FINAL REPORT
GEOTECHNICAL INVESTIGATION
PROPOSED MULOCK HOUSE BUILDING FOUNDATION UNDERPINNING
33 MULOCK DRIVE
NEWMARKET, ONTARIO

Prepared for:

THE CORPORATION OF THE TOWN OF NEWMARKET

Prepared By:

SIRATI & PARTNERS CONSULTANTS LIMITED

Project: SP23-01170-00
May 16, 2023

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1. INTRODUCTION

Sirati & Partners Consultants Limited (SIRATI) was retained by the Corporation of The Town of Newmarket (the "Client") to undertake a geotechnical investigation for the Mulock Property located at 33 Mulock Drive in Newmarket, Ontario (the "Site").

The purpose of this geotechnical investigation was to determine the subsurface conditions at four (4) borehole locations and from the findings in the boreholes make engineering recommendations for design parameters of the proposed underpinning of the existing foundation at Mulock House Building.

A geotechnical review of the test pits that were undertaken by the Client in the basement of the Mulock House was performed by SIRATI to examine the existing foundation and subsurface soil and presented in the following reference. The findings of the test pitting program were reviewed and incorporated in this report:

- **REF. 1**, Test Pitting Report, Proposed Development at the Basement of the Mulock House, 33 Mulock Drive, Newmarket, Ontario, Report No. SP22-1110-00-E, provided by SIRATI and Partners Consultants Ltd., dated March 28, 2023.

This report is provided based on the terms of reference presented above and on the assumption that the design will be in accordance with the 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, SIRATI should be contacted to review the design. It should be also noted as a result of changes it may then be necessary to carry out additional borings and reporting before the recommendations of this office can be relied upon.

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 and do not conform to generalized standards for services. 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 the Client and its designers. Third party use of this report without Sirati & Partners Consultants Limited (SIRATI) consent is prohibited. The limitation conditions presented in **Appendix B** form an integral part of the report and they must be considered in conjunction with this report.

2. FIELD AND LABORATORY WORK

Four (4) boreholes (BH/MW-201, BH-202, BH-203, and BH/MW-204, see Drawing 1 for location plan) were drilled at site to depth ranging between 6.6 m to 15.7 m below existing grade. Boreholes were drilled with solid stem continuous flight auger equipment by a drilling sub-contractor under the

direction and supervision of SIRATI 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 SIRATI's laboratory for detailed examination by the project engineer and for laboratory testing.

As well as visual examination in the laboratory, all the soil samples were tested for moisture content. Selected five (5) soil samples were subjected to grain size analyses and gradation curves are presented on Figure No. 6. The same five (5) samples were also subjected to Atterberg Limits testing and the results are presented on the respective borehole log and Figure Nos. 7 and 8.

Water level observations were made during drilling and in the open boreholes upon completion of drilling. Monitoring wells were installed in two of the drilled boreholes (BH/MW-201 and BH/MW-204).

The ground surface elevations at the borehole locations were surveyed by SIRATI personnel using differential GPS system and varied from 271.22 to 271.62 mASL. Table 1 summarizes the boreholes detail:

Table 1: Borehole Detail

BH No.	Date of Drilling	Northing (m) UTM Zone 17T	Easting (m) UTM Zone 17T	Ground Elevation (m)	Borehole Depth below Existing Grade (m)	Monitoring Well Installed
BH/MW-201	Apr. 17, 2023	4877063.255	621889.286	271.62	15.70	Yes
BH-202	Apr. 17, 2023	4877037.405	621881.865	271.61	6.60	No
BH-203	Apr. 18, 2023	4877043.948	621919.794	271.45	6.60	No
BH/MW-204	Apr. 18, 2023	4877058.846	621916.876	271.22	6.60	Yes

3. SITE AND SUBSURFACE CONDITIONS

The borehole locations are shown on Drawing 1. Notes on sample descriptions and the general features of fill material and native soil are presented on Drawing 1A. Detailed subsurface conditions are presented on the Borehole Logs; Drawings 2 to 5 The soil and groundwater conditions are summarized as follows.

3.1 Soil Conditions

Fill Material:

A layer of fill layer surfaced all boreholes. The fill material mainly consists of silty sand, with some gravel, trace clay, brown and moist. The fill layer extended to depth between 0.8 m (BH-202, BH-203 and BH/MW-204) and 4.6 m (BH/MW-201 below existing ground surface (mbgs).

The fill material is comprised of gravely sand or sand with some gravel overlying clayey silt and sand fill.

The measured SPT 'N' values in the fill material ranged from 2 to over 29 blows per 300 mm penetration, with an average value of 7 blows per 300 mm penetration, indicating a loose material.

Grain size analysis of clayey silt and sand fill material sample (BH/MW-201/SS3) was conducted, and the results are presented on Figure 6, with the following fractions:

Clay: 19%
Silt: 54%
Sand: 18%
Gravel: 9%

Lean Clay to Silty Clay:

Below the fill material, native cohesive soil consisting of lean clay to silty clay, with trace to some sand, trace gravel, trace cobbles, grey to brown, and moist to wet were encountered in all boreholes, extending to depths of 6.6 m to 15.7 m below existing ground surface (termination depth of boreholes).

The measured SPT 'N' values in the lean clay to silty clay material ranged from 6 to 50 blows per 300 mm penetration, with an average value of 23 blows per 300 mm penetration, indicating a very stiff to hard material.

Grain size analysis of lean clay to silty clay material samples (BH/MW-201/SS6, BH-202/SS2, BH-203/SS3, and BH/MW-204/SS3) were conducted, and the results are presented on Figure 6, with the following fractions:

Clay: 13-20%
Silt: 70-84%
Sand: 2-8%
Gravel: 0-2%

Atterberg limits testing was completed on four (4) representative lean clay to silty clay samples (BH/MW-201/SS6, BH-202/SS2, BH-203/SS3, and BH/MW-204/SS3). The liquid limit was found to be ranging between 25-27%, the plastic limit was found to be ranging 16-20%. The soil has a

plasticity index of ranging between 6-9% indicating an inorganic low plastic clay (cohesive). The result is presented in Figures 7 and 8. The soil moisture content of samples is ranging between 21-22% by weight and is below the liquid limit.

3.2 Groundwater Conditions

During drilling and upon completion of drilling, the short-term groundwater (unstabilized) was observed in all boreholes at depths ranging between 2.4 m and 5.5 m below the existing grade, with the exception of BH-202 which was dry upon completion of drilling. The stabilized groundwater table observed in the monitoring wells (BH/MW-201 and BH/MW-204) on April 26th, 2023, was found at depths ranging between 2.4 m and 3.1 m.

Table 2: Groundwater Levels Observed in Monitoring Wells

BH No.	Date of Drilling	Date of Observation	Depth of Groundwater below existing ground (m)	Elevation of Groundwater (m)
BH/MW-201	Apr. 17, 2023	Apr. 26, 2023	3.10	268.52
BH/MW-204	Apr. 18, 2023	Apr. 26, 2023	2.40	268.82

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

Upon Client request, the above-mentioned monitoring wells were decommissioned on May 4, 2023.

4. UNDERPINNING RECOMMENDATIONS

It is understood that the purpose of this geotechnical investigation was to determine the subsurface conditions at four (4) borehole locations and from the findings in the boreholes make engineering recommendations for design parameters of the proposed underpinning of the existing foundation at Mulock House Building basement.

Based on information provided by the Client, the elevation of the top of the existing slab in the basement is 270.64 m ASL and the elevation of the proposed top of slab after underpinning is expected to be at 269.94 m ASL and the underside of the slab will be at 269.74 m ASL. The following engineering recommendations regarding the geotechnical design aspects of the proposed basement underpinning should be reviewed once the final design grades and foundations have been finalized.

Basement underpinning is a construction technique used to strengthen or increase the depth of an existing basement foundation. It involves the process of excavating and reinforcing the foundation to provide additional support and stability.

The area around the foundation and floor slab in the basement is excavated in sections to expose the existing foundation walls. This can be done either from the outside or inside of the basement, depending on the accessibility and structural considerations.

To ensure the stability of the structure during the underpinning process, temporary supports such as shoring or hydraulic jacks are installed to bear the load of the foundation.

The underpinning process involves extending the depth or width of the foundation to provide additional support. There are various techniques for underpinning, including traditional mass concrete underpinning, mini-piled underpinning, and beam-and-base underpinning. The choice of technique depends on factors such as soil conditions, existing foundation type, and project requirements.

Once the underpinning is complete, reinforcement measures are taken to strengthen the newly extended foundation. This may involve adding steel beams, concrete footings, or other structural elements to enhance the load-bearing capacity.

As part of the underpinning process, it's important to address waterproofing and drainage concerns. Proper waterproofing membranes, drainage systems, and sump pumps may be installed to prevent water infiltration and ensure a dry basement environment.

After the underpinning work is completed, the excavated areas are backfilled and restored. This may include repairing walls, floors, and other elements affected during the construction process.

General recommendations regarding underpinning are as follow:

- The excavated area under the existing foundation should be backfilled with concrete to immediately under the existing foundation, in order to connect to the existing foundation.

- The base of existing foundation should be cleaned of any soil residues to provide a complete and smooth connection between the existing foundation and newly placed concrete.

- The base of the excavation must be thoroughly cleaned of all loosened, disturbed, wet, and/or softened soil, and/or water.

- The time lag between excavation and concrete placement should be minimized to limit softening and sloughing of the soil.

- The concrete should be placed without segregation, and carefully vibrated.

- Consultation should be made with the Structural Engineer to fill the potential gap between the existing foundation and the newly placed concrete. Pressure grouting may be an option to be considered.

Guidelines for Underpinning from the Canadian Foundation Engineering Manual (4th Edition) is provided in Figure 11.

Based on findings during the current investigation as well as reviewing the findings from the test pitting program that was undertaken by the Client (please refer to **REF. 1**) the following engineering recommendations regarding the geotechnical design aspects of the proposed basement underpinning are provided:

Conventional Spread/Strip Footings:

Based on the borehole information, the proposed slab in the basement after performing underpinning can be supported by conventional spread and strip footings at or below the depths provided in Table 3.

Table 3: Bearing Values and Founding Levels of Spread Footings

BH No.	Material	Bearing Capacity at SLS (kPa)	Factored Geotechnical Resistance at ULS (kPa)	Minimum Depth Below Existing Ground (m)	Founding Level at or Below Elevation (m)
BH/MW-201	Lean Clay	100	150	4.60	267.02
BH-202	Lean Clay	100	150	1.87	269.74
BH-203	Lean Clay	105	160	1.71	269.74
BH/MW-204	Silty Clay	120	180	1.48	269.74

It should be noted that the bearing capacities were provided based on the soil and groundwater condition at the borehole locations and as such, variability should be anticipated between the boreholes.

The geotechnical resistances provided above are given for loads that will be applied perpendicular to the surface of the footings. Where the load is not applied perpendicular to the footing, inclination of the load should be taken into account in accordance with Section 6.7.2 of the CHBDC (2014).

A Modulus of subgrade reaction 'K_s' of 20 MPa/m may be considered for the design of the foundation.

The foundations designed to the specified allowable bearing capacity at the serviceability limit states (SLS) are expected to settle less than 25 mm total and 19 mm differential. However, considering the existing state of the foundation, the planned underpinning, and the alterations in loading conditions throughout and following the underpinning process, it is anticipated that differential settlements may surpass the values mentioned earlier. Therefore, the design team should carefully evaluate the potential risks associated with utilizing conventional spread/strip or isolated footings, including total and differential settlements, as well as potential cracking in the existing walls and structures.

Additionally, it is crucial to acknowledge and take into account that the current foundations were initially designed to support the existing building loads. Consequently, modifying the building loads and conducting underpinning may result in altered loading conditions for both the new and existing foundation components, potentially leading to additional settlements in the foundations.

Helical Piles:

Helical piles offer an economically viable option for underpinning. The advantages of helical piles encompass remarkable uplift resistance, absence of drill spoil, elimination of concrete delays, low noise levels, and absence of vibrations. Helical piles consist of a steel shaft with one, two, or three auger flights. The pile is augured into the ground, advanced into competent soils (i.e. glacial till or shale) and the capacity confirmed using the measured torque required to advance the pile. The helical anchors are generally designed as end bearings and the friction from the existing fill should be conservatively ignored. The helical piles are particularly attractive as the helical plates can take advantage of the stiff to very stiff underlying deposits in end bearing. Using Helical Piles will minimize the risk of differential settlement.

The helical pile plates must be embedded at least 3 m into the very stiff cohesive soil deposit (lean Clay or Silty Clay), with 'N' value greater than 25 (or earlier torque refusal). A SS5 helical pile (please refer to EBS Geostructural Inc., Helical pile Capacity chart or any equivalent Helical Pile manufacturer), extending to the approximate elevation of 265 m or earlier refusal is estimated to support an approximate load of 200 kN in compression at the Serviceability Limit State (SLS) and 270 kN at the Ultimate Limit State (ULS). The tensile bearing capacity of such piles is expected to be 60 kN at SLS and 80 kN at ULS, per pile. The design capacity of the helical piles will need to be verified on site using a full-scale pile load test prior to installation of any production piles.

The required geotechnical resistance of helical anchor in compression would need to be confirmed by multiplying a resistance factor of 0.6 to the test load. For tension, the required geotechnical resistance of helical anchor should be confirmed by multiplying a resistance factor of 0.4 to the test load. Full-time monitoring by a Geotechnical Engineer will be required during the installation of piles, to monitor the applied torque depth of piles and confirm the design load capacity. A specialized design-build contractor must be retained to design and install the helical piles.

It is recommended that the center-to-center spacing between adjacent piles to be no less than five times the diameter of the largest helical piles. Spacing between the helical piles and other foundation elements, requires special consideration and is beyond the scope of this section.

5. FLOOR SLAB AND PERMANENT DRAINAGE

The floor slab can be supported on grade provided any disturbed native soils are removed and the base thoroughly inspected. Any backfill required to raise the grade can consist of inorganic soil, placed in shallow lifts (less than 300 mm thick prior to compaction) and compacted to 98 percent of Standard Proctor Maximum Dry Density (SPMDD).

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

A perimeter drainage system will be required around the exterior basement walls. The perimeter drainage is shown on Drawings 9 and 10, together with the underfloor drainage. Where the exposed

subgrade consists of cohesionless soils below the groundwater table, all openings including the subgrade must be covered or wrapped with filter fabric, typically a Class II non-woven textile with a filtration opening size (F.O.S.) of 50 to 100 µm.

The floor slab should be structurally independent of any load bearing structural elements and should tolerate expected foundation settlements as indicated above.

6. FROST PROTECTION

All footings exposed to seasonal freezing conditions must have at least 1.2 m 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.

It is also emphasized that underfloor drainage and/or an adequate free draining gravel base is required to minimize the risk of floor dampness. Floor dampness could lead to temporary icing and the risk of accidents.

7. EXCAVATIONS AND BACKFILL

The groundwater table observed in the monitoring wells installed in the cohesive soils was at depths ranging between 2.4 m and 3.1 m below existing grade, corresponding to the geodetic elevation ranging between 268.52 m ASL and 268.82 m ASL, seasonal fluctuations in groundwater table should be considered.

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

The existing fill in the boreholes is generally not suitable for re-use as backfill. The native soils free from topsoil and organics can be used as general construction backfill, provided their moisture content is within 2 percent of 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. Significant drying of the wet sandy soils will be required prior to their use as the backfill material.

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.

8. EARTH PRESSURES

The lateral earth and water pressure acting at any depth on the basement wall structure can be calculated by the following formula:

In soils above the groundwater table ($z < d_w$):

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

In soils below the groundwater table ($z \geq d_w$):

$$p = K \{\gamma d_w + \gamma_1 (z - d_w) + q\} + p_w$$

In which, $p_w = \gamma_w (z - d_w)$

where p = lateral earth and water pressure in kPa acting at a depth of z below ground surface

K = earth pressure coefficient

γ = unit weight of soil above groundwater table

γ_1 = submerged unit weight of soil below groundwater table

γ_w = unit weight of water, assuming $\gamma_w = 9.8$ kN/m^3

z = depth below ground surface to point of interest, in metres

d_w = depth of groundwater table below ground surface, in metres

q = value of surcharge in kPa

p_w = hydrostatic water pressure in kPa

The lateral earth pressure parameters are presented in Table 2:

Table 4: Lateral Earth Pressure Parameters

Parameter	Lean Clay
Unit Weight, γ, kN/m^3	21
Submerged Unit Weight, γ_1, kN/m^3	11.2
Friction Angle, ϕ, degrees (for undrained conditions of temporary shoring system)	0
Undrained Shear Strength, S_u, kPa	50
Active Earth Pressure Coefficient, K_a	0.45

Parameter	Lean Clay
Passive Earth Pressure Coefficient, K_p	1.55
Earth Pressure at rest Coefficient, K_0	0.65
Modulus of Subgrade Reaction, K_s, MN/m^3	20

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 founded on the competent native soils can be classified as “Class C”.

10. GENERAL COMMENTS ON REPORT

Sirati & Partners Consultants Limited 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 given the privilege of making this review, Sirati & Partners will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes required to determine the localized underground conditions between boreholes 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.

The limitation conditions presented in Appendix B form an integral part of the report and they must be considered in conjunction with this report.

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

Yours truly,

SIRATI & PARTNERS CONSULTANTS LIMITED

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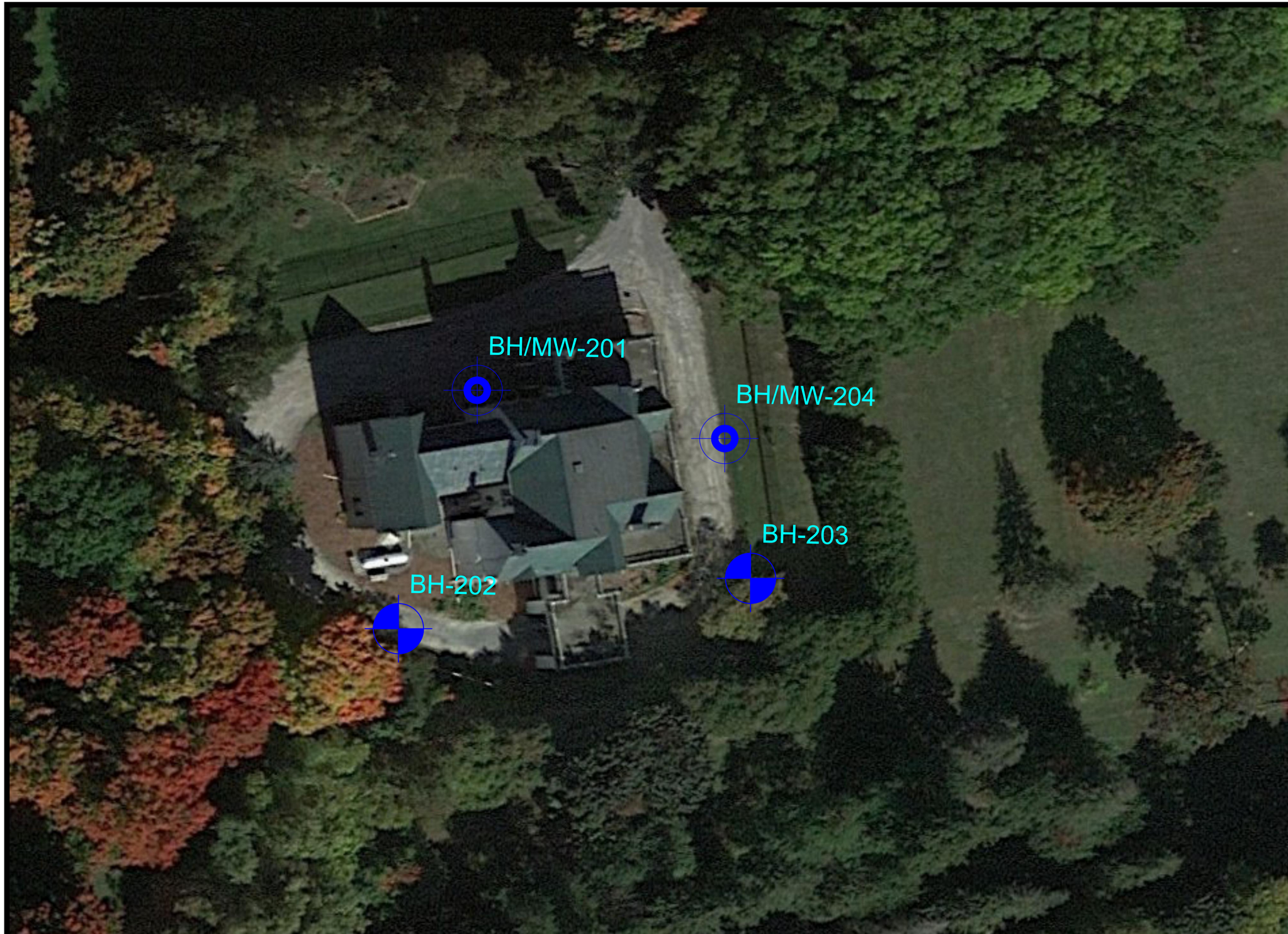
PROVINCE OF ONTARIO

Drawings



Source: Google Earth Map

SIRATI & PARTNERS
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North:

N

Legend:

- Geotechnical Borehole
- Borehole/ Monitoring Well

Project Title:

Geotechnical Investigation

Site Location:

16780 Yonge Street,
Newmarket, Ontario

Figure Title:

Borehole/ Monitoring Well Location Plan

Scale:	Project Number:
As Shown	SP23-01170-00
Date:	**Figure Number:**
April, 2023	1

Drawing 1A: Notes on Sample Descriptions

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Society for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by Sirati & Partners Consultants Limited also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has 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.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		

0.002 0.006 0.02 0.06 0.2 0.6 2.0 6.0 20 60 200

EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

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 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.

LOG OF BOREHOLE BH/MW-201

PROJECT: Geotechnical Investigation
CLIENT: The Corporation of The Town of Newmarket
PROJECT LOCATION: 16780 Yonge Street, Newmarket, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4877063.255 E 621889.286

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200 mm
Date: Apr-17-2023

REF. NO.: SP23-01170-00
ENCL NO.: 2

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
271.6									
0.0	**FILL:** gravelly sand, trace silt, trace cobbles, brown, moist, compact	1	SS	26	271				
1		2	SS	29					
270.1									
1.5	sand, trace to some gravel, trace silt, brown, very moist, compact	3	SS	15	270				
2	very loose, contaminated	4	SS						
269.0									
2.6	cleayey silt and sand, trace gravel, greyish brown, wet, soft	4A	SS	2	269				
3		5	SS	3	W. L. 268.5 m Apr 26, 2023	9	18	54	19
4					268				
267.1									
4.6	**LEAN CLAY:** trace to some sand, trace gravel, grey, wet, very stiff	6	SS	19	267	2	8	70	20
5									
6	hard	7	SS	32	266				
7					265				
8	stiff	8	SS	13	264				
9					263				
10	very stiff	9	SS	28	262				
11		10	SS	21	261				
12					260				

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

LOG OF BOREHOLE BH/MW-201

PROJECT: Geotechnical Investigation
CLIENT: The Corporation of The Town of Newmarket
PROJECT LOCATION: 16780 Yonge Street, Newmarket, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4877063.255 E 621889.286

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200 mm
Date: Apr-17-2023

REF. NO.: SP23-01170-00
ENCL NO.: 2

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	"N" BLOWS / 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	LEAN CLAY: trace to some sand, trace gravel, grey, wet, very stiff(Continued) hard		11	SS	34		259		○			
13												
	firm						258					
14			12	SS	6				○			
							257					
15												
	stiff		13	SS	11				○			
255.9							256					
15.7	**END OF BOREHOLE:** 1. Borehole was caved in 3.00 mbgs upon completion of drilling. 2. Water level was encountered at 2.4 mbgs upon completion of drilling. 3. Monitoring well was installed at BH/MW-201 with screen 12.2 to 15.2 mbgs upon completion of drilling. 4. Groundwater level was measured at 3.1 mbgs on Aril 26, 2023.											

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

SIRATI & PARTNERS

LOG OF BOREHOLE BH-202

PROJECT: Geotechnical Investigation
CLIENT: The Corporation of The Town of Newmarket
PROJECT LOCATION: 16780 Yonge Street, Newmarket, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4877037.405 E 621881.865

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150 mm
Date: Apr-17-2023

REF. NO.: SP23-01170-00
ENCL NO.: 3

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	ELEVATION	GR	SA	SI	CL
271.6 / 0.0	**FILL:** gravelly sand, trace silt, trace cobbles, brown, moist, compact	1	SS	21					
	clayey silt, trace to some sand, trace gravel, brown, moist, stiff	1A	SS	5					
270.9 / 0.8	**LEAN CLAY:** trace to some sand, trace gravel, brown, moist, very stiff	2	SS	22	271	2	84	14	
		3	SS	17	270				
	hard	4	SS	18	269				
	trace cobbles	5	SS	16	268				
		6	SS	18	267				
	grey	7	SS	19	266				
265.1 / 6.6	**END OF BOREHOLE:** 1. Borehole was open and dry upon completion of drilling.								

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)
REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

SPCL SOIL LOG /DRAFT SP23-01170-00.GPJ SPCL.GDT 23-5-12

SIRATI & PARTNERS

LOG OF BOREHOLE BH-203

PROJECT: Geotechnical Investigation
CLIENT: The Corporation of The Town of Newmarket
PROJECT LOCATION: 16780 Yonge Street, Newmarket, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4877043.948 E 621919.794

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150 mm
Date: Apr-18-2023

REF. NO.: SP23-01170-00
ENCL NO.: 4

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / 0.3 m "N"	ELEVATION	GR	SA	SI	CL
271.5 / 0.0	**FILL:** gravelly sand, trace silt, brown, moist, loose	1	SS						
	clayey silt, trace to some sand, trace gravel, brown, moist, firm, trace residual materials	1A	SS	7	271				
270.7 / 0.8	**LEAN CLAY:** trace to some sand, trace gravel, brown, moist, stiff	2	SS	12					
	trace cobbles, very stiff	3	SS	22	270	4	83	13	
		4	SS	24	269				
		5	SS	22	268				
	hard	6	SS	38	267				
	wet, very stiff	7	SS	28	266				
264.9 / 6.6	**END OF BOREHOLE:** 1. Borehole was open upon completion of drilling. 2. Water level was encountered at 5.5 mbgs upon completion of drilling.				265				

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)
REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

SPCL SOIL LOG /DRAFT SP23-01170-00.GPJ SPCL.GDT 23-5-12

SIRATI & PARTNERS

LOG OF BOREHOLE BH/MW-204

PROJECT: Geotechnical Investigation
CLIENT: The Corporation of The Town of Newmarket
PROJECT LOCATION: 16780 Yonge Street, Newmarket, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4877058.846 E 621916.876

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150 mm
Date: Apr-18-2023

REF. NO.: SP23-01170-00
ENCL NO.: 5

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
271.2 / 0.0	**FILL:** gravelly sand, trace silt, brown, moist, compact	1	SS	12		
270.9 / 0.1	clayey silt, trace to some sand, trace gravel, brown, moist, stiff	1A	SS	12	271	
270.5 / 0.8	**SILTY CLAY:** trace to some sand, trace gravel, brown, moist, firm	2	SS	6	270	
	very stiff	3	SS	17		2 83 15
	hard	4	SS	30	269	W. L. 268.8 m Apr 26, 2023
	trace cobbles	5	SS	44	268	
		6	SS	50	267	
	wet	7	SS	38	266	
264.7 / 6.6	**END OF BOREHOLE:** 1. Borehole was open upon completion of drilling. 2. Water level was encountered at 5.5 mbgs upon completion of drilling. 3. Monitoring well was installed at BH/MW-204 with screen 3.0 to 6.1 mbgs upon completion of drilling. 4. Groundwater level was measured at 2.4 mbgs on Aril 26, 2023.				265	

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE: 20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

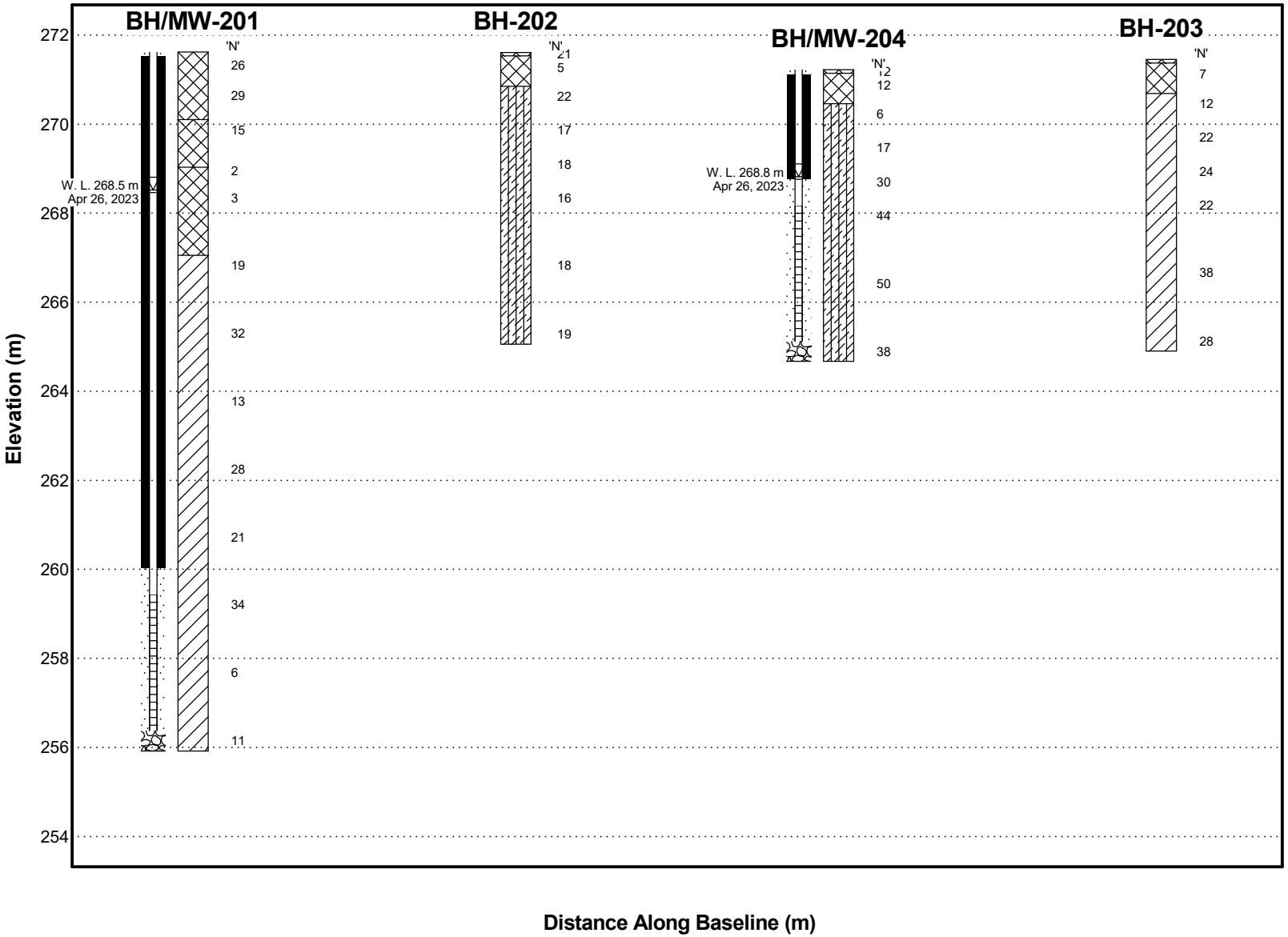
WATER CONTENT (%): 10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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



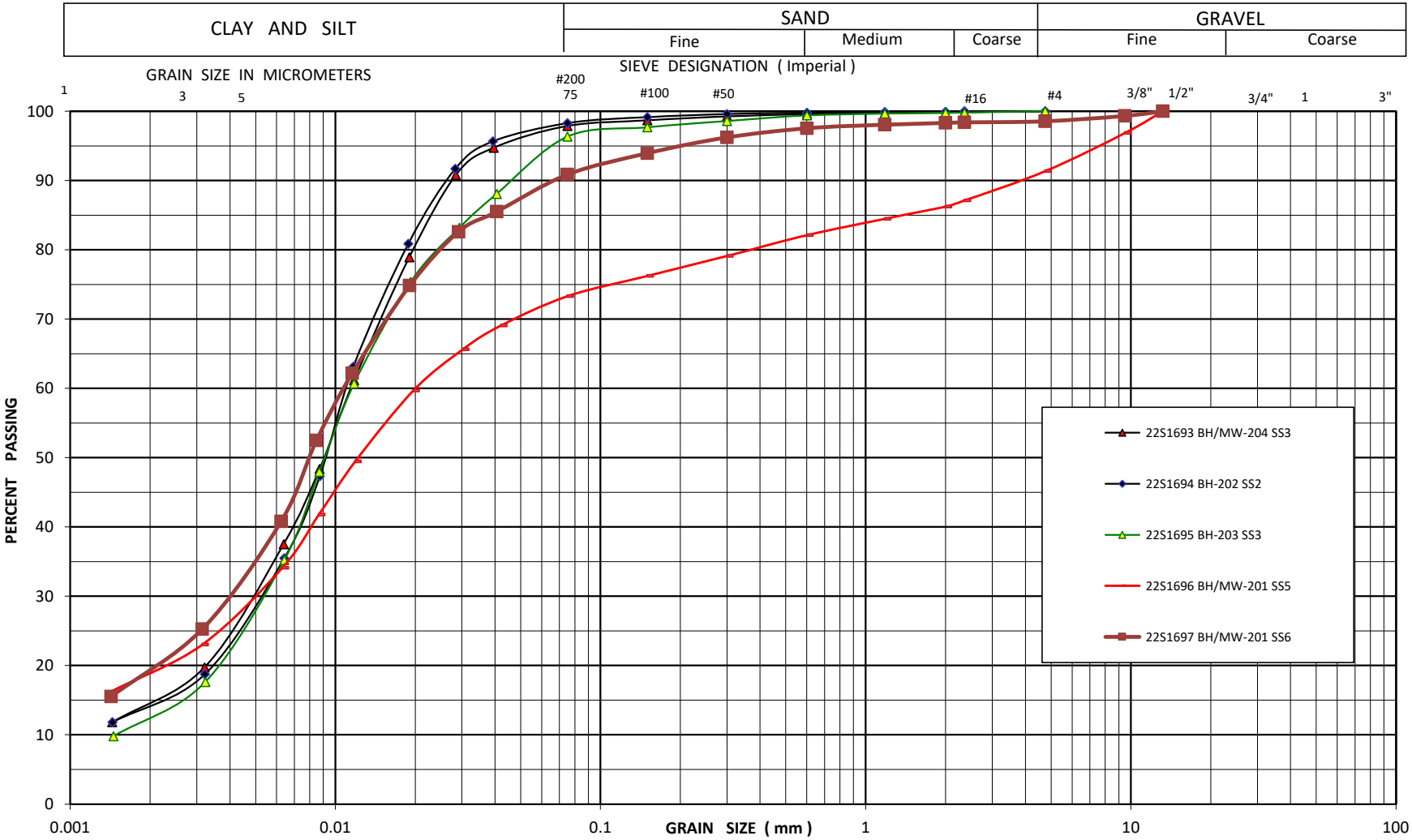
		DRAWING NO.
		JOB NO. SP23-01170-00
		DATE

SPCL FENCE (M)-SCREEN SP23-01170-00.GPJ SPL.GDT 23-5-12

SIRATI & PARTNERS

GRAIN SIZE DISTRIBUTION

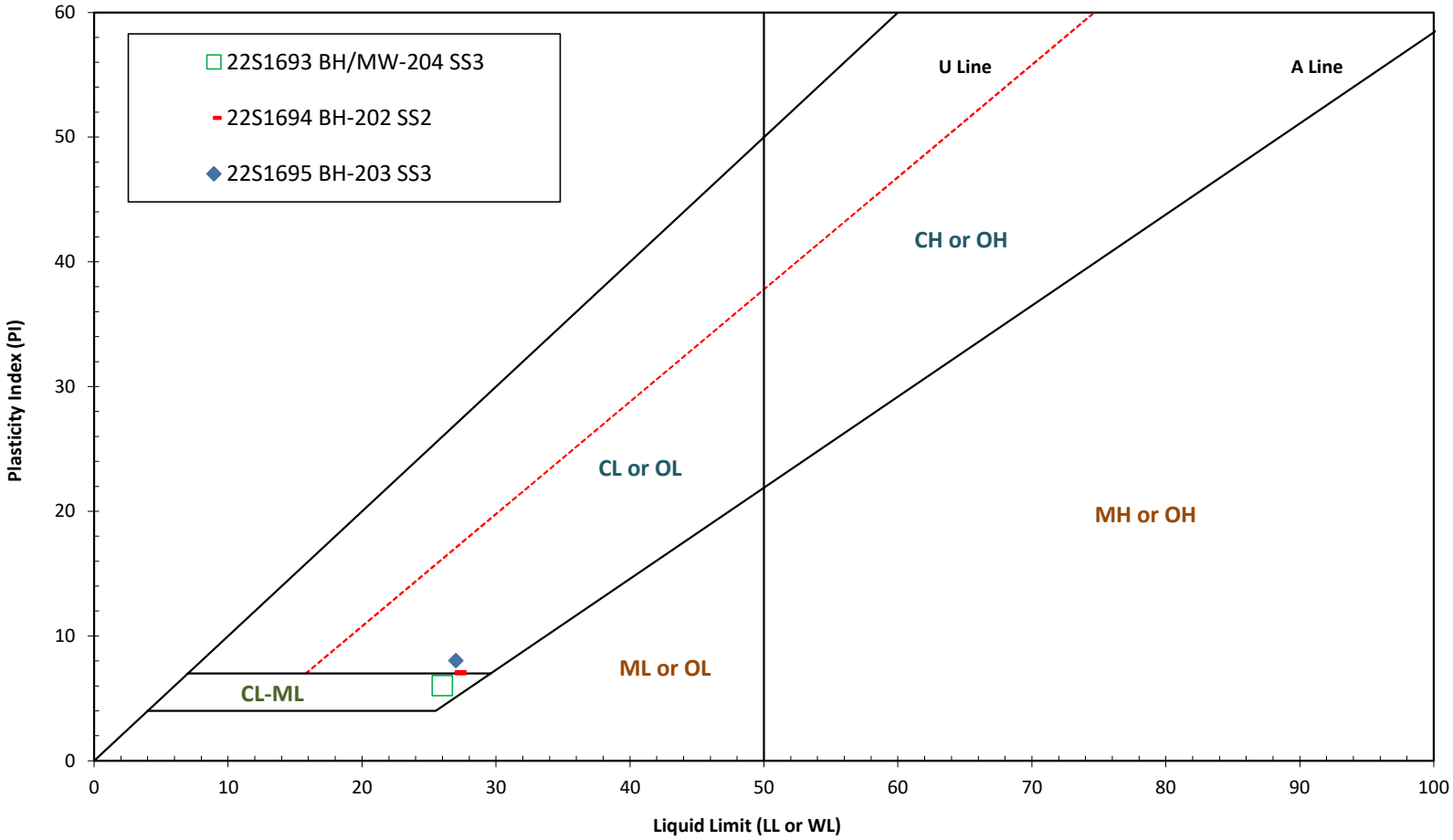
UNIFIED SOIL CLASSIFICATION SYSTEM



Project No.	:	SP23-01170-00
Date	:	27 April 2023
Figure No.	:	6

Atterberg's Limits Test Report

ASTM D4318-10



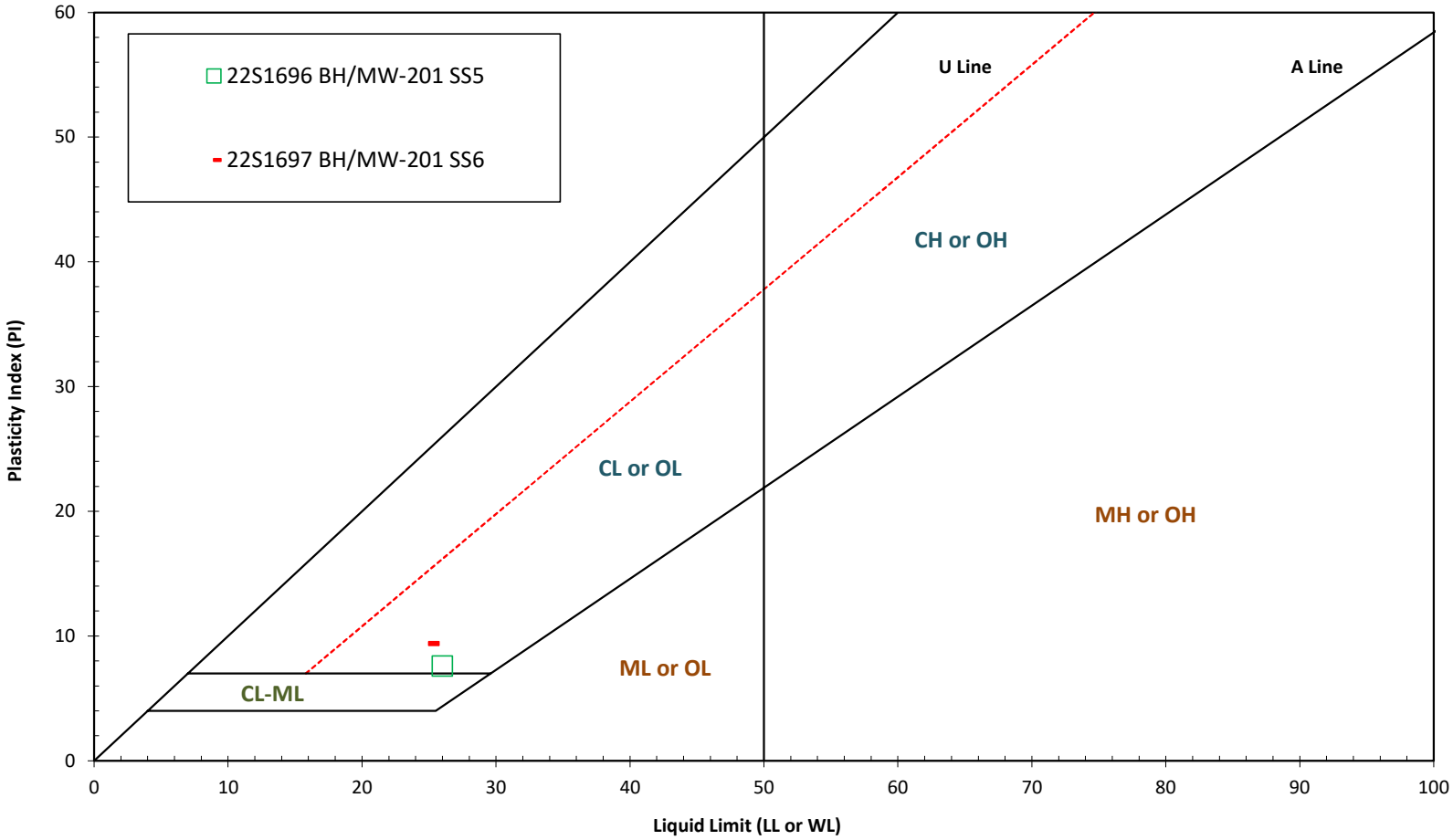
SIRATI & PARTNERS

Geotechnical Hydrogeological & Environmental Solutions

Date	:	27 April 2023
Project No.	:	SP23-01170-00
Figure No.	:	7

Atterberg's Limits Test Report

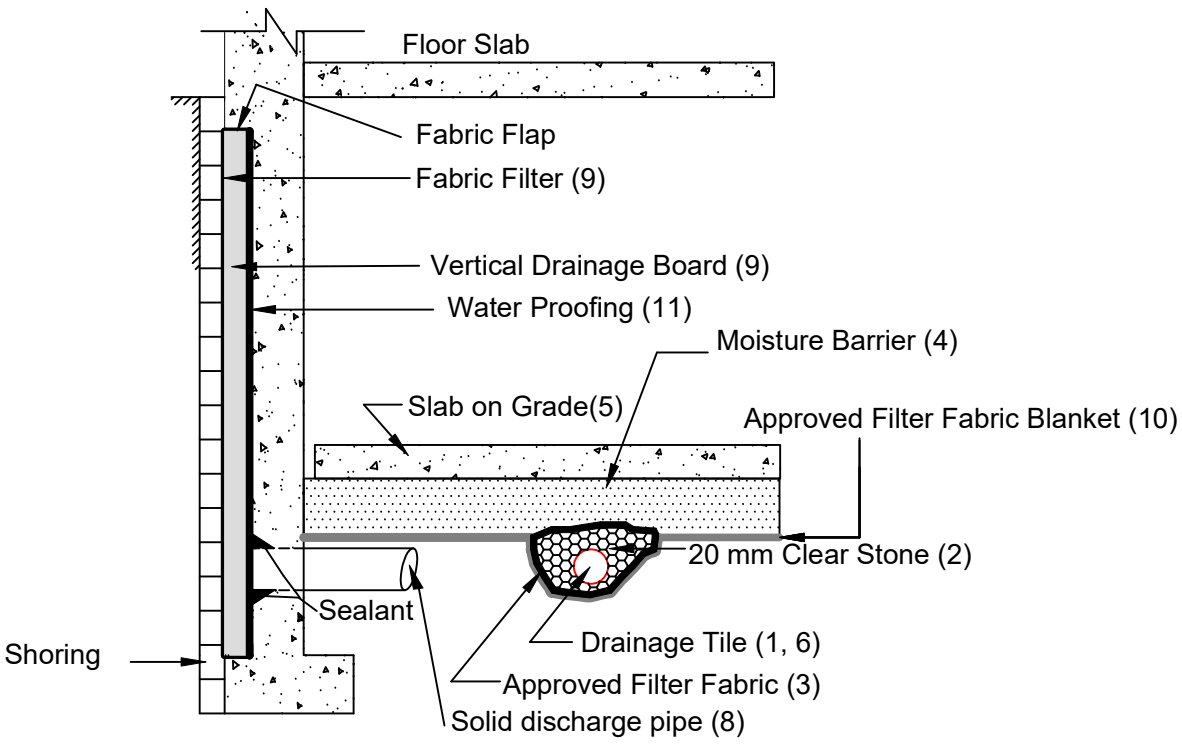
ASTM D4318-10



SIRATI & PARTNERS

Geotechnical Hydrogeological & Environmental Solutions

Date	:	27 April 2023
Project No.	:	SP23-01170-00
Figure No.	:	8

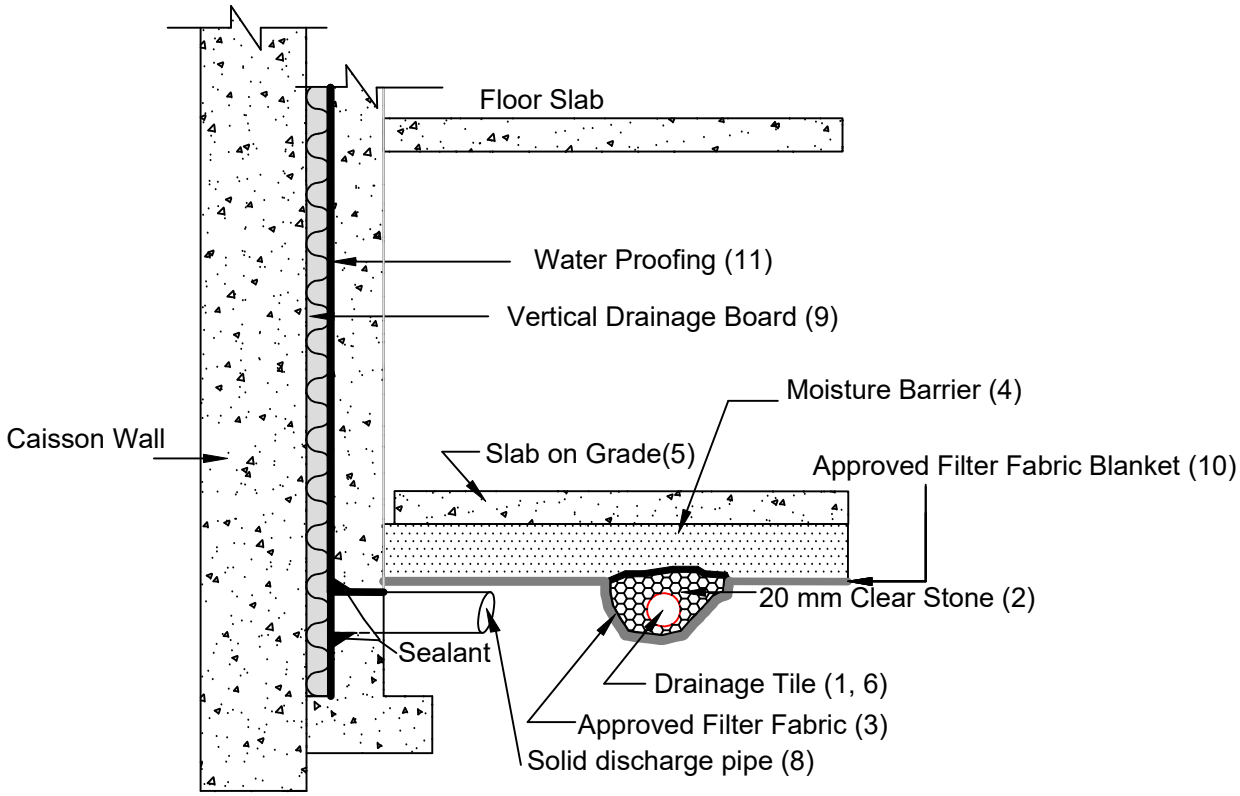


EXTERIOR FOOTING

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, place100 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 solider 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 minium of 1.2 m below exterior finished grade.
10. The entire subgrade to be sealed with approved filter fabric (Terrafix 270R or equivalent) if non-cohesive (sandy) soils below ground water table encountered.
11. The basement walls should be water proofed using bentonite or equivalent water-proofing system.
12. 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.
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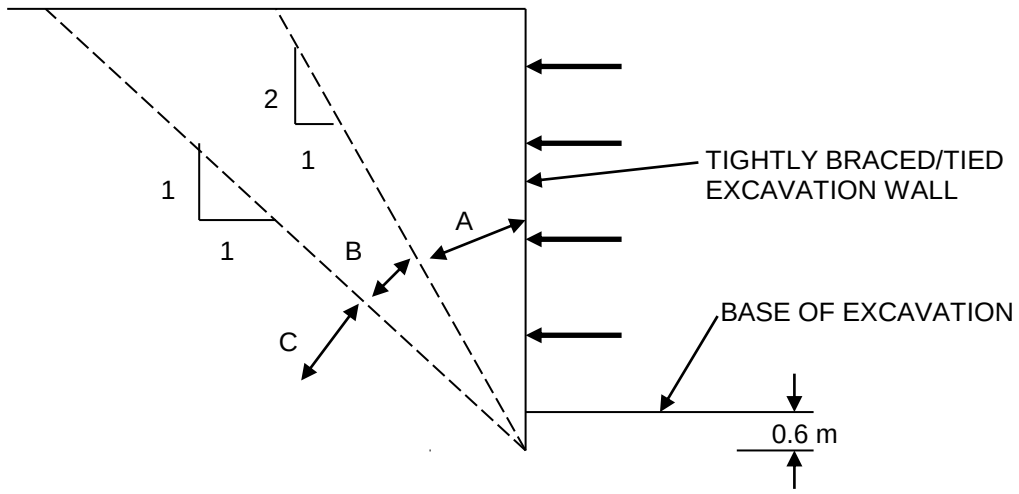
7. Do not connect the underfloor drains to perimeter drains.
8. Solid discharge pipe located at the middle of each bay between the solider piles, approximate spacing 2.5 m, outletting into a solid pipe leading to a sump.
9. Vertical drainage board mira-drain 6000 or eqivalent with filter cloth should be continous from bottom to 1.2 m below exterior finished grade.
10. The entire subgrade to be sealed with approved filter fabric (Terrafix 270R or equivalent) if non-cohesive (sandy) soils below ground water table encountered.
11. The basement walls must be water proofed using bentonite or equivalent water-proofing system.
12. 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

GUIDELINES FOR ENGINEERED FILL

GENERAL REQUIREMENTS FOR ENGINEERED FILL

Compacted imported soil that meets specific engineering requirements and is free of organics and debris and that has been continually monitored on a full-time basis by a qualified geotechnical representative is classified as engineered fill. Engineered fill that meets these requirements and is bearing on suitable native subsoil can be used for the support of foundations.

Imported soil used as engineered fill can be removed from other portions of a site or can be brought in from other sites. In general, most of Ontario soils are too wet to achieve the 100% Standard Proctor Maximum Dry Density (SPMDD) and will require drying and careful site management if they are to be considered for engineered fill. Imported non-cohesive granular soil is preferred for all engineered fill. For engineered fill, we recommend use of OPSS Granular 'B' sand and gravel fill material.

Adverse weather conditions such as rain make the placement of engineered fill to the required degree of density difficult or impossible; engineered fill cannot be placed during freezing conditions, i.e. normally not between December 15 and April 1 of each year.

The location of the foundations on the engineered fill pad is critical and certification by a qualified surveyor that the foundations are within the stipulated boundaries is mandatory. Since layout stakes are often damaged or removed during fill placement, offset stakes must be installed and maintained by the surveyors during the course of fill placement so that the contractor and engineering staff are continually aware of where the engineered fill limits lie. Excavations within the engineered fill pad must be backfilled with the same conditions and quality control as the original pad.

To perform satisfactorily, engineered fill requires the cooperation of the designers, engineers, contractors and all parties must be aware of the requirements. The minimum requirements are as follows; however, the geotechnical report must be reviewed for specific information and requirements.

1. Prior to site work involving engineered fill, a site meeting to discuss all aspects must be convened. The surveyor, contractor, design engineer and geotechnical engineer must attend the meeting. At this meeting, the limits of the engineered fill will be defined. The contractor must make known where all fill material will be obtained from and samples must be provided to the geotechnical engineer for review, and approval before filling begins.

2. Detailed drawings indicating the lower boundaries as well as the upper boundaries of the engineered fill must be available at the site meeting and be approved by the geotechnical engineer.

3. The building footprint and base of the pad, including basements, garages, etc. must be defined by offset stakes that remain in place until the footings and service connections are all constructed. Confirmation that the footings are within the pad, service lines are in place, and that the grade conforms to drawings, must be obtained by the owner in writing from the surveyor and Sirati & Partners Consultants Limited. Without this confirmation, no responsibility for the performance of the structure can be accepted by Sirati & Partners Consultants Limited (SIRATI). Survey drawing of the pre-and post-fill location and elevations will also be required.

4. The area must be stripped of all topsoil and fill materials. Subgrade must be proof-rolled. Soft spots must be dug out. The stripped native subgrade must be examined and approved by a SIRA -TI engineer prior to placement of fill.

5. The approved engineered fill material must be compacted to 100% Standard Proctor Maximum Dry Density throughout. Engineered fill should not be placed during the winter months. Engineered fill compacted to 100% SPMDD will settle under its own weight approximately 0.5% of the fill height and the structural engineer must be aware of this settlement. In addition to the settlement of the fill, additional settlement due to consolidation of the underlying soils from the structural and fill loads will occur and should be evaluated prior to placing the fill.

6. Full-time geotechnical inspection by SIRATI during placement of engineered fill is required. Workcannot commence or continue without the presence of the SIRATI representative.

7. The fill must be placed such that the specified geometry is achieved. Refer to the attached sketches for minimum requirements. Take careful note that the projection of the compacted pad beyond the footing at footing level is a minimum of 2 m. The base of the compacted pad extends 2 m plus the depth of excavation beyond the edge of the footing.

8. A bearing capacity of 150 kPa at SLS (225 kPa at ULS) can be used provided that all conditions outlined above are adhered to. A minimum footing width of 500 mm (20 inches) is suggested and footings must be provided with nominal steel reinforcement.

9. All excavations must be done in accordance with the Occupational Health and Safety Regulations of Ontario.

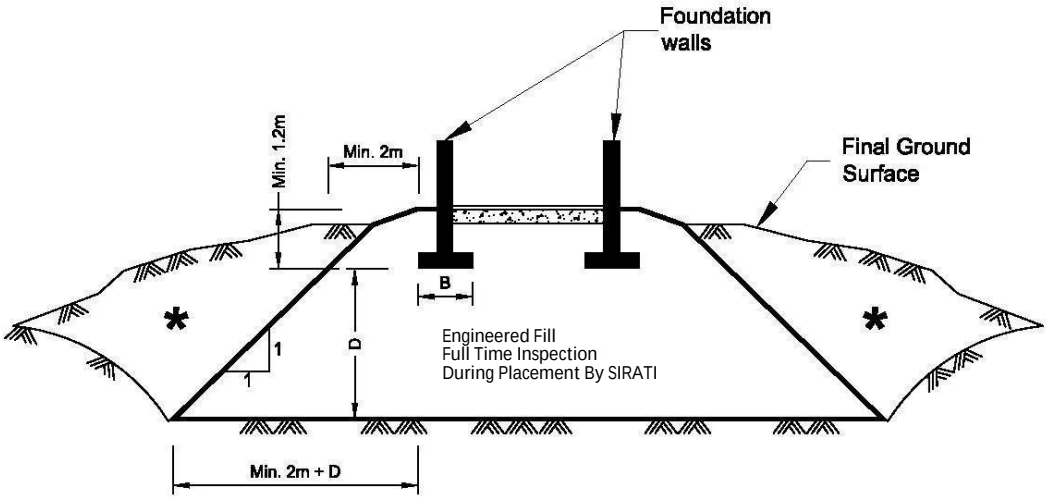
10. After completion of the engineered fill pad a second contractor may be selected to install footings. The prepared footing bases must be evaluated by engineering staff from SIRATI prior tofooting concrete placements. All excavations must be backfilled under full time supervision bySIRATI to the same degree as the engineered fill pad. Surface water cannot be allowed to pond inexcavations or to be trapped in clear stone backfill. Clear stone backfill can only be used with theapproval of SIRATI.

11. After completion of compaction, the surface of the engineered fill pad must be protected from disturbance from traffic, rain and frost. During the course of fill placement, the engineered fill must be smooth-graded, proof-rolled and sloped/crowned at the end of each day, prior to weekends and any stoppage in work in order to promote rapid runoff of rainwater and to avoid any ponding surface water. Any stockpiles of fill intended for use as engineered fill must also be smooth-bladed to promote runoff and/or protected from excessive moisture take up.

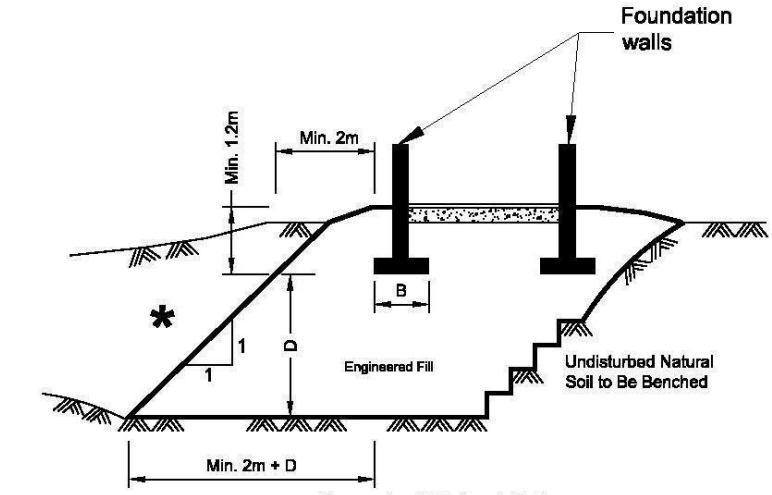
12. If there is a delay in construction, the engineered fill pad must be inspected and accepted by the geotechnical engineer. The location of the structure must be reconfirmed that it remains within the pad.

13. The geometry of the engineered fill as illustrated in these General Requirements is general in nature. Each project will have its own unique requirements. For example, if perimeter sidewalks are to be constructed around the building, then the projection of the engineered fill beyond the foundation wall may need to be greater.

14. These guidelines are to be read in conjunction with Sirati & Partners Consultants Limited (SIRA TI) report attached.



Competent Natural Soil To Be Confirmed By SIRATI



Backfill in this area to be as per the SIRATI report

Competent Natural Soil

Appendix B: Limitation and Use of 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 Sirati & Partners Consultants Limited (SIRATI) at the time of preparation. Unless otherwise agreed in writing by SIRATI, 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 borehole 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 boreholes may differ from those encountered at the borehole 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 borehole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc. Professional judgement was exercised in gathering and analyzing data and formulation of recommendations using current industry guidelines and standards. Similar to all professional persons rendering advice, SIRATI cannot act as absolute insurer of the conclusion we have reached. No additional warranty or representation, expressed or implied, is included or intended in this report other than stated herein the report.

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 boreholes 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. SIRATI 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. Any user of this report specifically denies any right to claims against the Consultant, Sub-Consultants, their officers, agents and employees in excess of the fee paid for professional services.

SIRATI engagement hereunder is subject to and condition upon, that SIRATI not being required by the Client, or any other third party to provide evidence or testimony in any legal proceedings pertaining to this finding of this report or providing litigations support services which may arise to be required in respect of the work produced herein by SIRATI. It is prohibited to publish, release or disclose to any third party the report produced by SIRATI pursuant to this engagement and such report is produced solely for the Client own internal purposes and which shall remain the confidential proprietary property of SIRATI for use by the Client, within the context of the work agreement. The Client will and does hereby remise and forever absolutely release SIRATI, its directors, officers, agents and shareholders of and from any and all claims, obligations, liabilities, expenses, costs, charges or other demands or requirements of any nature pertaining to the report produced by SIRATI hereunder. The Client will not commence any claims against any Person who may make a claim against SIRATI in respect of work produced under this engagement.