roadway traffic noise feasibility assessment to satisfy the requirements for a Zoning By-law Amendment (ZBA) application submission for the proposed residential building located at 439 Churchill Avenue North in Ottawa, Ontario. This report summarizes the methodology, results, and recommendations related to the assessment of exterior noise levels generated by local roadway traffic.

Our work is based on theoretical noise calculation methods conforming to the City of Ottawa[1] and Ministry of the Environment, Conservation and Parks (MECP)[2] guidelines. Noise calculations were based on architectural drawings prepared by Open Plan Architects Inc. in February 2022, with future traffic volumes corresponding to the City of Ottawa's Official Plan (OP) roadway classifications.

2. TERMS OF REFERENCE

The focus of this roadway traffic noise feasibility assessment is a proposed redevelopment comprising an addition to an existing two-storey commercial building along the east of Churchill Avenue North. The addition would comprise of a third level with a balcony along the west elevation which is supported by two beams, and an extension along the south and east elevations with an angled canopy above a side entrance. The extension along the south elevation is setback from the main façade. Additionally, at the west elevation is a triangular pediment above the main entrance and a staircase with rails on either side. Along the east elevation in a staircase with an overhang and wall to the south, as well as a screen, and outdoor parking spaces.

The site is surrounded by low-rise residential and commercial buildings in all directions. The major sources of traffic noise are Churchill Avenue North bordering the site immediately to the west, and Byron Avenue approximately 50 meters to the north. Figure 1 illustrates a complete site plan with surrounding context.

[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

3. OBJECTIVES

The principal objectives of this study are to (i) calculate the future noise levels on the study buildings produced by local roadway traffic, and (ii) explore potential noise mitigation options, 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

4.2.1 Criteria for Roadway Traffic Noise

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

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

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

Predicted noise levels at the plane of window (POW) dictate the action required to achieve the recommended sound levels. An open window is considered to provide a 10 dBA reduction in noise, while a standard closed window is capable of providing a minimum 20 dBA noise reduction[4]. A closed window due to a ventilation requirement will bring noise levels down to achieve an acceptable indoor environment[5]. Therefore, where noise levels exceed 55 dBA daytime and 50 dBA nighttime, the ventilation for the building should consider the need for having windows and doors closed, which triggers the need for forced air heating with provision for central air conditioning. Where noise levels exceed 65 dBA daytime and 60 dBA nighttime, air conditioning will be required and building components will require higher levels of sound attenuation[6].

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

4.2.2 Theoretical Roadway Noise Predictions

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

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

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

- Truck traffic on all roadways was taken to comprise 5% heavy trucks and 7% medium trucks, as per ENCG requirements for noise level predictions.
- The day/night split for all streets was taken to be 92%/8%, respectively.
- Ground surfaces were taken to be reflective due to the presence of hard (paved) ground.
- Topography was assumed to be a flat/gentle slope surrounding the study buildings.
- For select sources where appropriate, the proposed buildings as well as existing surrounding buildings were considered as barriers, partially or fully obstructing exposure to the source as illustrated by exposure angles in Figures 3 & 4.
- Noise receptors were strategically placed at four (4) locations around the study area, see Figure 2.
- Receptor distances and exposure angles are illustrated in Figures 3 & 4.

4.2.3 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[7] which provide additional details on future roadway expansions. Average Annual Daily Traffic (AADT) volumes are then based on data in Table B1 of the ENCG for each roadway classification. Table 2 (below) summarizes the AADT values used for each roadway included in this assessment.

TABLE 2: ROADWAY TRAFFIC DATA

Segment	Roadway Traffic Data	Speed Limit (km/h)	Traffic Volumes
Churchill Avenue North	2-Lane Major Collector	50	**12,000**
Byron Avenue	2-Lane Collector	50	**8,000**

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

5. RESULTS AND DISCUSSION

5.1 Roadway Traffic Noise Levels

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

TABLE 3: EXTERIOR NOISE LEVELS DUE TO ROAD TRAFFIC

Receptor Number	Receptor Height Above Grade (m)	Receptor Location	STAMSON 5.04 Noise Level (dBA)	
			Day	Night
1	7.5	POW –West Façade	68	60
2	7.5	POW – North Façade	64	56
3	7.5	POW – East Façade	48	41
4	7.5	POW – South Façade	62	55

*Noise levels at OLAs during the nighttime are not considered, as per the ENCG.

The results of the current analysis indicate that noise levels will range between 48 and 68 dBA during the daytime period (07:00-23:00) and between 41 and 60 dBA during the nighttime period (23:00-07:00). The highest noise level (68 dBA) occurs at the west façade, which is nearest and most exposed to Churchill Avenue North.

The noise levels predicted due to roadway traffic exceed the criteria listed in Section 4.2 for building components. Upgraded building components, including STC rated glazing elements and exterior walls, will be required where noise levels due to roadway traffic exceed 65 dBA, as discussed in Section 4.2.1. Results of the calculations also indicated that the 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 to be placed on all Lease, Purchase and Sale Agreements. Specific noise control measures can be developed once the design of the building has progressed sufficiently, typically at the time of site plan approval.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current analysis indicate that noise levels will range between 48 and 68 dBA during the daytime period (07:00-23:00) and between 41 and 60 dBA during the nighttime period (23:00-07:00). The highest noise level (68 dBA) occurs at the west façade, which is nearest and most exposed to Churchill Avenue North. Building components with a higher Sound Transmission Class (STC) rating will be required where exterior noise levels exceed 65 dBA. Due to the limited information available at the time of the study, which was prepared for a Zoning By-law Amendment application submission, detailed STC calculations could not be performed at this time. A detailed review of window and wall assemblies should be performed by a qualified engineer with expertise in acoustics during the detailed design stage of the development.

Results of the calculations also indicate the building will require central air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment. The following Type D Warning Clause will also be required to be placed on all Lease, Purchase and Sale Agreements:

> *"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 sound level limits of the Municipality and the Ministry of the Environment."*

No OLA's (Outdoor Living Areas) were specified on the building massing since any private baclonies or terraces which extend less than 4 m from the building façade do not qualify as such, per MECP guidelines.

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

This concludes our roadway traffic noise 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.

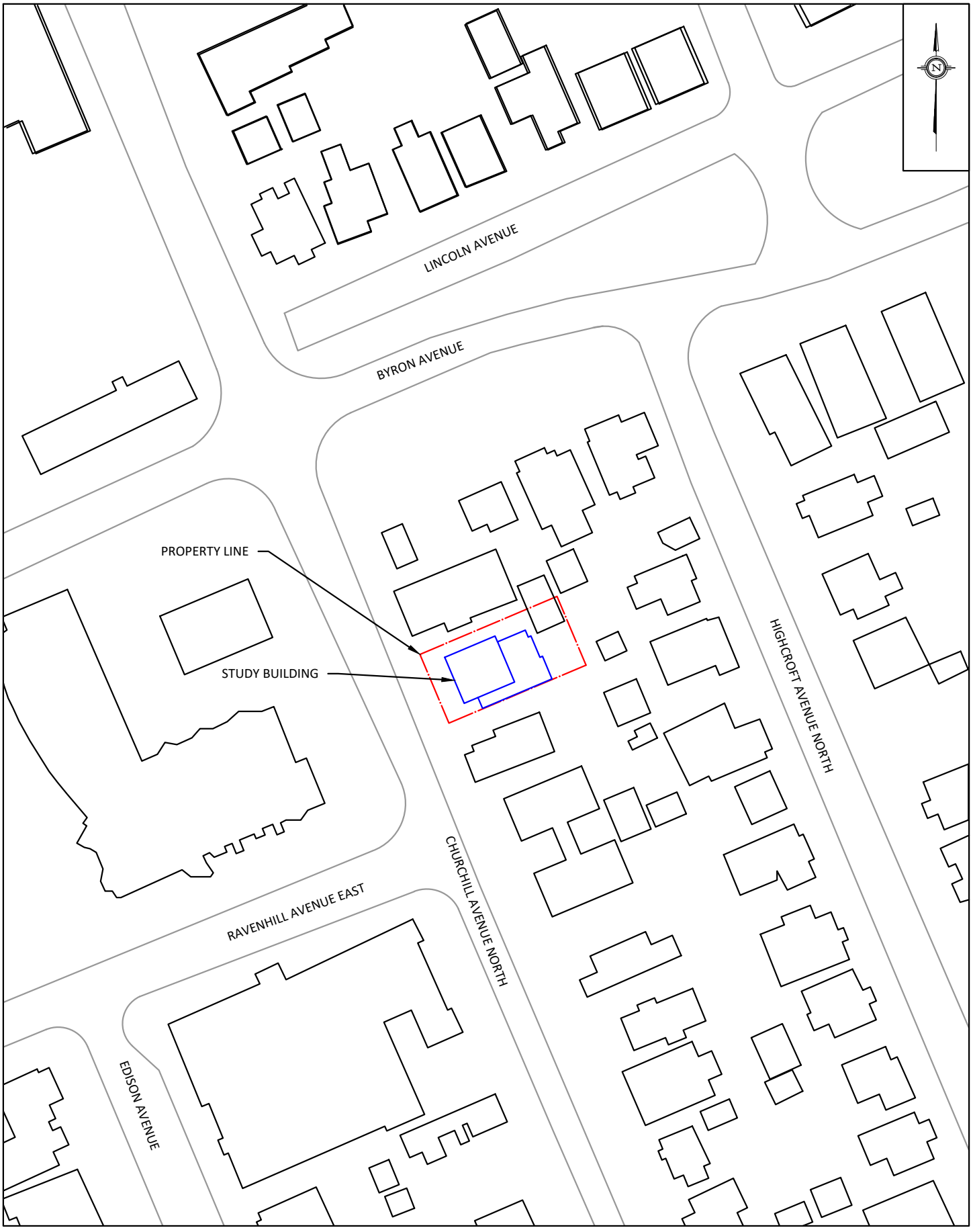
Sincerely,

Gradient Wind Engineering Inc.

Caleb Alexander, B.Eng.
Junior Environmental Scientist

Joshua Foster, P.Eng.
Lead Engineer

Gradient Wind File 22-039-T.Noise Feasibility



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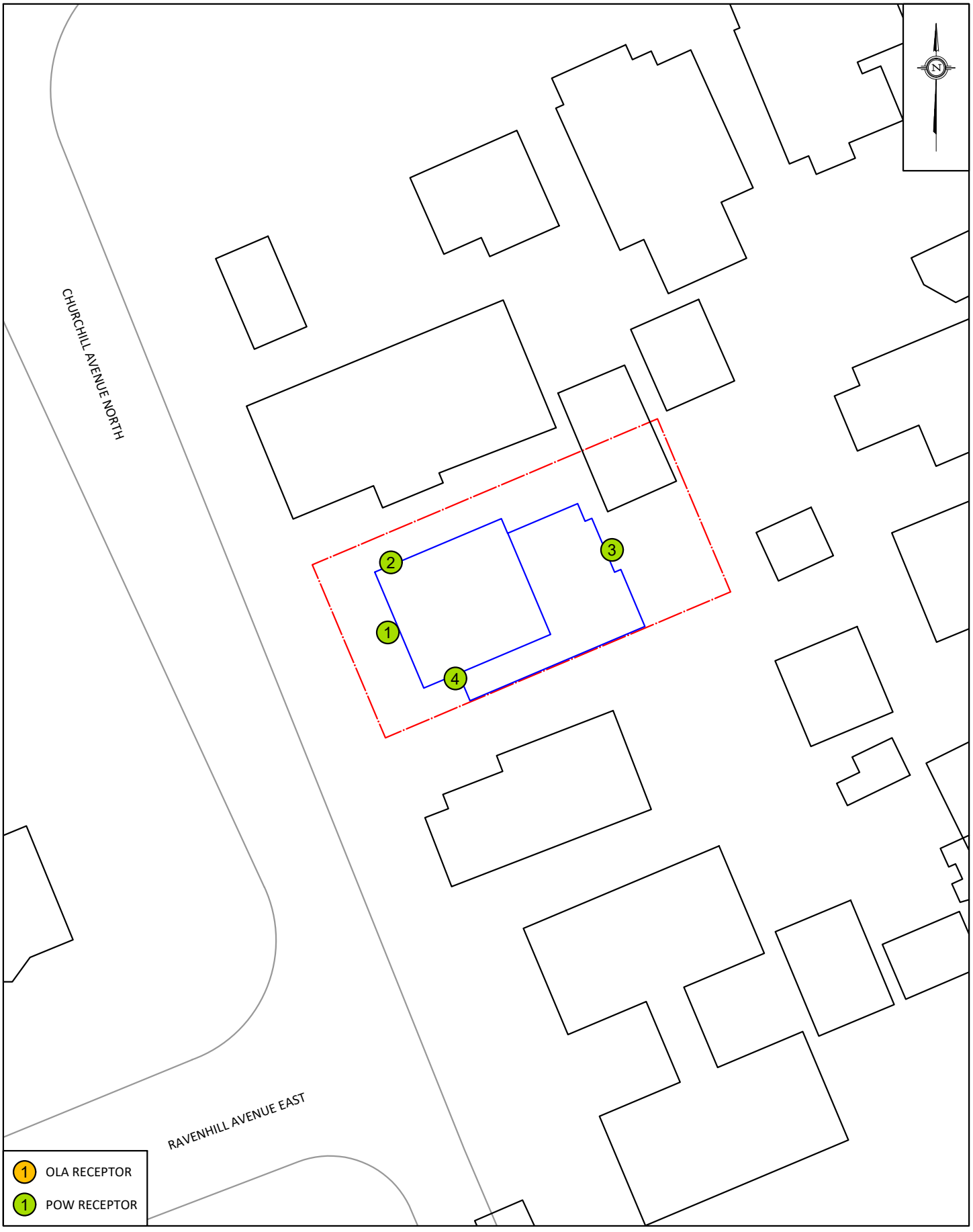
PROJECT	439 CHURCHILL AVENUE NORTH, OTTAWA ROADWAY TRAFFIC NOISE FEASIBILITY ASSESSMENT		DESCRIPTION
SCALE	1:1000 (APPROX.)	DRAWING NO.	GW22-039-1
DATE	FEBRUARY 15, 2022	DRAWN BY	C.A.

FIGURE 1:
SITE PLAN AND SURROUNDING CONTEXT



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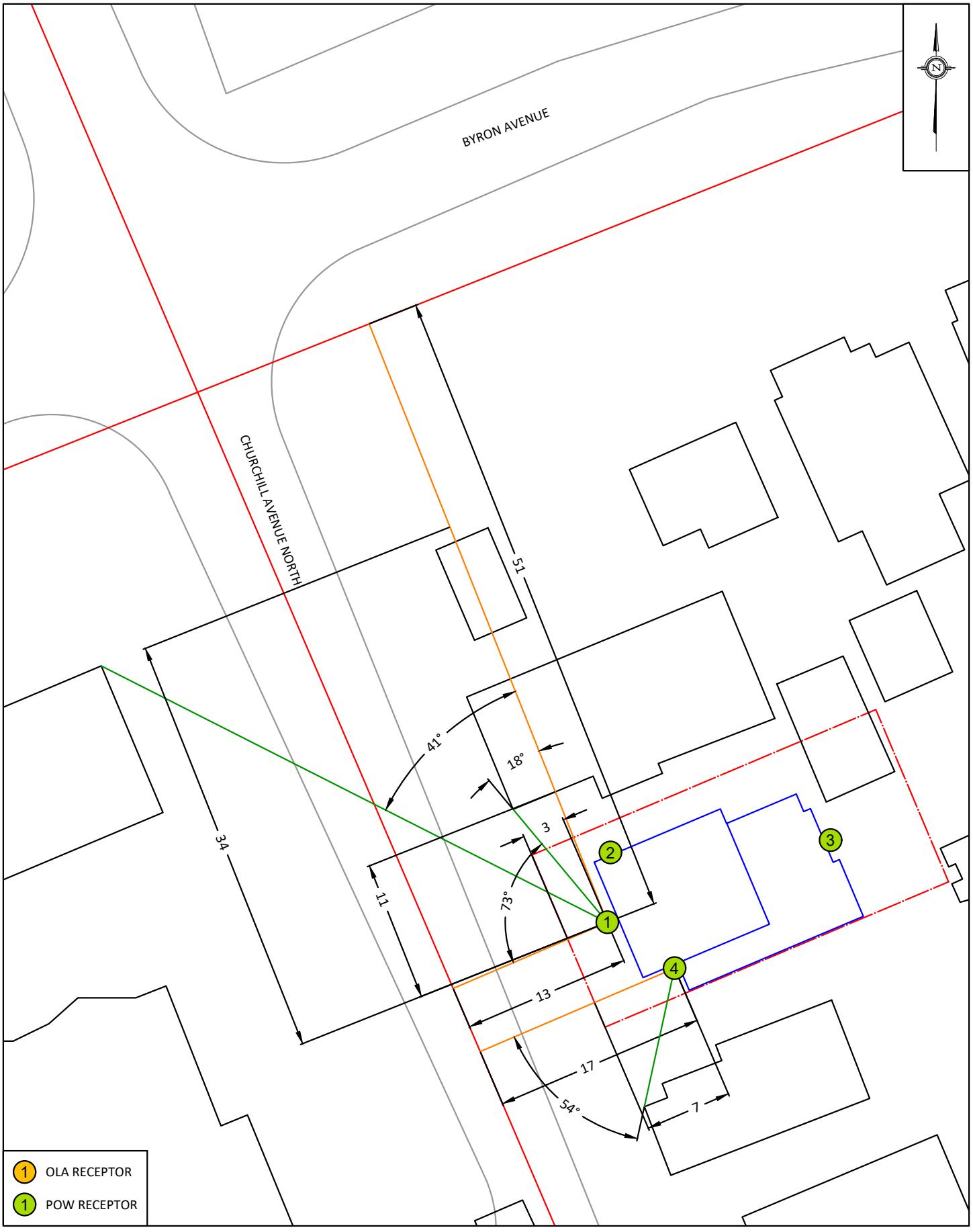
PROJECT	439 CHURCHILL AVENUE NORTH, OTTAWA ROADWAY TRAFFIC NOISE FEASIBILITY ASSESSMENT
SCALE	1:400 (APPROX.)
DRAWING NO.	GW22-039-2
DATE	FEBRUARY 15, 2022
DRAWN BY	C.A.

DESCRIPTION

FIGURE 2:
RECEPTOR LOCATION



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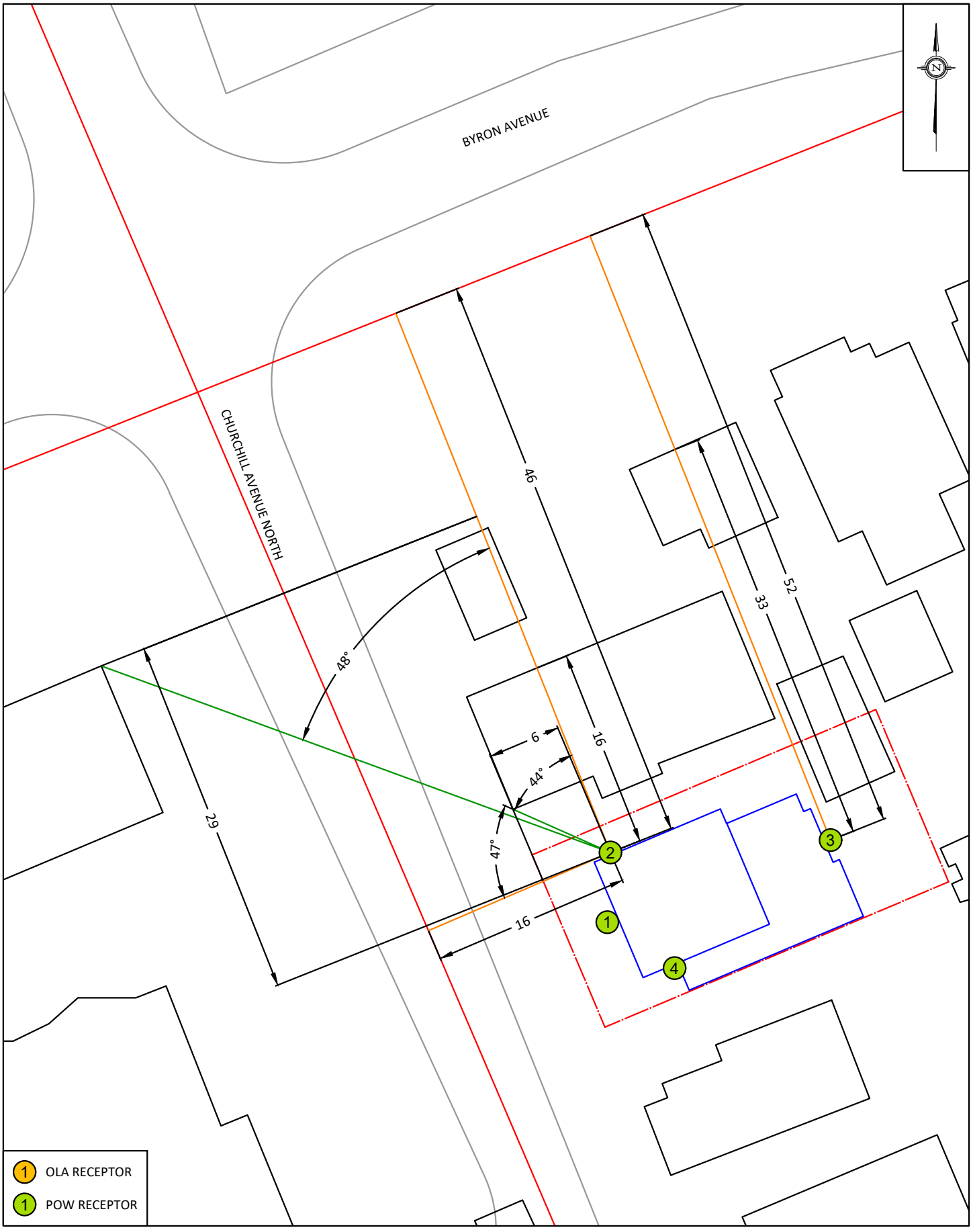
PROJECT	439 CHURCHILL AVENUE NORTH, OTTAWA ROADWAY TRAFFIC NOISE FEASIBILITY ASSESSMENT		DESCRIPTION
SCALE	1:400 (APPROX.)	DRAWING NO.	GW22-039-3
DATE	FEBRUARY 15, 2022	DRAWN BY	C.A.

FIGURE 3:
STAMSON INPUT PARAMETERS RECEPTORS 1&4



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PROJECT	439 CHURCHILL AVENUE NORTH, OTTAWA ROADWAY TRAFFIC NOISE FEASIBILITY ASSESSMENT
SCALE	1:400 (APPROX.)
DRAWING NO.	GW22-039-4
DATE	FEBRUARY 15, 2022
DRAWN BY	C.A.

DESCRIPTION

FIGURE 4:
STAMSON INPUT PARAMETERS RECEPTORS 2&3

APPENDIX A

STAMSON 5.04 – INPUT AND OUTPUT DATA

127 WALGREEN ROAD, OTTAWA, ON, CANADA K0A 1L0 | 613 836 0934
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```
STAMSON 5.0         NORMAL REPORT         Date: 16-02-2022 10:13:21
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Churchill (day/night)
----------------------------------------------
Car traffic volume  :  9715/845   veh/TimePeriod  *
Medium truck volume :   773/67    veh/TimePeriod  *
Heavy truck volume  :   552/48    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  12000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Churchill (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  :  15.00 / 15.00  m
Receiver height           :   7.50 / 7.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :  73.00 deg   Angle2 : 90.00 deg
Barrier height            :   6.00 m
Barrier receiver distance :   3.00 / 3.00   m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 2: Byron (day/night)
----------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Byron (day/night)
---------------------------------------
Angle1   Angle2           : -90.00 deg   -41.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  51.00 / 51.00  m
Receiver height           :   7.50 / 4.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -41.00 deg
Barrier height            :   9.00 m
Barrier receiver distance :  34.00 / 34.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 3: Byron 2 (day/night)
-------------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 3: Byron 2 (day/night)
-----------------------------------------
Angle1   Angle2           : -41.00 deg   0.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  51.00 / 51.00  m
Receiver height           :   7.50 / 4.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -18.00 deg   Angle2 : 0.00 deg
Barrier height            :   6.00 m
Barrier receiver distance :  11.00 / 11.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Results segment # 1: Churchill (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 !        7.50 !        6.30 !         6.30

ROAD (67.08 + 57.26 + 0.00) = 67.51 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     73   0.00  67.51   0.00   0.00  -0.43   0.00   0.00   0.00  67.08
-------------------------------------------------------------------------------
    73     90   0.00  67.51   0.00   0.00 -10.25   0.00   0.00  -4.88  52.38*
    73     90   0.00  67.51   0.00   0.00 -10.25   0.00   0.00   0.00  57.26
-------------------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 67.51 dBA


Results segment # 2: Byron (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 !        7.50 !        3.50 !         3.50

ROAD (0.00 + 42.22 + 0.00) = 42.22 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -41   0.00  65.75   0.00  -5.31  -5.65   0.00   0.00 -12.57  42.22
-------------------------------------------------------------------------------

Segment Leq : 42.22 dBA
```

```
Results segment # 3: Byron 2 (day)
----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !        7.50 !        6.20 !         6.20

ROAD (51.50 + 50.43 + 0.00) = 54.01 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -41    -18   0.00  65.75   0.00  -5.31  -8.94   0.00   0.00   0.00  51.50
-------------------------------------------------------------------------------
   -18      0   0.00  65.75   0.00  -5.31 -10.00   0.00   0.00  -4.87  45.56*
   -18      0   0.00  65.75   0.00  -5.31 -10.00   0.00   0.00   0.00  50.43
-------------------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 54.01 dBA

Total Leq All Segments: 67.71 dBA


Results segment # 1: Churchill (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 !        7.50 !        6.30 !         6.30

ROAD (59.48 + 49.66 + 0.00) = 59.91 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     73   0.00  59.91   0.00   0.00  -0.43   0.00   0.00   0.00  59.48
-------------------------------------------------------------------------------
    73     90   0.00  59.91   0.00   0.00 -10.25   0.00   0.00  -4.88  44.78*
    73     90   0.00  59.91   0.00   0.00 -10.25   0.00   0.00   0.00  49.66
-------------------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 59.91 dBA
```

```
Results segment # 2: Byron (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 !        2.50 !         2.50

ROAD (0.00 + 33.52 + 0.00) = 33.52 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -41   0.00  58.16   0.00  -5.31  -5.65   0.00   0.00 -13.67  33.52
-------------------------------------------------------------------------------

Segment Leq : 33.52 dBA


Results segment # 3: Byron 2 (night)
------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !        4.50 !        3.85 !         3.85

ROAD (43.91 + 30.82 + 0.00) = 44.11 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -41    -18   0.00  58.16   0.00  -5.31  -8.94   0.00   0.00   0.00  43.91
-------------------------------------------------------------------------------
   -18      0   0.00  58.16   0.00  -5.31 -10.00   0.00   0.00 -12.03  30.82
-------------------------------------------------------------------------------

Segment Leq : 44.11 dBA

Total Leq All Segments: 60.03 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 67.71
                           (NIGHT): 60.03
```

```
STAMSON 5.0         NORMAL REPORT         Date: 16-02-2022 10:13:30
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Churchill (day/night)
----------------------------------------------
Car traffic volume  :  9715/845   veh/TimePeriod  *
Medium truck volume :   773/67    veh/TimePeriod  *
Heavy truck volume  :   552/48    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  12000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Churchill (day/night)
--------------------------------------------
Angle1   Angle2           :   0.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  16.00 / 16.00  m
Receiver height           :   7.50 / 7.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :  47.00 deg   Angle2 : 90.00 deg
Barrier height            :   6.00 m
Barrier receiver distance :   6.00 / 6.00   m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 2: Byron (day/night)
-----------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Byron (day/night)
---------------------------------------
Angle1   Angle2           : -90.00 deg   -48.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  46.00 / 46.00  m
Receiver height           :   7.50 / 7.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -48.00 deg
Barrier height            :   9.00 m
Barrier receiver distance :  29.00 / 29.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 3: Byron 2 (day/night)
-------------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 3: Byron 2 (day/night)
-----------------------------------------
Angle1   Angle2           : -48.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  46.00 / 46.00  m
Receiver height           :   7.50 / 7.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :  48.00 deg   Angle2 : 90.00 deg
Barrier height            :   6.00 m
Barrier receiver distance :  16.00 / 16.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Results segment # 1: Churchill (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 !        7.50 !        5.25 !         5.25

ROAD (61.40 + 54.99 + 0.00) = 62.29 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
     0     47   0.00  67.51   0.00  -0.28  -5.83   0.00   0.00   0.00  61.40
-------------------------------------------------------------------------------
    47     90   0.00  67.51   0.00  -0.28  -6.22   0.00   0.00  -6.03  54.99
-------------------------------------------------------------------------------

Segment Leq : 62.29 dBA


Results segment # 2: Byron (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 !        7.50 !        3.71 !         3.71

ROAD (0.00 + 42.52 + 0.00) = 42.52 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -48   0.00  65.75   0.00  -4.87  -6.32   0.00   0.00 -12.04  42.52
-------------------------------------------------------------------------------

Segment Leq : 42.52 dBA
```

```
Results segment # 3: Byron 2 (day)
----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !        7.50 !        5.41 !         5.41

ROAD (58.15 + 49.27 + 0.00) = 58.68 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -48     48   0.00  65.75   0.00  -4.87  -2.73   0.00   0.00   0.00  58.15
-------------------------------------------------------------------------------
    48     90   0.00  65.75   0.00  -4.87  -6.32   0.00   0.00  -5.29  49.27
-------------------------------------------------------------------------------

Segment Leq : 58.68 dBA

Total Leq All Segments: 63.89 dBA


Results segment # 1: Churchill (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 !        7.50 !        5.25 !         5.25

ROAD (53.80 + 47.39 + 0.00) = 54.69 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
     0     47   0.00  59.91   0.00  -0.28  -5.83   0.00   0.00   0.00  53.80
-------------------------------------------------------------------------------
    47     90   0.00  59.91   0.00  -0.28  -6.22   0.00   0.00  -6.03  47.39
-------------------------------------------------------------------------------

Segment Leq : 54.69 dBA
```

```
Results segment # 2: Byron (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 !        7.50 !        3.71 !         3.71

ROAD (0.00 + 34.93 + 0.00) = 34.93 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -48   0.00  58.16   0.00  -4.87  -6.32   0.00   0.00 -12.04  34.93
-------------------------------------------------------------------------------

Segment Leq : 34.93 dBA


Results segment # 3: Byron 2 (night)
------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !        7.50 !        5.41 !         5.41

ROAD (50.56 + 41.68 + 0.00) = 51.09 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -48     48   0.00  58.16   0.00  -4.87  -2.73   0.00   0.00   0.00  50.56
-------------------------------------------------------------------------------
    48     90   0.00  58.16   0.00  -4.87  -6.32   0.00   0.00  -5.29  41.68
-------------------------------------------------------------------------------

Segment Leq : 51.09 dBA

Total Leq All Segments: 56.29 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 63.89
                           (NIGHT): 56.29
```

```
STAMSON 5.0        NORMAL REPORT        Date: 16-02-2022 10:13:44
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Byron (day/night)
-----------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Byron (day/night)
---------------------------------------
Angle1   Angle2           :   0.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  52.00 / 52.00  m
Receiver height           :   7.50 / 7.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :   0.00 deg   Angle2 : 90.00 deg
Barrier height            :   6.00 m
Barrier receiver distance :  33.00 / 33.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Results segment # 1: Byron (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 !        7.50 !        3.69 !         3.69

ROAD (0.00 + 48.28 + 0.00) = 48.28 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
     0     90   0.00  65.75   0.00  -5.40  -3.01   0.00   0.00  -9.06  48.28
-------------------------------------------------------------------------------

Segment Leq : 48.28 dBA

Total Leq All Segments: 48.28 dBA


Results segment # 1: Byron (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 !        7.50 !        3.69 !         3.69

ROAD (0.00 + 40.68 + 0.00) = 40.68 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
     0     90   0.00  58.16   0.00  -5.40  -3.01   0.00   0.00  -9.06  40.68
-------------------------------------------------------------------------------

Segment Leq : 40.68 dBA

Total Leq All Segments: 40.68 dBA




TOTAL Leq FROM ALL SOURCES (DAY): 48.28
                           (NIGHT): 40.68
```

```
STAMSON 5.0        NORMAL REPORT        Date: 16-02-2022 10:13:54
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Byron (day/night)
----------------------------------------
Car traffic volume  :  9715/845   veh/TimePeriod  *
Medium truck volume :   773/67    veh/TimePeriod  *
Heavy truck volume  :   552/48    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  12000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Byron (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  :  17.00 / 17.00  m
Receiver height           :   7.50 / 7.50   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -54.00 deg
Barrier height            :   6.00 m
Barrier receiver distance :   7.00 / 7.00   m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Results segment # 1: Byron (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 !        7.50 !        5.03 !         5.03

ROAD (0.00 + 53.68 + 61.74) = 62.37 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -54   0.00  67.51   0.00  -0.54  -6.99   0.00   0.00  -6.30  53.68
-------------------------------------------------------------------------------
   -54      0   0.00  67.51   0.00  -0.54  -5.23   0.00   0.00   0.00  61.74
-------------------------------------------------------------------------------

Segment Leq : 62.37 dBA

Total Leq All Segments: 62.37 dBA


Results segment # 1: Byron (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 !        7.50 !        5.03 !         5.03

ROAD (0.00 + 46.08 + 54.14) = 54.77 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -54   0.00  59.91   0.00  -0.54  -6.99   0.00   0.00  -6.30  46.08
-------------------------------------------------------------------------------
   -54      0   0.00  59.91   0.00  -0.54  -5.23   0.00   0.00   0.00  54.14
-------------------------------------------------------------------------------

Segment Leq : 54.77 dBA

Total Leq All Segments: 54.77 dBA


TOTAL Leq FROM ALL SOURCES (DAY): 62.37
                           (NIGHT): 54.77
```