Traffic Noise Assessment

398, 402, 406 Roosevelt Avenue

Ottawa, Ontario

REPORT: GWE17-179 – Noise

Prepared For:

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December 18, 2017

EXECUTIVE SUMMARY

This document describes a traffic noise assessment performed for a proposed mixed-use condominium development located at 398, 402, and 406 Roosevelt Avenue in Ottawa, Ontario. The development will be 6-storieys high, with commercial space on the first floor and part of the second floor, and residential use from the second to the sixth floor. There are private balconies/ terraces found on the second to the sixth floor. However, these are not considered as Outdoor Living Areas (OLA) since they are less than 4-metres in depth. The major source of vehicle transportation noise is from Richmond Road. Figure 1 shows the site plan and 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) architectural drawings received from Alcaide Webster Architects Inc.

The results of the current study indicate that noise levels due to roadway traffic over the site will range from 52 to 63 dBA during the daytime period (07:00-23:00) and from 44 to 56 dBA during the nighttime period (23:00-07:00). The highest noise level (i.e. 63 dBA) occurs on the south façade (Receptor 5), which is nearest and most exposed to Richmond Road. There are no noise sensitive OLAs associated with this development.

Results of the calculations also indicate that the development will require forced air heating with provisions for 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, as summarized in Section 6.

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1. INTRODUCTION

Gradient Wind Engineering Inc. (GWE) was retained by Domicile Development to undertake a traffic noise assessment in support of concurrent zoning by-law amendment (ZBA) and site plan application (SPA) for a proposed six storey mixed-use condominium development located at 398, 402, and 406 Roosevelt Avenue in Ottawa, Ontario. Our mandate within this study, as outlined in GWE proposal #17-263P, dated October 25, 2017, involves assessing exterior and interior noise levels generated by local roadway traffic. The assessment was performed on the basis of theoretical noise calculation methods conforming to the City of Ottawa[1] and the Ministry of the Environment and Climate Change (MOECC)[2] guidelines. Noise calculations were based on concept drawings received from Alcaide Webster Architects Inc. with future traffic volumes corresponding to the City of Ottawa's Official Plan (OP) roadway classifications.

2. TERMS OF REFERENCE

The focus of this traffic noise assessment is the proposed mixed-use condominium building on the property encompassing 398, 402 and 406 Roosevelt Avenue in Ottawa, Ontario. The proposed development is a six-storey building, with commercial space on the first floor and part of the second floor, and residential use from the second to the sixth floor. There is a basement level dedicated to storage spaces, parking spaces, mechanical and electrical rooms. Parking spaces are also available at grade on the west side of the building. The building rises with a uniform floor plan from Level 2 to Level 4, at which point the floor plan steps back on the north and east elevations to create space for private balconies. At Level six, the floor plan steps back on the north, west and south elevations to create space for private balconies. However, the private terraces and balconies are not considered noise-sensitive OLAs, being less than 4 metres in depth.

The major source of roadway noise is vehicle traffic Richmond Road. The site is surrounded by mixed-use land, mainly commercial developments along Richmond Road and residential neighborhoods beyond. Figure 1 illustrates a complete site plan with the surrounding context.

[1] City of Ottawa Environmental Noise Control Guidelines, SS Wilson Associates, May 10, 2006
[2] Ministry of the Environment – Publication NPC-300

3. OBJECTIVES

The main objective of this work is to calculate the future noise levels on the study building produced by local transportation traffic, and to ensure that interior noise levels do not exceed the allowable limits specified by the City of Ottawa's Environmental Noise Control Guidelines (ENCG), as outlined in Section 4.2 of this report.

4. METHODOLOGY

4.1 Background

Noise can be defined as any obtrusive sound. It is created at a source, transmitted through a medium, such as air, and intercepted by a receiver. Noise may be characterized in terms of the power of the source or the sound pressure at a specific distance. While the power of a source is characteristic of that particular source, the sound pressure depends on the location of the receiver and the path that the noise takes to reach the receiver. Measurement of noise is based on the decibel unit, dBA, which is a logarithmic ratio referenced to a standard noise level (2×10^{-5} Pascals). The 'A' suffix refers to a weighting scale, which better represents how the noise is perceived by the human ear. With this scale, a doubling of power results in a 3 dBA increase in measured noise levels and is just perceptible to most people. An increase of 10 dBA is often perceived to be twice as loud.

4.2 Criteria for Roadway Traffic 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 ENCG specifies that the recommended indoor noise limit range (that is relevant to this study) is 50, 45 and 40 dBA for retail space, living rooms and sleeping quarters respectively, as listed in Table 1. To account for deficiencies in building construction, theses levels should be targeted toward 47, 42 and 37 dBA.

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

Type of Space	Time Period	L_{eq} (dBA)
		Road
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]. 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].

4.3 Roadway Noise Assessment

4.3.1 Theoretical Roadway Noise Predictions

Noise predictions were performed with the aid of the MOECC computerized noise assessment program, STAMSON 5.04, for road analysis. Noise receptors were strategically identified at 7 locations around the study area, as illustrated in Figure 2. Roadway noise calculations were performed by treating each road segment 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:

[3] Adapted from ENCG 2016 – Part 1, Table 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

- Truck traffic on all roadways was taken to comprise of 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 all streets
- Reflective intermediate ground surfaces used
- Surrounding buildings on Richmond Road are in some cases used as barrier when the line of sight between the source and receiver is broken by the buildings
- Receptor heights based on elevation drawings dated November 30, 2017

4.3.2 Roadway Traffic Volumes

The ENCG dictates that noise calculations should consider future sound levels based on a roadway's classification at the mature state of development. Therefore, traffic volumes are based on the roadway classifications outlined in the City of Ottawa's Official Plan (OP) and Transportation Master Plan[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.

TABLE 2: ROADWAY TRAFFIC DATA

Source	Roadway Class	Speed Limit (km/h)	Official Plan AADT
Richmond Road	2-Lane Urban Arterial Undivided (2-UAU)	40	**15,000**

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

5. RESULTS AND DISCUSSION

5.1 Roadway Noise Levels

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

TABLE 3: EXTERIOR NOISE LEVELS DUE TO ROADWAY TRAFFIC

Receptor Number	Plane of Window Receptor Location	Roadway Noise Level (dBA)*	
		Day	Night
1	West Façade – 4th floor	52	44
2	South Façade – 4th floor	61	53
3	East Façade – 4th floor	60	52
4	West Façade – 6th floor	54	46
5	South Façade – 6th floor	63	56
6	East Façade – 6th floor	60	53
7	East Façade – 1st floor	59	52

The results of the current study indicate that noise levels due to roadway traffic over the site will range from 52 to 63 dBA during the daytime period (07:00-23:00) and from 44 to 56 dBA during the nighttime period (23:00-07:00). The highest noise level (i.e. 63 dBA) occurs on the south façade (Receptor 5), which is nearest and most exposed to Richmond Road. There are no noise sensitive OLAs associated with this development.

Results of the calculations also indicate that the development will require forced air heating with provisions for central 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, as summarized in Section 6 below.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current study indicate that noise levels due to roadway traffic over the site will range from 52 to 63 dBA during the daytime period (07:00-23:00) and from 44 to 56 dBA during the nighttime period (23:00-07:00). The highest noise level (i.e. 63 dBA) occurs on the south façade (Receptor 5), which is nearest and most exposed to Richmond Road. There are no noise sensitive OLAs associated with this development.

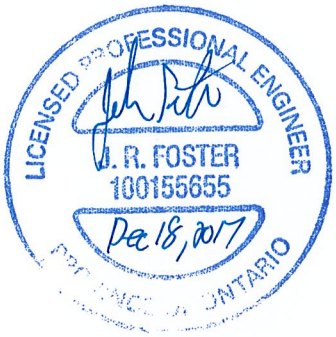
Results of the calculations also indicate that the development will require forced air heating with provisions for central air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment. In addition to ventilation requirements, Warning Clauses in all Lease, Purchase and Sale Agreements will be required as summarized below:

> *"Purchasers are advised that despite the inclusion of noise control features in the development and within the building units, sound levels due to increasing roadway traffic may, on occasion, interfere with some activities of the occupants as the sound levels exceed the sound level limits of the City of Ottawa and 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.*
>
> *This development has also been designed with forced air heating with provisions for central conditioning for all units. Installation of 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 of Ottawa and the Ministry of the Environment and Climate Change."*

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.



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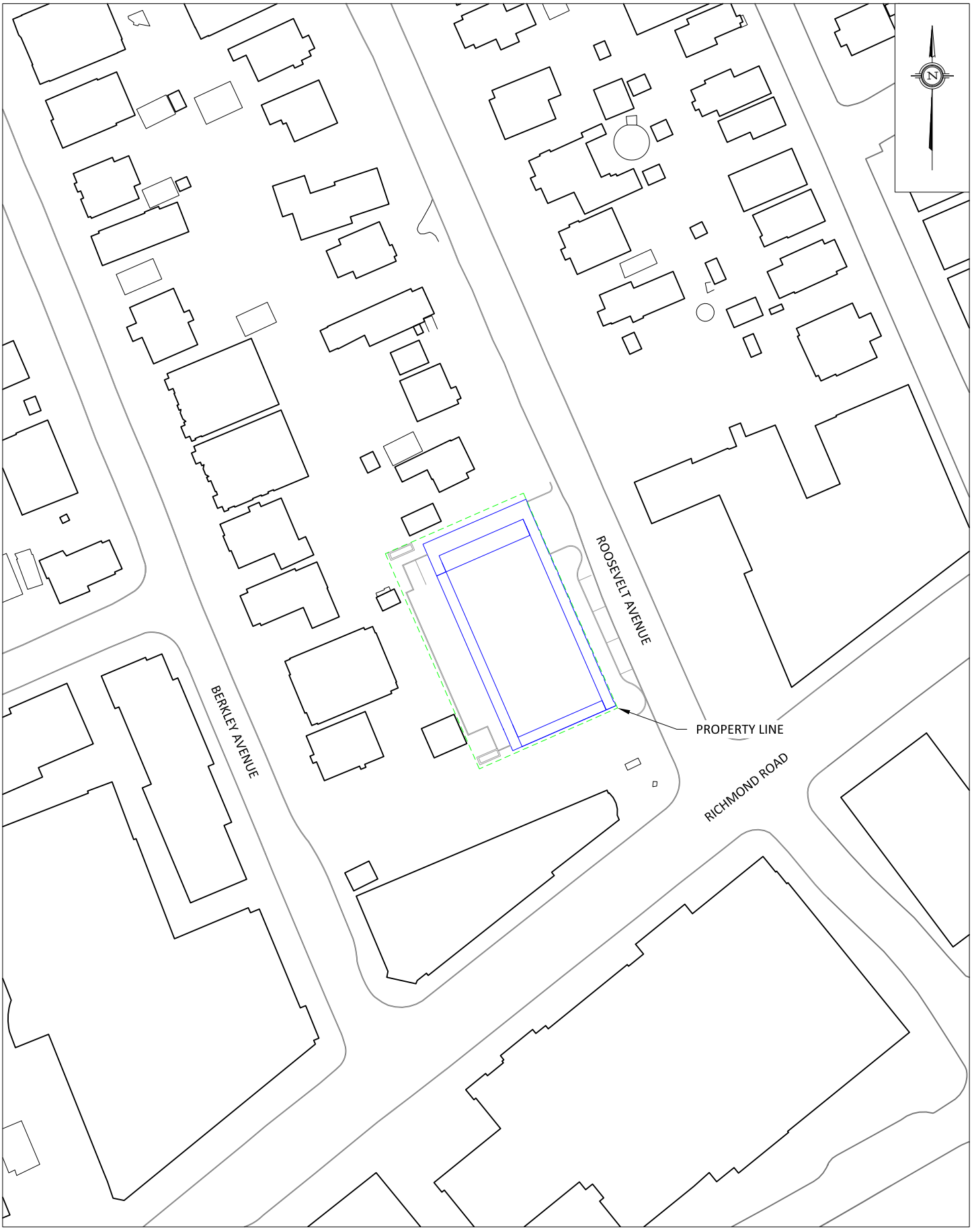

127 Walgreen Road
Ottawa, Ontario
(613) 836 0934

GRADIENT WIND ENGINEERING INC

PROJECT	398, 402, 406 ROOSEVELT AVENUE - TRAFFIC NOISE ASSESSMENT
SCALE	1:1000 (APPROX.)
DRAWING NO.	GWE17-179-1
DATE	DECEMBER 18, 2017
DRAWN BY	O.D.

DESCRIPTION

FIGURE 1:
SITE PLAN AND SURROUNDING CONTEXT

127 Walgreen Road
Ottawa, Ontario
(613) 836 0934

GRADIENT WIND ENGINEERING INC

PROJECT	398, 402, 406 ROOSEVELT AVENUE - TRAFFIC NOISE ASSESSMENT
SCALE	1:750 (APPROX.)
DRAWING NO.	GWE17-179-1
DATE	DECEMBER 18, 2017
DRAWN BY	O.D.

DESCRIPTION

FIGURE 2:
RECEPTOR LOCATIONS

APPENDIX A

TRAFFIC MODELLING INPUT AND OUTPUT DATA

```
STAMSON 5.0        NORMAL REPORT        Date: 07-12-2017 13:33:18
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Richmond (day/night)
----------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    40 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Richmond (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  :  39.00 / 39.00  m
Receiver height           :  11.50 / 11.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :   0.00 deg   Angle2 : 78.00 deg
Barrier height            :   8.00 m
Barrier receiver distance :  28.00 / 28.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Results segment # 1: Richmond (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 !       11.50 !        4.32 !         4.32

ROAD (0.00 + 44.67 + 50.78) = 51.73 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
     0     78   0.00  66.69   0.00  -4.15  -3.63   0.00   0.00 -14.24  44.67
-------------------------------------------------------------------------------
    78     90   0.00  66.69   0.00  -4.15 -11.76   0.00   0.00   0.00  50.78
-------------------------------------------------------------------------------

Segment Leq : 51.73 dBA

Total Leq All Segments: 51.73 dBA


Results segment # 1: Richmond (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 !       11.50 !        4.32 !         4.32

ROAD (0.00 + 37.07 + 43.18) = 44.13 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
     0     78   0.00  59.09   0.00  -4.15  -3.63   0.00   0.00 -14.24  37.07
-------------------------------------------------------------------------------
    78     90   0.00  59.09   0.00  -4.15 -11.76   0.00   0.00   0.00  43.18
-------------------------------------------------------------------------------

Segment Leq : 44.13 dBA

Total Leq All Segments: 44.13 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 51.73
                           (NIGHT): 44.13
```

```
STAMSON 5.0        NORMAL REPORT        Date: 07-12-2017 13:33:25
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Richmond (day/night)
----------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    40 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Richmond (day/night)
----------------------------------------------
Angle1   Angle2           : -90.00 deg   26.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  30.00 / 30.00  m
Receiver height           :  11.50 / 11.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -60.00 deg
Barrier height            :   7.00 m
Barrier receiver distance :  20.00 / 20.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 2: Richmond 2 (day/night)
-----------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    40 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 2: Richmond 2 (day/night)
-----------------------------------------------
Angle1   Angle2           :  26.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  30.00 / 30.00  m
Receiver height           :  11.50 / 11.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :  26.00 deg   Angle2 : 90.00 deg
Barrier height            :   8.00 m
Barrier receiver distance :  20.00 / 20.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Results segment # 1: Richmond (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 !       11.50 !        4.83 !         4.83

ROAD (0.00 + 48.26 + 60.47) = 60.72 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -60   0.00  66.69   0.00  -3.01  -7.78   0.00   0.00  -7.63  48.26
-------------------------------------------------------------------------------
   -60     26   0.00  66.69   0.00  -3.01  -3.21   0.00   0.00   0.00  60.47
-------------------------------------------------------------------------------

Segment Leq : 60.72 dBA


Results segment # 2: Richmond 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 !       11.50 !        4.83 !         4.83

ROAD (0.00 + 48.06 + 0.00) = 48.06 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
    26     90   0.00  66.69   0.00  -3.01  -4.49   0.00   0.00 -11.12  48.06
-------------------------------------------------------------------------------

Segment Leq : 48.06 dBA

Total Leq All Segments: 60.95 dBA
```

```
Results segment # 1: Richmond (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 !       11.50 !        4.83 !         4.83

ROAD (0.00 + 40.66 + 52.87) = 53.12 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -60   0.00  59.09   0.00  -3.01  -7.78   0.00   0.00  -7.63  40.66
-------------------------------------------------------------------------------
   -60     26   0.00  59.09   0.00  -3.01  -3.21   0.00   0.00   0.00  52.87
-------------------------------------------------------------------------------

Segment Leq : 53.12 dBA


Results segment # 2: Richmond 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 !       11.50 !        4.83 !         4.83

ROAD (0.00 + 40.47 + 0.00) = 40.47 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
    26     90   0.00  59.09   0.00  -3.01  -4.49   0.00   0.00 -11.12  40.47
-------------------------------------------------------------------------------

Segment Leq : 40.47 dBA

Total Leq All Segments: 53.35 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 60.95
                           (NIGHT): 53.35
```

```
STAMSON 5.0        NORMAL REPORT        Date: 07-12-2017 13:33:32
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Richmond (day/night)
-------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    40 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Richmond (day/night)
------------------------------------------
Angle1   Angle2           : -90.00 deg   15.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  31.00 / 31.00  m
Receiver height           :  11.50 / 11.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -54.00 deg
Barrier height            :   7.00 m
Barrier receiver distance :  20.00 / 20.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Results segment # 1: Richmond (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 !       11.50 !        5.05 !         5.05

ROAD (0.00 + 49.05 + 59.37) = 59.75 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -54   0.00  66.69   0.00  -3.15  -6.99   0.00   0.00  -7.49  49.05
-------------------------------------------------------------------------------
   -54     15   0.00  66.69   0.00  -3.15  -4.16   0.00   0.00   0.00  59.37
-------------------------------------------------------------------------------

Segment Leq : 59.75 dBA

Total Leq All Segments: 59.75 dBA


Results segment # 1: Richmond (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 !       11.50 !        5.05 !         5.05

ROAD (0.00 + 41.45 + 51.77) = 52.16 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -54   0.00  59.09   0.00  -3.15  -6.99   0.00   0.00  -7.49  41.45
-------------------------------------------------------------------------------
   -54     15   0.00  59.09   0.00  -3.15  -4.16   0.00   0.00   0.00  51.77
-------------------------------------------------------------------------------

Segment Leq : 52.16 dBA

Total Leq All Segments: 52.16 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 59.75
                           (NIGHT): 52.16
```

```
STAMSON 5.0        NORMAL REPORT        Date: 07-12-2017 13:33:37
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Richmond (day/night)
-------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    40 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Richmond (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  :  39.00 / 39.00  m
Receiver height           :  18.60 / 18.60  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :   0.00 deg   Angle2 : 78.00 deg
Barrier height            :   8.00 m
Barrier receiver distance :  28.00 / 28.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Results segment # 1: Richmond (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 !       18.60 !        6.32 !         6.32

ROAD (0.00 + 50.44 + 50.78) = 53.62 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
     0     78   0.00  66.69   0.00  -4.15  -3.63   0.00   0.00  -8.46  50.44
-------------------------------------------------------------------------------
    78     90   0.00  66.69   0.00  -4.15 -11.76   0.00   0.00   0.00  50.78
-------------------------------------------------------------------------------

Segment Leq : 53.62 dBA

Total Leq All Segments: 53.62 dBA


Results segment # 1: Richmond (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 !       18.60 !        6.32 !         6.32

ROAD (0.00 + 42.85 + 43.18) = 46.03 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
     0     78   0.00  59.09   0.00  -4.15  -3.63   0.00   0.00  -8.46  42.85
-------------------------------------------------------------------------------
    78     90   0.00  59.09   0.00  -4.15 -11.76   0.00   0.00   0.00  43.18
-------------------------------------------------------------------------------

Segment Leq : 46.03 dBA

Total Leq All Segments: 46.03 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 53.62
                           (NIGHT): 46.03
```

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STAMSON 5.0        NORMAL REPORT        Date: 07-12-2017 13:33:42
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Richmond (day/night)
-------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    40 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Richmond (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  :  32.00 / 32.00  m
Receiver height           :  18.60 / 18.60  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 63.40 + 0.00) = 63.40 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  66.69   0.00  -3.29   0.00   0.00   0.00   0.00  63.40
-------------------------------------------------------------------------------

Segment Leq : 63.40 dBA

Total Leq All Segments: 63.40 dBA


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

Source height = 1.50 m

ROAD (0.00 + 55.80 + 0.00) = 55.80 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.00  59.09   0.00  -3.29   0.00   0.00   0.00   0.00  55.80
-------------------------------------------------------------------------------

Segment Leq : 55.80 dBA

Total Leq All Segments: 55.80 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 63.40
                           (NIGHT): 55.80
```

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STAMSON 5.0        NORMAL REPORT        Date: 07-12-2017 13:33:47
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Richmond (day/night)
-------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    40 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Richmond (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  :  32.00 / 32.00  m
Receiver height           :  18.60 / 18.60  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 60.38 + 0.00) = 60.38 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90      0   0.00  66.69   0.00  -3.29  -3.01   0.00   0.00   0.00  60.38
-------------------------------------------------------------------------------

Segment Leq : 60.38 dBA

Total Leq All Segments: 60.38 dBA

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

Source height = 1.50 m

ROAD (0.00 + 52.79 + 0.00) = 52.79 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90      0   0.00  59.09   0.00  -3.29  -3.01   0.00   0.00   0.00  52.79
-------------------------------------------------------------------------------

Segment Leq : 52.79 dBA

Total Leq All Segments: 52.79 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 60.38
                           (NIGHT): 52.79
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STAMSON 5.0        NORMAL REPORT        Date: 07-12-2017 13:33:52
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Richmond (day/night)
-------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    40 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Richmond (day/night)
------------------------------------------
Angle1   Angle2           : -90.00 deg   15.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  31.00 / 31.00  m
Receiver height           :   1.60 / 1.60   m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -54.00 deg
Barrier height            :   7.00 m
Barrier receiver distance :  20.00 / 20.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Results segment # 1: Richmond (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 !        1.60 !        1.53 !         1.53

ROAD (0.00 + 43.44 + 59.37) = 59.48 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -54   0.00  66.69   0.00  -3.15  -6.99   0.00   0.00 -13.10  43.44
-------------------------------------------------------------------------------
   -54     15   0.00  66.69   0.00  -3.15  -4.16   0.00   0.00   0.00  59.37
-------------------------------------------------------------------------------

Segment Leq : 59.48 dBA

Total Leq All Segments: 59.48 dBA


Results segment # 1: Richmond (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 !        1.60 !        1.53 !         1.53

ROAD (0.00 + 35.85 + 51.77) = 51.88 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90    -54   0.00  59.09   0.00  -3.15  -6.99   0.00   0.00 -13.10  35.85
-------------------------------------------------------------------------------
   -54     15   0.00  59.09   0.00  -3.15  -4.16   0.00   0.00   0.00  51.77
-------------------------------------------------------------------------------

Segment Leq : 51.88 dBA

Total Leq All Segments: 51.88 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 59.48
                           (NIGHT): 51.88
```