10919 LONGWOODS ROAD
PROPOSED INDUSTRIAL SUBDIVISION

Geotechnical Investigation

Project Location:
10919 Longwoods Road
Municipality of Middlesex Centre, ON

Prepared for:
10919 Longwoods Road Inc.
10919 Longwoods Road
Municipality of Middlesex Centre, ON

Prepared by:
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365 Home Street
Stratford, ON N5A 2A5

March 27, 2019

MTE File No.: 45013-300

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1.0 INTRODUCTION

MTE Consultants Inc. (MTE) was retained by 10919 Longwoods Road Inc. to conduct a geotechnical investigation for a proposed industrial subdivision at 10919 Longwoods Road in the Municipality of Middlesex, Ontario, as shown on **Figure 1 in Appendix A**. The site is currently agricultural fields with a metal clad building located at the north end of the site along Longwoods Road. It is also understood that there were two houses at the north end of the site that have been demolished.

The site comprises approximately 2.5 hectares and will include eighteen (18) industrial lots. A Stormwater Management (SWM) block is proposed at the southwest corner of the site between lots 16 and 17. It is understood that each lot will be provided with individual wastewater treatment facilities (septic beds), wells and heating sources. No municipal services are proposed for the development. Two roadways are proposed within the subdivision to access the industrial lots. The proposed subdivision layout is referenced to MTE's Preliminary Site Plan, File No. 45013-100, dated February 2019.

The property is bordered to the south and west by agricultural fields; to the east by agricultural fields and residential buildings; and to the north by Longwoods Road and residential buildings. The ground surface is generally level at the site with a grade difference of approximately 1.5 to 2.0 m between the borehole locations.

The purpose of this geotechnical investigation is to determine the soil and groundwater conditions in the area of the proposed subdivision and provide geotechnical engineering recommendations for site grading, excavations and dewatering, foundations, slab-on-grade construction, pavement design, subdrainage requirements, and stormwater infiltration.

2.0 FIELD AND LABORATORY PROGRAM

The fieldwork for this investigation was carried out on March 20th and 21st, 2019 and involved the drilling of nine boreholes (Boreholes MW101-19 to MW106-19 and BH107-19 to BH109-19) to depths ranging from 6.6 to 6.7 m. The locations of the boreholes are shown on the Site Plan, **Figure 2 in Appendix A**.

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

The boreholes were advanced with a D50T track mounted drill rig equipped with continuous flight hollow stem augers, supplied and operated by London Soil Test Ltd.

Representative soil samples were recovered throughout the depths explored. Standard Penetration Tests (SPT) were carried out during sampling operations in the boreholes using conventional split spoon equipment. The SPT N-values recorded are plotted on the borehole logs in **Appendix B.**

Six 50 mm diameter monitoring wells were installed in Boreholes MW101-19 to MW106-19 to allow measurement of stabilized groundwater levels and groundwater sampling and testing. The installations comprised 1.5 m filtered screens and bentonite seals above the screens. Stabilized water level measurements were taken by MTE on March 26, 2019. Details of the installation and groundwater observations and measurements are provided on the appended borehole logs.

The monitoring wells were installed in accordance to Ontario Regulation 468/10. A licensed well technician must properly decommission all wells before construction. The construction, maintenance and abandonment of the wells are regulated under the province's Water Resources Act.

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

The fieldwork was monitored throughout by a member of our geotechnical engineering staff, who directed the drilling procedures; documented SPT tests; documented the soil stratigraphies; monitored the groundwater conditions; observed the monitoring well installation; and transported the recovered soil samples to our office for further classification.

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

All of the soil samples collected were submitted for moisture content testing with the results provided on the borehole logs in **Appendix B**. Additionally, seven soil samples were submitted for particle size distribution analyses and the results are provided in **Appendix C**. The remaining soil samples will be stored for a period of 3 months and will be discarded of at that time without prior request from the client to extend storage time.

3.0 SOIL CONDITIONS

Reference is provided to the appended borehole logs for soil stratigraphy details, SPT N-values, moisture content profiles, and groundwater observations and measurements. Soil conditions encountered at the site typically include topsoil overlying native deposits of sand and silt.

3.1 Topsoil

Topsoil was encountered surficially in all of the boreholes and was 205 to 355 mm thick (average thickness = 310 mm). The topsoil typically comprises dark brown/black sandy silt with some organics and was wet to saturated with some frozen portions at the time of the fieldwork. It is noted that plastic and glass fragments were observed within the topsoil in Borehole BH107-19.

3.2 Sand and Silt

Sand and silt was encountered beneath the topsoil in all of the boreholes and extends to the termination depth of each borehole. The sand and silt typically ranges in composition from light brown sand with some silt and trace clay to grey silt with some sand and trace clay. The results of seven particle size distribution analyses conducted on the sand and silt are provided in **Appendix C** and summarized in the following table;

TABLE 1 - RESULTS OF SAND AND SILT PARTICLE SIZE DISTRIBUTION ANALYSES

Borehole Number	Sample Depth (m)	Sand (%)	Silt (%)	Clay (%)
MW101-19	0.76 - 1.37	68	30	2
MW102-19	0.76 - 1.37	31	67	2
MW102-19	4.57 - 5.18	19	79	2
MW103-19	4.57 - 5.03	23	74	3
MW104-19	0.76 - 1.37	81	10	9
MW105-19	4.57 - 5.03	16	80	4
BH108-19	0.76 - 1.37	25	69	6

SPT N-values measured in the sand and silt typically increase with depth and range from 3 to 46 blows per 300 mm penetration of the split spoon sampler indicating very loose to dense conditions. It is noted the very loose to loose conditions extended to a maximum depth of 1.5 m.

Insitu moisture contents in the sand and silt range from 16 to 27% indicating wet to saturated conditions.

4.0 GROUNDWATER CONDITIONS

Groundwater observations and measurements were carried out in the open boreholes at the time of drilling and are summarized on the borehole logs. Saturated conditions were noted within the native soil deposits in each borehole at depths of 0.3 to 1.2 m (Elevation 233.4 to 235.2 m).

Upon completion of drilling activities, free groundwater was measured in all of the boreholes at depths of 0.3 to 1.5 m below the ground surface (Elevation 233.0 to 235.6 m). The stabilized groundwater level measurements completed in the six monitoring wells are summarized in the following table;

TABLE 2 - GROUNDWATER LEVEL MEASUREMENTS

Borehole Number	Borehole Elevation (masl)	Water Level Measured March 26, 2019 (mbgs)	Groundwater Level Elevation March 26, 2019 (masl)
MW101-19	235.0	0.6	234.4
MW102-19	235.6	0.7	234.9
MW103-19	235.3	1.0	234.3
MW104-19	236.4	1.3	235.1
MW105-19	234.2	0.6	233.6
MW106-19	235.5	1.2	234.3

The grey colour of the soil at depths of 1.5 to 5.0 m below ground surface (Elevation 230.7 to 233.3 m) is indicative of permanent saturated conditions and groundwater is not expected to drop below these levels.

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

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 General

The project involves the design of a proposed industrial subdivision at 10919 Longwoods Road in the Municipality of Middlesex, Ontario. The site comprises approximately 2.5 hectares of agricultural fields with a metal clad building located at the north end. It is understood that there were two houses at the north end of the site that have been demolished. The proposed subdivision will include eighteen (18) industrial lots with a SWM block at the southwest corner of the site between lots 16 and 17. It is understood that each lot will be provided with individual wastewater treatment facilities (septic beds), wells and heating sources. No municipal services are proposed for the development. Two roadways are proposed within the subdivision to access the industrial lots.

The subsurface stratigraphy at the site generally comprises topsoil overlying native deposits of sand and silt. The stabilized groundwater level was measured at depths of 0.6 to 1.3 m (Elevation 233.6 to 235.1 m).

Based on the results of this geotechnical investigation, the site is suitable for the proposed development; however, the groundwater table and upper loose native soils will affect design and construction. The following subsections of this report contain geotechnical recommendations pertaining to development of the property; including, site grading, excavations and dewatering, foundations, slab-on-grade construction, pavement design, subdrainage requirements, and stormwater infiltration.

5.2 Site Preparation

The first construction activity that will be required for the proposed development will be grading. A metal clad building located at the north end of the site and it is understood that there were two houses at the north end of the site that have been demolished. All buildings should be removed including old foundations and slabs.

Prior to carrying out any cutting and engineering fill operations, the surficial topsoil must be removed and stockpiled. The average topsoil thickness measured in the boreholes was 310 mm. It is recommended that the average topsoil thickness across the site be increased by 50 mm for removal/stripping calculations to account for variations at the site and over stripping. The upper loose deposits of sand and silt ranging from depths of 0.8 to 1.5 m are also not suitable to remain below the industrial buildings and must be removed. The topsoil and upper loose sand and silt could be used in landscaping areas.

Due to high moisture contents and the depth of the groundwater table, the native soils are not considered suitable for reuse as engineered fill. All engineered fill should be imported and placed in maximum 300 mm thick lifts and compacted to the following percentages;

TABLE 3 - ENGINEERED FILL REQUIREMENTS

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

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

Structural fill used for raising grades beneath the industrial buildings should comprise granular material such as OPSS 1010 Granular ‘A’. Subgrade fill material beneath the proposed pavement areas should meet the requirements of OPSS Select Subgrade Material. Any imported fill should be tested and verified by a geotechnical engineer prior to placement.

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

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

5.3 Excavations and Dewatering

All excavations at the site should be carried out in conformance with the Ontario Occupational Health and Safety Act and Regulations for Construction Projects. The predominate soils encountered in the boreholes would be classified as Type 3 soils, and temporary side slopes through this material must be cut at an inclination of 1.0 horizontal to 1.0 vertical or less from the base of the excavation, exclusive of groundwater effects. Where wet to saturated conditions are encountered, excavation side slopes should be expected to slough to flatter inclinations, potentially 3.0 horizontal to 1.0 vertical or flatter.

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

Moderate to significant groundwater inflow should be expected where the excavations extend into the groundwater table encountered between Elevation 233.6 to 235.1 m. It is envisioned that groundwater inflow from the excavations extending up to 0.3 m below the groundwater regime can be controlled using a gravity dewatering system with properly constructed sumps and perimeter interceptor ditches and filtered pumps. It is our opinion that extensive pumping will be required to handle the groundwater infiltration. Well points or an equivalent system may be required for any excavation work extending more than 0.3 m below the groundwater regime.

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

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

It is recommended test pits be excavated during the tendering stage of the project to familiarize potential contractors of the soil and groundwater conditions at the site.

5.4 Pavements

It is understood pavements will be constructed for the proposed roadways at the site. The pavement subgrade soils will comprise native inorganic soils or imported structural fill. Based on the results of the particle size distribution analyses and the shallow groundwater table at the site, the native soils would be considered highly frost-susceptible.

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

TABLE 4 - PAVEMENT DESIGN

Pavement Component	Industrial Streets
Asphalt Hot Mix	140 mm
OPSS 1010 Granular 'A' Base	150 mm
OPSS 1010 Granular 'B' Subbase	500 mm

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

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

The asphaltic concrete should comprise 40 mm of HL4 surface over 100 mm of HL8 binder placed in two lifts for the industrial roadways.

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

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

It is **strongly recommended** to install continuous subdrains beneath the pavement and connected to catchbasins. The purpose of the subdrains is to remove excess subsurface water in order to improve overall pavement serviceability and increase the pavement life. At a minimum subdrains should be provided in the low areas of pavement.

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

5.5 Curbs and Gutter and Sidewalks

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

- Minimum compressive strength = 30 MPa at 28 days
- Coarse aggregate = 19.0 mm nominal max. size
- Maximum slump = 60 mm for curb and gutter, 70 mm for sidewalks
- Air entrainment = 7.0 ± 1.5%

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

5.6 Foundation Design

It is anticipated that the proposed industrial buildings will be constructed using conventional strip footings and slab-on-grade floors. In general, the undisturbed compact native soils or approved structural fill is considered suitable to support the industrial buildings. The upper 0.8 to 1.5 m of loose sand and silt encountered in the boreholes is not suitable to support foundations due to low internal strength.

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

The founding materials are susceptible to disturbance by construction activity, especially during wet weather and care should be taken to preserve the integrity of the material as bearing strata.

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

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

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

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

In general, the native soils excavated from the foundation trench areas will not be suitable for reuse as foundation wall backfill due to high moisture content. Imported OPSS 1010 Granular 'B' material may be used as foundation wall backfill. The backfill should be placed in 300 mm thick lifts and compacted to at least 95% Standard Proctor Maximum Dry Density (SPMDD) on the outside of the proposed buildings; and 100% SPMDD on the inside of the proposed buildings. The backfill must be brought up evenly on both sides of walls not designed to resist lateral earth pressure.

5.7 Concrete Slab-on-Grade Floors

It is understood that the floor slabs for the proposed buildings will be constructed using conventional concrete slab-on-grade techniques, following removal of any topsoil, and organic soils, and inspecting the subgrade soils.

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

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

No special underfloor drains are required, provided the exterior grades are lower than the floor slabs and positively sloped away from the buildings.

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

The water to cement ratio and slump of the concrete utilized in the floor slabs should be strictly controlled to minimize shrinkage of the slabs. Control joints should be sawed into the slabs at regular intervals within 12 hours of initial concrete placement in order to prelocate shrinkage cracks.

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

5.8 Stormwater Management Block

It is understood that a SWM block is proposed for the development at the southwest corner of the site between lots 16 and 17. Boreholes MW105-19, MW106-19 and BH108-19 were advanced in the vicinity of the proposed SWM block. The stabilized groundwater level in Boreholes MW105-19 and MW106-19 was measured at 0.6 m and 1.2 m (Elevation 233.6 m and 234.3 m), respectively.

SWM inlet/outlet structures footing constructed on the compact undisturbed native soils encountered at depths of 0.8 to 1.5 m (Elevation 233.4 to 234.0 m) may be designed for a factored geotechnical bearing resistance at Ultimate Limit States (ULS) of 225 kPa, and soil bearing resistance for 25 mm of settlement at Serviceability Limit States (SLS) of 150 kPa.

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

Moderate groundwater inflow is anticipated in the excavations for the SWM block. Please refer to Section 5.3 for dewatering details.

Embankments for the SWM blocks should be at an inclination of 3.0 horizontal to 1.0 vertical or less from the base of the excavation and can be constructed with onsite native soils. If the native soils are wet or saturated then imported engineered fill is recommended. The native soils or imported engineered fill should be placed in 300 mm thick lifts and compacted to at least 95% SPMDD. The embankment surfaces should be topsoiled and sodded to prevent surface erosion. Further recommendations should be provided once final SWM block design details are known.

5.9 Stormwater Infiltration

It is understood that at-source infiltration of stormwater runoff from the development may also be considered for this site. Soak-away pits generally require soils with a minimum percolation rate of 15 mm/hr and a minimum separation between the bottom of the pit and the seasonally high water table of 1 m (MOE, 2003). Seven particle size distribution analyses were carried out on the sand and silt deposits encountered at the site. They are plotted on **Tables 1 and 2 in Appendix C**.

The vertical hydraulic conductivity (k) is derived from an empirical formulae by Kaubisch. The estimated design infiltration rate is based on recommendations found in the *Low Impact Development Stormwater Management Planning and Design Guide, Appendix C*, Version 1.0, 2011, published by the Toronto and Region (TRCA) and the Credit Valley (CVC) Conservation Authority, and the approximate relationship between hydraulic conductivity and infiltration rate. A Factor of Safety of 2.5 has been applied to the calculated infiltration rates.

TABLE 5 - INFILTRATION RATES FOR NATIVE SOILS

Borehole Number	Sample Depth (mbgs)	Borehole Elevation (masl)	Soil Type	Geometric Mean K-Value (m/sec)	Infiltration Rate (mm/hr)
MW101-19	0.76 - 1.37	235.0	Silty Sand	1.3E-06	20
MW102-19	0.76 - 1.37	235.6	Sandy Silt	1.3E-06	20
MW102-19	4.57 - 5.18	235.6	Silt	7.8E-10	3
MW103-19	4.57 - 5.03	235.3	Sandy Silt	1.0E-09	3
MW104-19	0.76 - 1.37	236.4	Sand	3.3E-06	25
MW105-19	4.57 - 5.03	234.2	Silt	2.9E-10	2
BH108-19	0.76 - 1.37	235.1	Sandy Silt	8.9E-10	3

The relatively shallow groundwater table encountered at the site will significantly reduce the infiltration capacity of the native soils and design infiltration rates should be confirmed with insitu testing.

Any infiltration gallery must be constructed at least 5 m from any structure and the base of the gallery at least 1 m below any foundation.

5.10 Construction Inspection and Testing

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

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

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

6.0 LIMITATIONS OF REPORT

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

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

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

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

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

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

Respectfully submitted,

MTE CONSULTANTS INC.

Ben Heinbuch, EIT
Senior Geotechnical Technician

Dan Gonser, P. Eng.
Geotechnical Engineer

MXW:dld

APPENDIX A

FIGURES

Figure 1- Location Plan
Figure 2 - Site Plan

REFERENCES:

- AERIAL IMAGE FROM GOOGLE EARTH PRO.

FIGURE 1 – LOCATION PLAN

Project: 45013-300 CAD: P:\45013\300\BH FIGURES\45013-300 BH FIGURES.DWG

MTE Engineers | Scientists | Surveyors

LOCATION PLAN

Project Name

10919 LONGWOODS ROAD PROPOSED INDUSTRIAL SUBDIVISION

Site	Client
10919 LONGWOODS ROAD, MUNICIPALITY OF MIDDLESEX, ON	10919 LONGWOODS ROAD INC.

Scale. (8.5x11)	MTE Project No.	Date	Figure No.
N.T.S.	45013-300	MARCH 27, 2019	1

LEGEND

BH107–19
MTE BOREHOLE

MW101–19
MTE MONITORING WELL

REFERENCES:

- AERIAL IMAGE FROM GOOGLE EARTH PRO.
- BOREHOLE ELEVATIONS SURVEYED BY MTE.

MTE
Engineers | Scientists | Surveyors

SITE PLAN

Project Name
10919 LONGWOODS ROAD PROPOSED INDUSTRIAL SUBDIVISION

Site	Client
10919 LONGWOODS ROAD, MUNICIPALITY OF MIDDLESEX, ON	10919 LONGWOODS ROAD INC.

Scale (11x17)	MTE Project No.	Date	Figure No.
1:2000	45013-300	MARCH 27, 2019	**2**

Project: 45013-300 CAD: P:\P\45013\300\BH FIGURES\45013-300 BH FIGURES.DWG
FIGURE 2 - SITE PLAN
March 27, 2019 — 11:39 a.m. — Plotted By: awilliams

APPENDIX B

BOREHOLE LOGS

Boreholes MW101-19 to MW106-19 &
BH107-19 to BH109-19

ID Number: MW101-19

Project: 10919 Longwoods Road Proposed Industrial Subdivision

Project No: 45013-300

Client: 10919 Longwoods Road Inc.

Site Location: 10919 Longwoods Road, Middlesex Centre, ON

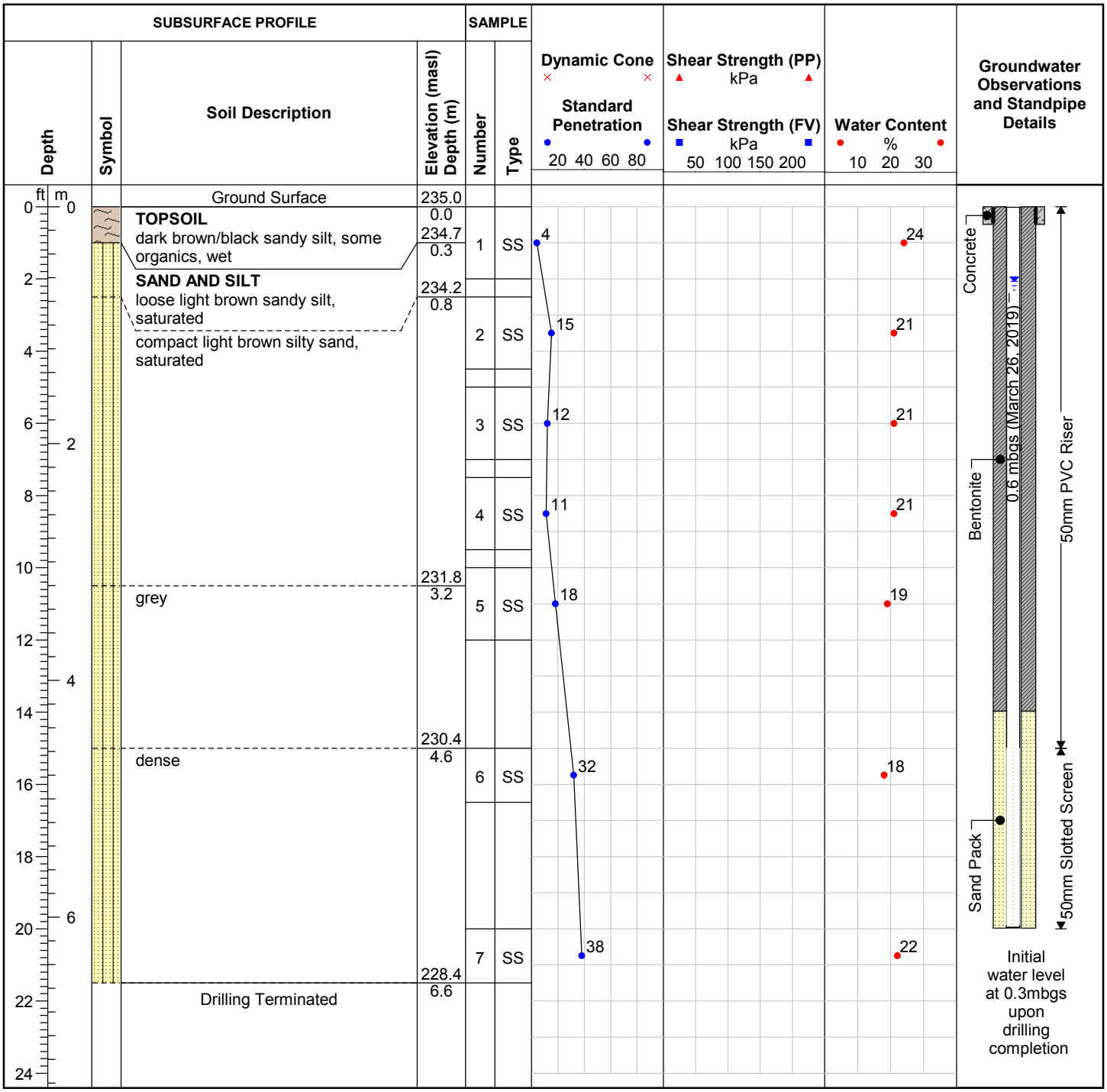
Drill Date: 3/20/2019

Drilling Contractor: London Soil Test Ltd.

Drill Rig: D50T Track

Drill Method: Hollow Stem Auger

Protective Cover: Monument Casing



Field Technician: M. Dalgliesh

Drafted by: B. Heinbuch

Reviewed by: D. Gonser

MTE

Sheet: 1 of 1

ID Number: MW102-19

Project: 10919 Longwoods Road Proposed Industrial Subdivision

Project No: 45013-300

Client: 10919 Longwoods Road Inc.

Site Location: 10919 Longwoods Road, Middlesex Centre, ON

Drill Date: 3/20/2019

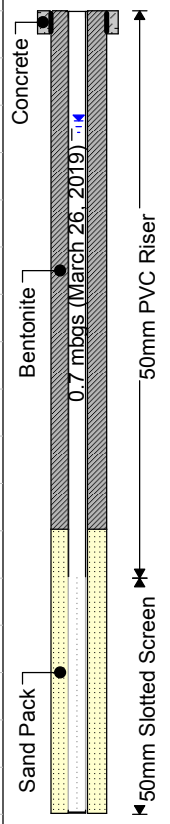
Drilling Contractor: London Soil Test Ltd.

Drill Rig: D50T Track

Drill Method: Hollow Stem Auger

Protective Cover: Monument Casing

SUBSURFACE PROFILE				SAMPLE		Dynamic Cone / Standard Penetration	Shear Strength (PP) / Shear Strength (FV) kPa	Water Content %	Groundwater Observations and Standpipe Details
Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Number	Type	20 40 60 80	50 100 150 200	10 20 30	
0 / 0		Ground Surface	235.6						
		TOPSOIL dark brown/black sandy silt, some organics, wet	0.0 / 235.3 / 0.3	1	SS	4		24	
2		**SAND AND SILT** loose dark brown sandy silt, wet	234.8 / 0.8						
		light brown, trace clay, saturated		2	SS	8		23	
4			234.1						
		compact	1.5	3	SS	10		22	
6 / 2			233.3						
		grey	2.3	4	SS	10		25	
8									
10				5	SS	10		23	
12 / 4									
14			231.0						
		compact grey silt, some sand, trace clay, saturated	4.6	6	SS	10		21	
16									
18									
20 / 6			229.5						
		compact grey sandy silt, saturated	6.1	7	SS	11		21	
22			228.9						
		Drilling Terminated	6.7						
24									



Initial water level at 0.8mbgs upon drilling completion

Field Technician: M. Dalgliesh

Drafted by: B. Heinbuch

Reviewed by: D. Gonser

MTE

Sheet: 1 of 1

ID Number: MW103-19

Project: 10919 Longwoods Road Proposed Industrial Subdivision

Project No: 45013-300

Client: 10919 Longwoods Road Inc.

Site Location: 10919 Longwoods Road, Middlesex Centre, ON

Drill Date: 3/20/2019

Drilling Contractor: London Soil Test Ltd.

Drill Rig: D50T Track

Drill Method: Hollow Stem Auger

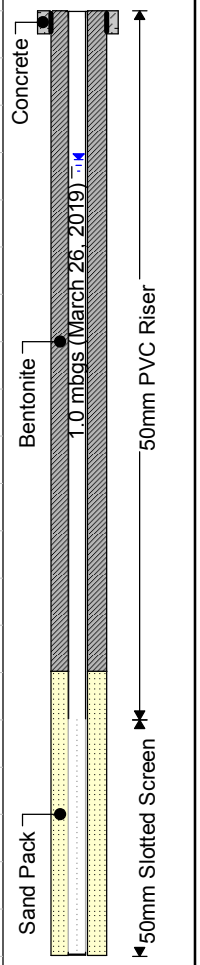
Protective Cover: Monument Casing

Depth (ft / m)	Soil Description	Elevation (masl) / Depth (m)	Sample Number	Sample Type	Dynamic Cone / Standard Penetration	Shear Strength (PP) kPa / Shear Strength (FV) kPa	Water Content %
0 ft / 0 m	Ground Surface	235.3					
0	**TOPSOIL** dark brown/black sandy silt, some organics, wet	0.0	1	SS	5		18
2	**SAND AND SILT** loose dark brown sandy silt, wet	234.5 / 0.8					
4	compact, saturated		2	SS	10		24
6 / 2	compact light brown silty sand, saturated	233.8 / 1.5	3	SS	17		20
8			4	SS	16		22
10			5	SS	19		19
12 / 4							
14		230.7					
16	compact grey sandy silt, trace clay, saturated	4.6	6	SS	29		19
18							
20 / 6	dense	229.2 / 6.1	7	SS	32		19
22		228.7					
24	Drilling Terminated	6.6					

Standard Penetration: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Water Content %: 10 20 30



Field Technician: M. Dalgliesh

Drafted by: B. Heinbuch

Reviewed by: D. Gonser

MTE

ID Number: MW104-19

Project: 10919 Longwoods Road Proposed Industrial Subdivision

Project No: 45013-300

Client: 10919 Longwoods Road Inc.

Site Location: 10919 Longwoods Road, Middlesex Centre, ON

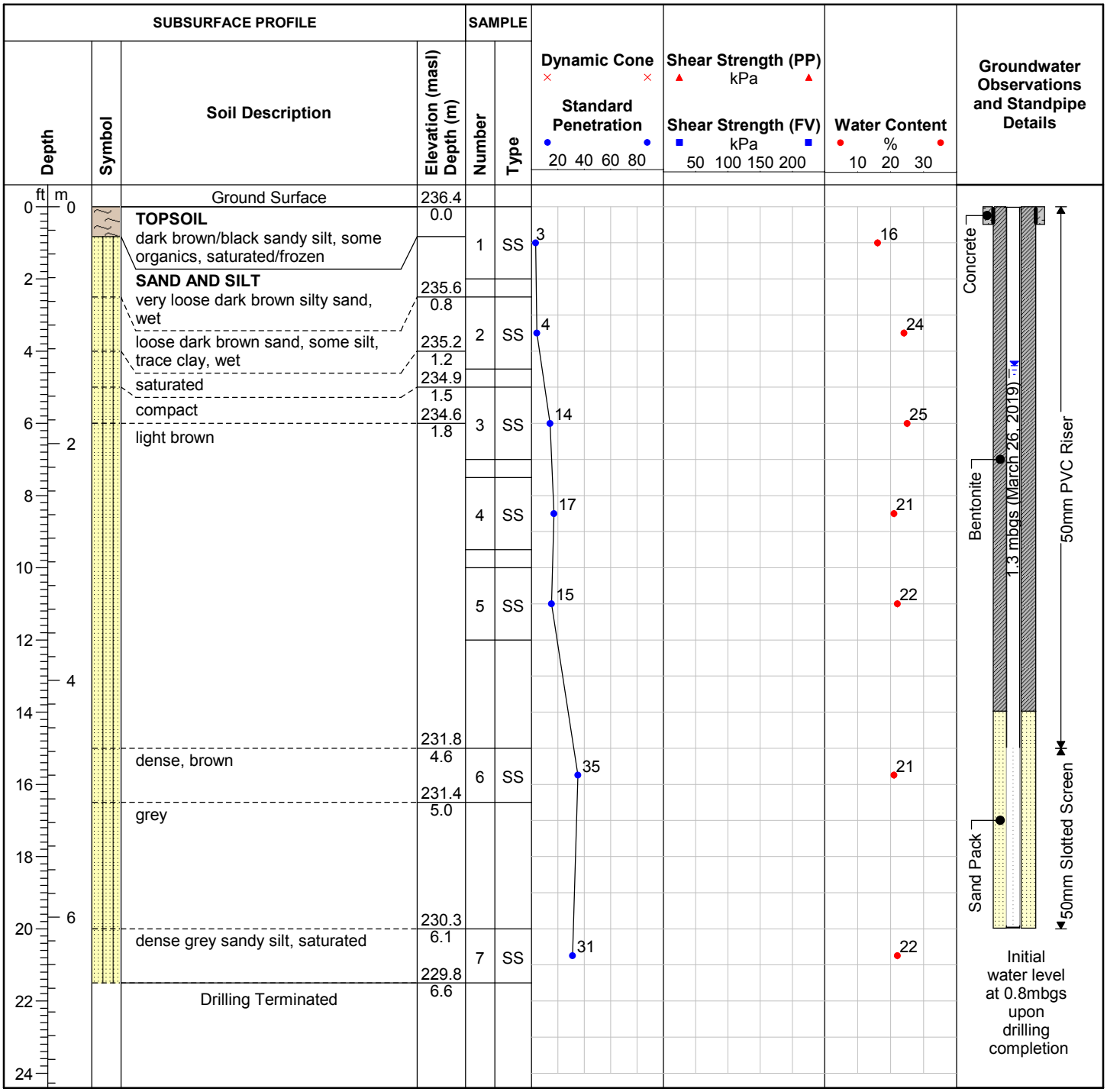
Drill Date: 3/20/2019

Drilling Contractor: London Soil Test Ltd.

Drill Rig: D50T Track

Drill Method: Hollow Stem Auger

Protective Cover: Monument Casing



Field Technician: M. Dalgliesh

Drafted by: B. Heinbuch

Reviewed by: D. Gonser

MTE

Sheet: 1 of 1

ID Number: MW105-19

Project: 10919 Longwoods Road Proposed Industrial Subdivision

Project No: 45013-300

Client: 10919 Longwoods Road Inc.

Site Location: 10919 Longwoods Road, Middlesex Centre, ON

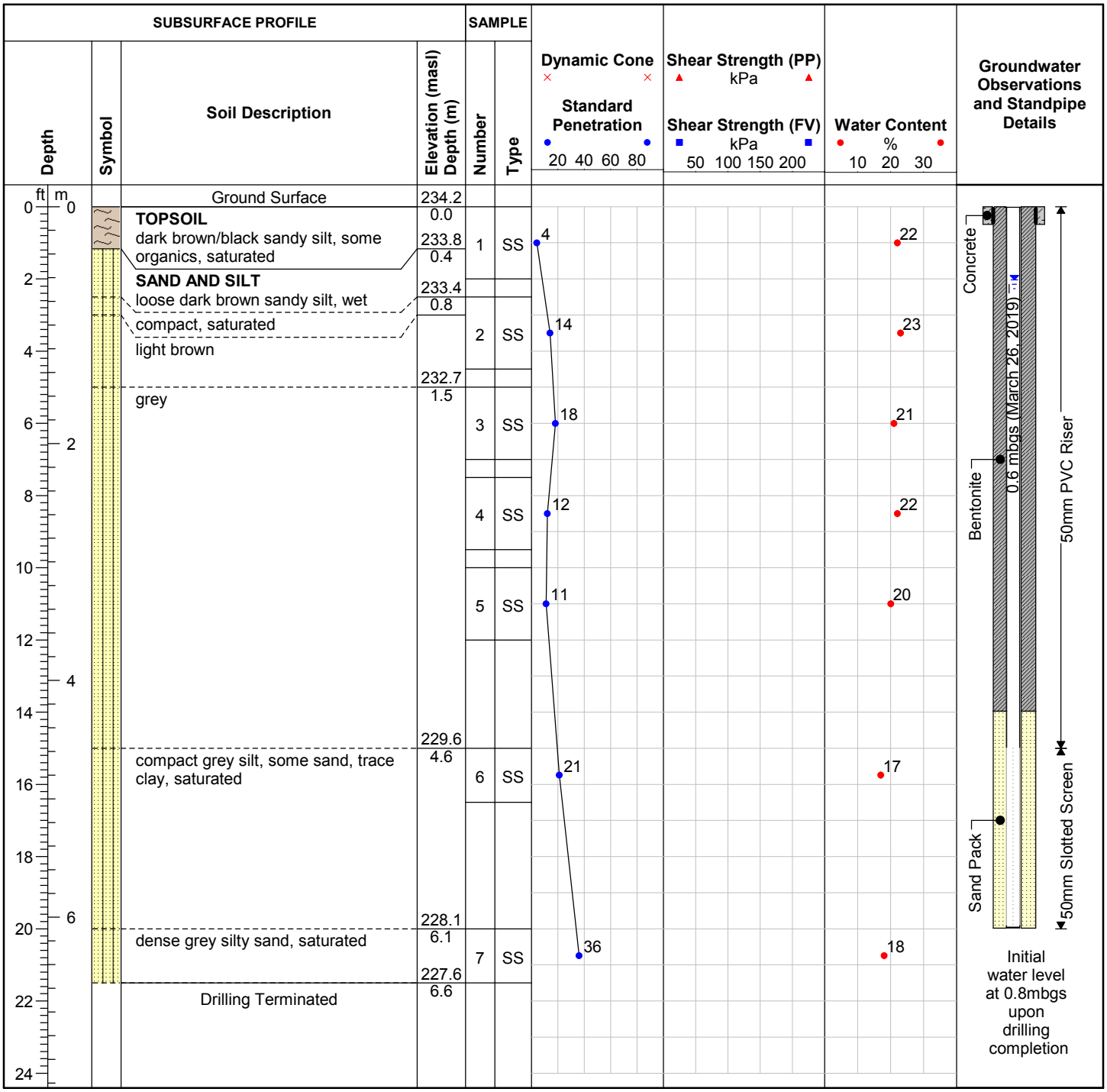
Drill Date: 3/20/2019

Drilling Contractor: London Soil Test Ltd.

Drill Rig: D50T Track

Drill Method: Hollow Stem Auger

Protective Cover: Monument Casing



Field Technician: M. Dalgliesh

Drafted by: B. Heinbuch

Reviewed by: D. Gonser

MTE

Sheet: 1 of 1

ID Number: MW106-19

Project: 10919 Longwoods Road Proposed Industrial Subdivision

Project No: 45013-300

Client: 10919 Longwoods Road Inc.

Site Location: 10919 Longwoods Road, Middlesex Centre, ON

Drill Date: 3/20/2019

Drilling Contractor: London Soil Test Ltd.

Drill Rig: D50T Track

Drill Method: Hollow Stem Auger

Protective Cover: Monument Casing

SUBSURFACE PROFILE				SAMPLE		Dynamic Cone / Standard Penetration	Shear Strength (PP) / Shear Strength (FV) kPa	Water Content %	Groundwater Observations and Standpipe Details
Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Number	Type	20 40 60 80	50 100 150 200	10 20 30	
0 / 0		Ground Surface	235.5						
		TOPSOIL dark brown/black sandy silt, some organics, wet	0.0 / 235.2 / 0.3	1	SS	4		18	
2		**SAND AND SILT** loose dark brown sandy silt, wet	234.7 / 0.8						
		saturated		2	SS	9		24	
4			234.0						
		compact, light brown	1.5	3	SS	10		21	
6 / 2									
8				4	SS	24		21	
10			232.5						
		grey	3.0	5	SS	13		20	
12									
14 / 4									
16				6	SS	17		22	
18									
20 / 6				7	SS	24		21	
22			228.9						
24		Drilling Terminated	6.6						

Concrete

Bentonite

Sand Pack

1.2 mbgs (March 26, 2019)

50mm PVC Riser

50mm Slotted Screen

Initial water level at 0.8mbgs upon drilling completion

Field Technician: M. Dalgliesh

Drafted by: B. Heinbuch

Reviewed by: D. Gonser

MTE

ID Number: BH107-19

Project: 10919 Longwoods Road Proposed Industrial Subdivision

Project No: 45013-300

Client: 10919 Longwoods Road Inc.

Site Location: 10919 Longwoods Road, Middlesex Centre, ON

Drill Date: 3/21/2019

Drilling Contractor: London Soil Test Ltd.

Drill Rig: D50T Track

Drill Method: Hollow Stem Auger

Protective Cover: Monument Casing

SUBSURFACE PROFILE				SAMPLE		Dynamic Cone / Standard Penetration	Shear Strength (PP) / Shear Strength (FV) kPa	Water Content %	Groundwater Observations and Standpipe Details
Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Number	Type	20 40 60 80	50 100 150 200	10 20 30	
0 / 0		Ground Surface	234.5						
		TOPSOIL dark brown/black sandy silt, some organics and plastic/glass fragments, saturated	0.0 / 234.2 / 0.3	1	SS	3		25	← Cuttings
2		**SAND AND SILT** very loose dark brown/red sandy silt, wet	233.7 / 0.8	2	SS	12		22	
4		compact, saturated	233.0						
		compact dark brown/red silty sand, saturated	1.5	3	SS	22		21	← Bentonite
6 / 2			232.2						
8		grey	2.3	4	SS	20		21	← Wet cave
10				5	SS	23		22	
12 / 4									
14			229.9						Water level at 1.5mbgs upon drilling completion
		dense grey sandy silt, saturated	4.6	6	SS	30		22	
16									
18									
20 / 6				7	SS	40		25	
			227.9						
22		Drilling Terminated	6.6						
24									

Field Technician: M. Dalgliesh

Drafted by: B. Heinbuch

Reviewed by: D. Gonser

MTE

Sheet: 1 of 1

Notes:
Bentonite forced into wet cave at 2.4mbgs

ID Number: BH108-19

Project: 10919 Longwoods Road Proposed Industrial Subdivision

Project No: 45013-300

Client: 10919 Longwoods Road Inc.

Site Location: 10919 Longwoods Road, Middlesex Centre, ON

Drill Date: 3/21/2019

Drilling Contractor: London Soil Test Ltd.

Drill Rig: D50T Track

Drill Method: Hollow Stem Auger

Protective Cover: Monument Casing

SUBSURFACE PROFILE				SAMPLE		Dynamic Cone / Standard Penetration	Shear Strength (PP) / Shear Strength (FV) kPa	Water Content %	Groundwater Observations and Standpipe Details
Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Number	Type	20 40 60 80	50 100 150 200	10 20 30	
0 / 0		Ground Surface	235.1						
		TOPSOIL dark brown/black sandy silt, some organics, saturated	0.0 / 234.7 / 0.4	1	SS	4		23	
2		**SAND AND SILT** loose dark brown sandy silt, wet	234.3 / 0.8						
		trace clay, saturated		2	SS	5		20	
4			233.6						
		compact, light brown	1.5	3	SS	12		20	
6 / 2			232.8						
		compact grey silty sand, saturated	2.3	4	SS	16		19	
10				5	SS	19		18	
12 / 4									
14			230.5						
		compact grey sandy silt, saturated	4.6	6	SS	19		20	
16									
18									
20 / 6			229.0						
		dense	6.1	7	SS	35		19	
22			228.5						
		Drilling Terminated	6.6						
24									

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

Water level at 1.5mbgs upon drilling completion

Field Technician: M. Dalgliesh

Drafted by: B. Heinbuch

Reviewed by: D. Gonser

MTE

Sheet: 1 of 1

Notes:
Bentonite forced into wet cave at 3.1mbgs

ID Number: BH109-19

Project: 10919 Longwoods Road Proposed Industrial Subdivision

Project No: 45013-300

Client: 10919 Longwoods Road Inc.

Site Location: 10919 Longwoods Road, Middlesex Centre, ON

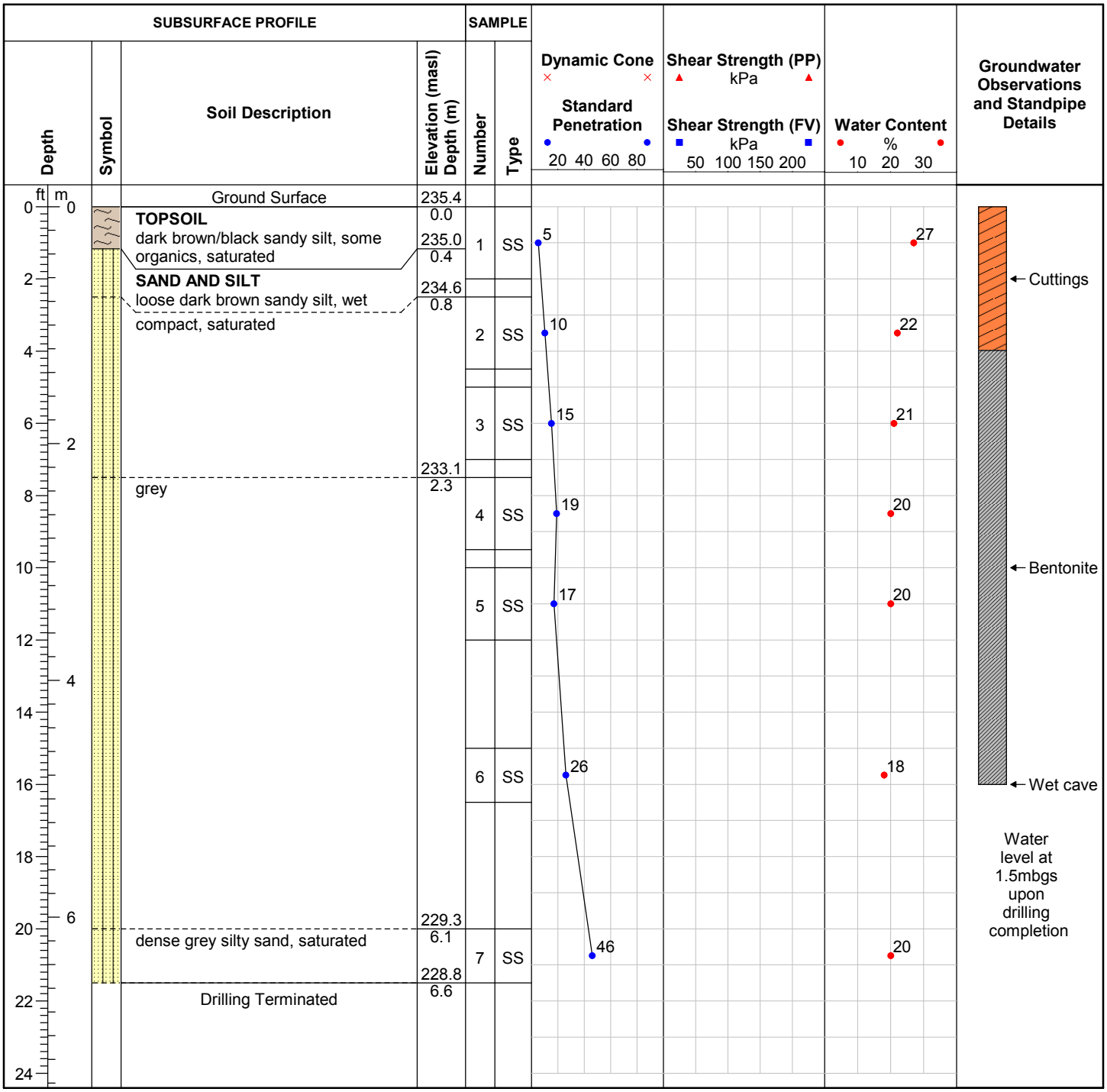
Drill Date: 3/21/2019

Drilling Contractor: London Soil Test Ltd.

Drill Rig: D50T Track

Drill Method: Hollow Stem Auger

Protective Cover: Monument Casing



Field Technician: M. Dalgliesh

Drafted by: B. Heinbuch

Reviewed by: D. Gonser

MTE

Sheet: 1 of 1

APPENDIX C

LABORATORY TEST RESULTS

Tables 1 & 2

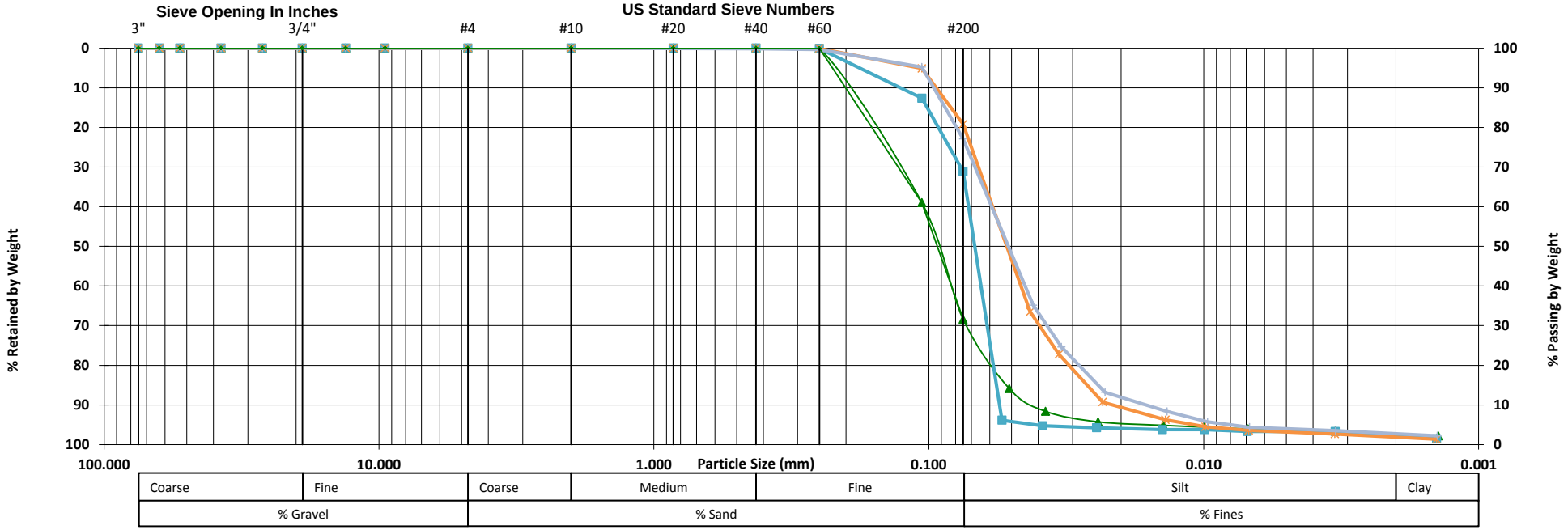
Particle Size Distribution Analysis Test Results

PROJECT NAME: Proposed Industrial Subdivision
CLIENT: 10919 Longwoods Road Inc.
LOCATION: 10919 Longwoods Road, Municipality of Middlesex Centre, ON

DATE SAMPLED: Mar. 20, 2019
DATE TESTED: Mar. 22-26, 2019

FILE No.: 45013-300
TABLE #: 1

Unified Soil Classification



Symbol	Borehole ID	Sample #	*Sample Depth*	Description
▲	MW101-19	SS-2	0.76-1.37 mbgs	Silty SAND, trace Clay
■	MW102-19	SS-2	0.76-1.37 mbgs	Sandy SILT, trace Clay
✳	MW102-19	SS-6	4.57-5.18 mbgs	SILT, some Sand, trace Clay
+	MW103-19	SS-6	4.57-5.03 mbgs	Sandy SILT, trace Clay

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

NOTES:

MTE Consultants Inc.
365 Home Street
Stratford, Ontario N5A 2A5
Phone: 519-271-7952
Fax: 519-271-3545
www.mte85.com

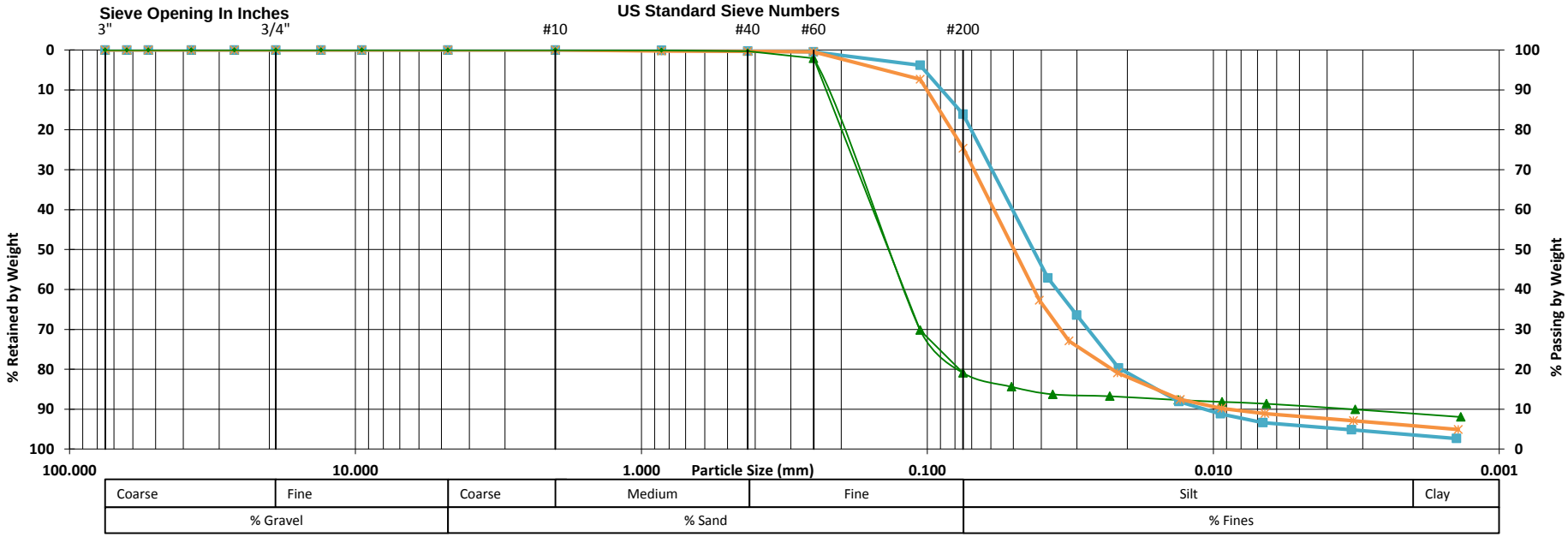
Particle Size Distribution Analysis Test Results

PROJECT NAME: Proposed Industrial Subdivision
CLIENT: 10919 Longwoods Road Inc.
LOCATION: 10919 Longwoods Road, Municipality of Middlesex Centre, ON

DATE SAMPLED: Mar. 20, 2019
DATE TESTED: Mar. 22-26, 2019

FILE No.: 45013-300
TABLE #: 2

Unified Soil Classification



Symbol	Borehole ID	Sample #	*Sample Depth*	Description
▲	MW104-19	SS-2	0.76-1.37 mbgs	SAND, some Silt, trace Clay
■	MW105-19	SS-6	4.57-5.03 mbgs	SILT, some Sand, trace Clay
✳	BH108-19	SS-2	0.76-1.37 mbgs	Sandy SILT, trace Clay

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

NOTES:

MTE Consultants Inc.
365 Home Street
Stratford, Ontario N5A 2A5
Phone: 519-271-7952
Fax: 519-271-3545
www.mte85.com

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London, Ontario N6A 3R4
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Fax: 519-271-3545