Geotechnical Engineering

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Geotechnical Investigation

Proposed Wastewater Treatment Plant Upgrades
14754 County Road 2
Ingleside, Ontario

Prepared For

EVB Engineering

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Report PG5299-1

Table of Contents

Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by EVB Engineering to conduct a geotechnical investigation for the proposed upgrades to the existing wastewater treatment plant located at 14754 County Road 2 in the Township of Ingleside, Ontario (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objectives of the geotechnical investigation were to:

- ❏ Determine the subsoil and groundwater conditions at this site by means of boreholes.

- ❏ Provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect the design.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains our findings and includes geotechnical recommendations pertaining to the design and construction of the subject development as they are understood at the time of writing this report.

2.0 Proposed Project

Based on the available conceptual drawings, it is understood that the proposed upgrades to the existing waster water treatment plant will consist of the construction of a new headworks building, a gravity settler, two primary clarifiers and two secondary clarifiers. Expansions to the existing aerobic digesters as well as the biosolids storage facilities have also been proposed. It is further understood that the buildings will have up to one basement level.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the geotechnical investigation was carried out from April 28 to 30, 2020. At that time, 14 boreholes were advanced to a maximum depth of 9.2 m. The borehole locations were selected by EVB Engineering prior to commencing the field program. The approximate locations of the boreholes are shown on Drawing PG5299-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were advanced using a track-mounted auger drill rig operated by a two-person crew. All fieldwork was conducted under the full-time supervision of our personnel under the direction of a senior engineer. The drilling procedure consisted of augering to the required depths at the selected locations, sampling and testing the overburden.

Sampling and In Situ Testing

Soil samples were collected from the boreholes using two different techniques, namely, sampled directly from the auger flights (AU) or collected using a 50 mm diameter split-spoon (SS) sampler. All samples were visually inspected and initially classified on site and subsequently placed in sealed plastic bags. All samples were transported to our laboratory for further examination and classification. The depths at which the auger and split spoon samples were recovered from the boreholes are shown as AU and SS, respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

A Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split spoon samples. The SPT results are recorded as "N" values on the Soil Profile and Test Data sheets. The "N" value is the number of blows required to drive the split spoon sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

The overburden thickness was evaluated by a dynamic cone penetration test (DCPT) completed at BH 8-20 and BH 13-20. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at the tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

The subsurface conditions observed in the test holes were recorded in detail in the field. The soil profiles are presented on the Soil Profile and Test Data sheets in Appendix 1 of this report.

Groundwater

Monitoring wells and flexible standpipes were installed in select boreholes during the field investigation to permit monitoring of the groundwater levels subsequent to the completion of the sampling program.

Sample Storage

All samples from the investigation will be stored in the laboratory for a period of one month after issuance of this report. The samples will then be discarded unless directed otherwise.

3.2 Field Survey

The test hole locations were selected by EVB Engineering prior to commencing the field program. The test hole locations and ground surface elevation at each test hole location were surveyed by Paterson and referenced to a geodetic datum. The location of the test holes and ground surface elevation at each test hole location are presented on Drawing PG5299-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

Soil samples were recovered from the subject site and visually examined in our laboratory to review the results of the field logging. Grain size distribution analysis was also completed on select samples obtained from the geotechnical investigation. The results of this testing are provided in Section 4.2.

3.4 Analytical Testing

One (1) soil sample was submitted for analytical testing to assess the potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The sample was analyzed to determine its concentration of sulphate and chloride along with its resistivity and pH. The laboratory test results are shown in Appendix 1 and the results are discussed in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The subject site is currently occupied by the existing wastewater treatment plant, with associated paved access lanes and landscaped areas, located on the western half of the site. The northern half of the subject site is undeveloped and was recently cleared of trees. The site is bordered by densely forested, undeveloped land to the east, the St. Lawrence River to the south and Long Sault Parkway to the west and County Road 2 to the north. The existing ground surface slopes downward gradually across the site from west to east, from approximate geodetic elevation 75 to 77.5 m.

4.2 Subsurface Profile

Overburden

Generally, the subsurface profile at the test hole locations consists of an approximate 50 to 150 mm thickness of topsoil underlain by a glacial till deposit.

The glacial till deposit was generally observed to consist of varying amounts of silt, clay and sand with gravel, cobbles and boulders. Within BH 4-20, boulders were cored from approximate depths of 4.6 to 6.1 m, 6.7 to 7.6 m, and 7.8 to 9.1 m in order to advance the borehole.

Practical refusal to the augering was encountered at approximate depths of 5.2 m and 9.2 m in BH 3-20 and BH 4-20, respectively. Refusal to the DCPT was encountered at approximate depths of 6.7 m and 6.1 m below the existing ground surface at BH 8-20 and BH 13-20, respectively.

Laboratory Testing

Grain size distribution analysis was completed on selected soil samples. The results of the grain size analyses are summarized in Table 1 and presented on the Grain Size Distribution Results sheets in Appendix 1.

Table 1 - Summary of Grain Size Distribution Analysis

Test Hole Number	Sample	Gravel (%)	Sand (%)	Silt & Clay (%)
BH 2-20	SS2	29.2	44.3	26.5
BH 7-20	SS4	20.7	48.0	31.3
BH 11-20	SS2	18.5	49	32.5

4.3 Groundwater

Groundwater levels were measured in the monitoring wells and the standpipes on May 7, 2020. The observed groundwater levels are summarized in Table 2.

Table 2 - Summary of Groundwater Level Readings

Test Hole Number	Ground Surface Elevation (m)	Groundwater Depth (m)	Groundwater Elevation (m)	Recording Date
BH 1-20	77.40	4.51	72.89	May 7, 2020
BH 2-20	77.05	3.66	73.39	May 7, 2020
BH 3-20	75.68	1.76	73.92	May 7, 2020
BH 4-20	75.53	1.44	74.09	May 7, 2020
BH 5-20	76.80	Piezometer Blocked	-	May 7, 2020
BH 6-20	75.22	1.24	73.98	May 7, 2020
BH 7-20	74.84	0.58	74.26	May 7, 2020
BH 8-20	75.89	Piezometer Blocked	-	May 7, 2020
BH 9-20	75.80	Piezometer Blocked	-	May 7, 2020
BH 10-20	76.49	3.01	73.48	May 7, 2020
BH 11-20	75.54	2.22	73.32	May 7, 2020
BH 12-20	75.29	2.71	72.58	May 7, 2020
BH 13-20	74.72	0.62	74.10	May 7, 2020
Note: - The ground surface elevations at the borehole locations are referenced to a geodetic datum.				

It should be noted that the groundwater levels could be influenced by surface water infiltrating the backfilled boreholes. Long-term groundwater levels can also be estimated based on the observed colour and consistency of the recovered soil samples. Based on these observations, the long-term groundwater table can be expected at approximately 3 to 5 m below ground surface. However, groundwater levels are subject to seasonal fluctuations and may vary at the time of construction.

The recorded groundwater levels are noted on the applicable Soil Profile and Test Data sheet presented in Appendix 1.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is satisfactory for the proposed development. Given the subsurface conditions encountered during the geotechnical investigation and the anticipated structural loads, foundation support of the proposed buildings and structures are recommended to consist of conventional shallow footings or a raft foundation bearing on the undisturbed, compact to very dense glacial till deposit.

The above and other considerations are further discussed in the following sections.

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and fill, such as those containing organic or deleterious materials, should be stripped from under any buildings, paved areas and other settlement sensitive structures.

Fill Placement

Fill used for grading beneath the proposed structures should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. This material should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building and paved areas should be compacted to at least 98% of the material’s standard Proctor maximum dry density (SPMDD).

Non-specified existing fill, along with site-excavated soil, can be used as general landscaping fill where settlement of the ground surface is of minor concern. This material should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If this material is to be used to build up the subgrade level for areas to be paved, it should be compacted in thin lifts to at least 95% of the material’s SPMDD.

Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless used in conjunction with a composite drainage membrane.

Protection of Subgrade (Raft Foundation)

Where a raft foundation is utilized, it is recommended that a minimum 75 mm thick lean concrete mud slab be placed on the undisturbed glacial till subgrade shortly after the completion of the excavation. The main purpose of the mudslab is to reduce the risk of disturbance of the subgrade under the traffic of workers and equipment.

5.3 Foundation Design

Conventional Spread Footings

Footings placed on an undisturbed, compact to very dense glacial till bearing surface can be designed using a bearing resistance value at SLS of **200 kPa** and a factored bearing resistance value at ULS of **300 kPa**. A geotechnical factor of 0.5 was incorporated to the bearing resistance value at ULS.

An undisturbed bearing surface consists of a surface from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to placement of the concrete footings.

Footings designed using the above noted bearing resistance values at SLS will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively.

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a glacial till bearing medium when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V, pass only through in situ soil or engineered fill of the same or higher capacity as the soil.

Raft Foundation

It is understood that a raft foundation is being considered to support proposed structures at the subject site. It is further understood that one underground level, which is expected to extend approximately 4 to 5 m below existing ground surface, will be required for several of the proposed structures.

The amount of settlement of the raft slab will be dependent on the sustained raft contact pressure. The loading conditions for the contact pressure are based on sustained loads, that are generally taken to be 100% Dead Load and 50% Live Load. The contact pressure provided considers the stress relief associated with the soil removal required for one underground level.

A bearing resistance value at SLS (contact pressure) of **200 kPa** will be considered acceptable for a raft supported on the undisturbed, compact to very dense glacial till. The factored bearing resistance (contact pressure) at ULS can be taken as **300 kPa**. For this case, the modulus of subgrade reaction was calculated to be **8 MPa/m** for a contact pressure of **200 kPa**.

The raft foundation design is required to consider the relative stiffness of the reinforced concrete slab and the supporting bearing medium.

Deadman Anchor Design

A deadman anchor system, utilizes a concrete anchor and the weight of soil over the concrete anchor to resist hydrostatic uplift . Typically, the horizontal load component is resisted by passive earth pressure (the net of passive minus active) and the vertical load component is resisted by the weight that can be mobilized by the anchor.

Geotechnical parameters for typical backfill materials compacted to 98% of standard Proctor maximum dry density (SPMDD) in 300 mm lift thicknesses are provided in Table 3, along with the associated earth pressure coefficients for horizontal resistance calculations for deadman anchors. General uplift cone or prism angles are provided in Figure 2 - Uplift Cone Angles for Backfill Material in Appendix 2 for cohesive and cohesionless soils.

For soil above the groundwater level the “drained” unit weight should be used and below groundwater level the “effective” unit weight should be used. Excavations backfilled in low permeability soils are expected to fill with water and the use of the effective unit weights would be prudent if drainage of the soils and fill adjacent to the concrete anchor is not provided.

For design purposes, it is recommended that the groundwater level should be assumed at ground surface.

A sieve analysis and modified Proctor test should be conducted on each of the fill materials proposed to obtain an accurate soil density to be expected, so that the applicable unit weights can be estimated.

The parameters provided in Table 3 are unfactored and, in the case of passive earth pressure coefficients, are "ultimate" values. As such, the appropriate factor of safety for working stress design, or resistance factor for limit states design (0.4 to 0.5) should be applied.

Table 3 - Geotechnical Parameters for Uplift Resistance Design							
Material Description	Unit Weight (kN/m^3)		Friction Angle (°) ϕ'	Friction Factor, tan δ	Earth Pressure Coefficients		
	Drained γ_{dr}	Effective γ'			Active K_A	At-Rest K_O	Passive K_P
Granular A crushed Stone	22	13.5	40	0.6	0.22	0.36	4.58
Granular B Type II	22.5	14	42	0.6	0.2	0.33	5.04
Compact, Glacial Till	20	12	33	0.5	0.29	0.46	3.39
Compact Sand	18	11	33	0.5	0.29	0.46	3.39

Notes:
- Properties for fill materials are for condition of 95% of modified Proctor maximum dry density.
- The earth pressure coefficients provided are for horizontal backfill profile.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class C**. Soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the Ontario Building Code 2012 for a full discussion of the earthquake design requirements.

5.5 Basement Slab Construction

For structures founded on a raft slab, a granular layer of OPSS Granular A crushed stone will be required to allow for the installation of sub-floor services above the raft slab foundation. The thickness of the OPSS Granular A crushed stone will be dependent on the piping requirements.

For a building founded on conventional shallow footings, it is recommended that the upper 200 mm of subfloor fill consists of 19 mm clear crushed stone. All backfill material within the footprint of the proposed building should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of its SPMDD.

A sub-slab drainage system, consisting of lines of perforated drainage pipe subdrains connected to a positive outlet, should be provided under the lowest level floor slab. The spacing of the sub-slab drainage pipes can be determined at the time of construction to confirm groundwater infiltration levels, if any. This is discussed further in Subsection 6.1.

5.6 Basement Wall

There are several combinations of backfill materials and retained soils that could be applicable for the basement walls of the subject structures. However, the conditions can be well-represented by assuming the retained soil consists of a material with an angle of internal friction of 30 degrees and a bulk (drained) unit weight of 20 kN/m^3.

Where undrained conditions are anticipated (i.e. below the groundwater level), the applicable effective (undrained) unit weight of the retained soil can be taken as 13 kN/m^3, where applicable. A hydrostatic pressure should be added to the total static earth pressure when using the effective unit weight.

Lateral Earth Pressures

The static horizontal earth pressure (p_o) can be calculated using a triangular earth pressure distribution equal to $K_o \cdot \gamma \cdot H$ where:

K_o = at-rest earth pressure coefficient of the applicable retained soil (0.5)
γ = unit weight of fill of the applicable retained soil (kN/m^3)
H = height of the wall (m)

An additional pressure having a magnitude equal to $K_o \cdot q$ and acting on the entire height of the wall should be added to the above diagram for any surcharge loading, q (kPa), that may be placed at ground surface adjacent to the wall. The surcharge pressure will only be applicable for static analyses and should not be used in conjunction with the seismic loading case.

Actual earth pressures could be higher than the "at-rest" case if care is not exercised during the compaction of the backfill materials to maintain a minimum separation of 0.3 m from the walls with the compaction equipment.

Seismic Earth Pressures

The total seismic force (P_{AE}) includes both the earth force component (P_o) and the seismic component (ΔP_{AE}).

The seismic earth force (ΔP_{AE}) can be calculated using $0.375 \cdot a_c \cdot \gamma \cdot H^2/g$ where:

a_c = $(1.45 - a_{max}/g)a_{max}$
γ = unit weight of fill of the applicable retained soil (kN/m^3)
H = height of the wall (m)
g = gravity, 9.81 m/s^2

The peak ground acceleration, (a_{max}), for the Ingleside area is 0.31g according to OBC 2012. Note that the vertical seismic coefficient is assumed to be zero.

The earth force component (P_o) under seismic conditions can be calculated using $P_o = 0.5\ K_o\ \gamma\ H^2$, where $K_o = 0.5$ for the soil conditions noted above.

The total earth force (P_{AE}) is considered to act at a height, h (m), from the base of the wall, where:

$h = \{P_o \cdot (H/3) + \Delta P_{AE} \cdot (0.6 \cdot H)\}/P_{AE}$

The earth forces calculated are unfactored. For the ULS case, the earth loads should be factored as live loads, as per OBC 2012.

5.7 Pavement Structure

Should a flexible pavement be required for the project, the recommended flexible pavement structures shown in Tables 3 and 4 would be applicable.

Table 3 - Recommended Flexible Pavement Structure - Car Only Parking Areas

Thickness (mm)	Material Description
50	**Wear Course -** HL-3 or Superpave 12.5 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
300	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill	

Table 4 - Recommended Flexible Pavement Structure - Access Lanes

Thickness (mm)	Material Description
40	**Wear Course -** HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course -** HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
450	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill	

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type II material. The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 99% of the SPMDD using suitable vibratory equipment.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

It is recommended that a perimeter foundation drainage system be provided for the proposed structures. The system should consist of a 150 mm diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 19 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structure. The pipe should have a positive outlet, such as a sump pump connected to a storm sewer/ditch outlet or directly to a storm sewer/ditch outlet.

Backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls, unless used in conjunction with a drainage geocomposite, such as Delta Drain 6000, connected to the perimeter foundation drainage system. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should otherwise be used for this purpose.

Sub-slab Drainage

For below-grade structures, sub-slab drainage will be required to control water infiltration. For preliminary design purposes, we recommend that 100 or 150 mm perforated pipes be placed at approximate 6 m centres. The spacing of the sub-slab drainage system should be confirmed at the time of completing the excavation when water infiltration can be better assessed.

Foundation Raft Slab Construction Joints

Where a raft is utilized, it is expected that the raft slab will be poured in sections. For the construction joint at each pour, a rubber water stop along with a chemical grout (Xypex or equivalent) should be applied to the entire vertical joint of the raft slab. Furthermore, a rubber water stop should be incorporated in the horizontal interface between the foundation wall and the raft slab.

6.2 Protection of Footings Against Frost Action

Perimeter foundations of heated structures are required to be insulated against the deleterious effects of frost action. A minimum of 1.5 m of soil cover, or a minimum of 0.6 m of soil cover in conjunction with adequate foundation insulation, should be provided.

Exterior unheated foundations, such as those for isolated exterior piers, are more prone to deleterious movement associated with frost action than the exterior walls of the heated structure and require additional protection, such as soil cover of 2.1 m or an equivalent combination of soil cover and foundation insulation.

6.3 Excavation Side Slopes

The side slopes of excavations in the soil and fill overburden materials should either be excavated at acceptable slopes or retained by shoring systems from the beginning of the excavation until the structure is backfilled.

Unsupported Excavations

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be excavated at 1H:1V or shallower. The shallower slope is required for excavation below groundwater level. The subsurface soils are considered to be a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

A trench box is recommended to protect personnel working in trenches with steep or vertical sides. Services are expected to be installed by “cut and cover” methods and excavations should not remain open for extended periods of time.

Temporary Shoring

Temporary shoring may be required to support the overburden soils. The design and approval of the shoring system will be the responsibility of the shoring contractor and the shoring designer who is a licensed professional engineer and is hired by the shoring contractor. It is the responsibility of the shoring contractor to ensure that the temporary shoring is in compliance with safety requirements, designed to avoid any damage to adjacent structures and include dewatering control measures. In the event that subsurface conditions differ from the approved design during the actual installation, it is the responsibility of the shoring contractor to commission the required experts to re-assess the design and implement the required changes. Furthermore, the design of the temporary shoring system should take into consideration a full hydrostatic condition which can occur during significant precipitation events.

The temporary shoring system may consist of a soldier pile and lagging system or steel sheet piles which could be cantilevered, anchored or braced. The shoring system is recommended to be adequately supported to resist toe failure, if required, by means of rock bolts or extending the piles into the bedrock through pre-augered holes, if a soldier pile and lagging system is the preferred method.

Any additional loading due to street traffic, construction equipment, adjacent structures and facilities, etc., should be added to the earth pressures described below. The earth pressures acting on the shoring system may be calculated using the following parameters.

Table 5 - Soil Parameters

Parameters	Values
Active Earth Pressure Coefficient (K_a)	0.33
Passive Earth Pressure Coefficient (K_p)	3
At-Rest Earth Pressure Coefficient (K_o)	0.5
Unit Weight (γ), kN/m^3	21
Submerged Unit Weight (γ), kN/m^3	13

The active earth pressure should be calculated where wall movements are permissible while the at-rest pressure should be calculated if no movement is permissible. The dry unit weight should be calculated above the groundwater level while the effective unit weight should be calculated below the groundwater level.

The hydrostatic groundwater pressure should be included to the earth pressure distribution wherever the effective unit weight are calculated for earth pressures. If the groundwater level is lowered, the dry unit weight for the soil/bedrock should be calculated full weight, with no hydrostatic groundwater pressure component.

For design purposes, the minimum factor of safety of 1.5 should be calculated.

Underpinning of Adjacent Structures

If the footings of the proposed structures are to extend within the lateral support zone of adjacent building foundations , underpinning of these structures would be required. The depth of the underpinning will be dependent on the depth of the neighbouring foundations relative to the foundation depths of the proposed building at the subject site.

6.4 Pipe Bedding and Backfill

At least 150 mm of OPSS Granular A should be used for pipe bedding for sewer and water pipes. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to at least 300 mm above the obvert of the pipe, should consist of OPSS Granular A or Granular B Type II with a maximum size of 25 mm. The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to 98% of the material's standard Proctor maximum dry density.

It should generally be possible to re-use the site materials above the cover material if the operations are carried out in dry weather conditions.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.5 m below finished grade) and above the cover material should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 225 mm thick loose lifts and compacted to a minimum of 95% of the material standard Proctor maximum dry density.

6.5 Groundwater Control

It is anticipated that groundwater infiltration into the excavations should be controllable using open sumps. The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

Groundwater Control for Building Construction

A temporary Ministry of the Environment, Conservation, and Parks (MECP) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum of 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MECP.

For typical ground or surface water volumes being pumped during the construction phase, between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MECP review of the PTTW application.

6.6 Winter Construction

Precautions must be taken if winter construction is considered for this project.

The subsoil conditions at this site mostly consist of frost susceptible materials. In the presence of water and freezing conditions, ice could form within the soil mass. Heaving and settlement upon thawing could occur.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the use of straw, propane heaters, tarpaulins or other suitable means. In this regard, the base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

The trench excavations should be carried out in a manner to avoid the introduction of frozen materials, snow or ice into the trenches.

6.7 Corrosion Potential and Sulphate

The results of analytical testing show that the sulphate content is less than 0.1%. This result is indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and the pH of the sample indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of a low to slightly aggressive corrosive environment.

7.0 Recommendations

A materials testing and observation services program is a requirement for the provided foundation design data to be applicable. The following aspects of the program should be performed by the geotechnical consultant:

- ❏ Observation of all bearing surfaces prior to the placement of concrete.
- ❏ Sampling and testing of the concrete and fill materials used.
- ❏ Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- ❏ Observation of all subgrades prior to backfilling.
- ❏ Field density tests to determine the level of compaction achieved.
- ❏ Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued, upon request, following the completion of a satisfactory materials testing and observation program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations provided in this report are in accordance with our present understanding of the project. We request permission to review our recommendations when the drawings and specifications are completed.

A geotechnical investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, we request immediate notification to permit reassessment of our recommendations.

The recommendations provided herein should only be used by the design professionals associated with this project. They are not intended for contractors bidding on or undertaking the work. The latter should evaluate the factual information provided in this report and determine its suitability and completeness for their intended construction schedule and methods. Additional testing may be required for their purposes.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than EVB Engineering or their agents is not authorized without review by Paterson for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
June 8, 2020
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Kevin A. Pickard, EIT. David J. Gilbert, P.Eng.

Report Distribution

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- ❑ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

GRAIN SIZE DISTRIBUTION ANALYSIS RESULTS

ANALYTICAL TESTING RESULTS

patersongroup Consulting Engineers

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Wastewater Treatment Plant Upgrades
14754 County Road 2, Ingleside, Ontario

DATUM Geodetic

FILE NO. PG5299

REMARKS

HOLE NO. BH 1-20

BORINGS BY CME-55 Low Clearance Drill **DATE** April 29, 2020

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	77.40
GLACIAL TILL: Brown clayey silt with sand, gravel, cobbles and boulders - borehole vacuumed to 1.8m depth	G	1			1	76.40
					2	75.40
	SS	2	29	17		
					3	74.40
3.66	SS	3	71	23		
GLACIAL TILL: Dense, brown sandy silt with gravel, cobbles and boulders	SS	4	58	30	4	73.40
	SS	5	33	50+	5	72.40
	SS	6	79	47	6	71.40
6.70	SS	7	62	39		
End of Borehole (GWL @ 4.51m - May 7, 2020)						

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Wastewater Treatment Plant Upgrades
14754 County Road 2, Ingleside, Ontario

DATUM Geodetic

FILE NO. PG5299

REMARKS

HOLE NO. BH 2-20

BORINGS BY CME-55 Low Clearance Drill **DATE** April 29, 2020

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	77.05
	G	1				
GLACIAL TILL: Brown clayey silt with sand, gravel, cobbles and boulders - borehole vacuumed to 2.7m depth					1	76.05
					2	75.05
					3	74.05
	SS	2	38	21		
	SS	3	12	25	4	73.05
4.42						
GLACIAL TILL: Grey silty sand with gravel, cobbles and boulders	SS	4	47	50+		
					5	72.05
	SS	5	0	22		
					6	71.05
	SS	6		7		
6.70						
End of Borehole (GWL @ 3.66m - May 7, 2020)						

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Wastewater Treatment Plant Upgrades
14754 County Road 2, Ingleside, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE April 29, 2020

FILE NO. PG5299

HOLE NO. BH 3-20

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	75.68
TOPSOIL	0.13	AU	1				
GLACIAL TILL: Brown clayey silt to silty clay with sand, gravel, cobbles and boulders	2.29	SS	2	83	12	1	74.68
		SS	3	100	9	2	73.68
GLACIAL TILL: Brown silty sand with gravel, cobbles and boulders, trace clay	5.16	SS	4	67	53	3	72.68
		SS	5	75	48	4	71.68
		SS	6	100	56	5	70.68
		SS	7	40	50+		

End of Borehole

Practical refusal to augering at 5.16m depth

(GWL @ 1.76m - May 7, 2020)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Wastewater Treatment Plant Upgrades
14754 County Road 2, Ingleside, Ontario

DATUM Geodetic

FILE NO. PG5299

REMARKS

HOLE NO. BH 4-20

BORINGS BY CME-55 Low Clearance Drill **DATE** April 29, 2020

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
TOPSOIL (0.13)	AU	1		
GLACIAL TILL: Dense to very dense, brown sandy silt to silty sand with gravel, cobbles and boulders	SS	2	46	32
	SS	3	50	51
- grey by 3.8m depth	SS	4	71	30
- cored through boulder from 4.57 to 6.10m, 6.70 to 7.62m and 7.82 to 9.14m depths	SS	5	36	50+
	SS	6		50+
	RC	1	40	
	RC	2	20	
	SS	7		48
	RC	3	39	
	SS	8	25	50+
	RC	4		
(9.24)	SS	9		50+

DEPTH (m)	ELEV. (m)
0	75.53
1	74.53
2	73.53
3	72.53
4	71.53
5	70.53
6	69.53
7	68.53
8	67.53
9	66.53

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %
20 40 60 80

Piezometer Construction

End of Borehole

Practical refusal to augering at 9.24m depth

(GWL @ 1.44m - May 7, 2020)

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Wastewater Treatment Plant Upgrades
14754 County Road 2, Ingleside, Ontario

DATUM Geodetic

FILE NO. PG5299

REMARKS

HOLE NO. BH 5-20

BORINGS BY CME-55 Low Clearance Drill **DATE** April 29, 2020

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	76.80
TOPSOIL 0.13							
GLACIAL TILL: Brown sandy silt with gravel, cobbles and boulders - borehole vacuumed to 1.8m depth		G	1			1	75.80
1.83						2	74.80
GLACIAL TILL: Brown clayey silt with sand, gravel, cobbles and boulders		SS	2	79	7		
						3	73.80
		SS	3	4	3		
3.66							
GLACIAL TILL: Very dense, grey silty sand with gravel, cobbles and boulders		SS	4	54	17	4	72.80
		SS	5	38	56	5	71.80
		SS	6	67	67		
6.10						6	70.80
End of Borehole (Piezometer dry/blocked - May 7, 2020)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %
20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Wastewater Treatment Plant Upgrades
14754 County Road 2, Ingleside, Ontario

DATUM Geodetic

FILE NO. PG5299

REMARKS

HOLE NO. BH 6-20

BORINGS BY CME-55 Low Clearance Drill

DATE April 29, 2020

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	75.22
TOPSOIL	0.10	AU	1				
GLACIAL TILL: Brown clayey silt with sand, gravel, cobbles and boulders	1.52	SS	2	62	38	1	74.22
GLACIAL TILL: Dense, brown silty sand to sandy silt with gravel, cobbles and boulders - grey by 3.0m depth	6.70	SS	3		50+	2	73.22
		SS	4		32	3	72.22
		SS	5	92	43	4	71.22
		SS	6		71	5	70.22
		SS	7	54	43	6	69.22
		SS	8	46	17		
		SS	9	21	40		

End of Borehole

(GWL @ 1.24m - May 7, 2020)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %
20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Wastewater Treatment Plant Upgrades
14754 County Road 2, Ingleside, Ontario

DATUM Geodetic

FILE NO. PG5299

REMARKS

HOLE NO. BH 7-20

BORINGS BY CME-55 Low Clearance Drill **DATE** April 29, 2020

SOIL DESCRIPTION	Strata depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	74.84
TOPSOIL	0.10	AU	1				
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles and boulders	1.37	SS	2	100	28	1	73.84
GLACIAL TILL: Compact to very dense, brown sandy silt with clay, gravel, cobbles and boulders	6.70	SS	3	75	22	2	72.84
		SS	4	62	46	3	71.84
		SS	5	79	34	4	70.84
		SS	6	0	50+		
		SS	7	29	63	5	69.84
		SS	8	96	62	6	68.84
		SS	9	0	50+		

End of Borehole

(GWL @ 0.58m - May 7, 2020)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Wastewater Treatment Plant Upgrades
14754 County Road 2, Ingleside, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE April 28, 2020

FILE NO. PG5299

HOLE NO. BH 8-20

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.05				
GLACIAL TILL: Brown clayey silt, some sand, gravel, cobbles and boulders - borehole vacuumed to 1.8m depth	3.66	G	1		
		SS	2	75	5
		SS	3		17
GLACIAL TILL: Very dense, brown silty sand with gravel, cobbles and boulders - grey by 4.4m depth	6.96	SS	4	88	59
		SS	5	71	38
		SS	6		62

DEPTH (m)	ELEV. (m)
0	75.89
1	74.89
2	73.89
3	72.89
4	71.89
5	70.89
6	69.89

Dynamic Cone Penetration Test commenced at 6.7m depth. Practical DCPT refusal at 6.96m depth

(Piezometer dry/blocked - May 7, 2020)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %
20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Wastewater Treatment Plant Upgrades
14754 County Road 2, Ingleside, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE April 28, 2020

FILE NO. PG5299

HOLE NO. BH 9-20

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.05				
GLACIAL TILL: Compact to very dense, brown silty sand with clay, gravel, cobbles and boulders - borehole vacuumed to 1.8m depth	6.10	G	1		
		SS	2	75	25
		SS	3	44	50+
		SS	4	54	37
		SS	5	50	50+
		SS	6		62
End of Borehole (Piezometer dry/blocked - May 7, 2020)					

DEPTH (m)	ELEV. (m)
0	75.80
1	74.80
2	73.80
3	72.80
4	71.80
5	70.80
6	69.80

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Wastewater Treatment Plant Upgrades
14754 County Road 2, Ingleside, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE April 28, 2020

FILE NO. PG5299

HOLE NO. BH10-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	76.49
TOPSOIL (to 0.05)							
GLACIAL TILL: Brown clayey silt to silty clay with gravel, cobbles and boulders		G	1			1	75.49
- borehole vacuumed to 1.8m depth						2	74.49
		SS	2	71	4		
(to 3.05)						3	73.49
GLACIAL TILL: Dense to very dense, brown sandy silt with clay, gravel, cobbles and boulders		SS	3	62	25		
		SS	4	67	41	4	72.49
		SS	5	92	79	5	71.49
		SS	6	33	50+		
(to 6.10)						6	70.49
End of Borehole							
(GWL @ 3.01m - May 7, 2020)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Wastewater Treatment Plant Upgrades
14754 County Road 2, Ingleside, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE April 28, 2020

FILE NO. PG5299

HOLE NO. BH11-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	75.54
TOPSOIL (to 0.08)							
GLACIAL TILL: Compact to very dense, brown silty sand to sandy silt with clay, gravel, cobbles and boulders - borehole vacuumed to 1.8m depth		G	1			1	74.54
						2	73.54
		SS	2	79	15		
						3	72.54
		SS	3	100	46		
		SS	4	54	9	4	71.54
		SS	5	33	32	5	70.54
		SS	6	58	99		
(to 6.10)						6	69.54
End of Borehole (GWL @ 2.22m - May 7, 2020)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Wastewater Treatment Plant Upgrades
14754 County Road 2, Ingleside, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE April 28, 2020

FILE NO. PG5299

HOLE NO. BH12-20

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	75.29
TOPSOIL 0.08							
GLACIAL TILL: Loose to dense, brown silty sand to sandy silt with clay, gravel, cobbles and boulders		G	1			1	74.29
- borehole vacuumed to 1.8m depth						2	73.29
		SS	2	12	3		
						3	72.29
		SS	3	54	44		
		SS	4	46	32	4	71.29
		SS	5	12	13	5	70.29
		SS	6	83	34		
6.10						6	69.29
End of Borehole							
(GWL @ 2.71m - May 7, 2020)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Wastewater Treatment Plant Upgrades
14754 County Road 2, Ingleside, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE April 29, 2020

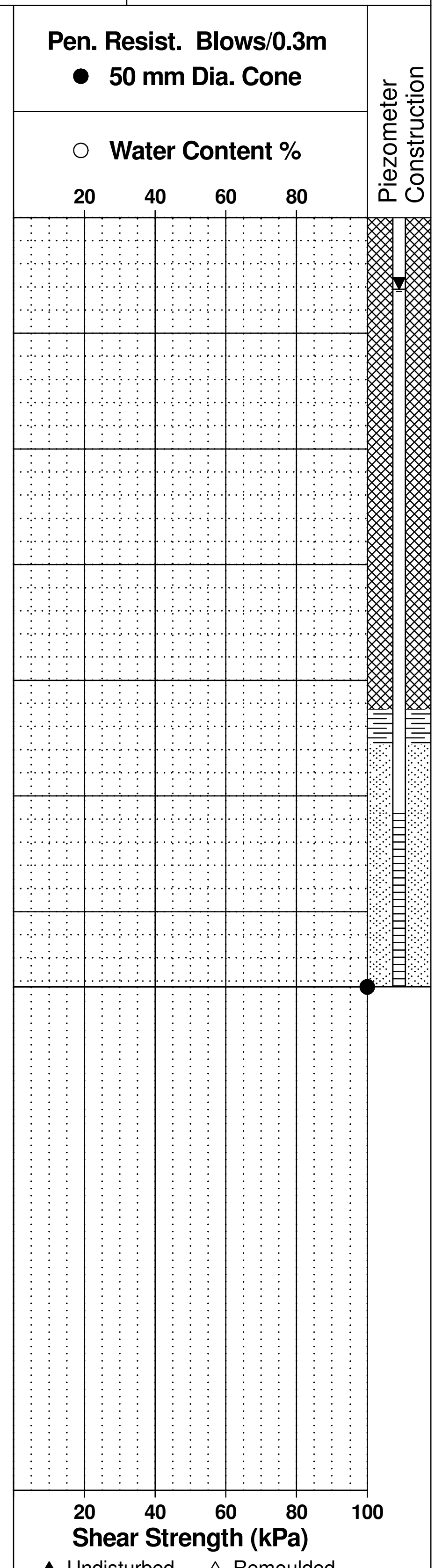
FILE NO. PG5299

HOLE NO. BH13-20

SOIL DESCRIPTION	Strata depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	74.72
TOPSOIL	0.13	AU	1				
GLACIAL TILL: Brown clayey silt with sand and gravel	0.76						
		SS	2	46	28	1	73.72
		SS	3	79	53	2	72.72
		SS	4	83	79		
GLACIAL TILL: Dense to very dense, brown sandy silt with gravel, cobbles and boulders						3	71.72
		SS	5	58	49		
		SS	6	75	29	4	70.72
		SS	7	42	34	5	69.72
		SS	8	12	24		
	6.65					6	68.72

Dynamic Cone Penetration Test commenced at 6.10m depth. Practical DCPT refusal at 6.65m depth.

(GWL @ 0.62m - May 7, 2020)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Wastewater Treatment Plant Upgrades
14754 County Road 2, Ingleside, Ontario

DATUM Geodetic

FILE NO. PG5299

REMARKS

HOLE NO. BH14-20

BORINGS BY CME-55 Low Clearance Drill **DATE** April 29, 2020

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	74.93		
TOPSOIL 0.15		AU	1						
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles and boulders		SS	2	75	8	1	73.93		
		SS	3	54	39	2	72.93		
2.34									
End of Borehole Practical refusal to augering at 2.34m depth (BH dry upon completion)									

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) ‘N’ value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

Relative Density	‘N’ Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

Consistency	Undrained Shear Strength (kPa)	‘N’ Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

Terminology used for describing soil strata based upon texture, or the proportion of individual particle sizes present is provided on the Textural Soil Classification Chart at the end of this information package.

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NXL size core. However, it can be used on smaller core sizes, such as BX, if the bulk of the fractures caused by drilling stresses (called “mechanical breaks”) are easily distinguishable from the normal in situ fractures.

RQD %	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC%	-	Natural moisture content or water content of sample, %
LL	-	Liquid Limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic limit, % (water content above which soil behaves plastically)
PI	-	Plasticity index, % (difference between LL and PL)
Dxx	-	Grain size which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D10	-	Grain size at which 10% of the soil is finer (effective grain size)
D60	-	Grain size at which 60% of the soil is finer
Cc	-	Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu	-	Uniformity coefficient = D60 / D10

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay (more than 10% finer than 0.075 mm or the #200 sieve)

CONSOLIDATION TEST

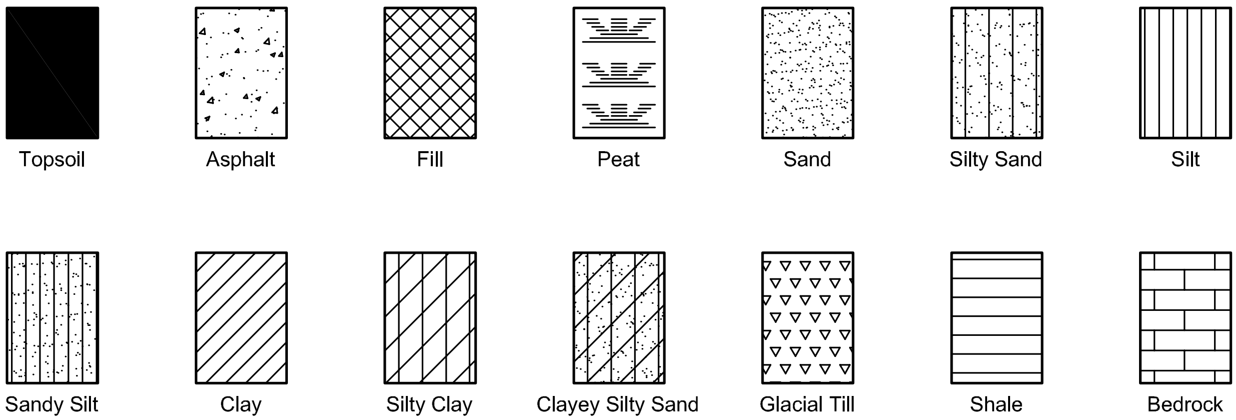
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
Wo	-	Initial water content (at start of consolidation test)

PERMEABILITY TEST

k	-	Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

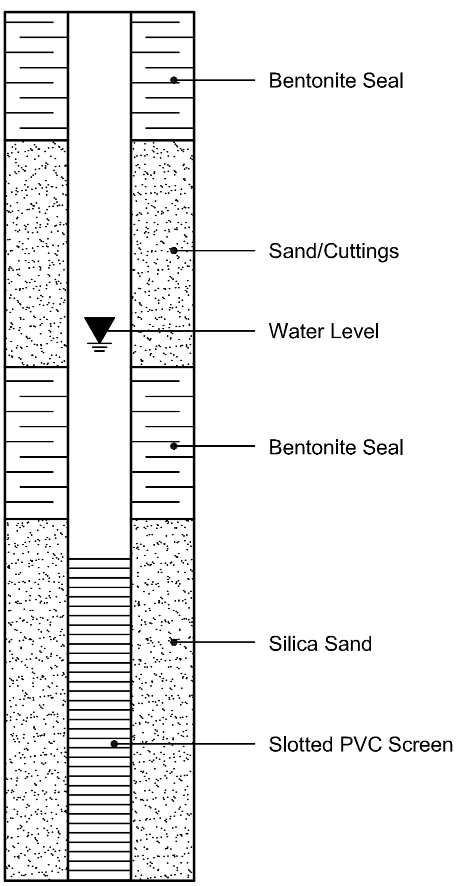
SYMBOLS AND TERMS (continued)

STRATA PLOT

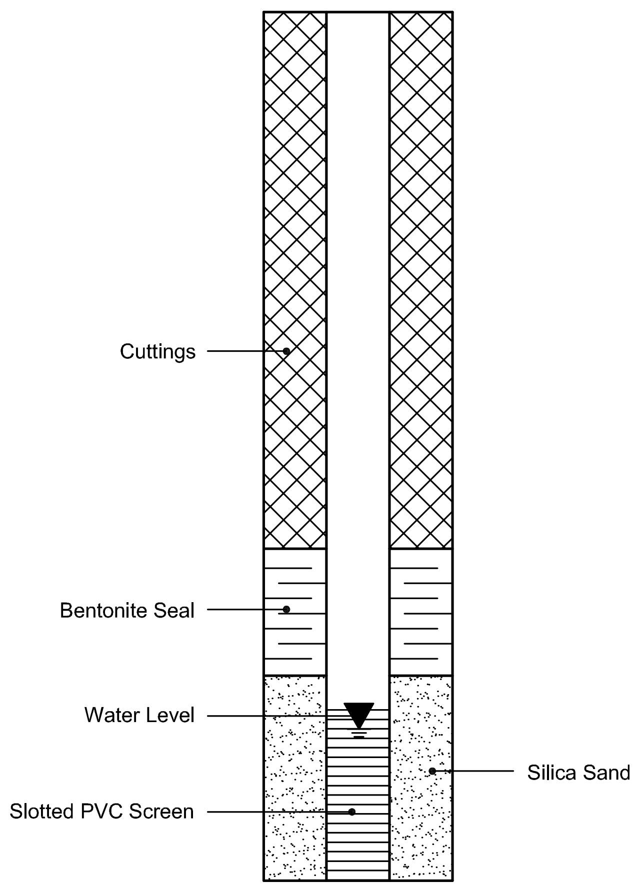


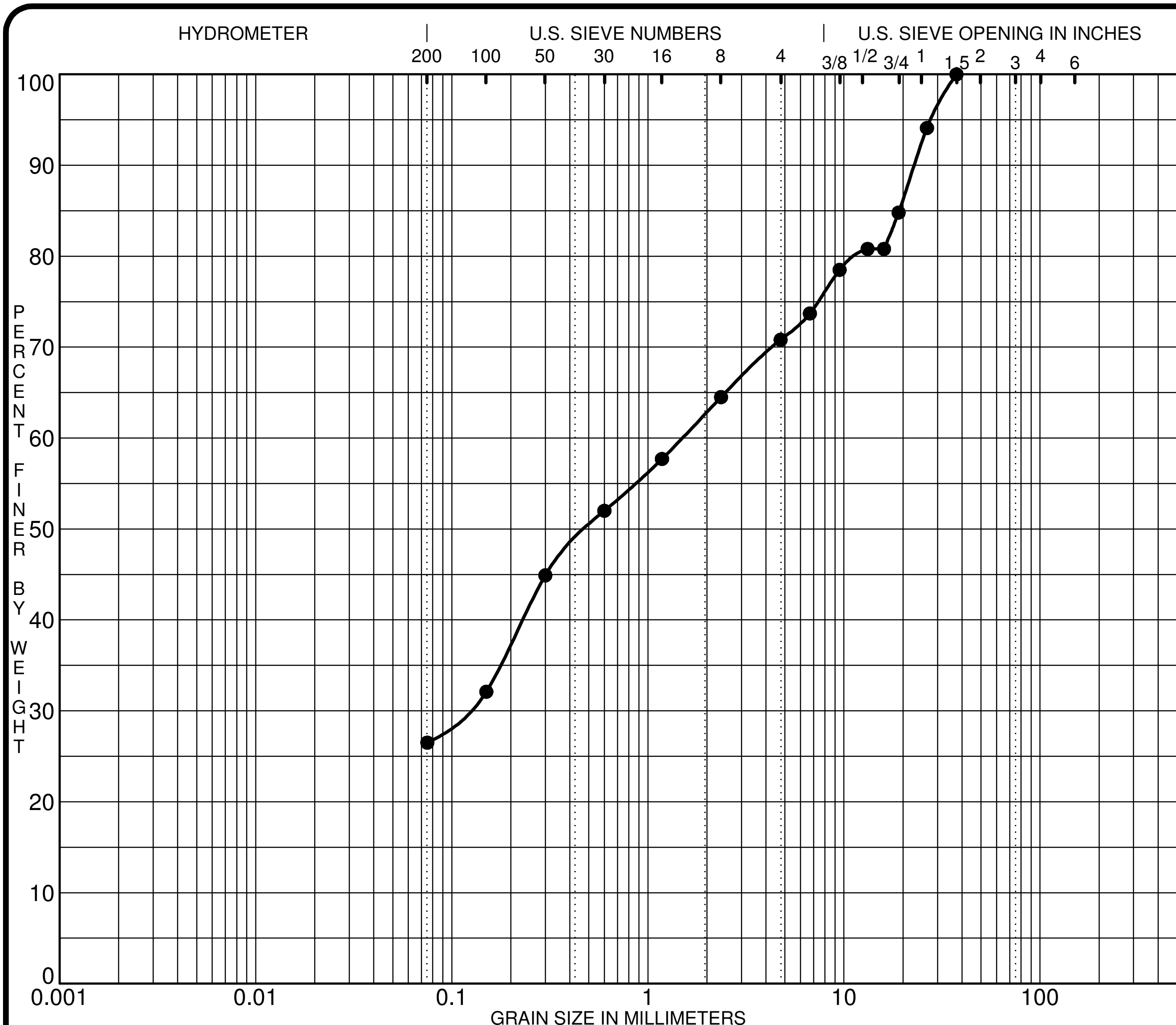
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
● BH 2-20	SS 2	CLAYEY SILTY SAND-GRAVEL						

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● BH 2-20	SS 2	37.50	1.49	0.116		29.2	44.3	26.5	

CLIENT **EVB Engineering**

FILE NO. **PG5299**

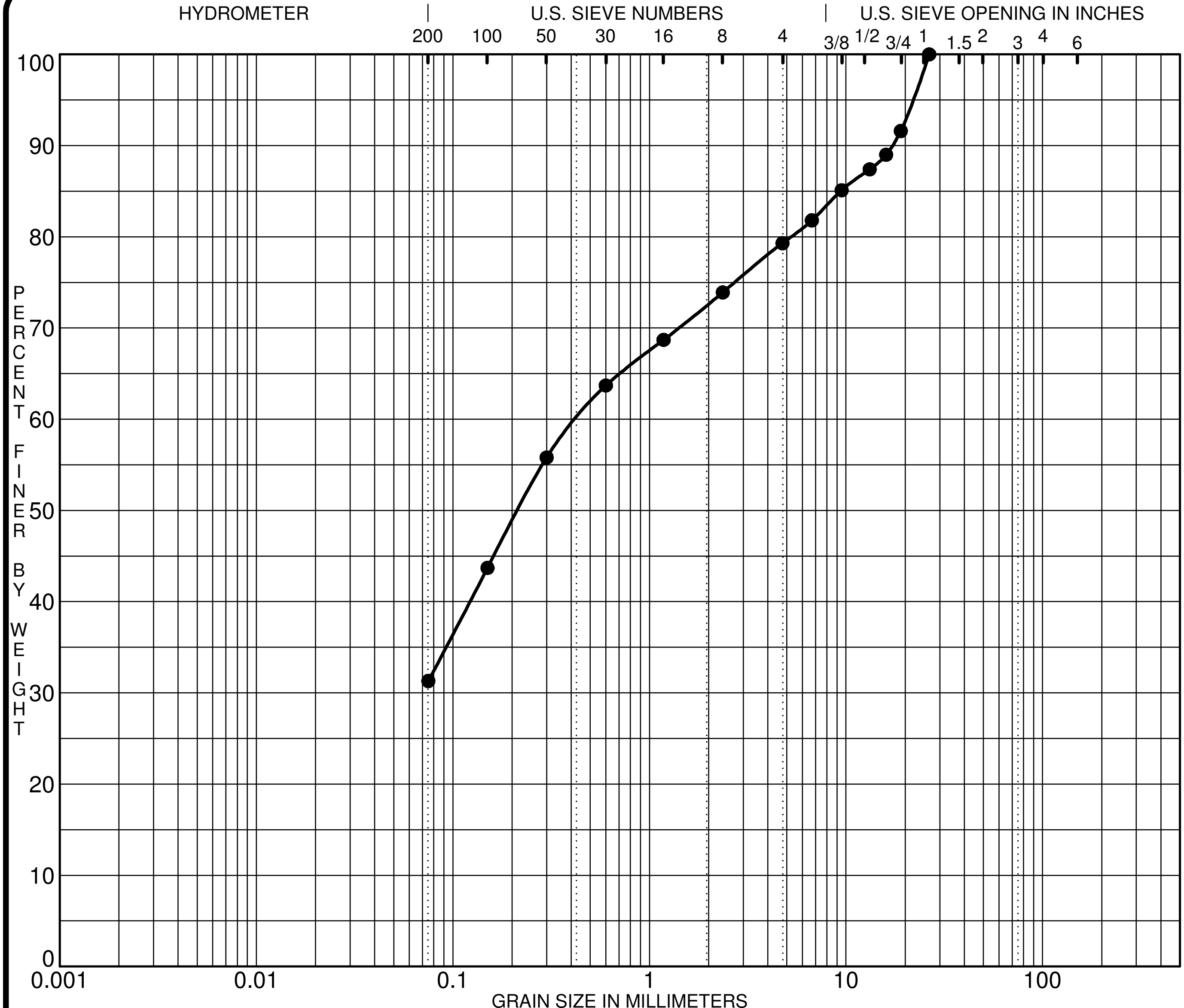
PROJECT **Geotechnical Investigation - Proposed Wastewater Treatment Plant Upgrades**

DATE **29 Apr 20**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

GRAIN SIZE DISTRIBUTION



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**BH 7-20**	**SS 4**	**CLAYEY SILTY SAND-GRAVEL**						

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 7-20**	**SS 4**	**26.50**	**0.43**			**20.7**	**48.0**	**31.3**	

CLIENT **EVB Engineering**

FILE NO. **PG5299**

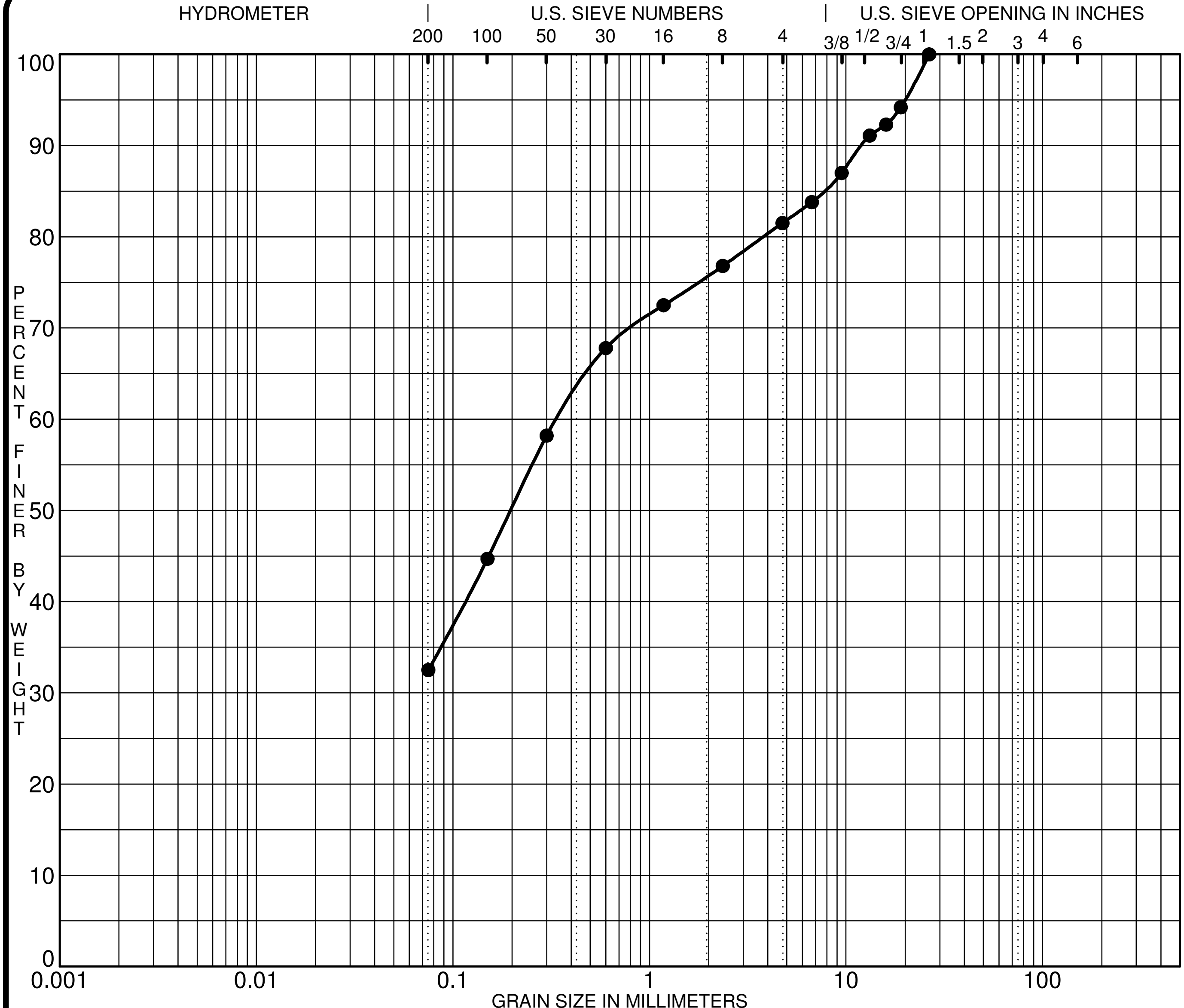
PROJECT **Geotechnical Investigation - Proposed Wastewater Treatment Plant Upgrades**

DATE **29 Apr 20**

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

GRAIN SIZE DISTRIBUTION



SILT OR CLAY	SAND			GRAVEL		COBBLES
	fine	medium	coarse	fine	coarse	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**BH11-20**	**SS 2**	**CLAYEY SILTY SAND-GRAVEL**						

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH11-20**	**SS 2**	**26.50**	**0.34**			**18.5**	**49.0**	**32.5**	

CLIENT **EVB Engineering**

FILE NO. **PG5299**

PROJECT **Geotechnical Investigation - Proposed Wastewater Treatment Plant Upgrades**

DATE **28 Apr 20**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

GRAIN SIZE DISTRIBUTION

Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO: 30106

Report Date: 15-May-2020

Order Date: 12-May-2020

Project Description: PG5299

	Client ID:	BH20-13-SS4	-	-	-
	Sample Date:	24-Apr-20 13:00	-	-	-
	Sample ID:	2020183-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	94.9	-	-	-
General Inorganics					
pH	0.05 pH Units	7.94	-	-	-
Resistivity	0.10 Ohm.m	101	-	-	-
Anions					
Chloride	5 ug/g dry	12	-	-	-
Sulphate	5 ug/g dry	9	-	-	-

APPENDIX 2

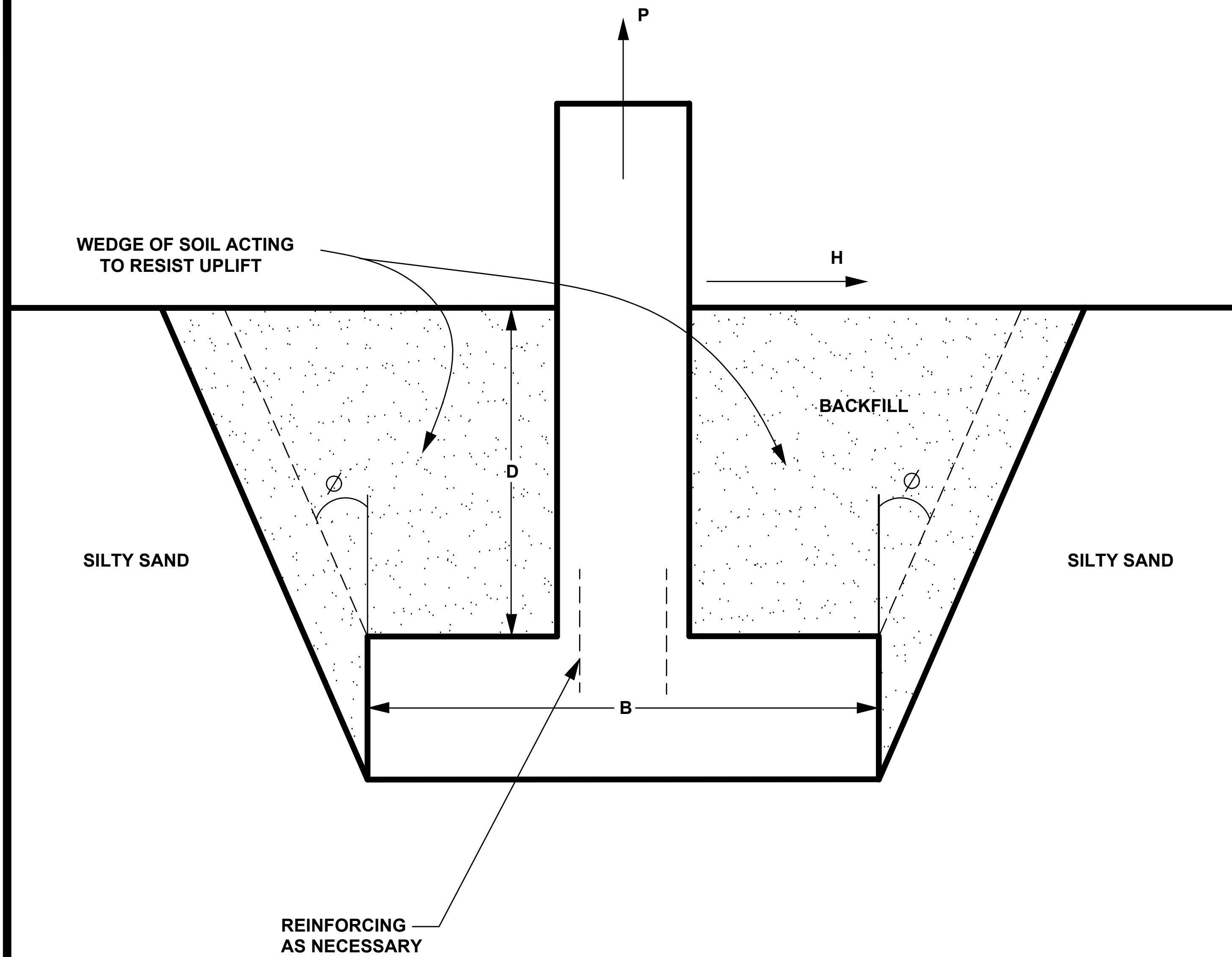
FIGURE 1 - KEY PLAN

FIGURE 2 - UPLIFT CONE ANGLES FOR BACKFILL MATERIALS

DRAWING PG5299-1 - TEST HOLE LOCATION PLAN

FIGURE 1

KEY PLAN

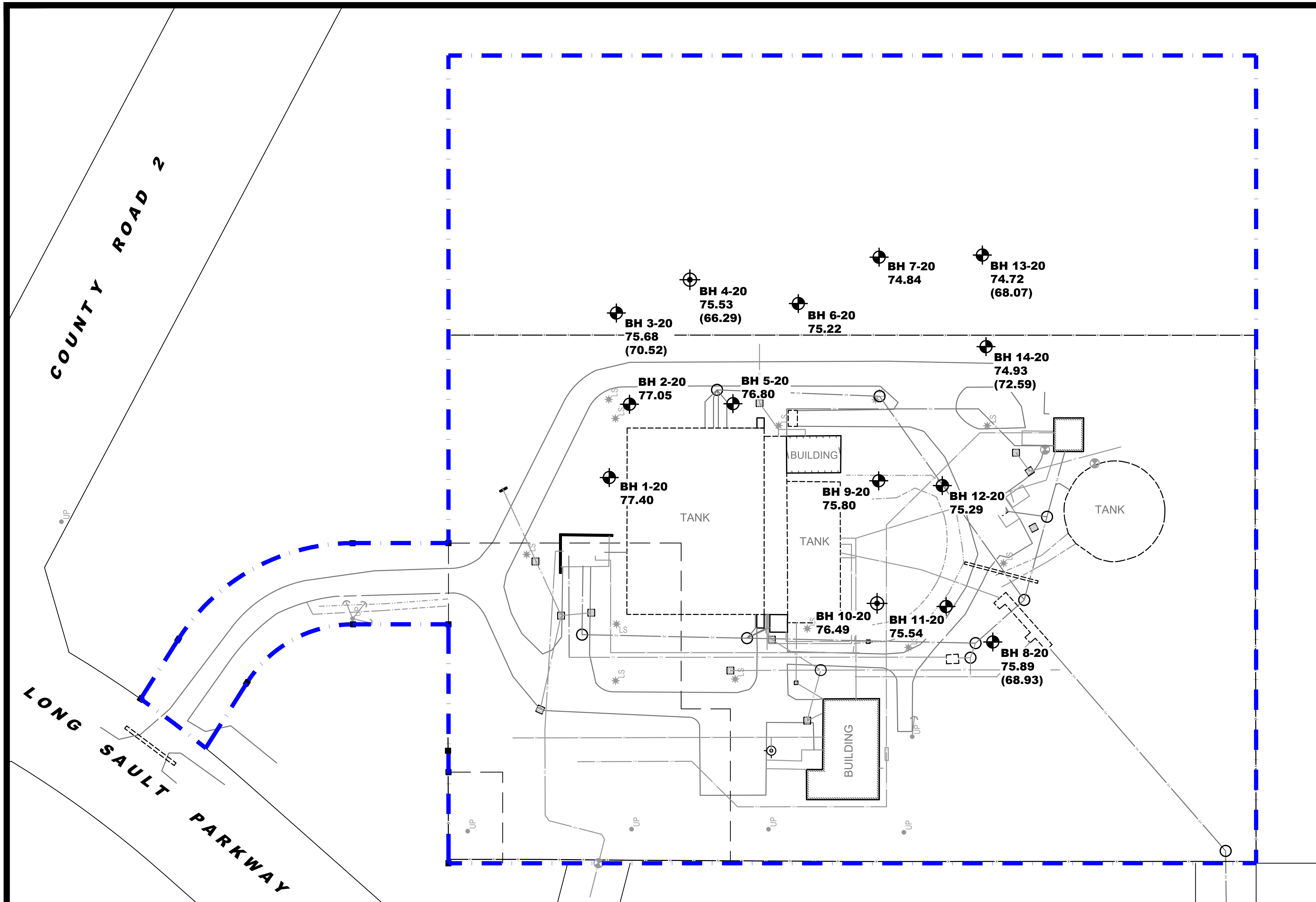


WHERE P = UPLIFT LOAD
H = HORIZONTAL LOAD
B = WIDTH OF FOOTING

Ø - USE 20° FOR COHESIONLESS SOIL (ie.- GRANULAR BACKFILL COMPACTED TO 95% MPMDD)
- USE 30° FOR COHESIVE SOIL (ie.- SILTY CLAY COMPACTED WITH A SHEEPSFOOT ROLLER)

FIGURE 2
UPLIFT CONE ANGLES FOR BACKFILL MATERIAL

patersongroup consulting engineers 154 Colonnade Road, Ottawa, Ontario K2E 7J5	EVB ENGINEERING PROP. WASTEWATER TREATMENT FACILITY UPGRADES 14754 COUNTY ROAD 2, INGLESIDE, ONTARIO	Report No.: PG5299-1		Scale: N.T.S.
		Date: 06/2020	Drawn: MPG	Approved: DG



LEGEND:

(symbol)	BOREHOLE LOCATION
(symbol)	BOREHOLE WITH MONITORING WELL LOCATION
75.89	GROUND SURFACE ELEVATION (m)
(68.93)	PRACTICAL REFUSAL TO AUGERING / DCPT ELEVATION (m)

ALL ELEVATIONS ARE REFERENCED TO A GEODETIC DATUM.

SCALE: 1:1000

0 10 20 30 40 50m 75m

p:\autocad drawings\geotechnical\pg52xx\pg5299\pg5299-1-test hole location plan.dwg

patersongroup
consulting engineers

154 Colonnade Road South
Ottawa, Ontario K2E 7J5
Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL

EVB ENGINEERING
GEOTECHNICAL INVESTIGATION
PROPOSED WASTEWATER TREATMENT PLANT UPGRADES
14754 COUNTY ROAD 2
INGLESIDE, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:1000	Date: 05/2020
Drawn by: YA	Report No.: PG5299-1
Checked by: KP	Dwg. No.: **PG5299-1**
Approved by: DJG	Revision No.: