GEOTECHNICAL INVESTIGATION

PROPOSED RESIDENTIAL DEVELOPEMNT
786 WILLIAM STREET
MIDLAND, ONTARIO

CMT Project 20-305.R01

Prepared for:

Jennark Homes

July 21, 2020

CMT ENGINEERING INC.

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July 21, 2020

20-305.R01

Jennark Homes
101 St. Andrew Street West, Suite 201
P.O. Box 85
Fergus, Ontario
N1M 1N6

Attention: Mr. Taylor McDaniel

Dear Sir:

Re: Geotechnical Investigation
Proposed Residential Development
786 William Street
Midland, 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,

Brittany Brown, C.Tech., rcji

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1.0 INTRODUCTION

The services of CMT Engineering Inc. (CMT Inc.) were retained by Mr. Taylor McDaniel of Jennark Homes to conduct a geotechnical investigation for the proposed residential development that is to be constructed at 786 William Street, Midland, Ontario. The location of the site is shown on Drawing 1.

It is understood that the project will comprise the construction of two, 5-storey, 40-unit residential buildings with basements, as well as associated access roads and parking areas. The northwest building is referenced as Building 1, with Building 2 being located to the southeast. The new buildings will be serviced by municipal watermains, sanitary and storm sewers.

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; soil design properties; and a summary of the laboratory results.

2.0 EXISTING SITE CONDITIONS

Currently, the site comprises a vacant lot, surfaced with grass and trees/shrubs. Large boulders were observed at the ground surface in the southeast portion of the site. An asphalt-surfaced access road crosses the site, connecting William Street to an existing townhouse complex, reportedly constructed in the 1970s, located to the northwest. A stormwater management pond that was reportedly constructed in 1998 is located in the southwest corner of the site and is to remain as is.

An existing watermain, fire hydrant, as well as sanitary sewers and storm sewers, with several associated manholes and catch basins, are located throughout the site. In some areas, the service trenches are reported to be in excess of 5.0 m below the ground surface.

The site is bounded by William Street to the east, an existing townhouse complex to the northwest, a storage unit complex to the southeast, and a wooded area to the southwest. The northern and eastern portions of the site are relatively flat, sloping slightly to the south, while the southwestern portion of the site slopes down significantly.

3.0 FIELD AND LABORATORY PROCEDURES

A previous site investigation was conducted by The Gonneau Building Group Inc. on August 21, 2017 and comprised the advancement of five (5) test pits throughout the site using a backhoe. The test pit depths ranged from about 1.7 m (5.6 ft) to 2.7 m (8.9 ft) below the existing ground surface.

The field investigation by CMT Inc. was conducted on June 25, 2020 and comprised the advancement of five (5) boreholes (referenced as Boreholes 101 to 105), using a Geoprobe 7822DT drillrig operated by employees of CMT Drilling Inc. The boreholes were advanced to depths of approximately 6.71 m (22.0 ft), with the exception of Borehole 104, which was advanced to approximately 5.18 m (17.0 ft) below the ground surface, due to refusal of the sampler.

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

Standard penetration testing (SPT) and sampling was carried out in all of the boreholes using 38 mm inside diameter split spoon sampling equipment and an automatic hammer, in accordance with ASTM D 1586 "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 approximately 3.0 m (10.0 ft) and about every 1.52 m (5.0 ft) thereafter to borehole termination in the boreholes. Macro core (MC5) sampling was generally conducted between the deeper SPT soil samples throughout Boreholes 101 to 105. 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. A representative sample from a borehole at the following depth was submitted to the CMT Inc. laboratory in St. Clements, Ontario for grain size analysis:

- Borehole 105 - depth 2.29 m to 2.90 m (7.5 ft to 9.5 ft)

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

The ground surface elevations at the borehole locations were surveyed by CMT Inc. (using laser survey equipment) following the completion of drilling. The top nut of the existing fire hydrant, located northeast of the site, at the corner of William Street and Birchwood Drive, was used as a temporary benchmark, with a reported elevation of 221.88 m based on the drawing by Capes Engineering, provided by the client. The ground surface elevations at the borehole locations ranged from approximately 216.24 m at Borehole 102 to 220.70 m at Borehole 104.

The locations of the temporary benchmark, boreholes and previous test pits 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 topsoil was encountered at the surface of all of the boreholes. The thickness of the topsoil ranged from approximately 80 mm to 150 mm (average 106 mm) and should be expected 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. ***Fill***

Brown to dark brown, silty sand fill with occasional organics, cobbles and boulders were encountered underlying the topsoil in Boreholes 101, 102 and 103. A layer of buried organics with occasional wood pieces was also encountered within the lower zone of the fill in Boreholes 101 and 102 (potential original topsoil layer that has been covered with fill). The fill depth ranged from approximately 0.76 m to 2.29 m below the ground surface and was generally deeper towards the south to southeast end of the site. The fill thickness should be anticipated to vary throughout the site, particularly in the areas mentioned above, and in the areas of existing service trenches. The fill was considered to be loose to compact, with SPT N-values of 6 to 15 blows per 0.3 m (average 9 blows per 0.3 m). Blow counts in excess of 100 blows per 0.3 m were noted within the fill soils in Borehole 102, however these blow counts can be attributed to the cobbles and boulders encountered. The fill was considered to be moist, with moisture contents ranging from about 7.6% to 15.3% (average 11.4%).

4.3. ***Silt and Sand (Till)***

Silt and sand, with trace gravel and clay was the predominant native soil encountered in the borehole locations. The silt and sand was encountered underlying the fill soils in Boreholes 101 to 103 and underlying the topsoil in Boreholes 104 and 105. Occasional cobbles and boulders were also encountered within the silt and sand till and should be anticipated throughout the site. The soil was observed to range in colour from brown to grey, grey-brown, and dark grey. The soil was considered to be compact to very dense, with SPT N-values ranging from 12 to 100+ blows per 0.3 m (average 43 blows per 0.3 m). The soil was considered to be moist to very moist, with moisture contents ranging from about 7.8% to 13.8% (average 10.5%).

4.4. Asphalt

Currently, there is an asphalt-surfaced access road that crosses the site. Borehole sampling was not carried out within the roadway, and as such, the thickness and condition of the asphalt and granular base is unknown.

4.5. Groundwater

Groundwater was not encountered during the drilling investigation on June 25, 2020; however, a wet silt and sand seam was encountered in Borehole 101. This is consistent with the accumulated groundwater encountered upon the completion of Test Pit 1, on August 21, 2017, which was advanced near the Borehole 101 location. Groundwater levels (particularly perched water) will generally depend on the amount of precipitation, control of surface water, as well as the time of year, and can fluctuate significantly in elevation and volume.

It should be noted that the typically dense silt and sand till has the potential to create perched water conditions in looser overlying soils, such as the fill encountered in Boreholes 101 and 102. It should be expected that caving or sloughing of the excavation walls will occur where soft/wet soils are encountered.

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 project will comprise the construction of two, 5-storey, 40-unit residential buildings with basements, as well as associated access roads and parking areas. The new buildings will be serviced by municipal watermains, sanitary and storm sewers.

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.

5.1. Serviceability and Ultimate Limit Pressure

Based on the information obtained from the boreholes, the following table provides 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:

Borehole ID	Ground Surface Elevation (m)	SLS kPa (psf)	ULS kPa (psf)	Estimated Highest Founding Elevation (m)	Depth to Highest Founding Elevation (m)	Soil Type
101	217.86	250 (5,000)	375 (7,500)	215.57 to 211.15 (termination)	2.29	Silt and Sand
102	216.24	250 (5,000)	375 (7,500)	213.19 to 209.53 (termination)	3.05	Silt and Sand
103	218.54	150 (3,000)	225 (4,500)	217.78 to 211.83 (termination)	0.76	Silt and Sand
104	220.70	250 (5,000)	375 (7,500)	219.94 to 215.52 (termination)	0.76	Silt and Sand
105	218.72	250 (5,000)	375 (7,500)	217.96 to 212.01 (termination)	0.76	Silt and Sand

The proposed founding elevations and required bearing capacities were not available at the time of report preparation. Based on review of the site grading plan by Capes Engineering, dated April 24, 2019, it is understood that the basement floor elevation is anticipated to be **217.89 m for Building 1** and **216.47 m for Building 2**. As such, it is expected that the placement of structural fill may be required to achieve the design grades for the proposed foundations, particularly in the area of Building 2. Given the varying depths of fill encountered in the boreholes, the founding soils must be inspected by qualified personnel prior to structural fill or foundation placement.

The serviceability limit pressure for good quality structural fill (OPSS 1010 Granular 'A', OPSS 1010 Type II or Type III Granular 'B') placed and compacted in accordance with Section 5.4.4 of this report is estimated to be 150 kPa (3,000 psf) at SLS and 225 kPa (4,500 psf). If a bearing pressure above 150 kPa (3,000 psf) at SLS is required, lean concrete fill should be used to achieve the design grades for the proposed foundations.

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 structural foundation drawings be cross-referenced with site servicing drawings (existing services and proposed services) 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 anticipated to exceed the generally acceptable limits of 25 mm (1") and 19 mm (3/4") respectively, assuming a minimum foundation width of 0.6 m (2.0 ft).

All exterior foundations must be provided with a minimum of 1.2 m of soil cover or equivalent thermal insulation (sufficient thermal insulation is required to protect all footings and slab-on-grades during construction until such a time that the structure is heated) 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 m of strata. The information obtained in the geotechnical field investigation was gathered from the upper 5.18 m to 6.71 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 soils at the recommended founding elevations provided in Section 5.1 of this report as well as structures founded on structural fill placed in accordance with Section 5.4.4 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 the estimated soil design parameters for imported granular fill, as well as the existing native soils encountered on-site. It should be noted that earth pressure coefficients (K_a, K_p, K_o) provided are for flat ground surface conditions and will differ for areas with slopes or embankments.

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

Soil Type	**Soil Density (kg/m^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 Gran 'A'/ Gran 'B' (OPSS 1010)	2,100	34°	0.28	3.54	0.44	0.45	0
Silt and Sand	1,800	32°	0.31	3.25	0.47	0.41	0

5.4. Site Preparation

The site preparation for the proposed residential development is anticipated to comprise the removal of topsoil/vegetation (including the buried organic soil), asphalt and unsuitable fill (as required), the subexcavation of any loose/soft 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 or lean mix concrete (as required) and site grading to achieve proposed grades. It is recommended that a provision for the subexcavation of deleterious fill and subsequent importing of granular fill materials be included in the tender documents. The existing fill soils could be used in landscaped areas where some settlement can be tolerated; otherwise it should be properly disposed of off-site.

5.4.1. Topsoil Stripping/Vegetation and Asphalt Removal

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

It is understood that the existing asphalt and granular road base is to be stockpiled following removal. Reuse of the granular material will be subject to approval from qualified geotechnical personnel. Otherwise, it may be used in landscaped areas, along with the topsoil, where some settlement can be tolerated. Alternatively, it should be properly disposed of off-site.

5.4.2. Subexcavation of Unsuitable Bearing Soil

The existing fill soils encountered in the boreholes were typically observed to be in a loose to compact state with organics encountered, and as such, would not be considered suitable to support the proposed structures, driveways and parking areas. Additionally, there is the potential that unforeseen unsuitable fill may be encountered and therefore, all existing fill (including the buried organic soils and any existing trench backfill), as well as any native soils that have inadequate bearing capacity or have been disturbed by the site development/construction process and is deemed unsuitable to support foundations or slab-on-grades, must be subexcavated from within the proposed building envelope, to expose approved competent subgrade soils. It would also be sound construction practice to subexcavate all existing unsuitable fill from the proposed driveway and parking lot areas that will be constructed. At a minimum, a thorough inspection will be required at the time of construction to assess the existing soil to ensure there are no deleterious materials (organic soils) within the subgrade.

Prior to reusing excavated site material as bulk fill, thorough field inspection and approval from qualified geotechnical personnel would be required to ensure that the materials do not comprise organics, topsoil or other deleterious materials.

5.4.3. Removal/Relocation of Existing Services

Currently, an existing watermain, fire hydrant, as well as sanitary sewers and storm sewers, with several associated manholes and catch basins, are located throughout the site. In some areas, the service trenches are reported to be in excess of 5.0 m below the ground surface. It is understood that some of the existing services are to be capped, removed and disposed of off-site.

Any existing services that are located within the proposed building envelopes must be removed/relocated. Any piping that has been 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 existing buried pipes 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/Structural Fill

Following the stripping of all topsoil and vegetation, asphalt removal, as well as the subexcavation all existing fill (including buried organic soil) and any relatively loose native soils that are not considered suitable to support foundations, the exposed subgrade must be proof-rolled, and any observed soft or unstable areas must be further 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 or bulk 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 foundations down 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);

- Approved imported granular fill materials (OPSS 1010 Type II or III Granular 'B' recommended for this application) or approved existing granular fill (free of asphalt) 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 (at or near to the optimum moisture content as determined by laboratory Proctor testing) 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 as well as slab-on-grades that will be subject to heavy loads or point loading (including any entrance slabs and other large expansive 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, bulk fill for driveways and parking areas) must be compacted to a minimum 95% SPMDD. It would be expected that the existing on-site soils, free of any deleterious or organic materials, would be suitable for use as bulk fill; however, depending on the time of year and weather conditions when construction takes place, soils may require air-drying in order to achieve the specified density; and

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

It should be noted that the existing native silt and sand till soils are compact to very dense. It is imperative that if the soils are utilized for backfilling of service trenched, the material must be broken down (pulverized) to minimize voids and reduce the potential for settlement. These soils should not be utilized as structural fill.

*5.5. **Foundation Subgrade Preparation***

The fine-grained silt and sand 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 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 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 footprint of any foundations (if feasible) in the excavation to promote surface drainage of rainwater or seepage and the collected water should be pumped out of the excavations. 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 fill materials must be maintained above freezing;
- Prior to placing concrete for the footings, the founding soils 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 the slab-on-grade construction, the subgrade soils should be proof-rolled. Any soft or weak zones, as well as any unsuitable fill or organics 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	Modulus of Subgrade Reaction (k)
Imported Gran 'A'/Gran 'B' (OPSS 1010)	81,000 kN/m^3 (300 lb/in^3)
Silt and Sand	47,500 kN/m^3 (175 lb/in^3)

In dry conditions, the floor slab can be founded on a minimum thickness of 150 mm (6") of Granular 'A' (OPSS 1010) and compacted to 100% SPMDD. Alternatively, (particularly in wet conditions), 150 mm (6") of 19 mm clear crushed stone (OPSS 1004) should be utilized instead of Granular 'A'. The use of 19 mm clear crushed stone assists in creating a moisture barrier by reducing/preventing capillary rise of moisture from the subgrade. 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 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 and at the location of out-swinging doors. 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 silt and sand (till) soils encountered in the boreholes, in a drained state (not saturated), would be classified as Type 2 soils under Reg 213/91. Type 2 soils must be sloped from within 1.2 m of the bottom of the excavation at a minimum gradient of 1 horizontal to 1 vertical. Soils underlain by Type 3 or Type 4 soils that are exposed in the excavation must be treated accordingly as Type 3 or Type 4 soils (see below). Soils in a saturated condition (if encountered) must be treated as Type 4 soils, addressed below.

Type 3 Soils - In general, the existing fill soils encountered in a drained state (not wet or 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, if encountered, 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.

Sloughing of the excavation walls should be expected when excavating into wet to saturated soils. As such, it may be necessary to increase the proposed width of the excavations to accommodate sloughing soils.

5.8. Construction Dewatering Considerations

Groundwater was not encountered during the drilling investigation on June 25, 2020; however, a wet silt and sand seam was encountered in Borehole 101. Although wet soils were not encountered in most of the borehole locations, it should be noted that due to the presence of dense, less permeable silt and sand till, perched water conditions should be anticipated, and may increase the moisture content within the overlying soil. Seepage should be expected where perched groundwater is present. Sloughing of excavation walls should also be expected if perched water conditions exist. Groundwater levels 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.

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

Flexible Pipes – The pipe bedding should be shaped to receive the bottom of the pipe. If necessary, pipe culvert frost treatment should be undertaken in accordance with OPSD-803.031. The trench excavations should be symmetrical with respect to the centre-line 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.

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.

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

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

In order to assist in maintaining dry buildings with respect to surface water seepage, it is recommended that exterior grades around the new buildings 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 foundations and/or beyond external slab-on-grades to a drainage swale or appropriate storm drainage system.

It is understood that the proposed new building will have basements, in which case a perimeter weeping tile system will be required. Perforated drainage tile should be installed around both the exterior and interior perimeter, and non-perforated pipe should be installed to direct the collected exterior water to a sump pit and good quality sump pump. Each unit with a basement should have its own separate sump pump system. It is recommended that sump pumps be equipped with a battery backup (in the event if a power outage).

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 imported sand or 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 100% SPMDD.

The native mineral soils, as well as fill soils which are free of any organics or deleterious materials, are generally considered suitable for reuse as trench backfill and bulk fill in the parking area and driveways. 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 (keeping in mind that frost tapers would be recommended to minimize differential frost heave at transitions from granular fill to frost-susceptible soils).

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

- Adequate heavy 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 95% 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.

It should be noted that the existing native silt and sand soils encountered were typically in a compact to very dense state. It is imperative that if these soils are utilized for backfill the material must be broken down (pulverized) to minimize voids and reduce the potential for settlement.

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

Any soils containing organics or other deleterious materials must be subexcavated from within the driveways 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 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. As such, it is recommended to install subdrains for this project (provided gravity drainage to a suitable outlet can be provided). 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 (recommended for this application), 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 or service. 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 subdrains be installed at regular intervals (to be designed based on layout of catch basins and storm sewers) through paved driveways and parking areas. It is also recommended to install subdrains through any areas that cannot tolerate differential frost heave such as accessibility ramps/sidewalks and areas of out-swinging doors. 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 loose/soft soils, increasing the thickness of the granular base, the use of reinforcing geotextiles or geogrids, or a combination of all.

It is expected that the driveways and parking areas will experience mostly light traffic (personal vehicles) and some heavy traffic (moving trucks, delivery trucks, maintenance and emergency vehicles). Based on the anticipated loading, the following pavement designs are provided for proposed light and heavy traffic areas:

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

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.

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

Should any new asphalt be 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 and intermediate binder 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 condition is further intensified during hot weather. In high traffic areas or areas subjected to frequent turning of heavy vehicles such a garbage trucks, it is recommended that rigid Portland cement pavement be considered.

5.12. ***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"*.

5.13. ***Chemical Analysis/Excess Soil Management***

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 by CMT Inc. as part of this geotechnical investigation; however an environmetal assessment is being completed by Try Environmental and will be forwarded by Try Environmental under separate cover. Should chemical analysis tests be required, the required tests vary and will be dependent on the disposal site utilized by general contractor.

Most commonly, the soils are tested for the following:

- Sodium Absorption Ratio (SAR) as per O. Reg. 153/04 as amended by R511.
- Chemical analysis including:
    - F1 – F4, VOC's, BTEX as per O. Reg 153/04;
    - SVOC as per O. Reg 153/04 as amended by R511; and
    - 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.

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; and

- 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 buildings.

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:

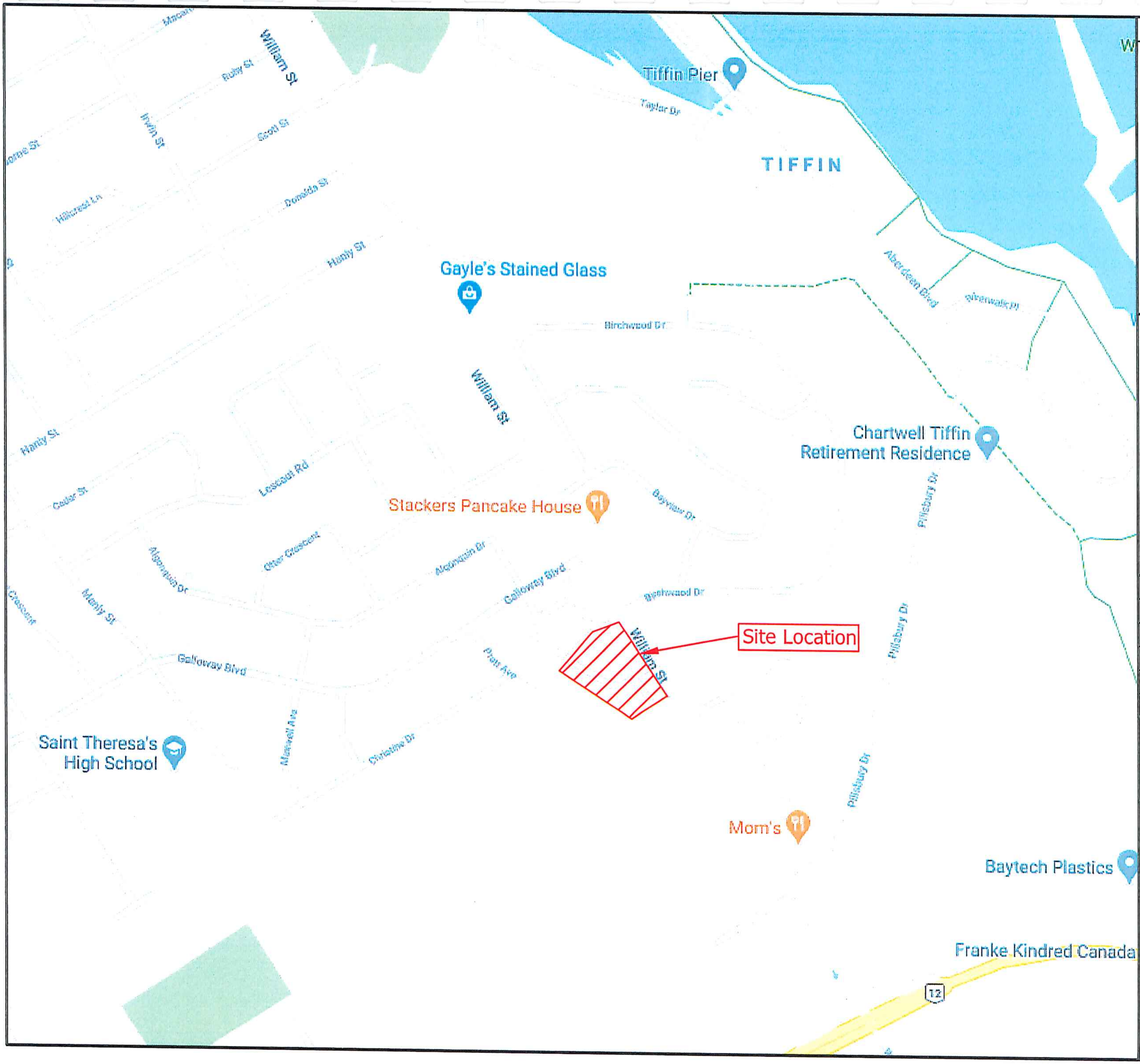
Brittany Brown, C.Tech., rcji

ks

LICENSED PROFESSIONAL ENGINEER
2020/07/22
N. J. CHORTOS
100210851
PROVINCE OF ONTARIO

Reviewed by:

Nathan Chortos, P.Eng.
Senior Geotechnical Engineer



NOTES:

Base map provided by Google.

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

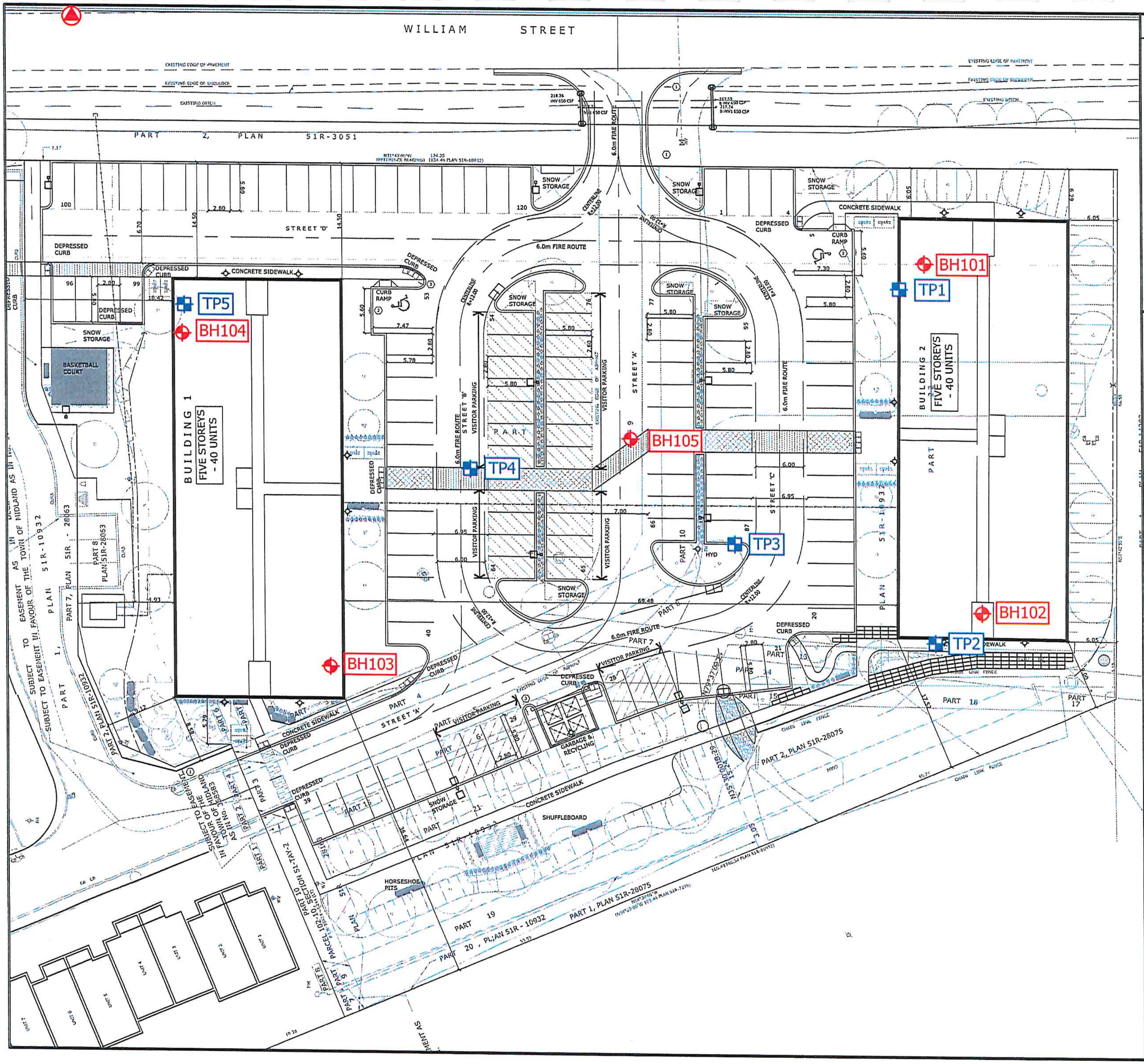
PROJECT:

Proposed Residential Development
786 William Street
Midland, Ontario

DRAWING TITLE:

SITE LOCATION MAP

PROJECT NO.: 20-305	DATE: July 9, 2020
SCALE: N.T.S.	DRAWING NO. 1



NOTES:

Base map by Capes Engineering
(Project No. 2018-009)

Legend

- ⊕ CMT Borehole (June 25, 2020)
- ▣ Approximate Location of Previous Test Pits (August 21, 2017)
- ▲ Temporary Benchmark (TBM) Top Nut of Fire Hydrant at Corner of Birchwood Drive and William Street Elevation = 221.88 m

NO.	DESCRIPTION	DATE

REVISIONS

CMT ENGINEERING INC.
1011 Industrial Crescent, Unit 1
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www.cmtinc.net

PROJECT:
Proposed Residential Development
786 William Street
Midland, Ontario

DRAWING TITLE:
AERIAL VIEW SHOWING
BOREHOLE LOCATIONS

PROJECT NO.: 20-305
DATE: July 9, 2020
SCALE: N.T.S.
DRAWING NO. 2

APPENDIX A

BOREHOLE LOGS

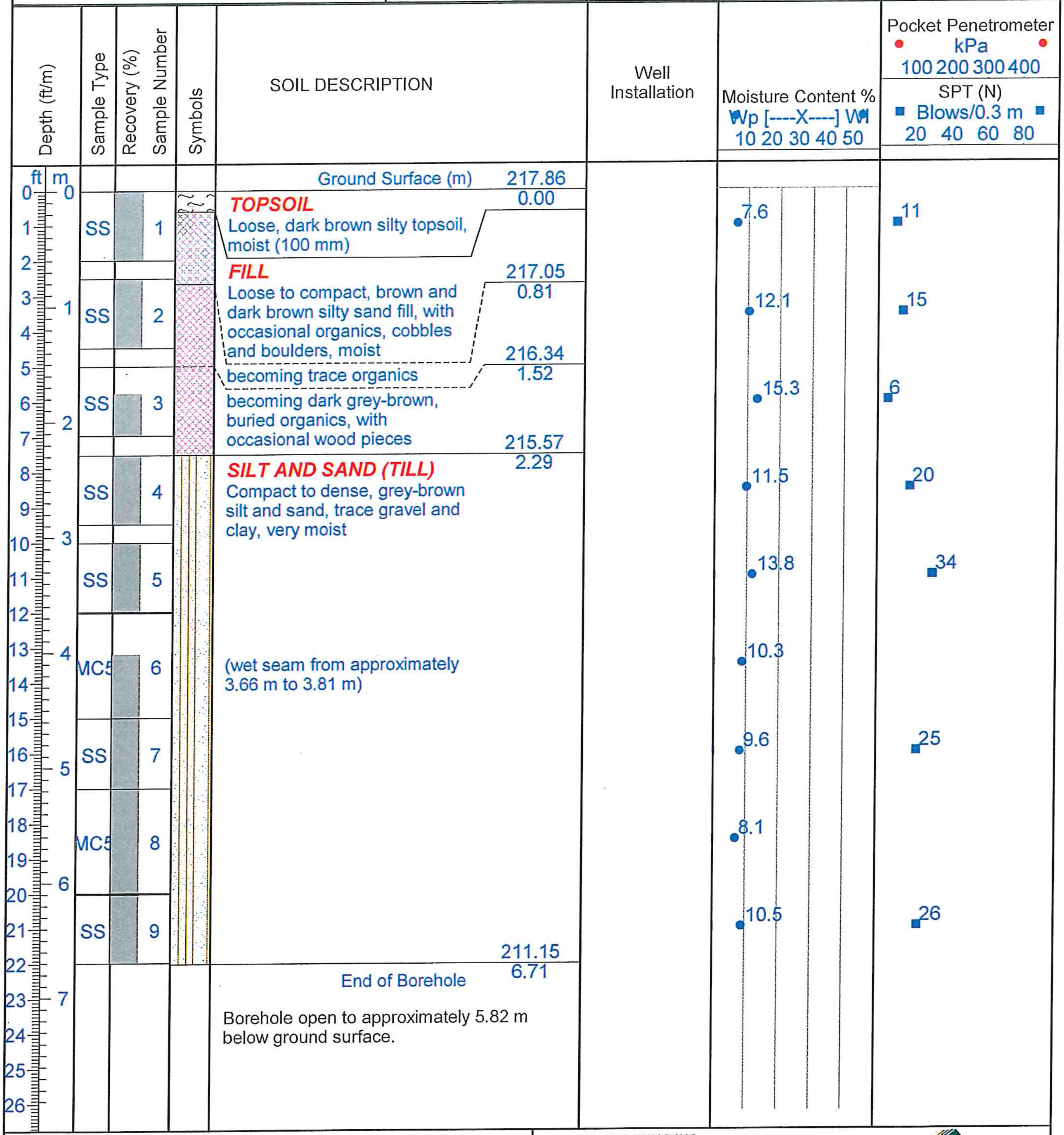
BOREHOLE 101

Page 1 of 1

Date Drilled: June 25, 2020
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 217.86 m
Logged by: BB

Project No.: 20-305
Project: Proposed Residential Development
786 William Street
Location: Midland, Ontario



SOIL DESCRIPTION

Ground Surface (m) 217.86

0.00 **TOPSOIL**
Loose, dark brown silty topsoil, moist (100 mm)

217.05
0.81 **FILL**
Loose to compact, brown and dark brown silty sand fill, with occasional organics, cobbles and boulders, moist

216.34
1.52 becoming trace organics
becoming dark grey-brown, buried organics, with occasional wood pieces

215.57
2.29 **SILT AND SAND (TILL)**
Compact to dense, grey-brown silt and sand, trace gravel and clay, very moist

(wet seam from approximately 3.66 m to 3.81 m)

211.15
6.71 End of Borehole

Borehole open to approximately 5.82 m below ground surface.

Sample Type	Sample Number	Moisture Content %	SPT (N)
SS	1	7.6	11
SS	2	12.1	15
SS	3	15.3	6
SS	4	11.5	20
SS	5	13.8	34
MC5	6	10.3	
SS	7	9.6	25
MC5	8	8.1	
SS	9	10.5	26

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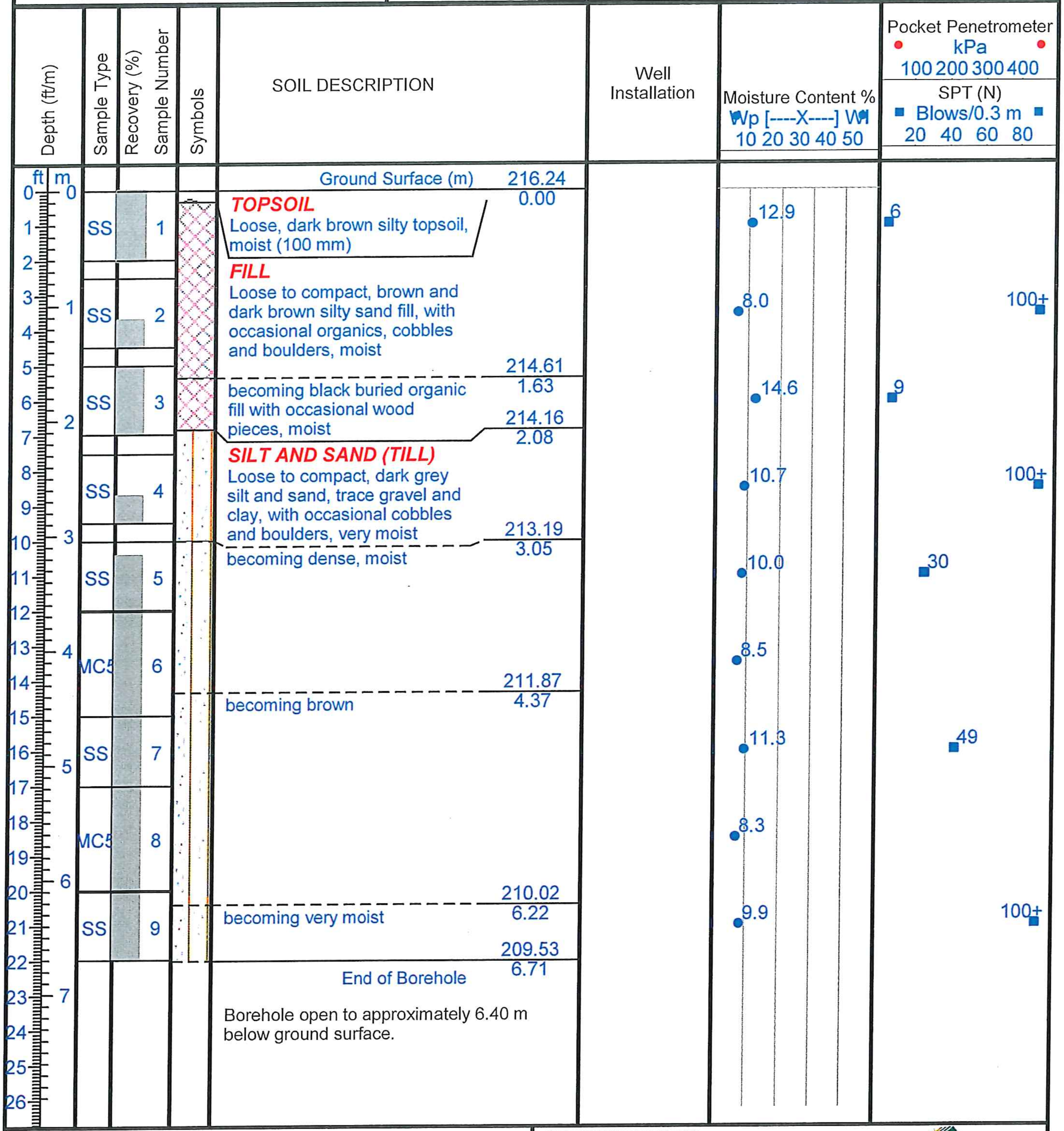
BOREHOLE 102

Page 1 of 1

Date Drilled: June 25, 2020
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 216.24 m
Logged by: BB

Project No.: 20-305
Project: Proposed Residential Development
786 William Street
Location: Midland, Ontario



Ground Surface (m)		216.24
		0.00
TOPSOIL	Loose, dark brown silty topsoil, moist (100 mm)	
FILL	Loose to compact, brown and dark brown silty sand fill, with occasional organics, cobbles and boulders, moist	214.61 1.63
	becoming black buried organic fill with occasional wood pieces, moist	214.16 2.08
SILT AND SAND (TILL)	Loose to compact, dark grey silt and sand, trace gravel and clay, with occasional cobbles and boulders, very moist	213.19 3.05
	becoming dense, moist	211.87 4.37
	becoming brown	210.02 6.22
	becoming very moist	209.53 6.71
End of Borehole		

Borehole open to approximately 6.40 m below ground surface.

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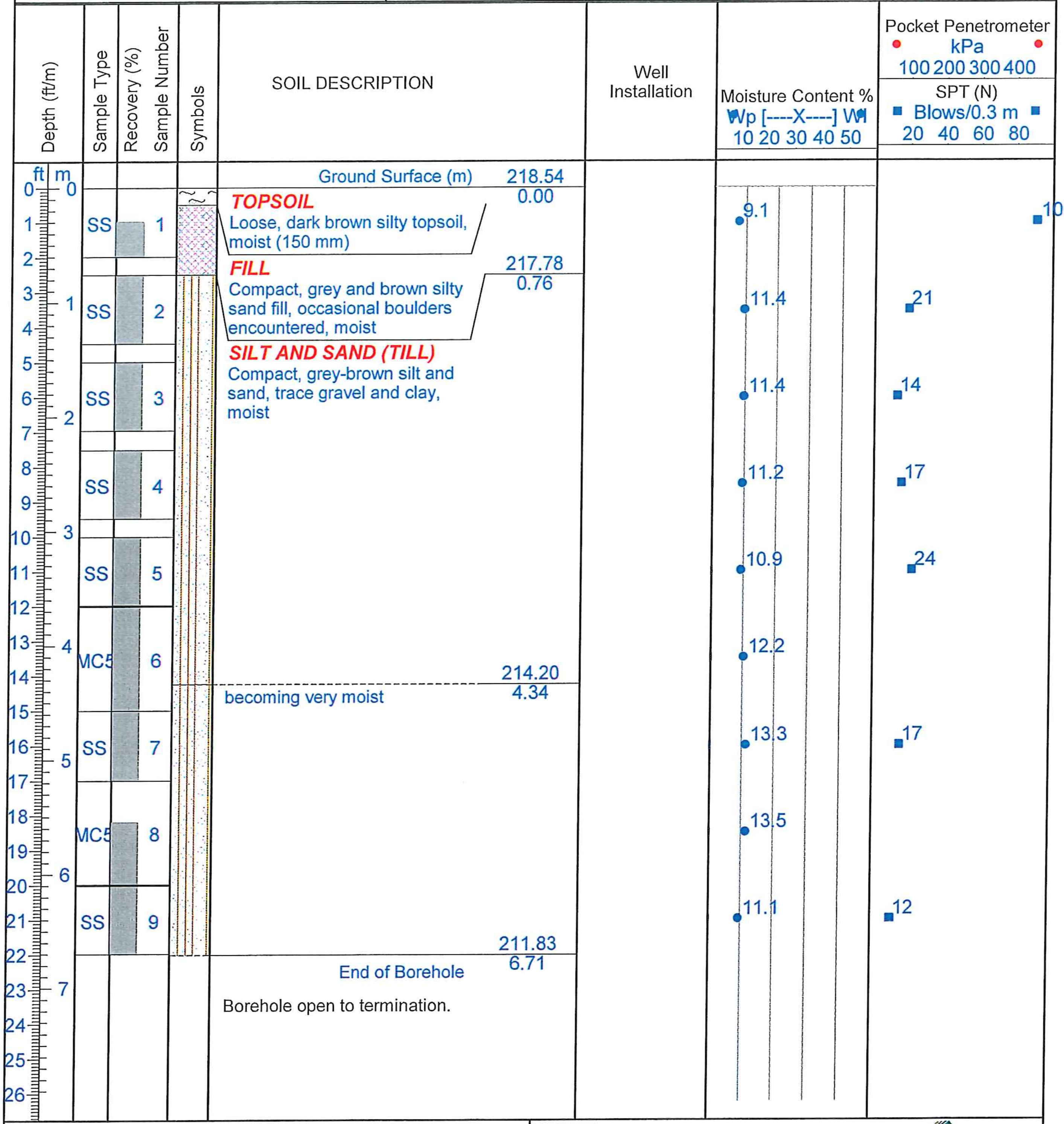
BOREHOLE 103

Date Drilled: June 25, 2020
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 218.54 m
Logged by: BB

Project No.: 20-305
Project: Proposed Residential Development
786 William Street
Location: Midland, Ontario



Ground Surface (m) 218.54 0.00

TOPSOIL
Loose, dark brown silty topsoil, moist (150 mm)

217.78 0.76

FILL
Compact, grey and brown silty sand fill, occasional boulders encountered, moist

SILT AND SAND (TILL)
Compact, grey-brown silt and sand, trace gravel and clay, moist

214.20 4.34

becoming very moist

211.83 6.71

End of Borehole

Borehole open to termination.

Sample Type	Sample Number	Moisture Content %	SPT (N) Blows/0.3 m
SS	1	9.1	100
SS	2	11.4	21
SS	3	11.4	14
SS	4	11.2	17
SS	5	10.9	24
MC5	6	12.2	
SS	7	13.3	17
MC5	8	13.5	
SS	9	11.1	12

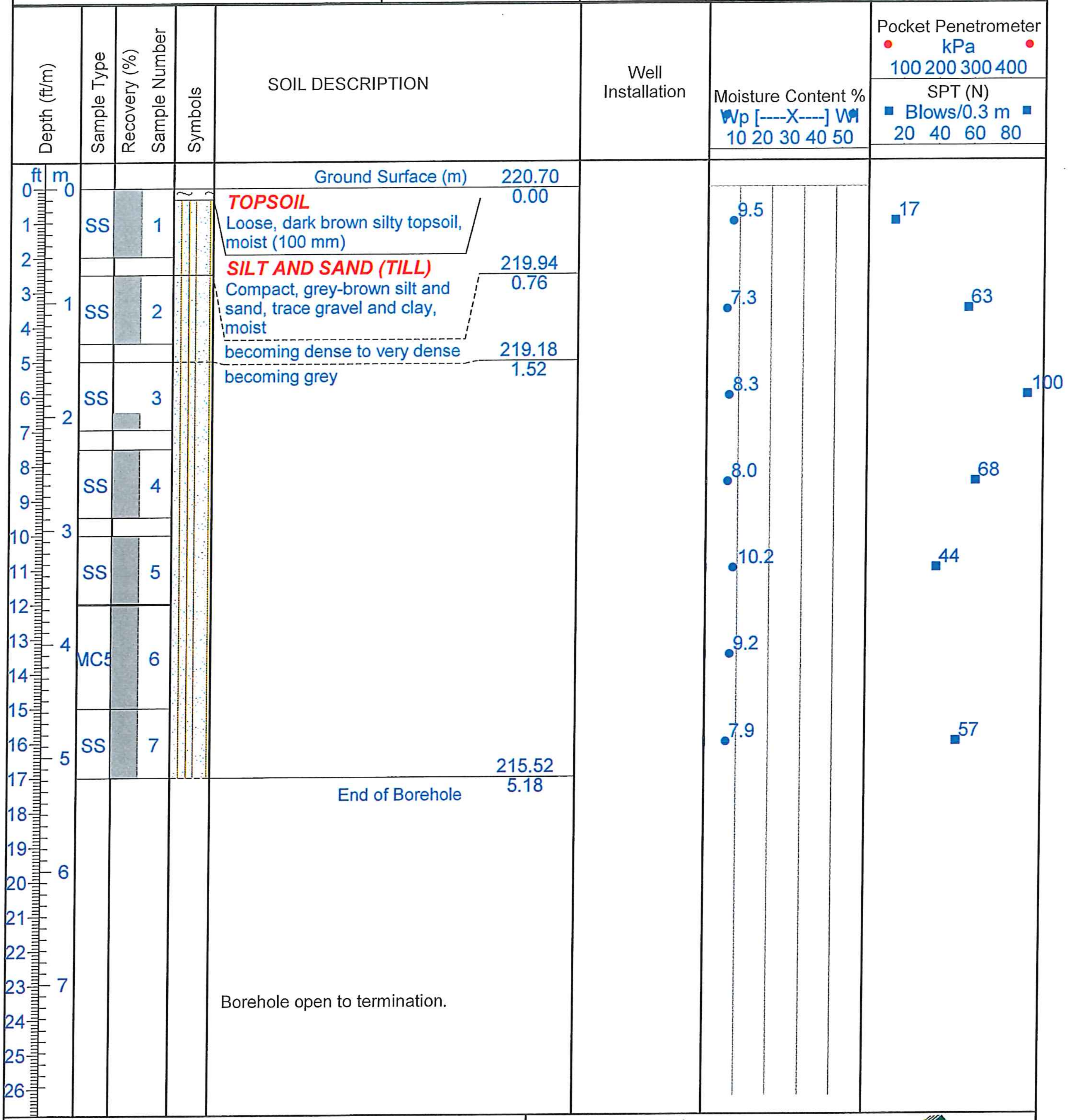
BOREHOLE 104

Page 1 of 1

Date Drilled: June 25, 2020
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 220.70 m
Logged by: BB

Project No.: 20-305
Project: Proposed Residential Development
786 William Street
Location: Midland, Ontario



SOIL DESCRIPTION	
Ground Surface (m)	220.70
TOPSOIL Loose, dark brown silty topsoil, moist (100 mm)	0.00
SILT AND SAND (TILL) Compact, grey-brown silt and sand, trace gravel and clay, moist	219.94 0.76
becoming dense to very dense	219.18 1.52
becoming grey	
	215.52 5.18
End of Borehole	

Borehole open to termination.

Sample Type	Sample Number	Moisture Content %	SPT (N)
SS	1	9.5	17
SS	2	7.3	63
SS	3	8.3	100
SS	4	8.0	68
SS	5	10.2	44
MC5	6	9.2	
SS	7	7.9	57

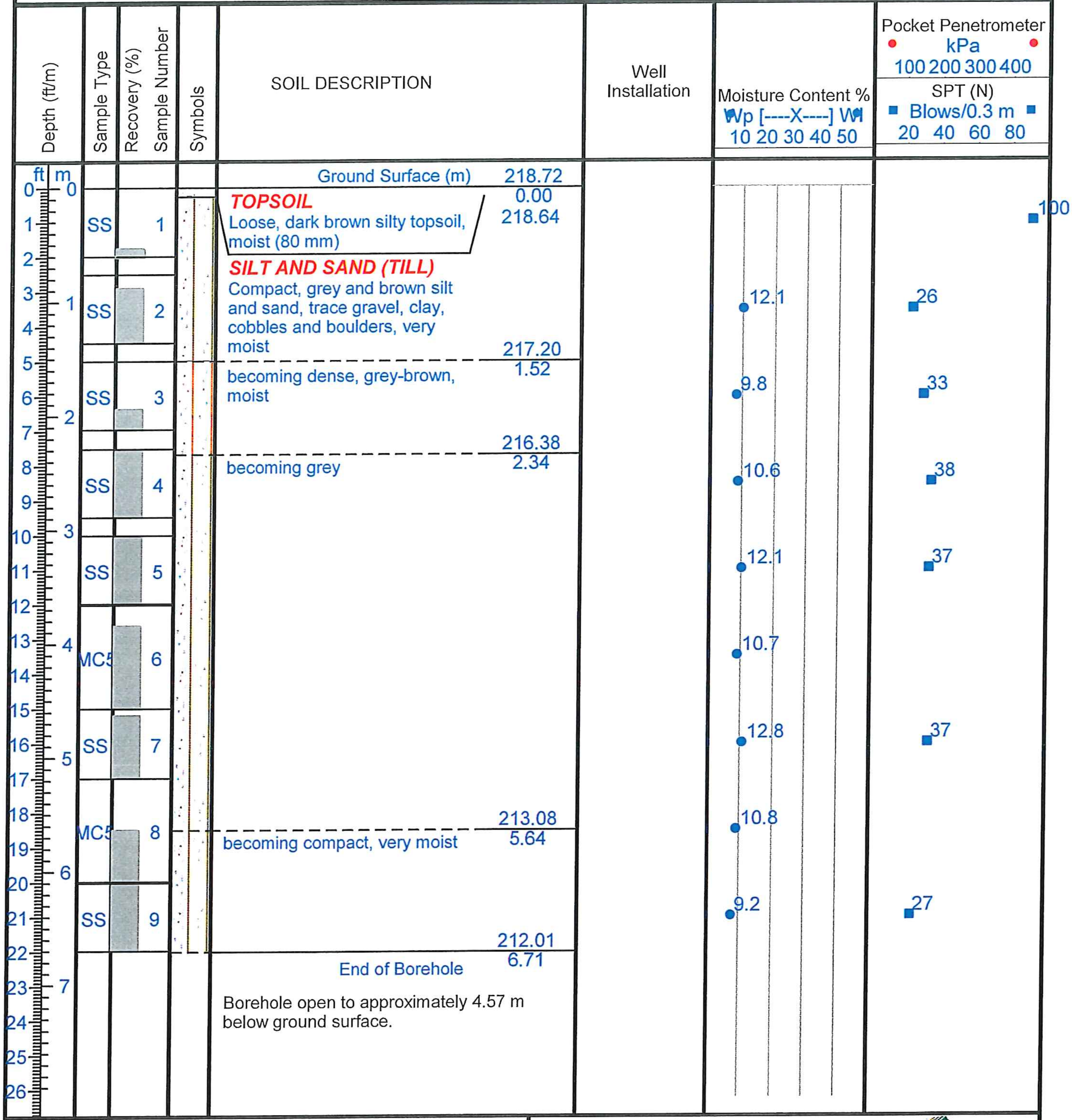
BOREHOLE 105

Page 1 of 1

Date Drilled: June 25, 2020
Rig: Geoprobe 7822DT
Contractor: CMT Drilling Inc.
Drilling Method: SPT

Elevation: 218.72 m
Logged by: BB

Project No.: 20-305
Project: Proposed Residential Development
786 William Street
Location: Midland, Ontario



Ground Surface (m) 218.72

0.00 218.64
TOPSOIL
Loose, dark brown silty topsoil, moist (80 mm)

SILT AND SAND (TILL)
Compact, grey and brown silt and sand, trace gravel, clay, cobbles and boulders, very moist

217.20 1.52
becoming dense, grey-brown, moist

216.38 2.34
becoming grey

213.08 5.64
becoming compact, very moist

212.01 6.71
End of Borehole

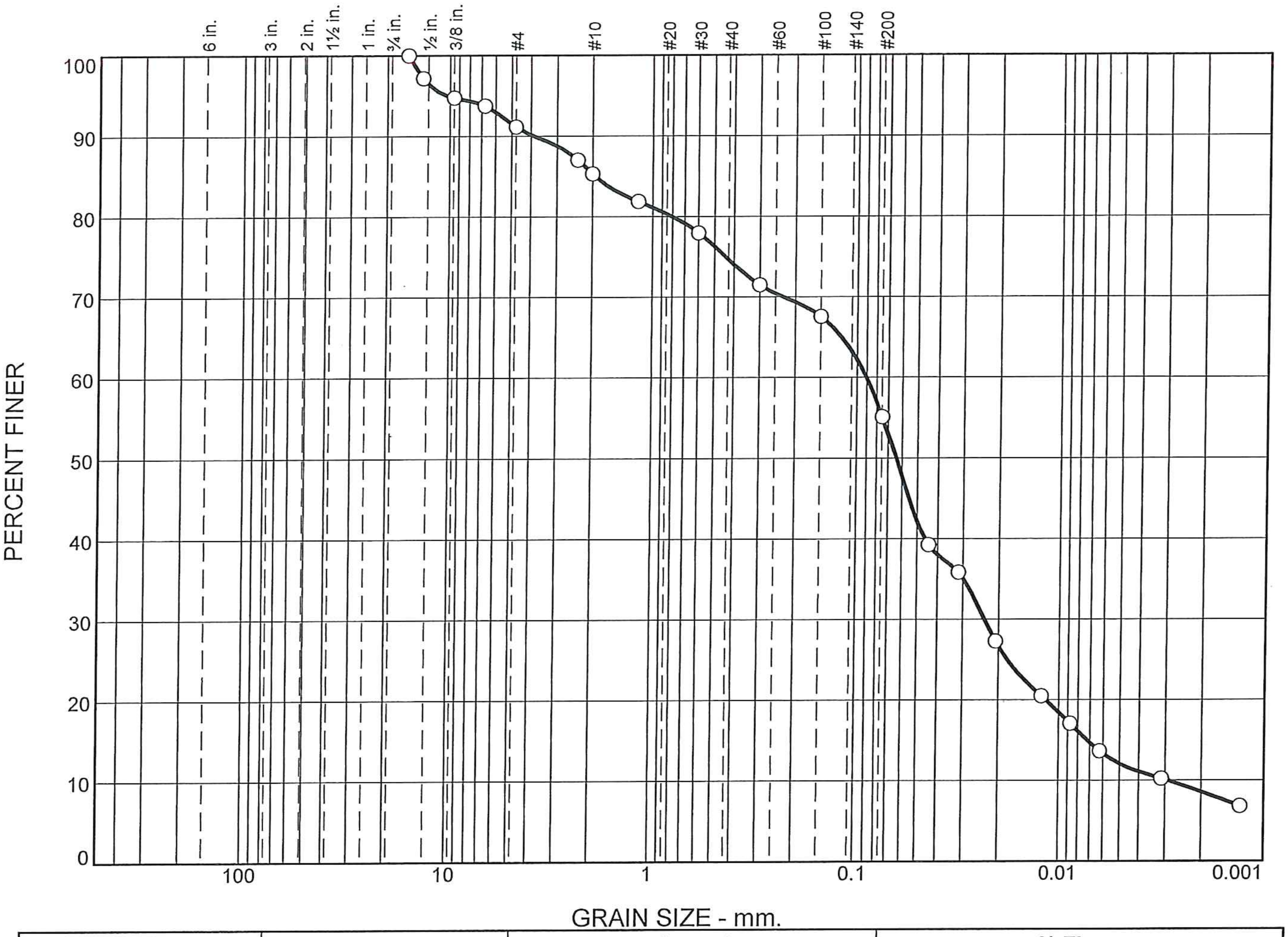
Borehole open to approximately 4.57 m below ground surface.

Sample Type	Sample Number	Moisture Content %	SPT (N)
SS	1		100
SS	2	12.1	26
SS	3	9.8	33
SS	4	10.6	38
SS	5	12.1	37
MC5	6	10.7	
SS	7	12.8	37
MC5	8	10.8	
SS	9	9.2	27

APPENDIX B

GRAIN SIZE ANALYSIS

Particle Size Distribution Report



	% Cobbles	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	8.9	5.8	10.7	19.5	46.5	8.6

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	BH105	4	2.29-2.90m	silt and sand, trace gravel and clay	ML
				Sampled by BB of CMT Engineering Inc., June 25, 2020	
				Tested by JM of CMT Engineering Inc., June 29, 2020	

CMT Engineering Inc.

St. Clements, ON

Client: Jennark Homes

Project: Proposed Residential Development
786 William Street, Midland, Ontario

Project No.: 20-305

Figure 1