Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Services

Paterson Group Inc.
Consulting Engineers
154 Colonnade Road South
Ottawa (Nepean), Ontario
Canada K2E 7J5

Tel: (613) 226-7381
Fax: (613) 226-6344
www.patersongroup.ca

patersongroup

Confederation Line
Level 1 Proximity Study

Proposed Multi-Storey Building
335 Roosevelt Avenue
Ottawa, Ontario

Prepared For

Uniform Urban Developments

July 27, 2020

Report: PG2178-2
Revision 1

1.0 Introduction

Paterson Group (Paterson) was commissioned by Uniform Urban Developments to conduct a Level 1 Confederation Line Proximity Study for the proposed development to be located at 335 Roosevelt Avenue in the City of Ottawa.

The objective of the current study was to:

- ❏ Review all current information available from the City of Ottawa with regards to the construction of the Confederation Line.

- ❏ Liaise between the City of Ottawa and the Uniform Urban Developments consultant team involved with the aforementioned project.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains a collaboration of architectural, civil, structural, geotechnical, and shoring design information as they pertain to the aforementioned project.

2.0 Development Details

Based on current plans, it is understood that the proposed development consists of 2 high-rise buildings and 4 low-rise residential buildings. These structures will have 2 levels of shared underground parking which will extend beyond the limits of the overlying buildings to the property lines.

The following is known about the Confederation Line and Dominion Station in the vicinity of the subject site:

- ❏ The Confederation Line is proposed to be located to the north of the subject site, within the existing recessed transitway structure.

- ❏ The proposed Confederation Line rails are anticipated to be located at the base of the existing transitway at approximate geodetic elevation 61 m.

- ❏ Based on the subsurface profile encountered at the borehole locations at 335 Roosevelt Avenue and our experience in the general area, bedrock is expected at approximate depths of 0.6 to 1.2 m below the existing ground surface at the subject site, which corresponds to approximate geodetic elevation 65 to 66 m.

3.0 Construction Methodology and Impact Review

Paterson has prepared a construction methodology summary along with possible impacts on the adjacent segment of the proposed Confederation Line based on the current building design details. The Construction Methodology and Impact Review is provided in Appendix A and presents the anticipated construction items, impact review and mitigation program recommended for the proposed Confederation Line and Dominion Station.

The primary issue will be vibrations associated with the bedrock blasting removal program. It is recommended that a vibration monitoring program be implemented to ensure vibration levels remain below recommended tolerances. Details of the recommended vibration monitoring program are presented below.

3.1 Vibration Monitoring and Control Program

Due to the proposed Confederation Line alignment and Dominion Station located in the vicinity of the subject site, the contractor should take extra precaution to minimize vibrations. The monitoring program will be required for the full duration of the shoring installation (if required) and blasting operations. The purpose of the vibration monitoring and control program (VMCP) is to provide a description of the measures to be implemented by the contractor to manage excavation operations and any other vibration sources during the construction for the proposed development. The VMCP will also provide a guideline for assessing results against the relevant vibration impact assessment criteria and recommendations to meet the required limits.

The monitoring program will incorporate real time results at the proposed Confederation Line and Dominion Station, located in the vicinity of the subject site. The monitoring equipment should consist of a tri-axial seismograph, capable of measuring vibration intensities up to 254 mm/s at a frequency response of 2 to 250 Hz.

The locations of the seismographs should be reviewed periodically throughout construction to ensure that the monitoring equipment remains along the alignment of the proposed Confederation Line with the closest radius to the construction activities. The seismograph locations should be approved by the project manager prior to installation.

During construction, the vibration monitor will be relocated for the ‘worst case’ location for each construction activity. When an event is triggered, Paterson will review the results and provide any necessary feedback. Otherwise, the vibration results will be summarized in the weekly report.

Proposed Vibration Limits

The excavation operations should be planned and conducted under the supervision of a licensed professional engineer who is an experienced bedrock excavation consultant. The following table outlines the vibration limits for the proposed Confederation Line and Dominion Station:

Table 1 - Structure Vibration Limits for the Confederation Line and Dominion Sta.

Dominant Frequency Range (Hz)	Peak Particle Velocity (mm/s)	Event	Description of Event
<10	all	none	no action required
<40	>10	trigger level	Warning e-mail sent to contractor.
<40	≥15	exceedance level	Exceedance e-mail and phone call to the contractor. All operations are ceased to review on-site activities.
>40	>15	trigger level	Warning e-mail sent to contractor.
>40	≥25	exceedance level	Exceedance e-mail and phone call to the contractor. All operations are ceased to review on-site activities.

Monitoring Data

The monitoring protocol should include the following information:

Trigger Level Event

- ❏ Paterson will review all vibrations over the established warning level, and;
- ❏ Paterson will notify the contractor if any vibrations occur due to construction activities and are close to exceedance level.

Exceedance Level Event

- ❏ Paterson will notify all the relevant stakeholders via email
- ❏ Ensure monitors are functioning
- ❏ Issue the vibration exceedance result

The data collected should include the following:

- ❑ Measured vibration levels
- ❑ Distance from the construction activity to monitoring location
- ❑ Vibration type

Monitoring should be compliant with all related regulations.

3.2 Incident/Exceedance Reporting

In case an exceedance occurs from construction activities, the Senior Project Management and any relevant personnel should be notified immediately. A report should be completed which contains the following:

- ❑ Identify the location of vibration exceedance
- ❑ The date, time and nature of the exceedance
- ❑ Purpose of the exceeded monitor and current vibration criteria
- ❑ Identify the likely cause of the exceedance
- ❑ Describe the response action that has been completed to date
- ❑ Describe the proposed measures to address the exceedance.

The contractor should implement mitigation measures for future excavation or any construction activities as necessary and provide updates on the effectiveness of the improvement. Response actions should be pre-determined prior to excavation, depending on the approach provided to protect elements. Processes and procedures should be in-place prior to completing any vibrations to identify issues and react in a quick manner in the event of an exceedance.

4.0 Proximity Study Requirement Responses

Based on the Confederation Line Proximity Study Guidelines dated October 23, 2013, a Level 1 Confederation Line Proximity Study is considered to be required for the proposed development. A Level 1 Confederation Line Proximity Study is required where the proposed development is located within the City of Ottawa's Development Zone of Influence.

The following table lists the applicable requirements for Level 1 study for each item and our associated responses:

Table 2
List of Confederation Line Level 1 Proximity Study Requirements

Level 1 Projects	Response
A site plan of the development with the centreline or reference line of the Confederation Line structure and/or right-of-way located and the relevant distances between the Confederation Line and developer's structure shown clearly;	See Confederation Line Proximity Plan (Drawing No. PG2178-3) presented in Appendix A.
Plan and cross-sections of the development locating the Confederation Line structure/right-of-way and founding elevations relative to the development, including any underground storage tanks and associated piping;	LRT Proximity Section A-A (Drawing No. PG2178-4) presented in Appendix A.
A geotechnical investigation report showing up-to-date geotechnical conditions at the site of the development. The geotechnical investigation shall be prepared in accordance with the Geotechnical Investigation and Reporting Guidelines for Development Applications in the City;	Refer to Geotechnical Investigation: Paterson Group Report PG2178-1 Revision 1 dated July 22, 2020 presented in Appendix B.
Structural, foundation, excavation and shoring drawings;	Structural, foundation, excavation, and shoring drawings will be provided once available for the proposed project.
Acknowledgment that the potential for noise, vibration, electro-magnetic interference and stray current from Confederation Line operations have been considered in the design of the project, and appropriate mitigation measures applied.	The potential for noise, vibration, electro-magnetic interference and stray current from Confederation Line operations have been considered in the design of the project and appropriate mitigation measures have been applied. The Transportation Noise & Ground Vibrations Impact Study dated June 25, 2020 and prepared by Gradient Wind Engineers & Scientists for this project is attached in Appendix C.

We trust that this information satisfies your immediate request.

Best Regards,

Paterson Group Inc.

Scott S. Dennis, P.Eng.

David J. Gilbert, P.Eng.

Report Distribution

- ❏ Uniform Urban Developments (1 copy)
- ❏ Paterson Group (1 copy)

APPENDIX A

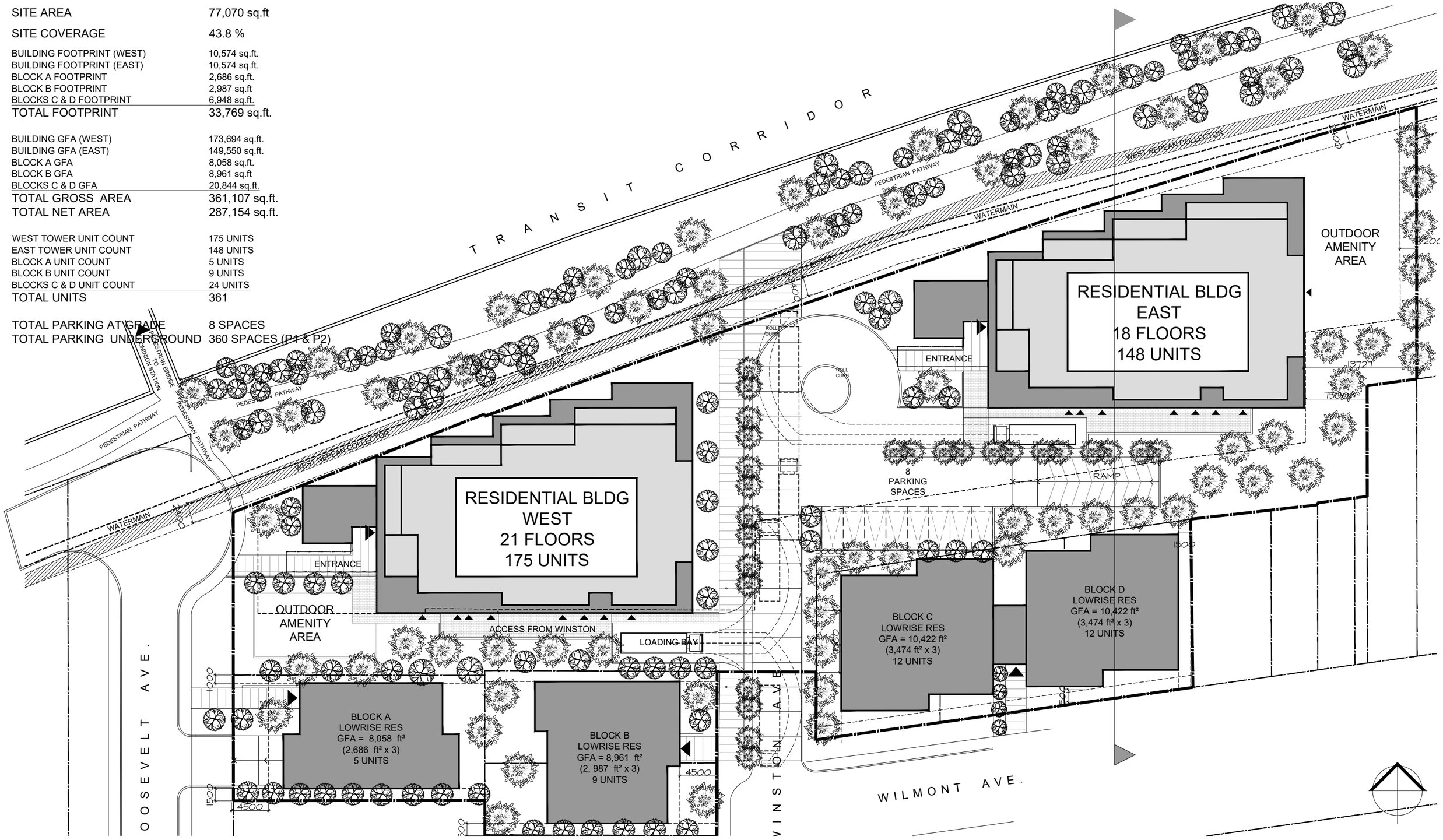
Site Plan

Confederation Line Proximity Plan and Section

Topographic Survey Plan

Construction Methodology and Impact Review

SITE AREA	77,070 sq.ft
SITE COVERAGE	43.8 %
BUILDING FOOTPRINT (WEST)	10,574 sq.ft.
BUILDING FOOTPRINT (EAST)	10,574 sq.ft.
BLOCK A FOOTPRINT	2,686 sq.ft.
BLOCK B FOOTPRINT	2,987 sq.ft
BLOCKS C & D FOOTPRINT	6,948 sq.ft.
TOTAL FOOTPRINT	33,769 sq.ft.
BUILDING GFA (WEST)	173,694 sq.ft.
BUILDING GFA (EAST)	149,550 sq.ft.
BLOCK A GFA	8,058 sq.ft.
BLOCK B GFA	8,961 sq.ft
BLOCKS C & D GFA	20,844 sq.ft.
TOTAL GROSS AREA	361,107 sq.ft.
TOTAL NET AREA	287,154 sq.ft.
WEST TOWER UNIT COUNT	175 UNITS
EAST TOWER UNIT COUNT	148 UNITS
BLOCK A UNIT COUNT	5 UNITS
BLOCK B UNIT COUNT	9 UNITS
BLOCKS C & D UNIT COUNT	24 UNITS
TOTAL UNITS	361
TOTAL PARKING AT GRADE	8 SPACES
TOTAL PARKING UNDERGROUND	360 SPACES (P1 & P2)



HOBIN

335 ROOSEVELT

SITE PLAN

SCALE 1:400
JUNE 23rd, 2020

PROPOSED CONFEDERATION LINE ALIGNMENT

APPROXIMATE DISTANCE FROM EDGE OF DEVELOPMENT TO PROPOSED CONFEDERATION LINE ALIGNMENT

17.0m

APPROXIMATE DISTANCE FROM EDGE OF DEVELOPMENT TO PROPOSED CONFEDERATION LINE ALIGNMENT

16.0m

MULTI - USE PATHWAY

PEDESTRIAN PATHWAY

PEDESTRIAN BRIDGE TO COMMON STATION

WATERMAIN

WATERMAIN

WATERMAIN

EXISTING 7 STOREY BUILDING

90 LOCKERS

EAST PARKING LEVEL - 2
105 SPACES

78 LOCKERS

WEST PARKING LEVEL - 2
76 SPACES

11 LOCKERS

ROOSEVELT AVE.

WINSTON AVE.

WILMONT AVE.

LEGEND:

A A CROSS SECTION

SCALE: 1:500

0 5 10 15 20 25 30m

patersongroup
consulting engineers

154 Colonnade Road South
Ottawa, Ontario K2E 7J5
Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL

UNIFORM URBAN DEVELOPMENTS

CONFEDERATION LINE PROXIMITY STUDY
335 ROOSEVELT AVENUE

OTTAWA, ONTARIO

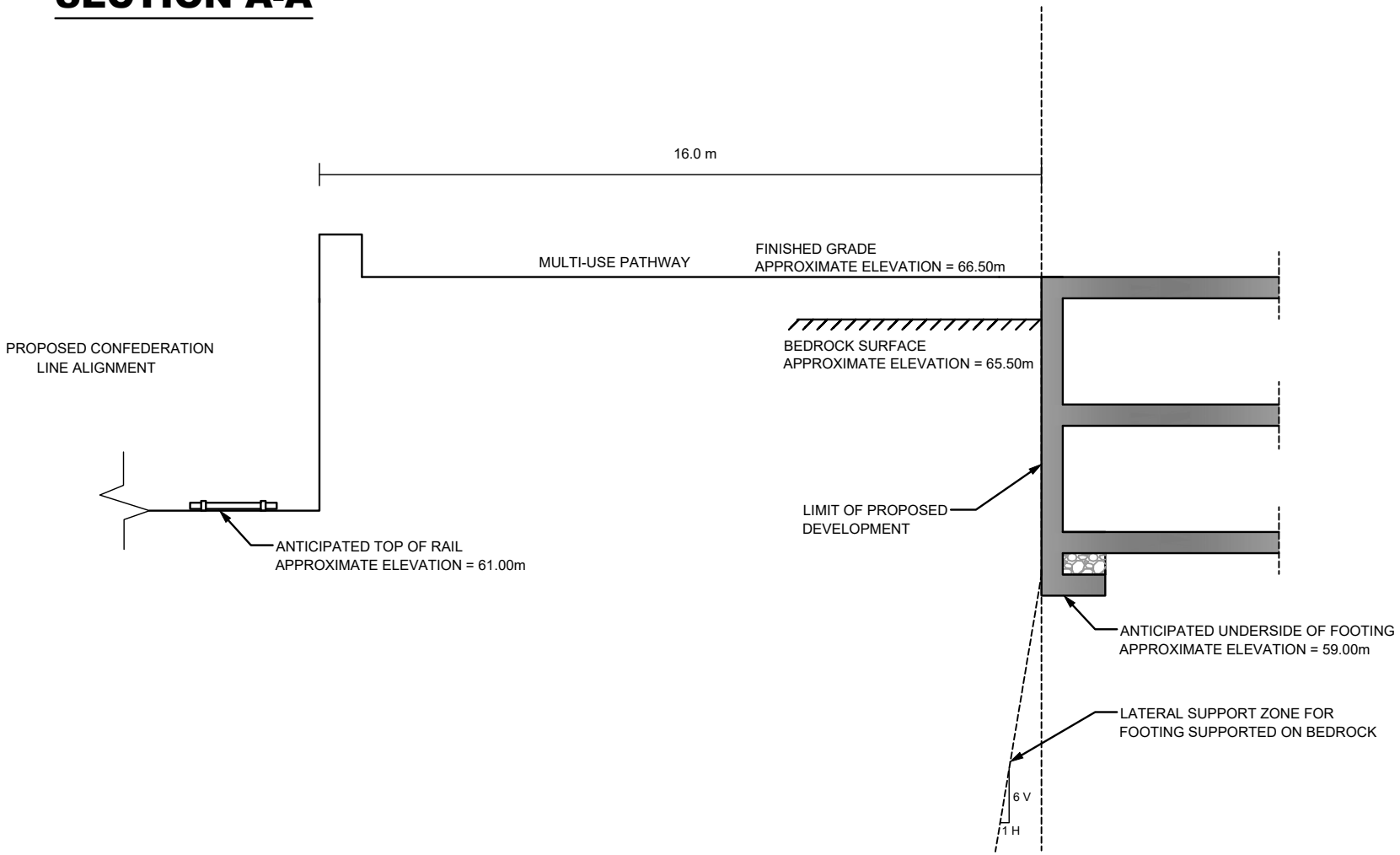
Title:

CONFEDERATION LINE PROXIMITY PLAN

Scale: 1:500	Date: 06/2020
Drawn by: RCG	Report No.: PG2178
Checked by: SD	PG2178-3
Approved by: DJG	Revision No.:

p:\autocad drawings\geotechnical\pg21xx\pg2178-3.dwg

SECTION A-A



patersongroup
consulting engineers

154 Colonnade Road South
Ottawa, Ontario K2E 7J5
Tel: (613) 226-7381 Fax: (613) 226-6344
www.patersongroup.ca

UNIFORM URBAN DEVELOPMENTS

CONFEDERATION LINE PROXIMITY STUDY
335 ROOSEVELT AVENUE

OTTAWA, **ONTARIO**

Title:

CROSS SECTION A-A

Scale: 1:150	**Date:** 06/2020
Drawn by: YA	**Report No.:** PG2178
Checked by: SD	**Drawing No.:** PG2178-4
Approved by: DJG	**Revision No.:**

p:\autocad drawings\geotechnical\pg21xx\pg2178-3.dwg

TOPOGRAPHICAL PLAN OF SURVEY OF

LOT 38
REGISTERED PLAN 114
LOTS 14 AND 15 (West Winston Avenue)
LOTS 21 & 22 AND PART OF LOT 20
(East Winston Avenue)
LOTS 17 AND 18 (West Moira Avenue)
PART OF WINSTON AVENUE
(Closed by By-Law 44-79 Inst. NS45831)
PART OF MOIRA AVENUE
(Closed By Judge's Order Inst. NS150801)REGISTERED PLAN 179
CITY OF OTTAWA

Surveyed by
ANNIS, O'SULLIVAN, VOLLEBEKK LTD.

Scale 1 : 300

12 9 6 3 0 6 12 Metres

Metric

DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

Surveyor's Certificate

I CERTIFY THAT:
1. This survey and plan are correct and in accordance with the Surveys Act, the Surveyors Act and the Land Titles Act and the regulations made under them.
2. The survey was completed on January 11, 2006.

JAN. 13, 2006
Date

E. H. HERWEYER
ONTARIO LAND SURVEYOR

UNDERGROUND SERVICE & INVERT INFORMATION ADDED SEPTEMBER 18, 2006.

ADDITIONAL TREE INFORMATION ADDED AUGUST 18, 2010.

ELEVATION OF TOP AND LOCATION OF NORTH EDGE OF 1.22ø WATERMAIN ADDED AUGUST 18, 2010.

ELEVATION OF TOP AND LOCATION OF SOUTH EDGE OF 1.22ø WATERMAIN AT (A) AND (B) ADDED OCTOBER 18, 2010.

ADDITIONAL CURBS AT WINSTON AND WILMONT AND LOCATION OF FIRE HYDRANT ADDED AUGUST 10, 2011.

ASSOCIATION OF ONTARIO LAND SURVEYORS PLAN SUBMISSION FORM 1585529

THIS PLAN IS NOT VALID UNLESS IT IS AN EMBOSSED ORIGINAL COPY ISSUED BY THE SURVEYOR

As per O.Reg. 826, Regulation 42(8), Section 29(3).

Notes & Legend

©	Denotes	LIGHT STANDARD
●	"	UTILITY POLE
	"	GUY WIRE
	"	DECIDUOUS TREE
	"	CONIFEROUS TREE
MH	"	MAINTENANCE HOLE (STORM SEWER)
MH	"	MAINTENANCE HOLE (SANITARY)
MH	"	MAINTENANCE HOLE (WATER VALVE)
	"	MAINTENANCE HOLE (UNIDENTIFIED)
	"	BOLLARD
	"	CATCHBASIN
	"	FIRE HYDRANT
x 65.00	"	LOCATION OF ELEVATIONS
x Inv=65.00* x Top=65.00*	"	ELEVATIONS OBTAINED FROM CITY OF OTTAWA AS-BUILT DRAWINGS (SEE UTILITY NOTES)
*	"	LOCATION OF ELEVATIONS ADDED AUG 18, 2010.
*	"	LOCATION OF ELEVATIONS ADDED AUG 10, 2011.
	"	PROPERTY LINE
— G —	"	UNDERGROUND GAS
— ST —	"	STORM SEWER
— S —	"	SANITARY SEWER
— W —	"	WATERMAIN
T/L	"	TOP OF LID/GRATE
Inv	"	INVERT
C/L	"	CENTRELINE
	"	SURVEY MONUMENT PLANTED
	"	SURVEY MONUMENT FOUND
SIB	"	STANDARD IRON BAR
SSIB	"	SHORT STANDARD IRON BAR
SSIB*	"	SHORT STANDARD IRON BAR (0.3m LONG)
IB	"	IRON BAR
CRIB	"	CORRUGATED ROUND IRON BAR
CC	"	CUT CROSS
S/W	"	SPIKE AND WASHER
WIT	"	WITNESS
(P1)	"	REGISTERED PLAN 114
(P2)	"	REGISTERED PLAN 179
(P3)	"	PLAN 4R-2731
(P4)	"	PLAN 5R-3875
(P5)	"	PLAN 5R-3958
(P6)	"	PLAN 5R-6341
(P7)	"	PLAN 4R-10545
(P8)	"	PLAN 5R-14473
(P9)	"	PLAN 4R-19763
(P10)	"	PLAN BY (AOG) OCTOBER 29, 1991
(P11)	"	PLAN BY (AOG) SEPTEMBER 29, 1983
(P12)	"	PLAN BY (857) JULY 30, 1997
(P13)	"	PLAN BY (857) MARCH 30, 1966
(P14)	"	PLAN BY (1287) AUGUST 28, 1992
(AOG)	"	ANNIS, O'SULLIVAN, VOLLEBEKK
CLF	"	CHAIN LINK FENCE
BF	"	BOARD FENCE
CRW	"	CONCRETE RETAINING WALL
OHW	"	OVERHEAD WIRES
EOG	"	EDGE OF GRAVEL
TOC	"	TOP OF CONCRETE CURB
Fin.	"	FINISHED
Bldg	"	BUILDING

BEARINGS ARE ASTRONOMIC DERIVED FROM THE WESTERLY LIMIT OF WINSTON AVENUE SHOWN TO BE N23°38'10"W ON PLAN 5R-3875.

SITE AREA = 5508 Square Metres
BOUNDARY INFORMATION COMPILED FROM EXISTING SURVEY PLANS

ELEVATIONS NOTES

1. ELEVATIONS SHOWN HEREON ARE REFERRED TO GEODETIC DATUM.
2. IT IS THE RESPONSIBILITY OF THE USER OF THIS INFORMATION TO VERIFY THAT THE JOB BENCHMARKS HAVE NOT BEEN ALTERED OR DISTURBED AND THAT THEIR RELATIVE ELEVATIONS AND DESCRIPTIONS AGREE WITH THE INFORMATION SHOWN ON THIS DRAWING.

UTILITY NOTES

1. UNDERGROUND UTILITY INFORMATION DERIVED FROM CITY OF OTTAWA PLAN 2179, DATED SEPT 27, 1988 AND CITY OF OTTAWA PLAN 2183, DATED JUNE 4, 1989.
2. THIS SURVEY COMPLETED UNDER WINTER/SNOW CONDITIONS. THIS DRAWING CANNOT BE ACCEPTED AS ACKNOWLEDGING ALL OF THE UTILITIES AND IT WILL BE THE RESPONSIBILITY OF THE USER TO CONTACT THE RESPECTIVE UTILITY AUTHORITIES FOR CONFIRMATION.
3. A FIELD LOCATION OF UNDERGROUND PLANT BY THE PERTINENT UTILITY AUTHORITY IS MANDATORY BEFORE ANY WORK INVOLVING BREAKING GROUND, PROBING, EXCAVATING ETC.

ANNIS, O'SULLIVAN, VOLLEBEKK LTD.
14 Concourse Gate, Suite 500
Nepean, Ont. K2E 7S6
Phone: (613) 727-0850 / Fax: (613) 727-1079
Email: Nepean@aovltd.com
Ontario Land Surveyors

Job No. 11093-10 TOPO Lt 38 Pl 114 Its in Pt 179 Ottawa D2 AUG 10-2011 | CRO

Construction Methodology and Impact Review		
Construction Item	**Potential Impact**	**Mitigation Program**
Item A - Installation of Temporary Shoring System - Where adequate space is not available for the overburden to be sloped, the overburden along the perimeter of the proposed building footprint will need to be shored in order to complete the construction of the underground parking levels. The shoring system is anticipated to consist of a soldier pile and lagging system.	Vibration issues during shoring system installation	Design of the temporary shoring system, in particular vibrations during installation, will take into consideration the presence of the proposed Confederation Line alignment and Dominion Station structure. Installation of the shoring system is not anticipated to have an adverse impact on the Confederation Line and Blair Station, nonetheless, a series of vibration monitoring devices are recommended to be installed to monitor vibrations. The vibration monitors would be remotely connected to permit real time monitoring and a vibration monitoring program would be implemented as detailed in Subsection 3.1 - Vibration Monitoring Program of Paterson Group Report PG2178-2 dated June 26, 2020.
Item B - Bedrock Blasting and Removal Program - Blasting of the bedrock will be required for the proposed buildings and parking garage structure construction. It is expected that up to approximately 6 to 7 m of bedrock removal is required based on the current design concepts for the proposed development.	Structural damage of Confederation Line and Dominion Station due to vibrations from blasting program.	Structural damage to the Confederation Line and Dominion Station during bedrock blasting and removal is not anticipated, nonetheless, a series of vibration monitoring devices are recommended to be installed along the LRT alignment to monitor vibrations. The vibration monitors would be remotely connected to permit real time monitoring and a vibration monitoring program would be implemented as detailed in Subsection 3.1 - Vibration Monitoring Program of Paterson Group Report PG2178-2 dated June 26, 2020.
Item C - Construction of Footings and Foundation Walls - The proposed building will include 2 levels of underground parking. Therefore, the footings will be placed over a clean, surface sounded limestone bedrock bearing surface.	Building footing loading on adjacent Confederation Line and Dominion Station structure, and excavation within the lateral support zone of the Confederation Line and Dominion Station structure.	Due to the distance between the proposed building and the Confederation Line and Dominion Station, the zone of influence from the proposed footings will not intersect the LRT structures. Further, although the underground parking levels for the proposed building will extend approximately 6 to 7 m below existing ground surface, due to the approximate 16 m distance between the proposed building and LRT structures, the building excavation will not impact the lateral support zone of the Confederation Line or Dominion Station structure.

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Geotechnical Investigation

Proposed Residential Development
335 Roosevelt Avenue
Ottawa, Ontario

Prepared For

Uniform Urban Developments

July 22, 2020

Report: PG2178-1 Revision 1

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

Paterson Group (Paterson) was commissioned by Uniform Urban Developments (Uniform) to prepare a geotechnical report for a proposed residential development to be located at 335 Roosevelt Avenue in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objectives of the current investigation were to:

- ❏ Determine the subsoil and groundwater conditions at this site by means of boreholes.
- ❏ Provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect the design.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains our findings and includes geotechnical recommendations pertaining to the design and construction of the subject development as they are understood at the time of writing this report.

Investigating the presence or potential presence of contamination on the subject property was not part of the scope of work of this present investigation, therefore, the present report does not address environmental issues. A Phase I-II was completed for this subject site by Paterson but is presented under a separate cover.

2.0 PROPOSED DEVELOPMENT

It is our understanding that the proposed residential development will consist of two and four high-rise and low-rise residential buildings, respectively. The two high-rise buildings are understood to be 18 and 21 storeys high, whereas the low-rise buildings will be 4 storeys high. It is further understood that the proposed basement levels will consist of two levels of underground parking which will extend to the property lines of the subject site.

3.0 METHOD OF INVESTIGATION

3.1 Field Investigation

Field Program

The field program for the investigation was carried out on November 9 and 10, 2010. At that time, five (5) boreholes were advanced to a maximum depth of 9.5 m. The borehole locations were distributed in a manner to provide general coverage of the subject site. The locations of the boreholes are shown on Drawing PG2178-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were put down using a truck-mounted auger drill rig operated by a two-person crew. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer. The drilling procedure consisted of augering to the required depths at the selected locations, sampling and testing the overburden. In addition, bedrock was cored at each borehole location using diamond drilling procedures.

Sampling and In Situ Testing

Soil samples were recovered using a 50 mm diameter split-spoon sampler or from the auger flights. The split-spoon and auger samples were classified on site, placed in sealed plastic bags, and transported to our laboratory for further review. The depths at which the split-spoon and auger samples were recovered from the boreholes are shown as SS and AU, respectively, on the Soil Profile and Test Data sheets in Appendix 1.

The Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split-spoon samples. The SPT results are recorded as “N” values on the Soil Profile and Test Data sheets. The “N” value is the number of blows required to drive the split-spoon sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

Diamond drilling was carried out in each borehole to determine the nature of the bedrock. Total core recovery (TCR) and rock quality designation (RQD) values were calculated for each drilled section (core run) of bedrock and are shown on the borehole logs. The TCR value is the ratio, in percentage, of the length of the bedrock sample recovered over the length of the core run. The RQD value is the ratio, in percentage, of the total length of rock pieces longer than 100 mm in one core run over the length of the core run. Each of these values are indicative of the quality of the bedrock.

The subsurface conditions observed in the test holes were recorded in detail in the field. The soil profiles are logged on the Soil Profile and Data sheets in Appendix 1 of this report.

Groundwater

A flexible polyethylene standpipe was installed in BH 1, BH 2 and BH 4. PVC monitoring wells (50 mm diameter) were installed in BH 3 and BH 5. These were installed to permit the monitoring of the groundwater level subsequent to the completion of the sampling program.

3.2 Field Survey

The borehole locations were selected, determined in the field and surveyed by Paterson. The ground surface elevation at each borehole location was referenced to a temporary benchmark (TBM), consisting of a magnetic nail in a utility pole. A geodetic elevation of 67.30 m has been provided to the TBM by Annis O'Sullivan Vollebekk Ltd. The location of the TBM and boreholes, as well as, the ground surface elevation at each borehole are presented on Drawing PG2178-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

Soil samples were recovered from the subject site and visually examined in our laboratory to review the results of the field logging.

4.0 OBSERVATIONS

4.1 Surface Conditions

At the time of the field program, three (3) existing buildings were present on the subject site. The remainder of the site was asphalt covered with the exception of a gravel area on the south portion of the property.

The site is bordered to the north by the transitway, to the west by Roosevelt Avenue, to the south by Winston Avenue and Wilmont Avenue, and to the east by a 7 storey residential building. The westernmost building was noted to be approximately 0.6 m below Roosevelt Avenue. Additionally, the transit-way located north of the subject site was noted to be approximately 6 m below the elevation of 335 Roosevelt Avenue. The subject site is relatively flat.

4.2 Subsurface Profile

The subsurface profile at the borehole locations consist of either asphaltic concrete or silty sand fill overlying fill consisting of silty sand with some gravel and clay. Native silty clay or silt was encountered below the fill material at most of the boreholes. Bedrock was encountered at depths between 0.7 and 1 m depths. Specific details of the soil profile at each borehole location are presented on the Soil Profile and Test Data sheets in Appendix 1.

The bedrock was cored at all borehole locations to determine its nature and quality. Based on the results of coring, the bedrock consists of limestone with layers of black shale. Values for TCR and RQD were calculated for each rock core and the quality of the bedrock was assessed based on these results.

Based on the observations, the upper 0.5 to 2 m of the bedrock is of poor to fair quality while the lower portion of the core is of good to excellent quality. The bedrock consists of limestone with interbedded shale, with a black shale limestone extending through the rock at depths between 1.5 and 3 m.

Based on available geological mapping, the subject site is located in an area where the bedrock consists of interbedded limestone and dolomite of the Gull River formation, which is encountered at depths varying between 1 and 2 m.

4.3 Groundwater

Groundwater levels (GWL) were measured in all boreholes on November 16, 2010. The measured GWL readings are presented in Table 2. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level could vary at the time of construction.

Table 1 - Groundwater Level Readings

Borehole Number	Ground Elevation (m)	Groundwater Levels		Recording Date
		Depth (m)	Elevation (m)	
BH 1	66.39	4.88	61.51	November 16, 2010
BH 2	66.37	6.53	59.84	November 16, 2010
BH 3	66.43	Dry	--	November 16, 2010
BH 4	66.64	3.84	62.80	November 16, 2010
BH 5	66.50	4.97	61.53	November 16, 2010

5.0 DISCUSSION

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is adequate for the proposed multi-storey buildings. The proposed buildings are expected to be founded on conventional spread footings placed on clean, surface sounded bedrock.

Considering that the site is underlain by shallow bedrock (within 1 m of the surface), shoring may not be necessary if the excavation of the overburden soils can be stepped back from the bedrock excavation face. Temporary rock bolts may be required to stabilize the walls of the excavation through bedrock.

Bedrock removal will be required to complete the two (2) levels of underground parking. Line drilling and controlled blasting where large quantities of bedrock need to be removed is recommended. The blasting operations should be planned and completed under the guidance of a professional engineer with experience in blasting operations.

A watermain alignment runs along the north property boundary in close proximity of the subject site. It is expected that the adjacent watermain could be subjected to potential vibrations associated with the bedrock blasting program. To ensure that no detrimental vibrations cause damage to the adjacent watermain, a vibration monitoring and control program is recommended to be undertaken during the blasting and excavation work required for the proposed building excavation.

The above and other considerations are further discussed in the following sections.

5.2 Site Grading and Preparation

Stripping Depth

Due to the relatively shallow bedrock depth at the subject site and the anticipated founding level for the proposed building, all existing overburden material will be excavated from within the proposed building footprint. Bedrock removal will be required for the construction of the parking garage levels.

Bedrock Removal

Based on the bedrock encountered in the area, it is expected that line-drilling in conjunction with hoe-ramming or controlled blasting will be required to remove the bedrock. In areas of weathered bedrock and where only a small quantity of bedrock is to be removed, bedrock removal may be possible by hoe-ramming.

Prior to considering blasting operations, the blasting effects on the existing services, buildings and other structures should be addressed. A pre-blast or pre-construction survey of the existing structures located in proximity of the blasting operations should be carried out prior to commencing site activities. The extent of the survey should be determined by the blasting consultant and should be sufficient to respond to any inquiries/claims related to the blasting operations.

As a general guideline, peak particle velocities (measured at the structures) should not exceed 25 mm per second during the blasting program to reduce the risks of damage to the existing structures.

The blasting operations should be planned and conducted under the supervision of a licensed professional engineer who is also an experienced blasting consultant.

Excavation side slopes in sound bedrock could be completed with almost vertical side walls. Where bedrock is of lower quality, the excavation face should be free of any loose rock. An area specific review should be completed by the geotechnical consultant at the time of construction to determine if rock bolting or other remedial measures are required to provide a safe excavation face for areas where low quality bedrock is encountered.

An existing watermain alignment is located approximately 2.5 m north of the subject site's north property line. Blasting can be used for most of the bedrock removal up to a minimum horizontal distance of 2 m from the outer edge of the existing watermain. It is recommended that bedrock removal be completed by hoe ramming and grinding techniques within 2 m from the watermain. Blasting operations will be reviewed and the 2 m minimum distance from the watermain may be increased if vibrations from the blasting operation are questionable.

Vibration monitors should be installed to measure the vibrations and to ensure that the vibration levels stay below 25 and 15 mm/s at the property boundary and watermain, respectively.

Vibration Considerations

Construction operations could cause vibrations, and possibly, sources of nuisance to the community. Therefore, means to reduce the vibration levels as much as possible should be incorporated in the construction operations to maintain a cooperative environment with the residents.

The following construction equipments could cause vibrations: piling equipment, hoe ram, compactor, dozer, crane, truck traffic, etc. The construction of the shoring system with soldier piles or sheet piling will require these pieces of equipments. Vibrations, caused by blasting or construction operations could cause detrimental vibrations on the adjoining buildings and structures. Therefore, it is recommended that all vibrations be limited.

Two parameters determine the recommended vibration limit, the maximum peak particle velocity and the frequency. For low frequency vibrations, the maximum allowable peak particle velocity is less than that for high frequency vibrations. As a guideline, the peak particle velocity should be less than 15 mm/s between frequencies of 4 to 12 Hz, and 50 mm/s above a frequency of 40 Hz (interpolate between 12 and 40 Hz). These guidelines are for current construction standards. These guidelines are above perceptible human level and, in some cases, could be very disturbing to some people, a pre-construction survey is recommended to minimize the risks of claims during or following the construction of the proposed building.

Vibration Monitoring and Control Plan

To ensure that no disturbance to the existing watermain occurs, a vibration monitoring and control plan (VMCP) is recommended during the excavation program. The purpose of the vibration monitoring and control plan is to provide measures to be implemented by the contractor to manage excavation operations and any other vibration sources during the construction for the proposed development. The VMCP will also provide a guideline for assessing results against the relevant vibration impact assessment criteria and recommendations to meet the required limits.

The monitoring program will incorporate real time results at the existing watermain segment adjacent to the subject site. The monitoring equipment should consist of a tri-axial seismograph, capable of measuring vibration intensities up to 254 mm/s at a frequency response of 2 to 250 Hz. At least two vibration monitoring devices should be placed adjacent to the existing watermain. It is recommended that the vibration monitoring devices be installed at invert level of the existing watermain and periodically inspected during the construction program.

A copy of the geotechnical report, which includes the VMCP should be provided to all parties involved with the construction for review. A meeting between Paterson and site contractor should be conducted prior to any excavation or construction of the subject site to review the following:

- ❏ Review the pre-condition/pre-construction survey;
- ❏ Control measures (i.e vibrations, noise);
- ❏ Monitoring locations;
- ❏ Tracking and reporting of excavation progress, and;
- ❏ Review procedure for exceedances (i.e vibrations, noise), complaints, evaluation and corrective measures.

When an event is triggered, Paterson will review the results and provide any necessary feedback. Otherwise, the vibration results will be summarized in the weekly report. The following table outlines the vibration limits for the adjacent watermain segment.

Table 2 - Structure Vibration Limits for adjacent Watermain Segment

Dominant Frequency Range (Hz)	Peak Particle Velocity (mm/s)	Event	Description of Event
<10	all	none	no action required
<40	>10	trigger level	Warning e-mail sent to contractor.
<40	≥15	exceedance level	Exceedance e-mail and phone call to the contractor. All operations are ceased to review on-site activities.
>40	>15	trigger level	Warning e-mail sent to contractor.
>40	≥20	exceedance level	Exceedance e-mail and phone call to the contractor. All operations are ceased to review on-site activities.

The monitoring protocol should include the following information:

Trigger Level Event

- ❏ Paterson will review all vibrations over the established warning level, and;
- ❏ Paterson will notify the contractor if any vibration occur due to construction activities and are close to exceedance level.

Exceedance Level Event

- ❏ Paterson will notify all the relevant stakeholders via email;
- ❏ Ensure monitors are functioning, and;
- ❏ Issue the vibration exceedance result.

Fill Placement

It is expected that a concrete slab will be poured directly over bedrock; therefore, fill used for grading beneath building will not be required, other than around the footings, as required.

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of their respective standard Proctor maximum dry density (SPMDD).

Excavated shale deteriorates upon exposure to air and is not generally suitable for re-use as an engineered fill.

5.3 Foundation Design

It is understood that footings will be founded on bedrock. Footings placed on a clean, surface sounded bedrock surface at this elevation can be designed using a bearing resistance value at serviceability limit states (SLS) of **1,000 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **1,500 kPa**. A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance value at ULS.

A clean, surface-sounded bedrock bearing surface should be free of loose materials, and have no near surface seams, voids, fissures or open joints which can be detected from surface sounding with a rock hammer.

A bearing resistance value at SLS of **2,000 kPa** and a factored bearing resistance value at ULS of **3,500 kPa** could be used if the bedrock is free of seams, fractures and voids within 1.5 m below the bedrock surface. This could be verified by completing and probing 50 mm diameter drill holes to a depth of 1.5 m below the founding level along the footing alignments. The drill holes should be spaced on about a 10 m grid interval or one (1) hole per significant pad footing. The drill hole inspection should be carried out by the geotechnical consultant.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a sound bedrock bearing medium when a plane extending down and out from the bottom edge of the footing at a minimum of 1H:6V (or flatter) passes only through sound bedrock or a material of the same or higher capacity as the bedrock, such as concrete. A weathered bedrock bearing medium will require a lateral support zone of 1H:1V (or flatter).

Settlement

Footings bearing on an acceptable bedrock bearing surface and designed for the bearing resistance values provided herein will be subjected to negligible potential post-construction total and differential settlements.

5.4 Design for Earthquakes

Shear wave velocity testing was completed for the subject site to accurately determine the applicable seismic site classification for the building from Table 4.1.8.4.A of the Ontario Building Code 2012. The shear wave velocity testing was completed by Paterson personnel. The results of the shear wave velocity test are attached to the present letter.

Field Program

The shear wave testing location is presented in Drawing PG2178-1 - Seismic Array Location Plan attached to this report. Paterson field personnel placed 24 horizontal geophones in a straight line in roughly a north-south orientation. The 4.5 Hz. horizontal geophones were mounted to the surface by means of two 75 mm ground spikes attached to the geophone land case. The geophones were spaced at 1 m intervals and connected by a geophone spread cable to a Geode 24 Channel seismograph.

The seismograph was also connected to a computer laptop and a hammer trigger switch attached to a 12 pound dead blow hammer. The hammer trigger switch sends a start signal to the seismograph. The hammer is used to strike an I-Beam seated into the ground surface, which creates a polarized shear wave. The hammer shots are repeated between four (4) to eight (8) times at each shot location to improve signal to noise ratio. The shot locations are also completed in forward and reverse directions (i.e.- striking both sides of the I-Beam seated parallel to the geophone array). The shot locations are located at the centre of the geophone array and 1, 2 and 10.5 m away from the first and last geophone.

Data Processing and Interpretation

Interpretation for the shear wave velocity results were completed by Paterson personnel. Shear wave velocity measurement was made using reflection/refraction methods. The interpretation is performed by recovering arrival times from direct and refracted waves. The interpretation is repeated at each shot location to provide an average shear wave velocity, Vs_{30}, of the upper 30 m profile, immediately below the building's foundation. The layer intercept times, velocities from different layers and critical distances are interpreted from the shear wave records to compute the bedrock depth at each location. The bedrock velocity was interpreted using the main refractor wave velocity, which is considered a conservative estimate of the bedrock velocity due to the increasing quality of the bedrock with depth. It should be noted that as bedrock quality increases, the bedrock shear wave velocity also increases.

It is understood that the footings of the proposed building are to be founded directly on the bedrock surface. Based on our analysis, the bedrock shear wave was calculated to be 2,220 m/s.

The Vs_{30} was calculated using the standard equation for average shear wave velocity calculation from the Ontario Building Code (OBC) 2012, as presented below.

$$V_{s30} = \frac{Depth_{OfInterest}(m)}{\left(\frac{(Depth_{Layer1}(m)}{Vs_{Layer1}(m/s)} + \frac{Depth_{Layer2}(m)}{Vs_{Layer2}(m/s)}\right)}$$

$$V_{s30} = \frac{30m}{\left(\frac{30m}{2{,}220m/s}\right)}$$

$$V_{s30} = 2{,}220m/s$$

Based on the results of the seismic testing, the average shear wave velocity, Vs_{30}, for shallow foundations located at the subject site is 2,220 m/s. Therefore, a **Site Class A** is applicable for the proposed building, as per Table 4.1.8.4.A of the OBC 2012.

5.5 Basement Wall

It is understood that the basement walls are to be poured against a waterproofing system, which will be placed against the exposed bedrock face. A nominal coefficient of at-rest earth pressure of 0.05 is recommended in conjunction with a bulk unit weight of 24.5 kN/m^3 (effective 15.5 kN/m^3). A seismic earth pressure component will not be applicable for the foundation wall, which is to be poured against the bedrock face. It is expected that the seismic earth pressure will be transferred to the underground floor slabs, which should be designed to accommodate these pressures. A hydrostatic groundwater pressure should be added for the portion below the groundwater level.

There are several combinations of backfill materials and retained soils that could be applicable for the basement walls of the subject structure. However, the conditions can be well-represented by assuming the retained soil consists of a material with an angle of internal friction of 30 degrees and a bulk (drained) unit weight of 20 kN/m^3. The applicable effective (undrained) unit weight of the retained soil can be taken as 13 kN/m^3, where applicable. A hydrostatic pressure should be added to the total static earth pressure when using the effective unit weight.

Lateral Earth Pressures

The static horizontal earth pressure (p_o) can be calculated using a triangular earth pressure distribution equal to $K_o \cdot \gamma \cdot H$ where:

K_o = at-rest earth pressure coefficient of the applicable retained soil, 0.5
γ = unit weight of fill of the applicable retained soil (kN/m^3)
H = height of the wall (m)

An additional pressure having a magnitude equal to $K_o \cdot q$ and acting on the entire height of the wall should be added to the above diagram for any surcharge loading, q (kPa), that may be placed at ground surface adjacent to the wall. The surcharge pressure will only be applicable for static analyses and should not be used in conjunction with the seismic loading case.

Actual earth pressures could be higher than the "at-rest" case if care is not exercised during the compaction of the backfill materials to maintain a minimum separation of 0.3 m from the walls with the compaction equipment.

Seismic Earth Pressures

The total seismic force (P_{AE}) includes both the earth force component (P_o) and the seismic component (ΔP_{AE}). The seismic earth force (ΔP_{AE}) can be calculated using $0.375 \cdot a_c \cdot \gamma \cdot H^2/g$ where:

a_c = $(1.45-a_{max}/g)a_{max}$
γ = unit weight of fill of the applicable retained soil (kN/m^3)
H = height of the wall (m)
g = gravity, 9.81 m/s^2

The peak ground acceleration, (a_{max}), for the Ottawa area is 0.32g according to OBC 2012. Note that the vertical seismic coefficient is assumed to be zero.

The earth force component (P_o) under seismic conditions can be calculated using $P_o = 0.5\ K_o\ \gamma\ H^2$, where $K_o = 0.5$ for the soil conditions noted above.

The total earth force (P_{AE}) is considered to act at a height, h (m), from the base of the wall, where:

$h = \{P_o \cdot (H/3) + \Delta P_{AE} \cdot (0.6 \cdot H)\}/P_{AE}$

The earth forces calculated are unfactored. For the ULS case, the earth loads should be factored as live loads, as per OBC 2012.

5.6 Rock Anchor Design

The geotechnical design of grouted rock anchors in sedimentary bedrock is based upon two possible failure modes. The anchor can fail either by shear failure along the grout/rock interface or by pullout of a 60 to 90 degree cone of rock with the apex of the cone near the middle of the bonded length of the anchor. It should be noted that interaction may develop between the failure cones of anchors that are relatively close to one another resulting in a total group capacity smaller than the sum of the load capacity of each anchor taken individually.

A third failure mode of shear failure along the grout/steel interface should also be reviewed by a qualified structural engineer to ensure all typical failure modes have been reviewed. Typical rock anchor suppliers, such as Dywidag Systems International (DSI Canada), have qualified personnel on staff to recommend appropriate rock anchor size and materials.

It should be further noted that centre to centre spacing between bond lengths be at least four (4) times the anchor hole diameter and greater than 1.2 m to lower the group influence effects. It is also recommended that anchors in close proximity to each other be grouted at the same time to ensure any fractures or voids are completely in-filled and that fluid grout does not flow from one hole to an adjacent empty one.

Anchors can be of the “passive” or the “post-tensioned” type, depending on whether the anchor tendon is provided with post-tensioned load or not prior to being put into service. To resist seismic uplift pressures, a passive rock anchor system can be used. It should be noted that a post-tensioned anchor will take the uplift load with much less deflection than a passive anchor.

Regardless of whether an anchor is of the passive or the post tensioned type, it is recommended that the anchor be provided with a bonded length, or fixed anchor length, at the base of the anchor, which will provide the anchor capacity, as well an unbonded length, or free anchor length, between the rock surface and the start of the bonded length. As the depth at which the apex of the shear failure cone develops is midway along the bonded length, a fully bonded anchor would tend to have a much shallower cone, and therefore less geotechnical resistance, than one where the bonded length is limited to the bottom part of the overall anchor.

Permanent anchors should be provided with corrosion protection. As a minimum, this requires that the entire drill hole be filled with cementitious grout. The free anchor length is provided by installing a plastic sleeve to act as a bond break.

Grout to Rock Bond

Generally, the unconfined compressive strength of limestone ranges between 60 and 120 MPa, which is stronger than most routine grouts. A factored tensile grout to rock bond resistance value at ULS of **1.0 MPa**, incorporating a resistance factor of 0.3, can be used. A minimum grout strength of 40 MPa is recommended.

Rock Cone Uplift

As discussed previously, the geotechnical capacity of the rock anchors depends on the dimensions of the rock anchors and the configuration of the anchorage system. Based on existing subsoils information, a **Rock Mass Rating (RMR) of 69** was assigned to the bedrock, and Hoek and Brown parameters (**m and s**) were taken as **0.575 and 0.00293**, respectively.

Recommended Rock Anchor Lengths

Rock anchor lengths can be designed based on the required loads. Rock anchor lengths for some typical loads have been calculated and are presented on the following page. Load specified rock anchor lengths can be provided, if required.

For our calculations the following parameters were used.

Table 3 - Parameters used in Rock Anchor Review	
Grout to Rock Bond Strength - Factored at ULS	1.0 MPa
Compressive Strength - Grout	40 MPa
Rock Mass Rating (RMR) - Good quality Limestone Hoek and Brown parameters	69 m=0.575 and s=0.00293
Unconfined compressive strength - Limestone bedrock	60 MPa
Unit weight - Submerged Bedrock	15 kN/m^3
Apex angle of failure cone	60^o
Apex of failure cone	mid-point of fixed anchor length

From a geotechnical perspective, the fixed anchor length will depend on the diameter of the drill holes. Recommended anchor lengths for a 75 and 125 mm diameter hole are provided in Table 4.

Table 4 - Recommended Rock Anchor Lengths - Grouted Rock Anchor				
Diameter of Drill Hole (mm)	Anchor Lengths (m)			Factored Tensile Resistance (kN)
	Bonded Length	Unbonded Length	Total Length	
75	1.2	0.6	1.8	250
	1.9	0.8	2.7	500
	3	1.5	4.5	1000
125	1.1	0.5	1.6	250
	1.5	0.7	2.2	500
	2.6	1	3.6	1000

It is recommended that the anchor drill hole diameter be within 1.5 to 2 times the rock anchor tendon diameter and the anchor drill holes be inspected by geotechnical personnel and should be flushed clean prior to grouting. The use of a grout tube to place grout from the bottom up in the anchor holes is further recommended.

The geotechnical capacity of each rock anchor should be proof tested at the time of construction. More information on testing can be provided upon request. Compressive strength testing is recommended to be completed for the rock anchor grout. A set of grout cubes should be tested for each day grout is prepared.

5.7 Pavement Design

Asphalt pavement is not anticipated to be required at the subject site. However, should pavement be reconsidered for the project, the recommended pavement structures shown in Tables 5 and 6 would be applicable.

Table 5 - Recommended Pavement Structure - Car Only Parking Areas

Thickness mm	Material Description
50	**Wear Course -** HL-3 or Superpave 12.5 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
300	**SUBBASE** - OPSS Granular B Type II
	SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill

Table 6 - Recommended Pavement Structure - Access Lanes

Thickness mm	Material Description
40	**Wear Course -** HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course -** HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
400	**SUBBASE** - OPSS Granular B Type II
	SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with Ontario Provincial Standard Specification (OPSS) Granular B Type I or Type II material.

The pavement granulars (base and subbase) should be placed in maximum 300 mm thick layers and compacted to a minimum of 100% of the materials' SPMDDs using suitable compaction equipment.

6.0 DESIGN AND CONSTRUCTION PRECAUTIONS

6.1 Foundation Drainage and Backfill

It is recommended that a perimeter foundation drainage system be provided for the proposed structure. It is understood that insufficient room is available for exterior backfill below the bedrock surface. The following system is suggested:

- ❏ Bedrock vertical surface
- ❏ Metal "V" pan
- ❏ Composite drainage layer

It is recommended that the composite drainage system (such as Miradrain G100N or equivalent) extend down to the footing level. It is recommended that 150 mm diameter sleeves at 3 m centres be cast in the footing or at the foundation wall/footing interface to allow the infiltration of water to flow to the interior perimeter drainage pipe. The perimeter drainage pipe and underfloor drainage system should direct water to sump pit(s) within the lower basement area.

Underfloor drainage may be required to control water infiltration due to groundwater lowering within the bedrock. For design purposes, we recommend that 100 or 150 mm in perforated pipes be placed at 3 to 4.5 m centres. The spacing of the underfloor drainage system should be confirmed at the time of completing the excavation when water infiltration can be better assessed.

Above the bedrock surface, backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls, unless used in conjunction with a drainage geocomposite, such as Miradrain G100N or Delta Drain 6000, connected to the perimeter foundation drainage system. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should otherwise be used for this purpose.

6.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effects of frost action. A minimum of 1.5 m of soil cover alone, or a minimum of 0.6 m of soil cover, in conjunction with foundation insulation, should be provided in this regard.

Exterior unheated footings, such as those for isolated exterior piers, are more prone to deleterious movement associated with frost action than the exterior walls of the structure proper and require additional protection, such as soil cover of 2.1 m or a combination of soil cover and foundation insulation.

6.3 Excavation Side Slopes

The side slopes of excavations in the soil and fill overburden materials should be either cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. It is assumed that sufficient room will be available for the greater part of the excavation to be undertaken by open-cut methods (i.e. unsupported excavations).The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or flatter. The flatter slope is required for excavation below groundwater level. The subsoil at this site is considered to be mainly a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

It is recommended that a trench box be used at all times to protect personnel working in trenches with steep or vertical sides. It is expected that services will be installed by "cut and cover" methods and excavations will not be left open for extended periods of time.

6.4 Pipe Bedding and Backfill

Bedding and backfill materials should be in accordance with the most recent Material Specifications & Standard Detail Drawings from the Department of Public Works and Services, Infrastructure Services Branch of the City of Ottawa.

At least 150 mm of OPSS Granular A should be used for pipe bedding for sewer and water pipes. A minimum of 300 mm of OPSS Granular A should be placed for bedding for sewer or water pipes when placed on bedrock subgrade. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to at least 300 mm above the obvert of the pipe should consist of OPSS Granular A. The bedding and cover materials should be placed in maximum 300 mm thick lifts compacted to a minimum of 99% of the material's SPMDD.

It is expected that the silt may be used above cover material if the excavation operations are carried out in dry weather conditions. Well fractured bedrock should be acceptable as backfill provided the rock fill is placed only from at least 300 mm above the top of the service pipe and that all stones 200 mm or larger in their longest dimension are removed.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to reduce differential frost heaving. The trench backfill should be placed in maximum 225 mm thick loose lifts and compacted to a minimum of 95% of the material's SPMDD. No stones 200 mm or greater in their longest dimension should be reused. Within the frost zone (1.8 m below finished grade), non frost susceptible materials should be used when backfilling trenches below the original bedrock level.

6.5 Groundwater Control

Groundwater Control for Building Construction

The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

Infiltration levels are anticipated to be low through the excavation face. The groundwater infiltration will be controllable with open sumps and pumps.

A temporary MECP permit to take water (PTTW) will be required for this project if more than 50,000 L/day are to be pumped during the construction phase. A minimum of four to five months should be allocated for completion of the application and issuance of the permit by the MECP.

Long-term Groundwater Control

Our recommendations for the proposed building's long-term groundwater control are presented in Subsection 6.1. Any groundwater encountered along the building's perimeter or sub-slab drainage system will be directed to the proposed building's cistern/sump pit. Provided the proposed groundwater infiltration control system is properly implemented and approved by the geotechnical consultant at the time of construction, it is expected that groundwater flow will be low (i.e.- less than 50,000 L/day) with peak periods noted after rain events. It is anticipated that the groundwater flow will be controllable using conventional open sumps.

6.6 Winter Construction

Precautions must be taken if winter construction is considered for this project.

The subsoil conditions at this site mostly consist of frost susceptible materials. In the presence of water and freezing conditions, ice could form within the soil mass. Heaving upon freezing and settlement upon thawing could occur.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the use of straw, propane heaters and tarpaulins or other suitable means. In this regard, the base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and/or the footings are protected with sufficient soil cover to prevent freezing at the founding level. Placing concrete directly over cold bedrock surfaces is not recommended.

The trench excavations should be carried out in a manner to avoid the introduction of frozen materials, snow or ice in the trenches. As well, pavement construction is difficult during winter. The subgrade consists of frost susceptible soils which will experience total and differential frost heaving as the work takes place. Also, the introduction of frost, snow or ice into the pavement materials, which is difficult to avoid, could adversely affect the performance of the pavement structure.

Precaution should be taken where excavations are carried out in close proximity of existing structures which may be adversely affected due to the freezing conditions. In particular, it should be recognized that where a shoring system is used, the soil behind the shoring system will be subjected to freezing conditions and could result in heaving of the structure(s) placed within or above frozen soil. Provisions should be made in the contract documents to protect the walls of the excavations from freezing, if applicable.

6.7 Protection of Existing Watermain

During the bedrock removal program for the proposed development, the existing watermain located just beyond the north property boundary of the subject site will require protection.

Bedrock Condition

Based on our existing information, the bedrock is expected at approximate elevation +/- 65.5 m. The upper portion of the bedrock is weathered and the bedrock quality improves with depth. The bedrock quality is generally fair to good based on the rock quality designation (RQD) findings below upper 1 to 2 m of weathered bedrock.

Paterson undertook a test pit excavation program on the subject property along the northern boundary on September 13, 2010. Three test pits were excavated using a rubber tired backhoe and our findings can be summarized as follows:

Subsurface Conditions	Test Pit 1	Test Pit 2	Test Pit 3
Pavement structure overlying sandy silt deposit thickness	810 mm	810 mm	710 mm
Weathered bedrock thickness	100 mm	none	none
Sound bedrock depth	910 mm	810 mm	710 mm

The approximate locations of the test pits are shown on Drawing PG2178-1 - Test Hole Location Plan in Appendix 2.

Bedrock Removal along the Northern Boundary

The bedrock removal for the subject site will be carried out using a combination of blasting and hoe-ramming techniques, especially along the northern boundary where the existing watermain is located. The bedrock removal along the northern boundary will be carried out as follows:

- ❏ Blasting can be used for most of the bedrock removal up to a minimum horizontal distance of 2 m from the outer edge of the existing watermain. A minimum line drilling spacing of 300 mm c/c will be required at the 2 m blasting boundary limit.
- ❏ The blasting contractor will control the blasting operation to keep peak particle velocities below 25 mm/s at the property boundary. It is expected that the blasting contractor will commence the blasting operation at the opposite end of the site so that blasting patterns and vibrations can be monitored and verified prior to attempting any blasting along the northern boundary adjacent to the existing watermain. This approach will allow the blasting contractor to adjust and control the blasting operation.
- ❏ Blasting operations will be reviewed and the 2 m minimum distance from the watermain may be increased if vibrations from the blasting operation are questionable.

- ❑ Within the minimum 2 m distance from the watermain, the bedrock will be removed using hoe-ramming or grinding techniques. Blasting will not be permitted. Line drilling spacing will be decreased to 200 mm c/c along the proposed excavation boundary. Similar to the blasting operations, hoe-ramming or grinding operations will be governed by the vibrations they produce along the property boundary adjacent to the watermain.

Monitoring and Reporting

- ❑ Two seismographs will be installed directly on the bedrock along the northern property line to monitor vibrations. Each blasting event will be reviewed and reported to the blasting contractor and the site superintendent.

- ❑ A weekly summary report will be issued presenting our findings and observations. Any concerns identified during the monitoring will be immediately reported, as discussed in Subsection 5.2, and the rock removal operations in the immediate area will be temporarily halted to address the concern.

7.0 RECOMMENDATIONS

It is a requirement for the foundation design data provided herein to be applicable that the following material testing and observation program be performed by the geotechnical consultant.

- ❏ Review of the bedrock excavation faces and the installation of the rock anchors, if applicable.
- ❏ Observation of all bearing surfaces prior to the placement of concrete.
- ❏ Sampling and testing of the concrete and fill materials used.
- ❏ Periodic observation of the condition of unsupported excavation side slopes in excess of 3.0 m in height, if applicable.
- ❏ Observation of all subgrades prior to backfilling.
- ❏ Density tests to determine the level of compaction achieved.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued upon the completion of a satisfactory material testing and observation program by the geotechnical consultant.

8.0 STATEMENT OF LIMITATIONS

The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review our recommendations when the drawings and specifications are complete.

The client should be aware that any information pertaining to soils and all borehole logs are furnished as a matter of general information only and borehole descriptions or logs are not to be interpreted as descriptive of conditions at locations other than those of the test holes.

A geotechnical investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, we request that we be notified immediately in order to permit reassessment of our recommendations.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Uniform Urban Developments and their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Drew Petahtegoose, B.Eng.

David J. Gilbert, P.Eng.

Report Distribution:

- ❑ Uniform Urban Developments (3 copies)
- ❑ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

patersongroup

Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development-335 Roosevelt Ave.
Ottawa, Ontario

DATUM TBM - Mag nail in utility pole, along southeast property line. Geodetic elevation = 67.30m.

FILE NO. PG2178

REMARKS

HOLE NO. BH 1

BORINGS BY CME 55 Power Auger **DATE** 9 November 2010

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	66.39
Asphaltic concrete 0.05		AU	1				
FILL: Dark brown silty sand, some gravel 0.46		SS	2		50+		
0.74		RC	1	94	22	1	65.39
Grey-brown **SILTY CLAY,** some sand		RC	2	100	51	2	64.39
BEDROCK: Grey limestone						3	63.39
- black shaley limestone from 1.5 to 2.5m depth		RC	3	100	78	4	62.39
		RC	4	100	84	5	61.39
		RC	5	100	35	6	60.39
		RC	6	100	96	7	59.39
		RC	7	100	100	8	58.39
9.47						9	57.39
End of Borehole							
(GWL @ 4.88m-Nov. 16/10)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %
20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup

Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development-335 Roosevelt Ave.
Ottawa, Ontario

DATUM TBM - Mag nail in utility pole, along southeast property line. Geodetic elevation = 67.30m.

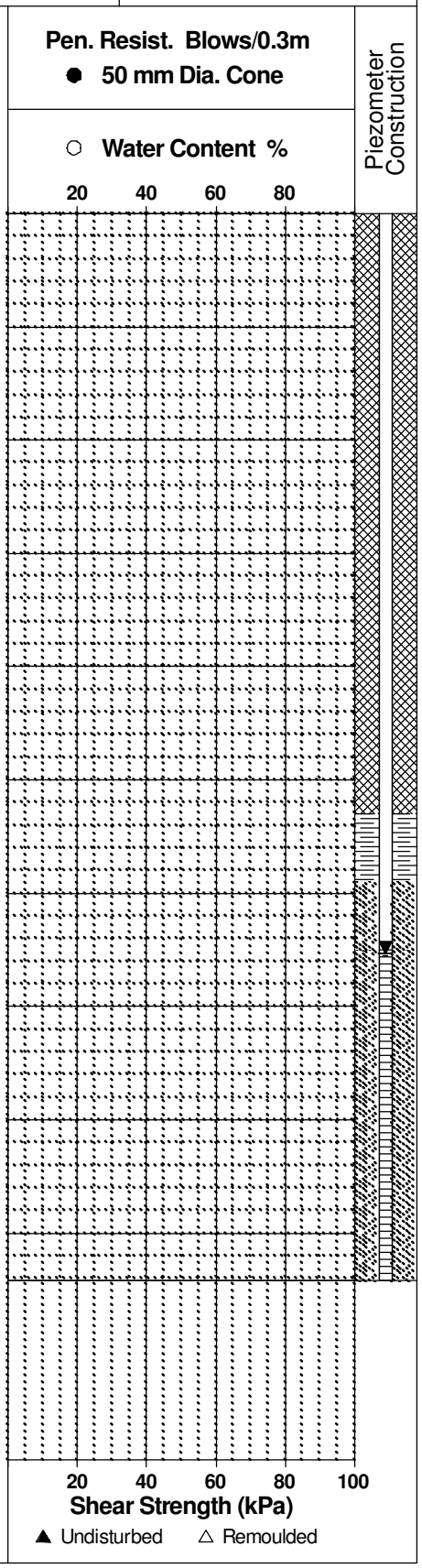
FILE NO. PG2178

REMARKS

HOLE NO. BH 2

BORINGS BY CME 55 Power Auger **DATE** 9 November 2010

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	66.37
Asphaltic concrete 0.05							
FILL: Dark brown silty sand, some gravel 0.46		AU	1				
Grey-brown **SILTY CLAY** 0.60		SS	2	0	50+		
		RC	1	84	58	1	65.37
		RC	2	100	57	2	64.37
BEDROCK: Grey limestone						3	63.37
- black shaley limestone from 1.6m to 2.5m depth		RC	3	98	83	4	62.37
		RC	4	100	92	5	61.37
		RC	5	98	98	6	60.37
		RC	6	100	93	7	59.37
		SS	7	100	100	8	58.37
9.42						9	57.37
End of Borehole							
(GWL @ 6.53m-Nov. 16/10)							



patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development-335 Roosevelt Ave.
Ottawa, Ontario

DATUM TBM - Mag nail in utility pole, along southeast property line. Geodetic elevation = 67.30m.

FILE NO. PG2178

REMARKS

HOLE NO. BH 3

BORINGS BY CME 55 Power Auger **DATE** 9 November 2010

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	66.43
Asphaltic concrete 0.05		AU	1				
FILL; Brown silty sand with gravel 0.60							
FILL: Light brown silty sand, some gravel, trace clay 0.97		SS	2	0	50+		
		RC	1	88	63	1	65.43
		RC	2	97	35	2	64.43
BEDROCK: Grey limestone						3	63.43
- black shaley limestone from 1.5m to 1.7m depth		RC	3	100	75	4	62.43
		RC	4	98	87	5	61.43
						6	60.43
		RC	5	98	85	7	59.43
		RC	6	100	89	8	58.43
		RC	7	96	96	9	57.43
9.40 End of Borehole							
(BH dry - Nov. 16/10)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %
20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup

Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development-335 Roosevelt Ave.
Ottawa, Ontario

DATUM TBM - Mag nail in utility pole, along southeast property line. Geodetic elevation = 67.30m.

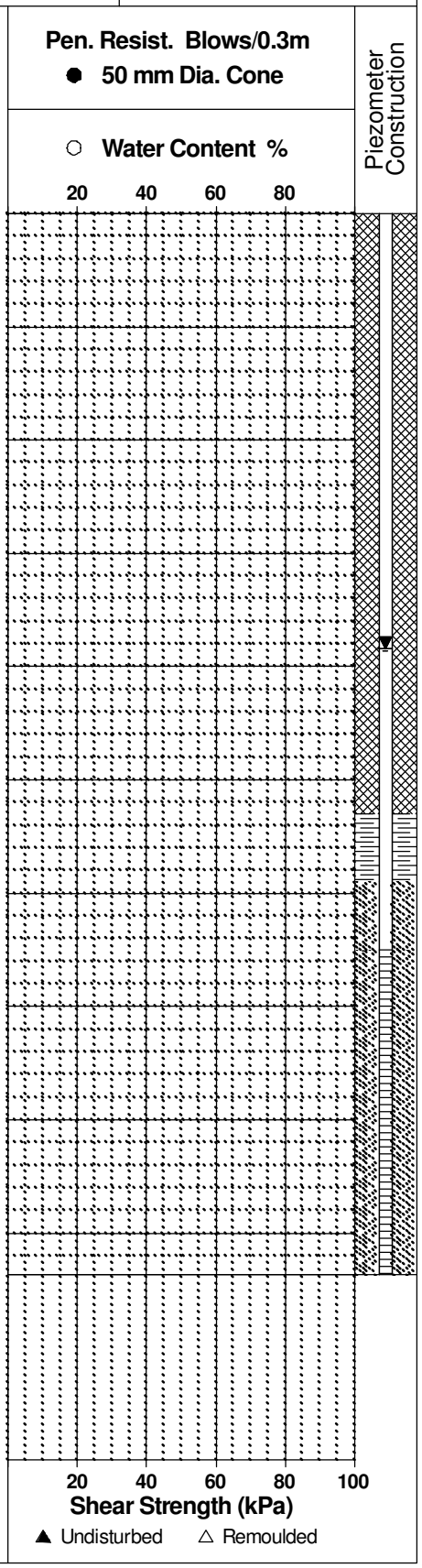
REMARKS

FILE NO. PG2178

HOLE NO. BH 4

BORINGS BY CME 55 Power Auger **DATE** 10 November 2010

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	66.64
Asphaltic concrete 0.04		AU	1				
Crushed stone 0.15							
FILL: Brown silty sand, some gravel 0.91		SS	2	90	10	1	65.64
Grey-brown **SILT** 1.17							
BEDROCK: Shaley limestone		RC	1	92	36	2	64.64
3.00						3	63.64
		RC	2	100	55	4	62.64
		RC	3	100	60	5	61.64
BEDROCK: Grey limestone						6	60.64
		RC	4	100	93	7	59.64
		RC	5	100	92	8	58.64
		RC	6	100	100	9	57.64
9.37							
End of Borehole							
(GWL @ 3.84m-Nov. 16/10)							



patersongroup

Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Residential Development-335 Roosevelt Ave.
Ottawa, Ontario

DATUM TBM - Mag nail in utility pole, along southeast property line. Geodetic elevation = 67.30m.

FILE NO. PG2178

REMARKS

HOLE NO. BH 5

BORINGS BY CME 55 Power Auger **DATE** 10 November 2010

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	66.50
FILL: Dark brown silty sand with gravel, trace metals, brick and asphalt		SS	1	50	8		
0.76							
FILL: Black silty sand		SS	2	78	50+	1	65.50
0.94							
Light brown **SILT**		RC	1	86	0		
0.99							
		RC	2	97	45	2	64.50
						3	63.50
		RC	3	98	85		
BEDROCK: Grey limestone						4	62.50
- shaley limestone from 1.9m to 2.0m depth		RC	4	100	77	5	61.50
						6	60.50
		RC	5	100	95		
						7	59.50
		RC	6	100	82	8	58.50
		RC	7	100	83	9	57.50
9.40							
End of Borehole							
(GWL @ 4.97m-Nov. 16/10)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) 'N' value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

Relative Density	'N' Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

Consistency	Undrained Shear Strength (kPa)	'N' Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

Terminology used for describing soil strata based upon texture, or the proportion of individual particle sizes present is provided on the Textural Soil Classification Chart at the end of this information package.

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NXL size core. However, it can be used on smaller core sizes, such as BX, if the bulk of the fractures caused by drilling stresses (called “mechanical breaks”) are easily distinguishable from the normal in situ fractures.

RQD %	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC%	-	Natural moisture content or water content of sample, %
LL	-	Liquid Limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic limit, % (water content above which soil behaves plastically)
PI	-	Plasticity index, % (difference between LL and PL)
Dxx	-	Grain size which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D10	-	Grain size at which 10% of the soil is finer (effective grain size)
D60	-	Grain size at which 60% of the soil is finer
Cc	-	Concavity coefficient = $(D30)^2$ / (D10 x D60)
Cu	-	Uniformity coefficient = D60 / D10

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay
(more than 10% finer than 0.075 mm or the #200 sieve)

CONSOLIDATION TEST

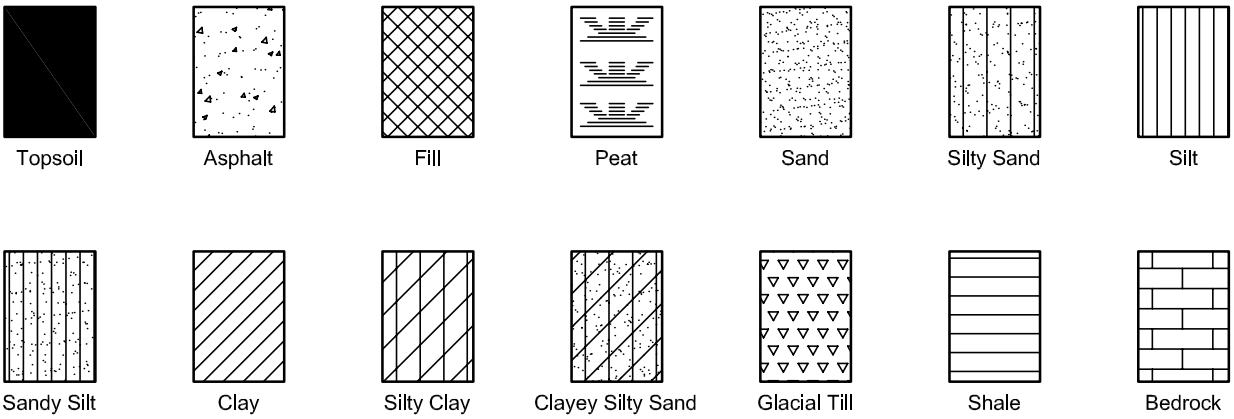
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
Wo	-	Initial water content (at start of consolidation test)

PERMEABILITY TEST

k	-	Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

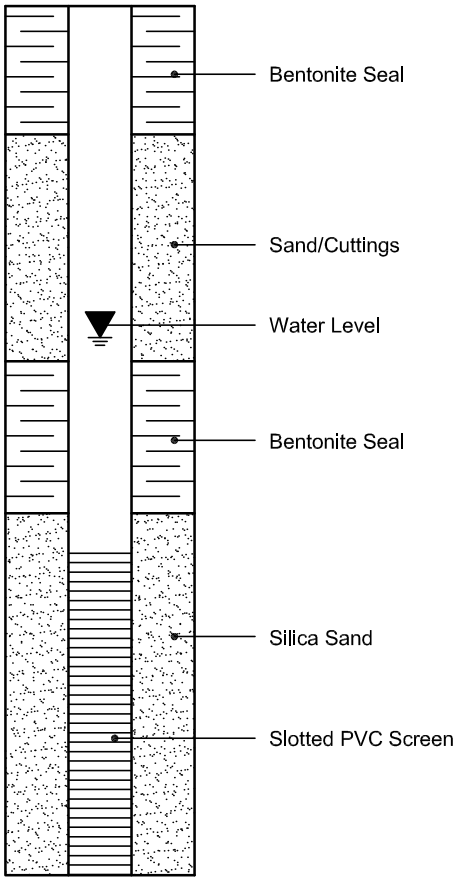
SYMBOLS AND TERMS (continued)

STRATA PLOT

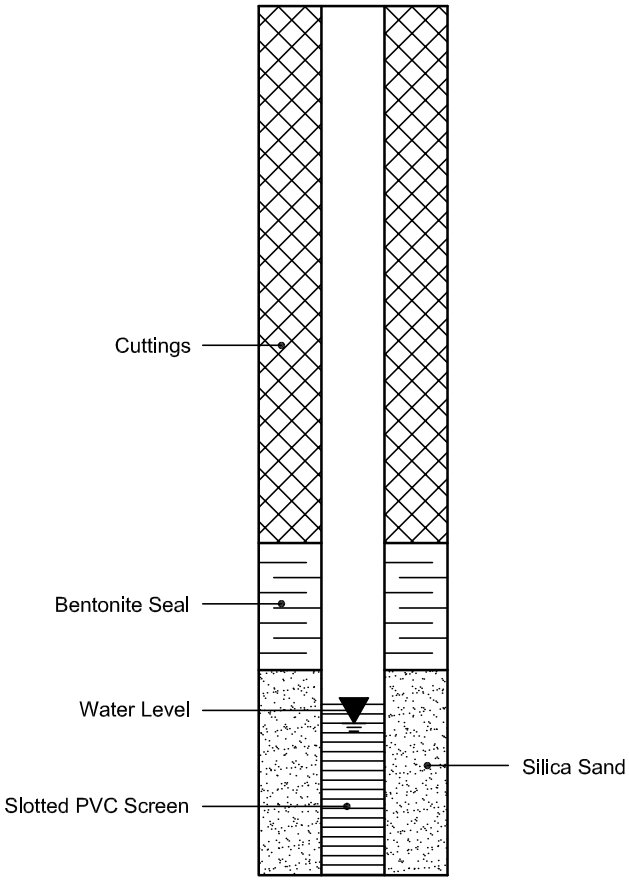


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG2178-1 - TEST HOLE LOCATION PLAN

FIGURE 1

KEY PLAN

PROPOSED CONFEDERATION LINE ALIGNMENT

APPROXIMATE DISTANCE FROM EDGE OF DEVELOPMENT TO PROPOSED CONFEDERATION LINE ALIGNMENT

17.0m

16.0m

MULTI USE PATHWAY

WATERMAIN

PEDESTRIAN BRIDGE TO COMMISSIONAIRES STATION

PEDESTRIAN PATHWAY

ROOSEVELT AVE.

WINSTON AVE.

WILMONT AVE.

RESIDENTIAL BLDG WEST 21 FLOORS

ENTRANCE

78 LOCKERS

ACCESS FROM WINSTON

RAMP

WEST PARKING LEVEL - 2
76 SPACES

LOADING BAY

11 LOCKERS

BLOCK A
LOWRISE RE
GFA = 10,744 ft²
(2,686 ft² x 4)

BLOCK B
LOWRISE RES
GFA = 11,888 ft²
(2, 972 ft² x 4)

BLOCK C
LOWRISE RE
GFA = 13,736 ft²
(3,434 ft² x 4)

BLOCK D
LOWRISE RE
GFA = 13,736 ft²
(3,434 ft² x 4)

RESIDENTIAL BLDG EAST 18 FLOORS

90 LOCKERS

8 PARKING SPACES

RAMP

ENTRANCE

EXISTING 7 STOREY BUILDING

TP 1 {0.91}

TP 2 {0.81}

TP 3 {0.71}

BH 1 66.39 [65.65]

BH 2 66.37 [65.68]

BH 3 66.43 [65.46]

BH 4 66.64 [65.47]

BH 5 66.50 [65.51]

TBM-MAG NAIL IN UTILITY POLE GEODETIC ELEVATION = 67.30m.

LEGEND:

- GEOPHONE LOCATIONS
- 20 — GEOPHONE NUMBER
- -10.5 — SHOT LOCATIONS
- BOREHOLE LOCATION
- TEST PIT LOCATION
- A A — CROSS SECTION LOCATION
- 66.39 — GROUND SURFACE ELEVATION (m)
- [65.65] — BEDROCK SURFACE ELEVATION (m)
- {0.91} — BEDROCK DEPTH (m)

BASE PLAN PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LIMITED.

SCALE: 1:500

0 5 10 15 20 25 30m

patersongroup
consulting engineers

154 Colonnade Road South
Ottawa, Ontario K2E 7J5
Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL
1	UPDATED TO LATEST CONCEPTUAL PLAN	07/09/2020	DP

UNIFORM URBAN DEVELOPMENTS

GEOTECHNICAL INVESTIGATION - PROPOSED RESIDENTIAL DEVELOPMENT 335 ROOSEVELT AVENUE

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:500	Date: 06/2020
Drawn by: RCG	Report No.: PG2178
Checked by: DP	PG2178-1
Approved by: DJG	Revision No.: 1

p:\autocad drawings\geotechnical\pg21xx\pg2178-3.dwg

APPENDIX B

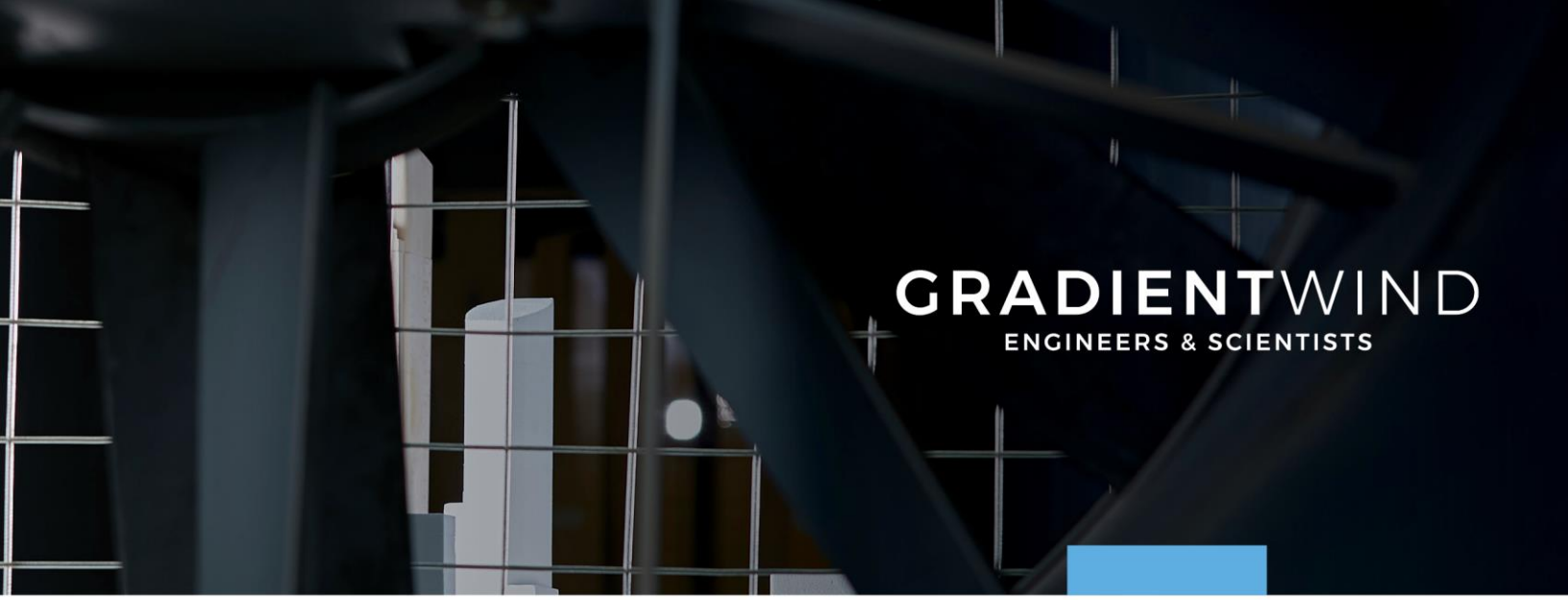
Geotechnical Investigation:

Paterson Group Report PG2178-1 Revision 1

dated July 22, 2020

APPENDIX C

Transportation Noise &
Ground Vibrations Impact Study
prepared by Gradient Wind Engineers & Scientists
dated June 25, 2020

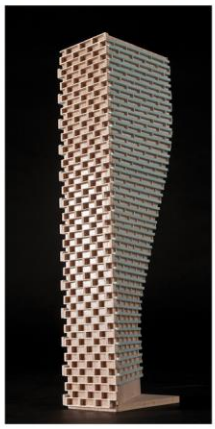


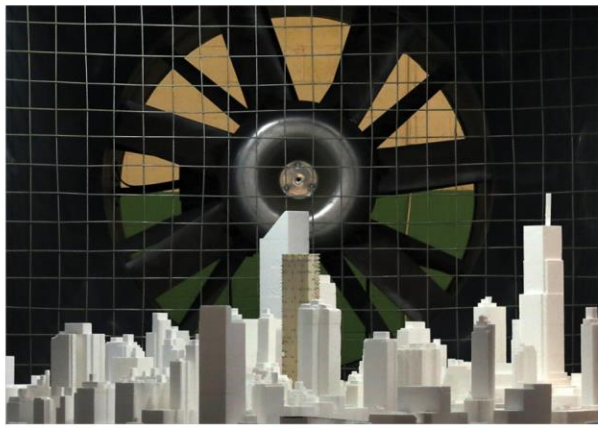
GRADIENTWIND
ENGINEERS & SCIENTISTS

TRANSPORTATION NOISE & GROUND VIBRATIONS IMPACT STUDY

335 Roosevelt Avenue
Ottawa, Ontario

REPORT #20-091-Transportation Noise & Vibration





June 25, 2020

DRAFT

PREPARED FOR

Uniform Urban Developments
117 Centerpointe Drive, Suite 300
Ottawa, ON K2G 5X3

Attn: Dan Tomka, P.Eng., Vice President, High-Rise
dtomka@uniformdevelopments.com

PREPARED BY

Efser Kara, MSc, LEED GA, Acoustic Scientist
Joshua Foster, P.Eng., Principal

EXECUTIVE SUMMARY

This report describes a transportation noise and ground vibration assessment undertaken for a proposed residential development located at 335 Roosevelt Avenue in Ottawa, Ontario to examine the impact of light rail transit corridor (proposed future LRT) traffic on the development to ensure that future occupants are afforded comfortable use of indoor and outdoor living spaces, as directed by the City of Ottawa's Environmental Noise Control Guidelines (ENCG).

The proposed residential development is located at 335 Roosevelt Avenu in Ottawa just at the intersection of Roosevelt and Winston Avenues. The development features two residential buildings; one lies between Roosevelt and Winston Avenues on the west side and the other on the east side of Winston Avenue. The west building comprises 21 and the east building comprises 18 storeys. The development features 125-car underground parking serving both buildings. Each building has 5th-floor amenity terraces located on the west side and Both east and west buildings have residential terraces on 17th and 20th floors, respectively.

The study site is not within a 100 metres of any existing or planned collector or arterial roadway. However, a light rail transit corridor, which is planned to be built on the north side of the study site, is the major source of noise and ground vibrations. Figure 1 illustrates a complete site plan with the surrounding context.

The Western LRT is the westerly extension of the City's Confederation Line. This report describes the assessment, methodology and results for existing and future environmental noise and vibration impacts influenced by the project undertaking, and provides recommendations for mitigation where required.

The assessment is based on (i) theoretical noise prediction methods that conform to the Ministry of the Environment, Conservation and Parks (MECP) (ii) ground-borne vibration prediction and assessment methodology as specified by the Federal Transit Authority (FTA) Protocol; (iii) noise level criteria as specified by the City of Ottawa's Environmental Noise Control Guidelines (ENCG); (iv) future rail traffic volumes based on the ultimate buildout LRT volumes were used which were established in the Confederation Line West Extension Environmental Assessment Study; and (v) drawings prepared by Hobin Architecture, dated June 2020.

The results of the current analysis indicate that noise levels will range between 34 and 60 dBA during the daytime period (07:00-23:00) and between 27 and 53 dBA during the nighttime period (23:00-07:00). The highest noise level (i.e. 60 dBA) occurs at the north façades of the East and West Buildings, which are nearest and most exposed to the LRT line. Outdoor Living Area (OLA) noise levels at building terraces and outdoor amenity areas are well below the 55 dBA ENCG criteria. Therefore no barriers will be required.

The results of the calculations also indicate that the dwellings should be designed with forced air heating and provisions for the installation of central air conditioning.

Warning clauses will be required to be placed on all Lease, Purchase and Sale Agreements, as summarized in Section 6.

The results of the vibration calculations indicated that the ground vibration levels will be approximately 0.11 mm/s, marginally above the threshold level of human perception to vibrations and the criterion of 0.10 mm/s. The ground-borne noise is estimated to be at 38 dBA. The exceedance is deemed to be trivial, therefore, mitigation for ground-borne vibrations and noise is not required. Details of the vibration calculations are presented in Appendix B.

With regards to stationary noise impacts, a stationary noise study will be performed once mechanical plans for the proposed building become available. This study would assess the impacts of stationary sources, such as 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 and NPC-300 limits. Noise impacts can generally be minimized by judicious selection and placement of the equipment. Generally, loader pieces of equipment such as cooling towers, generators and large make-up air units, should be placed in the mechanical penthouse or the high roof. Where necessary noise screens and silencers can be placed into the design.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by Uniform Urban Developments to undertake a transportation noise and vibration assessment for a proposed residential development located at 335 Roosevelt Avenue in Ottawa, Ontario. This report summarizes the methodology, results, and recommendations related to the assessment of exterior and interior noise & vibration levels generated by local transportation sources.

Our work is based on theoretical noise calculation methods conforming to the Ministry of the Environment, Conservation and Parks (MECP)[1] guidelines, City of Ottawa[2], and vibration assessment conforming to Federal Transit Authority (FTA) Protocol. Calculations were based on architectural drawings prepared by Hobin Architecture, dated June, 2020, with the ultimate buildout LRT volumes were used which were established in the Confederation Line West Extension Environmental Assessment Study.

2. TERMS OF REFERENCE

The focus of this study is the proposed residential development is located at 335 Roosevelt Avenu in Ottawa just at the intersection of Roosevelt and Winston Avenues. The development features two residential high-rise buildings; one lies between Roosevelt and Winston Avenues on the west side and the other on the east side of Winston Avenue; and four low-rise blocks (Block A, B, C, and D). The west building comprises 21 storeys and the east building comprises 18 storeys. Blocks A, B, C, and D comprise 3 storeys each. The West and East Buildings feature 125-car underground parking serving both buildings. Each building has 5th-floor amenity terraces located on the west side and Both east and west buildings have residential terraces on 17th and 20th floors, respectively. A linear park is located on the north side of the development which acts as a buffer between the development and the LRT corridor.

The major source of noise and ground vibrations impacting the site is a planned light rail transit corridor north of the site. At the time of writing of the report, construction has started on the line which is converting

[1] Ontario Ministry of the Environment and Climate Change – Environmental Noise Guidelines, Publication NPC-300, Queens Printer for Ontario, Toronto, 2013
[2] City of Ottawa Environmental Noise Control Guidelines, January 2016

an existing bus rapid transit network to LRT. There are no other major roadways within a 100 metres of the site. Figure 1 illustrates a complete site plan with the surrounding context.

3. OBJECTIVES

The principal objectives of this study are to (i) calculate the future noise levels on development produced by local transportation sources, (ii) measure the vibration levels on the study building produced from passing trains, (iii) ensure that interior and exterior noise levels do not exceed the allowable limits specified by the ENCG as outlined in Section 4.2.1 of this report, and (v) ensure vibration levels to not exceed the allowable limits specified by industry guidelines, such as the United States Federal Transit Authority (FTA).

4. METHODOLOGY

4.1 Noise 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 that has the same energy as a time-varying noise level over a period of time. For road and railways including LRT, 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 for roadway and LRT noise is 45 (during daytime) and 40 (during nighttime) for residences, as listed in Table 1. However, to account for deficiencies in building construction and control peak noise, these levels should be targeted toward 42, 37 for living areas during the daytime and sleeping quarters during the nighttime respectively.

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

Type of Space	Time Period	Leq (dBA)
		LRT
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	07:00 – 23:00	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 (or similar systems). Where noise levels exceed 65 dBA daytime and 60 dBA nighttime building components will require higher levels of sound attenuation[5].

[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] MOECP, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.1.3

Noise levels at outdoor living areas should be limited to 55 dBA where technically and administratively feasible. The City of Ottawa preferences for noise control prescribe the following hierarchy:

(i) Increased distance setback with absorptive ground cover (vegetation)
(ii) Relocation of noise-sensitive areas away from roadways and light rail transit corridors
(iii) Earth berms
(iv) Acoustic barriers

4.2.2 Theoretical LRT Noise Predictions

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

The LRT lines were treated as single line sources of noise which use, where appropriate, existing building locations and the study building as noise barriers partially or fully obstructing exposure to the source. In addition to the LRT volumes summarized in Table 2 below, theoretical noise predictions were also based on the following parameters:

(i) Noise receptors were strategically placed at seventeen (17) locations around the study area (see Figure 2).
(ii) Ground surfaces were taken as reflective where hard ground (pavement and concrete areas) present and absorptive where soft ground (grass, foliage, trees) present.
(iii) Topography was assumed to be a flat/gentle slope with a barrier for receptors influenced by the LRT which is located 5.5 metres below the grade level of the study site.
(iv) Plane of window (POW) receptor heights were taken to be at the centre of the highest storey window for both West and East Buildings, and Block A and Block C which are partially exposed to light rail transit corridor (see Table 3).
(v) The Outdoor living areas (OLA) are located at the terraces of both buildings. The 5th storey terrace receptors were taken at 14.75 m high. For the terrace on the 20th storey of the West Building, the receptor height was taken as 59.70 metes and for the 17th storey terrace of the East Building, the receptor height was 50.70 m. In addition to terrace OLA receptors, two receptors were used at grade level outdoor amenity spaces.

(vi) Receptor distance and exposure angles outlined in Figures 3-7.

4.2.1 Light Rail Traffic Volumes

The ENCG dictates that noise calculations should consider future sound levels based on the mature state of development of the roadway or transit system. Therefore, the ultimate buildout LRT volumes were used which were established in the Confederation Line West Extension Environmental Assessment Study. Table 2 below summarizes the light rail traffic volumes considered in the assessment.

TABLE 2: LIGHT RAIL TRAFFIC DATA

Railway	Railway Traffic Data		Speed Limit (km/h)	Traffic Volumes
	Existing (2020)	Projected (2035)		
Confederation Line LRT (Phase 2)	N/A	540/60*	70	N/A

* Daytime/nighttime volumes

4.3 Ground Vibration and Ground-borne Noise

Rail systems and heavy vehicles on roadways can produce perceptible levels of ground vibrations, especially when they are in close proximity to residential neighbourhoods or vibration-sensitive buildings. Similar to sound waves in air, vibrations in solids are generated at a source, propagated through a medium, and intercepted by a receiver. In the case of ground vibrations, the medium can be uniform, or more often, a complex layering of soils and rock strata. Also, similar to sound waves in air, ground vibrations produce perceptible motions and regenerated noise known as 'ground-borne noise' when the vibrations encounter a hollow structure such as a building. Ground-borne noise and vibrations are generated when there is an excitation of the ground, such as from a train. The repetitive motion of the wheels on the track or rubber tires passing over an uneven surface causes vibrations to propagate through the soil. When they encounter a building, vibrations pass along the structure of the building beginning at the foundation and propagating to all floors. Air inside the building excited by the vibrating walls and floors represents regenerated airborne noise. Characteristics of the soil and the building are imparted to the noise, thereby creating a unique noise signature.

Human response to ground vibrations is dependent on the magnitude of the vibrations, which is measured by the root mean square (RMS) of the movement of a particle on a surface. Typical units of ground

vibration measures are millimetres per second (mm/s), or inch per second (in/s). Since vibrations can vary over a wide range, it is also convenient to represent them in decibel units, or dBV. In North America, it is common practice to use the reference value of one micro-inch per second (µin/s) to represent vibration levels for this purpose. The threshold level of human perception to vibrations is about 0.10 mm/s RMS or about 72 dBV. Although somewhat variable, the threshold of annoyance for continuous vibrations is 0.5 mm/s RMS (or 85 dBV), five times higher than the perception threshold, whereas the threshold for significant structural damage is 10 mm/s RMS (or 112 dBV), at least one hundred times higher than the perception threshold level.

4.3.1 Criteria for Ground Vibration and Ground-borne Noise

In the United States, the Federal Transportation Authority (FTA) has set vibration criteria for sensitive land uses next to transit corridors. Similar standards have been developed by the MECP. These standards indicate that the appropriate criterion for residences is 0.10 mm/s RMS for vibrations. For mainline railways, a document titled *Guidelines for New Development in Proximity to Railway Operations*[6], indicates that vibration conditions should not exceed 0.14 mm/s RMS averaged over a one-second time-period at the first floor and above of the proposed building. The Federal Transportation Authority (FTA) criterion was adopted as the appropriate standard for this study. As the main vibration source is due to the light rail line which has frequent events, the 0.10 mm/s RMS (72 dBV) vibration criteria and 35 dBA ground-borne noise criteria were adopted for this study.

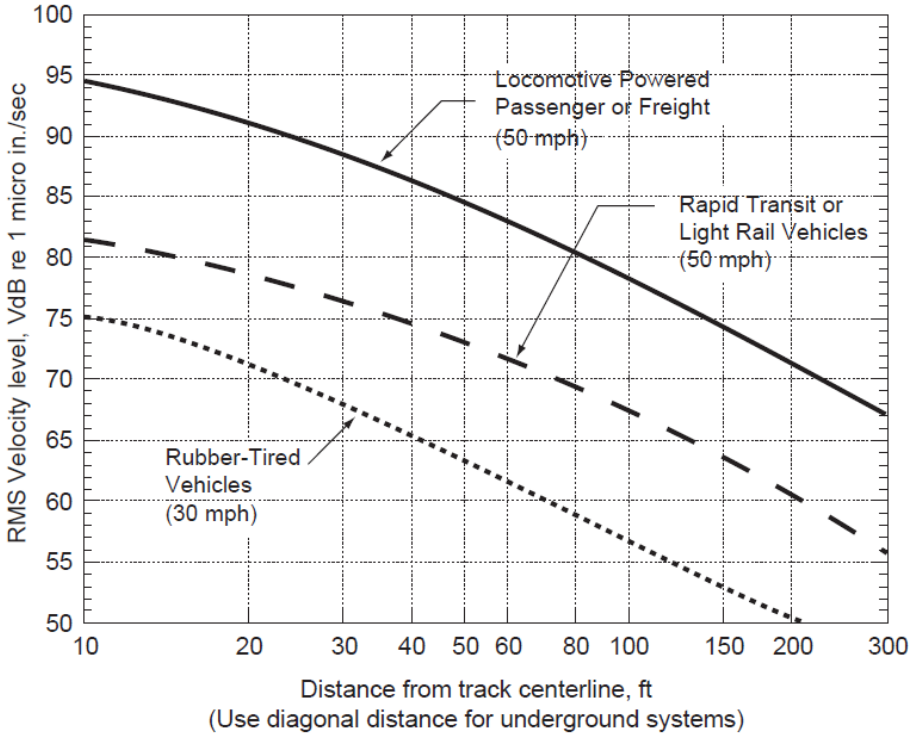
4.3.2 Theoretical Ground Vibration Prediction Procedure

Potential vibration impacts of trains were predicted using the FTA's *Transit Noise and Vibration Impact Assessment*[7] protocol. The FTA general vibration assessment is based on an upper bound generic set of curves that show vibration level attenuation with distance. These curves, illustrated in the figure below, are based on ground vibration measurements at various transit systems throughout North America. Vibration levels at points of reception are adjusted by various factors to incorporate known characteristics of the system being analyzed, such as operating speed of vehicle, conditions of the track, construction of

[6] Dialog and J.E. Coulter Associates Limited, prepared for The Federation of Canadian Municipalities and The Railway Association of Canada, May 2013
[7] C. E. Hanson; D. A. Towers; and L. D. Meister, Transit Noise and Vibration Impact Assessment, Federal Transit Administration, May 2006.

the track and/or tunnel; depth and geology; as well as the structural type of the impacted building structures. The vibration impact on the building was determined using a set of curves for LRT at a speed of 70 km/h. Adjustment factors were considered based on the following information:

- The maximum operating speed of the LRT near the study area is 70 km/h (43 mph)
- The distance between the development and the closest track is 20 m
- The vehicles are assumed to have soft primary suspensions
- Tracks are not welded though in otherwise good condition
- Soil conditions do not efficiently propagate vibrations
- The building's foundation is large masonry on piles



FTA GENERALIZED CURVES OF VIBRATION LEVELS VERSUS DISTANCE (ADOPTED FROM FIGURE 10-1, FTA TRANSIT NOISE AND VIBRATION IMPACT ASSESSMENT)

5. RESULTS AND DISCUSSION

5.1 LRT Noise Levels

The results of the railway 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 TRANSPORTATION SOURCES

Receptor Number	Receptor Type / Building	Receptor Locations	Receptor Height (m)	LRT Noise Levels (dBA)	
				Day	Night
1	POW / West Building	21st Floor – West Façade POW	62.70 m	58	52
2	POW / West Building	21st Floor – North Façade POW	62.70 m	59	53
3	POW / West Building	21st Floor – North Façade POW	62.70 m	60	53
4	POW / West Building	21st Floor – East Façade POW	62.70 m	48	42
5	POW / West Building	21st Floor – South Façade POW	62.70 m	49	42
6	POW / East Building	18th Floor – West Façade POW	53.70 m	58	51
7	POW / East Building	18th Floor – North Façade POW	53.70 m	59	53
8	POW / East Building	18th Floor – North Façade POW	53.70 m	60	53
9	POW / East Building	18th Floor – East Façade POW	53.70 m	54	47
10	OLA / West Building	5th Floor Terrace – West Façade OLA	14.75 m	47	N/A*
11	OLA / West Building	20th Floor Terrace – West Façade OLA	59.70 m	43	N/A*
12	OLA / East Building	5th Floor Terrace – West Façade OLA	14.75 m	46	N/A*
13	OLA / East Building	17th Floor Terrace – West Façade OLA	50.70 m	41	N/A*
14	OLA	Outdoor Amenity Area West	1.50 m	37	N/A*
15	OLA	Outdoor Amenity Area East	1.50 m	35	N/A*
16	POW / Block A	3rd Floor – North Facade	8.10 m	38	31
17	POW / Block C	3rd Floor – North Facade	7.75 m	34	27

* OLA noise levels during the nighttime are not considered as per the ENCG

Results of the current analysis indicate that noise levels at POW receptors will range between 34 and 60 dBA during the daytime period (07:00-23:00) and between 27 and 53 dBA during the nighttime period (23:00-07:00). The highest noise level (i.e. 60 dBA) occurs at the north façades of the East and West Buildings, which are nearest and most exposed to the LRT line. Outdoor Living Area (OLA) noise levels at building terraces and outdoor amenity areas are well below the 55 dBA ENCG criteria.

5.2 Noise Control Measures for LRT Traffic

As the results indicate, the noise levels at Plane of Window receptors do not exceed 65 dBA during daytime and 60 dBA during nighttime, therefore, upgraded building components will not be required. Building components compliant with the Ontario Building Code will be sufficient.

The results of the calculations also indicate that the buildings should be designed with forced air heating and provisions for the installation of central air conditioning. 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.

5.3 Vibration Impacts

The results of the vibration calculations indicated that the ground vibration levels will be approximately 0.11 mm/s, marginally above the threshold level of human perception to vibrations and the criterion of 0.10 mm/s. The ground-borne noise is estimated to be at 38 dBA. The exceedance is deemed to be trivial, therefore, mitigation for ground-borne vibrations and noise is not required. Details of the vibration calculations are presented in Appendix B.

6. CONCLUSIONS AND RECOMMENDATIONS

Results of the current analysis indicate that noise levels will range between 34 and 60 dBA during the daytime period (07:00-23:00) and between 27 and 53 dBA during the nighttime period (23:00-07:00). The highest noise level (i.e. 60 dBA) occurs at the north façades of the East and West Buildings, which are nearest and most exposed to the LRT line. Outdoor Living Area (OLA) noise levels at building terraces and outdoor amenity areas are well below the 55 dBA ENCG criteria.

The results of the calculations also indicate that the dwellings should be designed with forced air heating and provisions for the installation of central air conditioning. If installed at the occupants' discretion, air conditioning will allow windows and doors to remain close providing a quiet and comfortable indoor environment. Warning clauses will be required to be placed on all Lease, Purchase and Sale Agreements, as summarized below:

"Purchasers/tenants are advised that sound levels due to increasing Light Rail traffic may occasionally interfere with some outdoor activities as the sound levels may exceed the sound level limits of the City and the Ministry of the Environment.

This dwelling unit has also been designed with the provision for adding central air conditioning at the occupant's discretion and forced air heating. Installation of central 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."

In addition, the Rail Construction Program Office recommends that the warning clause identified below to be included in all agreements of purchase and sale and lease agreements for the proposed development including those prepared prior to the registration of the Site Plan Agreement:

"The Owner hereby acknowledges and agrees:

i) The proximity of the proposed development of the lands described in Schedule "A" hereto (the "Lands") to the City's existing and future transit operations, may result in noise, vibration, electromagnetic interferences, stray current transmissions, smoke and particulate matter (collectively referred to as "Interferences") to the development;

ii) It has been advised by the City to apply reasonable attenuation measures with respect to the level of the Interferences on and within the Lands and the proposed development; and

iii) The Owner acknowledges and agrees all agreements of purchase and sale and lease agreements, and all information on all plans and documents used for marketing purposes, for the whole or any part of the subject lands, shall contain the following clauses which shall also be incorporated in all transfer/deeds and leases from the Owner so that the clauses shall be covenants running with the lands for the benefit of the owner of the adjacent road:

'The Transferee/Lessee for himself, his heirs, executors, administrators, successors and assigns acknowledges being advised that a public transit light-rail rapid transit system (LRT) is proposed to be located in proximity to the subject lands, and the construction, operation and maintenance of the LRT may result in environmental impacts including, but not limited to noise, vibration, electromagnetic interferences, stray current transmissions, smoke and particulate matter (collectively referred to as the Interferences) to the subject lands. The Transferee/Lessee acknowledges and agrees that despite the inclusion of noise control features within the subject lands, Interferences may continue to be of concern, occasionally interfering with some activities of the occupants on the subject lands.

The Transferee covenants with the Transferor and the Lessee covenants with the Lessor that the above clauses verbatim shall be included in all subsequent lease agreements, agreements of purchase and sale and deeds conveying the lands described herein, which covenants shall run with the lands and are for the benefit of the owner of the adjacent road.'"

The results of the vibration calculations indicated that the ground vibration levels will be approximately 0.11 mm/s, marginally above the threshold level of human perception to vibrations and the criterion of 0.10 mm/s. The ground-borne noise is estimated to be at 38 dBA. The exceedance is deemed to be trivial, therefore, mitigation for ground-borne vibrations and noise is not required. Details of the vibration calculations are presented in Appendix B.

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.

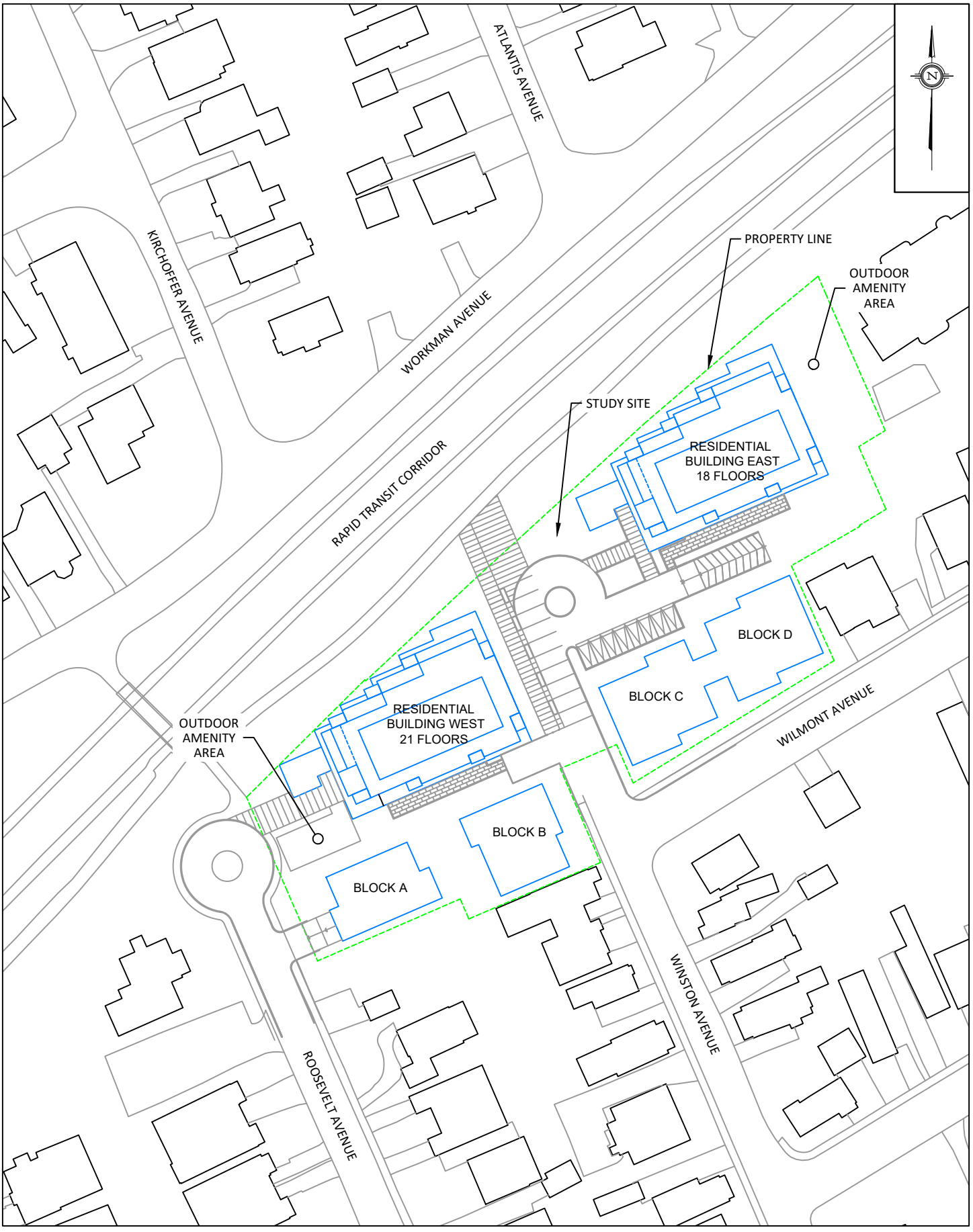
Sincerely,

Gradient Wind Engineering Inc.

Efser Kara, MSc, LEED GA
Acoustic Scientist

Joshua Foster, P.Eng.
Principal

Gradient Wind File#20-091 – Transportation Noise & Vibration



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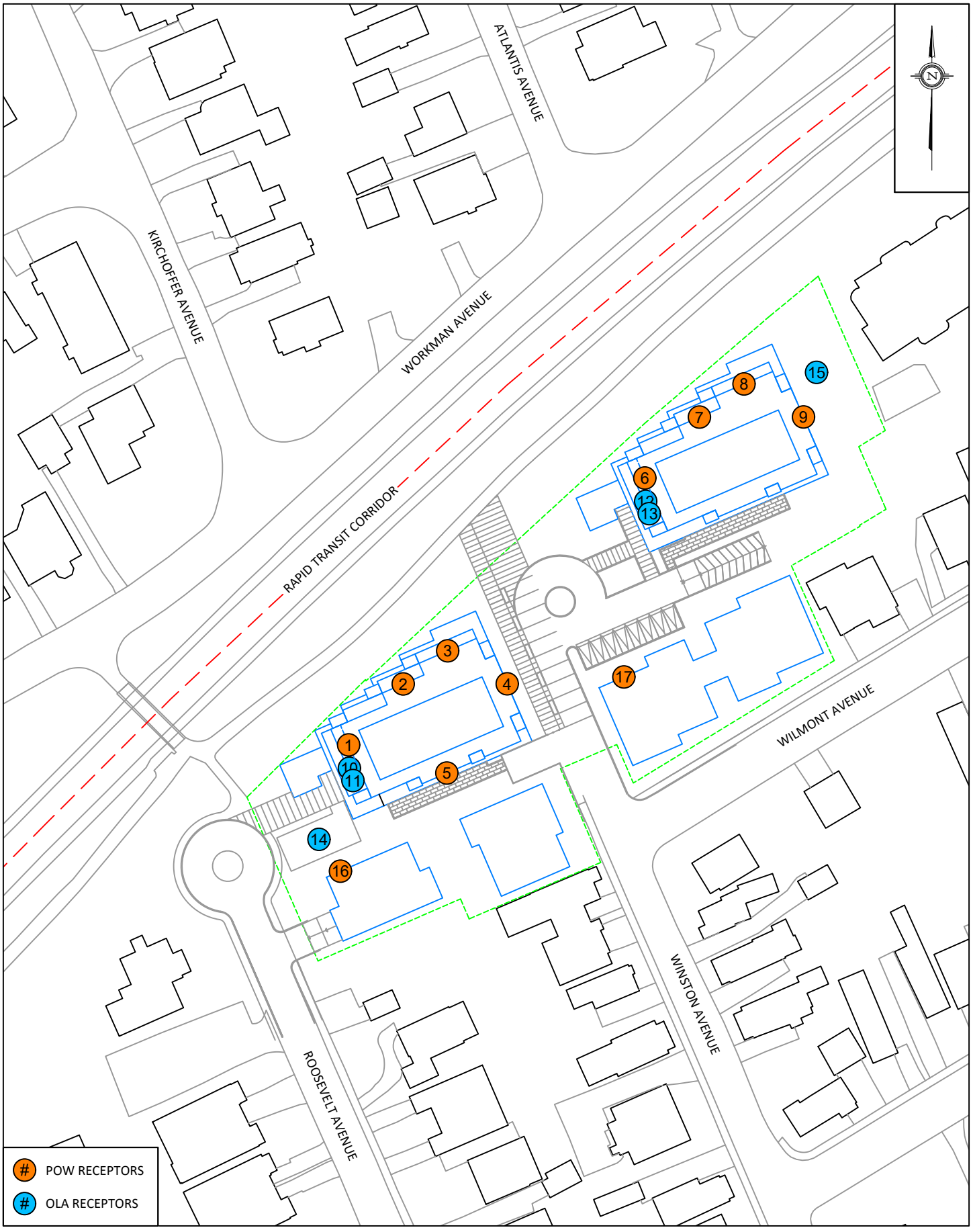
PROJECT	335 ROOSEVELT AVENUE RAILWAY TRAFFIC NOISE ASSESSMENT
SCALE	1:1000 (APPROX.)
DRAWING NO.	GW20-091-1
DATE	JUNE 19, 2020
DRAWN BY	E.K.
DESCRIPTION	FIGURE 1: SITE PLAN AND SURROUNDING CONTEXT



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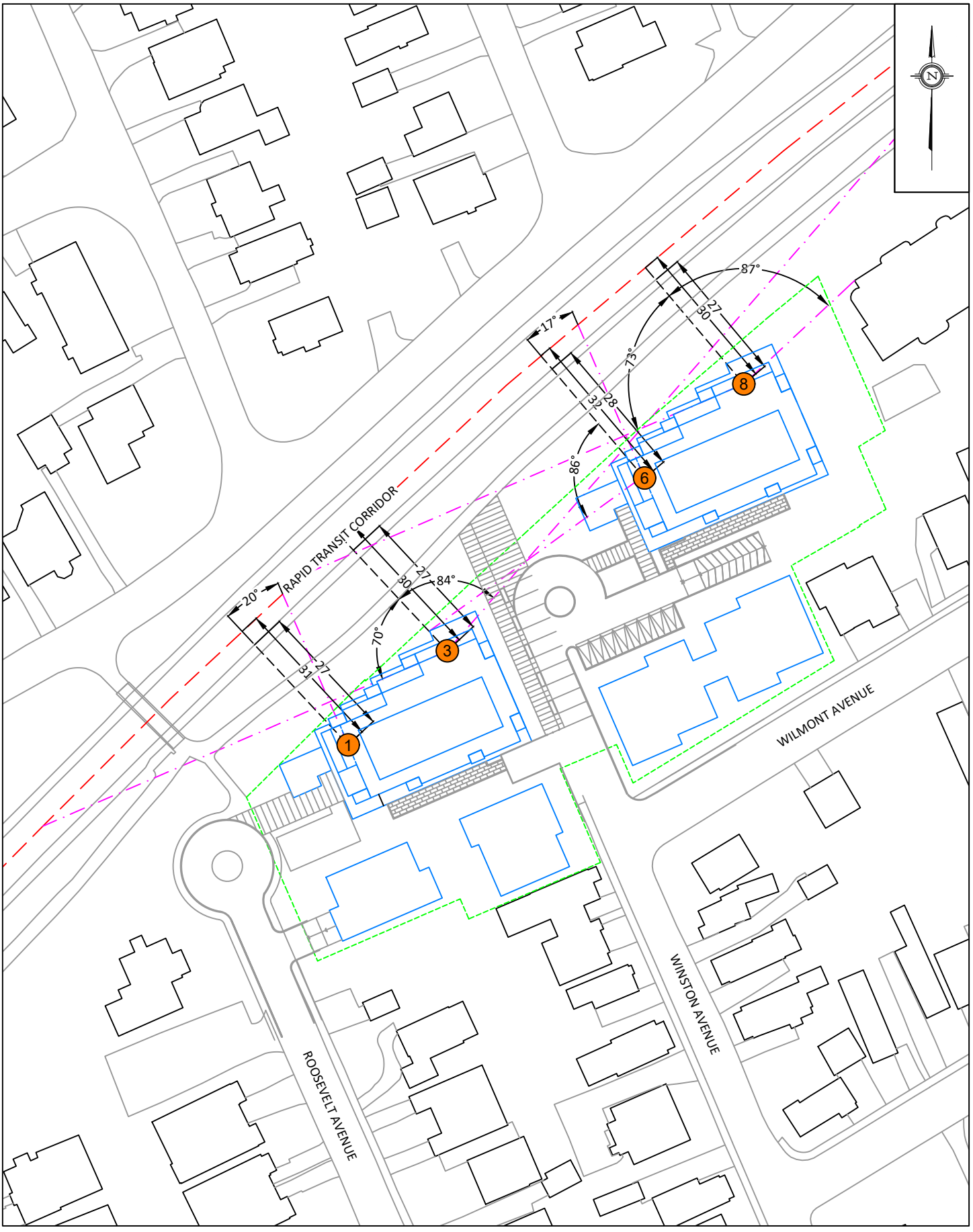
SCALE	1:1000 (APPROX.)	DRAWING NO.	GW20-091-2
DATE	JUNE 19, 2020	DRAWN BY	E.K.

FIGURE 2:
RECEPTOR LOCATIONS



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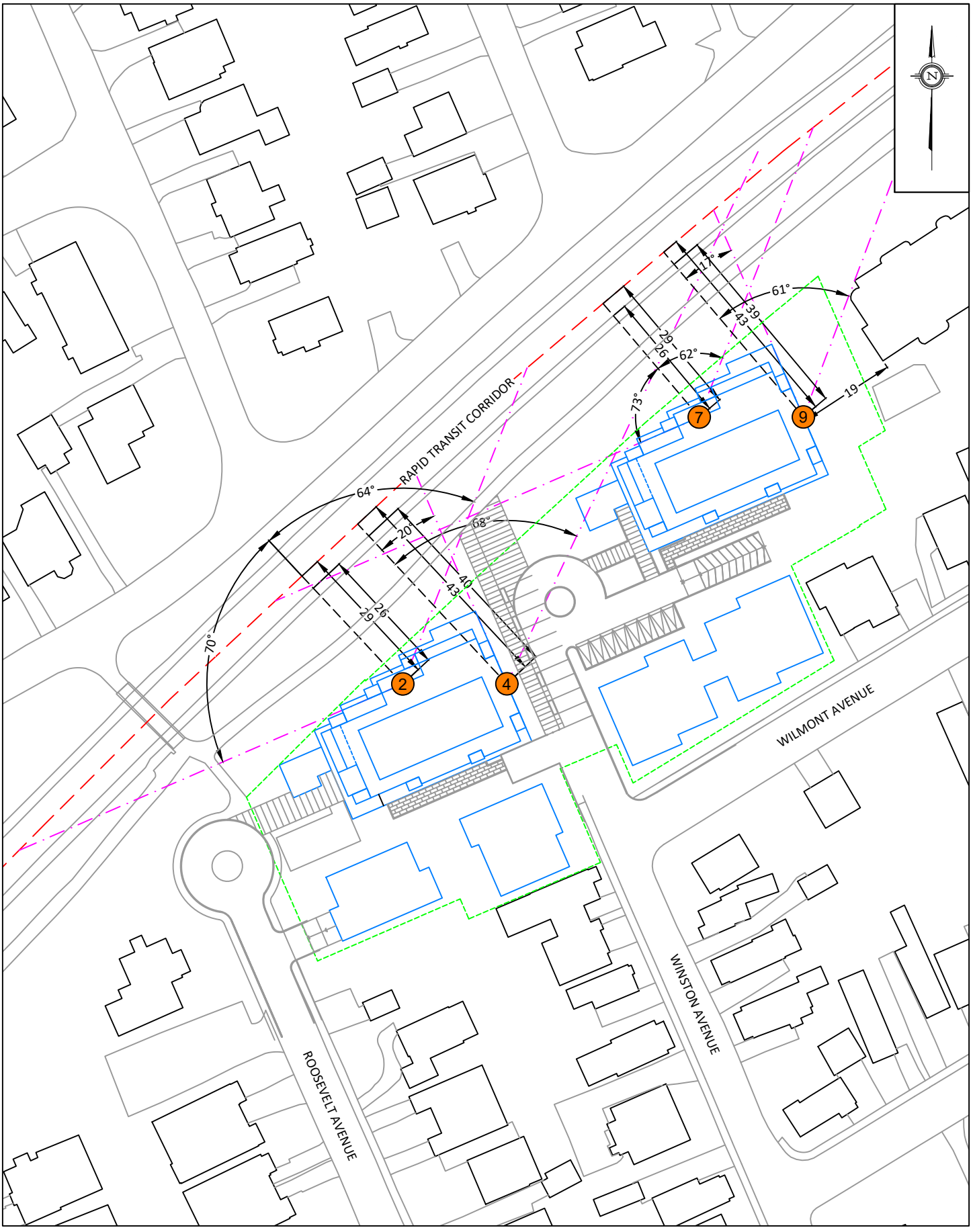
SCALE	1:1000 (APPROX.)
DRAWING NO.	GW20-091-3
DATE	JUNE 19, 2020
DRAWN BY	E.K.

DESCRIPTION

FIGURE 3:
STAMSON INPUT DATA
FOR RECEPTORS 1, 3, 6 AND 8



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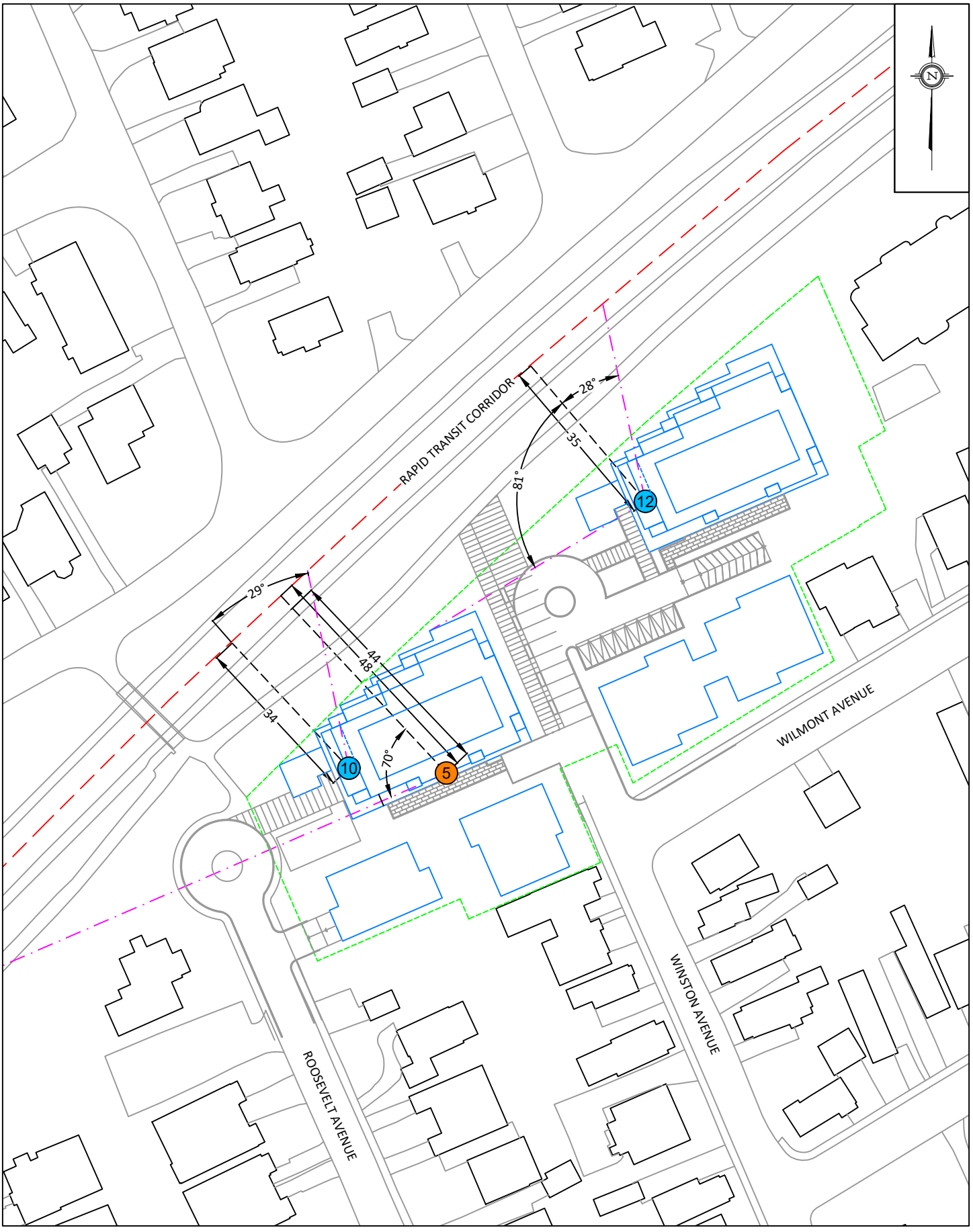
PROJECT	335 ROOSEVELT AVENUE RAILWAY TRAFFIC NOISE ASSESSMENT		DESCRIPTION
SCALE	1:1000 (APPROX.)	DRAWING NO.	GW20-091-4
DATE	JUNE 19, 2020	DRAWN BY	E.K.

FIGURE 4:
STAMSON INPUT DATA
FOR RECEPTORS 2, 4, 7 AND 9



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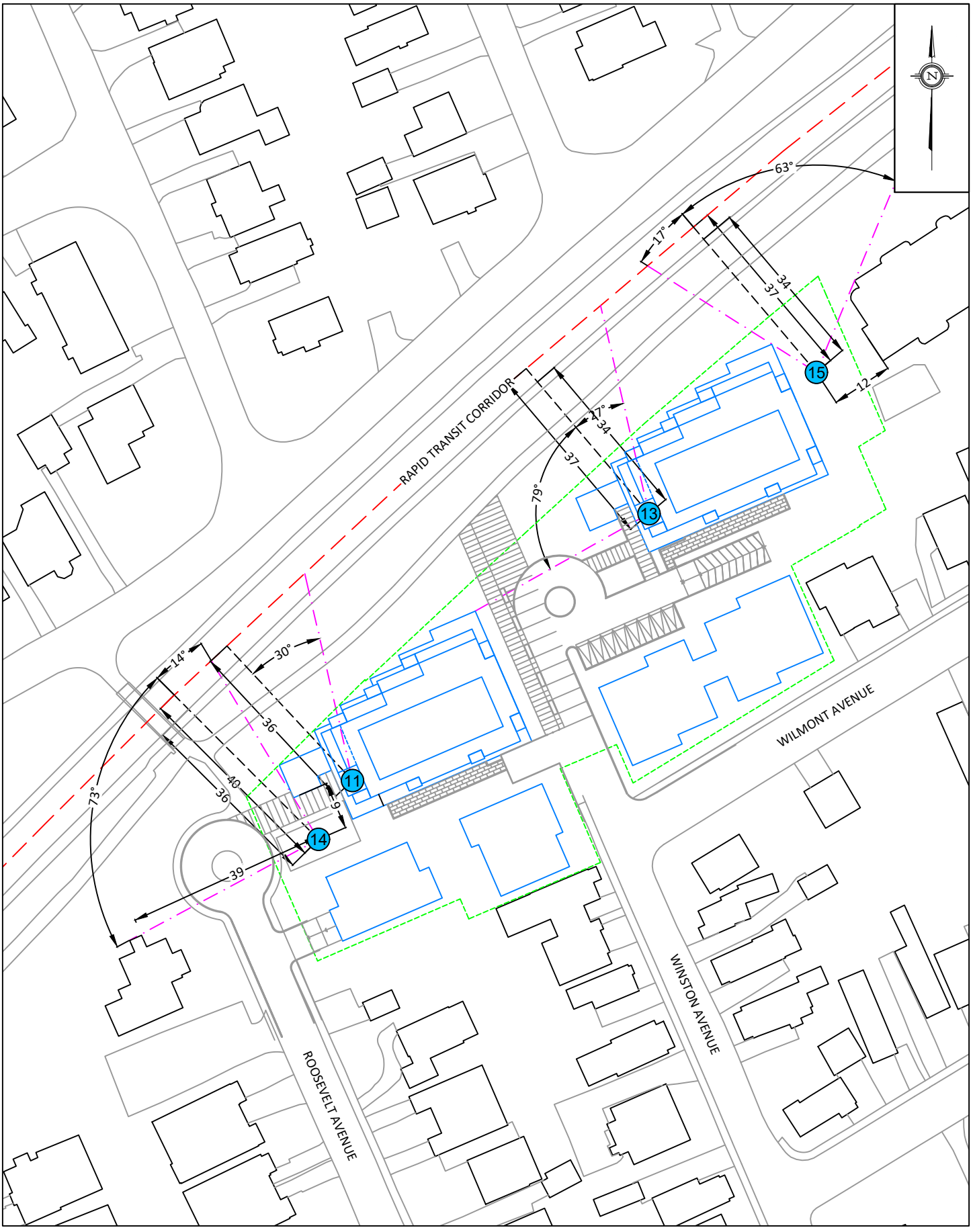
PROJECT	335 ROOSEVELT AVENUE RAILWAY TRAFFIC NOISE ASSESSMENT
SCALE	1:1000 (APPROX.)
DRAWING NO.	GW20-091-5
DATE	JUNE 19, 2020
DRAWN BY	E.K.

DESCRIPTION

FIGURE 5:
STAMSON INPUT DATA
FOR RECEPTORS 5, 10, AND 12



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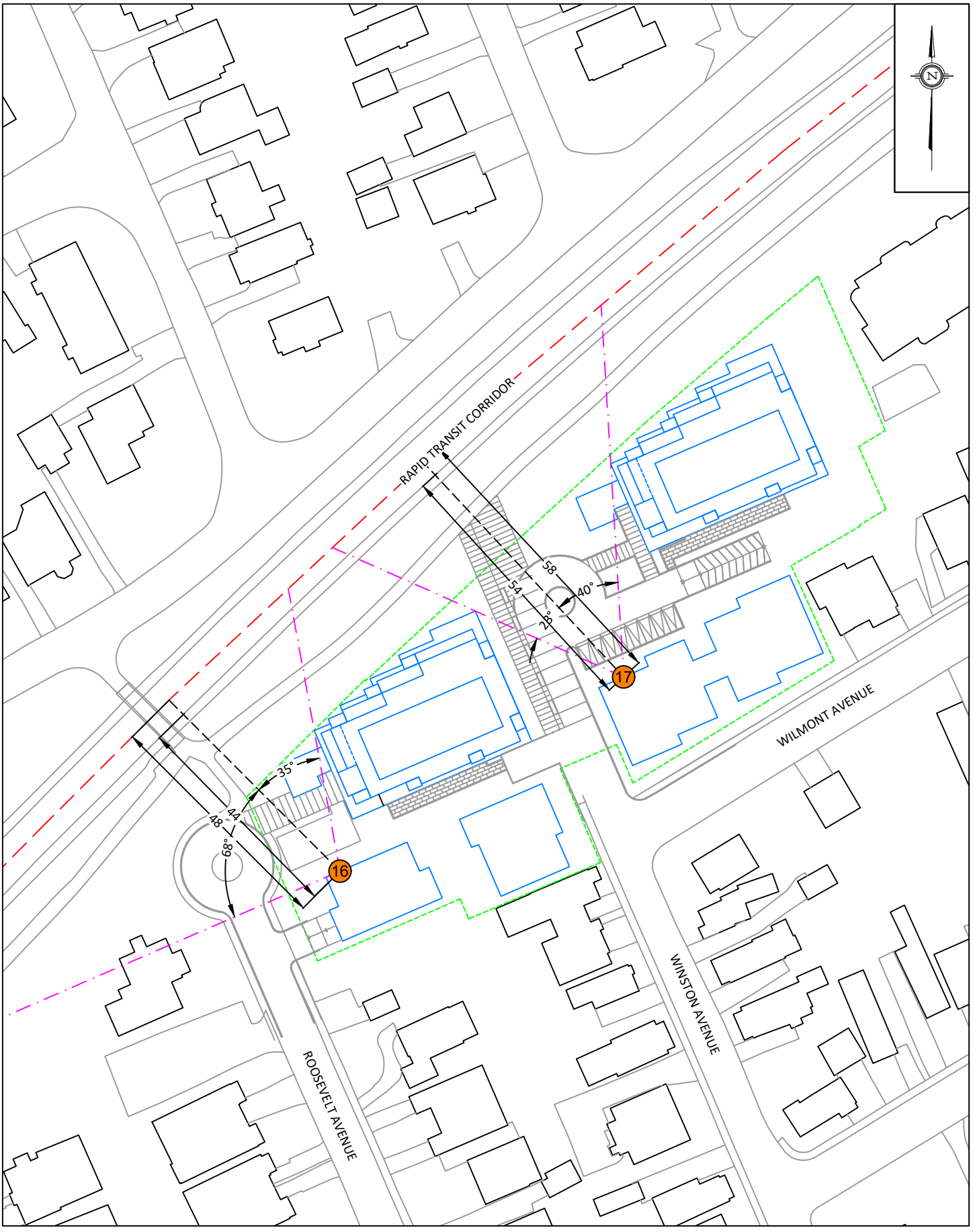
PROJECT	335 ROOSEVELT AVENUE RAILWAY TRAFFIC NOISE ASSESSMENT
SCALE	1:1000 (APPROX.)
DRAWING NO.	GW20-091-6
DATE	JUNE 19, 2020
DRAWN BY	E.K.

DESCRIPTION

FIGURE 6:
STAMSON INPUT DATA
FOR RECEPTORS 11, 13, 14, AND 15



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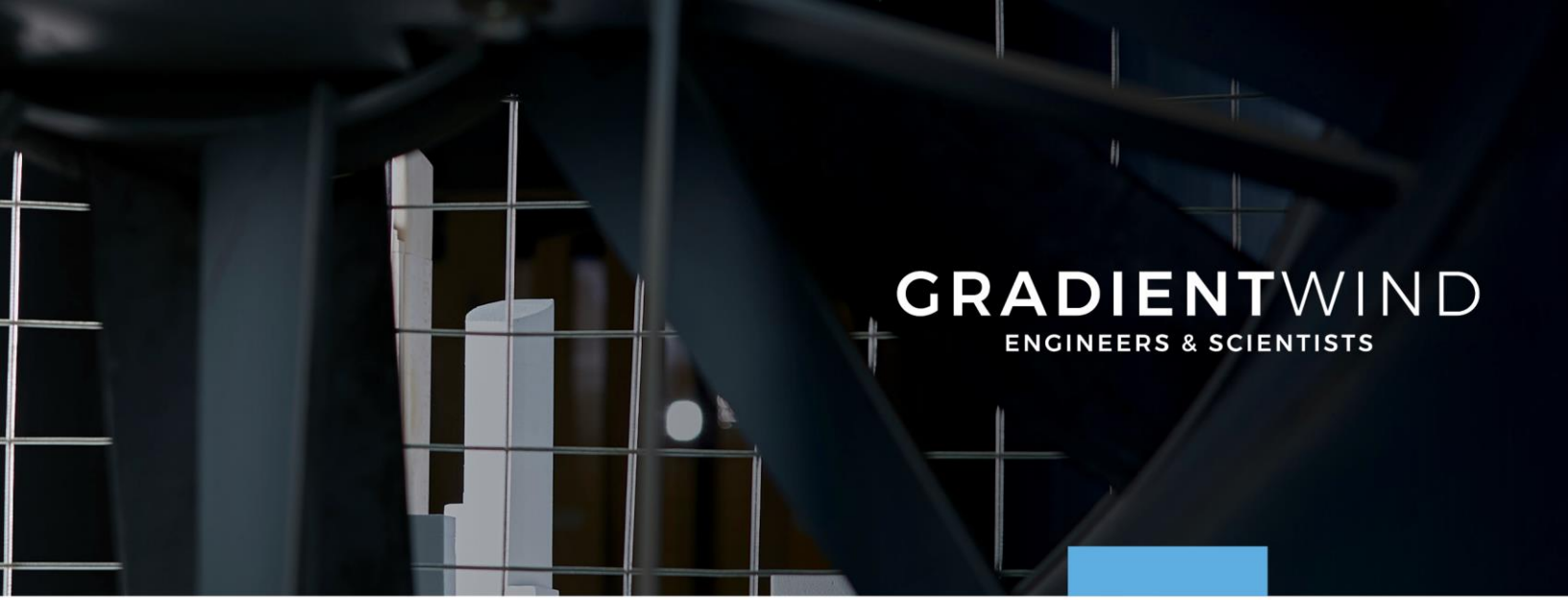
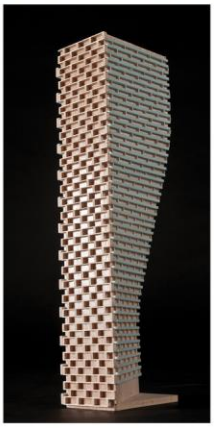
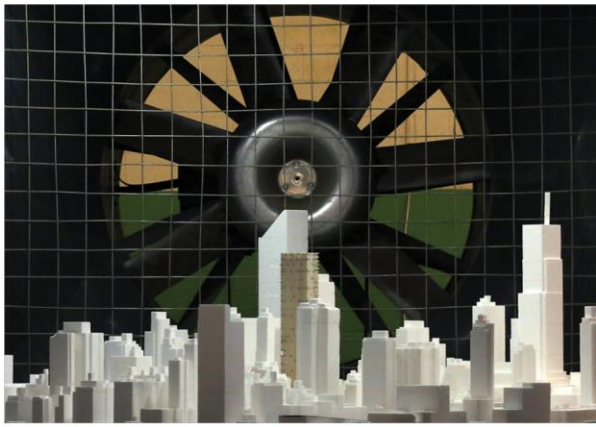
SCALE	1:1000 (APPROX.)
DRAWING NO.	GW20-091-7
DATE	JUNE 19, 2020
DRAWN BY	E.K.

DESCRIPTION

FIGURE 7:
STAMSON INPUT DATA
FOR RECEPTORS 16 AND 17







APPENDIX A

STAMSON INPUT-OUTPUT DATA

127 WALGREEN ROAD, OTTAWA, ON, CANADA K0A 1L0 | 613 836 0934
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STAMSON 5.0 NORMAL REPORT Date: 19-06-2020 12:21:34
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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

RT/Custom data, segment # 1: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh2 (day/night)

Angle1 Angle2 : -90.00 deg 20.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 31.00 / 31.00 m
Receiver height : 62.70 / 62.70 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -90.00 deg Angle2 : 20.00 deg
Barrier height : 0.00 m
Barrier receiver distance : 27.00 / 27.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 62.70 ! 3.74 ! 3.74

RT/Custom (0.00 + 58.15 + 0.00) = 58.15 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-90 20 0.00 63.44 -3.15 -2.14 0.00 0.00 -0.33 57.81*
-90 20 0.00 63.44 -3.15 -2.14 0.00 0.00 0.00 58.15
---

* Bright Zone !

Segment Leq : 58.15 dBA

Total Leq All Segments: 58.15 dBA

Results segment # 1: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 62.70 ! 3.74 ! 3.74

RT/Custom (0.00 + 51.61 + 0.00) = 51.61 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-90 20 0.00 56.91 -3.15 -2.14 0.00 0.00 -0.33 51.28*
-90 20 0.00 56.91 -3.15 -2.14 0.00 0.00 0.00 51.61
---

* Bright Zone !

Segment Leq : 51.61 dBA

Total Leq All Segments: 51.61 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 58.15
(NIGHT): 51.61

STAMSON 5.0 NORMAL REPORT Date: 18-06-2020 15:39:31
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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

RT/Custom data, segment # 1: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh2 (day/night)

Angle1 Angle2 : -70.00 deg 64.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 29.00 / 29.00 m
Receiver height : 62.70 / 62.70 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -70.00 deg Angle2 : 64.00 deg
Barrier height : 0.00 m
Barrier receiver distance : 26.00 / 26.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 62.70 ! 2.00 ! 2.00

RT/Custom (0.00 + 59.29 + 0.00) = 59.29 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-70 64 0.00 63.44 -2.86 -1.28 0.00 0.00 -1.80 57.49*
-70 64 0.00 63.44 -2.86 -1.28 0.00 0.00 0.00 59.29
---

* Bright Zone !

Segment Leq : 59.29 dBA

Total Leq All Segments: 59.29 dBA

Results segment # 1: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 62.70 ! 2.00 ! 2.00

RT/Custom (0.00 + 52.76 + 0.00) = 52.76 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-70 64 0.00 56.91 -2.86 -1.28 0.00 0.00 -1.80 50.96*
-70 64 0.00 56.91 -2.86 -1.28 0.00 0.00 0.00 52.76
---

* Bright Zone !

Segment Leq : 52.76 dBA

Total Leq All Segments: 52.76 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 59.29
(NIGHT): 52.76

STAMSON 5.0 NORMAL REPORT Date: 18-06-2020 15:40:03
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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

RT/Custom data, segment # 1: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh2 (day/night)

Angle1 Angle2 : -70.00 deg 84.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 30.00 / 30.00 m
Receiver height : 62.70 / 62.70 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -70.00 deg Angle2 : 84.00 deg
Barrier height : 0.00 m
Barrier receiver distance : 27.00 / 27.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 62.70 ! 1.77 ! 1.77

RT/Custom (0.00 + 59.75 + 0.00) = 59.75 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-70 84 0.00 63.44 -3.01 -0.68 0.00 0.00 -2.70 57.05*
-70 84 0.00 63.44 -3.01 -0.68 0.00 0.00 0.00 59.75
---

* Bright Zone !

Segment Leq : 59.75 dBA

Total Leq All Segments: 59.75 dBA

Results segment # 1: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 62.70 ! 1.77 ! 1.77

RT/Custom (0.00 + 53.22 + 0.00) = 53.22 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-70 84 0.00 56.91 -3.01 -0.68 0.00 0.00 -2.70 50.52*
-70 84 0.00 56.91 -3.01 -0.68 0.00 0.00 0.00 53.22
---

* Bright Zone !

Segment Leq : 53.22 dBA

Total Leq All Segments: 53.22 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 59.75
(NIGHT): 53.22

STAMSON 5.0 NORMAL REPORT Date: 18-06-2020 15:44:27
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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

RT/Custom data, segment # 1: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh2 (day/night)

Angle1 Angle2 : 20.00 deg 68.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 43.00 / 43.00 m
Receiver height : 62.70 / 62.70 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : 20.00 deg Angle2 : 68.00 deg
Barrier height : 0.00 m
Barrier receiver distance : 40.00 / 40.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 62.70 ! -0.28 ! -0.28

RT/Custom (0.00 + 48.05 + 0.00) = 48.05 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
20 68 0.00 63.44 -4.57 -5.74 0.00 0.00 -5.07 48.05

Segment Leq : 48.05 dBA

Total Leq All Segments: 48.05 dBA

Results segment # 1: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 62.70 ! -0.28 ! -0.28

RT/Custom (0.00 + 41.52 + 0.00) = 41.52 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
20 68 0.00 56.91 -4.57 -5.74 0.00 0.00 -5.07 41.52

Segment Leq : 41.52 dBA

Total Leq All Segments: 41.52 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 48.05
(NIGHT): 41.52

STAMSON 5.0 NORMAL REPORT Date: 18-06-2020 15:45:34
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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

RT/Custom data, segment # 1: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh2 (day/night)

Angle1 Angle2 : -90.00 deg -70.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 48.00 / 48.00 m
Receiver height : 62.70 / 62.70 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -90.00 deg Angle2 : -70.00 deg
Barrier height : 0.00 m
Barrier receiver distance : 44.00 / 44.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 62.70 ! 0.64 ! 0.64

RT/Custom (0.00 + 48.84 + 0.00) = 48.84 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-90 -70 0.00 63.44 -5.05 -9.54 0.00 0.00 -4.89 43.95*
-90 -70 0.00 63.44 -5.05 -9.54 0.00 0.00 0.00 48.84
---

* Bright Zone !

Segment Leq : 48.84 dBA

Total Leq All Segments: 48.84 dBA

Results segment # 1: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 62.70 ! 0.64 ! 0.64

RT/Custom (0.00 + 42.31 + 0.00) = 42.31 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-90 -70 0.00 56.91 -5.05 -9.54 0.00 0.00 -4.89 37.42*
-90 -70 0.00 56.91 -5.05 -9.54 0.00 0.00 0.00 42.31
---

* Bright Zone !

Segment Leq : 42.31 dBA

Total Leq All Segments: 42.31 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 48.84
(NIGHT): 42.31

STAMSON 5.0 NORMAL REPORT Date: 18-06-2020 15:46:11
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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

RT/Custom data, segment # 1: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh2 (day/night)

Angle1 Angle2 : -86.00 deg 17.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 32.00 / 32.00 m
Receiver height : 53.70 / 53.70 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -86.00 deg Angle2 : 17.00 deg
Barrier height : 0.00 m
Barrier receiver distance : 28.00 / 28.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 53.70 ! 2.34 ! 2.34

RT/Custom (0.00 + 57.72 + 0.00) = 57.72 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-86 17 0.00 63.44 -3.29 -2.42 0.00 0.00 -0.61 57.11*
-86 17 0.00 63.44 -3.29 -2.42 0.00 0.00 0.00 57.72
---

* Bright Zone !

Segment Leq : 57.72 dBA

Total Leq All Segments: 57.72 dBA

Results segment # 1: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 53.70 ! 2.34 ! 2.34

RT/Custom (0.00 + 51.19 + 0.00) = 51.19 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-86 17 0.00 56.91 -3.29 -2.42 0.00 0.00 -0.61 50.58*
-86 17 0.00 56.91 -3.29 -2.42 0.00 0.00 0.00 51.19
---

* Bright Zone !

Segment Leq : 51.19 dBA

Total Leq All Segments: 51.19 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 57.72
(NIGHT): 51.19

STAMSON 5.0 NORMAL REPORT Date: 18-06-2020 16:15:04
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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

RT/Custom data, segment # 1: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh2 (day/night)

Angle1 Angle2 : -73.00 deg 62.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 29.00 / 29.00 m
Receiver height : 53.70 / 53.70 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -73.00 deg Angle2 : 62.00 deg
Barrier height : 0.00 m
Barrier receiver distance : 26.00 / 26.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 53.70 ! 1.07 ! 1.07

RT/Custom (0.00 + 59.32 + 0.00) = 59.32 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-73 62 0.00 63.44 -2.86 -1.25 0.00 0.00 -4.04 55.29*
-73 62 0.00 63.44 -2.86 -1.25 0.00 0.00 0.00 59.32
---

* Bright Zone !

Segment Leq : 59.32 dBA

Total Leq All Segments: 59.32 dBA

Results segment # 1: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 53.70 ! 1.07 ! 1.07

RT/Custom (0.00 + 52.79 + 0.00) = 52.79 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-73 62 0.00 56.91 -2.86 -1.25 0.00 0.00 -4.04 48.75*
-73 62 0.00 56.91 -2.86 -1.25 0.00 0.00 0.00 52.79
---

* Bright Zone !

Segment Leq : 52.79 dBA

Total Leq All Segments: 52.79 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 59.32
(NIGHT): 52.79

STAMSON 5.0 NORMAL REPORT Date: 18-06-2020 16:15:37
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r8.te Time Period: Day/Night 16/8 hours
Description:

RT/Custom data, segment # 1: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh2 (day/night)

Angle1 Angle2 : -73.00 deg 87.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 30.00 / 30.00 m
Receiver height : 53.70 / 53.70 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -73.00 deg Angle2 : 87.00 deg
Barrier height : 0.00 m
Barrier receiver distance : 27.00 / 27.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 53.70 ! 0.87 ! 0.87

RT/Custom (0.00 + 59.92 + 0.00) = 59.92 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-73 87 0.00 63.44 -3.01 -0.51 0.00 0.00 -4.42 55.50*
-73 87 0.00 63.44 -3.01 -0.51 0.00 0.00 0.00 59.92
---

* Bright Zone !

Segment Leq : 59.92 dBA

Total Leq All Segments: 59.92 dBA

Results segment # 1: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 53.70 ! 0.87 ! 0.87

RT/Custom (0.00 + 53.38 + 0.00) = 53.38 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-73 87 0.00 56.91 -3.01 -0.51 0.00 0.00 -4.42 48.97*
-73 87 0.00 56.91 -3.01 -0.51 0.00 0.00 0.00 53.38
---

* Bright Zone !

Segment Leq : 53.38 dBA

Total Leq All Segments: 53.38 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 59.92
(NIGHT): 53.38

STAMSON 5.0 NORMAL REPORT Date: 18-06-2020 16:19:57
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r9.te Time Period: Day/Night 16/8 hours
Description:

RT/Custom data, segment # 1: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh2 (day/night)

Angle1 Angle2 : 17.00 deg 61.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 43.00 / 43.00 m
Receiver height : 53.70 / 53.70 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : 17.00 deg Angle2 : 61.00 deg
Barrier height : 0.00 m
Barrier receiver distance : 39.00 / 39.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

RT/Custom data, segment # 2: Conf.LinePh2 (day/night)
---
1 - Bus:
Traffic volume : 540/60 veh/TimePeriod
Speed : 50 km/h

Data for Segment # 2: Conf.LinePh2 (day/night)

Angle1 Angle2 : 61.00 deg 90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 43.00 / 43.00 m
Receiver height : 53.70 / 53.70 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : 61.00 deg Angle2 : 90.00 deg
Barrier height : 19.00 m
Barrier receiver distance : 19.00 / 19.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 53.70 ! 0.46 ! 0.46

RT/Custom (0.00 + 52.75 + 0.00) = 52.75 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
17 61 0.00 63.44 -4.57 -6.12 0.00 0.00 -4.74 48.01*
17 61 0.00 63.44 -4.57 -6.12 0.00 0.00 0.00 52.75
---

* Bright Zone !

Segment Leq : 52.75 dBA

Results segment # 2: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)

0.50 ! 53.70 ! 27.76 ! 27.76

RT/Custom (0.00 + 46.55 + 0.00) = 46.55 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
61 90 0.00 59.05 -4.57 -7.93 0.00 0.00 -0.36 46.19*
61 90 0.00 59.05 -4.57 -7.93 0.00 0.00 0.00 46.55
---

* Bright Zone !

Segment Leq : 46.55 dBA

Total Leq All Segments: 53.68 dBA

Results segment # 1: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 53.70 ! 0.46 ! 0.46

RT/Custom (0.00 + 46.21 + 0.00) = 46.21 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
17 61 0.00 56.91 -4.57 -6.12 0.00 0.00 -4.74 41.47*
17 61 0.00 56.91 -4.57 -6.12 0.00 0.00 0.00 46.21
---

* Bright Zone !

Segment Leq : 46.21 dBA

Results segment # 2: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 53.70 ! 27.76 ! 27.76

RT/Custom (0.00 + 40.01 + 0.00) = 40.01 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
61 90 0.00 52.52 -4.57 -7.93 0.00 0.00 -0.36 39.66*
61 90 0.00 52.52 -4.57 -7.93 0.00 0.00 0.00 40.01
---

* Bright Zone !

Segment Leq : 40.01 dBA

Total Leq All Segments: 47.14 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 53.68
(NIGHT): 47.14

STAMSON 5.0 NORMAL REPORT Date: 19-06-2020 15:14:59
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r10.te Time Period: Day/Night 16/8 hours
Description:

RT/Custom data, segment # 1: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh2 (day/night)

Angle1 Angle2 : -90.00 deg 29.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 34.00 / 34.00 m
Receiver height : 14.75 / 14.75 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -90.00 deg Angle2 : 29.00 deg
Barrier height : 14.75 m
Barrier receiver distance : 2.50 / 2.50 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 14.75 ! 13.30 ! 13.30

RT/Custom (0.00 + 47.15 + 0.00) = 47.15 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-90 29 0.00 63.44 -3.55 -1.80 0.00 0.00 -10.94 47.15

Segment Leq : 47.15 dBA

Total Leq All Segments: 47.15 dBA

Results segment # 1: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 14.75 ! 13.30 ! 13.30

RT/Custom (0.00 + 40.61 + 0.00) = 40.61 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-90 29 0.00 56.91 -3.55 -1.80 0.00 0.00 -10.94 40.61

Segment Leq : 40.61 dBA

Total Leq All Segments: 40.61 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 47.15
(NIGHT): 40.61

STAMSON 5.0 NORMAL REPORT Date: 19-06-2020 15:15:50
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r11.te Time Period: Day/Night 16/8 hours
Description:

RT/Custom data, segment # 1: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh2 (day/night)

Angle1 Angle2 : -90.00 deg 30.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 36.00 / 36.00 m
Receiver height : 59.70 / 59.70 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -90.00 deg Angle2 : 30.00 deg
Barrier height : 59.70 m
Barrier receiver distance : 2.50 / 2.50 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 59.70 ! 55.21 ! 55.21

RT/Custom (0.00 + 42.67 + 0.00) = 42.67 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-90 30 0.00 63.44 -3.80 -1.76 0.00 0.00 -15.21 42.67

Segment Leq : 42.67 dBA

Total Leq All Segments: 42.67 dBA

Results segment # 1: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 59.70 ! 55.21 ! 55.21

RT/Custom (0.00 + 36.14 + 0.00) = 36.14 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-90 30 0.00 56.91 -3.80 -1.76 0.00 0.00 -15.21 36.14

Segment Leq : 36.14 dBA

Total Leq All Segments: 36.14 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 42.67
(NIGHT): 36.14

STAMSON 5.0 NORMAL REPORT Date: 19-06-2020 15:17:31
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r12.te Time Period: Day/Night 16/8 hours
Description:

RT/Custom data, segment # 1: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh2 (day/night)

Angle1 Angle2 : -81.00 deg 28.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 35.00 / 35.00 m
Receiver height : 14.75 / 14.75 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -81.00 deg Angle2 : 28.00 deg
Barrier height : 14.75 m
Barrier receiver distance : 2.50 / 2.50 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 14.75 ! 13.34 ! 13.34

RT/Custom (0.00 + 46.06 + 0.00) = 46.06 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-81 28 0.00 63.44 -3.68 -2.18 0.00 0.00 -11.52 46.06

Segment Leq : 46.06 dBA

Total Leq All Segments: 46.06 dBA

Results segment # 1: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 14.75 ! 13.34 ! 13.34

RT/Custom (0.00 + 39.53 + 0.00) = 39.53 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-81 28 0.00 56.91 -3.68 -2.18 0.00 0.00 -11.52 39.53

Segment Leq : 39.53 dBA

Total Leq All Segments: 39.53 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 46.06
(NIGHT): 39.53

STAMSON 5.0 NORMAL REPORT Date: 19-06-2020 15:18:56
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r13.te Time Period: Day/Night 16/8 hours
Description:

RT/Custom data, segment # 1: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh2 (day/night)

Angle1 Angle2 : -79.00 deg 27.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 37.00 / 37.00 m
Receiver height : 50.70 / 50.70 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -79.00 deg Angle2 : 27.00 deg
Barrier height : 50.70 m
Barrier receiver distance : 2.50 / 2.50 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 50.70 ! 46.94 ! 46.94

RT/Custom (0.00 + 40.78 + 0.00) = 40.78 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-79 27 0.00 63.44 -3.92 -2.30 0.00 0.00 -16.44 40.78

Segment Leq : 40.78 dBA

Total Leq All Segments: 40.78 dBA

Results segment # 1: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 50.70 ! 46.94 ! 46.94

RT/Custom (0.00 + 34.25 + 0.00) = 34.25 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-79 27 0.00 56.91 -3.92 -2.30 0.00 0.00 -16.44 34.25

Segment Leq : 34.25 dBA

Total Leq All Segments: 34.25 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 40.78
(NIGHT): 34.25

STAMSON 5.0 NORMAL REPORT Date: 19-06-2020 14:30:55
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r14.te Time Period: Day/Night 16/8 hours
Description:

RT/Custom data, segment # 1: Conf.LinePh1 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh1 (day/night)

Angle1 Angle2 : -90.00 deg -73.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 40.00 / 40.00 m
Receiver height : 1.50 / 1.50 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -90.00 deg Angle2 : -73.00 deg
Barrier height : 6.00 m
Barrier receiver distance : 39.00 / 39.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

RT/Custom data, segment # 2: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 50 km/h

Data for Segment # 2: Conf.LinePh2 (day/night)

Angle1 Angle2 : -73.00 deg 14.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 40.00 / 40.00 m
Receiver height : 1.50 / 1.50 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -73.00 deg Angle2 : 14.00 deg
Barrier height : 0.00 m
Barrier receiver distance : 36.00 / 36.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

RT/Custom data, segment # 3: Conf-LinePh3 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 50 km/h

Data for Segment # 3: Conf-LinePh3 (day/night)

Angle1 Angle2 : 14.00 deg 90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 48.00 / 48.00 m
Receiver height : 1.50 / 1.50 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : 14.00 deg Angle2 : 90.00 deg
Barrier height : 5.20 m
Barrier receiver distance : 9.00 / 9.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh1 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 1.50 ! -4.84 ! -4.84

RT/Custom (0.00 + 28.86 + 0.00) = 28.86 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-90 -73 0.33 63.44 -5.67 -13.24 0.00 0.00 -15.67 28.86

Segment Leq : 28.86 dBA

Results segment # 2: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 1.50 ! -4.35 ! -4.35

RT/Custom (0.00 + 30.74 + 0.00) = 30.74 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-73 14 0.66 60.51 -7.07 -3.88 0.00 0.00 -18.83 30.74

Segment Leq : 30.74 dBA

Results segment # 3: Conf-LinePh3 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 1.50 ! 0.28 ! 0.28

RT/Custom (0.00 + 34.04 + 0.00) = 34.04 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
14 90 0.38 60.51 -6.96 -4.87 0.00 0.00 -14.64 34.04

Segment Leq : 34.04 dBA

Total Leq All Segments: 36.52 dBA

Results segment # 1: Conf.LinePh1 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 1.50 ! -4.84 ! -4.84

RT/Custom (0.00 + 22.33 + 0.00) = 22.33 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-90 -73 0.33 56.91 -5.67 -13.24 0.00 0.00 -15.67 22.33

Segment Leq : 22.33 dBA

Results segment # 2: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 1.50 ! -4.35 ! -4.35

RT/Custom (0.00 + 24.21 + 0.00) = 24.21 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-73 14 0.66 53.98 -7.07 -3.88 0.00 0.00 -18.83 24.21

Segment Leq : 24.21 dBA

Results segment # 3: Conf-LinePh3 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 1.50 ! 0.28 ! 0.28

RT/Custom (0.00 + 27.51 + 0.00) = 27.51 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
14 90 0.38 53.98 -6.96 -4.87 0.00 0.00 -14.64 27.51

Segment Leq : 27.51 dBA

Total Leq All Segments: 29.99 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 36.52
(NIGHT): 29.99

STAMSON 5.0 NORMAL REPORT Date: 19-06-2020 14:32:07
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r15.te Time Period: Day/Night 16/8 hours
Description:

RT/Custom data, segment # 1: Conf.LinePh1 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh1 (day/night)

Angle1 Angle2 : -17.00 deg 63.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 37.00 / 37.00 m
Receiver height : 1.50 / 1.50 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -17.00 deg Angle2 : 63.00 deg
Barrier height : 0.00 m
Barrier receiver distance : 34.00 / 34.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

RT/Custom data, segment # 2: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 50 km/h

Data for Segment # 2: Conf.LinePh2 (day/night)

Angle1 Angle2 : 63.00 deg 90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 37.00 / 37.00 m
Receiver height : 1.50 / 1.50 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : 63.00 deg Angle2 : 90.00 deg
Barrier height : 19.00 m
Barrier receiver distance : 12.00 / 12.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh1 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 1.50 ! -4.47 ! -4.47

RT/Custom (0.00 + 33.21 + 0.00) = 33.21 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-17 63 0.66 63.44 -6.51 -4.02 0.00 0.00 -19.71 33.21

Segment Leq : 33.21 dBA

Results segment # 2: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 1.50 ! -0.61 ! -0.61

RT/Custom (0.00 + 30.33 + 0.00) = 30.33 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
63 90 0.00 60.51 -3.92 -8.24 0.00 0.00 -18.03 30.33

Segment Leq : 30.33 dBA

Total Leq All Segments: 35.01 dBA

Results segment # 1: Conf.LinePh1 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 1.50 ! -4.47 ! -4.47

RT/Custom (0.00 + 26.67 + 0.00) = 26.67 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-17 63 0.66 56.91 -6.51 -4.02 0.00 0.00 -19.71 26.67

Segment Leq : 26.67 dBA

Results segment # 2: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 1.50 ! -0.61 ! -0.61

RT/Custom (0.00 + 23.79 + 0.00) = 23.79 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
63 90 0.00 53.98 -3.92 -8.24 0.00 0.00 -18.03 23.79

Segment Leq : 23.79 dBA

Total Leq All Segments: 28.47 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 35.01
(NIGHT): 28.47

STAMSON 5.0 NORMAL REPORT Date: 18-06-2020 16:24:43
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r16.te Time Period: Day/Night 16/8 hours
Description:

RT/Custom data, segment # 1: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh2 (day/night)

Angle1 Angle2 : -68.00 deg 35.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 2 (Reflective ground surface)
Receiver source distance : 48.00 / 48.00 m
Receiver height : 8.10 / 8.10 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -68.00 deg Angle2 : 35.00 deg
Barrier height : 0.00 m
Barrier receiver distance : 44.00 / 44.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 8.10 ! -3.91 ! -3.91

RT/Custom (0.00 + 37.96 + 0.00) = 37.96 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-68 35 0.00 63.44 -5.05 -2.42 0.00 0.00 -18.00 37.96

Segment Leq : 37.96 dBA

Total Leq All Segments: 37.96 dBA

Results segment # 1: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 8.10 ! -3.91 ! -3.91

RT/Custom (0.00 + 31.43 + 0.00) = 31.43 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-68 35 0.00 56.91 -5.05 -2.42 0.00 0.00 -18.00 31.43

Segment Leq : 31.43 dBA

Total Leq All Segments: 31.43 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 37.96
(NIGHT): 31.43

STAMSON 5.0 NORMAL REPORT Date: 18-06-2020 16:25:21
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r17.te Time Period: Day/Night 16/8 hours
Description:

RT/Custom data, segment # 1: Conf.LinePh2 (day/night)
---
1 - 4-car SRT:
Traffic volume : 540/60 veh/TimePeriod
Speed : 70 km/h

Data for Segment # 1: Conf.LinePh2 (day/night)

Angle1 Angle2 : -23.00 deg 40.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0 / 0
Surface : 2 (Reflective ground surface)
Receiver source distance : 58.00 / 58.00 m
Receiver height : 7.75 / 7.75 m
Topography : 2 (Flat/gentle slope; with barrier)
Barrier angle1 : -23.00 deg Angle2 : 40.00 deg
Barrier height : 0.00 m
Barrier receiver distance : 54.00 / 54.00 m
Source elevation : -5.50 m
Receiver elevation : 0.00 m
Barrier elevation : 0.00 m
Reference angle : 0.00

Results segment # 1: Conf.LinePh2 (day)

Source height = 0.50 m

Barrier height for grazing incidence

Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 7.75 ! -4.12 ! -4.12

RT/Custom (0.00 + 33.70 + 0.00) = 33.70 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-23 40 0.00 63.44 -5.87 -4.56 0.00 0.00 -19.30 33.70

Segment Leq : 33.70 dBA

Total Leq All Segments: 33.70 dBA

Results segment # 1: Conf.LinePh2 (night)

Source height = 0.50 m

Barrier height for grazing incidence

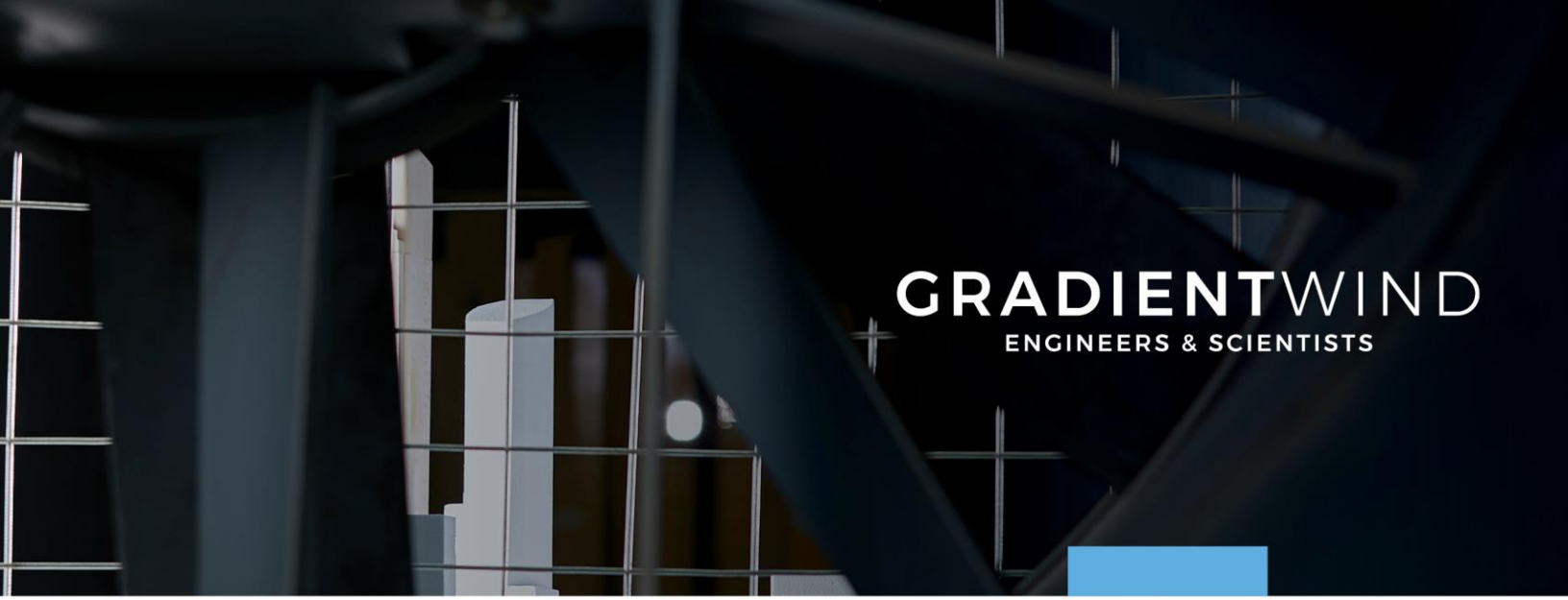
Source ! Receiver ! Barrier ! Elevation of
Height (m) ! Height (m) ! Height (m) ! Barrier Top (m)
---+---+---+---
0.50 ! 7.75 ! -4.12 ! -4.12

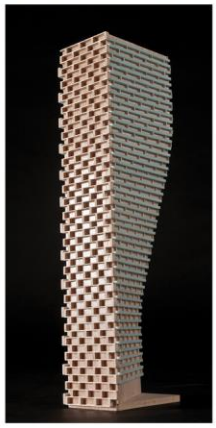
RT/Custom (0.00 + 27.17 + 0.00) = 27.17 dBA
Angle1 Angle2 Alpha RefLeq D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
---
-23 40 0.00 56.91 -5.87 -4.56 0.00 0.00 -19.30 27.17

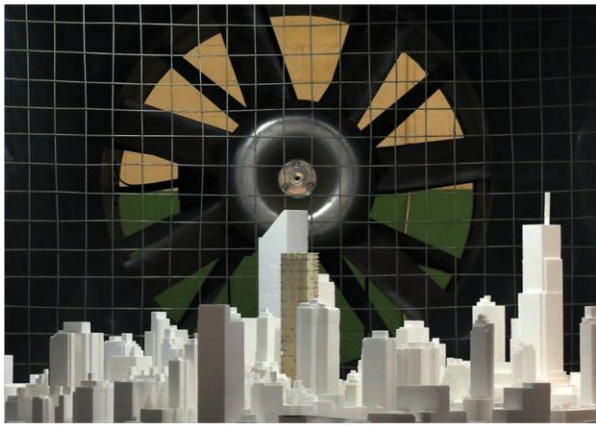
Segment Leq : 27.17 dBA

Total Leq All Segments: 27.17 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 33.70
(NIGHT): 27.17







APPENDIX B

FTA VIBRATION CALCULATIONS

127 WALGREEN ROAD, OTTAWA, ON, CANADA K0A 1L0 | 613 836 0934
GRADIENTWIND.COM

GW20-091

Possible Vibration Impacts on
335 Roosevelt Avenue
Perdicted using FTA General Assesment

Train Speed 70 km/h 43 mph

	Distance from C/L	
	(m)	(ft)
LRT	17.0	55.8

Vibration

From FTA Manual Fig 10-1

Vibration Levels at distance from track	72	dBV re 1 micro in/sec	

Adjustment Factors FTA Table 10-1

Speed reference 50 mph	-1	Operating Speed 43 mph	
Vehicle Parameters	0	Assume Soft primary suspension, Wheels run true	
Track Condition	0	Good condition	
Track Treatments	0	none	
Type of Transit Structure	0	Open cut	
Efficient vibration Propagation	2	Propagation through rock	
Vibration Levels at Fdn	73		0.111
Coupling to Building Foundation	0	Fondation on Bedrock	
Floor to Floor Attenuation	-4.0	Second Floor Ocupied	
Amplification of Floor and Walls	4		
Total Vibration Level	72.79	dBV or	0.111 mm/s
Noise Level in dBA	37.79	dBA	

APPENDIX D

Proximity Assessment:

PG2178-LET.02R1 dated July 27, 2020

patersongroup Consulting Engineers

154 Colonnade Road South
Ottawa, Ontario
Canada, K2E 7J5
Tel: (613) 226-7381
Fax: (613) 226-6344

Geotechnical Engineering
Environmental Engineering
Hydrogeology
Geological Engineering
Materials Testing
Building Science
Archaeological Services

www.patersongroup.ca

July 27, 2020
Report: PG2178-LET.02R1

Uniform Urban Developments
117 Centrepointe Drive, Suite 300
Ottawa, Ontario
K2G 5X3

Attention: **Mr. Dan Tomka**

Subject: **Proximity Assessment**
Proposed High-Rise Buildings
335 Roosevelt Avenue - Ottawa

Dear Madam,

Further to your request and authorization, Paterson Group (Paterson) prepared the current letter to summarize construction issues which could occur due to the proximity of the proposed development with respect to the proposed alignment of the Confederation Line. The following letter should be read in conjunction with Paterson Report PG2178-2 Revision 1 dated July 27, 2020.

1.0 Background Information

Based on current plans, it is understood that the proposed development will consist of 2 high-rise buildings and 4 low-rise residential buildings. These structures will have 2 levels of shared underground parking which will extend beyond the overlying building footprints to the property lines.

The following sections summarize our existing soils information and construction precautions for the proposed development, which may impact the proposed alignment of the Confederation Line and Dominion Station.

It should be noted that the information submitted as part of the current Proximity Study will be supplemented with construction plans issued for construction, once available.

2.0 Subsurface Conditions

Based on existing geotechnical information, the subsurface conditions in the immediate area of the subject site and adjacent Confederation Line alignment consist of the following:

- Existing surface grade is at an elevation of approximately 66.5 m.
- The overburden thickness is approximately 0.6 to 1.2 m.
- Bedrock surface elevation is at approximately 65.5 to 65.7 m.
- The bedrock at the subject site generally consists of approximately 1 m of poor quality shale bedrock, while the underlying bedrock was observed to be of fair to excellent quality.

LRT and Station Location

It is anticipated that the proposed Confederation Line alignment will be located approximately 16 to 17 m north of the subject site. A multi-use pathway is located between the subject site and the proposed Confederation Line alignment. The ground surface at the LRT alignment is located at approximate geodetic elevation 61 m, while the lowest level floor slab of the proposed underground parking levels is anticipated at approximate geodetic elevation 60 m.

The proposed Dominion Station is to be located approximately 45 m to the northwest of the subject site.

3.0 Construction Precautions and Recommendations

Influence of Proposed Development on Confederation Line

Based on existing subsurface information and building design details, the footings of the proposed buildings will be founded on sound bedrock. Lateral loads due to the building footings will be transferred directly into the bedrock well within a conservative 6V:1H zone of influence from the outside face of footing. Therefore, due to the depth of the proposed buildings, and the distance between the proposed buildings and the Confederation Line alignment, the proposed buildings will not apply additional loading to the Confederation Line or Dominion Station structures.

Further, although the underground parking levels for the proposed buildings will extend approximately 6 to 7 m below existing ground surface, due to the approximate 16 m distance between the proposed buildings and LRT structures, the buildings excavation will not impact the lateral support zone of the Confederation Line and Dominion Station structures, which are also anticipated to be founded on bedrock.

Excavation and Temporary Shoring

The overburden along the perimeter of the proposed building footprints will need to be sloped adequately or shored in order to complete the construction of the underground parking structure for the proposed development. Bedrock removal is also anticipated, which will be completed by line drilling, blasting and/or hoe ramming. The blasting and hoe ramming will be carried out by a contractor specializing in bedrock removal.

There are no adverse effects to the Confederation Line or Dominion Station with the approach being considered for the building excavation along this alignment. Also, there will be no disturbance to the bedrock mass between the buildings and the Confederation Line.

Where required, it is anticipated that the temporary shoring system will consist of a soldier pile and lagging system designed for at-rest earth pressures, using a pressure coefficient of $K_0 = 0.5$.

The geotechnical engineer will review the stability of the rock face underlying the overburden during excavation. Following the review of the rock face, the geotechnical engineer will determine if rock reinforcement is required, and if so, the extent to which rock reinforcement is required. This determination will include consideration for the Confederation Line and Dominion Station structure.

A seismograph would be installed adjacent to the Confederation Line to monitor vibrations during the bedrock removal program. A program detailing trigger levels and action levels is provided in Section 3.1 of the Paterson Report PG2178-2 Revision 1 dated July 27, 2020.

Pre-Construction Survey

Due to the anticipated construction activities for the proposed buildings, a pre-construction survey will be required for the Confederation Line and Dominion Station structure. Any existing structures in the immediate area of the proposed buildings will also undergo a pre-construction survey as per standard construction practices, where bedrock blasting will be required. Plans for construction of underground utilities and air exchange systems for the underground parking lot will be assessed as part of the pre-construction survey. At the time of preparation of this report, the civil and mechanical drawings are currently being prepared. The civil and mechanical plans will be forwarded once they are completed.

Groundwater Control

Groundwater observations during the geotechnical investigation indicated groundwater levels at approximately 4 to 6 m below the existing ground surface. Due to the presence of shallow bedrock at the site and in the general area, adverse effects related to ground surface settlement due to dewatering are expected to be negligible. The current groundwater level is fully within the bedrock unit, therefore, any depressurization of the groundwater table within the bedrock will have no adverse effects to surrounding structures including the Confederation Line and/or Dominion Station structure.

4.0 Conclusions and Recommendations

Based on the currently available information for the subject alignment and the existing subsurface information, the proposed buildings will not negatively impact the existing Confederation Line or Dominion Station structure. It should be noted that the information submitted as part of the current Proximity Study will be supplemented with drawings issued for construction and a field monitoring program as described in the application conditions.

We trust that this information satisfies your immediate request.

Best Regards,

Paterson Group Inc.

Scott S. Dennis, P.Eng.

David J. Gilbert, P.Eng.