1107 Garrison Road Mixed Use Development

Geotechnical Investigation Report

Project Location:

1107 Garrison Road, Fort Erie, ON

Prepared for:

1107 Garrison Road Limited Partnership
488 Huron Street
Toronto, ON

Prepared by:

MTE Consultants Inc.
365 Home Street
Stratford, ON N5A 2A5

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Engineers, Scientists, Surveyors.

Contents

Tables

Appendices

1.0 Introduction

MTE Consultants Inc. (MTE) was retained by 1107 Garrison Road Limited Partnership to conduct a geotechnical investigation for the proposed mixed-use development at 1107 Garrison Road in Fort Erie, Ontario. The subject area (the site) is located west of the Kraft Road and Garrison Road intersection, as shown on **Figure 1 in Appendix A**.

The site currently has multiple houses and sheds with a gravel driveway. The site encompasses approximately 1.4 hectares and there is a creek running along the eastern boundary line. It is understood that the mixed-use development will involve a commercial building at the north side of the property and a condominium building at the south side of the property. There will also be drive aisles and parking areas between the two buildings. It is anticipated that the development will be provided with new municipal services. The design details of the development are referenced from Archisystem Inc.'s Site Plan Drawing A1.0, dated January 5, 2021.

The ground surface generally slopes down from north to south at the site with a grade difference of approximately 1.5 to 2.0 m between the borehole locations.

The purpose of this geotechnical investigation is to determine the soil and groundwater conditions in the area of the proposed development and provide geotechnical engineering recommendations for site grading, site servicing, foundations, basements, floor slabs, and pavement design and subdrainage requirements.

2.0 Field and Laboratory Program

The fieldwork for this investigation was carried out on January 18 and 19, 2021 and involved the drilling of twelve (12) boreholes (Boreholes BH101-21 to BH112-21) to depths ranging from 2.1 to 4.6 m. It is noted that numerous boreholes were terminated upon auger refusal on suspected bedrock. The locations of the boreholes are shown on the Site Plan, **Figure 2 in Appendix A**.

Private and public utility companies were contacted prior to the start of drilling activities in order to isolate underground utilities near the boring locations.

The boreholes were advanced with a Diedrich D50T track mounted drill rig equipped with continuous flight solid stem augers, supplied and operated by Elite Drilling Services.

Representative soil samples were recovered throughout the depths explored. Standard Penetration Tests (SPT) were carried out during sampling operations in the boreholes using conventional split spoon equipment. Cohesive soil samples were tested in the field using a handheld pocket penetrometer to determine approximate shear strengths. The SPT N-values and approximate shear strengths recorded are plotted on the borehole logs in **Appendix B.**

Upon completion of drilling, the boreholes were backfilled with soil cuttings and bentonite in accordance with Ontario Regulation 468/10 (formerly O. Reg. 903) under the provinces Water Resources Act.

The fieldwork was monitored throughout by a member of our geotechnical engineering staff, who directed the drilling procedures; recorded SPT and approximate shear strength values; documented the soil stratigraphies; monitored the groundwater conditions; and transported the recovered soil samples to our office for further classification.

The geodetic ground surface elevations at the borehole locations were surveyed by MTE.

All of the soil samples collected were submitted for moisture content testing with the results provided on the borehole logs in **Appendix B**. Additionally, three soil samples were submitted for particle size distribution analyses and the results are provided in **Appendix C**. The remaining soil samples will be stored for a period of 1 month and will be discarded of at that time without prior request from the client to extend storage time.

3.0 Soil Conditions

Reference is provided to the appended borehole logs for soil stratigraphy details, SPT N-values, approximate shear strengths, moisture content profiles, and groundwater observations and measurements. Soil conditions encountered in the boreholes typically include topsoil and/or fill overlying native deposits of silt and clay, and glacial till.

3.1 Topsoil

Topsoil or topsoil fill materials were encountered surficially in in all of the boreholes and were 150 to 410 mm thick (average thickness of 300 mm). The composition of the topsoil was typically dark brown sandy silt and was wet at the time of the fieldwork. Topsoil was determined through visual observation and no nutrient testing for applicable plant growth was performed as part of the scope of work for this project.

3.2 Fill

Fill was encountered beneath the surficial topsoil fill in Boreholes BH106-21 and BH108-21 and extended to depths of 1.7 m and 0.6 m (Elevation 185.7 m and 186.1 m), respectively. The fill was dark brown to grey in colour and typically ranges in composition from sandy silt to silty sand and gravel. Topsoil was encountered throughout the fill. SPT N-values measured in the fill range from 3 to 8 blows per 300 mm penetration of the split spoon sampler indicating very loose to loose conditions.

Insitu moisture contents in the fill range from about 16 to 28% indicating wet to saturated conditions.

3.3 Silt and Clay

Grey/brown silt and clay layers were encountered beneath the topsoil in Boreholes BH101-21, BH109-21, and BH110-21 and were 0.4 to 0.5 m thick. SPT N-values measured in the silt and clay range from 3 to 6 blows per 300 mm penetration of the split spoon sampler. Approximate shear strengths measured in the cohesive silt and clay range from about 25 to 50 kPa, indicating soft to firm consistencies.

Insitu moisture contents in the silt and clay range from about 18 to 25% and appeared to be wetter than the plastic limit.

3.4 Glacial Till

Glacial till was encountered beneath the topsoil, fill, and/or silt and clay in all of the boreholes and continued to the termination depth of each borehole. The till was brown to grey in colour and typically ranges in composition from silt and clay to silt with some sand, gravel, and clay. The results of particle size distribution analyses conducted on samples of the till are provided in **Appendix C** and summarized in the following table;

Table 1 - Results of Glacial Till Particle Size Distribution Analyses

Borehole Number	Sample Depth (mbgs)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH101-21	1.5 - 2.1	1	13	48	38
BH104-21	2.3 - 2.9	2	14	45	39
BH106-21	2.3 - 2.9	2	17	47	34

SPT N-values measured in the till range from 3 to above 50 blows per 300 mm penetration of the split spoon sampler indicating very loose to very dense conditions. Approximate shear strengths measured in the cohesive deposits of till range from about 75 to above 200 kPa, indicating stiff to hard consistencies.

Insitu moisture contents in the till range from about 10 to 25% indicating very moist to saturated conditions. Cohesive deposits of the till appeared to range from drier than to wetter than the plastic limit.

3.5 Bedrock

It is noted Boreholes BH101-21 to BH108-21 were terminated on auger refusal on suspected dolostone bedrock of the Bois Blanc Formation, as per Ministry of Northern Development and Mines Bedrock Geology of Ontario Southern Sheet, Map No. 2544, at depths of 4.0 to 4.6 m below the existing ground surface (Elevation 180.8 to 182.8 m).

4.0 Groundwater Conditions

Groundwater observations and measurements were carried out in the open boreholes at the time of drilling and are summarized on the borehole logs. Saturated soil conditions encountered at the time of drilling are summarized in the following table;

Table 2 - Saturated Soil Conditions

Borehole Number	Saturated Soil Type	Depth of Saturated Soil (mbgs)	Elevation of Saturated Soil (masl)
BH101-21	Silt Till	3.8	181.6
BH102-21	Silt Till	3.8	181.7
BH103-21	Clayey Silt Till	3.8	181.9
BH104-21	Clayey Silt Till	4.0	182.1
BH105-21	Silt Till	3.8	181.6
BH106-21	Fill	0.8	186.6
BH107-21	Dry		
BH108-21	Silt Till	3.8	183.1
BH109-21	Dry		
BH110-21	Dry		
BH111-21	Dry		
BH112-21	Dry		

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations and local variations.

5.0 Discussion and Recommendations

5.1 General

The project will involve the mixed-use development of the property at 1107 Garrison Road in Fort Erie, Ontario. The site currently has multiple houses and sheds with a gravel driveway. The site encompasses approximately 1.4 hectares and there is a creek running along the eastern boundary line. It is understood that the mixed-use development will involve a commercial building at the north side of the property and a condominium building at the south side of the property. There will also be drive aisles and parking areas between the two buildings. It is anticipated that the development will be provided with new municipal services.

The subsurface stratigraphy at the site comprises topsoil and/or fill overlying native deposits of silt and clay, and glacial till. Saturated soil conditions were encountered within the fill in Borehole BH106-21 at a depth of 0.8 m (Elevation 186.6 m) and within the glacial till in Boreholes BH101-21 to BH105-21 and BH108-21 at depths of 3.8 to 4.0 m (Elevation 181.6 to 183.1 m). Wet conditions were also encountered within the topsoil, surficial fill, and upper native soils extending to depths of 0.8 m (Elevation 184.6 to 186.6 m) across the site.

Based on the results of this geotechnical investigation the site is suitable for the proposed development; however, the upper loose native soils and the depth of fill encountered in Borehole BH106-21 will affect design and construction. The following subsections of this report contain geotechnical recommendations pertaining to development of the property including site grading, site servicing, foundations, basements, floor slabs, and pavement design and subdrainage requirements.

5.2 Site Preparation

The first construction activity that will be required for the proposed development will be demolishing the existing buildings and sheds at the site. All existing foundations and slabs must be removed. The fill surrounding the existing buildings and sheds should also be removed; however, the depth of the fill was not confirmed at the time of this report.

Prior to carrying out any engineering fill operations, all topsoil, fill, trees, and deleterious material should be removed from the proposed building areas. The average depth of topsoil measured across the site was 300 mm. Fill was encountered in Boreholes BH106-21 and BH108-21 and extended to depths of 1.7 m and 0.6 m (Elevation 185.7 m and 186.1 m), respectively. The upper 0.8 m of soft to firm or very loose to loose native soils encountered across the site is not suitable to remain beneath any proposed building and should be removed. The topsoil, fill, and unsuitable native soils could be used in landscaping areas to raise grades.

The subgrade should be inspected and proof rolled in the presence of qualified geotechnical personnel to verify if the subgrade will provide support as intended in the original design. The primary purpose of the inspection is to identify poorly performing areas which should be sub-excavated.

Structural fill used for raising grades beneath the proposed buildings footings should comprise granular material such as OPSS 1010 Granular 'B', if required. Subgrade fill material beneath the proposed pavement areas and services should meet the requirements of OPSS 1010 Select Subgrade Material. Any imported fill should be tested and verified by qualified geotechnical personnel prior to placement.

The majority of the native soils are considered suitable for reuse as engineered fill. Wet and/or saturated soils are not considered suitable for engineered fill. Granular material such as OPSS 1010 Granular 'B' may also be used as engineered fill. All engineered fill should be placed in maximum 300 mm thick lifts and compacted to the following percentages;

Table 3 - Engineered Fill Requirements

Fill Use	Minimum Compaction Required
Structural fill to support buildings	100% SPMDD
Subgrade fill beneath pavements or services	95% SPMDD
Bulk fill in landscape areas	90% SPMDD

The native subgrade soils are very susceptible to disturbance due to the silt and clay content and it is recommended that construction traffic on the subgrade be minimized.

Structural fill pads should extend a minimum 0.3 m beyond the edge of the footing envelope of any building and down to subgrade at an angle of 45 degrees to the horizontal. Full time testing by geotechnical personnel is required during fill placement and compaction to monitor material quality, lift thickness, and verify the compaction by in-situ density testing (as per the 2012 Ontario Building Code).

In order to minimize the effects of weather and groundwater, fill operations onsite should be carried out in the dry summer months.

5.3 Site Servicing

5.3.1 Excavations and Dewatering

It is anticipated the development will be provided with new municipal services. It is also anticipated that the invert levels of the sewers will be at conventional depths.

Temporary excavations to conventional depths for installation of underground pipes at this site must comply with the Ontario Occupational Health and Safety Act and Regulations for Construction Projects. The topsoil, fill, silt and clay, and soft to firm or very loose to loose glacial till soils encountered in the boreholes would be classified as Type 3 soils (O. Reg. 213/91, s. 226 (4)). Temporary side slopes must be cut at an inclination of 1.0 horizontal to 1.0 vertical or less from the base of the excavation for open cut pipe installation. The compact to very dense or very stiff to hard glacial till soils encountered at the site are classified as Type 2 soils and the suspected dolostone bedrock at the site is classified as Type 1 soils, although it is not anticipated that excavations will extend into the suspected dolostone bedrock. The temporary side slopes for Type 1 and 2 soils can be cut near vertical at 1.2 m above the base of excavation and at an inclination of 1 horizontal to 1 vertical or less above this level, exclusive of groundwater effects. Where wet to saturated conditions are encountered, excavation side slopes should be expected to slough to flatter inclinations, potentially 3.0 horizontal to 1.0 vertical or flatter.

Trench side slopes must be continuously inspected especially after periods of heavy rainfall or snow melt to identify areas of instability. Surface water should be directed away from entering the trench.

Minor groundwater inflow should be expected where excavations extend into the wet surficial fill, and upper native soils extending to depths of up to 0.8 m (Elevation 184.6 to 186.6 m) across the site. It is envisioned that conventional sump pump techniques will be able to control the inflow in these areas.

Moderate groundwater inflow should be expected where excavations extend into the saturated fill encountered in Borehole BH106-21 at a depth of 0.8 m (Elevation 186.6 m). It is anticipated that excessive pumping may be required to control the inflow in this area.

It is not expected that excavations will extend into the saturated glacial till encountered in Boreholes BH101-21 to BH105-21 and BH108-21 at depths of 3.8 to 4.0 m (Elevation 181.6 to 183.1 m).

It will be necessary to flatten or support the excavation side slopes where groundwater seepage is occurring to ensure stability. Every excavation that a worker may be required to enter shall be kept reasonably free of water (O. Reg. 213/91, s. 230).

It should be noted that an Environmental Activity and Sector Registry (EASR) or Permit to Take Water (PTTW), issued by the Ministry of Environment, Conservation and Parks, will be required if the dewatering system/sumps result in a water taking of more than 50,000 L/day to 400,000 L/day, respectively. The design of the dewatering system should be left to the contractor's discretion to control groundwater at least 0.5 m below the invert level in order to provide stable excavation base. The contractor should notify the prime consultant in the event that he feels that an EASR/PTTW will be needed.

5.3.2 Pipe Bedding

It is anticipated invert elevation of the pipes will be at conventional 2 to 3 m depths below ground surface. No bearing problems are anticipated for pipes set on native inorganic subsoil, dolostone bedrock, or imported structural fill. The bedding material may need to be thickened if excavations encounter soft or spongy soil from the base of the service trench.

Pipe bedding for sewer services should be conventional Class 'B' pipe bedding comprising a minimum 150 mm thick layer of OPSS 1010 Granular 'A' aggregate below the pipe invert. Granular 'A' type aggregate should be provided around the pipe to at least 300 mm above the pipe and the bedding aggregate should be compacted to a minimum 95% Standard Proctor Maximum Dry Density (SPMDD).

A well-graded clear stone such as Coarse Aggregate for HL4 Asphaltic Concrete (OPSS 1003) could be used in the sewer trenches as bedding below the spring line of the pipe to facilitate sump pump dewatering, if necessary. The clear stone should be compacted with a plate tamper and fully wrapped with a non-woven filter cloth.

5.3.3 Trench Backfilling

The trenches above the specified pipe bedding should be backfilled with inorganic onsite soils placed in 300 mm thick lifts and compacted to at least 95% SPMDD. Where trenches enter the proposed buildings the backfill should be compacted to 100% SPMDD or 5 MPa lean-mix concrete may be used. Wet or saturated native mineral soils are not considered suitable for reuse as trench backfill. Any additional material required to be imported at the site should meet OPSS Select Subgrade Material specifications.

To minimize potential problems, backfilling operations should follow closely after excavation so that only a minimal length of trench is exposed. Care should be taken to protect side slopes of excavations by diverting surface run-off away from the excavations. If construction extends into the winter, then additional steps should be taken to minimize frost and ensure that frozen material is not used as backfill.

5.4 Pavement Structure

It is understood that pavements will be constructed for new drive aisles and parking areas at the site. Loading docks may also be constructed for the proposed commercial building and condominium building. The existing topsoil, fill, and deleterious material in the vicinity of the drive aisles, parking areas, and loading docks should be removed. Depending on finished grades at the site, the subgrade soils will consist of native soils or approved engineered fill.

The pavement component thicknesses in the following table are recommended based on the proposed pavement usage and the frost-susceptibility and strength of the subgrade soils;

Table 4 - Pavement Design

Pavement Component	Light Duty and Car Parking Areas	Truck Traffic Areas	Loading Docks and Heavy Truck Areas
Asphalt Hot Mix	90 mm	120 mm	-
Portland Cement Concrete	-	-	200 mm
OPSS 1010 Granular ‘A’ Base	150 mm	150 mm	200 mm
OPSS 1010 Granular ‘B’ Subbase	350 mm	450 mm	300 mm

Concrete testing should be performed onsite to determine the slump, temperature, and air entrainment of the concrete pavement structure; and concrete cylinders should be cast for compressive strength testing.

Samples of aggregates should be checked for conformance to OPSS 1010 prior to utilization on site and during construction. The Granular 'B' subbase and Granular 'A' base courses must be compacted to 100% SPMDD, as verified by insitu density testing.

The asphaltic concrete paving materials should conform to the requirements of OPSS 1150. The asphalt should be placed and compacted in accordance with OPSS 310. The Performance Graded Asphalt Cement (PG-AC) designation for the asphaltic concrete is 58-28.

The asphaltic concrete should comprise 40 mm of the HL3 surface over 50 mm of HL8 binder for light duty and car parking areas and 40 mm of HL3 surface over 80 mm of HL8 binder for truck traffic areas. Consideration should be given to using HL1 surface and a Heavy Duty Binder Course (HDBC) asphaltic concrete to improve pavement design lifespan in the drive aisles and truck traffic areas.

The pavement design is based on the assumption that construction will be carried out during the drier time of the year and that the subgrade soil is stable as determined by proof-rolling inspected by qualified geotechnical personnel. If the subgrade is wet and unstable, additional granular subbase will be required.

All materials and construction services required for the work should be in accordance with the relevant sections of the Ontario Provincial Standard Specifications.

It is recommended to install subdrains beneath the low lying areas of the pavement structure and connected to catchbasins. The purpose of the subdrains is to remove excess subsurface water in order to improve overall pavement serviceability and increase the pavement life.

The work of subdrain installation shall be in accordance with OPSS 405 and OPSD 216.021. The subdrain shall be 100 or 150 mm diameter perforated pipe conforming to OPSS 1801 or 1840, and wrapped with geotextile conforming to OPSS 1860.

5.5 Curbs and Gutter and Sidewalks

The concrete for curbs, gutters and sidewalks should be proportioned, mixed, placed and cured in accordance with the requirements of OPSS 353, and OPSS 1350 and shall meet the following specific requirements (OPSS 353.05.01):

- Minimum compressive strength = 30 MPa at 28 days
- Coarse aggregate = 19.0 mm nominal max. size
- Maximum slump = 60 mm for curbs and gutter, 70 mm for sidewalks
- Air entrainment = 6.5 ± 1.5%

During cold weather any freshly placed concrete must be covered with insulating blankets to protect against freezing as per OPSS 904. Three cylinders from each day's pour should be taken for compressive strength testing. Air entrainment, temperature and slump tests should be conducted on the same batch of concrete from the test cylinders made.

5.6 Foundation Design

It is understood that a condominium building will be constructed at the south side of the site in the vicinity of Boreholes BH101-21 to BH105-21 and a commercial building will be constructed at the north side of the site in the vicinity of Boreholes BH106-21 to BH108-21. It is also understood that the buildings may have basements and will be constructed using conventional strip and/or pad footings.

In general, the undisturbed compact to very dense or very stiff to hard native glacial till soils are considered suitable to support the proposed buildings foundations. The following table provides the minimum recommended depth and elevation for footing placement on suitable native soil;

Table 5 - Recommended Founding Elevation for Building Footings

Borehole Number	Borehole Ground Surface Elevation (masl)	Depth Below Existing Ground Surface to Suitable Native Soil (mbgs)	Elevation of Suitable Native Soil (masl)
Proposed Condominium Building			
BH101-21	185.4	0.8*	184.6
BH102-21	185.5	0.8*	184.7
BH103-21	185.7	0.8*	184.9
BH104-21	186.1	0.8*	185.3
BH105-21	185.4	0.8*	184.6
Proposed Commercial Building			
BH106-21	187.4	1.7	185.7
BH107-21	186.8	0.8*	186.0
BH108-21	186.9	0.8*	186.1

*It is noted 1.2 m of soil cover is required for frost protection

Conventional spread footings founded on the suitable undisturbed native soils or approved structural fill may be designed for a factored geotechnical bearing resistance at Ultimate Limit States (ULS) of 225 kPa, and soil bearing resistance for 25 mm of settlement at Serviceability Limit States (SLS) of 150 kPa.

A higher bearing capacity could be achieved if footings are founded on the suspected dolostone bedrock encountered at depths of 4.0 to 4.6 m (Elevation 180.8 to 182.8 m) across the site; however, it is not anticipated that footings will extend to these depths.

The founding native soils are very susceptible to disturbance by construction activity, especially during wet weather and care should be taken to preserve the integrity of the material as bearing strata. A mud mat immediately following excavation and approval of the native soils is recommended for the south side of the site.

The footing areas must be inspected by qualified geotechnical personnel to ensure that the soil conditions encountered at the time of construction are suitable to support the design resistances prior to pouring concrete. Any loose, disturbed, organic and deleterious material identified during the inspection should be removed from the footing areas and replaced with concrete.

All exterior floor slabs and footings in unheated areas must be provided with a minimum 1.2 m of earth cover or equivalent insulation after final grading in order to minimize the potential of damage due to frost action, as per Ontario Provincial Standard Drawing, OPSD 3090.101, dated November 2010. If construction is undertaken during the winter, the subgrade soil and concrete should be protected from freezing.

A modulus of subgrade reaction of 25 to 30 MPa/m should be used in the design of the floor slab.

A minimum 150 mm thick layer of Granular 'A' material uniformly compacted to 100% SPMDD should be provided directly beneath the floor slab for leveling and support purposes.

Where spread footings are constructed at different elevations, the difference in elevation in the individual footing should not be greater than one half of the clear distance between the footings. The lower footing should be constructed first so that if it is necessary to construct the lower footings at a greater depth than anticipated, the elevation of the upper footings can be adjusted accordingly. Stepped strip footings should be constructed in accordance with OBC Section 9.15.3.8.

A Site Classification ‘D’ should be used for earthquake load and effects in accordance with Table 4.1.8.4.A. of the 2012 Ontario Building Code.

All excavations at the site should be carried out in conformance with the Ontario Occupational Health and Safety Act and Regulations for Construction Projects. The topsoil, fill, silt and clay, and soft to firm or very loose to loose glacial till soils encountered at the site are classified as Type 3 soils, and temporary side slopes through this material must be cut at an inclination of 1.0 horizontal to 1.0 vertical or less from the base of the excavation. The compact to very dense or very stiff to hard glacial till soils encountered at the site are classified as Type 2. The temporary side slopes for Type 2 soils can be cut near vertical at 1.2 m above the base of excavation and at an inclination of 1 horizontal to 1 vertical or less above this level, exclusive of groundwater effects. Where wet to saturated conditions are encountered, excavation side slopes should be expected to slough to flatter inclinations, potentially 3.0 horizontal to 1.0 vertical or flatter.

5.6.1 Basements

It is understood that basements may be installed for the proposed buildings at the site. It is not expected that the basements will extend into the suspected dolostone bedrock encountered at depths of 4.0 to 4.6 m (Elevation 180.8 to 182.8 m) across the site. It is also not anticipated that the basements will extend into the saturated glacial till encountered in Boreholes BH101-21 to BH105-21 and BH108-21 at depths of 3.8 to 4.0 m (Elevation 181.6 to 183.1 m).

The basements floors should be designed a minimum 0.5 m above the seasonal high groundwater elevations at the site. If the separation from groundwater cannot be achieved, the basements must be waterproofed and designed to resist hydrostatic uplift. Further hydrogeological assessment would be required to determine the seasonal high groundwater elevation.

Basements at this site must be provided with perimeter weeping tile systems as per the Ontario Building Code (Section 9.14). The drain tile or pipe should be laid on undisturbed or well-compacted soil so that the top of the tile or pipe (minimum 100 mm diameter) is below the bottom of the basement floor slab. The top and sides of the drain tile or pipe shall be surrounded with not less than 150 mm of crushed stone or other clean coarse granular material containing no more than 10% of material that will pass the 4 mm sieve. The crushed stone should be wrapped with filter cloth. The weeping tile must drain to a suitable frost-free outlet or sump equipped with an automatic pump that will discharge water into a storm sewer service or other frost free outlet.

The portion of the exterior basement walls and floor slabs below finished ground level must be waterproofed as per the Ontario Building Code (Subsection 9.13.3). Free-draining sand materials should be used for basement and elevator pit wall backfill. The basement and elevator pit wall backfill should be graded to allow drainage away from the foundation.

The basement walls should be designed to resist the lateral earth pressure. For calculating the lateral earth pressure, the coefficient of earth pressure (K) may be assumed as 0.50 for cohesionless sandy soils and 1.0 for silt and clay (Section 24.12.3.3 Canadian Foundation Engineering Manual). The bulk unit weight of the retained backfill may be taken as 21 kN/m^3 for well-compacted soil. An appropriate factor of safety should be employed.

The subgrade for the basement floor slabs should comprise undisturbed native soil or well-compacted fill. A minimum 100 mm thick layer of coarse clean granular material containing not more than 10% material that will pass a 4 mm sieve shall be placed beneath slabs in buildings as per Subsection 9.16.2 of the Ontario Building Code. If the subgrade soil is wet, we strongly recommend that subfloor weeping tiles be placed and connected to the sump pit.

If a moisture-sensitive floor finish is to be applied to the slab, then we recommend that a 15 mil polyethylene moisture vapour barrier be installed directly beneath the slab as per Article 9.13.2.7 of the Ontario Building Code. The purpose of the vapour barrier is to reduce moisture transfer by diffusion as per Article 5.5.1.2 of the Ontario Building Code. Joints in the vapour barrier should be lapped not less than 100 mm.

Concrete testing should be performed onsite to determine the slump, temperature, and air entrainment; and concrete cylinders should be cast for compressive strength testing.

5.7 Construction Inspection and Testing

MTE recommends that geotechnical inspection and testing procedures be conducted throughout the various phases of the project.

Engineer site visits should be conducted to confirm geotechnical bearing resistances for footings. Soil compaction testing should be carried out on structural fill beneath the proposed buildings, foundation wall backfill, subslab granular fill, and trench backfill. Laboratory and field testing of the pavement structure components (granulars and asphaltic concrete) should be conducted, as well as concrete testing for foundations, curbs and sidewalks.

MTE offers soil compaction, concrete, and asphalt testing, as well as soil inspection services through our Stratford and London offices.

6.0 Limitations of Report

Services performed by MTE Consultants Inc. (MTE) were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the Geotechnical Engineering & Consulting profession practicing under similar conditions in the same geographic area were the services are provided. No other warranty or representation expressed or implied as to the accuracy of the information, conclusions or recommendations is included or intended in this report.

This report was completed for the sole use of the Client. This report is not intended to be exhaustive in scope or to imply a risk-free site. As such, this report may not deal with all issues potentially applicable to the site and may omit aspects which are or may be of interest to the reader.

In addition, it should be recognized that a soil sample result represents one distinct portion of a site at the time it is collected, and that the findings of this report are based on conditions as they existed during the time period of the investigation. The material in the report reflects our best judgment using the information available at the time the report was written. The soil and groundwater conditions between and beyond the test holes may differ from those encountered in the test holes. Should subsurface conditions arise that are different from those in the test holes MTE should be notified to determine whether or not changes should be made as a result of these conditions.

It should be recognized that the passage of time may affect the views, conclusions and recommendations (if any) provided in this report because groundwater conditions of a property can change, along with regulatory requirements. All design details were not known at the time of submission of this report and it is recommended MTE should be retained to review the final design documents prior to construction to confirm they are consistent with our report recommendations. Should additional or new information become available, MTE recommends that it be brought to our attention in order that we may determine whether it affects the contents of this report.

Any use which another party makes of this report, or any reliance on, or decisions to be made based upon it, are the responsibility of such parties. MTE accepts no responsibility for liabilities incurred by or damages, if any, suffered by another party as a result of decisions made or actions taken, based upon this report. Others with interest in the site should undertake their own investigations and studies to determine how or if the condition affects them or their plans. The contractors bidding on this project or undertaking the construction should make their own interpretation of the factual information and draw their own conclusions as to how subsurface conditions may affect their work.

The benchmark and elevations provided in this report are primarily established to identify differences between the test hole locations and should not be used for other purposes such as, planning, development, grading, and excavation.

All of which is respectfully submitted,

MTE Consultants Inc.

Ben Heinbuch, P.Eng.
Geotechnical Engineer
519-271-7952
bheinbuch@mte85.com

Brett Thorner, P.Eng.
Manager, Geotechnical - London
519-204-6510
bthorner@mte85.com

BRT:bgh

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Appendix A

Figures

Figure 1 - Location Plan

Figure 2 - Site Plan

REFERENCES:

- AERIAL IMAGE FROM GOOGLE EARTH

MTE
Engineers, Scientists, Surveyors
519-271-7952

SCALE: N.T.S

CLIENT
1107 GARRISON ROAD LIMITED PARTNERSHIP

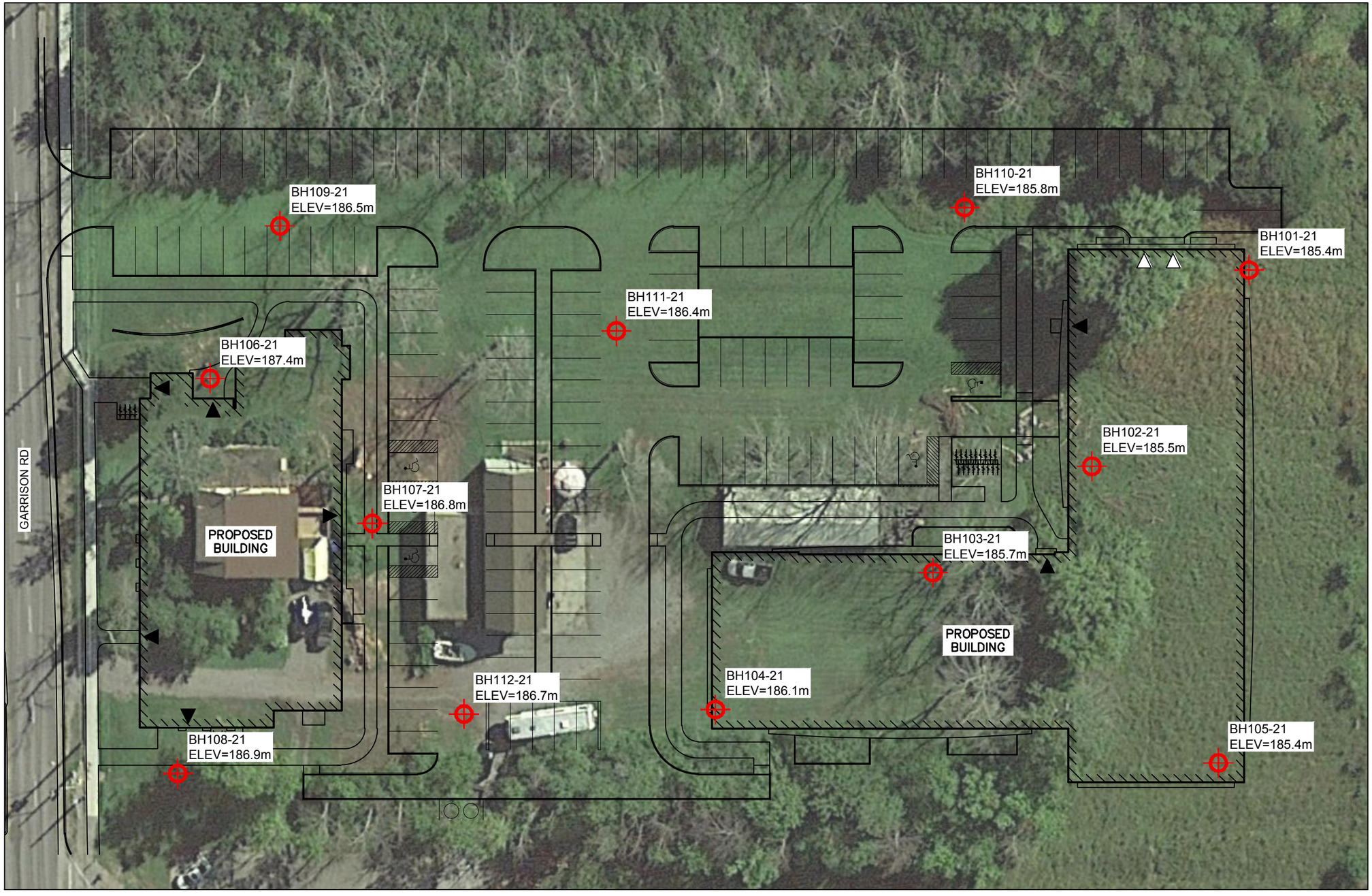
PROJECT
1107 GARRISON ROAD MIXED USE DEVELOPMENT

SITE
1107 GARRISON ROAD, FORT ERIE, ON

TITLE
LOCATION PLAN

Reviewed By	DMG
Prepared By	JJK
Drawn By	JJK
Date	JANUARY 2021
Project No.	48074-300
Figure No.	1

N
NORTH



LEGEND

BH101-21
MTE BOREHOLE 2021

REFERENCES:

- AERIAL IMAGE FROM GOOGLE EARTH
- GEODETIC GROUND SURFACE ELEVATIONS SURVEYED BY MTE
- CONCEPT PLAN REFERENCED FROM ARCHISYSTEM INC.'S SITE PLAN DRAWING A1.0 DATED JAN. 5, 2021

NORTH

SCALE: 1:500

MTE
Engineers, Scientists, Surveyors
519-271-7952

CLIENT
1107 GARRISON ROAD LIMITED PARTNERSHIP

PROJECT
1107 GARRISON ROAD MIXED USE DEVELOPMENT

SITE
1107 GARRISON ROAD, FORT ERIE, ON

TITLE
SITE PLAN

Reviewed By	DMG		
Prepared By	JJK	Project No.	48074-300
Drawn By	JJK	Figure No.	2
Date	JANUARY 2021		

Project: 48074-300 CAD: P:\P\48074\300\48074-300-BH FIGURES.DWG
2 SITE PLAN
January 26, 2021 - 11:11 a.m. - Plotted By: JKoch

Appendix B

Borehole Logs

Abbreviations and Symbols

MTE Boreholes BH101-21 to BH112-21

The following are abbreviations and symbols commonly used on borehole logs, figures and reports.

Sample Types

AS	Auger Sample
CS	Chunk Sample
BS	Bulk Sample
GS	Grab Sample
WS	Wash Sample
SS	Split Spoon
RC	Rock Core
SC	Soil Core
TW	Thinwall, Open
TP	Thinwall, Piston

Soil Tests

PP	Pocket Penetrometer
FV	Field Vane
SPT	Standard Penetration Test
CPT	Cone Penetration Test
WC	Water Content
WL	Water Level

Penetration Resistance

Standard Penetration Test, N (ASTM D1586)	The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) open spilt spoon sampler for a distance of 300 mm (12 in.).
Dynamic Cone Penetration Resistance	The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive an uncased 50 mm (2 in.) diameter, 60o cone attached to “A” size drill rods for a distance of 300 mm (12 in.).

Soil Description

Cohesive Soils	Undrained Shear Strength (Cu)	
Consistency	kPa	psf
Very Soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very Stiff	100 to 200	2,000 to 4,000
Hard	Above 200	Above 4,000

Cohesionless Soils	
Relative Density	SPT N Value
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Above 50

WH	Sampler advanced by static weight of hammer
WR	Sampler advanced by static weight of drilling rods
PH	Sampler advanced by hydraulic force
PM	Sampler advanced by manual force

DTPL	Drier than Plastic Limit
APL	About Plastic Limit
WTPL	Wetter than Plastic Limit
mbgs	Metres below Ground Surface

ID Number: BH101-21

Project: 1107 Garrison Road Mixed Use Development

Project No: 48074-300

Client: 1107 Garrison Road Limited Partnership

Site Location: 1107 Garrison Road, Fort Erie, ON

Drill Date: 1/18/2021

Drilling Contractor: Elite Drilling Services

Drill Rig: D50T Track Mount

Drill Method: Solid Stem Augers

Protective Cover: N/A

Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Sample Number	Sample Type	Dynamic Cone: Standard Penetration (20 40 60 80)	Shear Strength (PP) kPa / Shear Strength (FV) kPa (50 100 150 200)	Water Content % (10 20 30)
0 / 0		Ground Surface	185.4					
		TOPSOIL dark brown sandy silt, some organics, wet (410mm)	0.0 / 185.0	1	SS	3	25	25
2		**SILT AND CLAY** soft mottled grey/brown silt and clay, trace sand, WTPL	0.4 / 184.6					
		CLAYEY SILT TILL very stiff mottled grey/brown clayey silt, trace sand and gravel, DTPL	0.8 / 183.9	2	SS	17	175	13
4								
6 / 2		**SILT AND CLAY TILL** hard to very stiff mottled grey/brown to brown silt and clay, some sand, trace gravel, DTPL	1.5 / 181.6	3	SS	21	>200	13
8				4	SS	26	>200	13
10				5	SS	26	125	17
12								
4		**SILT TILL** compact grey silt, some sand and clay, trace gravel, saturated	3.8 / 180.8	6	SS	17		22
14								
		Drilling Terminated	4.6					
16								

Groundwater Observations and Standpipe Details: ← Cuttings; ← Bentonite; ← Wet Cave

Water encountered at 3.8mbgs during drilling

Field Technician: M. Dalgliesh

Drafted by: B. Ehgoetz

Reviewed by: D. Gonser

Sheet: 1 of 1

Notes:
Auger refusal on assumed bedrock at 4.6mbgs

ID Number: BH102-21

Project: 1107 Garrison Road Mixed Use Development

Project No: 48074-300

Client: 1107 Garrison Road Limited Partnership

Site Location: 1107 Garrison Road, Fort Erie, ON

Drill Date: 1/18/2021

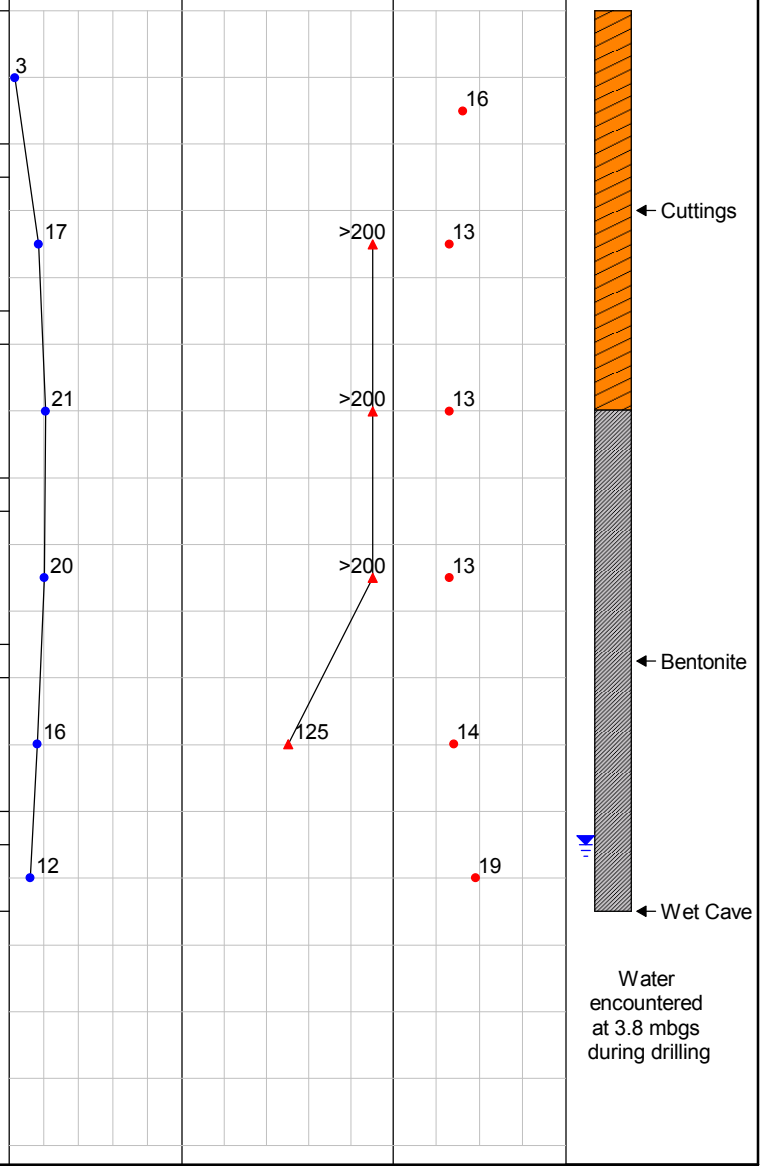
Drilling Contractor: Elite Drilling Services

Drill Rig: D50T Track Mount

Drill Method: Solid Stem Augers

Protective Cover: N/A

Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Sample Number	Sample Type
0 / 0		Ground Surface	185.5		
		TOPSOIL dark brown sandy silt, wet (360mm)	0.0 / 185.1	1	SS
2		**SILT TILL** very loose mottled grey/brown silt, some clay and gravel, trace sand, wet	0.4 / 184.7		
		CLAYEY SILT TILL hard to very stiff mottled grey/brown to brown clayey silt, some gravel, trace sand, DTPL	0.8	2	SS
4					
6 / 2				3	SS
8				4	SS
10				5	SS
12			181.7		
		SILT TILL compact grey silt, some clay and sand, trace gravel, saturated	3.8	6	SS
14 / 4			181.2		
		Drilling Terminated	4.3		
16					



Field Technician: M. Dalgliesh

Drafted by: B. Ehgoetz

Reviewed by: D. Gonser

Sheet: 1 of 1

Notes:
Auger refusal on assumed bedrock at 4.3mbgs

ID Number: BH103-21

Project: 1107 Garrison Road Mixed Use Development

Project No: 48074-300

Client: 1107 Garrison Road Limited Partnership

Site Location: 1107 Garrison Road, Fort Erie, ON

Drill Date: 1/18/2021

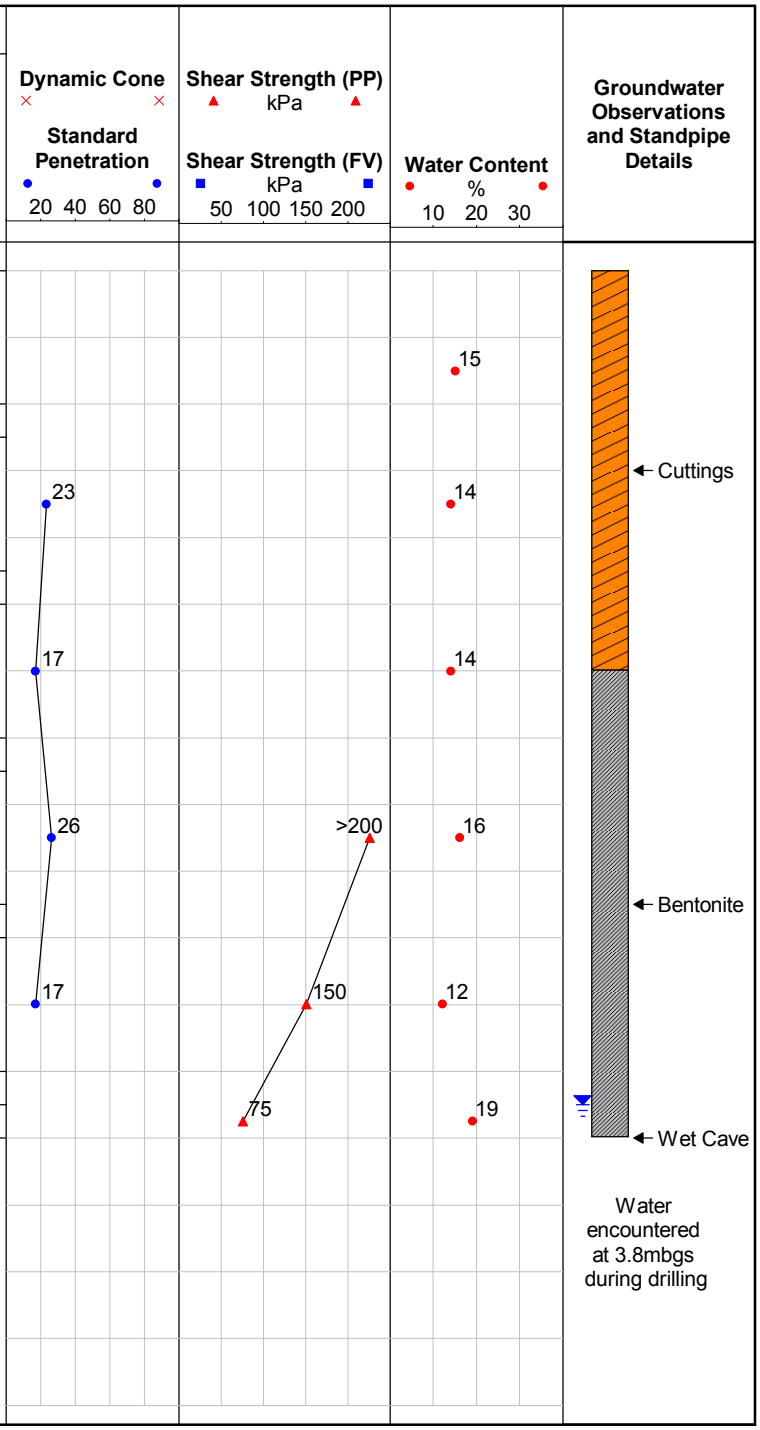
Drilling Contractor: Elite Drilling Services

Drill Rig: D50T Track Mount

Drill Method: Solid Stem Augers

Protective Cover: N/A

Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Sample Number	Sample Type
0 / 0		Ground Surface	185.7		
		TOPSOIL dark brown sandy silt, wet (300mm)	0.0 185.4	1	GS
2		**SILT TILL** mottled grey/brown silt, some clay and gravel, trace sand, wet	0.3 184.9		
		compact, very moist	0.8	2	SS
4					
6 / 2				3	SS
			183.4		
8		**CLAYEY SILT TILL** hard to very stiff brown clayey silt, some gravel, trace sand, DTPL	2.3	4	SS
10				5	SS
12			182.0		
		grey	3.7		
		stiff, WTPL		6	GS
14 / 4		Drilling Terminated			
16					



Field Technician: M. Dalgliesh

Drafted by: B. Ehgoetz

Reviewed by: D. Gonser

Sheet: 1 of 1

Notes:
Auger refusal on assumed bedrock at 4.0mbgs

ID Number: BH104-21

Project: 1107 Garrison Road Mixed Use Development

Project No: 48074-300

Client: 1107 Garrison Road Limited Partnership

Site Location: 1107 Garrison Road, Fort Erie, ON

Drill Date: 1/18/2021

Drilling Contractor: Elite Drilling Services

Drill Rig: D50T Track Mount

Drill Method: Solid Stem Augers

Protective Cover: N/A

Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Sample Number	Sample Type	Dynamic Cone Standard Penetration (20 40 60 80)	Shear Strength (PP) kPa / Shear Strength (FV) kPa (50 100 150 200)	Water Content % (10 20 30)	Groundwater Observations and Standpipe Details
		Ground Surface	186.1						
0 / 0		**TOPSOIL** dark brown sandy silt, some sand and gravel, wet (300mm)	0.0 185.8	1	SS	4		14	
		SILT TILL loose mottled grey/brown silt, some clay and gravel, trace sand, very moist	0.3 185.3						
2		compact	0.8	2	SS	18		14	
4									
6 / 2				3	SS	23		15	
			183.8						
8		**SILT AND CLAY TILL** hard to very stiff brown silt and clay, some sand, trace gravel, DTPL	2.3	4	SS	19	>200	15	
10				5	SS	23	175	13	
12			182.1						
4		grey, WTPL	4.0	6	GS			16	
14			181.8						
		Drilling Terminated	4.3						
16									

Groundwater Observations and Standpipe Details: ← Cuttings; ← Bentonite; ← Wet Cave

Water encountered at 4.0 mbgs during drilling

Field Technician: M. Dalgliesh

Drafted by: B. Ehgoetz

Reviewed by: D. Gonser

Sheet: 1 of 1

Notes:
Auger refusal on assumed bedrock at 4.3mbgs

ID Number: BH105-21

Project: 1107 Garrison Road Mixed Use Development

Project No: 48074-300

Client: 1107 Garrison Road Limited Partnership

Site Location: 1107 Garrison Road, Fort Erie, ON

Drill Date: 1/18/2021

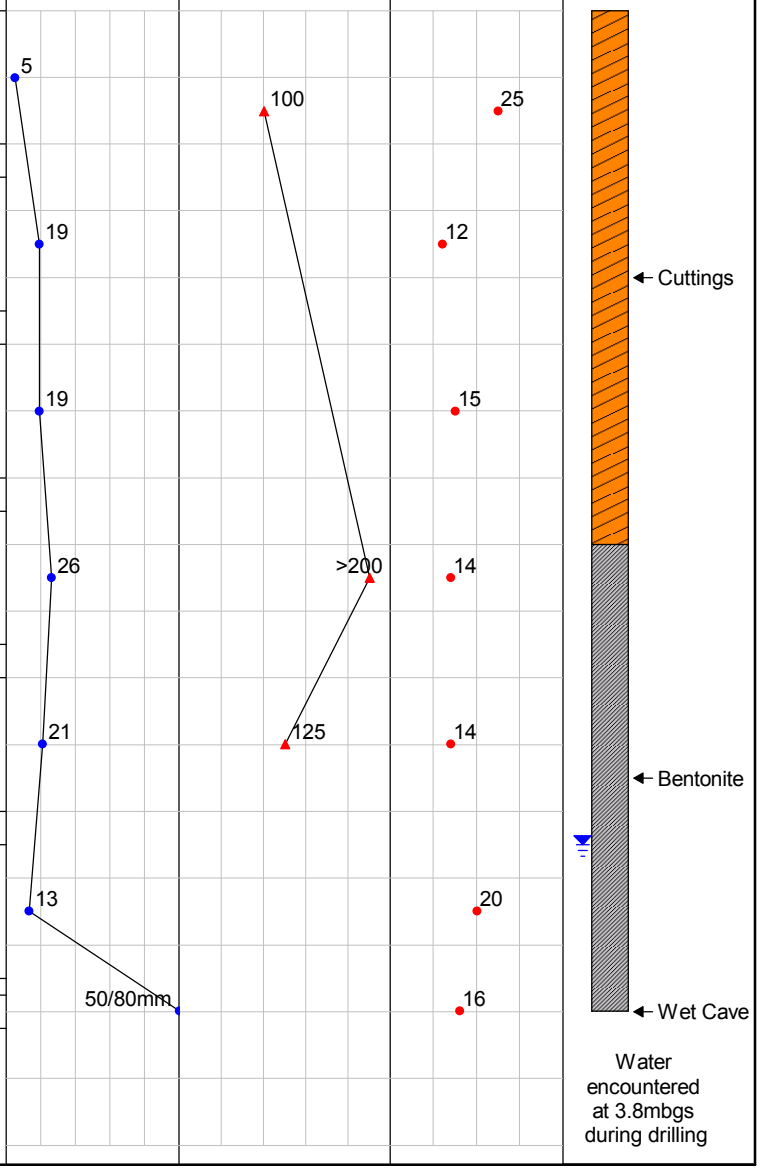
Drilling Contractor: Elite Drilling Services

Drill Rig: D50T Track Mount

Drill Method: Solid Stem Augers

Protective Cover: N/A

Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Sample Number	Sample Type
0 / 0		Ground Surface	185.4		
		TOPSOIL dark brown sandy silt, wet (330mm)	0.0 185.1	1	SS
2		**CLAYEY SILT TILL** stiff mottled grey/brown clayey silt, some gravel, trace sand, APL	0.3 184.6		
		SILT TILL compact mottled grey/brown silt, some clay and gravel, trace sand, very moist	0.8	2	SS
4					
6 / 2				3	SS
			183.1		
8		**CLAYEY SILT TILL** hard to very stiff brown clayey silt, some gravel, trace sand, DTPL	2.3	4	SS
10					
				5	SS
12			181.6		
		SILT TILL compact to very dense grey silt, some clay and sand, trace gravel, saturated	3.8	6	SS
14 / 4					
			180.8	7	SS
16		Drilling Terminated	4.6		



Field Technician: M. Dalgliesh

Drafted by: B. Ehgoetz

Reviewed by: D. Gonser

Sheet: 1 of 1

Notes:
Auger refusal on assumed bedrock at 4.6mbgs

ID Number: BH106-21

Project: 1107 Garrison Road Mixed Use Development

Project No: 48074-300

Client: 1107 Garrison Road Limited Partnership

Site Location: 1107 Garrison Road, Fort Erie, ON

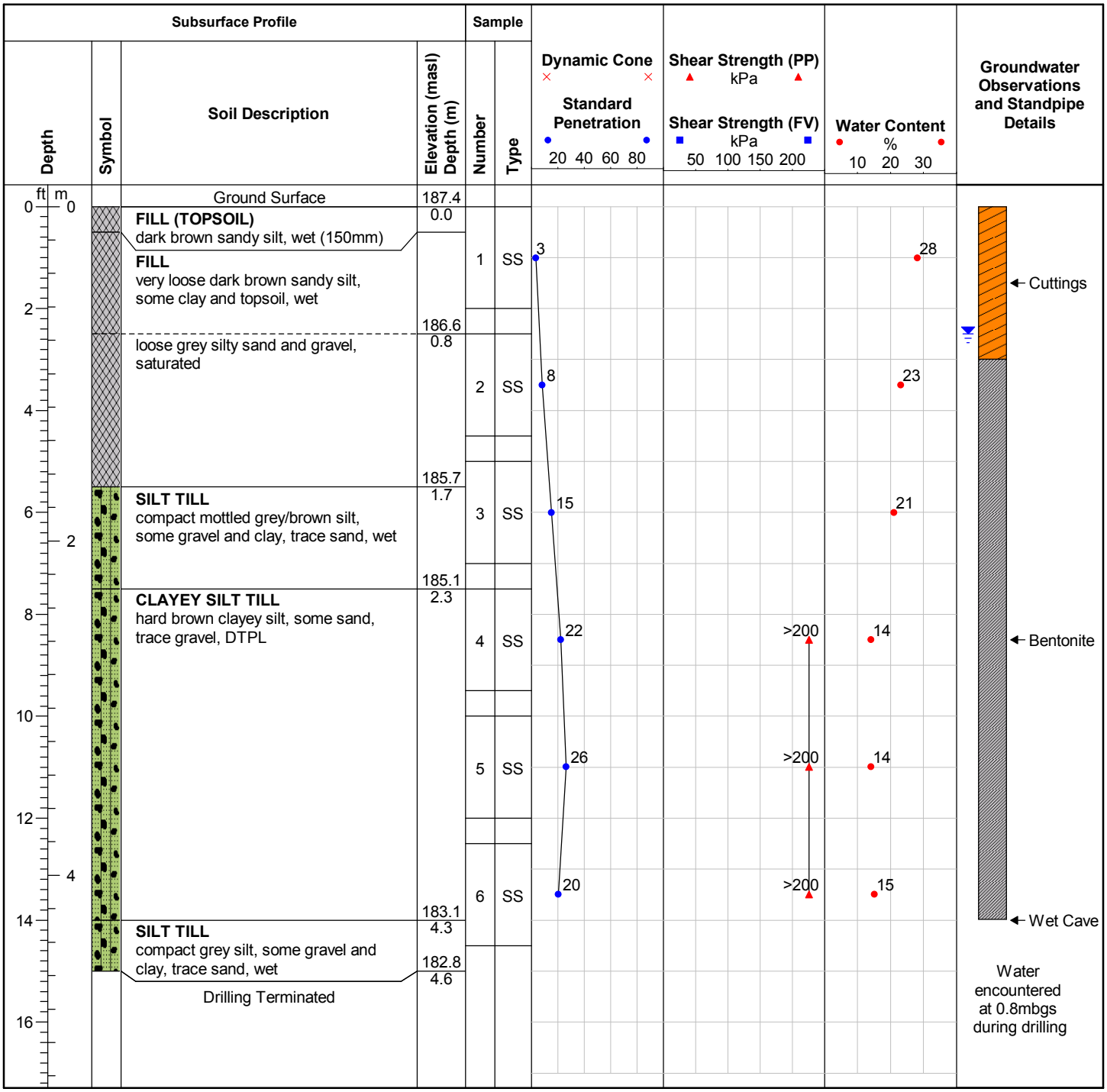
Drill Date: 1/19/2021

Drilling Contractor: Elite Drilling Services

Drill Rig: D50T Track Mount

Drill Method: Solid Stem Augers

Protective Cover: N/A



Field Technician: M. Dalgliesh

Drafted by: B. Ehgoetz

Reviewed by: D. Gonser

Sheet: 1 of 1

Notes:
Auger refusal on assumed bedrock at 4.6mbgs

ID Number: BH107-21

Project: 1107 Garrison Road Mixed Use Development

Project No: 48074-300

Client: 1107 Garrison Road Limited Partnership

Site Location: 1107 Garrison Road, Fort Erie, ON

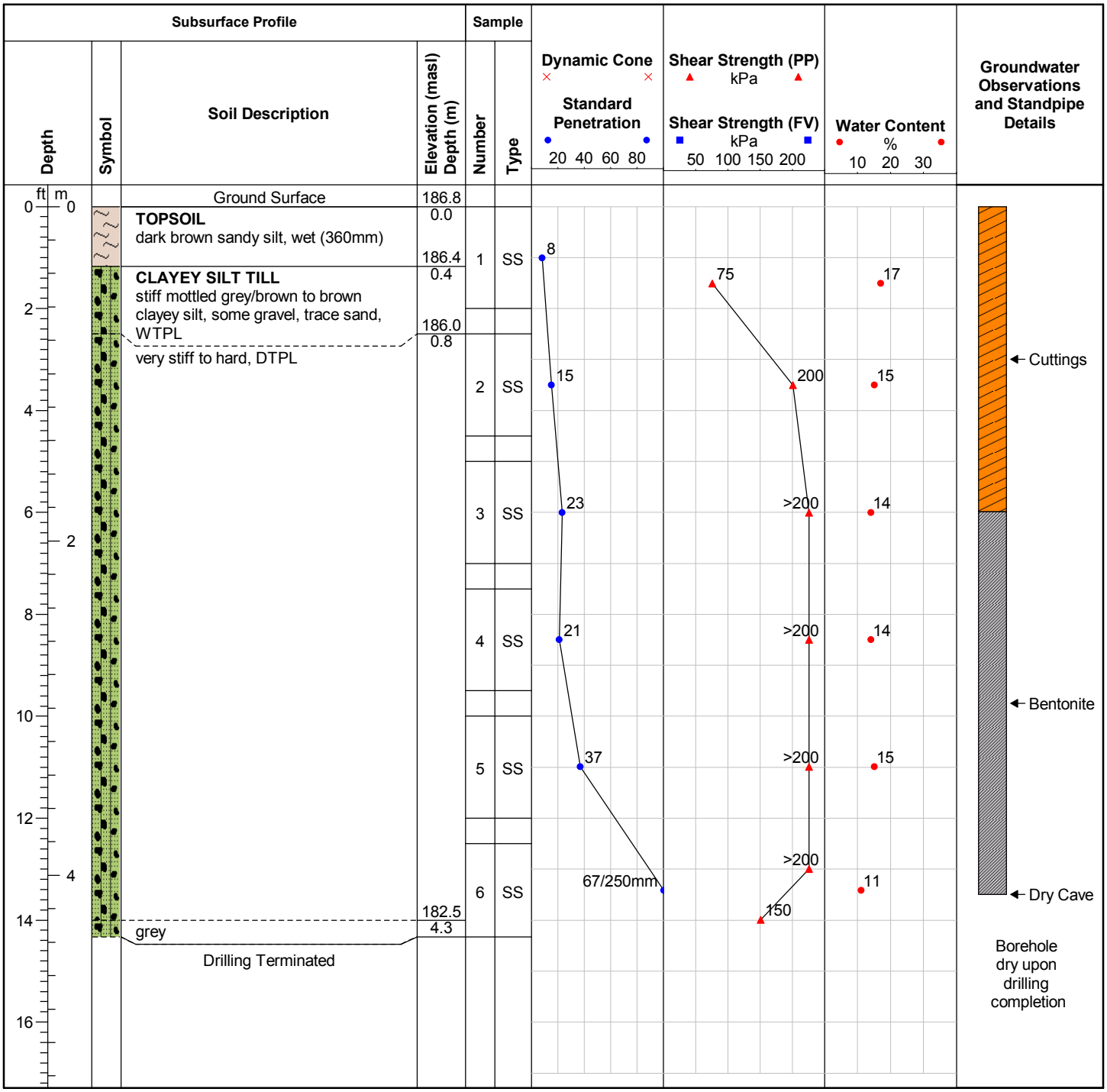
Drill Date: 1/19/2021

Drilling Contractor: Elite Drilling Services

Drill Rig: D50T Track Mount

Drill Method: Solid Stem Augers

Protective Cover: N/A



Field Technician: M. Dalgliesh

Drafted by: B. Ehgoetz

Reviewed by: D. Gonser

Sheet: 1 of 1

Notes:
Auger refusal on assumed bedrock at 4.4mbgs

ID Number: BH108-21

Project: 1107 Garrison Road Mixed Use Development

Project No: 48074-300

Client: 1107 Garrison Road Limited Partnership

Site Location: 1107 Garrison Road, Fort Erie, ON

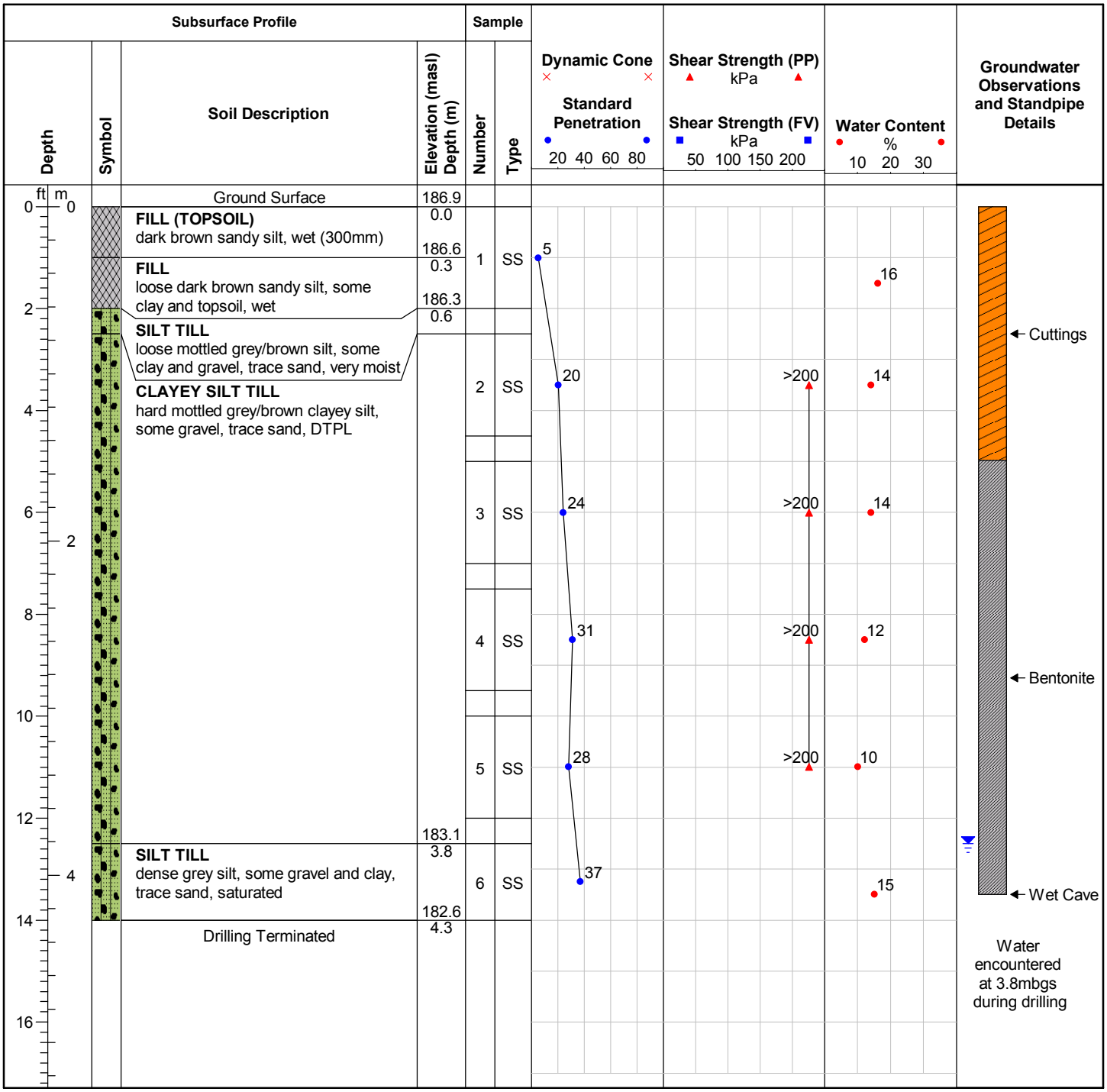
Drill Date: 1/19/2021

Drilling Contractor: Elite Drilling Services

Drill Rig: D50T Track Mount

Drill Method: Solid Stem Augers

Protective Cover: N/A



Field Technician: M. Dalgliesh

Drafted by: B. Ehgoetz

Reviewed by: D. Gonser

Sheet: 1 of 1

Notes:
Auger refusal on assumed bedrock at 4.3mbgs

ID Number: BH109-21

Project: 1107 Garrison Road Mixed Use Development

Project No: 48074-300

Client: 1107 Garrison Road Limited Partnership

Site Location: 1107 Garrison Road, Fort Erie, ON

Drill Date: 1/19/2021

Drilling Contractor: Elite Drilling Services

Drill Rig: D50T Track Mount

Drill Method: Solid Stem Augers

Protective Cover: N/A

Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Sample Number	Sample Type	Dynamic Cone / Standard Penetration (20 40 60 80)	Shear Strength (PP) kPa / Shear Strength (FV) kPa (50 100 150 200)	Water Content % (10 20 30)	Groundwater Observations and Standpipe Details
0 ft / 0 m		Ground Surface	186.5						
		TOPSOIL dark brown sandy silt, wet (250mm)	0.0 / 186.2						
		SILT AND CLAY firm mottled grey/brown silt and clay, WTPL	0.3 / 185.7	1	SS	6	50	18	Cuttings
		CLAYEY SILT TILL hard mottled grey/brown clayey silt, some gravel, trace sand, DTPL	0.8	2	SS	15	>200	14	Bentonite
2 m									
				3	SS	22	>200	13	Dry Cave
			184.4						Borehole dry upon drilling completion
		Drilling Terminated	2.1						
4 m									

Field Technician: M. Dalgliesh

Drafted by: B. Ehgoetz

Reviewed by: D. Gonser

MTE

ID Number: BH110-21

Project: 1107 Garrison Road Mixed Use Development

Project No: 48074-300

Client: 1107 Garrison Road Limited Partnership

Site Location: 1107 Garrison Road, Fort Erie, ON

Drill Date: 1/19/2021

Drilling Contractor: Elite Drilling Services

Drill Rig: D50T Track Mount

Drill Method: Solid Stem Augers

Protective Cover: N/A

Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Sample Number	Sample Type	Dynamic Cone / Standard Penetration (20 40 60 80)	Shear Strength (PP) kPa / Shear Strength (FV) kPa (50 100 150 200)	Water Content % (10 20 30)	Groundwater Observations and Standpipe Details
0 ft / 0 m		Ground Surface	185.8						
		TOPSOIL dark brown sandy silt, some organics, wet (360mm)	0.0 / 185.4	1	SS	3	50	19	Cuttings
2 ft		**SILT AND CLAY** firm mottled grey/brown silt and clay, trace sand, WTPL	0.4 / 185.0						
		CLAYEY SILT TILL hard mottled grey/brown clayey silt, some gravel, trace sand, DTPL	0.8	2	SS	13	>200	15	Bentonite
4 ft									Dry Cave
6 ft / 2 m				3	SS	19	>200	15	Borehole dry upon drilling completion
		Drilling Terminated	183.7 / 2.1						
8 ft									
10 ft									
12 ft / 4 m									
14 ft									
16 ft									

Field Technician: M. Dalgliesh

Drafted by: B. Ehgoetz

Reviewed by: D. Gonser

MTE

ID Number: BH111-21

Project: 1107 Garrison Road Mixed Use Development

Project No: 48074-300

Client: 1107 Garrison Road Limited Partnership

Site Location: 1107 Garrison Road, Fort Erie, ON

Drill Date: 1/19/2021

Drilling Contractor: Elite Drilling Services

Drill Rig: D50T Track Mount

Drill Method: Solid Stem Augers

Protective Cover: N/A

Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Sample Number	Sample Type	Dynamic Cone – Standard Penetration (20 40 60 80)	Shear Strength (PP) kPa / Shear Strength (FV) kPa (50 100 150 200)	Water Content % (10 20 30)	Groundwater Observations and Standpipe Details
0 / 0		Ground Surface	186.4						
		TOPSOIL dark brown sandy silt, wet (300mm)	0.0 / 186.1	1	SS	10		14	Cuttings
2 /		**SILT TILL** compact mottled grey/brown silt, some clay and gravel, trace sand, very moist to wet	0.3	2	SS	20		13	Bentonite
6 / 2				3	SS	20		13	Dry Cave
			184.3						Borehole dry upon drilling completion
		Drilling Terminated	2.1						
8									
10									
12 / 4									
14									
16									

Field Technician: M. Dalgliesh

Drafted by: B. Ehgoetz

Reviewed by: D. Gonser

MTE

Sheet: 1 of 1

ID Number: BH112-21

Project: 1107 Garrison Road Mixed Use Development

Project No: 48074-300

Client: 1107 Garrison Road Limited Partnership

Site Location: 1107 Garrison Road, Fort Erie, ON

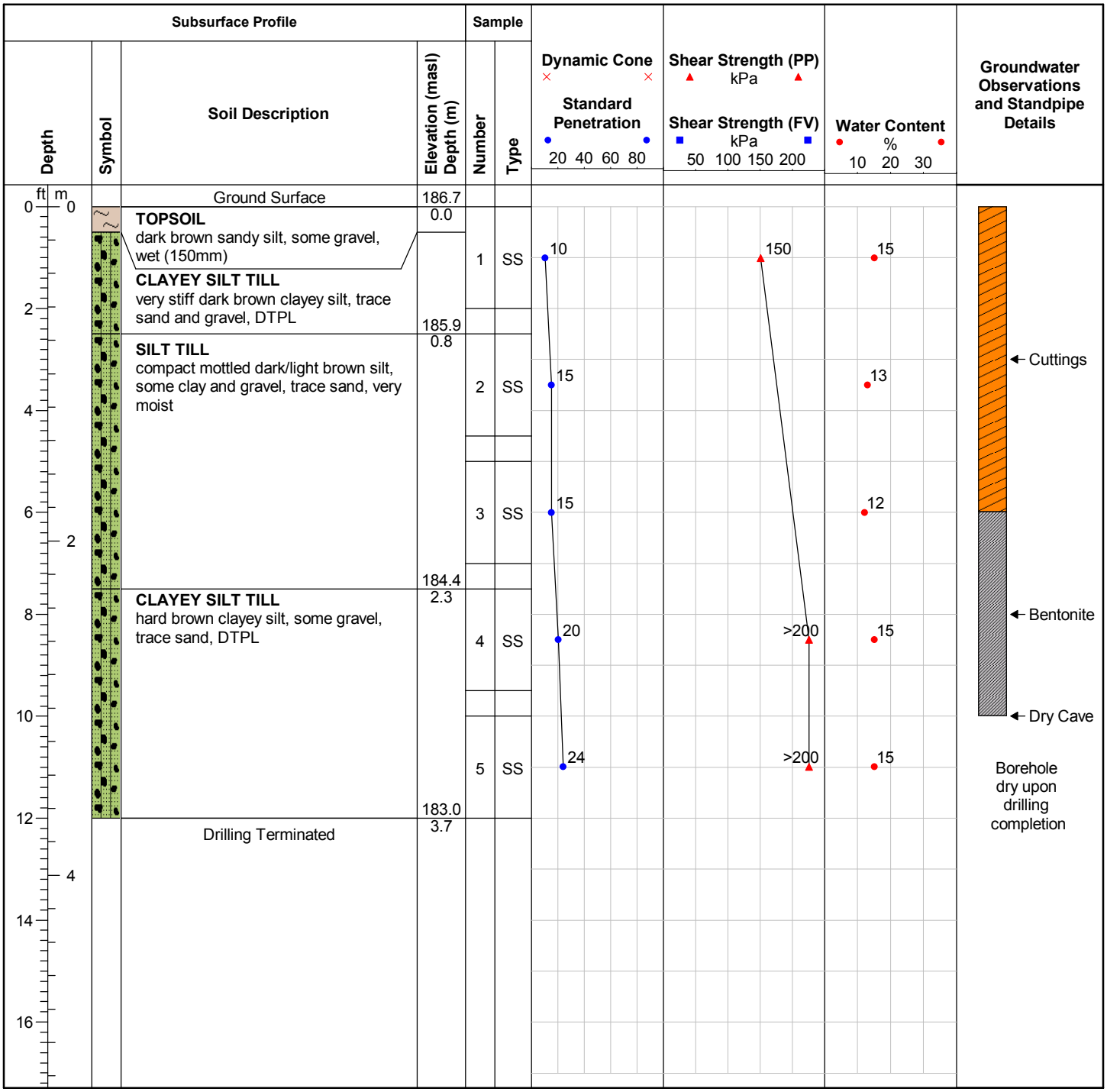
Drill Date: 1/19/2021

Drilling Contractor: Elite Drilling Services

Drill Rig: D50T Track Mount

Drill Method: Solid Stem Augers

Protective Cover: N/A



Field Technician: M. Dalgliesh

Drafted by: B. Ehgoetz

Reviewed by: D. Gonser

MTE

Sheet: 1 of 1

Appendix C

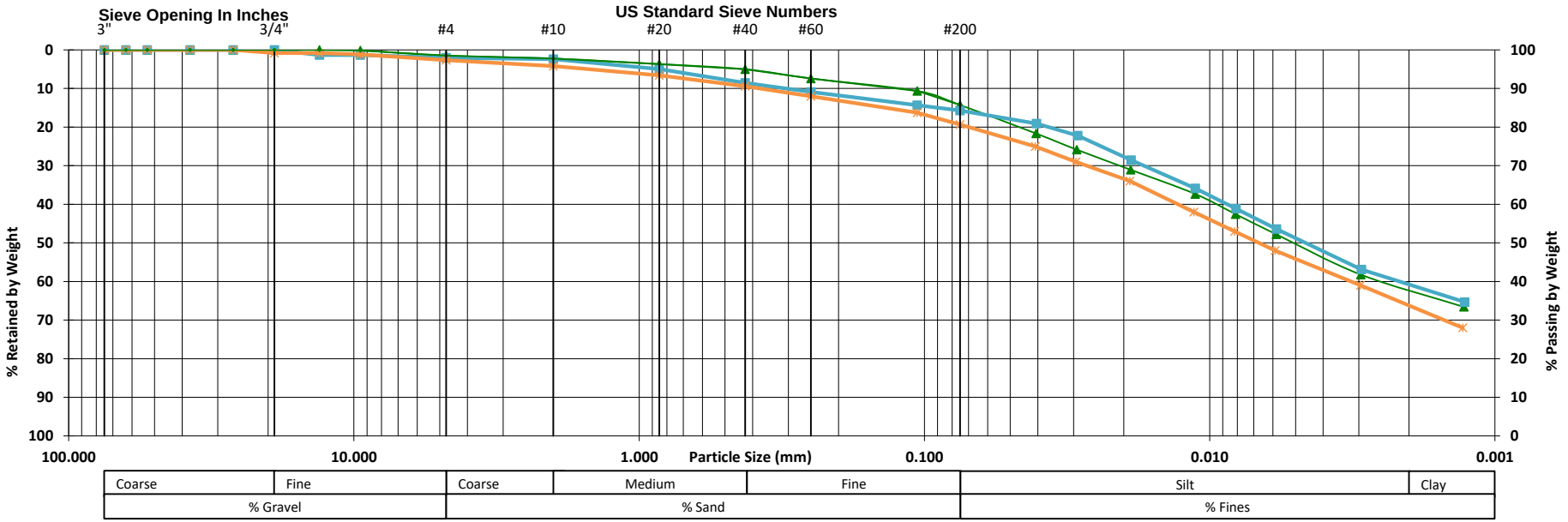
Laboratory Test Results

Table 101

Particle Size Distribution Analysis Test Results

Project Name:	**1107 Garrison Road Mixed Use Development**	**Date Sampled:**	**Jan. 18-19, 2021**	**MTE File No.:**	**48074-300**
Client:	**1107 Garrison Road Limited Partnership**	**Date Tested:**	**Feb. 1-4, 2021**	**Table No.:**	**101**
Project Location:	**1107 Garrison Road, Fort Erie, ON**				

Unified Soil Classification



Symbol	Borehole ID	Sample #	*Sample Depth*	Description
▲	BH101-21	SS-3	1.5-2.1 mbgs	SILT and CLAY TILL, some Sand, trace Gravel
■	BH104-21	SS-4	2.3-2.9 mbgs	SILT and CLAY TILL, some Sand, trace Gravel
✱	BH106-21	SS-4	2.3-2.9 mbgs	Clayey SILT TILL, some Sand, trace Gravel

NOTES:

CERTIFIED BY CCIL Canadian Council of Independent Laboratories
For specific tests as listed on www.ccil.com