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Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

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Building Science

Archaeological Services

Confederation Line Level 3 Proximity Study

Proposed Multi-Storey Buildings
383 Albert Street Development
Ottawa, Ontario

Prepared For

Claridge Homes

October 30, 2018

Report: PG4517-2

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1.0 Introduction

Paterson Group (Paterson) was commissioned by Claridge Homes to conduct a Level 3 Confederation Line proximity study for the proposed multi-storey buildings to be located at Albert and Lyon Street in the City of Ottawa.

The objective of the current study was to:

- Review all current information provided by the City of Ottawa with regards to the construction of the Confederation Line.

- Liaison between the City of Ottawa and the Claridge Homes 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 and geotechnical design information as they pertain to the aforementioned project.

2.0 Development Details

Based on current plans, it is understood that the proposed development will consist of 2 hi-rise mixed-use buildings. Towers A and B will have 27 storeys above-grade. The proposed buildings will share 5 levels of underground parking which will occupy the majority of the site. The north side of the proposed development will abut the existing Stage 1 Confederation Line tunnel alignment along Queen Street. Further, the proposed development will be connected to Lyon Street LRT Station at the northeast corner of the site. Based on the drawings provided by the City of Ottawa, the following is known about the Confederation Line in the vicinity of the subject site:

- The Confederation Line tunnel is located below ground with the top of rail (TOR) of the tunnel located at geodetic elevation 53.85 m, approximately 20 m below the existing ground surface at elevation 73.3 m adjacent to 383 Albert Street.

- The Lyon Street LRT Station, which is located on the northeastern portion of the site, is understood to extend to approximately elevation 56.5 m.

- Based on the subsurface profile at 383 Albert Street, bedrock is expected at a depth of approximately 4.5 to 5 m depth below the existing ground surface. The Confederation Line LRT tunnel is surrounded by sound bedrock.

3.0 Construction Methodology and Impact Review

Paterson has prepared a construction methodology summary along with possible impacts on the adjacent segment of the Confederation Line based on the current building design details. Table 2 - Construction Methodology and Impact Review in Appendix 1 presents the anticipated construction items, impact review and mitigation program recommended for the proposed Confederation Line LRT tunnel. One of the main issues 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 a recommended vibration monitoring program are presented below.

3.1 Vibration Monitoring and Control Program

Due to the presence of the existing Confederation Line tunnel alignment, the contractor should take extra precaution to minimize vibrations. The monitoring program will be required for the full construction duration for blasting operations, dewatering, backfilling and compaction, construction traffic and other construction activities. 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 Confederation Line tunnel structure adjacent to the subject site, and at Lyon Station, which is located within 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 monitoring equipment is to be placed within the adjacent tunnel section or station, or directly over the top of the tunnel structure or station, within a monitoring well placed as part of the vibration monitoring program.

The location should be reviewed periodically throughout construction to ensure that the monitoring equipment remains with the tunnel or station structure at the closest radius to the construction activities. The vibration monitor locations should be approved by the project manager prior to installation.

During construction, the vibration monitor will be relocated to be located in ‘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 Confederation Line tunnel and Lyon Station:

Table 1 - Structure Vibration Limits for the Confederation Line Tunnel

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 incident/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/incident
- ☐ Purpose of the exceeded monitor and current vibration criteria
- ☐ Identify the likely cause of the exceedance/incident
- ☐ Describe the response action that has been completed to date
- ☐ Describe the proposed measures to address the exceedance/incident.

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

Paterson was informed by the City of Ottawa that a Confederation Line Proximity Study - Level 3 should be completed for the proposed development. A Confederation Line Proximity Study - Level 3 is required where the proposed development connects to a Confederation Line station/facility, or where the proposed development is located on top of, or within 1 m of, a Confederation Line structure right-of-way.

The following table lists the applicable requirements for Level 1, Level 2, and Level 3 study and the response location for each item:

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;	Site Plan presented in Appendix 1
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 Sections presented in Appendix 1
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 Report PG4517-1Revision 1 dated October 10, 2018 presented in Appendix 2
Structural, foundation, excavation and shoring drawings;	Structural, foundation, excavation, and shoring drawings, will be provided prior to the Site Plan Agreement. Based on current design details, the proposed building foundation will consist of conventional footings placed directly over a clean, bedrock surface. No negative impacts are anticipated for the Confederation Line due to the proposed building location.
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.	A Transportation Noise and Vibration Feasibility Assessment prepared by Gradient Wind Engineering Inc. dated August 8, 2018 is presented in Appendix 3.

Table 3
List of Confederation Line Level 2 Proximity Study Requirements

Level 2 Projects	Response
A structural analysis or calculations of the effects of loadings, including construction loading, on the Confederation Line structure, and demonstrating that the Confederation Line will not be adversely affected by the development, including solutions to mitigate any impact on the Confederation Line structure.	No building loads will be imposed on the subject alignment of the Confederation Line as the adjacent building foundations of the proposed development will be constructed at an elevation to match the bottom of tunnel foundation. Refer to the LRT Proximity Sections provided in Appendix 1 and the Proximity Assessment Report PG4517-LET.01 dated October 10, 2018 presented in Appendix 4.
Documentation showing that the excavation support system and permanent structure adjacent to the Confederation Line property are designated for at-rest earth pressures.	The temporary shoring system will be designed for at-rest earth pressures as required by the site Geotechnical Report.
Structural drawings, including foundation plans, sections and details, floor plans, column and wall schedules and loads on foundation for the development. The relationship of the development to the Confederation Line structure should be depicted in both plan and section.	Refer to the LRT Proximity Sections provided in Appendix 1 and the Proximity Assessment Report PG4517-LET.01 dated October 10, 2018 presented in Appendix 4.
Shoring design criteria and description of excavation and shoring method.	The temporary shoring for the overburden is anticipated to consist of soldier piles and lagging. At the beginning of and during excavation, the geotechnical engineer will review the stability of the rock face underlying the overburden. 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 tunnel and Lyon Station. Refer to Proximity Assessment Report PG4517-LET.01 dated October 10, 2018 presented in Appendix 4.
Groundwater control plan, including the determination of the short-term (during construction) and long-term effects of dewatering on the Confederation Line structure, and provision of assurances that the influences of dewatering will have no impact on the Confederation Line structure.	Both the proposed structure at Albert and Lyon Streets and the Confederation Line tunnel are anticipated to be founded on sound bedrock. The settlement of the bedrock bearing surface will be negligible and long-term effects of dewatering will not induce settlement. Refer to Proximity Assessment Report PG4517-LET.01 dated October 10, 2018 presented in Appendix 4.

Table 3 (continued)
List of Confederation Line Level 2 Proximity Study Requirements

Level 2 Projects	Response
Proposal to replace/repair waterproofing system of the affected Confederation Line structure, including the Confederation Line expansion joint.	Repairs and/or replacement of the waterproofing system would match the existing waterproofing system currently in place on the Lyon Station.
Identification of utility installations proposed through or adjacent to Confederation Line property.	At the time of writing this report, the civil design is not known. These plans will be forwarded once they are completed. Refer to Proximity Assessment Report PG4517-LET.01 dated October 10, 2018 presented in Appendix 4.
Identification of the exhaust air quality and relationship of air in-take/discharge to the Confederation Line at-grade vent shaft openings and station entrance openings.	At the time of writing this report, the mechanical design is not known. These plans will be forwarded once they are completed. Refer to Proximity Assessment Report PG4517-LET.01 dated October 10, 2018 presented in Appendix 4.
Proposal for a pre-construction condition survey of the Confederation Line structure, including a survey to confirm locations of existing walls and foundations.	A thorough pre-construction survey of the Confederation Line will be completed.
Monitoring plan for movement of the shoring and Confederation Line structure prior to and during construction of the development, including an Action Protocol.	A monitoring plan to evaluate potential movement of the Confederation Line tunnel structure and Lyon Statio will be performed during the construction period.

Table 4
List of Confederation Line Level 3 Proximity Study Requirements

Level 3 Projects	Response
A general Ontario Building Code (OBC) compliance review, specifically including Section 3.12 Rapid Transit Stations, and including a plan depicting egress routes from the station.	An OBC review and egress routes from the station will be provided as the project design progresses.
Wind and snow load analyses.	The tunnel adjacent to the subject site is located below ground, therefore, wind and snow load analyses are not considered to be required.
Drawings/documentation of construction method, hoarding, construction access, and haul routes.	Drawings of construction method, hoarding, construction access, and haul routes will be prepared by the Contractor and will be provided prior to construction.
Details of remedial work to municipal structures to support roof at wall opening, including structural loads, and calculations.	These details will be provided as the project design progresses.
Details of stairs, doors, sprinklers and ventilation for the development connection.	These details will be provided as the project design progresses.
Provision of architectural finish material selection, including samples.	These finish materials will be provided as the project design progresses.
Wayfinding and signage plans.	These details will be provided as the project design progresses.
Landscape plans.	Landscape plans will be provided as the project design progresses.
Drawings of collector booth, CCTV, intercom, fire alarm, easier access elevator, all designated in conformance with the relevant OC Transpo Design Guidelines, including accessibility requirements.	These details will be provided as the project design progresses.
Provision of construction record (as-built) reproducible drawings and electronic files for municipal documentation records. The electronic file and the drawings are to be in Microstation (.dgn) format.	These drawings will be provided by the Contractor at the completion of construction.

We trust that this information satisfies your immediate request.

Best Regards,

Paterson Group Inc.

Scott Dennis

Scott S. Dennis, P.Eng.

Carlos P. Da Silva, P.Eng., ing., QP$_{ESA}$

LICENSED PROFESSIONAL ENGINEER
Oct. 17-2018
C. P. DA SILVA
PROVINCE OF ONTARIO

Report Distribution

☐ Claridge Homes (3 copies)
☐ Paterson Group (1 copy)

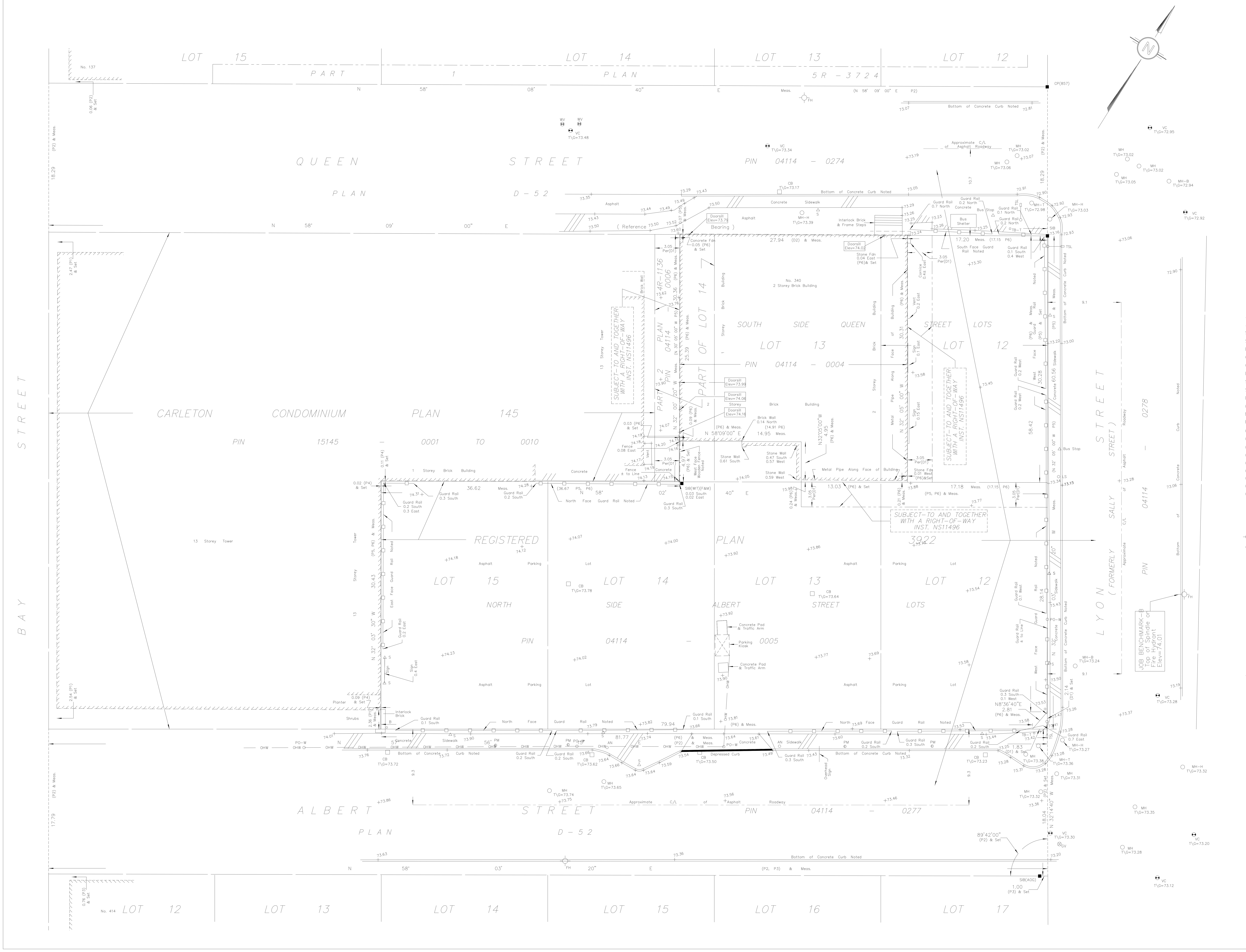
APPENDIX 1

Site Plan

Transverse LRT and Building Section

Topographic Survey Plan

Construction Methodology and Impact Review



TOPOGRAPHICAL PLAN OF SURVEY OF

PART OF LOTS 12, 13 And 14
(South Side Queen Street)
And
LOTS 13, 14, 15 And
PART OF LOT 12
(North Side Albert Street)
REGISTERED PLAN 3922
CITY OF OTTAWA
Surveyed by Annis, O'Sullivan, Vollebekk Ltd.

Scale 1 : 200

8.0 6.0 4.0 2.0 0 4 8 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, the Land Titles Act and the regulations made under them.
2. The survey was completed on the 5th day of December, 2007.

Date

Edward M. Lancaster
Ontario Land Surveyor

Notes & Legend

ASSOCIATION OF ONTARIO LAND SURVEYORS PLAN SUBMISSION FORM
16
THIS PLAN IS NOT VALID UNLESS IT IS AN EMBOSSED ORIGINAL COPY ISSUED BY THE SURVEYOR IN ACCORDANCE WITH Regulation 1026, Section 29 (3)

—□—	Denotes	Survey Monument Planted
—■—	"	Survey Monument Found
SIB	"	Standard Iron Bar
SSIB	"	Short Standard Iron Bar
IB	"	Iron Bar
CC	"	Cut Cross
CP	"	Concrete Pin
IBø	"	Round Iron Bar
S&W	"	Spike & Washer
SSIB*	"	Short Standard Iron Bar
IB*	"	Iron Bar
(WIT)	"	Witness
Meas.	"	Measured
Prop	"	Proportion
(AOG)	"	Annis, O'Sullivan, Vollebekk Ltd.
(P1)	"	Plan 4R-2194
(P2)	"	Plan D-52
(P3)	"	Plan 4R-10209
(P4)	"	Carleton Condominium Plan 145
(P5)	"	Plan 4R-1136
(P6)	"	Plan by (857), dated October 13, 1977
(D1)	"	Inst. CR627335
(D2)	"	Inst. NS11496
○ LS	"	Light Standard
◌	"	Deciduous Tree
⊕ FH	"	Fire Hydrant
○ MH	"	Maintenance Hole (Unidentified)
○ MH-B	"	Maintenance Hole (Bell Telephone)
○ MH-H	"	Maintenance Hole (Hydro)
○ MH-ST	"	Maintenance Hole (Storm Sewer)
○ MH-S	"	Maintenance Hole (Sanitary)
○ MH-T	"	Maintenance Hole (Traffic)
⋈ VC	"	Valve Chamber (Watermain)
⋈ WV	"	Water Valve
— OHW —	"	Overhead Wires
□ CB	"	Catch Basin
● FH-V	"	Fire Hydrant Valve
⊗ GV	"	Gas Valve
○ B	"	Bollard
△ S	"	Sign
○—□ TSL	"	Traffic Signal Light
◐ PM	"	Parking Meter
○ UP	"	Utility Pole
○ PO-W	"	Wood Pole
○ AN	"	Anchor
Ø	"	Diameter
+65.00	"	Location of Elevations
+65.00	"	Top of Curb Elevation
T/G	"	Top of Grate
□ TB-B	"	Bell Terminal Box
BF	"	Board Fence
CLF	"	Chain Link Fence
C/L	"	Centreline

Bearings are astronomic, derived from part of the southerly limit of Queen Street, shown to be N 58°09'00" E on Plan D-52.

Topographic data was collected under Winter Conditions. Snow cover and ice preclude determining location and elevation of some topographical data that is otherwise visible.

SITE AREA = 3075.1 m²

ELEVATION NOTES

1. Elevations shown are referred to geodetic datum.
2. It is the responsibility of the user of this information to verify that the job benchmark has not been altered or disturbed and that it's relative elevation and description agrees with the information shown on this drawing.

UTILITY NOTES

1. 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.
2. Only visible surface utilities were located.
3. A field location of underground plant by the pertinent utility authority is mandatory before any work involving breaking ground, probing, excavating etc.

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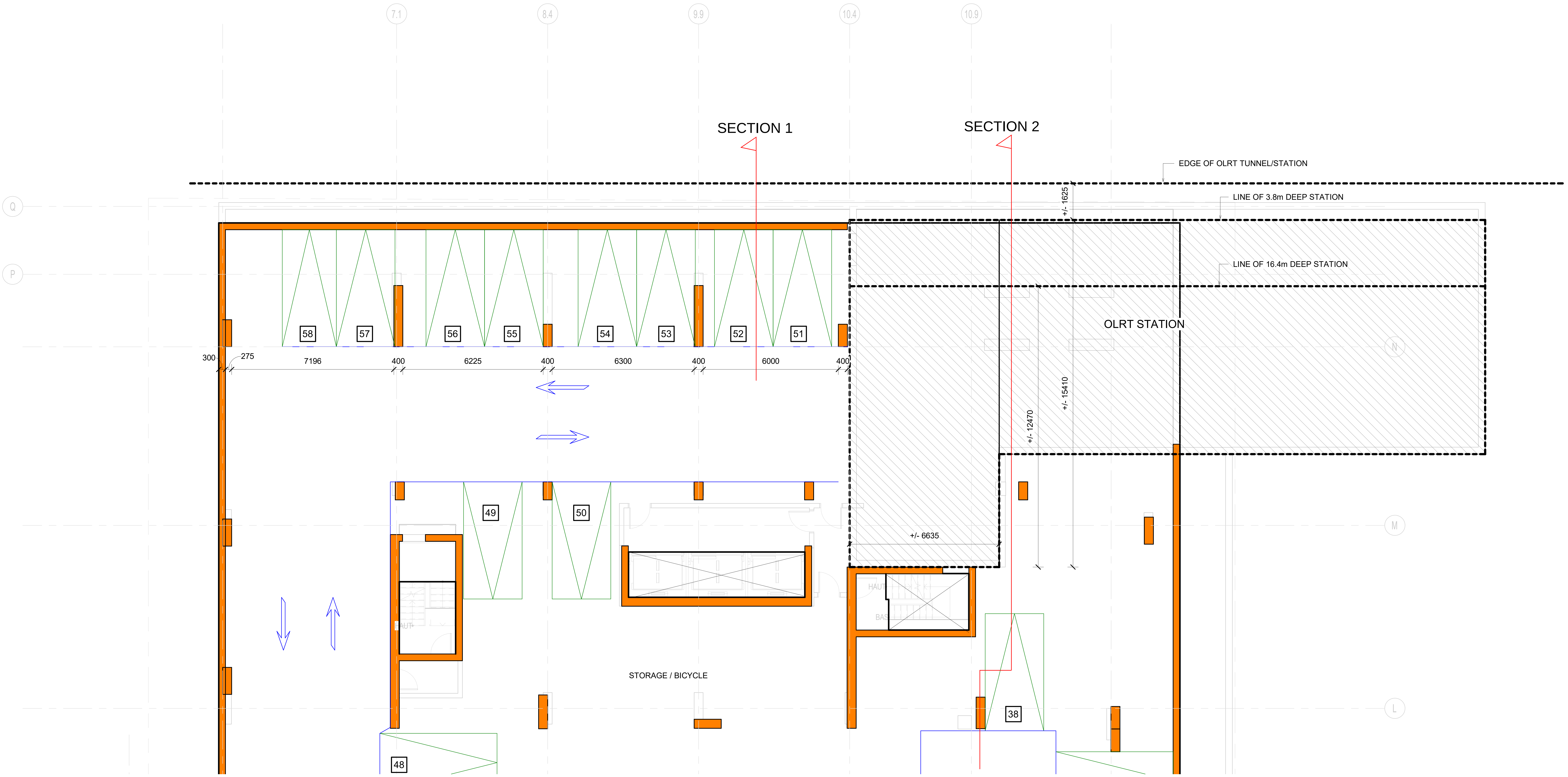
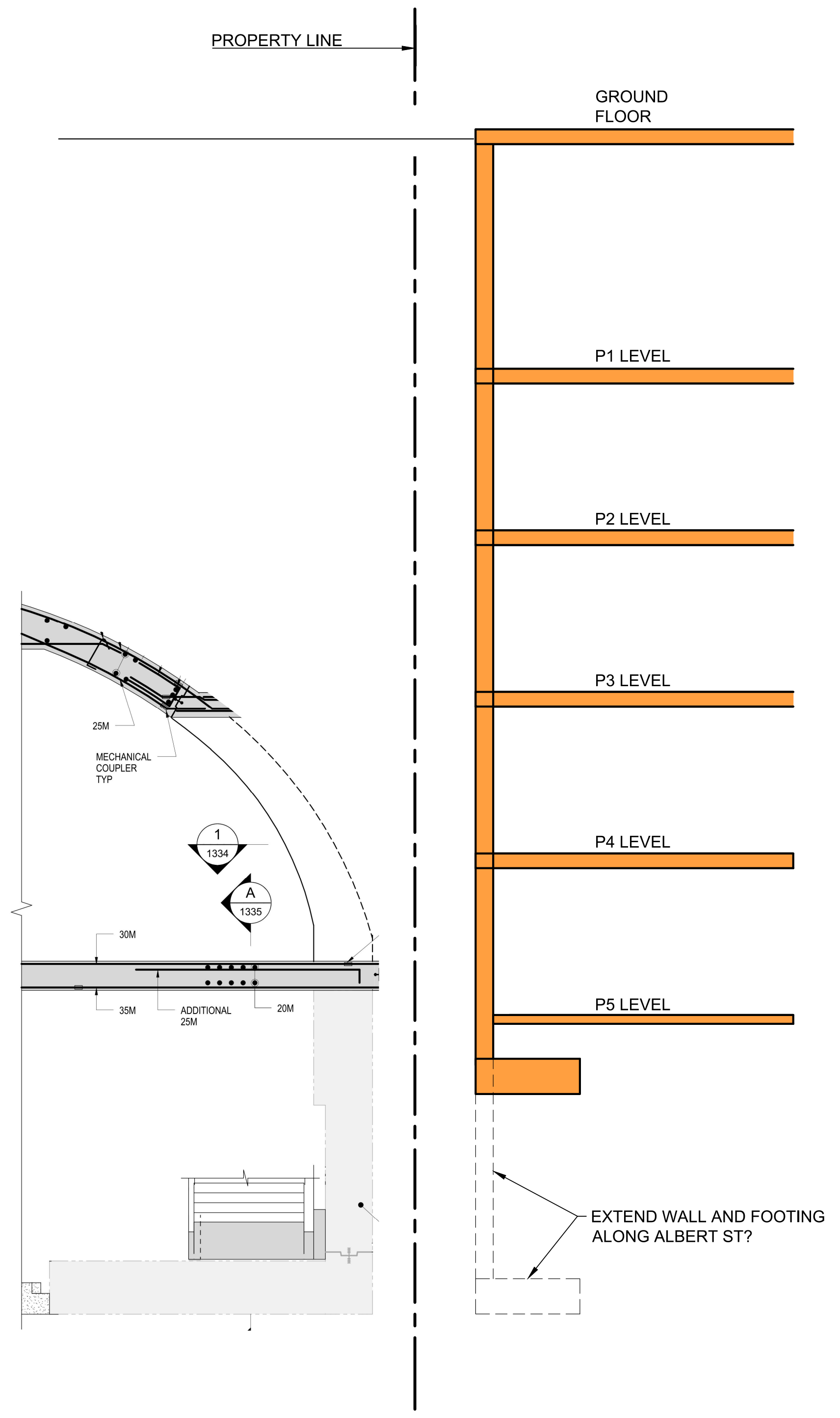
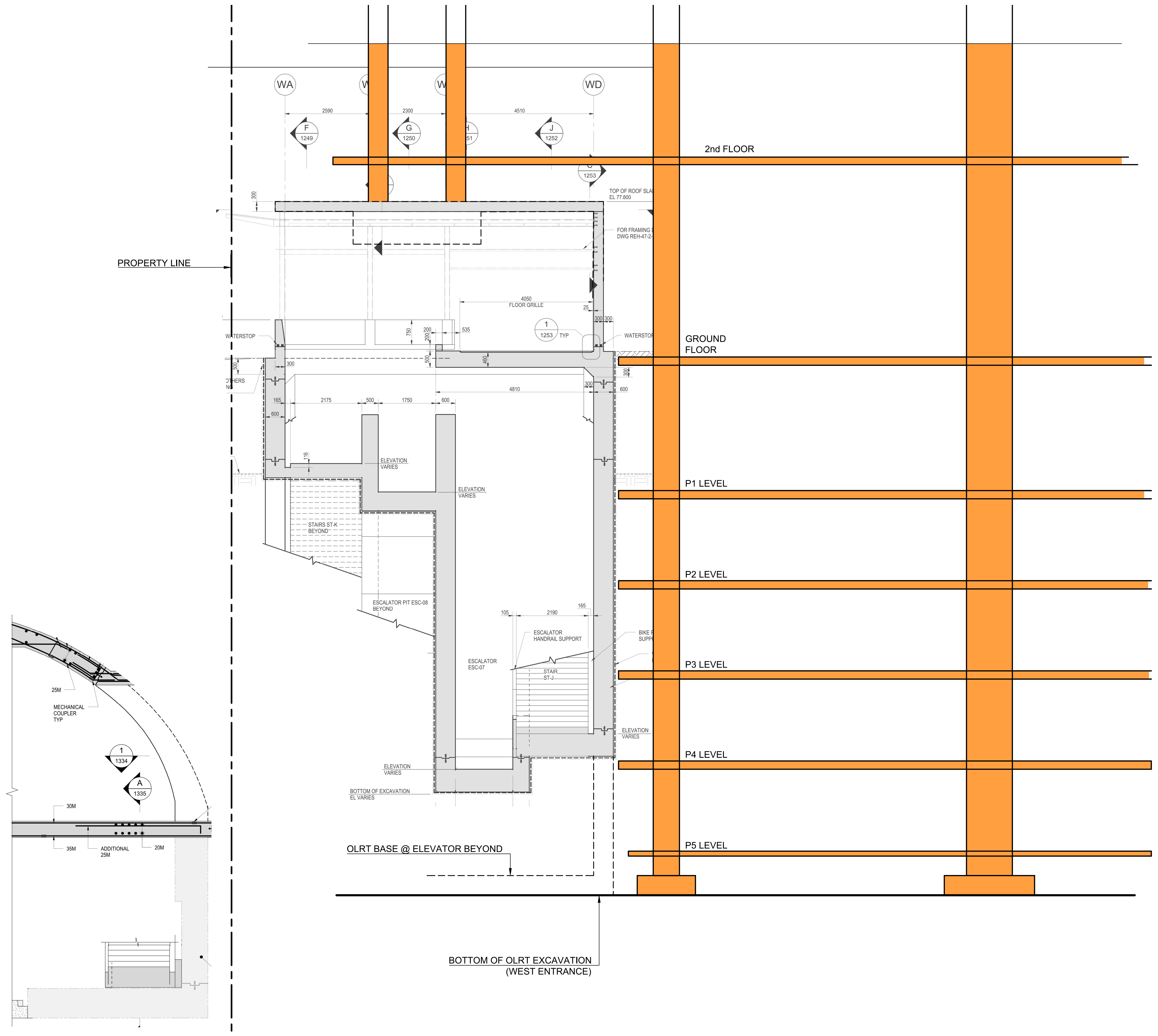
Job No. 8786-07 Claridge Lts 12 13 14 15 RP3922 TP D | N


7.1
8.4
9.9
10.4
10.9
SECTION 1
SECTION 2
EDGE OF OLRT TUNNEL/STATION
LINE OF 3.8m DEEP STATION
LINE OF 16.4m DEEP STATION
Q
P
N
M
L
+/- 1625
58
57
56
55
54
53
52
51
OLRT STATION
300
275
7196
400
6225
400
6300
400
6000
400
+/- 15410
+/- 12470
49
50
+/- 6635
HAUT
BAS
STORAGE / BICYCLE
38
48



SECTION 1



SECTION 2

Table 1 - Construction Methodology and Impact Review

Construction Item	Potential Impact	Mitigation Program
Item A - Installation of Temporary Shoring System - 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 soldier piles and lagging.	Encroachment due to temporary tieback anchorage system and vibration issues during shoring system installation	Design of the temporary shoring system, in particular the tiebacks anchorage systems and vibrations during installation, will take into consideration the presence of the existing Confederation Line tunnel and Lyon Station. A series of vibration monitoring devices are recommended to be installed within the tunnel structure and Lyon Station, or through a monitoring well over the top of the tunnel and station structures. 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 Report PG4517-2 dated October 10, 2018.
Item B - Excavation and Removal of Overburden to Bedrock Surface - The existing LRT tunnel top of rail (TOR) is located at elevation 53.5 m and the Lyon Station extends to approximately elevation 56.5 m.	Undermining LRT Tunnel and causing structural damage.	Based on the tunnel profile provided and available borehole information, the proposed development, the Confederation Line tunnel, and Lyon Station will be founded well below bedrock surface. The founding elevation of the proposed development will not extend below the tunnel. Should the founding elevation of the proposed tunnel extend below the Lyon Station structure, the geotechnical engineer will review excavation to ensure underming and/or damage of the station does not occur. The excavation would be evaluated as it progresses to ensure that the stability of the rock face under the structure to determine if rock reinforcement is required.
Item C - Bedrock Blasting and Removal Program - Blasting of the bedrock will be required for the proposed tower and parking garage structure construction. It is expected that up to approximately 15 m of bedrock removal is required based on the current design concepts for the proposed development. It is expected that the bedrock removal will be delineated by a series of tightly spaced coreholes along the south foundation wall to limit disturbance of the bedrock within the City right-of-way.	Structural damage of LRT tunnel due to vibrations from blasting program.	A series of vibration monitoring devices are recommended to be installed within the tunnel structure and Lyon Station, or through accessible monitoring wells over the top of the tunnel structure. 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 Report PG4517-2 dated October 10, 2018.
Item D - Installation of Footings and Foundation Walls - The portion of the proposed building adjacent to the LRT alignment consists of 5 levels of underground parking. Therefore, the footings will be placed over a clean, limestone bedrock bearing surface.	Building footing loading on adjacent LRT structure.	The proposed founding elevation of the building will be constructed to match the adjacent tunnel founding elevation. Therefore, no interaction or influence will be exerted by the new development on the tunnel foundation and foundation wall. The foundation walls of the proposed structure will not transfer load to the adjacent bedrock or tunnel, as all load will be transferred to the footings. For Lyon Station, the footings from the proposed development are anticipated to extend below the elevation of Lyon Station, and will therefore not exert any load on the station structure.

APPENDIX 2

Geotechnical Investigation:

Report PG4517-1 Revision 1

dated October 10, 2018

patersongroup

Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Studies

Geotechnical Investigation

Proposed High Rise Buildings
383 Albert Street
Ottawa, Ontario

Prepared For

Claridge Homes

July 18, 2018

Report: PG4517-1

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Table of Contents

Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Claridge Homes to conduct a geotechnical investigation for a proposed high rise buildings located at 383 Albert Street 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 test holes.
- ☐ 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 for this geotechnical investigation. An environmental program was carried out and the information is presented under separate cover.

2.0 Proposed Development

Based on current plans, it is understood that the proposed development will consist of 2 high rise mixed-use buildings. Two of the buildings (Tower A and B) will consist of 28 storeys. All of the proposed buildings will share an underground parking garage with 4 to 5 levels below the existing grade. The underground parking will occupy the majority of the site. It is also understood that the proposed building will be municipally serviced.

The proposed development will border the existing LRT tunnel along Queen Street and the Lyon Street LRT station at the northeast corner of the subject site. It is understood that the proximity to the existing LRT tunnel may affect the foundation design. The design considerations are further discussed in Subsection 5.3.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the investigation was carried out on July 3 to 6, 2018. At that time, 6 boreholes were advanced to a maximum depth of 4.8 m below existing grade across the subject site to provided general coverage of the proposed development. A previous investigation was completed in December 2013 by others. The locations of the test holes are shown on Drawing PG4517-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were drilled using a truck-mounted auger drill rig operated by a two person crew. The test hole procedure consisted of augering to the required depths at the selected locations and sampling the overburden soils. All fieldwork was conducted under the full-time supervision of personnel from Paterson's geotechnical division under the direction of a senior engineer.

Sampling and In Situ Testing

Soil samples were collected from the boreholes using a 50 mm diameter split-spoon (SS) sampler, or drill cuttings from the auger flights. Soil samples from the test pits were recovered from the side walls of the open excavation and all soil samples were initially classified on site. The split-spoon, auger samples and grab samples were placed in sealed plastic bags. All samples were transported to our laboratory for further examination and classification. The depths at which the split-spoon and auger samples were recovered from the test holes are shown as SS and AU, respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

Standard Penetration Testing (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 at three borehole locations to assess the bedrock quality. A recovery value and a Rock Quality Designation (RQD) value were calculated for each drilled section of bedrock and are shown on the Soil Profile and Test Data sheets in Appendix 1. The recovery value is the ratio, in percentage, of the length of the bedrock sample recovered over the length of the drilled section. The RQD value is the ratio, in percentage, of the total length of intact rock pieces longer than 100 mm in one drilled section over the length of the drilled section. These values are indicative of the quality of the bedrock.

Subsurface conditions observed in the boreholes were recorded in detail in the field. The soil profiles are presented on the Soil Profile and Test Data sheets in Appendix 1 of this report.

Groundwater

A 51 mm in diameter PVC groundwater monitoring well was installed in the boreholes to permit monitoring of the groundwater levels subsequent to the completion of the drilling program. Monitoring wells will be decomissioned prior to the commencement of construction and during the excavation program for shallow monitoring wells.

Monitoring Well Installation

A groundwater monitoring well was installed in all boreholes upon completion of the sampling program. Typical monitoring well construction details are described below:

❏ Slotted 32 mm diameter PVC screen at base of borehole for 1.5 m length.
❏ 32 mm diameter PVC riser pipe from the top of the screen to the ground surface.
❏ No.3 silica sand backfill within annular space around screen.
❏ 300 mm thick bentonite hole plug directly above PVC slotted screen.
❏ Clean backfill from top of bentonite plug to the ground surface.

Refer to the Soil Profile and Test Data sheets in Appendix 1 for specific monitoring well construction details.

3.2 Field Survey

The borehole locations were determined by Paterson personnel taking into consideration the presence of underground and aboveground services. The location and ground surface elevation at each borehole location was surveyed by Paterson personnel. The boreholes were surveyed with respect to a temporary benchmark (TBM), consisting of the top of grate of a catch basin located near the exit of the existing parking lot. A geodetic elevation of 73.5 m was provided for the TBM. The test hole locations and ground surface elevations at the test hole locations are presented on Drawing PG4517-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

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

All samples will be stored in the laboratory for a period of one month after issuance of this report. They will then be discarded unless we are otherwise directed.

4.0 Observations

4.1 Surface Conditions

The subject site is currently asphalt covered and used as an at-grade parking lot. The ground surface across the subject is relatively flat with a slight downslope towards the east. The ground surface was observed to be at grade with the adjacent roadways.

The site is bordered by a multi-storey existing building along the northwest and west border line, by Queen's LRT Station along the northeast corner and by a sales center along the southeast corner.

4.2 Subsurface Profile

Overburden

The subsurface profile at the borehole locations consists of a pavement structure consisting of asphaltic concrete followed by a layer of crushed stone with sand and gravel fill. Glacial till which consisting of compact to dense brown silty sand with gravel, cobbles and boulders was encountered below the above noted layers followed by limestone bedrock at a depth ranging between 4.4 to 4.8 m below existing grade. Based on our observations, the upper 1 to 3 m of the bedrock is of fair to good quality, while the majority of the bedrock core was noted to be good to excellent quality.

Specific details of the subsurface profile at each test hole location are presented on the Soil Profile and Test Data sheets in Appendix 1.

Bedrock

Based on available geological mapping, the bedrock in this area consists of interbedded limestone and dolomite bedrock of the Gull River formation with an overburden drift thickness of 2 to 5 m depth.

4.3 Groundwater

A total of 6 groundwater monitoring wells were installed as part of our geotechnical investigation. Groundwater level measurements were recorded at the monitoring well locations and our findings are presented in Table 1.

Table 1 - Groundwater Measurements at Monitoring Well Locations

Test Hole Location	Ground Surface Elevation (m)	GW Level Reading (m)	GW Level Elev. (m)
BH 1	74.31	6.8	67.51
BH 2	73.79	4.2	69.59
BH 3	73.76	Dry	n/a
BH 4	73.68	n/a - No Access	n/a
BH 5	74.09	n/a - No Access	n/a
BH 6	74.02	5.8	68.22

Based on the groundwater levels presented above, the measured levels are expected to be a perched groundwater condition influenced by the moderate imperviousness of the glacial till deposit overlying the bedrock surface. The new LRT tunnel along Queen Street in only partially waterproofed and is drained. The long term dewatering of the existing tunnel has depressurized the groundwater condition within the bedrock. The tunnel is founded at an elevation of approximately 51.0 m which is approximately 23 m below the existing grade. Therefore, the long term water level will be within the bedrock.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered acceptable for the proposed buildings. It is anticipated that the proposed high rise buildings will be founded over shallow footings placed on a clean, surface sounded bedrock at elevation of approximately 47.0 m.

It should be noted that an existing building is located along the west and northwest border lines of the subject site. The foundation of the adjacent multi-storey building is expected to be founded on the limestone bedrock. Similarly, it is expected that the LRT station building along the northeast corner is founded over the underlying bedrock at approximate elevation 51.0 m. Therefore, underpinning will not be required for the these buildings during excavation of the proposed buildings.

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

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

5.2 Site Grading and Preparation

Stripping Depth

Due to the depth of the bedrock, it is anticipated that all existing overburden material will be excavated from within the footprint of the proposed High Rise buildings.

Bedrock Removal

It is expected that line-drilling in conjunction with hoe-ramming or controlled blasting will be required to remove the bedrock for the underground parking levels. 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 can be carried out using almost vertical side walls. A minimum 1 m horizontal ledge, should be left between the bottom of the overburden excavation and the top of the bedrock surface to provide an area to allow for potential sloughing or to provide a stable base for the overburden shoring system.

Vibration Considerations

Construction operations are also the cause of 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, as much as possible, a cooperative environment with the residents.

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

Two parameters are used to determine the permissible vibrations, namely, 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). It should be noted that these guidelines are for today's construction standards. Considering that several old or sensitive buildings are encountered in the vicinity of the subject site, considerations should be given to lowering these guidelines. Considering that these guidelines are above perceptible human level and, in some cases, could be very disturbing to some people, it is recommended that a pre-construction survey be completed to minimize the risks of claims during or following the construction of the proposed building.

Fill Placement

Excavated limestone bedrock could be used as select subgrade material around the proposed building footings, provided the excavated bedrock is suitably crushed to 50 mm in its longest dimension and approved by the geotechnical consultant at the time of placement. Alternatively, an engineered fill such as an OPSS Granular A or Granular B Type II compacted to 98% of its SPMDD could be placed around the proposed footings.

Horizontal Rock Anchors

Horizontal rock anchors may be required at specific locations to prevent pop-outs of the bedrock, especially in areas where bedrock fractures are conducive to the failure of the bedrock surface.

The requirements for horizontal rock anchors will be evaluated during the excavation operations and should be discussed with the structural engineer during the design stage.

5.3 Foundation Design

Bearing Resistance Values

Footings placed on the upper levels of the limestone bedrock surface should be cleaned and surface sounded. This bearing medium can be designed using a bearing resistance value at ultimate limit states (ULS) of **3,000 kPa**, incorporating a geotechnical resistance factor of 0.5. 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 factored bearing resistance value at ULS of **6,000 kPa** could be used for footings founded on limestone bedrock at the proposed founding elevation of the parking garage provided the bedrock is free of seams, fractures and voids within 1.5 m below the founding level. This could be verified by completing and probing 50 mm diameter drill holes to a depth of 1.5 m below the founding level within the footprint(s) of the footing(s). At least one drill hole should be completed per major footing. The drill hole inspection should be carried out by the geotechnical consultant.

Consideration will be given to assessing the bedrock quality at the lower depths of the excavation program which can eliminate the need for bedrock probing.

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 using the bearing resistance values provided herein will be subjected to negligible potential post-construction total and differential settlements.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class A** for the foundations considered at this site provided a site specific shear wave velocity test is completed to confirm the seismic site classification. Soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the 2012 Ontario Building Code for a full discussion of the earthquake design requirements.

5.5 Basement Slab

All overburden soil will be removed from the subject site leaving the bedrock as the founding medium for the lower basement floor slab. If storage or other uses of the lower level where a concrete floor slab will be used it is recommended that the upper 200 mm of sub-slab fill consists of 19 mm clear crushed stone. All backfill material within the footprint of the proposed building should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of its SPMDD.

In consideration of the groundwater conditions encountered at the time of the fieldwork, a subfloor drainage system, consisting of lines of perforated drainage pipe subdrains connected to a positive outlet, should be provided in the clear stone under the lower basement floor. The spacing of the underfloor drainage system should be confirmed at the time of completing the excavation when water infiltration can be better assessed.

5.6 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. Below the bedrock surface, a nominal coefficient for 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.

Where soil is to be retained, 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. Undrained conditions are anticipated (i.e. below the groundwater level). Therefore, 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.

Two distinct conditions, static and seismic, must be reviewed for design calculations. The parameters for design calculations for the two conditions are presented below.

Static Conditions

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, 0.05
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 Conditions

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.

5.7 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 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.

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

Based on compressive strength testing results, the unconfined compressive strength of limestone at the site is 116 to 156 MPa, which is stronger than most routine grouts. Conservatively, a compressive strength of 100 MPa can be used for bedrock at the subject site. 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 75** was assigned to the bedrock, and Hoek and Brown parameters (**m and s**) were taken as **1.20 and 0.022**, 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 2 - 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	65 m=.575 and s=0.00293
Unconfined compressive strength - Limestone bedrock	80 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 total 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 3.

Table 3 - 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	0.55	1.75	250
	2.0	0.8	2.8	500
	3.2	1.4	4.6	1000
	5.3	2.2	7.5	2000
125	1.0	0.5	1.5	250
	1.7	0.7	2.4	500
	2.6	1.1	3.7	1000
	4.1	1.8	5.9	2000

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.

5.8 Pavement Structure

For design purposes, the pavement structure presented in the following table could be used for the design of access lanes, if required.

Table 4 - Recommended Pavement Structure - Access Lanes and Heavy Truck Loading Areas

Thickness (mm)	Material Description
40	**Wear Course -** Superpave 12.5 or HL-3 Asphaltic Concrete
50	**Binder Course** - Superpave 19.0 or HL-8 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
400	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Glacial Till or OPSS Granular B Type I or II material placed over bedrock.	

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 OPSS Granular B Type II material.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% of the material's SPMDD using suitable vibratory equipment.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

It is recommended that a perimeter foundation drainage system be provided for the proposed structure. It is expected that insufficient room is available for exterior backfill. It is suggested that an adequate drainage system would be as follows:

- ❏ Bedrock vertical surface should be prepared to receive the proposed membrane for the area below the first two underground parking levels. The surface will be prepared by grinding or using shotcrete to smooth out angular sections depending on the manufacturer's requirements of the proposed waterproofing membrane.
- ❏ A waterproofing membrane will be applied to the prepared vertical bedrock surface from 21 m below grade to the founding elevation (bottom elevation of LRT tunnel). The membrane will serve as a water infiltration suppression system. The membrane will also be placed along the horizontal surface beneath the perimeter footings to provide a better seal at the vertical and horizontal interface.
- ❏ A composite drainage layer will be placed against the excavation face and waterproofing membrane from the surface to the proposed founding elevation.
- ❏ 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

It is anticipated that underfloor drainage will be required to control water infiltration. For design purposes, we recommend that 150 mm in perforated pipes be placed in each bay. The spacing of the underfloor drainage system should be confirmed at the time of completing the excavation when water infiltration can be better assessed.

Adverse Effects of Dewatering on Adjacent Properties

Since the proposed development will be founded below the long term groundwater level, a waterproofing membrane was recommended to lessen the effects of water infiltration. Any minor dewatering of the site will be within the bedrock layer which is relatively shallow at the subject site. Therefore, no adverse effects to the surrounding buildings or properties are expected with the lowering of the groundwater in this area.

Foundation Backfill

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 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 and Temporary Shoring

The side slopes of the shallow excavations anticipated at this site should either be cut back at acceptable slopes or be retained by shoring systems from the start of the excavation until the structure is backfilled. It is expected that insufficient room will be available to permit 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.

Rock Stabilization

Horizontal rock anchors may be required at specific locations to prevent pop-outs of the bedrock, especially in areas where fractures in the bedrock are conducive to the failure of the bedrock surface.

The requirement for horizontal rock anchors will be evaluated during the excavation operations and should be discussed with the structural engineer during the design stage.

Temporary Shoring

Temporary shoring may be required on the overburden soil to complete the required excavations where insufficient room is available for open cut methods. The shoring requirements will depend on the depth of the excavation, the proximity of the adjacent buildings and underground structures and the elevation of the adjacent building foundations and underground services. Additional information can be provided when the above details are known.

For design purposes, the temporary system may consist of soldier pile and lagging system or interlocking steel sheet piling. Any additional loading due to street traffic, construction equipment, adjacent structures and facilities, etc., should be added to the earth pressures described below. These systems can be cantilevered, anchored or braced. Generally, it is expected that the shoring systems will be provided with tie-back rock anchors to ensure their stability. It is further recommended that the toe of the shoring be adequately supported to resist toe failure by means of rock bolts or extending the piles into the bedrock through pre-augered holes if a soldier pile and lagging system is used.

Generally, it is expected that the shoring systems will be provided with tie-back rock anchors to ensure their stability.

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.

The anchor derives its capacity from the bonded portion, or fixed anchor length, at the base of the anchor. An unbonded portion, or free anchor length, is also usually provided between the rock surface and the start of the bonded length. Because the depth at which the apex 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 capacity, than one where the bonded length was just the bottom part of the overall anchor.

The design of the rock anchors for temporary shoring can be based on the values provided in Subsection 5.7 of the present report.

The earth pressures acting on the shoring system may be calculated using the following parameters.

Table 5 - Soil Parameters for Shoring System Design

Parameters	Values
Active Earth Pressure Coefficient (K_a)	0.33
Passive Earth Pressure Coefficient (K_p)	3
At-Rest Earth Pressure Coefficient (K_o)	0.5
Unit Weight (γ), kN/m^3	20
Submerged Unit Weight (γ), kN/m^3	13

Soldier Pile and Lagging System

The active earth pressure acting on a soldier pile and lagging shoring system can be calculated using a rectangular earth pressure distribution with a maximum pressure of 0.65 K γ H for strutted or anchored shoring or a triangular earth pressure distribution with a maximum value of K γ H for a cantilever shoring system. H is the height of the excavation.

The active earth pressure should be used where wall movements are permissible while the at-rest pressure should be used if no movement is permissible.

The total unit weight should be used above the groundwater level while the submerged unit weight should be used below the groundwater level.

The hydrostatic groundwater pressure should be added to the earth pressure distribution wherever the submerged unit weights are used for earth pressure calculations should the level on the groundwater not be lowered below the bottom of the excavation. If the groundwater level is lowered, the total unit weight for the soil should be used full weight, with no hydrostatic groundwater pressure component.

Underpinning of Adjacent Structures

Based on the relatively shallow depth of the bedrock at the subject site, it is expected that the adjacent buildings are most likely founded on or very close to the bedrock surface except for the sales center. Therefore, underpinning may only be required for the sales center and should be confirmed in the field by the geotechnical consultant prior to commencement of excavation.

6.4 Pipe Bedding and Backfill

Bedding and backfill materials should be in accordance with the most recent Material Specifications and 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 bedding for sewer and water pipes when placed on soil 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 (concrete or PSM PVC pipes) or sand (concrete pipe). The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to a minimum of 95% of the material’s SPMDD.

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 the potential differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the material’s SPMDD.

6.5 Groundwater Control

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.

The rate of flow of groundwater into the excavation through the overburden and bedrock should be moderate for the expected subsurface conditions at this site. It is anticipated that pumping from open sumps will be sufficient to control the groundwater influx through the sides of the excavations.

A temporary MOECC permit to take water (PTTW) Category 3 will be required for this project since water infiltration is expected to be greater than 50,000 L/day during the construction phase. At least 3 to 4 months should be allowed for completion of the application and issuance of the permit by the MOECC.

Long-term Groundwater Control

Our recommendations for the proposed building's long-term groundwater control are presented in Subsection 6.1. Any groundwater which breaches the buildings' perimeter groundwater infiltration control systems will be directed to the proposed buildings' sump pits. It is expected that groundwater flow will be low (i.e.- less than 20,000 L/day) with peak periods noted after rain events. It is anticipated that the groundwater flow will be controllable using conventional open sumps.

Impacts on Neighbouring Structures

It is understood that preliminary concepts indicate that 8 levels of underground parking levels are planned for the proposed buildings. It is also understood that the neighbouring buildings are founded over bedrock bearing surface. Furthermore, based on the existing information, the LRT station was recently excavated to a maximum depth of 24 m below ground surface. Since the beginning of the LRT station construction, no issues related to localized groundwater lowering have been reported. Therefore, based on the proximity of neighbouring buildings and minimal zone impacted by the groundwater lowering, the proposed development will not negatively impact the neighbouring structures. It should be noted that no issues are expected with respect to groundwater lowering that would cause long term damage to adjacent structures surrounding the proposed buildings.

A proximity study will be completed once the final details of the proposed structure are available.

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 presence of water and freezing conditions ice could form within the soil mass. Heaving 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 the footings are protected with sufficient soil cover to prevent freezing at founding level.

The trench excavations should be carried out in a manner to avoid the introduction of frozen materials, snow or ice into the trenches. Precaution must be taken where excavations are carried in 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 document to protect the walls of the excavations from freezing, if applicable.

7.0 Recommendations

A materials testing and observation services program is a requirement for the provided foundation design data to be applicable. The following aspects of the program should be performed by the geotechnical consultant:

☐ Review of the geotechnical aspects of the excavation contractor's shoring design, prior to construction.

☐ Review the bedrock stabilization and excavation requirements.

☐ Review proposed foundation drainage design and requirements.

☐ 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 m in height, if applicable.

☐ Observation of all subgrades prior to backfilling.

☐ Field density tests to determine the level of compaction achieved.

☐ Sampling and testing of the bituminous concrete including mix design reviews.

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

8.0 Statement of Limitations

The recommendations provided in this report are in accordance with our present understanding of the project. We request permission to review our recommendations when the drawings and specifications are completed.

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 immediate notification 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 Claridge Homes or their agents is not authorized without review by Paterson for the applicability of our recommendations to the alternative use of the report.

Paterson Group Inc.

Faisal I. Abou-Seido, P.Eng.

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LICENSED PROFESSIONAL ENGINEER
C. P. DA SILVA
PROVINCE OF ONTARIO

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

BOREHOLE LOGS BY OTHERS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Building - 383 Albert Street
Ottawa, Ontario

DATUM TBM - Top of grate of catch basin located near exit of subject site. Geodetic elevation = 73.50m.

REMARKS

BORINGS BY CME 55 Power Auger

DATE July 3, 2018

FILE NO. PG4517

HOLE NO. BH 1

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
Asphaltic concrete 0.08				
FILL: Crushed stone with sand 0.69	AU	1		
FILL: Brown silty sand, tracel, trace organics 1.50	SS	2	42	9
GLACIAL TILL: Compact to dense, brown silty sand with gravel, cobbles, boulders, trace clay 4.78	SS	3	79	27
	SS	4	67	21
	SS	5	83	11
	SS	6	79	24
	SS	7	67	50+
BEDROCK: Grey limestone	RC	1	71	100
	RC	2	100	96
	RC	3	100	88
	RC	4	100	80
	RC	5	100	93
	RC	6	98	98

DEPTH (m)	ELEV. (m)
0	74.13
1	73.13
2	72.13
3	71.13
4	70.13
5	69.13
6	68.13
7	67.13
8	66.13
9	65.13
10	64.13
11	63.13
12	62.13
13	61.13

Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**

○ **Water Content %**

20 40 60 80

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

Monitoring Well Construction

patersongroup Consulting Engineers

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FILE NO. PG4517

HOLE NO. BH 1

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					13	61.13
	RC	7	100	98		
					14	60.13
					15	59.13
	RC	8	100	100		
					16	58.13
	RC	9	100	100		
					17	57.13
					18	56.13
BEDROCK: Grey limestone	RC	10	95	95		
					19	55.13
	RC	11	100	98		
					20	54.13
					21	53.13
	RC	12	100	100		
					22	52.13
	RC	13	96	88		
					23	51.13
	RC	14	100	100	24	50.13
24.41						
End of Borehole						
(GWL @ 6.80m - July 13, 2018)						

Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**

○ **Water Content %**

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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REMARKS

BORINGS BY CME 55 Power Auger

DATE July 4, 2018

FILE NO. PG4517

HOLE NO. BH 2

SOIL DESCRIPTION	Depth of base (m)
GROUND SURFACE	
Asphaltic concrete	0.08
FILL: Brown silty sand with gravel, cobbles	2.21
GLACIAL TILL: Compact to dense, brown silty sand with gravel, cobbles, boulders, trace clay	4.57
BEDROCK: Grey limestone	8.53
End of Borehole	
(GWL @ 4.20m - July 13, 2018)	

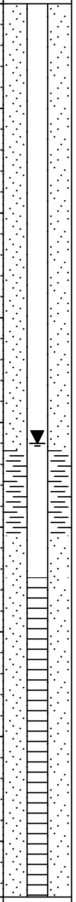
SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	75	35
SS	3	58	39
SS	4	67	15
SS	5	33	16
SS	6	75	13
RC	1	95	80
RC	2	100	97
RC	3	98	88

DEPTH (m)	ELEV. (m)
0	73.79
1	72.79
2	71.79
3	70.79
4	69.79
5	68.79
6	67.79
7	66.79
8	65.79

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

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

Monitoring Well Construction



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SOIL PROFILE AND TEST DATA

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REMARKS

BORINGS BY CME 55 Power Auger

DATE July 4, 2018

FILE NO. PG4517

HOLE NO. BH 3

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	73.76
Asphaltic concrete 0.14						
FILL: Crushed stone, some sand, gravel, trace brick	AU	1				
	SS	2	25	53	1	72.76
	SS	3	0	50+	2	71.76
	SS	4	33	24		
2.97					3	70.76
GLACIAL TILL: Compact to dense, brown silty sand, some gravel, cobble, boulders	SS	5	46	16		
	SS	6	73	50+	4	69.76
4.40						
BEDROCK: Grey limestone	RC	1	100	84	5	68.76
	RC	2	95	86	6	67.76
					7	66.76
	RC	3	100	88	8	65.76
					9	64.76
	RC	4	100	85	10	63.76
	RC	5	100	100	11	62.76
					12	61.76
	RC	6	100	98	13	60.76

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

Monitoring Well Construction

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

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SOIL PROFILE AND TEST DATA

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REMARKS

BORINGS BY CME 55 Power Auger

DATE July 4, 2018

FILE NO. PG4517

HOLE NO. BH 3

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Monitoring Well Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD				
GROUND SURFACE									
BEDROCK: Grey limestone						13	60.76		
		RC	7	100	98	14	59.76		
						15	58.76		
		RC	8	100	96				
						16	57.76		
		RC	9	100	88	17	56.76		
						18	55.76		
		RC	10	100	90				
						19	54.76		
		RC	11	100	100	20	53.76		
						21	52.76		
		RC	12	100	100				
						22	51.76		
		RC	13	100	100	23	50.76		
23.77									
End of Borehole (BH dry - July 13, 2018)									

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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Building - 383 Albert Street
Ottawa, Ontario

DATUM TBM - Top of grate of catch basin located near exit of subject site. Geodetic elevation = 73.50m.

REMARKS

BORINGS BY CME 55 Power Auger

DATE July 4, 2018

FILE NO. PG4517

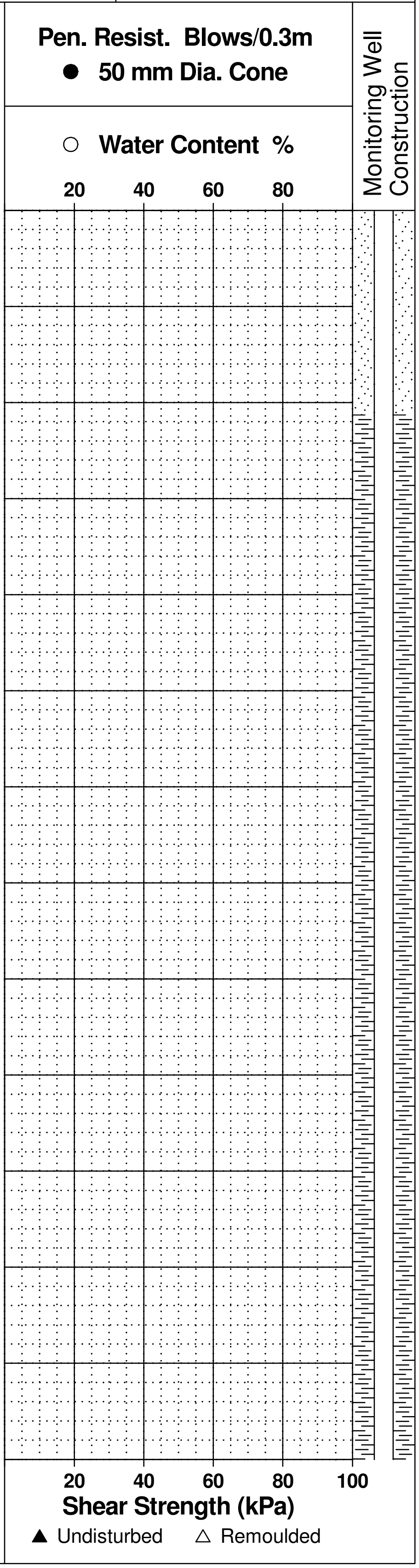
HOLE NO. BH 4

GROUND SURFACE

SOIL DESCRIPTION	Depth to base (m)
Asphaltic concrete	0.10
FILL: Brown silty sand with crushed stone, trace brick, coal	1.45
GLACIAL TILL: Compact, brown silty sand with gravel, cobbles, boulders	4.37
BEDROCK: Grey limestone	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	42	13
SS	3	75	30
SS	4	71	16
SS	5	83	12
SS	6	33	16
RC	1	95	82
RC	2	98	98
RC	3	100	93
RC	4	98	95
RC	5	100	98
RC	6	100	100

DEPTH (m)	ELEV. (m)
0	73.68
1	72.68
2	71.68
3	70.68
4	69.68
5	68.68
6	67.68
7	66.68
8	65.68
9	64.68
10	63.68
11	62.68
12	61.68
13	60.68



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Building - 383 Albert Street
Ottawa, Ontario

DATUM TBM - Top of grate of catch basin located near exit of subject site. Geodetic elevation = 73.50m.

REMARKS

BORINGS BY CME 55 Power Auger

DATE July 4, 2018

FILE NO. PG4517

HOLE NO. BH 4

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					13	60.68
	RC	7	100	100	14	59.68
	RC	8	100	100	15	58.68
	RC	9	100	91	16	57.68
	RC	10	100	100	17	56.68
BEDROCK: Grey limestone					18	55.68
	RC	11	100	100	19	54.68
	RC	12	100	100	20	53.68
	RC	13	100	92	21	52.68
	RC	14	98	94	22	51.68
					23	50.68
					24	49.68
25.02					25	48.68
End of Borehole No access to borehole - July 13,						

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

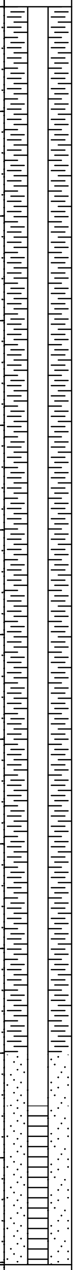
20 40 60 80

Shear Strength (kPa)

20 40 60 80 100

▲ Undisturbed △ Remoulded

Monitoring Well Construction



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
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DATUM TBM - Top of grate of catch basin located near exit of subject site. Geodetic elevation = 73.50m.

REMARKS

BORINGS BY CME 55 Power Auger

DATE July 4, 2018

FILE NO. PG4517

HOLE NO. BH 4

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Monitoring Well Construction
GROUND SURFACE		TYPE	NUMBER	% RECOVERY	N VALUE or RQD				
2018)									

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
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DATUM TBM - Top of grate of catch basin located near exit of subject site. Geodetic elevation = 73.50m.

REMARKS

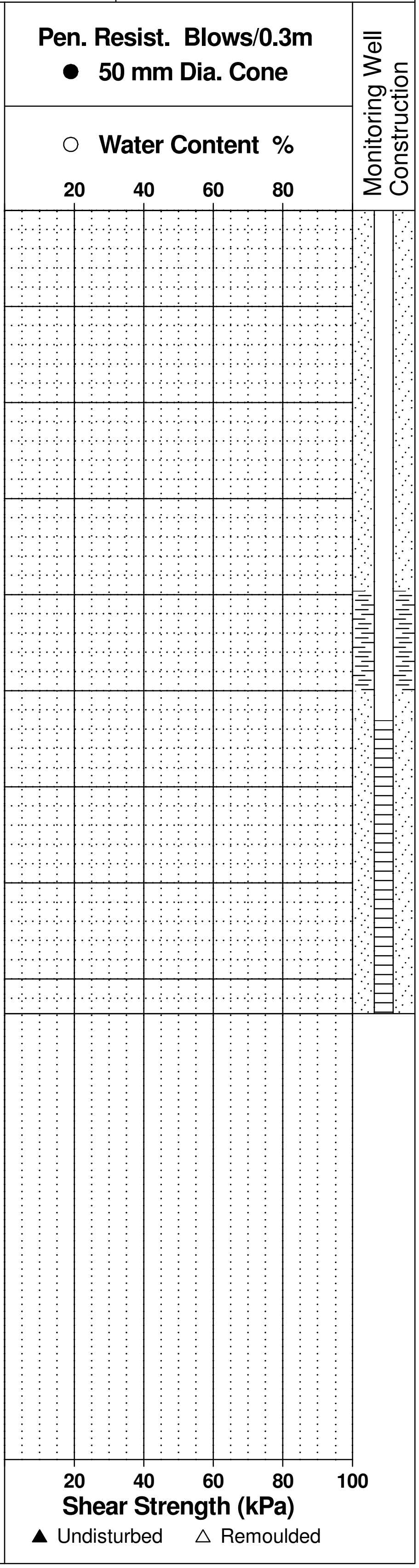
BORINGS BY CME 55 Power Auger

DATE July 5, 2018

FILE NO. PG4517

HOLE NO. BH 5

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	74.09
Asphaltic concrete 0.13							
FILL: Brown silty sand, some gravel		AU	1				
		SS	2	33	15	1	73.09
		SS	3	67	8		
2.20						2	72.09
GLACIAL TILL: Compact to dense, brown silty sand with gravel, cobbles, boulders		SS	4	62	32		
						3	71.09
		SS	5	50	20		
						4	70.09
4.42		SS	6	12	47		
BEDROCK: Grey limestone		RC	1	98	98	5	69.09
						6	68.09
		RC	2	100	95		
						7	67.09
		RC	3	83	83		
						8	66.09
8.36							
End of Borehole No access to borehole - July 13, 2018)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Mixed-Use Building - 383 Albert Street
Ottawa, Ontario

DATUM TBM - Top of grate of catch basin located near exit of subject site. Geodetic elevation = 73.50m.

REMARKS

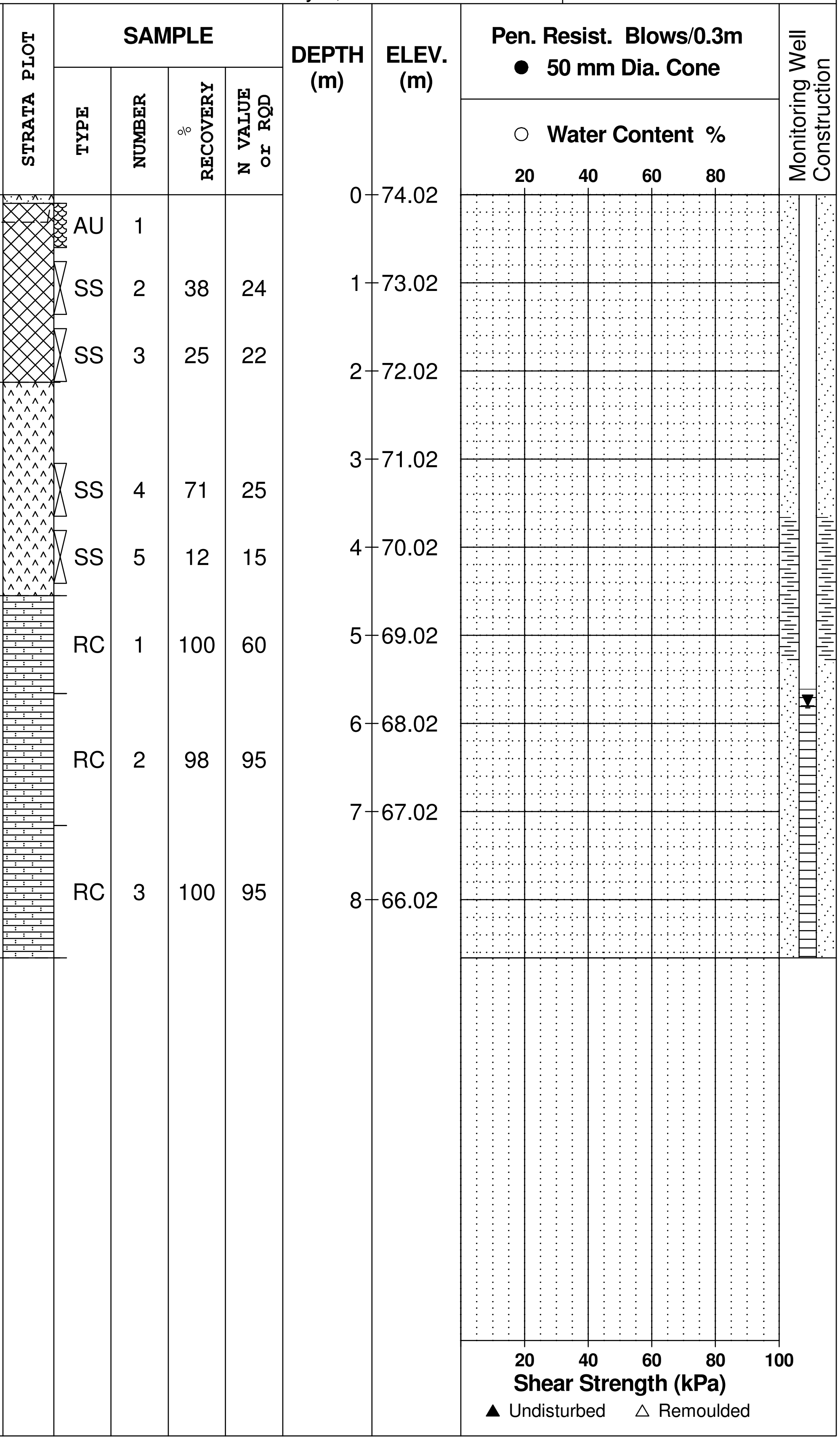
BORINGS BY CME 55 Power Auger

DATE July 6, 2018

FILE NO. PG4517

HOLE NO. BH 6

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						
Asphaltic concrete 0.10					0	74.02
FILL: Brown silty sand with crushed stone, trace brick	AU	1				
	SS	2	38	24	1	73.02
2.13	SS	3	25	22	2	72.02
GLACIAL TILL: Compact, brown silty sand with gravel, cobbles, boulders					3	71.02
	SS	4	71	25		
4.55	SS	5	12	15	4	70.02
BEDROCK: Grey limestone	RC	1	100	60	5	69.02
					6	68.02
	RC	2	98	95		
					7	67.02
8.66	RC	3	100	95	8	66.02
End of Borehole						
(GWL @ 5.80m - July 13, 2018)						



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 = $(D30)^2 / (D10 \times D60)$
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)

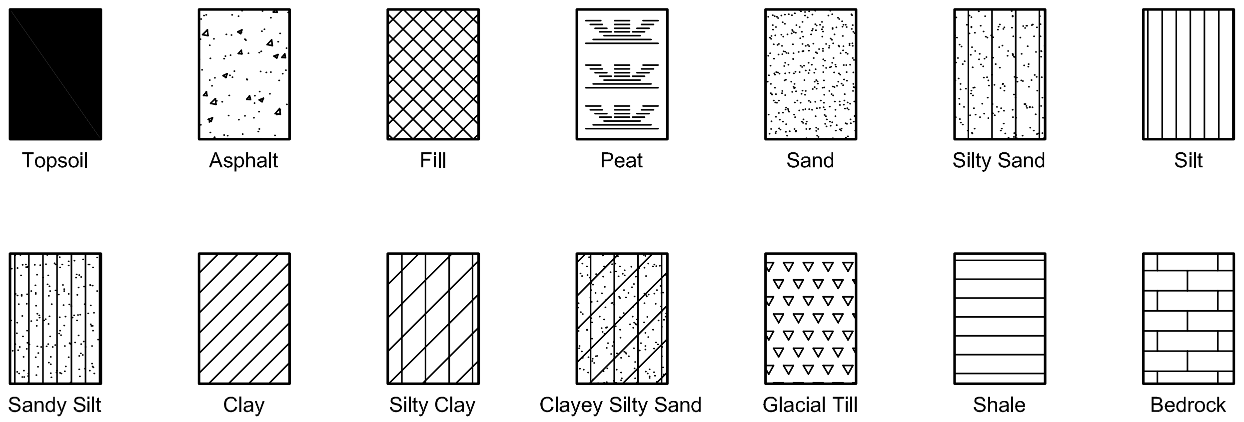
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

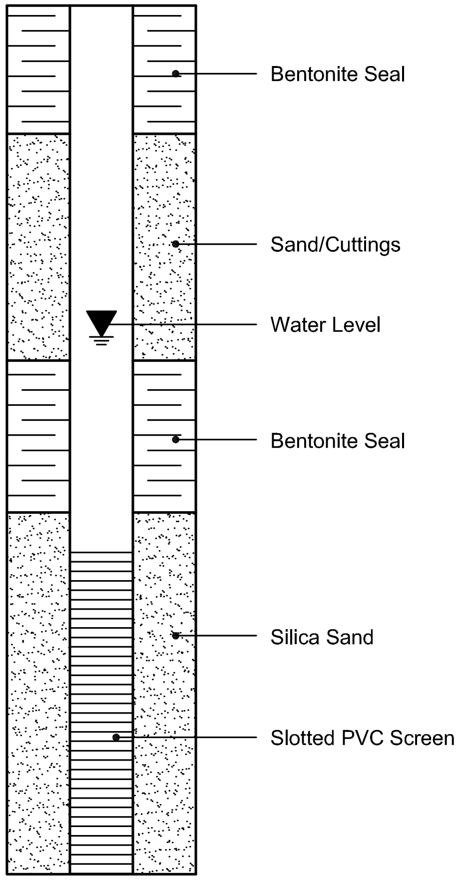
SYMBOLS AND TERMS (continued)

STRATA PLOT

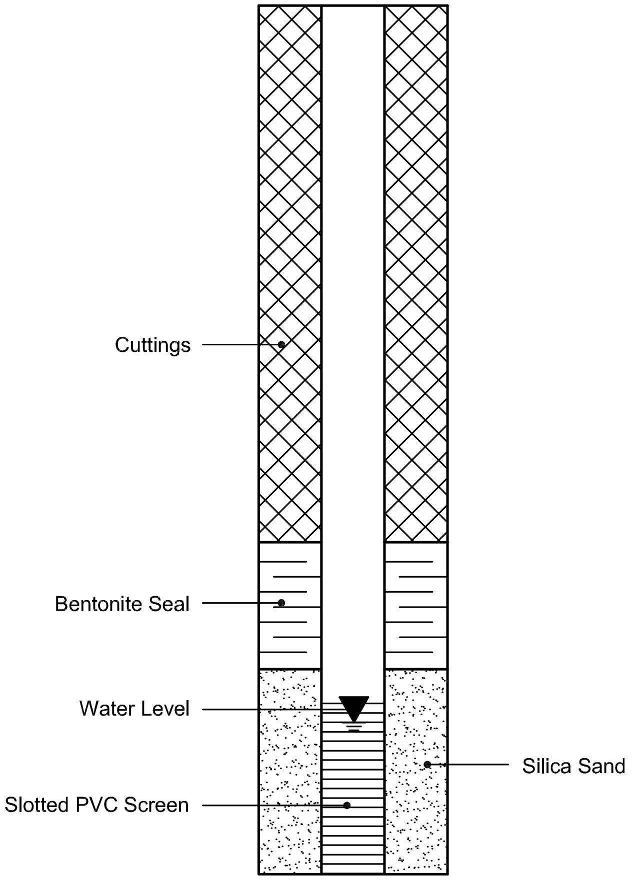


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Log of Borehole MW 1

Project No: OTT-00215048-A0

Figure No. 3

Project: Preliminary Geotechnical Investigation. Proposed Commercial and

Location: Residential Development. 383 Albert Street, Ottawa Ontario

Page. 1 of 1

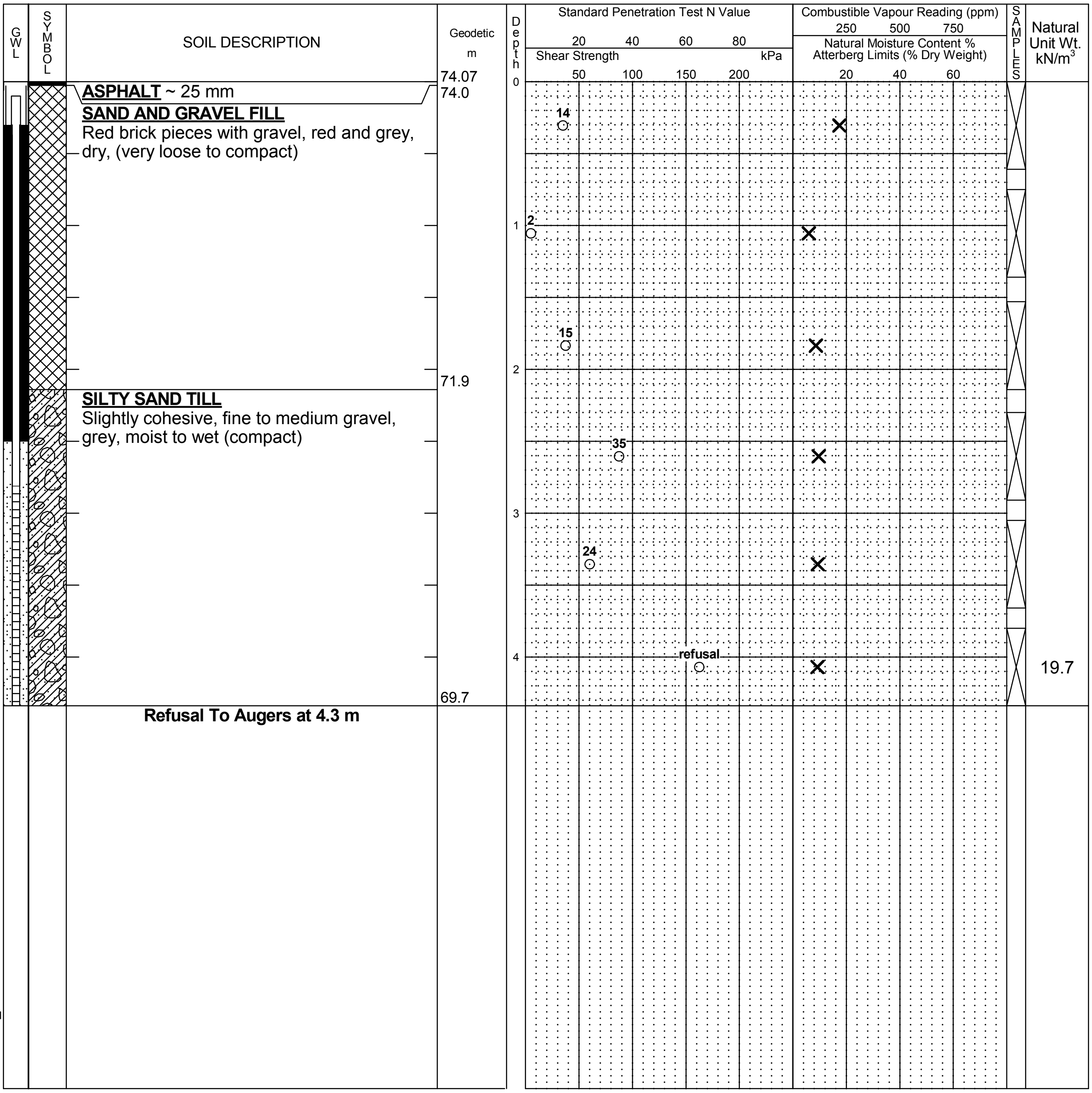
Date Drilled: 12/6/13

Drill Type: CME

Datum: Geodetic

Logged by: DC Checked by: SKA

Split Spoon Sample	☒	Combustible Vapour Reading	☐
Auger Sample	◨	Natural Moisture Content	✕
SPT (N) Value	○	Atterberg Limits	├─○
Dynamic Cone Test	───	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■		
Shear Strength by Vane Test	+ S	Shear Strength by Penetrometer Test	▲



Geodetic m	Soil Description
74.07 74.0	**ASPHALT** ~ 25 mm
	SAND AND GRAVEL FILL Red brick pieces with gravel, red and grey, dry, (very loose to compact)
71.9	**SILTY SAND TILL** Slightly cohesive, fine to medium gravel, grey, moist to wet (compact)
69.7	

Natural Unit Wt.: 19.7

Refusal To Augers at 4.3 m

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. A Monitoring Well with a 38mm diameter casing was installed in the borehole upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00215048-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
3 days	dry	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole MW 2

Project No: OTT-00215048-A0

Project: Preliminary Geotechnical Investigation. Proposed Commercial and

Location: Residential Development. 383 Albert Street, Ottawa Ontario

Figure No. 4(a)

Page. 1 of 2

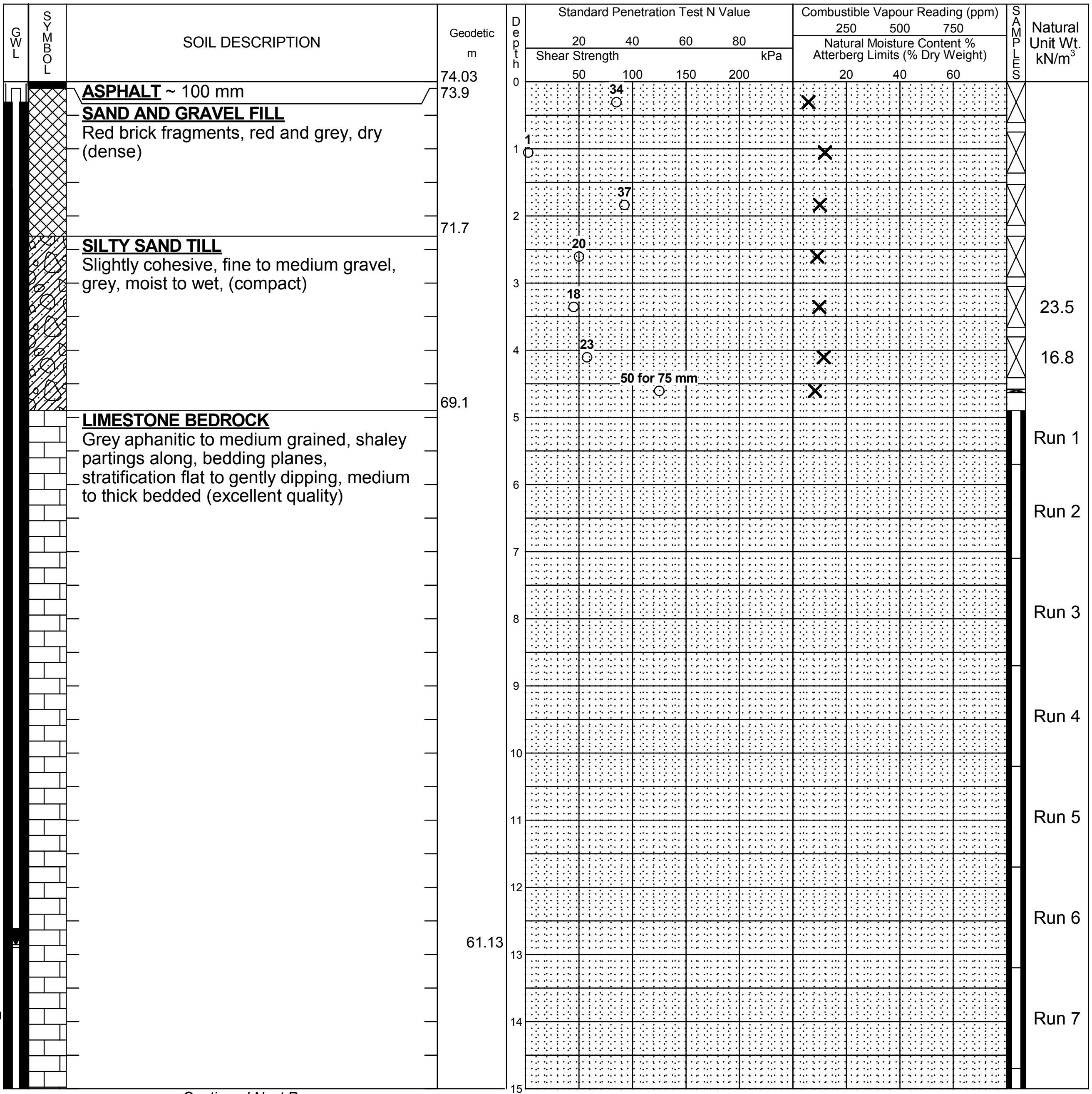
Date Drilled: 12/6/13

Drill Type: CME

Datum: Geodetic

Logged by: DC   Checked by: SKA

Split Spoon Sample	☒	Combustible Vapour Reading	☐
Auger Sample	◨	Natural Moisture Content	✕
SPT (N) Value	○	Atterberg Limits	├──○
Dynamic Cone Test	──	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■		
Shear Strength by Vane Test	+ S	Shear Strength by Penetrometer Test	▲



ASPHALT ~ 100 mm

SAND AND GRAVEL FILL
Red brick fragments, red and grey, dry (dense)

SILTY SAND TILL
Slightly cohesive, fine to medium gravel, grey, moist to wet, (compact)

LIMESTONE BEDROCK
Grey aphanitic to medium grained, shaley partings along, bedding planes, stratification flat to gently dipping, medium to thick bedded (excellent quality)

Continued Next Page

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. A Monitoring Well with a 38mm diameter casing was installed in the borehole upon completion.
3. Field work was completed by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00215048-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
3 days	12.9	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole MW 2

Project No: OTT-00215048-A0

Project: Preliminary Geotechnical Investigation. Proposed Commercial and

Figure No. 4(a)

Page. 2 of 2

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic m	Depth	Standard Penetration Test N Value 20 40 60 80 Shear Strength kPa 50 100 150 200	Combustible Vapour Reading (ppm) 250 500 750 Natural Moisture Content % Atterberg Limits (% Dry Weight) 20 40 60	SAMPLES	Natural Unit Wt. kN/m^3
		LIMESTONE BEDROCK Grey aphanitic to medium grained, shaley partings along, bedding planes, stratification flat to gently dipping, medium to thick bedded (excellent quality) *(continued)*	59.03	15				Run 8
				16				
				17				Run 9
				18				Run 10
				19				
				20				Run 11
				21				Run 12
				22				
				23				Run 13
				24				Run 14
				25				
			47.7	26				Run 15
		Borehole Terminated at 26.4 m Noted For Core Recovery refer to Figure 4(b)						

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. A Monitoring Well with a 38mm diameter casing was installed in the borehole upon completion.
3. Field work was completed by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00215048-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
3 days	12.9	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Figure 4 (b)

Core Recoveries from MW13-2 at 383 Albert Street, Ottawa

Run #	Depth (m)	Total Core Recovery %	Rock Quality Designation (RQD) %
1	4.93 – 5.69	100	93
2	5.69 – 7.14	100	100
3	7.14 – 8.69	100	89
4	8.69 – 10.16	100	90
5	10.16 – 11.69	100	100
6	11.69 – 13.19	100	100
7	13.19 – 14.66	98	98
8	14.66 – 16.18	100	100
9	16.18 – 17.68	100	100
10	17.68 – 19.21	98	95
11	19.21 – 20.73	100	97
12	20.73 – 22.20	100	100
13	22.20 – 23.73	100	100
14	23.73 – 25.20	100	100
15	25.20 – 26.35	100	100

Log of Borehole BH 3

Project No: OTT-00215048-A0

Figure No. 5

Page. 1 of 1

Project: Preliminary Geotechnical Investigation. Proposed Commercial and

Location: Residential Development. 383 Albert Street, Ottawa Ontario

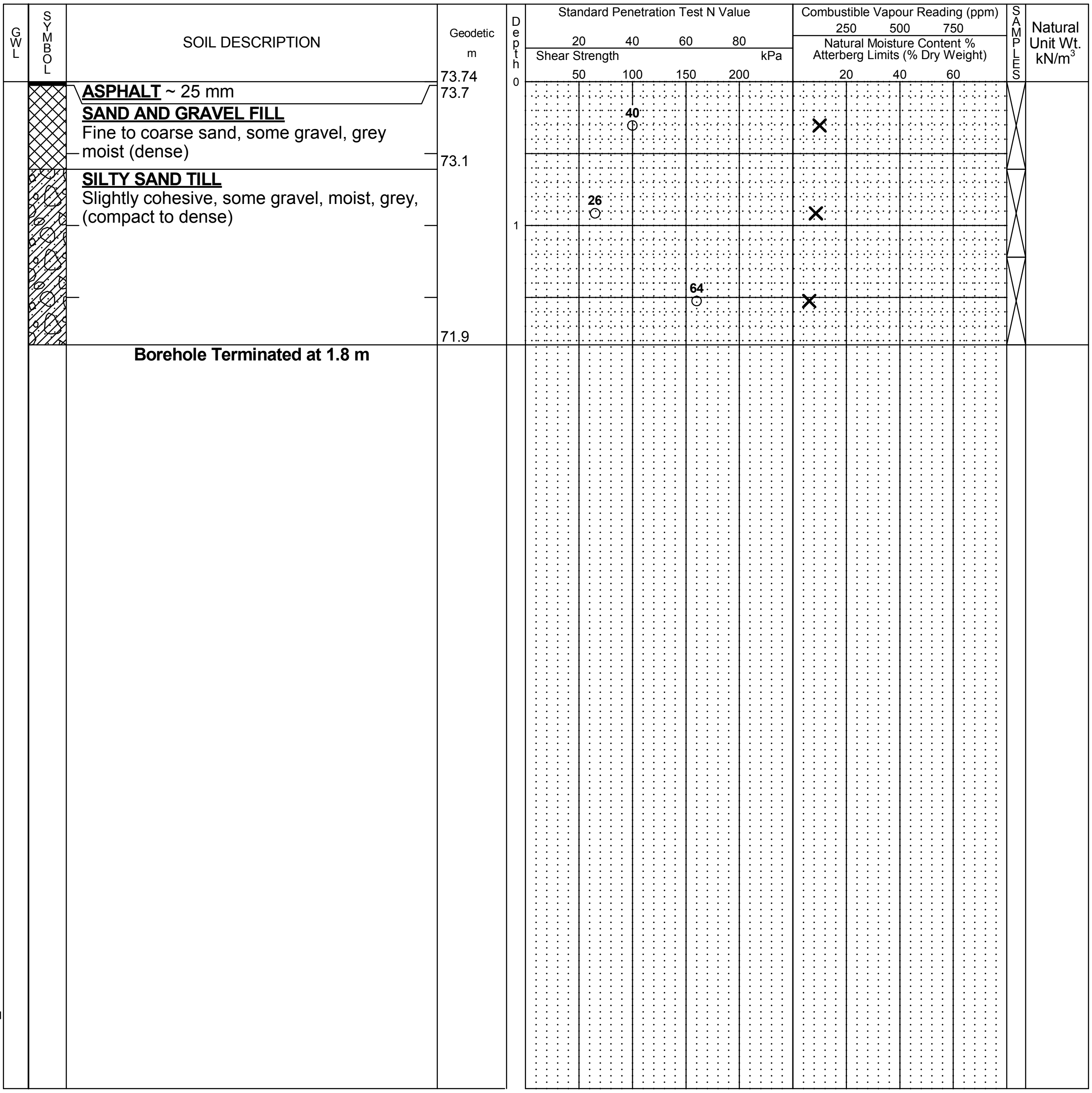
Date Drilled: 12/7/13

Drill Type: CME

Datum: Geodetic

Logged by: TG Checked by: SKA

Split Spoon Sample	⊠	Combustible Vapour Reading	☐
Auger Sample	◫	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢—○
Dynamic Cone Test	—	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		



ASPHALT ~ 25 mm

SAND AND GRAVEL FILL
Fine to coarse sand, some gravel, grey moist (dense)

SILTY SAND TILL
Slightly cohesive, some gravel, moist, grey, (compact to dense)

Borehole Terminated at 1.8 m

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. Hole was backfilled upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00215048-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE LOGS OF BOREHOLES_GEO.GPJ TROW OTTAWA.GDT 12/11/13

Log of Borehole MW 4

Project No: OTT-00215048-A0

Project: Preliminary Geotechnical Investigation. Proposed Commercial and

Location: Residential Development. 383 Albert Street, Ottawa Ontario

Figure No. 6

Page. 1 of 1

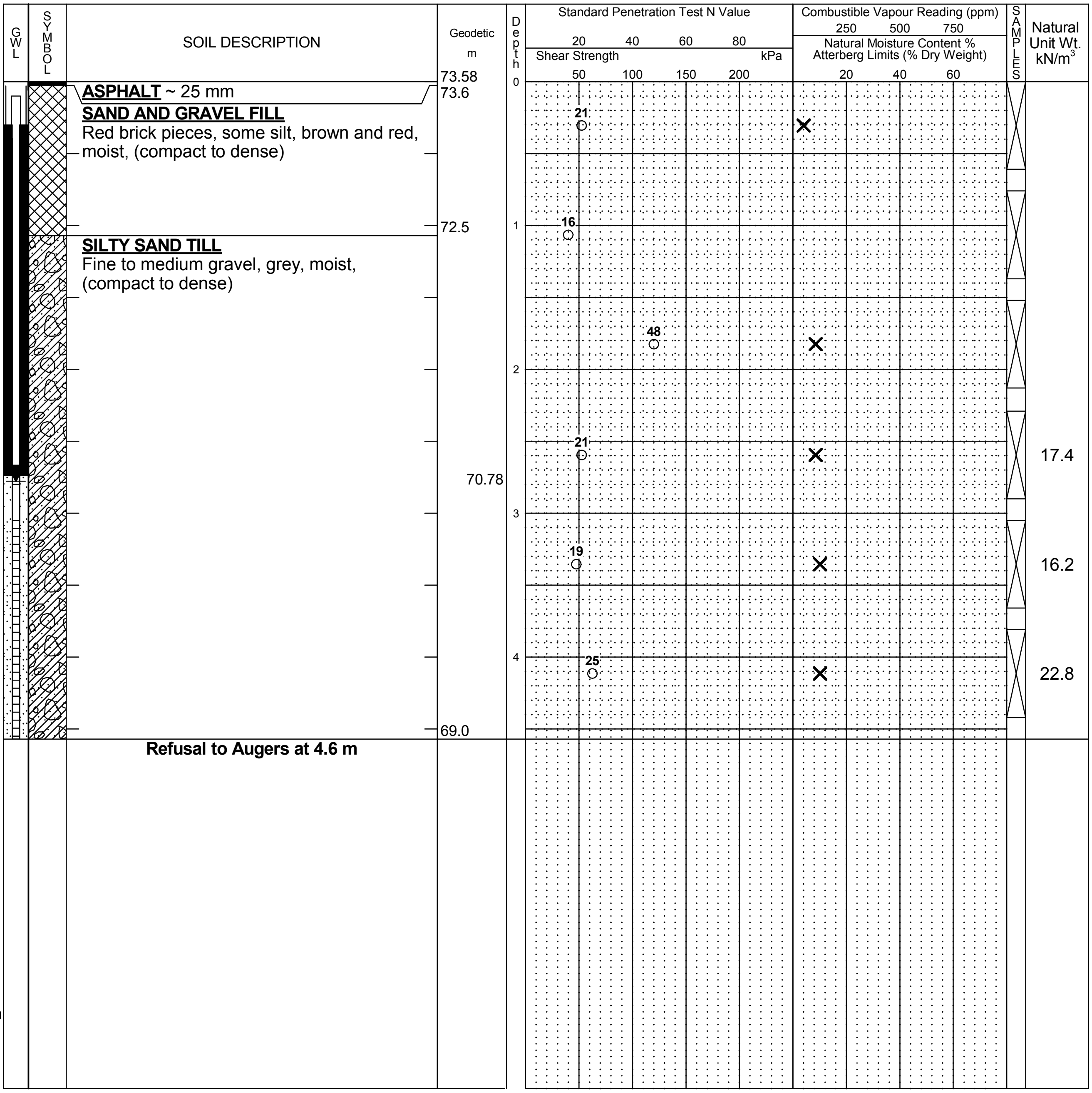
Date Drilled: 12/7/13

Drill Type: CME

Datum: Geodetic

Logged by: TG Checked by: SKA

Split Spoon Sample	☒	Combustible Vapour Reading	☐
Auger Sample	◨	Natural Moisture Content	✕
SPT (N) Value	○	Atterberg Limits	⊢○
Dynamic Cone Test	—	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■		
Shear Strength by Vane Test	+ S	Shear Strength by Penetrometer Test	▲



ASPHALT ~ 25 mm

SAND AND GRAVEL FILL

Red brick pieces, some silt, brown and red, moist, (compact to dense)

SILTY SAND TILL

Fine to medium gravel, grey, moist, (compact to dense)

Refusal to Augers at 4.6 m

NOTES:

1. Borehole data requires interpretation by exp. before use by others
2. A Monitoring Well with a 38mm diameter casing was installed in the borehole upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00215048-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
3 days	2.8	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH 5

Project No: OTT-00215048-A0

Project: Preliminary Geotechnical Investigation. Proposed Commercial and

Location: Residential Development. 383 Albert Street, Ottawa Ontario

Figure No. 7

Page. 1 of 1

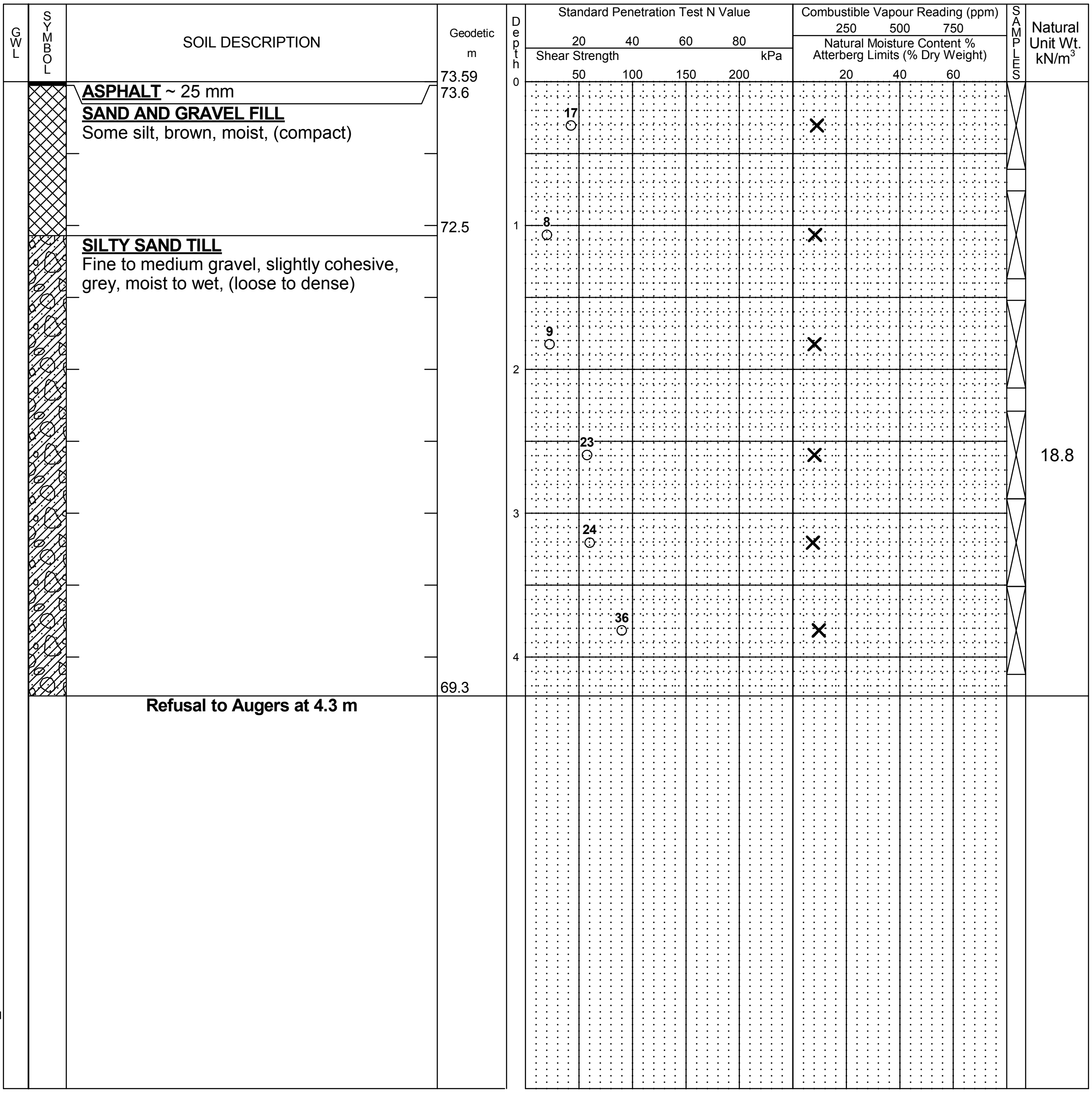
Date Drilled: 12/7/13

Drill Type: CME

Datum: Geodetic

Logged by: TG   Checked by: SKA

Split Spoon Sample	☒	Combustible Vapour Reading	☐
Auger Sample	◫	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	├─○
Dynamic Cone Test	───	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		



ASPHALT ~ 25 mm

SAND AND GRAVEL FILL
Some silt, brown, moist, (compact)

SILTY SAND TILL
Fine to medium gravel, slightly cohesive, grey, moist to wet, (loose to dense)

Refusal to Augers at 4.3 m

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. Hole was backfilled upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00215048-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole MW 6

Project No: OTT-00215048-A0

Project: Preliminary Geotechnical Investigation. Proposed Commercial and

Location: Residential Development. 383 Albert Street, Ottawa Ontario

Figure No. 8

Page. 1 of 1

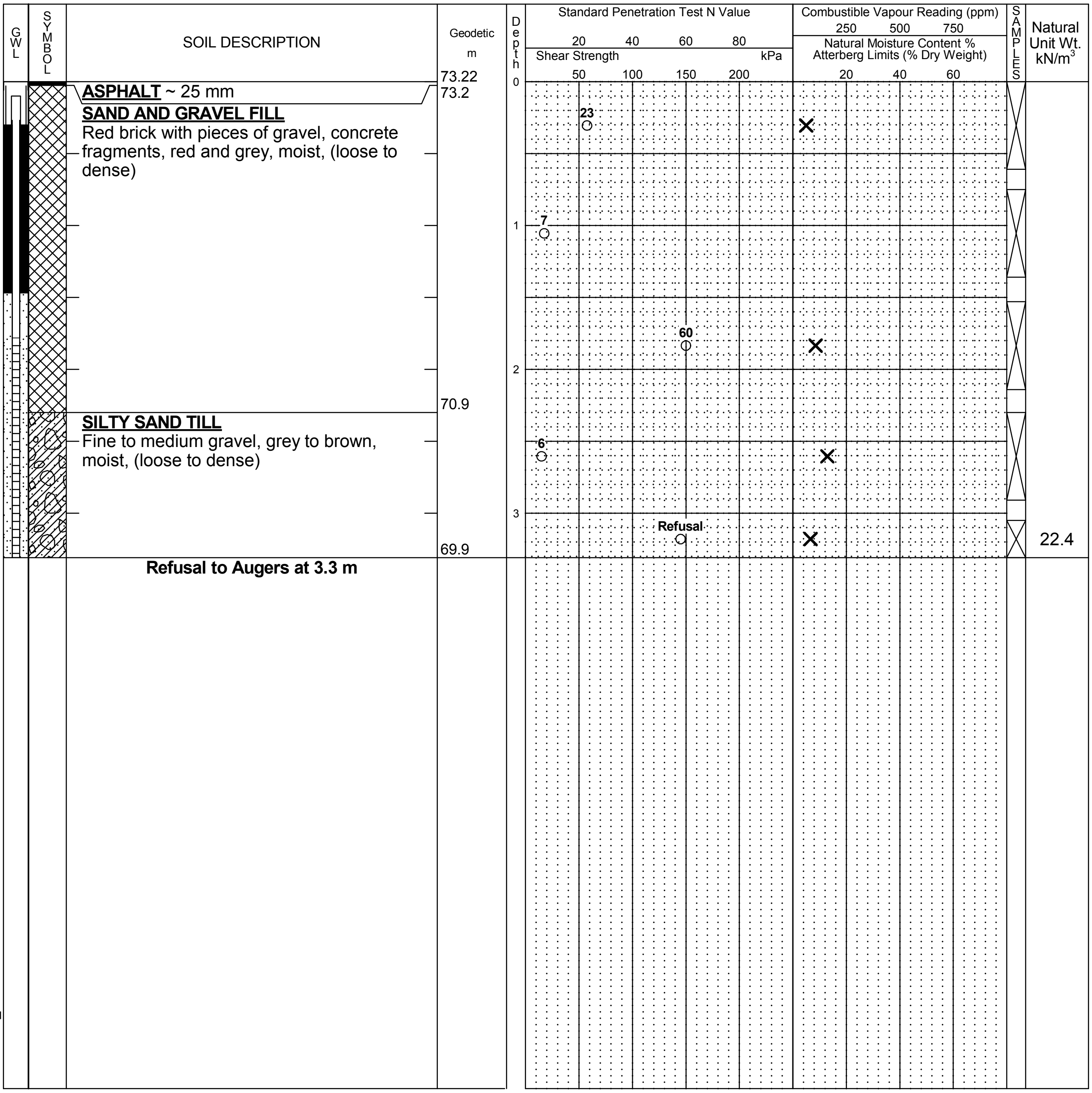
Date Drilled: 12/6/13

Drill Type: CME

Datum: Geodetic

Logged by: DC Checked by: SKA

Split Spoon Sample	☒	Combustible Vapour Reading	☐
Auger Sample	◨	Natural Moisture Content	✕
SPT (N) Value	○	Atterberg Limits	⊢○
Dynamic Cone Test	—	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■		
Shear Strength by Vane Test	+ S	Shear Strength by Penetrometer Test	▲



ASPHALT ~ 25 mm

SAND AND GRAVEL FILL
Red brick with pieces of gravel, concrete fragments, red and grey, moist, (loose to dense)

SILTY SAND TILL
Fine to medium gravel, grey to brown, moist, (loose to dense)

Refusal to Augers at 3.3 m

NOTES:
1. Borehole data requires interpretation by exp. before use by others
2. A Monitoring Well with a 38mm diameter casing was installed in the borehole upon completion.
3. Field work was supervised by an exp representative.
4. See Notes on Sample Descriptions
5. This Figure is to read with exp. Services Inc. report OTT-00215048-A0

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)
3 days	dry	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG4517-1 - TEST HOLE LOCATION PLAN

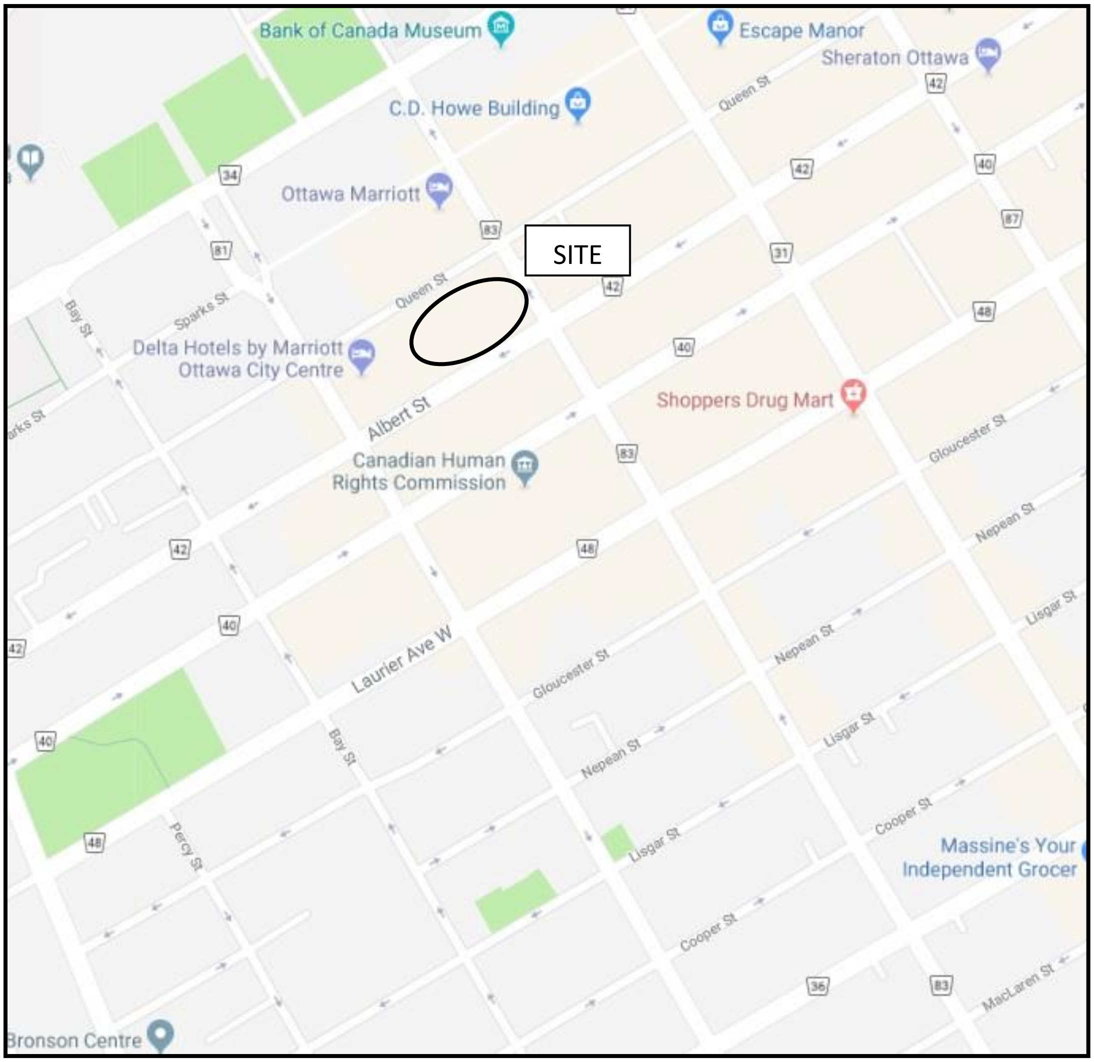
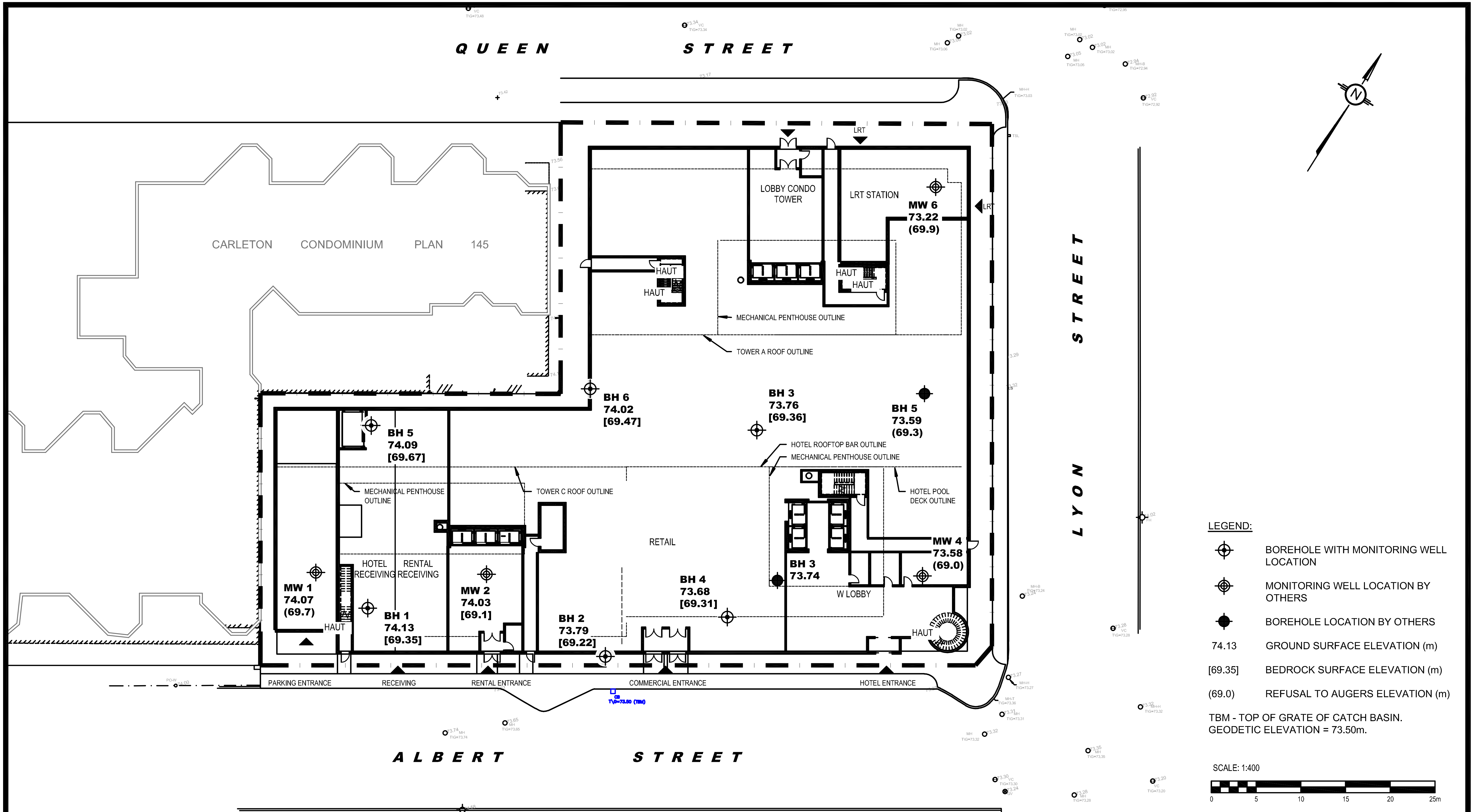


FIGURE 1

KEY PLAN



LEGEND:

⊕	BOREHOLE WITH MONITORING WELL LOCATION
⊕	MONITORING WELL LOCATION BY OTHERS
●	BOREHOLE LOCATION BY OTHERS
74.13	GROUND SURFACE ELEVATION (m)
[69.35]	BEDROCK SURFACE ELEVATION (m)
(69.0)	REFUSAL TO AUGERS ELEVATION (m)

TBM - TOP OF GRATE OF CATCH BASIN.
GEODETIC ELEVATION = 73.50m.

SCALE: 1:400

0 5 10 15 20 25m

p:\autocad drawings\geotechnical\pg45xx\pg4517\pg4517-1 thlp.dwg

patersongroup
consulting engineers

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Ottawa, Ontario K2E 7J5
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NO.	REVISIONS	DATE	INITIAL
0			

CLARIDGE HOMES
GEOTECHNICAL INVESTIGATION
PROP. MIXED-USE BUILDING - 383 ALBERT STREET
OTTAWA, ONTARIO

Title:
TEST HOLE LOCATION PLAN

Scale: 1:400	Date: 07/2018
Drawn by: MPG	Report No.: PG4517-1
Checked by: FA	Dwg. No.: PG4517-1
Approved by: FA	Revision No.: 0

APPENDIX 3

Noise and Vibration Feasibility Study
prepared by Gradient Wind Engineering Inc.
dated August 8, 2018

Transportation Noise & Vibration Feasibility Assessment

383 Albert Street & 340 Queen Street
Ottawa, Ontario

REPORT: GWE18-111 – Noise & Vibration

Prepared For:

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Claridge Homes
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Prepared By:

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Joshua Foster, P.Eng., Principal

August 8, 2018

EXECUTIVE SUMMARY

This document describes a transportation noise and vibration feasibility assessment performed for a proposed mixed-use development located at 383 Albert Street & 340 Queen Street in Ottawa, Ontario. The proposed development comprises three building components, referred to as Tower A Condo (26 storeys), Tower B Hotel (9 storeys), and Tower C Rental (26 storeys), which are connected by an 'L'- shaped 2-storey podium. Towers A, B, and C are situated clockwise beginning at the northeast corner of the site, respectively. Retail space is located at grade with hotel and residential amenity space and suites located on the remaining floors. Outdoor amenity space is provided atop the common podium, as well a atop Tower B as common terraces. The Confederation Line LRT will run underground along Queen street, just north of the site, which is a source of ground vibration. Major sources of transportation noise include roadway traffic along Lyon Street and Albert Street. Figure 1 illustrates a complete site plan with surrounding context.

The assessment is based on: (i) theoretical noise prediction methods that conform to the Ministry of the Environment, Conservation and Parks (MOECP) and City of Ottawa requirements; (ii) noise level criteria as specified by the City of Ottawa's Environmental Noise Control Guidelines (ENCG); and (iii) architectural drawings received from Neuf Architects, dated July 13, 2018.

The results of the current analysis indicate that noise levels will range between 39 and 70 dBA during the daytime period (07:00-23:00) and between 31 and 63 dBA during the nighttime period (23:00-07:00). The highest noise levels (i.e. 70 dBA) occur near the corner of Lyon Street and Albert Street.

The noise levels predicted due to roadway and LRT traffic exceed the criteria listed in Section 4.2 for building components. Upgraded building components, including STC rated glazing elements and exterior walls, will be required where noise levels exceed 65 dBA, as discussed in Section 4.2.1. Results of the calculations also indicate that the development will require air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment. In addition to ventilation requirements, Warning Clauses will also be required be placed on all Lease, Purchase and Sale Agreements. Specific noise control measures can be developed once the design of the building has progressed sufficiently, these are typically identified at the time of site plan control.

With regards to stationary noise impacts from roof top mechanical units, generators and other stationary sources associated with the development, on the proposed building and on surrounding noise-sensitive areas, once the mechanical plans for the proposed building become available, a stationary noise study will be performed. This study will include recommendations for any noise control measures that may be necessary to ensure noise levels at the proposed building and noise levels at the surrounding noise-sensitive buildings are below the City of Ottawa's Noise Guidelines. For this development potential equipment includes generators, roof top air-handling equipment, cooling towers or dry coolers, as well as refrigeration equipment for a possible grocery store tenant, located on the podium roof. Noise control for these units can be achieved by placing units away from noise-sensitive windows, judicious selection of quieter units, and introduction of silencers and noise screens.

Estimated vibration levels at the nearest property line to the LRT corridor are expected to be 0.06 mm/s RMS (67 dBV), based on the FTA protocol and a conservative offset distance of 13 m to the nearest track centerline. Details of the calculation are provided in Appendix B. Since predicted vibration levels do not exceed the criterion of 0.1 mm/s RMS at the property line, vibration mitigation would not be required. As vibration levels are acceptable, correspondingly regenerated noise levels are also expected to be acceptable.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (GWE) was retained by Claridge Homes to undertake a transportation noise and vibration feasibility assessment for a proposed mixed-use development located at 383 Albert Street & 340 Queen Street in Ottawa, Ontario. This report summarizes the methodology, results, and recommendations related to a transportation noise and vibration feasibility assessment, prepared in support of a rezoning application. GWE's scope of work involved assessing exterior noise and vibration levels generated by local roadway and railway traffic. The assessment was performed based on theoretical noise calculation methods conforming to the City of Ottawa[1] and Ministry of the Environment and Climate Change (MOECC)[2] guidelines. Noise calculations were based on architectural drawings received from Neuf Architects, dated July 13, 2018, with future roadway traffic volumes based on the City of Ottawa's Official Plan (OP) roadway classifications.

2. TERMS OF REFERENCE

The focus of this transportation noise and vibration feasibility assessment is the proposed mixed-use development located at 383 Albert Street & 340 Queen Street in Ottawa, Ontario. The study site is situated on a parcel of land bounded by Queen Street to the north, Lyon Street to the east, and Albert Street to the South. The Confederation Line LRT will run underground along Queen street, just north of the site, which is a source of ground vibration. Major sources of transportation noise include roadway traffic along Lyon Street and Albert Street. Figure 1 illustrates a site plan with surrounding context.

The proposed development comprises three building components, referred to as Tower A Condo (26 storeys), Tower B Hotel (9 storeys), and Tower C Rental (26 storeys), which are connected by an 'L'- shaped 2-storey podium. Towers A, B, and C are situated clockwise beginning at the northeast corner of the site, respectively. Retail space is located at grade with hotel and residential amenity space and suites located on the remaining floors. Outdoor amenity space is provided atop the common podium, as well a atop Tower B as common terraces. Private balconies are not considered to be noise sensitive unless they are greater than 4 metres in depth according to provincial noise guidelines.

---

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

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

3. OBJECTIVES

The main goals of this work are to: (i) calculate the future noise and vibration levels on the study building produced by local roadway and railway traffic, and (ii) determine whether noise and vibration levels exceed the allowable limits specified by the MOECP Noise Control Guidelines – NPC-300 as outlined in Section 4 of this report.

4. METHODOLOGY

4.1 Background

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

4.2 Roadway Traffic Noise

4.2.1 Criteria for Roadway Traffic Noise

For vehicle traffic, the equivalent sound energy level, L_{eq}, provides a measure of the time varying noise levels, which is well correlated with the annoyance of sound. It is defined as the continuous sound level, which has the same energy as a time varying noise level over a period of time. For roadways, the L_{eq} is commonly calculated on the basis of a 16-hour (L_{eq16}) daytime (07:00-23:00) / 8-hour (L_{eq8}) nighttime (23:00-07:00) split to assess its impact on residential buildings. The NPC-300 guidelines specify that the recommended indoor noise limit range (that is relevant to this study) is 50, 45 and 40 dBA for office space, residence living rooms/hotel sleeping quarters, and residence sleeping quarters respectively, as listed in Table 1. To account for deficiencies in building construction, theses levels should be targeted toward 47, 42 and 37 dBA.

TABLE 1: INDOOR SOUND LEVEL CRITERIA[3]

Type of Space	Time Period	L_{eq} (dBA)	
		Road	Rail
General offices, reception areas, retail stores, etc.	07:00 – 23:00	50	45
Living/dining/den areas of residences, hospitals, schools, nursing/retirement homes, day-care centres, theatres, places of worship, libraries, **individual or semi-private offices, conference rooms**, etc.	07:00 – 23:00	45	40
Sleeping quarters of hotels/motels	23:00 – 07:00	45	40
Sleeping quarters of residences, hospitals, nursing/retirement homes, etc.	23:00 – 07:00	40	35

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

For designated Outdoor Living Areas the sound level limit is 55 dBA during the daytime period. Only in cases were the required noise control measures are not feasible for technical, economic, or administrative reasons should an excess above the limit be acceptable.

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[3] Adapted from Table C-2, Part C, Section 3.2.3 of NPC-300

[4] Burberry, P.B. (2014). Mitchell's Environment and Services. Routledge, Page 125

[5] MOECC, Environmental Noise Guidelines, NPC 300 – Part C, Section 7.8

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

4.2.2 Roadway Traffic Volumes

The ENCG dictates that noise calculations should consider future sound levels based on a roadway's classification at the mature state of development. Therefore, traffic volumes are based on the roadway classifications outlined in the City of Ottawa's Official Plan (OP) and Transportation Master Plan[7] which provide additional details on future roadway expansions. Average Annual Daily Traffic (AADT) volumes are then based on data in Table B1 of the ENCG for each roadway classification. Table 2 (below) summarizes the AADT values used for each roadway included in this assessment.

TABLE 2: ROADWAY TRAFFIC DATA

Segment	Roadway Class	Speed Limit (km/h)	ENCG AADT Count
Lyon Street	2-UAU	50	**15,000**
Albert Street	2-UAU	50	**15,000**

4.2.3 Theoretical Roadway Traffic Noise Predictions

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

- Truck traffic on all roadways was taken to comprise 5% heavy trucks and 7% medium trucks, as per ENCG requirements for noise level predictions.
- Reflective intermediate ground surfaces used.
- Receptor heights placed at 1.5, 16, 32.5, 42.5 and 79.5 m for ground floor, 3rd Floor, 9th Floor, 13th Floor and 26th Floor respectively.
- Surrounding buildings used as noise barriers.
- The study site was treated as having flat/gently slopping topography.
- Noise receptors were strategically placed at 20 locations around the study area as illustrated in Figure 2.

---

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

4.3 Ground Vibrations

4.3.1 Ground Vibrations Background

Rail lines and transit systems can produce perceptible levels of ground vibrations, especially when they are in close proximity to residential neighbourhoods. Similar to sound waves in air, ground vibrations 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 excitation of the ground (from a train for instance). Repetitive motion of steel wheels on uneven rail cause vibrations to propagate through the soil until they encounter a building. The vibrations travel along the structure of the building, beginning at the foundation, and propagate to all floor levels. Air inside the building is also excited by the vibrating walls and floors and creates regenerated airborne noise. Characteristics of the soil and the building dictate the tone and intensity of the noise, thereby creating a noise signature that is unique to that structure and soil combination.

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 inches per second (in/s). The threshold level of human perception to vibrations is approximately 0.10 mm/s RMS. Although somewhat variable among humans, the threshold of annoyance for continuous vibrations is 1.0 mm/s RMS; this is ten times higher than the perception threshold. The threshold for cosmetic building damage is greater than 30 mm/s, at least three hundred times higher than the perception threshold level[8].

4.3.2 Ground Vibrations Criteria

In the United States, the Federal Transportation Authority (FTA) has set vibration criteria for sensitive land use next to Transit corridors. Similar standards have been developed by a partnership between the

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[8] C.H. Dowding, Blast Vibration Monitoring & Control, Prentice Hall, 1985

MOECP and the Toronto Transit Commission[9]. These standards indicate that the appropriate criteria for residential buildings is 0.10 mm/s RMS for vibrations. For main line railways, a document titled Guidelines for New Development in Proximity to Railway Operations[10] 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. As the main vibration source is due to the LRT lines, which will have frequent events, the 0.10 mm/s RMS (72 dBV) vibration criteria and 35 dBA ground borne noise criteria were adopted for this study.

4.3.3 Theoretical Ground Vibration Predictions

Potential vibration impacts of trains were predicted using the FTA's *Transit Noise and Vibration Impact Assessment*[11] 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 on page 11, 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 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:

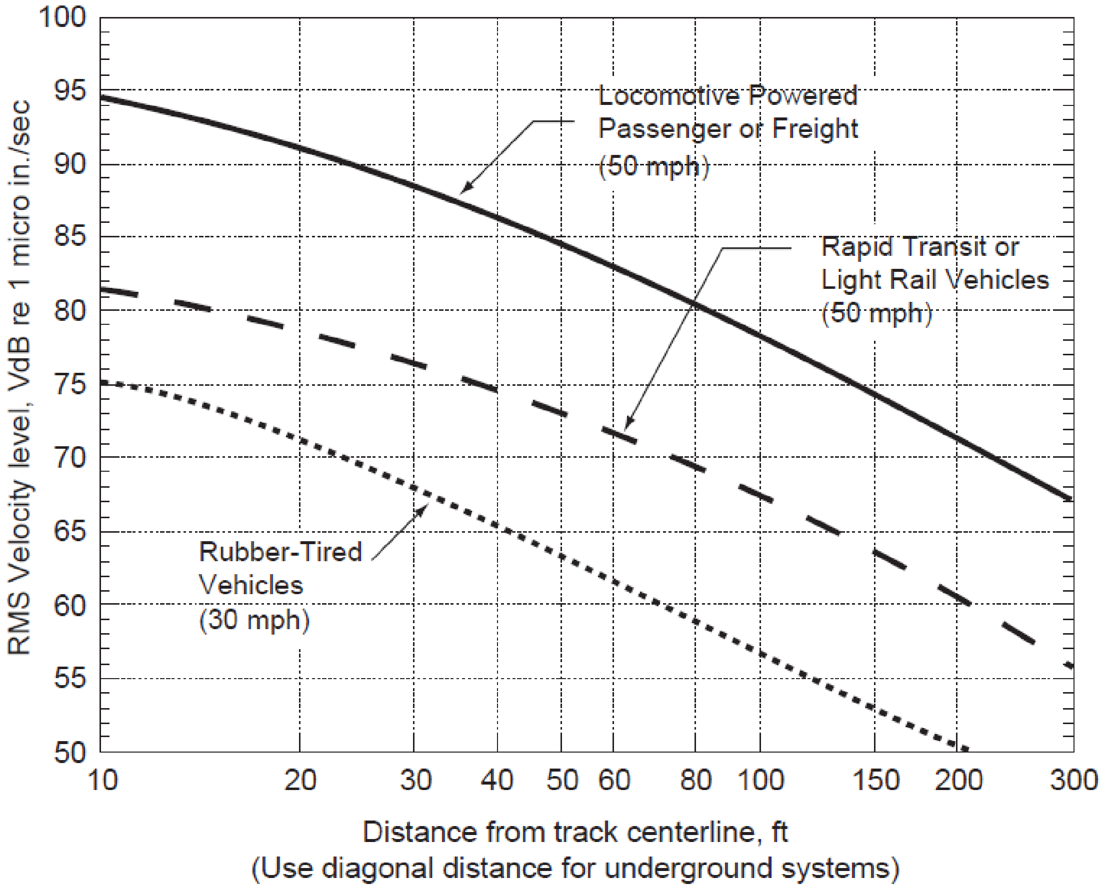
- The maximum operating speed of the LRT near the study area is 70 km/h (43 mph)
- The distance between the development and the closest track is 13 m
- The vehicles are assumed to have soft primary suspensions
- Tracks are not welded though in otherwise good condition
- Soil conditions do not efficiently propagate vibrations
- The building's foundation is large masonry on piles

---

[9] MOECC/TTC Protocol for Noise and Vibration Assessment for the Proposed Yonge-Spadina Subway Loop, June 16, 1993

[10] Dialog and J.E. Coulter Associates Limited, prepared for The Federation of Canadian Municipalities and The Railway Associated of Canada, May 2013

[11] C. E. Hanson; D. A. Towers; and L. D. Meister, Transit Noise and Vibration Impact Assessment, Federal Transit Administration, May 2006.



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

5. RESULTS AND DISCUSSION

5.1 Roadway Traffic Noise Levels

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

TABLE 3: EXTERIOR NOISE LEVELS DUE TO TRANSPORTATION SOURCES

Receptor Number	Receptor Location	Roadway Noise Levels (dBA)	
		Day	Night
1	Ground Floor – Podium – East Façade	70	63
2	Ground Floor – Podium – South Façade	70	63
3	13th Floor – Tower A – North Façade	65	58
4	13th Floor – Tower A – East Façade	69	61
5	13th Floor – Tower A – South Façade	65	58
6	13th Floor – Tower A – West Façade	39	31
7	13th Floor – Tower C – North Façade	40	33
8	13th Floor – Tower C – East Façade	65	58
9	13th Floor – Tower C – South Façade	69	61
10	13th Floor – Tower C – West Façade	65	58
11	26th Floor – Tower A – North Façade	65	58
12	26th Floor – Tower A – East Façade	69	61
13	26th Floor – Tower A – South Façade	66	58
14	26th Floor – Tower A – West Façade	39	31
15	26th Floor – Tower C – North Façade	41	33
16	26th Floor – Tower C – East Façade	67	60
17	26th Floor – Tower C – South Façade	69	61
18	26th Floor – Tower C – West Façade	65	58
19	3rd Floor – Podium – Rooftop Terrace	48	40
20	9th Floor – Tower B – Rooftop Terrace	54	47

The results of the current analysis indicate that noise levels will range between 39 and 70 dBA during the daytime period (07:00-23:00) and between 31 and 63 dBA during the nighttime period (23:00-07:00). The highest noise levels (i.e. 70 dBA) occur near the corner of Lyon Street and Albert Street.

The noise levels predicted due to roadway and railway traffic exceed the criteria listed in Section 4.2 for building components. Upgraded building components, including STC rated glazing elements and exterior walls, will be required where noise levels exceed 65 dBA, as discussed in Section 4.2.1. Results of the calculations also indicate that the development will require air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment. In addition to ventilation requirements, Warning Clauses will also be required be placed on all Lease, Purchase and Sale Agreements. Specific noise control measures can be developed once the design of the building has progressed sufficiently, these are typically identified at the time of site plan control.

5.2 Ground Vibrations & Ground-Borne Noise Levels

Estimated vibration levels at the nearest property line to the LRT corridor are expected to be 0.06 mm/s RMS (67 dBV), based on the FTA protocol and a conservative offset distance of 13 m to the nearest railway track centerline. Details of the calculation are provided in Appendix B. Since predicted vibration levels do not exceed the criterion of 0.1 mm/s RMS at the property line, vibration mitigation would not be required. As vibration levels are acceptable, correspondingly regenerated noise levels are also expected to be acceptable.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current analysis indicate that noise levels will range between 39 and 70 dBA during the daytime period (07:00-23:00) and between 31 and 63 dBA during the nighttime period (23:00-07:00). The highest noise levels (i.e. 70 dBA) occur near the corner of Lyon Street and Albert Street.

The noise levels predicted due to roadway and railway traffic exceed the criteria listed in Section 4.2 for building components. Upgraded building components, including STC rated glazing elements and exterior walls, will be required where noise levels exceed 65 dBA, as discussed in Section 4.2.1. Results of the calculations also indicate that the development will require air conditioning, which will allow occupants to keep windows closed and maintain a comfortable living environment. In addition to ventilation requirements, Warning Clauses will also be required be placed on all Lease, Purchase and Sale Agreements. Specific noise control measures can be developed once the design of the building has progressed sufficiently, these are typically identified at the time of site plan control.

With regards to stationary noise impacts from roof top mechanical units, generators and other stationary sources associated with the development, on the proposed building and on surrounding noise-sensitive areas, once the mechanical plans for the proposed building become available, a stationary noise study will be performed. This study will include recommendations for any noise control measures that may be necessary to ensure noise levels at the proposed building and noise levels at the surrounding noise-sensitive buildings are below the City of Ottawa's Noise Guidelines. For this development potential equipment includes generators, roof top air-handling equipment, cooling towers or dry coolers, as well as refrigeration equipment for a possible grocery store tenant, located on the podium roof. Noise control for these units can be achieved by placing units away from noise-sensitive windows, judicious selection of quieter units, and introduction of silencers and noise screens.

Estimated vibration levels at the nearest property line to the LRT corridor are expected to be 0.06 mm/s RMS (67 dBV), based on the FTA protocol and a conservative offset distance of 13 m to the nearest railway track centerline. Details of the calculation are provided in Appendix B. Since predicted vibration levels do not exceed the criterion of 0.14 mm/s RMS at the property line, vibration mitigation would not be required. As vibration levels are acceptable, correspondingly regenerated noise levels are also expected to be acceptable.

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.

Michael Lafortune, C.E.T.
Environmental Scientist
GWE18-111 – Noise & Vibration

LICENSED PROFESSIONAL ENGINEER
J. R. FOSTER
100155655
Aug 8, 2018
PROVINCE OF ONTARIO

Joshua Foster, P.Eng.
Principal

127 Walgreen Road
Ottawa, Ontario
(613) 836 0934

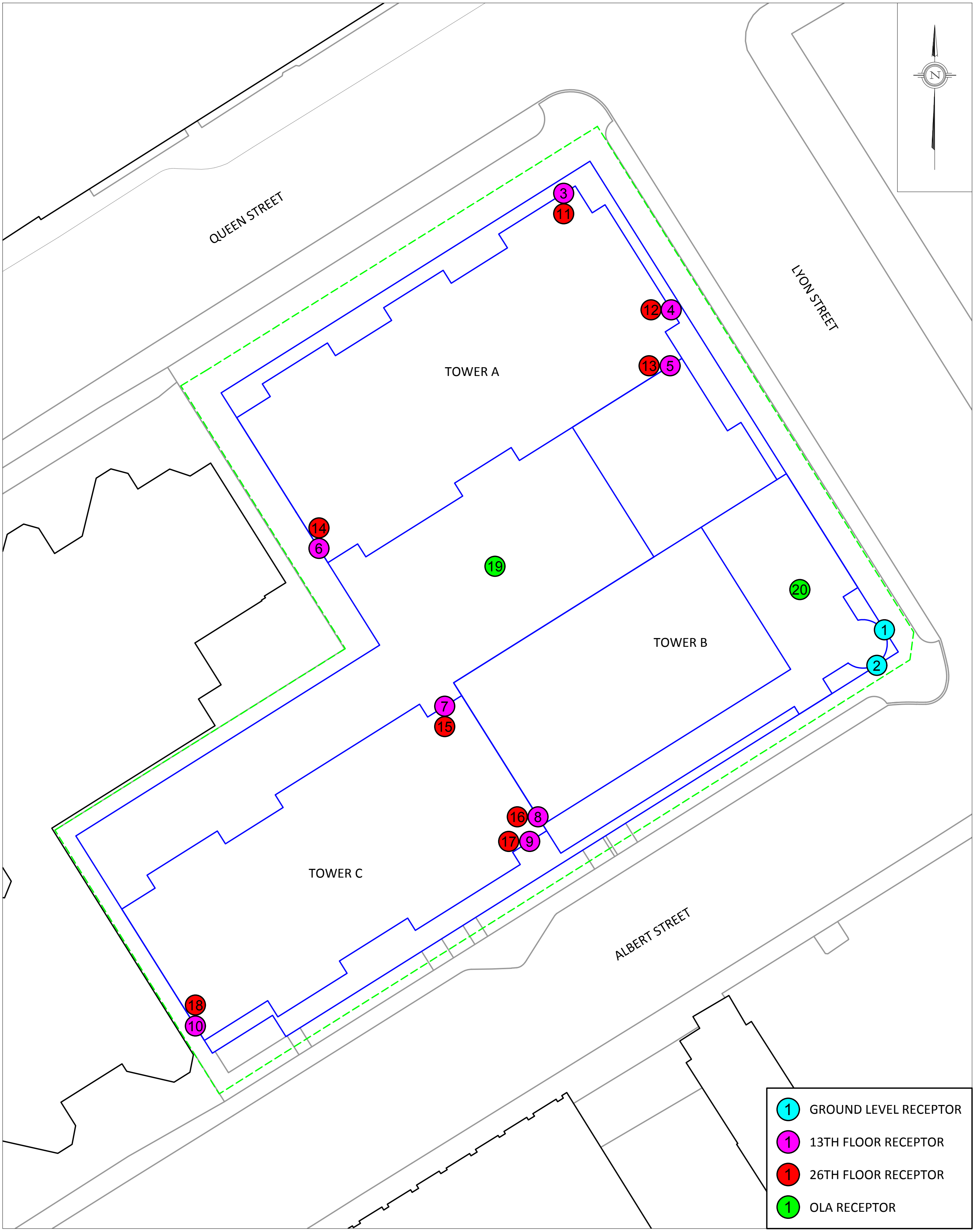
PROJECT
383 ALBERT STREET & 340 QUEEN STREET
TRANSPORTATION NOISE & VIBRATION FEASIBILITY ASSESSMENT

SCALE	DRAWING NO.
1:1000 (APPROX.)	GWE18-111-1

DATE	DRAWN BY
JULY 18, 2018	M.L.

DESCRIPTION

FIGURE 1:
SITE PLAN AND SURROUNDING CONTEXT



GWE
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PROJECT
383 ALBERT STREET & 340 QUEEN STREET
TRANSPORTATION NOISE & VIBRATION FEASIBILITY ASSESSMENT

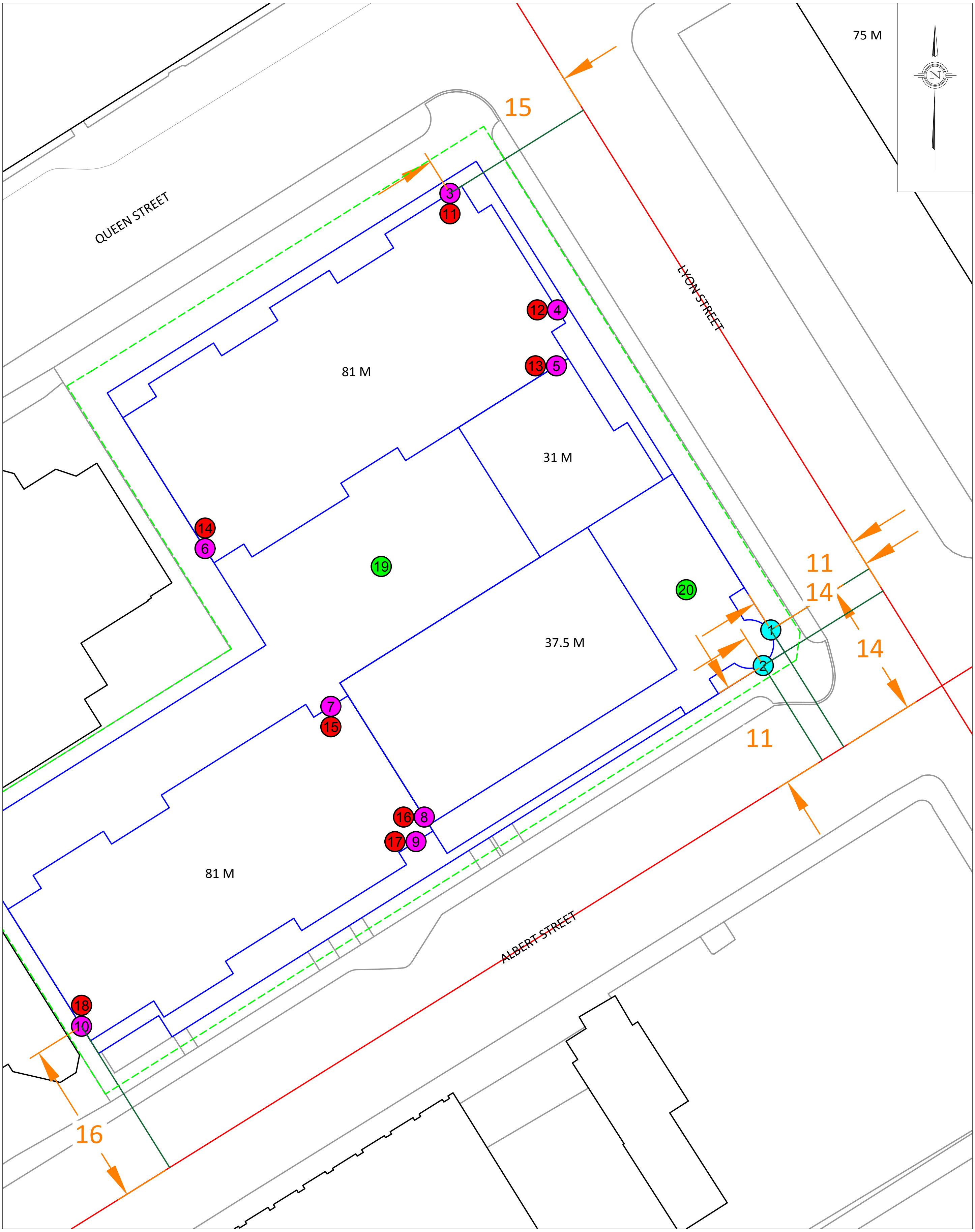
SCALE 1:500 (APPROX.)

DRAWING NO. GWE18-111-2

DATE JULY 18, 2018

DRAWN BY M.L.

DESCRIPTION
FIGURE 2:
RECEPTOR LOCATIONS



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PROJECT
383 ALBERT STREET & 340 QUEEN STREET
TRANSPORTATION NOISE & VIBRATION FEASIBILITY ASSESSMENT

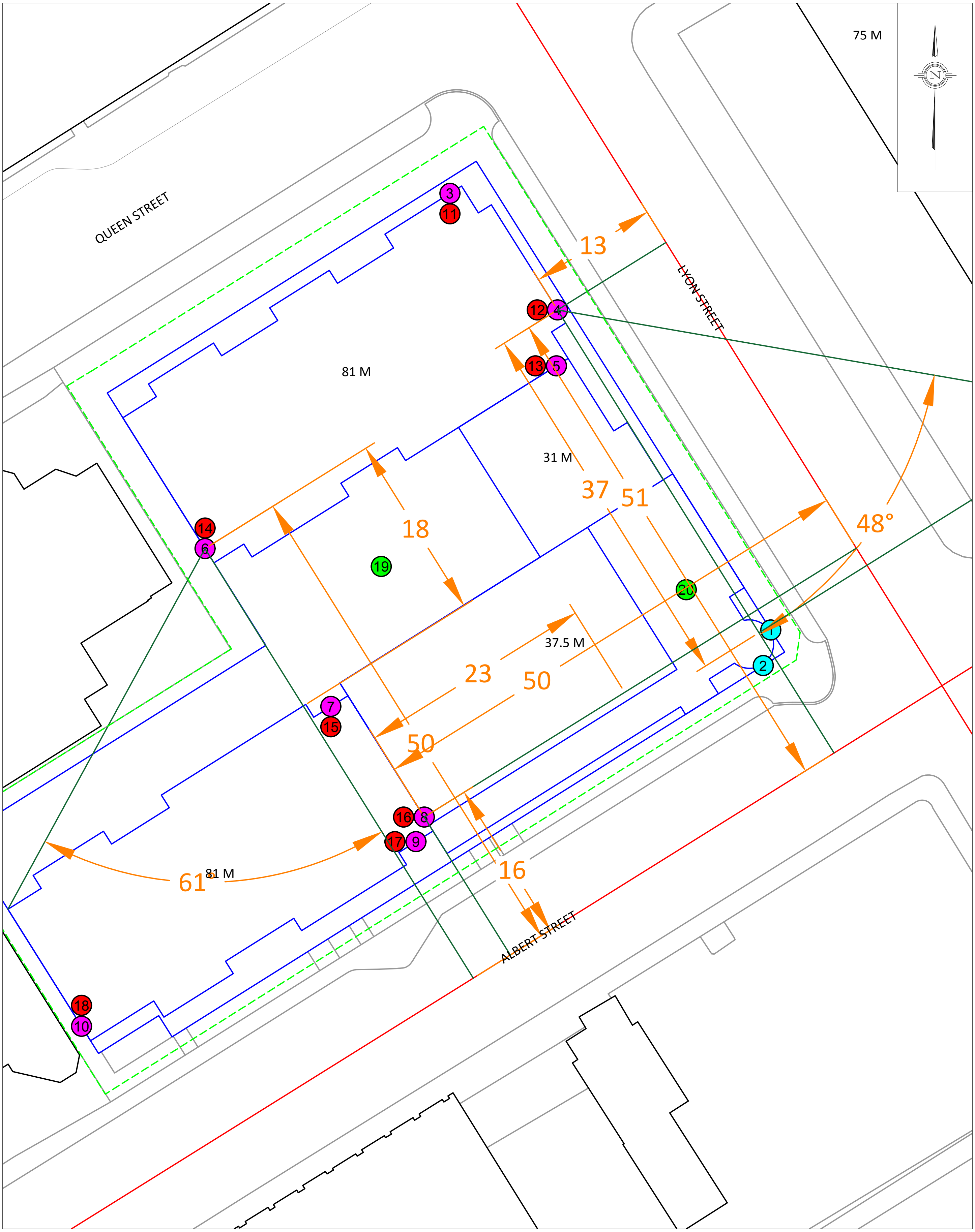
SCALE
1:500 (APPROX.)

DRAWING NO.
GWE18-111-3

DATE
JULY 18, 2018

DRAWN BY
M.L.

DESCRIPTION
FIGURE 3:
STAMSON INPUT - RECEPTOR 1, 2, 3, 10, 11, 18



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PROJECT
383 ALBERT STREET & 340 QUEEN STREET
TRANSPORTATION NOISE & VIBRATION FEASIBILITY ASSESSMENT

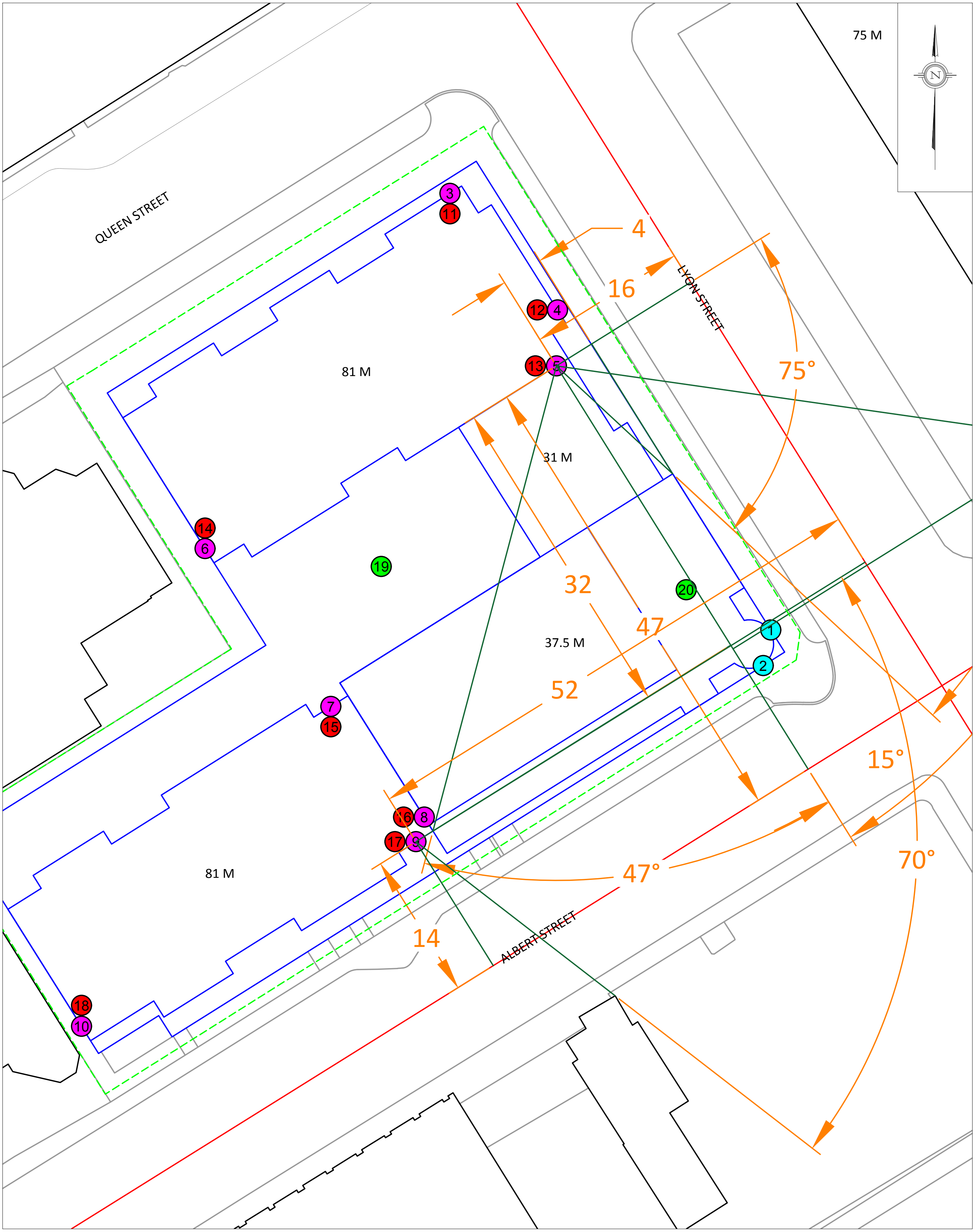
SCALE
1:500 (APPROX.)

DRAWING NO.
GWE18-111-4

DATE
JULY 18, 2018

DRAWN BY
M.L.

DESCRIPTION
FIGURE 4:
STAMSON INPUT - RECEPTOR 4, 6, 8, 12, 14, 16



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383 ALBERT STREET & 340 QUEEN STREET
TRANSPORTATION NOISE & VIBRATION FEASIBILITY ASSESSMENT

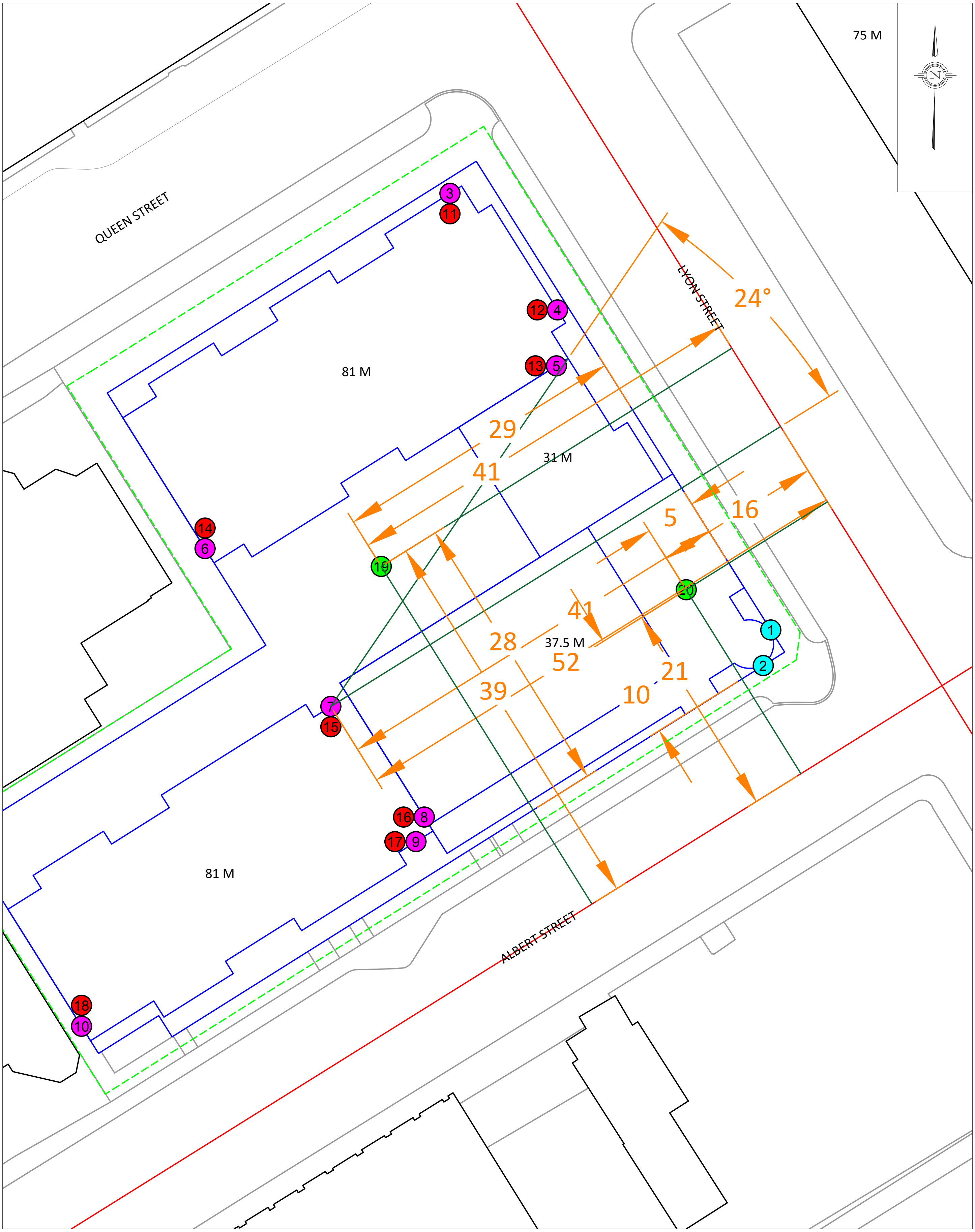
SCALE 1:500 (APPROX.)

DRAWING NO. GWE18-111-5

DATE JULY 18, 2018

DRAWN BY M.L.

DESCRIPTION
FIGURE 5:
STAMSON INPUT - RECEPTOR 5, 9, 13, 17



GRADIENT WIND
ENGINEERING INC

127 Walgreen Road
Ottawa, Ontario
(613) 836 0934

PROJECT	383 ALBERT STREET & 340 QUEEN STREET TRANSPORTATION NOISE & VIBRATION FEASIBILITY ASSESSMENT
SCALE	1:500 (APPROX.)
DRAWING NO.	GWE18-111-6
DATE	JULY 18, 2018
DRAWN BY	M.L.
DESCRIPTION	FIGURE 6: STAMSON INPUT - RECEPTOR 7, 15, 19, 20

APPENDIX A

STAMSON 5.04 INPUT AND OUTPUT DATA

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 15:36:13
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Lyon (day/night)
----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon (day/night)
--------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  15.00 / 15.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 2: Albert (day/night)
------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Albert (day/night)
----------------------------------------
Angle1   Angle2           : -90.00 deg   0.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  15.00 / 15.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 68.48 + 0.00) = 68.48 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  68.48   0.00   0.00   0.00   0.00   0.00   0.00
68.48
--------------------------------------------------------------------------
--

Segment Leq : 68.48 dBA
```

```
Results segment # 2: Albert (day)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 65.47 + 0.00) = 65.47 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90      0   0.00  68.48   0.00   0.00  -3.01   0.00   0.00   0.00
65.47
--------------------------------------------------------------------------
--

Segment Leq : 65.47 dBA

Total Leq All Segments: 70.24 dBA
```

```
Results segment # 1: Lyon (night)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 60.88 + 0.00) = 60.88 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
------------------------------------------------------------------------
--
   -90     90   0.00  60.88   0.00   0.00   0.00   0.00   0.00   0.00
60.88
------------------------------------------------------------------------
--

Segment Leq : 60.88 dBA
```

```
Results segment # 2: Albert (night)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 57.87 + 0.00) = 57.87 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90      0   0.00  60.88   0.00   0.00  -3.01   0.00   0.00   0.00
57.87
--------------------------------------------------------------------------
--

Segment Leq : 57.87 dBA

Total Leq All Segments: 62.64 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 70.24
                         (NIGHT): 62.64
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 33:09:17
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Lyon (day/night)
----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon (day/night)
--------------------------------------
Angle1   Angle2           :   0.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  15.00 / 15.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 2: Albert (day/night)
------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Albert (day/night)
----------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  15.00 / 15.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 65.47 + 0.00) = 65.47 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
     0     90   0.00  68.48   0.00   0.00  -3.01   0.00   0.00   0.00
65.47
----------------------------------------------------------------------------
--

Segment Leq : 65.47 dBA
```

```
Results segment # 2: Albert (day)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 68.48 + 0.00) = 68.48 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  68.48   0.00   0.00   0.00   0.00   0.00   0.00
68.48
--------------------------------------------------------------------------
--

Segment Leq : 68.48 dBA

Total Leq All Segments: 70.24 dBA
```

```
Results segment # 1: Lyon (night)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 57.87 + 0.00) = 57.87 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
     0     90   0.00  60.88   0.00   0.00  -3.01   0.00   0.00   0.00
57.87
--------------------------------------------------------------------------
--

Segment Leq : 57.87 dBA
```

```
Results segment # 2: Albert (night)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 60.88 + 0.00) = 60.88 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90     90   0.00  60.88   0.00   0.00   0.00   0.00   0.00   0.00
60.88
-------------------------------------------------------------------------
--

Segment Leq : 60.88 dBA

Total Leq All Segments: 62.64 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 70.24
                         (NIGHT): 62.64
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 33:09:57
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Lyon (day/night)
----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon (day/night)
--------------------------------------
Angle1   Angle2            : -90.00 deg   0.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  15.00 / 15.00  m
Receiver height            :  42.50 / 42.50  m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 65.47 + 0.00) = 65.47 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90      0   0.00  68.48   0.00   0.00  -3.01   0.00   0.00   0.00
65.47
--------------------------------------------------------------------------
--

Segment Leq : 65.47 dBA

Total Leq All Segments: 65.47 dBA
```

```
Results segment # 1: Lyon (night)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 57.87 + 0.00) = 57.87 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90      0   0.00  60.88   0.00   0.00  -3.01   0.00   0.00   0.00
57.87
--------------------------------------------------------------------------
--

Segment Leq : 57.87 dBA

Total Leq All Segments: 57.87 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 65.47
                         (NIGHT): 57.87
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 33:10:01
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Lyon (day/night)
----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon (day/night)
--------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  15.00 / 15.00  m
Receiver height           :  42.50 / 42.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 2: Albert (day/night)
------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Albert (day/night)
----------------------------------------
Angle1   Angle2           : -90.00 deg   0.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  51.00 / 51.00  m
Receiver height           :  42.50 / 42.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -48.00 deg
Barrier height            :  75.00 m
Barrier receiver distance :  37.00 / 37.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 68.48 + 0.00) = 68.48 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  68.48   0.00   0.00   0.00   0.00   0.00   0.00
68.48
--------------------------------------------------------------------------
--

Segment Leq : 68.48 dBA
```

```
Results segment # 2: Albert (day)
---------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       1.50 !       42.50 !       12.75 !        12.75

ROAD (0.00 + 37.32 + 57.42) = 57.47 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-----------------------------------------------------------------------------
--
   -90    -48   0.00  68.48   0.00  -5.31  -6.32   0.00   0.00 -19.53
37.32
-----------------------------------------------------------------------------
--
   -48      0   0.00  68.48   0.00  -5.31  -5.74   0.00   0.00   0.00
57.42
-----------------------------------------------------------------------------
--

Segment Leq : 57.47 dBA

Total Leq All Segments: 68.81 dBA
```

```
Results segment # 1: Lyon (night)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 60.88 + 0.00) = 60.88 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  60.88   0.00   0.00   0.00   0.00   0.00   0.00
60.88
--------------------------------------------------------------------------
--

Segment Leq : 60.88 dBA
```

```
Results segment # 2: Albert (night)
-----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       1.50 !       42.50 !       12.75 !        12.75

ROAD (0.00 + 29.72 + 49.83) = 49.87 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -48   0.00  60.88   0.00  -5.31  -6.32   0.00   0.00 -19.53
29.72
--------------------------------------------------------------------------
--
   -48      0   0.00  60.88   0.00  -5.31  -5.74   0.00   0.00   0.00
49.83
--------------------------------------------------------------------------
--

Segment Leq : 49.87 dBA

Total Leq All Segments: 61.21 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 68.81
                         (NIGHT): 61.21
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 33:10:06
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Lyon (day/night)
----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon (day/night)
--------------------------------------
Angle1   Angle2           :   0.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  16.00 / 16.00  m
Receiver height           :  42.50 / 42.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :  75.00 deg   Angle2 : 90.00 deg
Barrier height            :  37.50 m
Barrier receiver distance :   4.00 / 4.00   m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 2: Albert1 (day/night)
-------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Albert1 (day/night)
-----------------------------------------
Angle1   Angle2           : -90.00 deg   -15.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  47.00 / 47.00  m
Receiver height           :  42.50 / 42.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -50.00 deg
Barrier height            :  75.00 m
Barrier receiver distance :  32.00 / 32.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 3: Albert2 (day/night)
-------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 3: Albert2 (day/night)
-----------------------------------------
Angle1   Angle2           : -15.00 deg   47.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  47.00 / 47.00  m
Receiver height           :  42.50 / 42.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -15.00 deg   Angle2 : 47.00 deg
Barrier height            :  37.50 m
Barrier receiver distance :  32.00 / 32.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 4: Albert3 (day/night)
-------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 4: Albert3 (day/night)
-----------------------------------------
Angle1   Angle2            :  47.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  47.00 / 47.00  m
Receiver height            :  42.50 / 42.50  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             :  47.00 deg   Angle2 : 90.00 deg
Barrier height             :  81.00 m
Barrier receiver distance  :  32.00 / 32.00  m
Source elevation           :   0.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00
```

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

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       42.50 !       32.25 !        32.25

ROAD (64.40 + 50.62 + 0.00) = 64.58 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
     0     75   0.00  68.48   0.00  -0.28  -3.80   0.00   0.00   0.00
64.40
--------------------------------------------------------------------------
--
    75     90   0.00  68.48   0.00  -0.28 -10.79   0.00   0.00  -6.78
50.62
--------------------------------------------------------------------------
--

Segment Leq : 64.58 dBA
```

```
Results segment # 2: Albert1 (day)
----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       42.50 !       14.58 !        14.58

ROAD (0.00 + 37.49 + 56.41) = 56.46 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -50   0.00  68.48   0.00  -4.96  -6.53   0.00   0.00 -19.50
37.49
--------------------------------------------------------------------------
--
   -50    -15   0.00  68.48   0.00  -4.96  -7.11   0.00   0.00   0.00
56.41
--------------------------------------------------------------------------
--

Segment Leq : 56.46 dBA
```

```
Results segment # 3: Albert2 (day)
----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
-------------+--------------+--------------+---------------
       1.50 !       42.50 !       14.58 !        14.58

ROAD (0.00 + 38.89 + 0.00) = 38.89 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
---------------------------------------------------------------------------
--
   -15     47   0.00  68.48   0.00  -4.96  -4.63   0.00   0.00 -20.00
38.89
---------------------------------------------------------------------------
--

Segment Leq : 38.89 dBA
```

```
Results segment # 4: Albert3 (day)
----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       42.50 !       14.58 !        14.58

ROAD (0.00 + 37.70 + 0.00) = 37.70 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
    47     90   0.00  68.48   0.00  -4.96  -6.22   0.00   0.00 -19.60
37.70
--------------------------------------------------------------------------
--

Segment Leq : 37.70 dBA

Total Leq All Segments: 65.22 dBA
```

```
Results segment # 1: Lyon (night)
---------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       42.50 !       32.25 !        32.25

ROAD (56.80 + 43.03 + 0.00) = 56.98 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
     0     75   0.00  60.88   0.00  -0.28  -3.80   0.00   0.00   0.00
56.80
--------------------------------------------------------------------------
--
    75     90   0.00  60.88   0.00  -0.28 -10.79   0.00   0.00  -6.78
43.03
--------------------------------------------------------------------------
--

Segment Leq : 56.98 dBA
```

```
Results segment # 2: Albert1 (night)
------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
-------------+--------------+--------------+---------------
       1.50 !        42.50 !        14.58 !         14.58

ROAD (0.00 + 29.89 + 48.81) = 48.87 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -50   0.00  60.88   0.00  -4.96  -6.53   0.00   0.00 -19.50
29.89
--------------------------------------------------------------------------
--
   -50    -15   0.00  60.88   0.00  -4.96  -7.11   0.00   0.00   0.00
48.81
--------------------------------------------------------------------------
--

Segment Leq : 48.87 dBA
```

```
Results segment # 3: Albert2 (night)
------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
-------------+--------------+--------------+---------------
        1.50 !        42.50 !        14.58 !         14.58

ROAD (0.00 + 31.29 + 0.00) = 31.29 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -15     47   0.00  60.88   0.00  -4.96  -4.63   0.00   0.00 -20.00
31.29
--------------------------------------------------------------------------
--

Segment Leq : 31.29 dBA
```

```
Results segment # 4: Albert3 (night)
------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
-------------+--------------+--------------+---------------
       1.50 !        42.50 !        14.58 !         14.58

ROAD (0.00 + 30.10 + 0.00) = 30.10 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
    47     90   0.00  60.88   0.00  -4.96  -6.22   0.00   0.00 -19.60
30.10
--------------------------------------------------------------------------
--

Segment Leq : 30.10 dBA

Total Leq All Segments: 57.62 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 65.22
                         (NIGHT): 57.62
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 33:10:14
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Albert (day/night)
------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Albert (day/night)
----------------------------------------
Angle1   Angle2           :   0.00 deg   61.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  50.00 / 50.00  m
Receiver height           :  42.50 / 42.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :   0.00 deg   Angle2 : 61.00 deg
Barrier height            :  81.00 m
Barrier receiver distance :  18.00 / 18.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

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

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
------------+--------------+--------------+--------------
       1.50 !        42.50 !        27.74 !        27.74

ROAD (0.00 + 38.55 + 0.00) = 38.55 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
     0     61   0.00  68.48   0.00  -5.23  -4.70   0.00   0.00 -20.00
38.55
--------------------------------------------------------------------------
--

Segment Leq : 38.55 dBA

Total Leq All Segments: 38.55 dBA
```

```
Results segment # 1: Albert (night)
-----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       42.50 !       27.74 !        27.74

ROAD (0.00 + 30.96 + 0.00) = 30.96 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
     0     61   0.00  60.88   0.00  -5.23  -4.70   0.00   0.00 -20.00
30.96
--------------------------------------------------------------------------
--

Segment Leq : 30.96 dBA

Total Leq All Segments: 30.96 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 38.55
                         (NIGHT): 30.96
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 33:10:19
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Lyon1 (day/night)
-----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon1 (day/night)
---------------------------------------
Angle1   Angle2           : -90.00 deg   -24.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  52.00 / 52.00  m
Receiver height           :  42.50 / 42.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -24.00 deg
Barrier height            :  81.00 m
Barrier receiver distance :  41.00 / 41.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 2: Lyon1 (day/night)
-----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Lyon1 (day/night)
---------------------------------------
Angle1   Angle2            : -24.00 deg   0.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  52.00 / 52.00  m
Receiver height            :  42.50 / 42.50  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             : -24.00 deg   Angle2 : 0.00 deg
Barrier height             :  31.00 m
Barrier receiver distance  :  41.00 / 41.00  m
Source elevation           :   0.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00
```

```
Results segment # 1: Lyon1 (day)
--------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       42.50 !       10.17 !        10.17

ROAD (0.00 + 38.98 + 0.00) = 38.98 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -24   0.00  68.48   0.00  -5.40  -4.36   0.00   0.00 -19.74
38.98
--------------------------------------------------------------------------
--

Segment Leq : 38.98 dBA
```

```
Results segment # 2: Lyon1 (day)
--------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       42.50 !       10.17 !        10.17

ROAD (0.00 + 34.33 + 0.00) = 34.33 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -24      0   0.00  68.48   0.00  -5.40  -8.75   0.00   0.00 -20.00
34.33
--------------------------------------------------------------------------
--

Segment Leq : 34.33 dBA

Total Leq All Segments: 40.26 dBA
```

```
Results segment # 1: Lyon1 (night)
----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       42.50 !       10.17 !        10.17

ROAD (0.00 + 31.38 + 0.00) = 31.38 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
   -90    -24   0.00  60.88   0.00  -5.40  -4.36   0.00   0.00 -19.74
31.38
----------------------------------------------------------------------------
--

Segment Leq : 31.38 dBA
```

```
Results segment # 2: Lyon1 (night)
----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       42.50 !       10.17 !        10.17

ROAD (0.00 + 26.73 + 0.00) = 26.73 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -24      0   0.00  60.88   0.00  -5.40  -8.75   0.00   0.00 -20.00
26.73
--------------------------------------------------------------------------
--

Segment Leq : 26.73 dBA

Total Leq All Segments: 32.66 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 40.26
                         (NIGHT): 32.66
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 33:10:25
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Lyon (day/night)
----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon (day/night)
--------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  50.00 / 50.00  m
Receiver height           :  42.50 / 42.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : 90.00 deg
Barrier height            :  37.50 m
Barrier receiver distance :  23.00 / 23.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 2: Albert (day/night)
------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Albert (day/night)
----------------------------------------
Angle1   Angle2            : -90.00 deg   0.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  16.00 / 16.00  m
Receiver height            :  42.50 / 42.50  m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00
```

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

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
-------------+--------------+--------------+---------------
       1.50 !       42.50 !       23.64 !        23.64

ROAD (0.00 + 45.85 + 0.00) = 45.85 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  68.48   0.00  -5.23   0.00   0.00   0.00 -17.40
45.85
--------------------------------------------------------------------------
--

Segment Leq : 45.85 dBA
```

```
Results segment # 2: Albert (day)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 65.19 + 0.00) = 65.19 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
   -90      0   0.00  68.48   0.00  -0.28  -3.01   0.00   0.00   0.00
65.19
----------------------------------------------------------------------------
--

Segment Leq : 65.19 dBA

Total Leq All Segments: 65.24 dBA
```

```
Results segment # 1: Lyon (night)
---------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
-------------+--------------+--------------+---------------
       1.50 !       42.50 !       23.64 !        23.64

ROAD (0.00 + 38.25 + 0.00) = 38.25 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  60.88   0.00  -5.23   0.00   0.00   0.00 -17.40
38.25
--------------------------------------------------------------------------
--

Segment Leq : 38.25 dBA
```

```
Results segment # 2: Albert (night)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 57.59 + 0.00) = 57.59 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90      0   0.00  60.88   0.00  -0.28  -3.01   0.00   0.00   0.00
57.59
--------------------------------------------------------------------------
--

Segment Leq : 57.59 dBA

Total Leq All Segments: 57.64 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 65.24
                         (NIGHT): 57.64
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 33:10:30
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Lyon (day/night)
----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon (day/night)
--------------------------------------
Angle1   Angle2           :   0.00 deg   70.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  52.00 / 52.00  m
Receiver height           :  42.50 / 42.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 2: Albert (day/night)
------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Albert (day/night)
----------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  15.00 / 15.00  m
Receiver height           :  42.50 / 42.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 58.98 + 0.00) = 58.98 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
     0     70   0.00  68.48   0.00  -5.40  -4.10   0.00   0.00   0.00
58.98
--------------------------------------------------------------------------
--

Segment Leq : 58.98 dBA
```

```
Results segment # 2: Albert (day)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 68.48 + 0.00) = 68.48 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90     90   0.00  68.48   0.00   0.00   0.00   0.00   0.00   0.00
68.48
-------------------------------------------------------------------------
--

Segment Leq : 68.48 dBA

Total Leq All Segments: 68.94 dBA
```

```
Results segment # 1: Lyon (night)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 51.38 + 0.00) = 51.38 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------
--
     0     70   0.00  60.88   0.00  -5.40  -4.10   0.00   0.00   0.00
51.38
----------------------------------------------------------------------
--

Segment Leq : 51.38 dBA
```

```
Results segment # 2: Albert (night)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 60.88 + 0.00) = 60.88 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  60.88   0.00   0.00   0.00   0.00   0.00   0.00
60.88
--------------------------------------------------------------------------
--

Segment Leq : 60.88 dBA

Total Leq All Segments: 61.34 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 68.94
                          (NIGHT): 61.34
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 15:36:41
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Albert (day/night)
------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Albert (day/night)
----------------------------------------
Angle1   Angle2           :   0.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  16.00 / 16.00  m
Receiver height           :  42.50 / 42.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 65.19 + 0.00) = 65.19 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
     0     90   0.00  68.48   0.00  -0.28  -3.01   0.00   0.00   0.00
65.19
--------------------------------------------------------------------------
--

Segment Leq : 65.19 dBA

Total Leq All Segments: 65.19 dBA
```

```
Results segment # 1: Albert (night)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 57.59 + 0.00) = 57.59 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
     0     90   0.00  60.88   0.00  -0.28  -3.01   0.00   0.00   0.00
57.59
--------------------------------------------------------------------------
--

Segment Leq : 57.59 dBA

Total Leq All Segments: 57.59 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 65.19
                        (NIGHT): 57.59
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 16:48:21
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Lyon (day/night)
----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon (day/night)
--------------------------------------
Angle1   Angle2           : -90.00 deg   0.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  15.00 / 15.00  m
Receiver height           :  79.50 / 79.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 65.47 + 0.00) = 65.47 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90      0   0.00  68.48   0.00   0.00  -3.01   0.00   0.00   0.00
65.47
--------------------------------------------------------------------------
--

Segment Leq : 65.47 dBA

Total Leq All Segments: 65.47 dBA
```

```
Results segment # 1: Lyon (night)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 57.87 + 0.00) = 57.87 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90      0   0.00  60.88   0.00   0.00  -3.01   0.00   0.00   0.00
57.87
--------------------------------------------------------------------------
--

Segment Leq : 57.87 dBA

Total Leq All Segments: 57.87 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 65.47
                         (NIGHT): 57.87
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 16:48:27
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Lyon (day/night)
----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon (day/night)
--------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  15.00 / 15.00  m
Receiver height           :  79.50 / 79.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 2: Albert (day/night)
------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Albert (day/night)
----------------------------------------
Angle1   Angle2           : -90.00 deg   0.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  51.00 / 51.00  m
Receiver height           :  79.50 / 79.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -48.00 deg
Barrier height            :  75.00 m
Barrier receiver distance :  37.00 / 37.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 68.48 + 0.00) = 68.48 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
------------------------------------------------------------------------
--
   -90     90   0.00  68.48   0.00   0.00   0.00   0.00   0.00   0.00
68.48
------------------------------------------------------------------------
--

Segment Leq : 68.48 dBA
```

```
Results segment # 2: Albert (day)
---------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
------------+--------------+-------------+--------------
       1.50 !        79.50 !        22.91 !         22.91

ROAD (0.00 + 38.17 + 57.42) = 57.48 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -48   0.00  68.48   0.00  -5.31  -6.32   0.00   0.00 -18.67
38.17
--------------------------------------------------------------------------
--
   -48      0   0.00  68.48   0.00  -5.31  -5.74   0.00   0.00   0.00
57.42
--------------------------------------------------------------------------
--

Segment Leq : 57.48 dBA

Total Leq All Segments: 68.81 dBA
```

```
Results segment # 1: Lyon (night)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 60.88 + 0.00) = 60.88 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------
--
   -90     90   0.00  60.88   0.00   0.00   0.00   0.00   0.00   0.00
60.88
----------------------------------------------------------------------
--

Segment Leq : 60.88 dBA
```

```
Results segment # 2: Albert (night)
-----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       79.50 !       22.91 !        22.91

ROAD (0.00 + 30.58 + 49.83) = 49.88 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -48   0.00  60.88   0.00  -5.31  -6.32   0.00   0.00 -18.67
30.58
--------------------------------------------------------------------------
--
   -48      0   0.00  60.88   0.00  -5.31  -5.74   0.00   0.00   0.00
49.83
--------------------------------------------------------------------------
--

Segment Leq : 49.88 dBA

Total Leq All Segments: 61.21 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 68.81
                         (NIGHT): 61.21
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 16:48:32
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Lyon (day/night)
----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon (day/night)
--------------------------------------
Angle1   Angle2           :   0.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  16.00 / 16.00  m
Receiver height           :  79.50 / 79.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :  75.00 deg   Angle2 : 90.00 deg
Barrier height            :  37.50 m
Barrier receiver distance :   4.00 / 4.00   m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 2: Albert1 (day/night)
-------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Albert1 (day/night)
-----------------------------------------
Angle1   Angle2           : -90.00 deg   -15.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  47.00 / 47.00  m
Receiver height           :  79.50 / 79.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -50.00 deg
Barrier height            :  75.00 m
Barrier receiver distance :  32.00 / 32.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 3: Albert2 (day/night)
-------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 3: Albert2 (day/night)
-----------------------------------------
Angle1   Angle2            : -15.00 deg   47.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  47.00 / 47.00  m
Receiver height            :  79.50 / 79.50  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             : -15.00 deg   Angle2 : 47.00 deg
Barrier height             :  37.50 m
Barrier receiver distance  :  32.00 / 32.00  m
Source elevation           :   0.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00
```

```
Road data, segment # 4: Albert3 (day/night)
-------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 4: Albert3 (day/night)
-----------------------------------------
Angle1   Angle2            :  47.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  47.00 / 47.00  m
Receiver height            :  79.50 / 79.50  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             :  47.00 deg   Angle2 : 90.00 deg
Barrier height             :  81.00 m
Barrier receiver distance  :  32.00 / 32.00  m
Source elevation           :   0.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00
```

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

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       1.50 !       79.50 !       60.00 !        60.00

ROAD (64.40 + 57.41 + 0.00) = 65.19 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
------------------------------------------------------------------------
--
     0     75   0.00  68.48   0.00  -0.28  -3.80   0.00   0.00   0.00
64.40
------------------------------------------------------------------------
--
    75     90   0.00  68.48   0.00  -0.28 -10.79   0.00   0.00  -1.07
56.33*
    75     90   0.00  68.48   0.00  -0.28 -10.79   0.00   0.00   0.00
57.41
------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 65.19 dBA
```

```
Results segment # 2: Albert1 (day)
----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       79.50 !       26.39 !        26.39

ROAD (0.00 + 38.56 + 56.41) = 56.48 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90    -50   0.00  68.48   0.00  -4.96  -6.53   0.00   0.00 -18.43
38.56
--------------------------------------------------------------------------
--
   -50    -15   0.00  68.48   0.00  -4.96  -7.11   0.00   0.00   0.00
56.41
--------------------------------------------------------------------------
--

Segment Leq : 56.48 dBA
```

```
Results segment # 3: Albert2 (day)
----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       79.50 !       26.39 !        26.39

ROAD (0.00 + 43.01 + 0.00) = 43.01 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -15     47   0.00  68.48   0.00  -4.96  -4.63   0.00   0.00 -15.88
43.01
--------------------------------------------------------------------------
--

Segment Leq : 43.01 dBA
```

```
Results segment # 4: Albert3 (day)
----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       79.50 !       26.39 !        26.39

ROAD (0.00 + 38.45 + 0.00) = 38.45 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
    47     90   0.00  68.48   0.00  -4.96  -6.22   0.00   0.00 -18.85
38.45
--------------------------------------------------------------------------
--

Segment Leq : 38.45 dBA

Total Leq All Segments: 65.77 dBA
```

```
Results segment # 1: Lyon (night)
---------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
-------------+--------------+--------------+---------------
       1.50 !        79.50 !        60.00 !         60.00

ROAD (56.80 + 49.81 + 0.00) = 57.59 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
---------------------------------------------------------------------------
--
     0     75   0.00  60.88   0.00  -0.28  -3.80   0.00   0.00   0.00
56.80
---------------------------------------------------------------------------
--
    75     90   0.00  60.88   0.00  -0.28 -10.79   0.00   0.00  -1.07
48.74*
    75     90   0.00  60.88   0.00  -0.28 -10.79   0.00   0.00   0.00
49.81
---------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 57.59 dBA
```

```
Results segment # 2: Albert1 (night)
------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
-------------+--------------+--------------+---------------
       1.50 !       79.50 !       26.39 !        26.39

ROAD (0.00 + 30.96 + 48.81) = 48.88 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
---------------------------------------------------------------------------
--
   -90    -50   0.00  60.88   0.00  -4.96  -6.53   0.00   0.00 -18.43
30.96
---------------------------------------------------------------------------
--
   -50    -15   0.00  60.88   0.00  -4.96  -7.11   0.00   0.00   0.00
48.81
---------------------------------------------------------------------------
--

Segment Leq : 48.88 dBA
```

```
Results segment # 3: Albert2 (night)
------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
-------------+--------------+--------------+---------------
       1.50 !       79.50 !       26.39 !        26.39

ROAD (0.00 + 35.42 + 0.00) = 35.42 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -15     47   0.00  60.88   0.00  -4.96  -4.63   0.00   0.00 -15.88
35.42
--------------------------------------------------------------------------
--

Segment Leq : 35.42 dBA
```

```
Results segment # 4: Albert3 (night)
------------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
-------------+--------------+--------------+--------------
       1.50 !       79.50 !       26.39 !        26.39

ROAD (0.00 + 30.85 + 0.00) = 30.85 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
    47     90   0.00  60.88   0.00  -4.96  -6.22   0.00   0.00 -18.85
30.85
--------------------------------------------------------------------------
--

Segment Leq : 30.85 dBA

Total Leq All Segments: 58.17 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 65.77
                         (NIGHT): 58.17
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 33:08:43
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Albert (day/night)
------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Albert (day/night)
----------------------------------------
Angle1   Angle2           :   0.00 deg   61.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  50.00 / 50.00  m
Receiver height           :  79.50 / 79.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :   0.00 deg   Angle2 : 61.00 deg
Barrier height            :  81.00 m
Barrier receiver distance :  18.00 / 18.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

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

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       79.50 !       51.42 !        51.42

ROAD (0.00 + 38.55 + 0.00) = 38.55 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
     0     61   0.00  68.48   0.00  -5.23  -4.70   0.00   0.00 -20.00
38.55
--------------------------------------------------------------------------
--

Segment Leq : 38.55 dBA

Total Leq All Segments: 38.55 dBA
```

```
Results segment # 1: Albert (night)
-----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
-------------+--------------+--------------+---------------
       1.50 !        79.50 !        51.42 !         51.42

ROAD (0.00 + 30.96 + 0.00) = 30.96 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
     0     61   0.00  60.88   0.00  -5.23  -4.70   0.00   0.00 -20.00
30.96
--------------------------------------------------------------------------
--

Segment Leq : 30.96 dBA

Total Leq All Segments: 30.96 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 38.55
                         (NIGHT): 30.96
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 33:08:51
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Lyon1 (day/night)
-----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon1 (day/night)
---------------------------------------
Angle1   Angle2           : -90.00 deg   -24.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  52.00 / 52.00  m
Receiver height           :  79.50 / 79.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -24.00 deg
Barrier height            :  81.00 m
Barrier receiver distance :  41.00 / 41.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 2: Lyon1 (day/night)
-----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Lyon1 (day/night)
---------------------------------------
Angle1   Angle2            : -24.00 deg   0.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  52.00 / 52.00  m
Receiver height            :  79.50 / 79.50  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             : -24.00 deg   Angle2 : 0.00 deg
Barrier height             :  31.00 m
Barrier receiver distance  :  41.00 / 41.00  m
Source elevation           :   0.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00
```

```
Results segment # 1: Lyon1 (day)
--------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top   (m)
-------------+--------------+--------------+---------------
       1.50 !       79.50 !       18.00 !        18.00

ROAD (0.00 + 39.35 + 0.00) = 39.35 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
---------------------------------------------------------------------------
--
   -90    -24   0.00  68.48   0.00  -5.40  -4.36   0.00   0.00 -19.37
39.35
---------------------------------------------------------------------------
--

Segment Leq : 39.35 dBA
```

```
Results segment # 2: Lyon1 (day)
--------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       79.50 !       18.00 !        18.00

ROAD (0.00 + 35.87 + 0.00) = 35.87 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -24      0   0.00  68.48   0.00  -5.40  -8.75   0.00   0.00 -18.46
35.87
--------------------------------------------------------------------------
--

Segment Leq : 35.87 dBA

Total Leq All Segments: 40.96 dBA
```

```
Results segment # 1: Lyon1 (night)
----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       79.50 !       18.00 !        18.00

ROAD (0.00 + 31.76 + 0.00) = 31.76 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
----------------------------------------------------------------------------
--
   -90    -24   0.00  60.88   0.00  -5.40  -4.36   0.00   0.00 -19.37
31.76
----------------------------------------------------------------------------
--

Segment Leq : 31.76 dBA
```

```
Results segment # 2: Lyon1 (night)
----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       79.50 !       18.00 !        18.00

ROAD (0.00 + 28.27 + 0.00) = 28.27 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -24      0   0.00  60.88   0.00  -5.40  -8.75   0.00   0.00 -18.46
28.27
--------------------------------------------------------------------------
--

Segment Leq : 28.27 dBA

Total Leq All Segments: 33.37 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 40.96
                         (NIGHT): 33.37
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 33:08:56
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Lyon (day/night)
----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon (day/night)
--------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  50.00 / 50.00  m
Receiver height           :  79.50 / 79.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : 90.00 deg
Barrier height            :  37.50 m
Barrier receiver distance :  23.00 / 23.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 2: Albert (day/night)
------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Albert (day/night)
----------------------------------------
Angle1   Angle2            : -90.00 deg   0.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  16.00 / 16.00  m
Receiver height            :  79.50 / 79.50  m
Topography                 :      1       (Flat/gentle slope; no barrier)
Reference angle            :   0.00
```

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

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       1.50 !       79.50 !       43.62 !        43.62

ROAD (0.00 + 63.25 + 0.00) = 63.25 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
---------------------------------------------------------------------------
--
   -90     90   0.00  68.48   0.00  -5.23   0.00   0.00   0.00  -0.36
62.89*
   -90     90   0.00  68.48   0.00  -5.23   0.00   0.00   0.00   0.00
63.25
---------------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 63.25 dBA
```

```
Results segment # 2: Albert (day)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 65.19 + 0.00) = 65.19 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90      0   0.00  68.48   0.00  -0.28  -3.01   0.00   0.00   0.00
65.19
--------------------------------------------------------------------------
--

Segment Leq : 65.19 dBA

Total Leq All Segments: 67.34 dBA
```

```
Results segment # 1: Lyon (night)
---------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       79.50 !       43.62 !        43.62

ROAD (0.00 + 55.65 + 0.00) = 55.65 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-----------------------------------------------------------------------
--
   -90     90   0.00  60.88   0.00  -5.23   0.00   0.00   0.00  -0.36
55.29*
   -90     90   0.00  60.88   0.00  -5.23   0.00   0.00   0.00   0.00
55.65
-----------------------------------------------------------------------
--

 * Bright Zone !

Segment Leq : 55.65 dBA
```

```
Results segment # 2: Albert (night)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 57.59 + 0.00) = 57.59 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90      0   0.00  60.88   0.00  -0.28  -3.01   0.00   0.00   0.00
57.59
-------------------------------------------------------------------------
--

Segment Leq : 57.59 dBA

Total Leq All Segments: 59.74 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 67.34
                         (NIGHT): 59.74
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 33:09:01
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Lyon (day/night)
----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon (day/night)
--------------------------------------
Angle1   Angle2           :   0.00 deg   70.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  52.00 / 52.00  m
Receiver height           :  79.50 / 79.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
Road data, segment # 2: Albert (day/night)
------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Albert (day/night)
----------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  15.00 / 15.00  m
Receiver height           :  79.50 / 79.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 58.98 + 0.00) = 58.98 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
     0     70   0.00  68.48   0.00  -5.40  -4.10   0.00   0.00   0.00
58.98
--------------------------------------------------------------------------
--

Segment Leq : 58.98 dBA
```

```
Results segment # 2: Albert (day)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 68.48 + 0.00) = 68.48 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  68.48   0.00   0.00   0.00   0.00   0.00   0.00
68.48
--------------------------------------------------------------------------
--

Segment Leq : 68.48 dBA

Total Leq All Segments: 68.94 dBA
```

```
Results segment # 1: Lyon (night)
---------------------------------

Source height = 1.50 m

ROAD (0.00 + 51.38 + 0.00) = 51.38 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
------------------------------------------------------------------------
--
     0     70   0.00  60.88   0.00  -5.40  -4.10   0.00   0.00   0.00
51.38
------------------------------------------------------------------------
--

Segment Leq : 51.38 dBA
```

```
Results segment # 2: Albert (night)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 60.88 + 0.00) = 60.88 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
-------------------------------------------------------------------------
--
   -90     90   0.00  60.88   0.00   0.00   0.00   0.00   0.00   0.00
60.88
-------------------------------------------------------------------------
--

Segment Leq : 60.88 dBA

Total Leq All Segments: 61.34 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 68.94
                         (NIGHT): 61.34
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 33:09:06
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r18.te                 Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: Albert (day/night)
------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Albert (day/night)
----------------------------------------
Angle1   Angle2           :   0.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  16.00 / 16.00  m
Receiver height           :  79.50 / 79.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

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

Source height = 1.50 m

ROAD (0.00 + 65.19 + 0.00) = 65.19 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
------------------------------------------------------------------------
--
     0     90   0.00  68.48   0.00  -0.28  -3.01   0.00   0.00   0.00
65.19
------------------------------------------------------------------------
--

Segment Leq : 65.19 dBA

Total Leq All Segments: 65.19 dBA
```

```
Results segment # 1: Albert (night)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 57.59 + 0.00) = 57.59 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
     0     90   0.00  60.88   0.00  -0.28  -3.01   0.00   0.00   0.00
57.59
--------------------------------------------------------------------------
--

Segment Leq : 57.59 dBA

Total Leq All Segments: 57.59 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 65.19
                         (NIGHT): 57.59
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 33:09:12
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r19.te               Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: Lyon (day/night)
----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon (day/night)
--------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  41.00 / 41.00  m
Receiver height           :  16.00 / 16.00  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : 90.00 deg
Barrier height            :  31.00 m
Barrier receiver distance :  29.00 / 29.00  m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 2: Albert (day/night)
------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Albert (day/night)
----------------------------------------
Angle1   Angle2            : -90.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  39.00 / 39.00  m
Receiver height            :  16.00 / 16.00  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             : -90.00 deg   Angle2 : 90.00 deg
Barrier height             :  37.50 m
Barrier receiver distance  :  28.00 / 28.00  m
Source elevation           :   0.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00
```

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

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       16.00 !        5.74 !          5.74

ROAD (0.00 + 44.72 + 0.00) = 44.72 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
---------------------------------------------------------------------------
--
   -90     90   0.00  68.48   0.00  -4.37   0.00   0.00   0.00 -19.39
44.72
---------------------------------------------------------------------------
--

Segment Leq : 44.72 dBA
```

```
Results segment # 2: Albert (day)
---------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       1.50 !       16.00 !        5.59 !         5.59

ROAD (0.00 + 44.75 + 0.00) = 44.75 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
---------------------------------------------------------------------------
--
   -90     90   0.00  68.48   0.00  -4.15   0.00   0.00   0.00 -19.58
44.75
---------------------------------------------------------------------------
--

Segment Leq : 44.75 dBA

Total Leq All Segments: 47.75 dBA
```

```
Results segment # 1: Lyon (night)
---------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
-------------+--------------+--------------+---------------
       1.50 !       16.00 !        5.74 !          5.74

ROAD (0.00 + 37.12 + 0.00) = 37.12 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  60.88   0.00  -4.37   0.00   0.00   0.00 -19.39
37.12
--------------------------------------------------------------------------
--

Segment Leq : 37.12 dBA
```

```
Results segment # 2: Albert (night)
-----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       1.50 !       16.00 !        5.59 !         5.59

ROAD (0.00 + 37.15 + 0.00) = 37.15 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  60.88   0.00  -4.15   0.00   0.00   0.00 -19.58
37.15
--------------------------------------------------------------------------
--

Segment Leq : 37.15 dBA

Total Leq All Segments: 40.15 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 47.75
                         (NIGHT): 40.15
```

```
STAMSON 5.0        NORMAL REPORT        Date: 18-07-2018 33:09:49
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: r20.te               Time Period: Day/Night 16/8 hours
Description:


Road data, segment # 1: Lyon (day/night)
----------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 1: Lyon (day/night)
--------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  16.00 / 16.00  m
Receiver height           :  32.50 / 32.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : 90.00 deg
Barrier height            :  31.00 m
Barrier receiver distance :   5.00 / 5.00   m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00
```

```
Road data, segment # 2: Albert (day/night)
------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

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

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

Data for Segment # 2: Albert (day/night)
----------------------------------------
Angle1   Angle2            : -90.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  21.00 / 21.00  m
Receiver height            :  32.50 / 32.50  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             : -90.00 deg   Angle2 : 90.00 deg
Barrier height             :  31.00 m
Barrier receiver distance :  10.00 / 10.00  m
Source elevation           :   0.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00
```

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

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source       ! Receiver     ! Barrier      ! Elevation of
Height   (m) ! Height   (m) ! Height   (m) ! Barrier Top  (m)
-------------+--------------+--------------+---------------
       1.50 !       32.50 !       22.81 !        22.81

ROAD (0.00 + 52.66 + 0.00) = 52.66 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  68.48   0.00  -0.28   0.00   0.00   0.00 -15.54
52.66
--------------------------------------------------------------------------
--

Segment Leq : 52.66 dBA
```

```
Results segment # 2: Albert (day)
---------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       32.50 !       17.74 !        17.74

ROAD (0.00 + 49.48 + 0.00) = 49.48 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
---------------------------------------------------------------------------
--
   -90     90   0.00  68.48   0.00  -1.46   0.00   0.00   0.00 -17.54
49.48
---------------------------------------------------------------------------
--

Segment Leq : 49.48 dBA

Total Leq All Segments: 54.37 dBA
```

```
Results segment # 1: Lyon (night)
---------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       1.50 !       32.50 !       22.81 !        22.81

ROAD (0.00 + 45.06 + 0.00) = 45.06 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  60.88   0.00  -0.28   0.00   0.00   0.00 -15.54
45.06
--------------------------------------------------------------------------
--

Segment Leq : 45.06 dBA
```

```
Results segment # 2: Albert (night)
-----------------------------------

Source height = 1.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       1.50 !       32.50 !       17.74 !        17.74

ROAD (0.00 + 41.88 + 0.00) = 41.88 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj
SubLeq
--------------------------------------------------------------------------
--
   -90     90   0.00  60.88   0.00  -1.46   0.00   0.00   0.00 -17.54
41.88
--------------------------------------------------------------------------
--

Segment Leq : 41.88 dBA

Total Leq All Segments: 46.77 dBA
```

```
TOTAL Leq FROM ALL SOURCES (DAY): 54.37
                         (NIGHT): 46.77
```

APPENDIX B

FTA VIBRATION CALCULATIONS

Possible Vibration Impacts on 383 Albert Street & 340 Queen Street
Perdicted using FTA General Assesment

Train Speed 70 km/h 43.4 mph

	Distance from C/L	
	(m)	(ft)
Confederation	13.0	42.7

	Vibration		
From FTA Manual Fig 10-1			
Vibration Levels at distance from track	74	dBV re 1 micro in/sec	
Adjustment Factors FTA Table 10-1			
Speed reference 50 mph	-1	Speed Limit of 70 km/h (43.4 mph)	
Vehicle Parameters	0	Assume Soft primary suspension, Weels run true	
Track Condition	0	None	
Track Treatments	0	None	
Type of Transit Structure	0	None	
Efficient vibration Propagation	0	Propagation through rock	
Vibration Levels at Fdn	73		0.111
Coupling to Building Foundation	-10	Large Massonry on Piles	
Floor to Floor Attenuation	-2.0	Ground Floor Ocupied	
Amplification of Floor and Walls	6		
Total Vibration Level	66.8	dBV or	0.056 mm/s
Noise Level in dBA	31.8	dBA	

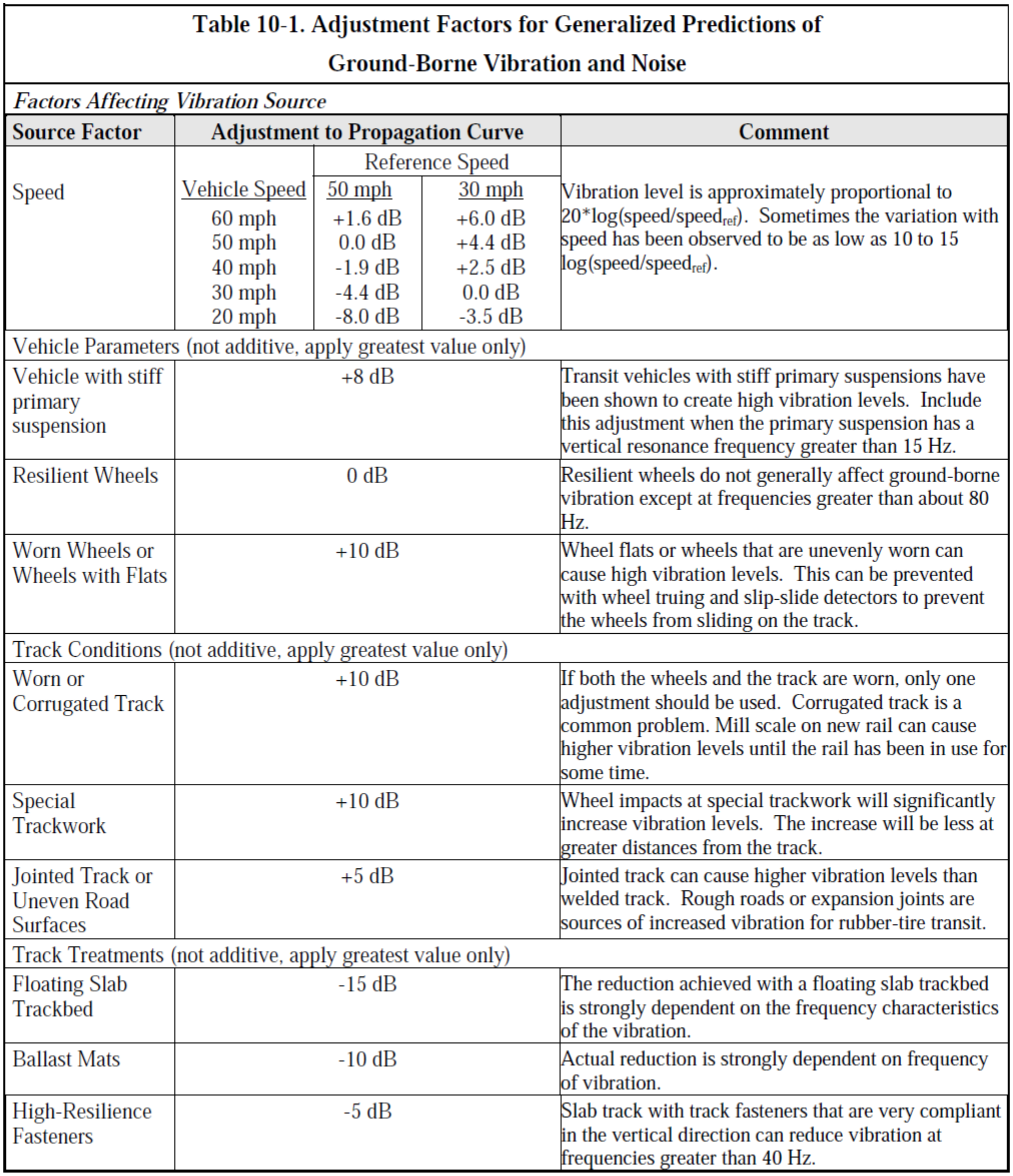


Table 10-1. Adjustment Factors for Generalized Predictions of Ground-Borne Vibration and Noise

Factors Affecting Vibration Source

Source Factor	Adjustment to Propagation Curve			Comment
		Reference Speed		
Speed	Vehicle Speed	50 mph	30 mph	Vibration level is approximately proportional to 20*log(speed/speed$_{ref}$). Sometimes the variation with speed has been observed to be as low as 10 to 15 log(speed/speed$_{ref}$).
	60 mph	+1.6 dB	+6.0 dB	
	50 mph	0.0 dB	+4.4 dB	
	40 mph	-1.9 dB	+2.5 dB	
	30 mph	-4.4 dB	0.0 dB	
	20 mph	-8.0 dB	-3.5 dB	
Vehicle Parameters (not additive, apply greatest value only)				
Vehicle with stiff primary suspension	+8 dB			Transit vehicles with stiff primary suspensions have been shown to create high vibration levels. Include this adjustment when the primary suspension has a vertical resonance frequency greater than 15 Hz.
Resilient Wheels	0 dB			Resilient wheels do not generally affect ground-borne vibration except at frequencies greater than about 80 Hz.
Worn Wheels or Wheels with Flats	+10 dB			Wheel flats or wheels that are unevenly worn can cause high vibration levels. This can be prevented with wheel truing and slip-slide detectors to prevent the wheels from sliding on the track.
Track Conditions (not additive, apply greatest value only)				
Worn or Corrugated Track	+10 dB			If both the wheels and the track are worn, only one adjustment should be used. Corrugated track is a common problem. Mill scale on new rail can cause higher vibration levels until the rail has been in use for some time.
Special Trackwork	+10 dB			Wheel impacts at special trackwork will significantly increase vibration levels. The increase will be less at greater distances from the track.
Jointed Track or Uneven Road Surfaces	+5 dB			Jointed track can cause higher vibration levels than welded track. Rough roads or expansion joints are sources of increased vibration for rubber-tire transit.
Track Treatments (not additive, apply greatest value only)				
Floating Slab Trackbed	-15 dB			The reduction achieved with a floating slab trackbed is strongly dependent on the frequency characteristics of the vibration.
Ballast Mats	-10 dB			Actual reduction is strongly dependent on frequency of vibration.
High-Resilience Fasteners	-5 dB			Slab track with track fasteners that are very compliant in the vertical direction can reduce vibration at frequencies greater than 40 Hz.

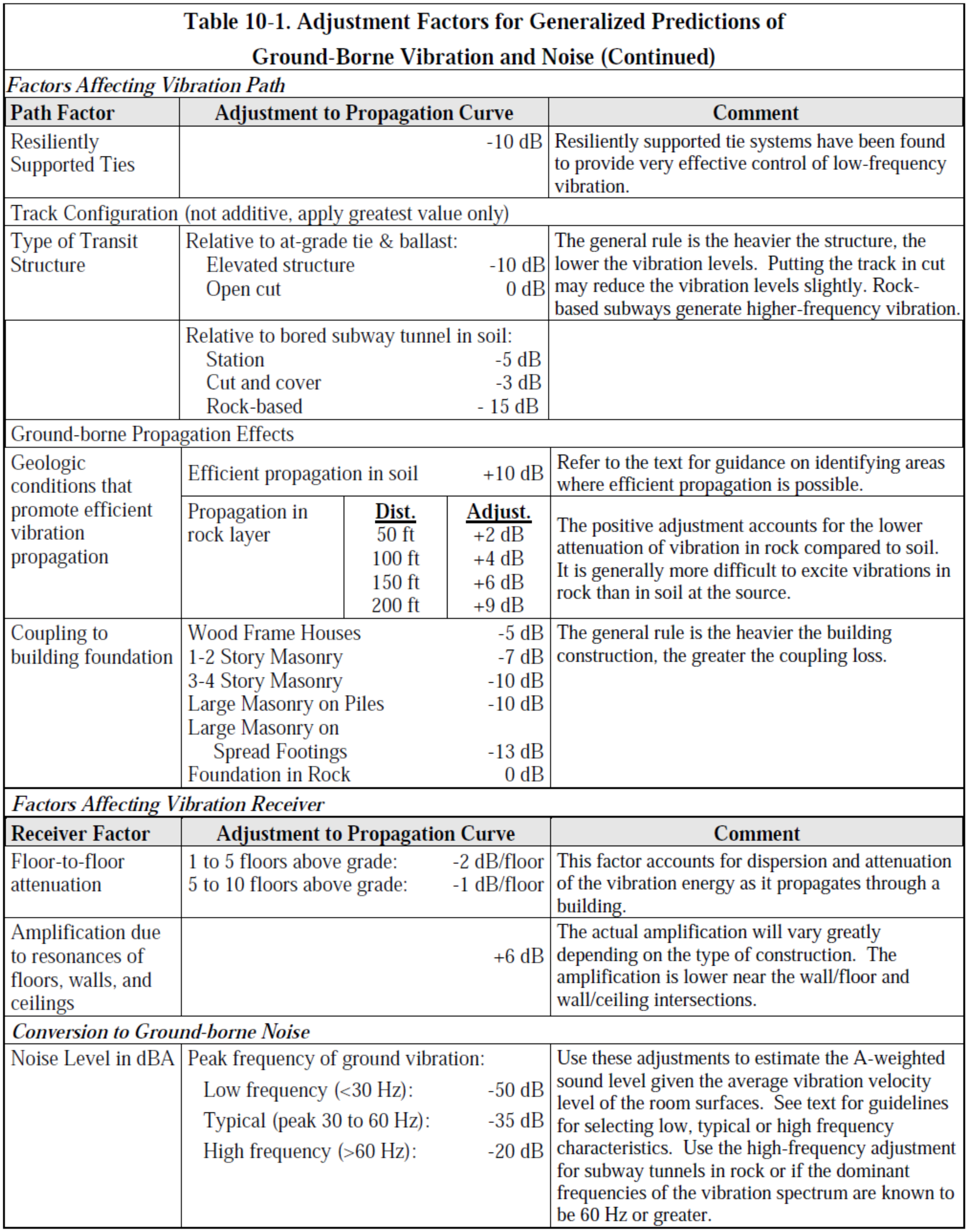


Table 10-1. Adjustment Factors for Generalized Predictions of Ground-Borne Vibration and Noise (Continued)

Factors Affecting Vibration Path		
Path Factor	**Adjustment to Propagation Curve**	**Comment**
Resiliently Supported Ties	-10 dB	Resiliently supported tie systems have been found to provide very effective control of low-frequency vibration.
Track Configuration (not additive, apply greatest value only)		
Type of Transit Structure	Relative to at-grade tie & ballast: Elevated structure -10 dB Open cut 0 dB	The general rule is the heavier the structure, the lower the vibration levels. Putting the track in cut may reduce the vibration levels slightly. Rock-based subways generate higher-frequency vibration.
	Relative to bored subway tunnel in soil: Station -5 dB Cut and cover -3 dB Rock-based - 15 dB	
Ground-borne Propagation Effects		
Geologic conditions that promote efficient vibration propagation	Efficient propagation in soil +10 dB	Refer to the text for guidance on identifying areas where efficient propagation is possible.
	Propagation in rock layer **Dist.** **Adjust.** 50 ft +2 dB 100 ft +4 dB 150 ft +6 dB 200 ft +9 dB	The positive adjustment accounts for the lower attenuation of vibration in rock compared to soil. It is generally more difficult to excite vibrations in rock than in soil at the source.
Coupling to building foundation	Wood Frame Houses -5 dB 1-2 Story Masonry -7 dB 3-4 Story Masonry -10 dB Large Masonry on Piles -10 dB Large Masonry on Spread Footings -13 dB Foundation in Rock 0 dB	The general rule is the heavier the building construction, the greater the coupling loss.
Factors Affecting Vibration Receiver		
Receiver Factor	**Adjustment to Propagation Curve**	**Comment**
Floor-to-floor attenuation	1 to 5 floors above grade: -2 dB/floor 5 to 10 floors above grade: -1 dB/floor	This factor accounts for dispersion and attenuation of the vibration energy as it propagates through a building.
Amplification due to resonances of floors, walls, and ceilings	+6 dB	The actual amplification will vary greatly depending on the type of construction. The amplification is lower near the wall/floor and wall/ceiling intersections.
Conversion to Ground-borne Noise		
Noise Level in dBA	Peak frequency of ground vibration: Low frequency (<30 Hz): -50 dB Typical (peak 30 to 60 Hz): -35 dB High frequency (>60 Hz): -20 dB	Use these adjustments to estimate the A-weighted sound level given the average vibration velocity level of the room surfaces. See text for guidelines for selecting low, typical or high frequency characteristics. Use the high-frequency adjustment for subway tunnels in rock or if the dominant frequencies of the vibration spectrum are known to be 60 Hz or greater.

APPENDIX 4

Proximity Assessment:

PG4517-LET.01 dated October 10, 2018

patersongroup

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October 10, 2018
Report: PG4517-LET.01

Claridge Homes
210 Gladstone Avenue
Ottawa, Ontario
K2P 0Y6

Attention: **Mr. Neil Malhotra**

Subject: **Proximity Assessment**
Proposed Multi-Storey Building
383 Albert Street - Ottawa

Dear Sir,

Further to your request and authorization, Paterson Group (Paterson) prepared the current letter report to summarize construction issues which could occur due to the proximity of the proposed development with respect to the subject alignment of the Confederation Line located adjacent to the site, and Lyon Station located within the subject site. The following letter should be read in conjunction with Paterson Report PG4517-2 dated October 10, 2018.

1.0 Background Information

Based on current plans, it is understood that the proposed development will consist of 2 high rise, mixed-use buildings. Tower A will consist of up to 26 storeys while Tower C will consist of 27 storeys. The proposed buildings will share 5 levels of underground parking which will occupy the majority of the site.

The following sections summarize our existing soils information and construction precautions for the proposed development, which may impact the subject alignment of the Confederation Line and Lyon 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, such as dewatering and discharge plans.

2.0 Subsurface Conditions

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

- ☐ Existing surface grade is at an elevation of approximately 73 to 74 m.
- ☐ The overburden thickness is approximately 4.3 to 5.0 m.
- ☐ Bedrock surface elevation is at approximately 69.1 to 69.7 m.
- ☐ The bedrock underlying the site generally consists of 1 to 3 m of limestone of fair to good quality, while the underlying bedrock was observed to be of good to excellent quality. Unconfined compressive strengths of similar limestone bedrock formations, where tested, typically exceed 80 MPa.

Tunnel and Station Location

Available drawings indicate that the Confederation Line will abut the property line at the subject site. The top of rail (TOR) in the tunnel is located at about elevation +53.85 m (geodetic) adjacent to the proposed development site. The founding elevation of the proposed building adjacent to the tunnel will match the bottom of tunnel foundation. Dependent on the final founding level of the proposed building, sub-excavation and the placement of lean-mix concrete may be required to match the bottom of tunnel foundation level.

The elevation of Lyon Station is understood to extent to approximately elevation 56.5 m, which is above the anticipated foundation elevation of the proposed building. Where the proposed building excavation extends below Lyon Station, the geotechnical engineer will review the stability of the rock face and provide recommendations for rock reinforcement, should it be required. This is discussed further below in Section 3.0.

3.0 Construction Precautions and Recommendations

Influence of Proposed Development on Tunnel and Lyon Station

Based on existing soils information and building design details, the footings of the proposed building will be founded on good quality bedrock. Where the footings of the proposed building are located adjacent to the tunnel, they will be constructed at an elevation to match the existing bottom of tunnel foundation. Therefore, no lateral loads from the proposed building will be transferred to the tunnel. The footings are expected to extend below the bottom of Lyon Station, therefore no lateral loads from the proposed building will be transferred to the station.

Excavation and Temporary Shoring

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 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.

It is anticipated that the temporary shoring system will consist of soldier piles and lagging designed for at-rest earth pressures, using a pressure coefficient of K_0=0.5 as per the geotechnical design recommendations outlined in Paterson Report PG4517-1 dated July 18, 2018.

The geotechnical engineer will review the stability of the rock face underlying the overburden, and where applicable, underlying Lyon Station. 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 Lyon Station and the Confederation Line Tunnel.

A seismograph would be installed either adjacent to or within the Confederation Line and Lyon Station 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 PG4517-2 dated October 10, 2018.

Pre-Construction Survey

As the proposed building at Albert & Lyon Street will be constructed after the construction of the Confederation Line, a pre-construction survey will be required for the tunnel structure and Lyon Station. Any existing structures in the immediate area of the proposed building will also undergo a pre-construction survey as per standard construction practices, where bedrock blasting will be required.

Groundwater Control

Groundwater observations during the geotechnical investigation indicated groundwater levels between 4.2 to 6.8 m below the existing ground surface and within the bedrock. The Confederation Line tunnel and Lyon Station are founded at an elevation similar to the proposed building, however, given that both structures are anticipated to be founded on sound bedrock, no adverse impacts to the Confederation Line tunnel are expected.

Tunnel Waterproofing System

As the proposed development will be connected to Lyon Station and will be constructed directly adjacent to the existing Confederation Line tunnel, the repair and/or replacement of the tunnel waterproofing system will be completed where damage occurs as a result of the proposed construction. The repairs and/or replacement waterproofing system would match the existing waterproofing system currently in-place on the tunnel structure.

4.0 Conclusions and Recommendations

Based on the currently available information for the subject alignment of the proposed building and the existing subsurface information, the proposed building will not negatively impact the existing Confederation Line tunnel or Lyon 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, dewatering and discharge plans, and field monitoring program as described in the application conditions.

We trust that this information satisfies your immediate request.

Best Regards,

Paterson Group Inc.

Scott Dennis

LICENSED PROFESSIONAL ENGINEER
Oct. 10, 2018
C. P. DA SILVA
PROVINCE OF ONTARIO

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