Trillium Line
Level 2 Proximity Study

Proposed Development

75 Breezehill Avenue – Ottawa, Ontario

Prepared for Fotenn

Report PG7354-1 dated December 9, 2024

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Appendices

Appendix A	Trillium Line Proximity Plan Cross Section A-A' Topographic Plan of Survey Site Plan Floor Plans Construction Methodology and Impact Review
Appendix B	Geotechnical Investigation, prepared by Paterson Group Report Number PG6622-1 Rev. 1 dated February 26, 2024
Appendix C	Traffic Noise and Vibration Feasibility Assessment, prepared by Gradient Wind Engineers and Scientists Report No. GW21-147-Noise & Vibration R1 dated November 20, 2023
Appendix D	Proximity Assessment PG7354-LET.01 dated December 9, 2024

1.0 Introduction

Paterson Group (Paterson) was commissioned by Fotenn to conduct a Level 2 Trillium Line Proximity Study for the proposed development to be located at 75 Breezehill Avenue, in the City of Ottawa.

The objectives of the current study are to:

- ❑ Review all current information provided by the City of Ottawa with regards to the Trillium Rail Line.
- ❑ Liaison between the City of Ottawa and the Fotenn consultant team involved with the aforementioned project.

This report has been prepared specifically and solely for the aforementioned project which is described herein. It contains a collaboration of civil, structural and geotechnical design information as they pertain to the propose development at the subject site.

2.0 Development Details

It is understood that the proposed development at 75 Breezehill Avenue will consist of a mixed-use development with 2 high-rise buildings having two levels of shared underground parking, occupying the majority of the site footprint. The development will also include associated access lanes and amenity areas. The design underside of the footing is anticipated to be at approximate geodetic elevation 56 m, and founded upon silty clay and or glacial till.

The following is known about the Trillium Line in the vicinity of the subject site:

- ❑ The Trillium Line rail runs parallel to the eastern boundary of the site.
- ❑ The existing Trillium Line rail is anticipated to be located near the ground surface at an approximate geodetic elevation of 58 m, while 75 Breezehill Avenue is located up slope to the west at an approximate geodetic elevation of 64 m.
- ❑ Based on the existing boreholes conducted at the subject site, bedrock is expected at an approximate geodetic elevations of 50 to 54 m.

3.0 Construction Methodology and Impact Review

Paterson has prepared a construction methodology summary along with possible impacts on the adjacent segment of the Trillium Line, based on the current building design details. The Construction Methodology and Impact Review is provided in Appendix A and presents the anticipated construction items, impact review and a mitigation program recommended for the Trillium Line. One of the main issues will be vibrations associated with the overburden removal program and the potential 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 Trillium Line, the contractor should take extra precautions to minimize vibrations. The vibration monitoring program will be required for the duration of the blasting operations and any other construction activities which are anticipated to induce significant vibrations.

The purpose of the Vibration Monitoring and Control Program (VMCP) is to describe the measures to be implemented by the contractor to manage excavation operations and any other vibration sources during the construction of 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.

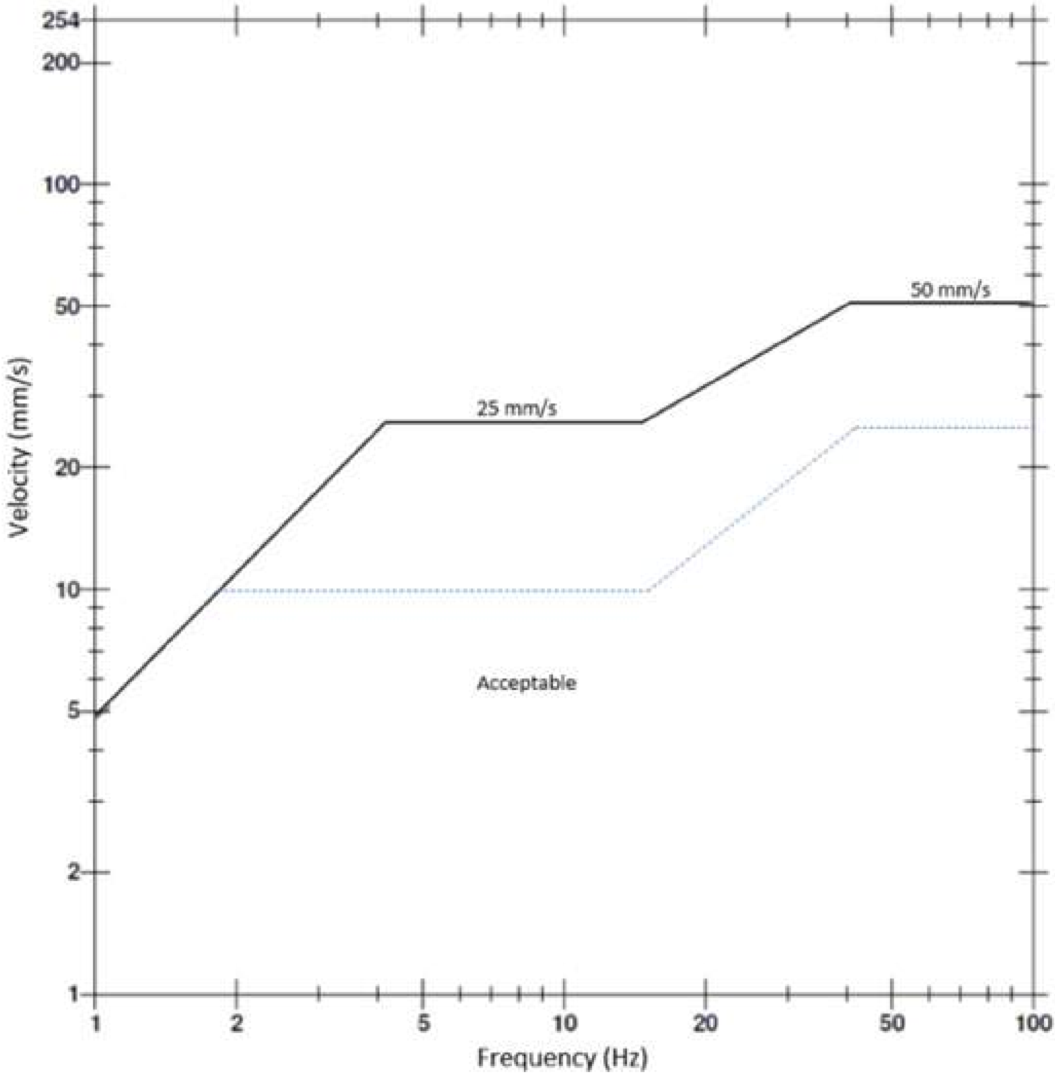
The monitoring program will incorporate real-time results at the Trillium Line, which is located to the east of the subject site. The monitoring equipment should consist of a tri-axial seismograph, capable of measuring vibration intensities up to 254 mm/s at a frequency response of 2 to 250 Hz. The monitoring equipment should be placed along the rail corridor, by the time construction has commenced at 75 Breezehill Avenue.

The location should be reviewed periodically throughout construction to ensure that the monitoring equipment remains within 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 the ‘worst case’ location for each construction activity. When an event is triggered, Paterson will review the results and provide any necessary feedback. Otherwise, the vibration results will be summarized in the weekly report.

Proposed Vibration Limits

The following figure outlines the recommended vibration limits for the Trillium Rail Line.

Vibration Limits – Trillium Line Rail Corridor



The excavation operations should be planned and conducted under the supervision of a licensed professional engineer who is an experienced bedrock or earthworks excavation consultant.

Monitoring Data

The monitoring protocol should include the following information:

Warning Level Event

- ❑ Paterson will review all vibrations over the established warning level, illustrated by the blue line in the above figure, and;
- ❑ Paterson will notify the contractor if any vibrations occur due to construction activities and are close to the exceedance level.

Exceedance Level Event

- ❑ Paterson will notify all the relevant stakeholders via email if any vibrations surpass the exceedance level, illustrated by the black line in the above figure,
- ❑ Ensure monitors are functioning, and;
- ❑ Issue the vibration exceedance result.

The data collected will include the following:

- ❑ Measured vibration levels,
- ❑ Distance from the construction activity to monitoring location, and;
- ❑ 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, and;
- ❑ 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 quickly in the event of an exceedance.

4.0 Proximity Study Requirement Responses

Paterson was informed by the City of Ottawa that a Level 3 Trillium Line Proximity Study should be completed for the proposed residential development. A Level 3 Trillium Line Proximity Study is required where the proposed development is located within the City of Ottawa's Development Zone of Influence.

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

Table 1 - List of Trillium Line Proximity Study Requirements	
Level 1 Projects	**Response**
A site plan of the development with the centreline or reference line of the Trillium Line structure and/or right-of-way located and the relevant distances between the Trillium Line and the developer's structure shown clearly;	See the Trillium Line Proximity Plan (Drawing No. PG7354-1 dated December 2024) presented in Appendix A.
Plan and cross-sections of the development locating the Trillium Line structure/right-of-way and founding elevations relative to the development, including any underground storage tanks and associated piping;	Refer to the Trillium Line Proximity Plan (Drawing No. PG7354-1 dated December 2024)) and Cross-Section A-A' (Drawing No. PG7354-2 dated December 2024) presented in Appendix A.
A geotechnical investigation report showing up-to-date geotechnical conditions at the site of the development. The geotechnical investigation shall be prepared in accordance with the Geotechnical Investigation and Reporting Guidelines for Development Applications in the City;	Refer to the Geotechnical Investigation Report prepared by Paterson Group (Report No. PG6622-1 Revision 1 dated February 26, 2024) presented in Appendix B.
Structural, foundation, excavation and shoring drawings;	Structural, foundation, excavation and shoring drawings will be provided prior to the Site Plan Agreement.

Structural, foundation, excavation and shoring drawings (continued);	Based on available design details, the proposed building foundation will consist of a raft foundation structure placed directly on a soil-bearing surface, or end-bearing piles driven to refusal on the bedrock surface.
Acknowledgment that the potential for noise, vibration, electro-magnetic interference and stray current from Trillium Line operations have been considered in the design of the project, and appropriate mitigation measures applied.	Refer to the Roadway Traffic Noise and Vibration Feasibility Assessment Report No. GW21-147-Noise & Vibration R1 prepared by Gradient Wind Engineers & Scientists dated November 20, 2023, which is presented in Appendix C.
Level 2 Projects	**Response**
A structural analysis or calculations of the effects of loadings, including construction loading, on the Trillium Line structure, and demonstrating that the Trillium Line will not be adversely affected by the development, including solutions to mitigate any impact on the Trillium Line structure.	No building loads will be imposed on the subject alignment of the Trillium Line or associated infrastructure due to a horizontal separation of approximately 22 m away from the building foundation. Refer to Cross-Section A-A' (Drawing No. PG7354-2 dated December 2024) and the Proximity Assessment Report (PG7354-LET.01 dated December 6, 2024), presented in Appendix D.
Documentation showing that the excavation support system and permanent structure adjacent to the Trillium Line property are designated for at-rest earth pressures.	A temporary shoring system will be designed to at-rest earth pressures as required by the site Geotechnical Investigation Report. Temporary shoring drawings will be submitted once they are finalized.
Structural drawings, including foundation plans, sections and details, floor plans, column and wall schedules and loads on the foundation for the development. The relationship of the development to the Trillium Line structure should be depicted in both the plan and section;	No building loads will be imposed on the subject alignment of the Trillium Line or associated infrastructure due to a horizontal separation of approximately 22 m away from the building foundation. Refer to Cross-Section A-A' (Drawing No. PG7354-2 dated December 2024) and the Proximity Assessment Report (PG7354-LET.01 dated December 6, 2024), presented in Appendix D. Structural drawings will be submitted once they are available.
Shoring design criteria and description of excavation and shoring method;	The temporary shoring system for the proposed development is anticipated to consist of soldier piles and lagging.

Shoring design criteria and description of excavation and shoring method (continued);	Additional shoring design criteria are provided in the aforementioned Geotechnical Investigation Report. The temporary shoring drawings will be submitted once they are finalized.
Groundwater control plan, including the determination of the short-term (during construction) and long-term effects of dewatering on the Trillium Line structure, and provision of assurances that the influences of dewatering will have no impact on the Trillium Line structure;	The Trillium Line and proposed development are anticipated to be constructed on the soil-bearing surface. However, due to the distance between the proposed development and the Trillium Line, no groundwater-lowering effects on the Trillium Line due to the proposed development are anticipated. Refer to Proximity Assessment Report (PG7354-LET.01 dated December 6, 2024), presented in Appendix D for additional details.
Proposal to replace/repair the waterproofing system of the affected Trillium Line structure, including the Trillium Line expansion joint;	As noted above, there will be at least a 22 m buffer between the Trillium Line and the proposed buildings at 75 Breezehill Avenue. Therefore, the replacement/repair of the waterproofing system is not applicable.
Identification of utility installations proposed through or adjacent to Trillium Line property.	At the time of writing this report, the utility design is not known. These plans will be forwarded once they are available.
Identification of the exhaust air quality and relationship of air intake/discharge to the Trillium Line at-grade vent shaft openings and station entrance openings.	At the time of writing this report, the mechanical design is not known. However, due to the 22 mm distance between the proposed development and the Trillium Line, any air intake/discharge will not be impacted.
Proposal for a pre-construction condition survey of the Trillium Line structure, including a survey to confirm locations of existing walls and foundations;	A thorough pre-construction condition survey of the Trillium Line will be completed prior to the start of construction at 75 Breezehill.
Monitoring plan for the movement of the shoring and Trillium Line structure prior to and during construction of the development, including an Action Protocol.	A monitoring plan for the movement of the temporary shoring system adjacent to the Trillium Line will be completed prior to construction and will be included with the temporary shoring drawing submission.

We trust that this information satisfies your immediate request.

Best Regards,

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
Dec. 9, 2024
S. S. DENNIS
100519516
PROVINCE OF ONTARIO

Otillia McLaughlin, B.Eng.

Scott S. Dennis, P.Eng.

APPENDIX A

Trillium Line Proximity Plan

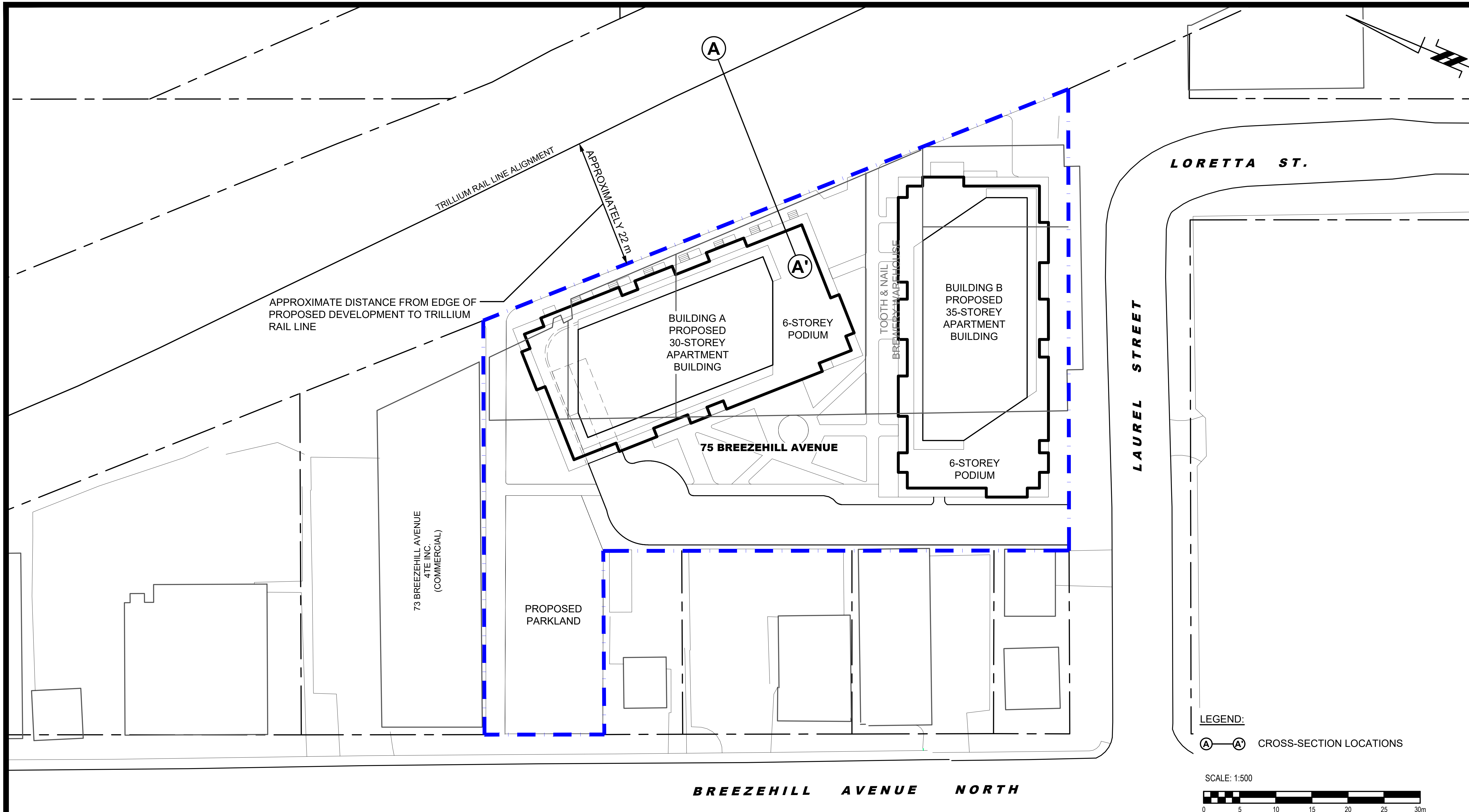
Cross Section A-A'

Topographic Survey Plan

Site Plan

Floor Plans

Construction Methodology and Impact Review



PATERSON GROUP

9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL

FOTENN
TRILLIUM LINE PROXIMITY STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
74 BREEZEHILL AVENUE

OTTAWA, ONTARIO

Title:

TRILLIUM LINE PROXIMITY PLAN

Scale: 1:500	Date: 12/2024
Drawn by: ZS	Report No.: PG7354-1
Checked by: OM	Dwg. No.: PG7354-1
Approved by: SD	Revision No.:

11x17

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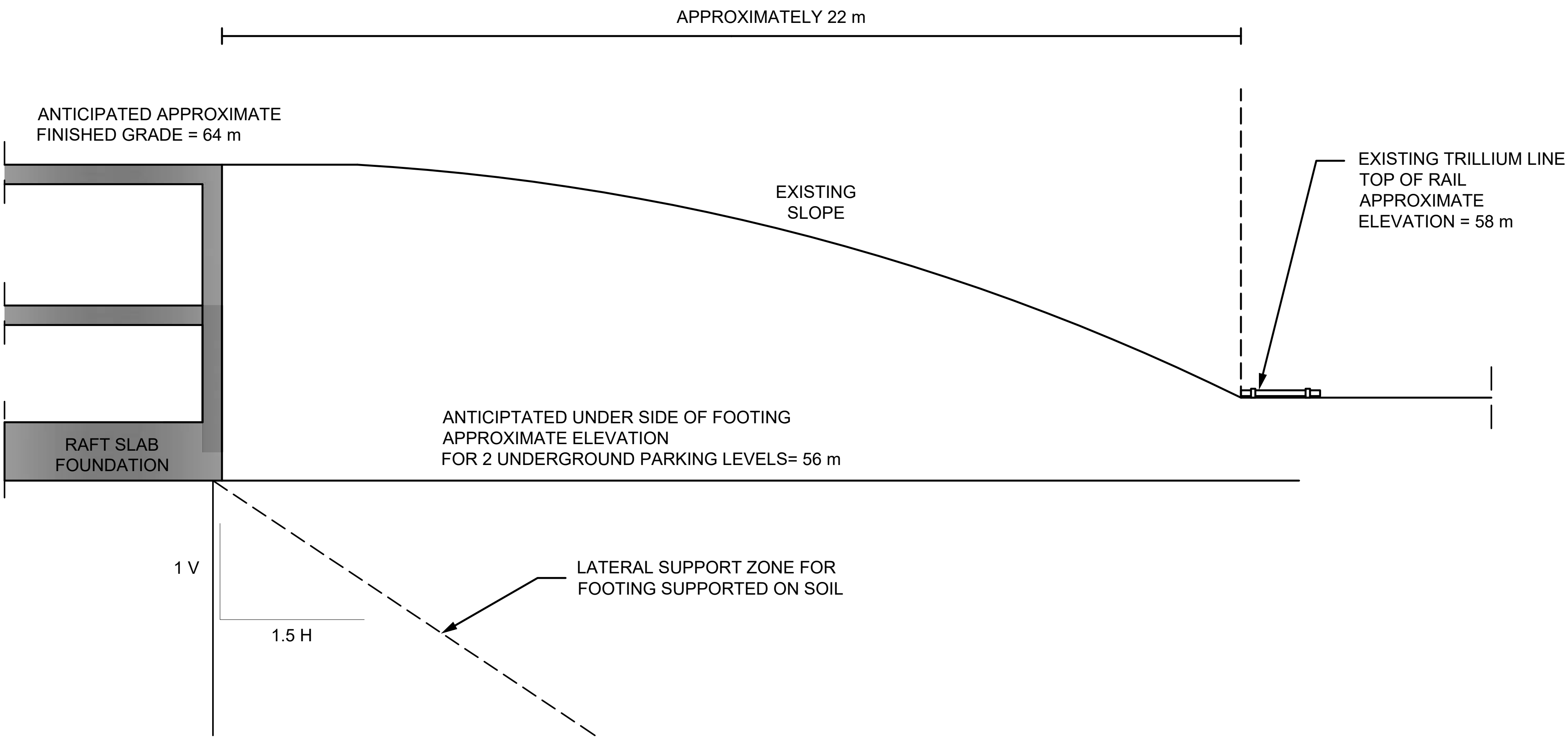
CROSS SECTION A -A '



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K2E 7T9
TEL: (613) 226-7381

FOTENN

TRILLIUM LINE PROXIMITY STUDY
75 BREEZEHILL AVENUE

OTTAWA, ONTARIO

Title:

CROSS SECTION A-A'

Scale: N.T.S.	Date: 12/2024
Drawn by: ZS	Report No.: PG7354-1
Checked by: OM	Drawing No.: PG7354-1
Approved by: SD	Revision No.:

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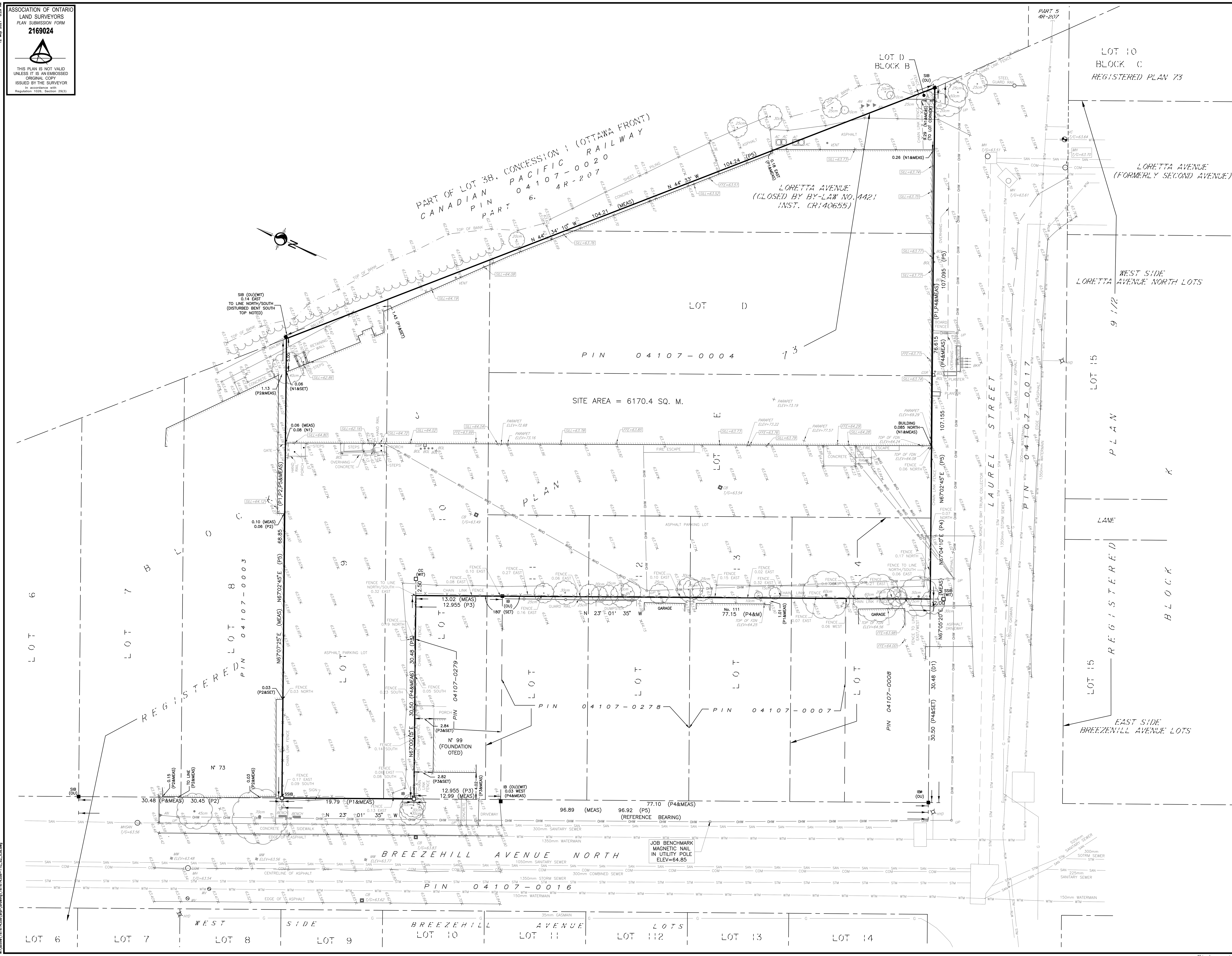
8-1/2x11

ASSOCIATION OF ONTARIO LAND SURVEYORS
PLAN SUBMISSION FORM
2169024

THIS PLAN IS NOT VALID UNLESS IT IS AN EMBOSSED ORIGINAL COPY ISSUED BY THE SURVEYOR
In accordance with Regulation 1026, Section 29(3)



TOPOGRAPHIC PLAN OF SURVEY OF

LOT D (BLOCK B),
PARTS OF LOTS 10, 11, 12, 13 AND 14
AND
ALL OF LOTS D, E AND 9 (BLOCK J)
AND
LORETTA AVENUE
(CLOSED BY BY-LAW NO. 4221, INST. CR104655)
REGISTERED PLAN 73
CITY OF OTTAWA

Scale 1:250

5 0 5 10 15 METRES

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

BEARING NOTE
BEARINGS ARE ASTRONOMIC AND ARE REFERRED TO THE EASTERLY LIMIT OF BREEZEHILL AVENUE NORTH, HAVING A BEARING OF N23Á01'55"W AS SHOWN ON PLAN 4R-207.

UTILITY NOTE
LOCATION OF UNDERGROUND SERVICES ARE APPROXIMATE AND PER THE CITY OF OTTAWA SHEETS, AND MUST BE VERIFIED PRIOR TO CONSTRUCTION.

ELEVATION NOTE
ELEVATIONS SHOWN HEREON ARE GEODETIC (CGVD-1928:1978) AND ARE DERIVED FROM THE CAN-NET VRS NETWORK MONUMENT: OTTAWA ELEVATION=95.230.

LEGEND (IF APPLICABLE)

■	DENOTES	FOUND MONUMENTS
□	"	SET MONUMENTS
IB	"	IRON BAR
IB Ï	"	ROUND IRON BAR
SIB	"	STANDARD IRON BAR
SSIB	"	SHORT STANDARD IRON BAR
WIT	"	WITNESS
PIN	"	PROPERTY IDENTIFICATION NUMBER
MEAS	"	MEASURED
PROP	"	PROPORTIONED
OU	"	ORIGIN UNKNOWN
SG, W&S	"	STANTEC GEOMATICS LTD.
P	"	REGISTERED PLAN 73
P1	"	PLAN BY 647 DATED NOVEMBER 4, 1980
P2	"	PLAN BY 1262 DATED JUNE 25, 1976
P3	"	PLAN BY 725 DATED JULY 30, 1975
P4	"	PLAN BY W&S DATWS AUGUST 28, 1998
P5	"	PLAN 4R-207
N1	"	FIELD NOTE BY 647 DATED NOV. 4, 1980
ACU	"	AIR CONDITIONING UNIT
AN	"	ANCHOR
BKR	"	BIKE RACK
BENCH	"	BENCH
BOL	"	BOLLARD
BOUL	"	BOULDER
CB	"	CATCH BASIN
DCB	"	DOUBLE CB
CBMH	"	CB MANHOLE
DCBMH	"	DOUBLE CB MANHOLE
SICB	"	SIDE INLET CB
GP	"	POLE GUYWIRE
GSR	"	GAS SERVICE REGULATOR
GV	"	GAS VALVE
HM	"	HYDRO METER
HTN	"	HYDRO TRANSFORMER
HYD	"	FIRE HYDRANT
JBX	"	JUNCTION BOX
LS	"	LIGHT STANDARD
MB	"	MAILBOX
MP	"	MONITORING PIN
MH	"	MAINTENANCE HOLE UNIDENTIFIED
MHB	"	MAINTENANCE HOLE BELL
MHF	"	MAINTENANCE HOLE FIBRE OPTIC
MHH	"	MAINTENANCE HOLE HYDRO
MHSA	"	MAINTENANCE HOLE SANITARY
MHST	"	MAINTENANCE HOLE STORM
MHT	"	MAINTENANCE HOLE TRAFFIC
MW	"	MONITORING WELL
OW	"	OBSERVATION WELL
PKM	"	PARKING METER
PLBX	"	PULL BOX
RWSL	"	RAILWAY SIGNAL LIGHT
RWSS	"	RAILWAY SWITCH STAND
SAT	"	SATELLITE DISH
SCLP	"	SCULPTURE
SCP	"	SUMP/CATCH PIT
SCV	"	SPRINKLER CONTROL VALVE
SN	"	SIGN
TB BELL	"	TERMINAL BOX - BELL
TB CATV	"	TERMINAL BOX - CABLE
TCB	"	TRAFFIC CONTROL BOX
UP	"	UTILITY POLE
VB	"	VALVE BOX
VC	"	VALVE CHAMBER
WV	"	WATER VALVE
	"	TREE STUMP
	"	TREE CONIFEROUS
	"	TREE DECIDUOUS

COM COM
COMBINED SEWER

SAN SAN SAN
SANITARY SEWER

WTM WTM WTM
WATERMAIN

G
GASMAIN

STM STM STM
STORM SEWER

OHW OHW OHW
OVERHEAD UTILITY WIRE

SURVEYOR'S CERTIFICATE
I CERTIFY THAT :
1. THIS SURVEY AND PLAN ARE CORRECT AND IN ACCORDANCE WITH THE SURVEYS ACT, THE SURVEYORS ACT AND THE REGULATIONS MADE UNDER THEM.
2. THE SURVEY WAS COMPLETED ON THE 5th DAY OF MAY, 2021.

May 12, 2021
DATE

FRANCIS LAU
ONTARIO LAND SURVEYOR

SRO MAP COORD.= 366051.60, 5029812.79

Stantec Geomatics Ltd.
CANADA LANDS SURVEYORS
ONTARIO LAND SURVEYORS
1331 CLYDE AVENUE, SUITE 400
OTTAWA, ONTARIO, K2C 3G4
TEL. 613.722.4420
stantec.com

DRAWN: NJ	CHECKED: KJ	PM: KJ	FIELD: ES/ZL	PROJECT No.: 161614358-110

This plan was signed with a scanned signature as a result of the Emergency Order related to the COVID-19 pandemic.

DRAWING NOTES

1. PROPERTY LINE
2. EXISTING BUILDING SETBACKS
3. HARD SURFACE PAVING, SEE LANDSCAPE PLAN FOR PATTERN AND TYPE
4. DEPRESSED CURB AND SIDEWALK TO CITY OF OTTAWA STANDARD DETAIL
5. GROUND COVER IN CONCRETE PLANTERS
6. RESERVED
7. BICYCLE PARKING SPACES
8. SIAMESE CONNECTION @ GROUND FLOOR
9. RESERVED
10. EXISTING FIRE HYDRANT
11. OUTLINE OF UNDERGROUND PARKING LEVELS
12. EXISTING TREE TO BE REMOVED
13. RESERVED
14. RELOCATE EXISTING UTILITY POLE AND GUIDE CABLES
15. RESERVED
16. RESERVED
17. EXTENT OF GROUND FLOOR
18. ENTRY DRIVEWAY TO U/G PARKING GARAGE
19. EXISTING UTILITY POLE
20. EXISTING 2 STOREY BUILDING TO BE REMOVED
21. SPLASH PAD
21. SOD AREA

SITE PLAN SYMBOLS

- CONCRETE UNIT PAVERS SURFACE
- PROPOSED CONCRETE SURFACE
- EXISTING CONCRETE CITY SIDEWALK
- NCC MULTI-USE PATHWAY
- SOFT LANDSCAPING
- BIKE RACK
- TWO WAY VEHICLE CIRCULATION
- MAIN/COMMERCIAL ENTRANCE
  BIKE ROOM/RESIDENTIAL ENTRANCE
- FIRE EXIT
- PROPERTY LINE
- ZONING SETBACKS

PROPERTY OWNER

FRED UNSWORTH
Ottawa, ON
E-Mail:fg_unsworth@rogers.com

LEGAL DESCRIPTION

SURVEYOR'S REAL PROPERTY REPORT
LOT D (BLOCK B),
PARTS of LOTS 10, 11, 12, 13 & 14
And **ALL OF LOTS D, E, AND 9**
(BLOCK J)
And **LORETTA AVE**
REGISTERED PLAN 73
CITY OF OTTAWA
Surveyed by Stantec Geomatics Ltd.

SURVEYOR

Stantec Geomatics Ltd.
Ontario Land Surveyors
1331 Clyde Avenue, Suite 400,
Ottawa, Ontario K2C 3G4
Tel: (613) 722-4420
E-Mail: brian.webster@stantec.com

URBAN PLANNER

FoTenn Consultants Inc.
223 McLeod Street
Ottawa, ON Canada, K2P 0Z8
Tel.: (613) 730-5709
E-Mail: beed@fotenn.com

LANDSCAPE ARCHITECT

CIVIL ENGINEER

PROJECT INFORMATION

EXISTING ZONING		IG1 H(11)
PROPOSED ZONING Zoning By-Law 2008-250		MC
SITE AREA		6172 sq. m. (66,433) sq. ft.
OPEN AREA		45.5% 2811 sq. m.(30,257) sq. ft.
BUILDING HEIGHT - VARIES		108M, 93M

PROJECT STATISTICS

BUILDING HEIGHT	BLDG. A BLDG. B	30 STOREY - 93 M 35 STOREY - 108 M
AMENITY AREA	6 m² PER UNIT	3,186 sq. m.

GROSS BUILDING - AREAS (30 STOREY BLDG.)

(CITY OF OTTAWA'S DEFINITION)

PARKING LEVELS (2 LEVELS U/G)		N/A
GROUND FLOOR		350 sq. m. (3,767) sq. ft.
L2 FLOOR		935 sq. m. (10,064) sq. ft.
L3-6 FLOOR	4 x 1,034 sq. m. 4 x (11,030) sq. ft.	4,136 sq. m. (44,120) sq. ft.
L7-30 FLOOR	24 x 515 sq. m. 24 x (5,543) sq. ft.	12,360 sq. m. (133,032) sq. ft.
TOTAL AREA		17,781 sq. m. (190,983) sq. ft.

GROSS BUILDING - AREAS (35 STOREY BLDG.)

(CITY OF OTTAWA'S DEFINITION)

PARKING LEVELS (2 LEVELS U/G)		N/A
GROUND FLOOR		387 sq. m. (4,166) sq. ft.
L2 FLOOR		1,038 sq. m. (11,173) sq. ft.
L3-6 FLOOR	4 x 1038 sq. m. 4 x (11,173) sq. ft.	4,152 sq. m. (44,692) sq. ft.
L7-35 FLOOR	29 x 502 sq. m. 29 x (5,403) sq. ft.	14,558 sq. m. (156,687) sq. ft.
MECHANICAL FLOORS		N/A
TOTAL AREA		21,135 sq. m. (216,718) sq. ft.

UNIT STATISTICS

STUDIO UNIT	29	5%
1 BEDROOM UNIT	134	25%
1 BEDROOM + STUDY UNIT	110	21%
2 BEDROOM UNIT	218	41%
3 BEDROOM UNIT	40	8%
TOTAL	531	

COMMERCIAL RETAIL Bldg A - 30 storey	0 sq. m. (0) sq. ft.
COMMERCIAL RETAIL Bldg B - 35 storey	407 sq. m. (4,385) sq. ft.
TOTAL AREA	407 sq. m. (4,385) sq. ft.

CAR PARKING

REQUIRED by ZONING BY-LAW

RESIDENCE	- 0.5 PER UNIT (457 UNITS) (AFTER 12 UNITS -10% FOR UG)	200
VISITOR	- 0.1 PER DWELLING UNIT (AFTER 12 UNITS -MAX 30)	30
COMMERCIAL RETAIL (RETAIL FOOD, BANK & CONVENIENCE STORE)	- 0 UNDER 500 sq.m.PER UNIT	0
TOTAL		230

PROVIDED

2 LEVEL UNDER GROUND PARKING	132
SURFACE	0
TOTAL	132

BICYCLE PARKING

REQUIRED

RESIDENCE	- 0.5 PER UNIT (457 UNITS)	229
COMMERCIAL RETAIL	- 1.0 PER 250m² OF G.F.A.	1
TOTAL		230

PROVIDED

EXTERIOR	8
INDOOR ON GROUND FLOOR	141
INDOOR ON P1 & P2 PARKING LEVELS	635
TOTAL	786

AMENITY AREA

PRIVATE AT GRADE	123 sq. m.
EXTERIOR COMMUNAL AT GRADE	2154 sq. m.
1st FLOOR LOBBIES	253 sq. m.
1st FLOOR COMMUNAL AMENITY	524 sq. m.
PRIVATE BALCONIES	5284 sq. m.
TOTAL =	8338 sq. m.
TOTAL COMMUNAL =	2931 sq. m.
REQUIRED - 6.0M² PER UNIT (476) =	3,186 sq. m.
REQUIRED COMMUNAL @ 50% =	1,593 sq. m.

rla/architecture

SITE PLAN

SCALE: 1: 200

PLOT DATE: 2022.09.20

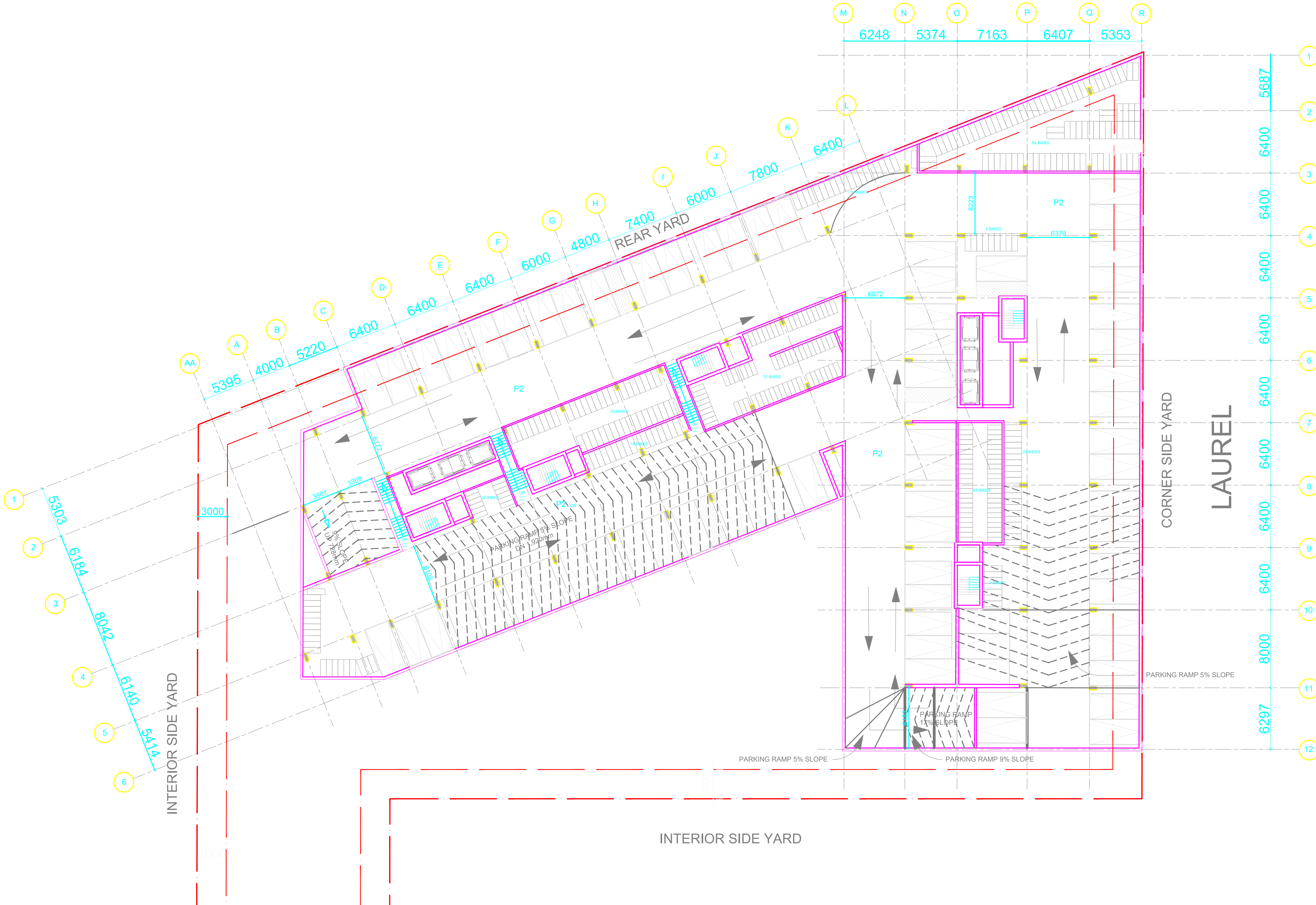
ISSUED FOR: REVISED ZONING AMENDMENT

7 5 B r e e z e h i l l A v e n u e

O T T A W A O N T A R I O

SHEET #
1

PROJ. # 2113



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P2 PARKING PLAN

SCALE 1:400

PLOT DATE: November 13, 2024

GFA

P2 PARKING: 41,473 SQ.FT.

348 BICYCLES STALLS + 69 CAR STALLS

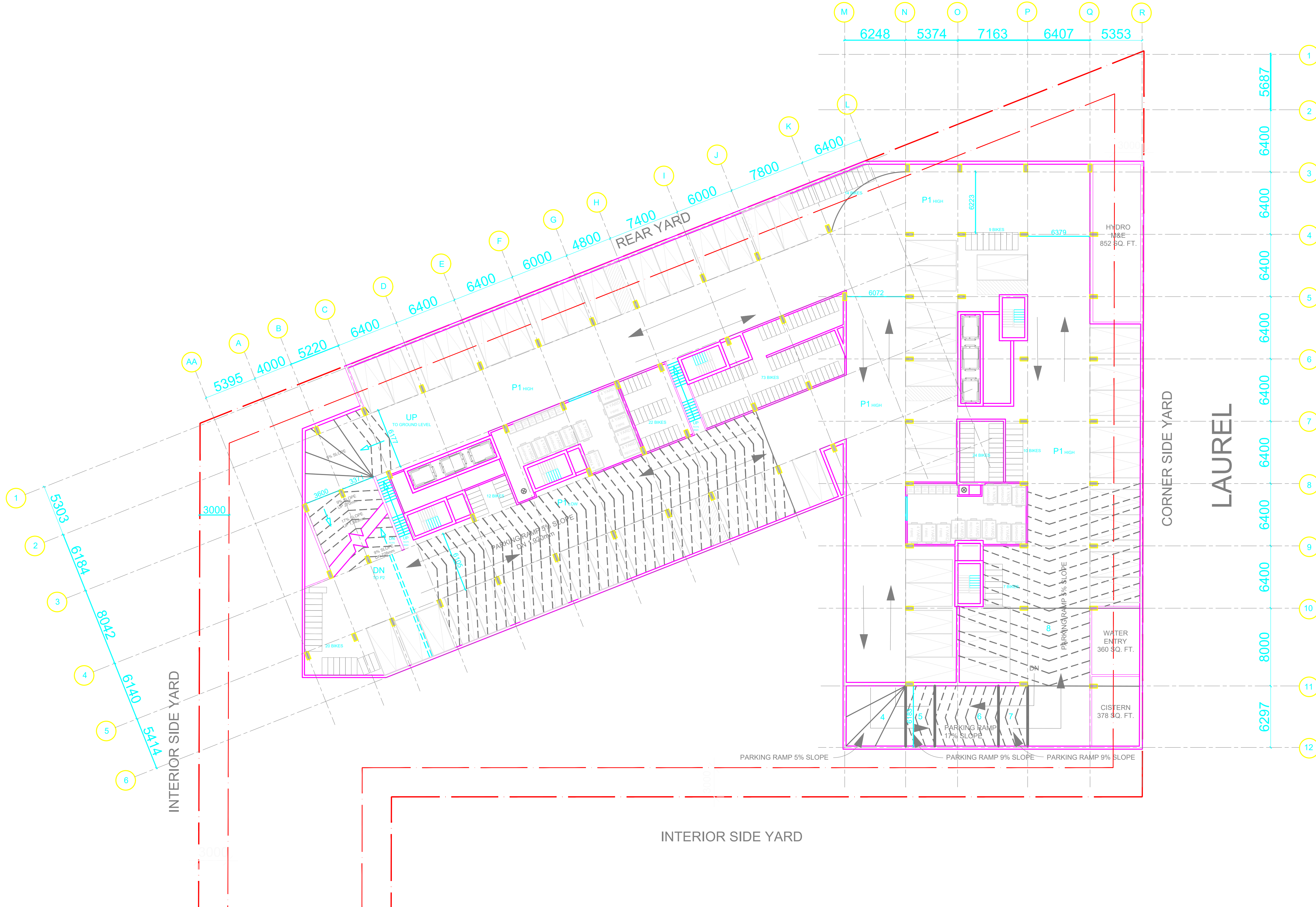
75 Breezehill Ave.

OTTAWA, ONTARIO

SHEET #

1

PROJ. # 2113



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P1 PARKING PLAN

SCALE 1:400

PLOT DATE: October 04, 2024

GFA

P1 PARKING: 41,473 SQ.FT.

191 BICYCLES STALLS + 55 CAR STALLS

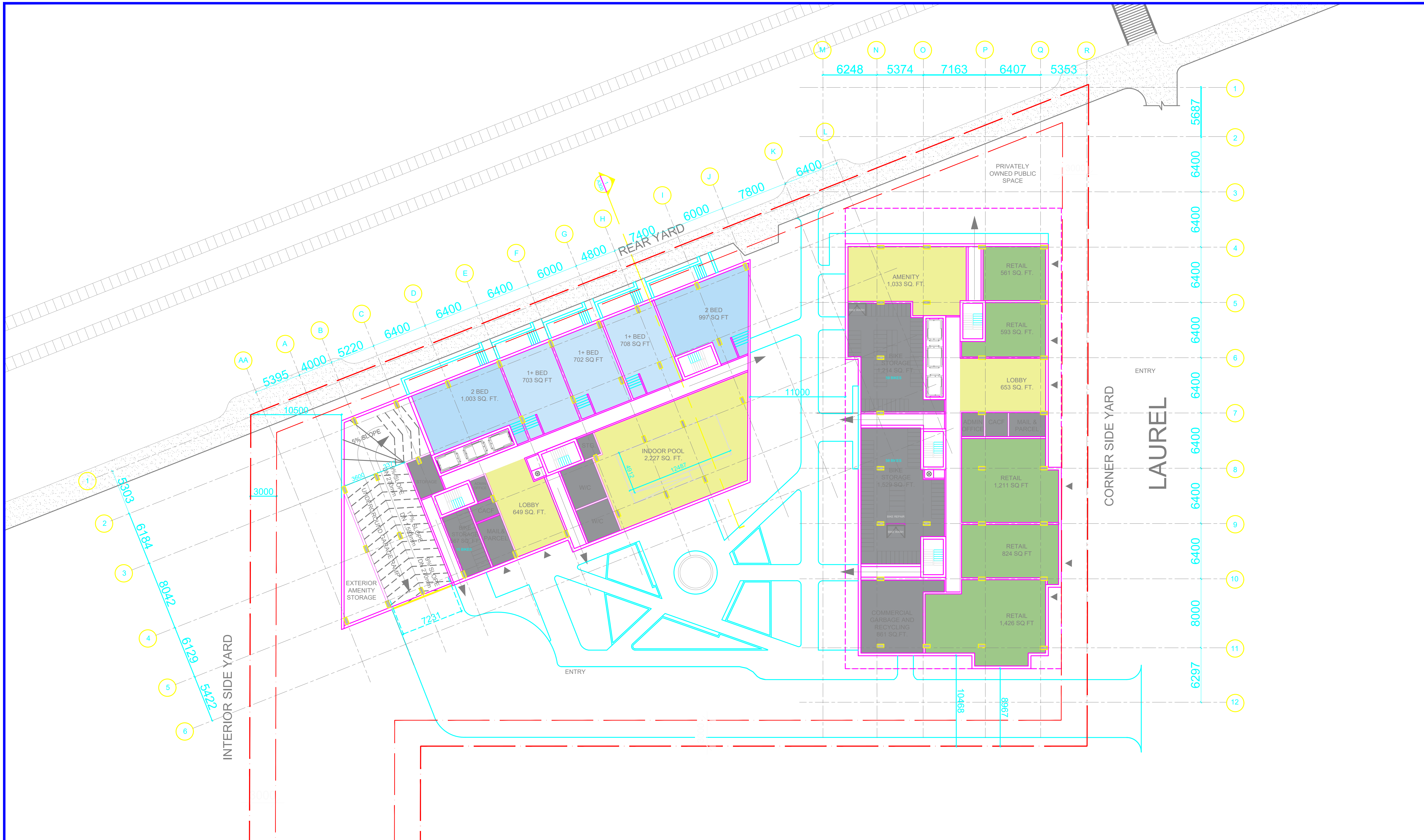
75 Breezehill Ave.

OTTAWA, ONTARIO

SHEET #

2

PROJ. # 2113



GROUND FLOOR PLAN

SCALE 1:400

PLOT DATE: November 13, 2024

GFA

BUILDING A: 12,661 SQ.FT.

BUILDING B: 11,846 SQ.FT.

132 BICYCLES STALLS

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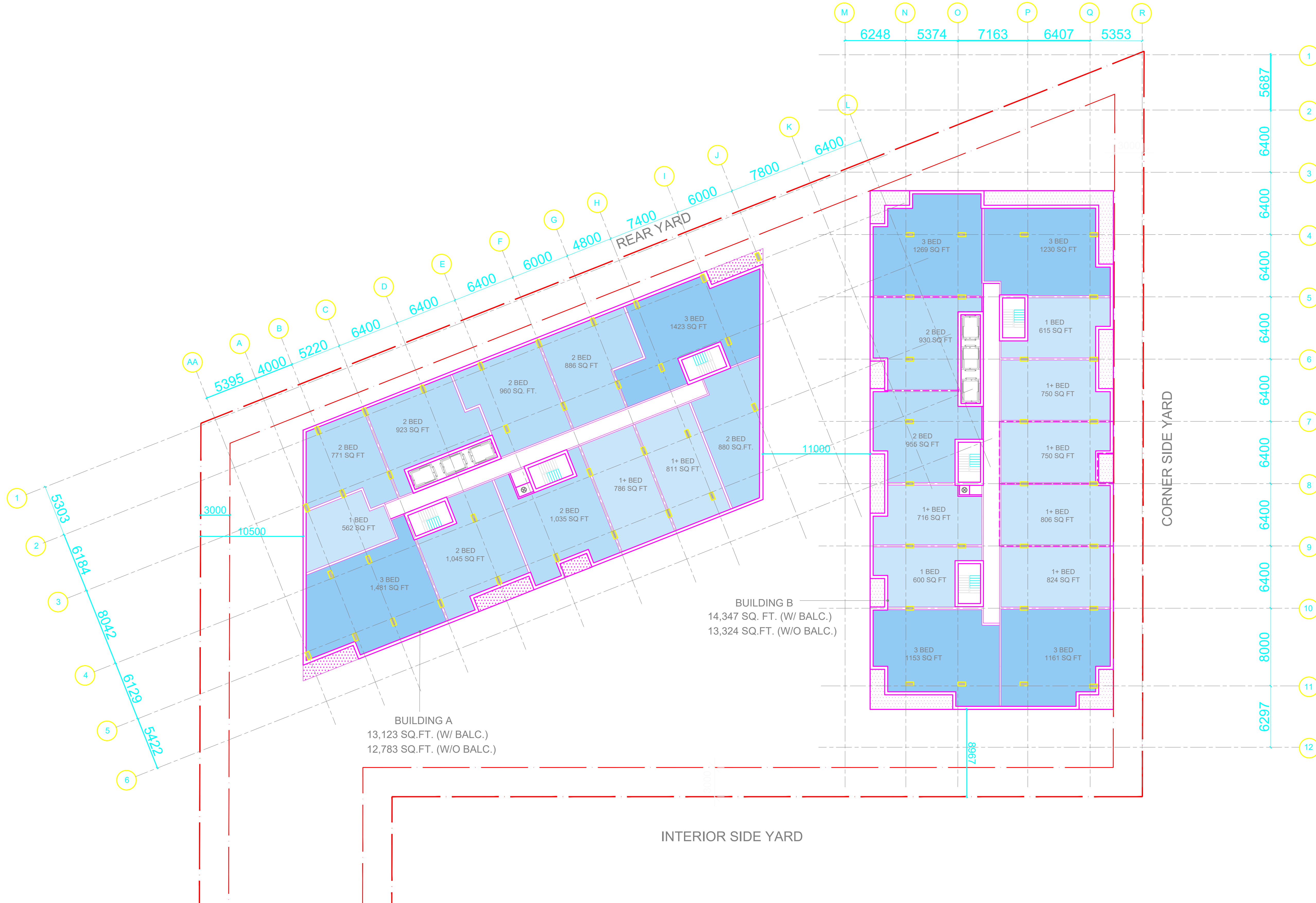
75 Breezehill Ave.

OTTAWA, ONTARIO

SHEET #

3

PROJ. # 2113



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L2 PLAN

SCALE 1:400

PLOT DATE: July 22, 2024

GFA

BUILDING A: W/BALC: 13,123 SQ.FT. W/OBALC: 12,783 SQ.FT

BUILDING B: W/BALC: 14,347 SQ.FT. W/OBALC: 13,324 SQ.FT

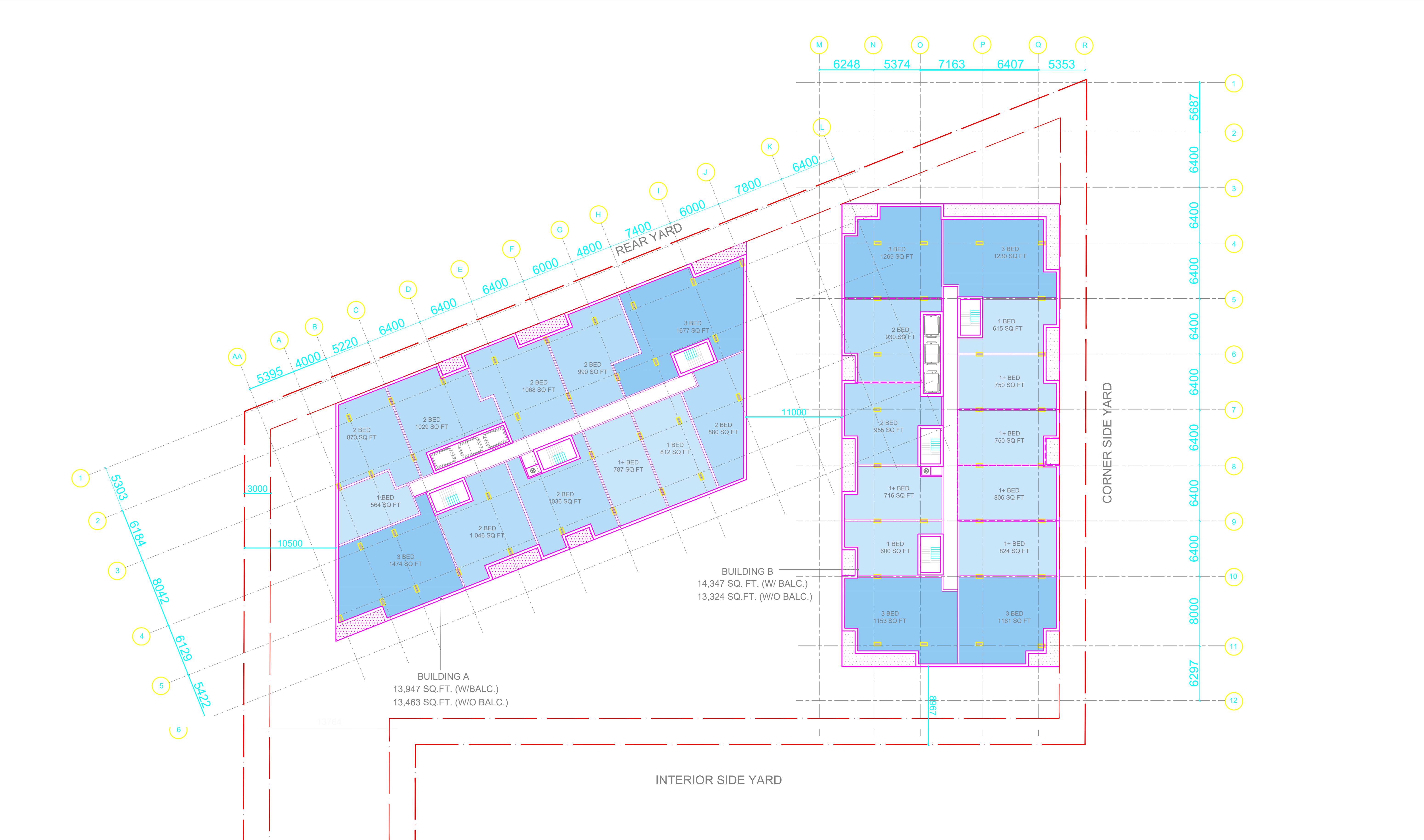
75 Breezehill Ave.

OTTAWA, ONTARIO

SHEET #

4

PROJ. # 2113



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L3-6 PLAN

SCALE 1:400

PLOT DATE: July 22, 2024

GFA

BUILDING A: W/BALC: 13,947 SQ.FT. W/OBALC: 13,463 SQ.FT

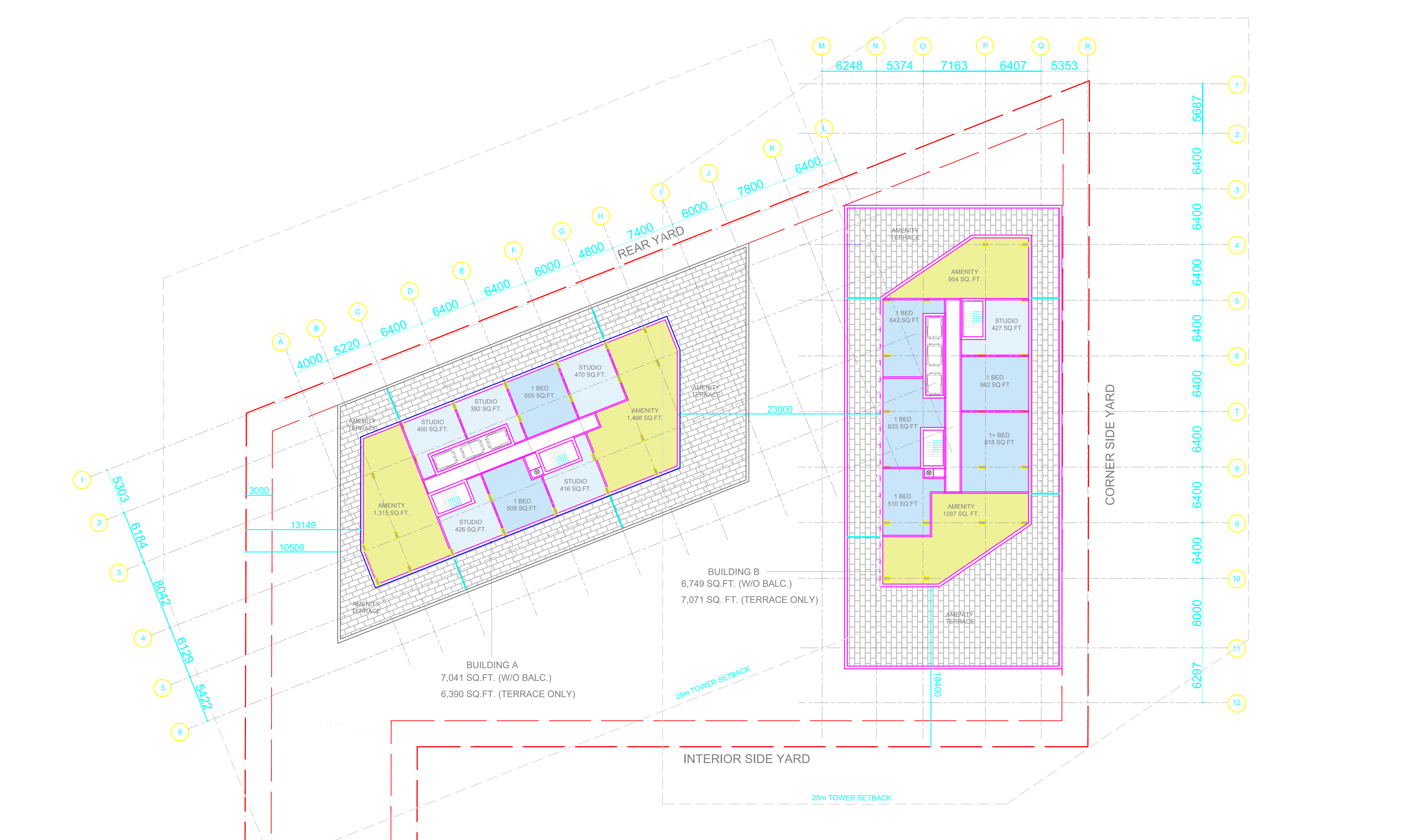
BUILDING B: W/BALC: 14,347 SQ.FT. W/OBALC: 13,324 SQ.FT

75 Breezehill Ave.

OTTAWA, ONTARIO

SHEET # 5

PROJ. # 2113



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L7 PLAN

SCALE 1:400

PLOT DATE: November 13, 2024

GFA

BUILDING A: TERRACE: 6,390 SQ.FT. W/OBALC: 7,041 SQ.FT

BUILDING B: TERRACE: 7,071 SQ.FT. W/OBALC: 6,749 SQ.FT

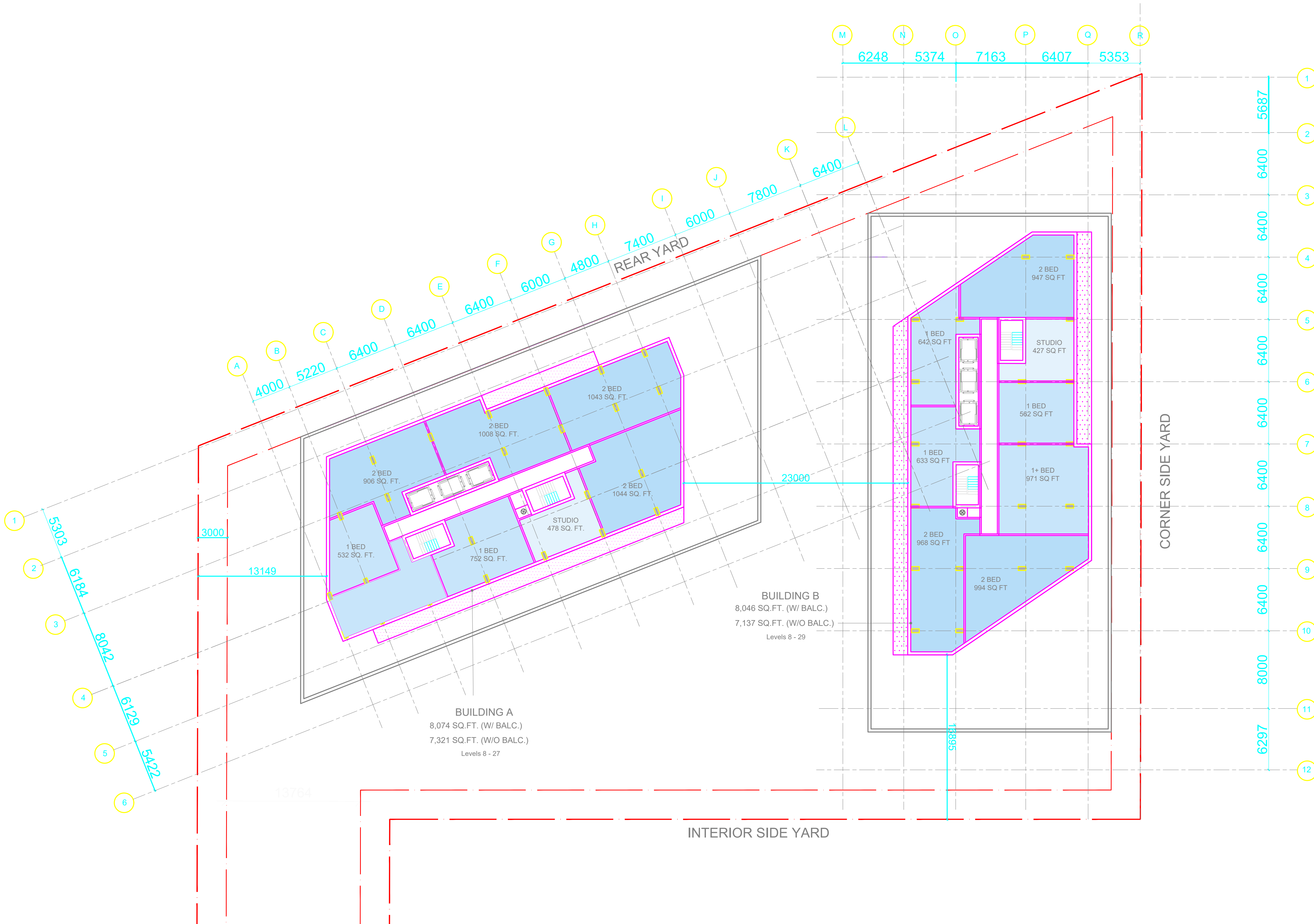
75 Breezehill Ave.

OTTAWA, ONTARIO

SHEET #

6

PROJ. # 2113



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TOWER L8-(27-30)

SCALE 1:400

PLOT DATE: July 22, 2024

GFA

BUILDING A: W/BALC: 8,074 SQ.FT. W/OBALC: 7,321 SQ.FT

BUILDING B: W/BALC: 8,046 SQ.FT. W/OBALC: 7,137 SQ.FT

75 Breezehill Ave.

OTTAWA, ONTARIO

SHEET # 7

PROJ. # 2113

Construction Methodology and Impact Review		
Construction Item	**Potential Impact**	**Mitigation Program**
Item A - Installation of Temporary Shoring System - Where adequate space is not available for the overburden to be sloped, the overburden along the perimeter of the proposed buildings footprints will need to be shored in order to complete the construction of the underground parking levels. The shoring system is anticipated to consist of a soldier pile and lagging system.	Vibration issues during shoring system installation.	Design of the temporary shoring system, in particular vibrations during installation, will take into consideration of the presence of the proposed Trillium Line. Installation of the shoring system is not anticipated to have an adverse impact on the Trillium Line, nonetheless, a series of vibration monitoring devices are recommended to be installed to monitor vibrations. The vibration monitors would be remotely connected to permit real-time monitoring and a vibration monitoring program would be implemented as detailed in Subsection 3.1 - Vibration Monitoring and Control Program of Paterson Group Report PG7354-1 dated December 6, 2024.
Item B - Bedrock Blasting and Removal Program - Blasting of the bedrock is not anticipated for the proposed development and parking garage structure construction. It is not expected that bedrock removal is required based on the current design concepts for the proposed residential development.	Structural damage of Confederation Line due to vibrations from blasting program.	Structural damage to the Trillium Line during bedrock blasting and removal is not anticipated, nonetheless, a series of vibration monitoring devices are recommended to be installed along the rail corridor to monitor vibrations. The vibration monitors would be remotely connected to permit real-time monitoring and a vibration monitoring program would be implemented as detailed in Subsection 3.1 - Vibration Monitoring and Control Program of Paterson Group Report PG7354-1 dated December 6, 2024.
Item C - Construction of Footings and Foundation Walls - The proposed building will include 2 levels of underground parking. Therefore, the footings will be placed over a soil bearing surface.	Building footing loading on adjacent Trillium Line, and excavation within the lateral support zone of the Trillium Line.	Due to the distance between the proposed building and the Trillium Line, the zone of influence from the proposed footings will not intersect the rail line structure. Further, although the underground parking levels for the proposed building will extend approximately 8 m below the existing ground surface, due to the approximate 22 m distance between the proposed building and rail line structure, the building excavation will not impact the lateral support zone of the Trillium Line.

PATERSON GROUP

APPENDIX B

Geotechnical Investigation Report:

Prepared By Paterson Group

Report No. PG6622-1 Revision 1 dated February 26, 2024

PATERSON GROUP

Geotechnical Investigation

Proposed Multi-Use High Rise Complex

75 Breezehill Avenue North

Ottawa, Ontario

Prepared for 2729685 Ontario Inc. c/o Fotenn

Report PG6622-1 Revision 1 dated February 26, 2024

Table of Contents

Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by 2729685 Ontario Inc. c/o Fotenn to conduct a geotechnical investigation for the proposed multi-use high rise complex to be located at 75 Breezehill Avenue North in the City of Ottawa, Ontario (refer to Figure 1 – Key Plan in Appendix 2 of this report).

The objective of the geotechnical investigation was to:

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

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

Investigating the presence or potential presence of contamination on the subject property was not part of the scope of work of the present investigation. Therefore, the present report does not address environmental issues.

2.0 Proposed Development

Based on the available drawings, it is understood that the proposed development at 75 Breezehill Avenue North will consist of two multi-use high rise buildings with two levels of shared underground parking level occupying the majority of the footprint of the subject site. Building A is proposed to include 35 storeys while Building B will host 30 storeys. It is understood that the proposed Building B will include approximately 472 m^2 of commercial space. Associated access lanes, landscaped areas and a park are also anticipated as a part of the development. It is expected that the proposed buildings will be municipally serviced.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the current geotechnical investigation was conducted on April 18 and 19, 2023, and consisted of advancing four boreholes to a maximum depth of 13.65 m below the existing ground surface. The borehole locations were distributed across the site in a manner to provide general coverage of the subject site. The locations of the boreholes are shown on Drawing PG6622-1 – Test Hole Location Plan included in Appendix 2.

The boreholes were advanced using a low-clearance track mounted drill rig operated by a two-person crew, while the boreholes in the existing underground parking were completed using a portable drill rig operated by a two-person crew. The testing procedure consisted of advancing to the required depths at the selected locations and sampling the overburden. All fieldwork was reviewed in the field by Paterson personnel under the direction of a senior engineer from the geotechnical division.

Sampling and In Situ Testing

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

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

Undrained shear strength testing was carried out at regular depth intervals in cohesive soils using a vane apparatus.

The thickness of the overburden was evaluated by a dynamic cone penetration test (DCPT) at boreholes BH 2-23 and BH 3-23.

The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at its tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

Rock samples were recovered using a core barrel and diamond drilling techniques. The bedrock samples were classified on site, placed in hard cardboard core boxes and transported to Paterson's laboratory. The depths at which rock core samples were recovered from the boreholes are presented as RC on the Soil Profile and Test Data sheets in Appendix 1.

The recovery value and a Rock Quality Designation (RQD) value were calculated for each drilled section of bedrock and are presented on the borehole logs. The recovery value is the length of the bedrock sample recovered over the length of the drilled section. The RQD value is the total length of intact rock pieces longer than 100 mm over the length of the core run. The values indicate the bedrock quality. The subsurface conditions observed at 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.

3.2 Field Survey

The borehole locations and ground surface elevation at each borehole location were surveyed by Paterson at the time of the field investigation using a high precision GPS unit. The borehole locations are referenced to a geodetic datum. The borehole locations and ground surface elevation at the boreholes are presented on Drawing PG6622-1 – Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

The soil samples recovered from the subject site were examined in our laboratory to review the results of the field logging. All soil samples were submitted for moisture content testing. All samples will be stored in the laboratory for a period of one month after the issuance of this report unless we are otherwise directed.

3.4 Analytical Testing

One (1) soil sample was submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures by Paterson. The samples were submitted to determine the concentration of sulphate and chloride, the resistivity, and the pH of the samples. The results are discussed further in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The subject site is currently occupied by a two-storey building with multiple commercial units and associated at grade parking and landscaped areas. The ground surface across the subject site is relatively flat with an approximate geodetic elevation of 64 m and is at grade with Breezehill Avenue, Laurel Street and the neighboring properties.

The subject site is bordered by a two-storey commercial building to the north, by Laurel Street to the south, by commercial/residential buildings and Breezehill Avenue to the west and by Light Rail Transit (LRT) tracks to the east.

4.2 Subsurface Profile

Building A

Overburden

The subsurface profile encountered at the borehole locations BH 1-23 and BH 2-23 generally consisted of a fill layer overlying hard to very stiff, brown silty clay transitioning to a very stiff to stiff grey silty clay, underlain by inferred glacial till extending to the bedrock surface. The fill material consisted of brown silty sand to silty clay with gravel, crushed stone and trace asphalt and was observed to extend to depths between 1.1 and 1.8 m below the existing ground surface.

Bedrock

Practical refusal to DCPT was encountered on inferred bedrock at a depth of 13.51 m below the existing ground surface at borehole BH 2-23. Based on available geological mapping, the subject site consists of interbedded shale and limestone of the Verulam formation and an approximate drift thickness of 0 to 10 m.

Building B

Overburden

The subsurface profile encountered at the borehole locations BH 3-23 and BH 4-23 generally consisted of a fill layer overlying hard to very stiff, brown silty clay transitioning to a very stiff to stiff grey silty clay. The silty clay was followed by very stiff to stiff and compact to dense glacial till, extending to the bedrock surface.

The fill material consisted of brown silty sand to silty clay with gravel, crushed stone and trace organics and was observed to extend to depths between 1.1 and 1.8 m below the existing ground surface.

Bedrock

Practical refusal to DCPT was encountered on inferred bedrock at a depth of 10.34 m below the existing ground surface at borehole BH 3-23. Practical refusal to augering was encountered on the bedrock surface at a depth of 9.73 m below the existing ground surface at BH 4-23. Based on available geological mapping, the bedrock in this area consists of interbedded limestone and shale of the Verulam Formation with an anticipated overburden drift thickness of 0 to 10 m.

Bedrock was encountered underlying the glacial till at borehole 4-23 at a depth of 9.83 m and consisted of good to excellent quality limestone. Reference should be made to the Soil Profile and Test Data sheets in the attachments for specific details of the soil profiles encountered at each borehole location.

4.3 Groundwater

Groundwater levels were measured on April 26, 2023 at the installed monitoring well locations. The groundwater level measurements are presented in Table 1 below.

Table 1 – Summary of Groundwater Levels

Borehole Number	Observation Method	Ground Surface Elevation (m)	Measured Groundwater Level		Date Recorded
			Depth (m)	Elevation (m)	
BH 1-23	Monitoring Well	63.95	3.30	60.65	April 26, 2023
BH 2-23	Monitoring Well	64.08	3.97	60.11	
BH 3-23	Monitoring Well	63.76	3.00	60.76	
BH 4-23	Monitoring Well	63.86	4.00	59.86	

Groundwater levels can be influenced by surface water infiltrating the backfilled boreholes and perched water within the borehole backfill material. Long-term groundwater levels can also be estimated based on the observed colour, consistency and moisture levels of the recovered soil samples. Based on these observations, the long-term groundwater table can be expected at approximately 4 to 5 m below the existing ground surface. The groundwater levels are noted on the applicable Soil Profile and Test Data Sheets presented in Appendix 1. It should also be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level could vary at the time of construction.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered suitable for the proposed development. It is recommended the proposed multi-storey buildings are founded on a raft foundation placed on an undisturbed, very stiff to stiff grey silty clay and/or compact to dense glacial till bearing surface.

Alternatively, For Building B, conventional spread footings may be extended to the bedrock surface via a lean concrete trench, placed over a clean, surface sounded, limestone bedrock surface.

End bearing piles are also recommended as a foundation option if the expected loads of the proposed buildings exceed the bearing resistance values provided in the previous options.

Due to the presence of a silty clay deposit within the subject site, any settlement-sensitive structures placed on a silty clay subgrade within the proposed development will be subjected to a permissible grade raise restriction.

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

5.2 Site Grading and Preparation

Stripping Depth

Existing footings, concrete slabs and other construction debris should be entirely removed from within the building perimeter. Under paved areas, existing construction remnants, such as foundation walls or slabs, should be excavated to a minimum of 1 m below final grade.

Topsoil and deleterious fill, such as those containing significant amounts of organic materials, or construction debris/remnants should be stripped from under any buildings, paved areas, pipe bedding and other settlement sensitive structures.

Vibration Considerations

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

The following construction equipment could cause vibrations: piling equipment, hoe ram, compactor, dozer, crane, truck traffic, etc. The construction of a shoring system with soldier piles or sheet piling will require these pieces of equipment. Vibrations, caused by blasting or construction operations could cause detrimental vibrations on the adjoining buildings and structures. Therefore, it is recommended that all vibrations be limited. Two parameters determine the recommended vibration limit, the maximum peak particle velocity and the frequency. For low frequency vibrations, the maximum allowable peak particle velocity is less than that for high frequency vibrations.

As a guideline, the peak particle velocity should be less than 15 mm/s between frequencies of 4 to 12 Hz, and 50 mm/s above a frequency of 40 Hz (interpolate between 12 and 40 Hz). These guidelines are for current construction standards. Considering there are several sensitive buildings in close proximity to the subject site, consideration to lowering these guidelines is recommended. These guidelines are above perceptible human level and, in some cases, could be very disturbing to some people, a pre-construction survey is recommended to minimize the risks of claims during or following the construction of the proposed buildings.

Fill Placement

Fill used for grading beneath the building footprint, unless otherwise specified, should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. The fill should be tested and approved prior to delivery to the site. It should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building area should be compacted to at least 99% of its standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids.

If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of their respective SPMDD. Site-excavated soils are not suitable for use as backfill against foundation walls unless a composite drainage blanket connected to a perimeter drainage system is provided.

Protection of Subgrade (Raft Foundation)

Since the subgrade material for the proposed foundations is expected to partially consist of very stiff to stiff silty clay, it is recommended that a minimum 75 mm thick lean concrete mud slab be placed on the silty clay subgrade shortly after the completion of the excavation.

The main purpose of the mud slab is to reduce the risk of disturbance of the subgrade under the traffic or workers and equipment and to provide a more consistent bearing surface transition with the glacial till. The final excavation to the raft bearing surface level and the placing of the mud slab should be completed in smaller sections to avoid exposing large areas of the silty clay to potential disturbances due to drying.

5.3 Foundation Design

<u>Raft Foundation</u>

Based on the expected loads from the proposed structure, a raft foundation bearing on the undisturbed, very stiff to stiff, grey silty clay and/or compact to dense glacial till bearing surface may be considered for foundation support for the proposed building or a combination of both bearing mediums. For design purposes, it was assumed that the base of the raft foundation would be located at an approximate depth of 7 to 8 m since it would be provided with two level of underground parking.

The amount of settlement of the raft slab will be dependent on the sustained raft contact pressure. The loading conditions for the contact pressure are based on sustained loads, that are generally taken to be 100% Dead Load and 50% Live Load.

For the raft slab foundation, a bearing resistance value at SLS (contact pressure) of **275 kPa** will be considered acceptable for a raft supported on the undisturbed, very stiff silty clay. The factored bearing resistance (contact pressure) at ULS can be taken as **420 kPa**. For this case, the modulus of subgrade reaction was calculated to be **11 MPa/m** for a contact pressure of **275 kPa**.

For the raft slab foundation, a bearing resistance value at SLS (contact pressure) of **350 kPa** will be considered acceptable for a raft supported on the undisturbed, Dense Glacial till. The factored bearing resistance (contact pressure) at ULS can be taken as **500 kPa**. For this case, the modulus of subgrade reaction was calculated to be **15 MPa/m** for a contact pressure of **350 kPa**.

The raft foundation design is required to consider the relative stiffness of the reinforced concrete slab and the supporting bearing medium. A geotechnical resistance factor of 0.5 was applied to the bearing resistance values at ULS.

Based on the following assumptions for the raft foundation, the high-rise portion of the proposed structure can be designed using the above parameters with a total and differential settlement of 25 and 15 mm, respectively.

Where the raft foundation is partly placed over silty clay and partly over glacial till, a minimum ground taper of 5H:1V is recommended to be placed at the transition zone. The silty clay should be subexcavated at a 5H:1V and replaced with OPSS Granular A or Granular B Type II and compacted to a 98% of the material's SPMDD. This will allow the foundation to smoothly transition from a silty clay bearing medium to a glacial till bearing medium. It is suggested that construction joints be considered within this area to withstand differential settlements, if occurred.

Conventional Foundation

Conventional spread footings placed on a clean, surface sounded limestone bedrock bearing surface and can be designed using a bearing resistance value of **1,500 kPa** at ULS incorporating a geotechnical resistance factor of 0.5.

Conventional Shallow Foundations (Auxiliary Structures)

If applicable, conventional spread footing bearing resistance values may be considered for isolated piers and other lightly loaded ancillary structures.

Strip footings, up to 3 m wide, and pad footings, up to 5 m wide, placed over a hard to very stiff, brown silty clay bearing surface can be designed using bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **225 kPa**.

Settlement

The above-noted bearing resistance values at SLS for soil bearing surfaces will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively. Footings bearing on an acceptable bedrock bearing surface and designed for the bearing resistance values provided herein will be subjected to negligible potential post-construction total and differential settlements.

Bearing Surface

An undisturbed soil bearing surface consists of one from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings.

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.

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.

Above the groundwater level, adequate lateral support is provided to silty clay and glacial till bearing surfaces when a plane extending down and out from the bottom edge of the footing at a minimum of 1H:1V passes only through in situ soil or engineered fill.

Adequate lateral support is provided to bedrock bearing medium when a plane extending down and out from the bottom edges 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 heavily fractured, weathered bedrock and/or overburden bearing medium will require a lateral support zone of 1H:1V (or flatter).

End Bearing Driven Piled Foundation

As an alternative to a raft foundation, or if the proposed raft bearing capacity is not sufficient to withstand the imposed structural loads, then consideration could be given to using concrete filled, steel pipe piles driven to refusal on the bedrock surface.

For deep foundations, concrete-filled steel pipe piles are generally utilized in the Ottawa area. Applicable pile resistance at SLS values and factored pile resistance at ULS values are given in Table 2 below. A resistance factor of 0.4 has been incorporated into the factored ULS values. Note that these are all geotechnical axial resistance values.

The geotechnical pile resistance values were estimated using the Hiley dynamic formula, to be confirmed during pile installation with a program of dynamic monitoring.

Table 2 – Pile Foundation Design Data					
Outside Pile Diameter (mm)	**Pile Wall Thickness (mm)**	**Geotechnical Axial Resistance**		**Final Set (blows/12mm)**	**Transferred Hammer Energy (kJ)**
		SLS (kN)	**Factored at ULS (kN)**		
245	9	910	1090	10	29
245	11	1050	1260	10	35
245	13	1250	1500	10	41

As a minimum, the pipe piles should be equipped with a base plate having a thickness of at least 20 mm to reduce potential damage to the pile tip during driving. Provision should be made for restriking all of the piles at least once, 48 hours after the initial driving, to confirm the design set and/or the permanence of the set, and to check for upward displacement due to driving adjacent piles.

It is recommended that a pile load test or dynamic monitoring and capacity testing be carried out at an early stage during the piling operations to verify the transferred energy from the piledriving equipment and determine the load carrying capacity of the piles. The recommended number of tests is dependent on the number of piles and pile sizes; as a guideline a minimum of 2 tests per pile size should be carried out. It is also recommended that the tested pile locations be spread out across the proposed building footprints.

The post construction settlement of structural elements which derive their support from piles bearing on bedrock should be negligible.

If piles are to be left exposed during winter months, some form of frost protection will be required to prevent frost adhesion and jacking of the piles. Further guidelines can be provided on these measures at the time of construction, if required.

Hybrid Foundation Design

A hybrid foundation design may be used where the underground parkade would be founded over a raft slab while the buildings can be supported by end bearing piles. A construction joint is expected to be provided between the two foundation systems. The bearing resistance values provided in the above sections would apply to each foundation system.

Permissible Grade Raise Restriction

Due to the presence of the silty clay deposit, a permissible grade raise restriction of **2.0 m** is recommended for perimeter grading around foundations placed over a silty clay subgrade at the subject site.

If higher than permissible grade raises are required, preloading with or without a surcharge, lightweight fill, and/or other measures should be investigated to reduce the risks of unacceptable long-term post construction total and differential settlements.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class C** for the foundations considered at this site. If the proposed footings will be founded within 3 m of the bedrock surface, a seismic site Class A or B may be achievable provided the site-specific shear wave velocity test is completed to accurately determine the applicable seismic site classification for foundation design of the proposed buildings, as presented in Table 4.1.8.4.A of the Ontario Building Code 2012.

Soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the Ontario Building Code 2012 for a full discussion of the earthquake design requirements.

5.5 Basement Slab

With the removal of all topsoil and deleterious materials within the footprint of the proposed building, a soil subgrade approved by Paterson personnel at the time of construction, is considered to be an acceptable subgrade surface on which to commence backfilling for the floor slab construction.

The recommended pavement structures noted in Subsection 5.7 will be applicable where the basement level underlying foundation support consists of piled foundations or conventional spread footings. The basement slab would be considered as a slab-on-grade where foundation support consists of piled foundations or conventional spread footings.

For buildings of slab-on-grade construction, it is recommended that the upper 200 mm of sub-slab fill consist of OPSS Granular A crushed stone. If storage or other uses of the lower level involve the construction of a concrete floor slab, the upper 200 mm of sub-slab fill is recommended to consist of 19 mm of clear crushed stone.

Any soft areas should be removed and backfilled with appropriate backfill material such as OPSS Granular B Type II, with a maximum particle size of 50 mm. It is recommended that the upper 200 mm of sub-slab fill consist of 19 mm clear crushed stone crushed stone for a basement slab.

Where a raft slab is utilized, a granular layer of OPSS Granular A will be required to allow for the installation of sub-floor services above the raft slab foundation. The thickness of the OPSS Granular A crushed stone will be dependent on the piping requirements.

All backfill material within the footprint of the proposed building should be placed in maximum 300 mm thick loose layers and compacted to a minimum of 98% of the SPMDD. 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. Any soft areas should be removed and backfilled with appropriate backfill material prior to placing any fill. OPSS Granular A or Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab.

A subfloor drainage system, consisting of lines of perforated drainage pipe subdrains connected to a positive outlet, should be provided in the clear stone backfill under the lowest 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. This is discussed further in Section 6.1 of this report.

5.6 Basement Wall

There are several combinations of backfill materials and retained soils that could be applicable for the proposed structure's underground parking and/or basement walls. 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 dry unit weight of 20 kN/m^3.

Where undrained conditions are anticipated, the applicable effective unit weight of the retained soil can be designed with 13 kN/m^3. A hydrostatic pressure should be added to the total static earth pressure when calculating the effective unit weight. The total earth pressure (P_{AE}) includes both the static earth pressure component (P_o) and the seismic component (ΔP_{AE}).

The total earth pressure (P_{AE}) includes both the static earth pressure component (P_o) and the seismic component ($\triangle P_{AE}$).

Lateral Earth Pressures

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

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

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

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

Seismic Earth Pressures

The total seismic force (P_{AE}) includes both the earth force component (P_o) and the seismic component (ΔP_{AE}).

The seismic earth force (ΔP_{AE}) can be calculated using $0.375 \cdot a_c \cdot \gamma \cdot H^2/g$ where:

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

The peak ground acceleration, (a_{max}), for the Ottawa area is 0.32 g 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.

5.8 Pavement Design

For design purposes, it is recommended that the rigid pavement structure for the underground parking level of the proposed buildings consist of Category C2, 32 MPa concrete at 28 days with air entrainment of 5 to 8%. The recommended rigid pavement structure is further presented in Table 3 below:

Table 3 – Recommended Rigid Pavement Structure – Underground Parking Level

Thickness (mm)	Material Description
150	**Exposure Class C2 – 32 MPa Concrete** (5 to 8% Air Entrainment)
300	**BASE** - OPSS Granular A Crushed Stone
SUBGRADE – Existing imported fill, or OPSS Granular B Type I or II material placed over bedrock.	

To control cracking due to shrinking of the concrete floor slab, it is recommended that strategically located saw cuts be used to create control joints within the concrete floor slab of the underground parking level. The control joints are generally recommended to be located at the center of the column lines and spaced at approximately 24 to 36 times the slab thickness (for example; a 0.15 m thick slab should have control joints spaced between 3.6 and 5.4 m). The joints should be cut between 25 and 30% of the thickness of the concrete floor slab and completed as early as 4 hour after the concrete has been poured during warm temperatures and up to 12 hours during cooler temperatures.

The flexible pavement structure presented in Table 4, presented below, should be used for access lanes and heavy loading parking areas.

Table 4 – Recommended Asphalt Pavement Structure – Access Lanes and Heavy Loading Parking Area

Thickness (mm)	Material Description
40	**Wear Course** - Superpave 12.5 Asphaltic Concrete
50	**Binder Course** - Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
450	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - OPSS Granular B Type II overlying the concrete podium deck	

Pavement Structure Over Podium Deck Area and Raft Foundations

It is anticipated that the podium deck structure will be provided for landscaping or to accommodate car only parking areas, access lanes, fire truck lanes and loading areas. Based on the concrete slab subgrade for this area and/or over basements located over a raft slab, the pavement structure indicated in the following tables may be considered for design purposes:

Table 5 - Recommended Pavement Structure - Car-Only Parking Areas (Podium Deck and Raft Slab)

Thickness (mm)	Material Description
50	**Wear Course** - HL-3 or Superpave 12.5 Asphaltic Concrete
200**	**Base** - OPSS Granular A Crushed Stone
See Below*	**Thermal Break*** - Rigid insulation (See Paragraph Below)
n/a	**Waterproofing Membrane and Protection Board**
SUBGRADE – Reinforced Concrete Podium Deck or Raft Slab *If specified by others, not required from a geotechnical perspective. Also not required in basements over a raft slab. **Thickness is dependent on grade of insulation as noted in paragraphs below.	

Table 6 - Recommended Pavement Structure – Access Lane, Fire Truck Lane, Ramp and Heavy Truck Parking Areas (Podium Deck and Raft Slab)

Thickness (mm)	Material Description
40	**Wear Course** - HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Wear Course** - HL-8 or Superpave 19.0 Asphaltic Concrete
300**	**Base** - OPSS Granular A Crushed Stone
See Below*	**Thermal Break*** - Rigid insulation (See Paragraph Below)
n/a	**Waterproofing Membrane and Protection Board**
SUBGRADE – Reinforced Concrete Podium Deck or Raft Slab * If specified by others, not required from a geotechnical perspective. Also not required in basements over a raft slab. **Thickness is dependent on grade of insulation as noted in paragraphs below.	

The transition between the pavement structure over the podium deck subgrade and soil subgrade beyond the footprint of the podium deck is recommended to be transitioned to match the pavement structures provided in the following section. For this transition, a 5H:1V frost taper is recommended between the two subgrade surfaces. Further, the base layer thickness should be increased to a minimum thickness of 600 mm below the top of the podium slab a minimum of 1.5 m horizontally from the face of the foundation wall prior to providing the recommended taper.

Should the proposed podium deck be specified by others to be provided a thermal break by the use of a layer of rigid insulation below the pavement structure, its placement within the pavement structure is recommended to be as per the above-noted tables.

The layer of rigid insulation is recommended to consist of a DOW Chemical High-Load 100 (HI-100), High-Load 60 (HI-60) or High Load (HI-40) extruded polystyrene. The pavement structures base layer thickness in Table 8 and Table 9 may be reduced by 25 mm if HI-100 is considered for this project. It should be noted that Styrofoam rigid insulation is not considered suitable for this application.

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on the contact zone between the subgrade material and the base stone in a dry condition. Failure to provide adequate drainage under conditions of heavy wheel loading can result in the fine subgrade soil being pumped into the voids in the stone subbase, thereby reducing load carrying capacity.

Where silty clay is anticipated at subgrade level, consideration should be given to installing subdrains during the pavement construction as per City of Ottawa standards. The subdrain inverts should be approximately 300 mm below subgrade level, and the subgrade surface should be crowned to promote water flow to drainage lines.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage and Waterproofing

The following recommendations may be considered for the architectural design of the buildings foundation drainage systems. It is recommended that Paterson be engaged at the design stage of the future buildings (and prior to tender) to review and provide supplemental information for the buildings foundation drainage system design.

Supplemental details, review of architectural design drawings and additional information may be provided by Paterson for these items for incorporation in the building design packages and associated tender documents. It is recommended that Paterson review all details associated with the foundation drainage system prior to tender.

Groundwater Suppression System

It is recommended that a groundwater suppression system be provided for the proposed structures. It is expected that insufficient room will be available for exterior backfill and the foundation wall will be cast as a blind-sided pour against a shoring system and the bedrock surface. It is recommended that the groundwater suppression system consist of the following:

❏ A waterproofing membrane should be placed against the shoring system between underside of footings and 3 m below existing ground surface. The height of the waterproofing layer should be confirmed on a per-building basis, however, is expected to vary between 3 and 4 m below existing ground surface. Where the membrane will extend against the shoring system, it is recommended to consist of a membrane with a bentonite-lined face for being paced against the shoring system. The membrane is recommended to overlap below the overlying perimeter foundation footprint by a minimum of 1 m inwards towards the building footprint and from the face of the overlying foundation. This will allow construction to proceed without imposing groundwater lowering within the surrounding area of the proposed buildings in the short and long term conditions.

❏ A composite drainage membrane (DeltaDrain 6000, MiraDrain G100N or equivalent) should be placed against the HDPE face of the waterproofing membrane with the geotextile layer facing the waterproofing layer from finished ground surface to the top of the footing.

- ❑ The foundation drainage boards should be overlapped such that the bottom end of a higher board is placed in front of the top end of a lower board. All endlaps of the drainage board sheets should overlap abutting sheets by a minimum of 150 mm. All overlaps should be sealed with a suitable adhesive and/or sealant material approved by the geotechnical consultant. It is highly recommended that the drainage board rolls be installed horizontally rather than vertically to minimize the number of vertical joints forming between the rolls.

- ❑ It is recommended that 150 mm diameter PVC sleeves at 6 m centers be cast in the foundation wall at the foundation wall/footing interface to allow the infiltration of water to flow to the interior perimeter drainage pipe. The sleeves should be connected to openings in the HDPE face of the drainage board layer. The perimeter drainage pipe and underfloor drainage system should direct water to sump pit(s) within the lower basement area via an underfloor and interior drainage pipe system.

The top endlap of the foundation drainage board should be provided with a suitable termination bar against the foundation wall to mitigate the potential for water to perch between the drainage board and foundation wall.

Interior Perimeter and Underfloor Drainage

An interior perimeter and underfloor drainage system will be required to redirect water from the building's foundation drainage system to the building's sump pit(s) if it will not discharge to an exterior catch basin structure. For preliminary design purposes, it is recommended that the interior perimeter and underfloor drainage pipes should consist of 100 or 150 mm diameter corrugated perforated plastic pipe sleeved with a geosock, placed at approximately 6 m.

The underfloor drainage pipe should be placed in each direction of the basement floor span and connected to the perimeter drainage pipe. The interior drainage pipe should be provided tee-connections to extend pipes between the perimeter drainage line and the HDPE-face of the composite foundation drainage board via the foundation wall sleeves.

The spacing of the underfloor drainage should be confirmed by Paterson at the time of excavation when water infiltration can be better assessed and once the foundation layout and sump system location has been finalized.

Foundation Backfill

Where applicable, 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 II granular material, should otherwise be used for this purpose.

Foundation backfill material should be compacted in maximum 300 mm thick loose lifts and with suitably sized vibratory compaction equipment (smooth-drum roller for crushed stone fill, sheepsfoot roller for soil fill).

Podium Deck Waterproofing Tie-In

Waterproofing layers for podium deck surfaces should overlap across and below the top end lap of the vertically installed composite foundation drainage board to mitigate the potential for water to migrate between the drainage board and foundation wall and as depicted in Figure 2 – Podium Deck to Foundation Wall Transition Detail.

Sidewalks and Walkways

Backfill material below sidewalk and walkway subgrade areas or other settlement sensitive structures which are not adjacent to the buildings should consist of free-draining, non-frost susceptible material. This material should be placed in maximum 300 mm thick loose lifts and compacted to at least 98% of its SPMDD under dry and above freezing conditions.

Foundation Raft Slab Construction Joints

If applicable, it is anticipated the raft slab will be poured in several pour segments. For the construction joint at each pour, a PVC water stop along with a chemical grout (Xypex or equivalent) should be applied to the entire vertical joint of the slab. Furthermore, a PVC water stop should be incorporated in the horizontal interface between the foundation wall and the raft slab.

Finalized Drainage and Waterproofing Design

Paterson should be provided with the finalized structural and architectural drawings for each building to provide a building specific waterproofing and drainage design which includes the above noted recommendations. The design will provide recommendations for other items such as minimum pipe spacings, pipe mechanical connections below grade, transitioning from blind to double sided pours (if applicable), etc.

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 1.5 m thick soil cover alone, or a combination of soil cover (minimum 0.6 m) in conjunction with foundation insulation should be provided in this regard.

The parking garage should not require protection against frost action due to the founding depth. Unheated structures, such as the access ramp wall footings or footings near garage bay doors frequently opened in freezing conditions, should be insulated against the deleterious effect of frost action. A minimum of 2.1 m of soil cover alone, or a minimum of 600 mm m of soil cover, in conjunction with foundation insulation should be provided. Paterson requests permission to review design drawings prior to construction to ensure proper frost protection is provided for these areas.

6.3 Excavation Side Slopes

The side slopes of the excavations in soil and fill overburden materials should either be excavated at acceptable slopes or retained by shoring systems from the beginning of the excavation until the structure is backfilled. Given the proximity of the underground parking levels to the property lines, it is expected that a temporary shoring will be required to support the excavation for this proposed development.

Temporary Side Slopes (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 shallower. The shallower slope is required for excavation below groundwater level. The subsurface soil is considered to be mainly a Type 2 and Type 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 maintain safe working distance from the excavation sides.

Excavation side slopes carried out for the building footprint are recommended to be provided surface protection from erosion by rain and surface water runoff if shoring is not anticipated to be implemented. This can be accomplished by covering the entire surface of the excavation side-slopes with tarps secured between the top and bottom of the excavation and approved by Paterson personnel at the time of construction. It is further recommended to maintain a relatively dry surface along the bottom of the excavation footprint to mitigate the potential for sloughing of side-slopes.

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.

A trench box is recommended to protect personnel working in trenches with steep or vertical sides. Services are expected to be installed by “cut and cover” methods and excavations should not remain open for extended periods of time.

Temporary Shoring

Temporary shoring is anticipated to be required to support the overburden soils for the underground parking levels. The design and approval of the shoring system will be the responsibility of the shoring contractor and the shoring designer who is a licensed professional engineer and is hired by the shoring contractor.
It is the responsibility of the shoring contractor to ensure that the temporary shoring is in compliance with safety requirements, designed to avoid any damage to adjacent structures and include dewatering control measures.

The shoring requirements designed by a structural engineer specializing in those works will depend on the depth of the excavation, the proximity of the adjacent structures and the elevation of the adjacent building foundations and underground services. The design and implementation of these temporary systems will be the responsibility of the excavation contractor and their design team. Inspections and approval of the temporary system will also be the responsibility of the designer. The geotechnical information provided below is to assist the designer in completing a suitable and safe shoring system.

The designer should take into account the impact of a significant precipitation event and designate design measures to ensure that a precipitation will not negatively impact the shoring system or soils supported by the system.

Any changes to the approved shoring design system should be reported immediately to the owner's structural design prior to implementation.

The temporary system could 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 included to the earth pressures described below. These systems could 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. The shoring system is recommended to be adequately supported to resist toe failure and inspected to ensure that the sheet piles extend well below the excavation base. It should be noted if consideration is being given to utilizing a raker style support for the shoring system that lateral movements can occur and the structural engineer should ensure that the design selected minimizes these movements to tolerable levels.

The earth pressures acting on the shoring system may be calculated using the parameters provided in Table 7.

Table 7 – Soil Parameters for Calculating Earth Pressures Acting on Shoring System

Parameter	Value
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

The active earth pressure should be calculated where wall movements are permissible while the at-rest pressure should be calculated if no movement is permissible. The dry unit weight should be calculated above the groundwater level while the effective unit weight should be calculated below the groundwater level.

The hydrostatic groundwater pressure should be included to the earth pressure distribution wherever the effective unit weight is calculated for earth pressures. If the groundwater level is lowered, the dry unit weight for the soil should be calculated full weight, with no hydrostatic groundwater pressure component.

For design purposes, the minimum factor of safety of 1.5 should be calculated.

Excavation Base Stability (If Applicable)

The base of supported excavations can fail by three general modes:

- Shear failure within the ground caused by inadequate resistance to loads imposed by grade difference inside and outside of the excavation,
- Piping from water seepage through granular soils, and
- Heave of layered soils due to water pressures confined by intervening low permeability soils.

The potential for base heave in cohesive soils should be determined for stability of flexible retaining systems. The factor of safety with respect to base heave, FS_b, is:

$FS_b = N_b s_u / \sigma_z$

where:

N_b - stability factor dependent upon the geometry of the excavation and given in Figure 1 on the following page.

s_u - undrained shear strength of the soil below the base level
σ_z - total overburden and surcharge pressures at the bottom of the excavation

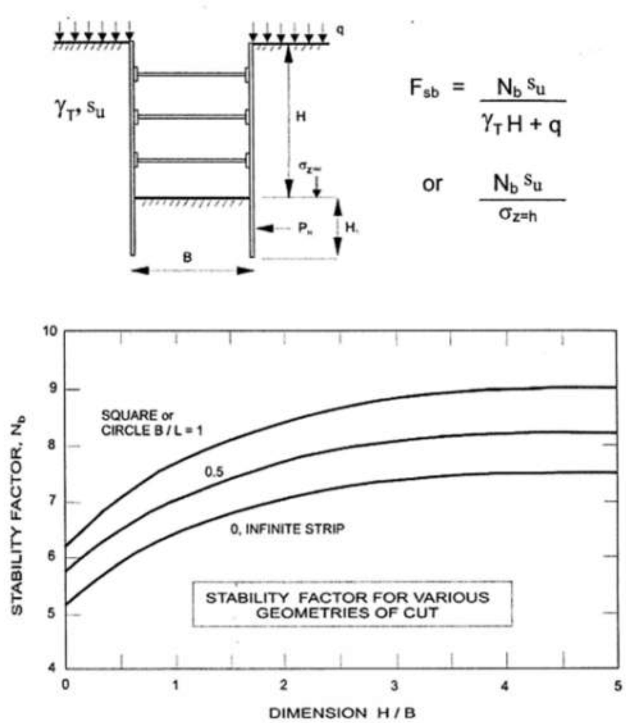

Figure 1 – Stability Factor for Various Geometries of Cut

In the case of stiff clays or compact sands, a factor of safety of 2 is recommended for base stability.

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.

The pipe bedding for the sewer and water pipes should consist of at least 150 mm of OPSS Granular A. The bedding layer thickness should be increased to a minimum of 300 mm where the subgrade will consist of grey silty clay. The material should be placed in a maximum 225 mm thick loose lifts and compacted to a minimum of 98% of its SPMDD. The bedding material should extend at least to the spring line of the pipe.

The cover material, which should consist of OPSS Granular A, should extend from the spring line of the pipe to at least 300 mm above the obvert of the pipe. The material should be placed in maximum 225 mm thick lifts and compacted to a minimum of 98% of its SPMDD.

It should generally be possible to re-use the moist (not wet) site-generated fill above the cover material if the excavation and filling operations are carried out in dry weather conditions. Wet site-generated fill, such as the grey silty clay, will be difficult to re-use, as the high-water contents make compacting impractical without an extensive drying period.

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 minimize 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.

Clay Seals

To reduce long-term lowering of the groundwater level at this site, clay seals should be provided in the service trenches, where applicable. The seals should be at least 1.5 m long and should extend from trench wall to trench wall. Generally, the seals should extend from the frost line and fully penetrate the bedding, sub bedding and cover material.

The barriers should consist of relatively dry and compatible brown silty clay placed in maximum 225 mm thick loose layers and compacted to a minimum of 95% of the material's SPMDD. The clay seals should be placed at the site boundaries and at strategic locations at no more than 60 m intervals in the service trenches.

6.5 Groundwater Control

Due to the relatively impervious nature of the overlying silty clay within the upper portion of the soil profile, it is anticipated that groundwater infiltration into the excavations should be low and controllable using open sumps.

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.

Groundwater Control for Building Construction

A temporary Ministry of the Environment, Conservation and Parks (MECP) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum of 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MECP.

For typical ground or surface water volumes being pumped during the construction phase, typically between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16.

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 building's perimeter groundwater infiltration control system will be directed to the sump pit. Provided the proposed groundwater infiltration control system is properly implemented and approved by the geotechnical consultant at the time of construction, it is expected that groundwater flow will be very low to negligible. A more accurate estimate of groundwater flow can be provided at the time of construction, once the pressure relief chamber valve is closed and full hydrostatic pressure Is applied to the structure.

Impact on Neighboring Properties

It is understood that between two levels of underground parking are planned for the proposed buildings. Based on the existing groundwater level and considering that the proposed buildings will be subject to the water suppression system provided herein, long-term groundwater lowering will be minimal and will take place within a limited range of the proposed buildings.

Based on the proximity of neighboring buildings and the 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 building.

6.6 Winter Construction

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

The subsoil conditions at this site mostly consist of frost susceptible materials. In the presence of water and freezing conditions ice could form within the soil mass. Heaving and settlement upon thawing could occur where excavations are completed in proximity to existing structures which may be adversely affected due to the freezing conditions.

In particular, where a shoring system is constructed, the soil behind the shoring system will be subjected to freezing conditions and could result in heaving of the structure(s) placed within or above frozen soil.
Provisions should be made in the contract documents to protect the walls of the excavations from freezing, if and where applicable.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the installation of straw, propane heaters and/or glycol lines and tarpaulins or other suitable means. 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 foundation is protected with sufficient soil cover to prevent freezing at founding level.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the installation of straw, propane heaters and/or glycol lines and tarpaulins or other suitable means. 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 foundation is protected with sufficient soil cover to prevent freezing at founding level. Trench excavations, foundation construction and pavement construction are difficult activities to complete during freezing conditions without introducing frost in the subgrade or in the excavation walls and bottoms. Precautions should be considered if such activities are to be completed during freezing conditions. Additional information could be provided, if required.

Under winter conditions, if snow and ice is present within imported fill below future basement slabs, then settlement of the fill should be expected and support of a future basement slab and/or temporary supports for slab pours will be negatively impacted and could undergo settlement during spring and summer time conditions. Paterson should complete periodic inspections during fill placement to ensure that snow and ice quantities are minimized in settlement-sensitive areas.

6.7 Corrosion Potential and Sulphate

The results of analytical testing from an adjacent site show that the sulphate content is less than 0.1%. This result is indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and the pH of the sample indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of an aggressive to very aggressive corrosive environment.

6.8 Landscaping Considerations

Tree Planting Considerations

It is understood the proposed buildings will include two to six levels of underground parking and the structures will be founded on foundation located at a minimum of 7 m below finished grade. Given the depth of foundations proposed for the structures, it is expected that the support of the foundations derives from soil located below the depth that dewatering by tree roots. Therefore, foundation distress due to potential moisture depletion caused by trees is not expected to occur at the subject site. Since the structures are not anticipated to be founded upon silty clay soils affected by the depth of root penetration, City approved trees within the subject site will not be subject to planting restrictions as based on the *City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines*) from a geotechnical perspective.

7.0 Recommendations

It is recommended that the following be carried out by Paterson once preliminary and future details of the proposed development have been prepared:

- ❑ Review preliminary and detailed grading, servicing, landscaping and structural plan(s) from a geotechnical perspective.
- ❑ Review of the geotechnical aspects of the excavation contractor's shoring design, if not design by Paterson, prior to construction, if applicable.
- ❑ Review of architectural plans pertaining to groundwater suppression system, underfloor drainage systems and waterproofing details for elevator shafts.

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

- ❑ Review and inspection of the installation of the foundation drainage systems.
- ❑ Observation of all bearing surfaces prior to the placement of concrete.
- ❑ Observation of driving and re-striking of all pile foundations.
- ❑ Sampling and testing of the concrete and fill materials.
- ❑ 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 and follow-up field density tests to determine the level of compaction achieved.
- ❑ 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 the completion of a satisfactory inspection program by the geotechnical consultant.

All excess soil must be handled as per *Ontario Regulation 406/19: On-Site and Excess Soil Management*.

8.0 Statement of Limitations

The recommendations provided are in accordance with the present understanding of the project. Paterson requests permission to review the recommendations when the drawings and specifications are completed.

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, Paterson requests immediate notification to permit reassessment of our recommendations.

The recommendations provided herein should only be used by the design professionals associated with this project. They are not intended for contractors bidding on or undertaking the work. The latter should evaluate the factual information provided in this report and determine the suitability and completeness for their intended construction schedule and methods. Additional testing may be required for their purposes.

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 2729685 Ontario Inc. c/o Fotenn 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.

LICENSED PROFESSIONAL ENGINEER
Feb. 26, 2024
F. I. ABOU-SEIDO
100156744
PROVINCE OF ONTARIO

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Multi-Use High-Rise Complex
75 Breezehill Avenue, Ottawa, Ontario

DATUM Geodetic

FILE NO. **PG6622**

REMARKS

HOLE NO. **BH 1-23**

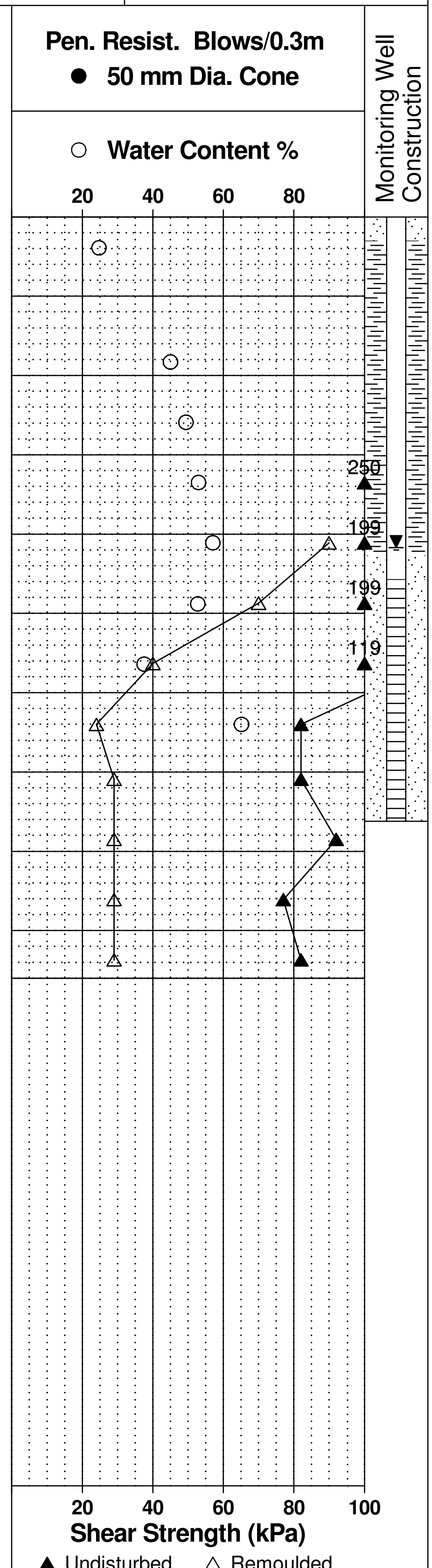
BORINGS BY CME-55 Low Clearance Drill **DATE** April 18, 2023

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
Asphaltic concrete	0.05	AU	1		
FILL: Brown silty sand ith gravel, crushed stone, some clay	0.18				
	0.60	SS	2	17	13
FILL: Brown silty sand with gravel, trace clay and asphalt	1.07	SS	3	100	12
FILL: Brown silty clay with sand and gravel		SS	4	100	8
Hard to very stiff, brown **SILTY CLAY**		SS	5	100	P
		SS	6	100	P
		SS	7	100	P
		SS	8	92	P
- stiff and grey by 6.0m depth	9.60	SS	9	75	

End of Borehole

(GWL @ 4.17m - June 13, 2023)

DEPTH (m)	ELEV. (m)
0	63.95
1	62.95
2	61.95
3	60.95
4	59.95
5	58.95
6	57.95
7	56.95
8	55.95
9	54.95



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Multi-Use High-Rise Complex
75 Breezehill Avenue, Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE April 18, 2023

FILE NO. PG6622

HOLE NO. BH 2-23

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
Asphaltic concrete	0.08				
FILL: Brown silty sand with gravel and crushed stone	0.28	AU	1		
FILL: Brown silty sand with gravel, trace clay and asphalt	1.45	SS	2	50	9
FILL: Brown silty sand with gravel	1.83	SS	3	17	24
Hard to very stiff, brown **SILTY CLAY**		SS	4	100	16
		SS	5	100	10
		SS	6	92	P
		SS	7	92	P
		SS	8	100	P
- stiff to very stiff and grey by 5.9m depth		SS	9	100	P
- trace sand and gravel by 9.4m depth		SS	10	25	P
	9.75	SS	11		P
Dynamic Cone Penetration Test commenced at 9.75m depth. Cone pushed to 11.0m depth.	13.51				

End of Borehole

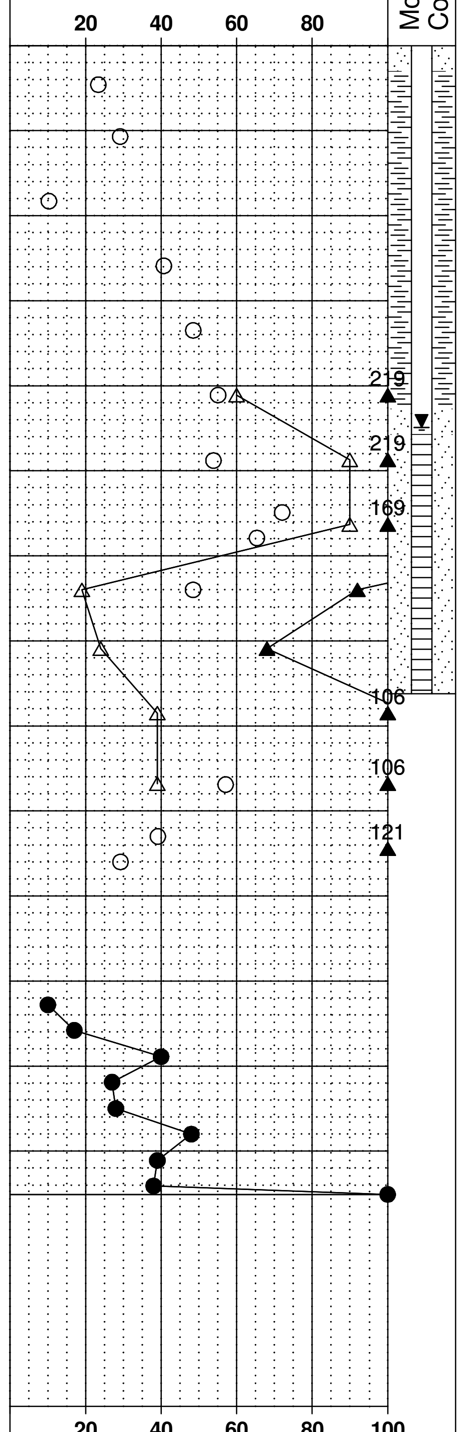
Practical DCPT refusal at 13.51m depth.

(GWL @ 4.49m - June 13, 2023)

DEPTH (m)	ELEV. (m)
0	64.08
1	63.08
2	62.08
3	61.08
4	60.08
5	59.08
6	58.08
7	57.08
8	56.08
9	55.08
10	54.08
11	53.08
12	52.08
13	51.08

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

○ Water Content %



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

Monitoring Well Construction

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Multi-Use High-Rise Complex
75 Breezehill Avenue, Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE April 18, 2023

FILE NO. PG6622

HOLE NO. BH 3-23

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	63.76
Asphaltic concrete	0.08						
FILL: Brown silty sand with gravel and crushed stone	0.25	AU	1				
	0.91	SS	2	25	13	1	62.76
FILL: Brown silty clay with sand, gravel, trace organics		SS	3	100	14	2	61.76
Hard to very stiff, brown **SILTY CLAY**		SS	4	100	8		
		SS	5	100	P	3	60.76
		SS	6	100	P	4	59.76
- stiff to very stiff and grey by 4.6m depth		SS	7	100	P	5	58.76
	6.02	SS	8	100	P		
GLACIAL TILL: Compact, grey silty clay, trace sand, gravel and cobbles		SS	9	92	P	6	57.76
- gravel content increasing with depth	7.54	SS	10	75	5	7	56.76
GLACIAL TILL: Compact, grey silty sand to sandy silt with clay, gravel, cobbles and boulders		SS	11	83	10	8	55.76
		SS	12	100	50+		
	9.75	SS	13		20	9	54.76
Dynamic Cone Penetration Test commenced at 9.75m depth.	10.34					10	53.76
End of Borehole							

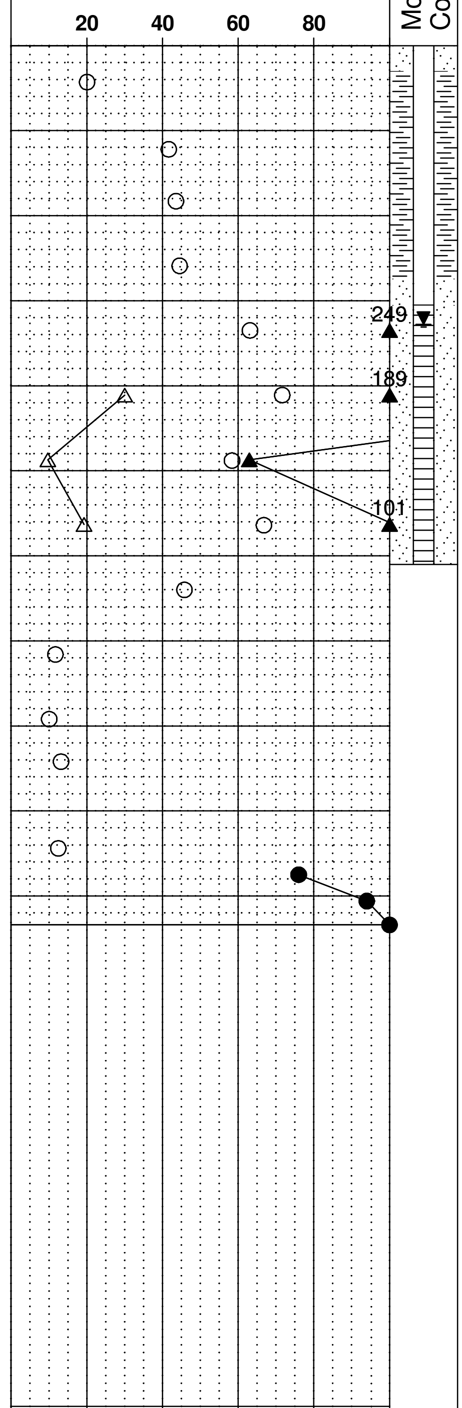
Practical DCPT refusal at 10.34m depth.

(GWL @ 3.28m - June 13, 2023)

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

○ Water Content %

Monitoring Well Construction



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Multi-Use High-Rise Complex
75 Breezehill Avenue, Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

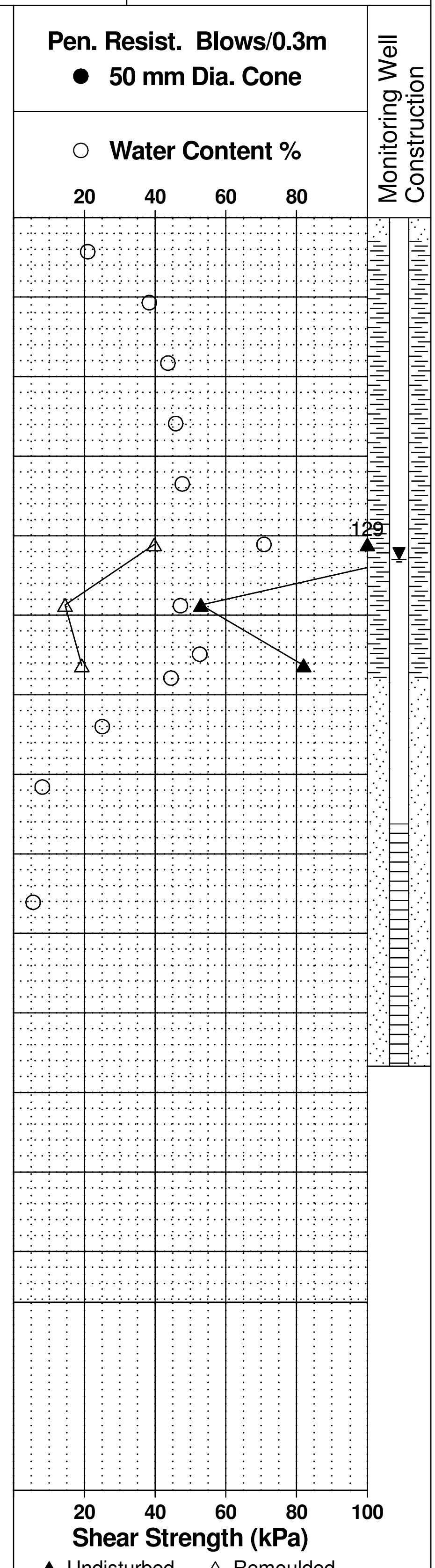
DATE April 19, 2023

FILE NO. PG6622

HOLE NO. BH 4-23

SOIL DESCRIPTION	Bottom depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
Asphaltic concrete	0.05	AU	1		
FILL: Brown silty sand with gravel and crushed stone	0.25 / 0.69	SS	2	33	15
FILL: Brown silty clay, trace gravel		SS	3	100	14
Very stiff to stiff, brown **SILTY CLAY**		SS	4	100	11
		SS	5	100	7
		SS	6	100	P
- grey by 4.5m depth		SS	7	100	P
- trace gravel by 5.8m depth	6.10	SS	8	100	P
GLACIAL TILL: Compact, grey silty clay, some sand, gravel, cobbles and boulders		SS	9	67	7
		SS	10	75	9
	8.08	SS	11	0	19
GLACIAL TILL: Compact to dense, grey silty sand to sandy silt with gravel, cobbles and boulders	9.83	SS	12	38	47
		RC	1	100	91
BEDROCK: Good to excellent quality, grey limestone		RC	2	100	88
	13.64	RC	3	100	100
End of Borehole					
(GWL @ 4.30m - June 13, 2023)					

DEPTH (m)	ELEV. (m)
0	63.86
1	62.86
2	61.86
3	60.86
4	59.86
5	58.86
6	57.86
7	56.86
8	55.86
9	54.86
10	53.86
11	52.86
12	51.86
13	50.86



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 relative strength of cohesionless soils is the compactness condition, 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. An SPT N value of “P” denotes that the split-spoon sampler was pushed 300 mm into the soil without the use of a falling hammer.

Compactness Condition	‘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 shear vane tests, unconfined compression tests, or occasionally by the Standard Penetration Test (SPT). Note that the typical correlations of undrained shear strength to SPT N value (tabulated below) tend to underestimate the consistency for sensitive silty clays, so Paterson reviews the applicable split spoon samples in the laboratory to provide a more representative consistency value based on tactile examination.

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, S_t, is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil. The classes of sensitivity may be defined as follows:

Low Sensitivity:	$S_t < 2$
Medium Sensitivity:	$2 < S_t < 4$
Sensitive:	$4 < S_t < 8$
Extra Sensitive:	$8 < S_t < 16$
Quick Clay:	$S_t > 16$

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 NQ or larger size core. However, it can be used on smaller core sizes, such as BQ, 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, generally recovered using a piston sampler
G	-	"Grab" sample from test pit or surface materials
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size BQ, NQ, HQ, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

WC%	-	Natural water 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 at 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

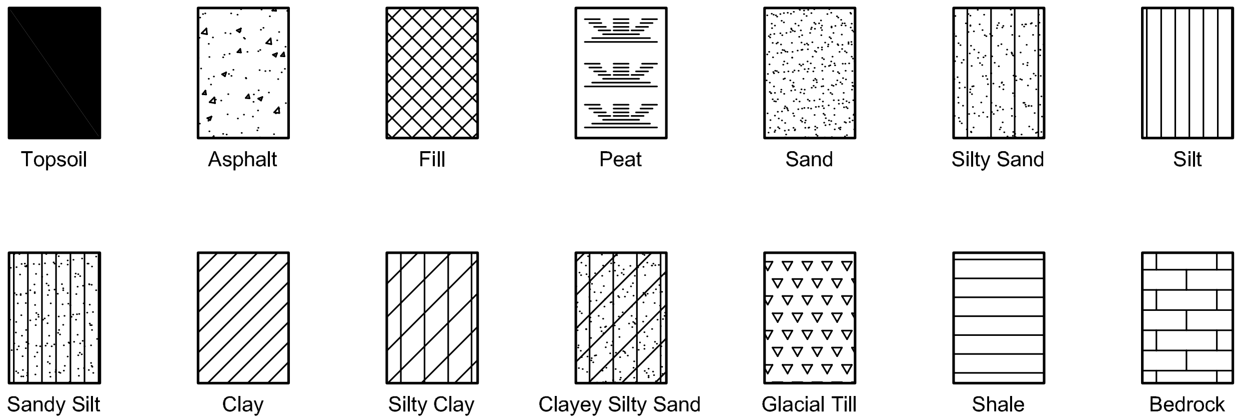
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void 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.

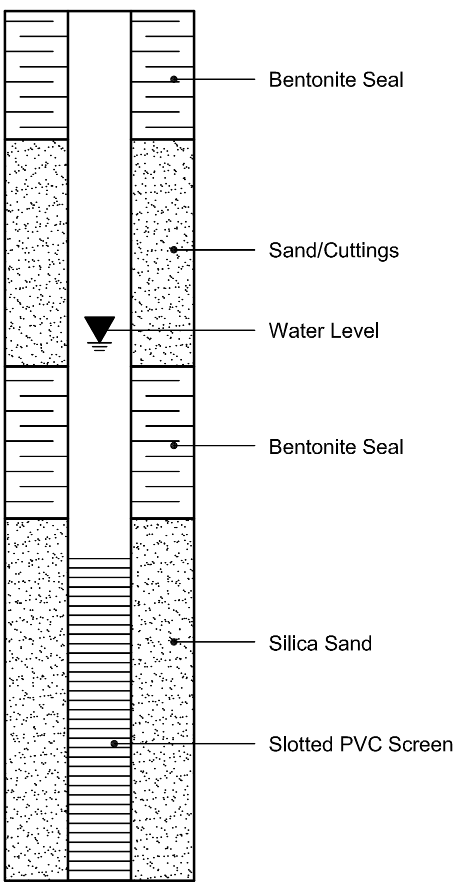
SYMBOLS AND TERMS (continued)

STRATA PLOT

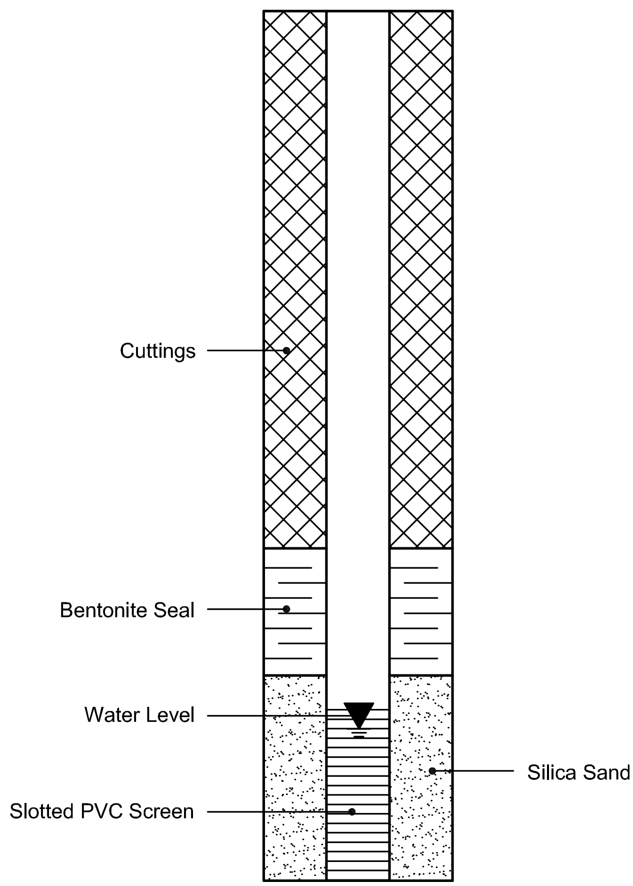


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



PARACEL LABORATORIES LTD.

Order #: 2316337

Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO: 57262

Report Date: 24-Apr-2023

Order Date: 19-Apr-2023

Project Description: PG6622

	MDL/Units				
Client ID:		BH2-23 SS6	-	-	-
Sample Date:		18-Apr-23 09:00	-	-	-
Sample ID:		2316337-01	-	-	-
		Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	66.5	-	-	-
General Inorganics					
pH	0.05 pH Units	7.67	-	-	-
Resistivity	0.1 Ohm.m	19.8	-	-	-
Anions					
Chloride	10 ug/g dry	199	-	-	-
Sulphate	10 ug/g dry	155	-	-	-

APPENDIX 2

FIGURE 1 – KEY PLAN

FIGURE 2 – PODIUM TO FOUNDATION TRANSITION DETAIL

DRAWING PG6622-1 – TEST HOLE LOCATION PLAN

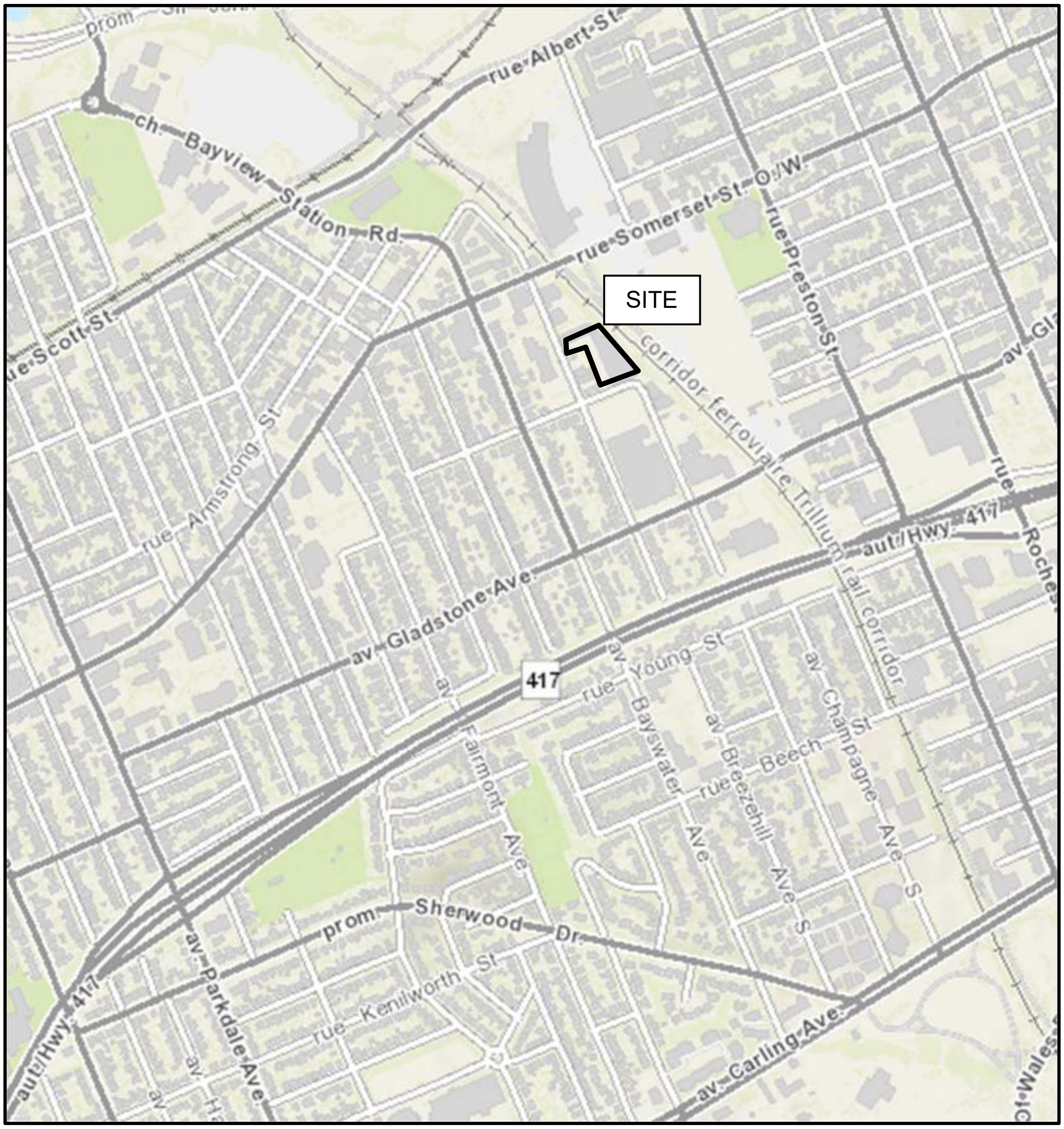
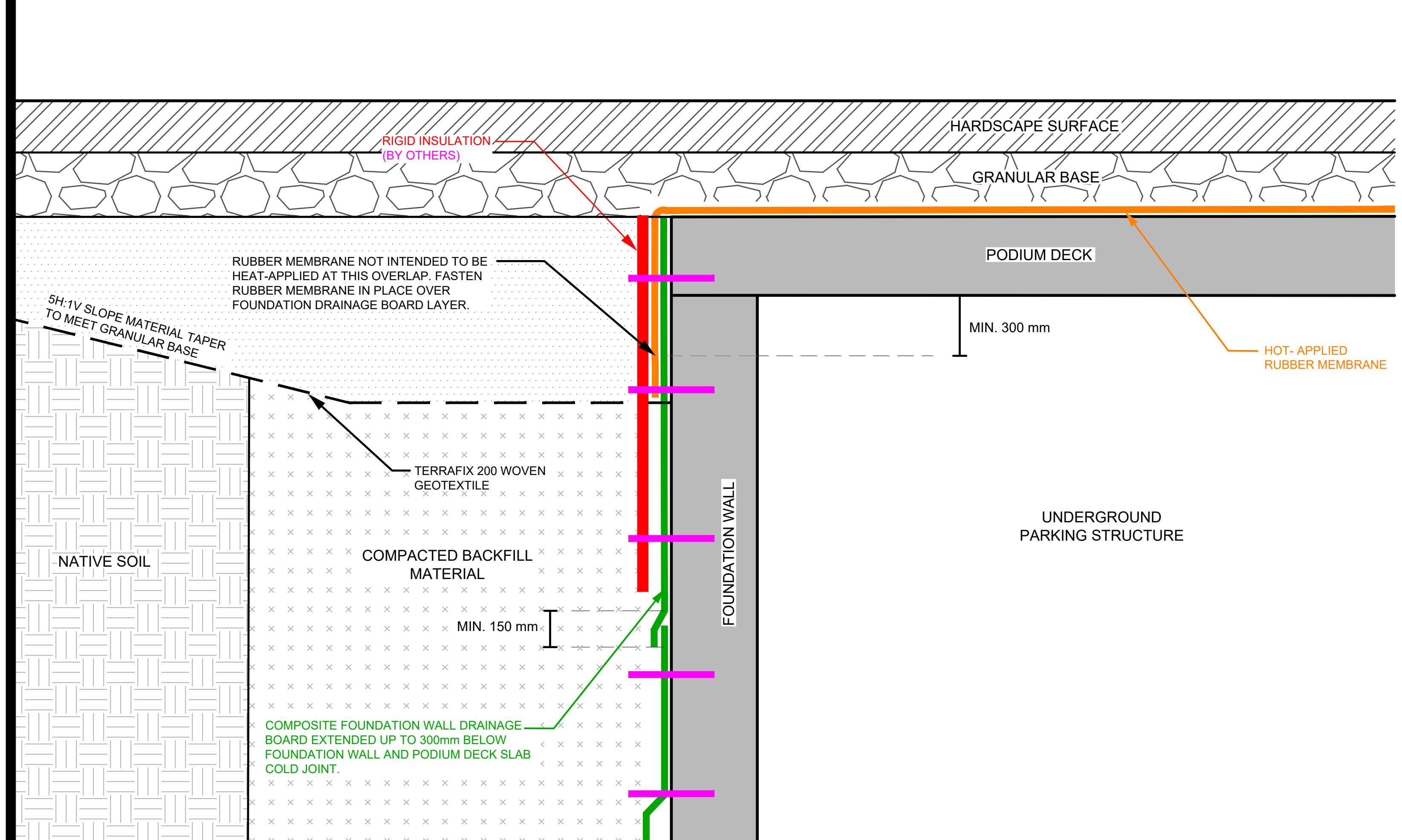


FIGURE 1

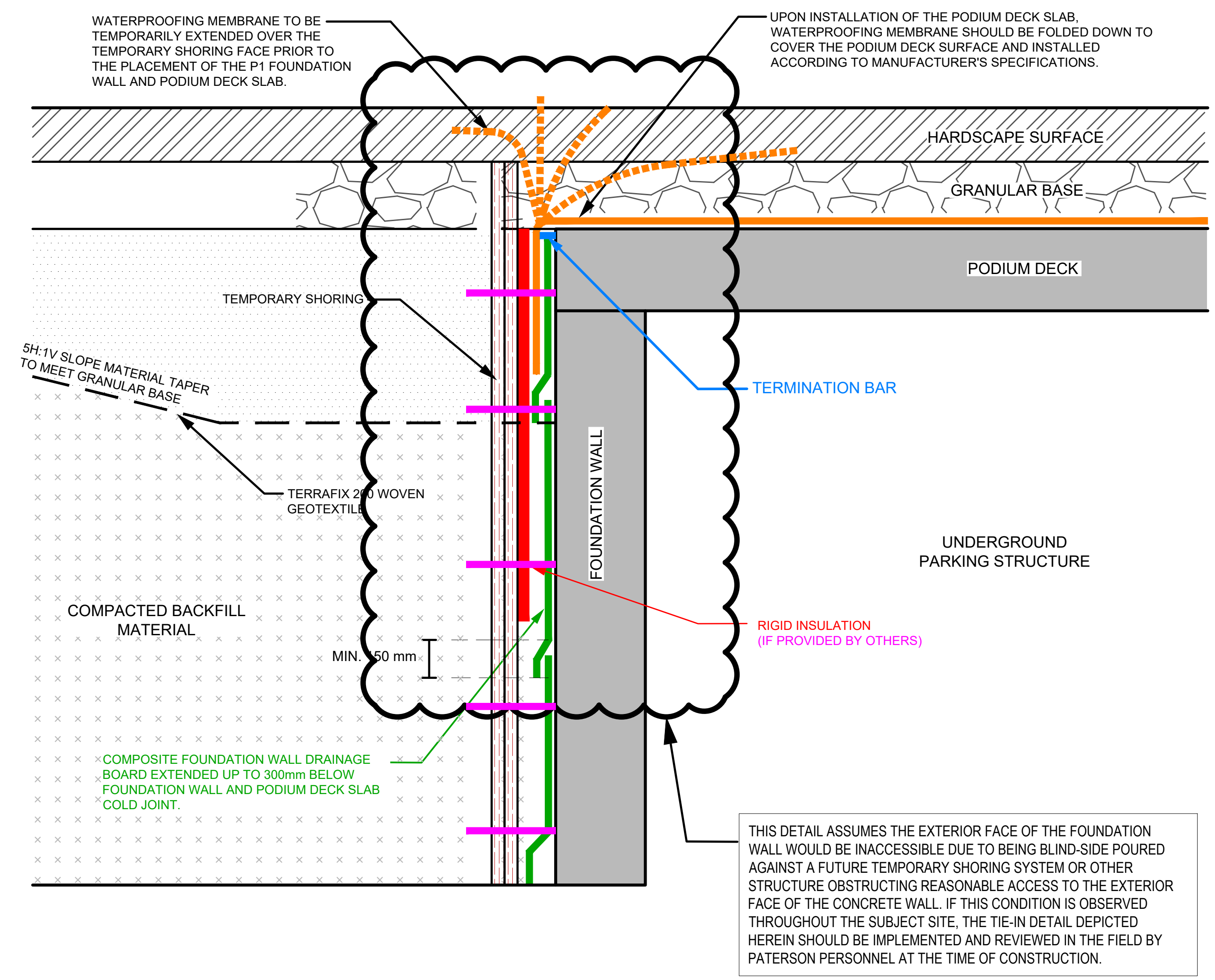
KEY PLAN

PATERSON GROUP

OPTION A - DOUBLE-SIDE POURED TOP OF FOUNDATION WALL



OPTION B - BLIND-SIDE POURED TOP OF FOUNDATION WALL



NOTES:

THE ABOVE DETAIL FOR HOT RUBBER AND DRAINAGE BOARD OVERLAP IS APPLICABLE TO ALL EDGE-PORTIONS OF THE PODIUM DECK AND/OR SUSPENDED GROUND FLOOR SLAB STRUCTURE.

APPLICABILITY THICKNESS AND EXTENSIONS OF RIGID INSULATION ARE SPECIFIED BY OTHERS

WHERE THE GRADING SURFACE TERMINATES AGAINST THE BUILDING FACE AND PAVEMENT STRUCTURE IS NOT LOCATED ABOVE THE EDGE OF THE FOUNDATION WALL AND PODIUM DECK SLAB AS DEPICTED HEREIN, IT IS RECOMMENDED TO PROVIDE A SUITABLE TERMINATION BAR TO SEAL THE TOP ENDLAP OF THE HOT-APPLIED RUBBER MEMBRANE LAYER TO THE VERTICAL FACE OF THE STRUCTURE. THIS WOULD BE REQUIRED TO MITIGATE THE POTENTIAL FOR THE MIGRATION OF WATER BEHIND THE RUBBER MEMBRANE.

ALL PORTIONS OF THE ABOVE-NOTED DETAIL (INSULATION OF FOUNDATION DRAINAGE BOARD, TERMINATION BAR, HOT-RUBBER MEMBRANE OVER SLAB, FOUNDATION WALL CONSTRUCTION JOINT AND OVERLAPPING/SHINGLING OF DRAINAGE BOARD) SHOULD BE REVIEWED AT THE TIME OF CONSTRUCTION BY PATERSON PERSONNEL.

PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
0			

SHOPPES AT FAIRWINDS C/O NA (GOULBORN) LIMITED PARTNERSHIP

GEOTECHNICAL INVESTIGATION
PROPOSED MULTI-USE DEVELOPMENT
5705 HAZELDEAN ROAD

OTTAWA, ONTARIO

Title:
PODIUM DECK TO FOUNDATION WALL DRAINAGE SYSTEM TIE-IN DETAIL

Scale: N.T.S	Date: 06/2023
Drawn by: RCG	Report No.: PG6622-1
Checked by: OC	Dwg. No.: FIGURE 2
Approved by: FA	Revision No.: 0

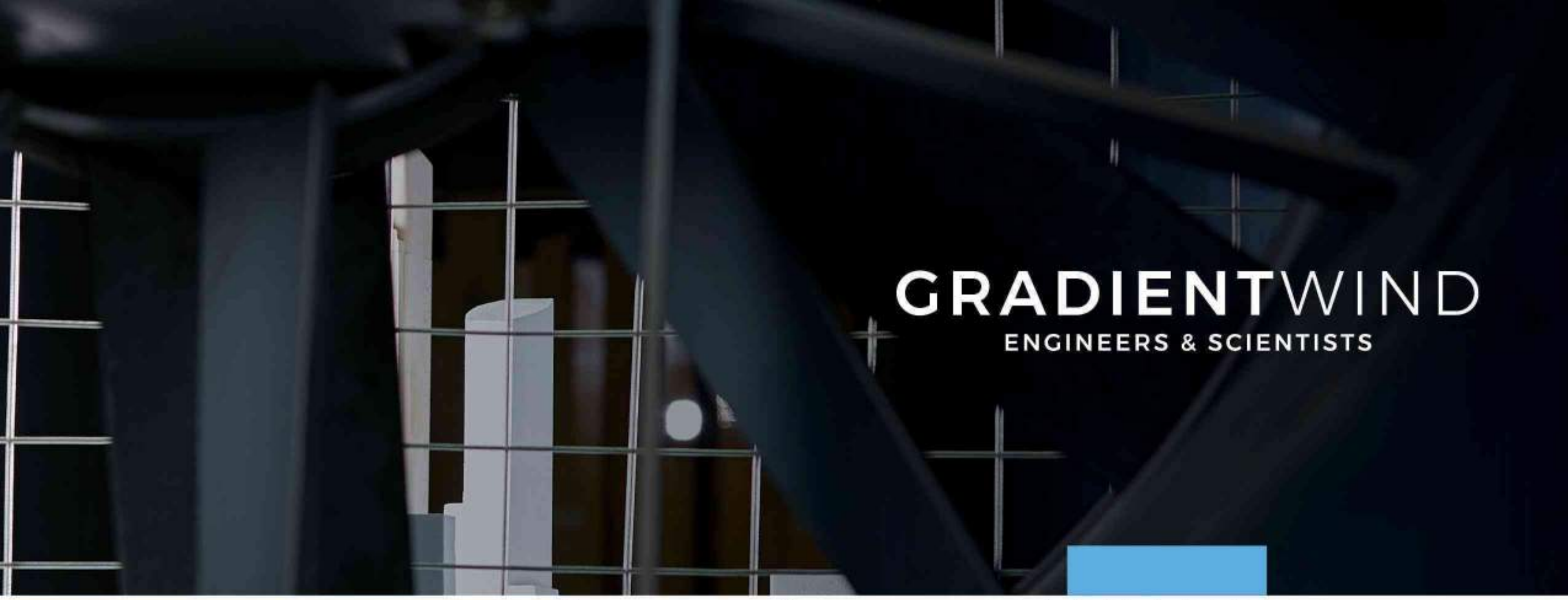
p:\autocad drawings\geotechnical\pg66xx\pg6622\fig 2.dwg

APPENDIX C

Traffic Noise and Vibration Feasibility Assessment:

Prepared by Gradient Wind Engineers and

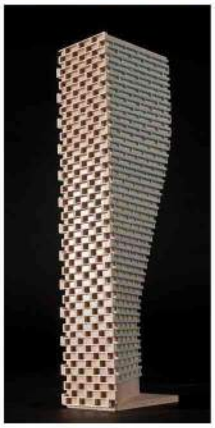
Scientists Report No. GW21-147-Noise & Vibration R1 dated November 20, 2023



ENVIRONMENTAL NOISE & VIBRATION FEASIBILITY ASSESSMENT

35 Laurel Street
Ottawa, Ontario

REPORT: GW21-147-Noise & Vibration R1



November 20th, 2023

PREPARED FOR
2729685 Ontario Inc.
The Estate of Carson Unsworth
320 McRae Avenue
Ottawa, ON K1Z 5R8

PREPARED BY
Adam Bonello, B.Eng., Junior Environmental Scientist
Joshua Foster, P.Eng., Lead Engineer

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

EXECUTIVE SUMMARY

This report describes an environmental noise & vibration feasibility assessment in support of the Zoning By-law Amendment (ZBA) application for the proposed residential development at 35 Laurel Street in Ottawa, Ontario. The proposed development comprises two buildings, Building A (30 storeys) and Building B (35 storeys), situated to the north and south, respectively, along the east elevation of the subject site. The major sources of transportation noise are Highway 417 and the Trillium Line LRT. The primary property impacting the study site for stationary noise is the Canadian Bank Note (CBN) facility located at 975 Gladstone Avenue, south of the study site. Sources of stationary noise include rooftop mechanical equipment and a loading dock. Figure 1 illustrates a site plan with surrounding context.

The assessment is based on (i) theoretical noise prediction methods that conform to the Ministry of the Environment, Conservation and Parks (MECP) and City of Ottawa requirements; (ii) noise level criteria as specified by the City of Ottawa's Environmental Noise Control Guidelines (ENCG); (iii) architectural drawings prepared by Roderick Lahey Architects in May 2023 and the revision in October 2023, and; (iv) mechanical information assumed by Gradient Wind based on experience with nearby projects.

The results of the current analysis indicate that transportation noise levels will range between 53 and 70 dBA during the daytime period (07:00-23:00) and between 47 and 62 dBA during the nighttime period (23:00-07:00). The highest noise level (i.e. 70 dBA) occurs along the south façade of Building B, which has the most exposure to Highway 417 to the south. Noise levels at the Building B podium terraces exceed the criteria for outdoor living areas. It is expected that a noise screen will be required. Building components with a higher Sound Transmission Class (STC) rating will be required on façades where noise levels exceed 65 dBA.

In addition to upgraded windows, the development will require the installation of central air conditioning (or similar mechanical system) will be required for all units in the development, which will allow occupants to keep windows closed and maintain a comfortable living environment. Warning Clauses will be required in all Agreements of Lease, Purchase and Sale.

Specific transportation noise control measures will be determined as part of a detailed study conducted at the time of Site Plan Application (SPA).

Due to the influence of existing stationary sources associated with the adjacent Canadian Bank Note (CBN) facility on the site, which exceed the Class 1 area sound level limits, it is recommended that the new development be considered as a Class 4 area. For infill situations under the ENCG, new noise sensitive buildings that have ventilation systems to allow windows and doors to remain closed as an integral part of their design can apply to be deemed a Class 4 designation, which has applicable sound level limits of 60 and 55 dBA during the daytime and nighttime, respectively. Once approved by council, existing landowners should be notified of the designation which they can use in dealing with their MECP approval applications. A stationary Warning Clause will be required in all Agreements of Lease, Purchase and Sale of residential units, as summarized in Section 6.

Stationary noise impacts from the development on the surroundings can be minimized by judicious placement mechanical equipment such as its placement on a roof or in a mechanical penthouse, or the incorporation of silencers and noise screens as necessary. It is recommended that any large pieces of HVAC equipment be placed in the middle of the roof, avoiding line of site with the surrounding residential dwellings. A stationary noise assessment for on-site equipment will be conducted during detailed design.

The estimated ground vibration level at the nearest point of reception is expected to be 0.02 mm/s RMS (57.8 dBV) based on the FTA protocol. Since predicted vibration levels are below the criterion of 0.10 mm/s RMS, no mitigation will be required. Since estimated vibration levels were found to be less than 0.10 mm/s peak partial velocity (ppv), ground borne noise levels are also expected to be below the ground borne noise criteria of 35 dB.

TABLE OF CONTENTS

1. INTRODUCTION

Gradient Wind Engineering Inc. (Gradient Wind) was retained by The Estate of Carson Unsworth to undertake an environmental noise & vibration feasibility assessment in support of the Zoning By-law Amendment (ZBA) application for the proposed residential development at 35 Laurel Street in Ottawa, Ontario. This report summarizes the methodology, results and recommendations related to an environmental noise feasibility assessment.

The present scope of work involves assessing exterior noise and ground vibration levels at the study site generated by the surrounding industrial properties and transportation sources. The assessment was performed based on theoretical noise calculation methods conforming to the City of Ottawa[1] and Ministry of the Environment, Conservation and Parks (MECP) NPC-300[2] guidelines, architectural drawings prepared by Roderick Lahey Architects in October 2023, mechanical information assumed by Gradient Wind based on experience with nearby projects, surrounding street layouts obtained from the City of Ottawa, and recent site imagery.

2. TERMS OF REFERENCE

The subject site is located at 35 Laurel Street in Ottawa, situated to the north at the intersection of Laurel Street and Loretta Avenue North, on a 'L'-shaped parcel of land bounded by Laurel Street to the south, Breezehill Avenue North and low-rise buildings to the west, a low-rise building to the north, and the O-Train Line 2 to the east. Throughout this report, Laurel Street is considered project south. The proposed development comprises two buildings, Building A (30 storeys) and Building B (35 storeys), situated to the north and south, respectively, along the east elevation of the subject site. Each building includes a six-storey podium, and the buildings are topped with a mechanical penthouse (MPH) and share two below-grade parking levels. A proposed parkland is located at the northwest corner of the subject site.

Above the below-grade parking, the ground floor of Building A includes a residential main entrance to the west, an indoor amenity at the northwest corner, residential units along the east elevation, and an indoor

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

[2] Ministry of the Environment, Conservation and Parks (MECP), Environmental Noise Guideline – Publication NPC-300, August 2013

pool at the southwest corner. An exterior amenity is situated to the west of Building A. Access to the shared underground parking is provided by a ramp to the north of Building A via a laneway from Laurel Street. Levels 2-6 are reserved for residential use. Level 7 includes indoor amenities to the north and south and residential units throughout the remainder of the level. At Level 7, the building steps back from the north and south elevations and from the east and west elevations to accommodate common amenity terraces and private terraces, respectively. Levels 8-30 rise above the podium with a nominally rectangular planform and comprise residential units.

The ground floor of Building B includes a residential main entrance to the south, retail spaces to the southeast and southwest, a commercial garbage and recycling space at the northwest corner, bike storage spaces to the north, and an indoor amenity at the northeast corner. Levels 2-6 are reserved for residential use. Level 7 includes indoor amenities to the east and west and residential units throughout the remainder of the level. At Level 7, the building steps back from the east and west elevations and from the north and south elevations to accommodate common amenity terraces and private terraces, respectively. Levels 8-35 rise above the podium with a nominally rectangular planform and comprise residential units.

The near-field surroundings include low-rise massing from the southeast clockwise to the northeast with a high-rise building and a mid-rise residential building to the west, and a green space to the east. To the east of the site, the O-Train Line 2 and the Trillium Pathway extend from the northwest to the southeast. Notably, a 30-storey development is approved (Site Plan Control) at 1040 Somerset Street West, approximately 75 m to the north-northwest, a 28-storey development is approved (ZBLA) at 1050 Somerset West, approximately 90 m to the northwest, a development comprising mixed-use residential mid- and high-rise buildings (ranging from 9 to 30 storeys) and townhouse blocks is approved (ZBLA) at 933 Gladstone Avenue, to the east across the O-Train Line 2, and a development comprising three mixed-use towers (30, 33, and 35 storeys) is approved (ZBLA) at 951 Gladstone Avenue and 145 Loretta Avenue North, approximately 85 m to the southeast.

The major sources of transportation noise are Highway 417 and the Trillium Line LRT. The primary property impacting the study site for stationary noise is the Canadian Bank Note (CBN) facility located at 975 Gladstone Avenue, south of the study site. The CBN facility is expected to operate 24 hours a day. However, certain sources are likely to have reduced operation during the nighttime period between 23:00 and 07:00. Sources of stationary noise include rooftop mechanical equipment and a loading dock.

Other stationary noise sources surrounding the study comprise small rooftop units associated with the surrounding commercial properties. A review of satellite imagery does not reveal any sources that would not be mitigated by setback distance to the study site. Further analysis of these sources will not be required. The commercial properties east of Loretta Avenue North are expected to cease operations, as the land is slated for redevelopment. The Public Works Canada Yard to the north does not contain any significant sources of stationary noise. Vehicles idling on nearby roadways are not classified as sources of stationary noise, as these are not within the property line of the proposed development. As such these other sources of noise were ruled insignificant. Figure 1 illustrates a complete site plan with surrounding context. Figure 3 illustrates the location of all stationary noise sources included in this study.

3. OBJECTIVES

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

4. METHODOLOGY

4.1 Background

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

4.2 Transportation Noise

4.2.1 Criteria for Transportation Noise

For vehicle traffic, the equivalent sound energy level, L_{eq}, provides a measure of the time varying noise levels, which is well correlated with the annoyance of sound. It is defined as the continuous sound level that has the same energy as a time varying noise level over a period of time. For roadways, the L_{eq} is commonly calculated on the basis of a 16-hour (L_{eq16}) daytime (07:00-23:00) / 8-hour (L_{eq8}) nighttime (23:00-07:00) split to assess its impact on residential buildings. The City of Ottawa's Environmental Noise Control Guidelines (ENCG) specifies that the recommended indoor noise limit range (that is relevant to this study) is 50, 45 and 40 dBA for retail, living rooms and sleeping quarters, respectively, as listed in Table 1. However, to account for deficiencies in building construction and control peak noise, these levels should be targeted toward 47, 42 and 37 dBA.

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

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

Predicted noise levels at the plane of window (POW) dictate the action required to achieve the recommended sound levels. An open window is considered to provide a 10 dBA reduction in noise while a standard closed window is capable of providing a minimum 20 dBA noise reduction[4]. Therefore, where noise levels exceed 55 dBA daytime and 50 dBA nighttime, the ventilation for the building should consider

[3] Adapted from ENCG 2016 – Tables 2.2b and 2.2c

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

the need for having windows and doors closed, which normally triggers the need for central air conditioning (or similar systems). Where noise levels exceed 65 dBA daytime and 60 dBA nighttime building components will require higher levels of sound attenuation[5].

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

(i) Increased distance setback with absorptive ground cover (vegetation)
(ii) Relocation of noise sensitive areas away from roadways (provide blockage with building massing)
(iii) Earth berms
(iv) Acoustic barriers

4.2.2 Roadway and LRT Traffic Volumes

The ENCG dictates that noise calculations should consider future sound levels based on a roadway's classification at the mature state of development. Therefore, traffic volumes are based on the roadway classifications outlined in the City of Ottawa's Official Plan (OP) and Transportation Master Plan[6] which provide additional details on future roadway expansions. Average Annual Daily Traffic (AADT) volumes are then based on data in Table B1 of the ENCG for each roadway classification. Trillium Line LRT volumes and speed are based on Gradient Wind's past experience with the Trillium Line on other projects. Table 2 (below) summarizes the AADT values used for each roadway and LRT line included in this assessment.

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

TABLE 2: ROADWAY AND RAILWAY TRAFFIC DATA

Segment	Roadway Traffic Data	Speed Limit (km/h)	Traffic Volumes
Highway 417	8-Lane Freeway	100	146,664
Trillium Line	LRT	50	192/24*

*-Daytime/nighttime volumes

4.2.3 Theoretical Transportation Noise Predictions

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

Roadway noise calculations were performed by treating each road segment as a separate line source of noise, and by using existing building locations as noise barriers. In addition to the traffic volumes summarized in Table 4, theoretical noise predictions were based on the following parameters:

- Truck traffic on all roadways was taken to comprise 5% heavy trucks and 7% medium trucks, as per ENCG requirements for noise level predictions.
- The day/night split was taken to be 92%/8% respectively for all streets.
- Ground surfaces were taken to be absorptive and reflective based on specific source-receiver path ground characteristics.
- Site topography is considered as gently sloping.
- LRT was modelled using 4-car SRT vehicle type in STAMSON.

Noise receptors were strategically placed at six locations around the study area (see Figure 2).

4.3 Stationary Noise

4.3.1 Criteria for Stationary Noise

For stationary sources, the L_{eq} is commonly calculated on an hourly interval, while for roadways, the L_{eq} is calculated on the basis of a 16-hour daytime/8-hour nighttime split as previously mentioned in Section 4.2.1

Stationary sources are defined in the ENCG as "all sources of sound and vibration, whether fixed or mobile, that exist or operate on a premises, property or facility, the combined sound and vibration levels of which are emitted beyond the property boundary of the premises, property or facility, unless the source(s) is (are) due to construction" [7]. This applies to the plane of window and outdoor amenity spaces serving the development.

The surrounding area of the development would typically be defined as a Class 1 (Urban) environment, as background noise levels are dominated by human activities such as roadway and transit sources. The ENCG and NPC-300 also allow for the consideration of a Class 4 area for new proposed noise sensitive land uses where air conditioning will form an integral part of the design. For a development to be considered a Class 4 area, the planning authority must agree to the condition, which requires city council approval. Once the development has been approved as a Class 4 area, the surrounding source owners will be notified and can then use the Class 4 designation for their approval process with the MECP. In the case of this development, Class 4 has been granted for properties being impacted by the CBN facility, therefore Class 4 will be used for the basis of this study. The exclusionary sound level limits for Class 1 and 4 areas are summarized in Table 3 below. The applicable sound level limit is the higher of either the values in Table 3 or background noise levels due to sources such as transportation.

TABLE 3: EXCLUSIONARY LIMITS FOR CLASS 1/4 AREA

Time of Day	Class 1		Class 4	
	Outdoor Points of Reception	Plane of Window	Outdoor Points of Reception	Plane of Window
07:00 – 19:00	50	50	55	60
19:00 – 23:00	50	50	55	60
23:00 – 07:00	N/A	45	N/A	55

4.3.2 Assumptions

Gradient Wind has assumed mechanical information of the development based on experience with similar developments, and available noise reports on the City of Ottawa's development applications website, such as the Noise & Vibration Impacts Feasibility Study 145 Loretta Ave & 951 Gladstone Avenue Ottawa,

[7] City of Ottawa Environmental Noise Control Guidelines, page 10

Ontario, prepared by J.E. Coulter Associates Limited, dated August 8, 2019. The following assumptions have been made in the analysis:

(i) The locations and quantity of rooftop units are based on a review of satellite imagery and Gradient Wind's experience with similar developments and the J.E. Coulter Associates Limited report.
(ii) Sound data for rooftop units are based on manufacturer's data.
(iii) The rooftop mechanical units are assumed to operate continuously over a 1-hour period during the daytime and nighttime period.
(iv) Screening effects of the parapets have been conservatively excluded in the modelling.

4.3.3 Determination of Noise Source Power Levels

Mechanical information for the CBN facility has been based on Gradient Wind's experience with similar developments and a review of satellite imagery. Gradient Wind also considered information presented in other noise reports prepared for other developments in the area, such as Noise & Vibration Impacts Feasibility Study 145 Loretta Ave & 951 Gladstone Avenue Ottawa, Ontario, prepared by J.E. Coulter Associates Limited, dated August 8, 2019. Based on our assumptions, Gradient Wind had good correlation with the J.E. coulter noise results.

4.3.1 Stationary Source Noise Predictions

The impact of the surrounding stationary noise sources on the 35 Laurel Street development was determined by computer modelling. Stationary noise source modelling is based on the software program *Predictor-Lima* developed from the International Standards Organization (ISO) standard 9613 Parts 1 and 2. This computer program is capable of representing three-dimensional surfaces and first reflections of sound waves over a suitable spectrum for human hearing. The methodology has been used on numerous assignments and has been accepted by the MECP as part of Environmental Compliance Approvals applications.

Three individual noise sensor locations were selected in the *Predictor-Lima* model to measure the noise impact at points of reception (POR) during the daytime (07:00 – 19:00) and nighttime (19:00 – 07:00) periods (see Figure 4). For each location, various heights were examined. POR locations included the outdoor living areas (OLA's) and the plane of windows (POW's) of the 35 Laurel Street development. All mechanical equipment was represented as point sources in the model. Air temperature, pressure and humidity were set to 10°C, 101.3 kPA and 70%, respectively. Ground absorption over the study area was determined based on topographical features (such as water, concrete, grassland, etc.). A coefficient of 0 was used for hard surfaces, such as concrete and paved areas, and 1 for soft surfaces, such as grass and vegetative areas. Existing and proposed buildings were added to the model to account for screening and reflection effects from building façades. Modelling files and outputs are available upon request.

4.4 Ground Vibration & Ground-borne Noise

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

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

4.4.1 Ground Vibration Criteria

In the United States, the Federal Transportation Authority (FTA) has set vibration criteria for sensitive land uses next to transit corridors. Similar standards have been developed by a partnership between the MECP and the Toronto Transit Commission[8]. 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[9], 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.

4.4.2 Theoretical Ground Vibration Prediction Procedure

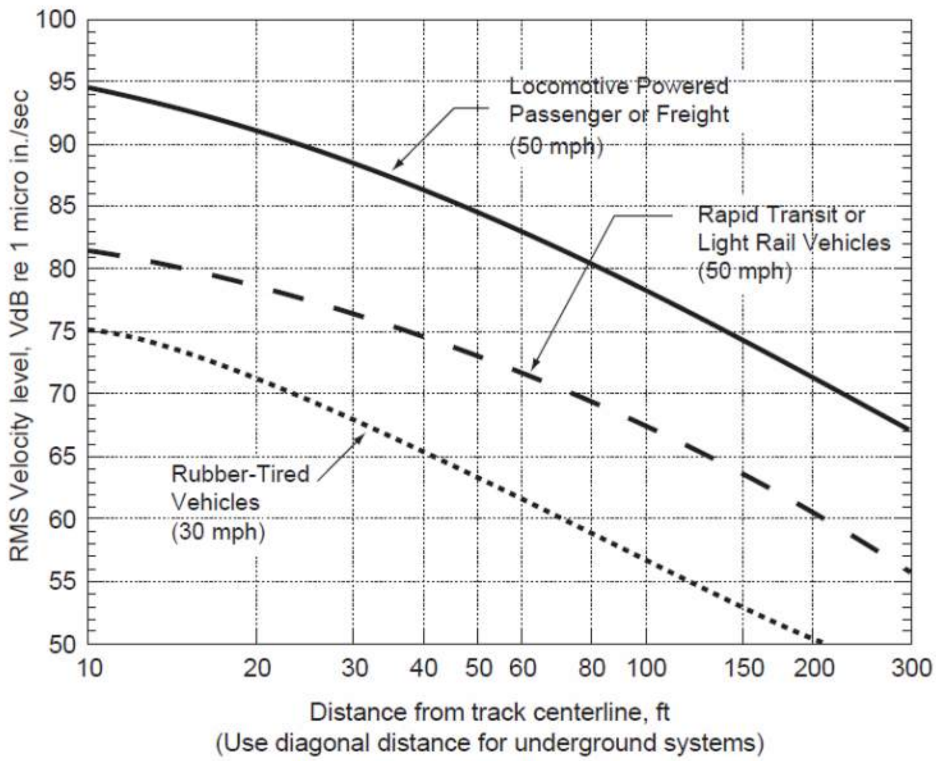
Potential vibration impacts of the future Confederation LRT rail line, currently under construction, were predicted using the FTA's Transit Noise and Vibration Impact Assessment[10] protocol. The FTA general vibration assessment is based on an upper bound generic set of curves that show vibration level attenuation with distance. These curves, illustrated in the figure below, are based on ground vibration measurements at various transit systems throughout North America. Vibration levels at points of reception are adjusted by various factors to incorporate known characteristics of the system being analyzed, such as operating speed of vehicle, conditions of the track, construction of the track and geology, as well as the structural type of the impacted building structures. Based on the setback distance of the closest building, initial vibration levels were deduced from a curve for light rail trains at 50 miles per hour (mph) and applying an adjustment factor of -1.2 dBV to account for an operational speed of 43.4

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

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

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

mph (70 km/h). The track was assumed to be jointed with no welds. Details of the vibration calculations are presented in Appendix B.



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

5. RESULTS AND DISCUSSION

5.1 Transportation Noise Levels

The results of the roadway noise calculations are summarized in Table 6 below. A complete set of input and output data from all STAMSON 5.04 calculations are available in Appendix A.

TABLE 4: EXTERIOR NOISE LEVELS DUE TO TRANSPORTATION SOURCES

Receptor Number	Receptor Height Above Grade (m)	Receptor Location	STAMSON Roadway Noise Level (dBA)	
			Day	Night
1	91.5	Building A – East Façade	53	47
2	106.5	Building B – South Façade	70	62
3	20.5	Building B – Podium Terrace	65	N/A*
4	106.5	Building B – East Façade	67	60
5	20.5	Building B – Podium Terrace	65	N/A*
6	20.5	Building A – Podium Terrace	60	N/A*

**Noise levels during the nighttime are not considered for OLAs*

The results of the current analysis indicate that transportation noise levels will range between 53 and 70 dBA during the daytime period (07:00-23:00) and between 47 and 62 dBA during the nighttime period (23:00-07:00). The highest noise level (i.e. 70 dBA) occurs along the south façade of Building B, which has the most exposure to Highway 417 to the south.

5.2 Stationary Noise Levels

Noise levels from existing stationary sources across the study site were found to be as high as 55 dBA during the nighttime period. These levels exceed the Class 1 criteria but are below the Class 4 limits. The anticipated sound levels across the development are summarized in Table 5 and are based on the assumptions outlined in Section 4.3.2.

TABLE 5: NOISE LEVELS FROM STATIONARY SOURCES

Receptor Number	Receptor Height Above Grade/Roof (m)	Receptor Location	Noise Level (dBA)		Exclusionary Limits		Meets ENCG Class 4 Criteria	
			Day	Night	Day	Night	Day	Night
R1	1.5	Building B Podium South Façade	54	54	60	55	YES	YES
R2	30	Building B Tower South Façade	54	54	60	55	YES	YES
	60		53	53	60	55	YES	YES
	90		52	52	60	55	YES	YES
	106.5		51	51	60	55	YES	YES
R3	1.5	Building B Podium Terrace	55	55	60	55	YES	YES

Noise contours throughout the study site can be seen in Figure 5 and 6 for daytime and nighttime conditions. The main contributor of noise at these locations are the chiller units. The most impacted area of the development is the south façade of Building B, which has direct exposure to and the least setback from the CBN facility.

5.3 Ground Vibrations & Ground-borne Noise Levels

Based on an offset distance of 27 metres between the Trillium Line railway centerline and the nearest building foundation, the estimated ground vibration level at the nearest point of reception is expected to be 0.02 mm/s RMS (57.8 dBV) based on the FTA protocol. Details of the calculation are provided in Appendix B. Since predicted vibration levels are below the criterion of 0.10 mm/s RMS, no mitigation will be required.

According to the United States Federal Transit Authority's vibration assessment protocol, ground borne noise can be estimated by subtracting 35 dB from the velocity vibration level in dBV. Since estimated ground vibration levels were found to be less than 0.10 mm/s peak partial velocity (ppv), ground borne noise levels are also expected to be below the ground borne noise criteria of 35 dB.

6. CONCLUSIONS AND RECOMMENDATIONS

The results of the current analysis indicate that transportation noise levels will range between 53 and 70 dBA during the daytime period (07:00-23:00) and between 47 and 62 dBA during the nighttime period (23:00-07:00). The highest noise level (i.e. 70 dBA) occurs along the south façade of Building B, which has the most exposure to Highway 417 to the south. Noise levels at the Building B podium terraces exceed the criteria for outdoor living areas. It is expected that a noise screen will be required. Building components with a higher Sound Transmission Class (STC) rating will be required on façades where noise levels exceed 65 dBA.

In addition to upgraded windows, the development will require the installation of central air conditioning (or similar mechanical system) will be required for all units in the development, which will allow occupants to keep windows closed and maintain a comfortable living environment. Warning Clauses will be required in all Agreements of Lease, Purchase and Sale.

Specific transportation noise control measures will be determined as part of a detailed study conducted at the time of Site Plan Application (SPA).

Due to the influence of existing stationary sources associated with the adjacent Canadian Bank Note (CBN) facility on the site, which exceed the Class 1 area sound level limits, it is recommended that the new development be considered as a Class 4 area. For infill situations under the ENCG, new noise sensitive buildings that have ventilation systems to allow windows and doors to remain closed as an integral part of their design can apply to be deemed a Class 4 designation, which has applicable sound level limits of 60 and 55 dBA during the daytime and nighttime, respectively. Once approved by council, existing landowners should be notified of the designation which they can use in dealing with their MECP approval applications. The following stationary Warning Clause will be required in all Agreements of Lease, Purchase and Sale of residential units.

> *"Purchasers/tenants are advised that sound levels due to the adjacent commercial facilities may interfere with outdoor activities as the sound levels may exceed the sound level limits of the City of Ottawa and the Ministry of the Environment.*

Purchasers/tenants are further advised that sound levels due to the adjacent commercial facility are required to comply with sound level limits that are protective of indoor areas and are based on the assumption that windows and exterior doors are closed. This dwelling unit has been supplied with a ventilation/air conditioning system which will allow windows and exterior doors to remain closed."

Stationary noise impacts from the development on the surroundings can be minimized by judicious placement mechanical equipment such as its placement on a roof or in a mechanical penthouse, or the incorporation of silencers and noise screens as necessary. It is recommended that any large pieces of HVAC equipment be placed in the middle of the roof, avoiding line of site with the surrounding residential dwellings. A stationary noise assessment for on-site equipment will be conducted during detailed design.

The estimated ground vibration level at the nearest point of reception is expected to be 0.02 mm/s RMS (57.8 dBV) based on the FTA protocol. Since predicted vibration levels are below the criterion of 0.10 mm/s RMS, no mitigation will be required. Since estimated vibration levels were found to be less than 0.10 mm/s peak partial velocity (ppv), ground borne noise levels are also expected to be below the ground borne noise criteria of 35 dB.

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.

LICENSED PROFESSIONAL ENGINEER
J. R. FOSTER
100155655
PROVINCE OF ONTARIO

Adam Bonello, B. Eng.
Junior Environmental Scientist

Joshua Foster, P.Eng.
Lead Engineer

Gradient Wind File #21-147-Noise & Vibration R1

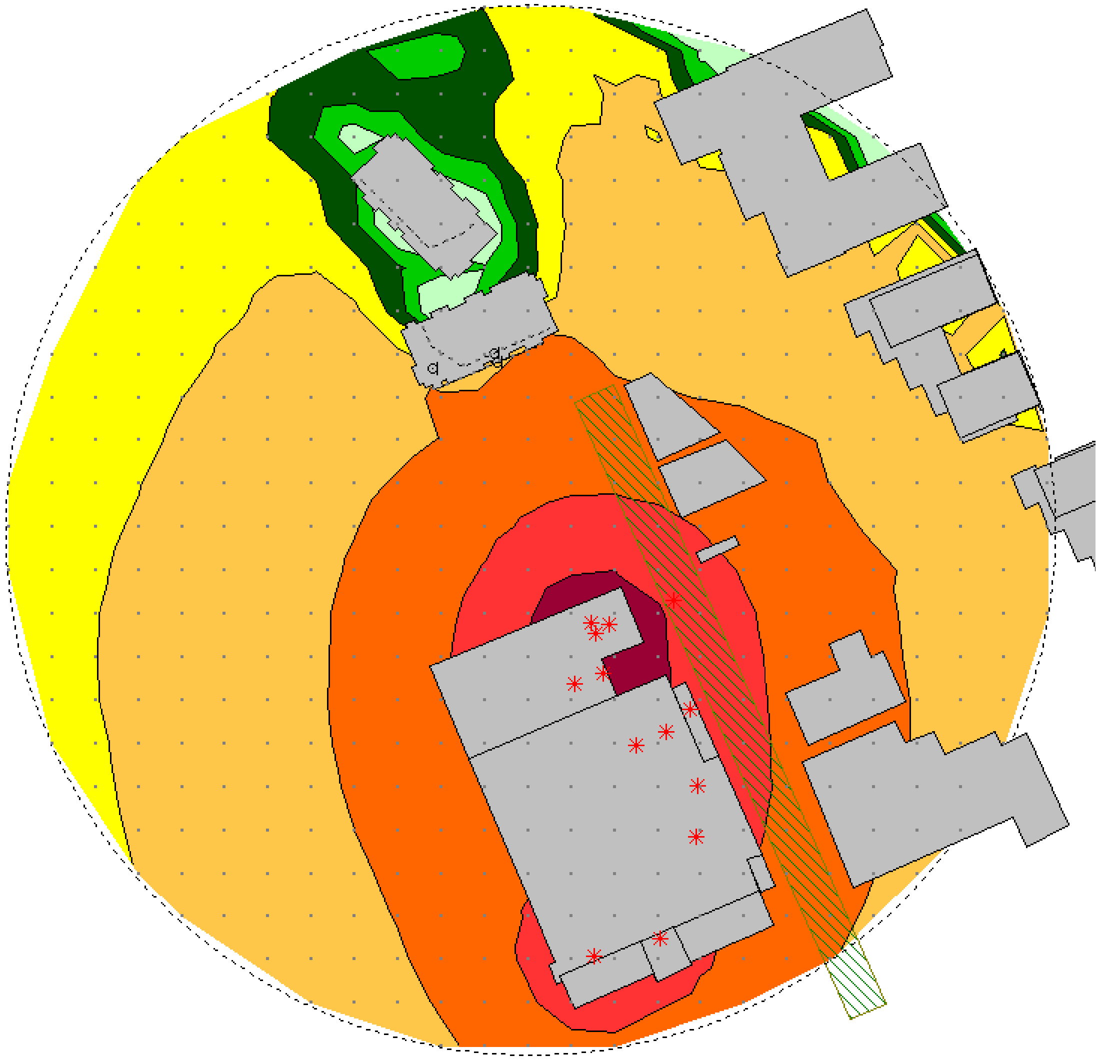
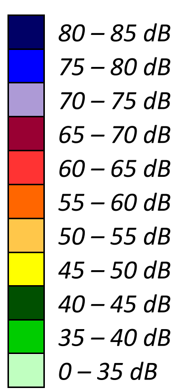


FIGURE 5: DAYTIME/NIGHTTIME STATIONARY NOISE CONTOURS (20 M ABOVE GRADE)

	80 – 85 dB
	75 – 80 dB
	70 – 75 dB
	65 – 70 dB
	60 – 65 dB
	55 – 60 dB
	50 – 55 dB
	45 – 50 dB
	40 – 45 dB
	35 – 40 dB
	0 – 35 dB

FIGURE 6: DAYTIME/NIGHTTIME STATIONARY NOISE CONTOURS (ISO VIEW)



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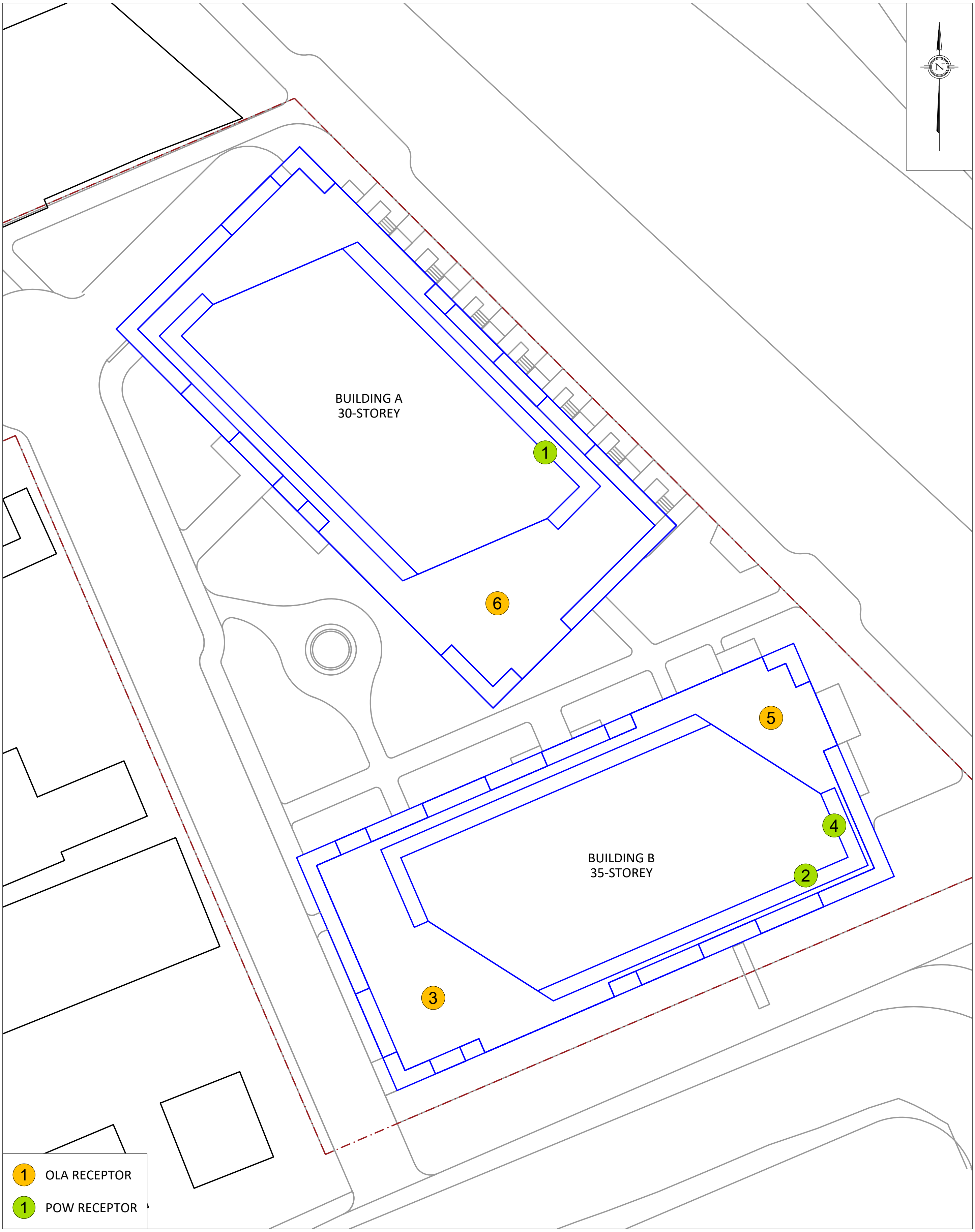
PROJECT: 35 LAUREL STREET, OTTAWA ENVIRONMENTAL NOISE & VIBRATION FEASIBILITY ASSESSMENT		DESCRIPTION: FIGURE 1: SITE PLAN AND SURROUNDING CONTEXT
SCALE: 1:3000 (APPROX.)	DRAWING NO.: GW21-147-1	
DATE: NOVEMBER 20, 2023	DRAWN BY: A.B.	



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SCALE	1:500 (APPROX.)	DRAWING NO.	GW21-147-2
DATE	NOVEMBER 20, 2023	DRAWN BY	A.B.

DESCRIPTION

FIGURE 2:
TRANSPORTATION NOISE
RECEPTOR LOCATIONS

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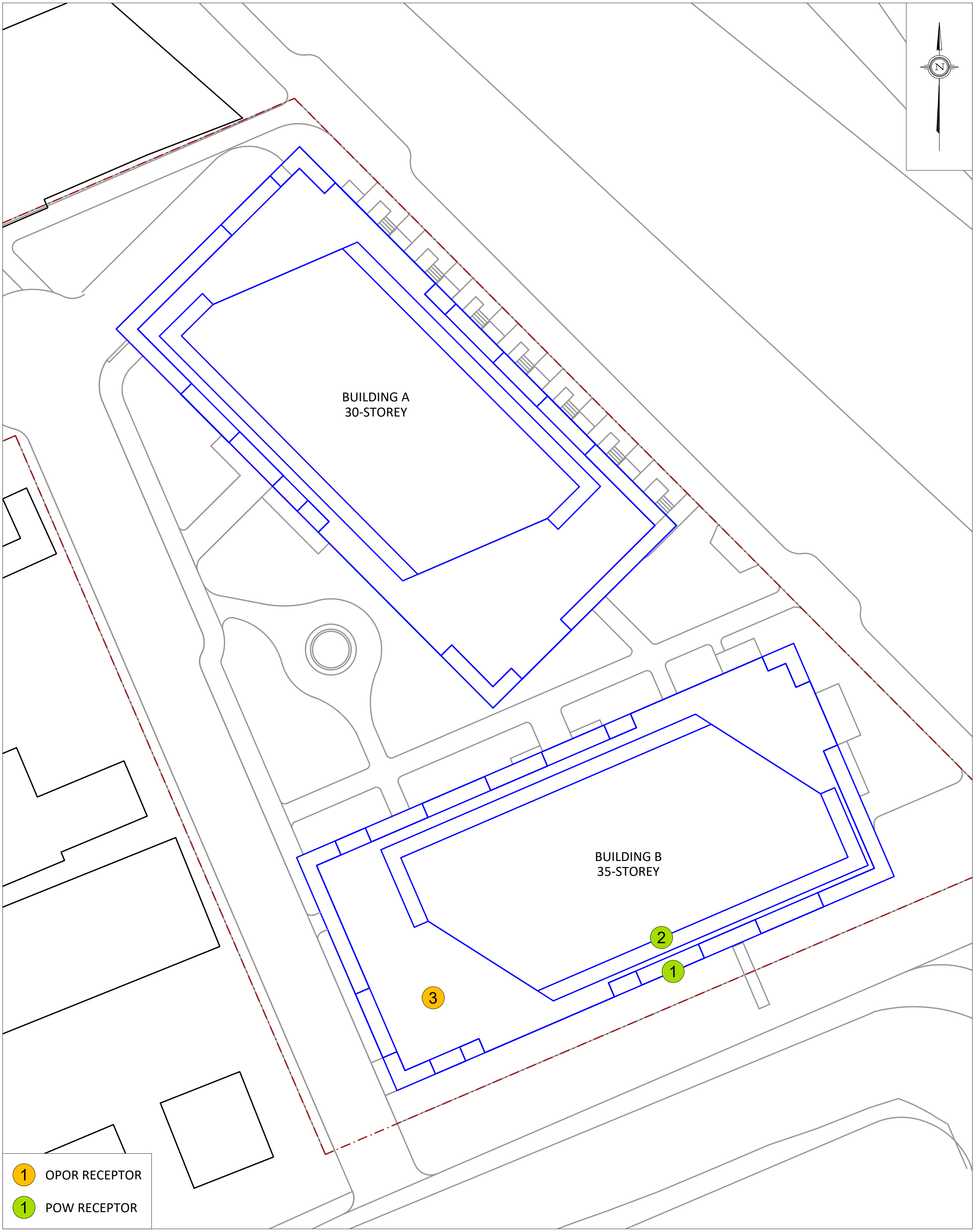
	SCALE: 1:1000 (APPROX.)	DRAWING NO.: GW21-147-3	
	DATE: NOVEMBER 20, 2023	DRAWN BY: A.B.	



GRADIENTWIND ENGINEERS & SCIENTISTS 127 WALGREEN ROAD , OTTAWA, ON 613 836 0934 • GRADIENTWIND.COM	PROJECT 35 LAUREL STREET, OTTAWA ENVIRONMENTAL NOISE & VIBRATION FEASIBILITY ASSESSMENT		DESCRIPTION FIGURE 4: STATIONARY NOISE RECEPTOR LOCATIONS
	SCALE 1:500 (APPROX.)	DRAWING NO. GW21-147-4	
	DATE NOVEMBER 20, 2023	DRAWN BY A.B.	

APPENDIX A

STAMSON INPUT AND OUTPUT DATA

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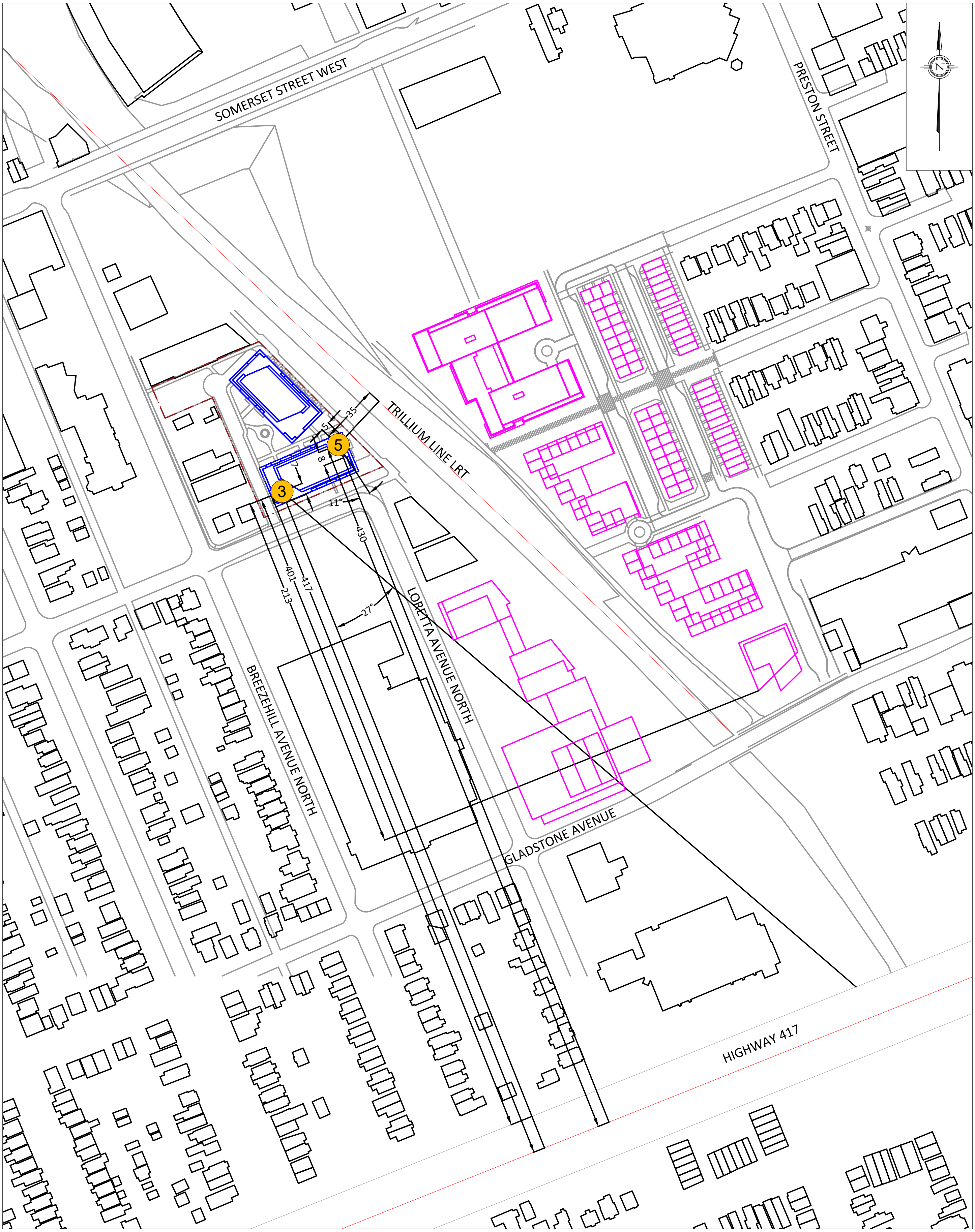
127 WALGREEN ROAD , OTTAWA, ON 613 836 0934 • GRADIENTWIND.COM	SCALE 1:3000 (APPROX.)	DRAWING NO. GW21-147-A1	FIGURE A1: STAMSON INPUT PARAMETERS - R1,2
	DATE NOVEMBER 20, 2023	DRAWN BY A.B.	



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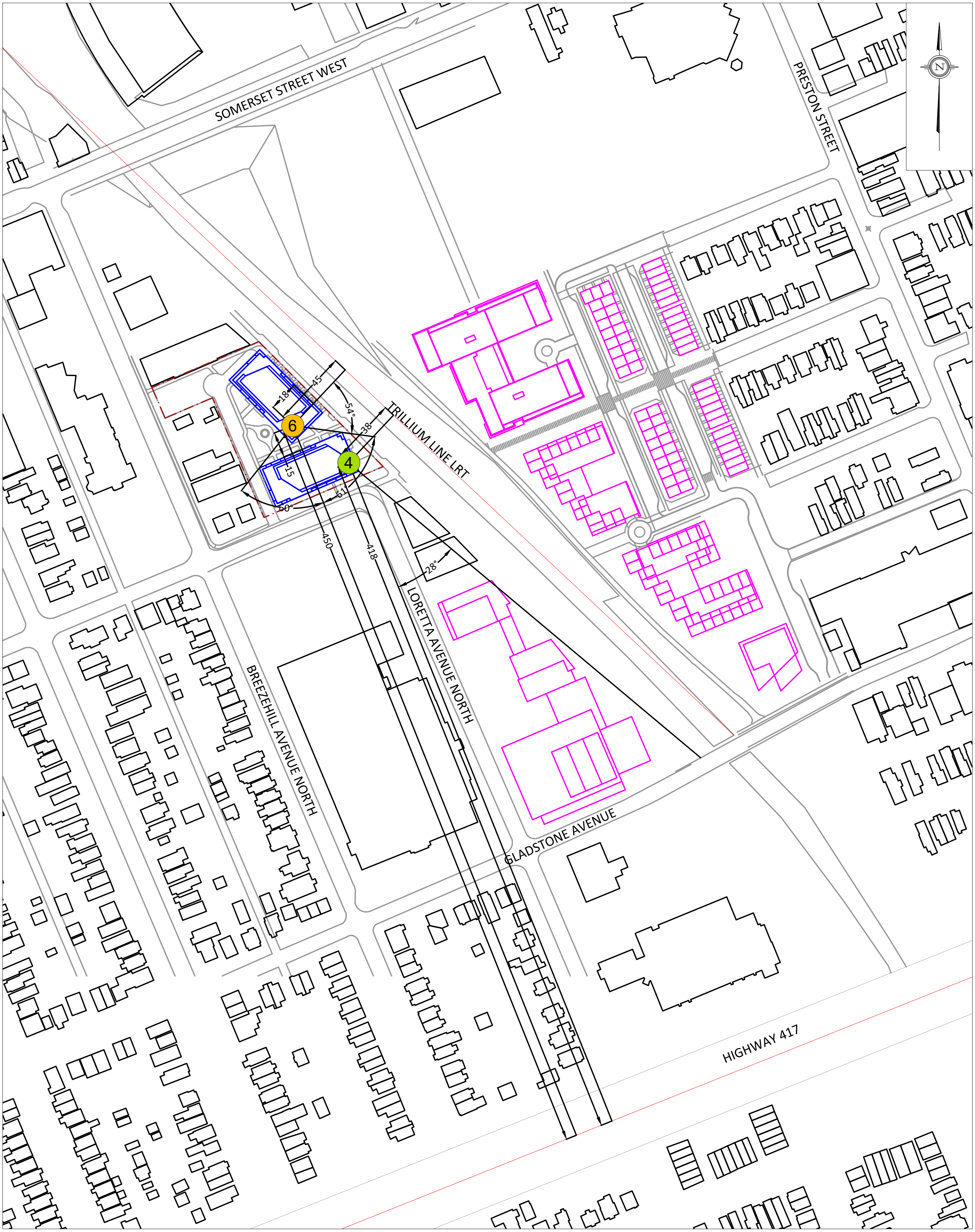
PROJECT 35 LAUREL STREET, OTTAWA ENVIRONMENTAL NOISE & VIBRATION FEASIBILITY ASSESSMENT		DESCRIPTION FIGURE A2: STAMSON INPUT PARAMETERS - R3,5
SCALE 1:3000 (APPROX.)	DRAWING NO. GW21-147-A2	
DATE NOVEMBER 20, 2023	DRAWN BY A.B.	



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PROJECT: 35 LAUREL STREET, OTTAWA ENVIRONMENTAL NOISE & VIBRATION FEASIBILITY ASSESSMENT		DESCRIPTION: FIGURE A3: STAMSON INPUT PARAMETERS - R4,6
SCALE: 1:3000 (APPROX.)	DRAWING NO. GW21-147-A3	
DATE: NOVEMBER 20, 2023	DRAWN BY: A.B.	

```
STAMSON 5.0        NORMAL REPORT        Date: 19-10-2023 14:10:49
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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

RT/Custom data, segment # 1: LRT (day/night)
---------------------------------------------
1 - 4-car SRT:
Traffic volume    :   192/24    veh/TimePeriod
Speed             :    50 km/h

Data for Segment # 1: LRT (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  :  31.00 / 31.00  m
Receiver height           :  91.50 / 91.50  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: LRT (day)
------------------------------

Source height = 0.50 m

RT/Custom (0.00 + 52.87 + 0.00) = 52.87 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  56.02  -3.15   0.00   0.00   0.00   0.00  52.87
----------------------------------------------------------------------

Segment Leq : 52.87 dBA

Total Leq All Segments: 52.87 dBA

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

Source height = 0.50 m

RT/Custom (0.00 + 46.85 + 0.00) = 46.85 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  50.00  -3.15   0.00   0.00   0.00   0.00  46.85
----------------------------------------------------------------------

Segment Leq : 46.85 dBA
```

```
Total Leq All Segments: 46.85 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 52.87
                         (NIGHT): 46.85
```

```
STAMSON 5.0        NORMAL REPORT        Date: 19-10-2023 14:10:01
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Highway 417 (day/night)
-----------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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: Highway 417 (day/night)
---------------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 414.00 / 414.00 m
Receiver height           : 106.50 / 106.50 m
Topography                :      2       (Flat/gentle slope; with
barrier)
Barrier angle1            : -23.00 deg   Angle2 : 90.00 deg
Barrier height            :   4.50 m
Barrier receiver distance : 400.00 / 400.00 m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00

Results segment # 1: Highway 417 (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 !       106.50 !         5.05 !          5.05

ROAD (65.71 + 67.98 + 0.00) = 70.00 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------------
   -90    -23   0.00  84.41   0.00 -14.41  -4.29   0.00   0.00   0.00  65.71
----------------------------------------------------------------------------
   -23     90   0.00  84.41   0.00 -14.41  -2.02   0.00   0.00  -4.60  63.37*
   -23     90   0.00  84.41   0.00 -14.41  -2.02   0.00   0.00   0.00  67.98
----------------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 70.00 dBA

Total Leq All Segments: 70.00 dBA

Results segment # 1: Highway 417 (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 !       106.50 !         5.05 !          5.05

ROAD (58.11 + 60.38 + 0.00) = 62.40 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------------
   -90    -23   0.00  76.81   0.00 -14.41  -4.29   0.00   0.00   0.00  58.11
----------------------------------------------------------------------------
   -23     90   0.00  76.81   0.00 -14.41  -2.02   0.00   0.00  -4.60  55.78*
   -23     90   0.00  76.81   0.00 -14.41  -2.02   0.00   0.00   0.00  60.38
----------------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 62.40 dBA
Total Leq All Segments: 62.40 dBA

RT/Custom data, segment # 1: LRT (day/night)
--------------------------------------------
```

```
1 - 4-car SRT:
Traffic volume    :   192/24    veh/TimePeriod
Speed             :    50  km/h

Data for Segment # 1: LRT (day/night)
-------------------------------------
Angle1   Angle2            :  23.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  44.00 / 44.00  m
Receiver height            : 106.50 / 106.50 m
Topography                 :      1       (Flat/gentle slope; no
barrier)
Reference angle            :   0.00

Results segment # 1: LRT (day)
------------------------------

Source height = 0.50 m

RT/Custom (0.00 + 47.06 + 0.00) = 47.06 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
    23     90   0.00  56.02  -4.67  -4.29   0.00   0.00   0.00  47.06
----------------------------------------------------------------------

Segment Leq : 47.06 dBA

Total Leq All Segments: 47.06 dBA

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

Source height = 0.50 m

RT/Custom (0.00 + 41.04 + 0.00) = 41.04 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
    23     90   0.00  50.00  -4.67  -4.29   0.00   0.00   0.00  41.04
----------------------------------------------------------------------

Segment Leq : 41.04 dBA

Total Leq All Segments: 41.04 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 70.02
                         (NIGHT): 62.43
```

```
STAMSON 5.0        NORMAL REPORT        Date: 12-07-2023 16:16:18
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: 417A (day/night)
----------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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: 417A (day/night)
--------------------------------------
Angle1   Angle2           : -90.00 deg   -27.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 417.00 / 417.00 m
Receiver height           :  20.50 / 20.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -90.00 deg   Angle2 : -46.00 deg
Barrier height            :   0.00 m
Barrier receiver distance : 213.00 / 213.00 m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00

Road data, segment # 2: 417B (day/night)
----------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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: 417B (day/night)
--------------------------------------
Angle1   Angle2            : -27.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   : 417.00 / 417.00 m
Receiver height            :  20.50 / 20.50  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             : -27.00 deg   Angle2 : 90.00 deg
Barrier height             :   4.50 m
Barrier receiver distance  : 401.00 / 401.00 m
Source elevation           :   0.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00

Results segment # 1: 417A (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 !       20.50 !       10.79 !        10.79

ROAD (0.00 + 62.06 + 58.81) = 63.74 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
--------------------------------------------------------------------------
   -90    -46   0.09  84.41   0.00 -15.74  -6.61   0.00   0.00  -0.31  61.75*
   -90    -46   0.09  84.41   0.00 -15.74  -6.61   0.00   0.00   0.00  62.06
--------------------------------------------------------------------------
   -46    -27   0.09  84.41   0.00 -15.74  -9.85   0.00   0.00   0.00  58.81
--------------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 63.74 dBA

Results segment # 2: 417B (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 !       20.50 !        2.22 !          2.22

ROAD (0.00 + 59.30 + 0.00) = 59.30 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
--------------------------------------------------------------------------
   -27     90   0.00  84.41   0.00 -14.44  -1.87   0.00   0.00  -8.80  59.30
--------------------------------------------------------------------------

Segment Leq : 59.30 dBA

Total Leq All Segments: 65.07 dBA

Results segment # 1: 417A (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 !       20.50 !       10.79 !         10.79

ROAD (0.00 + 54.46 + 51.22) = 56.14 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
--------------------------------------------------------------------------
   -90    -46   0.09  76.81   0.00 -15.74  -6.61   0.00   0.00  -0.31  54.15*
   -90    -46   0.09  76.81   0.00 -15.74  -6.61   0.00   0.00   0.00  54.46
--------------------------------------------------------------------------
   -46    -27   0.09  76.81   0.00 -15.74  -9.85   0.00   0.00   0.00  51.22
--------------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 56.14 dBA

Results segment # 2: 417B (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 !        20.50 !         2.22 !          2.22

ROAD (0.00 + 51.70 + 0.00) = 51.70 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
--------------------------------------------------------------------------
   -27     90   0.00  76.81   0.00 -14.44  -1.87   0.00   0.00  -8.80  51.70
--------------------------------------------------------------------------

Segment Leq : 51.70 dBA

Total Leq All Segments: 57.47 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 65.07
                         (NIGHT): 57.47
```

```
STAMSON 5.0        NORMAL REPORT        Date: 19-10-2023 14:13:32
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: Highway 417 (day/night)
-----------------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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: Highway 417 (day/night)
---------------------------------------------
Angle1   Angle2           : -90.00 deg   0.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 418.00 / 418.00 m
Receiver height           : 106.50 / 106.50 m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            : -28.00 deg   Angle2 : 0.00 deg
Barrier height            :   4.50 m
Barrier receiver distance : 403.00 / 403.00 m
Source elevation          :   0.00 m
Receiver elevation        :   0.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00

Results segment # 1: Highway 417 (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 !       106.50 !         5.26 !          5.26

ROAD (65.33 + 61.88 + 0.00) = 66.95 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
--------------------------------------------------------------------------
   -90    -28   0.00  84.41   0.00 -14.45  -4.63   0.00   0.00   0.00  65.33
--------------------------------------------------------------------------
   -28      0   0.00  84.41   0.00 -14.45  -8.08   0.00   0.00  -3.97  57.90*
   -28      0   0.00  84.41   0.00 -14.45  -8.08   0.00   0.00   0.00  61.88
--------------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 66.95 dBA

Total Leq All Segments: 66.95 dBA

Results segment # 1: Highway 417 (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 !       106.50 !         5.26 !          5.26

ROAD (57.73 + 54.28 + 0.00) = 59.35 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
--------------------------------------------------------------------------
   -90    -28   0.00  76.81   0.00 -14.45  -4.63   0.00   0.00   0.00  57.73
--------------------------------------------------------------------------
   -28      0   0.00  76.81   0.00 -14.45  -8.08   0.00   0.00  -3.97  50.31*
   -28      0   0.00  76.81   0.00 -14.45  -8.08   0.00   0.00   0.00  54.28
--------------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 59.35 dBA

Total Leq All Segments: 59.35 dBA
```

```
RT/Custom data, segment # 1: LRT (day/night)
--------------------------------------------
1 - 4-car SRT:
Traffic volume    :   192/24    veh/TimePeriod
Speed             :    50  km/h

Data for Segment # 1: LRT (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  38.00 / 38.00  m
Receiver height           : 106.50 / 106.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: LRT (day)
------------------------------

Source height = 0.50 m

RT/Custom (0.00 + 51.99 + 0.00) = 51.99 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  56.02  -4.04   0.00   0.00   0.00   0.00  51.99
----------------------------------------------------------------------

Segment Leq : 51.99 dBA

Total Leq All Segments: 51.99 dBA

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

Source height = 0.50 m

RT/Custom (0.00 + 45.97 + 0.00) = 45.97 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  50.00  -4.04   0.00   0.00   0.00   0.00  45.97
----------------------------------------------------------------------

Segment Leq : 45.97 dBA

Total Leq All Segments: 45.97 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 67.09
                         (NIGHT): 59.54
```

```
STAMSON 5.0        NORMAL REPORT        Date: 12-07-2023 16:14:35
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: 417 (day/night)
---------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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: 417 (day/night)
-------------------------------------
Angle1   Angle2            : -90.00 deg   -11.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   : 430.00 / 430.00 m
Receiver height            :  20.50 / 20.50  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             : -90.00 deg   Angle2 : -11.00 deg
Barrier height             :  19.00 m
Barrier receiver distance  :   8.00 / 8.00   m
Source elevation           :   0.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00

Results segment # 1: 417 (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 !       20.50 !       20.15 !        20.15

ROAD (0.00 + 64.65 + 0.00) = 64.65 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
--------------------------------------------------------------------------
   -90    -11   0.00  84.41   0.00 -14.57  -3.58   0.00   0.00  -1.43  64.83*
   -90    -11   0.09  84.41   0.00 -15.89  -3.87   0.00   0.00   0.00  64.65
--------------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 64.65 dBA

Total Leq All Segments: 64.65 dBA

Results segment # 1: 417 (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 !       20.50 !       20.15 !        20.15

ROAD (0.00 + 57.05 + 0.00) = 57.05 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
--------------------------------------------------------------------------
   -90    -11   0.00  76.81   0.00 -14.57  -3.58   0.00   0.00  -1.43  57.23*
   -90    -11   0.09  76.81   0.00 -15.89  -3.87   0.00   0.00   0.00  57.05
--------------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 57.05 dBA

Total Leq All Segments: 57.05 dBA

RT/Custom data, segment # 1: LRT (day/night)
--------------------------------------------
1 - 4-car SRT:
Traffic volume    :   192/24    veh/TimePeriod
Speed             :    50  km/h

Data for Segment # 1: LRT (day/night)
-------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
```

```
Surface                    :      1        (Absorptive ground surface)
Receiver source distance   :  35.00 / 35.00  m
Receiver height            :  20.50 / 20.50  m
Topography                 :      2        (Flat/gentle slope; with barrier)
Barrier angle1             : -90.00 deg   Angle2 : 90.00 deg
Barrier height             :  19.00 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

Results segment # 1: LRT (day)
------------------------------

Source height = 0.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       0.50 !       20.50 !       17.64 !        17.64

RT/Custom (0.00 + 44.05 + 0.00) = 44.05 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  56.02  -3.68   0.00   0.00   0.00  -8.29  44.05
----------------------------------------------------------------------

Segment Leq : 44.05 dBA

Total Leq All Segments: 44.05 dBA

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

Source height = 0.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       0.50 !       20.50 !       17.64 !        17.64

RT/Custom (0.00 + 38.03 + 0.00) = 38.03 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  50.00  -3.68   0.00   0.00   0.00  -8.29  38.03
----------------------------------------------------------------------
```

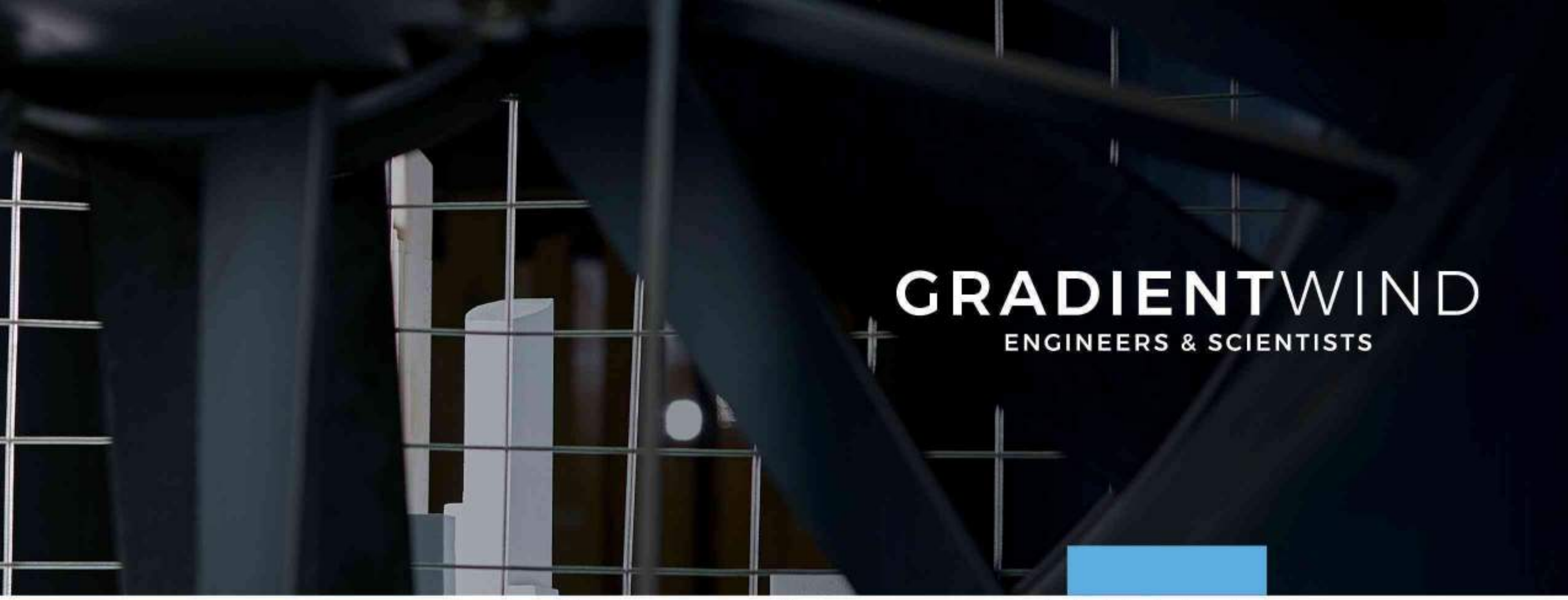
```
Segment Leq : 38.03 dBA

Total Leq All Segments: 38.03 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 64.69
                         (NIGHT): 57.10
```

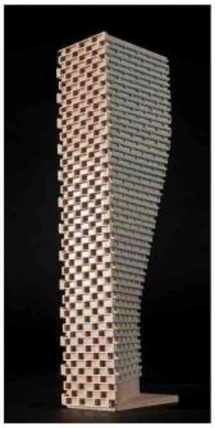
```
STAMSON 5.0        NORMAL REPORT        Date: 12-07-2023 16:24:40
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

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


Road data, segment # 1: 417 (day/night)
---------------------------------------
Car traffic volume  : 118739/10325 veh/TimePeriod  *
Medium truck volume :  9445/821   veh/TimePeriod  *
Heavy truck volume  :  6747/587   veh/TimePeriod  *
Posted speed limit  :   100 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): 146664
    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: 417 (day/night)
-------------------------------------
Angle1   Angle2            : -90.00 deg   60.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      1       (Absorptive ground surface)
Receiver source distance   : 450.00 / 450.00 m
Receiver height            :  20.50 / 20.50  m
Topography                 :      2       (Flat/gentle slope; with barrier)
Barrier angle1             : -61.00 deg   Angle2 : 60.00 deg
Barrier height             :  80.00 m
Barrier receiver distance  :  15.00 / 15.00  m
Source elevation           :   0.00 m
Receiver elevation         :   0.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00

Results segment # 1: 417 (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 !       20.50 !       19.87 !        19.87

ROAD (59.73 + 47.91 + 0.00) = 60.01 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
--------------------------------------------------------------------------
   -90    -61   0.09  84.41   0.00 -16.10  -8.58   0.00   0.00   0.00  59.73
--------------------------------------------------------------------------
   -61     60   0.00  84.41   0.00 -14.77  -1.72   0.00   0.00 -20.00  47.91
--------------------------------------------------------------------------

Segment Leq : 60.01 dBA

Total Leq All Segments: 60.01 dBA

Results segment # 1: 417 (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 !       20.50 !       19.87 !        19.87

ROAD (52.13 + 40.31 + 0.00) = 52.41 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
--------------------------------------------------------------------------
   -90    -61   0.09  76.81   0.00 -16.10  -8.58   0.00   0.00   0.00  52.13
--------------------------------------------------------------------------
   -61     60   0.00  76.81   0.00 -14.77  -1.72   0.00   0.00 -20.00  40.31
--------------------------------------------------------------------------

Segment Leq : 52.41 dBA

Total Leq All Segments: 52.41 dBA

RT/Custom data, segment # 1: LRT (day/night)
--------------------------------------------
1 - 4-car SRT:
Traffic volume    :   192/24    veh/TimePeriod
Speed             :    50 km/h

Data for Segment # 1: LRT (day/night)
-------------------------------------
Angle1   Angle2           :   0.00 deg   54.00 deg
Wood depth                :      0        (No woods.)
No of house rows          :      0 / 0
Surface                   :      1        (Absorptive ground surface)
Receiver source distance  :  45.00 / 45.00  m
```

```
Receiver height           :  20.50 / 20.50  m
Topography                :      2       (Flat/gentle slope; with barrier)
Barrier angle1            :   0.00 deg   Angle2 : 54.00 deg
Barrier height            :  19.00 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: LRT (day)
------------------------------

Source height = 0.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       0.50 !       20.50 !       12.50 !        12.50

RT/Custom (0.00 + 27.26 + 0.00) = 27.26 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     0     54   0.00  56.02  -4.77  -5.23   0.00   0.00 -18.76  27.26
----------------------------------------------------------------------

Segment Leq : 27.26 dBA

Total Leq All Segments: 27.26 dBA

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

Source height = 0.50 m

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       0.50 !       20.50 !       12.50 !        12.50

RT/Custom (0.00 + 21.24 + 0.00) = 21.24 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     0     54   0.00  50.00  -4.77  -5.23   0.00   0.00 -18.76  21.24
----------------------------------------------------------------------

Segment Leq : 21.24 dBA
```

```
Total Leq All Segments: 21.24 dBA

TOTAL Leq FROM ALL SOURCES (DAY): 60.01
                          (NIGHT): 52.41
```





APPENDIX B

FTA VIBRATION CALCULATIONS

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

GW21-147 26-Oct-23

Possible Vibration Impacts on 35 Laurel Street
Perdicted using FTA General Assesment

Train Speed 50 km/h 31 mph

	Distance from C/L	
	(m)	(ft)
CN	27.0	88.6

		Vibration	
From FTA Manual Fig 10-1			
	Vibration Levels at distance from track	68	dBV re 1 micro in/sec
Adjustment Factors FTA Table 10-1			
	Speed reference 50 mph	-4	Speed Limit of 50 km/h (31 mph)
	Vehicle Parameters	0	Assume Soft primary suspension, Wheels 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	64	0.040
	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	57.84783	dBV or 0.020 mm/s
	Noise Level in dBA	22.84783	dBA

Table 6-11 Source Adjustment Factors for Generalized Predictions of GB Vibration and Noise

Source Factor	Adjustment to Propagation Curve			Comment
		Reference Speed		
Speed	Vehicle Speed	50 mph	30 mph	Vibration level is approximately proportional to $20\log(speed/speed_{ref})$, see Eq. 6-4.
	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.
Track Conditions (not additive, apply greatest value only)				
Worn or Corrugated Track	+10 dB			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. If there are adjustments for vehicle parameters and the track is worn or corrugated, only include one adjustment.
Special Trackwork within 200 ft	+10 dB (within 100 ft) +5 dB (between 100 and 200 ft)			Wheel impacts at special trackwork will greatly increase vibration levels. The increase will be less at greater distances from the track. Do not include an adjustment for special trackwork more than 200 ft away.
Jointed Track	+5 dB			Jointed track can cause higher vibration levels than welded track.
Uneven Road Surfaces	+5 dB			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.

*Mill scale on a new rail is a slightly corrugated condition caused by certain steel mill techniques.

Table 6-12 Path Adjustment Factors for Generalized Predictions of GB Vibration and Noise

Path Factor	Adjustment to Propagation Curve		Comment
Resiliently Supported Ties (Low-Vibration Track, LVT)	-10 dB		Resiliently supported tie systems have been found to provide very effective control of low-frequency vibration.
Track Structure (not additive, apply greatest value only)			
Type of Transit Structure	Relative to at-grade tie & ballast:		In general, 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.
	Elevated structure	-10 dB	
	Open cut	0 dB	
	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.	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.
	50 ft	+2 dB	
	100 ft	+4 dB	
	150 ft	+6 dB	
	200 ft	+9 dB	
Coupling to building foundation	Wood-Frame Houses	-5 dB	In general, the heavier the building construction, the greater the coupling loss.
	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	

APPENDIX D

Proximity Assessment:

Report PG7354-LET.01 dated December 9, 2024

Consulting Engineers
9 Auriga Drive
Ottawa, Ontario
K2E 7S8
Tel: (613) 226-7381

Geotechnical Engineering
Environmental Engineering
Hydrogeology
Materials Testing
Building Science
Noise and Vibration Studies

patersongroup.ca

December 9, 2024
File: PG7354-LET.01

Fotenn
420 O'Connor Street
Ottawa, Ontario
K2P 1W4

Attention: **Thomas Freeman**

Subject: **Proximity Assessment**
Proposed Residential Development
75 Breezehill Avenue, Ottawa, ON

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 proposed Trillium Line Light Rail project. This letter should be read in conjunction with the Geotechnical Investigation Report (Report No. PG6622-1 Revision 1 dated February 26, 2024 prepared by Paterson Group Inc.).

1.0 Background Information

The proposed development at 75 Breezehill Avenue will consist of two residential buildings. The first building is noted as Building A rising to 30 storeys and Building B rising to 35 storeys. It is further understood that both structures will share a common two-level underground parking structure occupying the majority of the footprint of the subject site. At the time of issuance of this report, it is understood that the subject Trillium Rail Line corridor will be located to the east of the subject site.

The following sections summarize our existing soil information and construction precautions for the proposed development, which may impact the subject alignment of the Trillium Line.

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, temporary shoring design drawings, foundation and subsurface walls/structure design drawings, a Blast Assessment Report and field monitoring program as described in the application conditions.

2.0 Subsurface Conditions

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

- The existing surface grade is at a geodetic elevation of approximately 63 m.
- The overburden thickness is approximately 10 to 14 m.
- Bedrock surface elevation is at an approximate geodetic elevation of 54 to 50 m.
- The bedrock underlying the site consists of a good to excellent quality interbedded shale and limestone of the Verulam Formation.

Rail Line Location

The GeoOttawa Rail Alignment O-Train tool indicates that an approximate setback of 22 m is present between the property line and the proposed Trillium Line. The rail corridor runs parallel to the eastern property boundary. It is understood that the underground parking levels for the proposed buildings will occupy the majority of the subject site, extending to the eastern property boundary. Therefore, an approximate horizontal separation of 22 m is present between the subject alignment of the Trillium Rail Line and the proposed underground parking structure at 75 Breezehill Avenue.

Based on available information the Trillium Rail Line elevation is at an approximate elevation of 58 m along the subject alignment. The founding elevation of the proposed buildings will be at approximate geodetic elevation 56. Therefore, a vertical differential of approximately 2 m is present between the founding levels of the two structures with a horizontal separation of at least 22 m.

3.0 Construction Precautions and Recommendations

Influence of Proposed Residential Development on Rail Corridor

From existing soil information and building design details, the proposed buildings will be founded on a soil bearing surface. Therefore, lateral loads due to the building footings will be transferred directly on the soil well within a conservative 1.5H:1V zone of influence from the outside face of the footing.

Further, in reviewing available information, the proposed development to be located at 75 Breezehill Avenue will not cause additional loading on the subject alignment of the Trillium Line.

Excavation and Temporary Shoring

The overburden along the perimeter of the proposed buildings' footprints will need to be temporarily shored with a solder pile and lagging system in order to complete the construction of the underground parking structure.

Bedrock removal is not anticipated, but if required, would 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 should be noted that the temporary shoring system will be designed for at-rest earth pressures as per geotechnical design recommendations outlined in the Geotechnical Investigation (Report No. PG6622 Revision 1 dated February 26, 2024, prepared by Paterson Group).

A seismograph is recommended to be installed either adjacent to or within the Trillium Line corridor as part of the Vibration Monitoring and Control Program to monitor vibrations during the excavation. A vibration monitoring program detailing trigger levels and action levels will be detailed by Paterson. The monitoring program will be required for the full construction duration for blasting operations, dewatering, backfilling and compaction, construction traffic and other construction activities.

Pre-Construction Survey

A pre-construction survey will be required for the rail corridor structure. Any existing structures in the immediate area of the proposed buildings will also undergo a pre-construction survey as per standard construction practices, where bedrock blasting is required.

Groundwater Control

Groundwater observations during the geotechnical investigation indicated groundwater levels 4 to 5 m below the existing ground surface. Further, due to the 22 m distance between the proposed development and Trillium Line, any dewatering during the excavation will not impact the Trillium Line.

Corridor Waterproofing System

Due to the separation between the proposed buildings at 75 Breezehill Avenue and the subject alignment of the Trillium Line, it is anticipated that the replacement or repair of the waterproofing systems for the corridor structure will not be required during construction.

4.0 Conclusions and Recommendations

Based on the currently available information for the subject alignment of the proposed buildings and the existing soil information, the proposed buildings will not negatively impact the proposed rail alignment.

It should be noted that the information submitted as part of the current Proximity Study will be supplemented with construction plans issued for construction, structural drawings, temporary shoring design drawings, foundation and subsurface walls/structure design drawings, a Blast Assessment Report and field monitoring program as described in the application conditions.

We trust that this information meets your immediate request.

Best Regards,

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
Dec. 9, 2024
S. S. DENNIS
100519516
PROVINCE OF ONTARIO

Otillia McLaughlin, B.Eng.

Scott S. Dennis, P.Eng.