



Geotechnical Investigation

TBR Land Development Inc.

Type of Document:

Final Report

Project Name:

Sinclair Avenue Development
St. Thomas, Ontario

Project Number:

LON00018385GE

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1. Introduction and Background

1.1 Introduction

EXP Services Inc. (EXP) was retained by TBR Land Development Inc. to conduct a Geotechnical Investigation relating to a proposed residential development on Sinclair Avenue in St. Thomas, Ontario, hereinafter referred to as the 'Site'. The overall Site size is approximately 1.6 hectares. The Site backs onto a former rail line and fronts Sinclair Avenue. The proposed development includes nineteen (19) single family residential lots at the west end of Sinclair Avenue and an R7 development block towards the east end of Sinclair Avenue. No details were provided for the R7 development block at the time of writing this report. Authorization for EXP to proceed with the Geotechnical Investigation was given by TBR Land Development Inc.

Based on an interpretation of the factual test hole data and a review of soil and groundwater information from test holes advanced at the Site, EXP has provided geotechnical engineering guidelines to support the proposed Site development.

1.2 Terms of Reference

The geotechnical investigation was done in general accordance with terms outlined in EXP's Proposal P20-247 emailed to the Client. Client authorization was received in an email.

The purpose of the investigation was to examine the subsoil and groundwater conditions at the Site by advancing ten (10) boreholes at the Site at the locations illustrated on the attached Borehole Location Plan, **Drawing 1**.

Based on an interpretation of the factual test hole data, and a review of soil and groundwater information from test holes advanced at the Site, EXP has provided engineering guidelines to assist with the geotechnical design and construction of the proposed development. More specifically, this report provides comments on excavations, dewatering, backfill, foundation design, basement construction, slab-on-grade construction, site servicing, earthquake design considerations, pavement design, curbs and sidewalks, and infiltration potential related to LID.

This report is provided based on the terms of reference presented above and, on the assumption, that the design will be in accordance with applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning geotechnical aspects of the codes and standards, this office should be contacted to review the design.

The information in this report in no way reflects on the environmental aspects of the soil. Should specific information in this regard be needed, additional testing may be required.

Reference is made to **Appendices D and E** of this report, which contains further information necessary for the proper interpretation and use of this report.

2. Methodology

The fieldwork was carried out on November 11 and 12, 2020. In general, the geotechnical investigation consisted of the advancement of ten (10) boreholes at the locations denoted on **Drawing 1** as BH1 to BH10 inclusive.

As required for Phase II Environmental Site Assessment, three (3) monitoring wells were installed at the boreholes. Therefore, the suffix “/MW” is added to denote a monitoring well was installed at the borehole location.

Prior to the investigation, buried service clearances were obtained for the boreholes.

The boreholes were advanced to varying depths of 4.6 m to 9.8 m below ground surface (bgs) using a locally contracted track mounted drilling unit equipped with solid stem, soil sampling and soil testing equipment and a geoprobe with Direct Push (DP) equipment. Within each borehole, disturbed samples were recovered using conventional split spoon sampling equipment. Standard Penetration Tests (SPT's) were also performed throughout selected boreholes to assess the compactness or consistency of the underlying soils, and to obtain representative samples. The boreholes are described on the Borehole Logs (see **Appendix A**).

During the drilling, the stratigraphy within each borehole was examined and logged in the field by EXP geotechnical personnel. Observations of the groundwater level were also noted in the open test holes and were recorded on the attached Logs. Following the drilling, the boreholes without wells were backfilled with bentonite hole plug and excavated material, to satisfy the requirements of O. Reg. 903. Fifty-millimeter diameter PVC monitoring wells were installed at Boreholes BH5/MW, BH8/MW and BH10/MW. Details of the monitoring well construction are provided on the attached Borehole Logs.

Representative samples of the various soil strata encountered at the test locations were taken to our laboratory in London for further examination by a geotechnical engineer and laboratory classification testing. Laboratory testing for this investigation comprised routine moisture content determinations (results presented on the borehole logs) and two grain size analyses.

Samples remaining after the classification testing will be stored for a period of three months following the date of reporting. After this time, they will be discarded unless prior arrangements are made for longer storage.

Borehole locations were established in the field by EXP personnel based on information provided in the RFP. The ground surface elevations of Boreholes BH1 through BH8 inclusive were surveyed to the cover of the existing sanitary manhole 2, located opposite Municipal Number 22 (Elevation 242.22 m); while Boreholes BH9 and BH10 were surveyed to the existing sanitary manhole 1 cover opposite Municipal Number 32 (Elevation 241.98 m) as provided in the drawing prepared by Development (London) Limited, Existing Conditions Plan Sheet 1, DEL20-024, dated June 11, 2020.

3. Site and Subsurface Conditions

3.1 Site Description

In general, the Site is located on the north side of Sinclair Avenue in St. Thomas, Ontario. Currently, the Site is undeveloped and is vegetated with trees, brush and grass. A former rail line ran along the north boundary of the property, just south of Talbot Street. The site is relatively flat facing onto Sinclair Avenue with a berm along the north boundary where the rail line had been located. The change in elevation across the Site based on the borehole elevations is 3.8 m.

The following sections provide a summary of the soil conditions and groundwater conditions.

3.2 Soil Stratigraphy

The detailed stratigraphy encountered in each borehole and the results of routine laboratory testing carried out on representative samples of the subsoil are given on the borehole logs presented in **Appendix A** and summarized in the following paragraphs. It must be noted that the boundaries of the soil indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect transition zones for geotechnical design and should not be interpreted as exact planes of geological change.

Topsoil

Topsoil was found at surface at all boreholes. The topsoil ranged in thickness from 150 mm to 300 mm.

It should be noted that topsoil quantities should not be established from the information provided at the borehole locations only. If required, a more detailed analysis (involving shallow test pits) is recommended to accurately quantify the amount of topsoil to be removed for construction purposes.

Fill

Fill was observed below the topsoil at Boreholes BH6, BH8 and BH10. The fill varied from clayey silt to sand and gravel with trace topsoil and cinders and occasional brick fragments. It was generally brown in colour and was in a moist, compact state. The fill was approximately 2.9 m thick at Borehole BH6 and about 0.7 m thick at Boreholes BH8 and BH10.

Clayey Silt Till

Clayey silt till was encountered below the fill at Boreholes BH6, BH8 and BH10 and below the topsoil at all other boreholes. All boreholes were terminated in the till. It varied in colour from brown/grey to brown to grey and contained trace to some sand and trace to some gravel. The till displayed a consistency of soft to hard based on SPT N Values of 3 to 35 for 300 mm penetration of the split spoon hammer. In situ moisture contents varied from 10 to 26 percent indicating moist conditions. The till became grey between 1.5 m and 3.8 m bgs. Two grain size analyses were conducted on selected samples of the till. The results are summarized below and provided in **Appendix B** as Figures 1 and 2.

Table 1 – Grain Size Analyses, Till

Borehole	Gravel	Sand, %	Silt, %	Clay, %
BH3, S2, near 0.76 m bgs	2	12	49	37
BH10, S3, near 1.5 m bgs	2	14	50	34

3.3 Groundwater Conditions

Details of the groundwater conditions observed within the boreholes are provided on the Borehole Logs. Moisture contents of selected samples are provided on the logs in **Appendix A**.

At completion of drilling, all boreholes were open and dry. Two return visits were made for water level readings on November 19 and December 10, 2020. The table below summarizes the findings.

Table 2 – Water Level Readings in the Monitoring Wells

Borehole	Ground Surface Elevation m	Depth Borehole Drilled to, m	Depth Well Installed to, m	Water Level Reading, m			
				November 19, 2020		December 10, 2020	
				Depth	Elev.	Depth	Elev.
BH5/MW	241.0	9.8	9.1	Dry	N/A	9.2	231.8
BH8/MW	238.0	8.2	6.1	5.6	232.4	4.7	233.3
BH10/MW	241.4	7.5	7.0	Dry	N/A	4.6	236.8

It is believed that the above water levels are not a stabilized groundwater table but a perched groundwater within fill materials above less permeable clay soils. However, the depth to the groundwater table may vary in response to climatic or seasonal conditions, and, as such, may differ at the time of construction, with high levels in wet seasons. Capillary rise effects should also be anticipated in fine-grained soil deposits.

3.4 Methane Gas Testing

An RKI Gx-2003 Gas Detector was used in the upper levels of the open boreholes. The unit measures low explosive limit (LEL) combustibles, methane gas, oxygen content, Carbon Monoxide and Hydrogen Sulfide in standard confined space gases. No significant methane gas concentrations were detected upon completion of drilling for this investigation in any of the boreholes.

4. Discussion and Recommendations

4.1 General

It is understood that the proposed development will include nineteen (19) single family residential lots at the west end of Sinclair Avenue and an R7 development block towards the east end of Sinclair Avenue. No details were provided for the R7 development block. It is assumed that the single-family homes will have basements.

The following sections of this report provide geotechnical comments regarding site preparation, excavations, dewatering, foundations, basement construction, slab-on-grade construction, site servicing, pavement design, seismic considerations and infiltration potential related to LID.

4.2 Site Preparation

Prior to placement of foundations and/or engineered fill, any existing fill, loose soils, topsoil and/or otherwise deleterious materials should be stripped from the footing area of the proposed buildings.

In the proposed building areas where the subgrade requires reconstruction to achieve the design elevation, engineered fill should be used. The geometric requirements for engineered fill are provided on **Drawing 2**. A representative from this office must be on site to ensure a competent subgrade prior to the placement of engineered fill. Full time monitoring of the engineered fill is required to confirm adequate compaction is being achieved.

In areas along the proposed roadways, fill material used to raise grades may consist of on-site excavated soils or imported granular fill, approved by an engineer. The fill should be placed in maximum 300 mm (12 inch) thick lifts and uniformly compacted to 95 percent SPMDD below one metre depth of road surface and 98 percent SPMDD in the top metre of road surface to provide adequate stability for the new pavements.

In situ compaction testing should be carried out during the fill placement to ensure that the specified compaction is being achieved.

If imported fill material is used at the Site, verification of the suitability of the fill may be required from an environmental standpoint. Conventional geotechnical testing will not determine the suitability of the material in this regard. Analytical testing and environmental site assessment may be required at the source. This will best be assessed prior to the selection of the material source. A quality assurance program should be implemented to ensure that the fill material will comply with the current MECP standards for placement and transportation.

4.3 Excavation and Groundwater Control

Excess Soil Management

It should be noted that Ontario Regulation 406/19 made under the Environmental Protection Act (November 28, 2019) is scheduled to be implemented on January 1, 2021. The new regulation will dictate the testing protocol that will be required for the management and disposal of Excess Soils. As set forth in the Regulation, specific analytical testing protocols will need to be implemented and followed based on the volume of soil to be managed. The testing protocols are specific as to whether the soils are stockpiled or in-situ. In either scenario, the testing protocols are far more onerous than have been historically carried out as part of standard industry practices. These decisions should be factored in and accounted for prior to the initiation of the project-defined scope of work. EXP would be pleased to

assist with the implementation of a soil management and testing program that would satisfy the requirements of Ontario Regulation 406/19.

The following is the regulated sampling and testing regiment.

Table 3 – Recommended Ex-Situ (e.g., Stockpiles)

Soil Volume	Sampling Frequency
<130 m ³	Minimum of 3
>130 - 220 m ³	4
>220 - 5000 m ³	5-32*
>5000 m ³	$N = 32 + (\text{Volume} - 5000) / 300$

*refer to stockpile sampling frequency in O.Reg. 153/04 for specifics. Essentially, one sample for every 150 m³ after 800 m³

Table 4 – Recommended In-Situ

Soil Volume	Sampling Frequency
<600 m ³	Minimum of 3
>600 m ³ - 10,000 m ³	1 sample per every additional 200 m ³
>10,000 m ³ – 40,000 m ³	1 sample per every additional 450 m ³
>40,000 m ³	1 sample per every additional 2000 m ³

Soil Analytical Testing Requirements:

- Samples to be tested for a minimum of Petroleum Hydrocarbons (PHCs) – Fractions F1-F4, Benzene, Toluene, Ethylbenzene & Xylenes (BTEX), Metals & Hydrides, including Electrical Conductivity (EC) and Sodium Absorption Ration (SAR), only if from an area where de-icing has historically occurred.
- Any potential Contaminant of Concern identified in past uses report (comes into effect January 1, 2022)
- Leachate analysis (not required for volumes under 350 m³: between 350 m³ and 600 m³ (minimum of 3); greater than 600 m³ (10 % of samples). Note, leachate not required unless address and Area of Potential Environmental Concern (APEC), as identified in the past uses report (January 1, 2022).

General

All work associated with design and construction relative to excavations must be carried out in accordance with Part III of Ontario Regulation 213/91 under the Occupational Health and Safety Act. Based on the results of the geotechnical investigation and in accordance with Section 226 of Ontario Regulation 213/91, the clayey silt till encountered within the boreholes is classified as Type 3 soil. Excavations in Type 3 soils must be sloped at a minimal inclination of 1H:1V from the base of excavation.

Geotechnical inspection at the time of excavation can confirm the soil type present.

It should be noted that the presence of cobbles and boulders in natural glacial deposits may influence the progress of excavation and construction.

Excavation Support

The recommendations for side slopes given above would apply to most of the conventional excavations expected for the proposed development. However, in areas adjacent to existing structures and buried services that are located above the base of the excavations, side slopes may require support to prevent possible disturbance or distress to these structures. This concept also applies to connections to existing services. In granular soils above the groundwater and in cohesive natural soils, bracing will not normally be required if the structures are behind a 45-degree line drawn up from the toe of the excavation. In wet sandy soils, the setback should be about 3H to 1V if bracing is to be avoided.

For support of excavations such as for any deep manholes, trench boxes or shoring such as sheeting or soldier piles and lagging can be considered. The design and use of the support system should conform to the requirements set out in the most recent version of the Occupational Health and Safety Act for Construction Projects and approved by the Ministry of Labour. Excavations should conform to the guidelines set out in the proceeding section and the Safety Act. The shoring should also be designed in accordance with the guidelines set out in the Canadian Foundation Engineering Manual, 4th Edition. Soil-related parameters considered appropriate for a soldier pile and lagging system are shown below.

Where applicable, the lateral earth pressure acting on the excavation shoring walls may be calculated from the following equation:

$$P = K (\gamma h + q)$$

where, p = lateral earth pressure in kPa acting at depth h ;

γ = natural unit weight, a value of 20.5 kN/m³ may be assumed;

h = depth of point of interest in m;

q = equivalent value of any surcharge on the ground surface in kPa.

The earth pressure coefficient (K) may be taken as 0.25 where small movements are acceptable and adjacent footing or movement sensitive services are not above a line extending at 45 degrees from the bottom edge of the excavation; 0.35 where utilities, roads, sidewalks must be protected from significant movement; and 0.45 where adjacent building footings or movement sensitive services (gas and water mains) are above a line of 60 degrees from the horizontal extending from the bottom edge of the excavation.

For long term design, a K at rest (K_0) of a minimum of 0.5 should be considered.

The above expression assumes that no hydrostatic pressure will be applied against the shoring system. It should be recognized that the final shoring design will be prepared by the shoring contractor. It is not possible to comment further on specific design details until this design is completed.

If the shoring is exposed to freezing temperatures, appropriate insulation may be provided to prevent outward movement.

The performance of the shoring must be checked through monitoring for lateral movement of the walls of the excavation to ensure that the shoring movements remain within design limits. The most effective method for monitoring the shoring movements can best be devised by this office when the shoring plans become available. The shoring designer should however assess the specific site requirements and submit them to the engineer for review and comment.

Construction Dewatering

Based on the results of the field drilling program, groundwater infiltration is not anticipated during excavation for buildings and services. In the event of minor groundwater seepage during excavation for foundations or site servicing, it can likely be accommodated using conventional sump pumping techniques. If groundwater infiltration persists, more extensive dewatering measures may be required.

Collected water from service trenches and temporary excavations should be discharged a sufficient distance away from the excavated area to prevent the discharge water from returning to the excavation. Sediment control measures should be provided at the discharge point of the dewatering system. Caution should also be taken to avoid any adverse impacts to the environment.

Although not anticipated for this project, it should be noted that for projects requiring positive groundwater control with a removal rate more than 50,000 litres per day, an Environmental Activity and Sector Registry (EASR) or Permit to Take Water (PTTW) will be required. PTTW applications are required for removal rates more than 400,000 L per day and will need to be approved by the MECP according to Sections 34 and 98 of the Ontario Water Resources Act R.S.O. 1990 and the Water Taking and Transfer Regulation O. Reg. 387/04. It is noted that a standard geotechnical investigation will not determine all the groundwater parameters which may be required to support the PTTW application. Accordingly, a detailed hydrogeological assessment from a quantitative point of view may be required to estimate the quantity of water to be removed. EXP can assist if the need arises.

4.4 Foundation Construction

Shallow Strip and Spread Footings on Natural Competent Soils

Foundations for the proposed development can be set on the natural, competent clayey silt till soils at 0.9 m bgs to 1.2 m bgs except at the BH6 location where thick fill was encountered and extended to depth of 3.2 m bgs.

The following table summarizes the recommended highest depths and elevations at the borehole locations:

Table 5 – Founding Depths/elevations and Bearing Resistances

Borehole No.	Geodetic Ground Surface Elevation (m)	Highest Depth below Existing Grade (m)	Highest Bearing Elevation (m)
BH1	238.7	0.9	237.8
BH2	240.7	0.9	239.8
BH3	242.0	0.9	241.1
BH4	241.8	0.9	240.9

Borehole No.	Geodetic Ground Surface Elevation (m)	Highest Depth below Existing Grade (m)	Highest Bearing Elevation (m)
BH5/MW	241.0	0.9	240.1
BH6	240.3	3.2	237.1
BH7	240.2	0.9	239.3
BH8/MW	238.0	1.2	236.8
BH9	241.2	0.9	240.3
BH10/MW	241.4	1.2	240.2

The following allowable bearing pressures (net stress increase) can be used on the natural, undisturbed clayey silt till at the depths/elevations noted above or deeper:

Bearing Resistance at Serviceability Limit States (SLS) 145 kPa (3,000 psf)

Factored Bearing Resistance at Ultimate Limit States (ULS) 220 kPa (4,500 psf)

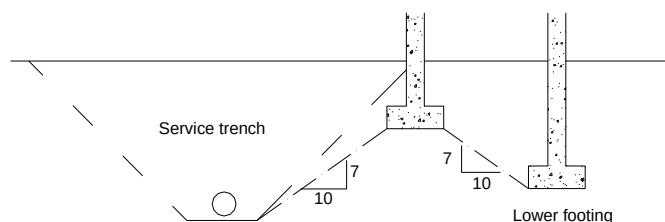
Strip and Spread Footings on Engineered Fill

If grades are to be raised or restored such as at the BH6 location, engineered fill can be used for foundation support. The available SLS bearing capacity for the engineered fill is 145 kPa (3,000 psf). **Drawing 2** provides requirements for engineered fill placement. The subgrade level for footings set on engineered fill can be set higher than the depths noted above.

All organic material and unsuitable soils should be removed from the footprint area of the buildings prior to engineered fill placement. A proof roll should be carried out over the subgrade in the presence of an EXP representative. Any soft spots detected by the proof roll should be dug out and replaced with competent material under the direction of an EXP representative.

Foundations - General

Footings at different elevations should be located such that the higher footings are set below a line drawn up at 10 horizontal to 7 vertical from the near edge of the lower footing. This concept should also be applied to service excavations, etc. to ensure that undermining is not a problem.



FOOTINGS NEAR SERVICE TRENCHES OR AT DIFFERENT ELEVATIONS

Provided that the footing bases are not disturbed due to construction activity, precipitation, freezing and thawing action, etc., and the aforementioned bearing pressures are not exceeded, the total and differential settlements of footings designed in accordance with the recommendations of this report and with careful attention to construction detail are expected to be less than 25 mm and 20 mm (1 and $\frac{3}{4}$ inch), respectively.

All footings exposed to seasonal freezing conditions should be protected from frost action by at least 1.2 m (4 ft) of soil cover or equivalent insulation.

It should be noted that the recommended bearing capacities have been calculated by EXP from the borehole information for the design stage only. The investigation and comments are necessarily on-going as new information of underground conditions becomes available (i.e., where more specific information becomes available with respect to conditions between borehole locations when foundation construction is underway). The interpretation between the boreholes and the recommendations of this report must therefore be checked through field inspections provided by EXP to validate the information for use during the construction stage.

4.5 Basement Construction

It is assumed that the residents will have basements. The basement floors can be constructed using cast slab-on-grade techniques provided the subgrade is stripped of all topsoil and other obviously objectionable material. The subgrade should then be thoroughly proof-rolled. Any soft zones detected during the proof-rolling should be dug out and replaced with clean, compactable material, placed in accordance with the requirements outlined in **Section 4.2**.

A minimum 200 mm (8 inch) thick compacted layer of 19 mm ($\frac{3}{4}$ inch) clear crushed stone should be placed between the prepared subgrade and the floor slab to serve as a moisture barrier.

For design, the modulus of subgrade reaction (k) can be taken as 20 MPa/m for a minimum of 200 mm of 19 mm clear, crushed stone, or 300 mm of OPSS Granular 'A' constructed as specified.

In accordance with the OBC all basement walls should be damp-proofed and must be designed to resist a horizontal earth pressure 'P' at any depth 'h' below the surface as given by the following expression:

$$P = K (\gamma h + q)$$

where, P = lateral earth pressure in kPa acting at depth h;

γ = natural unit weight of existing soils, a value of 20.5 kN/m³ may be assumed;

γ = natural unit weight of free draining layer, a value of 21.5 kN/m³ may be assumed;

h = depth of point of interest in m;

q = equivalent value of any surcharge on the ground surface in kPa.

K = earth pressure coefficient, assumed to be 0.4

Installation of perimeter drains is required for basements at the Site. The above expression assumes that the perimeter drainage system prevents the build-up of any hydrostatic pressure behind the wall. Suggestions for permanent perimeter drainage are given on **Drawing 3**.

4.6 Slab-on-Grade Construction

Preparation of the subgrade for structures without basements should include the removal of all topsoil and/or deleterious material from the proposed building area. The entire floor slab area should then be thoroughly proof-rolled with a heavy roller and examined by a Geotechnical Engineer. Any excessively soft or loose areas should be sub-excavated and replaced with suitable compacted fill. Where the exposed subgrade requires reconstruction to achieve the design elevations, structural fill should be used. It is recommended that structural fill comprises granular material, such as OPSS Granular 'B', or approved alternative material. The fill should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98 percent Standard Proctor Maximum Dry Density (SPMDD). For best compaction results, the *in situ* moisture content of the fill should be within about three percent of optimum, as determined by Standard Proctor density testing.

No special underfloor drains are required provided that the exterior grades are lower than the floor slab, and positively sloped away from the slab. It is recommended that an impermeable soil seal such as clay, asphalt or concrete be provided on the surface to minimize water infiltration from the exterior of the building. See **Drawing 4** for drainage and backfill recommendations for slab-on-grade construction.

A moisture barrier, consisting of a 200 mm (8 in.) thick, compacted layer of 19 mm (3/4 in.) clear, crushed stone, should be placed between the prepared subgrade and the floor slab. A less desirable option would include 300 mm (12 in.) thick OPSS Granular 'A' compacted to a minimum of 100 percent SPMDD.

For design, the modulus of subgrade reaction (k) can be taken as 20 MPa/m for a minimum of 200 mm of 19 mm clear, crushed stone, or 300 mm of OPSS Granular 'A' constructed as specified.

The installation and requirement of a vapour barrier under a concrete slab should conform to the flooring manufacturer's and designer's requirements. Moisture emission testing will be required to determine the concrete condition prior to flooring installation. In order to minimize the potential for excess moisture in the floor slab at the time of the flooring installation, a concrete mixture with a low water-to-cement ratio (i.e., 0.45 to 0.55) should be used. Chemical additives may be required at the time of placement to make the concrete workable and should be used in place of additional water at the point of placement. Ongoing liaison from this office will be required.

The water-to-cement ratio and slump of concrete utilized in the floor slabs should be strictly controlled to minimize shrinkage of the slabs. Adequate joints should be provided in the floor slab to further control cracking. During placement of concrete at the construction site, testing should be performed on the concrete.

4.7 Foundation Backfill

In general, the existing natural, non-organic soils excavated from the foundation area should be suitable for re-use as foundation wall backfill behind the free-draining layer. The materials to be re-used should be within three percent of optimum moisture for best compaction results. Materials should be stockpiled according to their composition; i.e. sandy soils should not be mixed with till soils.

The backfill must be brought up evenly on both sides of walls not designed to resist lateral earth pressures.

During construction, the fill surface around the perimeter of structures should be sloped in such a way that the surface runoff water does not accumulate around the structure.

4.8 Site Servicing

Based on the results of the investigation, it is anticipated that services will be set into the natural or engineered clayey silt till soils. No bearing problems are anticipated for services set into these soils. The subgrade soil should be inspected by EXP during construction to verify/ensure a competent subgrade is present.

The bedding aggregate should be placed around the pipe to at least 300 mm (12 inch) above the pipe. The bedding course may be thickened if portions of the subgrade become wet during excavation. The bedding aggregate should be compacted to a minimum 95 percent SPMDD.

Water and sewage lines installed outside of heated areas should be provided with a minimum 1.2 m (4 ft) of soil cover for frost protection.

In general, the natural soils excavated from the service trench areas should be suitable for reuse as trench backfill. The materials to be re-used should be within three percent of optimum moisture for best compaction results. Materials should be stockpiled according to their composition; i.e. sandy soils should not be mixed with till soils.

Backfill above the bedding aggregate can consist of the excavated (inorganic) soils, compacted in maximum 300 mm thick lifts to a minimum of 95 % SPMDD. A program of in situ density testing should be set up to ensure that satisfactory levels of compaction are achieved. **Drawings 5 and 6** provide typical trench backfill requirements and **Appendix C** provides suggested inspection testing guidelines.

As noted previously, disposal of excavated materials off-site should conform to current MECP guidelines.

4.9 Earthquake Design Considerations

The recommendations for the geotechnical aspects to determine the earthquake loading for design using the OBC 2012 are presented below.

The subsoil and groundwater information at this Site have been examined in relation to Section 4.1.8.4 of the OBC 2012. The subsoils on Site generally consist of firm to very stiff clayey silt till deposits. It is anticipated that the proposed structures will be founded on the till or engineered fill.

Table 4.1.8.4.A. Site Classification for Seismic Site Response in OBC 2012 indicated that to determine the Site Classification, the average properties in the top 30 m (below the lowest founding level) are to be used. The boreholes advanced on Site were to a maximum of about 9.8 m depth. Therefore, the Site Classification recommendation would be based on the available information as well as our interpretation of conditions below the boreholes based on our knowledge of the soil conditions in the area.

Based on the above assumptions, interpretations in combination with the known local geological conditions, the Site Class for the proposed development is “D” as per Table 4.1.8.4.A, Site Classification for Seismic Site Response, OBC 2012.

4.10 Pavement Design

Areas to be paved should be stripped of all topsoil, organics and other obviously unsuitable material. The exposed subgrade must then be thoroughly proof-rolled. Any soft zones revealed by this or any other observations must be over-excavated and backfilled with approved material. All fill required to backfill service trenches or to raise the subgrade to design levels must conform to requirements outlined previously. Preferably, the natural inorganic excavated soils should be used to maintain uniform subgrade conditions, provided adequate compaction can be achieved.

Provided the preceding recommendations are followed, the pavement thickness design requirements given in Table 6 are recommended for the anticipated loading and subgrade conditions.

Table 6 – Recommended Pavement Structure Thicknesses

Pavement Layer	Compaction Required	Local Road	Heavy Duty Areas
Asphaltic Concrete – Wearing Course	92% MRD ¹ or 97% BRD ¹	40 mm HL-3	50 mm HL3
Asphaltic Concrete – Binder Course	92% MRD ¹ or 97% BRD ¹	50 mm HL-8	60 mm HL8
Granular 'A' (Base)	100 % SPMDD ¹	150 mm	150 mm
Granular 'B' (Subbase)	100 % SPMDD ¹	300 mm	400 mm

- Notes:
1. MRD = Maximum Relative Density; BRD = Bulk Relative Density; and SPMDD = Standard Proctor Maximum Dry Density.
 2. The subgrade must be compacted to 98 % SPMDD.
 3. The above recommendations are minimum requirements.

The recommended pavement structures provided in the above table are based on the natural subgrade soil properties determined from visual examination and textural classification of the soil samples. Consequently, the recommended pavement structures should be considered for preliminary design purposes only. Other granular configurations may also be possible provided the granular base equivalency (GBE) thickness is maintained. These recommendations on thickness design are not intended to support heavy and concentrated construction traffic, particularly where only a portion of the pavement section is installed.

If construction is undertaken under adverse weather conditions (i.e., wet or freezing conditions) subgrade preparation and granular sub-base requirements should be reviewed by the geotechnical engineer. If the sub-base is set on wet or dilatant silty soils, a geotextile will be required. A non-woven type geotextile such as Terrafix 270R or equivalent would be suitable for this application.

If only a portion of the pavement will be in place during construction, the granular subbase may have to be thickened, and/or the subgrade improved with a geotextile separator or geogrid stabilizing layer. This is best determined in the field during the site servicing stage of construction, prior to road construction.

If a geogrid stabilizing layer is recommended at the time of construction, the source of the granular material should be reviewed to verify its compatibility with the geogrid. For example, where Tensar BX1100 (or equivalent) is utilized,

the Granular B material should have a nominal size of 26.5 mm, with a maximum of 25 percent (by mass) passing the 4.75 mm sieve size. EXP would be pleased to review the project specifications and proposed source of imported materials to verify compatibility.

Samples of both the Granular 'A' and Granular 'B' aggregates should be checked for conformance to OPSS 1010 and City of St. Thomas standards prior to use on Site, and during construction. The Granular 'B' subbase and the Granular 'A' base courses must be compacted to 100 percent SPMDD.

The asphaltic concrete paving materials should conform to the requirements of OPSS 1150 and City of St. Thomas standards. The asphalt should be placed in accordance with OPSS 310 and compacted to at least 97 percent of the BRD.

Good drainage provisions will optimize pavement performance. The finished pavement surface should be free of depressions and should be sloped (preferably at a minimum grade of two percent) to provide effective surface drainage toward catch basins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas. In low areas, sub drains should be installed to intercept excess subsurface moisture and prevent subgrade softening, as shown on **Drawing 7**. This is particularly important in heavier traffic areas at the Site entrances. The locations and extent of sub-drainage required within the paved areas should be reviewed by this office in conjunction with the proposed grading.

A program of in situ density testing must be carried out to verify that satisfactory levels of compaction are being achieved.

4.11 Curbs and Sidewalks

The concrete for the curbs and sidewalks should be proportioned, mixed placed and cured in accordance with the requirements of OPSS 353, OPSS 1350.

During cold weather, the freshly placed concrete should be covered with insulating blankets to protect against freezing.

The subgrade for the sidewalks should consist of undisturbed natural soil or well-compacted fill. A minimum 150 mm thick layer of compacted (minimum 98 percent SPMDD) Granular 'A' should be placed below the sidewalk slabs.

4.12 Methane Gas

An RKI Gx-2003 Gas Detector was used in the upper levels of the open boreholes. The unit measures low explosive limits (LEL) combustibles, methane gas, oxygen content, carbon monoxide and hydrogen sulfide in standard confined space gases. Methane gas was not detected in any of the boreholes at the time of this investigation. Based on the present information, no special methane gas abatement measures are indicated at this Site.

4.13 Low Impact Development (LID)

It is understood that LID stormwater management design requires the practical availability of unsaturated, sufficiently pervious soil with depth and aerial extent to accommodate the infiltration of stormwater run-off created by land development. The boreholes on Site generally encountered topsoil overlying less permeable glacial till deposits.

Based on the information collected at the borehole locations, and the above cited criteria, the near surface soils encountered on Site have low potential for use in LID stormwater management design. The following table summarizes the estimated hydraulic conductivity, K; percolation time, T; and infiltration rate 1/T as determined from the grain size analyses.

Table 7 – Low Impact Development Potential

Borehole No.	Sample Depth, m	Soil Description	Hydraulic Conductivity, K cm/sec	Percolation Time, T minutes/cm	Infiltration Rate, 1/T mm/hr
BH3, S2	0.76	Clay and Silt, Some Sand, Trace Gravel	1×10^{-7} to 1×10^{-8}	>50	<5
BH10, S3	1.5	Clayey Silt, Some Sand, Trace Gravel	1×10^{-7} to 1×10^{-8}	>50	<5

The gradations are generally representative of the soils available for consideration in LID design at the Site. The gradation results are provided in **Appendix B**. The above numbers are based on laboratory gradation test results and should be verified by field testing.

It is understood that recommended factors of safety will be applied to the estimated parameters cited above for use in design.

4.14 Inspection and Testing Requirements

An effective Inspection and Testing Program is an essential part of construction monitoring. The Inspection and Testing Program typically includes the following items:

- Subgrade examination following removal of existing services (if any), fill and organics, prior to foundation installation and engineered fill placement (if required);
- Inspection and materials testing during engineered fill placement (full-time supervision is recommended) and site servicing works, including soil sampling, laboratory testing (moisture contents and Standard Proctor density test on the pipe bedding, trench backfill and engineered fill material), monitoring of fill placement, and in situ density testing;
- Footing base examinations to confirm suitability to support the design bearing pressures; and, visual examination of concrete reinforcing steel placement in footings set on engineered fill.
- Inspection and testing for underfloor subgrade and granular placement.
- Materials testing for concrete foundations, floor slab, curbs and sidewalks.
- Inspection and materials testing during paving work including laboratory testing and in situ density testing.

EXP would be pleased to prepare an inspection and testing work program prior to construction, incorporating the above items.

5. General Limitations

The information presented in this report is based on a limited investigation designed to provide information to support an assessment of the current geotechnical conditions within the subject property. The conclusions and recommendations presented in this report reflect site conditions existing at the time of the investigation. Consequently, during the future development of the property, conditions not observed during this investigation may become apparent. Should this occur, EXP should be contacted to assess the situation, and the need for additional testing and reporting. EXP has qualified personnel to provide assistance in regards to any future geotechnical and environmental issues related to this property.

Our undertaking at EXP, therefore, is to perform our work within limits prescribed by our Clients, with the usual thoroughness and competence of the engineering profession. No other warranty or representation, either expressed or implied, is included or intended in this report.

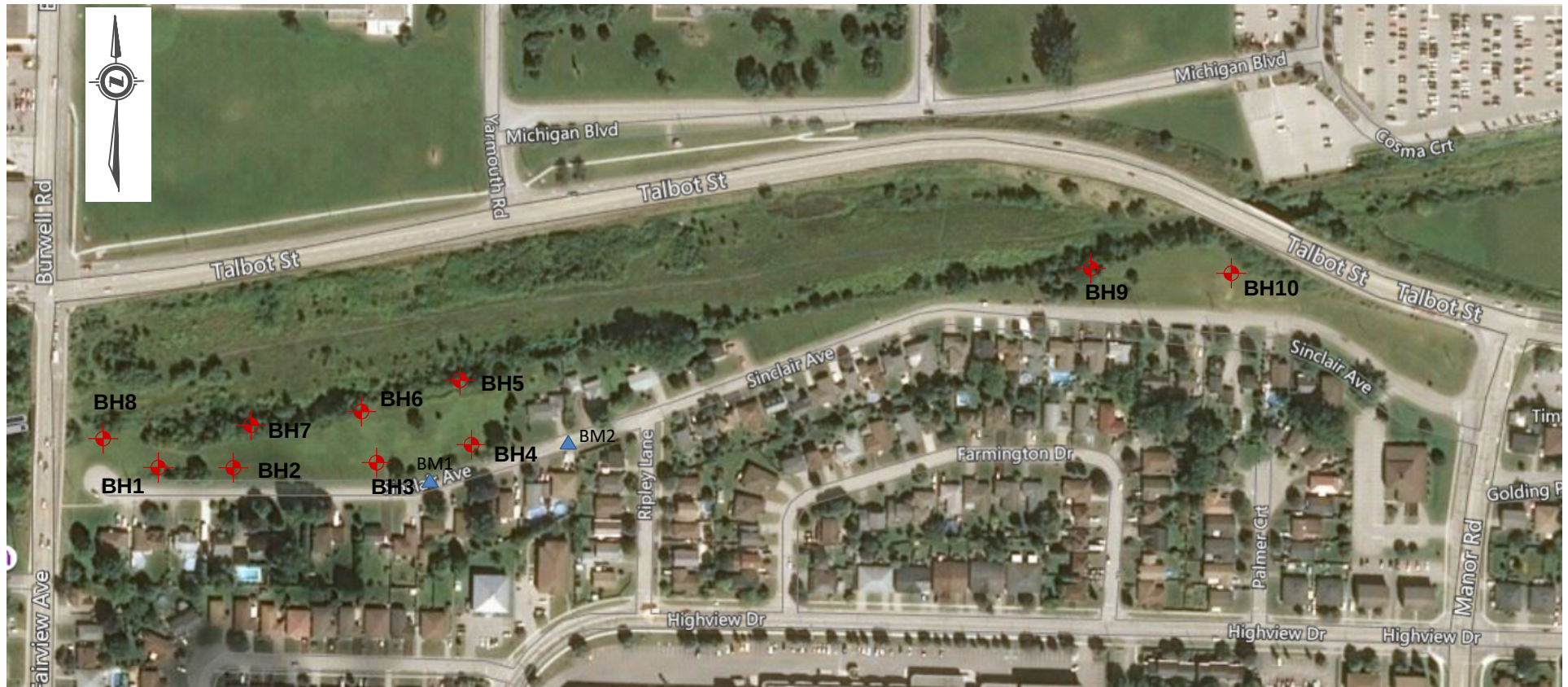
The comments given in this report are intended only for the guidance of design engineers. The number of test holes required to determine the localized underground conditions between test holes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

EXP should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not afforded the privilege of making this review, EXP will assume no responsibility for interpretation of the recommendations in this report

This report was prepared for the exclusive use of **TBR Land Development Inc.** and may not be reproduced in whole or in part, without the prior written consent of EXP, or used or relied upon in whole or in part by other parties for any purposes whatsoever. Any use which a third party makes of this report, or any part thereof, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. EXP accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We trust this report is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

Drawings



BH10 - Approximate Borehole Location



BM1 - Bench Mark set on existing SAMH 2 cover, Elevation 242.22 m, located opposite MN 22.



BM2 - Bench Mark set on existing SAMH 1 cover, Elevation 241.98 m, located opposite MN 32.

Notes:

1. The boundaries and soil types have been established only at test hole locations. Between test holes they are assumed and may be subject to considerable error.
2. Topsoil quantities should not be established from the information provided at the test hole locations.
3. Soil samples will be retained in storage for 3 months and destroyed unless Client advises that an extended period is required.
4. The site plan has been reproduced from drawings provided by the Client and should be read in conjunction with EXP Report LON-00018385-GE.

Geotechnical Investigation

Sinclair Avenue Development

Sinclair Avenue, St. Thomas, Ontario

TBR Land Development Inc.

Borehole Location Plan



EXP Services Inc.
15701 Robin's Hill Road
London, ON, N5V 0A5

PREPARED BY
V.C.

REVIEWED BY
A.S.

November 2020

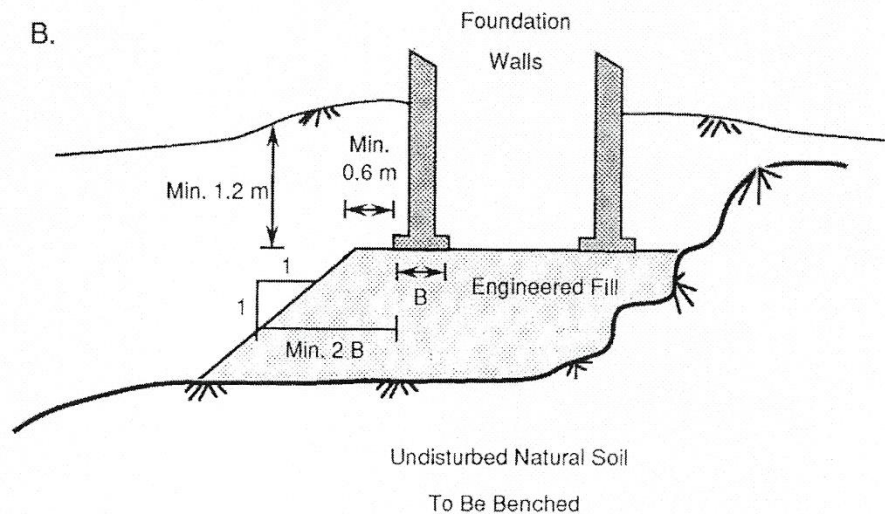
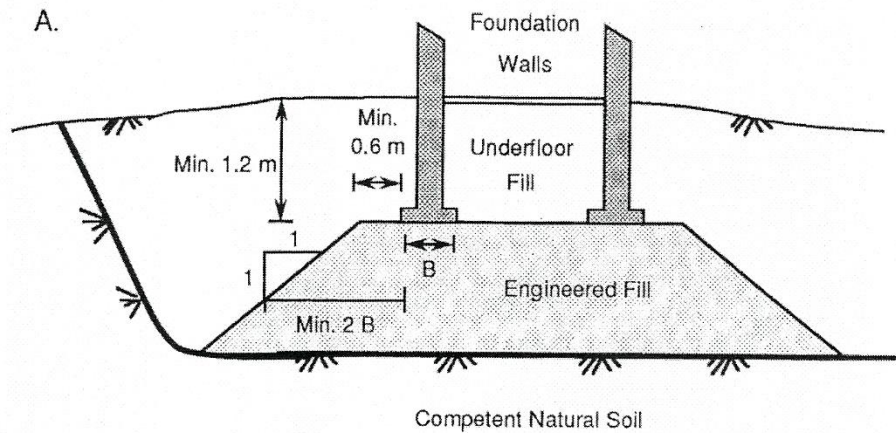
NTS

LON-00018385-GE

1

DRAWING 2 – GEOMETRIC REQUIREMENTS FOR FOUNDATIONS ON ENGINEERED FILL

Schematic (Not to Scale)



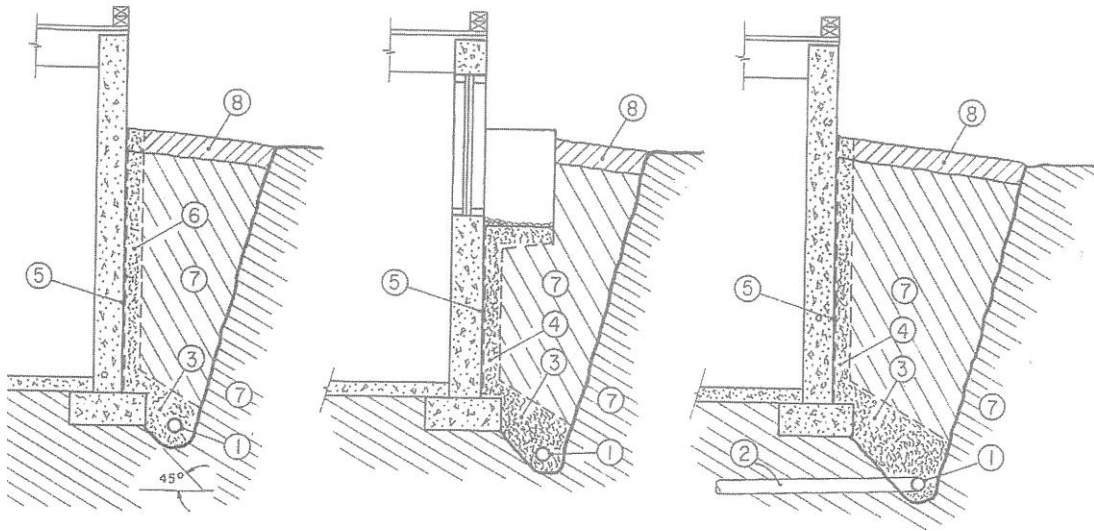
SECTION VIEW

Section A – Typical Section of Slab-on-Grade Building
 Section B – Typical Section of Building with Basement
 Refer to Detailed Notes on following page.

NOTES FOR ENGINEERED FILL PLACEMENT:

1. The area must be stripped of all topsoil contaminated fill material, and other unsuitable soils, and proof rolled. Soft spots must be dug out. The stripped natural subgrade must be examined and approved by an EXP Engineer prior to placement of engineered fill.
2. In areas where engineered fill is placed on a slope, the fill should be benched into the approved subgrade soils. EXP would be pleased to provide additional comments and recommendations in this regard, if required.
3. All excavations must be carried out in accordance with the Occupational Health and Safety Regulation of Ontario (Construction Projects - O.Reg. 213.91)
4. Material used for engineered fill must be free of topsoil, organics, frost and frozen material, and otherwise unsuitable or compressible soils, as determined by a Geotechnical Engineer. Any material proposed for use as engineered fill must be examined and approved by EXP, prior to use onsite. Clean compactable granular fill is preferred.
5. Approved engineered fill should be placed in maximum 300 mm thick lifts, and uniformly compacted to 100% Standard Proctor dry density throughout. For best compaction results, engineered fill should be within 3 percent of its optimum moisture content, as determined by the Standard Proctor density test. Imported fill should satisfy the MECP regulations and requirements.
6. Full time geotechnical monitoring, inspection and insitu density (compaction) testing by EXP is required during placement of the engineered fill.
7. Site grades should be maintained during area grading activities to promote drainage, and to minimize ponding of surface water on the engineered fill mat. Rutting by construction equipment should be kept to a minimum, where possible. Additional work to ensure suitability of engineered fill may be required if fill is placed in extreme (hot/cold) weather.
8. The fill must be placed such that the specified geometry is achieved. Refer to sketches (previous page) for minimum requirements. Proper environmental protection will be required, such as providing frost penetration during construction, and after the completion of the engineered fill mat.
9. An allowable bearing pressure of 145 kPa (3000 psf) may be used provided that all conditions outlined above, and in the Geotechnical Report are adhered to.
10. These guidelines are to be read in conjunction with the attached Geotechnical Report. (EXP Project No. LON-00018385GE)
11. For foundations set on engineered fill, footing enhancement and/or concrete reinforcing steel placement is recommended. The footing geometry and extent of concrete reinforcing steel will depend on site specific conditions. In general, consideration may be given to having a minimum strip footing width of 500 mm (20 inches), containing nominal steel reinforcement. Alternatively, concrete reinforcement may be recommended in the top and bottom of the foundation wall strip. The final footing geometry and extent of reinforcement is best determined in the field, by a Geotechnical Engineer.

DRAWING 3 – BACKFILL AND BASEMENT DRAINAGE DRAWING (NOT TO SCALE)

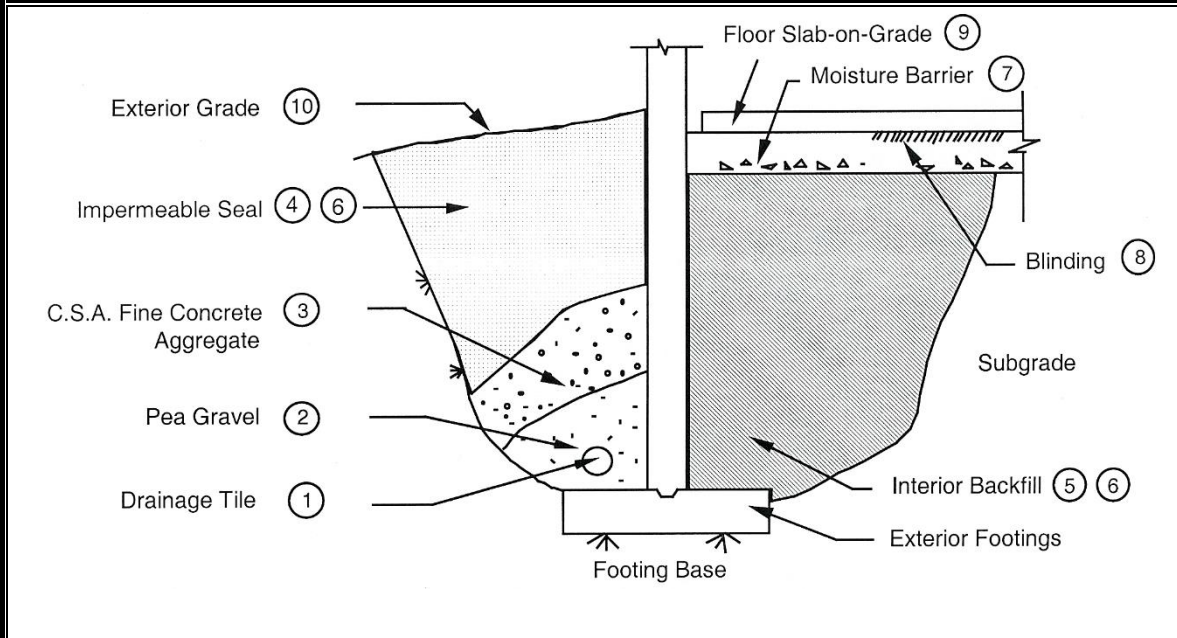


NOTES:

1. Perforated or slotted pipe placed about 300 mm below the upper level of the basement floor slab;
2. Unperforated drain pipe connected to a positive sump; connect to appropriate trap and backwater valve before connecting to sewer, where applicable. Provide appropriate access to the trap for inspection and cleaning;
3. Filter material that is compatible with the grain size characteristics of the foundation and backfill soils, as well as the perforations of the pipe;
4. Filter material continuously or intermittently placed next to the foundation wall to intercept water from window wells and low areas near building (see also 6);
5. Damp-proofing on wall;
6. Optional use of sheet drain or synthetic filter blanket next to foundation wall to replace the soil filter described in 4;
7. Foundation and backfill soils, which may contain fine grain and erodible materials; and,
8. "Topping-off" material, graded away from the building to redirect surface water from the foundations. Low permeability soils, or concrete or asphalt, are preferred.

Reference: Canadian Geotechnical Society 2006, *Canadian Foundation Engineering Manual*, 4th Edition, (Figure 12.1, p184).

DRAWING 4 – DRAINAGE AND BACKFILL RECOMMENDATIONS (NOT TO SCALE)

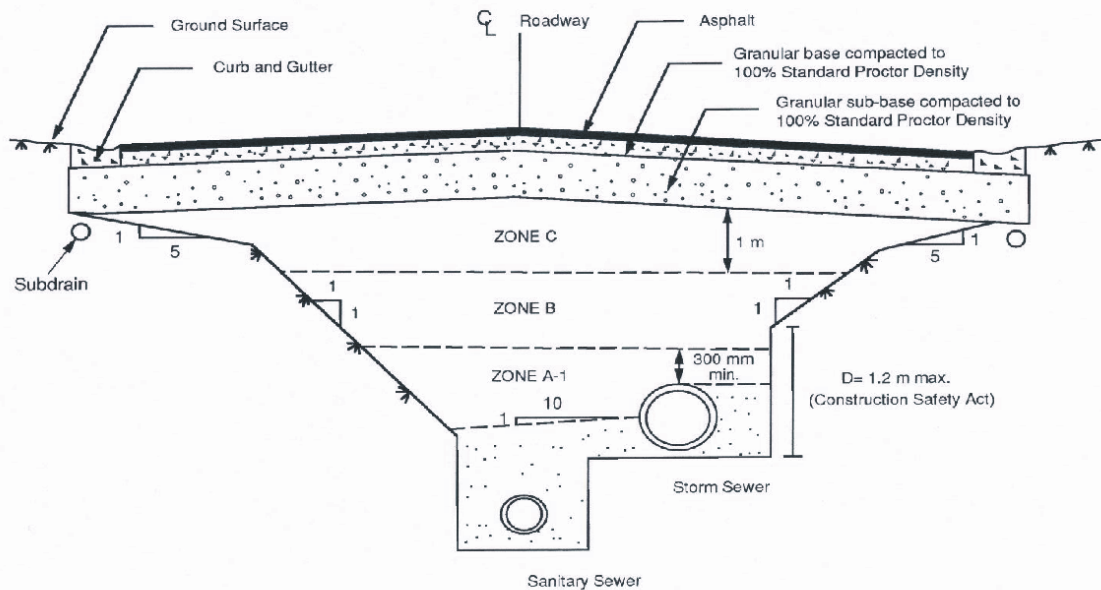


NOTES:

1. Drainage tile to consist of 100 mm (4 in) diameter weeping tile or equivalent perforated pipe leading to a positive sup or outlet. Invert to be minimum of 150 mm (6 in) below underside of interior floor slab.
2. Pea gravel 150 mm (6 in.) top and sides of drain. If drain is not on footing, place 100 mm (4 in.) of pea gravel below drain. 20 mm (3/4 in.) clear stone may be used provided if it is covered by an approved porous geotextile fabric membrane (Terrafix 270R or equivalent).
3. C.S.A. fine concrete aggregate to act as filter material. Minimum 300 mm (12 in.) top and side of drain. This may be replaced by an approved porous geotextile membrane (Terrafix 270R or equivalent).
4. Impermeable backfill seal of compacted clay, clayey silt or equivalent. If original soil is free-draining, seal may be omitted. Compact backfill to 95 percent Standard Proctor Maximum Dry Density.
5. The interior fill may be any clean, inorganic soil which may be compacted to at least 95 percent Standard Proctor density in this confined space.
6. Do not use heavy compaction equipment within 450 mm (18 in.) of the wall. Do not fill or compact within 1.8 m (6 ft) of wall unless fill is placed on both sides simultaneously.
7. Moisture barrier to be at least 200 mm (8 in.) of compacted 20 mm (3/4 in.) clear, crushed stone or equivalent free-draining material.
8. If the 20 mm (3/4 in.) clear stone requires surface binding, use 60 mm (1/4 in.) clear stone chips.
9. Slab on grade should not be structurally connected to wall or footing.
10. Exterior grade to slope away from building.

**This system is not normally required if the floor is at least 300 mm (1 ft.)
above exterior grade.**

DRAWING 5 – TYPICAL BACKFILL DETAIL STORM AND SANITARY SEWER (COMMON TRENCH)



SECTION VIEW

NOTES:

ZONE A

Granular bedding satisfying current OP Standards compacted to 95% Standard Proctor maximum dry density.

ZONE A-1

To be compacted to at least 95% Standard Proctor maximum dry density.

ZONE B

To be compacted to at least 95% Standard Proctor maximum dry density.

ZONE C

To be compacted to 98% Standard Proctor maximum dry density.

The excavations shown above are for Type 1 or 2 soils. Where excavations extend through Type 3 soils, the side walls should be sloped back at a maximum inclination of 1 horizontal to 1 vertical from the base (Reference O.Reg 213/91).

DRAWING 6 – TRENCH BACKFILL REQUIREMENTS

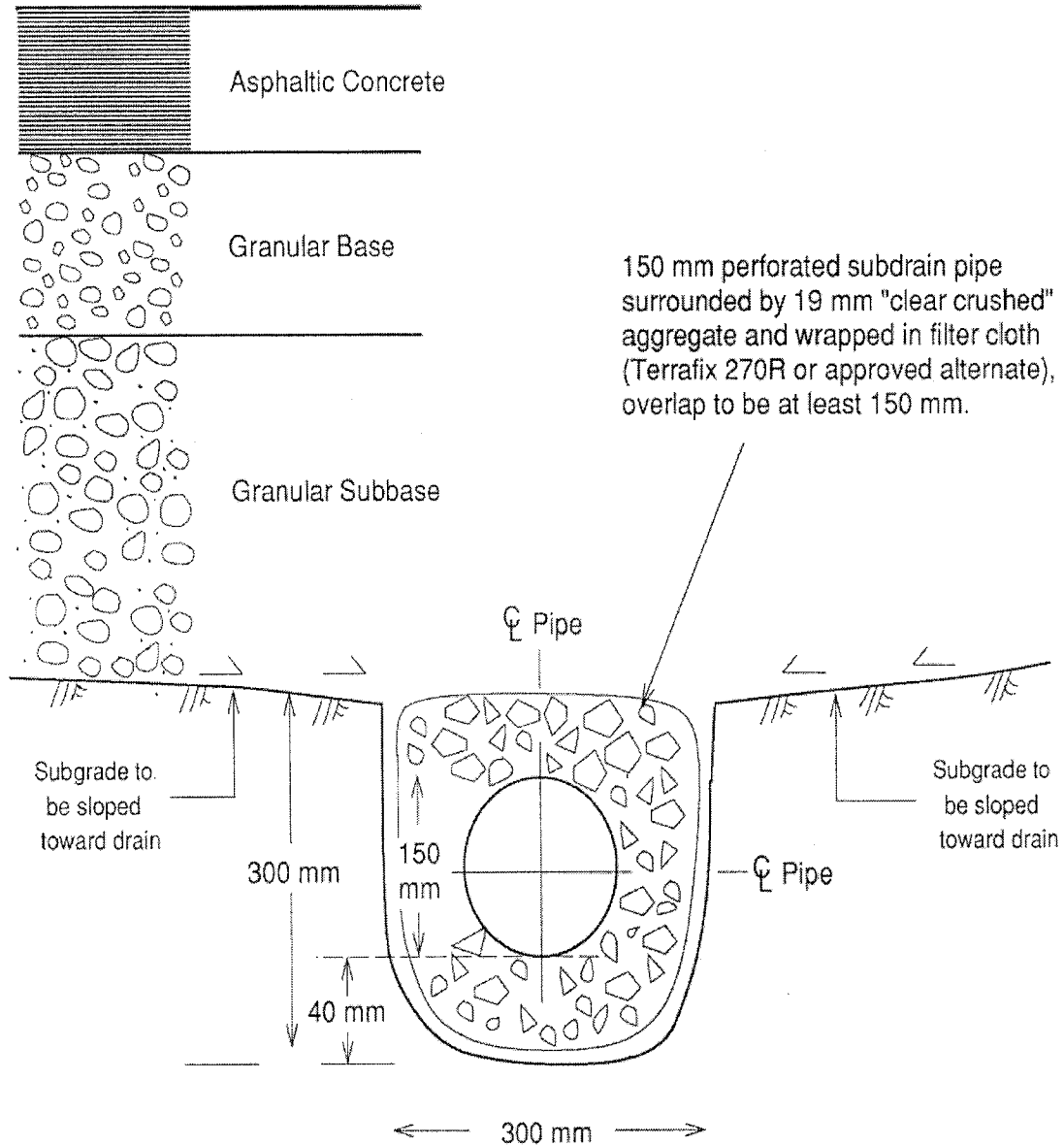
Requirements for backfill in service trenches, etc. should conform to current OPS requirements. A summary of the general recommendations for trench backfill is presented on Drawing 5.

The bedding materials for the services designated as Zone A on the attached drawings should consist of approved granular material satisfying the current OPS minimum standards and specifications. (Class B bedding should provide adequate support for the pipes). These materials should be uniformly compacted to 95 percent of standard Proctor dry density. Some problems may be encountered in maintaining alignment when bedding pipes in wet sandy soil. If Granular 'A' or other sandy material is used for bedding, they may become 'spongy' when saturated. If significant amounts of clear stone are used to stabilize the base, a geotextile should be incorporated to avoid problems with migration of fine grained materials and differential settlement under the pipes as the groundwater rises after backfilling. For minor local use of crushed stone without a geotextile filter, a graded HL3 stone is preferable.

The backfill in Zone B will consist of the native material. This material should be placed in loose lifts not exceeding 300 mm (12 inches) and be uniformly compacted to at least 95 percent of the standard Proctor maximum dry density. Material wetter than 5 percent above optimum must be allowed to dry sufficiently or should be discarded or used in landscaped areas.

The upper 1 meter of the general backfill (i.e. Zone C) should be placed in loose lifts not exceeding 300 mm (12 inches) and be uniformly compacted to at least 98 percent of the standard Proctor maximum dry density. To achieve satisfactory compaction, the fill material should be within 3 percent of standard Proctor optimum moisture content at placement.

DRAWING 7 – PAVEMENT SUBDRAIN DETAIL



NOTES:

1. All dimensions in millimetres.
2. All sub drains to be set on at least 1% grade draining to a positive outlet.
3. Subgrade soil conditions should be verified onsite, during subgrade preparation works, following site servicing installations.

Scale: NTS

Appendix A – Borehole Logs

NOTES ON SAMPLE DESCRIPTIONS

- All descriptions included in this report follow the 'modified' Massachusetts Institute of Technology (M.I.T.) soil classification system. The laboratory grain-size analysis also follows this classification system. Others may designate the Unified Classification System as their source; a comparison of the two is shown for your information. Please note that, with the exception of those samples where the grain size analysis has been carried out, all samples are classified visually and the accuracy of the visual examination is not sufficient to differentiate between the classification systems or exact grain sizing. The M.I.T. system has been modified and the EXP classification includes a designation for cobbles above the 75 mm size and boulders above the 200 mm size.

UNIFIED SOIL CLASSIFICATION	Fines (silt and clay)		Sand			Gravel		Cobbles
			Fine	Medium	Coarse	Fine	Coarse	
M.I.T. SOIL CLASSIFICATION	Clay	Silt	Sand			Gravel		
			Fine	Medium	Coarse			
Sieve Sizes								
			200	40	10	4	3/4	
Particle Size (mm)	0.002	0.06	0.075	0.2	0.6	2.0	5.0	20
								80

- Fill:** Where fill is designated on the borehole log, it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description therefore, may not be applicable as a general description of the site fill material. All fills should be expected to contain obstructions such as large concrete pieces or subsurface basements, floors, tanks, even though none of these obstructions may have been encountered in the borehole. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact and correct composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. The fill at this site has been monitored for the presence of methane gas and the results are recorded on the borehole logs. The monitoring process neither indicates the volume of gas that can be potentially generated or pinpoints the source of the gas. These readings are to advise of a potential or existing problem (if they exist) and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic waste that renders the material unacceptable for deposition in any but designated land fill sites; unless specifically stated, the fill on the site has not been tested for contaminants that may be considered hazardous. This testing and a potential hazard study can be carried out if you so request. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common, but not detectable using conventional geotechnical procedures.
- Glacial Till:** The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process, the till must be considered heterogeneous in composition and as such, may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (75 to 200 mm in diameter) or boulders (greater than 200 mm diameter) and therefore, contractors may encounter them during excavation, even if they are not indicated on the borehole logs. It should be appreciated that normal sampling equipment can not differentiate the size or type of obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited area; therefore, caution is essential when dealing with sensitive excavations or dewatering programs in till material.



BOREHOLE LOG

BH1

Sheet 1 of 1

CLIENT **TBR Land Development Inc.** PROJECT NO. **LON-00018385-GE**
PROJECT **Sinclair Avenue Development** DATUM **Local**
LOCATION **Sinclair Avenue, St. Thomas, ON** DATES: Boring **November 12, 2020** Water Level _____

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES				MOISTURE CONTENT (%)	SHEAR STRENGTH																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
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NOTES

- 1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00018385-GE.
- 2) bgs denotes below ground surface.
- 3) Borehole open and dry upon completion of drilling.
- 4) No significant methane gas concentration was detected upon completion of drilling.
- 5) Borehole surveyed to top of existing Sanitary Manhole 2 cover, located in front of Municipal Number 22 (Geodetic Elevation: 242.22 m).

SAMPLE LEGEND

- ☒ AS Auger Sample ☒ SS Split Spoon ■ ST Shelby Tube
☒ Rock Core (eg. BQ, NQ, etc.) ☒ VN Vane Sample

OTHER TESTS

- G Specific Gravity C Consolidation
H Hydrometer CD Consolidated Drained Triaxial
S Sieve Analysis CU Consolidated Undrained Triaxial
γ Unit Weight UU Unconsolidated Undrained Triaxial
P Field Permeability UC Unconfined Compression
K Lab Permeability DS Direct Shear

WATER LEVELS

- ▽ Apparent ▼ Measured ▲ Artesian (see Notes)



BOREHOLE LOG

BH2

Sheet 1 of 1

CLIENT **TBR Land Development Inc.** PROJECT NO. **LON-00018385-GE**
PROJECT **Sinclair Avenue Development** DATUM **Local**
LOCATION **Sinclair Avenue, St. Thomas, ON** DATES: Boring **November 12, 2020** Water Level _____

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES				MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)		● S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane	Atterberg Limits and Moisture W _p W W _L ● SPT N Value 10 20 × Dynamic Cone 30 40
0	240.7	TOPSOIL - 300 mm			AS	S1			20		
1	240.4	CLAYEY SILT TILL - brown, trace to some sand, stiff to very stiff, moist			SS	S2	70	8	17		
2					SS	S3	100	14	14		
3		- becoming grey near 2.3 m bgs			SS	S4	100	16	16		
4					SS	S5		14	17		
5	235.5				SS	S7	90	14	17		
6		End of Borehole at 5.2 m bgs.									
7											
8											
9											
10											

NOTES

- 1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00018385-GE.
- 2) bgs denotes below ground surface.
- 3) Borehole open and dry upon completion of drilling.
- 4) No significant methane gas concentration was detected upon completion of drilling.
- 5) Borehole surveyed to top of existing Sanitary Manhole 2 cover, located in front of Municipal Number 22 (Geodetic Elevation: 242.22 m).

SAMPLE LEGEND

- ☒ AS Auger Sample ☒ SS Split Spoon ■ ST Shelby Tube
☒ Rock Core (eg. BQ, NQ, etc.) ☒ VN Vane Sample

OTHER TESTS

- G Specific Gravity C Consolidation
H Hydrometer CD Consolidated Drained Triaxial
S Sieve Analysis CU Consolidated Undrained Triaxial
γ Unit Weight UU Unconsolidated Undrained Triaxial
P Field Permeability UC Unconfined Compression
K Lab Permeability DS Direct Shear

WATER LEVELS

- ▽ Apparent ▼ Measured ▲ Artesian (see Notes)



BOREHOLE LOG

BH3

Sheet 1 of 1

CLIENT **TBR Land Development Inc.** PROJECT NO. **LON-00018385-GE**
PROJECT **Sinclair Avenue Development** DATUM **Local**
LOCATION **Sinclair Avenue, St. Thomas, ON** DATES: Boring **November 12, 2020** Water Level _____

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES				MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)		◆ S Field Vane Test (#=Sensitivity)	▲ Penetrometer ■ Torvane
0	242.0	TOPSOIL - 250 mm									
1	241.8	CLAYEY SILT TILL - brown, trace to some sand, stiff to hard, moist Gr 2% Sa 12% Si 49% Cl 37%			SS	S1			17		
2					SS	S2	70	16	13		
3					SS	S3	90	20	14		
4					SS	S4	70	35	14		
5		- becoming grey near 2.7 m bgs - coarse gravel layer encountered near 3.1 m bgs			SS	S5	90	28	10		
6					AS	S6			15		
7					SS	S7	100	13	16		
8											
9											
10	235.3	End of Borehole at 6.7 m bgs.			SS	S8	100	17	16		

NOTES

- 1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00018385-GE.
- 2) bgs denotes below ground surface.
- 3) Borehole open and dry upon completion of drilling.
- 4) No significant methane gas concentration was detected upon completion of drilling.
- 5) Borehole surveyed to top of existing Sanitary Manhole 2 cover, located in front of Municipal Number 22 (Geodetic Elevation: 242.22 m).

SAMPLE LEGEND

- ☒ AS Auger Sample ☒ SS Split Spoon ■ ST Shelby Tube
☒ Rock Core (eg. BQ, NQ, etc.) ☒ VN Vane Sample

OTHER TESTS

- G Specific Gravity C Consolidation
H Hydrometer CD Consolidated Drained Triaxial
S Sieve Analysis CU Consolidated Undrained Triaxial
γ Unit Weight UU Unconsolidated Undrained Triaxial
P Field Permeability UC Unconfined Compression
K Lab Permeability DS Direct Shear

WATER LEVELS

- ▽ Apparent ▼ Measured ▲ Artesian (see Notes)



BOREHOLE LOG

BH4

Sheet 1 of 1

CLIENT TBR Land Development Inc. PROJECT NO. LON-00018385-GE
PROJECT Sinclair Avenue Development DATUM Local
LOCATION Sinclair Avenue, St. Thomas, ON DATES: Boring November 12, 2020 Water Level _____

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES				MOISTURE CONTENT (%)	SHEAR STRENGTH				
					TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)		◆ S Field Vane Test (#=Sensitivity)				
										▲ Penetrometer ■ Torvane				
										Atterberg Limits and Moisture				
										W _P W W _L				
● SPT N Value × Dynamic Cone														
10 20 30 40				100 200 kPa										
0	241.8													
	241.6	TOPSOIL - 200 mm			AS	S1			20					
		CLAYEY SILT TILL - brown, trace to some sand, stiff to very stiff, moist			SS	S2	70	19	15					
-1					SS	S3	90	18	17					
-2					SS	S4	100	23	15					
-3		- becoming grey near 3.1 m bgs			SS	S5	100	18	17					
-4					AS	S6			17					
-5					SS	S7	100	12	17					
-6														
-7	235.1				SS	S8	100	14	16					
-8		End of Borehole at 6.7 m bgs.												
-9														
-10														

NOTES

- 1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00018385-GE.
- 2) bgs denotes below ground surface.
- 3) Borehole open and dry upon completion of drilling.
- 4) No significant methane gas concentration was detected upon completion of drilling.
- 5) Borehole surveyed to top of existing Sanitary Manhole 2 cover, located in front of Municipal Number 22 (Geodetic Elevation: 242.22 m).

SAMPLE LEGEND

- ☒ AS Auger Sample ☒ SS Split Spoon ■ ST Shelby Tube
☒ Rock Core (eg. BQ, NQ, etc.) ☒ VN Vane Sample

OTHER TESTS

- G Specific Gravity C Consolidation
H Hydrometer CD Consolidated Drained Triaxial
S Sieve Analysis CU Consolidated Undrained Triaxial
γ Unit Weight UU Unconsolidated Undrained Triaxial
P Field Permeability UC Unconfined Compression
K Lab Permeability DS Direct Shear

WATER LEVELS

- ▽ Apparent ▼ Measured ▲ Artesian (see Notes)



BOREHOLE LOG

BH5/MW

Sheet 1 of 1

CLIENT **TBR Land Development Inc.** PROJECT NO. **LON-00018385-GE**
PROJECT **Sinclair Avenue Development** DATUM **Local**
LOCATION **Sinclair Avenue, St. Thomas, ON** DATES: Boring **November 11, 2020** Water Level **Dec 10/20**

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES				MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)		◆ S Field Vane Test (#=Sensitivity)	▲ Penetrometer ■ Torvane
										100 200 kPa	
										Atterberg Limits and Moisture	
										W _P W W _L	● SPT N Value × Dynamic Cone
										10 20 30 40	
0	241.0	TOPSOIL - 150 mm			SS	S1	85	7	15	●	○
	240.9	CLAYEY SILT TILL - brown, trace to some sand, trace gravel, firm to stiff, moist			SS	S2	90	10	18	●	○
-1					SS	S3	100	6	26	●	○
-2					SS	S4	100	13	16	●	○
-3					SS	S5	100	14	14	●	
-4		- becoming grey near 3.8 m bgs			SS	S6	100	14	15	●	○
-5					SS	S7	100	14	15	●	○
-6					SS	S8	100	14	16	●	○
-7											
-8					SS	S9	100	13	17	●	○
-9											
-10	231.3	End of Borehole at 9.8 m bgs.			SS	S10		11	16	●	○

NOTES

- 1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00018385-GE.
- 2) bgs denotes below ground surface.
- 3) Borehole open and dry upon completion of drilling.
- 4) No significant methane gas concentration was detected upon completion of drilling.
- 5) Borehole surveyed to top of existing Sanitary Manhole 2 cover, located in front of Municipal Number 22 (Geodetic Elevation: 242.22 m).
- 6) Water level readings: November 19, 2020: Dry
December 10, 2020: 9.2 m bgs, Elevation 231.8 m

SAMPLE LEGEND

AS Auger Sample SS Split Spoon ST Shelby Tube
Rock Core (eg. BQ, NQ, etc.) VN Vane Sample

OTHER TESTS

G Specific Gravity C Consolidation
H Hydrometer CD Consolidated Drained Triaxial
S Sieve Analysis CU Consolidated Undrained Triaxial
γ Unit Weight UU Unconsolidated Undrained Triaxial
P Field Permeability UC Unconfined Compression
K Lab Permeability DS Direct Shear

WATER LEVELS

▽ Apparent ▼ Measured ▲ Artesian (see Notes)



BOREHOLE LOG

BH6

Sheet 1 of 1

CLIENT TBR Land Development Inc. PROJECT NO. LON-00018385-GE
PROJECT Sinclair Avenue Development DATUM Local
LOCATION Sinclair Avenue, St. Thomas, ON DATES: Boring November 11, 2020 Water Level _____

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES				MOISTURE CONTENT (%)	SHEAR STRENGTH				
					TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)		◆ S Field Vane Test (#=Sensitivity)				
										▲ Penetrometer ■ Torvane				
										Atterberg Limits and Moisture				
										100	200 kPa			
											W _p W W _L			
											● SPT N Value	× Dynamic Cone		
											10	20	30	40
0	240.3													
	240.2	TOPSOIL - 150 mm			DP	S1			13					
-1		FILL - clayey silt, brown, trace to some sand, occasional brick fragments and cinders, compact, moist			DP	S2			14					
-2					DP	S3			15					
-3	237.3				DP	S4			11					
		CLAYEY SILT TILL - brown/grey, trace sand, stiff, moist			DP	S5			16					
-4					DP	S6			15					
-5					DP	S7								
-6					DP	S8								
-7					DP	S9								
	232.7				DP	S10								
-8		End of Borehole at 7.6 m bgs.												
-9														
-10														

NOTES

- 1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00018385-GE.
- 2) bgs denotes below ground surface.
- 3) Borehole open and dry upon completion of drilling.
- 4) No significant methane gas concentration was detected upon completion of drilling.
- 5) Borehole surveyed to top of existing Sanitary Manhole 2 cover, located in front of Municipal Number 22 (Geodetic Elevation: 242.22 m).

SAMPLE LEGEND

- ☒ AS Auger Sample ☒ SS Split Spoon ■ ST Shelby Tube
☒ Rock Core (eg. BQ, NQ, etc.) ☒ VN Vane Sample

OTHER TESTS

- G Specific Gravity C Consolidation
H Hydrometer CD Consolidated Drained Triaxial
S Sieve Analysis CU Consolidated Undrained Triaxial
γ Unit Weight UU Unconsolidated Undrained Triaxial
P Field Permeability UC Unconfined Compression
K Lab Permeability DS Direct Shear

WATER LEVELS

- ▽ Apparent ▼ Measured ▲ Artesian (see Notes)



BOREHOLE LOG

BH7

Sheet 1 of 1

CLIENT **TBR Land Development Inc.** PROJECT NO. **LON-00018385-GE**
PROJECT **Sinclair Avenue Development** DATUM **Local**
LOCATION **Sinclair Avenue, St. Thomas, ON** DATES: Boring **November 12, 2020** Water Level _____

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES				MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)		◆ S Field Vane Test (#=Sensitivity)	
										▲ Penetrometer	■ Torvane
									100	200 kPa	
										W _P W W _L	
										● SPT N Value	× Dynamic Cone
										10	20 30 40
0	240.2	TOPSOIL - 300 mm			AS	S1			20		
1 2 3 4 5 6	239.9	CLAYEY SILT TILL - brown, trace to some sand, stiff to hard, moist - becoming grey near 3.0 m bgs			SS	S2	70	15	16		
			SS	S3	100	36	14				
			SS	S4	90	24	16				
			SS	S5	100	18	16				
			AS	S6			16				
			SS	S7	100	14	15				
			SS	S8	100	16	16				
7	233.5	End of Borehole at 6.7 m bgs.									
8											
9											
10											

NOTES

- 1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00018385-GE.
- 2) bgs denotes below ground surface.
- 3) Borehole open and dry upon completion of drilling.
- 4) No significant methane gas concentration was detected upon completion of drilling.
- 5) Borehole surveyed to top of existing Sanitary Manhole 2 cover, located in front of Municipal Number 22 (Geodetic Elevation: 242.22 m).

SAMPLE LEGEND

- ☒ AS Auger Sample ☒ SS Split Spoon ■ ST Shelby Tube
☒ Rock Core (eg. BQ, NQ, etc.) ☒ VN Vane Sample

OTHER TESTS

- G Specific Gravity C Consolidation
H Hydrometer CD Consolidated Drained Triaxial
S Sieve Analysis CU Consolidated Undrained Triaxial
γ Unit Weight UU Unconsolidated Undrained Triaxial
P Field Permeability UC Unconfined Compression
K Lab Permeability DS Direct Shear

WATER LEVELS

- ▽ Apparent ▼ Measured ▲ Artesian (see Notes)



BOREHOLE LOG

BH8/MW

Sheet 1 of 1

CLIENT **TBR Land Development Inc.** PROJECT NO. **LON-00018385-GE**
PROJECT **Sinclair Avenue Development** DATUM **Local**
LOCATION **Sinclair Avenue, St. Thomas, ON** DATES: Boring **November 11, 2020** Water Level **Dec 10/20**

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES				MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)		● S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane	Atterberg Limits and Moisture W _p W _L W _U ● SPT N Value × Dynamic Cone
0	238.0										
	237.9	TOPSOIL - 150 mm									
	237.2	FILL - sand and gravel over sand, some clay, some silt, some cinders, moist									
1		CLAYEY SILT TILL - brown, trace to some sand, trace gravel, stiff, moist									
		- becoming grey near 1.5 m bgs									
2											
3											
4											
5											
6											
7											
8	230.4	End of Borehole at 7.6 m bgs.									
9											
10											

NOTES

- 1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00018385-GE.
- 2) bgs denotes below ground surface.
- 3) Borehole open and dry upon completion of drilling.
- 4) No significant methane gas concentration was detected upon completion of drilling.
- 5) Borehole surveyed to top of existing Sanitary Manhole 2 cover, located in front of Municipal Number 22 (Geodetic Elevation: 242.22 m).
- 6) Water level readings: November 19, 2020: 5.6 m bgs, Elevation 232.4 m
December 10, 2020: 4.7 m bgs, Elevation 233.3 m

SAMPLE LEGEND

- ☒ AS Auger Sample ☒ SS Split Spoon ■ ST Shelby Tube
☒ Rock Core (eg. BQ, NQ, etc.) ☒ VN Vane Sample

OTHER TESTS

- G Specific Gravity C Consolidation
H Hydrometer CD Consolidated Drained Triaxial
S Sieve Analysis CU Consolidated Undrained Triaxial
γ Unit Weight UU Unconsolidated Undrained Triaxial
P Field Permeability UC Unconfined Compression
K Lab Permeability DS Direct Shear

WATER LEVELS

- ▽ Apparent ▼ Measured ▲ Artesian (see Notes)



BOREHOLE LOG

BH9

Sheet 1 of 1

CLIENT **TBR Land Development Inc.** PROJECT NO. **LON-00018385-GE**
PROJECT **Sinclair Avenue Development** DATUM **Local**
LOCATION **Sinclair Avenue, St. Thomas, ON** DATES: Boring **November 12, 2020** Water Level _____

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES				MOISTURE CONTENT (%)	SHEAR STRENGTH		
					TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)		◆ S Field Vane Test (#=Sensitivity)		
										▲ Penetrometer	■ Torvane	
												Atterberg Limits and Moisture
									100	200 kPa		
										W _P W W _L		
										● SPT N Value	× Dynamic Cone	
										10	20 30 40	
0	241.2	TOPSOIL - 300 mm			AS	S1			19			
-1	240.9	CLAYEY SILT TILL - brown, trace to some sand, stiff to very stiff, moist - becoming grey near 2.3 m bgs			SS	S2	45	8	19			
-2					SS	S3	90	13	17			
-3					SS	S4	100	20	16			
-4					SS	S5	100	20	16			
-5					AS	S6			15			
-6					SS	S7		18	16			
-7	234.7					SS	S8		12	15		
-8			End of Borehole at 6.6 m bgs.									
-9												
-10												

NOTES

- 1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00018385-GE.
- 2) bgs denotes below ground surface.
- 3) Borehole open and dry upon completion of drilling.
- 4) No significant methane gas concentration was detected upon completion of drilling.
- 5) Borehole surveyed to top of existing Sanitary Manhole 1 cover, located in front of Municipal Number 32 (Geodetic Elevation: 241.98 m).

SAMPLE LEGEND

- ☒ AS Auger Sample ☒ SS Split Spoon ■ ST Shelby Tube
☒ Rock Core (eg. BQ, NQ, etc.) ☒ VN Vane Sample

OTHER TESTS

- G Specific Gravity C Consolidation
H Hydrometer CD Consolidated Drained Triaxial
S Sieve Analysis CU Consolidated Undrained Triaxial
γ Unit Weight UU Unconsolidated Undrained Triaxial
P Field Permeability UC Unconfined Compression
K Lab Permeability DS Direct Shear

WATER LEVELS

- ▽ Apparent ▼ Measured ▲ Artesian (see Notes)



BOREHOLE LOG

BH10/MW

Sheet 1 of 1

CLIENT **TBR Land Development Inc.** PROJECT NO. **LON-00018385-GE**
PROJECT **Sinclair Avenue Development** DATUM **Local**
LOCATION **Sinclair Avenue, St. Thomas, ON** DATES: Boring **November 11, 2020** Water Level **Dec 10/20**

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES				MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)		● S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane	Atterberg Limits and Moisture W _p W W _L ● SPT N Value × Dynamic Cone
0	241.4										
	241.3	TOPSOIL - 150 mm			SS	S1	80	6	27	●	○
	240.6	FILL - clayey silt, brown, trace sand, trace gravel, topsoil inclusions, firm, moist									
-1		CLAYEY SILT TILL - brown, trace to some sand, trace gravel, soft to stiff, moist			SS	S2	70	3	16	●	○
-2		Gr Sa Si Cl 2% 14% 50% 34%			SS	S3	100	12	15	●	○
		- becoming grey near 2.3 m bgs			SS	S4	100	14	15	●	○
-3					SS	S5	100	11	15	●	○
-4					SS	S6	100	12	15	●	○
-5					SS	S7	100	11	16	●	○
-6					SS	S8	100	8	16	●	○
-7	234.4	End of Borehole at 7.0 m bgs.									
-8											
-9											
-10											

NOTES

- 1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00018385-GE.
- 2) bgs denotes below ground surface.
- 3) Borehole open and dry upon completion of drilling.
- 4) No significant methane gas concentration was detected upon completion of drilling.
- 5) Borehole surveyed to top of existing Sanitary Manhole 1 cover, located in front of Municipal Number 32 (Geodetic Elevation: 241.98 m).
- 6) Water level reading: November 19, 2020: Dry
December 10, 2020: 4.6 m bgs, Elevation 236.8 m

SAMPLE LEGEND

AS Auger Sample SS Split Spoon ST Shelby Tube
Rock Core (eg. BQ, NQ, etc.) VN Vane Sample

OTHER TESTS

G Specific Gravity C Consolidation
H Hydrometer CD Consolidated Drained Triaxial
S Sieve Analysis CU Consolidated Undrained Triaxial
γ Unit Weight UU Unconsolidated Undrained Triaxial
P Field Permeability UC Unconfined Compression
K Lab Permeability DS Direct Shear

WATER LEVELS

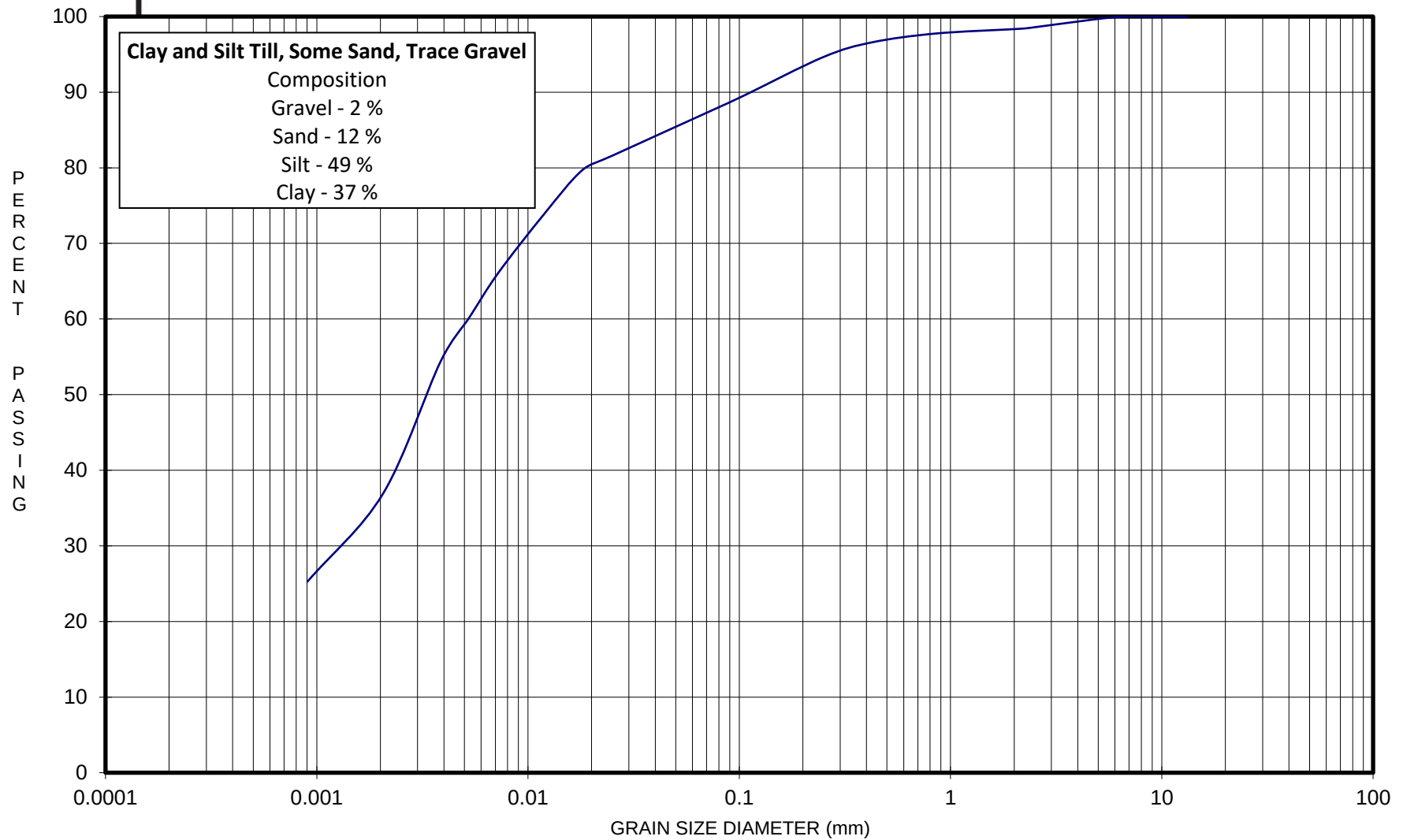
Apparent Measured Artesian (see Notes)



Appendix B – Geotechnical Laboratory Testing Results



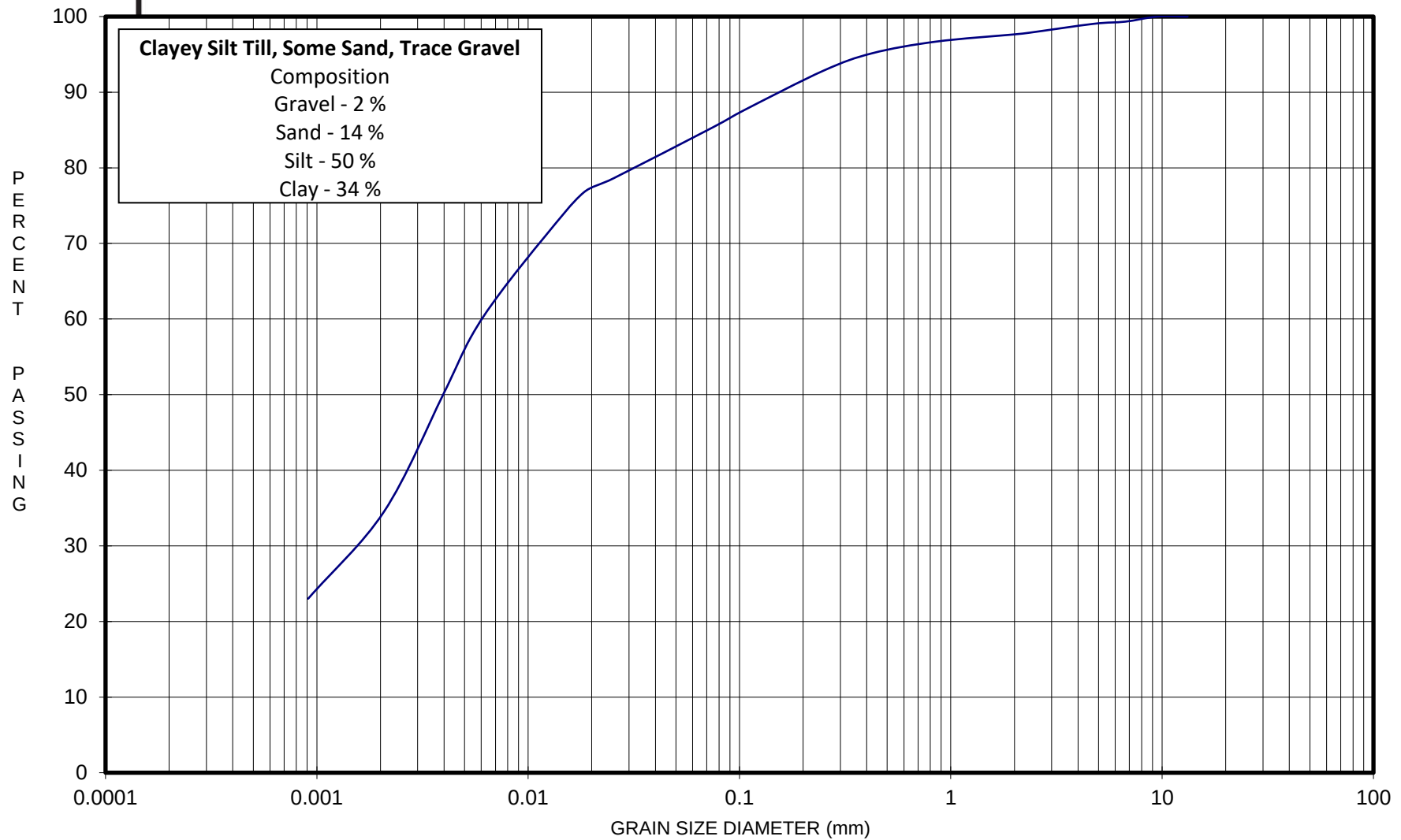
MECHANICAL GRAIN SIZE ANALYSIS



CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	
	SILT			SAND			GRAVEL			
MODIFIED M.I.T. CLASSIFICATION										
Sample Description: BH 3 S2, near 0.76 m bgs						Project: LON00018385			Figure 1	



MECHANICAL GRAIN SIZE ANALYSIS



CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	
	SILT			SAND			GRAVEL			
MODIFIED M.I.T. CLASSIFICATION										
Sample Description: BH 10 S3, near 1.5 m bgs						Project: LON00018385			Figure 2	

Appendix C – Inspection and Testing

INSPECTION & TESTING SCHEDULE

The following program outlines suggested minimum testing requirements during backfilling of service trenches and construction of pavements. In adverse weather conditions (wet/freezing), increased testing will be required. The testing frequencies are general requirements and may be adjusted at the discretion of the engineer based on test results and prevailing construction conditions.

I TRENCH BACKFILL

- | | |
|------------------------|--|
| ZONE A | <ul style="list-style-type: none"> - one in situ density test per 100 cubic meters or 50 linear metres of trench whichever is less - one laboratory grain size and Proctor density test per 50 density tests or 4000 cubic metres or on change of material (source, visual) |
| ZONE A1 | <ul style="list-style-type: none"> - one in situ density test per 75 cubic metres of material or 25 linear metres of each lift of fill - one laboratory grain size and Proctor density test per each 50 density tests or 4000 cubic metres of material placed or as directed by the engineer |
| ZONES B & C | <ul style="list-style-type: none"> - one in situ density test per 150 cubic metres of material or 50 linear metres or each lift whichever is less - one laboratory grain size and Proctor density test per 50 density tests or 4000 cubic metres of material placed or as directed by the engineer |

II PAVEMENT MATERIALS

- | | |
|---------------------------|--|
| GRANULAR SUBBASE | <ul style="list-style-type: none"> - one in situ density test per 50 linear metres of road - one laboratory grain size and standard Proctor test per 50 density tests or 4000 cubic metres or each change of material (visual, source), as determined by the engineer |
| GRANULAR BASE | <ul style="list-style-type: none"> - one in situ density test per 50 linear metres of road - one laboratory grain size and Proctor per 50 density tests or 8000 cubic metres or change in material (visual, source), as determined by the engineer - Benkelman beam testing at 10 metre intervals per lane, after final grading and compaction. Asphaltic concrete should not be placed until rebound criteria have been satisfied. |
| ASPHALTIC CONCRETE | <ul style="list-style-type: none"> - one in situ density test per 25 linear metres of roadway - one complete Marshall Compliance test including stability flow, etc. for each mix type to check mix acceptability. One extraction and gradation test per each day of paving to be compared to job mix formula |

NOTES: Where testing indicates inadequate compaction, additional fill should not be placed until the area is recompacted and retested at the discretion of the engineer.

Appendix D - Limitations and Use of Report

Limitations and Use of Report

BASIS OF REPORT

This report ("Report") is based on site conditions known or inferred by the geotechnical investigation undertaken as of the date of the Report. Should changes occur which potentially impact the geotechnical condition of the site, or if construction is implemented more than one year following the date of the Report, the recommendations of EXP may require re-evaluation.

The Report is provided solely for the guidance of design engineers and on the assumption that the design will be in accordance with applicable codes and standards. Any changes in the design features which potentially impact the geotechnical analyses or issues concerning the geotechnical aspects of applicable codes and standards will necessitate a review of the design by EXP. Additional field work and reporting may also be required.

Where applicable, recommended field services are the minimum necessary to ascertain that construction is being carried out in general conformity with building code guidelines, generally accepted practices and EXP's recommendations. Any reduction in the level of services recommended will result in EXP providing qualified opinions regarding the adequacy of the work. EXP can assist design professionals or contractors retained by the Client to review applicable plans, drawings, and specifications as they relate to the Report or to conduct field reviews during construction.

Contractors contemplating work on the site are responsible for conducting an independent investigation and interpretation of the borehole results contained in the Report. The number of boreholes necessary to determine the localized underground conditions as they impact construction costs, techniques, sequencing, equipment and scheduling may be greater than those carried out for the purpose of the Report.

Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates are based on investigations performed in accordance with the standard of care set out below and require the exercise of judgement. As a result, even comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations or building envelope descriptions involve an inherent risk that some conditions will not be detected. All documents or records summarizing investigations are based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated. Some conditions are subject to change over time. The Report presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, these should be disclosed to EXP to allow for additional or special investigations to be undertaken not otherwise within the scope of investigation conducted for the purpose of the Report.

RELIANCE ON INFORMATION PROVIDED

The evaluation and conclusions contained in the Report are based on conditions in evidence at the time of site inspections and information provided to EXP by the Client and others. The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose as communicated by the Client. EXP has relied in good faith upon such representations, information and instructions and accepts no responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of any misstatements, omissions, misrepresentation or fraudulent acts of persons providing information. Unless specifically stated otherwise, the applicability and reliability of the findings, recommendations, suggestions or opinions expressed in the Report are

only valid to the extent that there has been no material alteration to or variation from any of the information provided to EXP.

STANDARD OF CARE

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Appendix E – Legal Notification

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