DARCY DRIVE RESIDENTIAL DEVELOPMENT

Geotechnical Investigation Report

Project Location:
Darcy Drive
Strathroy, ON

Prepared for:
Turner Homes Ltd.
PO Box 29
Strathroy, ON

Prepared by:
MTE Consultants Inc.
123 St. George Street
London, ON N6A 3A1

April 29, 2019

MTE File No.: 45102-700

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1.0 INTRODUCTION

MTE Consultants Inc. (MTE) was retained by Turner Homes Ltd. to conduct a geotechnical investigation for a proposed new subdivision located west of the Darcy Drive and north of Laura Lane intersection in Strathroy, Ontario. The site was originally severed from Municipal Address 28444 Centre Road. The site is currently vacant with numerous fill stockpiles and comprises approximately 6.9 acres (28,100 m^2). The site is bordered to the north and west by commercial buildings; to the east by residential buildings and Darcy Drive; and to the south by a vacant field, as shown on **Figure 1 in Appendix A**.

It is understood the proposed subdivision will include the construction of 20 single-storey detached lots and 74 townhomes accessed from Darcy Drive. It is understood that the buildings will have basements and will be provided full municipal services. The proposed development details are referenced from Kirkness Consulting's Site Plan Drawing, dated November 3, 2018.

The ground surface generally slopes from northwest to southeast from approximate Elevation 237.0 to 234.5 metres (m).

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, site servicing, foundations, slab-on-grade construction, and pavement design and subdrainage.

2.0 FIELD AND LABORATORY PROGRAM

The fieldwork for this investigation was carried out on April 12, 2019 and involved the drilling of six boreholes (Boreholes BH101-19 to BH106-19) to depths ranging from 6.6 to 8.1 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 Dietrich D50T track mounted drill rig equipped with continuous flight solid 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.**

Upon completion of drilling, monitoring wells were installed in BH103-19, BH104-19 and BH106-19. 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.

Three 50 mm diameter monitoring wells were installed in Boreholes MW103-19, MW104-19 and 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 April 24, 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.

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

The ground surface elevations at the borehole locations were surveyed by MTE and referenced to geodetic datum.

All of the soil samples collected were submitted for moisture content testing and five soil samples were submitted for particle size distribution analyses. The results of the laboratory tests are provided in **Appendix C**. The remaining soil samples will be stored for a period of 1 month 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 surficial organic fill (topsoil) and variable fill materials overlying silt, silty sand and sand deposits.

3.1 Fill Material

Surficial organic fill (topsoil) was encountered at the ground surface in all boreholes. The topsoil varied in thickness from about 150 to 800 millimeters (mm) with an average thickness of about 590 mm. Topsoil was determined through visual observation and no nutrient testing for applicable plant growth was performed as part of the scope of work for this project.

Variable fill material was encountered beneath the topsoil in all boreholes except BH105-19 and was 0.1 to 1.3 m thick with an average thickness of about 0.8 m. The fill typically ranges in composition from silt to sandy silt with varying amounts of organics. SPT N-values measured in the fill range from 4 to 15 blows per 300 mm penetration of the split spoon sampler indicating loose to compact conditions.

Insitu moisture contents in the fill range from 16 to 23% indicating very moist to wet conditions.

3.2 Interlayered Silts and Sands

Silt, clayey silt, sandy silt, silty sand and sand were encountered beneath the fill material in all of the boreholes. The interlayered silts and sands were 4.6 to 6.4 m thick and continued to the termination depth of the boreholes. The results of five particle size distribution analyses conducted on the silts and sands are provided in **Appendix C** and summarized in the following table;

TABLE 1 - RESULTS OF SILTS AND SANDS PARTICLE SIZE DISTRIBUTION ANALYSES

Borehole Number	Sample Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH101-19	1.52 – 2.13	12	10	45	33
BH103-19	6.10 – 6.55	0	85	13	2
BH104-19	4.57 – 5.18	0	18	79	3
BH105-19	2.29 – 2.90	6	8	57	29
BH106-19	7.62 – 8.08	2	21	71	6

SPT N-values measured in the silts and sands range from 3 to 40 blows per 300 mm penetration of the split spoon sampler indicating very loose to dense conditions.

Insitu moisture contents in the silts and sands range from 5 to 30% indicating moist 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. Groundwater was encountered in the boreholes during drilling on April 12, 2019 at a depth of about 4.0 to 7.6 m or approximate Elevations 229.4 to 230.4 m.

Upon completion of drilling activities, monitoring wells were installed in boreholes BH103-19, BH104-19 and BH106-19. Groundwater was measured in the monitoring wells at a depth of about 4.7 to 7.1 m below the ground surface or approximate Elevation 229.7 to 229.9 m on April 24, 2019. 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 subdivision development to the northwest of the Darcy Drive and Laura Lane intersection in Strathroy, Ontario. The site is currently vacant with numerous fill stockpiles, and comprises approximately 6.9 acres (28,100 m^2). The proposed development will include the construction of 20 single-storey detached lots and 74 townhomes accessed from Darcy Drive. It is understood that the buildings will have basements and will be provided full municipal services.

The subsurface stratigraphy at the site comprises fill material overlying interlayered silt and sand deposits. Free groundwater was measured at Elevation 230.0 m or about 5 to 7 m below ground surface.

Based on the results of this geotechnical investigation, the site is suitable for the proposed subdivision development; however, fill materials in the southwest portion of the site will affect design and construction. The following subsections of this report contain geotechnical recommendations pertaining to development of the property including site grading, site servicing, foundations, slab-on-grade construction, and pavement design and subdrainage. Final recommendations should be provided once development details are finalized.

5.2 Site Preparation

The first construction activity that will be required for the proposed development will be grading. Prior to carrying out any cutting and engineering fill operations, the surficial fill materials must be removed from the proposed development area. The average fill thickness measured in the boreholes was about 1.3 m. It is noted that 2.0 m of fill was present in Borehole BH102-19. It is also noted that numerous fill stockpiles were observed onsite and the quantity of fill within these piles was not determined. Fill thickness across the site will be variable. The fill soils could be used in landscaping areas.

Following removal of the fill, the subgrade should be proof rolled in the presence of a geotechnical engineer to verify if the subgrade will provide support as intended in the original design. The primary purpose of proof rolling is to identify soft or spongy areas which should be sub-excavated.

The majority of the native silt and sand soils above the groundwater level are suitable for reuse as engineered fill provided the material is not above the optimum water content for compaction purposes. If the native material is too saturated or if sufficient drying time cannot be allotted, imported fill may be used provided it meets the approval. All engineered fill should be placed in maximum 300 mm thick lifts and compacted to the following percentages;

TABLE 2 - 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

Structural fill used for raising grades beneath any building areas should be comprised of granular material such as Ontario Provincial Standard Specification (OPSS) Granular 'B' Type I. Subgrade fill beneath the proposed roadways 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 recommended during fill placement and compaction to monitor material quality, lift thickness, and verify the compaction by in-situ density testing.

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

5.3 Foundation Design

It is understood that the proposed buildings for the development may be constructed with slab-on-grade floors or with full basements.

Conventional spread footings founded on the compact undisturbed native soils or approved structural fill may be designed for a factored geotechnical bearing resistance at Ultimate Limit States (ULS) of 185 kPa, and soil bearing resistance for 25 mm of settlement at Serviceability Limit States (SLS) of 125 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.

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 fill soils encountered at the site are 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. The native sand and gravel and glacial till soils encountered at the site are classified as Type 2 soils and temporary side slopes must be cut near vertical at 1.2 m above the base of excavation and at an inclination of 1 horizontal to 1 vertical or less above this level, exclusive of groundwater effects.

5.3.1 Basements

It is understood that basements may be installed for the buildings at the site. The basement excavations will encounter isolated groundwater conditions within the silt and sand deposits and free groundwater was measured in the boreholes between Elevations 229.7 and 229.9 m. We recommend the basement floor levels be designed a minimum 0.5 m above the seasonal high groundwater elevations.

Basements at this site must be provided with perimeter weeping tile systems as per the Ontario Building Code (Section 9.14). The drain tile or pipe should be laid on undisturbed or well-compacted soil so that the top of the tile or pipe (minimum 100 mm diameter) is below the bottom of the basement floor slab. The top and sides of the drain tile or pipe shall be surrounded with not less than 150 mm of crushed stone or other clean coarse granular material containing no more than 10% of material that will pass the 4 mm sieve. The crushed stone should be wrapped with filter cloth. The weeping tile must drain to a suitable frost-free outlet or sump equipped with an automatic pump that will discharge water into a storm sewer service or other frost free outlet.

The portion of the exterior basement wall and floor slab below finished ground level must be waterproofed as per the Ontario Building Code (Subsection 9.13.3). Free-draining sand materials should be used for basement wall backfill. The basement wall backfill should be graded to allow drainage away from the foundation.

The basement walls should be designed to resist the lateral earth pressure. For calculating the lateral earth pressure, the coefficient of earth pressure (K) may be assumed as 0.50 for cohesionless sandy soils and 1.0 for silt and clay (Section 24.12.3.3 Canadian Foundation Engineering Manual). The bulk unit weight of the retained backfill may be taken as 21 kN/m^3 for well-compacted soil. An appropriate factor of safety should be employed.

The subgrade for the basement floor slabs should comprise undisturbed compact native soil or well-compacted fill. A minimum 100 mm thick layer of coarse clean granular material containing not more than 10% material that will pass a 4 mm sieve shall be placed beneath slabs in houses as per Subsection 9.16.2 of the Ontario Building Code. If the subgrade soil is wet, we strongly recommend that subfloor weeping tiles be placed and connected to the sump pit.

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 slab 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.

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

5.5 Site Servicing

5.5.1 Excavations and Dewatering

It is understood that the development will receive full municipal services. It is anticipated that the invert levels for the watermain and sanitary and storm sewers will be at conventional depths.

Temporary excavations to conventional depths for installation of underground services at this site must comply with the Ontario Occupational Health and Safety Act and Regulations for Construction Projects. The fill soils and native silt and sand soils encountered in the boreholes would be classified as Type 3 soils (O. Reg. 213/91, s. 226 (4)). Temporary side slopes must be cut at an inclination of 1.0 horizontal to 1.0 vertical or less from the base of the excavation for open cut service installation.
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.

Minor groundwater inflow should be expected where the excavations extend into the wet fill soils and seepage zones encountered within the native silt and sand soils. Free groundwater was measured at approximate Elevation 230.0 m. It is anticipated that conventional sump pumping techniques will be sufficient to control the inflow to a depth of about 4.5 m below ground surface. 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).

5.5.2 Pipe Bedding

It is anticipated that invert elevation of the pipes will be at conventional 2 to 3 m depths below ground surface. The existing fill and organic soils encountered at the site are not suitable to support pipes without undergoing possible detrimental post-construction settlement. The fill and organic soil should be subexcavated from below the pipes and replaced with well-compacted granular soil, or the pipes should be constructed in structurally supported pipe conduits.

Pipe bedding for water and sewer services should be conventional Class 'B' pipe bedding comprising a minimum 150 mm thick layer of OPSS Granular 'A' aggregate below the pipe invert. Granular 'A' type aggregate should be provided around the pipe to at least 300 mm above the pipe and the bedding aggregate should be compacted to a minimum 95% SPMDD, as per OPSS.

A well-graded clear stone such as Coarse Aggregate for HL4 Asphaltic Concrete (OPSS 1003) could be used in the sewer trenches as bedding below the spring line of the pipe to facilitate sump pump dewatering, if necessary. The clear stone should be compacted with a plate tamper and fully wrapped with a non-woven geotextile.

5.5.3 Trench Backfilling

The trenches above the specified pipe bedding should be backfilled with inorganic onsite soils placed in 300 mm thick lifts and compacted to at least 95% SPMDD. Wet or saturated native soils are not considered suitable for reuse as trench backfill. Any additional material required to be imported at the site should meet OPSS Select Subgrade Material specifications.

To minimize potential problems, backfilling operations should follow closely after excavation so that only a minimal length of trench is exposed. Care should be taken to protect side slopes of excavations by diverting surface run-off away from the excavations. If construction extends into the winter, then additional steps should be taken to minimize frost and ensure that frozen material is not used as backfill.

5.6 Pavements

It is understood that new roadways will be constructed as part of the planned development. The following table provides pavement structure components for construction on a properly shaped and prepared subgrade as per Benkelman Beam spring rebound coefficients for silt and sand subgrades for residential local roadways.

TABLE 3 - CONVENTIONAL PAVEMENT DESIGN

Pavement Component	Light Duty	Heavy Duty
Asphalt Hot Mix	90 mm	110 mm
OPSS 1010 Granular 'A' Base	150 mm	150 mm
OPSS 1010 Granular 'B' Subbase	300 mm	400 mm

Heavy duty pavement designs should be used in areas of frequent large vehicle traffic such as garbage trucks or fire truck turn arounds.

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 HL3 surface over 50 mm of HL8 binder for the light duty pavement option and 50 mm of HL3 surface over 60 mm of HL8 binder for the heavy duty pavement option.

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 and 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 OPSS.

It is strongly recommended to install subdrains beneath the low areas of 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. Consideration should be given to providing continuous subdrains along the perimeter edges of the parking area to promote drainage of the granular materials.

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.

5.7 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), as per the Municipality of Strathroy-Caradoc Servicing Standards, dated October, 2016:

- 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 = 6.0 ± 1.0%

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.

5.8 Stormwater Infiltration

It is understood that at-source infiltration of stormwater runoff from the development may also be considered for this site. It is also understood that the existing dry SWM pond at the site may be decommissioned and a new storm sewer installed connecting to the existing infrastructure to the south. 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). Five particle size distribution analyses were carried out on the interlayered silt and sand deposits encountered at the site. They are plotted on **Table 1 in Appendix C**.

The geometric mean 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 4 - INFILTRATION RATES FOR NATIVE SOILS

Borehole Number	Sample Depth (m)	Borehole Elevation (m)	Soil Type	Geometric Mean K-Value (m/sec)	Infiltration Rate (mm/hr)
BH101-19	1.52 – 2.13	234.8	Clayey Silt	7.8E-10	3
BH103-19	6.10 – 6.55	234.4	Sand	3.8E-05	49
BH104-19	4.57 – 5.18	234.8	Silt	4.5E-08	8
BH105-19	2.29 – 2.70	236.1	Clayey Silt	1.7E-10	2
BH106-19	7.62 – 8.08	237.0	Sandy Silt	1.8E-07	12

Due to the interlayered soils at the site and the low permeability of the native silt, clayey silt and sandy silt soils, it is our preliminary opinion that at-source infiltration of stormwater runoff will be challenging for this development. Areas of sands and silty sands may be capable of at-source infiltration but the thickness of these layers, depths encountered and their proximity to the groundwater level is relatively unknown between the borehole locations and may make the design difficult. Additional investigation at the exact locations of the proposed at-source infiltration locations may be necessary to assist in design.

5.9 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 proposed building, foundation wall backfill, subslab granular fill, service pipe bedding and trench backfill. Laboratory and field testing of the pavement structure components (granulars and aphaltic concrete) should be conducted, as well as concrete testing for foundations, curbs and sidewalks.

MTE offers soil compaction, concrete and asphaltic concrete 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.

Brett Thorner, P.Eng.
Geotechnical Engineer

Montana Wilson, M.Eng. P.Eng. PMP
Civil and Geotechnical Division Manager

BRT:MXW:dld

APPENDIX A

FIGURES

Figure 1- Location Plan
Figure 2 - Site Plan

FIGURE 1 – LOCATION PLAN Project: 45102–700 CAD: P:\P\45102\700\BH FIGURES\45102–700–BHFIGURES–CDP–17_04_2019.DWG

REFERENCES:

- AERIAL IMAGE FROM GOOGLE EARTH PRO.

MTE
Engineers |Scientists |Surveyors

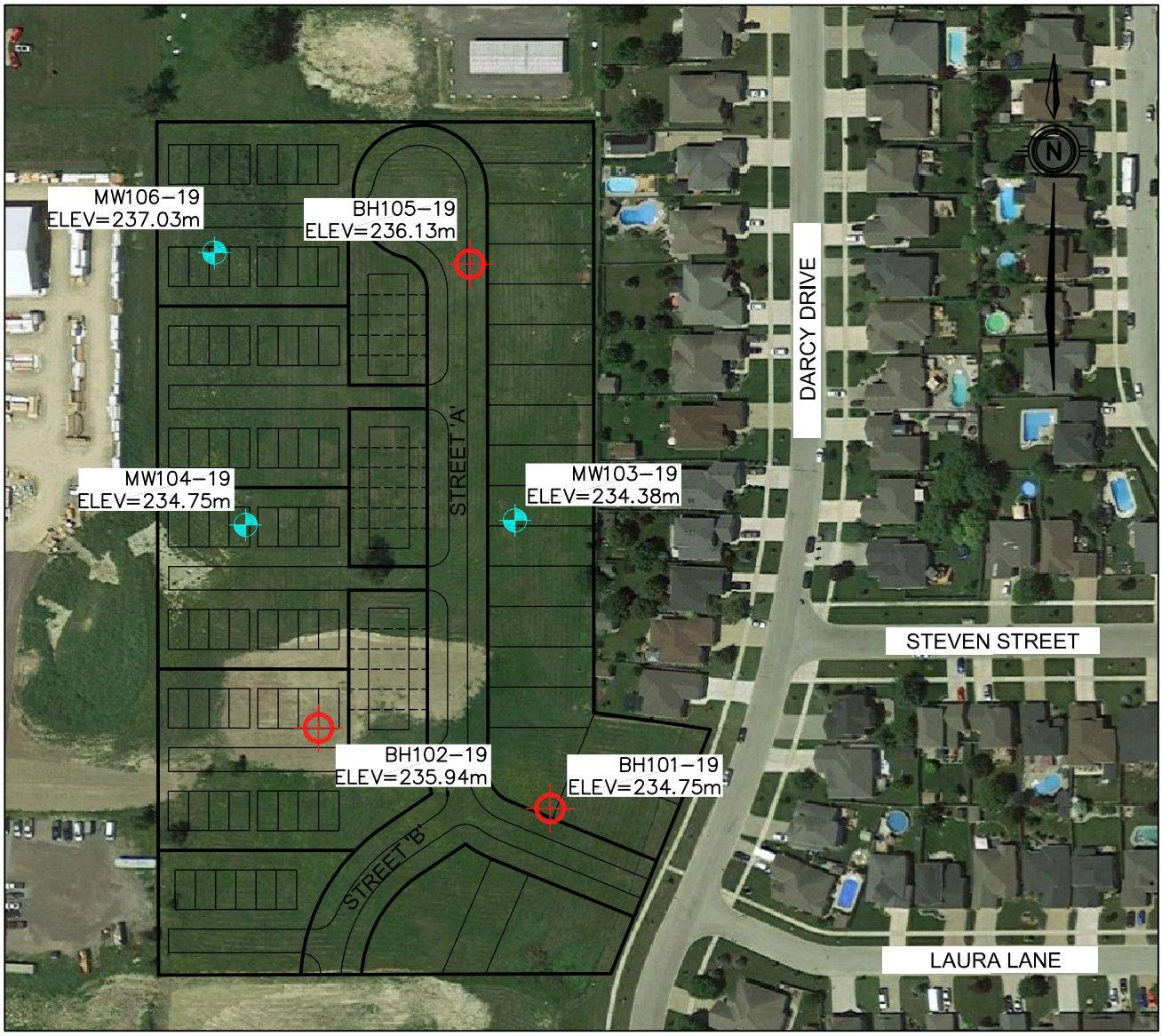
LOCATION PLAN

Project Name
DARCY DRIVE RESIDENTIAL DEVELOPMENT

Site	Client
DARCY DRIVE, STRATHROY, ON	TURNER HOMES LTD.

Scale. (8.5x11)	MTE Project No.	Date	Figure No.
N.T.S.	45102-700	APRIL 17, 2019	1

FIGURE 2 - SITE PLAN Project: 45102-700 CAD: P:\P\45102\700\BH FIGURES\45102-700-BHFIGURES-CDP-17_04_2019.DWG



LEGEND

BH101-19 — MTE BOREHOLE

MW103-19 — MONITORING WELL

REFERENCES:

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

MTE
Engineers | Scientists | Surveyors

SITE PLAN

Project Name
DARCY DRIVE RESIDENTIAL DEVELOPMENT

Site	Client
DARCY DRIVE, STRATHROY ON	TURNER HOMES LTD.

Scale. (8.5x11)	MTE Project No.	Date	Figure No.
1:2000	45102-700	APRIL 17, 2019	2

APPENDIX B

BOREHOLE LOGS

Boreholes BH101-19 to BH106-19

LIST OF ABBREVIATIONS AND SYMBOLS

The following are abbreviations and symbols commonly used on borehole logs, figures and in the text of reports:

Sample Types			
AS	Auger Sample	**SS**	Split Spoon
CS	Chunk Sample	**RC**	Rock Core
BS	Bulk Sample	**SC**	Soil Core
GS	Grab Sample	**TW**	Thinwall, Open
WS	Wash Sample	**TP**	Thinwall, Piston

Soil Tests	
PP	Pocket Penetrometer
FV	Field Vane
SPT	Standard Penetration Test
CPT	Cone Penetration Test
WC	Water Content
WL	Water Level

Penetration Resistance	
Standard Penetration Test, N (ASTM D1586)	The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) open spilt spoon sampler for a distance of 300 mm (12 in.).
Dynamic Cone Penetration Resistance	The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive an uncased 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

Soil Description		
Cohesive Soils	**Undrained Shear Strength (C_u)**	
Consistency	kPa	psf
Very Soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very Stiff	100 to 200	2000 to 4000
Hard	above 200	above 4000
Cohesionless Soils		
Relative Density	SPT N Value	
Very Loose	0 to 4	
Loose	4 to 10	
Compact	10 to 30	
Dense	30 to 50	
Very Dense	above 50	

WH	Sampler advanced by static weight of hammer
WR	Sampler advanced by static weight of drilling rods
PH	Sampler advanced by hydraulic force
PM	Sampler advanced by manual force

DTPL	Drier than Plastic Limit
APL	About Plastic Limit
WTPL	Wetter than Plastic Limit
mbgs	Metres below Ground Surface

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

ID Number: BH101-19

Project: Proposed Residential Development

Project No: 45102-700

Client: Turner Homes Ltd.

Site Location: Darcy Drive, Strathroy, ON

Drill Date: 4/12/2019

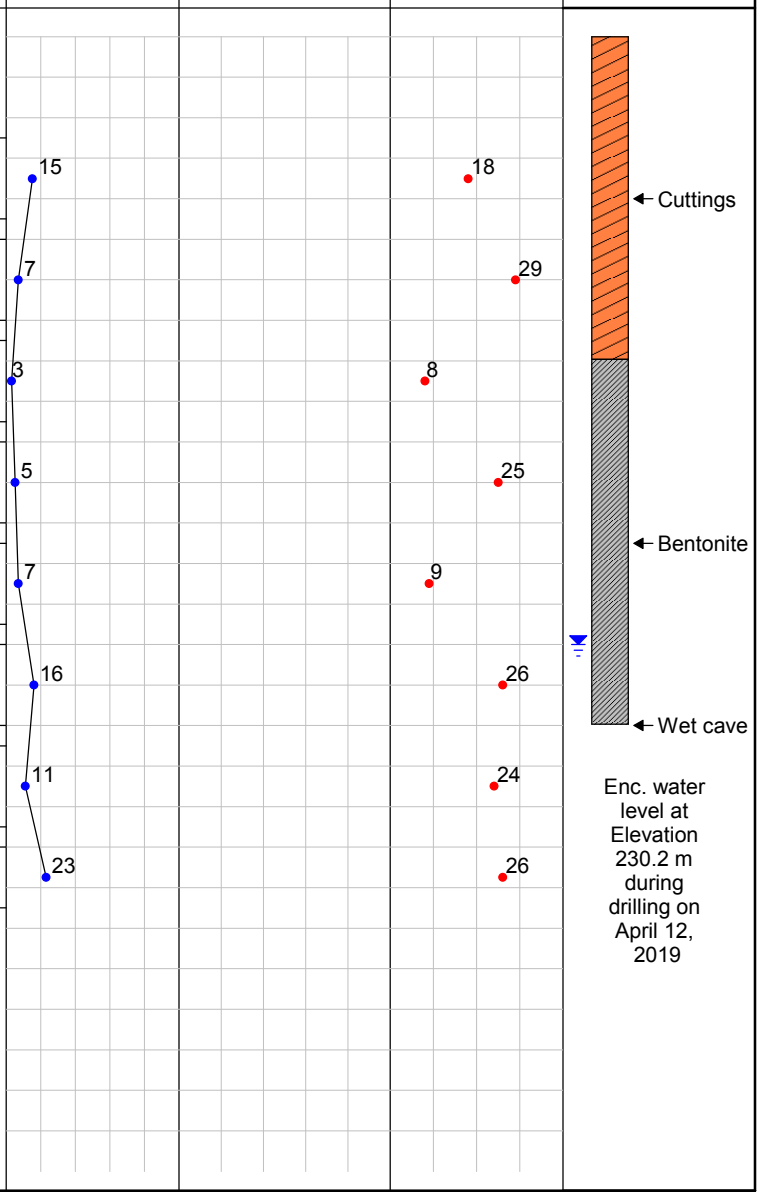
Drilling Contractor: London Soil Test Ltd.

Drill Rig: D50T Track

Drill Method: Soild Stem Augers

Protective Cover: N/A

Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Sample Number	Sample Type
0 / 0		Ground Surface	234.8		
0 / 0		**FILL** dark brown/black sandy silt (topsoil), very moist	0.0		
2 / 0		dark brown to brown silt, some clay and sand, trace to some topsoil, very moist	234.0		
4 / 1		compact	0.8	1	SS
4 / 1			233.3		
6 / 2		**CLAYEY SILT** loose brown clayey silt, some gravel and sand, wet	1.5	2	SS
8 / 2			232.5		
8 / 2		**SILTY SAND** very loose to loose brown silty sand, very moist to wet	2.3	3	SS
10 / 3				4	SS
12 / 4				5	SS
14 / 4			230.2		
16 / 5		**SILT** compact brown silt, some sand, saturated	4.6	6	SS
16 / 5			229.5		
18 / 5		**SAND** compact brown sand, some silt, saturated	5.3	7	SS
20 / 6				8	SS
22 / 6			228.2		
22 / 6		Drilling Terminated	6.6		
26 / 8					
28 / 8					



Field Technician: M. Dalgliesh

Drafted by: B. Heinbuch

Reviewed by: B. Thorner

MTE

Sheet: 1 of 1

ID Number: BH102-19

Project: Proposed Residential Development

Project No: 45102-700

Client: Turner Homes Ltd.

Site Location: Darcy Drive, Strathroy, ON

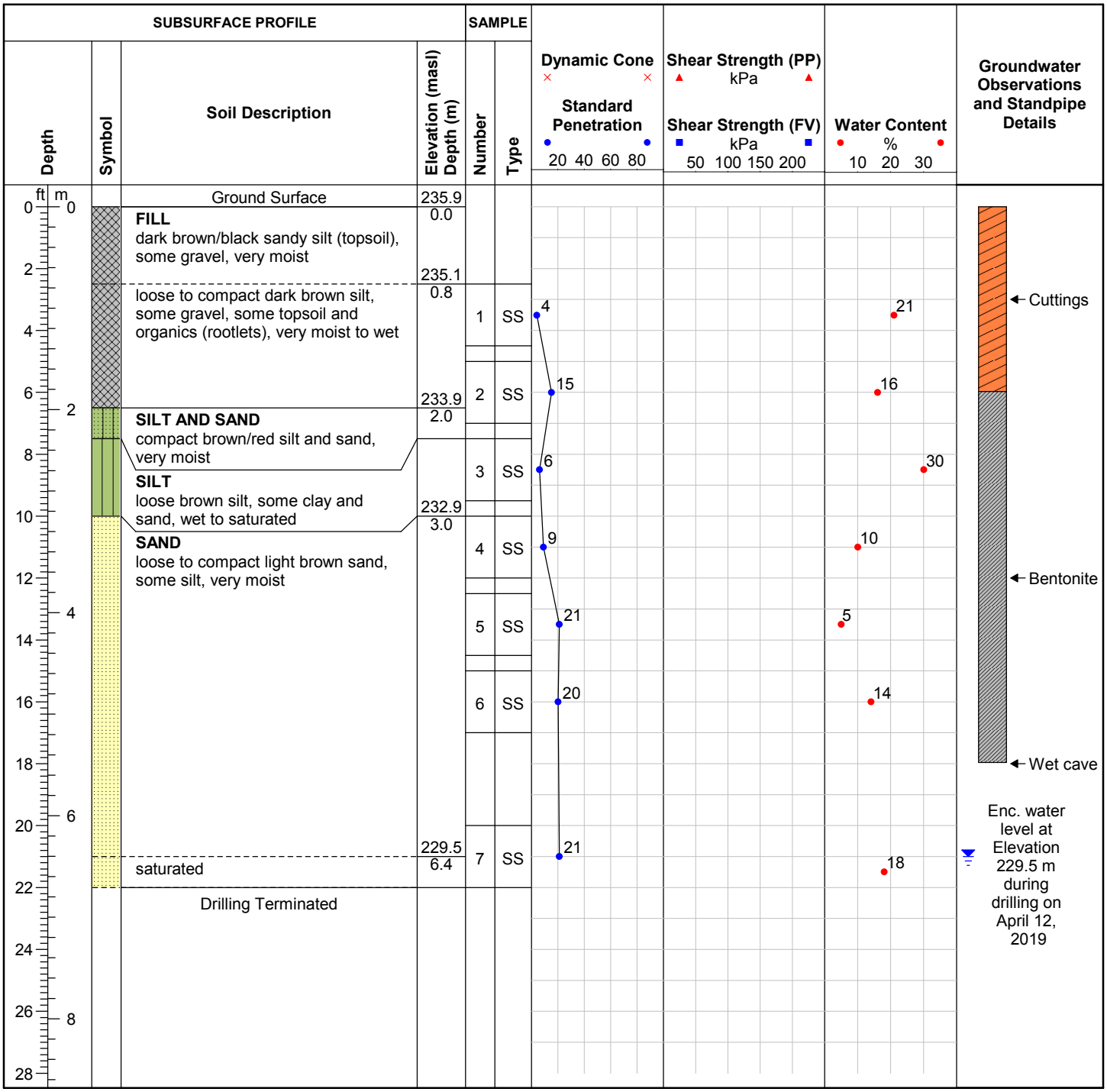
Drill Date: 4/12/2019

Drilling Contractor: London Soil Test Ltd.

Drill Rig: D50T Track

Drill Method: Soild Stem Augers

Protective Cover: N/A



Field Technician: M. Dalgliesh

Drafted by: B. Heinbuch

Reviewed by: B. Thorner

MTE

Sheet: 1 of 1

ID Number: MW103-19

Project: Proposed Residential Development

Project No: 45102-700

Client: Turner Homes Ltd.

Site Location: Darcy Drive, Strathroy, ON

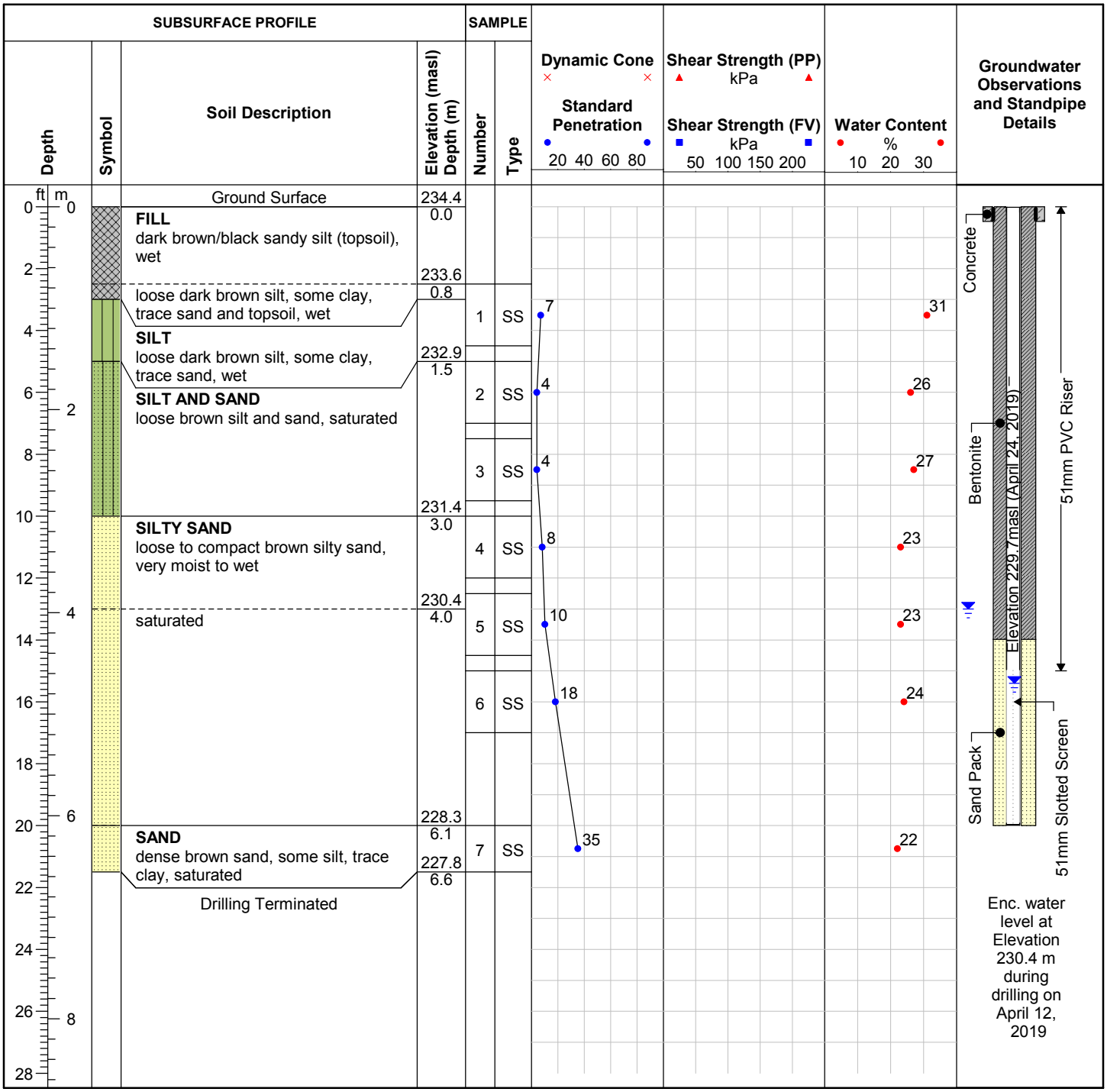
Drill Date: 4/12/2019

Drilling Contractor: London Soil Test Ltd.

Drill Rig: D50T Track

Drill Method: Soild Stem Augers

Protective Cover: Monument Casing



Field Technician: M. Dalgliesh

Drafted by: B. Heinbuch

Reviewed by: B. Thorner

MTE

Sheet: 1 of 1

ID Number: MW104-19

Project: Proposed Residential Development

Project No: 45102-700

Client: Turner Homes Ltd.

Site Location: Darcy Drive, Strathroy, ON

Drill Date: 4/12/2019

Drilling Contractor: London Soil Test Ltd.

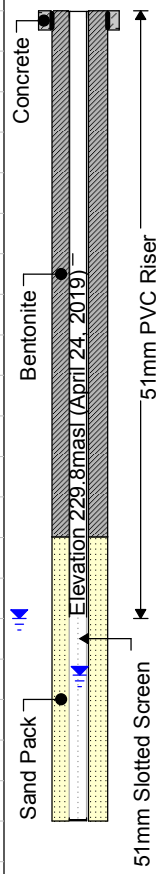
Drill Rig: D50T Track

Drill Method: Soild Stem Augers

Protective Cover: Monument Casing

Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Sample Number	Sample Type
0 / 0		Ground Surface	234.8		
		FILL dark brown/black sandy silt (topsoil), very moist	0.0		
		dark brown silt, some clay and sand, trace gravel, very moist	234.0 / 0.8		
		SILT compact brown silt, some clay and sand, very moist to wet		1	SS
		saturated	233.3 / 1.5		
2 / 2		**SILTY SAND** compact light brown sand, some gravel and silt, very moist	232.8 / 2.0	2	SS
				3	SS
				4	SS
4 / 4				5	SS
		SILT compact brown silt, some sand, trace clay, saturated	230.2 / 4.6	6	SS
6 / 6		**SAND** compact brown sand, some silt, saturated	228.7 / 6.1	7	SS
		Drilling Terminated	228.1 / 6.7		

Depth (ft / m)	Dynamic Cone Standard Penetration (20 40 60 80)	Shear Strength (PP) kPa	Shear Strength (FV) kPa (50 100 150 200)	Water Content % (10 20 30)
0 / 0				
2 / 2	13			21
4 / 4	28			20
6 / 6				9
8 / 8	18			9
10 / 10	14			8
12 / 12				
14 / 14	25			8
16 / 16	16			22
18 / 18				
20 / 20	25			22
22 / 22				
24 / 24				
26 / 26				
28 / 28				



Enc. water level at Elevation 230.2 m during drilling on April 12, 2019

Field Technician: M. Dalgliesh

Drafted by: B. Heinbuch

Reviewed by: B. Thorner

MTE

Sheet: 1 of 1

ID Number: BH105-19

Project: Proposed Residential Development

Project No: 45102-700

Client: Turner Homes Ltd.

Site Location: Darcy Drive, Strathroy, ON

Drill Date: 4/12/2019

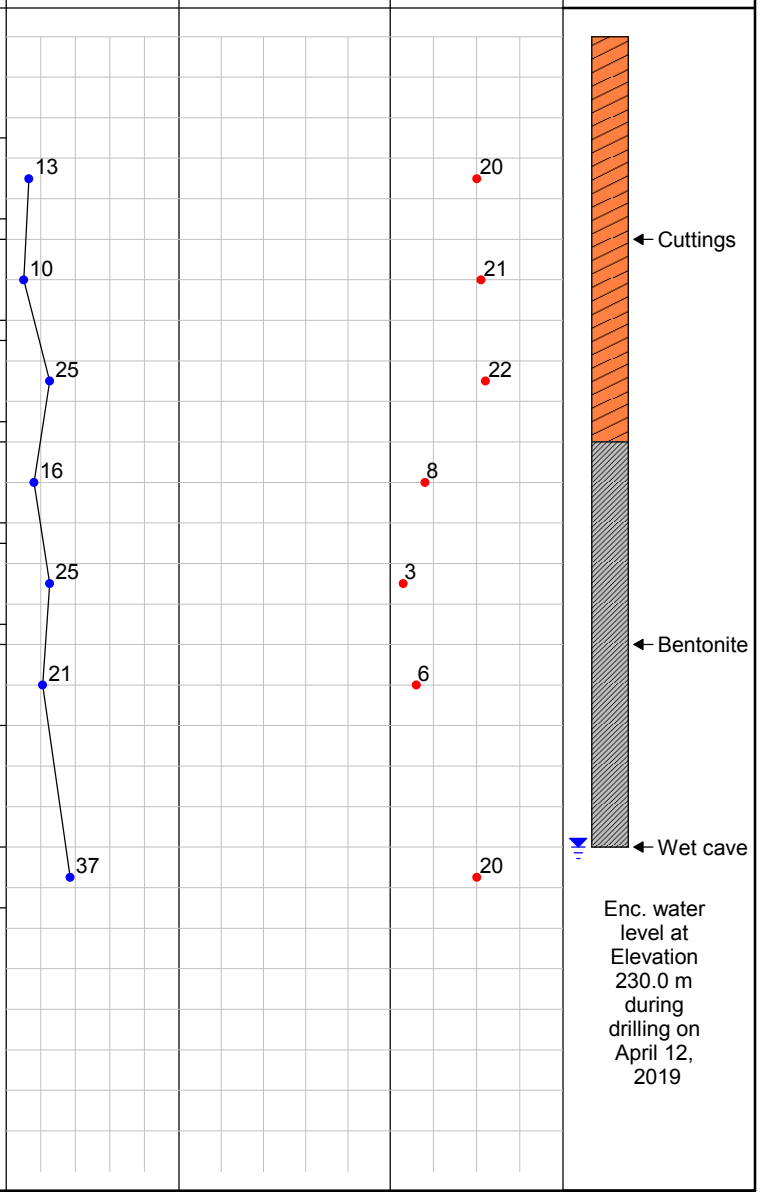
Drilling Contractor: London Soil Test Ltd.

Drill Rig: D50T Track

Drill Method: Soild Stem Augers

Protective Cover: N/A

Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Sample Number	Sample Type
0 / 0		Ground Surface	236.1		
0 / 0		**FILL** dark brown/black sandy silt (topsoil), very moist	0.0 235.3		
2 / 0		**SILT** compact brown silt, some clay, trace sand, wet	0.8	1	SS
4 / 1				2	SS
6 / 2			233.8		
8 / 2		**CLAYEY SILT** compact brown clayey silt, trace sand and gravel, wet	2.3 233.4	3	SS
10 / 3		**SILTY SAND** compact brown silty sand, very moist	2.7	4	SS
12 / 4			232.3		
12 / 4		**SAND** compact brown sand, some silt, very moist	3.8	5	SS
16 / 5				6	SS
18 / 5					
20 / 6			230.0		
20 / 6		**SILTY SAND** dense brown silty sand, saturated	6.1 229.5	7	SS
22 / 7		Drilling Terminated	6.6		
24 / 7					
26 / 8					
28 / 8					



Enc. water level at Elevation 230.0 m during drilling on April 12, 2019

Field Technician: M. Dalgliesh

Drafted by: B. Heinbuch

Reviewed by: B. Thorner

MTE

Sheet: 1 of 1

ID Number: MW106-19

Project: Proposed Residential Development

Project No: 45102-700

Client: Turner Homes Ltd.

Site Location: Darcy Drive, Strathroy, ON

Drill Date: 4/12/2019

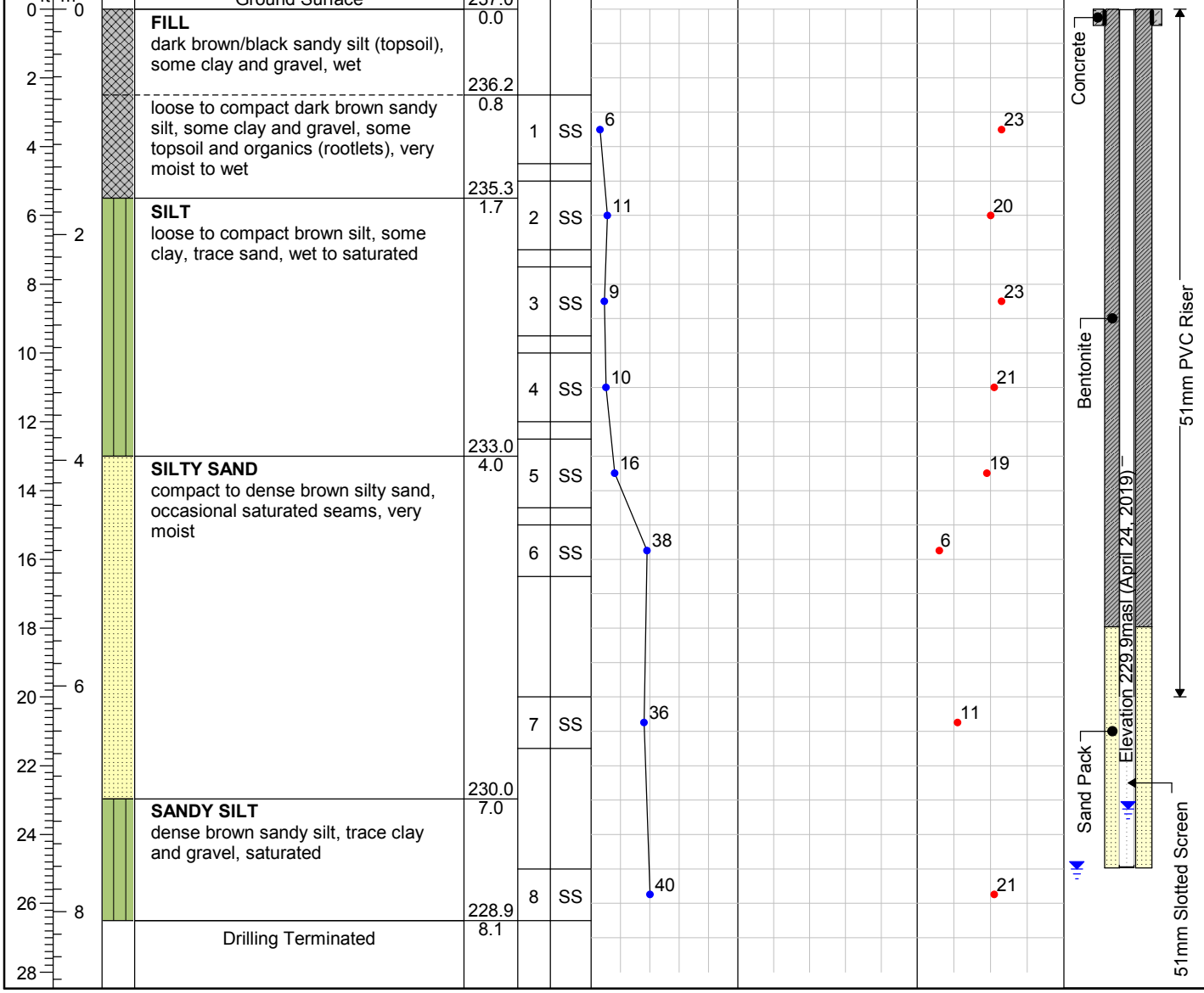
Drilling Contractor: London Soil Test Ltd.

Drill Rig: D50T Track

Drill Method: Soild Stem Augers

Protective Cover: Monument Casing

Depth (ft / m)	Symbol	Soil Description	Elevation (masl) / Depth (m)	Sample Number	Sample Type
0 / 0		Ground Surface	237.0		
0 / 0		**FILL** dark brown/black sandy silt (topsoil), some clay and gravel, wet	0.0 / 236.2		
2 / 0.8		loose to compact dark brown sandy silt, some clay and gravel, some topsoil and organics (rootlets), very moist to wet	0.8 / 235.3	1	SS
6 / 2		**SILT** loose to compact brown silt, some clay, trace sand, wet to saturated	1.7 / 233.0	2	SS
				3	SS
				4	SS
12 / 4		**SILTY SAND** compact to dense brown silty sand, occasional saturated seams, very moist	4.0 / 230.0	5	SS
				6	SS
20 / 6				7	SS
24 / 7.3		**SANDY SILT** dense brown sandy silt, trace clay and gravel, saturated	7.0 / 228.9	8	SS
26 / 8		Drilling Terminated	8.1		
28					



Field Technician: M. Dalgliesh

Drafted by: B. Heinbuch

Reviewed by: B. Thorner

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Sheet: 1 of 1

Notes:
Enc. water level at Elevation 229.4 m during drilling on April 12, 2019

APPENDIX C

LABORATORY TEST RESULTS

Table 101

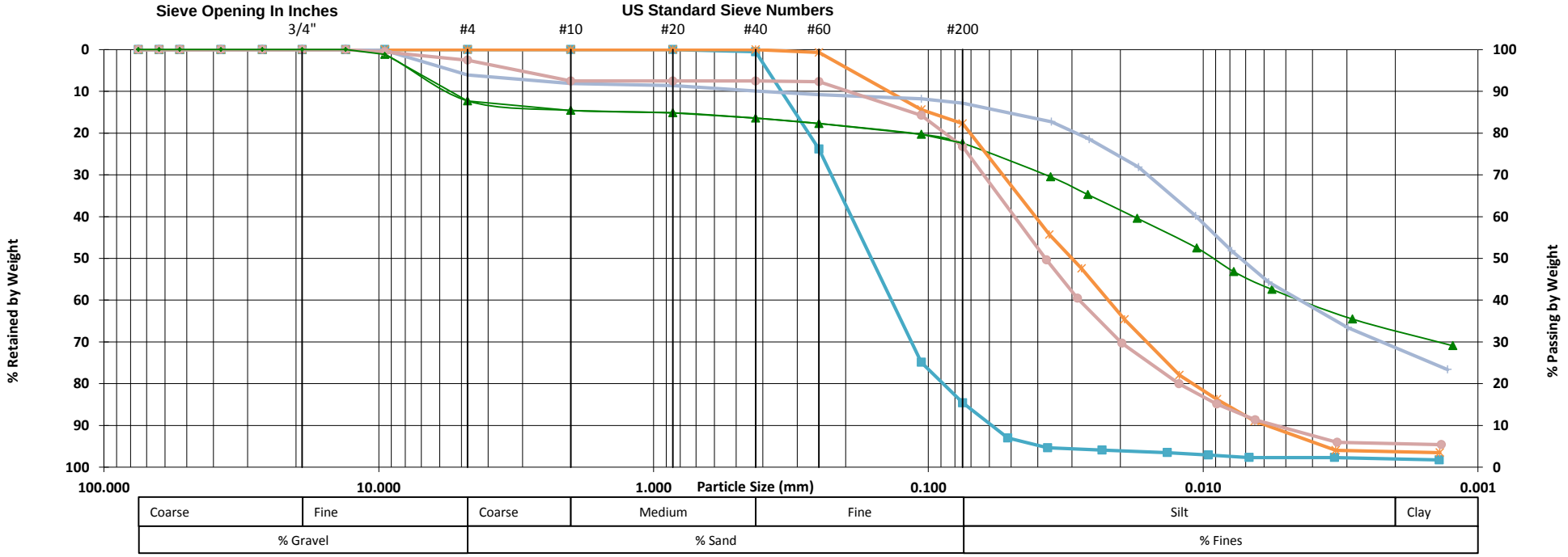
Particle Size Distribution Analysis Test Results

PROJECT NAME: Proposed Residential Development
CLIENT: Turner Homes Ltd.
LOCATION: Darcy Drive, Strathroy, ON

DATE SAMPLED: April, 12, 2019
DATE TESTED: April 16-18, 2019

FILE No.: 45102-700
TABLE #: 101

Unified Soil Classification



Symbol	Borehole ID	Sample #	*Sample Depth*	Description
▲	BH101-19	SS-2	1.5-2.1 mbgs	Clayey SILT, some Gravel and Sand
■	MW103-19	SS-7	6.1-6.6 mbgs	SAND, some Silt, trace Clay
✳	MW104-19	SS-6	4.6-5.2 mbgs	SILT, some Sand, trace Clay
+	BH105-19	SS-3	2.3-2.9 mbgs	Clayey SILT, trace Sand and Gravel
●	MW106-19	SS-8	7.6-8.1 mbgs	Sandy SILT, trace Clay and Gravel

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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
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Phone: 905-639-2552
Fax: 905-639-7727

520 Bingemans Centre Drive
Kitchener, Ontario N2B 3X9
Phone: 519-743-6500
Fax: 519-743-6513

560 Wellington Street, Fourth Floor
London, Ontario N6A 3R4
Phone: 519-204-6510
Fax: 519-204-6511

365 Home Street
Stratford, Ontario N5A 2A5
Phone: 519-271-7952
Fax: 519-271-3545