Aurora Sanitary Pumping Station
Aurora, Ontario

Type of Document:

Geotechnical Investigation

Submitted to:

Highfair Investments Inc. c/o Treasure Hill

Project Number:

BRM-21000267-D0

Submitted By:

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Date Submitted:

May 5, 2021

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1. Introduction

This report presents the results of a geotechnical investigation carried out for the proposed Aurora Sanitary Pumping Station in the Town of Aurora, Ontario. The work was authorized by Highfair Investments Inc.

Based on the provided information and conceptual drawing, it is our understanding that the total area of the pumping station is about 500 m^2. The proposed pumping station includes the following structures, as shown on Drawing No. 1:

- Control Building – a single storey slab-on-grade structure;
- Emergency Storage Tank – 5.5 m in diameter;
- Wet Well – 4.0 m in diameter, extend to an approximate depth of 13.0 m;
- Valve Chamber – approximate 4.0 m by 3.0 m in size; and
- Parking areas.

The exact structural details for the structures were not available at the time of preparation of this report.

The purpose of the geotechnical investigations was to determine the subsurface conditions at the subject site by drilling a limited number of sampled boreholes and based on the factual borehole data, to provide geotechnical engineering guidelines for the design and construction of the proposed development. Specifically, recommendations and / or comments regarding structure foundations and pavement were to be provided.

This report contains the findings of the investigation, together with our recommendations and comments. The anticipated construction conditions are also discussed but only to the extent that they may affect the geotechnical design. The construction methods discussed express our opinion only and are not intended to direct contractors how to carry out the construction. Contractors should also be aware that the data and their interpretation presented in this report may not be sufficient to assess all factors that may have an effect upon construction.

The comments and recommendations given in this report are based on the terms of reference presented above and on the assumption that design will be in accordance with applicable codes and standards. If changes are made either in the design phase or during construction, this office must be retained to review these modifications. The result of this review may be a modification of our recommendations or the requirement of additional field or laboratory work to check whether the changes are acceptable from a geotechnical viewpoint.

2. Site Description and Regional Geology

The subject site is located within a residential area at the northwest quadrant of Bayview Avenue and Vandor Sideroad in the Town of Aurora. This site is currently a vacant parcel of land between Archerhill Court and Bayview Avenue. The ground surface is generally flat.

The site is located in the Schomberg Clay Plains physiographic region of Southern Ontario. The top portion of this physiographic region, close to Oak Ridges Moraine, generally contains deep deposits of stratified clay and silt. Although the deposits consist of significant contents of clay, but their behaviour is more like that of silt than clay. This may be attributed to the clay contains about 50% calcium and magnesium carbonates.[1] The overburden soils are underlain by the Blue Mountain shale bedrock. The Blue Mountain Formation consists of dark blue-grey to brown to black shale with thin interbeds of limestone or calcareous siltstone. Ontario Geotechnical Borehole database, Ontario Groundwater Wells records and regional drift thickness mapping indicate that the depth to bedrock in the area of the site may be greater than 85 m. A tributary of the northward flowing Holland River was observed on the east and north sides of the proposed pumping station. The direct distance from the watercourse to the development is greater than 70 m.

[1] Chapman, L.J. and Putnam, D.F. (1984). The Physiography of South Ontario, 3rd Edition.

3. Geotechncial Investigation Procedures

A total of two (2) boreholes (designated as Boreholes 5 and 101) were drilled to depths of 8.2 and 20.3 m below the existing ground, respectively. The approximate borehole locations are shown on the attached Drawing No. 1 - Borehole Location Plan.

The borehole locations were established prior to the drilling works by EXP personnel using hand-held Global Positioning System (GPS) units – Garmin eTrex Legend H. The exploratory boreholes were also located in the field by EXP from adjacent surface features. The top elevations of the boreholes were established by Sokkia GCS3 Global Navigation Satellite System (GNSS) receiver based on information derived from the TopNET Live Network Service GPS. The vertical positioning accuracy of the instrument is ± 5 mm. The accuracy of the instrument was checked against a Town of Aurora benchmark described as follows:

- B.M. #2155: Bronze plate on top of concrete monument located at the northwest corner of Vandorf Sideroad & Englehard Drive. Being 4.5 m west of concrete curb of Englehard Drive; recorded geodetic elevation of 287.412 m.

Prior to the commencement of drilling operations, underground services were cleared to minimize the risk of encountering any such services during the drilling operations.

Drilling and sampling operations, carried out in January and April 2021, were completed by a combination of solid / hollow stem continuous flight auger using truck mounted drill rigs owned and operated by specialist contractors. Conventional split-spoon samples were recovered from the boreholes.

A representative of EXP was present throughout the drilling operations to monitor and direct the drill operations, and to record subsoil and groundwater information. Representative samples of the subsurface soils were recovered from the boreholes at regular intervals using nominal 50 mm O.D. split spoon sampling equipment driven by automatic hammers mounted on the drill rigs, in accordance with the procedures of Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils (ASTM D1586). Pocket Penetrometer (PP) tests on relatively undisturbed clayey soil samples were carried out to estimate undrained shear strengths. Furthermore, in Borehole 101, where the consistency of clayey soils permitted, field vane tests were performed to measure in-situ undrained shear strength of the clayey soils. All split spoon samples were returned to EXP's Brampton laboratory for further geotechnical testing. The following tests were performed on selected soil samples:

- Moisture content
- Unit weight

Where the drilling method allowed, groundwater levels were observed in the open boreholes during the course of the fieldwork. Monitoring wells were installed in both boreholes to permit subsequent monitoring of the groundwater level at the well locations. The monitoring wells consist of nominal 50 mm diameter PVC pipe with a slotted screen sealed at depths within the borehole / monitoring well. Above the monitoring well screens, the annulus surrounding the pipes were grouted to the surface with cement / bentonite grout.

4. Subsurface Conditions

The detailed soil profiles encountered in each borehole and the results of geotechnical laboratory testing are indicated on the attached borehole logs (Drawing Nos. 6 and 9). It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change.

Notes on Sample Description and Soil Types (Drawing No. 1A) preceding the borehole logs form an integral part of and should be read in conjunction with this report.

The following is a brief description of the subsurface conditions encountered during the geotechnical investigation.

4.1 Soil Conditions

Topsoil

Topsoil was encountered in both boreholes, which were drilled near the footprints of the proposed pumping station structures. The thickness of topsoil found in the borehole locations ranged from 150 to 250 mm.

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.

Fill Materials

Fill materials were encountered below the topsoil in Borehole 101. The fill typically consisted of clayey silt to silty clay with trace content of sand. This layer extended to a depth of 0.5 m below the existing ground surface or to an elevation of 277.5 m.

The brown fill material was in a loose state of compaction as suggested by a SPT N-value of 5 blows/0.3 m. The moisture content within the fill was found to be about 23 percent of dry weight, indicating a moist condition.

Silty Clay

Below the topsoil in Borehole 5 and the fill in Borehole 101, the soil explored consisted of a layer of silty clay, extending to borehole termination depths of 8.2 and 20.3 m below the ground surface or to elevations ranging from approximately 269.7 to 257.7 m. It was found that this deposit contains trace sand and trace gravel.

This brown to grey soil has a typical firm to very stiff consistency as suggested by the SPT N-values obtained in this stratum which varied from 3 to 26 blows/0.3 m. Field vane tests were carried out to estimate undrained shear strength in the investigation. The tests confirmed the consistency of this deposit, indicating the deposit to yield undrained shear strengths in the range of 50 to 100 kPa. The sensitivity of this stratum ranges from 1.4 to 3.0, indicating a low to medium sensitive soil, according to Canadian Foundation Engineering Manual, 4th Edition. In addition, Pocket Penetrometer (PP) tests on relatively undisturbed clayey soil samples were performed to estimate undrained shear strength. The results of PP tests indicated the undrained shear strengths of the silty clay ranged from 15 to in excess of 225 kPa, but it is considered to be an extremely rough estimation.

This deposit was moist, with natural moisture contents ranging from about 19 to 27 percent of dry weight. The unit weight of this soil unit ranged from 19.9 to 22.5 kN/m^3, with an average of 20.7 kN/m^3.

4.2 Groundwater Conditions

Groundwater conditions were assessed by taking readings in open holes during the course of the fieldwork and in the installed monitoring wells. Short-term observations in the monitoring wells are recorded on the attached borehole logs and summarized in Table 01 below.

Table 01: Observed Groundwater Levels

Borehole No.	Depth/Elevation of Monitoring Well Tip (m)	Screened Strata	Date of Water Level Measurement (mm/dd/yyyy)	Measured Water Level Depth/Elevation (m)
5	7.6 / 270.4	Silty clay	01/20/2021	0.7 / 277.3
101	19.8 / 258.2	Silty clay	04/23/2021	0.8 / 277.2

Based on the configurations of the monitoring wells and the observation of groundwater, the depth of groundwater level varied from Elevation 277.3 to 277.2 m at the time of the investigation. It should be noted that the groundwater level would be subject to seasonal variations and fluctuations in response to major weather events.

For design purposes, it is our opinion that the groundwater level is considered to be at an approximate Elevation 277.5 m.

5. Geotechnical Recommendations

The control building will be a single level slab-on-grade structure on a properly prepared subgrade. The emergency storage tank is anticipated to be a below grade structure, and its bottom level is unknown. Based on the provided information, the bottom level of the proposed wet well will be about 13.0 m below the existing grade, i.e. approximate Elevation 265.0 m.

The valve chamber may be a precast concrete structure. According to Drawing No W-103, Design Criteria Manual for Engineering Plans, Town of Aurora (August 15, 2019), the minimum depth of the chamber may be 2.5 m below the existing ground surface. However, the valve chamber will be installed north of the existing sanitary sewer, which is connected by a forcemain. To facilitate the connection of existing sanitary sewers, the bottom elevation of proposed chamber is likely to match that of the linear infrastructure, i.e. close to or slightly below the sanitary sewer obvert level of 273.2 m.

Based on these assumptions, the following subsections provide engineering guidelines for the design and construction of the proposed development.

5.1 Recommendations for Pumping Station Structures

5.1.1 Foundations

Below topsoil and fill, this site is underlain by a firm to very stiff silty clay deposit, extending to a borehole termination depth of 20.3 m below the ground surface or to an elevation of 257.7 m. Design groundwater level is at 277.5 m. Based on the aforementioned foundation levels of the proposed structures, the foundations will be founded on the silty clay. The following geotechnical resistances are available for foundations bearing on undisturbed silty clay deposit:

- Elevation 276.5 – 274.0 m Factored geotechnical resistance at ULS = 300 kPa
  Geotechnical Reaction at SLS = 200 kPa
- Elevation 274.0 – 258.0 m Factored geotechnical resistance at ULS = 150 kPa
  Geotechnical Reaction at SLS = 100 kPa

Since the installation of the control building, emergency storage tank, wet well and valve chamber is a case of unloading, the bearing resistance is not critical for the slab. For the structural design of the concrete slab-on-grade, a combined modulus of subgrade reaction coefficient of 10 MPa/m can be used on the native firm to very stiff silty clay. The base of the chamber can be implemented in accordance with OPSD Division 1100.

5.1.2 Frost Protection

According to OPSD 3090.101, design frost protection depth for the general area is 1.5 m. Therefore, for any foundation elements or buried utilities which are sensitive to frost actions should have a permanent soil cover of at least 1.5 m or its thermal equivalent of artificial insulation.

5.1.3 Excavation, Dewatering, Drainage and Backfill

Excavation will be made through topsoil, fill materials and native silty clay. A hydraulic excavator should be adequate for the excavation. Excavations must be carried out in conformance with the Occupational Health and Safety Act (OHSA). In accordance with OHSA, the soils at this site may be classified as:

- Fills — Type 3 soil above water level
- Silty clay — Type 3 soil above groundwater level; Type 4 soil below groundwater level

Shallow temporary unsupported cut in the fill and native soil to the frost level should be able to be excavated at 1H:1V slope at this site. For Type 4 soil, the temporary unsupported excavation should be flattened to 3H:1V. These slopes should be visually monitored for any movement. Where workers must enter excavations extending deeper than 1.2 m, the trench walls must be suitably sloped and / or braced in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects.

All excavations should be inspected, evaluated and approved by the Geotechnical Engineer who is familiar with the findings of this investigation. Immediately after the approval, a minimum 50 mm thick skim coat of concrete of minimum compressive strength of 5 MPa (i.e. mud slab) should be placed in the excavations for ease of construction and placement of the proposed structures.

To maintain the stability of cut slopes during construction, additional loading such as stockpile, heavy machinery or any surcharge loads should not be present within a horizontal distance from the crest of the slope equal to the vertical height of the cut, during construction.

At the crest of the excavation, the ground is generally flat. We recommend that measures should be taken to intercept surface water coming down the slope to the excavation area and drain it sideways and away from the face of the slope.

Backfilling using a well graded, compacted granular soil such as Granular 'B' material should be conducted. The use of such material, if thoroughly compacted, would reduce the post construction settlements to a negligible amount and may also expedite the compaction process.

The proposed tank, well and chamber should be designed as water-tight structures, and to endure the lateral earth pressure and a design groundwater table at Elevation 277.5 m.

Due to the low permeability of the fill and natural deposit, the quantity of seepage through these strata into the excavation area is expected to be low. It is believed that for site excavations, excessive seepage into open excavations is not anticipated and the seepage can be handled by gravity drainage and pumping from filtered sumps.

5.1.4 Temporary Shoring

For the proposed structures that requires deep excavations, temporary shoring will be required to retain the soil to facilitate the excavations. For this site, the temporary shoring system will be retaining the fills and native silty clay.

For the shoring work, a soldier pile and lagging may be considered. Alternatively, for the wet well which will be about 4.0 m in diameter, consideration can be given to place a precast well into a predrilled larger diameter hole and have the annular spaces filled with a liquid cementitious grout.

The temporary shoring of the soil boundaries for this project should be designed on the basis of the state-of-the-art information given in the latest edition of the Canadian Foundation Engineering Manual (CFEM). The following parameters that are considered to be applicable for this project and have been used successfully on many other deep excavations in the Toronto area and surround areas are as follows:

Earth Pressure Calculation

- For overburden

K = 0.25	where minor movement (0.002H) can be tolerated
K = 0.35	where utilities, roads, sidewalks must be protected from significant movement, or where vibration from traffic is factored
K = 0.40	where movements are to be minimized such as near adjacent building footings or movement sensitive services (i.e. gas and watermains)

- Surcharges due to the adjacent structures, equipment, stockpiles or other loadings behind the wall should also be considered in the design.

For global stability check

- For overburden $\gamma = 21.0$ kN/m^3 c = 0 kPa Ø = 30°
- For water $\gamma = 10.0$ kN/m^3

- Surcharge is to be determined by shoring contractor.

For soil anchors in the stiff silty clay

- Bond resistance = 15 kPa (Higher bond resistance can be achieved if regroutable anchors are used. This will have to be designed and verified by the shoring designer / contractor.)
- The recommended design parameters should be confirmed by load testing a number of anchors to 200 percent design load in accordance with the current edition of the CFEM. As a minimum for this site, at least two 200 percent anchor load tests should be carried out to verify the capacity of the anchors, and confirmed by EXP. The design for the production anchors should then be modified based on the test results, where necessary. All remaining temporary anchors must be installed in similar procedures and proof tested to 133 percent design load.

In general, due to the existence of layered soils, the apparent earth pressure distribution (Method d) as outlined in the CFEM can be used for calculating the earth pressures, see Drawing No. 10. If the shoring system does not extend up to the top of the ground, the sloped bank should either be treated as a surcharge to the shoring system or alternatively, a higher K value, reflecting the sloping ground, should be used.

It is recommended that the contract have a performance specification limiting movement. A maximum of 13 mm is generally acceptable for a street where movement sensitive utilities are not nearby. Otherwise, the engineering departments of the utility companies must be contacted to assess what movement is acceptable. Anchor spacing and elevation, and the timing of the excavation and anchoring operations are critical in determining the movements.

5.1.5 Lateral Earth Pressure

If water is retained such as in the case of tanking the underground structure, submerged unit weight can be used for the retained soil below the groundwater table and full hydrostatic pressure should be considered. The lateral earth pressure acting on permanent walls or bracing may be calculated from the following equation:

$$p = K [\gamma (h - h_w) + \gamma' h_w + q) + \gamma_w h_w$$

where p = lateral earth pressure in kPa acting at depth h
K = earth pressure coefficient, recommend 0.4 for soil
γ = unit weight above groundwater table, recommend 21 kN/m^3 for soil
γ' = submerged unit weight, recommend (γ - 10) kN/m^3 for soil
γ_w = unit weight of water, 10 kN/m^3
h = depth to point of interest in m
h_w = depth below water table to point of interest in m

q = equivalent value of surcharge on the ground surface in kPa (minimum of 12 kPa)

Hydrostatic water pressure on the permanent walls can be determined assuming the groundwater level at Elevation 277.5 m if the groundwater is not drained. All basement walls must be waterproofed to 1 m above the groundwater table.

The above expression assumes that the perimeter walls will be designed to resist both the soil and full hydrostatic pressures. If the perimeter drains are used and the groundwater is drained, this equation can be simplified to:

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

An additional uniform earth pressure equivalent to 0.5 H (kPa), where H is the height of wall in m, should be included in design of permanent walls for seismic loading considerations.

5.1.6 Earthquake Considerations

The recommendations for the geotechnical aspects to determine the earthquake loading for design using the Ontario Building Code (OBC) 2012 are presented below.

Subsoil Conditions

The subsoil and groundwater information at this site have been examined in relation to Section 4.1.8.4 of the OBC. The subsoils at this subject site generally consist of fill and silty clay. It is anticipated that the proposed structures will be founded on the native silty clay.

Depth of Boreholes

Table 4.1.8.4.A Site Classification for Seismic Site Response of the OBC indicated that to determine the site classification, the average properties in the top 30 m (below the lowest basement level) are to be used. The deepest borehole advanced at this site was at about 20.3 m in depth below existing grade. Therefore, the site classification recommendation would be based on the available information from boreholes.

Site Classification

Based on the above assumptions, interpretations and the general understanding of soil conditions of the area, the seismic class for the proposed structures at this site is Class D, as per the Table 4.1.8.4.A of the OBC. Accordingly, the foundation factors Fa and Fv can be obtained from Tables 4.1.8.4.B and 4.1.8.4.C of the OBC, respectively, for the design of the structure.

5.1.7 Settlement

As mentioned in Section 5.1.1 of this report, the installation of the control building, emergency storage tank, wet well and valve chamber is a case of unloading. The settlements under the induced stresses of the proposed structures could be negligible (less than about 10 mm). The limited settlements are results of recompression on slight heaved excavation surfaces that may occur due to the unloading during the excavation.

5.2 Pavement Structure

The pavement structure of the parking area should be designed in accordance with Design Criteria Manual for Engineering Plans, Town of Aurora (August 15, 2019). The recommended minimum pavement structure is presented in the following table.

Table 02: Minimum Pavement Structure Thickness

Pavement Layer	Compaction Requirements	Parking Area
Asphaltic Concrete (OPSS 310 / 1150)	92 to 96.5% MRD[1]	50 mm HL3 75 mm HL 8
OPSS Granular A Base (OPSS 1010)[3]	100% SPMDD[2]	150 mm
OPSS Granular B Type I (OPSS 1010)[3]	100% SPMDD[2]	300 mm

Notes:
1. MRD – Maximum relative density
2. SPMDD - Denotes standard Proctor maximum dry density, MTO LS-706 (Procedure 3)
3. 19 mm crusher run limestone may be substituted by Granular A and 50 mm crusher run limestone may be substituted by Granular B. However, mixing of material types within the same structure will not be permitted.

Within the subject pavement areas evaluated in this project, the subgrade type is predominately reworked or native silty clay. The Town of Aurora pavement design for the residential collector and industrial usage should satisfy the required traffic loading. The materials being used in this project should comply with the Town's material specifications or OPSS.

The upper 300 mm of the subgrade of the proposed parking areas should be compacted to 98% SPMDD and 95% below. As part of the subgrade preparation, the reworked areas should be stripped of obviously unsuitable materials. Fill required to raise the grades to design elevations should be organic-free and at a moisture content which will permit compaction to the densities indicated. 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.

The foregoing design in Table 02 assumes that construction is carried out during dry periods and that the subgrade is stable under the load of construction equipment. If construction is carried out during wet weather, and heaving or rolling of the subgrade is experienced, additional thickness of granular material may be required.

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 that 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 gradient of 2 - 3%) to provide effective surface drainage toward unpaved ground surface. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas.

6. General Comments

The information presented in this report is based on a limited investigation designed to provide information to support an overall assessment of the geotechnical conditions of the subject property. The conclusions presented in this report reflect site conditions existing at the time of the investigation.

EXP Services Inc. 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, EXP Services Inc. 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.

More specific information, with respect to the conditions between samples, or the lateral and vertical extent of materials, may become apparent during excavation operations. The interpretation of the borehole information must, therefore, be validated during excavation operation. Consequently, during the future development of the property, conditions not observed during this investigation may become apparent; should this occur, EXP Services Inc. should be contacted to assess the situation and additional testing and reporting may be required. EXP Services Inc. has qualified personnel to provide assistance in regards to future geotechnical and environmental issues related to this property.

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

EXP Services Inc

Honglin Wang

LICENSED PROFESSIONAL ENGINEER
H. WANG
100075398
PROVINCE OF ONTARIO

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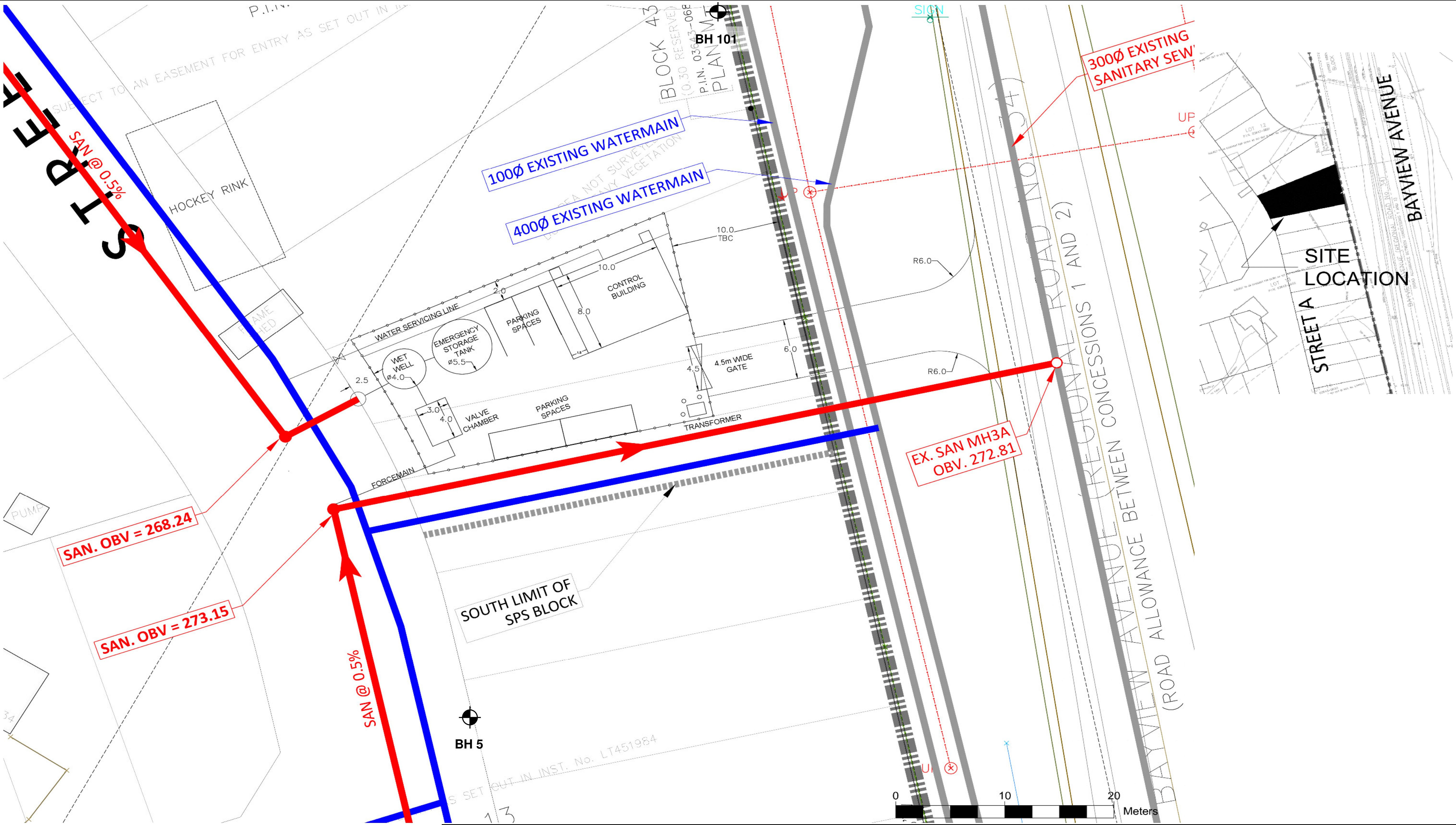
DRAWINGS



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LEGEND:

Approximate Borehole Location

EXP Services Inc.

DRAWN :	HW
CHECKED :	SC
P.M. :	DD
SCALE :	NFS
PAPER SIZE :	11 x 17

BOREHOLE LOCATION PLAN

Aurora Sanitary Pumping Station

Residential Subdivision

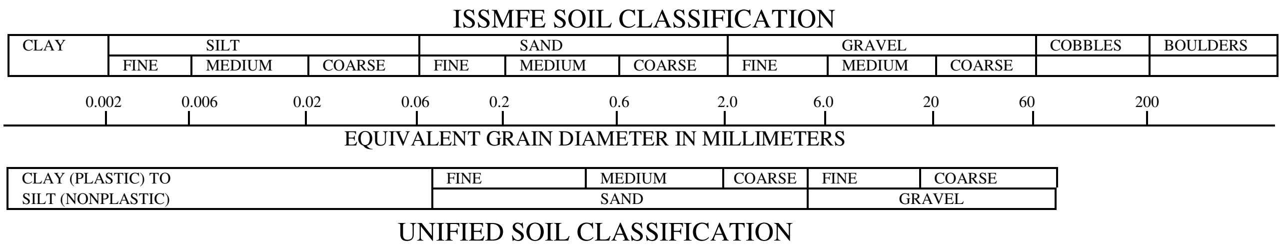
5 - 70 Archerhill Court, Aurora, Ontario

REFERENCE : BRM-21000267-D0

DRAWING NO. : 1

Notes on Sample Descriptions and Soil Types **Drawing 1A**

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 **exp** also follow the same system. Others may use different classification systems; 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.



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.

4. Excerpt from “OHSA Regulations for Construction Projects,” Part III, Section 226:

- **Soil Types**

Type 1 Soil

a) is hard, very dense and only able to be penetrated with difficulty by a small sharp object;

b) has a low natural moisture content and a high degree of internal strength;

c) has no signs of water seepage; and

d) can be excavated only by mechanical equipment.

Type 2 Soil

a) is very stiff, dense and can be penetrated with moderate difficulty by a small sharp object;

b) has a low to medium natural moisture content and a medium degree of internal strength; and

c) has a damp appearance after it is excavated.

Type 3 Soil

a) is stiff to firm and compact to loose in consistency or is previously excavated soil;

b) exhibits signs of surface cracking;

c) exhibits signs of water seepage;

d) if it is dry, may run easily into a well-defined conical pile; and

e) has a low degree of internal strength.

Type 4 Soil

a) is soft to very soft and very loose in consistency, very sensitive and upon disturbance is significantly reduced in natural strength;

b) runs easily or flows, unless it is completely supported before excavating procedures;

c) has almost no internal strength;

d) is wet or muddy; and

e) exerts substantial fluid pressure on its supporting system.

O. Reg. 213/91, s. 226

Log of Borehole 5

Project No. BRM-21000267-A0

Drawing No. 6

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: Archerhill Court, Aurora

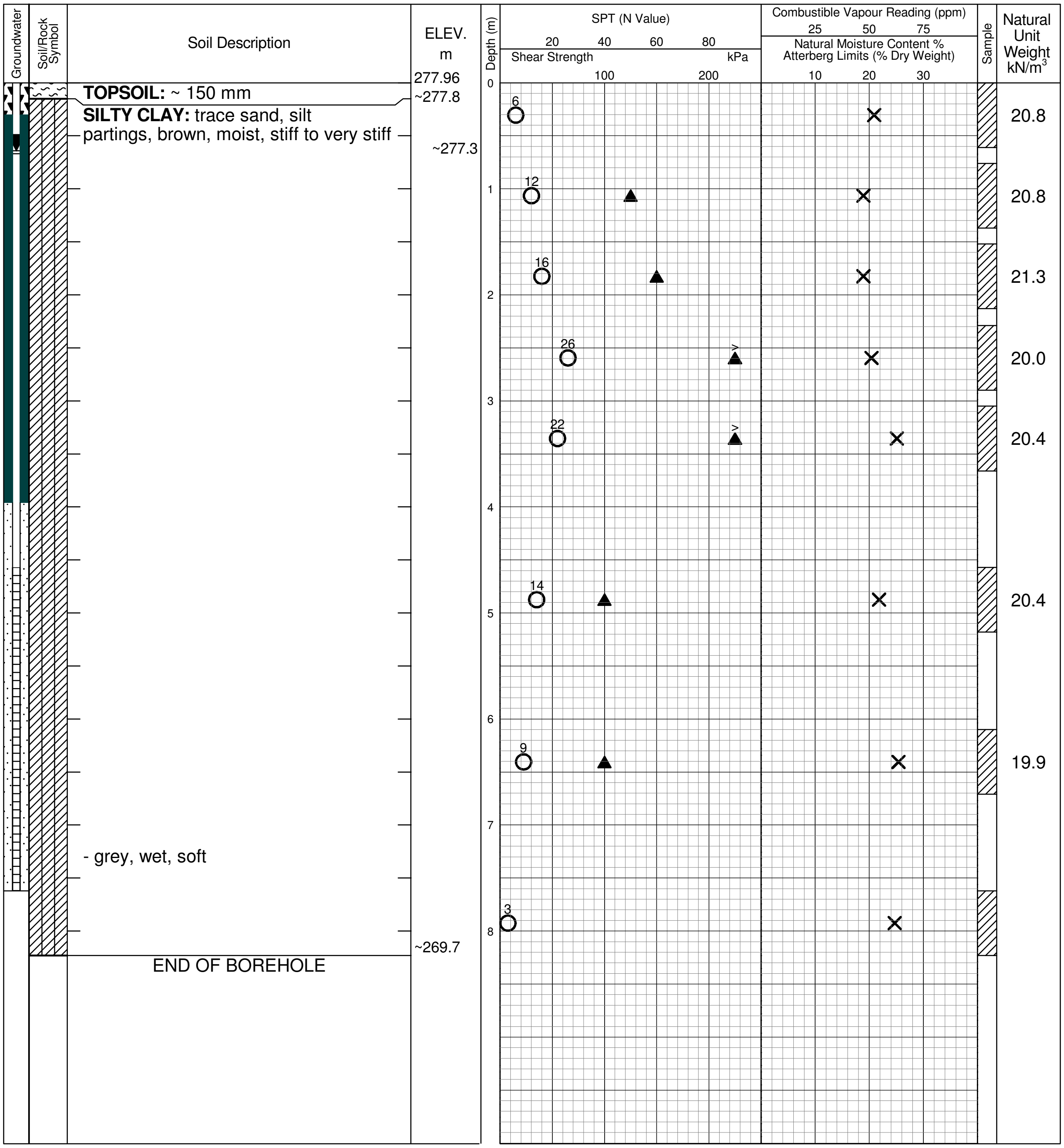
Date Drilled: January 7, 2021

Drill Type: CME 75 Track

Datum: Geodetic

Auger Sample	⊠	Combustible Vapour Reading	□
SPT (N) Value	○ ▨	Natural Moisture	×
Dynamic Cone Test	—	Plastic and Liquid Limit	├──○
Shelby Tube	■	Undrained Triaxial at % Strain at Failure	⊕
Field Vane Test	S	Penetrometer	▲

Soil Description	ELEV. m
	277.96
TOPSOIL: ~ 150 mm	~277.8
SILTY CLAY: trace sand, silt partings, brown, moist, stiff to very stiff	~277.3
- grey, wet, soft	
END OF BOREHOLE	~269.7



Date	Water Level (m)	Hole Open to (m)
On Completion	4.27	Open
January 20, 2021	0.67	

EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 4/30/21

exp.

Log of Borehole 101

Project No. BRM-21000267-A0

Drawing No. 9

Project: Geotechnical Investigation

Sheet No. 1 of 2

Location: Archerhill Court, Aurora

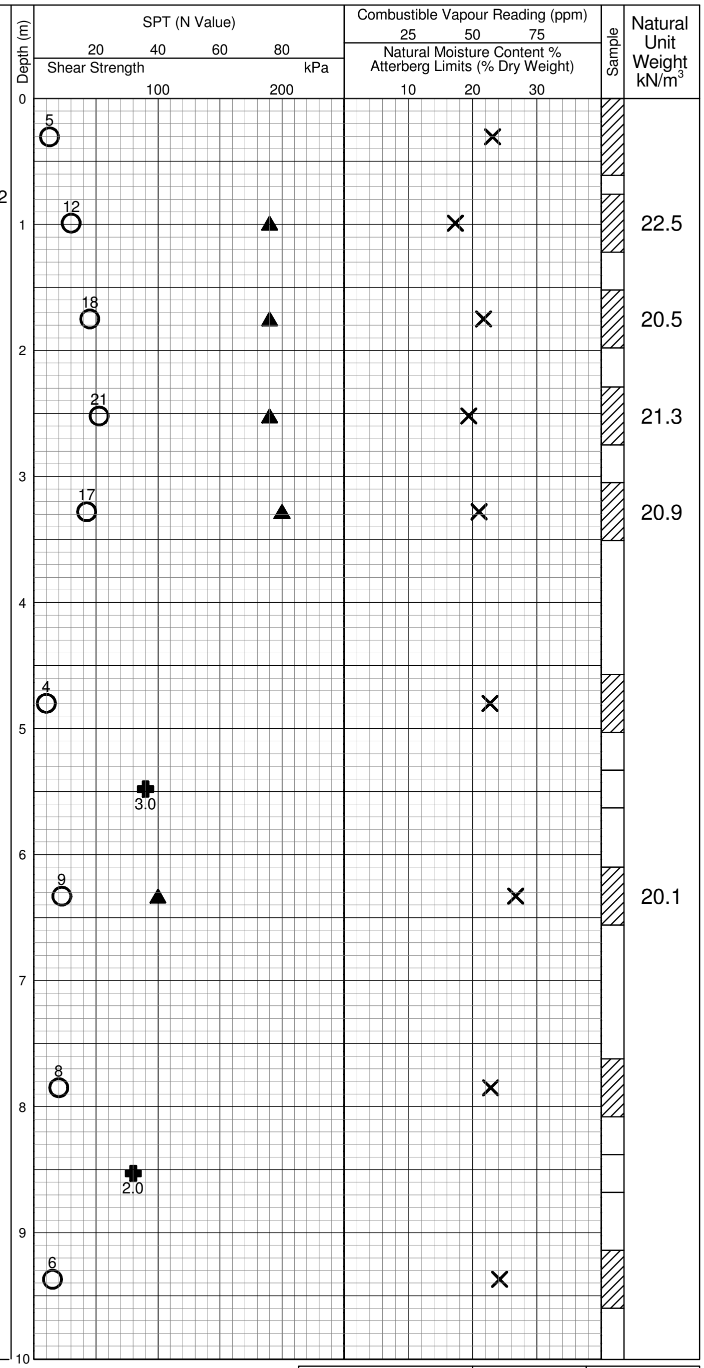
Date Drilled: April 15, 2021

Drill Type: CME 75 Track

Datum: Geodetic

Auger Sample	⊠
SPT (N) Value	○ ▨
Dynamic Cone Test	——
Shelby Tube	■
Field Vane Test	✚ S
Combustible Vapour Reading	□
Natural Moisture	✕
Plastic and Liquid Limit	├──○
Undrained Triaxial at % Strain at Failure	⊕
Penetrometer	▲

Soil Description	ELEV. m
	277.99
TOPSOIL: ~ 250 mm	~277.7
FILL: clayey silt to silty clay, trace sand, brown, moist (reworked parent material)	~277.5
SILTY CLAY: trace sand, trace gravel, brown, moist, firm to very stiff	~277.2
- grey, wet	



Continued Next Page

Date	Water Level (m)	Hole Open to (m)
April 23, 2021	0.83	

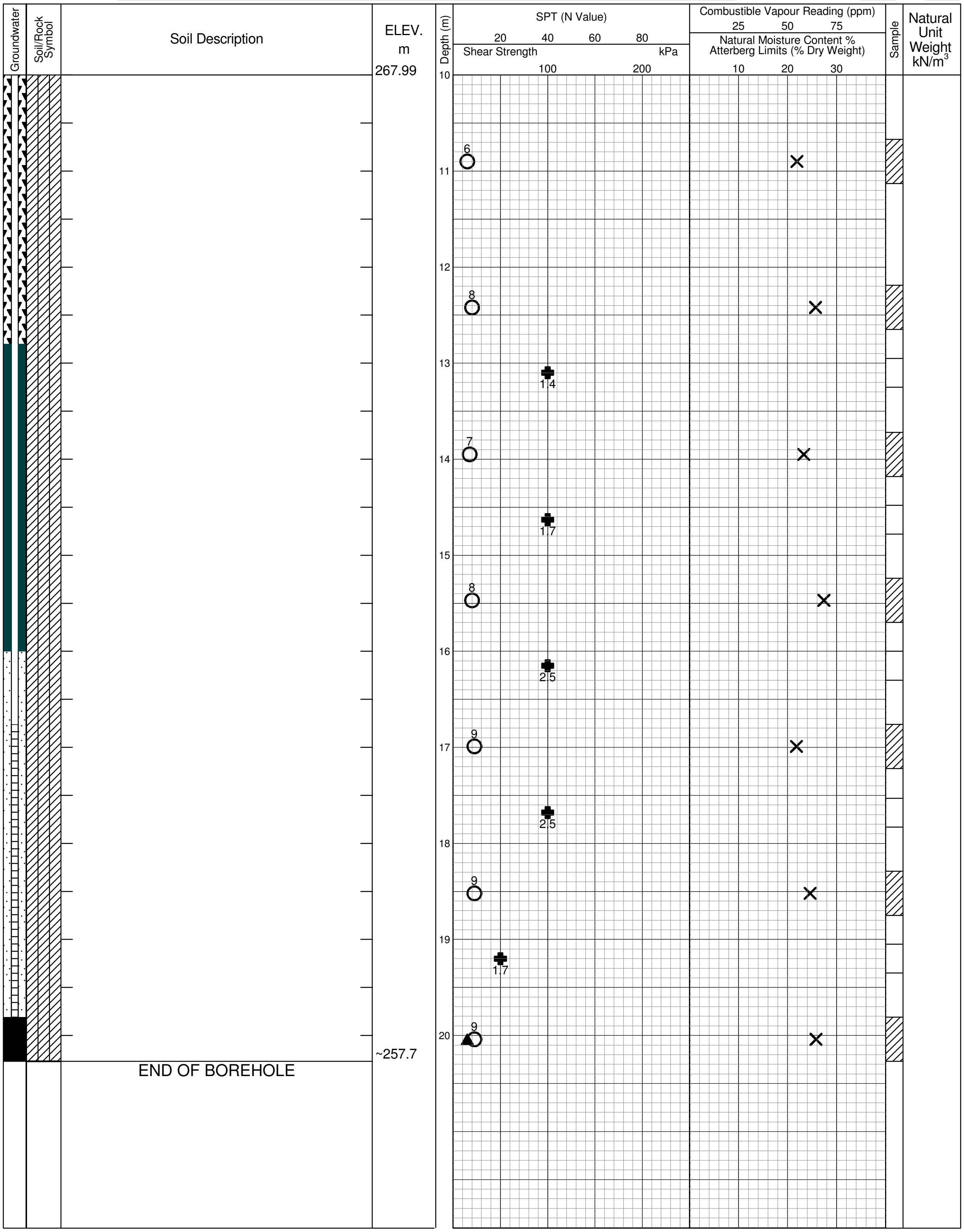
exp.

EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 4/30/21

Log of Borehole 101

Project No. BRM-21000267-A0 Drawing No. 9

Project: Geotechnical Investigation Sheet No. 2 of 2



EXPLOGBRAMPTON BOREHOLE LOGS.GPJ NEW.GDT 4/30/21

Date	Water Level (m)	Hole Open to (m)
April 23, 2021	0.83	

exp.

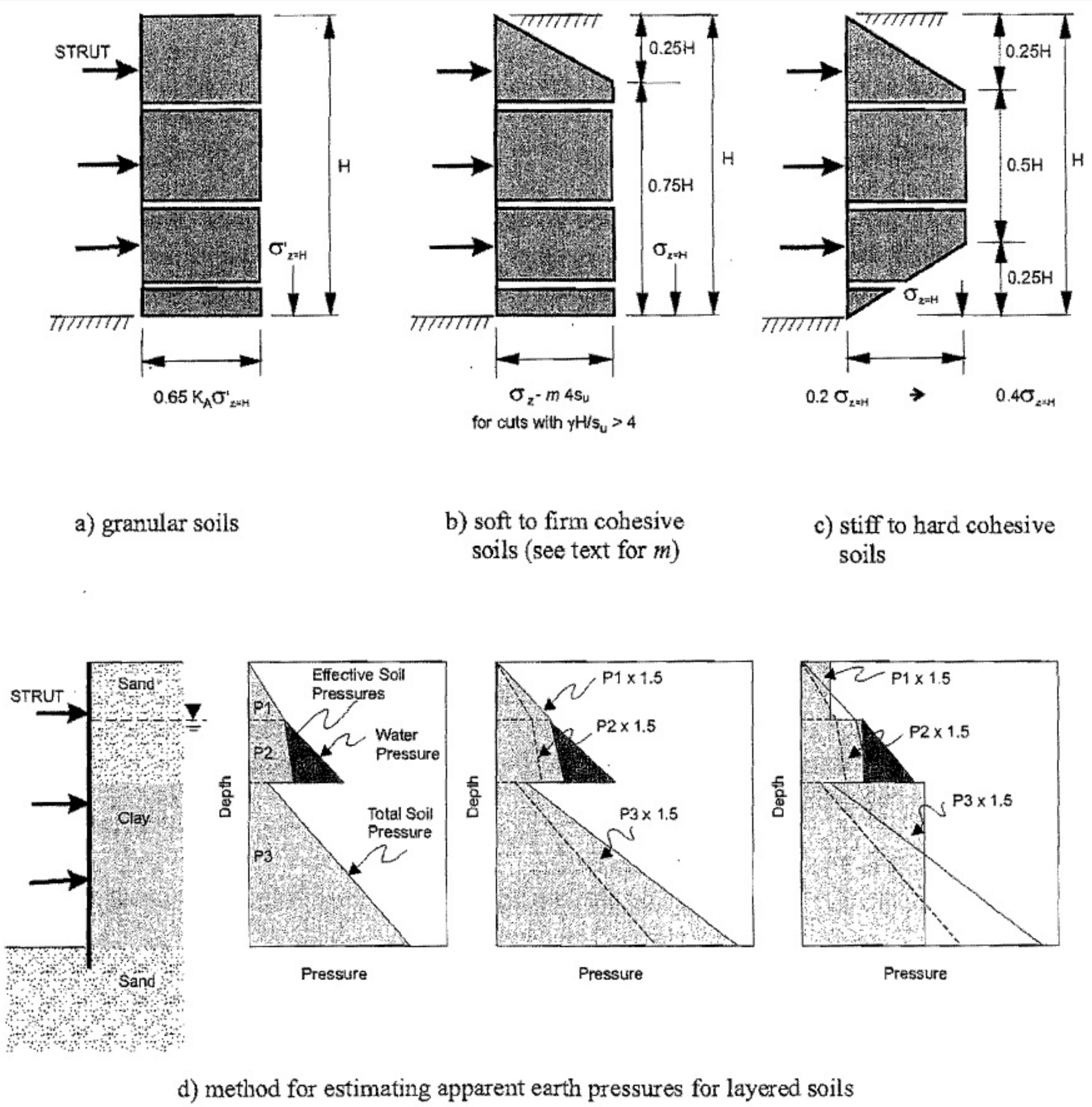


FIGURE 26.8 *Apparent earth pressure distributions*

APPARENT EARTH PRESSURE DISTRIBUTION

Source: Canadian Geotechnical Society (2006). "*Canadian Foundation Engineering Manual*", 4th Edition, Section 26.10.3 - Supported Excavations & Flexible Retaining Structures / Multi-Anchor, Multiple-Raker and Internally Braced (Strutted) Retaining Structures / Braced Retaining Structures Loading Conditions