GEOTECHNICAL INVESTIGATION

PROPOSED RESIDENTIAL DEVELOPMENT
BEATTY LINE NORTH AT FARLEY ROAD
FERGUS, ONTARIO

CMT Project 18-085.R01

Prepared For:

Van Harten Surveying Inc.

April 9, 2018

CMT ENGINEERING INC.

CMT Engineering Inc.
CONSULTING ENGINEERS
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
***Tel:* 519-699-5775**
***Fax:* 519-699-4664**
www.cmtinc.net

April 9, 2018 18-085.R01

Van Harten Surveying Inc.
660 Riddell Road, Unit 1
Orangeville, Ontario
L9W 5K5 3J2

Attention: Mr. Mike Vaughan, P.Eng.

Dear Mike:

Re: Geotechnical Investigation
Proposed Residential Development
Beatty Line North at Farley Road
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 very truly,

Shawn Wheatley, B.Sc

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1.0 INTRODUCTION

The services of CMT Engineering Inc. (CMT Inc.) were retained by Mike Vaughan, P.Eng. of Van Harten Surveying Inc. to conduct a geotechnical investigation for the residential development that is proposed to be constructed at a site located at the southwest corner of the intersection of Beatty Line North and Farley Road in Fergus, Ontario. The site will encompass four (4) existing separate properties (6552, 6554, 6556, and 6558 Beatty Line North). Concept Plan 14 indicates that the proposed development will comprise a four (4) storey apartment building with seventy-one (71) units and paved surface parking for 95 vehicles; fifteen (15) detached residential lots; ten (10) semi-detached residential lots; and a 7.3 m road allowance to service the site. The location of the site is shown on Drawing 1.

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; and a summary of the laboratory test results.

2.0 EXISTING SITE CONDITIONS

The property currently contains four (4) residential homes with various detached outbuildings. The site slopes down to the north, with over 4 m change in total elevation across the site. There are multiple mature trees located throughout the property. The site is bounded by Beatty Line North to the northeast, Farley Road to the northwest, and residential properties to the southwest and southeast. It is understood that the existing residences are currently serviced by municipal utilities.

3.0 FIELD AND LABORATORY PROCEDURES

Prior to the commencement of the field drilling program, locates were organized by CMT Inc. to ensure that underground utilities would not be damaged.

The drilling field investigation was conducted on March 21 and March 22 2018, and comprised the advancement of twelve (12) boreholes (referenced as Boreholes 1 to 12), utilizing a Geoprobe 7822DT drill rig operated by employees of CMT Drilling Inc.

The borehole depths ranged from 4.27 m (14.0 ft) to 5.18 m (17.0 ft) below the existing ground surface elevations. Soil sampling was undertaken utilizing the Standard Penetration Test (SPT), as well as Macro Core (MC5) systems for Boreholes 1 to 12. Standard Penetration Testing (SPT) was generally conducted at 0.76 m (2.5 ft) intervals to a depth of 3.66 m (12.0 ft), after which SPT sampling was conducted at 1.5 m (5.0 ft) intervals to borehole termination. MC5 continuous sampling was conducted between the 1.5 m (5.0 ft) SPT sampling interval, from 3.66 m to

4.57 m (12.0 ft to 15.0 ft). 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 samples from the following boreholes and depths were submitted to our laboratory for grain size analyses:

- Borehole 8 – depth 4.57 m to 5.18 m
- Borehole 10 – depth 1.52 m to 2.13 m

The borehole logs are provided in Appendix A and the grain size analyses are provided in Appendix B.

CMT Inc. surveyed the ground surface elevations at the borehole locations on March 28, 2018. The top of the manhole cover, located on Beatty Line North, adjacent from house #6556, was utilized as a temporary benchmark with a reported elevation of 418.49 m. The ground surface elevations at the borehole locations ranged from 417.92 m to 420.05 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.

4.1. Topsoil

Very loose to compact, dark brown, silty, organic topsoil was encountered at the surface of all boreholes. The topsoil ranged in thickness from 120 mm to 520 mm (average 340 mm). The topsoil was considered moist to wet.

4.2. Sandy Silt

Brown, red-brown, or mottled dark brown, sandy silt, with up to some gravel and clay, was encountered underlying the topsoil in all the boreholes. Trace amounts of organic material and rootlets were present in the upper portion of the sandy silt, directly underlying the topsoil. The sandy silt was considered very loose to very dense, generally increasing with depth, with SPT N-values ranging from 2 to over 100 blows per 0.30 m (average 20 blows per 0.30 m). The sandy silt was considered moist to saturated, with moisture contents ranging from 7.4% to 23.8% (average 12.9%).

4.3. Silt

Brown to light brown silt, with some sand, trace to some gravel, and up to trace amounts of clay, was encountered underlying the sandy silt in Boreholes 2, 3, 4, 8, 11 and 12. The silt was considered compact to very dense, with SPT N-values ranging from 12 to over 100 blows per 0.30 m (average 70 blows per 0.30 m). The silt was considered moist to wet, with moisture contents ranging from 6.3% to 15.4% (average 10.5%).

4.4. Sandy Silt Till

Grey-brown, sandy silt till, with some clay and trace gravel, was encountered underlying the sandy silt in Boreholes 1, 5, 6, 7, 9, and 10, and underlying the silt in Boreholes 2, 3, 8, and 11. The sandy silt till was considered very dense, with SPT N-values ranging from 62 to over 100 blows per 0.30 m (average 91 blows per 0.30 m). The sandy silt till was considered moist to wet, with moisture contents ranging from 5.8% to 13.5% (average 8.2%).

4.5. Groundwater

Accumulated groundwater was observed in Boreholes 6 and 10 only. Groundwater was observed in Borehole 6 at a depth of 4.01 m, corresponding to an elevation of 416.74 m. Groundwater was observed in Borehole 10 at a depth of 4.04 m, corresponding to an elevation of 414.41 m. Minor caving of the open boreholes and wet soil conditions were observed throughout the site. It should be noted that the dense, fine-grained, sandy silt till soils typically encountered in the lower zone of the boreholes have the potential to create perched water conditions. 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.

Recommendations with respect to dewatering conditions are provided in Section 5.8 of this report.

5.0 DISCUSSION AND RECOMMENDATIONS

It is understood that the proposed development will comprise a four (4) storey apartment building with seventy-one (71) units and paved surface parking for 95 vehicles; fifteen (15) detached residential lots; ten (10) semi-detached residential lots; and a 7.3 m road allowance to service the site.

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

Utilizing the information obtained from the boreholes, the following table provides the estimated highest founding elevation on the existing soils:

Borehole No.	Ground Surface Elevation (m)	SLS kPa (psf)	ULS kPa (psf)	Estimated Highest Founding Elevation (m)	Soil Type
1	418.78	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	417.26 to 415.73 415.73 to termination	Sandy Silt Sandy Silt
2	420.05	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	418.53 to 417.76 417.76 to termination	Silt Silt/Sandy Silt
3	421.21	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	419.38 to 418.72 418.72 to termination	Sandy Silt Sandy Silt/Silt
4	420.42	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	419.66 to 418.13 418.13 to termination	Silt Silt
5	421.26	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	420.50 to 419.74 419.74 to termination	Sandy Silt Sandy Silt
6	420.75	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	419.23 to 418.46 418.46 to termination	Sandy Silt Sandy Silt
7	418.72	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	417.20 to 416.05 416.05 to termination	Sandy Silt Sandy Silt
8	418.64	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	417.62 to 416.30 416.30 to termination	Silt Silt/Sandy Silt
9	417.92	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	416.40 to 415.33 415.33 to termination	Sandy Silt Sandy Silt
10	418.45	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	416.93 to 415.25 415.25 to termination	Sandy Silt Sandy Silt
11	418.05	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	416.53 to 415.00 415.00 to termination	Sandy Silt Silt/Sandy Silt
12	418.92	150 (3,000) 250 (5,000)	225 (4,500) 375 (7,500)	418.16 to 416.63 416.63 to termination	Sandy Silt Silt

Based on the bearing capacities and elevations provided in the table above, suitable founding elevations for conventional foundations designed with a minimum bearing capacity of 150 kPa (3,000 psf) at SLS and 225 kPa (4,500 psf) at ULS range below elevations 416.60 m to 420.5 m for Boreholes 1 to 12. It should be noted that the above-referenced elevations of soils capable of supporting foundations designed with a bearing capacity of 150 kPa (3,000 psf) at SLS and 225 kPa (4,500 psf) at ULS corresponds with depths ranging from approximately 0.76 m to 2.34 m below the existing ground surface at the borehole locations.

Suitable founding elevations for conventional foundations designed with a minimum bearing capacity of 250 kPa (5,000 psf) at SLS and 375 kPa (7,500 psf) at ULS range below elevations 415.00 m to 419.74 m for Boreholes 1 to 12. It should be noted that the above-referenced elevations of soils capable of supporting foundations designed with a bearing capacity of 250 kPa (5,000 psf) at SLS and 375 kPa (7,500 psf) at ULS corresponds with depths ranging from approximately 1.05 m to 3.20 m below the existing ground surface at the borehole locations.

Soil capable of supporting foundations is generally encountered below the topsoil and loose sandy silt soils containing organic material. Therefore, the topsoil and loose sandy silt soils containing organic material must be subexcavated in the areas of the proposed structures. The founding soil must be assessed at the time of construction by qualified geotechnical personnel in order to confirm their founding suitability.

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 structural fill placed and compacted in accordance with Section 5.4.4 of this report and constructed on approved competent native soil is estimated to be at least 150 kPa (3,000 psf) at SLS and 225 kPa (4,500 psf) at ULS. Alternatively, footings could be stepped down to bear on approved undisturbed founding soils.

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 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 C (very dense soils) for structures founded on the native soils at the recommended founding elevations provided in Section 5.1 of this report. For foundations constructed on structural fill, placed in accordance with Section 5.4.4 of this report, the site classification for seismic site response would also be considered Site Class C (very dense soil). 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 the soil design parameters for imported granular fill, as well as the existing native soils encountered on-site. The soil design parameters can be utilized for the design of perimeter shoring, foundations and retaining walls, as required:

Soil Type	Soil Density (kg/m^3)	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 (μ)
Imported Gran 'A'/Gran 'B' (OPSS 1010)	2,100	34°	0.28	3.54	0.44	0.45
Sandy silt	1,900	32°	0.31	3.25	0.47	0.41
Silt	1,900	30°	0.31	3.00	0.50	0.41
Sandy Silt Till	1,900	34	0.28	3.54	0.44	0.45

5.4. Site Preparation

The site preparation for the proposed new residential development will include the demolition of the existing residential dwellings on the property, topsoil stripping, vegetation grubbing, the removal or relocation of existing services, the subexcavation of all unsuitable native soils deemed not capable of supporting the design bearing capacity, 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 must be removed from within the proposed building, roadway and parking lot envelopes 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, driveway and parking lot envelopes 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. If an excavator with a smooth bucket is utilized for stripping, there would generally be less potential for topsoil to become intermixed with the underlying, generally loose to very loose subsoil and therefore less concern of over-excavation to remove all topsoil. If the topsoil is stripped with wheeled equipment or bulldozers, then there is an increased potential for the topsoil and subsoil to become intermixed, subsequently requiring additional excavation to remove all topsoil. This is further influenced by rutting which can occur during wet conditions.

5.4.2. Building Demolition

Currently, four (4) residential dwellings, as well as numerous detached outbuildings, exist on the property which are to be demolished and removed. All above-grade structures as well as all foundations, concrete slabs, and loose backfill must be removed within the proposed building envelopes, driveways, and surface parking lot areas.

Provided any concrete from the former building foundations, as well as any other concrete on-site (if encountered) is reduced to a maximum size of 100 mm, and all reinforcing steel and any deleterious materials are removed, the reduced concrete material may be combined with imported granular fill or approved native soils to be utilized as fill on-site. The reuse of this material will be subject to approval from qualified geotechnical personnel. All excavations following demolition must be inspected and backfilled according to the procedures outlined in Section 5.4.4 of this report. It is recommended that approved native soils or imported sand and gravel (OPSS 1010 Granular 'B' or an approved alternative) be placed as structural fill to backfill the building demolition area.

5.4.3. Removal/Relocation of Existing Services

All existing underground services that may be located within the proposed building envelopes and/or driveways 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. All terminated pipes must be completely sealed with watertight mechanical covers, concrete or grout at termination points to prevent the migration of soils into pipe voids which can result in potential settlement. All existing trench backfill material associated with any existing underground services must be subexcavated and the subsequent excavation should be backfilled with approved soils placed in accordance with Section 5.4.4 of this report.

Based on the age and location of the existing buildings, it would be expected that the existing residential dwellings may have at some point been serviced by an on-site sewage system which should include a septic tank and associated distribution piping. The presence and/or location of existing septic systems were not observed/confirmed as part of this geotechnical investigation. The existing owners were consulted to determine if a septic system may exist and if so, where it may be located; however, they indicated that the house was currently serviced by municipal sewer and water. Any existing septic system components (including septic tank, distribution piping and associated clear stone bedding) must be removed and disposed of properly off-site.

The presence of any existing potable water wells was not observed/confirmed during the geotechnical investigation. Water piping that exits the basement could be followed in order to try and locate any potential potable water wells that may be located on the property. It is a requirement of the Ontario Water Resources Act, Regulation 903, that any wells be decommissioned by an MOE licensed well contractor if they are no longer required. A well that has been constructed to provide drinking water would require an MOE licensed well contractor with a Class 1 or Class 2 license to decommission the well in accordance with Reg. 903.

All existing backfill and any disturbed soils associated with the removal of any septic system and/or well components must be subexcavated and the subsequent excavation must be backfilled with approved soils placed in accordance with Section 5.4.4 of this report.

5.4.4. Site Grading

Following the stripping of topsoil and subexcavation of any loose soils deemed not capable of supporting foundations, slab-on-grade and/or driveway and parking lot pavement structures, the exposed subgrade 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 site grades should be placed according to the following procedures:

- Prior to placement of any structural fill, the subgrade for the proposed new buildings 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 down to the competent native 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 materials) and 0.2 m (8") in depth for silts and clays, or the capacity of the compactor (whichever is less);

- Granular fill materials can be compacted utilizing adequate heavy vibratory smooth drum or padfoot compaction equipment;

- Fine-grained silt soils 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 (exterior foundation wall backfill in landscaped areas, bulk fill for roadway and driveways) must be compacted to a minimum 95% SPMDD;

- Granular 'B' subbase and Granular 'A' base materials for the roadway and driveways must be compacted to 100% SPMDD.

Based on the subsurface conditions observed in the boreholes, wet soils may be encountered, depending on the depth of excavation. For soils excavated from the zone of saturation, significant air-drying along with working of the soils may be required in order to achieve the specified compaction of 95% SPMDD for bulk fill for the parking lot and driveways or 100% for structural fill. Utilizing the existing soils during site grading may be more achievable if work is completed during the generally drier summer months. Reuse of excavated soils on-site will be subject to approval from qualified geotechnical personnel.

Should the native subgrade soils at the design founding elevation in the proposed building envelope(s) 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;

5.5. Foundation Subgrade Preparation

The native soils encountered in the boreholes are sensitive to change 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:

- 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 (as required, an environmental consultant should be consulted prior to any on-site water being pumped and/or discharged to municipal outlets to ensure that proper procedures are followed). 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 conditions, the founding native soils and any potential fill materials must be maintained above freezing;

- Prior to pouring 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 remains 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 poured in order to protect the structural integrity of the founding soils;

- Due to the non-cohesive nature of the native soils observed in the boreholes, significant sloughing should be expected during excavation work.

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

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

The following table provides the modulus of subgrade reaction (k) for the native soils encountered on site:

Soil Type	Modulus of Subgrade Reaction (k)
Sandy Silt	41,000 kN/m^3 (150 lb/in^3)
Silt	54,000 kN/m^3 (200 lb/in^3)
Sandy Silt Till	61,000 kN/m^3 (225 lb/in^3)
Imported Sand and Gravel (OPSS 1010)	81,000 kN/m^3 (300 lb/in^3)

Floor slabs can be founded on a minimum thickness of 100 mm (4") of coarse, clean granular material containing not more than 10% of material that will pass a 4 mm sieve in accordance with the current OBC. The clean granular material should be consolidated to prevent future settlement.

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

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 dense to very dense silt and sandy silt till soils encountered in a drained state (not saturated) would be classified as Type 2 soils under Reg 213/91. The Type 2 soils must be sloped to within 1.2m of its bottom with a slope having a minimum gradient of 1 horizontal to 1 vertical. All saturated soils encountered must be treated as Type 4 soils, as described below.

Type 3 Soils - In general, the native sandy silt, as well as the compact silt encountered 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. 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.

It should be noted that the native sandy silt, silt as well as sandy silt till soils typically became very dense in the lower zone of the boreholes (N-values in excess of 50 blows per 0.30 m). Excavations that extend into these soils may prove difficult to excavate with conventional excavating equipment, impacting the production schedule. It is imperative that when the very dense/hard soils are utilized for backfilling of service trenches, the material must be broken down (pulverized) to minimize voids and reduce the potential for settlement. It is not recommended that these blocky excavated soils be utilized as structural fill.

5.8. Construction Dewatering Considerations

Accumulated groundwater was observed in Boreholes 6 and 10 only. Groundwater was observed in Borehole 6 at a depth of 4.01 m, corresponding to an elevation of 416.74 m. Groundwater was observed in Borehole 10 at a depth of 4.04 m, corresponding to an elevation of 414.41 m.

At the time of the investigation, the proposed finished floor elevations were not known. Therefore, it is recommended that the groundwater conditions be confirmed during the initial excavations. At that time, recommendations regarding footing size and damp-proofing/waterproofing can be made.

The very dense soils encountered in the boreholes have the potential to create perched water conditions in the overlying soils. Perched water conditions 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.

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 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 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 95% 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. The general contractor is responsible to protect service piping from damage by heavy equipment.

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.

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

In order to assist in maintaining the buildings dry from 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 (if side yard limits allow) to a drainage swale or appropriate storm drainage system.

The founding elevations for the proposed structures were not available at the time of preparation of this report. CMT Inc. can provide further recommendations for building drainage once the design drawings are completed and the founding elevations have been confirmed.

If the new buildings will have basements, then an exterior perimeter weeping tile system comprising perforated drainage pipe with a factory installed filter sock, bedded in 19 mm clear crushed stone and wrapped in 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. The portion of the piping that connects the exterior weeping tile 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 weeping tile 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 imported Granular 'B' Type I, Type II 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. 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.

The native mineral soils are generally considered suitable for reuse as foundation wall backfill, trench backfill and bulk fill in the driveways and parking areas; however, any wet soils will require significant air-drying in order to achieve the specified field 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 as required.

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;
- Loose lift thicknesses should not exceed 0.3 m (12") for granular soils or 0.2 m (8") for clay and 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 95% SPMDD in non-structural 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

All existing topsoil, vegetation (including tree root structures as well as loose soils that are typically associated with root structures) and any fill or native soils containing organics or other deleterious material must be subexcavated from within the driveway and parking areas. 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 granular base, the subgrade 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 catch basins or to the parking

lot/driveway edge (provided collection and proper gravity drainage to a suitable outlet is provided). 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, and to help minimize frost heave. The native soils comprise highly frost susceptible, fine-grained silt or sandy silt soils; therefore, it is highly 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 heave. 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 subdrains be installed through all low areas of the parking lot/driveway and ideally along the curb line. It is also recommended to install subdrains through any areas that cannot tolerate differential frost heave such as accessibility ramps/sidewalks. 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.

Should the subgrade soils comprise free-draining granular fill (minimum 1.0 m thick with positive drainage at the interface with any relatively impermeable soils, or perched water table), then the installation of subdrains may not be required.

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 driveway/parking lots will typically experience light traffic (personal vehicles) as well as 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 40 mm (1.5") 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 (such as 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 OPSS1150 and OPSS310.

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.

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/tight turning areas, it is recommended that rigid portland cement pavement be considered.

5.11. Excess Soil Management

5.11.1. 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. Most commonly, the soils are tested for the following:

- F1-F4, VOC's, BTEX as per O. Reg. 153/04 as amended by R511
- SVOC as per O. Reg. 153/04 as amended by R511
- Metals/Inorganics as per O. Reg. 153/04 amended by R511

The chemical analysis results are then compared to Ontario Regulation 153/04 - as amended by O.Reg. 511 – April 15, 2011 Standards = [Suite] – ON-511-T1/T2-SOIL-RPI. Specifically, the results were compared in *T1-Soil-Res/Park/Inst/Ind/Com/Commu Property Use*, *T2-Soil-Res/Park/Inst. Property Use (Coarse)* and *T3-Soil-Res/Park/Inst. Property Use (Fine)*.

5.11.2. TCLP Requirement

If soils are transported to a land fill facility, additional chemical testing in accordance with Ontario Regulation 347, Schedule 4, as amended to Ontario Regulation 558/00, dated March 2001, Toxicity Characteristic Leaching Procedure (TCLP) will be required.

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.

6.0 SITE INSPECTIONS

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

This report is intended for the Client named herein and for their Client. The report should be read in its entirety, and no portion of this report may be used as a separate entity. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties.

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.

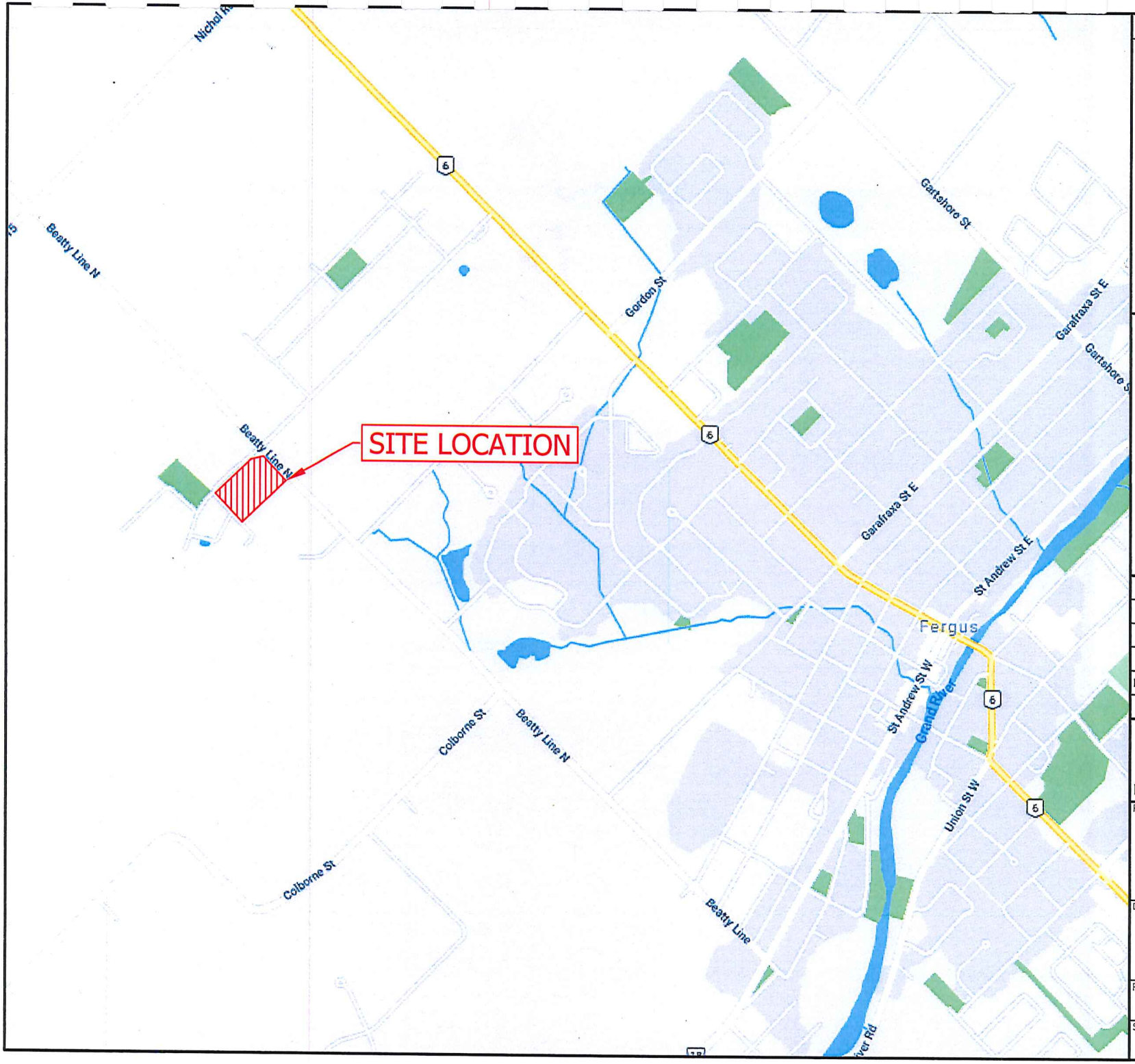
We trust that this report meets with your present requirements. Should you have any questions, please do not hesitate to contact our office.

Prepared by:

Shawn Wheatley, B.Sc

Reviewed by:

Robert Koopmans, P.Eng.
Consulting Engineer



NOTES:

Base map provided by Waterloo Region GIS Viewer

N

NO.	DESCRIPTION	DATE

REVISIONS

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
Tel.: 519-699-5775
Fax: 519-699-4664
www.cmtinc.net

PROJECT:

Residential Development
Beatty Line N at Farley Road,
Fergus, Ontario

DRAWING TITLE:

SITE LOCATION MAP

PROJECT NO.:	DATE:
18-085	April 3, 2018
SCALE: N.T.S.	DRAWING NO. 1

NOTES:

1. This drawing is for information purposes only. Locations and sizes of existing and proposed structures are approximate only, and should not be used for construction.
2. Base image is provided by Google Earth

N

NO.	DESCRIPTION	DATE

REVISIONS

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
Tel.: 519-699-5775
Fax: 519-699-4664
www.cmtinc.net

PROJECT:

Residential Development
Beatty Line N at Farley Road,
Fergus, Ontario

DRAWING TITLE:

SITE PLAN SHOWING
BOREHOLE LOCATIONS

PROJECT NO.:	DATE:
18-085	April 3, 2018
SCALE:	DRAWING NO.
N.T.S.	2

APPENDIX A

BOREHOLE LOGS

BOREHOLE 1

Date Drilled: March 21, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 418.78 m
Logged by: SW

Project No.: 18-085
Project: Residential Development
Location: 6552 Beatty Line North
Fergus, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION		Well Installation	Moisture Content % Wp [----X----] Wl 10 20 30 40	Pocket Penetrometer kPa 100 200 300 400 / SPT (N) Blows/0.3 m 20 40 60 80
					Ground Surface (m)	418.78			
0	SS		1		**TOPSOIL** Very loose, dark brown, silty organic topsoil, wet (500 mm)	0.00		27.3	3
						418.28			
1					**SANDY SILT** Loose, mottled brown to dark brown, sandy silt, trace gravel, with trace organics and rootlets, wet	0.50			
2	SS		2					13.5	8
						417.26			
3	SS		3		becoming compact, brown, with trace clay, no organics or rootlets, moist	1.52		9.6	12
4									
	SS		4			416.19		11.2	39
5					becoming dense	2.59			
						415.73			
6	SS		5		**SANDY SILT TILL** Very dense, grey-brown sandy silt till, some clay, trace gravel, moist	3.05		7.3	63 450
7									
	MC		6		Sand seam encountered at 3.20 m BGS, wet (50 mm)			7.5	450
8									
	SS		7					6.1	100+
						414.06			
					End of Borehole	4.72			

Caving encountered at 4.57 m below ground surface.

No groundwater encountered upon completion.

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
www.cmtinc.net

BOREHOLE 2

Date Drilled: March 21, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 420.05 m
Logged by: SW

Project No.: 18-085
Project: Residential Development
Location: 6552 Beatty Line North
Fergus, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION	Elevation / Depth	Well Installation	Moisture Content % (Wp [----X----] Wl)	Pocket Penetrometer kPa	SPT (N) Blows/0.3 m
					Ground Surface (m)	420.05				
0	SS		1		**TOPSOIL** Compact, dark brown, silty organic topsoil, moist (450 mm)	0.00 / 419.60 / 0.45		34.1	12	
1	SS		2		**SANDY SILT** Compact, brown, sandy silt, trace gravel and clay, with trace organics and rootlets, wet	418.53 / 1.52		16.5	14	
2	SS		3		**SILT** Compact, brown to light brown silt, some sand, trace gravel and clay, moist	417.76 / 2.29		12.1	12	
3	SS		4		Becoming very dense			13.2	58	
4	SS		5		**SANDY SILT TILL** Very dense, grey sandy silt till, some clay, trace gravel, moist	416.80 / 3.25		7.7	100+ / 450	
	MC5		6					7.4	450	
					End of Borehole	415.78 / 4.27				

No caving encountered in borehole.

No groundwater encountered upon completion.

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
www.cmtinc.net

BOREHOLE 3

Date Drilled: March 21, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 421.21 m
Logged by: SW

Project No.: 18-085
Project: Residential Development
Location: 6552 Beatty Line North
Fergus, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION	Elevation / Depth	Well Installation	Moisture Content % (Wp [----X----] Wl)	Pocket Penetrometer kPa / SPT (N) Blows/0.3 m
					Ground Surface (m)	421.21			
0 ft / 0 m					**TOPSOIL** Very loose, dark brown, silty organic topsoil, moist (240 mm)	0.00			
1	SS		1					20.5	2
2					**SANDY SILT** Very loose, red-brown sandy silt, trace gravel and clay, with trace organics and rootlets, wet	420.45 / 0.76			
3 / 1	SS		2		Becoming brown, no organics or rootlets			13.9	2
4									
5	SS		3					9.7	12
6 / 2					Becoming compact, some gravel, moist	419.38 / 1.83			
7	SS		4					9.0	51
8					Becoming very dense, some clay	418.72 / 2.49			
9									
10 / 3	SS		5		**SILT** Very dense, grey-brown silt, some sand, trace gravel and clay moist	418.16 / 3.05		14.5	100+
11									
12	MC5		6		Wet sand seam at 3.15 m (50mm)	417.55 / 3.66		7.2	450
13 / 4					**SANDY SILT TILL** Very dense, grey-brown sandy silt till, some clay, trace gravel, moist				
14									
15	SS		7					8.9	100+
16 / 5									
17					End of Borehole	416.03 / 5.18			
18					Caving encountered at 1.07 m below ground surface.				
19					No groundwater encountered upon completion.				
20 / 6									

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
www.cmtinc.net

BOREHOLE 4

Date Drilled: March 22, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 420.42 m
Logged by: SW

Project No.: 18-085
Project: Residential Development
Location: 6552 Beatty Line North
Fergus, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION	Elevation / Depth	Well Installation	Moisture Content % (Wp [----X----] Wl)	Pocket Penetrometer kPa / SPT (N) Blows/0.3 m
					Ground Surface (m)	420.42			
0 ft / 0 m					***TOPSOIL*** Very loose, dark brown, silty organic topsoil, moist (370 mm)	0.00 / 420.05 / 0.37			
1	SS		1					11.9	2
2					***SANDY SILT*** Loose, dark brown sandy silt, trace gravel and clay, with trace organics and rootlets, moist	419.66 / 0.76			
3 / 1	SS		2					14.7	6
4					Becoming brown, very moist to wet, no organics or rootlets				
5									
6	SS		3					12.6	5
7 / 2						418.13 / 2.29			
8	SS		4		***SILT*** Very dense, grey-brown silt, some sand, trace gravel, moist			8.6	100+
9									
10 / 3									
11	SS		5					9.6	67
12									
13 / 4	MC5		6					14.8	
14									
15									
16 / 5	SS		7					15.4	100+
17						415.24 / 5.18			
18					End of Borehole				
19									
20 / 6									

Caving encountered at 4.65 m below ground surface.

No groundwater encountered upon completion.

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
www.cmtinc.net

BOREHOLE 7

Date Drilled: March 22, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 418.72 m
Logged by: SW

Project No.: 18-085
Project: Residential Development
Location: 6552 Beatty Line North
Fergus, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION	Elevation / Depth	Well Installation	Moisture Content % (Wp [----X----] Wl) 10 20 30 40	Pocket Penetrometer kPa 100 200 300 400 / SPT (N) Blows/0.3 m 20 40 60 80
					Ground Surface (m)	418.72			
0 ft / 0 m	SS		1		***TOPSOIL*** Loose, dark brown, silty organic topsoil, wet (520 mm)	0.00 / 418.20		16.4	6
2 ft / 1 m	SS		2		***SANDY SILT*** Compact, mottled brown to dark brown sandy silt, some clay, trace gravel, with trace organics and rootlets, wet	0.52 / 417.20		11.4	14
5 ft / 1.5 m	SS		3		Becoming loose, brown, moist, no organics or rootlets	1.52 / 416.43		12.9	6
7 ft / 2 m	SS		4		Becoming compact	2.29 / 416.05		8.3	21
9 ft / 2.5 m	SS		5		Becoming very dense	2.67 / 415.06		8.9	100+
12 ft / 3.5 m	MC5		6		***SANDY SILT TILL*** Very dense, grey-brown sandy silt till, some clay, trace gravel, moist	3.66 / 413.54		7.3	
15 ft / 4.5 m	SS		7			5.18		7.1	100+
17 ft / 5 m					End of Borehole				

Caving encountered at 3.05 m below ground surface.

No groundwater encountered upon completion.

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
www.cmtinc.net

BOREHOLE 8

Date Drilled: March 22, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 418.64 m
Logged by: SW

Project No.: 18-085
Project: Residential Development
Location: 6552 Beatty Line North
Fergus, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION	Elevation / Depth	Well Installation	Moisture Content % Wp [----X----] Wl (10 20 30 40)	Pocket Penetrometer kPa (100 200 300 400) / SPT (N) Blows/0.3 m (20 40 60 80)
					Ground Surface (m)	418.64			
0					***TOPSOIL***	0.00			
1	SS		1		Very loose, dark brown, silty organic topsoil, wet (170 mm)			22.7	2
2					***SANDY SILT***				
3	SS		2		Very loose brown to dark brown mottled sandy silt, trace gravel and clay, with trace organics and rootlets, moist	417.88 0.76		14.0	5
4					Becoming loose, some clay and gravel, wet	417.62 1.02			
5	SS		3		Becoming light brown, some gravel, trace clay, moist, no organics or rootlets	417.12 1.52		10.1	6
6					Becoming wet				
7						416.30 2.34			
8	SS		4		***SILT*** Dense, light brown silt, some sand, trace gravel and clay, very moist			12.3	45
9						415.59 3.05			
10					Becoming very dense				
11	SS		5					7.8	100+
12						414.98 3.66			
13	MC5		6		***SANDY SILT TILL*** Grey-brown sandy silt till, some clay, trace gravel, moist			6.1	450
14									
15									
16	SS		7					7.6	100+ 450
17						413.46 5.18			
18					End of Borehole				
19					Caving encountered at 4.93 m below ground surface.				
20					No groundwater encountered upon completion.				

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
www.cmtinc.net

BOREHOLE 9

Date Drilled: March 21, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 417.92 m
Logged by: SW

Project No.: 18-085
Project: Residential Development
Location: 6552 Beatty Line North
Fergus, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION	Elevation / Depth	Well Installation	Moisture Content % (Wp [----X----] Wl)	Pocket Penetrometer kPa / SPT (N) Blows/0.3 m
					Ground Surface (m)	417.92			
0 ft / 0 m					***TOPSOIL***	0.00			
1	SS		1		Very loose, dark brown, silty organic topsoil, wet (390 mm)	417.53 / 0.39		23.1	2
2					***SANDY SILT***				
3 / 1 m	SS		2		Very loose, brown to dark brown mottled sandy silt, some clay, trace gravel, with trace organics and rootlets, wet	417.16 / 0.76		12.0	4
4					Becoming loose				
5					Becoming compact, moist	416.40 / 1.52			
6	SS		3		Becoming brown, no organics or rootlets	416.09 / 1.83		10.7	14
7 / 2 m									
8	SS		4			415.33 / 2.59		9.8	49
9					***SANDY SILT TILL***				
10 / 3 m					Dense, grey-brown sandy silt till, some clay, trace gravel, moist	414.87 / 3.05			
11	SS		5		Becoming very dense			5.8	100+
12									
13 / 4 m	MC5		6					6.4	
14						413.50 / 4.42			
15					End of Borehole				
16 / 5 m									
17									
18									
19									
20 / 6 m									

Caving encountered at 4.17 m below ground surface.

No groundwater encountered upon completion.

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
www.cmtinc.net

BOREHOLE 10

Date Drilled: March 21, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 418.45 m
Logged by: SW

Project No.: 18-085
Project: Residential Development
Location: 6552 Beatty Line North
Fergus, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION		Well Installation	Moisture Content % Wp [----X----] Wl 10 20 30 40	Pocket Penetrometer kPa 100 200 300 400 / SPT (N) Blows/0.3 m 20 40 60 80
					Ground Surface (m)	418.45			
0 ft / 0 m					**TOPSOIL**	0.00			
1	SS		1		Very loose, dark brown, silty organic topsoil, wet (340 mm)	418.11 0.34		28.9	2
2					**SANDY SILT**				
3 / 1	SS		2		Very loose brown sandy silt, trace gravel and clay, with trace organics and rootlets, wet	417.69 0.76		19.8	13
4					Becoming loose, no organics or rootlets				
5						416.93			
6 / 2	SS		3		Becoming compact, some clay, moist	1.52		11.1	22
7						416.16			
8	SS		4		Becoming dense	2.29		10.9	34
9									
10 / 3						415.25			
11	SS		5		Becoming very dense	3.20		10.4	100+
12						414.79			
13 / 4	MC5		6		**SANDY SILT TILL** Very dense, grey-brown sandy silt till, some clay, trace gravel, moist	3.66		6.3	
14						414.18			
15					End of Borehole	4.27			
16 / 5									
17									
18									
19									
20 / 6									

Caving encountered at 4.11 m below ground surface.

Groundwater encountered at 4.04 m below ground surface upon completion.

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
www.cmtinc.net

BOREHOLE 11

Date Drilled: March 21, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 418.05 m
Logged by: SW

Project No.: 18-085
Project: Residential Development
Location: 6552 Beatty Line North
Fergus, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION	Elevation	Depth	Well Installation	Moisture Content % (Wp [----X----] Wl)	Pocket Penetrometer kPa	SPT (N) Blows/0.3 m
					Ground Surface (m)	418.05					
0 ft / 0 m	SS		1		**TOPSOIL** Very loose, dark brown, silty organic topsoil, wet (120 mm)		0.00		22.8	2	
2 ft					**SANDY SILT** Very loose brown sandy silt, trace gravel and clay, with trace organics and rootlets, wet	417.29	0.76				
3 ft / 1 m	SS		2		Becoming loose, some gravel, no organics or rootlets				11.1	5	
5 ft					Becoming compact, some clay, moist	416.53	1.52				
6 ft / 2 m	SS		3						10.9	15	
8 ft	SS		4		**SILT** Very dense, grey-brown silt, some sand trace gravel and clay, moist	415.48	2.57		7.0	23	
10 ft / 3 m	SS		5						6.3		100+
12 ft	MC		6		**SANDY SILT TILL** Very dense, grey sandy silt till, some clay, trace gravel, moist	414.39	3.66		7.1	400	
16 ft / 5 m	SS		7						12.7	62	450
17 ft					End of Borehole	412.87	5.18				

Caving encountered at 5.03 m below ground surface.

No groundwater encountered upon completion.

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1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
www.cmtinc.net

BOREHOLE 12

Date Drilled: March 22, 2018
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 418.92 m
Logged by: SW

Project No.: 18-085
Project: Residential Development
Location: 6552 Beatty Line North
Fergus, Ontario

Depth (ft/m)	Sample Type	Recovery (%)	Sample Number	Symbols	SOIL DESCRIPTION	Elevation	Depth	Well Installation	Moisture Content % (Wp [----X----] Wl)	Pocket Penetrometer kPa	SPT (N) Blows/0.3 m
					Ground Surface (m)	418.92	0.00				
0 ft / 0 m	SS		1		**TOPSOIL** Loose, dark brown, silty organic topsoil, wet (260 mm)	418.66	0.26		23.8	5	
					SANDY SILT Loose brown to dark brown mottled sandy silt, some clay, trace gravel, with trace organics and rootlets, wet	418.16	0.76				
3 ft / 1 m	SS		2		Becoming compact, brown, some gravel, moist, no organics or rootlets				10.6	10	
6 ft / 2 m	SS		3						10.3	21	
						416.63	2.29				
	SS		4		**SILT** Dense, light brown silt, some sand, trace gravel, moist				12.2	48	
10 ft / 3 m						415.87	3.05				
	SS		5		Becoming very dense, some gravel				10.0	66	
13 ft / 4 m	MC5		6						7.3		
16 ft / 5 m	SS		7						6.7	100+	
						413.74	5.18				
20 ft / 6 m					End of Borehole						

Caving encountered at 4.67 m below ground surface.

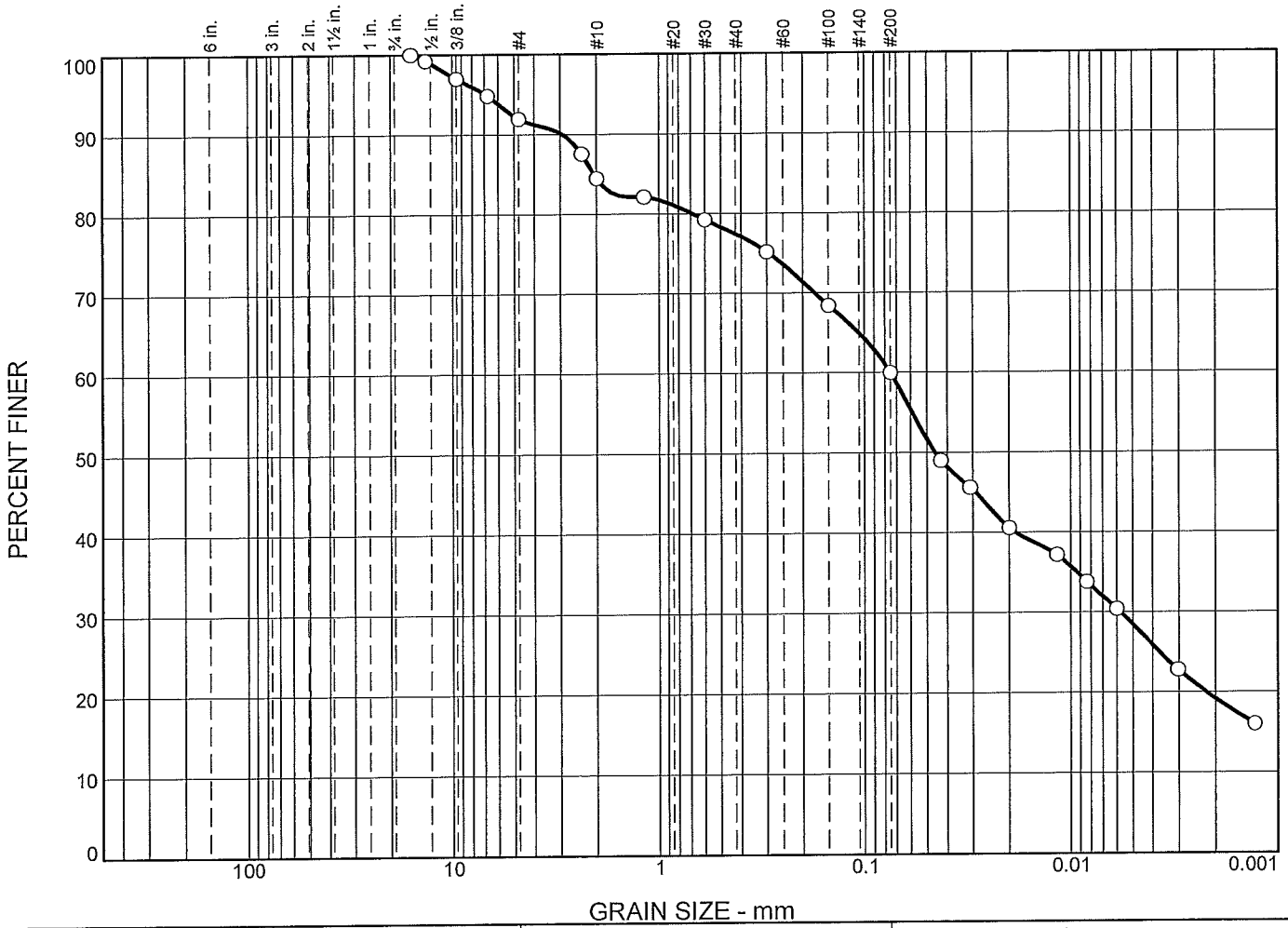
No groundwater encountered upon completion.

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
St. Clements, Ontario N0B 2M0
phone 519-699-5775 fax 519-699-4664
www.cmtinc.net

APPENDIX B

GRAIN SIZE ANALYSES

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	8.1	7.4	7.1	17.4	40.9	19.1

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH8	7	4.57-5.18m	sandy silt, some clay, trace gravel	ML
				Tested by JM of CMT Engineering Inc., March 27, 2018	

CMT Engineering Inc.

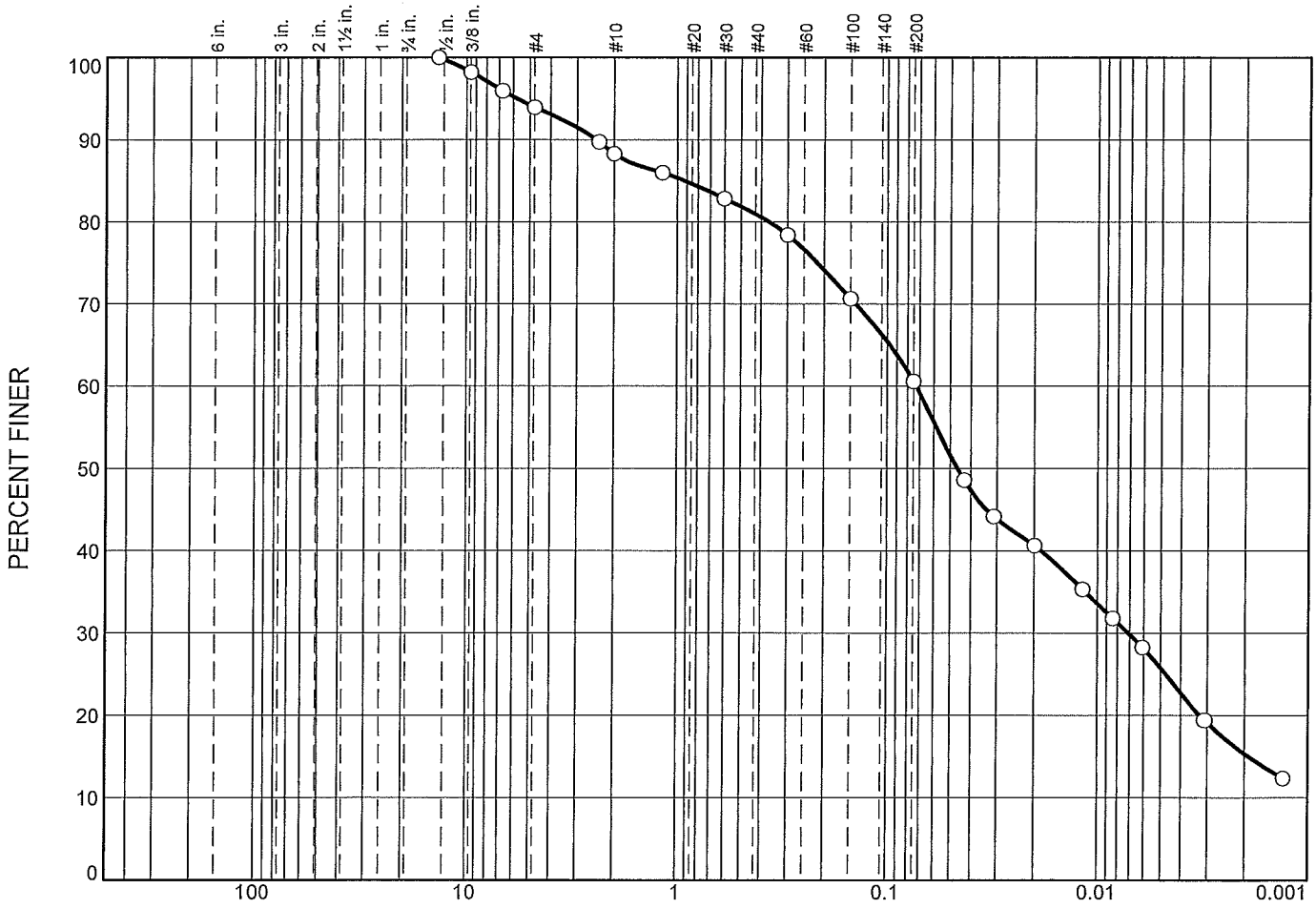
St. Clements, ON

Client: Van Harten Surveying Ltd.

Project: Proposed Residential Development
Beatty Line North at Farley Road, Fergus, Ontario

Project No.: 18-085 **Figure** 1

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	6.1	5.6	7.4	20.3	45.3	15.3

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH10	3	1.52-2.13m	sandy silt, some clay, trace gravel	ML
				Tested by JM of CMT Engineering Inc., March 27, 2018	

CMT Engineering Inc.

St. Clements, ON

Client: Van Harten Surveying Ltd.

Project: Proposed Residential Development
Beatty Line North at Farley Road, Fergus, Ontario

Project No.: 18-085 **Figure** 2