

# **GEOTECHNICAL INVESTIGATION**

**GEOTECH – PROPOSED TOWNHOUSE DEVELOPMENT  
465 GARAFRAXA STREET WEST  
FERGUS, ONTARIO**

**CMT Project 22-765.R01**

**Prepared for:**

**Habitat for Humanity**

**November 28, 2022**





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November 28, 2022

22-765.R01

Habitat for Humanity  
104 Dawson Road  
Suite 100B  
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N1H 1A6

Attention: Janey Secnic

Dear Janey:

**Re: Geotechnical Investigation  
Geotech – Proposed Townhouse Development  
465 Garafraxa Street West  
Fergus, Ontario**

As requested, CMT Engineering Inc. conducted a geotechnical investigation at the above referenced site, and we are pleased to present the enclosed report.

We trust that this information meets your present requirements, and we thank you for allowing us to undertake this project. Should you have any questions, please do not hesitate to contact our office.

Yours truly,

A handwritten signature in black ink, appearing to read 'Jake Feeney', written in a cursive style.

Jake Feeney P. Eng.

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## **1.0 INTRODUCTION**

The services of CMT Engineering Inc. (CMT Inc.) were retained by Janey Secnic of Habitat for Humanity to conduct a geotechnical investigation for the proposed new townhouse development to be constructed at 465 Garafraxa Street West, Fergus, Ontario. The location of the site is shown on Drawing 1.

It is understood that the project will involve the construction of three (3) townhouse blocks with associated roadways and parking areas.

The purpose of the geotechnical investigation was to assess the existing soil and groundwater conditions encountered in the boreholes. Included in the assessment are the soil classification and groundwater observations, as well as comments and recommendations regarding geotechnical resistance (bearing capacity); serviceability limit states (anticipated settlement); dewatering considerations; site classification for seismic site response; recommendations for site grading, site servicing, excavations and backfilling; recommendations for slab-on-grade construction; pavement design/drainage; soil design properties; and a summary of the laboratory results.

The recommendations provided in this report are solely based on the information obtained from the boreholes advanced on the subject site.

## **2.0 EXISTING SITE CONDITIONS**

The site of the proposed residential development is located to the Northwest of Garafraxa Street West. The site is bounded by Garafraxa Street West to the Southeast, undeveloped land to the Northeast and Northwest, and agricultural land to the Southwest. The site currently comprises vacant land, with some trees and a walking trail. In general, the site topography is relatively flat with existing ditches throughout the proposed construction area. It is understood that the site is to be serviced by municipal services.

## **3.0 FIELD AND LABORATORY PROCEDURES**

The field investigation was conducted on November 16, 2022 and comprised the advancement of seven (7) boreholes (referenced as Boreholes 1 to 7), utilizing a Geoprobe 7822DT drillrig operated by employees of CMT Drilling Inc. Boreholes 1 to 5 were advanced to depths of approximately 5.18 m (17.00 ft) below the existing ground surface in the area of the proposed townhouses. Boreholes 6 and 7 were advanced to depths of approximately 1.52 m (5.00 ft) below the existing ground surface in the area of the proposed parking lot. Prior to the field investigation being carried out, underground service locates were undertaken to ensure that existing utilities would not be damaged, or any personnel injured.

Standard penetration testing and sampling was carried out in Boreholes 1 to 5 using 38 mm inside diameter split spoon sampling equipment and an automatic hammer, in accordance with ASTM D1586 "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils". SPT soil sampling was generally conducted at 0.76 m (2.5 ft) intervals to 3.05 m (10.00 ft) and every 1.52 m (5.00 ft) thereafter, to borehole termination. Macro core (MC5) direct push sampling was conducted between the SPT soil samples conducted below 3.05 m (10.0 ft) depth and throughout Boreholes 6 and 7. Technical staff from CMT Inc. observed the drilling operation and collected and logged the recovered soil samples. A small portion of each sample was placed in a sealed, marked jar for moisture content determinations.

Representative soil samples from the boreholes at the following depths were submitted to the CMT Inc. laboratory in St. Clements, Ontario for grain size analyses:

- Borehole 3 – depth 1.52 m to 2.13 m (5.00 ft to 7.00 ft); and
- Borehole 5 – depth 3.05 m to 3.66 m (10.00 ft to 12.00 ft).

The borehole logs are provided in Appendix A and the resulting grain size analyses can be found in Appendix B.

The ground surface elevations of the boreholes were surveyed by CMT Inc. (using laser survey equipment) following the completion of drilling. The ground surface elevation of the existing bell pedestal located on the Southeast side of the site beside Garafraxa Street West was utilized as a temporary benchmark, with an assumed elevation of 100.00 m. As such, the ground surface elevation at the borehole locations ranged from approximately 99.34 m to 100.20 m. The locations of the boreholes are shown on Drawing 2.

#### **4.0 SUBSOIL CONDITIONS**

The soils encountered in the boreholes are described briefly below and a more detailed stratigraphic description is provided on the borehole logs in Appendix A. The following paragraphs have been simplified into terms of major soil strata. The soil boundaries indicated have been inferred from non-continuous samples and observations of sampling and drilling resistance and typically represent transitions from one soil type to another rather than exact planes of geological change. Further, the subsurface conditions are anticipated to vary between and beyond the borehole locations.

#### **4.1. Topsoil**

Loose, dark brown, silty, organic topsoil in a moist state was encountered at the surface of Boreholes 4 and 7 and buried within the sand and gravel fill soil at Boreholes 1 and 2. The thickness of the topsoil was observed to range from about 300 mm to 600 mm (average 450 mm) at the borehole locations, however the thickness of the topsoil is anticipated to vary throughout the site. Materials noted as topsoil in this report were classified based on visual and textural evidence. Testing of organic content or for other nutrients was not carried out.

#### **4.2. Sand and Gravel Fill**

Brown sand and gravel fill was encountered at the surface of Boreholes 1 to 3 and 6. Black buried topsoil was observed within the sand and gravel fill at Boreholes 1 and 2. The sand and gravel fill were compact with SPT N-values ranging from about 14 to 19 blows per 0.30 m (average 17 blows per 0.30 m). The sand and gravel fill soils are considered to be moist, with moisture contents ranging from about 7.6% to 10.6% (average 9.4%).

#### **4.3. Silt Fill**

Brown silt fill with trace gravel was encountered at the surface of Borehole 4. Black staining was observed within the silt fill. The silt fill was considered to be firm with a SPT N-value of about 4 blows per 0.30 m. The silt fill was considered to be moist, with a moisture content of about 11.8%.

#### **4.4. Silty Sand**

Brown silty sand was encountered underlying the sand and gravel fill at Borehole 1, the sandy silt at Borehole 2, the silt fill at Borehole 4 and the topsoil at Borehole 5 and 7. The silty sand was observed to extend to the termination depth of Borehole 7. The silty sand was considered to be loose to compact with SPT N-values ranging from about 9 to 29 blows per 0.30 m (average 18 blows per 0.30 m). The silty sand soils are considered to be moist, with moisture contents ranging from about 5.2% to 14.3% (average 9.7%).

#### **4.5. Sandy Silt/Sandy Silt Till**

Brown to grey sandy silt/sandy silt till with some clay and trace gravel were encountered underlying the silty sand at Boreholes 1, 2, 4 and 5 and underlying the sand and gravel fill at Boreholes 2, 3 and 6. The sandy silt/sandy silt till was observed to extend to the termination depths of Boreholes 1 to 6. The sandy silt/sandy silt till was considered to be stiff to hard with SPT N-values ranging from about 10 to greater than 100 blows per 0.30 m (average 43 blows per 0.30 m). The sandy silt/sandy silt till soils are considered to be moist, with moisture contents ranging from about 3.1% to 15.9% (average 9.3%).

#### **4.6. Groundwater**

No accumulated groundwater or seepage was observed upon completion of the boreholes. It should be noted that the stiff to hard sandy silt till soils encountered in the boreholes have the potential to create perched groundwater conditions in any overlying soils. Groundwater conditions (particularly perched water) are generally dependent on the weather conditions, amount of precipitation, site grading and other measures in place to control surface water drainage, as well as the time of year, and can fluctuate significantly in elevation over time.

Recommendations with respect to dewatering conditions are provided in Section 5.8 of this report, and recommendations regarding waterproofing and drainage are presented in Section 5.10.

### **5.0 DISCUSSION AND RECOMMENDATIONS**

This section of the report provides CMT Inc.'s interpretation of the factual geotechnical data obtained during the investigation and is intended for the guidance of the owner and design engineer. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. Contractors bidding on or undertaking the work should make their own independent interpretation of the factual subsurface information provided as it affects their proposed construction means and methods, equipment selection, scheduling, pricing, and the like.

Utilizing the information gathered during the geotechnical investigation and assuming that the borehole information is representative of the subsoil conditions throughout the site, the following comments and recommendations are provided.

**5.1. Serviceability and Ultimate Limit Pressure**

Based on the information obtained from the boreholes, the following table provides a summary of the estimated geotechnical reaction at the Serviceability Limit State (SLS) and the factored geotechnical resistance at the Ultimate Limit State (ULS) at the various elevations, including soil type:

BH No.	Ground Surface Elevation (m)	SLS kPa (psf)	ULS kPa (psf)	Estimated Highest Founding Elevations (m)	Depth Below Existing Grade to Founding Elevation (m)	Soil Type
BH1	100.20	150 (3,000)	225 (4,500)	99.13 to 97.15	1.07	Sand and Gravel Fill/Silty Sand/Sandy Silt Till
		200 (4,000)	300 (6,000)	97.15 to 95.02 (termination)	3.05	
BH2	99.83	150 (3,000)	225 (4,500)	98.86 to 97.54	0.97	Sandy Silt/Silty Sand/Sandy Silt Till
		200 (4,000)	300 (6,000)	97.54 to 94.65 (termination)	2.29	
BH3	99.34	150 (3,000)	225 (4,500)	98.58 to 97.05	0.76	Sandy Silt Till
		200 (4,000)	300 (6,000)	97.05 to 94.16 (termination)	2.29	
BH4	99.40	100 (2,000)	150 (3,000)	98.64 to 97.11	0.76	Silty Sand/Sandy Silt Till
		150 (3,000)	225 (4,500)	97.11 to 96.35	2.29	
		200 (4,000)	300 (6,000)	96.35 to 94.22 (termination)	3.05	
BH5	100.17	150 (3,000)	225 (4,500)	99.57 to 97.12	0.60	Silty Sand/Sandy Silt Till
		200 (4,000)	300 (6,000)	97.12 to 94.99 (termination)	3.05	

Based on the bearing capacities and elevations provided in the table above, soils suitable to support conventional foundations designed with an estimated bearing capacity of 150 kPa (3,000 psf) at SLS and 225 kPa (4,500 psf) at ULS were typically encountered in the shallower native soils encountered underlying the fill soils in the boreholes at depths ranging from 0.6 m to 2.29 m below the existing ground surface.



Based on the bearing capacities and elevations provided in the table above, soils suitable to support conventional foundations designed with an estimated bearing capacity of 200 kPa (4,000 psf) at SLS and 300 kPa (6,000 psf) at ULS were typically encountered in the deeper native till soils encountered in the boreholes at depths ranging from 2.29 m to 3.05 m below the existing ground surface.

Should footings be designed to be constructed at elevations higher than the elevations indicated in the table above, then structural fill will be required in order to achieve the design grades for the proposed foundations. The serviceability limit pressure for granular structural fill placed and compacted in accordance with Section 5.4.4 of this report is estimated to be at least 150 kPa (3,000 psf). Alternatively, lean mix concrete fill could be used for this application.

Footings could also be stepped down to bear on approved undisturbed founding soils. Due to the presence of fill soils on the subject site, it is imperative that the founding soils be assessed at the time of construction by qualified geotechnical personnel in order to confirm their founding suitability.

Footings founded on soil may be placed at a higher elevation relative to another footing provided that the slope between the outside face of the footings is separated by a minimum slope of 10 horizontal to 7 vertical (10H:7V) with an imaginary line projected from the underside of the footings.

It is recommended that the structural foundation drawings be cross-referenced with site servicing drawings to ensure that service pipes do not conflict with building foundations (including the zone of influence down and away from the footings).

With respect to the Serviceability Limit State (SLS), the total and differential footing settlements are not expected to exceed the generally acceptable limits of 25 mm (1") and 19 mm (3/4") respectively.

All exterior footings must be provided with a minimum of 1.2 m of soil cover or equivalent thermal insulation in order to provide protection against frost action.

CMT Inc. would be pleased to review design drawings when they become available and provide further recommendations with respect to bearing and foundation elevations.

### 5.2. Seismic Site Classification

The site classification for seismic response in Table 4.1.8.4 of the 2012 Ontario Building Code relates to the average properties of the upper 30.0 m of strata. The information obtained in the geotechnical field investigation was gathered from the upper 5.18 m of strata. Based on the information gathered in the geotechnical field investigation, the site classification for seismic site response would be considered Site Class D (stiff soils) for structures founded on the native soils or structural fill at the recommended founding elevations provided in Section 5.1 of this report. The structural engineer responsible for the design of the structure should review the earthquake loads and effects.

### 5.3. Soil Design Parameters

The following table provides estimated soil design parameters for imported granular fill, as well as the existing native soils encountered on-site. It should be noted that earth pressure coefficients ( $K_a$ ,  $K_p$ ,  $K_o$ ) provided are for flat ground surface conditions and will differ for areas with slopes or embankments.

The estimated soil design parameters can be utilized for the design of perimeter shoring, foundations and retaining walls, as required.

Soil Type	Soil Density (kg/m <sup>3</sup> )	Friction Angle (Degree)	Coefficient of Active Pressure ( $K_a$ )	Coefficient of Passive Pressure ( $K_p$ )	Coefficient of At-Rest Pressure ( $K_o$ )	Coefficient of Friction ( $\mu$ )	Cohesion (Undrained) (kPa)
Imported Granular 'A' / Granular 'B' (OPSS 1010)	2,100	34°	0.28	3.54	0.44	0.45	0
Silty Sand	1,800	32°	0.31	3.25	0.47	0.41	0
Sandy Silt Till	1,850	30°	0.33	3.00	0.50	0.38	0
Sand and Gravel	1,900	34°	0.28	3.54	0.44	0.45	0

### 5.4. Site Preparation

The site preparation for the proposed new townhouses is anticipated to include the removal of topsoil and vegetation, the subexcavation of any unsuitable fill and any native soils deemed not capable of supporting the design bearing capacity, removal, or relocation of any existing services, followed by the placement of structural fill (as required) and site grading to achieve proposed grades.

#### **5.4.1. Topsoil Stripping/Vegetation Removal**

All topsoil (including buried topsoil) must be removed from within the proposed building, parking lot and driveway areas to expose approved competent subgrade soils. The topsoil may be used in landscaped areas where some settlement can be tolerated; otherwise, it should be properly disposed of off-site.

All vegetation and trees (including tree root structures as well as any loose soils that are typically associated with root structures) must be removed from within the proposed building, parking lot and driveway areas to expose approved competent subgrade soils.

The volume of topsoil removed during the stripping process can be influenced by the equipment utilized for the stripping process as well as the moisture conditions at the time of stripping.

#### **5.4.2. Removal/Relocation of Existing Buried Piping**

Any existing underground services (if present) that may be located within the proposed building areas should be removed/relocated. If left in place, the location of existing services must be reviewed to ensure that they do not conflict with proposed foundation locations. This includes any existing subdrains that may be present. Any piping that is left in place that is no longer active must be completely sealed with watertight mechanical covers, concrete, or grout at termination points to prevent the migration of soils into pipe voids, which may result in potential settlement. All existing trench backfill material associated with any underground services must be subexcavated and the subsequent excavation must be backfilled with approved soils placed in accordance with Section 5.4.4 of this report.

#### **5.4.3. Fill Removal**

Any existing fill (including any existing trench backfill), as well as any native soils that have inadequate bearing capacity or have been disturbed by construction processes and is deemed unsuitable to support foundations or slab-on-grades, must be subexcavated from within the proposed building areas, exterior entranceways, perimeter sidewalks, and perimeter concrete slab areas to expose approved competent subgrade soils. It would also be sound construction practice to subexcavate all existing unsuitable fill from the paved parking areas; however, this may not be cost-effective. At a minimum, thorough inspection will be required at the time of construction to assess the existing fill to ensure there is no buried topsoil or other deleterious materials within the subgrade soils.

Remedial action may also be required to further consolidate any existing fill if it is decided to leave it in place. If any existing fill is left in place, provisions for the alterations to the design of the pavement structure should be included in the tender documents. Review of the subgrade and potential changes to the design of the pavement structure, as required, will be addressed at the time of construction.

Prior to reusing excavated material on-site as potential bulk fill, thorough field inspection and approval by qualified geotechnical personnel would be required to ensure that existing fill materials are not comprised of organics, topsoil, or other deleterious materials.

#### **5.4.4. Site Grading**

Following removal of the debris as well as the subexcavation of any fill or native soils deemed unsuitable of supporting the design bearing capacity, the exposed subgrade soils must be proof-rolled, and any soft or unstable areas must be subexcavated and replaced with approved fill materials.

Any fill materials required to achieve the design grades should be placed according to the following procedures:

- Prior to placement of any structural fill or bulk fill, the subgrade for the proposed buildings and parking lot must be prepared large enough to accommodate a 1:1 slope commencing a distance of 1.0 m beyond the outside edge of the proposed foundation and pavement edge (where feasible) to the approved competent founding soils;
- Soils approved for use as structural fill must be placed in loose lifts not exceeding 0.3 m (12") in depth for granular soils (recommended fill material) and 0.2 m (8") in depth for silts and clays (not recommended for this application), or the capacity of the compactor (whichever is less);
- Granular fill materials (OPSS 1010 Type III Granular 'B' recommended for this application) can be compacted utilizing adequate heavy vibratory smooth drum or padfoot compaction equipment;
- Fine-grained silt and clay soils (not recommended) must be compacted utilizing adequate heavy padfoot vibratory compaction equipment;
- Approved fill materials must be at suitable moisture contents to achieve the specified compaction. Soil moisture will also be dependent on weather conditions at the time of construction. Granular soils may require the addition of water in order to achieve the specified compaction;

- Approved structural fill materials that will support structures (including foundations, interior slab-on-grades, sidewalks and large expansive exterior slabs) must be compacted to 100% standard Proctor maximum dry density (SPMDD);
- Approved bulk fill (foundation wall backfill, bulk fill under slab-on-grades that will not support footings or heavy point loading) must be compacted to a minimum 98% SPMDD. It would be expected that the native soils would be suitable for use as bulk fill; however, depending on the time of year and weather conditions when construction takes place, soils excavated at depth may require air-drying in order to achieve the specified density;
- Granular 'B' subbase and Granular 'A' base materials for the paved parking areas must be compacted to 100% SPMDD.

Any wet soils encountered in the boreholes will require significant air-drying along with working of the soils in order to achieve the specified compaction. Utilizing the existing soils during site grading may be more achievable if work is completed during the generally drier summer months. It should be noted, however, that due to the nature of some of the soils, during hot dry weather, the addition of water might be required in order to achieve the specified compaction. Reuse of excavated soils on-site will be subject to approval from qualified geotechnical personnel.

#### **5.5. Foundation Subgrade Preparation**

The native soils encountered in the boreholes are sensitive to changes in moisture content and can become loose/soft if the soils are subjected to additional water or precipitation, as well as severe drying conditions. The native subgrade soils could also be easily disturbed if traveled on during construction. Once they become disturbed, they are no longer considered adequate for the support of shallow foundations.

To ensure and protect the integrity of the founding soils during construction operations, the following is recommended:

- Should the native soils at the design founding elevation in the proposed building envelope comprise wet or saturated soils, then a granular drainage layer, constructed in accordance with Section 9.14.4 of the current Ontario Building Code (OBC) may be required. Alternatively, a lean mix concrete mud mat may be poured overlying the subgrade soils to provide a stable base;

- During construction, the subgrade should be sloped to a sump (as required) located outside the building footprints (if feasible) in the excavation to promote surface drainage of rainwater or seepage and the collected water should be pumped out of the excavation. It is critical that all water be controlled (not allowed to pond) and that the subgrade and foundation preparation commence in dry conditions;
- Construction equipment travel and foot traffic on the founding soils should be minimized;
- If construction is to be undertaken during subzero weather conditions, the founding native soils and any potential fill materials must be maintained above freezing;
- Prior to placing concrete for the footings, the footing area must be cleaned of all disturbed or caved materials;
- The foundation formwork and concrete should be installed as soon as practical following the excavation, inspection, and approval of the founding soils. The longer that the excavated soils remain open to weather conditions and groundwater seepage, the greater the potential for construction problems to occur;
- If it is expected that the founding soils will be left open to exposure for an extended period of time, it is recommended that a 75 mm concrete mud slab be placed in order to protect the structural integrity of the founding soils.

Due to the variability of the native soils encountered in the boreholes, all foundation excavations must be reviewed by qualified personnel to confirm the suitability of the founding fill soils prior to foundation placement.

#### **5.6. Slab-on-Grade/Modulus of Subgrade Reaction**

Prior to the placement of the granular base for any slab-on-grades, the subgrade soils must be proof-rolled. Any soft or weak zones, as well as the unsuitable fill in the subgrade, should be subexcavated and backfilled with approved fill materials (see Sections 5.4.4 and 5.10 of this report).

The following table provides the estimated modulus of subgrade reaction (k) for imported granular fill, as well as the native soils encountered on-site:

Soil Type	Estimated Modulus of Subgrade Reaction (k)
Imported Sand and Gravel (OPSS 1010)	81,000 kN/m <sup>3</sup> (300 lb/in <sup>3</sup> )
Sandy Silt/Sandy Silt Till	61,200 kN/m <sup>3</sup> (225 lb/in <sup>3</sup> )
Silty Sand	61,200 kN/m <sup>3</sup> (225 lb/in <sup>3</sup> )
Sand and Gravel	68,000 kN/m <sup>3</sup> (250 lb/in <sup>3</sup> )

In dry conditions, floor slabs can be founded on a minimum thickness of 150 mm (6") of Granular 'A' (OPSS 1010) and compacted to 100% SPMDD. If wet to saturated conditions are encountered during the excavation of the site, it would be recommended that for any basement floor slabs, 150 mm (6") of 19 mm clear crushed stone (OPSS 1004) should be used instead of Granular 'A'. Utilizing clear crushed stone for the slab-on-grade base can assist in providing a moisture barrier by reducing the potential for capillary rise of moisture from the subgrade soils. Compactive effort is required to consolidate the clear stone. The 19 mm clear crushed stone should meet the physical property and gradation requirements of OPSS 1004.

It is recommended that areas of extensive exterior slab-on-grade (sidewalks and accessibility ramps) be constructed with a Granular 'B' subbase (450 mm) and a Granular 'A' base (150 mm), as well as incorporating subdrains, to promote rapid drainage and reduce the effects of frost heaving. This is particularly critical at barrier-free access points. Alternatively, structural frost slabs could be designed and constructed, or sufficient thermal insulation could be provided, at all door entrances and areas of barrier-free access.

### **5.7. Excavations**

All excavations must be carried out in accordance with Ontario Regulation 213/91 (Reg 213/91) of the Occupational Health and Safety Act and Regulations for Construction Projects.

**Type 2 Soils** - In general, the native sandy silt till soils encountered in the boreholes in a drained state (not saturated), would be classified as Type 2 soils under Reg 213/91. The Type 2 soils must be sloped from within 1.2 m of the bottom of the excavation having a minimum gradient of 1 horizontal to 1 vertical. Soils underlain by Type 3 or 4 soils that are exposed in the excavation must be treated accordingly as Type 3 or 4 soils (see below). All saturated soils encountered must be treated as Type 4 soils, as described below.

**Type 3 Soils** - In general, the silty sand/silty sand and any existing fill materials (including backfill of existing foundations and services) in a drained state (not saturated), would be classified as Type 3 soils under Reg 213/91. The Type 3 soils must be sloped from the bottom of the excavation at a minimum gradient of 1 horizontal to 1 vertical. Soils underlain by Type 4 soils that are exposed in the excavation must be treated accordingly as Type 4 soils (see below). All saturated soils encountered must be treated as Type 4 soils, as described below.

**Type 4 Soils** - In general, any wet to saturated soils would be classified as Type 4 soils under Reg 213/91. Type 4 soils must be sloped from the bottom of the excavation at a minimum gradient of 3 horizontal to 1 vertical.

If it is not practical to excavate according to the above requirements, then a trench support system (designed in accordance with the Ontario Health and Safety Act Regulations) may be utilized. When using a temporary trench support system consisting of trench boxes to reduce the lateral extent of the excavations, it should be noted that the support system is intended primarily to protect workers as opposed to controlling lateral soil movement. Any voids between the excavation walls and the support system should be immediately filled to reduce the potential for loss of ground and to provide support to existing adjacent utilities and structures, and it is recommended that the excavation be carried out in short sections, with the support system installed immediately upon excavation completion.

#### **5.8. Construction Dewatering Considerations**

Groundwater conditions (particularly perched water) are generally dependent on the amount of precipitation, control of surface water, as well as the time of year, and can fluctuate significantly in elevation and volume. As such, provisions for site dewatering should be part of the site development and construction process.

Seepage control requirements during construction will depend upon the area of work on the site, the depth of the excavations, the time of year, the amount of precipitation and the control of surface water. As required, seepage should generally be adequately controlled using conventional construction dewatering techniques such as pumping from sump pits. However, if heavy seepage occurs (particularly in the saturated soil deposits), it may be necessary to increase the number of pumps during construction.

Dewatering should be performed in accordance with OPSS 517 and the control of water must be in accordance with OPSS 518. It is the responsibility of the contractor to propose a suitable dewatering system based on the groundwater elevation at the time of construction. Collected water should discharge a sufficient distance away from the excavation to prevent re-entry. Sediment control measures must be installed at the discharge point of the dewatering system to avoid any potential adverse impacts on the environment.



### **5.9. Service Pipe Bedding**

The native soils encountered in the geotechnical investigation are generally considered suitable for indirect support of the site service pipes. Should instability due to saturated soil conditions be encountered, it may be necessary to increase the thickness of the granular base and utilize 19 mm clear stone to create an adequate supporting base for the service pipes and/or manholes. Pipe embedment, cover and backfill for both flexible and rigid pipes should be in accordance with all current and applicable OPSD, OPSS and OBC standards and guidelines and as follows:

**Flexible Pipes** – The pipe bedding should be shaped to receive the bottom of the pipe. If necessary, pipe culvert frost treatment should be undertaken in accordance with OPSD-803.031. The trench excavations should be symmetrical with respect to the centreline of the pipe. The granular material placed under the haunches of the pipe must be compacted to 100% SPMDD prior to the continued placement and compaction of the embedment material. The homogeneous granular material used for embedment should be placed and compacted uniformly around the pipe. Should wet conditions be encountered at the base of the trench, then the pipe bedding should consist of 19 mm clear stone (meeting OPS Specifications) wrapped completely in a geotextile fabric such as Terrafix 270 or equivalent.

**Rigid Pipes** - In general, the pipe installation recommendations for rigid pipes are the same as those for flexible pipes, except that the minimum bedding depth below a rigid pipe should be  $0.15D$  (where  $D$  is the pipe diameter). In no case should this dimension be less than 150 mm or greater than 300 mm.

Any service pipes that are not provided with sufficient frost coverage must be protected with the necessary equivalent thermal insulation. The general contractor is responsible to protect existing and new service piping from damage by heavy equipment.

### **5.10. Perimeter Building Drainage, Foundation Wall Backfill and Trench Backfill**

In order to assist in maintaining a dry building with respect to surface water seepage, it is recommended that exterior grades around the building be sloped down and away at a 2% gradient or more, for a distance of at least 1.5 m. Any surface discharge rainwater leaders must be constructed with solid piping that discharges with positive drainage at least 1.5 m away from the building foundation and/or beyond sidewalks to a drainage swale or appropriate storm drainage system.

In order to reduce the effects of surficial frost heave in areas that will be hard surfaced, it is recommended that the exterior foundation backfill consist of free-draining granular material such as approved on-site sand or sand and gravel or imported Granular 'B' Type I or Type III (OPSS 1010), with a maximum aggregate size not exceeding 100 mm, and that it extend a minimum lateral distance of 600 mm out from the foundation walls and/or beyond perimeter sidewalks and entranceway slabs. It is critical that particles greater than 100 mm in diameter are not in contact with the foundation wall to prevent point loading and overstressing. The backfill material used against the foundation walls must be placed so that the allowable lateral capacities of the foundation walls are not exceeded. Where only one side of a foundation wall will be backfilled, and the height of the wall is such that lateral support is required, or where the concrete strength has not been achieved, the wall must be braced or laterally supported prior to backfilling. In situations where both sides of the wall are backfilled, the backfill should be placed in equal lifts, not exceeding 200 mm differential on each side during backfill operations and the backfill should be compacted to a minimum of 98% SPMDD.

Foundations constructed within or below the any zone of wet soils may be subject to flooding in the event of a power failure or equipment malfunction. Therefore, it would be recommended that foundations be constructed above any saturated zones. If this is not feasible, it is recommended that good quality sump pumps be utilized and that, at a minimum, the systems be equipped with a battery backup (in the event of a power outage) preferably with a separate functioning sump pump(s). Groundwater elevations (perched and regional water tables) are dependent on weather and seasonal conditions and should be expected to fluctuate. The construction of foundations, slabs-on-grade, and deep structures such as sump pits within or below zones of saturation will require design of site-specific waterproofing and dewatering systems constructed in accordance with the 2012 OBC.

If the proposed townhouses are to have basements, an exterior perimeter drainage system comprising perforated drainage pipe with a factory installed filter sock, bedded in 19 mm clear crushed stone, and wrapped in a geotextile filter fabric such as Terrafix 270R (or equivalent), must be installed at an elevation that is below the proposed basement slab-on-grade elevation and provided with positive drainage into a sump pit or pits. The portion of the piping that connects the exterior drainage system into the sump pit must comprise solid piping to prevent exterior water from being introduced into the interior subslab stone. It may be prudent to install perforated drainage pipe in the interior basement as well to provide an outlet for any water that may collect in the subslab stone. It is also recommended that a capped cleanout port(s) be extended up to the ground surface elevation to provide future access (if required). The rainwater leaders must not be connected to the perimeter drainage system.

The native soils, as well as approved fill materials (non-organic) are generally considered suitable for reuse as trench backfill and bulk fill in the parking lot; however, any wet soils encountered may require air-drying in order to achieve the specified compaction. Air-drying cannot typically be achieved during winter construction; therefore, depending on the time of year that construction takes place, it may be more feasible to utilize an imported granular fill for this project.

The existing fill soils are generally considered suitable for reuse as trench backfill and bulk fill in the parking lot areas.

Backfilling operations should be carried out with the following minimum requirements:

- Adequate heavy smooth drum or padfoot vibratory compaction equipment should be used for the compaction and to break down any large blocky pieces of soil;
- Loose lift thicknesses should not exceed 0.3 m (12") for granular soils or 0.2 m (8") for silt soils or the capacity of the compactor (whichever is less);
- The soils must be at suitable moisture contents to achieve compaction to a minimum 98% SPMDD in non-structural bulk fill areas. Service trenches excavated within the zone of influence of footings for structures must be compacted to a minimum of 100% SPMDD;
- It is recommended that inspection and testing be carried out during construction to confirm backfill quality, thickness and to ensure that compaction requirements are achieved;
- Service trench backfill materials may consist of approved excavated soils with no particles greater than 100 mm and no topsoil or other deleterious materials;
- If construction operations are undertaken in the winter, strict consideration should be given to the condition of the backfill material to make certain that frozen material is not used.

### **5.11. Pavement Design/Drainage**

Any soils containing organics or other deleterious material must be stripped/subexcavated from within the parking area. It is recommended to either subexcavate any existing loose subgrade materials or provide further consolidation with vibratory compaction equipment in order to prepare a proper, stable subgrade. Prior to placement of the new granular base, the subgrade soils must be proof-rolled, and any soft or unstable areas should be subexcavated and replaced with suitable drier materials. The subgrade should be graded smooth (free of depressions) and properly crowned to ensure positive drainage, with a minimum grade of 3% toward the drainage outlet or curb line. When service pipes are installed, pipe bedding and backfilling should be undertaken as indicated in Sections 5.9 and 5.10 of this report.

Rapid drainage of the pavement structure is critical to ensure long-term performance. The requirement for subdrains will be dependent on the composition of the prepared parking subgrade soils. Based on the information from the boreholes it is expected that the subgrade will comprise fine-grained, frost-susceptible soils. As such, it is recommended to install subdrains, provided gravity drainage to a suitable outlet can be provided. It is recommended to install minimum 100 mm diameter perforated subdrains to collect and redirect water beneath the pavement surface. Subdrains should be designed and installed in accordance with OPSS 405 and OPSD 216.021. If Granular 'A' bedding (OPSS 1010) is utilized, the subdrains should be equipped with a factory installed filter sock. If 19 mm clear stone (OPSS 1004) is utilized as bedding for the subdrain, then the bedding must be wrapped completely with geotextile filter fabric such as Terrafix 270R (or equivalent) and a factory installed filter sock is not required. Installation of rigid subdrains allows for better grade control and less potential for damage during installation; however, it would be expected that there would be higher cost implications associated with the installation of rigid subdrains over flexible subdrains. Positive drainage through grade control of subdrains is critical, as improperly installed subdrains can turn drainage systems into reservoirs, which can fuel frost action. The subdrains will hasten the removal of water, thereby reducing the risk and effects of frost heaving and load transfer in saturated conditions. It is suggested that, at a minimum, subdrains be installed along the edge of the roadway pavement to prevent water from entering the subbase. The subdrains should be installed in a 0.3 m (1.0 ft) by 0.3 m (1.0 ft) trench in the subgrade and bedded approximately 50 mm (2") above the bottom of the trench. The subgrade must be prepared with positive drainage to the subdrains and the subdrains must be installed with positive drainage into a catch basin structure or other suitable outlet.

The native subgrade soils are sensitive to change in moisture content and can become loose or soft if the soils are subject to inclement weather and seepage or severe drying. Furthermore, the subgrade soils could be easily disturbed if traveled on during construction. As such, where this material will be exposed, it is recommended that the granular subbase be placed immediately upon completion of the subgrade preparation to protect the integrity of the subgrade soils.

Should wet to saturated conditions be encountered during construction, site assessments may be required to determine what options can be undertaken to construct a modified pavement base. These options may include subexcavation of wet soils and increasing the thickness of the granular base, the use of reinforcing geotextiles, or a combination of both.

It is expected that the parking lot will be subject to mostly light traffic (personal vehicles) as well as some heavy traffic (delivery trucks, maintenance, and emergency vehicles).

Based on the anticipated loading, the following pavement design is provided:

Material	Recommended Thickness For New Pavement	
	Light Duty	Heavy Duty
Asphaltic Concrete	HL3 - 40 mm (1.5") HL4 or HL8 - 50 mm (2.0")	HL3 - 50 mm (2.0") HL4 or HL8 - 60 mm (2.5")
Granular 'A' Base (OPSS 1010)	150 mm (6.0")	150 mm (6.0")
Granular 'B' Subbase (OPSS 1010)	400 mm (16.0")	450 mm (18.0")

Frost tapers must be constructed at any changes from light traffic to heavy traffic areas. If heavy traffic routes are not delineated by barriers or if it is anticipated that heavy equipment (loader and dump trucks) will be utilized for snow removal, it would be recommended that the heavy traffic pavement structure be utilized throughout.

Construction joints in the surface asphalt must be offset a minimum of 150 mm to 300 mm (6" to 12") from construction joints in the binder asphalt so that longitudinal joints do not coincide.

Where new asphalt is joined into existing asphalt, it is recommended that the existing asphalt be sawcut in a straight line prior to being milled to a depth of 40 mm and a width of 150 mm as per OPSD 509.010. It is recommended that a tackcoat in conformance with OPSS 308 be applied to the edge and surface of all milled asphalt prior to placement of new asphalt.

The granular base and subbase materials must conform to the physical property and gradation requirements of OPSS 1010 and must be compacted to 100% SPMDD. Asphaltic concrete should be supplied, placed and compacted to a minimum 92.0% Marshall maximum relative density, in accordance with OPSS 1150 and OPSS 310.

The pavement should be designed to ensure that water will not pond on the pavement surface. If the surface asphalt is not placed within a reasonable time following placement of the binder asphalt, it is recommended that the catch basin lids are set at a lower elevation or apertures provided to allow surface water to drain into the catch basins and not accumulate around the catch basins. The strength of the pavement structure relies on all of the components to be in place in order to provide the design strength; therefore, it is strongly recommended that the surface asphalt be placed shortly after placement of the binder asphalt so as to avoid undue stress on the binder asphalt by not having the complete pavement structure in place.

It should be noted that, currently, asphalt mixes tend to be more flexible and, as such, there is a tendency for damage to occur from vehicles turning their steering wheels or applying excessive brake pressure. The damage can occur from both passenger vehicles as well as large vehicles. The condition is further intensified during hot weather. In high traffic areas, it is recommended that rigid Portland cement pavement be considered.

## **5.12. Excess Soil Management**

### **5.12.1. Chemical Testing was NOT Undertaken**

Generally, if surplus soils are to be exported off-site, it will be necessary to perform chemical analysis of the soils. Chemical analysis was **not** undertaken as part of this geotechnical investigation. Should chemical analysis tests be required, the required tests vary and will be dependent on the disposal site utilized by the general contractor.

### **5.12.2 Leachate Testing Requirement**

If soils are transported off-site, additional chemical testing may be required. The extent of the leachate testing will be determined by the results of the initial chemical testing as well as the requirements of the disposal site.

The chemical analysis results would be compared to the site condition standards of Ontario Regulation 406/19. Typically, the results are compared to; *T1-Leachate Screening Levels – Res/Park/Inst/Ind/Com/Commu Property Use*; *T3.1-Leachate Screening Levels – Ind/Com/Commu/Property Use*.

When transporting soils off-site, the following is recommended:

- All chemical analyses and environmental assessment reports must be fully disclosed to the receiving site owners/authorities, whom must agree to receive the material;

- An environmental consultant must confirm the land use at the receiving site is compatible to receive the material;
- An environmental consultant must monitor the transportation and placement of the materials to ensure that the material is placed appropriately at the pre-approved site;
- The excess materials may not be transported to a site that has previously had a Record of Site Condition (RSC) filed, unless the material meets the criteria outlined in the RSC.

It should be noted that landfill sites will generally only accept laboratory test results that have been completed within 30 days of exporting. Therefore, it is recommended that provisions for chemical analysis be included in the tender documents. It should also be noted that the laboratory testing generally takes five (5) working days to process with a regular turnaround time.

### **5.13. Radon**

According to information provided by Health Canada, radon is a radioactive gas that is naturally formed through the breakdown of uranium in soil, rock, and water. When radon escapes the earth in the outdoors, it mixes with fresh air, resulting in concentrations that are too low to be of concern. However, when radon enters an enclosed space, such as a building, high concentration of radon can accumulate and become a health concern. Health Canada indicates that most buildings and homes have some level of radon in them. Unfortunately, it is not possible to predict before construction whether or not a new building will have high radon levels as radon can only be detected by radon measurement devices, which would be installed in a building, post construction. Section 9.13.4.1 Soil Gas Control of the current 2012 Ontario Building Code (OBC) states that *"Where methane or radon gases are known to be a problem, construction shall comply with the requirements for soil gas control in MMAH Supplementary Standard SB-9, Requirements for Soil Gas Control"*.

## **6.0 SITE INSPECTION**

Qualified geotechnical personnel should supervise excavation inspections as well as compaction testing for structural filling, site grading, and site servicing. This will ensure that footings are founded in the proper strata and that proper material and techniques are used and the specified compaction is achieved. CMT Engineering Inc. would be pleased to review the design drawings and provide an inspection and testing program for the construction of the proposed development.

## **7.0 LIMITATIONS OF THE INVESTIGATION**

The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review our recommendations when the drawings and specifications are complete, or if the proposed construction should differ from that mentioned in this report.

It is important to emphasize that a soil investigation is, in fact, a random sampling of a site and the comments are based on the results obtained at the test locations only. It is therefore assumed that these results are representative of the subsoil conditions across the site. Should any conditions at the site be encountered which differ from those found at the test locations, we request that we be notified immediately in order to permit a reassessment of our recommendations.

It should be noted that this report specifically addresses geotechnical aspects of the project and does not include any investigations or assessments relating to potential subsurface contamination. As such, there should be no assumptions or conclusions derived from this report with respect to potential soil or water contamination. Soil or water contamination is generally caused by the presence of xenobiotic (human-made) chemicals or other alteration processes in the natural soil and groundwater environment. If necessary, the investigation, assessment and rehabilitation of soil and water contaminants should be undertaken by qualified environmental specialists.

The samples obtained during the geotechnical investigation will be stored for a period of three months, after which time they will be disposed of unless alternative arrangements are made.

This report is intended solely for the client named. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the reliability of such third parties. The factual data, interpretation, and recommendations in this report pertain to a specific project as described in this report and are not applicable to any other project or site location. If the project is modified in concept, location or elevation, deviates from the assumptions stated herein, CMT Inc. should be given an opportunity to confirm that the recommendations are still valid. The subject geotechnical exploration and this report address only the geotechnical aspects of the proposed project; potential environmental impacts or related issues are beyond the defined scope of this work and have not been addressed.

We trust that this report meets with your present requirements. Should you have any questions, please do not hesitate to contact our office.

Prepared by:



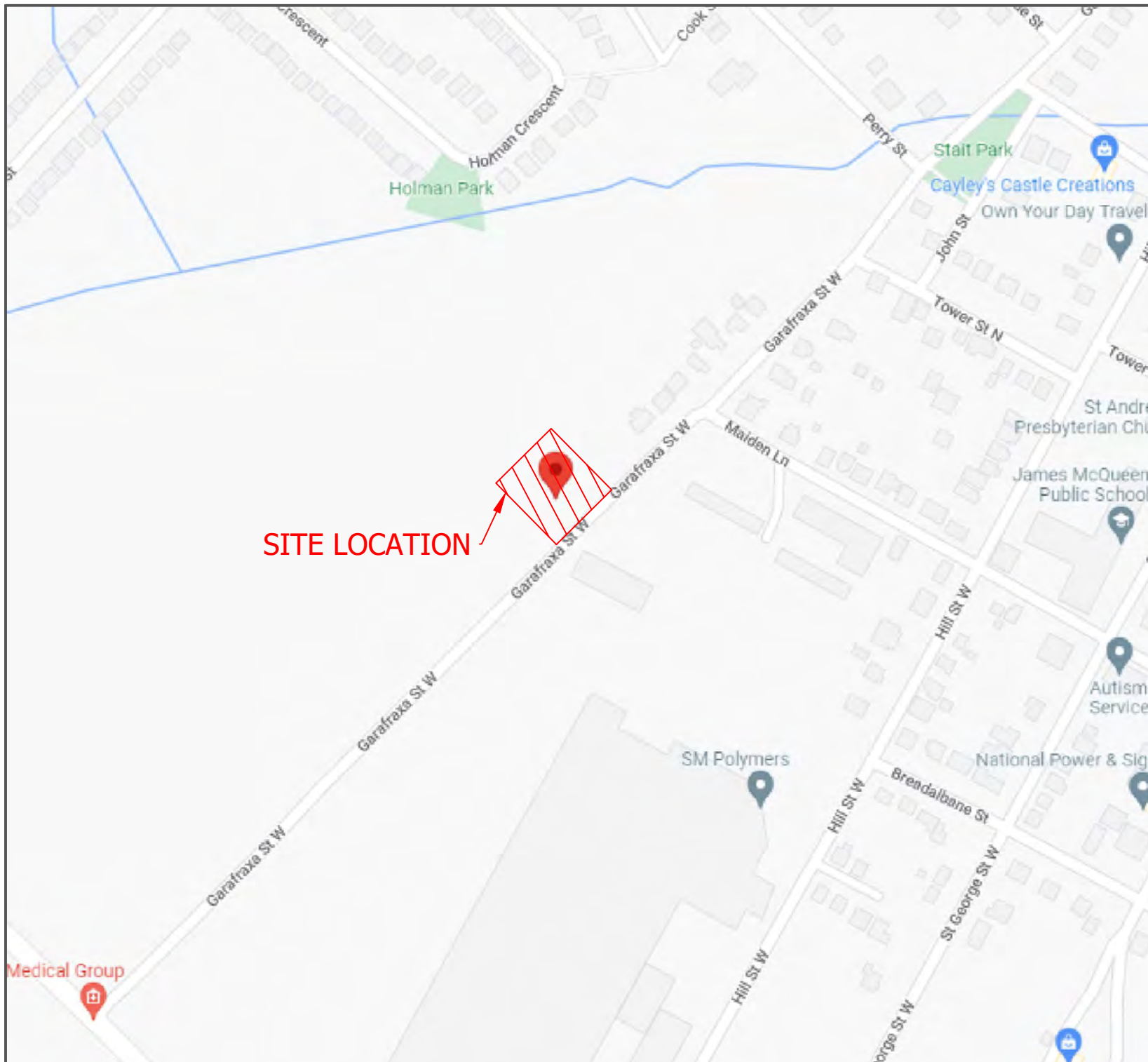
Jake Feeney P. Eng.  
ht



Reviewed by:

Nathan Chortos, P.Eng.  
Senior Geotechnical Engineer





**SITE LOCATION**

**NOTES:**

Base map provided by Google.



NO.	DESCRIPTION	DATE

**REVISIONS**



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 St. Clements, Ontario N0B 2M0  
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 Fax: 519-699-4664  
 www.cmtinc.net

PROJECT:  
**TOWNHOUSE DEVELOPMENT**  
 465 Garafraza Street West  
 Fergus, Ontario

DRAWING TITLE:  
**SITE LOCATION MAP**

PROJECT NO.:	DATE:
22-765	November 24, 2022
SCALE:	DRAWING NO.
N.T.S.	1



**APPENDIX A**

**BOREHOLE LOGS**



CMT Engineering Inc.  
 1011 Industrial Crescent  
 St. Clements, Ontario, N0B 2M0  
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 Fax: 519-699-4664

# BOREHOLE NUMBER 1

**PROJECT:** Proposed Townhouse Development  
**PROJECT ADDRESS:** 465 Garafraxa Street West  
**PROJECT LOCATION:** Fergus, Ontario  
**GROUND ELEVATION:** 100.20 m  
**LOGGED BY:** J. Feeney  
**SAMPLING METHOD:** SPT

**PROJECT NUMBER:** 22-765  
**DRILLING DATE:** 22-11-16  
**DRILLING CONTRACTOR:** CMT Drilling Inc.  
**DRILLING EQUIPMENT:** Geoprobe 7822DT

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	▲ SPT N VALUE ▲			
							10	20	30	40
1	[Cross-hatched pattern]	<b>Sand and Gravel Fill:</b> Compact, brown sand and gravel fill, trace silt, moist	0.00, 100.20	SPT 1	49	2-7-12-16 (19)	7.6	19		
		<b>Topsoil:</b> Black silty, organic, buried topsoil layer	0.60, 99.60							
2	[Cross-hatched pattern]	<b>Sand and Gravel Fill:</b> Compact, brown sand and gravel fill, trace silt, moist	1.07, 99.13	SPT 2	100	3-5-14-15 (19)	10.6	19		
		<b>Silty Sand:</b> Compact, brown silty sand, moist	1.52, 98.68	SPT 3	100	8-9-10-10 (19)	12.8	19		
3	[Diagonal hatched pattern]	<b>Sandy Silt Till:</b> Very stiff, brown sandy silt till, some clay, trace gravel, moist	2.29, 97.91	SPT 4	100	5-9-12-11 (21)	9.7	21		
		becoming hard	3.05, 97.15	SPT 5	100	10-28-33-33 (61)	7.2	>>		
4	[Diagonal hatched pattern]			MC5 6	100		8.6			
		becoming grey	4.57, 95.63	SPT 7	100	30-48-44-37 (92)	7.8	>>		

Borehole open to about 5.18 m below the ground surface, No accumulated groundwater observed upon completion.  
 Bottom of borehole at 5.18 m, Elevation 95.02 m.

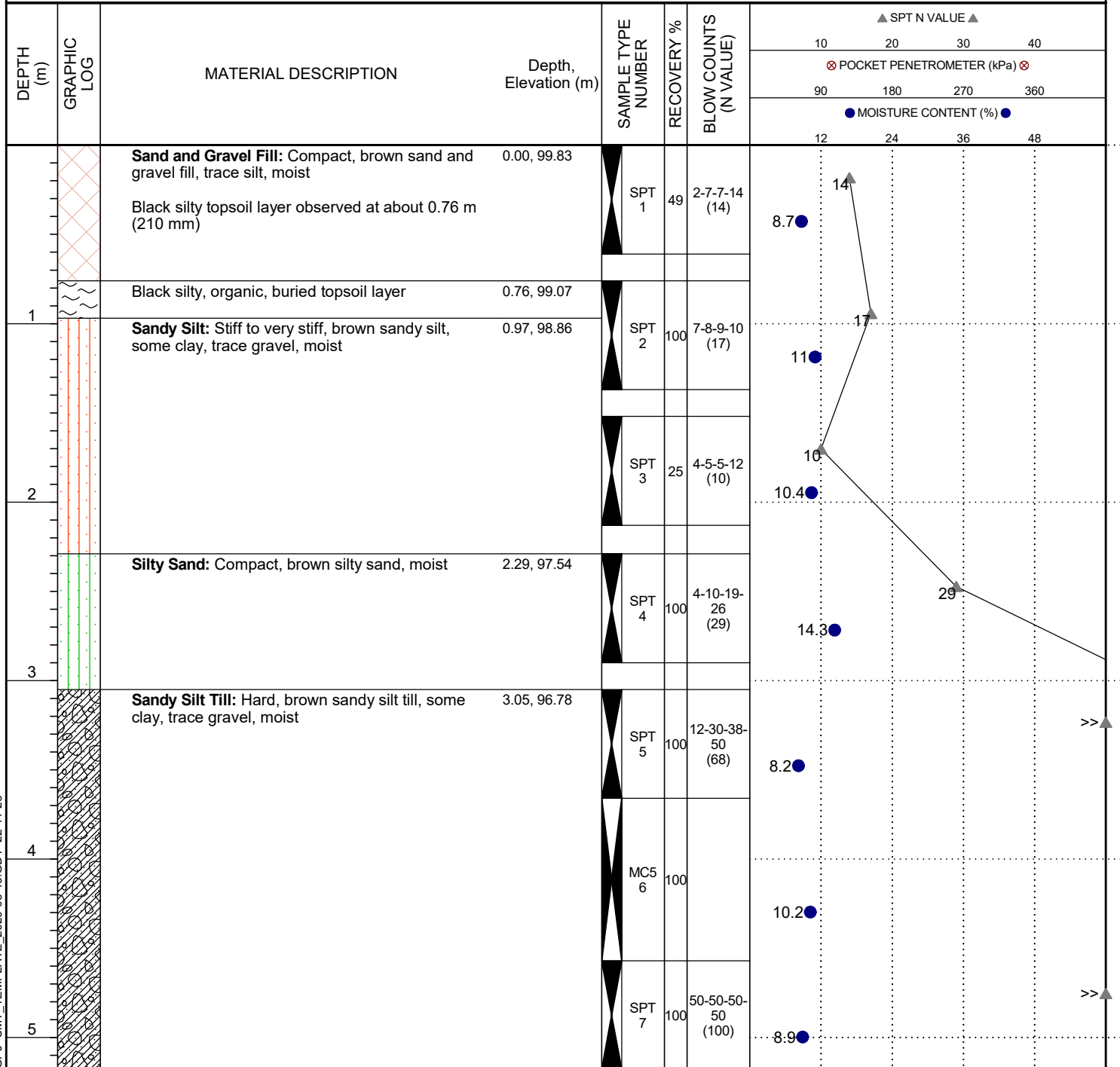
BOREHOLE LOG2 22-765.GPJ CMT\_TEMPLATE\_2020-05-15.GDT 22-11-28



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# BOREHOLE NUMBER 2

**PROJECT:** Proposed Townhouse Development  
**PROJECT ADDRESS:** 465 Garafraxa Street West  
**PROJECT LOCATION:** Fergus, Ontario  
**PROJECT NUMBER:** 22-765  
**DRILLING DATE:** 22-11-16  
**DRILLING CONTRACTOR:** CMT Drilling Inc.  
**DRILLING EQUIPMENT:** Geoprobe 7822DT  
**GROUND ELEVATION:** 99.83 m  
**LOGGED BY:** J. Feeney  
**SAMPLING METHOD:** SPT



Borehole caved at about 2.95 m below the ground surface. No accumulated groundwater observed upon completion.  
 Bottom of borehole at 5.18 m, Elevation 94.65 m.

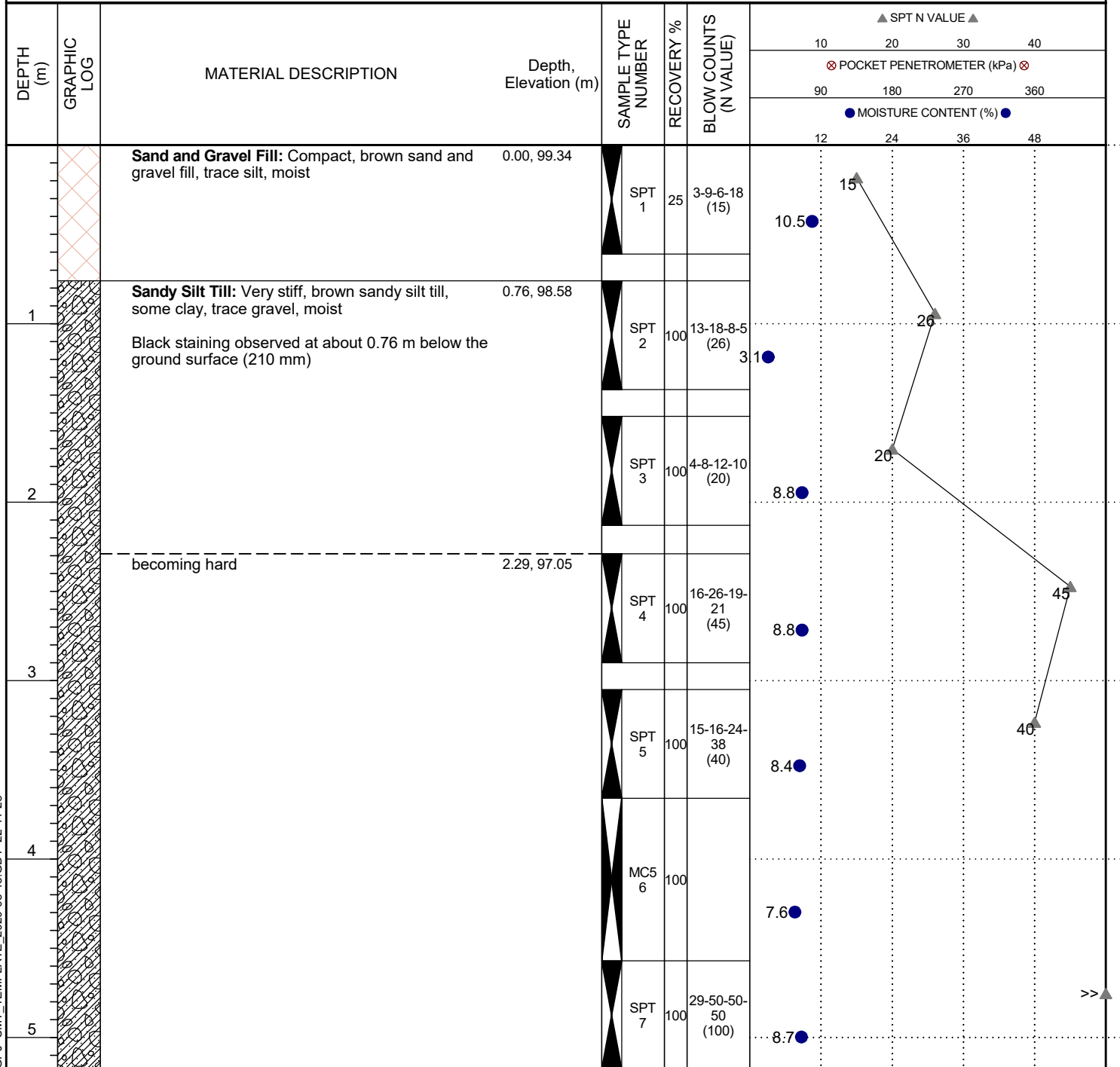
BOREHOLE LOG2 22-765.GPJ CMT\_TEMPLATE\_2020-05-15.GDT 22-11-28



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# BOREHOLE NUMBER 3

**PROJECT:** Proposed Townhouse Development  
**PROJECT ADDRESS:** 465 Garafraxa Street West  
**PROJECT LOCATION:** Fergus, Ontario  
**PROJECT NUMBER:** 22-765  
**DRILLING DATE:** 22-11-16  
**DRILLING CONTRACTOR:** CMT Drilling Inc.  
**DRILLING EQUIPMENT:** Geoprobe 7822DT  
**GROUND ELEVATION:** 99.34 m  
**LOGGED BY:** J. Feeney  
**SAMPLING METHOD:** SPT



Borehole caved at about 4.88 m below the ground surface. No accumulated groundwater observed upon completion.  
 Bottom of borehole at 5.18 m, Elevation 94.16 m.

BOREHOLE LOG2 22-765.GPJ CMT\_TEMPLATE\_2020-05-15.GDT 22-11-28



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# BOREHOLE NUMBER 4

**PROJECT:** Proposed Townhouse Development  
**PROJECT ADDRESS:** 465 Garafraxa Street West  
**PROJECT LOCATION:** Fergus, Ontario  
**GROUND ELEVATION:** 99.40 m  
**LOGGED BY:** J. Feeney  
**SAMPLING METHOD:** SPT

**PROJECT NUMBER:** 22-765  
**DRILLING DATE:** 22-11-16  
**DRILLING CONTRACTOR:** CMT Drilling Inc.  
**DRILLING EQUIPMENT:** Geoprobe 7822DT

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	▲ SPT N VALUE ▲							
							10	20	30	40				
							⊗ POCKET PENETROMETER (kPa) ⊗							
							● MOISTURE CONTENT (%) ●							
							12	24	36	48				
		<b>Silt Fill:</b> Firm, brown silt fill, trace gravel, moist Black staining observed	0.00, 99.40	SPT 1	49	1-2-2-2 (4)					11.8			
1		<b>Silty Sand:</b> Loose, brown silty sand, moist	0.76, 98.64	SPT 2	100	3-4-5-7 (9)					8.8			
2		<b>Sandy Silt Till:</b> Stiff, brown sandy silt till, some clay, trace gravel, moist	1.52, 97.88	SPT 3	100	6-6-3-3 (9)					9.3			
		becoming very stiff	2.29, 97.11	SPT 4	100	7-7-10-7 (17)					15.9			
				SPT 5	100	8-13-15-16 (28)					9.8			
4				MC5 6	100						10.6			
		becoming hard	4.57, 94.83	SPT 7	100	30-27-25-23 (52)					8.5			

Borehole open to about 5.18 m below the ground surface, No accumulated groundwater observed upon completion.  
 Bottom of borehole at 5.18 m, Elevation 94.22 m.

BOREHOLE LOG2 22-765.GPJ CMT\_TEMPLATE\_2020-05-15.GDT 22-11-28



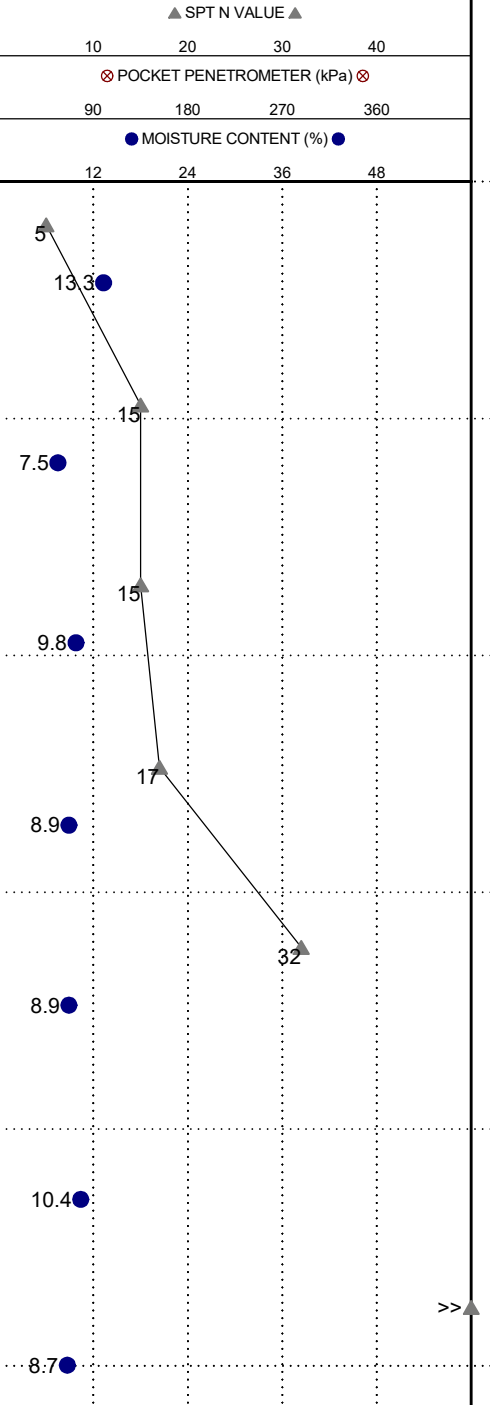
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 Fax: 519-699-4664

# BOREHOLE NUMBER 5

**PROJECT:** Proposed Townhouse Development  
**PROJECT ADDRESS:** 465 Garafraxa Street West  
**PROJECT LOCATION:** Fergus, Ontario  
**GROUND ELEVATION:** 100.17 m  
**LOGGED BY:** J. Feeney  
**SAMPLING METHOD:** SPT

**PROJECT NUMBER:** 22-765  
**DRILLING DATE:** 22-11-16  
**DRILLING CONTRACTOR:** CMT Drilling Inc.  
**DRILLING EQUIPMENT:** Geoprobe 7822DT

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	▲ SPT N VALUE ▲			
							10	20	30	40
		<b>Topsoil:</b> Loose, dark brown, silty, organic topsoil, moist	0.00, 100.17	SPT 1	49	2-2-3-4 (5)				
1		<b>Silty Sand:</b> Compact, brown silty sand, moist	0.60, 99.57	SPT 2	100	6-6-9-14 (15)				
2		<b>Sandy Silt Till:</b> Stiff to very stiff, brown sandy silt till, some clay, trace gravel, moist	1.52, 98.65	SPT 3	100	8-8-7-7 (15)				
3				SPT 4	100	7-8-9-15 (17)				
4				SPT 5	100	18-13-19-19 (32)				
5		becoming hard	3.05, 97.12	MC5 6	100					
				SPT 7	100	32-50-50-50 (100)				



Borehole open to about 5.18 m below the ground surface, No accumulated groundwater observed upon completion.  
 Bottom of borehole at 5.18 m, Elevation 94.99 m.

BOREHOLE LOG2 22-765.GPJ CMT\_TEMPLATE\_2020-05-15.GDT 22-11-28





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# BOREHOLE NUMBER 6

**PROJECT:** Proposed Townhouse Development  
**PROJECT ADDRESS:** 465 Garafraxa Street West  
**PROJECT LOCATION:** Fergus, Ontario  
**PROJECT NUMBER:** 22-765  
**DRILLING DATE:** 22-11-16  
**DRILLING CONTRACTOR:** CMT Drilling Inc.  
**DRILLING EQUIPMENT:** Geoprobe 7822DT  
**GROUND ELEVATION:** 99.51 m  
**LOGGED BY:** J. Feeney  
**SAMPLING METHOD:** MC5

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	▲ SPT N VALUE ▲						
							10	20	30	40			
		<b>Sand and Gravel Fill:</b> Brown sand and gravel fill, trace silt, moist	0.00, 99.51										
		<b>Sandy Silt Till:</b> Brown sandy silt till, some clay, trace gravel, moist	0.60, 98.91	MC5 1	100								
1													
													12.5 ●

Borehole open to 1.52 m below the ground surface , elevation. No accumulated groundwater observed upon completion.  
 Bottom of borehole at 1.52 m, Elevation 97.99 m.



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# BOREHOLE NUMBER 7

**PROJECT:** Proposed Townhouse Development  
**PROJECT ADDRESS:** 465 Garafraxa Street West  
**PROJECT LOCATION:** Fergus, Ontario  
**PROJECT NUMBER:** 22-765  
**DRILLING DATE:** 22-11-16  
**DRILLING CONTRACTOR:** CMT Drilling Inc.  
**DRILLING EQUIPMENT:** Geoprobe 7822DT  
**GROUND ELEVATION:** 99.70 m  
**LOGGED BY:** J. Feeney  
**SAMPLING METHOD:** MC5

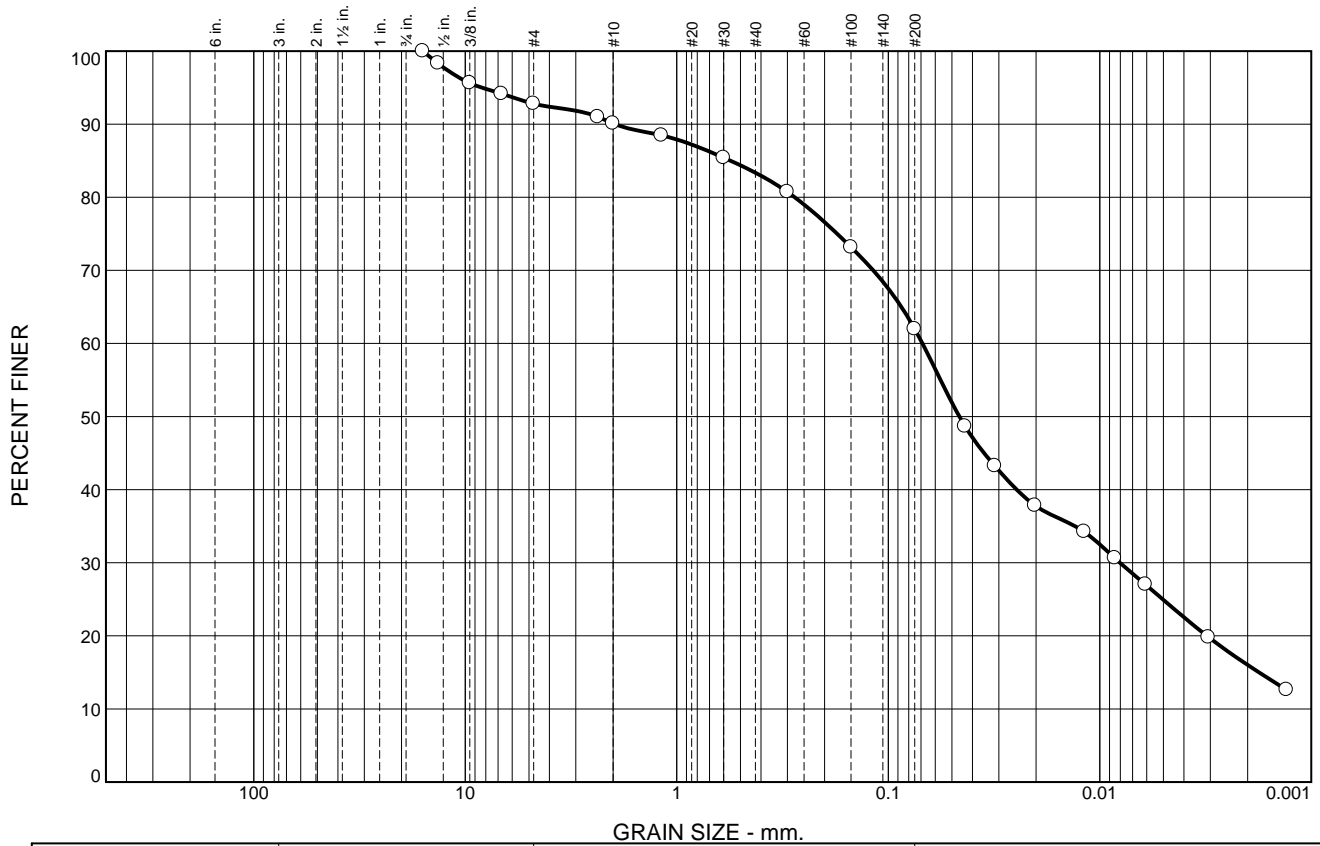
DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	▲ SPT N VALUE ▲						
							10	20	30	40			
		<b>Topsoil:</b> Dark brown, silty, organic topsoil, moist	0.00, 99.70										
		<b>Silty Sand:</b> Brown silty sand, moist	0.30, 99.40										
1				MC5 1	100								
													5.2●

Borehole open to 1.52 m below the ground surface , elevation. No accumulated groundwater observed upon completion.  
 Bottom of borehole at 1.52 m, Elevation 98.18 m.

**APPENDIX B**

**GRAIN SIZE ANALYSES**

# Particle Size Distribution Report



Symbol	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	7.2	2.7	6.7	21.4	46.0	16.0

SOIL DATA					
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH3	3	1.52-2.13m	sandy silt, some clay, trace gravel	ML
				Sampled by JF of CMT Engineering Inc. November 16, 2022	
				Tested by JM of CMT Engineering Inc. November 18, 2022	

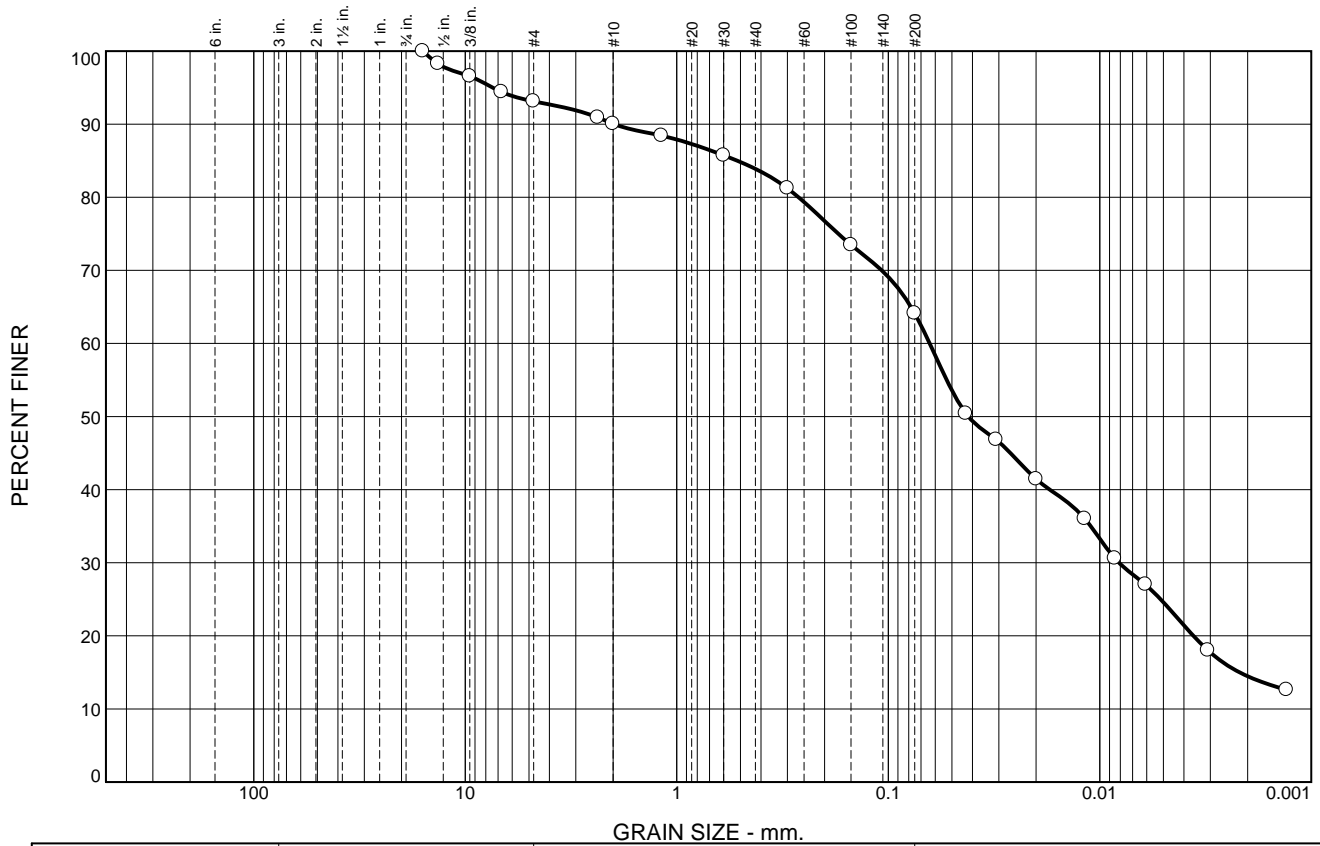
**CMT Engineering Inc.**

**St. Clements, ON**

**Client:** Habitat for Humanity  
**Project:** 465 Garafraxa Street West  
 Fergus, Ontario  
**Project No.:** 22-765

**Figure 1**

# Particle Size Distribution Report



Symbol	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	6.9	3.0	6.2	19.8	49.6	14.5

SOIL DATA					
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH5	5	3.05-3.66m	sandy silt, some clay, trace gravel	ML
				Sampled by JF of CMT Engineering Inc. November 16, 2022	
				Tested by JM of CMT Engineering Inc. November 18, 2022	

**CMT Engineering Inc.**

**St. Clements, ON**

**Client:** Habitat for Humanity  
**Project:** 465 Garafraxa Street West  
 Fergus, Ontario  
**Project No.:** 22-765

**Figure 2**