PRELIMINARY
Geotechnical Investigation
Proposed Residential Development
5160 – 5170 Ninth Line
Mississauga, Ontario

PREPARED FOR:
Branthaven Development

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Project No: 21-071-100
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DRAWINGS

1. INTRODUCTION

DS Consultants Ltd (DS) was retained by Branthaven Development to carry out a preliminary geotechnical investigation for the proposed residential development to be located at 5160 and 5170 Ninth Line, Mississauga, Ontario.

Based on the provided latest architecture drawings, it is understood that the proposed residential development will consist of a six-storey building with one level of underground parking/basement.

Design grades are not known at this stage. Therefore, our recommendations are preliminary and must be confirmed/updated when the site/foundation plans are available.

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 preliminary engineering recommendations for the following:

1. Foundations
2. Floor slabs and permanent drainage
3. Excavations and backfill
4. Earth pressures
5. Temporary Shoring System
6. Earthquake considerations
7. Pavement

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 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, this office should be contacted to review the design. 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 Branthaven Development and its architects and designers. Third party use of this report without DS Consultants Ltd. consent is prohibited.

2. FIELD AND LABORATORY WORK

Four boreholes (BH21-1 to BH21-4, see Drawing 1 for borehole location plan) were drilled at the subject site to depths ranging from 8.2 to 18.9 m.

Boreholes were drilled with solid stem continuous flight auger equipment by a drilling sub-contractor under the direction and supervision of DS Consultants Limited 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 Consultants Ltd. laboratory for detailed examination by the project engineer and for laboratory testing.

As well as visual examination in the laboratory, all soil samples were tested for moisture contents. Grain size analyses were carried out on selected five (5) soil samples and gradation curves for grain size analyses are presented on **Drawing 6**. Atterberg Limits testing was carried on selected one sample and results are presented on the respective borehole logs.

Water level observations were made during drilling and in the open boreholes at the completion of the drilling operations. Monitoring wells were installed in boreholes BH21-1, BH21-2 and BH21-3 for long-term groundwater level measurements.

The ground surface elevations at the borehole locations were surveyed by DS, using a differential GPS unit.

3. 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 the boreholes are presented in the individual borehole logs Drawings 2 to 5. The subsurface conditions in the boreholes (by DS) are summarized in the following paragraphs.

3.1 Soil Conditions

Pavement/Topsoil/Organic Material

Pavement structure was present at the surface at borehole BH21-1. The pavement consisted of about 75 mm thick asphalt layer followed by granular base, about 280 mm in thickness, consisting of sand and gravel.

A surficial layer of topsoil/organic material, ranging from 100 to 150 mm in thickness, was observed at the surface at boreholes BH21-2 to BH21-4.

It should be noted that the thickness of the topsoil explored at the borehole locations may not be representative for the site and should not be relied on to calculate the amount of topsoil at the site.

Shallow hand-dug test-pits should be carried out to calculate the amount of topsoil at site accurately.

Fill Materials:

Fill materials consisting of clayey silt material was detected in all the boreholes below the pavement/topsoil/organic layer and extended to an approximate depth of 0.8 m below the existing ground surface. The fill layer contained some to trace of organics, rootlets, sand, gravel and cobbles. The moisture content of this moist fill layer varied from 5 to 26%.

The type/quantity and extent of the existing fill layer can be explored by further test pit investigation prior to excavations.

Clayey Silt/Clayey Silt to silty Clay Till:

Clayey silt to clayey silt/silty clay till deposit was encountered below the fill layer in all the boreholes and extended to an approximate depth of 16.8 m in Borehole BH21-1 and to the maximum explored depth of Boreholes BH21-2 to BH21-4. This clayey deposit contained some sand, gravel and cobbles. SPT ‘N’ values measured in this clayey/till deposit ranged from 8 to 38 blows per 300mm of penetration, indicating a stiff to hard consistency. The moisture content of this moist clayey till deposit varied from 9 to 18%.

Grain size analyses of four silty clay till soil samples (BH1/SS7, BH2/SS8, BH3/SS7 and BH4/SS5) were conducted. The result is shown on **Drawing 6** with the following fractions:

Clay: 18 to 22%

Silt: 43 to 47%

Sand: 27 to 29%

Gravel: 4 to 8%

Atterberg Limits tests of the above silty clay till soil samples (BH1/SS7, BH2/SS8, BH3/SS7 and BH4/SS5) were conducted. The result is shown on the borehole logs and are summarized as follows:

Liquid limit (W_L): 20.4 to 21.0%

Plastic limit (W_P): 12.1 to 12.6%

Plasticity index (PI): 8.0 to 8.8%

Lower Cohesionless Soil Sandy Silt Till Deposit:

Lower deposit of sandy silt till with some to trace of clay, gravel and cobbles was encountered underlying clayey silt to clayey silt/silty clay till in Borehole BH21-1 extending to the maximum explored depths of borehole.

SPT ‘N’ value measured within this sandy silt till layer was 52 blows per 300mm of penetration, indicating very dense relative density. The moisture content of this moist sandy silt till layer was approximately 10%.

Grain size analyses of one (1) soil sample from the sandy silt till deposits (BH21-1/SS13) were conducted, and the results are presented in **Drawing 6**, with the following fractions:

Clay:	10%
Silt:	43%
Sand:	41%
Gravel:	6%

3.2 Groundwater Conditions

During drilling or upon completion, no free-standing water was found in borehole BH21-4 on short-term basis. Groundwater levels in the monitoring wells installed at three (3) DS borehole locations (BH21-1, BH21-2 and BH21-3) measured on July 2, 2021 are provided below on Table 1.

Table 1: Groundwater Levels Observed in DS Monitoring Wells

DS BH No.	Ground Surface Elevation (m)	Date of Drilling	Date of Observation	Depth of Groundwater (m)	Elevation of Groundwater (m)
BH21-1	190.9	June 30, 2021	July 2, 2021	7.4	183.5
BH21-2	191.8	June 29, 2021	July 2, 2021	1.9	189.9
BH21-3	192.1	June 28, 2021	July 2, 2021	1.8	190.3

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

Therefore, reference should be made to the hydrogeology study report prepared by DS for further details on the volume flow and groundwater control.

4. FOUNDATIONS

Subject to design grades/loads and due to the variable soil conditions and the presence of less competent soils, the proposed six storey building with a single level of underground parking/basement can be supported on conventional strip spread footings and/or raft foundations founded in native undisturbed clayey silt/till deposit. Soil bearing resistance and founding depths/elevations are presented in Table 2.

Table 2: Bearing Values and Founding Levels of conventional Footings and raft foundations in Native Soils

BH No.	Borehole Elevation (m)	Bearing Capacity at SLS (kPa)	Factored Geotechnical Resistance at ULS (kPa)	Minimum Depth below Existing Ground (m)	Founding Level At or Below Elevation (m)
BH21-1	190.9	200 125	300 175	1.5 5.5	189.4 185.4
BH21-2	191.8	200	300	2.0	189.8
BH21-3	192.1	200	300	2.0	190.1
BH21-4	191.1	200 150 200	300 225 300	1.0 3.0 5.0	190.1 188.1 186.1

The soils become weaker, below the upper crust, with depth due to the presence of less competent clayey soils. The footings founded at higher elevation must ensure that the soils at a lower elevation are not overstressed by assuming 2V to 1H load spread.

Due to the variable soil conditions and the presence of less competent clayey soils below the proposed Footings, settlement analyses will be required when the foundation plan/design loads areas available to evaluate/quantify the total and differential settlements.

If the calculated settlement exceeds the tolerable limits, then deep foundation alternative should be considered.

Further borehole investigation will be required after the demolition of the existing structures to confirm the subsurface soil, groundwater conditions, type and depth of foundation alternative to be utilized and recommended bearing resistance.

All footing bases must be inspected by this office prior to pouring concrete. The excavated footing/raft 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.

Prior to placing concrete, all footing/raft bases must be inspected by this office to confirm the founding soil conditions and design bearing capacity.

All footings exposed to seasonal freezing conditions must have at least 1.2 m soil cover for frost protection, including the footings in the vicinity of air shafts and exit/entry doors.

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.

In the vicinity of the existing buried utilities, all footings must be lowered to undisturbed native soils, or alternatively the services must be structurally bridged.

It should be noted that the recommended bearing capacities have been calculated by DS from the available 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. FLOOR SLAB

The basement (P1) floor slab can be supported on grade supported by competent native undisturbed clayey silt/till soils.

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

A permanent perimeter and subfloor drainage system will be required around the exterior basement walls. The perimeter and underfloor drainages for shoring systems are shown on **Drawings 7** (for open excavation) and **Drawings 8 & 9** (for shoring).

5.1 ELEVATOR PITS

The elevator pits should be designed as a water-tight structures and should be fully waterproofed to avoid any water leaks and will not require perimeter drainage around the pit at lower elevation.

6. EARTH PRESSURES

The lateral earth pressures acting on the basement and retaining walls can 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, K = 0.4.

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 a drainage system will be installed to prevent the build-up of any hydrostatic pressure behind the wall.

7. EARTHQUAKE CONSIDERATION

Based on the drilled boreholes and our review of the general subsurface information in the area, and according to Table 4.1.8.4.A of OBC 2012, the subject site for the proposed development founded on undisturbed native soils could be classified as 'Class C' for seismic site response.

However, Shear Wave Velocity Test (SWVT) will be required to confirm site classification.

8. EXCAVATIONS AND GROUNDWATER CONTROL

Excavations in overburden can be carried out with heavy hydraulic backhoe.

The water seepage from the clayey silt till will be slow and can be handled by conventional pumping from sumps. In case of significant wet sand layers (although not anticipated) if encountered during excavations, then dewatering system such as well points will be required.

The groundwater levels measured in the monitoring wells (in Boreholes BH21-1, BH21-2 and BH21-3, on July 2, 2021) varied from 1.8 m to 7.4 m, at approximate elevations varying from 190.3 to 183.5 m, as presented in Table 1.

DS completed a hydrogeological study at the subject site and more comments regarding the type and extent of groundwater control required were addressed in the hydrogeology report.

It should be noted that the till is a non-sorted sediment and therefore may contain boulders. Possible large obstructions such as buried concrete pieces are also anticipated in the fill material. Provisions must be made in the excavation contract for the removal of possible boulders in the till or 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 materials, firm to stiff clayey deposits can be classified as Type 3 Soil above the groundwater table and as Type 4 Soil below the groundwater table. Very stiff to hard clayey deposits can be classified as Type 2 Soil above the groundwater table and as Type 3 Soil below the groundwater table.

Select inorganic fill and native soils free from topsoil and organics can be used as general construction backfill. 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.

Underfloor fill should be compacted to at least 98 percent of Standard Proctor Maximum Dry Density (SPMDD).

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. TEMPORARY SHORING

It is expected that the proposed building will be constructed in an open excavation. However, subject to the final building location and the proximity to the property line and existing underground services, 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 walls to support adjacent structures is given on **Drawing 10.**

The shoring system must be designed in accordance with the 4th Edition of the Canadian Foundation Engineering Manual. 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, where H is the shoring height
    (c) passive earth pressure for soldier piles (unfactored) Kp=4 for dense and hard native deposits.
2) For stability check

$\phi = 32^\circ$

C = 0

$\gamma = 21$ kN/m^3

surcharge is to be determined by shoring contractor.

3) For soil anchors

An allowable bond value of 75 kPa is suggested for post-grouted anchors in very stiff to hard and dense to very dense deposits. An allowable bond value of 50 kPa is suggested for post-grouted anchors in stiff deposits. However, this suggested bond value is preliminary since the contractor's installation methods and grouting procedures will determine the actual soil to concrete bond value. Hence, the contractor must decide on a capacity and confirm its availability by field load testing. Gravity poured concrete can result in low bond values while pressure grouted anchors will give higher values and produce a more satisfactory anchor. All anchors must be tested as indicated in the Foundation Manual, 4th edition.

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 the sand from 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 ϕ is the soil friction angle and H is the shoring height.

The top anchor must not be placed lower than 3.0 metres below the top of level ground surface. Anchors will require casing when penetrating through wet sand and silt layers.

The contractor must decide the anchor capacity and confirm its availability. All anchors must be tested as indicated in the Canadian Foundation Engineering 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% of the shoring height (H). Vertical movements increase the horizontal movements because of the reduced stress in the inclined anchors and must be kept well below this value.

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.

10. PAVEMENTS

10.1 Pavement Structure above Garage Slab

In order to provide surface drainage over the garage roof, granular material must be used to obtain slope for drainage.

The following asphalt pavement structures are recommended for light and heavy duty areas:

Light Duty Areas:	60 mm HL3HS
	150 mm Granular A (min. 100 mm variable thickness to provide 2% slope for drainage)
	Protection board to prevent piercing of waterproofing membrane
	Structural Concrete Slab
Heavy Duty Areas:	40 mm HL3HS
	80 mm HDBC
	300 mm Crusher Run Limestone
	Protection board to prevent piercing of waterproofing membrane
	Structural Concrete Slab

Concrete Pavers Pavement Structure:

70 mm Concrete Pavers

25 mm Sand Leveling underlain by filter fabric

200 mm Concrete Slab (Subbase) with 25 mm diameter drain holes @ 3,000 mm spacing.

150 mm Granular A (min. 100 mm variable thickness to provide 2% slope for drainage)

Protection board to prevent piercing of waterproofing membrane

Structural Concrete Slab

If this method is used, a bi-level drainage system is required.

If the underlying concrete slab (parking garage roof) has been sloped to provide adequate surface drainage, the placement of granular drainage layer is not required, and asphalt concrete can be placed directly on top of the protection board.

The critical section of pavement will be at the transition from the infinitely rigid substructure onto soil/backfill subgrade.

As a result, we suggest that an approach type slab be constructed at the entrance/exit points. The approach slab will alleviate detrimental effects of dynamic loading/settlement/pavement depression in the backfill to the rigid substructure.

10.2 At Grade Asphalt Pavement Structure

The recommended pavement structures provided in Table 2 are based upon an estimate of the subgrade soil properties determined from visual examination and textural classification of the soil samples. The values may need to be adjusted based on the city/regional standards. Consequently, the recommended pavement structures should be considered for preliminary design purposes only. A functional design life of eight to ten years has been used to establish the pavement recommendations. This represents the number of years to the first rehabilitation, assuming regular maintenance is carried out. If required, a more refined pavement structure design can be performed based on specific traffic data and design life requirements and will involve specific laboratory tests to determine frost susceptibility and strength characteristics of the subgrade soils, as well as specific data input from the client.

The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions.

Stringent construction control procedures should be maintained to ensure uniform subgrade moisture and density conditions are achieved. In addition, the need for adequate drainage cannot be over-emphasized. The finished pavement surface and underlying subgrade should be free of depressions and should be sloped (preferably at a minimum grade of two percent) to provide effective surface drainage toward catch basins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas. Subdrains should be installed to intercept excess subsurface moisture and prevent subgrade softening. This is particularly important in heavy-duty pavement areas.

Table 2: Recommended Pavement Structure Thickness for Parking Lots

Pavement Layer	Compaction Requirements	Light Duty Parking (Cars)	Heavy Duty Parking (Delivery Trucks)
Asphaltic Concrete	92.0 to 96.5% Maximum Relative Density (MRD)	40 mm HL 3 or SP 12.5 40 mm HL 8 or SP 19.0	40 mm HL 3 or SP 12.5 80 mm HL 8 or SP 19.0
OPSS Granular A Base (or 20mm Crusher Run Limestone)	100% SPMDD*	150 mm	150 mm
OPSS Granular B (or 50mm Crusher Run Limestone)	100% SPMDD	250 mm	350 mm

* Denotes Standard Proctor Maximum Dry Density, ASTM-D698
The subgrade must be compacted to 98% SPMDD for at least the upper 500 mm unless accepted by DS Consultants Ltd.

Additional comments on the construction of parking areas and access roadways are as follows:

1. As part of the subgrade preparation, proposed parking areas and access roadways should be stripped of topsoil and other obvious objectionable material. Fill required to raise the grades to design elevations should conform to backfill requirements outlined in previous sections of this report. The subgrade should be properly shaped, crowned then proof-rolled in the full-time presence of a representative of this office. Soft or spongy subgrade areas should be sub-excavated and properly replaced with suitable approved backfill compacted to 98% SPMDD.

2. The locations and extent of sub-drainage required within the paved areas should be reviewed by this office in conjunction with the proposed lot grading.

Assuming that satisfactory crossfalls in the order of two percent have been provided, subdrains extending from and between catch basins may be satisfactory.

In the event that shallower crossfalls are considered, a more extensive system of sub-drainage may be necessary and should be reviewed by DS Consultants Ltd.

3. The most severe loading conditions on light-duty pavement areas and the subgrade may occur during construction. Consequently, special provisions such as restricted access lanes, half-loads during paving, etc., may be required, especially if construction is carried out during unfavourable weather.

4. It is recommended that DS Consultants Ltd. be retained to review the final pavement structure designs and drainage plans prior to construction to ensure that they are consistent with the recommendations of this report.

10.3 Concrete Sidewalk

It is understood that the sidewalks may be constructed in the area. Recommendations for the pavement structure of the sidewalk are as follows:

150 mm Concrete, over 150 mm Granular 'A' Base

The Granular 'A' base must be compacted to at least 100 percent of Standard Proctor Maximum Dry Density (SPMDD). The subgrade must be stripped of topsoil or other unsuitable material. The top 300 mm of the subgrade must be compacted to at least 98 percent of SPMDD. Prior to placing the Granular 'A' base material, the subgrade must be inspected by the geotechnical engineer.

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 Terraprobe borehole locations.

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.

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.

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Drawings

C:\0Sharon\21-071-100 Cofini Property 5160 and 5170 Ninth Line\1-QGIS\Geotechnical\Figure 1 – Borehole and Monitoring Well Locations.qgs Jul-30 07:39

Legend

🟥 Approx Property Boundary

⌖ Borehole

⌖ Monitoring Well

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Project: GEOTECHNICAL INVESTIGATION
5160 & 5170 Ninth Line , Mississauga, ON

Title: **BOREHOLE AND MONITORING WELL LOCATIONS**

N

Client:
BRANTHAVEN DEVELOPMENT

Size: 8.5 x 11

Rev: 0

Approved By: L.M

Drawn By: S.Y

Date: July 2021

Scale: As Shown

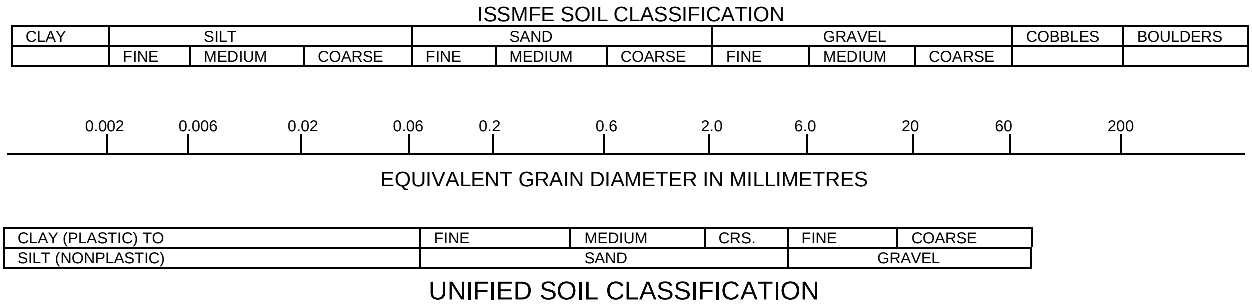
Project No.: 21-071-100

Darwing 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.



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.

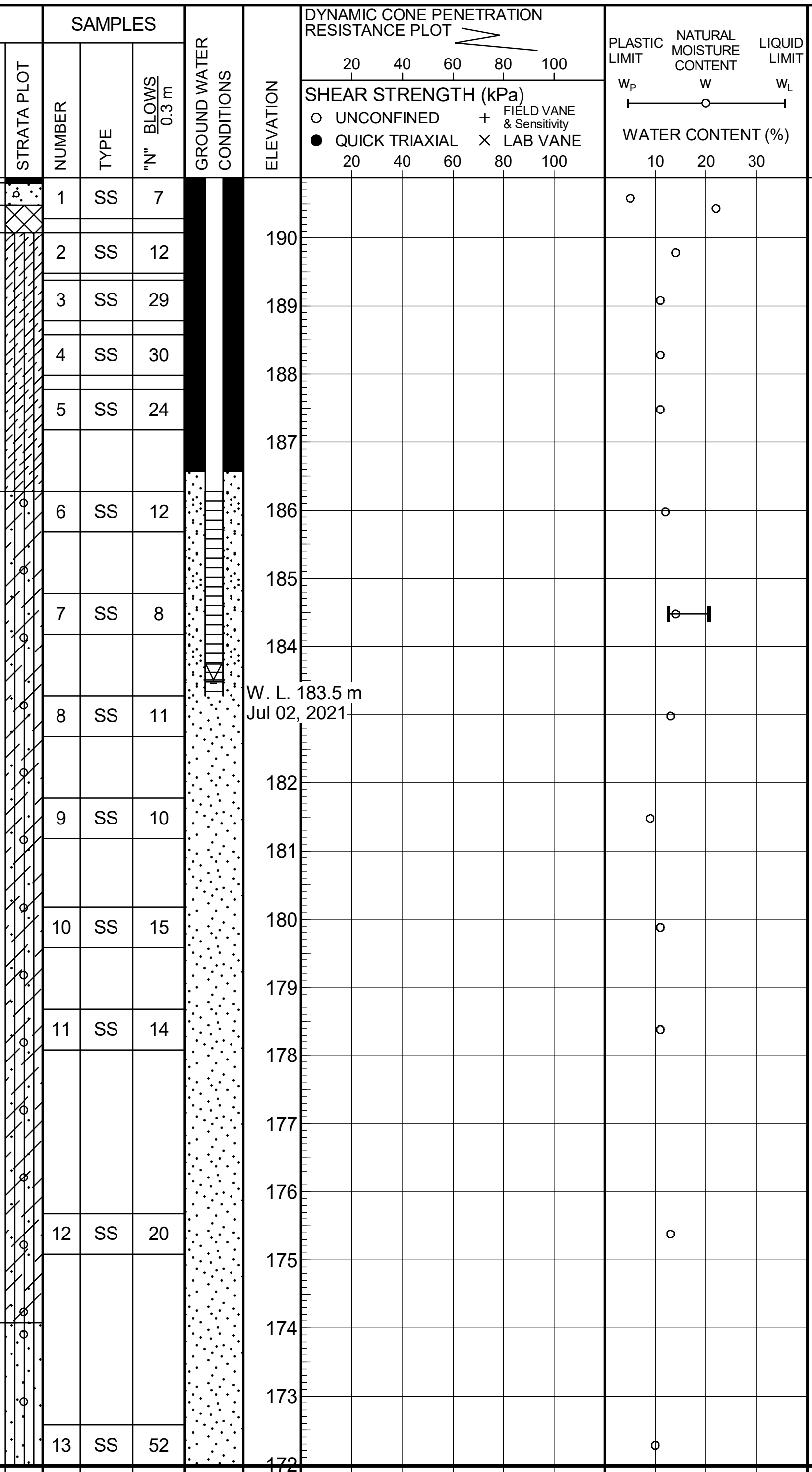
LOG OF BOREHOLE BH21-1

PROJECT: Geotechnical Investigation
CLIENT: Branthaven Development
PROJECT LOCATION: Cofini Property, 5160 & 5170 Ninth Line , Mississauga, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4821358.776 E 601978.592

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Jun-30-2021

REF. NO.: 21-071-100
ENCL NO.: 2

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
190.9					
190.8 0.1	**ASPHALT:** 75mm	1	SS	7	
190.5 0.4	**SAND AND GRAVEL:** 280mm				
190.1 0.8	**FILL:** clayey silt, trace sand, trace rootlets, trace gravel, brown, moist, firm	2	SS	12	
	CLAYEY SILT: trace sand, some gravel, brown, moist, stiff to hard	3	SS	29	
		4	SS	30	
		5	SS	24	
186.3 4.6	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, grey, moist, stiff to very stiff	6	SS	12	
		7	SS	8	6 27 46 21
		8	SS	11	
	very moist at 9.1m	9	SS	10	
		10	SS	15	
		11	SS	14	
		12	SS	20	
174.1 16.8	**SANDY SILT TILL:** trace clay, trace gravel, occasional cobble, grey, very moist, very dense				
172.0		13	SS	52	6 41 43 10
18.9	**END OF BOREHOLE:** Notes: 1) 50mm dia. monitoring well installed upon completion. 2) Water Level Readings: Date: Water Level(mbgl): July 2, 2021 7.37				



GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

LOG OF BOREHOLE BH21-2

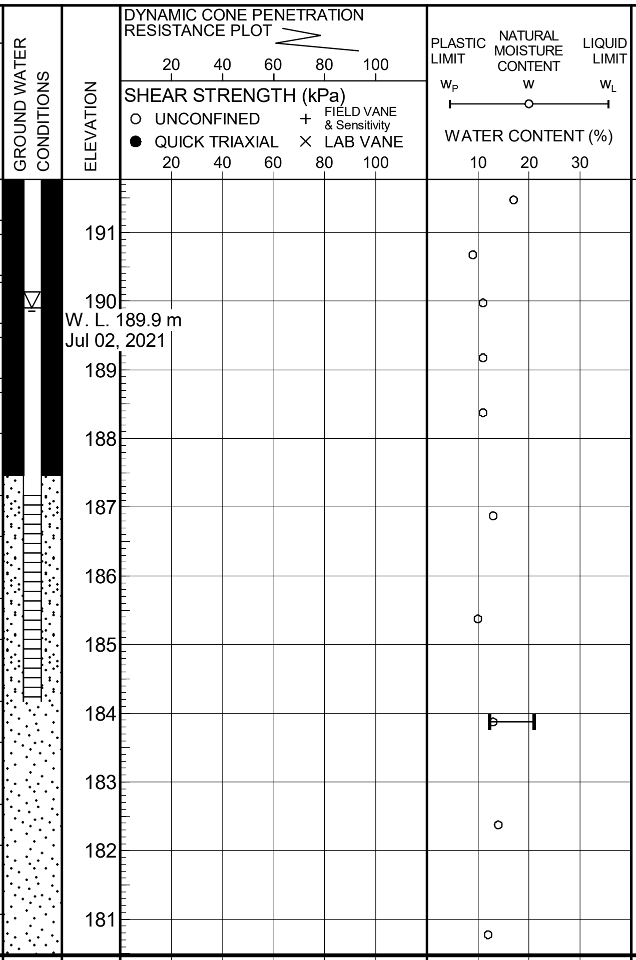
PROJECT: Geotechnical Investigation
CLIENT: Branthaven Development
PROJECT LOCATION: Cofini Property, 5160 & 5170 Ninth Line , Mississauga, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4821426.007 E 601916.827

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Jun-29-2021

REF. NO.: 21-071-100
ENCL NO.: 3

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION
191.8	
191.6 0.2	**TOPSOIL:** 150mm
	FILL: clayey silt, trace sand, trace gravel, trace rootlets/organics, brown, moist, stiff
191.0 0.8	**CLAYEY SILT:** trace sand, some gravel, brown, moist, very stiff to hard
189.5 2.3	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, occasional cobble, brown, moist, stiff to hard grey at 4.6m
184.2 7.6	**SILTY CLAY TILL:** sandy, trace gravel, grey, moist, stiff to very stiff
180.5 11.3	**END OF BOREHOLE:** Notes: 1) Monitoring well installed upon completion. 2) Water Level Readings: Date: Water Level(mbgl): July 2, 2021 1.87

SAMPLES NUMBER	TYPE	"N" BLOWS / 0.3 m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
1	SS	8				
2	SS	38				
3	SS	26				
4	SS	28				
5	SS	34				
6	SS	14				
7	SS	25				
8	SS	14	4	28	46	22
9	SS	13				
10	SS	18				



POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
$+^3, \times^3$: Numbers refer to Sensitivity
○ ^{8}=3% Strain at Failure

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LOG OF BOREHOLE BH21-3

1 OF 1

PROJECT: Geotechnical Investigation
CLIENT: Branthaven Development
PROJECT LOCATION: Cofini Property, 5160 & 5170 Ninth Line , Mississauga, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4821361.507 E 601895.67

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Jun-28-2021

REF. NO.: 21-071-100
ENCL NO.: 4

SOIL PROFILE		SAMPLES					
(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.1							
192.0 0.1	**TOPSOIL:** 100mm	1	SS	15			
191.3 0.8	**FILL:** clayey silt, trace sand, trace gravel, occasional cobble, trace rootlets, brown, moist, very stiff	2	SS	14		191	
	CLAYEY SILT: trace sand, trace gravel, brown, moist, stiff to hard	3	SS	21	W. L. 190.3 m Jul 02, 2021		
		4	SS	26			
		5	SS	23		189	
						188	
187.5 4.6	**CLAYEY SILT TILL:** some sand to sandy, trace gravel, occasional cobble, grey, moist, very stiff	6	SS	22		187	
186.0 6.1	**SILTY CLAY TILL:** sandy, trace gravel, grey, moist, very stiff	7	SS	19		186	8 27 47 18
						185	
183.9	greyish brown at 7.6m	8	SS	21		184	
8.2	**END OF BOREHOLE:** Notes: 1) 50mm dia. monitoring well installed upon completion. 2) Water Level Readings: Date: Water Level(mbgl): July 2, 2021 1.81						

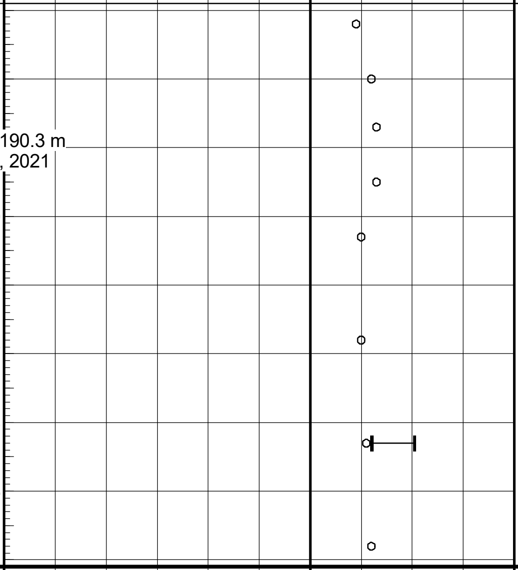
DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × 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
○ 8=3% Strain at Failure

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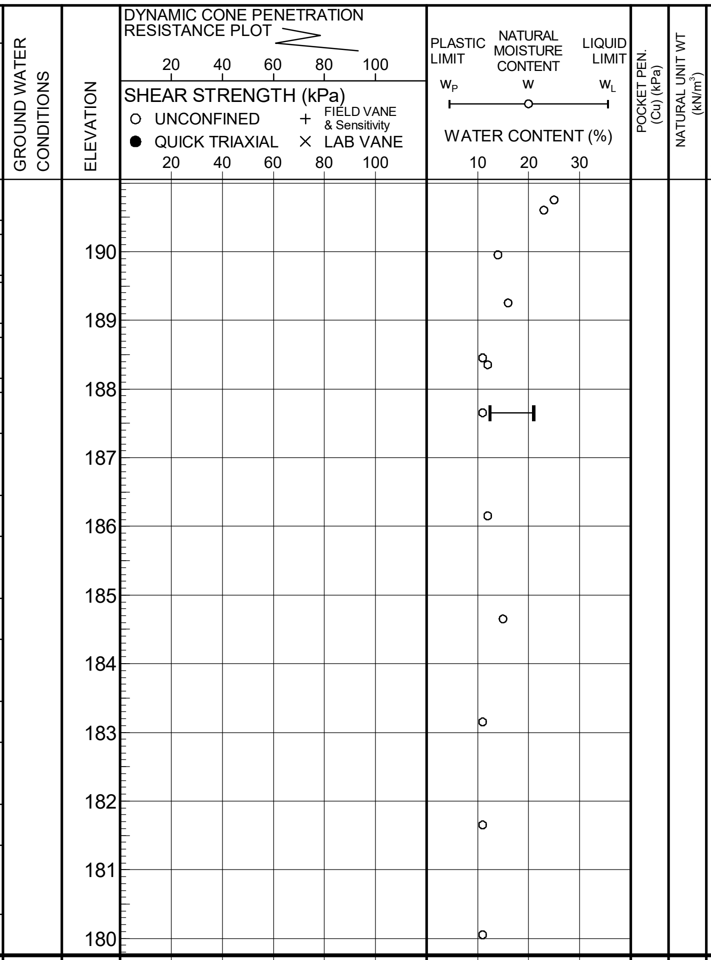
LOG OF BOREHOLE BH21-4

PROJECT: Geotechnical Investigation
CLIENT: Branthaven Development
PROJECT LOCATION: Cofini Property, 5160 & 5170 Ninth Line , Mississauga, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4821312.073 E 601942.531

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Jun-28-2021

REF. NO.: 21-071-100
ENCL NO.: 5

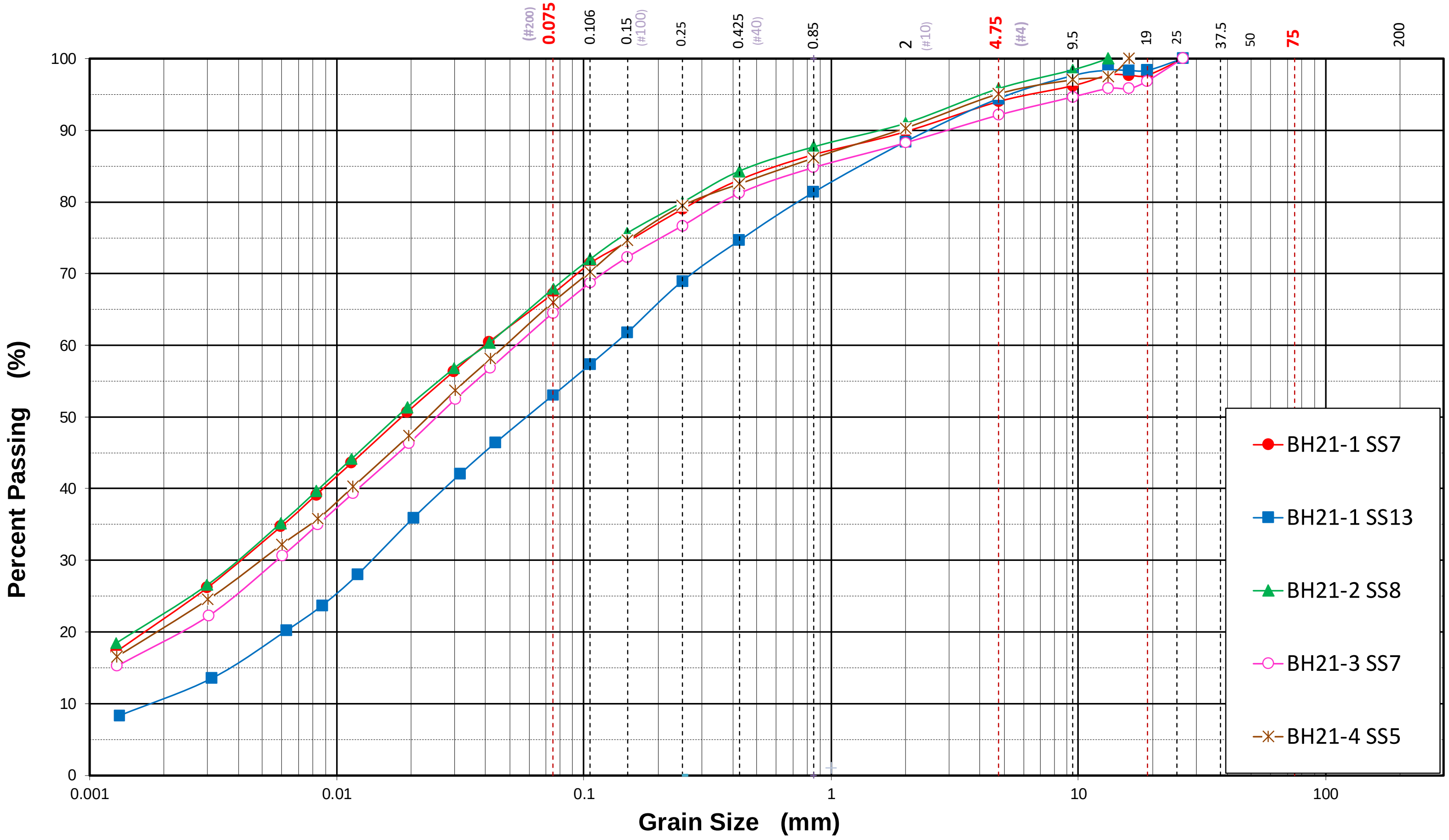
SOIL PROFILE		SAMPLES			REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS 0.3 m	GR SA SI CL
191.1					
0.0	**TOPSOIL:** 100mm	1	SS	4	
191.0 0.1	**FILL:** clayey silt, trace sand, trace rootlets/organics, some gravel, brown, moist, firm				
190.3 0.8	**CLAYEY SILT TILL:** some sand, trace gravel, occasional cobble, brown, moist, very stiff	2	SS	19	
		3	SS	19	
		4	SS	23	
188.0 3.1	**SILTY CLAY TILL:** sandy, trace gravel, grey, moist, stiff to very stiff	5	SS	11	5 29 46 20
		6	SS	14	
		7	SS	16	
		8	SS	26	
		9	SS	18	
		10	SS	17	
179.8 11.3	**END OF BOREHOLE:** Notes: 1) Borehole open and dry upon completion.				



GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

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

Particle Size Distribution (ASTM-D421/D422)



Silt and Clay		Sand			Gravel		Cobble +
Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	

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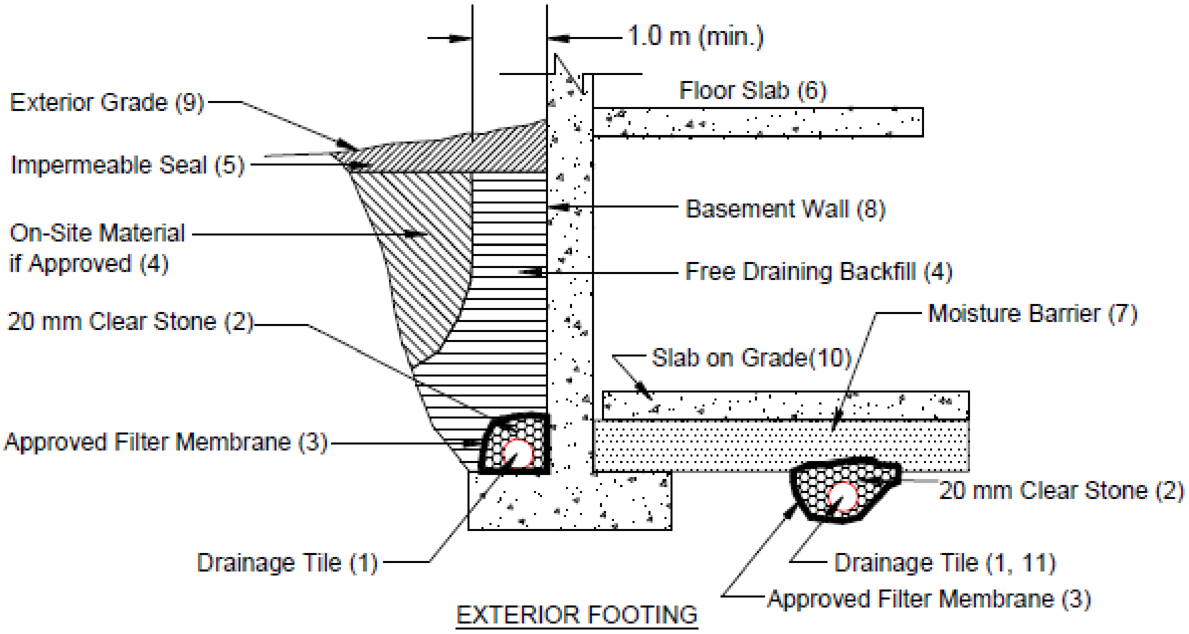
www.dsconsultants.ca

Project	**Cofini Property**	Project No	**21-071-100**
Location	**5160 & 5170 Ninth Line, Mississauga, ON.**	Date	**Jul-12-2021**
Client	**Branthaven Development**	Figure No	6

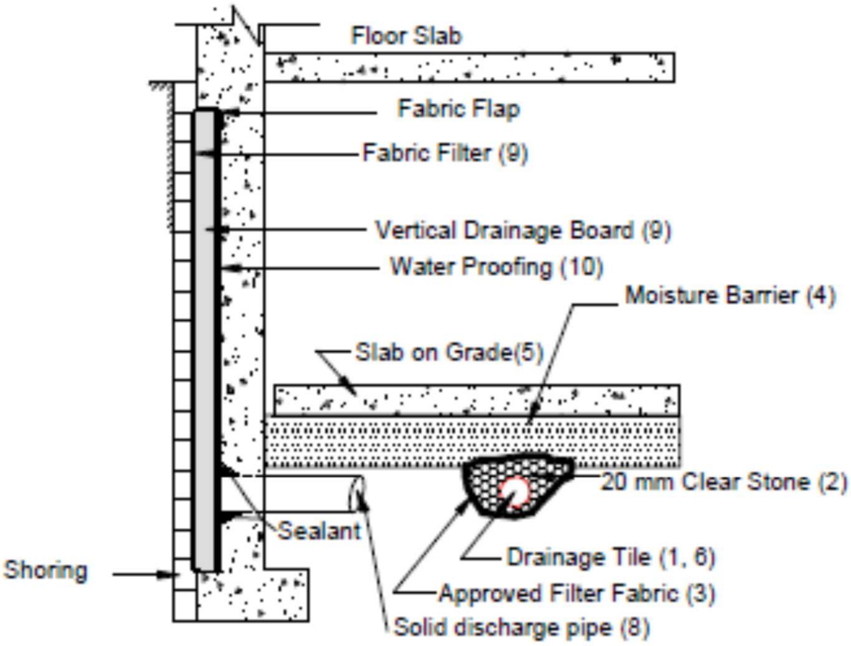


Notes

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet.
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. Free Draining backfill - OPSS Granular B or equivalent compacted to the specified density. Do not use heavy compaction equipment within 450 mm (18") of the wall. Use hand controlled light compaction equipment within 1.8 m (6') of wall. The minimum width of the Granular 'B' backfill must be 1.0 m.
5. Impermeable backfill seal - compacted clay, clayey silt or equivalent. If original soil is free-draining, seal may be omitted. Maximum thickness of seal to be 0.5 m.
6. Do not backfill until wall is supported by basement and floor slabs or adequate bracing.
7. 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.
8. Basement wall to be damp proofed /water proofed.
9. Exterior grade to slope away from building.
10. Slab on grade should not be structurally connected to the wall or footing.
11. Underfloor drain invert to be at least 300 mm (12") below underside of floor slab.
12. 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).
13. The entire subgrade to be sealed with approved filter fabric (Terrafix 270R or equivalent) if non-cohesive (sandy) soils below ground water table encountered.
14. Do not connect the underfloor drains to perimeter drains.
15. Review the geotechnical report for specific details.

DRAINAGE AND BACKFILL RECOMMENDATIONS
Basement with Underfloor Drainage

(not to scale)



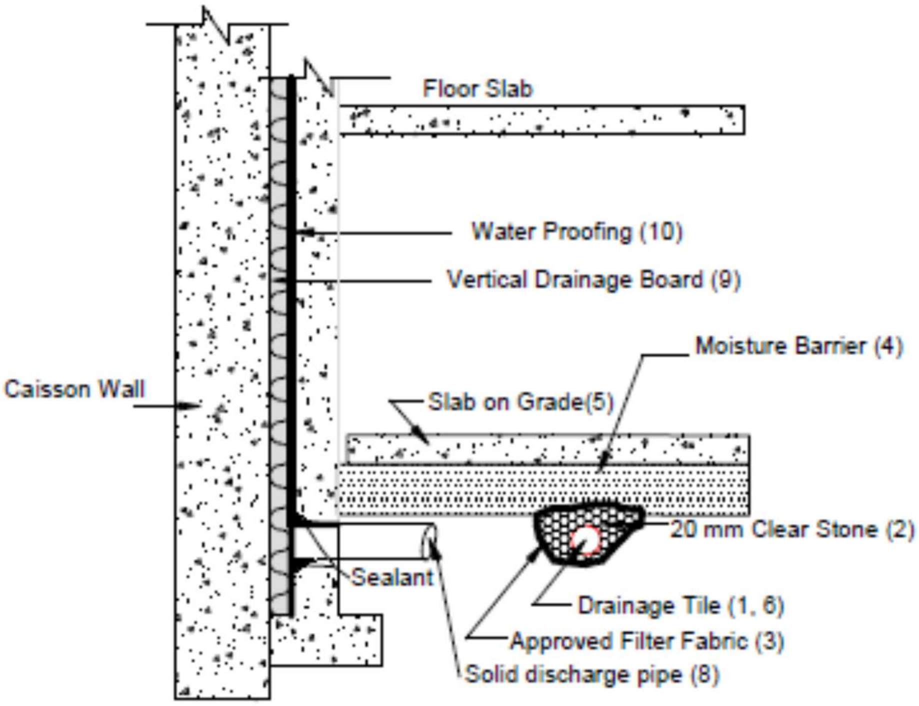
EXTERIOR FOOTING

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, 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 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, 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 mira-drain 6000 or eqivalent with filter cloth should be continous 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.

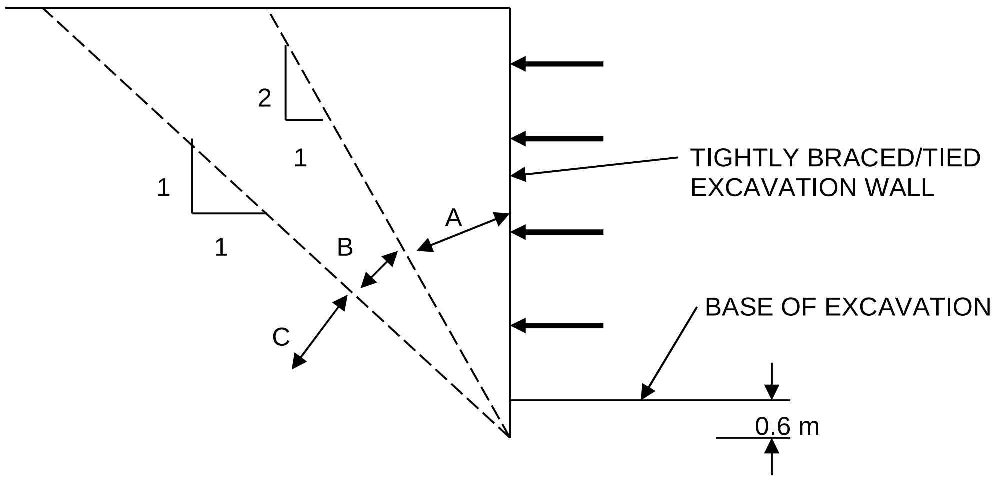
DRAINAGE RECOMMENDATIONS
Shored Basement wall with Underfloor Drainage System

(not to scale)

Project: 21-071-100 **Drawing 10**

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)