Geotechnical Investigation
Proposed Residential Development
2430 St. Paul Avenue, Niagara Falls, Ontario

Project No.:
NT23181

Submitted To:
TriLend
8830 Jane Street
Vaughn, Ontario
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c/o ACK Architects STUDIO Inc.

Attention:
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1.0 INTRODUCTION

This report presents the results of the geotechnical investigation carried out at 2430 St. Paul Avenue, Niagara Falls, Ontario. The investigation was authorized by Mr. Bryce Coates on behalf of TriLend.

It is understood that the proposed project would consist of a residential development that includes the construction of two condominium buildings (15-storey and 19-storey) with a total of 295 units. It is understood that the slope of the site will be utilized to add units below the first floor and provide access to the adjacent Eagle Valley Golf Club. Also proposed are two (2) levels of underground parking, along with new asphaltic concrete paved parking areas and underground utility installations. The grade elevation has been established at 192.00 m. The P2 parking floor elevations has been proposed at about 180.00± m.

The purpose of this investigation was to determine the subsurface soil and groundwater conditions at the site by advancing sixteen (16) boreholes and based on an assessment of the factual borehole data, provide an engineering report containing design and construction recommendations of foundations, the excavation conditions and groundwater control, backfilling recommendations, and related earthworks from a geotechnical point-of-view.

A Vibration Zone of Influence Study and Vibration Monitoring Plan in connection with the proposed development was prepared by RWH Engineering Inc. and presented in Appendix D following the text of this report.

This report is based on the above summarised project description, and on the assumption that the design and construction will be performed in accordance with applicable codes and standards. Any significant deviations from the proposed project design may void the recommendations given in this report. If significant changes are made to the proposed design, then this office must be consulted to review the new design with respect to the results of this investigation.

2.0 FIELD WORK

A total of sixteen (16) sampled boreholes were advanced at the locations illustrated in the attached Drawing No. 1, Borehole Location Plan. All boreholes were advanced using a track-mounted drilling rig implementing hollow stem continuous flight auger and rock core equipment on October 11 to 18, 2023.

The field work was carried out under the direction and supervision of a staff member of NTIL, who logged the boreholes in the field, observed the subsurface sampling, and monitored the groundwater conditions. Borehole Nos. 1 to 16 were advanced to depths between 4.4 and 16.4 m below ground surface. On completion of drilling, all boreholes were backfilled in general accordance with Ontario Regulation 903.

Representative samples of the subsoils were recovered from the borings at selected depth intervals using split barrel sampling equipment driven in accordance with ASTM Specification D1586. Rock core drilling and sampling of rock for site exploration was performed in accordance with ASTM Specification D2113. After undergoing a general field examination, the soil and rock samples were preserved and transported to the soil laboratory. Details of the conditions encountered in the boreholes, together with the results of the field and laboratory tests, are presented in Borehole Log Nos. 1 to 16, Appendix A, inclusive following the text of this report.

In addition, three (3) monitoring wells were installed at Borehole Nos. 1, 7 and 16 to determine the depth/elevation of the stabilized static water level and support the dewatering procedures that may be required during the construction.

The location and ground surface elevation of the boreholes were surveyed by representatives of NTIL for the purpose of this report. The ground surface elevations were referenced to a temporary benchmark (TBM) which is shown on Drawing No. 1, Appendix A, and described as the top of manhole MH1 SAN, with Elevation 181.55 m, as per Site Plan, 2334 St. Paul Development, Drawing SP1, Dated November 30, 2022, prepared by ACK Architects Studio Inc.

3.0 LABORATORY TESING

Soil samples obtained from the in-situ tests were examined in the field and subsequently brought to our laboratory for visual, tactile, and olfactory classifications to confirm field classification. Moisture content determination of all retrieved samples occurred.

The bedrock cores were preserved in wax-coated cardboard boxes and returned to the soil laboratory for examination, where three (3) unconfined compressive strength tests were conducted on select samples. A summary of the Unconfined Compressive Strength test results is presented on **Section 5.6 Bedrock**.

In addition, two (2) grain size distribution analysis tests were carried out on representative soil samples to establish the physical and engineering properties. Grain Size Distribution test results are presented on Figures No. 1 and 2, in Appendix B.

4.0 EXISTING SITE CONDITIONS

The subject site is located at northeast corner of St. Paul Avenue and Mountain Road in Niagara Falls, Ontario. For descriptive purposes in this report St. Paul Avenue has been assigned a north to south alignment. The site is bounded by St. Paul Avenue to the west, Mountain Road to the south, and the Eagle Valley Golf Club to the north and east.

It is noted that the site presents earthmoving works from previous development. The southern edge presents soil cuts, whilst the rest of the site presents an embarkment covered with a granular base surface layer.

5.0 SUBSURFACE CONDITIONS

5.1 General

The detailed subsurface conditions encountered in the sixteen (16) boreholes advanced as part of this geotechnical investigation are shown on the Borehole Log Sheets, Appendix A, inclusive. The borehole locations are indicated on the Borehole Location Plan, Drawing No. 1.

The stratigraphic boundaries shown on the borehole logs are inferred from non-continuous sampling conducted during advancement of the borehole drilling procedures and, therefore, represent transitions between soil types rather than exact planes of geologic change. The subsurface conditions will vary between and beyond the borehole locations.

5.2 Topsoil and Granular Base

Topsoil was encountered at the ground surface at Borehole Nos. 1, 3, 4, 7, 10, 11, 13, 14, 15 and 16 with measured thicknesses between 25 and 100 mm.

Granular base was encountered at ground surface at Borehole Nos. 2, 5, 6, 8, 9 and 12 with measured granular base thicknesses between 750 and 900 mm.

5.3 Fill Materials

Fill materials were encountered below the topsoil and granular base consisting of varying percentage of clay, silt, and sand. Fill materials were found at all borehole locations, except for Borehole Nos. 15 and 16, extending to depths between 0.7 and 5.6 m below ground surface. The fill materials at Borehole Nos. 2, to 6, 8, 9, 11, 12 and 13 comprised silty clay/clayey silt with trace of sand and gravel, containing occasional organic matter, rootlets, brick, and asphalt fragments. The fill materials at Borehole Nos. 1, 7, 10 and 14 contained mainly silty sand with trace of clay and gravel, containing occasional organic matter, rootlets, and wood fragments.

The SPT “N”-values measured within the fill materials ranged from 3 to 37 blows per 300 mm of penetration. Natural moisture contents were measured between 3 and 21%, indicating a damp to moist moisture condition.

5.4 Fine Granular Deposits

The fill materials were underlain by fine granular deposits, extending to borehole depths between 4.4 and 13.0 m below ground surface. Borehole Nos. 1, 2, 4, 5, 6, 8, 9, 10, 14 and 15 were terminated upon auger/split spoon refusal on encountered bedrock. Borehole No. 14 was terminated on inferred cobbles/boulders.

The fine granular deposits were mainly comprised of fine to medium sand with varying percentages of silt (from trace of silt to silty deposits), and trace of clay. Medium to coarse grained sand was observed with depth at Borehole Nos. 1, 3, 4, 5, 10, 15 and 16.

The SPT “N”-values measured within the sandy silt ranged from 3 to greater than 100 blow per 300 mm

of penetration, indicating a very loose to very dense compactness condition. Natural moisture contents were measured between 3 and 32%, indicating a damp to saturated moisture condition.

Two (2) grain size analyses were conducted on select samples of the stratum as summarized in the table below. The results of this testing are included in Appendix B.

Borehole and Sample No.	Sample Depth (m)	Soil Fractions (%)			
		Gravel	Sand	Silt	Clay
BH-3 SS-3	1.50 – 2.15	5.2	74.1	16.6	4.1
BH-9 SS-7	6.10 – 6.70	0	84.4	13.0	2.6

5.5 Silty Clay / Clayey Silt

Locally at Borehole No. 15, the topsoil was underlain by a native deposit of silty clay / clayey silt extending to a depth of 2.2 m below existing grade.

The silty clay / clayey silt generally contained some sand to sandy deposits, with trace of gravel, containing occasional to frequent sand/silt seams/lenses.

The SPT "N"-values measured within the cohesive deposit ranged from 8 to 15 blows per 300 mm of penetration. Undrained shear strength measured on slightly disturbed SPT samples using a pocket penetrometer were about 175 kPa. Based on the above test results, the silty clay / clayey silt deposit is considered to have a stiff to very stiff consistency. Natural moisture contents were measured between 12 and 15%, and the plasticity was generally observed to range from dryer than plastic limit (DTPL) to about plastic limit (APL).

5.6 Bedrock

Auger/split spoon refusal on inferred bedrock was encountered at depths between 5.6 and 13.0 meters below the existing ground surface at Borehole Nos. 1 through 10, 15 and 16. Boreholes were advanced to maximum exploration depths between 3.4 and 3.5 meters below bedrock surface, into the underlying bedrock using diamond coring techniques at Borehole Nos. 3, 7 and 16. The bedrock was found to consist of grey Cherty Limestone of the Bois Blanc Formation. The bedrock is generally described as strong rock; however, the upper levels tend to be occasional to highly fractured (Appendix C, Rock Core Photographs).

A summary of the recovery, rock quality designation, and unconfined compressive strength testing of the rock cores are presented in the tables below for each borehole location.

Borehole No. 3	**Run 1 [5.64 – 6.00 mbgs]**	**Run 2 [6.00 – 7.47 mbgs]**	**Run 3 [7.47 – 9.02 mbgs]**
Recovery	59 %	100 %	100 %
RQD*	88 % [Good]	100 % [Excellent]	100 % [Excellent]
Unconfined Compressive Strength Test	N/A	Sample 1 [6.00 – 6.20 mbgs] 109.61 MPa	N/A

*Rock Quality Designation: Very Poor [0-25%], Poor [25-50%], Fair [50-75%], Good [75-90%], Excellent [90-100%]

Borehole No. 7	**Run 1 [6.55 – 7.54 mbgs]**	**Run 2 [7.54 – 9.17 mbgs]**	**Run 3 [9.17 – 10.09 mbgs]**
Recovery	100 %	100 %	100 %
RQD*	90 % [Good]	100 % [Excellent]	100 % [Excellent]
Unconfined Compressive Strength Test	Sample 1 [6.80 – 7.03 mbgs] 79.89 MPa	N/A	N/A

*Rock Quality Designation: Very Poor [0-25%], Poor [25-50%], Fair [50-75%], Good [75-90%], Excellent [90-100%]

Borehole No. 16	**Run 1 [12.95 – 14.03 mbgs]**	**Run 2 [14.03 – 15.51 mbgs]**	**Run 3 [15.51 – 16.42 mbgs]**
Recovery	100 %	100 %	100 %
RQD*	39 % [Poor]	98 % [Excellent]	100 % [Excellent]
Unconfined Compressive Strength Test	Sample 1 [13.84 – 14.03 mbgs] 108.28 MPa	N/A	N/A

*Rock Quality Designation: Very Poor [0-25%], Poor [25-50%], Fair [50-75%], Good [75-90%], Excellent [90-100%]

5.7 Groundwater

Groundwater conditions were monitored during and following completion of borehole sampling. However, groundwater levels are not anticipated to have stabilized during the short term of the investigation. Monitoring wells were installed in Borehole Nos. 1, 7 and 16, inclusive.

The table below summarizes the stabilized static water level readings in the monitoring wells.

Borehole No.	Ground Surface Elevation (m)	Date	Water Level Below Existing Ground Surface (m)	Water Level Elevation (m)
1	178.44	November 16, 2023	2.85	175.59
		January 11, 2024	2.81	175.63
7	179.57	November 16, 2023	1.31	178.26
		January 11, 2024	1.19	178.38
16	184.73	November 16, 2023	7.26	177.47
		January 11, 2024	7.22	177.51

Based on the measured groundwater levels in monitoring wells, borehole drilling/sampling observations and the laboratory moisture contents test results, the groundwater table at the site exists at depths between 1.2± and 7.3± m below existing grades, corresponding to elevations between 175.6± and 178.4± m.

Seasonal variations in the water table should be anticipated, with higher levels occurring during wet weather conditions (i.e., spring thaw and late fall) and lower levels occurring during dry weather.

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 General

It is understood that the proposed development would consist of a residential development that includes the construction of two condominium buildings (15-storey and 19-storey) with a total of 295 units. It is understood that the slope of the site will be utilized to add units below the first floor and provide access to the adjacent Eagle Valley Golf Club. Also proposed are two (2) levels of underground parking, along with new asphaltic concrete paved parking areas and underground utility installations. The grade elevation has been established at 192.00 m. The P2 parking floor elevations has been proposed at about 180.00± m.

In general, the surficial topsoil, granular base and fill materials extended to depths between 0.1 and 5.6 m below ground surface and were underlain by very loose to very dense fine granular deposit which extended to depths between 4.4 and 13.0 m below ground surface. The fine granular deposit was underlain by Cherty Limestone bedrock which extended to maximum depths of exploration.

Based on the measured groundwater levels in monitoring wells, borehole drilling/sampling observations and the laboratory moisture contents test results, the groundwater table at the site exists at depths between 1.2± and 7.3± m below existing grades, corresponding to elevations between 175.6± and 178.4± m. The observed groundwater table will fluctuate seasonally and in response to major weather events.

6.2 Pile Foundations

The existing topsoil and fill materials are not considered suitable for supporting the building foundations and floor slab of the proposed 15 and 19-storey buildings, in their present condition. The proposed buildings may be supported on grouted Micropiles advanced into the Cherty Limestone bedrock. The Ultimate Limit State [ULS] Micropile capacities are typically 3,660 kN [compression] and 2,440 kN [tension] for a 209-millimetre diameter Micropile. The capacities are a function of the Micropile diameter, bond length, bar diameter and bar capacity. The contractor would undertake load testing to confirm the supplied bearing capacities on test piles, these test piles are to be sacrificial and thus not permitted to be used as part of the building foundation, and these test piles are to be located within the building footprint. Micropile foundation schemes are proprietary in nature and are commonly pursued as a design-build arrangement with a specialty contractor. It is recommended that an experienced contractor be consulted to comment on this foundation option.

Alternatively, driven piles may also be considered to transfer the building loads into the underlying bedrock level. The proposed buildings could be supported on closed end concrete filled steel pipe piles driven to practical refusal onto the underlying bedrock. The driven piles would be designed to sustain the driving forces compatible with the load carrying capacities required. Typically, the 'working' bearing capacity [SLS] of 300-millimetre nominal diameter pipe piles of sufficient wall thickness driven with a pile driver of sufficient output energy is on the order of 1350 kN [~150 tons]. It is noted that piles driven to refusal will develop their capacity very quickly when the bedrock is reached and therefore it is important that the piles are not over-stressed during pile driving as structural damage to the piles can occur as a result of over-driving. Pre-augering may be required for the steel pipe piles to assist in the driving operation of the piles.

Another alternative would be the use of steel H-section piles [HP310 x 1100] to support the building loads. These H-sections typically have a working' [SLS] bearing capacity of 1,600 kN. Nevertheless, the vibrations associated with the installation of driven pile foundations may be of concern to adjacent structures.

6.3 Caissons

Alternatively, a drilled caisson foundation would allow for the transfer of the building loads to "non-yielding" bedrock capable of bearing the loads without excessive settlement.

Assuming that the advancement of the caissons can be lined to bedrock, for preliminary design purposes, the caisson can be designed for end bearing with a factored geotechnical resistance at ULS of 8000 kPa. The caissons would need to be advanced pass the weathered bedrock and into fresh rock. Since the bedrock is a "non-yielding" material, The ULS governs the foundation design.

Even with the use of liners, there is a possibility that groundwater could infiltrate from fissures and joints in the rock (and if not adequately sealed coarse granular soil under hydrostatic pressure from above the bedrock). If a liner is used, it may not be practical to remove the liner prior to pouring concrete, the contractor should maintain a positive head of concrete in the liner while it is being removed to avoid the intrusion of loose materials (known as 'necking') into the caisson, due to cave from the side walls. The fine granular and silty clay/clayey silt deposits above the bedrock may make it difficult for the contractor to 'seal' the liner to allow for dewatering of the caissons, if water is encountered. In the even that is it not possible to fully dewater the open caissons, the concrete should be pumped to the bottom with the use of a tremie pipe. It is recommended that an experienced contractor be consulted to comment on this foundation option.

6.4 Engineered Fill and Footing Foundations for Areas Outside of Towers Deep Foundations

Foundations constructed to support the underground parking lot may be designed implementing Engineered Fill and Footing Foundations. A construction joint between portions of the building constructed on spread footings and deep foundations will be required to accommodate the differential settlement between the two different foundation types. Significantly loaded footings should have a minimum width of 1.0 metre, with the design bearing value reducing linearly with depth such that a theoretical footing of zero width has zero design bearing capacity. For the foundations cast on the fine granular material we would recommend the placement of a thin concrete 'mud' slab over the footing beds once evaluated. This will protect the footing beds from disturbance and provide a clean working surface for the placement of formwork and reinforcing steel.

It is recommended to remove poor condition soils and construct engineered fill in foundation area and areas to be raised in order to suitably support the future underground parking lot foundations, floor slabs, and adjacent pavement areas.

Imported sand and gravel containing less than 8% silt sized particles can be used to construct the engineered fill under controlled and supervised conditions. The moisture content of the soil is required to be within 3% dry of its optimum moisture condition to achieve the specified degree of compaction. The excavated fill materials contain organic matter and, therefore are not suitable to be reused for engineered fill construction.

Engineered fill is to be constructed in accordance with the following procedures in order to support the future foundations and floor slabs, if adopted:

1. All existing topsoil, pavement structure, fill materials, buried topsoil and otherwise deleterious materials (including organic material) are to be excavated/removed to expose the underlying competent native subgrade.

2. The exposed subgrade surface is to be thoroughly recompacted by large heavy compaction equipment (10 tonne recommended) and inspected by qualified geotechnical personnel. Any loose or soft areas identified should be excavated to the level of competent soil.

3. If wet/saturated subgrade condition is encountered, the initial lift to raise the grade will require coarse pit run sand and gravel, 450 to 600 mm thick and be statically rolled in order to stabilize and "bridge" the prepared subgrade.

4. The required grades can then be achieved by placing imported sand and gravel (OPSS Granular B Type I) in maximum 300 mm thick lifts and compacted to no less that 100% Standard Proctor maximum dry density (SPMDD) to the underside of the proposed footings and to at least 95% SPMDD for floor slab support. The moisture content of the soil requires to be within 3% dry of its optimum moisture condition to achieve the specified degree of compaction.

5. Engineered fill must be placed such that the fill pad extends horizontally outwards from all footings/foundation at least the same distance as to how thick the engineered fill pad will exist between the underside of future footings and the approved native subgrade; and

6. All fill placement and compaction operations must be supervised on a full-time basis by qualified geotechnical personnel to approve fill material and ensure the specified degree of compaction has been achieved.

Footings cast on approved engineered fill can be designed using a Geotechnical Reaction of 150 kPa at SLS and a Factored Geotechnical Resistance of 225 kPa at ULS.

Vibration could be generated from various construction equipment, such as compactors and rollers which could be harmful to potential surrounding structures and buildings during construction. Peak particle velocity (PPV) of ground motion is widely accepted as the best descriptor of potential for vibration damage to structures. The safe vibration limit can be set to 10 to 20 mm/s PPV, depending on the sensitivity of any potential surrounding structures to vibration.

Vibration monitoring can be carried out to measure the PPV of ground motion from vibration generated from typical compaction equipment at the beginning of the project in the potentially critical areas. This will set criteria and establish the type of equipment to be used for this project.

A Vibration Zone of Influence Study and Vibration Monitoring Plan in connection with the proposed development was prepared by RWH Engineering Inc. and presented in Appendix D following the text of this report.

It is noted that the support conditions afforded by the founding soils are not typically uniform across the site, nor are the loads on the various foundation elements. In this regard it is recommended that all footings and foundation walls be provided with nominal steel reinforcement. Such nominal reinforcement would typically consist of two continuous 15M bars in the footings and a similar two 15M bars approximately 300 millimetres from the top of the foundation walls. The reinforcing bars should be bent to reinforce around corners and window openings, provided with sufficient overlap and tied at splice locations. The provision of such nominal reinforcing steel is considered good practice as it will work to limit any cracking of foundation walls, reducing the potential need for costly post construction repairs. The reinforcement will also aid the foundation walls in resisting the lateral forces associated with the often early backfill typical in commercial construction.

All footings exposed to the environment must be provided with a minimum of 1.2 metres of earth cover or equivalent insulation to protect against frost penetration. This frost protection would also be required if construction were undertaken during the winter months.

It is imperative that a soils engineer be retained from this office to provide geotechnical engineering services during the excavation and foundation construction phases of the project. This is to observe compliance with the design concepts and recommendations of this geotechnical investigation report, and to allow changes to be made in the event that subsurface conditions differ from the conditions identified at the borehole locations.

6.5 Helical Piles

Helical piles can also be selected as an alternative foundation support for the underground parking areas and be used in the areas where fill materials and deep organic soils were encountered since they can transfer the structural loads through the existing soft/loose soils to the underlying competent soil stratum/bed rock.

Helical piles typically comprise either steel solid square shafts or hollow round shafts with one or more helices attached at the bottom, which are installed using torque energy via conventional hydraulic equipment. The capacity of installed helical piles is established by monitoring the torque during installation. The required torque is determined based on load testing on various soil condition and types, as it has been shown that the axial capacity is directly related to the torque.

For this site, helical piles founded on bedrock located about 5.6 to 13.0 m below existing grades can be used to provide support for the proposed underground parking structure. Recommendations on helical pile type, size, bearing capacities and service loads can be provided by NTIL after additional boreholes are advanced to confirm the subsurface soil condition across the site.

Helical pile foundations schemes are proprietary in nature and are commonly pursued as a design-build arrangement with a specialty contractor. It is recommended that an experienced contractor be consulted to comment on this foundation option. The use of helical piles would negate the necessity of the need to remove large volumes of fill material/soil off site.

6.6 Excavation and Groundwater Control

It is anticipated that the excavations for the proposed residential development will extend to depths between 0.7 and 5.6 metres below the present grade to remove poor conditions fill materials. All excavations must comply with the current Occupations Health and Safety Act and Regulations for Construction Projects. Excavations slopes steeper than those required in the Safety Act must be supported or a trench box must be provided, and a senior Geotechnical Engineer from this office should supervise the work.

Water seepage through surface runoff should be anticipated. Any water that may seep into the excavations could be removed using conventional construction 'dewatering' techniques, such as pumping from sumps and ditches. More water should be expected when connections are made with existing services. Surface water should be directed away from the excavations.

Based on the monitoring well measurement records, the groundwater table at the site lies at depths between 1.2± and 7.3± m below existing grades, corresponding to elevations between 175.6± and 178.4± m. Therefore, it is anticipated that the excavation works will be located above the observed groundwater table.

6.7 Floor Slab Construction

The underground parking level floor slabs may be constructed using conventional slab-on-grade techniques on a prepared subgrade. The exposed subgrade surface should then be well compacted in the presence of a representative of Niagara Testing and Inspection Ltd., using a smooth drum compactor. Any soft 'spots' delineated during this work must be sub-excavated and replaced with quality backfill material compacted to 100 percent of its standard Proctor maximum dry density. Imported granular fill is preferred due to its relative insensitivity to weather conditions, its relative ease in achieving the required degree of compaction and its quick response to applied stresses.

As with all concrete floor slabs, there is a tendency for the floor slabs to crack. The slab thickness, concrete mix design, amount of steel and/or fibre reinforcement and/or wire mesh placed into the concrete slab, if any, will there be a function of the owner's tolerance for cracks in, and movements of, the slabs-on-grade, etc. The 'saw-cuts' in the concrete floors, for crack control, should extend a minimum of 1/3 the thickness of the slab.

A moisture barrier will be required under the floor slabs such as the placement of at least 200 millimetres of well-compacted 20-millimetre clear crushed stone. At a minimum the moisture barrier material should contain no more than 10 percent passing the No. 4 sieve.

Curing of the slab-on-grade must be carefully specified to ensure that slab curl is minimised. This is especially critical during the hot summer months of the year when the surface of the slab tends to dry out quickly while high moisture conditions in the moisture barrier or water trapped on top of any 'poly' sheet at the saw cut joints and cracks, and at the edges of the slabs, maintains the underside of the slab in a moist condition.

It is also important that the concrete mix design provide a limiting water/cement ratio and total cement content, which will mitigate moisture related problems with low permeance floor coverings, such as

debonding of vinyl and ceramic tile. It is equally important that excess free water not be added to the concrete during its placement as this could increase the potential for shrinkage cracking and curling of the slab.

6.8 Earthquake Considerations

In accordance with The Ontario Building Code 2012 (OBC), the proposed structure should be designed to resist earthquake load and effects as per OBC Subsection 4.1.8.

Based on the anticipated condition of the underlying soil condition encountered at the borehole locations, the site can be classified as a Site Class E – Soft Soil as per OBC Table 4.1.8.4.A (Page B4-24). The conducting of site-specific shear wave velocity testing may allow for the site to be classified as a higher Class. The seismic data, from Supplementary Standard SB-1 of the Ontario Building Code, for the City of Niagara Falls are as follows.

City	Sa[0.2]	Sa[0.5]	Sa[1.0]	Sa[2.0]	Sa[5.0]	Sa[10.0]	PGA	PGV
Niagara Falls	0.321	0.157	0.072	0.0320	0.0076	0.0030	0.207	0.121

The structural engineer responsible for the project should review the earthquake loads and effects.

6.9 Backfill Considerations

The majority of the excavated soil will consist of the fill materials and the native fine granular deposits, as encountered in the boreholes and described above. Select portions of the fill materials may be used for backfilling purposes, however, this is best assessed in the field at the time of construction. Unsuitable excavated fill material may be used in non-settlement sensitive areas, such as landscaping areas. The native fine granular materials are generally considered suitable for use as service trench backfill and engineered fill, provided they can be effectively moisture conditions to within 3 percent of standard Proctor optimum moisture content. Some moisture conditioning may be required depending upon the weather conditions at the time of construction.

Cohesive soils are sensitive to moisture and may become difficult to compact when they become ‘wet’. Any ‘wet’ soils should be spread out and allowed to air-dry until considered suitable for compaction or discarded. The on-site soils are considered to be frost susceptible and have the potential to ‘heave’ because of freezing. The on-site soils are not considered to be free-draining and should not be used where this characteristic is required.

It is noted that the use of a free draining granular fill material, such as an Ontario Provincial Standard Specification [OPSS] Granular ‘B’ product, is generally preferred for use a backfill against foundation walls. Such materials are more readily compacted in restricted access areas, are less sensitive to moisture conditions and generally provide more positive support to interior and exterior floor slabs and pavements.

We note that where backfill material is placed near or slightly above its optimum moisture content, the potential for long-term settlements due to the ingress of groundwater and collapse of the fill structure is reduced. It is therefore very important that the placement moisture content of the backfill soils be within

3 percent of its standard Proctor optimum moisture content during placement and compaction to minimise long term subsidence [settlement] of the fill mass. Any imported fill should have its moisture content within 3 percent of its optimum moisture content and meet the necessary environmental guidelines. We would recommend that all sub-excavated areas of the site remediation work be backfilled with a well graded granular product compacted to 100 percent of its standard Proctor density.

The backfilling and compaction operations should be monitored by a representative of Niagara Testing and Inspection Ltd. to monitor uniform compaction of the backfill material to project specification requirements. Service trench and foundation wall backfill should be compacted to a minimum of 98 percent of the material's standard Proctor density. The upper one metre should be compacted to 100 percent. The backfill should be placed in loose lifts not exceeding 300 millimetres and should be compacted with sufficient compaction equipment that will not significantly disturb the native soils below. Close supervision is prudent in areas that are not readily accessible to compaction equipment, for instance near the end of compaction 'runs'. A method should be developed to assess compaction efficiency employing the on-site compaction equipment and backfill materials during construction.

6.10 Lateral Earth Pressure

The unbalanced foundation walls and any other soil retaining structures should be designed to resist the lateral earth pressure acting against these walls. Based on a well-compacted and drained backfill soil, soil retaining structures should be designed to resist the lateral earth pressure acting against these walls. The horizontal pressure 'P', at a depth 'H', may be estimated using the following:

$$P = K (\gamma H + q)$$

where:

P =	Lateral earth pressure	kPa
K =	earth pressure coefficient	
γ =	unit weight	kN/m^3
H =	unbalanced height of wall	m
q =	surcharge load, if present, plus 15 kPa due to heavy compaction equipment	kPa

Suggested material properties and parameters are presented in the table below.

Material	Bulk Unit Weight ($kN/m^{3)}$	Angle of Internal Friction [°]	Active Earth Coefficient [K_a]	Passive Earth Coefficient [K_p]	At Rest Earth Coefficient [K_o]
Granular "A"	22	35	0.27	3.7	0.43
Granular "B" Type I	21	32	0.31	3.3	0.47
Silty Clay Fill	18	25	0.41	2.46	0.58
Native Fine Granular	20	29	0.35	2.88	0.52

*If below groundwater level and no drainage system provided, effective unit weight [$\gamma' = \gamma - \gamma_w$] and hydrostatic pressure should be considered

It is recommended that granular material [i.e., Granular "A" or Granular "B" as per OPSS 1010] be used as a backfill behind foundation walls [if any]. The granular material will facilitate drainage to a perimeter drainage system to reduce hydrostatic pressure acting on the walls [if below groundwater]. Heavy compaction equipment should not be used for wall backfill. Adequate slope of the surface layer should be maintained to drain any runoff away from the building to designated locations [i.e., manholes and catch basins].

6.11 Manholes, Catch Basins, and Thrust Blocks

With the manholes, catch basins, valve chambers, etc. founded on the native fine granular deposits or engineered fill, assuming all founding surfaces are carefully prepared to remove all loose and disturbed material, the bearing surfaces will be practically non-yielding under the anticipated loads. Proper preparation of the founding soils will therefore accentuate the protrusion of these structures above the pavement surface if compaction of the fill around these structures is not adequate, causing settlement of the surrounding paved surfaces. Conversely, the pavement surfaces may rise above the valve chambers under frost action. To alleviate the potential for these types of differential movements, free-draining, non-frost susceptible material should be provided as backfill around the structures located within any paved roadway limits and compacted to 100% of its standard Proctor maximum dry density. A geofabric separator should be provided between the free draining material and the on-site fine-grained soils to prevent intrusion of fines.

The thrust blocks in the native fine granular deposits or engineered fill may be sized as recommended by the applicable Ontario Provincial Standard Specification [OPSS]. A design allowable bearing pressure of 150 kPa [~3000 psf] may conservatively be used in the design of thrust blocks. Any backfill required behind the blocks should be granular and should be compacted to 100% of their standard Proctor density.

7.0 Pavement Considerations

The parking and access driveway areas should be stripped of all unsuitable materials. The exposed subgrade should be proof-rolled with 3 to 4 passes of a loaded tandem truck in the presence of a representative of Niagara Testing and Inspection Ltd., immediately prior to the placement of the sub-base material. Any areas of distress revealed by this, or any other means must be sub-excavated and replaced with suitable backfill material. Alternatively, the soft areas may be repaired by the placement of coarse aggregate, such as 50-millimetre clear crushed stone. The need for sub-excavations of a softened subgrade will be reduced if construction is undertaken during periods of dry weather and careful attention is paid to the compaction operations. The fill placed over shallow utilities cuts into or across the street must also be compacted to 100% of its standard Proctor maximum dry density.

Good drainage provisions will optimise the long-term performance of the pavement structure. The subgrade must be properly crowned and shaped to promote drainage to the subdrain system. Subdrains should be installed to intercept excess subsurface water and to prevent softening of the subgrade material. Surface water should not be allowed to pond adjacent to the outer limits of the paved area.

The most severe loading conditions on the subgrade typically occur during the course of construction, therefore precautionary measures may have to be taken to ensure that the subgrade is not unduly disturbed by construction traffic. These measures would include minimising the amount of heavy traffic travelling over the subgrade, such as during the placement of granular base layers.

If construction is conducted under adverse weather conditions, additional subgrade preparation may be required. During wet weather conditions, such as typically experienced during the Fall and Spring months, it should be anticipated that the additional subgrade preparation would be required, such as the provision of a Granular B sub-base coarse material. It is also important that the sub-base and base coarse granular layers of the pavement structure be placed as soon after exposure and preparation of the subgrade level as practical.

The suggested pavement structures outlined below are based on subgrade parameters estimated based on visual and tactile examinations of the on-site soils and experience. The outlined pavement structure may be expected to have an approximate ten-year life, assuming that regular maintenance is performed. Should a more detailed pavement structure design be required, site specific traffic information would be needed, together with detailed laboratory testing of the subgrade soils.

Pavement Layer	Light Duty Pavement Structure	Heavy Duty Pavement Structure
Asphaltic Concrete [Compaction of 92 % to 96.5 % of MRD*]	HL3-HS – 65 mm	HL3-HS – 40 mm HL8-HS – 65 mm
OPSS Granular Material	350 mm plus of Granular "A" Base to design grade or an inspected subgrade or Granular "A" Base – 150 mm Granular "B" Type II Sub-Base Course – 200 mm	500 mm plus of Granular "A" Base to design grade or an inspected subgrade or Granular "A" Base – 150 mm Granular "B" Type II Sub-Base Course – 350 mm

*MRD: Maximum Relative Density

Depending on the arrangement of light duty and heavy duty pavement sections, the transition between sections may present some difficulty for contractors. In this regard, consideration might be given to a slightly increased light duty pavement structure consisting of 50 millimetres of HL8 binder course and 40 millimetres of HL3 surface course asphaltic concrete. This structure will provide for a continuous depth of surface course asphalt allowing for ease of construction. As well such a structure would have an improved performance over an increased design life. Such an arrangement of asphalt layers would also allow for future rehabilitation with a 'mill and pave' type operation.

This design is considered adequate, provided that the subgrade has been prepared as specified and is good and firm before the sub-base course material is placed. If the subgrade is soft, remedial measures as discussed above may have to be implemented and/or the sub-base thickness may have to be increased. The granular sub-base and base courses and asphaltic concrete layers should be compacted to OPSS or the Town of Dunnville's requirements. A programme of in-place density testing must be carried out to monitor that compaction requirements are being met. If construction is conducted under adverse weather conditions, additional subgrade preparation may be required. We note that this pavement structure is not to be considered as a construction roadway design.

8.0 CLOSURE

The comments provided in this document are intended only for the guidance of the design team. The subsoil descriptions and borehole information are only intended to describe conditions at the sixteen (16) borehole locations. Contractors placing bids of undertaking this project should carry out due diligence in order to verify the results of this investigation and to determine how the subsurface conditions will affect their operations.

We trust that this geotechnical report is sufficient for your present requirements. Should you require any additional information or clarifications as to the contents of this document, then please do not hesitate to contact the undersigned.

Yours very truly,
Niagara Testing and Inspection Ltd.

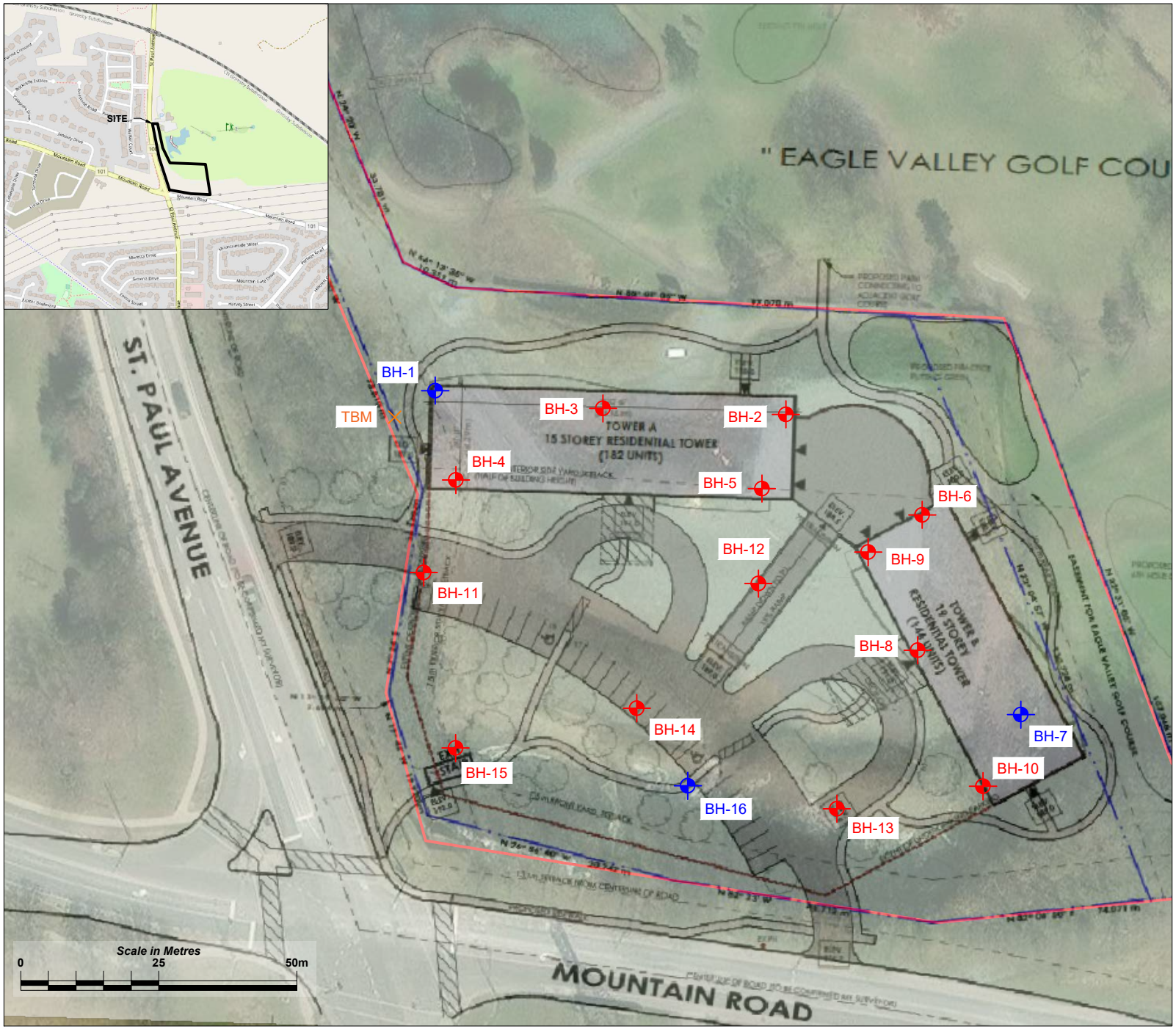
Marcelo Pereira, M.Sc., EIT
Geotechnical Designer

Dwayne Neill, P.Eng.
Project Engineer

Appendix A

Drawings & Borehole Logs

NTiL
NIAGARA TESTING AND INSPECTION LTD.



LEGEND

- Borehole Location
- Borehole with Monitoring Well Location
- Site Boundary
- TBM — Temporary Benchmark
  Top of Manhole MH1 SAN
  Elevation = 181.55 masl (Geodetic)

NTiL
NIAGARA TESTING AND INSPECTION LTD.

CLIENT: **TRILEND**

PROJECT:
GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
2430 ST. PAUL AVENUE, NIAGARA FALLS, ONTARIO

TITLE:
BOREHOLE LOCATION PLAN

DRAWN BY: MP

CHECKED BY: DN

DATE: JANUARY 2024

PROJECT NO: NT23181

SCALE: AS SHOWN

NO:
DRAWING 1

REFERENCE: ACK Architects Studio Inc.; 2334 St. Paul Development; 2334 St, Paul Ave, Niagara Falls, ON L2E 6S4; "Site Plan"; Project No. 2022-187; DWG No. SP1; Dated Nov. 30, 2022.
BASE MAP PROVIDED BY NIAGARA NAVIGATOR, https://maps-beta.niagararegion.ca/Navigator/
NOTE: FOR ILLUSTRATION PURPOSES ONLY, ALL LOCATIONS APPROXIMATE.

Soil Abbreviations and Explanation of Borehole Logs

TERMINOLOGY DESCRIBING COMMON SOIL TYPES:

Topsoil	-	mixture of soil and humus capable of supporting vegetation
Peat	-	mixture of visible and invisible fragments of decayed organic matter
Till	-	unstratified glacial deposit which may range from clay to boulders
Fill	-	soil materials identified as being placed anthropologically

CLASSIFICATION (UNIFIED SYSTEM)

Clay	<0.002mm		
Silt	0.002 to .075mm		
Sand	0.075 to 4.75mm		
		Fine	0.075 to 0.425 mm
		Medium	0.425 to 2.0 mm
		Coarse	2.0 to 4.75 mm
Gravel	4.75 to 75mm		
		Fine	4.75 to 19 mm
		Coarse	19 to 75 mm
Cobbles	75 to 300mm		
Boulders	>300mm		

TERMINOLOGY

Soil Composition	**% by Weight**
"traces"	<10%
"some"(eg. some silt)	10-20%
Adjective (eg. sandy)	20-35%
"and"(eg. sand and gravel)	35-50%

Standard Penetration Resistance (SPT): Standard Penetration Resistance ('N' Values) refers to the number of blows required to advance a standard (ASTM D1586) 51 mm Ø (2 inch) split-spoon sampler by the use of a free falling, 63.5 Kg (140lbs) hammer. The number of blows from the drop weight is recorded for every 15 cm (6 inches). The hammer is dropped from a distance of 0.76m (30 inches) providing 474.5 Joules per blow. When the sampler is driven a total of 45 cm (18 inches) into the soil, the standard penetration index ('N' Value) is the total number of blows for the last 30 cm (12 inches).

Dynamic Cone Penetration Resistance (DCPT): Dynamic Cone Penetration Resistance is similar to a SPT with the 474.5 Joule/blow impulse provided by the free falling hammer where the split-spoon sampler is replaced by a 51 mm Ø, 60˚ conical point and the number of blows is recorded continuously for every 30 cm (12 inches).

COHESIVE SOILS CONSISTENCY

	(kPa)	**(P.S.F.)**	**Nominal 'N' Value**
Very Soft	<12	<250	0-2
Soft	12-25	250-500	2-4
Firm	25-50	500-1000	4-8
Stiff	50-100	1000-2000	8-15
Very Stiff	100-200	2000-4000	15-30
Hard	>200	>4000	>30

RELATIVE DENSITY OF COHESIONLESS SOIL

	'N' Value
Very Loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

MOISTURE CONDITIONS:

Cohesive Soil
DTPL- Drier than plastic limit
APL- About plastic limit
WTPL- Wetter than plastic limit
MWTPL- Much wetter than plastic limit

Cohesionless Soil
Damp
Moist
Wet
Saturated

SAMPLE TYPES AND ADDITIONAL FIELD TESTS

SS	Split Spoon Sample (obtained from SPT)	**GS**	Grab Sample	**PP**	Pocket Penetrometer
		BS	Bulk Sample	**FV**	Field Vane
AS	Auger Sample	**TW**	Thin Wall Sample or Shelby Tube	**DMT**	Flat Plate Dilatometer

LABORATORY TESTS

SG	Specific Gravity	**S**	Sieve Analysis	**W**	Water Content
H	Hydrometer	**P**	Field Permeability	**K**	Lab Permeability
W_p	Plastic Limit	**W_l**	Liquid Limit	**I_p**	Plasticity Index
GSA	Grain Size Analysis	**C**	Consolidation	**UNC**	Unconfined compression

NTiL
NIAGARA TESTING & INSPECTION LTD.

RECORD OF BOREHOLE: BH-1

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654496 E, 4777781 N

SHEET 1 of 1
DATE STARTED: October 18, 2023
DATE COMPLETED: October 18, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	178.4	Ground Surface									
	0.0	**100 mm Topsoil**									
		Silty Sand Fill dark brown to brown trace clay and gravel contains organics occ. clay seams moist loose to compact	SS	1	2,2,6,12			8	12.6		
			SS	2	7,6,4,4			10	5.6		
	177.0										
	1.4	**Fine to Medium Sand** reddish brown some silt to silty trace gravel moist to wet compact	SS	3	2,6,11,16			17			
			SS	4	4,6,7,7			13	20.5		
	175.1		SS	5	4,9,8,7			17	11.3		
	3.4	occ. medium to coarse grained pockets becomes saturated									
			SS	6	3,4,6,8			10	22.9		
			SS	7	2,6,8,10			14	22.3		
	171.1							>100			
	7.3	Auger/Spoon Refusal on Bedrock	SS	8	50/25mm						
		End of Borehole									

Concrete
Steel Casing
Bentonite
Silca Sand
2" Slot 10 Screen

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 2.85 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: N/A

INITIAL WATER LEVEL DATE: November 16, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

Note: This borehole log has been prepared for Geotechnical purposes and does not necessarily contain information suitable for an Environmentall assessment of the subsurface conditions. Borehole details as presented, do not constitute a through understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer.

RECORD OF BOREHOLE: BH-2

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm I.D. Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654559 E, 4777776 N

SHEET 1 of 2
DATE STARTED: October 13, 2023
DATE COMPLETED: October 13, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	181.4	Ground Surface									
	0.0	**900 mm Granular Material** trace sand	GS	1							
	180.5										
	0.9	**Silty Clay / Clayey Silt Fill** brown trace sand and gravel occ. rootlets, organics, brick fragments moist	SS	2	6,6,3,2			9			
			SS	3	2,1,2,2			3	19.0		
			SS	4	0,2,2,3			4	19.5		
			SS	5	2,3,4,6			7	14.8		
	176.7										
	4.7	occ. rootlets and organics contains buried topsoil	SS	6	3,3,4,5			7	16.8	5.3 mbgs	
	175.7										
	5.6	**Fine to Medium Sand** reddish brown trace to some silt, trace gravel saturated compact to very dense	SS	7	4,6,9,7			15	24.0		
							25.0				

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 5.3 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 5.6 m

INITIAL WATER LEVEL DATE: October 13, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

RECORD OF BOREHOLE: BH-2

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm I.D. Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654559 E, 4777776 N

SHEET 2 of 2
DATE STARTED: October 13, 2023
DATE COMPLETED: October 13, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES				DEPTH SCALE ft / m	FIELD TESTING	LAB TESTING	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)		SPT (N) 20 40 60 80; SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40		
			SS	8	2,5,6,7		26.0 / 8.0	11	24.3		
	172.2 / 9.1	becomes gravelly freq. rock fragments occ. silt seams	SS	9	,19,50/125m		30.0 / 9.0	>100	11.5		
	171.8 / 9.6	Spoon / Auger Refural on Bedrock									
		End of Borehole					50.0 / 15.0				

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 5.3 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 5.6 m

INITIAL WATER LEVEL DATE: October 13, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

Note: This borehole log has been prepared for Geotechnical purposes and does not necessarily contain information suitable for an Environmentall assessment of the subsurface conditions. Borehole details as presented, do not constitute a through understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer.

RECORD OF BOREHOLE: BH-3

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm Hollow Stem Auger/Rock Coring
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654539 E, 4777778 N

SHEET 1 of 2
DATE STARTED: October 11, 2023
DATE COMPLETED: October 11, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80; DYNAMIC CONE; SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	177.4	Ground Surface									
	0.0	**50 mm Topsoil**									
		Silty Clay / Clayey Silt Fill brown trace gravel occ. sand seams, rootlets moist	SS	1	3,5,5,5			10	16.4		
	176.7 0.7	**Fine to Medium Sand** reddish brown some silt to silty trace gravel and clay damp to moist very loose to compact	SS	2	7,10,8,5			18	4.1		
			SS	3	2,2,4,3			6 11 7	19.0		**Grain Size Dist.:** **BH-3 SS-3** Gravel - 5.2% Sand - 74.1% Silt - 16.6% Clay - 4.1%
	175.2 2.2	becomes saturated	SS	4	1,2,1,1			5 3 4	23.5		
			SS	5	1,2,1,2			6 3 5	17.7		
								8 51 47			
	172.6 4.7	becomes Medium to Coarse grained	SS	6	2,7,8,45			14 15	12.8		
	171.9 5.5	Freq. gravels									
	171.7 5.6	**Bedrock - Cherty Limestone** **Run 1: 5.64 - 6.00 m**	RC	1							**Rock Quality Designation (RQD)** 0-25% - Very Poor 25-50% - Poor 50-75% - Fair 75-90% - Good 90-100% - Excellent
	171.4	Top 0.1 m gravels									
	6.0	Occasional fracturing Recovery - 59% RQD - 88%									
		Bedrock - Cherty Limestone **Run 2: 6.00 - 7.47 m** Occasional fracturing and voids Recovery - 100% RQD - 100% **Sample 1: 6.00 m - 6.20 m** **Unconfined Compressive Strength** **109.61 MPa**	RC	2							
	169.9 7.5										

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: N/A
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: N/A

INITIAL WATER LEVEL DATE: N/A
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

RECORD OF BOREHOLE: BH-3

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm Hollow Stem Auger/Rock Coring
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654539 E, 4777778 N

SHEET 2 of 2
DATE STARTED: October 11, 2023
DATE COMPLETED: October 11, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES				DEPTH SCALE ft / m	FIELD TESTING	LAB TESTING	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)		SPT (N) 20 40 60 80; DYNAMIC CONE; SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40		
	168.3	**Bedrock - Cherty Limestone** **Run 3: 7.47 - 9.02 m** Recovery - 100% RQD - 100%	RC	3			26.0 (8.0) 27.0 28.0 29.0				
	9.0	End of Borehole					30.0 (9.0) 31.0 32.0 33.0 (10.0) 34.0 35.0 36.0 (11.0) 37.0 38.0 39.0 (12.0) 40.0 41.0 42.0 43.0 (13.0) 44.0 45.0 46.0 (14.0) 47.0 48.0 49.0 (15.0) 50.0				

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: N/A
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: N/A

INITIAL WATER LEVEL DATE: N/A
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

Note: This borehole log has been prepared for Geotechnical purposes and does not necessarily contain information suitable for an Environmentall assessment of the subsurface conditions. Borehole details as presented, do not constitute a through understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer.

RECORD OF BOREHOLE: BH-4

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm I.D. Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654505 E, 4777763 N

SHEET 1 of 2
DATE STARTED: October 11, 2023
DATE COMPLETED: October 11, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	180.7	Ground Surface									
	0.0	**75 mm Topsoil**									
		Silty Clay / Clayey Silt Fill brown to grey trace to some sand trace gravel occ. rootlets, organics contains wood and asphalt fragments moist	SS	1	3,3,4			7	16.3		
			SS	2	4,5,6,7			11	14.9		
			SS	3	3,5,7,11			12	17.7		
	178.5										
	2.1	occ. silt seams	SS	4	4,3,2,3			5	17.3		
	177.8										
	2.9	**Fine to Medium Sand** brown some silt to silty, trace gravel moist compact to very dense	SS	5	3,6,9,21			15	8.2		
	176.3										
	4.4	becomes Medium to Coarse grained occ. rock fragments	SS	6	8,13,12,8			25	5.8		
	175.2									5.5 mbgs	
	5.5	becomes saturated	SS	7	10,50/125m			>100	11.0		
	173.2										
	7.5		SS	8	6,6,8,12			14			

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 5.5 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 5.8 m

INITIAL WATER LEVEL DATE: October 11, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

RECORD OF BOREHOLE: BH-4

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm I.D. Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654505 E, 4777763 N

SHEET 2 of 2
DATE STARTED: October 11, 2023
DATE COMPLETED: October 11, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES				DEPTH SCALE ft / m	FIELD TESTING	LAB TESTING	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)		SPT (N) 20 40 60 80; SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40		
		becomes reddish brown, Fine grained		8	6,6,8,12		26.0 / 8.0				
	171.8						27.0 / 8.0				
							28.0 / 8.0				
							29.0 / 9.0	>100			
	8.8	Auger/Spoon Refusal on Bedrock	SS	9	50/25mm		30.0 / 9.0				
		End of Borehole					31.0 / 9.0				
							32.0 / 10.0				
							33.0 / 10.0				
							34.0 / 10.0				
							35.0 / 10.0				
							36.0 / 11.0				
							37.0 / 11.0				
							38.0 / 11.0				
							39.0 / 12.0				
							40.0 / 12.0				
							41.0 / 12.0				
							42.0 / 13.0				
							43.0 / 13.0				
							44.0 / 13.0				
							45.0 / 13.0				
							46.0 / 14.0				
							47.0 / 14.0				
							48.0 / 14.0				
							49.0 / 15.0				
							50.0				

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 5.5 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 5.8 m

INITIAL WATER LEVEL DATE: October 11, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

Note: This borehole log has been prepared for Geotechnical purposes and does not necessarily contain information suitable for an Environmentall assessment of the subsurface conditions. Borehole details as presented, do not constitute a through understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer.

RECORD OF BOREHOLE: BH-5

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm I.D. Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654552 E, 4777763 N

SHEET 1 of 2
DATE STARTED: October 13, 2023
DATE COMPLETED: October 13, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	181.6	Ground Surface									
	0.0	**750 mm Granular Material** trace sand	GS	1							
	180.8										
	0.8	**Silty Clay / Clayey Silt Fill** brown trace sand and gravel occ. rootlets, organics, brick fragments moist	SS	2	2,4,4,5			8	17.3		
			SS	3	2,2,2,3			4	21.4		
			SS	4	3,5,4,6			9			
			SS	5	3,3,4,4			7	13.8		
	176.8										
	4.7	occ. rock fragments	SS	6	5,7,7,8			14		5.3 mbgs	
	176.3										
	5.3	**Fine to Medium Sand** reddish brown some silt, trace gravel wet to saturated compact	SS	7	9,11,9,9			20	21.3		
			SS	8	3,6,8,10			14	22.7		

ft / m: 0.0 / 0.0; 1.0; 2.0; 3.0 / 1.0; 4.0; 5.0; 6.0 / 2.0; 7.0; 8.0; 9.0; 10.0 / 3.0; 11.0; 12.0; 13.0; 14.0; 15.0 / 4.0; 16.0; 17.0; 18.0; 19.0 / 5.0; 20.0; 21.0; 22.0 / 6.0; 23.0; 24.0; 25.0 / 7.0

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 5.3 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 5.6 m

INITIAL WATER LEVEL DATE: October 13, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

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RECORD OF BOREHOLE: BH-5

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm I.D. Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654552 E, 4777763 N

SHEET 2 of 2
DATE STARTED: October 13, 2023
DATE COMPLETED: October 13, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES				DEPTH SCALE ft / m	FIELD TESTING	LAB TESTING	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)		SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40		
			SS	9	2,5,6,8		26.0 / 8.0	11	23.5		
							27.0				
							28.0				
							29.0 / 9.0				
	172.3 / 9.3	becomes Medium to Coarse grained					30.0				
		freq. sandy silt pockets	SS	10	6,7,6,7		31.0	13	14.9		
							32.0				
	171.7 / 9.9	Auger Refural on Bedrock					33.0 / 10.0				
		End of Borehole					34.0				
							35.0				
							36.0 / 11.0				
							37.0				
							38.0				
							39.0 / 12.0				
							40.0				
							41.0				
							42.0 / 13.0				
							43.0				
							44.0				
							45.0				
							46.0 / 14.0				
							47.0				
							48.0				
							49.0 / 15.0				
							50.0				

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 5.3 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 5.6 m

INITIAL WATER LEVEL DATE: October 13, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

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RECORD OF BOREHOLE: BH-6

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm I.D. Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654582 E, 4777764 N

SHEET 1 of 2
DATE STARTED: October 18, 2023
DATE COMPLETED: October 18, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	181.4	Ground Surface									
	0.0	**750 mm Granular Material** trace sand	GS	1							
	180.6										
	0.8	**Silty Clay / Clayey Silt Fill** brown trace sand and gravel occ. rootlets, organics occ. sand seams/lenses moist	SS	2	3,2,3,3			5	15.1		
			SS	3	2,2,2,3			4	16.2		
			SS	4	2,2,1,1			3	15.0		
			SS	5	2,1,2,2			3	15.2		
	177.1										
	4.3	becomes sandy occ. rootlets and organics contains buried topsoil									
	176.7										
	4.7	**Fine to Medium Sand** reddish brown some silt to silty moist to wet compact	SS	6	9,10,14,24			24	14.7	5.5 mbgs	
	175.0		SS	7	4,5,8,8			13	23.8		
	6.4	becomes saturated									

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 5.5 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 6.1 m

INITIAL WATER LEVEL DATE: October 18, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

RECORD OF BOREHOLE: BH-6

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm I.D. Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654582 E, 4777764 N

SHEET 2 of 2
DATE STARTED: October 18, 2023
DATE COMPLETED: October 18, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES				DEPTH SCALE ft / m	FIELD TESTING	LAB TESTING	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)		SPT (N) 20 40 60 80; SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40		
			SS	8	2,5,5,7		26.0 / 8.0	10	17.9		
							27.0				
							28.0				
							29.0				
	172.3 / 9.1	Spoon / Auger Refural on Bedrock					30.0 / 9.0	>100			
		End of Borehole	SS	9	50/25mm						
							31.0				
							32.0				
							33.0 / 10.0				
							34.0				
							35.0				
							36.0 / 11.0				
							37.0				
							38.0				
							39.0 / 12.0				
							40.0				
							41.0				
							42.0				
							43.0 / 13.0				
							44.0				
							45.0				
							46.0 / 14.0				
							47.0				
							48.0				
							49.0 / 15.0				
							50.0				

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 5.5 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 6.1 m

INITIAL WATER LEVEL DATE: October 18, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

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RECORD OF BOREHOLE: BH-7

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm Hollow Stem Auger/Rock Coring
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654599 E, 4777731 N

SHEET 1 of 2
DATE STARTED: October 11, 2023
DATE COMPLETED: October 12, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	178.6 / 0.0	Ground Surface									
		50 mm Topsoil									
		Silty Sand Fill brown trace gravel contains rootlets and wood fragments	SS	1	2,2,2,2			4	11.2		
	177.9 / 0.7	moist									
		Fine to Medium Sand reddish brown some silt to silty trace clay	SS	2	3,6,6,6			12	19.3		
	177.1 / 1.4	moist loose to compact									
		becomes saturated	SS	3	2,3,4,5			7	24.0		
			SS	4	0,3,5,6			8	23.7		
			SS	5	3,4,7,9			11	16.3		
			SS	6	2,5,5,6			10	24.2		
	172.3 / 6.2	freq. silt pockets	SS	7	3,7, 50/125mm			>100	22.5		
	172.0 / 6.6	**Bedrock - Cherty Limestone** ***Run 1:* 6.55 - 7.54 m** Occasional fracturing Recovery - 100% RQD - 90% **Sample 1: 6.80 m - 7.03 m** **Unconfined Compressive Strength** **79.89 MPa**	RC	1							
	171.0 / 7.5										

ft m
0.0 0.0
1.0
2.0
3.0 1.0
4.0
5.0
6.0 2.0
7.0
8.0
9.0
10.0 3.0
11.0
12.0
13.0 4.0
14.0
15.0
16.0 5.0
17.0
18.0
19.0
20.0 6.0
21.0
22.0
23.0 7.0
24.0
25.0

Concrete
Steel Casing
Bentonite
Silca Sand
2" Slot 10 Screen

Rock Quality Designation (RQD)
0-25% - Very Poor
25-50% - Poor
50-75% - Fair
75-90% - Good
90-100% - Excellent

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 1.31 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: N/A

INITIAL WATER LEVEL DATE: November 16, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

RECORD OF BOREHOLE: BH-7

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm Hollow Stem Auger/Rock Coring
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654599 E, 4777731 N

SHEET 2 of 2
DATE STARTED: October 11, 2023
DATE COMPLETED: October 12, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES				DEPTH SCALE ft / m	FIELD TESTING	LAB TESTING	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)		SPT (N) 20 40 60 80; SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	Silica Sand	
	169.4	**Bedrock - Cherty Limestone** **Run 2: 7.54 - 9.17 m** Recovery - 100% RQD - 100%	RC	2			26.0 – 8.0 27.0 28.0 29.0 30.0 – 9.0				
	9.2 168.5	**Bedrock - Cherty Limestone** **Run 3: 9.17 - 10.09 m** Recovery - 100% RQD - 100%	RC	3			31.0 32.0 33.0 – 10.0				
	10.1	End of Borehole					34.0 35.0 36.0 – 11.0 37.0 38.0 39.0 – 12.0 40.0 41.0 42.0 43.0 – 13.0 44.0 45.0 46.0 – 14.0 47.0 48.0 49.0 – 15.0 50.0 51.0 52.0				

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 1.31 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: N/A

INITIAL WATER LEVEL DATE: November 16, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

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RECORD OF BOREHOLE: BH-8

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm I.D. Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654583 E, 4777744 N

SHEET 1 of 2
DATE STARTED: October 18, 2023
DATE COMPLETED: October 18, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	181.6	Ground Surface									
	0.0	**750 mm Granular Material** trace sand	GS	1							
	180.8										
	0.8	**Silty Clay / Clayey Silt Fill** brown trace sand and gravel occ. rootlets, organics moist	SS	2	1,2,3,2			5	19.8		
			SS	3	1,1,2,3			3	18.2		
			SS	4	0,1,2,2			3	19.1		
	178.4										
	3.2	becomes sandy occ. rootlets and organics contains buried asphalt	SS	5	3,10,12,13			22	7.1		
	177.5									4.3 mbgs	
	4.1	**Fine to Medium Sand** reddish brown some silt to silty wet to saturated compact	SS	6	4,6,7,6			13	23.5		
			SS	7	4,5,5,5			10	25.1		

ft m
0.0 0.0
1.0
2.0
3.0 1.0
4.0
5.0
6.0 2.0
7.0
8.0
9.0
10.0 3.0
11.0
12.0
13.0 4.0
14.0
15.0
16.0 5.0
17.0
18.0
19.0
20.0 6.0
21.0
22.0
23.0 7.0
24.0
25.0

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 4.3 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 5.5 m

INITIAL WATER LEVEL DATE: October 18, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

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RECORD OF BOREHOLE: BH-8

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm I.D. Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654583 E, 4777744 N

SHEET 2 of 2
DATE STARTED: October 18, 2023
DATE COMPLETED: October 18, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES				DEPTH SCALE ft / m	FIELD TESTING	LAB TESTING	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)		SPT (N) 20 40 60 80; SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40		
			SS	8	3,5,5,8		26.0 / 8.0	10	24.7		
	172.4 / 9.1	Spoon / Auger Refural on Bedrock	SS	9	50/5mm		30.0 / 9.0	>100			
		End of Borehole					31.0 / 10.0				
							36.0 / 11.0				
							39.0 / 12.0				
							43.0 / 13.0				
							46.0 / 14.0				
							50.0 / 15.0				

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 4.3 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 5.5 m

INITIAL WATER LEVEL DATE: October 18, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

RECORD OF BOREHOLE: BH-9

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm I.D. Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654574 E, 4777757 N

SHEET 1 of 2
DATE STARTED: October 13, 2023
DATE COMPLETED: October 13, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	181.5	Ground Surface									
	0.0	**750 mm Granular Material** trace sand	GS	1							
	180.8										
	0.8	**Silty Clay / Clayey Silt Fill** brown trace sand and gravel occ. rootlets, organics, brick fragments moist	SS	2	4,5,8,8			13	13.2		
			SS	3	3,4,5,6			9	16.8		
			SS	4	2,4,6,8			10	13.9		
	178.2		SS	5	5,6,7,10			13	16.4		
	3.4	becomes sandy									
	176.8	occ. rootlets and organics contains buried topsoil									
	4.7	**Fine to Medium Sand** reddish brown some silt to silty trace clay moist to wet compact	SS	6	6,12,15,14			27	31.7	4.7 mbgs	
	175.9										
	5.6	becomes saturated	SS	7	1,3,8,8			11	13.9		**Grain Size Dist.:** **BH-9 SS-7** Gravel - 0% Sand - 84.4% Silt - 13.0% Clay - 2.6%

ft: 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0

m: 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 4.7 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 4.9 m

INITIAL WATER LEVEL DATE: October 13, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

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RECORD OF BOREHOLE: BH-9

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm I.D. Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654574 E, 4777757 N

SHEET 2 of 2
DATE STARTED: October 13, 2023
DATE COMPLETED: October 13, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES				DEPTH SCALE ft / m	FIELD TESTING	LAB TESTING	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)		SPT (N) 20 40 60 80; SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40		
			SS	8	2,3,5,9		26.0 / 8.0	8	28.5		
	172.7						27.0				
	8.8	Spoon / Auger Refural on Bedrock					28.0				
			SS	9	50/25mm		29.0 / 9.0	>100			
		End of Borehole					30.0				
							31.0				
							32.0				
							33.0 / 10.0				
							34.0				
							35.0				
							36.0 / 11.0				
							37.0				
							38.0				
							39.0 / 12.0				
							40.0				
							41.0				
							42.0				
							43.0 / 13.0				
							44.0				
							45.0				
							46.0 / 14.0				
							47.0				
							48.0				
							49.0 / 15.0				
							50.0				

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 4.7 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 4.9 m

INITIAL WATER LEVEL DATE: October 13, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

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RECORD OF BOREHOLE: BH-10

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654589 E, 4777707 N

SHEET 1 of 2
DATE STARTED: October 17, 2023
DATE COMPLETED: October 17, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	184.2	Ground Surface									
	0.0	**50 mm Topsoil**									
		Silty Sand Fill reddish brown to brown trace sand and gravel contains rootlets, organics and wood fragments occ. to freq. clay seams damp to moist	SS	1	3,3,,4,5			7	11.0		
			SS	2	3,3,4,3			7	6.5		
			SS	3	2,3,4,5			7	12.6		
	182.0										
	2.2	**Fine to Medium Sand** reddish brown trace to some silt and gravel compact damp to moist very loose to compact	SS	4	1,2,2,1			4	9.5		
			SS	5	2,1,1,2			2	7.8		
			SS	6	1,2,2,2			4	6.5		
	177.8		SS	7	6,7,11,10			18	21.0	▽	
	6.4	becomes wet									

ft m
0.0 0.0
1.0
2.0 1.0
3.0
4.0 2.0
5.0
6.0 3.0
7.0
8.0 4.0
9.0
10.0 5.0
11.0
12.0 6.0
13.0
14.0 7.0
15.0
16.0
17.0
18.0
19.0
20.0
21.0
22.0
23.0
24.0
25.0

▽ Groundwater Level Upon Completion:
▽ Secondary Groundwater Level:

INITIAL WATER LEVEL: 6.7 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 6.7 m

INITIAL WATER LEVEL DATE: October 17, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

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RECORD OF BOREHOLE: BH-10

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654589 E, 4777707 N

SHEET 2 of 2
DATE STARTED: October 17, 2023
DATE COMPLETED: October 17, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES				DEPTH SCALE ft / m	FIELD TESTING	LAB TESTING	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)		SPT (N) 20 40 60 80; SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40		
			SS	8	4,7,8,9		26.0 / 8.0	15	24.9		
							27.0				
							28.0				
							29.0 / 9.0				
			SS	9	3,6,7,7		30.0	13	20.0		
							31.0				
							32.0				
							33.0 / 10.0				
							34.0				
							35.0				
			SS	10	3,7,9,13		36.0 / 11.0	16	19.3		
							37.0				
							38.0				
							39.0 / 12.0				
	172.0						40.0				
	12.2	becomes medium to coarse grained contains rock fragments	SS	11	3,10,40, 50/100 mm		41.0	50	15.7		
	171.4						42.0				
	12.8	Spoon / Auger Refusal on Bedrock					43.0 / 13.0				
		End of Borehole					44.0				
							45.0				
							46.0 / 14.0				
							47.0				
							48.0				
							49.0 / 15.0				
							50.0				

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 6.7 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 6.7 m

INITIAL WATER LEVEL DATE: October 17, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

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RECORD OF BOREHOLE: BH-11

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm I.D. Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654501 E, 4777750 N

SHEET 1 of 2
DATE STARTED: October 17, 2023
DATE COMPLETED: October 17, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	182.5	Ground Surface									
	0.0	**75 mm Topsoil**									
		Silty Clay / Clayey Silt Fill brown trace to some sand trace gravel contains rootlets and organics moist	SS	1	3,5,5,5			10	11.7		
			SS	2	3,4,5,6			9	15.3		
			SS	3	7,15,13,17			28	14.5		
			SS	4	6,9,7,6			16	10.8		
	179.5										
	2.9	**Silty Sand Fill** brown trace gravel occ gravel seams, rock fragments contains brick and tie wire fragments dampt to moist	SS	5	4,3,12,26			15	5.7		
			SS	6	9,11,26,23			37	3.1		
	176.8										
	5.6	**Medium to Coarse Sand** brown trace to some gravel trace silt wet to saturated compact to dense	SS	7	9,15,19,14			34	12.8		
							25.0				

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: Dry
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 6.1 m

INITIAL WATER LEVEL DATE: October 17, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

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RECORD OF BOREHOLE: BH-11

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm I.D. Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654501 E, 4777750 N

SHEET 2 of 2
DATE STARTED: October 17, 2023
DATE COMPLETED: October 17, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES				DEPTH SCALE ft / m	FIELD TESTING	LAB TESTING	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)		SPT (N) 20 40 60 80; SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40		
	174.2		SS	8	5,6,13,15		26.0 / 8.0	19	13.5		
	8.2	End of Borehole					27.0 / 8.0				
							28.0 / 9.0				
							29.0 / 9.0				
							30.0 / 9.0				
							31.0 / 9.0				
							32.0 / 10.0				
							33.0 / 10.0				
							34.0 / 10.0				
							35.0 / 10.0				
							36.0 / 11.0				
							37.0 / 11.0				
							38.0 / 11.0				
							39.0 / 12.0				
							40.0 / 12.0				
							41.0 / 12.0				
							42.0 / 13.0				
							43.0 / 13.0				
							44.0 / 13.0				
							45.0 / 13.0				
							46.0 / 14.0				
							47.0 / 14.0				
							48.0 / 14.0				
							49.0 / 15.0				
							50.0				

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: Dry
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 6.1 m

INITIAL WATER LEVEL DATE: October 17, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

RECORD OF BOREHOLE: BH-12

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm I.D. Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654549 E, 4777750 N

SHEET 1 of 1
DATE STARTED: October 17, 2023
DATE COMPLETED: October 17, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES				DEPTH SCALE ft / m	FIELD TESTING	LAB TESTING	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)		SPT (N) 20 40 60 80; SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40		
	181.6	Ground Surface									
	0.0	**750 mm Granular Material** trace sand	GS	1							
	180.8										
	0.8	**Silty Clay / Clayey Silt Fill** brown trace sand and gravel occ. rootlets, organics, wood and brick fragments moist	SS	2	4,5,5,6			10	12.6		
			SS	3	3,4,5,6			9	14.2		
			SS	4	3,4,5,4			9			
			SS	5	2,2,3,5			5	15.7		
	177.5										
	4.1	**Fine to Medium Sand** brown to reddish brown some silt moist to saturated compact	SS	6	5,8,9,11			17	17.0	5.3 mbgs	
	174.9		SS	7	4,6,8,10			14	22.6		
	6.7	End of Borehole									

ft: 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0

m: 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 5.3 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 5.5 m

INITIAL WATER LEVEL DATE: October 17, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

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RECORD OF BOREHOLE: BH-13

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654569 E, 4777707 N

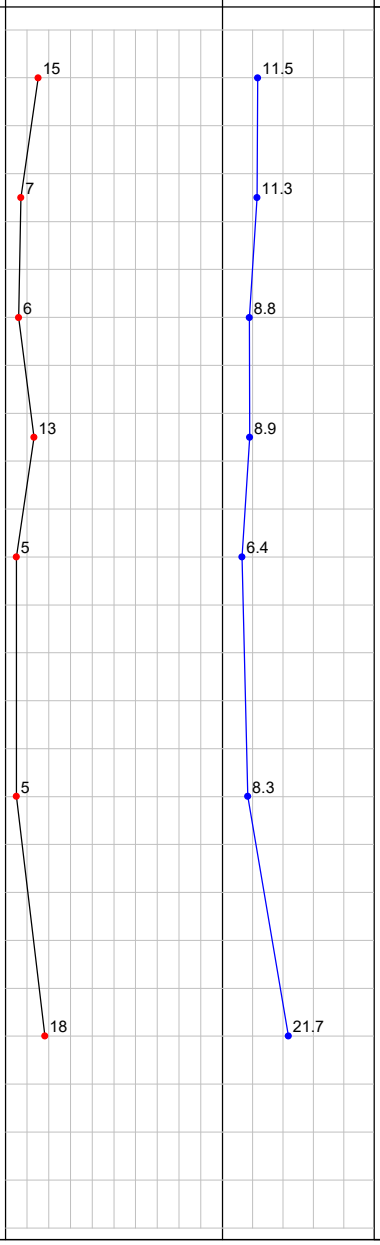
SHEET 1 of 1
DATE STARTED: October 17, 2023
DATE COMPLETED: October 17, 2023
DATUM: Temporary Benckmark

LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)
	184.6	Ground Surface				
	0.0	**25 mm Topsoil**				
		Silty Clay / Clayey Silt Fill brown to reddish brown trace sand and gravel contains rootlets moist	SS	1	2,6,9,4	
	183.6		SS	2	4,4,3,3	
	1.1	**Silty Sand** brown to greyish brown trace gravel damp to moist loose to compact	SS	3	3,4,2,1	
	182.0		SS	4	9,9,4,3	
	2.6	occ. sand/gravel seams/pockets	SS	5	2,2,3,3	
			SS	6	2,3,2,3	
	179.0					
	5.6	becomes wet to saturated	SS	7	5,8,10,10	
	177.9					
	6.7	End of Borehole				

DEPTH SCALE ft / m

FIELD TESTING: SPT (N) 20 40 60 80; SHEAR STRENGTH (kPa) 50 100 150 200

LAB TESTING: MOISTURE CONTENT (%) 10 20 30 40



WELL INSTALLATION

COMMENTS and ADDITIONAL LAB TESTING

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: Dry
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 5.8 m

INITIAL WATER LEVEL DATE: October 17, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

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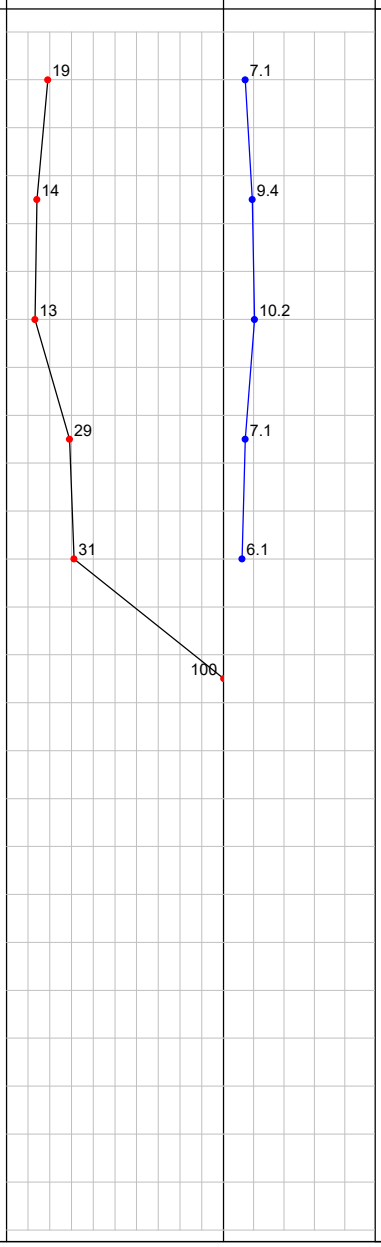
RECORD OF BOREHOLE: BH-14

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654533 E, 4777725 N

SHEET 1 of 1
DATE STARTED: October 17, 2023
DATE COMPLETED: October 17, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	184.6	Ground Surface									
	0.0	**25 mm Granular**									
		Clayey Silt to Silty Sand Fill reddish brown to brown contains rootlets, wood fragments occ. sand/silt/clay seams/pockets damp to moist	SS	1	3,9,10,14						
			SS	2	5,5.9,8						
	182.7		SS	3	5,6,7,7						
	1.8	**Silty Sand** reddish brown trace to some gravel damp to moist dense to very dense freq. gravel pockets, inferred cobbles, boulders and rock fragments	SS	4	8,16,13,17						
			SS	5	8,15,16,47						
			SS	6	10,43, 50/125 mm						
	180.1										
	4.4	Auger Refusal on Inferred Cobbles/Boulders End of Borehole									



Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: Dry
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: Open

INITIAL WATER LEVEL DATE: October 17, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

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RECORD OF BOREHOLE: BH-15

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654504 E, 4777722 N

SHEET 1 of 2
DATE STARTED: October 18, 2023
DATE COMPLETED: October 18, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	184.6	Ground Surface									
	0.0	**50 mm Topsoil**									
		Silty Clay / Clayey Silt brow some sand to sandy, trace gravel occ. to freq. sand/silt seams/lenses stiff to very stiff DTPL to APL	SS	1	3,3,5,6			8 / 175	12.4		
			SS	2	6,6,9,10			15 / 175	14.5		
			SS	3	3,6,7,8			13	15.2		
	182.4										
	2.2	**Silt** reddish brown trace sand and clay moist	SS	4	5,7,10,13			17	17.2		
			SS	5	7,10,8,11			18	15.1		
	180.7										
	4.0	**Fine to Medium Sand** greyish brown some silt to silty, and gravel compact damp to moist occ. clay/sand/gravel seams	SS	6	4,6,7,7			13	5.9		
			SS	7	5,9,10,12			19	11.7	October 18, 2023	

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 7.0 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 8.2 m

INITIAL WATER LEVEL DATE: October 18, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

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RECORD OF BOREHOLE: BH-15

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm Hollow Stem Auger
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654504 E, 4777722 N

SHEET 2 of 2
DATE STARTED: October 18, 2023
DATE COMPLETED: October 18, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	176.7 7.9	occ. clay seams becomes wet to saturated	SS	8	5,7,10,11		26.0 / 8.0	17	12.2		- Spoon dripping - N 'value' affected by hydrostatic pressure
	175.2 9.4	occ. coarse grained pockets	SS	9	2,3,3,4		31.0 / 9.0		23.3		
	174.4 10.2	**Sandy Silt** reddish brown trace to some sand trace gravel dense saturated	SS	10	6,11,30,31		36.0 / 11.0	41	25.6		
	172.1 12.5	Spoo/Auger Refusal on Bedrock End of Borehole	SS	11	36,24, 50/25mm		41.0 / 12.5	>100			
							46.0 / 14.0				
							50.0 / 15.0				

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 7.0 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: 8.2 m

INITIAL WATER LEVEL DATE: October 18, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

RECORD OF BOREHOLE: BH-16

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm Hollow Stem Auger/Rock Coring
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654541 E, 4777712 N

SHEET 1 of 3
DATE STARTED: October 12, 2023
DATE COMPLETED: October 13, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	184.7	Ground Surface									
	0.0	**100 mm Topsoil**									
		Fine to Medium Sand brown to greyish brown trace silt and gravel damp to moist compact to dense	SS	1	4,8,8,7			16	5.3		
			SS	2	4,5,6,7			11	3.4		
			SS	3	5,8,9,9			17	2.5		
			SS	4	3,7,7,11			14	2.5		
			SS	5	6,10,12,15			22	3.2		
			SS	6	6,10,11,10			21	2.7		
	178.3										
	6.4	becomes wet to saturated	SS	7	7,11,11,18			22	14.7		

ft 0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0 21.0 22.0 23.0 24.0 25.0
m 0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0

Concrete
Steel Casing
Bentonite
Silca Sand
2" Slot 10 Screen

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 7.26 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: N/A

INITIAL WATER LEVEL DATE: November 16, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

RECORD OF BOREHOLE: BH-16

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm Hollow Stem Auger/Rock Coring
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654541 E, 4777712 N

SHEET 2 of 3
DATE STARTED: October 12, 2023
DATE COMPLETED: October 13, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES					FIELD TESTING	LAB TESTING		
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)	DEPTH SCALE ft / m	SPT (N) 20 40 60 80 / SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
	175.4						26.0 / 8.0			Silica Sand	
	9.3	becomes Medium to Coarse grained	SS	8	15,16,15,12		27.0	31	15.1		
							28.0				
							29.0 / 9.0				
			SS	9	5,12,11		30.0	23	16.3		
							31.0				
							32.0				
							33.0 / 10.0				
							34.0				
							35.0				
			SS	10	4,7,12,16		36.0 / 11.0	19	16.4		
	173.0						37.0				
	11.7	**Silt** reddish brown trace to some sand dense saturated					38.0				
							39.0 / 12.0				
							40.0				
			SS	11	8,17,20,20		41.0	37	25.4		
	171.8						42.0				
	13.0	**Bedrock - Cherty Limestone** **Run 1: 12.95 - 14.03 m** [12.95 - 13.20 m] Highly fractured Recovery - 100% RQD - 39% **Sample 1: 13.84 m - 14.03 m** **Unconfined Compressive Strength 108.28 MPa**	RC	1			43.0 / 13.0				**Rock Quality Designation (RQD)** 0-25% - Very Poor 25-50% - Poor 50-75% - Fair 75-90% - Good 90-100% - Excellent
							44.0				
	170.7						45.0				
	14.0	**Bedrock - Cherty Limestone** **Run 2: 14.03 - 15.51 m** Occatonal fracturing Recovery - 100% RQD - 98%	RC	2			46.0 / 14.0				
							47.0				
							48.0				
							49.0 / 15.0				
	169.2						50.0				
	15.5						51.0				
							52.0				

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 7.26 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: N/A

INITIAL WATER LEVEL DATE: November 16, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

RECORD OF BOREHOLE: BH-16

PROJECT NO.: NT23181
PROJECT: Proposed Residential Development
LOCATION: 2430 St. Paul Avenue, Niagara Falls, ON
CLIENT: Trilend

DRILLING COMPANY: Davis Drilling Ltd.
DRILLING METHOD: 83 mm Hollow Stem Auger/Rock Coring
DRILL RIG: Track Mount CME-55
BOREHOLE COORDINATE (UTM): 654541 E, 4777712 N

SHEET 3 of 3
DATE STARTED: October 12, 2023
DATE COMPLETED: October 13, 2023
DATUM: Temporary Benckmark

SOIL PROFILE			SAMPLES				DEPTH SCALE ft / m	FIELD TESTING	LAB TESTING	WELL INSTALLATION	COMMENTS and ADDITIONAL LAB TESTING
LITHOLOGY PLOT	ELEVATION (m / mbgs)	DESCRIPTION	TYPE	NUMBER	SPT 'N' VALUE	RECOVERY (%)		SPT (N) 20 40 60 80; SHEAR STRENGTH (kPa) 50 100 150 200	MOISTURE CONTENT (%) 10 20 30 40		
	168.3	**Bedrock - Cherty Limestone**	RC	3			53.0 / 16.0				
		Run 3: 15.51 - 16.42 m					54.0				
		Recovery - 100%					55.0				
		RQD - 100%					56.0 / 17.0				
	16.4	End of Borehole					57.0				
							58.0				
							59.0 / 18.0				
							60.0				
							61.0				
							62.0 / 19.0				
							63.0				
							64.0				
							65.0 / 20.0				
							66.0				
							67.0				
							68.0 / 21.0				
							69.0				
							70.0				
							71.0 / 22.0				
							72.0				
							73.0				
							74.0 / 23.0				
							75.0				
							76.0				
							77.0 / 24.0				
							78.0				
							79.0				

Groundwater Level Upon Completion:
Secondary Groundwater Level:

INITIAL WATER LEVEL: 7.26 m
SECONDARY WATER LEVEL: N/A
BOREHOLE CAVE UPON COMPLETION: N/A

INITIAL WATER LEVEL DATE: November 16, 2023
SECONDARY WATER LEVEL DATE: N/A

LOGGED: MP
COMPILED: MP
CHECKED: DN

Niagara Testing and Inspection Ltd.
3300 Merrittville Highway, Unit 5
Thorold, Ontario, L2V 4Y6

Note: This borehole log has been prepared for Geotechnical purposes and does not necessarily contain information suitable for an Environmentall assessment of the subsurface conditions. Borehole details as presented, do not constitute a through understanding of all potential conditions present and require interpretative assistance from a qualified Geotechnical Engineer.

Appendix B

Laboratory Test Results

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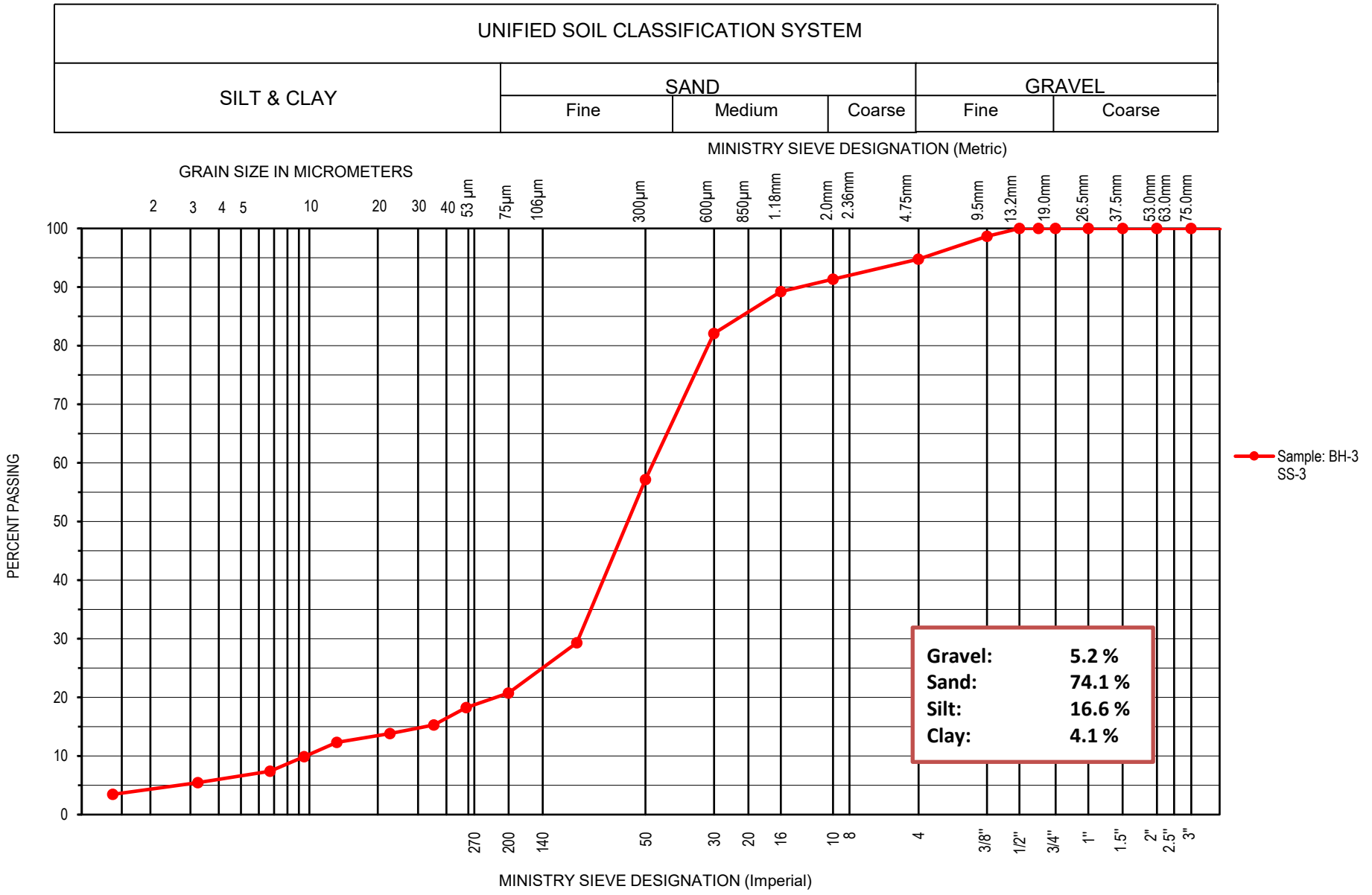
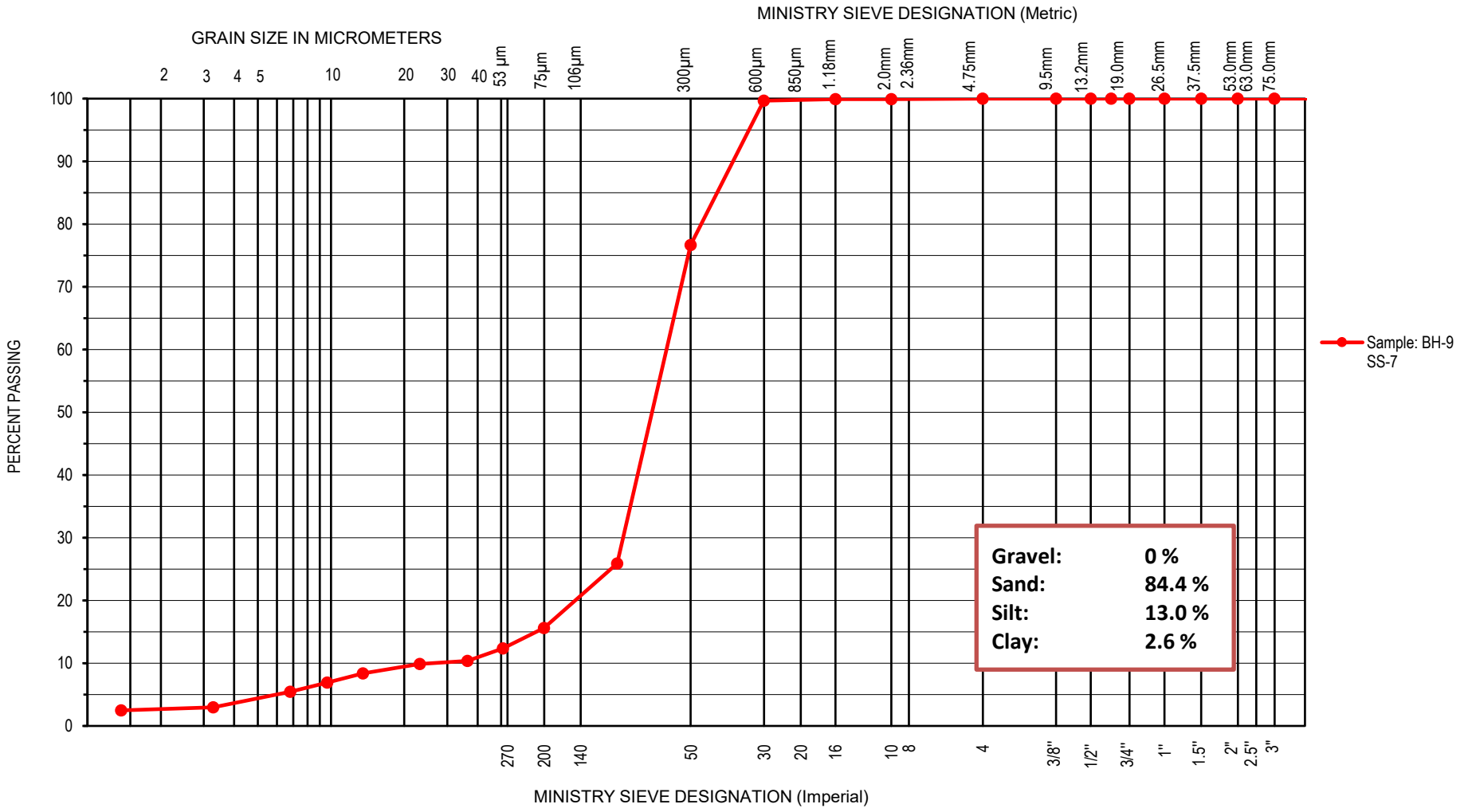


CLIENT **TriLend**	PREPARED BY KC	PROJECT Sieve / Hydrometer Analysis 2430 St. Paul Avenue, Niagara Falls, Ontario	DATE January 10, 2024
Niagara Testing and Inspection Ltd. 3300 Merrittville Highway, Unit #5 Thorold, Ontario	CHECKED BY MP	TITLE Grain Size Distribution	PROJECT NO NT23181 FIGURE NO 1

UNIFIED SOIL CLASSIFICATION SYSTEM					
SILT & CLAY	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

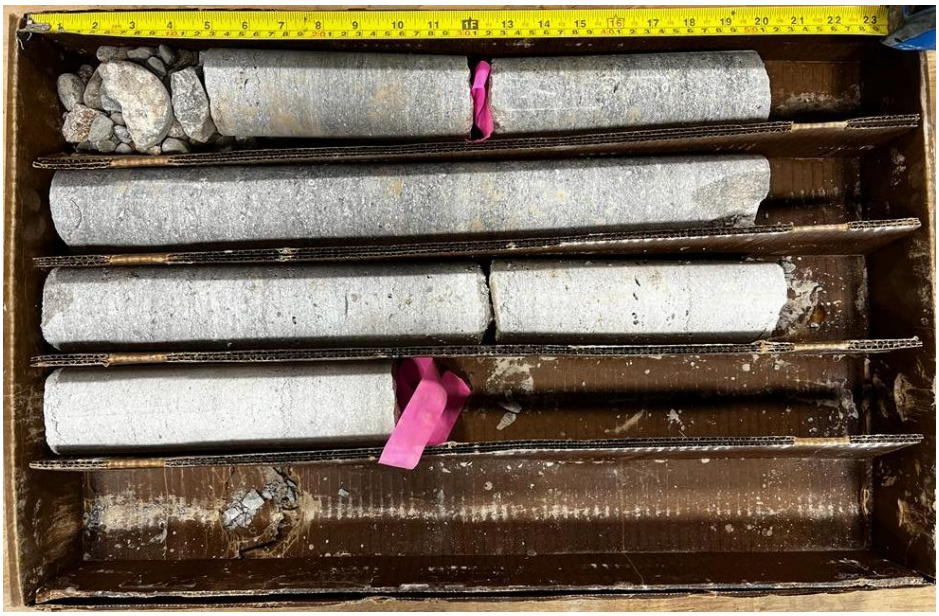


CLIENT: **TriLend**	PREPARED BY: KC	PROJECT: Sieve / Hydrometer Analysis 2430 St. Paul Avenue, Niagara Falls, Ontario	DATE: January 10, 2024
			PROJECT NO: NT23181
Niagara Testing and Inspection Ltd. 3300 Merrittville Highway, Unit #5 Thorold, Ontario	CHECKED BY: MP	TITLE: Grain Size Distribution	FIGURE NO: 2

Appendix C

Rock Core Photographs

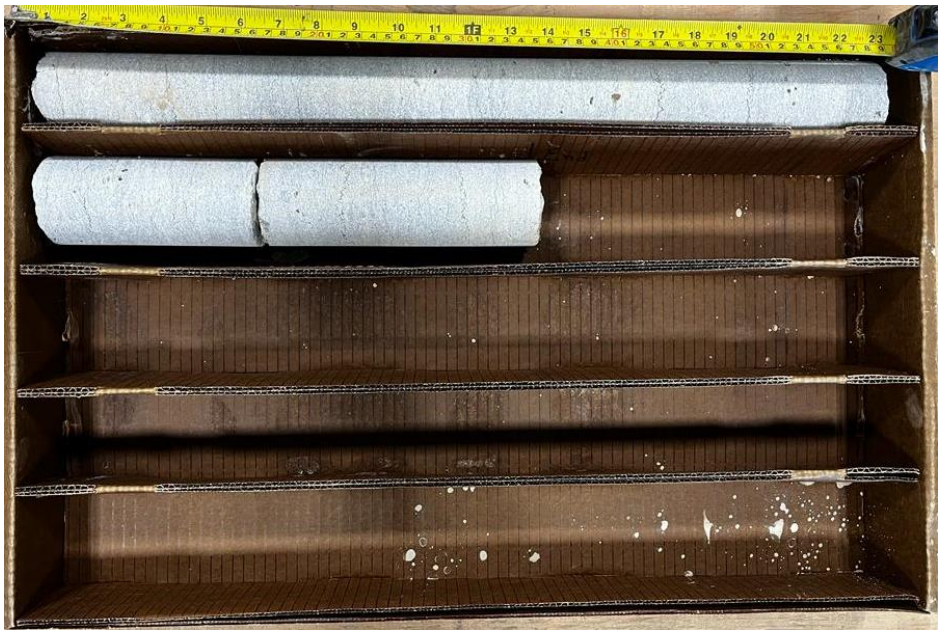
NTiL
NIAGARA TESTING AND INSPECTION LTD.



Borehole: BH-3
Sample: RC1 Depth: 5.64m to 6.00m
Sample: RC2 Depth: 6.00m to 7.47m

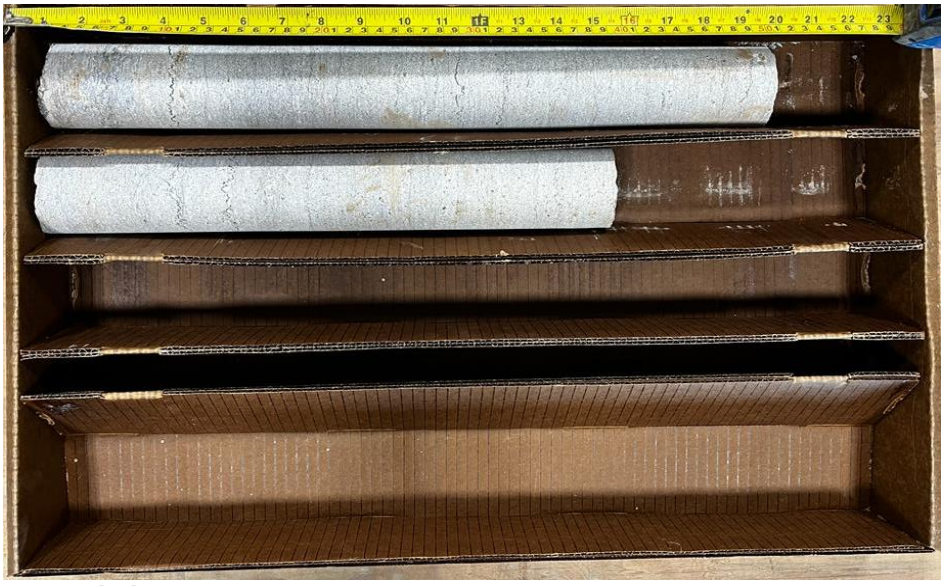
Borehole: BH-3
Sample: RC3 Depth: 7.47m to 9.02m

Borehole: BH-7
Sample: RC1 Depth: 6.55m to 7.54m
Sample: RC2 Depth: 7.54m to 9.17m



Borehole: BH-7
Sample: RC3 Depth: 9.17m to 10.09m

Borehole: BH-16
Sample: RC1 Depth: 12.95m to 14.03m
Sample: RC2 Depth: 14.03m to 15.51m



Borehole: BH-16
Sample: RC3 Depth: 15.51m to 16.42m

Appendix D

Vibration Zone of Influence Study
Prepared by RWH Engineering Inc.
Project No.: M24-003
Date: 01/18/2024

NTiL
NIAGARA TESTING AND INSPECTION LTD.

2340 St. Paul Avenue Development

Vibration Zone of Influence Study

Revision 0

Prepared For:

Niagara Testing and Inspection Limited

RWH Engineering Project Number: M24-003
Date Submitted: 01/18/2024

Vibration Monitoring Plan

1. Scope

RWH Engineering Inc. (RWH) has been retained by to prepare a Vibration Zone of Influence Study and Vibration Monitoring Plan in connection with the proposed development located at 2430 St. Paul Avenue, Niagara Falls, Ontario. This Vibration Zone of Influence Study and Vibration Monitoring Plan has been prepared in general accordance with guidelines provided by the City of Toronto Bylaw 514-2008 (which have generally been accepted as good practice throughout this area) and reference material provided in California Department of Transportation (Caltrans) Transportation and Construction Vibration Guidance Manual. This document outlines the vibration study and vibration monitoring plan prepared by RWH in connection with the vibratory soil compaction for drill rig working surface construction, drilled caissons, shoring installation, excavation, and associated works. The focus for monitoring is to record the vibrations resulting from site activities and associated construction activities to ensure the observed peak particle velocities remain below the allowable limits. This monitoring plan includes schedule, instrumentation, monitoring location, the zone of influence (attached in Appendix A) and ambient background vibration study (attached in Appendix B).

2. Vibration Zone of Influence

2.1 Zone of Influence Limits

The zone of influence is defined as the area where the potential peak particle velocity is equal or greater to 5mm/s for ordinary structures. The provided zones of influence have been established based on published literature, previous experience, the silty clay/clayey silt fill and silty sand fill soil conditions encountered as per Niagara Testing and Inspection Ltd. Geotechnical Report dated January 2024, and generally accepted practices within the jurisdiction. Table 1 indicates the zone of influence for common structures where this threshold will be applied.

Table 1 - Zone of Influence for Construction Activities (5mm/s)

Activity	Zone of Influence (m)	Comments
Impact or Vibratory Pile Driving	20	Provided zone of influence is approximate and indicative of typical equipment – actual zone of influence is best assessed on the selected equipment at time of construction.
Vibratory Compaction	8	Vibratory compaction of soil.
Caisson Drilling	5	Measured from edge of drilled hole.
Excavation	3	Measured from inside shoring pile face.

Ground modification techniques such as dynamic compaction or rapid impact compaction may result in higher construction induced vibrations. The induced vibrations for such techniques are highly dependent upon means and methods, but can produce zones of influence on the order of 50m. If such methods are to be considered it is recommended that the means and methods are reviewed with the selected contractor.

The estimated zone of influence is provided overlaying A.C.K architects Studio Inc. site plan drawings (2022-187) No ordinary structures are within the zone of influence of the proposed works.

Where designated heritage structures or other sensitive structures are present, the more stringent criteria of German Standard DIN 4150-3 are applied.

A review of the online database of heritage properties for the City of Niagara Falls identified no designated heritage properties within or near to the vibration zone of influence. The closest heritage property is located at 2922 St Paul Avenue (Oswald House), which is 900m from the subject property. It is anticipated that this property will be outside of the expected vibration zone of influence.

Pipes, sewers, telecommunications, catch basins, and other services are more resilient in terms of vibration and a limit of 50mm/s is more appropriate. Such utilities tend not to be damaged by ground-borne vibrations, but rather because of displacements or force exerted by larger clasts in the soil (i.e., boulders and cobbles), ground loss, or unintended contact with equipment. We note that utility information was not provided for review. In the event that Enbridge facilities are in near proximity adherence to Enbridge's *Third-Party Requirements in the Vicinity of Natural Gas Facilities Standard* will be required.

2.2 Zone of Influence Discussion

As there are no neighbouring structures as identified above within the zone of influence, a monitoring program will not be required.

Closure

If you have any questions, please do not hesitate to contact us.

RWH Engineering Inc.

Muhammad Chaudhary, P.Eng.

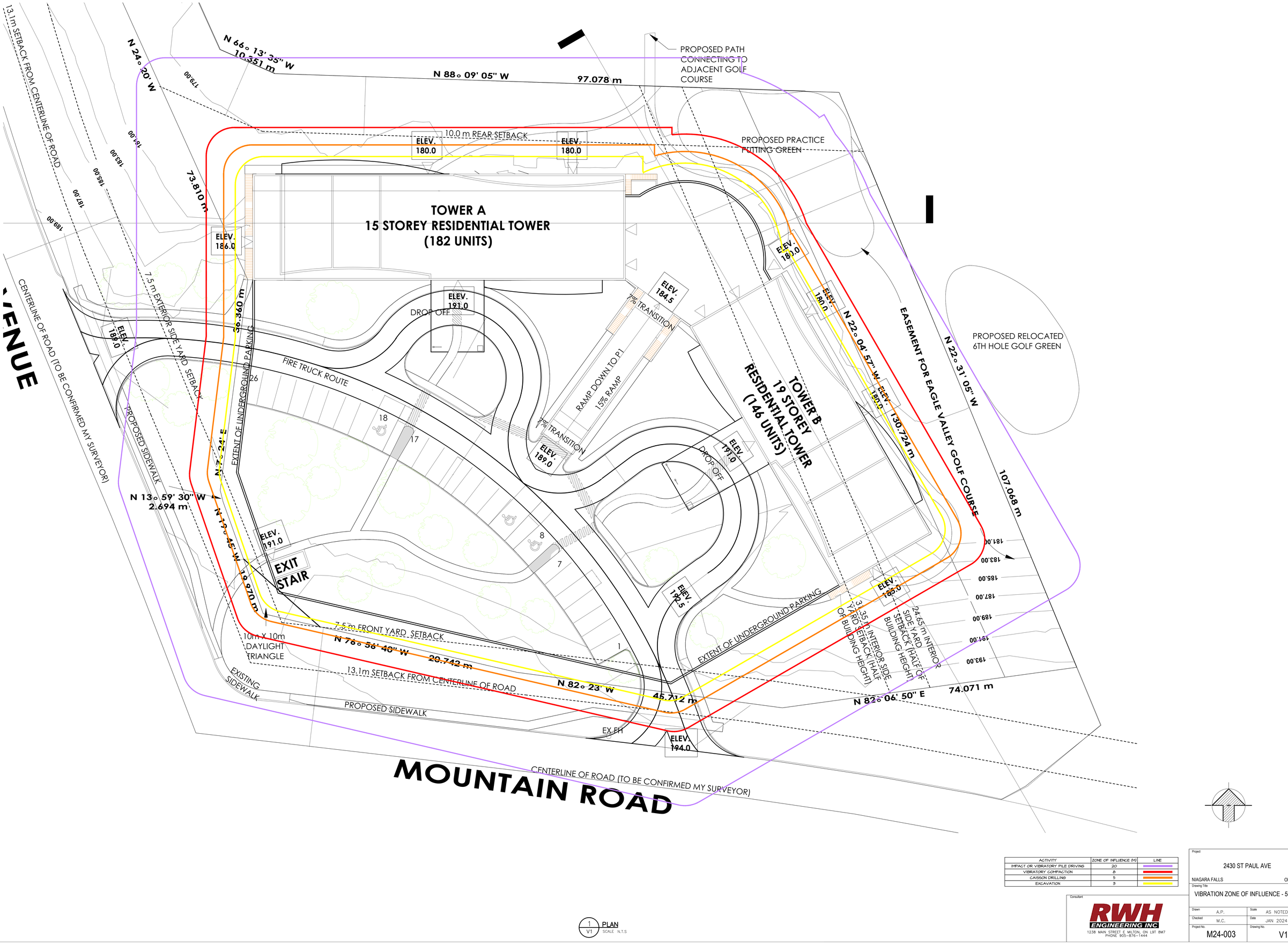
Project Manager

Robert Mara

Construction Services Manager

Appendix A – Vibration Zone of Influence Markup

1238 Main St. E. Milton, Ontario L9T 8M7
Phone: 905.876.1444
www.rwhengineering.ca



ACTIVITY	ZONE OF INFLUENCE (M)	LINE
IMPACT OR VIBRATORY PILE DRIVING	20	
VIBRATORY COMPACTION	8	
CAISSON DRILLING	5	
EXCAVATION	3	

1 / V1 PLAN
SCALE N.T.S

RWH ENGINEERING INC
1238 MAIN STREET E. MILTON, ON L9T 8M7
PHONE 905-876-1444

Project: 2430 ST PAUL AVE
NIAGARA FALLS ONTARIO
Drawing Title: VIBRATION ZONE OF INFLUENCE - 5mm/s

Drawn	A.P.	Scale	AS NOTED
Checked	M.C.	Date	JAN 2024
Project No.	M24-003	Drawing No.	V1

C:\USERS\MCSHARP\ONEDRIVE - HC MATSON INC\DESKTOP\PAST PROJECTS\VIBRATION MONITORING\24-003 2340 ST. PAUL AVENUE ZOI DRAWINGS\2024-01-18_M23-0013_ 2340 ST. PAUL AVENUE_V1-V2_REVIZOI.DWG