

Report on
Geotechnical Investigation
Clockwork Phase 2 Development
1429 Dundas Street East
Oakville, Ontario

Prepared For:
Mattamy Development Corp.

Project No. 19-294-101
August 1, 2023



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1. INTRODUCTION

DS Consultants Ltd. (DS) was retained by Mattamy Development Corporation to undertake a geotechnical investigation for the Clockwork - Phase 2 development (Building 3) of the property located at 1429 Dundas Street East, Oakville, Ontario.

It is understood that the proposed development will consist of a mid-rise building with 2 levels of underground parking (P2). Based on the available design information, finished floor level of the P2 slab will at Elevation 154.8m.

The purpose of this geotechnical investigation was to determine the subsurface conditions at borehole locations and from the findings at the boreholes make geotechnical recommendations for the following:

- 1) Foundations
- 2) Floor slabs and permanent drainage
- 3) Excavations and groundwater control
- 4) Temporary shoring
- 5) Earth pressures
- 6) Earthquake considerations

This report deals with geotechnical issues only. Hydrogeological report by DS is presented under a separate cover.

This report is provided on the basis of 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 the geotechnical aspects of the codes and standards, this office should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations can cater to the changed design.

The site investigation and recommendations follow generally accepted practice for geotechnical consultants in Ontario. The format and contents are guided by client specific needs and economics. Laboratory testing for most part follows ASTM or CSA Standards or modifications of these standards that have become standard practice.

This report has been prepared for Mattamy Development Corporation, its architect and designers. Use of this report by third party without DS consent is prohibited.

2. FIELD AND LABORATORY WORK

in June 2022, six (6) boreholes (BH22-9 to BH22-14, see **Drawing 1** for borehole locations) were drilled in the area of proposed Clockwork Phase 2 development, to depths ranging from 10.8 to 18.7m below the existing ground surface. All boreholes were drilled to shale bedrock.

Three boreholes (BH19-200 to BH19-202) were drilled to a depth of 11.2m below the existing grade, within or close to the Phase 2 development in 2019.

Boreholes were drilled using solid/hollow stem continuous flight augers equipment by a drilling sub-contractor under the direction and supervision of DS personnel. Samples were retrieved at regular intervals with a 50 mm O.D. split-barrel sampler driven with a hammer weighing 624 N and dropping 760 mm in accordance with the Standard Penetration Test (SPT) method. The samples were logged in the field and returned to the DS laboratory for detailed examination by the project engineer and for laboratory testing.

Shale bedrock was cored in one (1) borehole (BH22-14) to a depth of 18.7m. The bedrock was cored with HQ-2 double tube wireline equipment providing 63mm dia. rock core samples. The coring was carried out under the full-time supervision of a representative from DS who identified and described the rock samples, noting and recording the percentages of total and solid rock core recovery, RQD values, fracture index and the percentage and thicknesses of hard layers.

As well as visual examination in the laboratory, all soil samples from the boreholes were tested for moisture contents. Grain size analyses of selected soil samples were conducted, and the results are presented on the individual logs and on **Drawing 9**. Atterberg Limits tests of two (2) samples were conducted and the results are shown on the borehole logs.

Water level observations were made during and upon completion of drilling. Monitoring wells of 50mm diameter were installed in two (2) boreholes (BH22-13 and BH19-200) for the long-term groundwater levels measurements.

The surface elevations at the borehole locations were surveyed by DS, using differential GPS system. It should be noted that the elevations at the as-drilled borehole/well locations were not provided by a professional surveyor and should be considered approximate. Contractors performing any work referenced to the borehole elevations should confirm the borehole elevations for their work.

3. SITE AND SUBSURFACE CONDITIONS

The borehole location plan is shown on **Drawing 1**. General notes on sample description are provided on **Drawing 1A**. The subsurface conditions in boreholes BH22-9 to BH22-14 are presented in the individual borehole logs on **Drawings 2 to 7**. A generalized sub-surface profile is

presented on **Drawing 8**. The subsurface conditions in the previously drilled boreholes in DUC Phase 2 area (BH19-200 to BH19-202) are presented in the individual borehole logs presented in **Appendix B**.

3.1 Soil and Bedrock Conditions

Topsoil & Fill Materials: A surficial topsoil layer of about 100mm thickness was encountered in BH22-9. Fill materials were found in all boreholes, except BH22-12 and BH22-13, extending to depths ranging from 0.8 to 1.5m. The fill material generally consisted of clayey silt to silty clay with inclusions of trace to some topsoil. The SPT 'N' values measured in the fill generally ranged from 7 to 17 blows per 300 mm penetration, indicating its firm to very stiff consistency.

Silty Clay Till: The native soils in the boreholes consisted of silty clay till deposits extending to depths of 9.1 to 12.2m, overlying sandy silt to silty sand till, till/shale complex or shale bedrock. The SPT 'N' values measured in the silty clay till ranged from 10 to more than 50 blows per 300 mm penetration, indicating its stiff to hard consistency.

Grain size analyses of two (2) silty clay till samples (BH22-9/SS6, and BH22-13/SS10) were conducted and the results are presented on **Drawing 9**, with the following fractions:

Clay: 19 to 22%
Silt: 47 to 49%
Sand: 25 to 27%
Gravel: 5 to 6%

Atterberg Limits tests of two (2) silty clay till samples (BH22-9/SS6, and BH22-13/SS10) were conducted and the results are shown on the borehole logs and summarized below:

Liquid Limit: 22 to 24%
Plastic Limit: 14%
Plasticity Index: 8 to 10

Sandy Silt to Silty Sand Till: Sandy silt to silty sand till deposits were encountered in BH22-11, BH22-12 and BH22-14 below the silty clay till deposits, and overlying shale bedrock. The SPT 'N' values measured in the sandy silt to silty sand till ranged from 46 to more than 50 blows per 300 mm penetration, indicating its dense to very dense state.

Grain size analysis of one (1) silty sand till sample (BH22-14/SS11) was conducted and the results are presented on **Drawing 9**, with the following fractions:

Clay: 5%
Silt: 42%
Sand: 44%
Gravel: 9%

Till/Shale Complex: Below the silty clay till deposits and above the shale bedrock, a transition unit of till/shale complex (sandy silt to silty sand till mixed with highly weathered shale fragments) was encountered in majority of the boreholes. The till/shale complex was generally present in a very dense state, with measured SPT ‘N’ values of over 50 blows per 300mm of spoon penetration.

Shale Bedrock: The shale bedrock of Queenston Formation was encountered in BH22-9 to BH22-14, and BH19-200 at depths ranging from 10.5 to 15.4m below the existing grade, corresponding to Elevations 145.4 to 153.6m, as presented in **Table 1** below.

Table 1: Depth and Elevation of Shale Bedrock Surface

Borehole No.	Depth of Shale Bedrock Surface below Existing Ground (m)	Approximate Elevation of Shale Bedrock Surface (m)	Notes
BH22-9	10.5	152.5	Augered
BH22-10	12.0	150.3	Augered
BH22-11	12.4	149.3	Augered
BH22-12	13.5	148.7	Augered
BH22-13	13.5	148.0	Augered
BH22-14	15.4	145.4	Bedrock cored
BH19-200	11.0	153.6	Augered

Because of the method of drilling and sampling, the surface elevations of the bedrock can be different than indicated on the borehole logs. Commonly the till overlying the shale contains slabs of limestone which would give a false indication of the bedrock level. Similarly, the depth of weathering cannot be determined accurately due to the presence of limestone layers. **Appendix A** presents more details and general comments about the shale bedrock in Greater Toronto Area.

Shale bedrock was cored in one (1) borehole (BH22-14) to a depth of 18.7m. The bedrock was cored with HQ-2 double tube wireline equipment providing 63mm dia. rock core samples.

Total Core Recovery (TCR): The total core recovery indicates the total length of rock core recovered, expressed as a percentage of the actual length of the core run. The total core recovery was generally good, with values ranging from 95% to 100%.

Solid Core Recovery (SCR): The solid core recovery is the total length of solid, full diameter rock core that was recovered, expressed as a percentage of the length of the core run. Solid core recovery ranged from 80% to 100%. The SCR index was generally influenced by the orientations of the fractures. SCR was low when fractures oblique to the borehole axis were intercepted.

Rock Quality Designation (RQD): The rock quality designation index is obtained by measuring the total length of recovered rock core pieces which are longer than 100mm and expressing their sum total length as a percentage of the length of the core run. RQD is a function of the frequency of joints, bedding plane partings and fractures in the rock cores. While the use of double tube core

barrels provided reasonably good protection of the core during drilling and core retrieval, the fissile nature of the shale greatly influences the RQD values of the rock cores. Consequently, it is believed that the RQD values recorded underestimate the rock quality classification of the laminated fissile shale. On the basis of the recorded RQD values which range from 70% to 100%, the rock quality is estimated to be “fair to excellent”.

Hard Layers: Based on the visual examination of the rock cores, an attempt was made to identify and record the thickness and percentages of the relatively harder siltstone and limestone layers. The percentage of the “hard layers” per core run was up to 23%. The thickness of these layers varied but was generally less than 150mm. The thicker layers have been observed to be as much as 750 to 900 mm at other sites. The layers are actually lenses and they can vary significantly in thickness over short distance. Encountering such thick layers should be anticipated. It is also common to encounter closely spaced groupings of thin strong limestone/siltstone layers which individually may only be 25 to 50mm thick but collectively can be 1m in thickness.

Methane Gas: Though not encountered during borehole drilling, methane gas is expected in the bedrock. Appropriate care and monitoring is essential in all confined bedrock excavations, particularly for caissons.

3.2 Groundwater Conditions

Groundwater table measured in the monitoring wells on June 14, 2022, was recorded at depths ranging from 5.5 to 6.2m below the existing grade, corresponding to Elevations 155.3 to 159.1m, as summarized in **Table 2**.

Table 2: Summary of Groundwater Level Measurements in Monitoring Wells

Borehole No.	Ground Surface Elev. (m)	Date of Observation	Depth of Groundwater (m)	Elevation of Groundwater (m)
BH22-13	161.5	June 14, 2022	6.2	155.3
BH19-200*	164.6	Nov.15/19	2.9	161.7
		June 14, 2022	5.5	159.1

*Previously installed monitoring well in 2019

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to major weather events.

4. FOUNDATIONS

It is understood that the proposed development will consist of a mid-rise building with 2 levels of underground parking (P2). Based on the available design information, finished floor level of the P2 slab will at Elevation 154.8m. Footings will be founded 1 to 2m below the P2 slab.

Based on the borehole information, the proposed buildings with 2 levels of basement can be supported by footings/raft founded on undisturbed native soils, designed for bearing capacity values of 350 to 500 kPa at SLS (Serviceability Limit States), and for a factored geotechnical resistance of 525 to 750 kPa at ULS (Ultimate Limit States). The bearing values and corresponding founding levels of footings are provided in **Table 3** below.

Table 3: Bearing Values and Founding Levels of Footings on Undisturbed Native Soil

BH No.	Founding Soil	Bearing Capacity at SLS (kPa)	Bearing Capacity at ULS (kPa)	Founding Depth at or below Existing Ground (m)	Founding Elevation at or below (m)
BH22-9	Till/Shale Complex	500	750	9.1	153.6
BH22-10	Silty Clay Till	500	750	8.3	154.0
BH22-11	Silty clay till/Sandy silt till	500	750	8.0	153.7
BH22-12	Silty clay till/silty sand till	350	525	7.7	154.5
		500	750	9.0	153.2
BH22-13	Silty Clay Till	350	525	7.9	153.6
		500	750	10.0	151.5
BH22-14	Silty Clay Till	350	525	8.0	153.5
		500	750	10.5	150.4
BH19-201	Clayey silt till	500	750	9.3	154.2
BH19-202	Silty clay till	500	750	9.1	154.0

Foundations designed to the specified bearing capacity values at the serviceability limit states (SLS) are expected to settle less than 25 mm total and 19 mm differential.

All footing bases must be inspected by this office prior to pouring concrete. The excavated footing bases must be covered with 50 mm thick mud slab immediately after inspection and cleaning, in order to avoid disturbance of the founding soil due to weathering and construction activity.

Where it is necessary to place footings at different levels, the upper footing must be founded below an imaginary 10 horizontal to 7 vertical line drawn up from the base of the lower footing. The lower footing must be installed first to help minimize the risk of undermining the upper footing.

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

5. FROST PROTECTION

All footings exposed to seasonal freezing conditions must have at least 1.2 metres of soil cover for frost protection.

There is no official rule governing the required founding depth for footings below unheated basement floors. Certainly, it will not be greater than the 1.2 m required in Southern Ontario for exterior footings. Un-monitored experience indicates that a shallower depth ranging from 0.82 to 0.9 m for interior column footings and 0.4 m for wall footings has been successful where 2 or more basement levels apply. The 0.82 m depth is believed to be close to the minimum structural requirement for interior column footings. Adjacent to air shafts and entrance and exit doors, a footing depth of 1.2 m below floor level is required or, alternatively, insulation protection must be provided.

6. FLOOR SLAB AND PERMANENT DRAINAGE

The basement floor slab can be supported on the native grade provided all fill and surficially loose/disturbed soils are removed and the base thoroughly proof rolled. Any backfill required to raise the grade can consist of inorganic soil, placed in shallow lifts and compacted to 98 percent of Standard Proctor Maximum Dry Density (SPMDD).

A moisture barrier consisting of at least 200mm of 19mm clear crushed stone should be installed under the floor slab.

A perimeter drainage system will be required around the exterior basement walls. Underfloor drainages are also required. The perimeter and underfloor drainages systems using soldier piles and timber lagging and caisson wall are shown on **Drawings 10 and 11**.

7. EARTH PRESSURES

The lateral earth pressures acting on basement walls may be calculated from the following expression:

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

where p	=	Lateral earth pressure in kPa acting at depth h
K	=	Earth pressure coefficient equal to 0.40 for vertical walls and horizontal backfill used for permanent construction. Water pressure must be considered, if continuous wall drains are not used.
γ	=	Unit weight of backfill, a value of 21 kN/m ³ may be assumed
h	=	Depth to point of interest in metres
q	=	Equivalent value of surcharge on the ground surface in kPa

The above expression assumes that the perimeter drainage system prevents the build-up of any hydrostatic pressure behind the wall.

8. EXCAVATION AND GROUNDWATER CONTROL

Excavations in the overburden can be carried out with heavy hydraulic backhoe. Groundwater table measured in the monitoring wells on June 14, 2022, was recorded at depths ranging from 5.5 to 6.2m below the existing grade, corresponding to Elevations 155.3 to 159.1m. Any excavation in sandy silt to silty sand till below the groundwater table will require positive dewatering, otherwise it will result in flowing sides and disturbed base. Groundwater seepage from the upper silty clay till deposits is expected to be slow and controllable by conventional methods pumping from collection sumps and ditches.

DS Consultants completed a hydrogeology study for the subject site. Detailed comments regarding the type and extent of groundwater control required during construction are provided in our hydrogeology report.

Excavation of the shale can be carried out using heaviest available single tooth ripper equipment. The limestone beds are frequent and may overlie the shale bedrock surface at some locations. It may be necessary at some locations to utilize jackhammer type equipment to “open” the limestone layers for the ripper.

It should be noted that the glacial till soils may contain boulders. Large obstructions in the fill material are anticipated. Provisions must be made in the excavation contract for the removal of boulders in the till and large obstructions in the fill material.

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, the fill material and stiff clayey soils can be classified as Type 3 Soil above the groundwater table and as Type 4 Soil below the groundwater

table. The very stiff to hard clayey soils can be classified as Type 2 Soil above the groundwater table and as Type 3 below the groundwater table. The sandy silt to silty sand till can be classified as Type 3 Soil above the groundwater table and as Type 4 Soil below the groundwater table.

The native soils free from topsoil and organics can be used as general construction backfill, provided its moisture content is within 2 percent of the optimum moisture content. Loose lifts of soil, which are to be compacted, should not exceed 200 mm. Depending on the time of construction and weather, some excavated material may be too wet to compact and will require aeration prior to its use.

Imported granular fill, which can be compacted with hand held equipment, should be used in confined areas. The excavated soils are not considered to be free draining. Where free draining backfill is required, imported granular fill such as OPSS Granular B should be used.

It should be noted that the excavated soils are subject to moisture content increase during wet weather which would make these materials too wet for adequate compaction. Stockpiles should be compacted at the surface or be covered with tarpaulins to minimize moisture uptake.

9. EARTHQUAKE CONSIDERATIONS

Based on the borehole information and according to Table 4.1.8.4.A of OBC 2012, the subject site for the proposed building with two (2) levels of basement can be classified as “Class C” for seismic site response.

10. TEMPORARY SHORING

It is understood that the proposed excavations may be supported by a temporary shoring system consisting of timber lagging and soldier piles. A tightly braced caisson wall may be required to support adjacent structures. The requirement for caisson wall to support adjacent structure is given on **Drawing 12**.

The shoring system must be designed in accordance with the 4th Edition of the Canadian Foundation Engineering Manual. The surcharge loading from adjacent structures must be considered. The soil parameters estimated to be applicable for this design are as follows:

- 1) Earth Pressure Coefficient for shoring:
 - (a) where movement must be minimal $K=0.45$
 - (b) where minor movement ($.002H$) can be tolerated $K=0.30$
 - (c) passive earth pressure for soldier piles (unfactored) $K_p=4.0$ for hard/dense to very dense soils

2) For stability check

$$\phi = 31^\circ$$

$$C = 0$$

$$\gamma = 21 \text{ kN/m}^3$$

surcharge is to be determined by shoring contractor.

3) For soil and rock anchors

An allowable bond value of 75 kPa can be used for post grouted anchors in very stiff to hard and dense to very dense soils. A bond stress of 600 kPa (90 psi) can be used in sound bedrock for the design of anchors.

The values depend on anchor installation methods and grouting procedures. Gravity poured concrete can result in low bond values while pressure grouted anchors will give higher values and produce a more satisfactory anchor.

Casing will be required during the construction of the tiebacks to prevent caving of soils. The soldier piles should be installed in pre-augered holes taken below the deepest excavation. The holes should be filled with concrete below the excavation level and half bag mix above the base of the excavation. The concrete strength must be specified by the shoring designer. Temporary liners may be required to help prevent caving during the installation period. Positive measures may be required to prevent the loss of soil through the spaces between the lagging boards. This could probably be achieved by placing well-graded sand and gravel behind the lagging boards or by installing a geotextile filter cloth.

Soil anchors will be required to support the shoring. The anchors must be of a length that meets the Canadian Foundation Manual recommendations. It is important to note that the minimum length lies beyond the $45 - \phi/2 + .15H$ line drawn from the base of the soldier pile and the overall stability of the system must be checked at each anchor level, where H is the shoring height.

The top anchor must not be placed lower than 3.0 meters below the top of level ground surface. Anchors will require casing when penetrating through wet sand and silt layers. The bond values 600 kPa in sound shale are suggested but these values are preliminary since the contractor's installation procedures will determine the actual soil to concrete bond value. Hence, the contractor must decide on a capacity and confirm its availability. All anchors must be tested as indicated in the Foundation Manual, 4th edition.

Adhesion on the buried caisson shaft or behind the shoring system must be neglected when designing this shoring system.

Movement of the shoring system is inevitable. Vertical movements will result from the vertical load on the soldier piles resulting from the inclined tiebacks and inward horizontal movement results from earth and water pressures. The magnitude of this movement can be controlled by sound construction practices, and it is anticipated that the horizontal movement will be in the range of 0.1 to 0.25%H.

To ensure that movements of the shoring are within an acceptable range, monitoring must be carried out. Vertical and horizontal targets on the soldier piles must be located and surveyed before excavation begins. Weekly readings during excavation should show that the movements will be within those predicted; if not, the monitoring results will enable directions to be given to improve the shoring.

11. GENERAL COMMENTS AND LIMITATIONS OF REPORT

DS Consultants Ltd. (DS) 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 accorded the privilege of making this review, DS will assume no responsibility for interpretation of the recommendations in the report.

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to DS at the time of preparation. Unless otherwise agreed in writing by DS, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.


The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the

thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.


Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. DS 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 accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

DS CONSULTANTS LTD

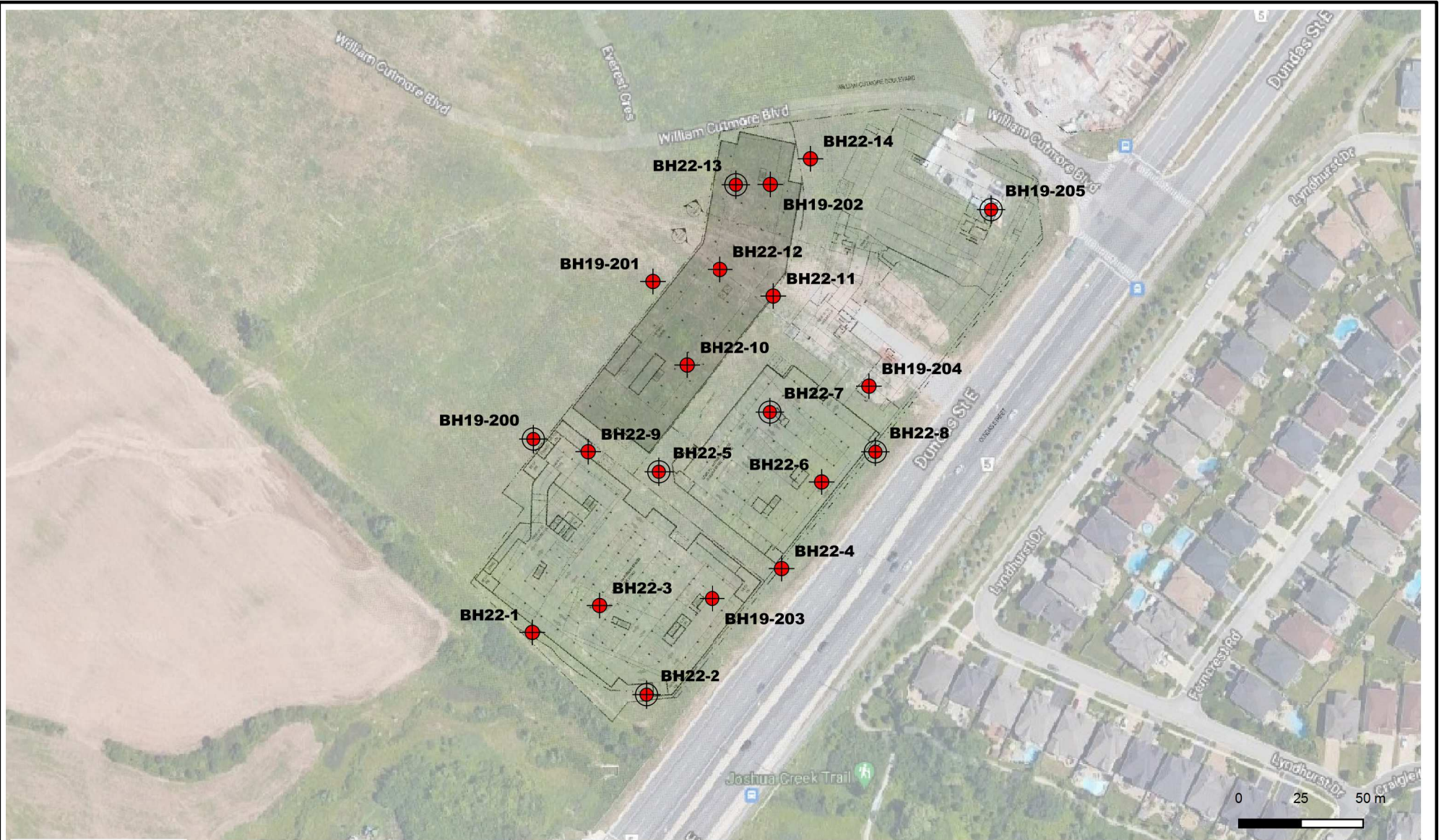

Alka Sangar, M.Eng., P.Eng.






Fanyu Zhu, Ph.D., P.Eng.





Drawings



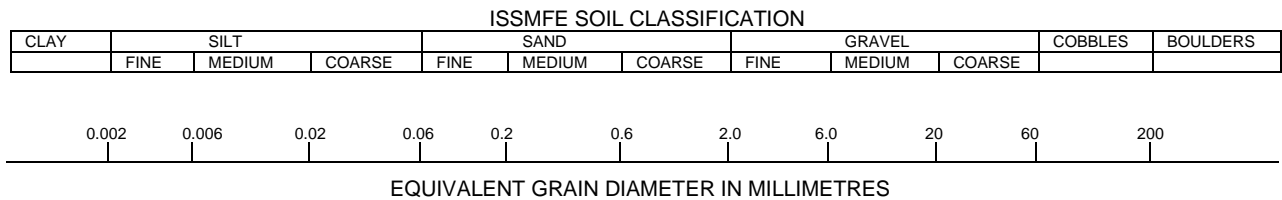
Legend

-  Borehole
-  Monitoring Well

 <p>DS CONSULTANTS LTD. 6221 Highway 7, UNIT 16 Vaughan, Ontario L4H 0K8 Telephone: (905) 264-9393 www.dsconsultants.ca</p>	Project: GEOTECHNICAL INVESTIGATION Bressa DUC Block - 1429 Dundas Street E., Oakville, ON			
	Title: BOREHOLE LOCATION PLAN			
Client: MATTAMY DEVELOPMENT CORP.	Size: 8.5 x 11	Approved By: A.S	Drawn By: S.Y	Date: July 2022
	Rev: 0	Scale: As Shown	Project No.: 19-294-100	Drawing No.: 1
	Image/Map Source: Google Satellite Image			

Drawing 1A: Notes On Sample Descriptions

1. All sample descriptions included in this report generally follow the Unified Soil Classification. Laboratory grain size analyses provided by DS also follow the same system. Different classification systems may be used by others, such as the system by the International Society for Soil Mechanics and Foundation Engineering (ISSMFE). Please note that, with the exception of those samples where a grain size analysis and/or Atterberg Limits testing have been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.



CLAY (PLASTIC) TO			FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)			SAND			GRAVEL	

UNIFIED SOIL CLASSIFICATION

2. **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 may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. 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 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. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional preliminary geotechnical site investigation.
3. **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 (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

<p>PROJECT: Geotechnical Investigation - Clockwork Phase 2 CLIENT: Mattamy Homes PROJECT LOCATION: 1429 Dundas St. E, Oakville, ON DATUM: Geodetic BH LOCATION: See Drawing 1 N 4817578.04 E 604757.94</p>	<p>DRILLING DATA Method: Hollow Stem Auger Diameter: 200mm Date: Jun/02/2022</p> <p style="text-align: right;">REF. NO.: 19-294-101 ENCL NO.: 2</p>
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SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			"N" BLOWS 0.3 m	SHEAR STRENGTH (kPa)						
163.0	TOPSOIL: 100mm		1	SS	12									
160.9	FILL: silty clay, trace gravel, brown, moist, stiff to very stiff		2	SS	22									
161.5	SILTY CLAY TILL: sandy, trace gravel, occasional cobble, reddish brown, moist, stiff to hard		3	SS	27									
161.0			4	SS	24									
160.5			5	SS	13									
160.0			6	SS	11									6 25 47 22
159.5			7	SS	29									
159.0	grey at 4.6m		8	SS	36									
153.9	SANDY SILT TILL/SHALE COMPLEX: reddish brown, moist, very dense		9	SS	50/ 30mm									
152.5	SHALE BEDROCK: weathered, reddish brown		10	SS	50/ 25mm									
150.3	END OF BOREHOLE: Notes: 1) Borehole was wet at the bottom upon completion.													

DS SOIL LOG-2021-FINAL 19-294-101 GEO PHASE 2 BOREHOLES.GPJ DS.GDT 8/2/23

PROJECT: Geotechnical Investigation - Clockwork Phase 2
 CLIENT: Mattamy Homes
 PROJECT LOCATION: 1429 Dundas St. E, Oakville, ON
 DATUM: Geodetic
 BH LOCATION: See Drawing 1 N 4817640.69 E 604832.79

DRILLING DATA
 Method: Hollow Stem Auger
 Diameter: 200mm
 Date: Jun/03/2022
 REF. NO.: 19-294-101
 ENCL NO.: 4

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20	40						
161.7															
0.0	FILL: silty clay, some gravel, brown, moist, firm to stiff		1	SS	7										
160.2			2	SS	9										
1.5	SILTY CLAY TILL: sandy, trace gravel, occasional cobble/boulder, reddish brown, moist, stiff to hard		3	SS	24										
			4	SS	32										
			5	SS	21										
			6	SS	19										
	grey below 6.1m		7	SS	13										
			8	SS	33										
52.6			9	SS	50										
9.1	SANDY SILT TILL: trace clay, trace gravel, grey, moist, very dense		10	SS	79										
	wet at 10.7m														
149.3			11	SS	50/										
149.4	SHALE BEDROCK: Queenston Formation, reddish brown, weathered														
12.6	END OF BOREHOLE: Notes: 1) Water at the depth of 10.7m during drilling.														

DS SOIL LOG-2021-FINAL 19-294-101 GEO PHASE 2 BOREHOLES.GPJ DS.GDT 8/2/23

GROUNDWATER ELEVATIONS
 Measurement 1st 2nd 3rd 4th

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ = 3% Strain at Failure

PROJECT: Geotechnical Investigation - Clockwork Phase 2
 CLIENT: Mattamy Homes
 PROJECT LOCATION: 1429 Dundas St. E, Oakville, ON
 DATUM: Geodetic
 BH LOCATION: See Drawing 1 N 4817685.5 E 604817.76

DRILLING DATA
 Method: Hollow Stem Auger
 Diameter: 200mm
 Date: Jun/06/2022
 REF. NO.: 19-294-101
 ENCL NO.: 6

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)			
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20	40							60	80	100
161.5	SILTY CLAY TILL: sandy, trace gravel, occasional cobble/boulder, reddish brown, moist, stiff to hard grey below 3.1m		1	SS	19													
161			2	SS	33													
160			3	SS	38													
159			4	SS	32													
158			5	SS	18													
157			6	SS	18													
156			7	SS	12													
154			8	SS	45													
153			9	SS	20													
151			10	SS	50/100mm													
149.3	SANDY SILT TILL/SHALE COMPLEX: reddish brown, moist, very dense		11	SS	53													
148.0			12	SS	50/100mm													
147.7	SHALE BEDROCK: weathered, reddish brown																	
13.8	END OF BOREHOLE: Notes: 1) 50mm dia. monitoring well installed upon completion. 2) Water Level Readings: Date: Water Level(mbg): June 14, 2022 6.2																	

W. L. 155.3 m
Jun 14, 2022

DS SOIL LOG-2021-FINAL 19-294-101 GEO PHASE 2 BOREHOLES.GPJ.DS.GDT 8/2/23

GROUNDWATER ELEVATIONS
 Measurement 1st 2nd 3rd 4th

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ = 3% Strain at Failure

PROJECT: Geotechnical Investigation - Clockwork Phase 2
 CLIENT: Mattamy Homes
 PROJECT LOCATION: 1429 Dundas St. E, Oakville, ON
 DATUM: Geodetic
 BH LOCATION: See Drawing 1 N 4817695.96 E 604847.76

DRILLING DATA
 Method: Hollow Stem Auger
 Diameter: 200mm
 Date: Jun/03/2022
 REF. NO.: 19-294-101
 ENCL NO.: 7

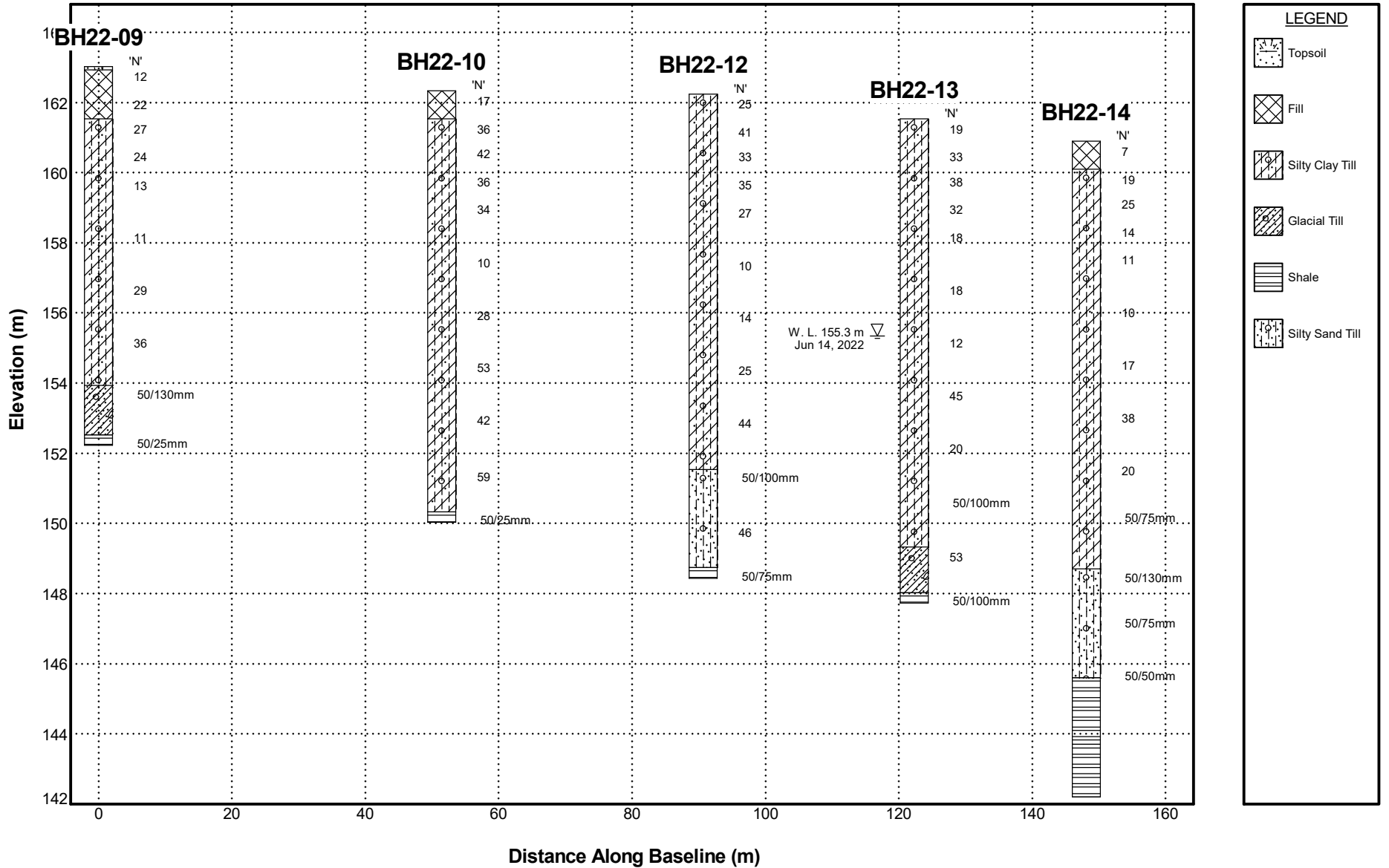
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			"N" BLOWS 0.3 m	SHEAR STRENGTH (kPa)						
160.9														
0.0	FILL: silty clay, trace sand, brown, moist, firm		1	SS	7									
160.1														
0.8	SILTY CLAY TILL: some sand to sandy, trace gravel, occasional cobble/boulder, reddish brown, moist, stiff to hard		2	SS	19									
			3	SS	25									
			4	SS	14									
	grey below 3.1m		5	SS	11									
			6	SS	10									
			7	SS	17									
			8	SS	38									
			9	SS	20									
			10	SS	50/ 75mm									
148.7														
12.2	SILTY SAND TILL: trace clay, trace gravel, reddish brown, very moist, very dense		11	SS	50/ 130mm									9 44 42 5
			12	SS	50/ 75mm									
145.6														
15.3	SHALE BEDROCK: Queenston Formation, reddish brown, weathered TCR=100%, SCR=100%, RQD=82% Hard layer=22%, Maximum hard layer thickness=130mm		13 R1	SS RC	50/ 50mm									
			R2	RC										
143.7														
17.2	TCR=95%, SCR=80%, RQD=70% Hard layer=17%, Maximum hard layer thickness=100mm		R3	RC										
142.2														
18.7	END OF BOREHOLE: Notes: 1) Rock core starts at 15.7m.													

DS SOIL LOG-2021-FINAL 19-294-101 GEO PHASE 2 BOREHOLES.GPJ DS.GDT 8/2/23

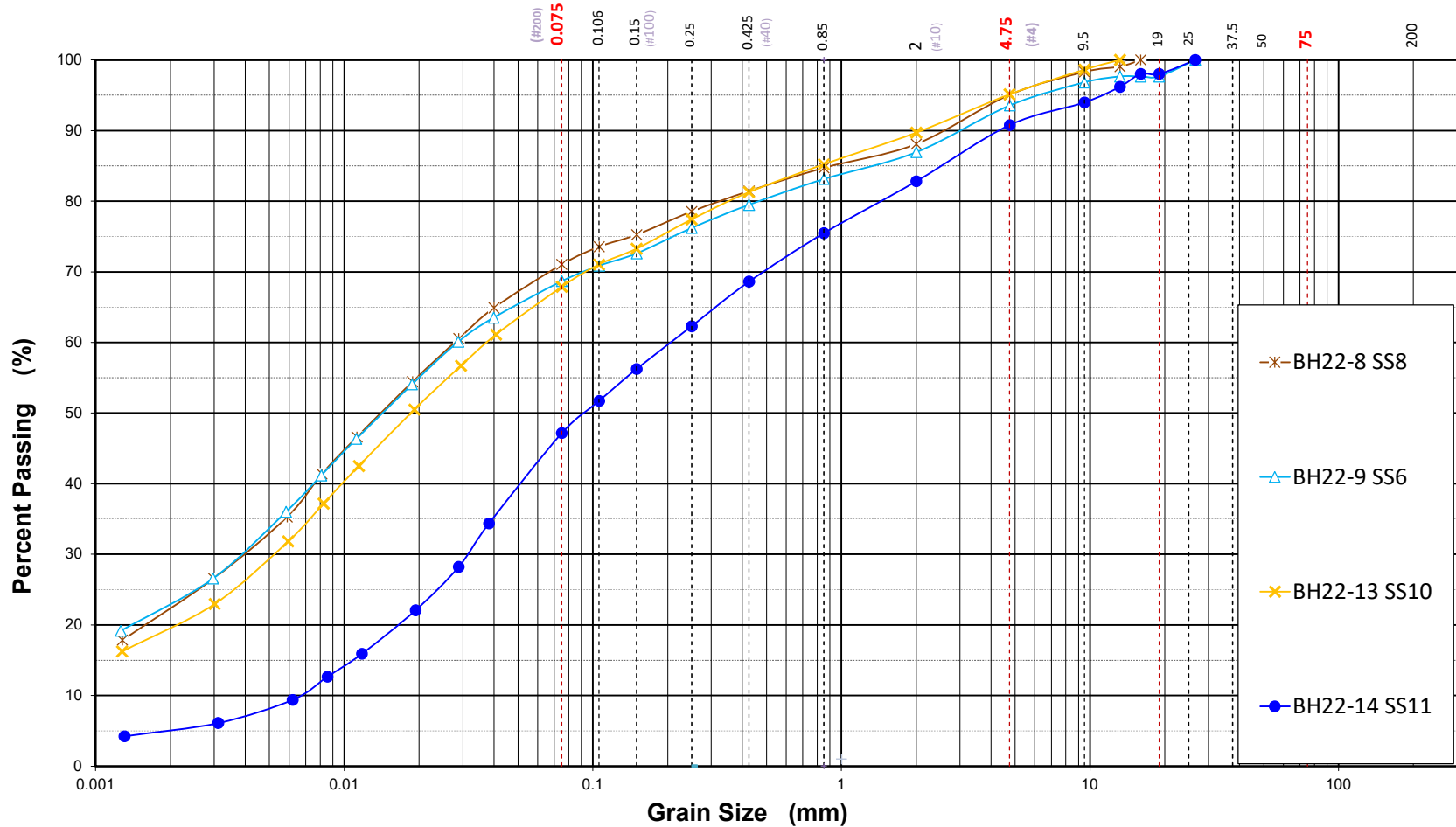
GROUNDWATER ELEVATIONS
 Measurement 1st 2nd 3rd 4th


GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ●=3% Strain at Failure

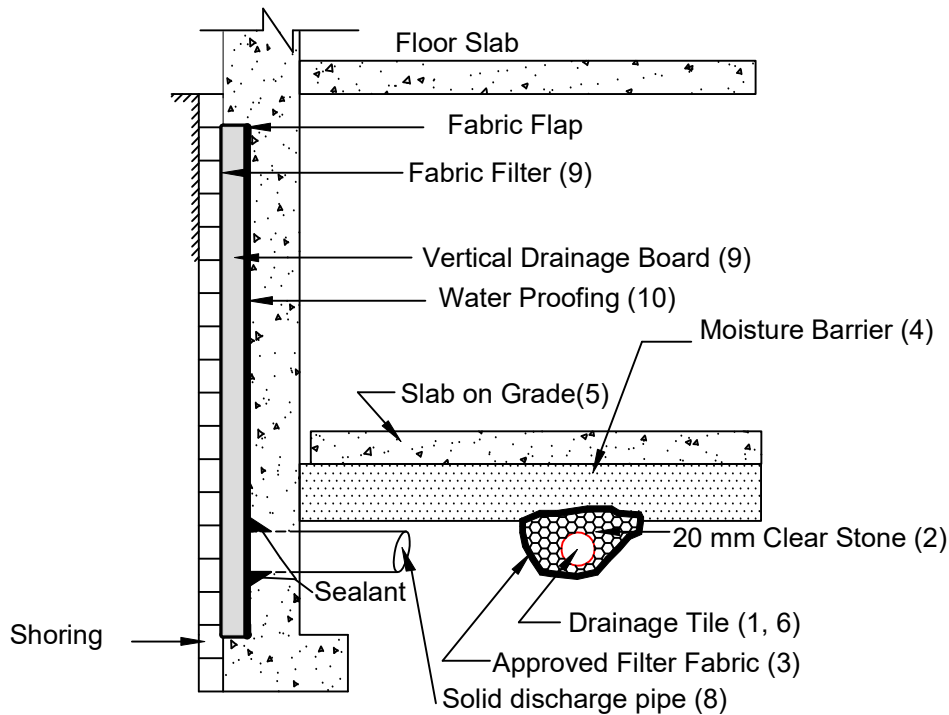
DS FENCE (M) 19-294-101 GEO PHASE 2 BOREHOLES.GPJ DS_GDT_8/2/23



Particle Size Distribution (ASTM-D421/D422)



Silt and Clay		Sand			Gravel		Cobble +
Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	
 <p>DS CONSULTANTS LTD. 6221 Highway 7, Unit 16 Vaughan, Ontario, L4H 0K8 Telephone: (905) 264-9393 www.dsconsultants.ca</p>	Project	Clockwork - Phase 2				Project No	19-294-101
	Location	1429 Dundas Street East, Oakville, ON				Date	Jun-14-2022
	Client	Mattamy Homes Canada				Figure No	9



EXTERIOR FOOTING

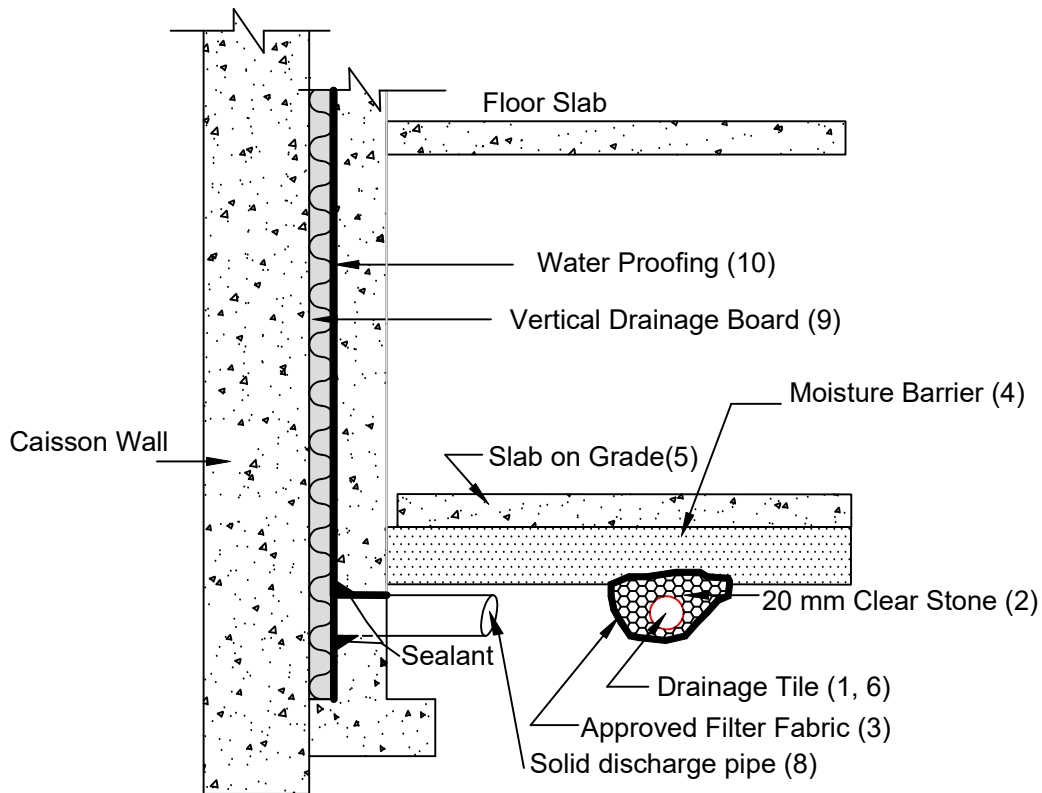
Notes

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet, spaced between columns.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place 100 mm (4 inches) of stone below drain.
3. Wrap the clear stone with an approved filter membrane (Terrafix 270R or equivalent).
4. Moisture barrier to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors.
5. Slab on grade should not be structurally connected to the wall or footing.
6. Underfloor drain invert to be at least 300 mm (12") below underside of floor slab.
Drainage tile placed in parallel rows 6 to 8 m (20 to 25') centers one way. Place drain on 100 mm (4") clear stone with 150 mm (6") of clear stone on top and sides. Enclose stone with filter fabric as noted in (3).
7. Do not connect the underfloor drains to perimeter drains.
8. Solid discharge pipe located at the middle of each bay between the soldier piles, approximate spacing 2.5 m, outletting into a solid pipe leading to a sump.
9. Vertical drainage board with filter cloth should be kept a minimum of 1.2 m below exterior finished grade.
10. The basement walls should be water proofed using bentonite or equivalent water-proofing system.
11. Review the geotechnical report for specific details. Final detail must be approved before system is considered acceptable.

DRAINAGE RECOMMENDATIONS

Shored Basement wall with Underfloor Drainage System

(not to scale)



EXTERIOR FOOTING

Notes

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet, spaced between columns.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place 100 mm (4 inches) of stone below drain .
3. Wrap the clear stone with an approved filter membrane (Terrafix 270R or equivalent).
4. Moisture barrier to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors.
5. Slab on grade should not be structurally connected to the wall or footing.
6. Underfloor drain invert to be at least 300 mm (12") below underside of floor slab.
Drainage tile placed in parallel rows 6 to 8 m (20 to 25') centers one way. Place drain on 100 mm (4") clear stone with 150 mm (6") of clear stone on top and sides. Enclose stone with filter fabric as noted in (3).
7. Do not connect the underfloor drains to perimeter drains.
8. Solid discharge pipe located at the middle of each bay between the soldier piles, approximate spacing 2.5 m, outletting into a solid pipe leading to a sump.
9. Vertical drainage board mira-drain 6000 or equivalent with filter cloth should be continuous from bottom to 1.2 m below exterior finished grade.
10. The basement walls must be water proofed using bentonite or equivalent water-proofing system.
11. Review the geotechnical report for specific details. Final detail must be approved before system is considered acceptable.

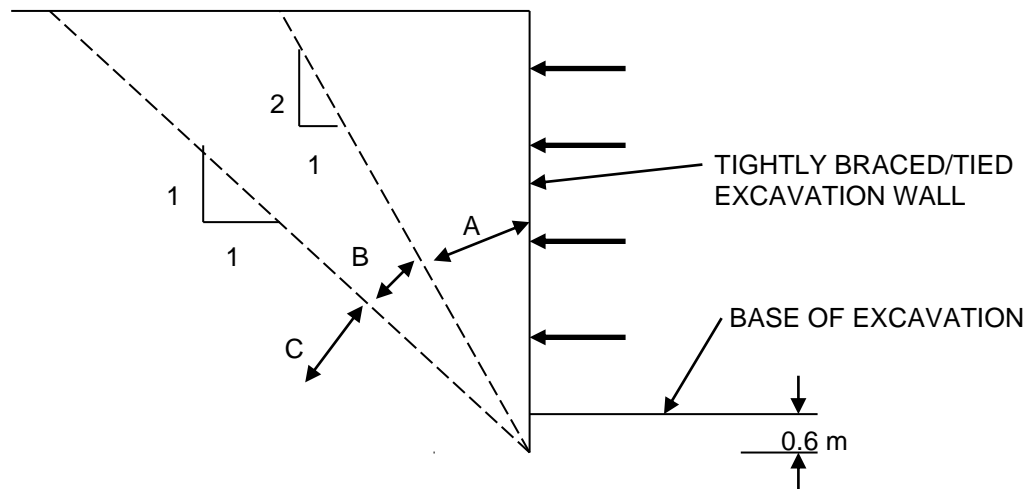
DRAINAGE RECOMMENDATIONS

Shored Basement wall with Underfloor Drainage System

(not to scale)

Guidelines for Underpinning in Soil and Excavation Support

Existing foundations located within Zone A normally require underpinning, especially for heavy structures. For some foundations in Zone A, it may be possible to eliminate underpinning and control foundation movement by tightly braced excavation walls, such as caisson walls.



- Zone A** Foundations located within this zone normally require underpinning. Horizontal and vertical pressures on the excavation wall of non underpinned foundations must be considered
- Zone B** Foundations located within this zone normally do not require underpinning. Horizontal and vertical pressures on the excavation wall of non underpinned foundations must be considered
- Zone C** Underpinning to structures is normally founded in this zone. Lateral pressure from underpinning is not normally considered

(Reference: Figure 26.27 from Canadian Foundation Engineering Manual, 4th Edition)

Appendix A:

General Comments on Shale Bedrock Photographs of Rock Cores

General Comments – Bedrock in Greater Toronto Area

The bedrock that makes spread footings or caissons a popular choice for high-rise foundation support is a shale or shale limestone composition. The highest member, the Queenston Formation, is generally found west of Toronto, while the Georgian Bay Formation underlies most of Metro Toronto, with the Collingwood Formation east of Toronto. The Queenston is, relatively speaking, the weaker of the three formations that are likely to support caissons or footings.

The Georgian Bay as well as the Queenston and Collingwood Formation are of Middle Ordovician Age. It is defined as the rock unit that overlies the bluish grey shales of the Collingwood Formation and is in turn overlain by the red shale of the Queenston Formation. The Georgian Bay Formation consists of bluish and grey shale with interbeds of sandstone, limestone and dolostone. Towards the west where the Georgian Bay formation underlies the Queenston Formation, the limestone content increases significantly and limestone and/or sandstone may comprise as much as 70 to 90 percent of the bedrock. The hard layers are usually less than about 100 to 150 mm thick but some layers are much thicker. The thicker layers have been observed to be as much as 750 to 900 mm at some sites. The layers are actually lenses and they can vary significantly in thickness over short distances.

The upper portion of the bedrock is commonly weathered for a depth of 600 to 1000 mm and within this weathered zone hard limestone layers or lenses are common. These hard limestone layers can result in contractual problems for augers, and can provide misleading bedrock elevations. Where the weathering is more extensive a shale till layer may be found above the bedrock. In the sound bedrock, the limestone, sandstone, dolostone is hard to very hard.

Stress relief features such as folds and faults are common in the bedrock. In these features, the rock is heavily fractured and sheared, and contains layers of shale rubble and clay. Weathering is much deeper than the surrounding rock in these features and often there is a lateral migration of the stress relief features resulting in sound unweathered bedrock overlying fractured and weather bedrock. The stress relief features are usually in the order of 4 to 6 m wide, but the depth can vary from 4 to 5 m to in excess of 10 m. These features occur randomly.

The bedrock contains significant high locked in horizontal stresses. These stresses can impose significant loads on tunnel walls but the slower rate of construction for basements allows for a relaxation of these stresses and they are not normally a problem for basement construction.

Groundwater seepage below the top 1000 mm is generally small, however, at several locations in Toronto and Mississauga large quantities have been encountered.

Bedding joints in the bedrock are very close-to-close, smooth planar in the shale and rough planar in the limestone. Significant vertical jointing is common.

Where the bedrock was cored, a detailed description of the rock core is appended to the borehole log.

Design features related to the bedrock are discussed in other sections of this report, and these general comments must be considered with these comments.

Methane gas exists in the bedrock, normally below the top 1000 mm and more concentrated with depth. Appropriate care and monitoring is essential in all confined bedrock excavations, particularly caissons and tunnels.

19-294-101

BH22-14

R1: ~51'3" ~56'3"

R2: ~56'3" ~61'3"



Appendix B:

Borehole Logs for BH19-200 to BH19-202

PROJECT: Geotechnical Investigation - Bressa Phase 1 Development
 CLIENT: Mattamy Development Corp.
 PROJECT LOCATION: Bressa DUC Block, 1429 Dundas Street E., Oakville
 DATUM: Geodetic
 BOREHOLE LOCATION: See Drawing 1 N 4817583.13 E 604735.87

DRILLING DATA
 Method: Solid Stem Auger
 Diameter: 150mm
 Date: Nov/04/2019
 REF. NO.: 19-294-100
 ENCL NO.: 2

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS 0.3 m			20	40						
164.6														
0.0	FILL: clayey silt, sandy, trace gravel, trace topsoil, reddish brown, moist, stiff to very stiff	1	SS	30										
1		2	SS	13										
163.1														
1.5	SILTY CLAY TILL: trace gravel, occasional cobble, reddish brown, moist, very stiff to hard	3	SS	27										
2		4	SS	26										
3		5	SS	37										
4														
5														
6		6	SS	26										
7														
8		7	SS	16										
9														
155.6														
9.0	CLAYEY SILT TILL: trace gravel, shale pieces, grey, moist, very stiff to hard	8	SS	30								200	4 28 46 22	
10														
153.6														
153.0	SHALE: highly weathered, reddish brown	9	SS	87/280mm										
11.2	SHALE: highly weathered, reddish brown	10	SS	87										
	END OF BOREHOLE: Notes: 1) Water at depth of 4.3m during drilling. 2) 50mm dia. monitoring well installed upon completion. 3) Water level Reading: Date: Water Level (mbgl): Nov 15, 2019 2.91													

DS SOIL LOG 19-294-100_WEST OF BRESSA.GPJ_DS.GDT_11/22/19

GROUNDWATER ELEVATIONS
 Measurement 1st 2nd 3rd 4th

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ = 3% Strain at Failure

PROJECT: Geotechnical Investigation - Bressa Phase 1 Development
 CLIENT: Mattamy Development Corp.
 PROJECT LOCATION: Bressa DUC Block, 1429 Dundas Street E., Oakville
 DATUM: Geodetic
 BOREHOLE LOCATION: See Drawing 1 N 4817646.56 E 604784

DRILLING DATA
 Method: Solid Stem Auger
 Diameter: 150mm
 Date: Nov/04/2019
 REF. NO.: 19-294-100
 ENCL NO.: 3

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)								
163.5	FILL: clayey silt, trace gravel, reddish brown, moist, very stiff		1	SS	15											
			2	SS	17											
			3	SS	26											
161.7	SILTY CLAY TILL: trace gravel, occasional cobble, reddish brown, moist, very stiff to hard		4	SS	38											
			5	SS	39											
			sand seams below 4.5m													
			hit a stone at 6.1m													
			6	SS	35											
155.9	CLAYEY SILT TILL: trace gravel, grey, moist, stiff to hard		7	SS	50/ 50mm											
			8	SS	12											
			9	SS	63											
			10	SS	86											
152.3	sandy below 10.7m															
11.2	END OF BOREHOLE: Notes: 1) Borehole dry upon completion.															

DS SOIL LOG 19-294-100_WEST OF BRESSA.GPJ_DS.GDT_11/22/19

GROUNDWATER ELEVATIONS
 Measurement

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ● = 3% Strain at Failure

