GEOTECHNICAL INVESTIGATION

PROPOSED RESIDENTIAL DEVELOPMENT
5782 6th LINE EAST
ARISS, ONTARIO

CMT Project 21-209.R01

Prepared for:

Will-O Homes

June 10, 2021

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June 10, 2021 21-209.R01

Will-O Homes
Box 187
Petersburg, Ontario
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Attention: Mr. Kevin Smith

Dear Sir:

Re: Geotechnical Investigation
Proposed Residential Development
5782 6th Line East
Ariss, 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,

Jake Feeney B.Eng., EIT.

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1.0 INTRODUCTION

The services of CMT Engineering Inc. (CMT Inc.) were retained by Mr. Kevin Smith of Will-O Homes to conduct a geotechnical investigation for the proposed residential development to be constructed at 5782 6th Line East in Ariss, Ontario. The location of the site is shown on Drawing 1.

It is understood that the project will involve the construction of seventeen (17) estate homes, approximately 2,500 ft^2 to 3,500 ft^2 in size. It is understood that each home is proposed to have roughly one (1) three-car garage, four (4) bedrooms and four (4) to five (5) bathrooms. Private Class IV septic systems and drilled wells are proposed to service the residences.

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 on the southwest side of 6th Line East in Ariss. The site is bounded by 6th Line East to the northeast, residential property to the southeast, Kissing Bridge Trail and Wellington Road 86 to the southwest, and agricultural fields to the northwest. The site currently comprises agricultural land. In general, the site topography is undulating slightly throughout the proposed construction area.

3.0 FIELD AND LABORATORY PROCEDURES

The field investigation was conducted on May 13 and 26, 2021 and comprised the advancement of six (6) boreholes (referenced as Boreholes 1 to 6), utilizing a Geoprobe 7822DT drillrig operated by employees of CMT Drilling Inc. Boreholes 1 to 6 were advanced to depths of approximately 6.10 m (20.00 ft) below the existing ground surface in the area of the proposed development. Prior to the field investigation being carried out, underground service locates were undertaken to ensure that existing utilities would not be damaged, or personnel injured.

Standard penetration testing and sampling was carried out in Boreholes 1 to 6 using a 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 typically conducted between the SPT soil samples conducted below 3.05 m (10.00 ft) depth. 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 boreholes at the following depths were submitted to the CMT Inc. laboratory in St. Clements, Ontario for grain size analyses:

- Borehole 1 – depth 2.29 m to 2.90 m (7.50 ft to 9.50 ft)
- Borehole 2 – depth 0.76 m to 1.37 m (2.50 ft to 4.50 ft)
- Borehole 3 – depth 3.05 m to 3.66 m (10.00 ft to 12.00 ft)
- Borehole 4 – depth 1.52 m to 2.13 m (5.00 ft to 7.00 ft)
- Borehole 5 – depth 1.52 m to 2.13 m (5.00 ft to 7.00 ft)
- Borehole 6 – 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.

Monitoring wells were installed at all six of the borehole locations and comprised 3.05 m (10.00 ft) long slotted screens. The monitoring well screens were backfilled with #2 filter sand and the riser pipes were backfilled with bentonite. The monitoring wells were installed in accordance with the Ontario Water Resources Act, Regulation 903 (O. Reg. 903) by well technicians licensed by the Ministry of the Environment, Conservation and Parks (MECP). The well records are provided in Appendix C.

The ground surface elevations of the boreholes were surveyed by GM BluePlan Engineering Limited prior to the commencement of drilling. The ground surface elevations at the borehole locations ranged from approximately 345.50 m to 350.22 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, moist, dark brown, silty, organic topsoil was encountered at the surface of all borehole locations. The thickness of the topsoil was observed to range from about 300 mm to 610 mm (average 520 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 with trace silt was encountered underlying the topsoil at Borehole 6. The sand and gravel fill had an approximate thickness of 1,680 mm. The sand and gravel fill was considered to be compact to dense, with SPT N-values ranging from about 13 to 47 blows per 0.30 m (average 30 blows per 0.30 m). The sand and gravel fill soils are considered to be moist to saturated, with measured moisture contents ranging from about 6.7% to 13.3% (average 10.0%). It should be noted that the sand and gravel fill is likely backfill from a nearby field drain.

4.3. Sand and Gravel

Brown to reddish brown sand and gravel with trace silt was encountered underlying the sandy silt at Boreholes 2 and 5 and underlying the topsoil at Borehole 4. The sand and gravel was considered to be compact to very dense, with SPT N-values of about 19 blows per 0.30 m. The sand and gravel soils are considered to be moist to saturated, with measured moisture contents ranging from about 6.1% to 16.3% (average 11.2%).

4.4. Sandy Silt

Grey to brown sandy silt to sand and silt with trace to some clay and trace to no gravel was encountered underlying the topsoil at Boreholes 1, 2, 3 and 5; underlying the sand and gravel at Boreholes 2, 4, and 5; and underlying the sand and gravel fill at Borehole 6. The sandy silt was observed to extend to the termination depth of all six (6) boreholes. Oxidation staining was observed within the sandy silt at Boreholes 3 and 4. The sandy silt was considered to be very loose to very dense, with SPT N-values ranging from 4 to greater than 100 blows per 0.30 m (average 42 blows per 0.30 m). The sandy silt soils are considered to be moist to wet, with measured moisture contents ranging from about 5.5% to 17.6% (average 9.3%).

4.5. Groundwater

Monitoring wells were installed in all boreholes to measure the static groundwater levels. The water levels were measured by CMT Inc. personnel on June 8, 2021.

The measured elevations of water in the monitoring wells, the estimated wet to saturated zones, as well as the ground surface and bottom of borehole elevations, are provided in the following table:

Borehole No.	Ground Surface Elevation (m)	Measured Elevation of Water in Monitoring Well June 8, 2021 (m)	Estimated Wet to Saturated Zones (m)	Bottom of Borehole Elevation (m)
1	349.18	347.86 (1.32)	--	343.08
2	345.58	344.16 (1.42)	344.97 to 343.90	339.48
3	345.50	344.09 (1.41)	--	339.40
4	350.22	347.04 (3.18)	347.93 to 347.17	344.12
5	347.45	345.92 (1.53)	343.18 to 342.88	341.35
6	349.04	348.38 (0.66)	347.52 to 346.75	342.94

It should be noted that the typically fine-grained sandy silt soils have the potential to create perched groundwater in the overlying soils. 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

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:

MW 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
1	349.18	75 (1,500)	115 (2,300)	348.52 to 347.66	0.66	Sandy Silt
		150 (3,000)	225 (4,500)	347.66 to 343.08 (termination)	1.52	
2	345.58	150 (3,000)	225 (4,500)	344.36 to 339.48 (termination)	1.22	Sandy Silt/Sand and Gravel
3	345.50	75 (1,500)	115 (2,300)	344.59 to 343.98	0.91	Sandy Silt Clayey Silt
		150 (3,000)	225 (4,500)	343.98 to 339.40 (termination)	1.52	
4	350.22	150 (3,000)	225 (4,500)	349.31 to 344.12 (termination)	0.91	Sand and Gravel/Sandy Silt
5	347.45	150 (3,000)	225 (4,500)	346.69 to 341.35 (termination)	0.76	Sandy Silt/Sand and Gravel
6	349.04	150 (3,000)	225 (4,500)	348.13 to 345.99	0.91	Sand and Gravel Fill/Sandy Silt
		75 (1,500)	115 (2,300)	345.99 to 342.94 (termination)	3.05	

*Highest founding elevations presented above do not take into account groundwater conditions.

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 underlying the topsoil and loose upper soils encountered in the boreholes. Soils suitable to support conventional foundations designed with an estimated bearing capacity of

75 kPa (1,500 psf) at SLS and 115 kPa (2,300 psf) at ULS were typically encountered below the topsoil in the borehole locations. It is recommended that footings be founded at least one (1) footing width (minimum 0.5 m) above the high groundwater table at the site. Depending on the groundwater conditions at the time of construction, it may be necessary to install a granular drainage layer or mud mat to provide a suitable base for the foundations. This will depend on the bearing capacity required for the founding strata. If required, the granular drainage layer must conform to the requirements listed in Section 9.14.4 of the OBC 2012. The founding soils 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 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 wet to saturated 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 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 6.10 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 (Ka, Kp, Ko) 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^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)	Cohesion (Undrained) (kPa)
Imported Granular 'A'/ Granular 'B' (OPSS 1010)	2,100	34°	0.28	3.54	0.44	0.45	0
Sandy Silt	1,750	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 residential development 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 must be removed from within the proposed building and roadway 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 and roadway 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.

5.4.2. Removal/Relocation of Existing Buried Piping

It should be noted that a hickenbottom was noted in the area of Boreholes 5 and 6. Any existing underground services (if present) that may be located within the proposed building envelopes must 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 field tiles or 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 has been disturbed by demolition/construction processes and are considered to be unsuitable to support foundations or slab-on-grades, must be subexcavated from within the proposed building envelopes, 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 driveway 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 or loose/soft native soils if it is decided to leave them 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 topsoil and vegetation, 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 roadway 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; and

- Granular 'B' subbase and Granular 'A' base materials for the paved parking areas must be compacted to 100% SPMDD.

Any wet to saturated soils encountered during the excavation 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 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:

- Should the native soils at the design founding elevation in the proposed building envelopes 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/ditched to a sump (as required) located outside the building footprint (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 poured in order to protect the structural integrity of the founding soils.

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^3 (300 lb/in^3)
Sandy Silt	33,955 kN/m^3 (125 lb/in^3)
Sand and Gravel	68,000 kN/m^3 (250 lb/in^3)

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. It should be noted that wet to saturated soil conditions were encountered in the boreholes. As such, if wet to saturated soils are encountered during the excavation, it would be recommended that 150 mm (6") of 19 mm clear crushed stone (OPSS 1004) should be used as a base for the floor slabs 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 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, any existing fill materials (backfill of existing foundations and services) as well as the sand and gravel soils 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

It should be noted that the groundwater was measured to be relatively shallow throughout the borehole locations. 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, however there is the potential for a high groundwater table to be encountered. 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. Additionally, it may be necessary to place granular bedding/backfill immediately upon placing the pipe to prevent the pipe from floating in wet conditions. 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 centre-line 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 0.15*D* (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 zone of wet to saturated soils noted in the boreholes 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 the wet to 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). Each residence should have its own sump pit and 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 dwellings 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 driveway areas; 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.

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

The existing topsoil, vegetation, and any soils containing organics or other deleterious material must be stripped/subexcavated from within the roadway 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 roadway and driveway subgrade soils. It is expected that the subgrade soils will generally be comprised of 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). 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 roadway 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 - 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 (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. Infiltration

The following information is based on the grain size analyses that were undertaken on soil samples obtained from Borehole 1 (depth 2.29 m to 2.90 m or 7.50 ft to 9.50 ft), Borehole 3 (depth 3.05 m to 3.66 m or 10.00 ft to 12.00 ft) and Borehole 6 (depth 3.05 m to 3.66 m or 10.00 ft to 12.00 ft).

The sample from Borehole 1 comprised sandy silt with some clay and trace gravel (ML) and the estimated coefficient of permeability (k) of this sample is 1.22×10^{-6} cm/sec.

The sample from Borehole 3 comprised sandy silt with some clay and trace gravel (ML) and the estimated coefficient of permeability (k) of this sample is 2.44×10^{-6} cm/sec.

The sample from Borehole 6 comprised sand and silt with some clay and trace gravel (SM) and the estimated coefficient of permeability (k) of this sample is 4.08×10^{-6} cm/sec.

A detailed stratigraphic description of the soils encountered for each borehole is provided in the borehole logs (Appendix A). The grain size analyses can be found in Appendix B of this report.

5.13. Percolation Rate (T-time) Determination

It is understood that new septic systems are to be designed at a later date. The following is a summary of the percolation rate (T-time) determinations by CMT Inc.

The sample from Borehole 2 (depth 0.76 m to 1.37 m or 2.50 ft to 4.50 ft) was determined to be sand and silt with trace clay and can be classified as SM using the Unified Soil Classification System. The corresponding estimated soil percolation rate, as referenced to Section 6 of the Supplementary Guidelines to the Ontario Building Code 2012 (amended in 2019), would be T = 20 min/cm.

The sample from Borehole 4 (depth 1.52 m to 2.13 m or 5.00 ft to 7.00 ft) was determined to be sandy silt with some clay and gravel and can be classified as ML using the Unified Soil Classification System. The corresponding soil percolation rate, as referenced to Section 6 of the Supplementary Guidelines to the Ontario Building Code 2012 (amended in 2019), would be T = 25 min/cm.

The sample from Borehole 5 (depth 1.52 m to 2.13 m or 5.00 ft to 7.00 ft) was determined to be sandy silt with some clay and trace gravel and can be classified as ML using the Unified Soil Classification System. The corresponding soil percolation rate, as referenced to Section 6 of the Supplementary Guidelines to the Ontario Building Code 2012 (amended in 2019), would be T = 30 min/cm.

It should be noted that these test results are based on single samples obtained during the investigation and do not constitute as guarantees for the entire site. Additional test samples should be obtained and tested if there is a variation observed at any time.

A detailed stratigraphic description of the soils encountered for each borehole is provided in the borehole logs (Appendix A). The grain size analyses can be found in Appendix B of this report.

5.14. Excess Soil Management

5.14.1. Chemical Testing was NOT Undertaken

Generally, if surplus soils are to be exported off-site, it will be necessary to undertake 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

5.14.2. TCLP Requirement

If soils are transported to a landfill 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.

5.15. 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 B.Eng., EIT.

ks

Reviewed by:

Nathan Chortos, P.Eng.
Senior Geotechnical Engineer

NOTES:

Base map provided by Google.

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

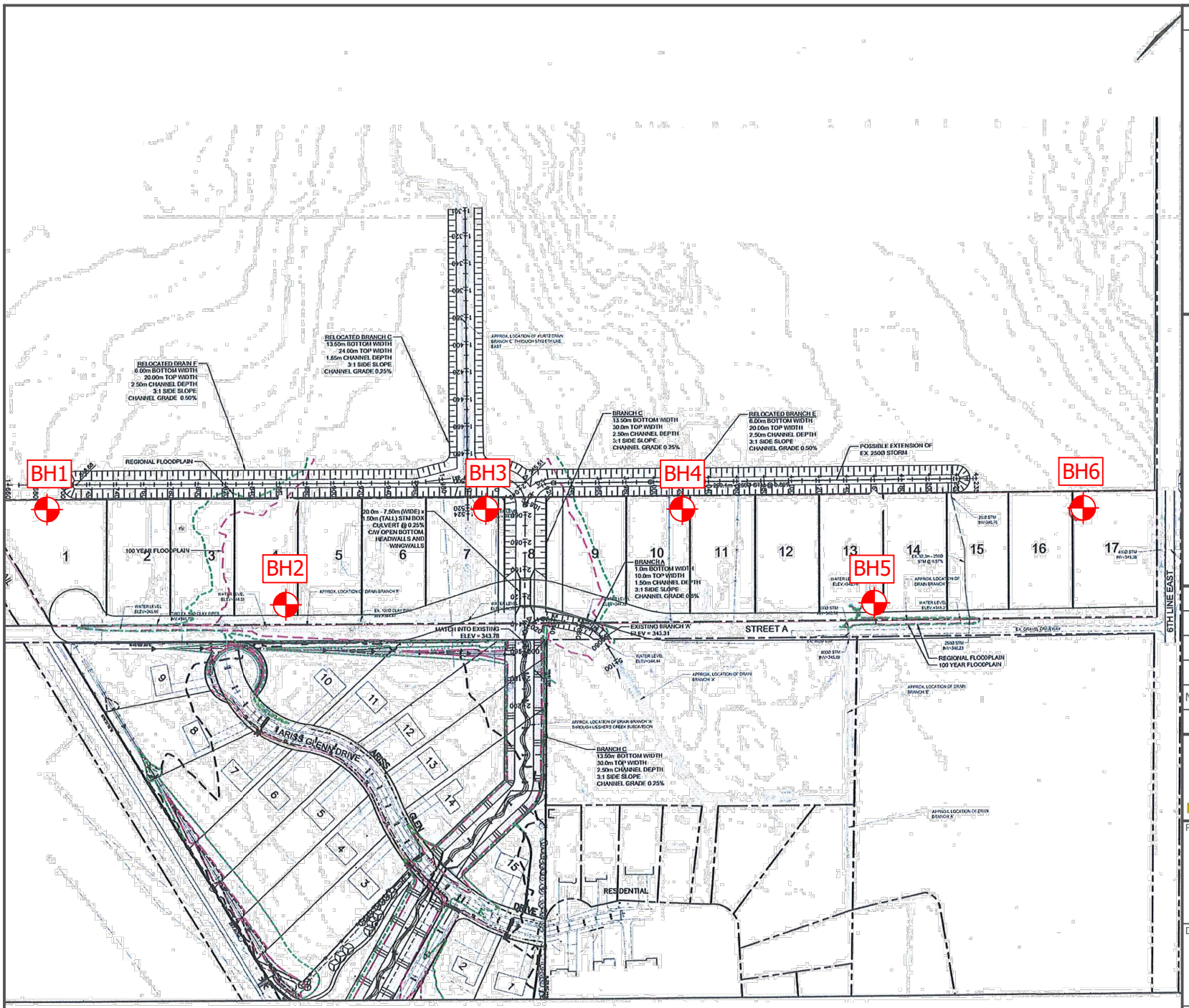
PROJECT:

PROPOSED DEVELOPMENT
5782 6th Line East
Ariss, Ontario

DRAWING TITLE:

SITE LOCATION MAP

PROJECT NO.:	DATE:
21-209	June 7, 2021
SCALE:	DRAWING NO.
N.T.S.	1



NOTES:

Base map provided by GM BluePlan Engineering

Legend

CMT Borehole with Monitoring Well

NO.	DESCRIPTION	DATE

REVISIONS

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PROJECT:

PROPOSED DEVELOPMENT
5782 6th Line East
Ariss, Ontario

DRAWING TITLE:

AERIAL VIEW SHOWING BOREHOLE LOCATIONS

PROJECT NO.:	DATE:
21-209	June 7, 2021
SCALE:	DRAWING NO.
N.T.S.	2

APPENDIX A

BOREHOLE LOGS

CMT Engineering Inc.
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BOREHOLE NUMBER 1

PROJECT: Proposed Development
PROJECT ADDRESS: 5782 6th Line East
PROJECT NUMBER: 21-209
PROJECT LOCATION: Ariss, Ontario
DRILLING DATE: 21-5-13
GROUND ELEVATION: 349.18 m
DRILLING CONTRACTOR: CMT Drilling Inc.
LOGGED BY: J. Feeney
DRILLING EQUIPMENT: Geoprobe 7822DT
SAMPLING METHOD: SPT

DEPTH (m)	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	SPT N VALUE / POCKET PEN. (kPa) / MOISTURE CONTENT (%)	WELL DIAGRAM
0	**Topsoil:** Loose, dark brown, silty, organic topsoil, moist (380 mm)	0.00, 349.18	SPT 1	49	1-1-1-1 (2)	2 kPa; 17.2 %	
	Sandy Silt: Very loose, grey-brown sandy silt, some clay, trace gravel, moist	0.38, 348.80					
1	becoming loose	0.76, 348.42	SPT 2	100	2-2-7-5 (9)	9; 12.3 %	Bentonite Seal Water Level: 347.86 m (1.32 mbgs)
2	becoming compact, brown	1.52, 347.66	SPT 3	100	5-7-13-13 (20)	20; 10.4 %	38mm Riser
3	becoming dense	2.29, 346.89	SPT 4	100	9-17-23-33 (40)	40; 8.6 %	
	becoming very dense, sand and silt	3.05, 346.13	SPT 5	100	35-50-50-50 (100)	>>; 350 kPa; 11.6 %	
4			MC5 6	100		350 kPa; 7.8 %	#2 Sand Pack
	becoming grey	4.57, 344.61	SPT 7	100	20-20-30-50 (50)	50; 350 kPa; 7.2 %	38mm Slotted Screen
5			MC5 8	100		250 kPa; 7.8 %	
6	Bottom of borehole at 6.10 m, Elevation 343.08 m.						

CMT Engineering Inc.
1011 Industrial Crescent
St. Clements, Ontario, N0B 2M0
Telephone: 519-699-5775
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BOREHOLE NUMBER 2

PROJECT: Proposed Development
PROJECT ADDRESS: 5782 6th Line East
PROJECT NUMBER: 21-209
PROJECT LOCATION: Ariss, Ontario
DRILLING DATE: 21-5-13
GROUND ELEVATION: 345.58 m
DRILLING CONTRACTOR: CMT Drilling Inc.
LOGGED BY: J. Feeney
DRILLING EQUIPMENT: Geoprobe 7822DT
SAMPLING METHOD: SPT

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	SPT N VALUE / POCKET PEN. (kPa) / MOISTURE CONTENT (%)	WELL DIAGRAM
		Topsoil: Loose, dark brown, silty, organic topsoil, moist (610 mm)	0.00, 345.58	SPT 1	49	0-1-2-2 (3)	3; 16.8	
1		**Sandy Silt:** Loose, brown sand and silt, trace clay, wet	0.61, 344.97	SPT 2	100	1-2-2-21 (4)	4; 17.6	Bentonite Seal
		Sand and Gravel: Compact, reddish brown sand and gravel, trace silt, wet	1.22, 344.36					Water Level: 344.16 m (1.42 mbgs)
2		**Sandy Silt:** Compact, brown sand and silt, trace clay and gravel, moist	1.68, 343.90	SPT 3	100	4-11-12-8 (23)	23; 12.1	38mm Riser
		becoming very dense and sandy with some clay	2.29, 343.29	SPT 4	100	50-50-50-50 (100)	>>; 6.1	
3				SPT 5	100	47-50-50-50 (100)	>>; 5.5	
		becoming grey	3.66, 341.92					
4				MC5 6	100		6.4	#2 Sand Pack
				SPT 7	49	42-50-50-50 (100)	>>; 5.9	38mm Slotted Screen
5								
				MC5 8	100		6.5	
6								

Bottom of borehole at 6.10 m, Elevation 339.48 m.

CMT Engineering Inc.
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St. Clements, Ontario, N0B 2M0
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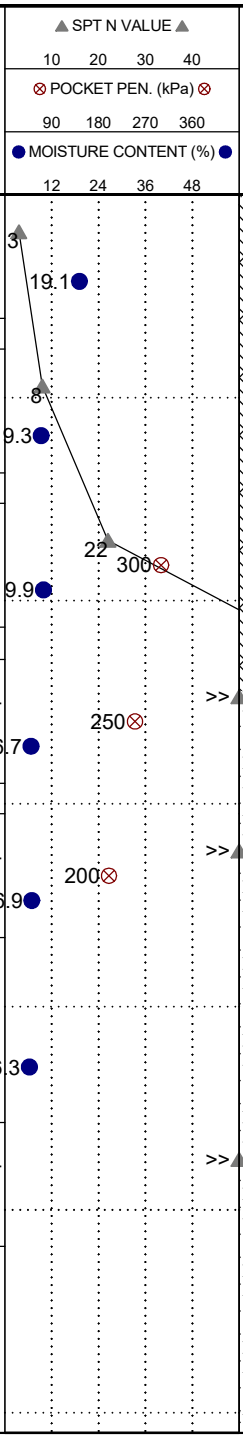
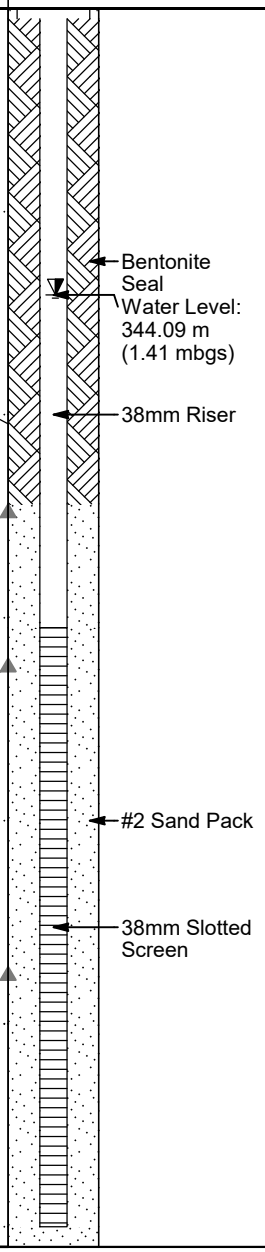
BOREHOLE NUMBER 3

PROJECT: Proposed Development
PROJECT ADDRESS: 5782 6th Line East
PROJECT NUMBER: 21-209
PROJECT LOCATION: Ariss, Ontario
DRILLING DATE: 21-5-13
GROUND ELEVATION: 345.50 m
DRILLING CONTRACTOR: CMT Drilling Inc.
LOGGED BY: J. Feeney
DRILLING EQUIPMENT: Geoprobe 7822DT
SAMPLING METHOD: SPT

DEPTH (m)	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)
	Topsoil: Loose, dark brown, silty, organic topsoil, moist (610 mm)	0.00, 345.50	SPT 1	49	1-1-2-3 (3)
1	**Sandy Silt:** Loose, brown sandy silt, some clay, trace gravel, moist	0.61, 344.89	SPT 2	100	2-2-6-8 (8)
	becoming compact	1.52, 343.98	SPT 3	100	9-11-11-11 (22)
2	Oxidation staining observed				
	becoming very dense	2.29, 343.21	SPT 4	100	13-48-37-50 (85)
3	becoming grey	3.05, 342.45	SPT 5	100	32-50-50-50 (100)
4			MC5 6	100	
5			SPT 7	100	50-50-50-50 (100)
6			MC5 8	100	





Bottom of borehole at 6.10 m, Elevation 339.40 m.

CMT Engineering Inc.
1011 Industrial Crescent
St. Clements, Ontario, N0B 2M0
Telephone: 519-699-5775
Fax: 519-699-4664

BOREHOLE NUMBER 4

PROJECT: Proposed Development
PROJECT ADDRESS: 5782 6th Line East
PROJECT NUMBER: 21-209
PROJECT LOCATION: Ariss, Ontario
DRILLING DATE: 21-5-13
GROUND ELEVATION: 350.22 m
DRILLING CONTRACTOR: CMT Drilling Inc.
LOGGED BY: J. Feeney
DRILLING EQUIPMENT: Geoprobe 7822DT
SAMPLING METHOD: SPT

DEPTH (m)	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)
0	**Topsoil:** Loose, dark brown, silty, organic topsoil, moist (610 mm)	0.00, 350.22	SPT 1	49	0-1-1-3 (2)
1	**Sand and Gravel:** Compact, brown sand and gravel, trace silt, moist	0.61, 349.61	SPT 2	49	11-8-11-11 (19)
2	**Sandy Silt:** Compact, brown sandy silt, some clay and gravel, moist	1.52, 348.70	SPT 3	100	3-5-7-8 (12)
	becoming grey and wet Oxidation staining observed	2.29, 347.93	SPT 4	100	4-7-8-11 (15)
3	becoming moist	3.05, 347.17	SPT 5	100	5-8-7-14 (15)
4			MC5 6	100	
5			SPT 7	100	9-13-15-18 (28)
6			MC5 8	100	

SPT N VALUE: 10 20 30 40
POCKET PEN. (kPa): 90 180 270 360
MOISTURE CONTENT (%): 12 24 36 48

Plotted values: 2, 15.3, 19, 6.1, 12, 8.9, 15, 8.8, 15, 250, 9.4, 150, 8.5, 28, 100, 8.6, 200, 8

WELL DIAGRAM: Bentonite Seal; 38mm Riser; Water Level: 347.04 m (3.18 mbgs); #2 Sand Pack; 38mm Slotted Screen

Bottom of borehole at 6.10 m, Elevation 344.12 m.

CMT Engineering Inc.
1011 Industrial Crescent
St. Clements, Ontario, N0B 2M0
Telephone: 519-699-5775
Fax: 519-699-4664

BOREHOLE NUMBER 5

PROJECT: Proposed Development
PROJECT ADDRESS: 5782 6th Line East
PROJECT NUMBER: 21-209
PROJECT LOCATION: Ariss, Ontario
DRILLING DATE: 21-5-26
GROUND ELEVATION: 347.45 m
DRILLING CONTRACTOR: CMT Drilling Inc.
LOGGED BY: J. Feeney
DRILLING EQUIPMENT: Geoprobe 7822DT
SAMPLING METHOD: SPT

DEPTH (m)	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)	SPT N VALUE / POCKET PEN. (kPa) / MOISTURE CONTENT (%)	WELL DIAGRAM
	Topsoil: Loose, dark brown, silty, organic topsoil, moist (300 mm)	0.00, 347.45	SPT 1	49	2-2-2-3 (4)	4, 23, 13.1	
	Sandy Silt: Loose, brown sand and silt, trace clay and gravel, moist	0.30, 347.15					
1	becoming dense	0.76, 346.69	SPT 2	49	8-14-18-12 (32)	32	Bentonite Seal
	becoming compact and sandy with some clay	1.52, 345.93	SPT 3	100	12-10-9-14 (19)	19, 250, 9	Water Level: 345.92 m (1.53 mbgs)
2							38mm Riser
	becoming dense and grey	2.29, 345.16	SPT 4	100	7-14-18-18 (32)	32, 450, 9.9	
3			SPT 5	100	12-17-16-42 (33)	33, 450, 8.5	
4			MC5 6	100		450, 16.3	#2 Sand Pack
	Sand and Gravel: Very dense, brown sand and gravel, trace silt, saturated	4.27, 343.18					
	Sandy Silt: Very dense, brown sand and silt, trace clay and gravel, moist	4.57, 342.88	SPT 7	100	17-27-37-50 (64)	>>, 450, 12.9	38mm Slotted Screen
5	becoming grey and sandy with some clay	5.03, 342.42				7.4	
			MC5 8	100		300, 12.1	
6							

Bottom of borehole at 6.10 m, Elevation 341.35 m.

CMT Engineering Inc.
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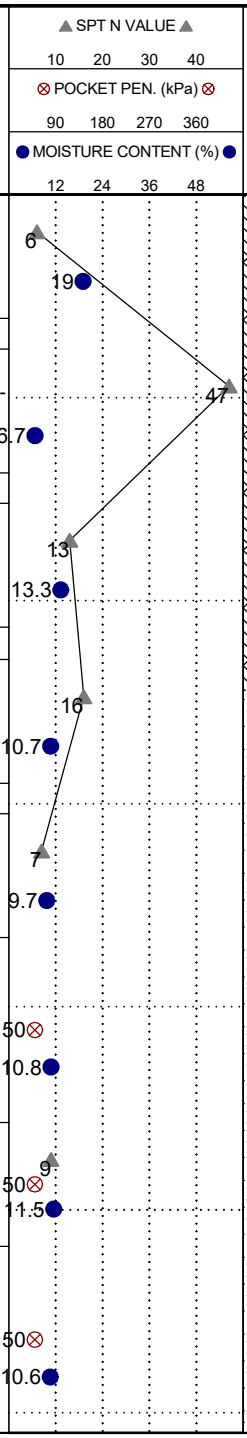
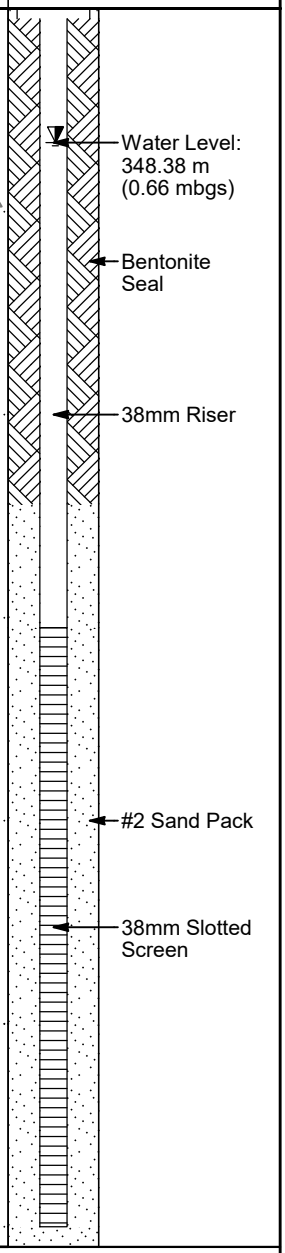
St. Clements, Ontario, N0B 2M0
Telephone: 519-699-5775
Fax: 519-699-4664

BOREHOLE NUMBER 6

PROJECT: Proposed Development
PROJECT ADDRESS: 5782 6th Line East
PROJECT NUMBER: 21-209
PROJECT LOCATION: Ariss, Ontario
DRILLING DATE: 21-5-26
GROUND ELEVATION: 349.04 m
DRILLING CONTRACTOR: CMT Drilling Inc.
LOGGED BY: J. Feeney
DRILLING EQUIPMENT: Geoprobe 7822DT
SAMPLING METHOD: SPT

DEPTH (m)	MATERIAL DESCRIPTION	Depth, Elevation (m)	SAMPLE TYPE NUMBER	RECOVERY %	BLOW COUNTS (N VALUE)
0	**Topsoil:** Loose, dark brown, silty, organic topsoil, moist (610 mm)	0.00, 349.04	SPT 1	49	1-2-4-5 (6)
1	**Sand and Gravel Fill:** Dense, brown sand and gravel fill, trace silt, moist (1,680 mm)	0.61, 348.43	SPT 2	74	15-24-23-15 (47)
	becoming compact and saturated	1.52, 347.52	SPT 3	16	9-6-7-6 (13)
2					
	Sandy Silt: Compact, brown sand and silt, some clay, trace gravel, moist	2.29, 346.75	SPT 4	100	4-7-9-8 (16)
3	becoming loose	3.05, 345.99	SPT 5	100	2-2-5-6 (7)
4			MC5 6	100	
			SPT 7	100	4-4-5-6 (9)
5			MC5 8	100	
6	Bottom of borehole at 6.10 m, Elevation 342.94 m.				



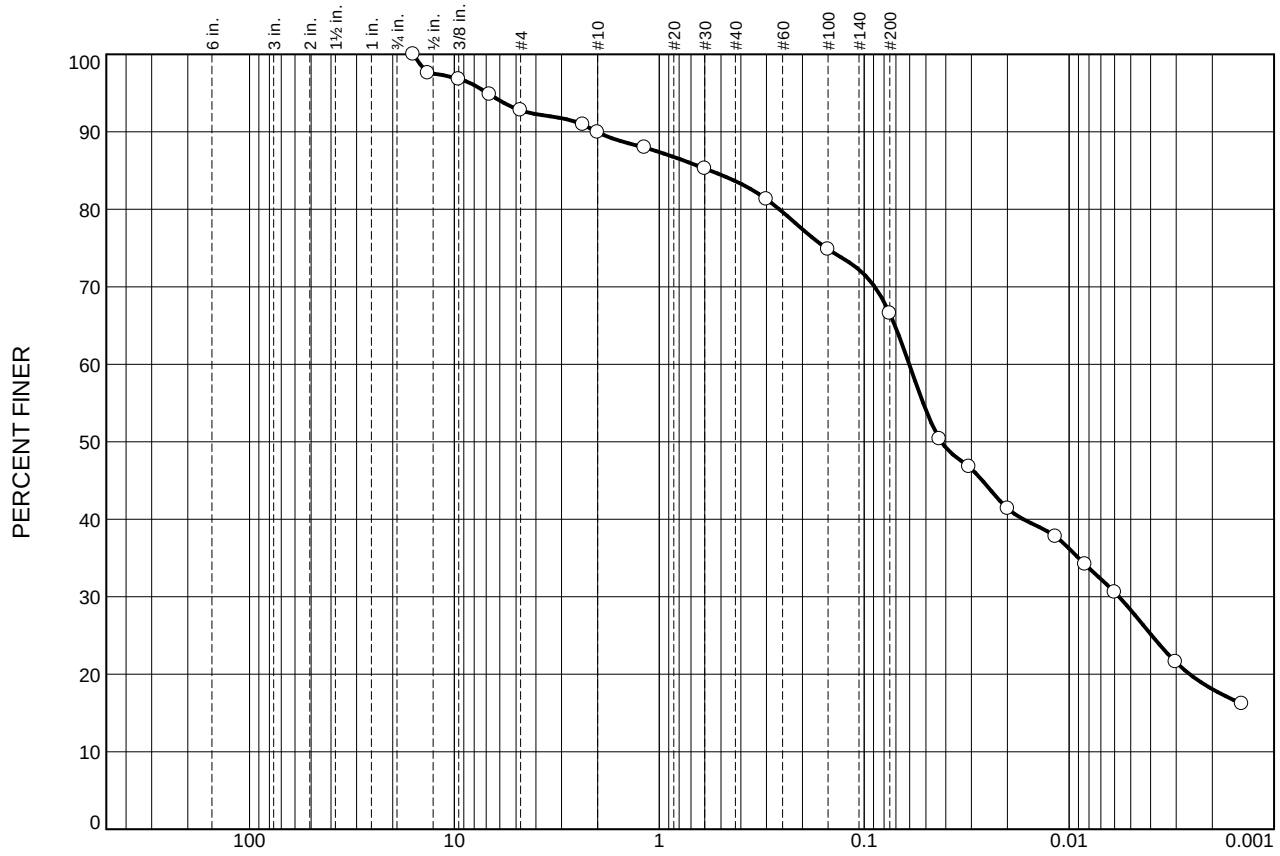


BOREHOLE LOG WITH WELL2 21-209.GPJ CMT_TEMPLATE_2020-05-15.GDT 21-6-9

APPENDIX B

GRAIN SIZE ANALYSES

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	7.2	2.9	6.3	17.0	48.5	18.1

SOIL DATA					
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH1	4	2.29-2.90m	sandy silt, some clay, trace gravel	ML
				Estimated Coefficient of Permeability; k = 1.22 x 10^{-6} cm/sec	
				Sampled by JF of CMT Engineering Inc., May 13, 2021	
				Tested by JM of CMT Engineering Inc., May 28, 2021	

CMT Engineering Inc.

St. Clements, ON

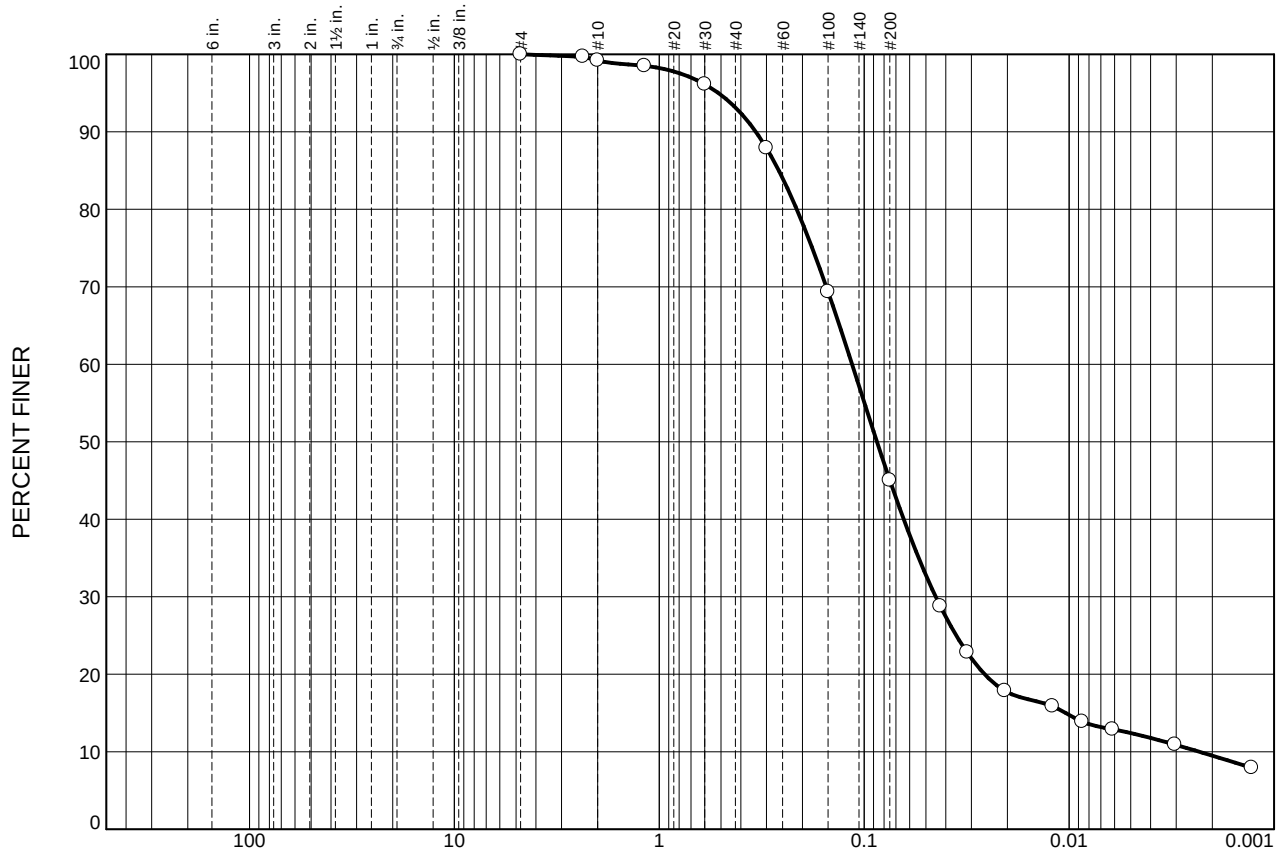
Client: Will-O Homes

Project: 5782 6th Line East
Ariss, Ontario

Project No.: 21-209

Figure 1

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.8	6.1	48.1	35.5	9.5

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH2	2	0.76-1.37m	sand and silt, trace clay	SM
				Estimated Percolation Rate; T = 20 min/cm	
				Sampled by JF of CMT Engineering Inc., May 13, 2021	
				Tested by JM of CMT Engineering Inc., May 28, 2021	

CMT Engineering Inc.

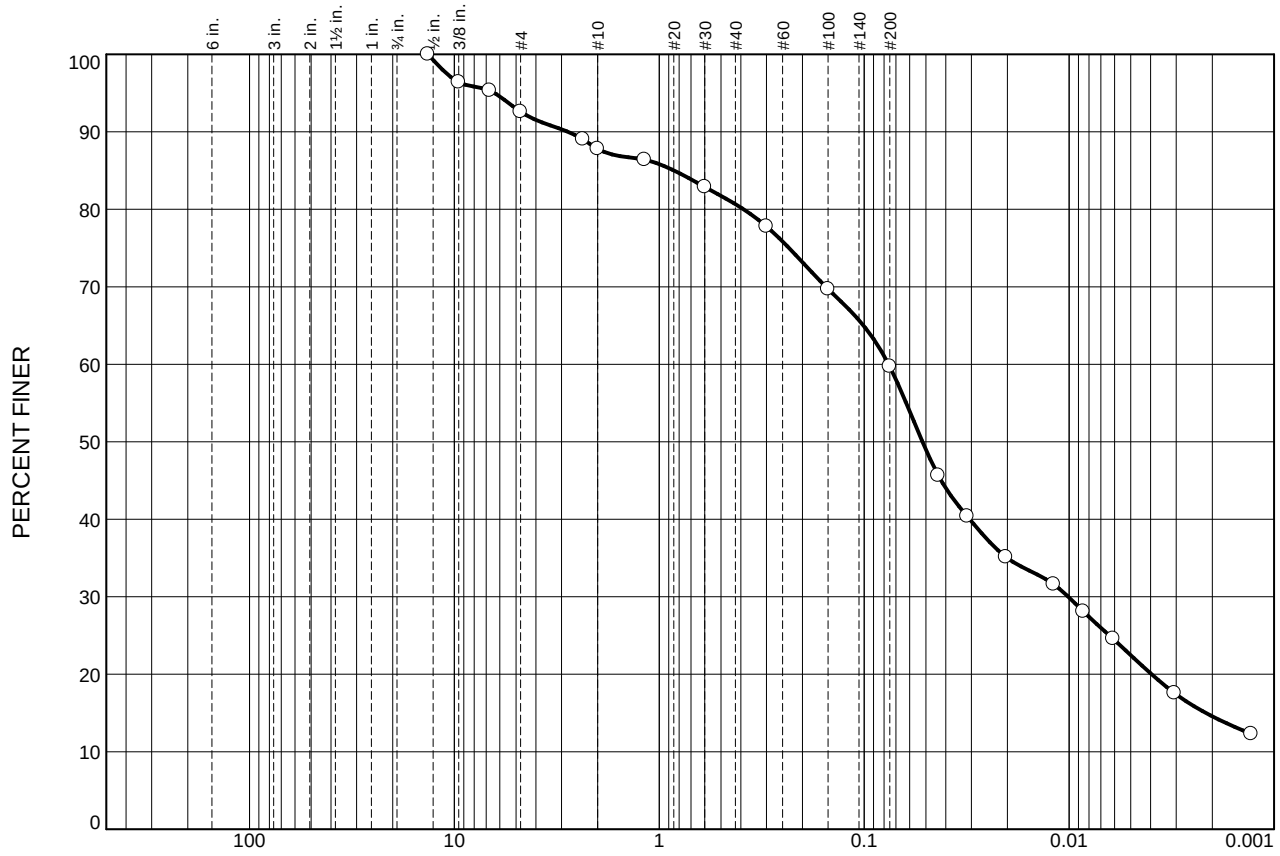
St. Clements, ON

Client: Will-O Homes

Project: 5782 6th Line East
Ariss, Ontario

Project No.: 21-209 **Figure** 2

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	7.4	4.8	7.1	21.0	45.1	14.6

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH3	5	3.05-3.66m	sandy silt, some clay, trace gravel	ML
				Estimated Coefficient of Permeability; k = 2.44 x 10^{-6} cm/sec	
				Sampled by JF of CMT Engineering Inc., May 13, 2021	
				Tested by JM of CMT Engineering Inc., May 28, 2021	

CMT Engineering Inc.

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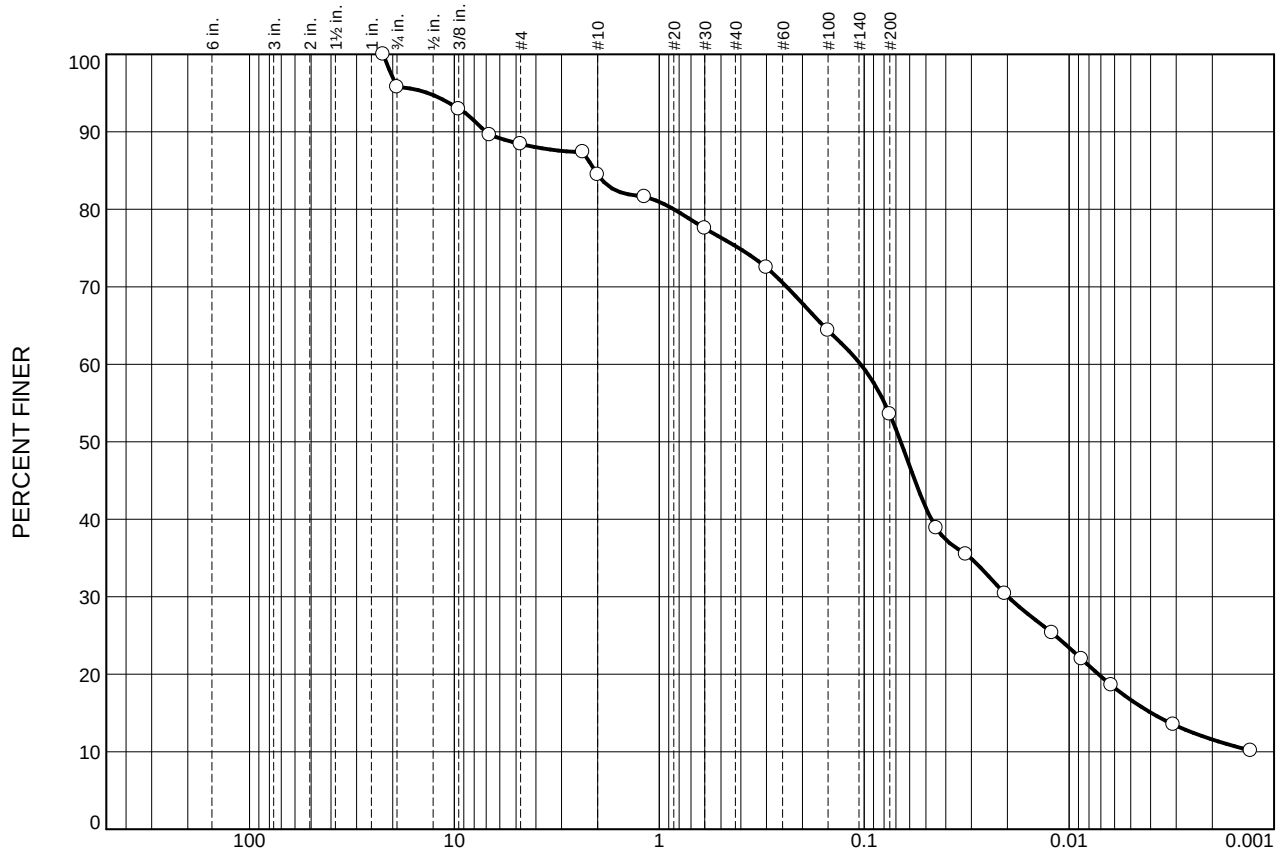
Project: 5782 6th Line East
Ariss, Ontario

Project No.: 21-209

Figure 3

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	4.2	7.4	3.9	9.2	21.7	42.0	11.6

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH4	3	1.52-2.13m	sandy silt, some clay, and gravel	ML
				Estimated Percolation Rate; T = 25min/cm	
				Sampled by JF of CMT Engineering Inc., May 13, 2021	
				Tested by JM of CMT Engineering Inc., May 28, 2021	

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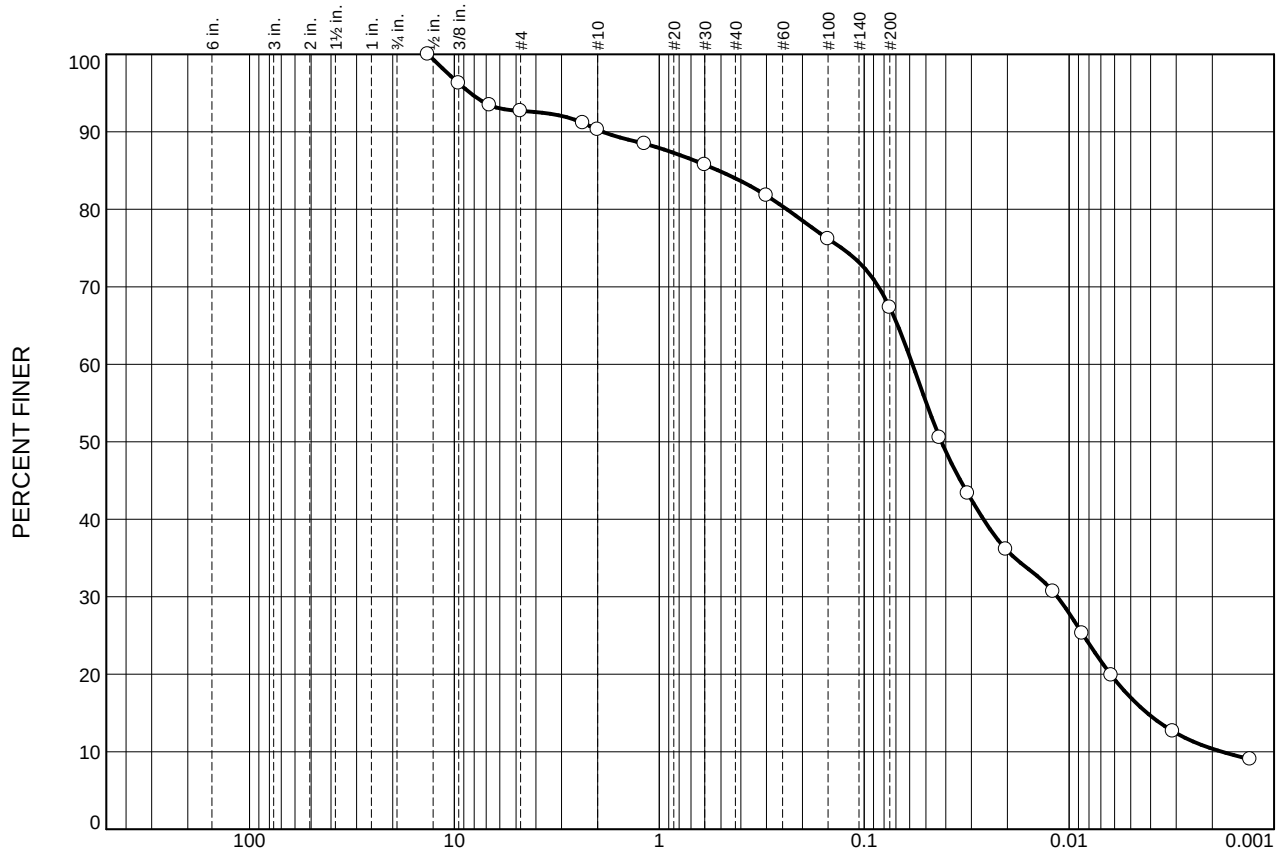
Ariss, Ontario

Project No.: 21-209

Figure 4

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	7.3	2.4	6.3	16.7	56.9	10.4

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH5	3	1.52-2.13m	sandy silt, some clay, trace gravel	ML
				Estimated Percolation Rate; T = 30 min/cm	
				Sampled by JF of CMT Engineering Inc., May 13, 2021	
				Tested by JM of CMT Engineering Inc., May 28, 2021	

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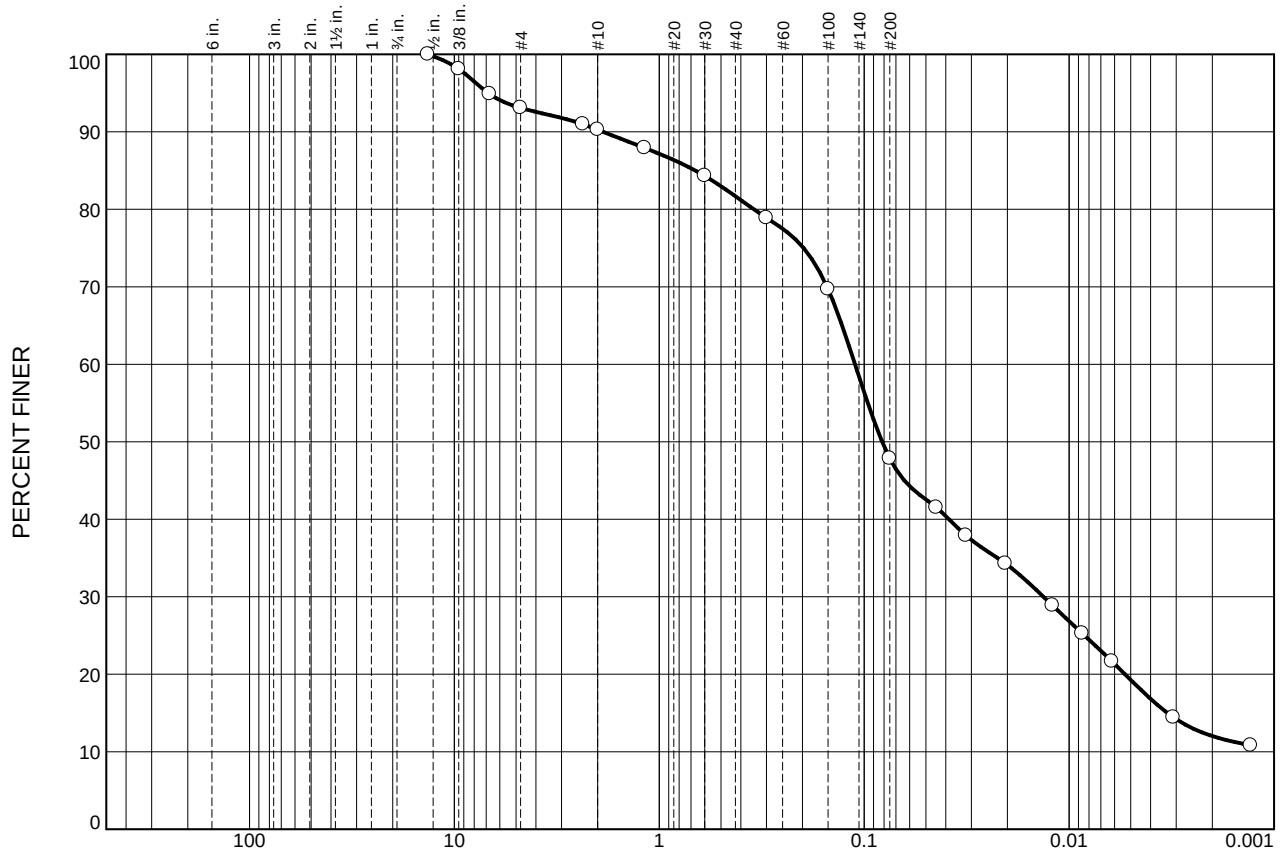
St. Clements, ON

Client: Will-O Homes

Project: 5782 6th Line East
Ariss, Ontario

Project No.: 21-209 **Figure** 5

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	6.9	2.8	8.6	33.9	35.8	12.0

SOIL DATA					
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH6	5	3.05-3.66m	sand and silt, some clay, trace gravel	SM
				Estimated Coefficient of Permeability; k = 4.08 x 10^{-6} cm/sec	
				Sampled by JF of CMT Engineering Inc., May 13, 2021	
				Tested by JM of CMT Engineering Inc., May 28, 2021	

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St. Clements, ON

Client: Will-O Homes

Project: 5782 6th Line East
Ariss, Ontario

Project No.: 21-209 **Figure** 6

APPENDIX C

WELL LOG RECORDS